AUTHENTICITY IN ART

WITH SPECIAL REFERENCE TO CONSERVATION OF ART OBJECTS

Platinum Jubilee Volume

EDITOR
DR. V. JEYARAJ

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With Special Reference to Conservation of Art Objects

PLATINUM JUBILEE VOLUME

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Editor
Dr. V. Jeyaraj

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Foreword

The Chemical Conservation and Research Laboratory of the Government Museum, Chennai is well known for its activities in the field of conservation of antiquities and works of art, training, research, publication etc., in India. It was established in 1930 with the efforts of the then Superintendent of the Museum, Dr. F.H. Gravely. It had Dr. S. Paramasivan as its first Curator of this Laboratory, who had done a yeoman service n this field and was drawn by the Archaeological Survey of India for the conservation of paintings in South India during the 1940s. His publications on the work done in the Laboratory are globally well known. The subsequent Curators viz. Mr. R. Subramaniam, Mr. N. Harinarayana, Mr. S. Thangavelu have continued the activities and the Laboratory is now a approved research institute by the University of Madras for doing research in Chemical Conservation and Anthropology.

Dr. V. Jeyaraj, Head, Chemical Conservation and Research Laboratory is instrumental for various activities of the museum. This Laboratory has completed 75 years of useful service in the field of conservation of cultural property through conservation of antiquities and works of art, conservation awareness programmes, training programmes, seminars, workshops, research programmes, publication etc. It was felt necessary that the Platinum Jubilee of the Laboratory should be celebrated. As part of the celebrations an international seminar on Authenticity of Art with Special Reference to the Conservation of Antiquities in collaboration with the Indian Association for the Study of Conservation of Cultural Property, New Delhi from 14^{th} to 16^{th} December 2005. It attracted both national and international experts in the field. Some of the papers presented by the experts in the seminar and invited papers have been compiled and brought out by Dr. V. Jeyaraj, Head of Conservation of this museum. This title Authenticity in Art and Conservation will be useful for those involved in the preservation of cultural property. This is a feather in the cap of the publication of the Chemical Conservation and Research Laboratory, Government Museum, Chennai - 8.

Chennai-600 008, M.A. Siddique
6-3-2006.

Acknowledgement

The Chemical Conservation and Research Laboratory of the Government Museum, Chennai owes to the conservation giants who built the laboratory and its activities in the past. Today it is considered as one of the laboratories for training the conservators in the field by the Government of India. It is the first laboratory in Asia, which started training conservators of this country. It is a research laboratory recognised by the University of Madras for conducting research leading to Ph. D. Degree. This Laboratory has been considered for conserving manuscripts as Manuscripts Conservation Centre. It conducts various training programmes for conservators, museologists, teachers, students etc., through out the year. It is responsible for creating awareness in conservation in this part of this country. It conducted an International Seminar on Conservation of Stone Objects with Special Reference to Limestone Objects in 2000 and the papers were published as a Special Volume subsequently in 2001. This volume has been used by the conservators as a good guide in conservation of stone objects.

During the celebrations of the Platinum Jubilee of the Laboratory, an International Seminar on Authenticity in Art with Special Reference to the Conservation of Art Objects was conducted from 14^{th} to 16^{th} December 2005 and some of the papers presented and invited papers have been taken and edited by me. This book has been chapterised as Introduction to Authenticity, Instruments and Authenticity, Authentication and Conservation, Authentication of Metal Objects, Authentication of Wooden Objects, Authentication of Paper Objects, Authentication of Paintings, and Authentication of General Materials, Conclusion. This will be a useful tool for those who work in the field for preserving the art and cultural properties for posterity.

6/3/2006

Chennai-600 008,
6-3-2006.

(V. Jeyaraj)

INTRODUCTION

1 Chemical Conservation and Research Laboratory - An Introduction

History of the Laboratory

With the valuable collection at the Government Museum, Chennai, it was felt necessary to treat the bronzes disfigured by corrosive crusts in order to expose the decorative details and to eliminate the bronze disease, which brought in added deterioration. As a result of the discussion with various chemists, the electrolytic restoration of bronzes was started in the museum. The Chemical Conservation and Research Laboratory in the museum owes to the scientific vision and foresight of Dr. F. H. Gravely, Superintendent of the Government Museum, Chennai in the early 1930s. Dr. S. Paramasivan was appointed as the Chemist in 1930. He was very active both in conservation and research activities. Besides the treatment of bronze objects, ethnological, prehistoric and numismatic objects were treated. In 1935, the Government Museum, Chennai was also of help to the Archaeological Survey of India in the examination of wall paintings at Tanjore, Sittannavasal etc.

In 1937, a separate Chemical Conservation Laboratory Block (Old Chemistry Block) was built. A two storied building for the Laboratory was constructed in 1963. In 1997, the Chemical Conservation and Research Laboratory was recognised as a research institution to conduct research leading to Ph. D. Degree and Dr. V. Jeyaraj, Curator of the Laboratory was recognised as a Research Supervisor by the University of Madras. At present five part-time scholars are working under him.

This Laboratory has taken up both preventive and interventive conservation of manuscripts under the auspices of the National

Mission for Manuscripts, New Delhi. The Curator is the Co-ordinator of the Manuscripts Conservation Centre which is located in the Laboratory itself.

Research Activities

One of the foremost activities of the Laboratory is to conduct research in conservation and materials of the past. In the beginning much research was conducted by Dr. S. Paramasivan, the first Curator of the Laboratory on paintings and metallic antiquities. The research findings were published in leading scientific journals both in India and abroad. The research activities continued successfully by the Curators of the Laboratory till date. At present research projects such as Conservation of Traditional Textiles, Conservation of Church Buildings and Antiquities, Conservation of Metallic Antiquities, Conservation of Manuscripts, Status of Museums in India, Conservation Status in Indian Museums etc., are under progress.

Conservation Research Activities

The Laboratory is interested in the conservation research in order to find out new techniques and materials in collaboration with leading research institutions such as Indira Gandhi Centre for Atomic Research, Kalpakkam; Indian Institute of Technology, Chennai; Anna University, Chennai etc. The Laboratory was recognised as a research institution in 1997 by the Madras University to conduct research leading to Ph.D. Degree.

Publications

The publication of this laboratory from its inception is commendable. Leading national and international journals such as Indian Academy of Sciences, The Current Science, Conservation of Cultural Property in India, Technical Studies, Studies in Conservation, etc., published the out come of the research works of this laboratory. Besides hundreds of research and popular articles many books and bulletins have been published. Handbook on Conservation in Museums, Care of Museum Objects, Conservation of Archival Materials, An Introduction to the Chemical Conservation and Research Laboratory, Care of Archival Materials, Conservation of Temple Objects, Conservation of Cultural Property in India, Care of Paintings, Conservation of Cultural Heritage, Metal Conservation, Heritage Management etc., are some of its publications. Many conservation reports have been prepared by the successive Curators regularly through out the career of this laboratory. The present Curator has prepared about fifty reports.

Training

In order to disseminate the expertise of the laboratory, in 1974, a refresher course on *Care of Museum Objects* was started. It was well received by professionals and students of museum related subjects. In 1995, a course on *Care of Temple Antiquities* was started for the Executive Officers of the Hindu Religious and Charitable Endowments Department. In 1997, a course on *Care of Archival Materials* was conducted exclusively for the Archivists. Students from the Government College of Fine Arts, Chennai were given practical training for a period of 3 months on the conservation of museum objects especially on paintings. Slowly this course was named as the course on Care of Art Objects. Capsule Course on Conservation of Cultural Heritage was the latest course conducted for the Curators, Executive Officers of the Hindu Religious and Charitable Endowments Department, Archaeologists, Police Officials, Engineers etc., at Salem, Trichy, Madurai and Chennai. Besides these, training programmes to the school and college students are also given both in Chennai and districts on Care of Cultural Materials and Preservation of Monuments. It has entered its name as the number one in the field by introducing *Internship Training* for a period of one year.

Conservation Services

Even though the strength of the staff in the Laboratory is very small, the Laboratory is extending service to the public and institutions interested in the preservation of objects of the past at nominal charges. The Laboratory is not able to meet the requirements of the museum as well as the outside demand due to want of staff in the Laboratory. On request, the Curator delivers lectures on conservation in order to popularise the subject. Talks are delivered both in radio and television channels on the subject.

Conservation Gallery

For the first time in India, in 1996, the Chemical Conservation and Research Laboratory of the Government Museum, Chennai has set up the Conservation Gallery in order to educate the visitors on the preservation of the cultural and artistic heritage of our country.

Staff

At present only four members of staff man the Laboratory. One volunteer and four research scholars are helping in the laboratory activities. The Manuscripts Conservation Centre has two staff members to carry out conservation of manuscripts.

Curator, Head of the Laboratory

Dr. V. Jeyaraj

Ph. D. Research Scholars

Mr. B. Livingston Jebaraj
Ms.Y.A.Divya Durga Prasad
Ms. Bessie Cecil
Rev. Fr. Dr. A.Vijay Kiran
Ms. V. Indumathi

Laboratory Staff

Mr. J. D. Jagannathan
Laboratory Assistant
Mr. P. Raja Balachandra Murugan
Technical Assistant
Mr. J. Kumaran
Office Assistant

Contract Staff

Mr. S. Senthilkumar & Mr. B. Thirunavukarasu
Project Staff (NMM)

2 Milestones of the Chemical Conservation and Research Laboratory

*V. Jeyaraj**

1930-	Establishment of the Conservation Laboratory - Appointment of the first Curator to the Laboratory.
1931-	Installation of motor generator for electrolytic restoration.
1934-	Preservation and x-ray studies of Nagapattinam bronzes.
1935-	Preliminary report on the mural paintings in the Brahadiswara Temple at Tanjore (June to July 1935).
1937-	Study and preservation of wall paintings at Sittannavasal.
1938-	Studies of the techniques of wall paintings in fifteen well known sites.
1939-	Systematic study of the metallography of bronze objects and prehistoric implements.
1944-	Examination of *Maratha* paintings in the Tanjore Palace and the *Chola* paintings in Brahadiswara temple at Tanjore.
1952 -	Experiments in museum climate in the National Art Gallery and the main Museum building; experiments in the use of latex for taking moulds of image and coins.
1953-	Experiments in the use of Asiatic seaweed for preparing moulds.

1954 - Research in the treatment of metal objects in the John Hockins University (by R. Subramaniam) Special exhibition on Glass.

1961- Special exhibition on Electrolytic Treatment of Bronze Images.

1962- Preparation of three reports on museum objects in humid and hot climates, electrolytic restoration of metals and Study of stones for ICOM Committees.

1963- Report on the preservation of bronzes in the Tanjore Art Gallery.

1972- Preservation of paintings in the Venugopala Shrine in the temple at Srirangam.

1973- Preservation of marbles in the St.George's Cathedral, Madras.

Preservation of oil paintings in the Rajaji Hall, Madras.

Examination of ancient pottery specimens for the University of Madras, Department of Archaeology.

Preparation of report on Conservation of Museum Objects in the Pudukkottai Museum.

1974- Report on preservation of newspapers in the Swadesamitran office.

Special exhibition on Conservation of Iron Objects.

Examination of paintings around the Golden Lily Tank in the Meenakshi- Sundareswarar Temple in Madurai. Starting the Course "Care of Museum Objects".

1975- Preservation of Tallapakkam Annamacharya copper plates of the Tirupati- Tirumala Devasthanam at Tirupati, Andhra Pradesh.

Examination of a temple car at Nedungudi near Pudukkottai and report on its conservation.

Examination of paintings in Sri Varadarajaswamy temple in Kancheepuram and report on their conservation.

Examination of salt - encrusted pillars in the temple at Thiruvallur and report on suggested treatment sent to the Temple authorities.

1976- Experiments on analysis of three small metal objects through the use of isotope - excited x-ray fluorescence in the Bhabha Atomic Research Centre, Bombay.

Preservation of British prints of the Raj Bhavan, Madras.

1977- Preservation of marble statues and tablets in the St. Andrew's Church, Egmore.

1978- A Special Exhibition on Conservation of Paper Prints

V. Jeyaraj was appointed as Curator of the Laboratory.

1979- Preservation of oil paintings in the Madras Medical College.

1982- Treatment of Dupleix statue, Pondicherry.

A Laboratory Assistant post was created and Mr. J. D. Jagannathan was appointed.

Golden Jubilee Celebrations of the Laboratory was celebrated.

Conservation of Textiles" – All India Seminar was conducted.

Special Exhibition on Conservation of Textiles

1983- Restoration of marble sculptures and tablets at St. George's Cathedral, Chennai. Curator, V. Jeyaraj, registered for his Ph.D. Degree.

1984- Treating a large Vishnu stone statue at CIPET, Chennai.

1985-	Setting up of Micro-analytical Corner in the Laboratory.
1986-	Conducting Conservation Course for Madurai University M.A. (History of Art) students.
1987-	Treatment to the Tanjore Art Gallery bronzes.
1988-	Workshop on "Conservation of Textiles". Treatment of old records at Simpson Company, Chennai.
1989-	Treatment of paper prints and oil paintings at Raj Bhavan, Chennai.
1990-	Ph.D. Degree was awarded to V. Jeyaraj for the thesis on "Correlation between Composition, Corrosion Products and Metallographic Structure of Metallic Antiquities" by the University of Madras. Treatment of palm-leaf manuscripts at Vidhya Peedam, Sholinghur.
1991-	Workshop on "Conservation of Paintings" in collaboration with National Research Laboratory for Conservation, Lucknow.
1992-	Treatment of 500 Chola bronzes for the Exhibition "South Indian Bronzes".
1993-	N.S.S. Special Camp - Preservation of Our Heritage.
1994-	Award of U.K. Visiting Fellowship to Dr. V. Jeyaraj by the Nehru Trust, New Delhi.
1995-	Course on "Care of Temple Antiquities" for Temple Executive Officers.
1996-	Course on "Care of Archival Materials" for Archivists. The Laboratory was recognised as a research laboratory to conduct research leading to Ph. D. Degree by the University of Madras, Chennai. Report on Technical Study of Coins of Arcot Nawabs.

1997- Recognised as a Guide to supervise the work of Ph.D. Scholars

Joint project on Finger Printing of South Indian Bronzes with the Indira Gandhi Centre for Atomic Research, Kalpakkam.

1998- Awarded a Small Study and Research Grant from the Nehru Trust for the Study of Indian Collections at the Victoria and Albert Museum on "Directory of Museums in Tamil Nadu".

1999- Conducted the Silver Jubilee Celebrations of the Course on Care of Museums Objects.

Oratorical competition and exhibition on Conservation of Museum Objects were conducted.

One-day seminar on Conservation of Cultural Property was conducted and the proceedings of the seminar were brought out.

Dr. V. Jeyaraj, Curator of the Laboratory was elected as the Vice-President of the Indian Association for the Study of Conservation of Cultural Property, New Delhi.

Awarded a Small Study and Research Grant from the Nehru Trust for the study on "Directory of Monuments in Tamil Nadu.

Mr. B. Livingstone Jebaraj, a part-time research scholar registered his name in the University of Madras under Dr. V. Jeyaraj, Curator of the Laboratory to undertake research in Conservation of Chola Coins.

2000- Dr. V. Jeyaraj was awarded the Getty Travel Award to participate in the IIC Conference in Melbourne, Australia

2001- Seminar on "Protection of Cultural Property" under the auspices of the Inauguration of the District Museum at Virudhunagar International Seminar on

Conservation of Stone Objects Exhibition on Conservation of Stone Objects was conducted Publication of a pamphlet on the Exhibition on Conservation of Stone Objects and the release of the abstracts book of the International Seminar.

Mr. A. Rajendran, a part-time research scholar on Conservation of Wall Paintings and Ms. Y. A. Divya Durga Prasad, a full time research scholar on Conservation of Paintings registered their names in the University of Madras for Ph. D. under Dr. V. Jeyaraj.

International seminar on conservation of stone objects with special reference to limestone objects was conducted in the museum.

An exhibition on conservation of stone objects was conducted in the Contemporary Art Gallery.

Dr. V. Jeyaraj, Curator of the Laboratory was elected as the President of the Indian Association for the Study of Conservation of Cultural Property, New Delhi.

2002- Report on Conservation of Wall Paintings at the Thiagaraja Temple, Thiruvar.

Reprinted three books by Dr. V. Jeyaraj and published a book on Care of Paintings.

Conservation of two large sized Thanjavur Panel Paintings at Arulmigu Meenakshi Sundereswarar Temple, Madurai.

Workshop on Conservation of Panel Paintings at Madurai for two weeks

Course on Care of Museum Objects

A booklet on Conservation of Thanjavur Panel Paintings (Tamil) was published.

Capsule Courses on Conservation of Cultural Heritage at Chennai, Thiruchirappalli, Salem and Madurai for Curators, Archaeologists, Epigraphists, Executive Officers, Police Officials Engineers etc.

2003- Ms. Bessie Cecil registered her name under Dr. V. Jeyaraj for conducting research leading to Ph. D. Degree.

2004- Government Museum Manuscripts Conservation Centre was formed as a unit of the National Mission for Manuscripts in the Laboratory. A Trainers' Training Programme on Preventive Conservation of Manuscripts was conducted for Conservators of South India for one week.

Rev. Fr. Dr. A.Vijay Kiran registered his name under Dr. V. Jeyaraj for conducting research leading to Ph. D. Degree on church antiquities.

2005- 31st Refresher Course on Care of Museum Objects with Special Reference to Manuscripts.

Workshops in Preventive Conservation of Manuscripts at Erode, Tirunelveli, Madurai and Palani.

Awareness Rallies on Preservation of Manuscripts - One-day Workshop for Librarians from South India on Preventive Conservation of Information Materials.

Publication of a book on Preventive Conservation of Information Materials.

Publication of books by Dr. V. Jeyaraj on Heritage Management (Museology).

Directory of Museums in Tamilnadu, Directory of Monuments in Tamilnadu and Coins of Arcot Nawabs.

Restoration of 22 large sized oil paintings on canvas for the University of Madras, Chennai.

Conducted the International Seminar on Authenticity in Art with Special Reference to their Conservation from 14th to 16th December 2005.

An exhibition on Authenticity in Art was conducted in the Centenary Exhibition Hall of the museum where demonstration of authenticating methods was done.

2006- Restoration of British paper prints from Raj Bhavan, Chennai.

Conducted workshops on Preventive Conservation of Manuscripts in Kanyakumari, Palani and Kanchipuram and awareness rallies in preservation of manuscripts.

3 Authenticity in Art-An Introduction

*V. Jeyaraj**

Introduction

The word authentic means real, genuine and true. A forged object/painting, for example, will not be inauthentic in every respect when compared to the original object/painting. Counterfeit coin/paper money may be both a fraudulent token of legal tender but at the same time a genuine piece of metal/paper. Authenticity can be classified into two categories. First, works of art can possess what we may call *nominal authenticity*, defined simply as the correct identification of the origins, authorship, or provenance of an object, ensuring, as the term implies, that an object of aesthetic experience is properly named. However, the concept of authenticity often connotes something else, having to do with an object's character as a true expression of an individual's or a society's values and beliefs. This second authenticity can be called *expressive authenticity*.

Nominal Authenticity

Forgery

Many of the most often-discussed issues of authenticity have centered around art forgery. A forgery is defined as a work of art whose history of production is misrepresented by someone to an audience normally for financial gain. A forging artist paints or sculpts a work in the style of a famous artist in order to market the resultant object as having been created by the famous artist. Exact copies of existing works are seldom forged, as they will be difficult to sell to knowledgeable buyers. The concept of forgery necessarily involves *deceptive intentions* on the part of the forger or the seller of the work: this distinguishes forgeries from innocent copies or merely erroneous attributions. Common parlance also allows that an honest copy can later be used as a forgery, even though it was not originally intended as such, and can come to be called a forgery. In such cases a defrauding seller acts on an unknowing buyer by misrepresenting the provenance of a work, perhaps even with the additions of a false signature or certificate of authenticity. The line between innocent copy and overt forgery can be, as we shall see, difficult to discern.

Honest Misidentification

Authenticity is contrasted with falsity or fakery in ordinary sense discourse, but, as noted, falsity need not imply fraud at every stage of the production of a fake. Blatant forgery and the intentional misrepresentation of art objects has probably been around as long as there has been an art market — it was prevailing rife even in ancient Rome. However, many works of art that are called inauthentic are merely misidentified. Fraudulence is approached only when what is merely an optimistic guess is presented as well-established knowledge, or when the person making the guess uses position or authority to give it a weight exceeding what it deserves. The line, however, that divides unwarranted optimism from fraudulence is hazy at best. Authenticity, therefore, is a much broader issue than one of simply spotting and rooting out fakery in the arts. The will to establish the nominal authenticity of a work of art, identifying its maker and provenance — in a phrase, determining how the work came to be — comes from a general desire to understand a work of art according to its original canon of criticism: What did it mean to its creator? How was it related to the cultural context of its creation? To what established genre did it belong? What could its original audience have been expected to make of it? What would they have found engaging or important about it? These questions are often framed in terms of artists' intentions, which will in part determine and constitute the identity of a work; and intentions can arise and be understood only in a social context and at a historical time. External context and artistic intention are thus intrinsically related. We should resist, however, the temptation to imagine that ascertaining nominal authenticity will inevitably favour some old or original object over a later artefact. There may be Roman sculptures, copies of older Greek originals, which are in some respects aesthetically better than their older prototypes, as there may be copies by Raja Ravi Varma or other well known artists that are aesthetically more pleasing than the originals. But in all such cases, value and meaning can be rightly assessed only against a background of correctly determined nominal authenticity.

When the painting, Mono Lisa was stolen, it is learnt that copies were made and sold. The intention was to get money by selling the copies, not selling the original. But unfortunately, the person who tried to sell the original was caught and luckily the original reached the Louvre Museum, Paris.

In general, knowledge that a work is a forgery, or even the suspicion that it is, conditions our viewing of the object, assigning it "a role as training toward perceptual discrimination." It is by trying to perceive as yet invisible differences between originals and forgeries that we actually do learn to detect them.

Expressive Authenticity

In contrast to nominal authenticity, there is another fundamental sense of the concept indicated by two definitions of authenticity mentioned in the *Oxford English Dictionary* : "possessing original or inherent authority," and, connected to this, "acting of itself,

self-originated." This is the meaning of "authenticity" as the word shows up in existential philosophy, where an authentic life is one lived with critical and independent sovereignty over one's choices and values; the word is often used in a similar sense in aesthetic and critical discourse. In his discussion of authenticity of musical performance, Peter Kivy points out that, while the term usually refers to historical authenticity, there is another current sense of the term: performance authenticity as "faithfulness to the performer's own self, original, not derivative or aping of someone else's way of playing" (Kivy 1995). Here authenticity is seen as committed, personal expression, being true musically to one's artistic self, rather than true to an historical tradition. From nominal authenticity, which refers to the empirical facts concerning the origins of an art object — what is usually referred to as provenance — we come now to another sense of the concept, which refers less to cut-and-dried fact and more to an emergent value possessed by works of art. I refer to this second, problematic sense of authenticity as *expressive authenticity*.

The nominal authenticity of a work of art of any culture may be impossible in many cases to know, but where it is possible; it is a plain empirical discovery. To identify expressive authenticity, on the other hand, is a much more contentious matter, involving any number of disputable judgments.

Conclusion

Art authentication becomes inevitable as it is necessary to preserve the genuine materials of the past for posterity. If the available scientific methods are pooled together and used to authenticate the art objects, then one or more methods will be of immense help to the Curator in authenticating the objects. When there is no method available, then only the stylistic features or the adherent matter on the object will come to our help as in the case of Pathur Nataraja in the London Court.

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**Curator, Chemical Conservation and Research Laboratory, Government Museum, Chennai-600 008.*

PAINTINGS

4 Strategies for Authentication of Paintings

*K.K. Gupta**

Introduction

It is not uncommon for a conservator to come across occasions when he is required to authenticate a painting, whether it belongs to a certain period or is attributed to a certain artist. Till recent past these questions used to be answered either on the stylistic grounds or on the basis of visual condition and nature of the constituents of a painting. These methods of authentication, however, are subject to questions as the knowledge of style and material used in different schools, periods and by different artists can be easily acquired through various sources. In addition, the new paintings can be exposed to such conditions as to alter their appearance to look old. More and more expertise and technology have been employed to achieve this end, for the simple reason that the monetary stakes are very high. Today the value of a painting depends mainly upon its being antiquity or its attribution to a popular artist and not so much upon its merit or quality. With the increase in the employment of technology in the art of faking, a number of scientific techniques are being developed to test the authenticity of these works of art.

Over 500 years ago, Vermeer said something meaning, "As long as there is art there will be forgeries." The fact is that art forgeries go well even before his time, and will continue well past our own. But today, art forgery is more common than ever before. The reasons for forgeries are so prevalent today are many, the main among them is money. In order to avoid the entry of forged works of art in the museums or art galleries, the detectives of the art world who are conservators, historians, or scientists in the laboratory need to join hands to detect the fakes.

History of Forgery in Paintings

Art falsification and forgery are ancient endeavors, though these were not so widely practiced before the collection of antiques came into vogue. During the Renaissance Michelangelo himself, according to Vasari, carved a marble cupid, buried it for some time to give it an antique look, and sold it as an ancient sculpture. Hans van Meergeren (1884–1947), a Dutch painter is most famous for his forgeries of Vermeer. He did not copy existing Vermeer's, but copied his style and sold them as new discoveries of the lost paintings by Vermeer. He sold them to Hermann Goering and was put on trial after World War II for selling national treasures. He proved himself innocent by even painting another "Vermeer" in his jail cell.

Methods of a Forger

Before planning the strategy to authenticate a painting, it is important to visualize the possible alternatives available to a forger to achieve specific compositional and superficial effects in paintings. By the use of this knowledge suitable methods could be formulated to detect the use of these artificial measures for giving the painting an old look. Great many materials and techniques have been used in this art of deception of preparing fakes.

A forger may gather the knowledge about the style, brush work, material and the subjects of the type of painting he wants to create and also about the alterations which the ageing processes are likely to produce. Based on this accumulated knowledge the fakes can be produced, and more the knowledge he gathers more closely he can reproduce the appearance of the intended painting. Such paintings can stand the tests of authentication in a better way.

Another method of deception employed to resist the detection of fake is by painting over damaged paintings transforming them into complete paintings. Since old materials have already been used in such cases, detection becomes difficult. In addition, the chances of appearance of pentimenti phenomena are greater. Such paintings can sieve through many tests of authentication. Some of the methods used by Van Meegeren, a noted Dutch forger of paintings was buying, then cleaning, 17th century works of art with pumice and water, being careful to leave the network of cracks in the bottom white layer of paint.

'Pastiche' has become quite common method of producing fakes. Pastiche is painting made by the combination of elements of several different genuine works, which may or may not be by the same hand. In this, background may be taken from one painting, figures from another and other elements of the painting from still others. In this way several damaged paintings are used to make one complete painting. The advantage in this method is that during examination even if the brush strokes may not tally with any artist, one will not find mistakes in the details and the tests would in any case indicate its components being old.
Fakes also include copies or even mechanical reproductions of works of known artists, not initially meant to pass for the original, or intended to defraud.

As art forgery detection techniques become more sophisticated, a squeeze is put on the forger necessitating his need to fool more and more scientific tests.

Basis of Authentication of Paintings

For much of history, authentication has been a matter of connoisseurship rather than science, with experts relying on intuition, personal idiosyncrasies or minute physical examination to identify discrepancies such as unnaturally regular cracquelure in oil paintings or the tell-tale absence of staining and signs of wear in bound documents. One art guru, Berenson was famed for smelling and licking paintings to detect their recent origin. This does not seem completely unreasonable because the oil paint may have smell and taste for some time during its drying which may be some years. There are some individuals who claim to have extra-ordinary ability to detect authenticity. In The Hitler Diaries, Charles Hamilton boasts that his 'feel test' can distinguish between a genuine and forged document in "two or three seconds" or by inspecting only a "half dozen words".

A systematic procedure for authentication of paintings, however, takes into account three important factors: Style, Provenance and Scientific Analysis.

Style

Is the object possible in terms of style, technique and subject matter? Different schools of paintings and different artists have their own style and the favourite subject matters. This is the responsibility of the art historian or a professional acquainted with the artist in question. Some help in establishing the authenticity of a painting is taken from the shapes of objects, costumes and furniture etc., depicted in it. There is a possibility that the objects painted in the later work do not match with the objects in fashion in earlier period and if so, the authenticity of the painting can be doubted. Also since drawing of some parts of the body, like ears and hands is difficult and need greater skill, these often differ considerably from hand to hand. So by comparing these areas of the painting in question, with the known paintings of the artist or of the period one may get some indication regarding its authenticity.

Provenance

Does the object have a reasonable and well-documented history? Provenance is probably the most critical element in establishing the authenticity of a painting and does not appear to have any substitute. It is of greatest concern to the person making the final decisions as to a piece's authenticity. An excellent provenance for a painting would be a bill of sale from a gallery or a serious collector, a photo of the work in an exhibition catalogue, or, best of all, publication in the catalogue, showing that the work has been completely accepted by the art historians as authentic. The collector contemplating a purchase should, however, be aware that determined forgers may – and often do – invent documentation supporting their objects' history.

Scientific Analysis

Decisions regarding authenticity, based just on style and provenance have often been questioned. No matter how well painted, and how detailed the documented provenance, if the object consists of materials not available in the artist's lifetime, it cannot be considered authentic. For a painting to be authentic, all of the materials found and all of the techniques used in its fabrication should point to its being painted during the supposed period or by the artist to which it is attributed. Authenticity is also ruled out if evidence suggests deliberate alteration of the piece. Since the materials used and the marks of tampering in the painting can only be identified by the use of scientific methods, it is in the past fifty years that authentication has moved from the library into the laboratory.

Scientific examination basically looks for anomalies in chemical and physical composition and in the condition of the painting. Scientific authentication of paintings is based on negative evidence and takes a sort of 'guilty until innocent approach'. Science is generally very good at producing evidence of falsification but often equally poor at proving authenticity. So it is the failure to find any evidence of a painting being fake, brings it close to authentic. It is, therefore, difficult to say for sure a work to be authentic; only thing which can be said is that no evidence could be found to doubt its authenticity.

While examining a painting for authentication, it is important to take into consideration all the factors, which are likely to affect the observations with regard to the specific examination. The factors of prime importance which may be responsible for this are the material used, the style and technique applied in the execution, and the effect of time and environment on the completed paintings.

Materials employed in the fabrication of a painting's support, ground, paint, varnish or any other layer may give some information about the period of the painting. If the history, discovery or manufacture of materials used is known, their presence in a painting could give some idea of the period of its execution. The pigments and inks used by artists and writers broadly reflect the technology available at the time and have thus changed over the centuries (eg from inks based on soot and oak-tree gall to those based on petrochemicals). Laboratory analysis of the pigment can provide an indication of an item's age.

The period of a painting would naturally be later than the latest of the materials used in its fabrication. The quality of the materials may act as an additional guide to this, as this can also give some indication as to the possible technology used in achieving that quality. This in turn would indicate the earliest possible period of the painting if the history of that technique is known. Prussian blue and artificial ultramarine, for example, were discovered in 1704 and 1820 respectively and so, the paintings in which these pigments are detected cannot be earlier than these dates. It is, therefore, essential to detect, as closely as possible, the materials and techniques used and to see, through the knowledge of art history, whether these were available during the supposed period of the painting.

X-rays have played a very important role in seeing through the structure of the paintings and thus detecting the fakes. In one of the wood panel paintings, the x-ray revealed that under the painting the wood had wormholes that were filled by lead paint. This made the painting a suspect because it is assumed that no right-minded artist would have worked with such a poor quality wood panel.

X-ray can reveal a painting beneath a painting that can shed light on its origins. If it is established that the under-painting, as it is called, is of a later date than its supposed date, painting cannot be accepted as genuine. A painting titled "Absinthe Drinker," supposed to have been done by Picasso, while being examined by X-radiography, was found to have an abstract painting underneath, which was a historical impossibility. It was also discovered by use of x-rays that the Meegeren's fakes Vermeer's paintings had five layers instead three used by Vermeer. However, it may be noted that painting over a painting is not always a result of forgery. Wood panels and canvas have been quite expensive, and thus precious to the artist. Neither forger nor master artist could afford to make poor use of canvas or wood panel. That is why different artists have used them over and over again. Sometimes, three of four paintings have been found over each other on one canvas or wood panel. There are many examples that are simply over paintings done without any devious intent. These under paintings, therefore, occur both legitimately and in forgeries.

Brush Work in a Miniature Painting as Seen with Radiography

X-radiography, if properly used can record the brush work of the artist. Handling of material in making a painting is different from artist to artist, period to period and area to area. Every artist has its own characteristic style of working which includes the selection of themes, brush work, colours and treatment of details. The style generally develops from the influences he had, his temperament and the circumstances to which he was exposed. Thus, the technique of a painting can often act as a useful clue in establishing its authenticity. The imitation of brush work, for example, is completely beyond the capacity of any forger and so if the records of the brushwork of known artists are available, authenticity of the paintings can be established with a fair degree of accuracy.

The condition of a painting at a particular time depends upon several factors which include the material and technique, environmental conditions to which it was exposed, handling and other interaction with the painting. Though the ageing symptoms depend upon a number of factors, the condition of the painting, if carefully examined and interpreted may prove to be very useful aid in authenticating it. In case of one of the forgeries by van

Meegeren, was confirmed by dating the paintings according to the proportion of a certain lead isotope in the lead-based paint. The actual isotope content of the paint was compared with the expected content had the work been painted in Vermeer's day.

Pentimenti are phenomena in which the under-drawing or under-painting become visible at some areas of a painting due to changes in refractive indices of overlying layers. If due to this phenomenon or by other means one gets some proof of alteration in the painting, one can say with a fair degree of certainty that the painting is genuine as alteration by the artist himself never exists in a fake painting. In a copy or a fake, everything is carefully planned and every detail of composition pre-exists and so there is no reason for error or afterthoughts. An oil painting on canvas, Artist -Raja Ravi Varma and X -radiograph of a portion of the painting, showing alteration by the artist. Courtsey-Sri Chitra Art Gallery, Trivandrum. The intentional or accidental use of the hands and fingers in creating a work of art provides the perfect opportunity for using fingerprint identification in identifying an artist. Paintings and other works of art frequently preserve the marks of the hands and fingers that created them. Every time we touch something we leave behind a unique mark. So do artists working with paints, inks and dyes among the many substances used in their creations. These substances may require hours, days or weeks to dry. During this time if an impression is left, the dry surface will preserve the print even for hundreds of years and can be used as a tool for establishing the authenticity of a painting, if the finger prints of the artist are known, from his authentic paintings or any other source.

For getting information regarding the above-mentioned factors various physical, chemical or instrumental methods such as dentro-chronology radio-carbon dating ultraviolet, infrared, X-rays examinations, wet analysis, mass spectrometry are employed. Since these methods are not individually exhaustive, combination of methods are mostly used to gather complete information required. Also since it is not desirable to sacrifice even a small portion of a painting, particularly the small ones, non-destructive techniques of examination should be opted as far as possible.

Limitations

In spite of scientific developments and technical expertise in the field of detection of composition and tampering in a painting, it is not really possible to claim that all the problems of authentication can always be solved. More often than not the conclusions derived regarding authentication are subject to debate. There are several ifs and buts to derive correct inference and so to categorically declare a particular painting as authentic or fake is often a difficult proposition. There have been cases where a particular painting which was declared fake later turned out to be genuine and vice versa.

As such, there cannot be anything wrong with the recording of facts by scientific equipments, but the problems sometimes lies with the interpretation of results and deriving conclusions from the observations. The history of the materials used in a painting could be a strong evidence against its authenticity but at times results based on this method may be misleading. If the samples taken from a painting happens to be from the restored areas and it indicates the presence of material which was discovered after its supposed period, a genuine painting may be branded as fake. Sometimes, however, the forger may take advantage from the same logic. It is, therefore, important to identify correctly the restored areas of the painting to be examined and samples should be drawn from the original areas. The identification of restored areas itself may sometimes pose insurmountable problems.

The tests based on the material and style has been countered by the use of materials having long history, and style of the artist, period and provenance can be followed by studying these in depth. The brush work, though strictly characteristic of the artist, can be imitated to some extent with the help of X-ray photographs of the genuine paintings by the artist.

Signs of ageing have also been duplicated by using various methods. Cracks in paint, for example, can be created by using faulty technique and yellowed look of a painting by using tinted varnish. So the deteriorated condition of the paintings is not always a sure sign of genuineness and vice versa. There exist many genuine paintings without cracks but there is hardly any fake painting without cracks.

In case of 'Pastiche', since the paintings are composed of pieces of different genuine works, even if the brush strokes may not tally with any artist, one will not find mistakes in the details and the tests would indicate its components being old. In such cases it would not be easy to pronounce it a fake, which although may be a fact.

As an example of limitation of the methods used for detecting the fakes, all the paintings created by Van Meegeren were technical tours de force. The pigments matched what was available in the 17th century. The canvases all came from the 17th century. The aging process he created after four years of research was almost undetectable.

So, despite modern technological advances, much forgery remains impervious to detection by other than empirical means. Critical expertise in the styles and aesthetics of various periods is still the principal tool of the authenticator. Artistic clumsiness, a jumble of styles or motifs, and a discernible emphasis on the aesthetic values of the forger's own day more consistently reveals fakery than does technical analysis. As scientific techniques grow more sophisticated, so do the techniques of forgers. Without proof of origin its valuation as false or authentic is at best a matter of subjective human judgment.

Conclusion

Authentication of a work of art is truly inter-disciplinary work of science, art and logic. To be able to correctly establish the authenticity of a painting, one needs to have many qualities of a good detective. He should not only be a keen observer of all the relevant, though small, details but also have a meticulous thinking to combine all the factual observations with his knowledge of art history, to arrive at conclusion. For that, he should have a sound knowledge of history of art and technology, the capability and limitations of different scientific equipment and also a good logic and reasoning power. He should be fair and should not have any preconceived ideas to avoid any subjective influence on his conclusions.

Though there is no denying the fact that the greater the knowledge one has in all these relevant fields, the better it is, what is important, is that he should be capable of knowing the limitations of various methods, and the extent of possible errors. He should also have access to a large and varied library so as to be able to evaluate and use the information made available by different experts.

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5 Authentication of Oil Paintings in India : Need for Research and Database

*Sreekumar Menon**

Introduction

Faking and forging art works might have started when people started loving creativity and collectors and connoisseurs of art started collecting fine pieces of art for decorating their houses/palaces. During ancient times, in the schools of art in Europe and in India, for e.g. A Buddha statue or a Tanjore painting; several copies of a single artefact were made as idols but many of them were neither attributed to a particular creator nor were signed by the artist. Often various artists who were specialists in different fields contributed to a single work. These works were carried out either for religious purposes or were commissioned by rulers of different dynasties. This tradition has almost become extinct today and only non-attributed art works available today are in the form of crafts or are copies made of originals which are known as fake art works.

Fake is the term used to define art works which were copied from original and are sold as copies itself, where as forgery is when an art work copied from an existing art work or executed in the style of an artist with an intention to pass it off as an original.

It is a well known fact that Indian art market is flooded with forged art works, majority of them being paintings.

So Why Paintings?

Indian contemporary paintings are now internationally rated very high and investment on these paintings are considered to be one of the safest which yield high returns than any other financial investment. But this is not the only reason for its demand among forgers. Even though technique of a well known artist may be of high quality, a budding up artist or an art student with a good hand can create the paintings of same technical quality. It is the idea and creativity of the artist that sells. So it is easier to copy the idea of a famous painter and make a painting similar to his and sell it as original for monetary gain. For eg. Jamini Roy is one of the most forged Indian painters just because of his simple and easy style which his paintings were easy to copy. Very often it becomes a very tedious process or impossible to authenticate a painting just by having a look at it and studying the quality of art work, especially when there are no systematic studies carried out on an artist, which is the case of all the artists of Indian origin.

This paper is an effort to explore the methodology for a detailed study and research on the techniques of paintings which is one of the basic requirements not only for authentication but also would aid in conservation of these paintings. The information gained should be stored as a database for comparative analysis.

Authentication of Paintings

When question of authenticity arises, the first question that comes into ones mind is whom should one approach or who can authenticate a painting?

The sad fact is that nobody in India as it is impossible for people to single handedly authenticate a painting and moreover it requires a thorough art historic and scientific research on individual artist to authenticate a painting.

The study required to build a database and the databax can be broadly divided into two, 1) Art Historic Research and

2) Scientific Analysis. These studies are complimentary to each other.

Art Historic Research

a) The first step of building a database is referring to libraries.

More famous the artist, more the literature available. It should be based on 3Ws

- Where, When and Why did the artist paint?

Where - An artist might have travelled during his time and painted at various sites, which might have had an affect on his themes, style and raw materials.

When - With time an artist becomes more proficient in his technique and ideas and materials might change which in turn contributes to difference in the style of paintings.

Why – There are different reasons for producing an art work, may be it is an idea of the artist or it may be a commission work by a client, which restricts the independency of the artist to a great extent to use his own ideas. These changes in style and technique have to be chronologically recorded, which can be utilized in comparative authentication.

b) Database of images of the artist's work

An extensive database of all the known works of the artist, including sketches and existing copies by other artists, have to be collected and stored separately as photographs and literature. It would also be useful to collect the details on the works of the teacher of the artist, artist's assistants, and other artists of the same period.

c) Provenance

Where does the painting come from? The seals and inscriptions on the reverse of the canvas, stretcher, frame or backing cloths would be useful in determining the history of ownership. In fact every museum should have a thorough record of each painting related to their ownership, and how and when the painting was acquired.

d) The web

This would be the first place to search for information related to a painting. There are a lot of powerful search engines and art dictionaries available in the web.

e) Conservation studios and individual conservators

Maximum amount of information could be obtained from conservators who have worked on the paintings by the artist. Knowingly or unknowingly many facts would have been recorded in condition and treatment reports of the paintings. Photography which is an important part of any conservation treatment would be of immense use to find some basic facts about the painting. Detailed photographs taken before, during and after conservation will give a lot of information about the style, technique and history of the painting.

f) Personal diaries of artists, assistants and clients of the artist

The study of diaries of the artists and assistants would give valuable information related to the technique of the artist, the days when and where the artist worked, working atmosphere and inspiration for creating a work. One should also look into the historic records of palaces, libraries etc., for similar information. This might also give light to information related to the raw materials used by the artist. In most of the cases, artist prepared/procured raw materials by himself or clients provided the raw materials. This is important to know about the quality of raw materials, which would aid in scientific study.

Scientific Research

Scientific research has to be done in co-ordination with art historic research as both are complimentary to each other. A lot of scientific research techniques are in some way or other related to art historic information on the artist's technique. Artists are not always confined by the medium in which they work. It is hence very important that we understand the techniques and processes used by artists.

a) Visual Examination

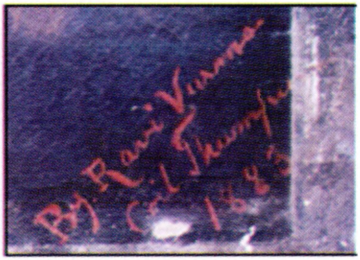
Simple visual examination aided with magnification with simple magnifying lens is the basic step of scientific research.
Information gained by this simple method are:

- Type of brush strokes of the artist.
- Was the artist right/left handed?
- Kind of support the artist preferred/used – like weave structure/thread count of canvas, type of wood, did the artist used prepared supports?
- The type of colours used in signatures.
- The colour of ground used.
- Type of frames and stretchers used etc.

b) Signature Analysis

This requires a specialist handwriting analyst. Detail analysis of signature includes the following:

- Comparison – A database of pictures of authentic signatures is required to compare the signature.



Variation in signatures of Raja Ravi Varma with time.

- Stylistic – It is possible that the signature of the artist varied over their life; even then they retain dominant characteristics. For eg. Ravi Varma signed in about three different styles (see figure). One has to record the changes in signature with time. The size of the signatures. Is the signature done in a flow without any stops?
- Scientific – Type of paint used in signing, does the same type of colour used in the painting or was the paint used for signing available during artist's time?

c) Analysis of Support/Stretcher and Frame

Type of support used by an artist depends on the source where he procured the support from. If an artist bought raw materials from a single supplier then most probably the support would be similar in all his paintings or changes in the support can be traced from the records of the supplier. If the artist used supplies available at sites for his work, then the supports would change with the movement of the artist. The study requires an in-depth research with art historic study.

d) Pigment Analysis

The knowledge of major pigments used by the artist would be useful for comparative analysis. There are various non-destructive and micro-analytical techniques that can be effectively used in maintaining a permanent record of pigments used. Since new pigments were invented or changes in micro composition of pigments occurred with time, scientific analysis of pigments would be of use in authentication.

e) Analysis of Cross-sections

Study of cross-sections of paint layer reveals the structure of the paint thereby throwing light into the technique of the artist. This is a destructive technique but at the same time is very useful in authentication studies if properly carried out. Cross-section analysis gives information on how the artist did build up the layers of paint, did he applied a glaze coat for effects, what was the thickness of the ground and paint layers etc. Moreover, cross-sections can be stored as a permanent database allowing researchers to have a fresh look at them at a later stage if required to clarify doubts regarding the technique of the artist.

e) Examination with Invisible Radiations

Invisible radiations like x-rays, infra-red rays and ultra-violet rays are used to study different aspects of a painting, like structure of the painting, under-drawings, over paints, retouching etc., which are properties unique to the paintings and also adds information on the technique of the artist.

Different techniques are used to add more information about the artist to the database. They range from simple Polarized Light Microscopy to advanced methods like High Power Liquid Chromatography and Magnetic Imaging. Study of varnishes used in oil paintings if the original varnish still exists on the paintings (which are not very often found), study of oil used as medium etc., are also carried out in specific cases according to the availability of samples, equipment and experienced people.

Conclusion

Building a database on an artist requires a multi-disciplinary approach and could only be accomplished by a collaborative research conducted by professionals in different fields. The approach differs depending upon the artist, the type of work and the possibility and availability of technique to be used.

It is also evident that the success of a project of this kind solely depends on the willingness of different organizations, individuals and collectors to share their knowledge and art works for the sake of art.

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6 Evaluation of Methods for Determining Authenticity of Paintings

*B.V. Kharbade**

Introduction

With the development of advanced analytical tools for materials analysis, various laboratories of the West have attempted to use these techniques in authentication of art objects. Some of the reported methods based on examination of craquelures, analysis of pigments, physical and chemical properties, analysis of ground, binder, coating, canvas, dating of wood used in panel painting and stretcher were evaluated on the samples taken from the Raja Raja Varma Paintings of the Art Gallery, Mysore. The results and discussion on the subject are presented in this paper.

Experimental

The cracks in the paintings were examined visually and by magnifying lens. Depth of crack and pattern also were studied by IR reflectography. Size of grains in pigments and purity were determined by examining under the stereo microscope. Media of the paints were extracted using specially developed apparatus by the author for extracting plant gums, which hydrolyses on heating. Extracted aliquot was separated and identified using thin layer chromatography[1]. For protein media, staining method of E. Martin[2] in which thin cross section of paint layer embedded in polyester resin and stained with Amido Black AB1 and AB2 reagents.

Speckles were taken from the paint layer with fine sharp edged needle and subjected to X-ray diffraction and infrared studies for pigment identification.

Samples from the wooden stretcher were taken with the micro-drill having ultra micro bead. Wood dust collected after leaving from the depth of first 2-3 mm and pressed to transparent pellet mixing with potassium bromide powder (Figures 1 and 2)

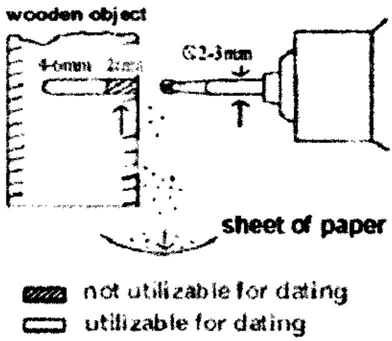

Figure 1 - wood dust collected from the painting stretcher by drilling leaving dust from the first 2-3 mm depth for IR studies.

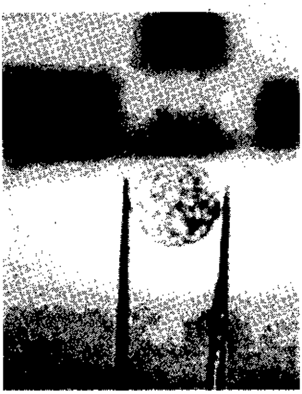

Figure 1

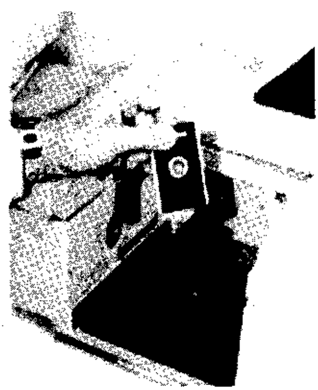

Figure 2

Figure 2- Wood dust mixed with potassium bromide and pressed in a die to form a transparent disc which is then placed at sample stage of IR Spectrophotometer.

Results and Discussion

Cracks in oil paintings usually appears after 60-120 years depending upon their materials. This characteristic provides one of the possibilities of establishing authenticity in the paintings. Cracks in 'Syrendri' one of the famous works of Raja Ravi Varma (Fig 3) indicates that the painting is an antique .

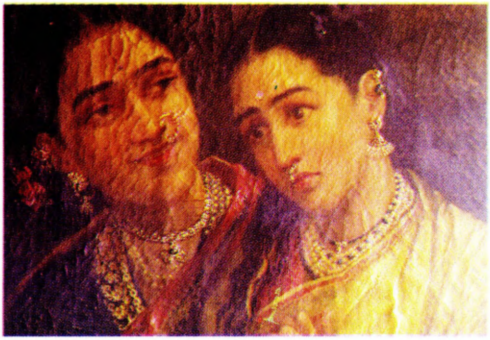

Figure 3 – 'Syrendri' of Raja Ravi Varma showing cracks, which establishes painting's authenticity.

The size of grains of pigments is also decissive parameter in determining whether painting is antique or recent. Visible grains shows the pigments were ground by hand while invisible grains indicates the work of recent production.

The paintings can be authenticated from its wooden stretchers. Gottfried Matthaes, Director, Museum of Art and Science, Milan, Italy has developed the method of dating of wooden objects using IR Spectrometry, and later patented in 1995s. The same method was used in this study to authenticate the painting. It is based on the principle that molecular changes occurs in wood on ageing are recorded by IR Spectrometry, which are then matched with known dated wood . If the graph matches fully, then the wood surely be of the same age of the standard. Figure 4 shows the IR spectra of the sample and standard.

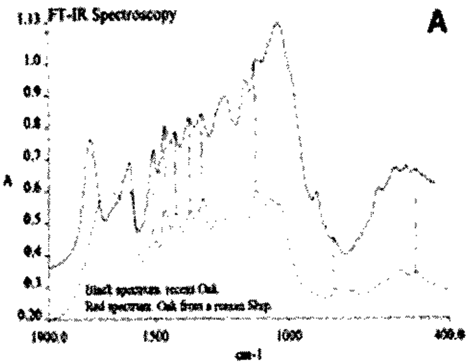

Figure 4—Infra red spectra of sample and standard dated wood

Infra red spectra of the wood samples taken from the stretchers of Raja Ravi Varma painting could not be dated due to non availability of spectra of dated woods. The work on building up IR standards is underway.

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WOODEN OBJECTS

7 Authentication of Wooden Artefacts : Kondapalli Figure - A Case Study

*V. Jeyaraj**

Introduction

Forgeries are making copies of works of art or craft made for fraudulent purposes or in order to deceive. Sometimes the original objects are altered in character or added to, for the purpose of enhancing the value. Forgers are at increase. Copies are made and they are simulated in appearance as that of the originals. Some times, the original art pieces are altered and the forger's name is inscribed. Coins, sculptures, bronzes, paintings etc., are forged. There were famous forgeries like the Piltdown forgery during the current century, which rocked the art and archaeological world. Since then, many instances have come to light and are well known all over the world and India is no exception. This paper deals with the authentication procedure as far as the wooden objects are concerned.

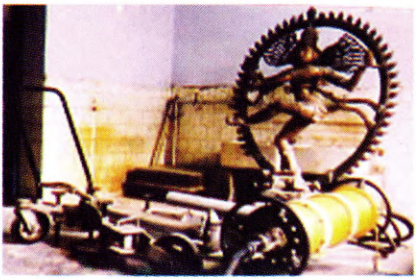
Wooden Objects

Trees are gift of the Nature. Trees are the sources of wood. Wood is mostly got from trees of monocot and dicot plants/ trees. Carvings are done on wood from dicots. Wood carvings were mainly used in temple cars. Normally wood from *mahua* trees were used for carving wooden sculptures. Now-a-days teak wood is also used for carving besides, rose wood, sandal wood etc. Kondapalli wooden toys are one such item besides various furniture and household objects.

Kondapalli Wooden Toys

Kondapalli toys are absolutely light-weight and come from Kondapalli, a little village near Vijayawada. The style is warm and realistic with the faces of the toys being highly expressive. The themes are centred on the village and village life. However, the process being highly flexible, the art form has found many admirers in foreign countries. The wood is first seasoned. Every single unit is separately carved and joined to the body with an adhesive paste of tamarind seeds, then coated with lime glue. Painting is done with brushes made of goat's hair. You can see a wide range of themes from animals, occupations and daily life, besides mythological characters.

X-Radiography Set-up



In order to find out the defects of authentification marks in side the objects, the wooden object should be exposed to x-rays. The x-ray equipment should be set up in such a way that the radiographs can be very easily recorded. The x-ray may be generated from uranium also. It is very strong and therefore precautionary measures should be taken when the experiments are made.

A Kondapalli Type of Figure

A wooden object, which is very light, was received for treatment from an individual in the Laboratory of the Government Museum, Chennai. The technique of manufacture was noticed to be that of the Kondapalli toy making.

Dimensions of the Wooden Object

The wooden object was found to have the dimension as follows:
Height : 73 cms

Breadth : 31 cms
Thickness : 20 cms
The weight was around seven kilograms.

X-radiograph of the Wooden Object

Radiology is one of the fundamental non-destructive tools of investigation and examination of works of art including wooden objects. It has been used for ascertaining internal initial subsequent construction scheme, as used by the artists, in the past or subsequent work done on the objects for restoration purposes or to detect forgeries of the original works of some master pieces.

Kondapalli Tpye Wooden Figure

The x -radio graph revealed that the wood has joints in the shoulder portion. The joints have been made with the help of two long iron nails. This is a proof for its authenticity and it also reveals the method of fabri -cation also.

Radiographed Figure

Conservation of the Kondapalli Toy

The Kondapalli toy was cleaned with rectified spirit as it has the water colour on the toy. The torn portions were pasted to their positions with the help of tamarind paste. The portions which had lost the colour were retouched. The loose portions were fixed firmly and pasted carefully. Only vegetable colours were used to replace the loss of pigments.

Conclusion

The Kondapalli figure making has dwindled and the artisans in Andhra Pradesh have switched to furniture work. There is a fall in the export of Kondapalli toys due to the chemicals used in the toy making. But the museums have to preserve the toys for posterity. Any retouching alway alters the originality. Therefore, the retouched areas should be noted and kept. Print it is always better to keep the objects without retouching to keep the originality impact.

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IVORY OBJECTS

8 Authentication of Ivory Artifacts

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Introduction

Museums are the repositories of genuine and authentic cultural properties of the human race for the sake of posterrity. This is one of the most important functions of any museum. However, this function though seems to be a hustle free function, it is not so. Museums face similar type of difficulties, which are faced by other institutions which are worried about authentication such as banks, dealers in precious metals. These difficulties arise because of human greed, manipulation for name and fame or perverted and cunning mind to mislead the society for the sake of personal profit or just for the sake of it.

The history of museums always contains the juicy stories about the fakes, forgeries and deceptions. To mention a few examples: Dead Sea Scroll, Bronze Horse, Ivory Bedposts

Though one has to study not only individual material and specialize, but also individual artifact too. Hence, it is difficult to master every material and every object. Each Curator may specialise in one or the other material and design history and pool their knowledge for the professional advantage and to fight against the criminal tendencies of deceptive brains.

In the above light, this paper focuses on authentication of ivory artifacts.

Introduction to Ivory

When most people think of ivory, they think of elephants and their huge curved tusks. Those tusks are actually teeth, and that is what ivory is. Ivory, apart from elephant tusk is also obtained from other animals with large teeth, such as the walrus, hippopotamus, garwhal and sperm whale. As some of these animals, particularly elephants, are endangered species, it's now illegal to import/export most ivory. Since 1989, there has been a worldwide ban on any trade in elephant's ivory. Due to regulations, the value of ivory carvings has tremendously increased.

Ivory was the most fascinating material to work for craftsman since the ages.

This run-away market is not just for Oriental ivory, but almost as strong for African figures. 19^{th} century and earlier European ivory has all but disappeared. The ivory market surged upward almost unnoticed by the general public. It has done what silver did in the early 1980's.

Ivory specimens date back to the earliest dynasties of Egypt. A great wealth of ivory-carving has survived from early Christian times in the West and many fine works in ivory have also come down to us from remote civilizations in China and the Near East.

Types of Ivory and Their Sources

True ivory from large teeth of:

- Elephant
- Walrus
- Hippopotamus
- Garwhal and
- Sperm whale

Fossil or mammoth ivory of the tusk of woolly mammoths lived on this planet thousands of years ago, and are preserved by freezing. The tusks are true fossils, so although this term is commonly used, the name is accurate. Antique ivory is the preferred designation.

Problems in Identification

It is fairly easy to distinguish between varieties of complete teeth or tusks, but pieces of these are more difficult to identify. The cross-section must be carefully studied (preferably under a microscope) and compared with known samples. Particular attention must be paid to the grain of the central (pulp) cavity.

- Difficulty in making out the tools used for carvings
- Identification of ivory of Asian and African origin

Physical Properties

Colour —White to yellowish. Ivory tends to yellow with age and takes on a mellow brownish-yellow patina.
Optics – Refractive Index - I. 1.54.
Durability — Hardness 2.5. Tough. Workable with ordinary steel cutting tools. Ivory is soft, making it a timeless favourite for carving.
Crystal Structure — Ivory has a distinctive, "engine-turned" cellular appearance under magnification.
Specific Gravity — 1.7-2.0
Conductivity – Poor conductor of heat; Good conductor of electricity.

Chemical Composition
Inorganic Constituents

Calcium phosphate
Magnesium phosphate

Calcium carbonate
Calcium fluoride

Organic Constituents

Ossein (Protein)
Collagen matrix

Difference between Ivory and Related Material

Ivory shows annual rings like that of tree when viewed in transverse-section, as a new layer is added each year.
Bone has stripes.
Vegetable ivory has no rings.
Walrus ivory, from the upper canines of this vertebrate is chemically similar, but inner zone appears much more translucent, with circular opaque markings due to a higher degree of crystallinity.

Difference between Ivory and Bone

Ivory is basically an elephant tusk (upper incisors) and bone is from any large animal.
Fibre of ivory is more solid than bone. So ivory is smooth and bone is coarse.
Unlike bone, ivory has no blood vessel system, and is therefore denser.
Ivory contains more magnesium phosphate and bone contains more calcium carbonate.
They differ in their ratios of hydroxyapatite $Ca_{10}(PO_4)_6(OH)_2$ to collagen.
Bone – 1:2 :: collagen: hydroxyapatite + 5% by weight of water;
Ivory 1:3 :: collagen: hydroxyapatite + 10% by weight of water
They differ in their micro and macro structures.

Ivory has a remarkable micro structure of very fine tubules, whose unique gyratory pattern produces the 'engine turning markings', which is missing in bone.

Ivory shows annual rings like that of tree when viewed in transverse-section, as a new layer is added each year where as bone has stripes.

Ivory is less fragile and bone is more fragile.

Ivory can absorb more water than bone.

To some extent ivory can be softened by very hot water or vinegar where as bone can be slightly softened by water, extensively in acid (vinegar, sour milk), which impairs its mechanical property.

Ivory is mainly used for decorative purposes and bone for defence and articles of daily use.

Ivory is cream coloured and bone is whitish.

Colour of ivory varies according to its origin.

In the sunlight, ivory bleaches.

If much handled, ivory develops a fine yellow / brown patina from the grease and other exudates of the hands.

When burnt ivory becomes grey, a feature which can be used decoratively.

Common Properties of Ivory and Bone

Anisotropic (directional property): warping due to change in relative humidity and temperature.

Different mechanical characteristics along the different planes

Decomposition: Protein andossein decompose by prolonged exposure to humid condition.

Porous in nature hence absorbs moisture.

Colour: light in colour and gets dirt easily.

Brittleness: due to ageing.

Darkness: If exposed to sun light.

Fragility: If submerged in alkaline water it becomes fragile.

Deterioration/ Ageing of Ivory

Deterioration in ivory is due to following four aspects:

- Physical
- Chemical
- Biological
- Man-made

Physical Deterioration

It absorbs moisture if stored in damp conditions or cracks if allowed to dry out.
It also contracts in the cold and expands in the heat.

Chemical Deterioration

It decomposes in wet condition.

Biological Deterioration

When new, ivory is white or pale yellow. It darkens naturally with age, becoming darker yellow or brownish. The patina, which the age brings adds to the aesthetic value.

Man-made Deterioration

Because it is organic, ivory can be easily damaged if mishandled. Immersing in water and use of harsh cleaning agents, stringing material in beads causes deterioration.

Why Forgery?

The causes for adopting the root of forgery are:

Demand Push

Ivory was the most fascinating material to work for craftsman since the ages. When a material was required for the finest carving, the choice fell on ivory. Ivory though of standard shape, was the more suitable material for fine work and lent itself to decorative treatment. It could be carved, etched, stained, painted, gilded, inlaid with metals, precious and semi-precious stones. It could be used, moreover, for inlaying in wood, and for veneering. Ivory was in demand for the plaques and reliefs that were used for diptyches and bookbinding. It was also ideal for carving figurines and statuettes.

Increased concern and interest in the past created a value for the objects of the past and thus also promoted a market in fake artifacts.

Increasing number of museums and art connoisseurs and their increased financial powers and willingness to spend any amount, round the world have motivated faking.

Supply Constrains

- Limited supply, due to its animal origin and distribution of the animal.
- Further, in current times, the regulations and
- Ban on ivory carvings.

"The desire to own objects of the past, especially those which are scares because of the effects of age and decay or of high aesthetic value, has led to the creation of fakes and forgeries to satisfy the demand" observes M. James. His general observation holds good even for ivory.

Aesthetic entity and the values attached to it by the present day society, the history, uniqness command huge price for the antiquities giving a big margin of profiteering by faking as it is economically feasible and lucrative.

Advancement in Technology

The same developments in technology and knowledge which allow one to deduce the 'real thing' promotes fascination in the art of the fakes of antiquity.

History of Faking

History of faking dates back to 490 B.C. In the earliest days, Greek temples had a function of creation of collection of old and unusual objects. This tendency was also spread to Greek philosophers and early educational institutions. The Romans copied the Greek idea of temple treasures and building personal collections. A fashion for the ancient Greek led to copying and faking ancient Greek statuary for satisfying the demands and ego of Roman elites. Since then the problem of authentication has cropped up. Synthetic ivory, called ivorine, was sold as far back as the 1920's.

Types of Forgery

Use of forged material and passing it off as true ivory.
Using true ivory as material but faking the antiquities of demand in toto by

- Artificial aging
- Fake patina
- Fake incrustations.

Using true ivory antiquities and adding, modifying their integrity.
Misleading about the origin of true ivory.
Interspersing true ivory work with bone.
Use of ivory dust on artifacts of imitation material.
Misleading about the tools used in carving true ivory.

Fake Material Used as Ivory

Animal Origin

Bone looks and feels much different from ivory, although treated bone is sometimes sold as an ivory substitute.
Antler is another related material used as ivory substitute.
Extremely rare pieces can even be made from hippo and walrus tusks and passed off as true ivory.

Plant Origin

Vegetable ivory, which comes from the tagua nut, is a widely used substitute.
The seed of the ivory palm is another source of vegetable ivory.

Synthetic Origin

- Celluloid plastic is the most common imitator. While it might look the same, it feels different.
- Plastic and plastic resin
- French ivory, ivorette, and ivorine are trade marked ivory imitations.

Preliminary Tests for Authenticity

There are three basic steps for determining the authenticity. They are,
1) Is it ivory or a plastic reproduction?
2) If genuine ivory, is it a contemporary or antique work? and
3) If antique, how valuable is it?
The first step can be accomplished easily by:

Melt Test

Heat a needle or pin (held by pliers) red hot and attempt to insert it in an inconspicuous place in the specimen. If it melts, it is a plastic reproduction. Real ivory is extremely dense and a poor conductor of heat; the worst result will be a very small black dot.

Ultraviolet Radiation

Genuine and plastic items can be compared under a long wave ultraviolet light, (of the type commonly used to illuminate fluorescent posters) the genuine piece appearing brighter.
Note: This test may not always work, as the difference between he two is not great.

Static Electricity

Briskly rub the artifact with a piece of silk or flannel. A plastic artifact so treated will readily pick up dust, ashes, or small pieces of paper. Rubbing generates a static electrical charge which will be quickly neutralised by a genuine artifact, a good conductor of electricity.

Note

This test may not work in high humidity, as water vapour in the air will drain off the electrical charge on a plastic replica. It will also be invalid if the plastic has been treated with anti-static chemical. If a specimen picks up fluff it is definitely a replica; if it does not then it may be genuine as the test is not necessarily conclusive.

Physical Inspection

Compare a known genuine article in one hand with the item in question the other. A genuine tooth may feel "colder" than the plastic counterpart due to the greater heat conduction by the natural ivory. (HINT: switch hands every few seconds).
Lift two pieces similar in size. Real ivory, being denser, will appear to beheavier.

Note: The overall weight to size ratio ("heaviness") will depend on the depth of the root cavity.

The second question is not so easily answered. However, one may take-up.

Visual Inspection

Under 30X magnification (pocket magnifiers the surface of the specimen may be watched for:

Air Bubbles

Very small, perfectly round air bubbles may be seen on the surface near each end, along the bottom edge, and inside the tooth cavity, if genuine.

Grain

Pay particular attention to the butt end of the tooth, where the material can be observed in cross-section. Genuine ivory has a definite "grain," whereas plastic will probably be smooth and featureless.

Cracks

Compare the engraved lines to any age cracks in the tooth. Genuine teeth, as they age, will tend to develop small cracks running the long direction of the tooth. The extent of cracking depends on the way the tooth has been cared for. Well cared for specimens may show minimum cracking, but those subjected to extremes of temperature may show more extensive damage. Further, observe how the engraved lines cut across vertical age cracks. If the engraved line is deeper than the natural crack, the work is of recent origin.

The third question is the most difficult to answer. However one can observe, Stylistic pattern associated with object which could be most helpful. The work of each geographical area, period, paleography or inscription and artists are unique; Experts and art historians can identify the identity and its worth.

Analytical tools

Various techniques used by forgers are now so efficient that the experts often find themselves incapable of being 100% certain that the object they have to study is a fake. However, there are highly sophisticated methods used to be absolutely sure.

C^{14} Dating

Measuring the level of carbon 14 allows dating for organic material ivory. This technique is more expensive. Dating techniques as the scientific techniques are less reliable, if an art object consists of only one very resistant material, such as ivory.

Electron Microscope

As far as an analysis by electron microscope is concerned, it enables one to observe possible mechanical abrasions, which may have been used "to age" an inscription.

X-Ray

Dental x-rays may show the pulp cavity of the real tooth extending almost its entire length, whereas this feature will not be seen in plastic pieces. Ordinary dental negatives are too small; the tests can be better performed by an oral surgeon, who is equipped to handle larger sizes. Some experimentation and controlled development times are necessary.

Electronuclear or Particle Accelerators

This is a complicated method which can enable one to discover any possible trickery on the patina only. Electronuclear or particle accelerators allow us to measure the oxygen 16/oxygen 18 ratio which varies over time. If patinas are contaminated or damaged by aggressive washing, then the results are misleading.

Activation Analysis

Nuclear-chemical techniques are frequently used to analyze materials for trace elements - elements that occur in minute amounts. The technique used is called activation analysis. A sample is irradiated with nuclear projectiles, usually neutrons, to convert stable nuclides into radioactive ones, which are then measured with nuclear radiation detectors.

Activation analysis can (without chemical separation) measure nanogram (4 × 10-11 oz) concentrations of about 35 elements in such materials as soil, rocks, meteorites, and lunar samples. Activation analysis can be used to analyze biological samples, such as human blood and tissue; however, fewer elements can be observed in biological materials without chemical separations.

Reviews and Case Study

Reviews

Art and Archeology Technical Abstracts (AATA) online database covered 171 articles (out of 1 lakh) related to authenticity/ forgery of various materials and six related to analytical techniques in this connection, till date. This indicates the rarity of reports on authentication, which is an important issue but neglected area. Of which only four articles dealt with ivory artifacts and only one with ivory related to India.

Of the four reported articles, two articles were in German language and the abstract of Josef Riederer suggested that dating technique is not of much use in detecting age of ivory whereas H. Graven talked of "factory' made (i.e., forged) medieval ivory triptychs and gave insight of methods used by forgery factories. M. C. Ross in 1939 rejected the view of Raymond Koechlin's view regarding forgery of Gothic ivory mirror case. The remaining one case from India reported by A.S. Bisht dealt with 12 ivory bedposts which were offered to the National Museum, New Delhi for purchase. This case is taken up as an example of case study.

Case Study

Only one case on the detection of fakes in ivory was reported in the Journal – Conservation of Cultural Property in India in the year 1989 by A. S. Bisht, the Chief Restorer of National Museum, New Delhi. In this report a case of twelve ivory bedposts which were offered in 1988 to the museum for sale were examined in the Conservation Laboratory of the museum for authentication.

The author has listed the following problems in detection of fakes

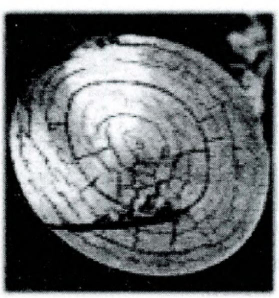
Stylistic considerations which were the main flanks of detection in the earlier days showed considerable margin of errors.
Lack of scientific authentication the fakes may go out unnoticed.
Law enforcing agencies do not have teeth to quickly distinguishing the fakes from original and vice versa.
Well meaning legal Acts cannot be enforced due to the problem of authentication.
Lack of people's participation and museum movement is also responsible for fakes.
Inadequate detection facilities, low priority and lack of funds are other banes.
Renewed interest of museums to acquire the prized possessions encouraged over night operators.
Generally genuine and fake artifacts are bundled up for sale to cover up fakes.

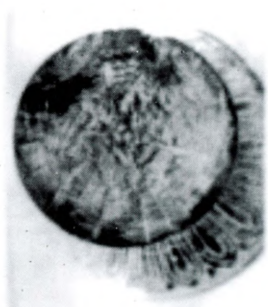
Ivory Bedposts

Genuine Fake

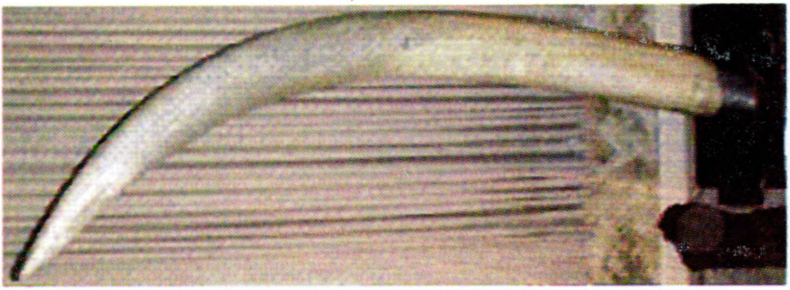
Transverse Section of Ivory

Genuine Fake





Illustrations of Ivory Objects



Elephant's Ivory Tusk,
at least 4.5 feet tall!

Painted Ivory Carving

Conclusions

Scientific techniques have proved to be of essential importance for the identification of forgeries.

Scientific, epigraphic and archaeological expertise do not produce the same result.

Even the regular and trusted art dealer, knowingly or unknowingly may pass of the fakes.

It is always good practice to have a committee of experts drawn from all related areas.

Policy of taking the artifacts on approval and returning the same if not found genuine within three years of acquisition is a good practice.

No one takes the responsibility to authenticate an object due to the pitfalls, not even the professional associations.

Careful study of many examples will allow the collector to gain familiarity with this subject.

Watch out for Interpol reports, professional journals and study.

Encourage discussions/ objective reporting by professionals to share the experience.

Reliable body of knowledge must be assembled about ivory to permit identification of fakes.

In the course of a police investigation, arresting a forger is still the best way of identifying fakes.

Your best protection is a thorough knowledge of the subject. The tests outlined here are only suggestions.

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9 Authentication of Ivory Objects in Indian Context

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Ivory is a hard, white, opaque substance that is the bulk of the teeth and tusks of animals such as the elephant, hippopotamus, and is therefore a characteristic unique to the order.

The word ivory was traditionally applied to the tusks of elephants. However, the chemical structure of the teeth and tusks of mammals is the same regardless of the species of origin and the trade in certain teeth and tusks other than elephant is well established and widespread. Therefore, ivory can correctly be used to describe any mammalian teeth or tusks of commercial interest, which is large enough to be carved or scrimshawed.

Teeth and tusks have the same origin. Teeth are specialised structure adapted for food mastication. Tusks, which are extremely large teeth projecting beyond the lips, have evolved from teeth and give certain species an evolutionary advantage. The teeth of most mammals consist of a root and the tusk proper.

Teeth and tusks have the same physical structures viz. pulp cavity, dentine, cememtum and enamel. The innermost area is the pulp cavity. The pulp cavity is an empty space within the tooth that conforms to the to the shape of the pulp.

Odontoblastic cells line the pulp cavity and are responsible for the production of dentine. Dentine, which is the main component of carved ivory objects, forms a layer of consistent thickness around the pulp cavity and comprises the bulk of the tooth and tusk. Dentine is a mineralised connective tissue with an organic matrix of collagenous proteins. The inorganic component of dentine consists of dahllite. Dentine contains a microscopic structure called dentinal tubules, which are micro-canals that radiate outward through the dentine from the pulp cavity to the exterior cementum border. These canals have different configuration in different ivories and their diameter ranges between 0.8 and 2.2 microns. Their length is dictated by the radius of the tust. The three dimensional configuration of the dentinal tubules is under genetic control and is therefore a characteristic unique to the order.

Exterior to the dentine lies the cementum layer. Cementum forms a layer surrounding the dentine of tooth and tusk roots. Its main function is to adhere the tooth and tusk root to the mandibular and maxillary jaw bones. Incremental lines are commonly seen in cementum.

Enamel, the hardest animal tissue, covers the surface of the tooth or tusk which receives the most wear, such as the tip or crown. Ameloblasts are responsible for the formation of enamel and are lost after the enamel process is complete. Enamel exhibits a prismatic structure with prisms that run perpendicular to the crown or tip. Enamel prism patterns can have both taxonomic and evolutionary significance.

Ivory Substitute

Ivory became the preferred substance for many kinds of artistic and utilitarian carvings but the supply were seldom sufficient. Moreover the ban on ivory trade was also one of the causes for the emergence of the substitutes.

i) Natural ivory substitutes are- bone, shell, hornbill ivory, horn antler and vegetable ivory.

Bone

Bone-both animal and human- is in a sense the poor man's ivory. It is mainly the middle portions of the long bones that are used for carving. The longitudinal surface often shows short dark lines (i.e. the canals that pipe the vital fluid in living bone). Commercially, oil or wax was sometimes rubbed into the surface in order to cover such spots ad mark, thus increasing the difficulty of distinguishing bon from Ivory.

Bone and ivory are entirely different. There is only solution of the pores of ivory it is not as brittle as bone. It absorbs water readily and cracks. Furthermore, ivory is of a bigger size, contains more phosphate of magnesium (bone contains more carbonate of calcium or lime), is better to carve, is scare and, above all has the religious sanctity.

Shell

Shell is calcium carbonate and found as the protective covering of a soft body of mollusk. Shell can be polished to a very smooth hard surface.

Helmeted Hornbill

Of the many varieties of hornbill bird, only the helmeted hornbill furnishes an ivory like substance. At the front of the head, above the beak, this rather ugly bird has a casque, as dense as elephant ivory. The casque is a hollow, roughly cylindrical attachment. And it can be carved and polished. It is used for intricate small objects.

Horn

The substance of which horn, claws and hoofs are made is termed as horn. It is an out growth of the skin. Some of those horn products became possible after craftsmen discovered that moist, heated horn becomes malleable under pressure. Rhino horn has been used for carving small artistic pieces including Japanese netsuke.

Vegetable Ivory

The principal source of vegetable ivory was the inner seed of the nut, from the ivory palm tree (Phytelephas macrocarpa). The plant is known as the "tagua" by the Indians. The seeds have the shape and size of hen's egg. In its very young stage, the seed contains a clear insipid fluid, which gradually becomes so hard as to make it valuable as a substitute for animal ivory. The substance is then smooth, takes a reasonably good polish and takes stain well and it is easy to work with. It resembles fine ivory in texture and colour.

An older system for making vegetable ivory consisted of boiling potatoes in sulphuric acid, by which they become extremely hard and ivory like in texture.

ii) Manufactured ivory substitutes fall into three categories:
a) Organic resin and inorganic material
b) Casein and a resin material
c) Ivory sawdust with a binder or resin

Procedure of Faking

1. Colouration

The changing colouration of most aging ivory is unpredictable. Although some ivories remain creamy white for centuries, other darkens or yellow. Ivory also dries out over time and thereby loses its natural shine and often develop cracks. The variation in colour of ivories can be brought about by

a. Different effect of the degree of heat and drying inflicted upon the ivory. These colours are caused by a sequence of chemical and physical changes in the ivory. Thus, an unusual colour in an ivory carving may not always be due to the effect of age.
b. The simple method has been to soak the carved pieces for weeks or months in tea, coffee, tobacco juice etc.

2. Cracks

Old ivories often develop cracks. Because such ivories are respected for their antique value, fakes have appeared in which the cracks were made quickly by,

a.) Altering baking and freezing the carved ivory or immersing it in boiling water for a while and then immediately baking it in an extremely hot oven, result in sudden contraction and expansions that may open fissures along the grain.
b.) Chemicals are used to produce spot heating.
c.) Application of carefully controlled pressure or a blow with an awl can also create an opening.
d.) And finally the use of a thin pointed instrument such as a wedge can create a tiny valley, when stained, exactly replicates an "age crack".

3. Patination

Patination is probably the most significant physical attribute in the dating of an old netsuke. Patination can be simulated by

a.) Carefully applying a tinted stain to the ivory's raw surface, machine polishing, and then using appropriate chemicals as finishing agents.

b.) Some polymer resins lend a shiny and extremely durable finish.

c.) In 19th Century, staining of netsuke was commonly done with brown dye devised from 'Yasha' (similar to horse 'chestnut') and it was even used in some cases, to hide the defects in the materials.

Authentication Methods

Tooth and tusk ivory can be carved into an almost infinite variety of shapes and objects. A small example of carved ivory objects is small statuary, netsuke, jewelry, flatware handles, furniture inlays, and piano keys. Additionally, wart hog tusks, and teeth from sperm whales, killer whales and hippos can also be scrimshawed or superficially carved, thus retaining their original shapes as morphologically recognizable objects.

The identification of ivory and ivory substitutes is based on the physical and chemical class characteristics of these materials. These pages present an approach to identification using the macroscopic and microscopic physical characteristics of ivory in combination with a simple chemical test using ultraviolet light. There are some tables included to summarize the class characteristics, to give a flowchart for the preliminary identification of ivory and to give a list of supplies.

Before planning the strategy to authenticate an ivory, it is important to visualize the possible alternatives available to a forger to achieve his goal so accordingly, suitable methods can be formulated for detection. The factors of prime importance, while examining an ivory for authentication, which are likely to affect the observations with regards to specific the examination are the material used, the style and technique in execution and the effect of time and environment on the ivory. So study of authenticity of an ivory object can be based on the following steps, though every aspect has its own limitation.

Authentication of Material

The identification of ivory and ivory substitutes is based on the physical and chemical class characteristics of these materials, to identification using the macroscopic and microscopic physical characteristics of ivory in combination with a simple chemical test using ultraviolet light.

a) Microscopic and Macroscopic Test

Polished cross-sections of elephant and mammoth ivory dentine display uniquely characteristic Schreyer lines. Schreyer lines are commonly referred to as cross-hatchings, engine turnings, or stacked chevrons. Schreyer lines can be divided into two categories. The easily seen lines which are close to the cementum are the outer Schreyer lines. The faintly discernable lines found around the tusk nerve or pulp cavities are the inner Schreyer lines. The intersections of Schreyer lines form angles. These Schreyer angles appear in two forms: concave angles and convex angles. Concave angles have slightly concave sides and open to the medial (inner) area of the tusk. Convex angles have somewhat convex sides and open to the lateral (outer) area of the tusk. Outer Schreyer angles, both concave and convex, are acute in extinct proboscidea and obtuse in extant proboscidea.

A photocopy machine is used to capture Schreyer angles from mammoth and elephant ivory cross-sections. The cross-section is placed on the glass plate of a photocopy machine. A blue photocopy transparency sheet may be placed between the object and the glass plate to enhance the detail of the photocopy.

Enlargement of the photocopy may also improve the image and facilitate the measurement process.

After a photocopy of the ivory cross-section has been obtained, Schreyer angles may be marked and measured. Use a pen or pencil and a ruler to mark and extend selected outer Schreyer angle lines.

NOTE: Only outer Schreyer angles should be used in this test

Once the angles have been marked and extended, a protractor is used to obtain an angle measurement. Several angles, including both concave and convex angles, should be marked and measured. Once the angles have been marked and measured, the angle average is calculated.

Because specimens from both extinct and extant sources may present angles between 90 degrees and 115 degrees in the outer Schreyer pattern area, the differentiation of mammoth from elephant ivory should never be based upon single angle measurements when the angles fall in this range.

When averages are used to represent the angles in the individual samples, a clear separation between extinct and extant proboscideans is observed. All the elephant samples had averages above 100 degrees, and all the extinct proboscideans had angle averages below 100 degrees.

Another feature may be used to identify mammoth ivory. Mammoth ivory will occasionally display intrusive brownish or blue-green coloured blemishes caused by an iron phosphate called vivianite. Elephant ivory will not display intrusive vivianite discolouration in its natural state. It is of interest to note that when the discolouration is barely perceptible to the eye, the use of a hand-held ultraviolet light source causes the blemished area to stand out with a dramatic purple velvet-like appearance. Even if discoloured, elephant ivory will not have the characteristic fluorescence of vivianite.

Chemical Test

1. Chemical tests can be conducted either on the object or by taking some samples to study the material evidence.
   i.) A method of distinguishing vegetable ivory from real ivory is to apply little sulphuric acid. With genuine ivory, there is no discolouration, whereas, sulphuric acid applied to vegetable ivory causes an irreversible pink colouration.
   ii.) A second technique requires removal of the material allow chemical analysis that could identifiy ivory.

But these are destructive methods as a sample is needed.

2. Chemicals can even be used for examination of the patination.

Patination is probably the most significant physical attribute in the dating of an old ivory object. With the help of certain solvents the artificial patination comes out easily.

3. Chemically, in both bone and ivory, the main inorganic constituent is calcium phosphate associated with carbonate and fluoride, and magnesium phosphate. Inorganic component is dentine, $Ca_{10}(PO_4)_6(CO_3)H_2O$.

The ratio of phosphate to calcium ions for ivory is around 1.86: 1.0; whereas the ratio for bone is 2.1:1.0

Moreover, the concentration of magnesium in ivory is at least three times lighter than in bone. Ivory contains more phosphate of magnesium. Also, ivory contains much less carbonates of lime than do bones.

Organic constituent is ossein, present al least 30% by weight, which is high molecular weight protein.

Chemically, horn consists of horny epidermis cell whose main constituent is keratin, a high molecular weight protein that contains sulphur.

Chemically, helmeted hornbill is also keratin.
Shell is chemically calcium carbonate.
Chemically, vegetable ivory is cellulose.

Manufactured ivory substitutes can be ivory dust plus resins, poly ester or phenolic resins and so on.

Physical Test

With the help of physical analysis one could also identify ivory. But here also small sample is required.

i.) Specific Gravity Test

Ivory has a specific gravity between 1.65 and 1.95 in almost all instances.

If the carving floats in water, it is not ivory (Assuming that it has no hollow interior). We can fairly and reliably reject as 'non ivory' any carving that has a specific gravity outside 1.65 to 1.95.

ii.) Hardness

Hardness of ivory is 2-1/2.

iii.) Burning Test

1.) This method requires firmly pressing the point of red hot needle in to an inconspicuous spot. If this point penetrates the surface, then the material is neither ivory nor bone.

2.) Burning causes a characteristic odour in different substances in ivory, there will be no smoke, only the smell of drills tooth. Horn is mainly keratin. So on burning, it smells unpleasantly of burning hair.

3.) Synthetic material- Celluloid, it burns readily unlike ivory. If it is resin, this will result in smoke smelling of burning plastic.

iv.) Refractive Index

Ivory has a refractive index of 1.56.

v.) By Handling

Constant handling seems to lead to absorbing the subject through the fingertips. Handling develops the best possible way of recognizing the resin reproductions of all forms of ivory carving.

Because ivory is dense, it conducts the heat of hand always and seems to be cold; plastic in contrast feels warm. Once the genuine and reproduction have been compared, the different is obvious.

vi.) By Observation

Wear and tear are invaluable guides to authenticity, but, once again, recognizing the right kind of wear requires experience.

vii.) By Heat

If horn is heated to higher temperature, it melts. If ivory and bone are heated in air, the organic constituent ossein burns, while the mineral constituent remains in the form of white ash. If they are heated in a closed vessel (partial vaccum), the organic constituents are carbonized, forming ivory or bone black.

Invisible Radiation Tests

"Ultraviolet rays" have a property of florescence, where it is absorbed by the materials and a portion or it is released as a longer wave length, and then it comes under visible area. This particular phenomen of light is called florescence. This florescence is characteristic of different materials, as regards the colour and intensity of florescence.

However, correct usage of a uv lamp calls for great care in interpretation of the florescence seen. It is essential to know what the hue of genuine surface would look like, before comparisons can be drawn with false material.

Different ivories and various substitutes give different uv florescence.

Mammoth ivory occasionally displays intrusive brownish or blue green coloured blemishes caused by an iron phosphate called 'vivianite, whereas elephant ivory will not display intrusive vivianite discolouration in its natural state. If the discolouration is barely perceptible to the eye, the use of a hand held ultraviolet light source causes the blemished area to stand out with dramatic "purple velvet - like appearance".

Ivory substitutes are readily distinguishable from ivory by virtue of their ultraviolet light reactivity in combination with their physical characteristics, as shown in the table below:

Source	UV Characteristics
Ivory	White/blue florescence
Bone	Fluoresces like ivory i.e. between white and blue, the shade changes
Shell	Mottled dull blue florescence
Helmeted hornbill	Red colour appears blue (i.e. which is on the periphery); Ivory colour remains true
Vegetable ivory	Fluoresces similar to ivory
Manufactured ivory substitutes (Casein + celluloid may appear "mocha" Resin)	Absorbs UV Light: dull blue appearance
Manufactured ivory substitutes (Ivory dust + Resin)	Absorbs UV Light; dull dust + Resin) blue appearance
Manufactured ivory substitutes (Polyester or phenolic resins)	Absorbs UV Light; dull blue appearance

Fourier Transform Infrared (FT-IR) Spectroscopy

It is a non-destructive technique for the chemical analysis of materials, based upon molecular interaction with infrared radiation. The analytical product of this technique is expressed in an interferogram.

Though pure casein displays uv fluorescence similar to ivory, however, the chemical structures are easily distinguishable by FT-IR.

II. Style

Style of executing an art work in ivory is different from place to place, period to period, and from artist to artist like Chinese ivories from Tang dynasty to Ming dynasty have their characteristic stylistic features. Even the degree of finishing or smoothness is also one of the aspects of stylistic features. An artist develops a particular style depending upon various aspects. Thus, the style can often act as a useful clue in establishing the authenticity. But a forger may gather the knowledge about the style of ivory he wants to create, from various sources. So, we cannot simply rely on the stylistic or iconographic features for authenticity, though it helps to some extent in some cases.

III. Technique

There are various methods of working ivory like carving, sawing, turning, engraving, etching, etc. Different techniques were employed earlier for executing different subjects. Like Scrimshaw was either scratched, pin pricked etc. So engraving was done that was later rubbed with lampblack. It had specific technique and carving was not done in this case. Moreover, some periods are characterized by their intricate works. So here comes the use of very fine tools.

So, the technique for making an art object can be known, through various sources, by a forger. So, again a problem can arise as regards the authentic technique.

IV. Authentication of Condition of an Ivory

The condition of an ivory at a particular time depends upon several factors which includes environmental conditions, and other interactions. Though ageing depends upon various factors, but a close examination of the material is necessary.

i) A natural/ age crack in an ivory at a deep point where dryness has created stress within the structure. Thus, in a genuine split there is always a wide point with tails that become thinner as a tissue extends outward. Furthermore, ivory cracks along the grains, not at an angle to it. Finally dirt tends to accumulate in a fissure that makes it appear black. Moreover SEM studies can be conducted to study the crack pattern's genuineness.

(ii) Patination, is probably the most significant physical attribute in the dating of an ivory. The natural ageing process lends the surface of the usually white ivory a mellow tone, ranging in colour from yellow to deep orange. Unless destroyed by incorrect cleaning, this naturally formed "skin" appears as a shiny coat with a velvety feel.

Patination can be examined with the help of chemical and also under uv. Artificial coating usually comes out with solvents. The tone and intensity of genuine patination vary according to the type of ivory, and also to the atmospheric conditions to which type piece has been exposed to.
Moreover, even the genuine could have been innocently coated, for protective purpose and with time every coating changes the colour and gives florescence.

Moreover, the distinction between a natural "skin" and a machine polish can be perceived only by trained eye and an experienced sense of touch.

iii.) Scientific methods of dating the material, as distinct from its artistic treatment, have proved of interest. The appearance, weight and tactile qualities of ivory are some indication of age to those who have long worked with it. Scientific tests useful in determining the age of at least ancient ivory.

Case Study

The faking of art and antiquities occur not only in cultures in which old objects and objects associated under famous individual can command high prices, but even the most venerated major have been repaired and replaced, as necessary.

Ivory Bed Posts

National Museum, New Delhi was offered a few ivory bed posts for acquisition. Here, only two of them have been quoted. Laboratory was supposed to examine and conclude. So scientific study was conducted and they were compared with a genuine ivory which had aged naturally.

(i) According to iconographic study, both the pieces seem to be of 17^{th} century. The details of the carving are of very high quality workmanship and artistic excellence.

(ii) The chemical composition was alike, and therefore they were genuine ivory pieces.

(iii) The patination, however, was not similar. In one of the cases, it seemed as if some coating was coming out with solvents. Moreover scrapping of the outer layer was done and the presence of cotine' was confirmed as reported by the National Museum, New Delhi. Moreover, under uv. lamp, the 2^{nd} piece, gave a greenish, yellow fluorescence, while the 1^{st} piece, gave the usual blue to purple fluorescence proving that it was not naturally and genuinely patinated.

(iv) The SEM studies of the microstructure also confirmed the structural composition. The SEM of the offered piece and of the naturally aged ivory piece, respectively. In the former case, the cracking pattern is wide and it does not show fine cracking pattern. Moreover, it did not tally with that of the naturally aged ivory piece, which shows a fine cracking pattern. So it shows that cracking pattern was induced artificially.

(v) However, the study of these ivories under stereomicroscope, especially of the transverse section, made the position different. The cracking pattern in the 2nd piece was proceeding in the arc of a circle which was quite natural and in the first piece, it was irregular having no pattern which would match with the ivory having the 'natural' cracks by ageing.

Thus, on the basis of these examinations, the first ivory, piece turned out to be a forgery, as reported by National Museum, New Delhi.

Conclusion

To be able to correctly establish the authenticity of an ivory, one needs to have many qualities, he should not only be a keen observer of all relevant information, though small details, but also have a meticulous thinking. He should combine all the factual observations with his knowledge of art history, to arrive at a proper conclusion. For that, he should have a sound knowledge of history of art and technology; the capability and limitations of different scientific equipment and also a good logic and reasoning power.

One should be capable of knowing the limitations of various methods, the extent of possible errors and of having access to a large and varied library enabling to evaluate and use the information made available by different experts.

We can not base our conclusion on one single proof but on totality. Even if we are not able to discover any of the fake materials used, we cannot easily conclude it 'genuine'.

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PAPER OBJECTS

10 Fingerprinting of Paper Paintings by Photodocumenting Their Hidden Lacunae Using Differential Lighting

*Anil Risal Singh**

Introduction

There may be cracking and flaking in the paint of paper paintings, and there may also be sometimes uneven paper fibres or bits of extraneous materials in the vasali of the paintings. The lacunae in the paint and fibres/extraneous material in the vasali will normally be distributed at random, and their extent and spatial distribution in a painting can be used to fingerprint it. Copying a painting could be easy, but it is impossible to duplicate its internal structure. Thus fingerprint remains unique to the painting.

Ordinarily defects in the vasali are not visible, and lacunae in the paint may also not be discernible if it is repainted with perfection. Ultra-violet and Infra-red photographic technique have been employed to obtain information on the over paint and some times the sub-surface, but their techniques require special photographic materials, camera and studio equipment.

A simple method to fingerprint paper paintings by making innovative and imaginative use of visible light and using commonly available photographic equipment has been standardised by the author, and detailed procedure is described here stepwise. The method could also be used for translucent objects.

Principle

Lighting is by far the most important element in photography and it is rightly said that understanding light is the key to success in photography and innovative and imaginative use of the intensity and direction of light could do wonders in photography.

Hidden lacunae in any translucent object like paper painting will become visible from the front when painting is illuminated differentially the backside being illuminated brighter. Thus a painting can be photographed along with the hidden lacunae by illuminating it from both the sides. The differential illumination can be achieved by the following two ways:

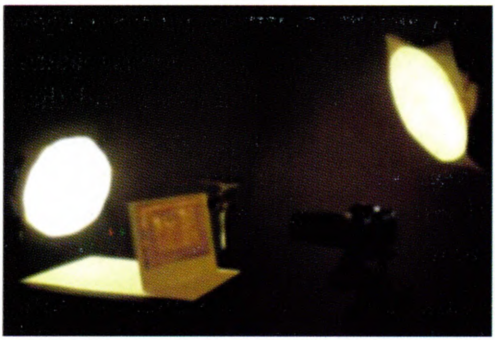

Figure 1

1.By use of two light sources of different intensities and keeping the brighter one at the back of the painting.

2. By use of two light sources of the same intensity and keep them at different distances from the object, back light should be at closer distance to the object than that of the front light.

As the brighter or closer light positioned behind the object is switched on, transmittance could be observed. The light will penetrate deep cracks, paint surface losses and reveals lacunae and distinguishing features of the painting. Figure1. Shows set-up for differential lighting

This method is very useful to study the manner and pattern of cracks, surface losses and alteration, the pattern of cracks and

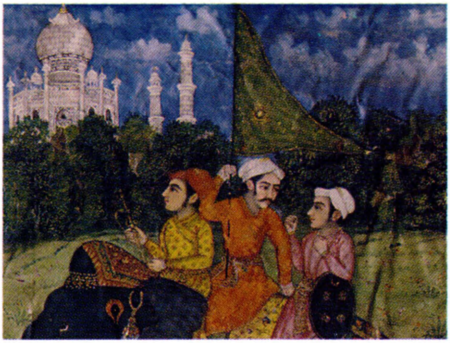

Figure 2

manner of surface loss will be different for every painting and other translucent objects, which will be worked as finger print of the object and also help in establishing authenticity of the art object. It may be possible to copy a work of art superficially, but almost impossible to duplicate the internal structure of it. There are examples that many forgeries are made so skilfully that even the art experts can easily be misled.

The forger, van Magreen, created original paintings, which the art critics accepted as true Vermeers. Only detailed laboratory and photographic tests, revealed differences, which cannot be detected by the eye of the most experienced connoisseur. This simple but innovative photographic technique of differential lighting could be very useful in detecting such forgeries and alterations.

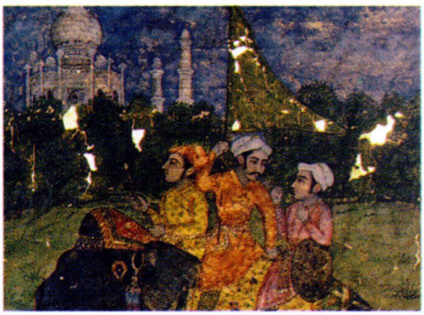

Figure 3

The result of this simple technique will be very astonishing as one could see the difference between the photograph taken under normal light condition (figure 2) and photograph of the same painting under the differential light condition (figure 3).

Equipments

For this technique very simple and readily available photographic equipment is needed.

1. A 35 mm single lens reflex camera.
2. A macro-lens preferably of 105 mm focal length, because it allows more workable space, macro-lens is very handy where close-ups are needed.
3. A steady tripod stand and a cable release.
4. Two light sources preferably photoflood lamps.

Procedure

A good quality mount board is taken and folded into two in a way that flaps are not separated from each other.

Windows are cut in the centre of both the flaps of the mount board of the size little smaller than the painting.

The painting is sandwiched inside the flaps and secured with the help of paper clip in a manner that no harm or damage is caused to the painting.

The mounted painting is kept in the vertical position on a table having white matt surfaced top. Horizontal position is recommended for oversize or fragile paintings; in such cases a light-box will be needed.

The painting is illuminated from both the sides (back and front) and the illumination is adjusted by moving the lights nearer or farther as the situation demands, making hidden lacunae visible from the front. The camera is kept on a sturdy tripod in front of the painting and the camera is aligned perpendicular to the painting.

The camera is adjusted by setting, focusing and exposure value etc. and 3-4 exposures with bracketing are taken.

Remember

There are some points, which should be remembered while taking photographs using differential light:

1. For thicker paintings brighter backlight will be needed.
2. Lights should not be very close to the painting and also not to be lit for longer duration, as it will be harmful to the painting.

Precaution

1. Backlight should be brighter but use diffused front light.
2. Light from the lamp kept at the back of the painting should not fall on the lens of the camera.
3. Flash-gun is not recommended, instead use photo-flood lamps because the effect in continuous lighting could be seen more easily

Conclusion

This is a very simple method by which any custodian of paper paintings can fingerprint the collection is short time. While digitising the collection of paintings, photograph under differential lighting can also be taken into consideration so that there is no loss of time in the work.

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11 Charactrization of Kodali Karuppur Saree

Bessie Cecil and V. Jeyaraj***

Introduction

India, with a well-developed culture and a distinct life style very different from that of other countries in architecture, social structure, religions, ornaments and jewellery, household furniture, utensils, textiles and many other artifacts shows a well developed creativity and sophisticated technology.

The texture of Indian cotton textiles and decorations on them, both woven and printed show the involvement of the weavers and the taste of the patrons. Sophisticated motifs were developed indigenously as well as with inspirations from motifs of Persian, Chinese classical textiles and ornamentation. Though the embroidery and work on cotton has been existent for a long time in the Indian textile history in the Western, North Western and Mid Eastern regions of Indian subcontinent, on loom decoration did not start until Persian traders and warriors brought in the tradition of extra warp / weft decoration.

Though the zari tradition and extra warp / weft and self woven cotton textiles and silk textiles have provenly been there as the evidence from the painting of Ajanta and Ellora Caves, temple murals from Daraswaram, Patteeswaram, Thanjavur and in many sculptures) for the past 500 years any definite record of such traditions do not exist with us. Ancient literatures (*Ramayana, Mahabaratha, Sangam* period literature etc., talk about intricate designs on textiles, which could easily have been printed, hand-painted or resist designd. The zari tradition of India is unique in its interlocking inlay work as in our yarn tie and dye, *Patan Patola* of Gujarat. The early Mughal fabrics and Persian fabrics indicate weaving with gold thread.

The traditions of plain weave with zari extra warp as boarder and *palluv* in weft has also been practiced in the cotton weaving area of *Venkatagiri*, Andhra Pradesh. The flat zari weaving of *Balrampuram* of Kerala is a simple tradition. *Varanasi* gold thread work of extra warp fancy weave decoration arrived from China through Tibet. In *Masulipatnam*, the weavers were involved in the block printing art, while *Kalahasti*, the *Balojas* (a caste involved in making bangles) took the art of painting on cloth known as *Kalamkari*. Owing to Muslim rule in *Golconda*, the Masulipatnam design vocabulary was influenced by Persian motifs and designs, widely adopted to suit their taste. Under the British rule the designs as well as the end use of the fabric differed – for garments as well as furnishings. During this period floral designs were popular. The Mughal kings quickly adopted this technique for surface decoration as yardage. The interlock system was arrived from the idea of spindle weaving *jamdani* from *Auadh* (*Oudh*) the Eastern province and *Dakka Jamdani* of Bengal are derivatives of the *Bhaluchar* technique. Prior to the tradition of interlock weaving was brought down South through trade and invasion during *Maratha* period, *Koorai* sarees, the *Sungudi* sarees of *Madurai* and *Kandangi* sarees *of Chettinadu* were the native tradition. In the south, the *Sourastrian*, *Maharastrian* weavers were practicing a technique with cotton warp and weft, the technique was spindle interlock weaving (the technique will be discussed in detail in later chapters) with cotton and zari wefts alternating each other appropriately to form a design in the body of the woven cloth with visible or tactile pattern. In *Tanjore*, the Maratha rulers perpetuated the tradition of cotton brocade technique using natural dyes hand painted or block printed textile. This was done in the eastern kingdom, *Kodali Karuppur,* from here began the tradition of *Kodali Karuppur* weaving.

Historical Background

The name of the village now called Kodali Karuppur, was known as Neela Meghapuram located in the Oodaipallam taluk of district Trichinopoly at a distance of one kilometer from the river Kollidam. During the Maratha rule the cross culture and the exchange of techniques evolved to an advanced weaving technique called the *Kodali Karuppur.*

The present area surrounding *Kodali Karuppur* namely *Kumbakonam* and *Thirubuvanam* were purely silk weaving areas. Though there are no solid evidences that these areas peaked in cotton weaving tradition. At present these areas practice extra warp fancy weaving technique, which is a recent addition. The cotton weave of the area was basically for local peasant consumption with coarse yarns. As the area grew affluent with farm products exports to other states, the weavers started manufacturing finer yarned cotton fabrics such as *dhothis*, *sarees* and *anghavastras.* The climate and the social pleasantness enabled the weavers to create cotton fabrics of fine texture, which was for the affluent members of the society. It is only natural that these fabrics took in zari to decorate and add value to the unstitched garments. The weaving was so fine that it attracted the royalties of the kingdom and these weavers started weaving a new line of fabrics specially designed and produced for the king's household. Plain band and checks similar to the *Madurai Koorai* saree were the existing technique but the new varieties were demanded by the royal society so they designed designs based on the inlay work or interlocking system or the loom embroidery.

The ornamentation with gold brocade on cotton ground woven fabric were further embellished by natural dyes applied by *kalam* or the engraved wooden blocks, which was used as sarees and *dhotis* by the royal family during the period of *Raja Serfoji*. The origin of the fabric is ascribed to Raja Serfoji of Thanjavur (1798-1832) who announced that a contest would take place to choose the best entrant, which would be given as present to this queen on the occasion of her birthday. The date is significant as by this time the existing *chintz* repertoire of the region had been enriched by the addition of the expertise and patterning drawn from the high quality fabrics specifically made for export to the Thai Court. A *Kavarai Chettiar* who created a *Karuppur* prototype with his pen won the contest. The specific characteristic of this form of patterning was that *kalamkari* technique was provided with a shimmering textual quality because the cotton fibres interspaced with the zari/ metallic yarn in the *jamdani* figured portions absorbed the dye and formed continuity in pattern with the rest of the painted cotton surface. The king was so pleased that the whole village was granted to the winner as his reward. After this, *Karuppur* painted and block printed fabrics were to be worn by royalty for all religious ceremonies including marriages when the bride would cover her head with this fabric when she entered the groom's house for the first time. The *veshtis* / dhotis made for men and the saris for worn by widows had an off-white ground with patterning reserved only for the border areas.

Materials

Cotton : Cotton yarn is spun from fine short yarns of cotton plant fruit. The yarn or the fibre varies from an inch to 2 ½" in length. These fibres are collected from the plant as crop. The collected cotton deseeded, beaten out of impurities and compressed into wades. Using various twisting techniques (depending on the region) the fibres are made into yarns and then given higher twist and double twist. The yarn is sized with starch and wound around spindles. These yarns are meticulously placed on the warp beam to the required width of the saree. The count of the yarn was usually 100s and 120s.

Zari: Twisted cotton or silk yarns, which is much thinner than the required yarn thickness is wrapped by a fine, flattened gold plate. This is done mechanically wound so that a gold wire wraps the inner core of cotton or silk without any gap or overlap. Later silver was used to make zari, which was gold plated.

Techniques

Plain Weave

In plain weave the threads interlace in alternate order and if the warp and weft threads are balanced – that is, are similar in thickness and number per unit space, the two series of threads bend about equally. In this class of plain cloth thread gives the maximum amount of support to the adjacent threads and in proportion to the quantity of material employed, the texture is stronger and firmer than any other ordinary cloth. The weave is used for structures, which range from very heavy and coarse canvas the blankets made of thick yarns to the lightest and finest muslin made in extremely fine yarns. Plain weave produces the simplest form of interlacing, but it is used to a greater extent than any other weave and diverse methods of ornamenting and of varying the structure is employed..

Weft Interlocking or *Jamdani*

The discontinuous weft of cotton and zari, the weft thread does not extend the full width of the textile, the cotton weft is interlocked with zari thread where and when the motif appears, the zari highlighting the design. The inlay work is a *jamdani* technique. To explain *jamdani* technique we need to say a few words about throw shuttle plain weave. The ends of the warp are divided into two bunches of alternating yarns, which go up and down after every throw of a pick. The inlay weaving technique is such that spindles are used to create a pattern as well as the body. Where there is a zari design, the zari spindle moves between the split ends and comes out after hooking on to the body yarn i.e., cotton, thus creating a zari surface against the cotton body surface. Counting the number of ends to incorporate, the looping decides the form of the design, as the treddling proceeds. The design, from the flat bands, to the simpler designs into the more complicated tree of life and fern like patterns and then on to the body is a very complicated journey. The borders run along either side of the saree from the *palluv* end to the saree's end. The *Kodali Karuppur* sarees do not have minor *palluv* on the inner end.

Wooden Block Print

The wooden blocks are engraved with pre-determined design. The engraved blocks that have been made for printing have allowances for finer white areas. Although the use of the *kalam* would provide increased scope for artistic ingenuity, where price was an important factor, a quicker method would have distinct advantages the use of the block. This is when the need of engineered block was required. The term engineer block can be explained as blocks which will fit to create a pre – destined pattern and which will sit comfortably around the acceptably placed inlay gold motifs. The weaver and the block printer sat together to design the final product. This is the uniqueness of *Kodali Karuppur* technique, which cannot be seen in any other textile tradition.

Kalamkari

Kalamkari literally means, *kalam* - pen and *kari* - work, i.e., art work done using a pen. The uniqueness of *Kalamkari* is the only type of painting done using dyes. Natural dyes were used for both block printing and painting.

The Motifs

Motifs and support motifs were derived from pattern like circles, squares, *thilagam* and fern like pattern, which belonged to the already existing vocabulary of patterns and motifs. Initially it is supposed that these fabrics were undyed showing the interlock motifs in the subdued golden sheen. The weaver wanting to add definition to these motifs painted / printed with natural dyes.

The Colours

With regard to the colour palette Kodali Hadaway, noted that the colours in Karuppur painted fabrics were predominantly in shades of black, red comprising deep purplish and yellow. Colours like indigo blue were later entrants into the Karuppur repertoire. The specialty is that the finished products are mellow. Bright colours are used but the finish is not gaudy. The fabric looks better with further washing, with the designs standing out even better against the background.

The Dyes

The dyes were obtained by extracting colours from parts of plants - roots, leaves along with mineral salts of iron, tin, copper, alum, etc., which are used as mordant. The natural dyes and colours were red, blue, yellow and black as basic colours were *kora* of the cotton, yellow of the *myrobolan*, black of the iron solution, blue from *indigo* and red from *chay* roots. The *myrobolan* and alum were used *mordants*.

Conclusion

The sophisticated process of engineered inlay zari weaving and block printing which was existent during Maratha period in Thanjavur could not be pursued due to lack of patronage. In the West where for centuries chemists had searched for fast coloured dyes to replace fugitive dyes, the trade hand - painted and printed cloths from India to the West was arrested and machine-printed cloths made in Manchester imitating the Indian design vocabulary appeared in the bazaar of India in turn leading to a rapid shift in Indian craft centre from the old, time consuming processes of natural dyeing to the use of synthetic dyes. The Britishers suppressed cotton weaving when they took over rule from the regional rulers. Most of the elevated and developed weaving technique have disappeared. One of the great traditions, which disappeared during the period, was the *Kodali Karuppur* weaving technique

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12 On Authenticating Textiles of Indigenous Origin

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Introduction

On the galaxy of cultural heritage, a rich cultural heritage that is yet to be appreciated completely is the textile tradition since many ancient designs, techniques employed and materials used continue as living traditions within this realm. Textiles, which constitute a major genre of the tangible cultural heritage of mankind is used by the indigenous communities could be check dichotomized chiefly into 1. Textiles that are fabricated by the indigenous communities for their own use and 2. Textiles that are fabricated by other communities and used by the indigenous communities. As the former category is woven by the indigenous communities it may or may not possess embellishments whereas in the case of the latter category the embellishments become obligatory, to specify ethnic marks. Generally, the indigenous communities tend to impregnate unknowingly their ethnic marks by means of their indigenous techniques, themes and materials available in their cultural milieu. Contrary to this trend, when they happen to procure already woven textiles, they try to embellish in their own way, conjoining therein unknowingly their ethnic marks. In other words, in such situations, embellishments characteristic of their ethnicity turn into ethnic marks. Of all the art manufacturers of India, her beautiful textiles are certainly the oldest.

Textile Collections in the Government Museuam, Chennai

Government Museum, Chennai has textile collections such as *kalamkari* work of temple hangings from Kalahasti, Pallakollu (Andhra Pradesh), Masulipatnam, Pichawari works, Kumbakonam shawls, Madurai and Kancheepuram sarees. The *Kalamkari* works are unique and are used in South India as decorative textile embellishments required for Temple hangings and canopies. For example, the Krishna Lila scenes are done on separate bits and added later. Red, blue and brown are the chief colours used. The background of the cloth is white. The flower border flanking the panels decorates the Kalamkari works.The Kalamkari work from Pallakollu in the collection of Government Museum, Chennai is of the size 5' 8"x5'. The shaded designs and pattern outlines in gold are exquisite. The Ponneri printed cotton fabrics are authenticated by designs of dots (Chanda), straight lines of dots (Jali), curvy lines (Charkana) made out of ordinary block printing while in the Ponneri prints of Pudukkottai, designs are by the wax resist print, which is made by brass blocks.

Calicoes of Masulipatnam are authenticated by prints and chintzes produced in Europe, where the motifs are flame pattern or kalka, butis or floral sprays, diapers, birds especially the peacock. These textiles are further authenticated by the resist dyeing and block printing as well. The most common design of the *kalamkari* work is the 'Tree of life' along with floral and geometrical design.

Ancient literatures, sculptures and paintings testify to the perfection of textiles in India nearly 2000 years ago. Spindle whorls and copper needles have been found in Mohenjo-daro. The Rig Veda refers to *hiranya-drapi* of a shining gold woven cloak, the Mahabharata to *manichirai* 'probably' a fabric with pearls woven into borders; Pali literature to *kaseyyaka* of Banaras. Greek writers like Strabo and Megasthenes describe garments of India worked in gold and embedded with various semi precious and or precious stones bearing floral motifs in finest muslin. Old sculptures and paintings depict patterned garments, probably brocades and embroideries. Decoration is usually used for customary reasons. For instance, silk interwoven with gold is auspicious for Hindus, silk *patola* of Gujarat is construed as wedding saree; the *namaboli*, the traditional block printed textile of Bengal worn around the shoulders is used as ritual garment. In this paper, the author with some choice textile materials from the collections of Government Museum, Chennai tries to pinpoint the ethnic marks present in them and thereby attempt to authenticate those textiles.

Some colours are popular everywhere; others are favoured in different regions. For example, Nagas like manjit red, Assamese blue, Punjabis yellow, majenda and purple while people of Madhya Pradesh, Chennai and Uttar Pradesh have fascination towards dark red, maroon and a medley of colour with green, blue and dominant red respectively. Contrary to this, Rajputana textile has double dyeing resulting in different colours producing a kaleidoscopic effect.

Some of the techniques of producing colour pattern on textiles like *bandana* or tie-dyeing, block printing like lion, tiger and painting are authenticated by familiar forms of animals, birds, like peacock swan, parrot etc., dancing women and geometric designs.

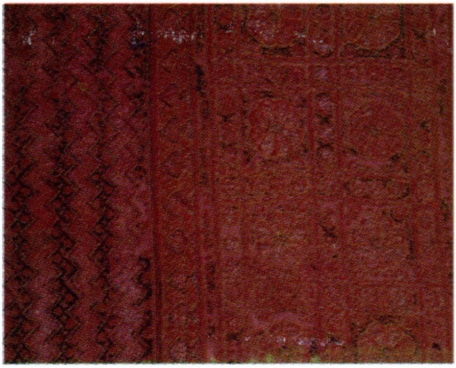
Jamdani or figured muslin is found in Patna and in South India. The tribal people use attractive textiles, which they spin. Bright coloured geometric and abstract patterns woven are the patterns of the Nagas, Manipur and Tripura. The Hand-painted *kalamkari* made for temple use at Kalahasti in the North Arcot district is authenticated by tie & dye technique called *ikat*, in which the warp and weft threads are separately tie-dyed. Kodali karuppur saris emerged as a wedding sari of the Maratha royal family, which had gone into obscurity along with the same dynasty.

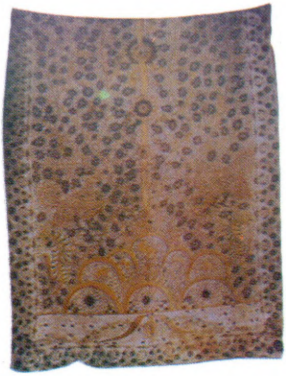
In Tamilnadu, Thirubhuvanam, Ayyampet, Arni, Kancheepuram and Dharmavaram are famous for silk saris authenticated by multicolour and designs like *thazhampoo,* peacock, swan, lotus, temple car, *kalasam,* mango, *rudraksham.* Selective ethnic group would be discussed in this paper.

Kodali Karuppur

In Kodalikaruppur saree, the process of printing or hand painting is the form of the design is left with the white back ground of the fabric and the other areas are filled in with colour. It could be observed that here the block is used to active the white line of the design to give an emphasis to the motifs. The weaving technique here is further with hand emblissed will hand painted palluv. technique in the body, border and Palluv. Motifs like star (Tara) in the border, tilakam (Chanda) in the body are with jari weft in jamdani weave. In the palluv the areas are woven with cotton weft wherever the motifs are printed, while the rest of the body is woven with jari. While printing these saree the areas of cottonground, which are with jari, will take the color and the jari shines through the color of the fabric, and thus stands unique. According to William S.Hadaway, 1912: Painting and Printing in the South, this saree is quiet distinct and exclusive among decorated cotton fabrics as it is woven and hand painted, printed with blocks. He mentions that it emerged as the wedding saree of the Maratha royal family and was not in the reach of any commoner.

Kodali Karuppur Sari Design





Hand Painted Kalamkari Curtains from Sri Kalahasti-20th Century (Now at Government Museium, Chennai)

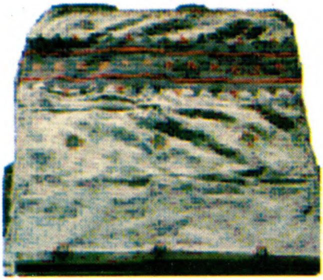
In otherwords, the Kodali karuppur is the brocade with cotton of jamdani weave hand-painted and block printed in *Kalamkari* with vegetable colours. It is interesting to note that it costed Rs.500 in the year 1912 itself. (mentioned by William S.Hadaway). The technique involved the integration of highly developed craftsmanship from the North and South.

Tribal Textiles

Toda's Pootkhuly

The Toda men and women use shawls woven by hand. The shawl has floral patterns and geometric designs and is called as Pootkhuly. The Toda men wear the dhoti till the knee and wear the Pootkhuli whereas the Toda women wear the Pootkhuli in such a way that it covers their chest and shoulders. Toda ladies are good in doing the traditional embroidery and design work that express the artistic heritage. In Toda language, embroidery is referred by the term 'pukhoor'. The use of black and red colour threads called as 'kaag' is prominently used by them. Depending on the usage of the cloth they are called by different names. For example embroidery on a new cloch for wraping the corpse during funeral ceremonies is called 'pekhaadar pootkhuly' which means the safe transportation of the Toda spirit to the other world. In the traditional motif, usage of same motif in pairs called as 'twehdr pukhoor', is seen. It is the symbolic representation of the hills, peaks, shoals, valleys and slopes since the life of the Toda is closely interlinked with nature. When the motif is a flower of a marshy grass, it is called as 'modhiry pukhoor'. Representation of giant squirrel in pootkhuli is called as 'peshk pukhoor'.

'Meeshtufykon pootkhuli', derives its name from the feather pattern of the peafowl. The honey comb pattern of pootkhuly is called as the 'kwudrkorr pukhoor'. Application of the body design of the cobra in pootkhuly is called as 'awkhofveirshy'. 'Tagaarsh pukhoor', is a motif named after the ladies jewellery. 'Kopan pukhoor is a motif inspired by the butterflies. 'Podwarshk pukhoor', is named after the cobra hood shaped flowers of the Arisaema family, which has very beautiful colours.



Pootkhuly

Display of Toda Textile at the Government Museum, Udhagamandalam

Some of the later evolved motif based pootkhulies are as follows:

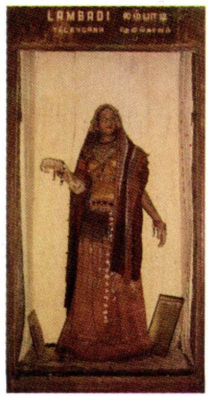
'Kaashtk pukhoor'	- Based on the design of the Exacum flowers and the star.
'Peersh pukhoor'	- Based on sun motif.
'Pathh pukhoor'	- Based on the seated vulture motif.
'Kadg pukhoor'	- Based on the Rosa leschenaultiana flower (Nilgiri wild rose). Rosaceae family
'Pelzk pukhoor'	- Based on the lamp motif
'Pub pukhoor'	- Based on the snake motif.
'Monipoof pukhoor'	- Based on the Oenothera tetraptera flower. Ochnaceae (Six o'clock flower).
'Ir kwehdr pukhoor'	- Based on the buffalo hor motif.
'Nershkon pukhoor'/	- 'Kadoryem pukhoor' Based on the Watch motif. 'Kon konody pukhoor-Based on the spectacle motif.

The motifs are embroidered mostly in the main central portion of the pootkhuly asprincipal patterns. The 'Tagaarsh' and 'Awkhofueirshy', designs are used on the outer fringe portions of both sides of the cloch.

The embellishments that are incorporated in the textiles of the Lambadis are as follows:

In the *'bhuka' the* pattern of contrasting colour bands are represented in the array of red, blue, light blue and pink wherein both the central and marginal red stripes are highlighted by presenting them with serrated margin in white. Further, to highlight the central band of red it is highlighted by means of sky-blue stripes on both sides. To differentiate the light and the dark shades of sky-blue and dark red respectively, a band of pale red is woven in-between.

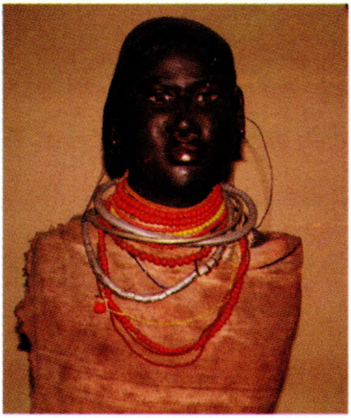
Embellished Lambadi Textile



Lambadi Woman in Traditional Attaire

Blouse

The body of the blouse is in royal golden hue. The bust line is demarcated by introducing a patch of red in fabric, and is stitched as applique. Circular coins like discs of lead bearing floral motifs are stitched on it. The edge of the blouse is embellished with bits of glass stitched on a fabric of red hue. To embellish further, rows of metallic beads of golden colour are also stitched on both its margin. To demarcate the golden hue from the stitched portion of the red fabric a relatively pale red fabric is introduced on both the margins. Rows of metallic beads are once again incorporated in the margins of the fabric of pale red. It is interesting to note that the embellishment of metallic beads in golden hue serves a double purpose of merging with the colour of the body portion (in the case of top row) and diminishing the dark red color (in the case of the bottom row). Next in the waist region alternating bands of red and blue are represented.



Self Women Cloth of the Gadabas

It is dark red in colour. Thin stripe of black line within relatively thick white band is present. The broad bands in contrasting colours of red and blue in dark shades are highlighted by introducing stripes in pink, which are further highlighted, by introducing relatively thin lines in black within relatively broader white band. In other words, to demarcate the thin black band they are presented within broader white bands.

Kanchipuram sarees, which are specific to Tamilnadu is authenticated by silk yarns in the proportion of 2:2 and for 1" more than 100 threads are woven which gives strength and beauty stands as well as ethnic mark. Border and the palluv are woven separately and blended with the body, which differentiates it from other silk sarees. Thus the Kanchipuram silk sarees occupies an important place in the art of weaving.

Kanchipuram Silk Saree Border Design

In Kalakshetra sarees, instead of gold and silver, (zari) silk threads alone are used, based on designs from Koorainadu, Kutralam and Kumbakonam.

Conclusion

In this paper, an attempt is made to identify the ethnic marks that are present in certain textiles of indigenous origin such as kalamkari of Kalahasti and Masulipatnam (Andhra Pradesh), Pookuly of the Todas of the Nilgiris (Tamilnadu), textile of Lambadis of Dharmapuri district (Tamilnadu), silk saris of Kanchipuram (Tamilnadu), textiles of the Gadabas of Ganjam (Orissa). Thus, in this study, 1. Application of gall ink and presence of Telugu legends (in the case of *kalamkari of kalahasti*); 2. Use of certain indigenous motifs and natural dyes (in the case of kalamkari of Masulipatnam); 3. Embroidering of characteristic geometric designs (in the case of Pookuly of the Nilgiris); 4. Embedding of glass pieces along with cowry shells as embellishments (in the case of Lambadi textiles of Dharmapuri district); 5. Demarcating the body of the saree from the palluv through distinctive patch of yarns during weaving (in the case of silk sarees of Kanchipuram) and 6. Weaving of thick and coarse cloth with thick stripes of contrasting dark colours for own use (in the case of the self woven textiles of the Gadabas of Ganjam) are identified as the respective ethnic marks. As a concluding remark, in this paper, it is suggested that such ethnic marks could be used in authenticating the textiles of indigenous origin. Further research in this field will reveal more ehnic marks.

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METAL OBJECTS

13 Iron Age in Uttar Pradesh and Authenticity

*Hari Narain**

Introduction

It is commonly believed that mankind passed successively through three stages of culture, namely the Stone Age, Bronze Age and Iron Age. In recent years, it has been found that in some regions Copper Age intervened between those of stone and bronze, while some other parts of the world passed directly from the Stone Age to the Iron Age. In certain remote corners of the earth, notably in Africa, and south of Sahara desert, there still live people who have not yet advanced beyond the Stone Age conditions.

The art of smelting the iron ore to produce the metal and then forging it into an object probably first begun in the 3rd millennium B.C[1], but at that time, bronze was in complete domination and used in the form of domestic articles, tools and weapons etc. Towards the end of the Bronze Age, the civilization of Eastern Mediterranean[2] suffered a series of disturbances due to lack in tin supply and the production of bronze rapidly diminished and the use of iron in the carburised form increased very rapidly, around 1200 B.C.

Snodgrass[3] reported that "iron was first adopted as the supply of tin from bronze preparation was disrupted due to some unknown reasons". The change from bronze to iron (carburised iron i.e. steel) as the other preferred the ancient metallurgists as one of the remarkable changes have regarded metal and its superiority to bronze was widely accepted. The earliest smiths, it seems, used stone hammer without handles for forging etc., as reported by Richard[4].

Centuries of experimentation had taught the ancient man different techniques, particularly how to extract copper metal from its ores by keeping the furnace temperature around 1200°C. Alloying copper with tin and other metals, casting operations, recycling of scrap metal and relationship between work hardening by cold hammering and heat treatment (annealing) to resoften an embittered copper and its alloys were fully achieved. Bronze Age smiths were well aware of the limitation of cold worked 10% bronzes, specially its use for rock cutting, etc. Iron in the form of freshly smelted bloom was unsuitable for many of the uses for which bronze was used. Though iron ores were available, a new technology was needed, as the smith was well aware that a metal could be extracted from a rock with the use of heat and charcoal (wood), it could be hardened by cold work and softened by heat. But the difficulty was not that iron neither could be cast nor could be alloyed by mixing ores. It could not be hardened by adding an element to the molten iron as in the case of bronze. For iron to become superior to bronze, it must be alloyed with carbon and with other elements, like silicon, phosphorous, titanium, chromium, manganese, molybdenum, nickel, tungsten, etc. Sometimes these elements come from the iron ore itself. But the chemical analysis of ancient iron objects did not show a significant presence of these elements, except silicon, nickel, chromium titanium, manganese and phosphorous. Iron objects having high nickel content are considered to be meteoritic in origin[5].

Early iron-finds particularly those before 1200 B.C. could have been meteoric in origin. Ancient metal workers in widely separated regions have used meteoric iron, like Incas of Peru, Mayas of Yucatan and Aztecs of Mexico[6]. Excavations in the Mississippi and Ohio valleys revealed that the Indians of South and North America were acquainted with the use of meteoric iron. Evidences are also available which confirm that the Eskimos of Greenland[7,8] also used meteoric fragments as knives and spearheads for domestic and hunting purposes. Meteoric iron almost always contains nickel more than four percent. Some of the Asia Minor (i.e. Troy II (I, 2300B.C.) objects were studied by Tylecote[9] which showed nickel content as 2.44% and 3.91%. He writes, "This is much higher than nickel obtained from nickeliferous iron ores. This shows the possibility of the use of meteoric iron, along with the other smelted iron". The literary evidence for the presence of iron, prior to 1200 B.C. is equally impressive.

There are references to iron as an item of diplomatic exchange. In one of the presents, Tushratta, the king of Mitanni sent to the Pharaoh of Egypt in the early 14th Century B.C.[10], "One dagger its blade is of iron, its haft trimmed with lapis lazuli, its pommel is of An.gub.me (stone), it is fashioned with gold, its hangers have a trim of purple (wool) twice overlaid with gold; 14 shekels of gold are used on it".

Egyptian tombs[11] have yielded meteoric iron dated to about 3500 B.C. Iron from later tombs such as those of Tutankhamun (1340 B.C.) and princesses Aashai at Deir-el-Behari (2050 B.C.) has also been found to be meteoric origin. The findings of the 18th Dynasty i.e. from the tomb of Tutankhamun [12] (Circa 1350-40 B.C.) are worth mentioning here. The dagger found in this grave was quite bright and free from rust when found. But the scientists speculate that Tutankhamun had imported a replacement blade for this dagger. Other iron artefacts like knives, blades, arrowheads and chisels etc., have been reported from Egyptian territory dating back to 1200 B.C. - 700 B.C.[13, 14]

The Hittites[15, 16], who were powerful for nearly a millennium from a little before 2000 B.C., had a good knowledge of iron smelting in the 14th Century B.C. Coke and Aschenbrenner[17] have demonstrated the possibility of iron being a by-product of copper technology. Presence of metallic iron in copper and bronze objects of the PreIron Age period at Timna (Israel), Nichosia (Greece), Serena (Greek Macedonia) and Sinai in a high range between 5-15% has been recorded. In India, Sahi[18] propounded the idea of metallic iron being produced during the Copper Age in 1980. Sahi has cited several iron rich slag samples from chalcolithic Ahar (Rajasthan). Lahri[19] has noted recently iron objects and copper based objects with iron content between 2-66%. Which are contemporary with or belonging to the period immediately postdating the mature phase of the Indus Valley Civilisation (~1500 B.C.). Shahi's and Lahiri's evidences suggest that the technological base for the production of iron was present in some parts of India in the Chalcolithic period. One of the objects at Lothal with an iron content of 66.1% reported by Sahi seemed to be an iron object. Another Harappan site is Allahadino in Sindh where Fairserns[20] noted the presence of iron. At Ahar, the early presence of iron could be contemporary with the Harappan phase

In India, the people of Indus Valley Civilization did not know iron as no iron object has been found at Mohenjodaro and Harappa[21, 22]. Archaeological evidence is lacking for the next two thousands years, but iron is mentioned several times in the Atharva Veda[23] the later of the four Vedas, believed to be between 1200-1000 B.C. Thus, the knowledge of iron working must have reached the Indian peninsula not very long after the fall of Hittite Empire. Neogi[24] and Bannerjee[25] tried to trace the history of iron in India but mainly on the literary evidence. The key issue in the literary context is to determine the meaning of the Rig Vedic work Ayes, an issue over which there has never been a consensus of opinion. Neoga has mentioned that there was extensive use of iron for making weapons and other objects during Ramayana and Mahabharata periods. No doubt iron weapons and even an iron statue, have been profusely mentioned in the epics, however, archaeologically the periods of Ramayana and Mahabharata are still controversial. At the present stage of our knowledge it can only be said that iron was abundant in use during the Epic period.

It is also reported in the literature that the defeated Indian king Porus presented the Great King of Macedonia a steel cake weighting about 30 lbs to Alexander in 326 B.C[26, 27]. This shows the importance of the Indian steel had at that time. Looking upon the cultural heritage, left by our ancestors, the name of the great Iron Pillar at Delhi shines like a star among others. The Delhi pillar[28] belongs to the Gupta period (320 - 495 A.D.) This pillar was supposed to have been brought here, evidently from somewhere else by Tamar King Anand Pal[29]. Cunningham[30, 31] writing about this pillar, describes that "A wrought iron pillar weighing several tons could be forged as early as 4th Century A.D. and remains more or less rust free since then reminds us that how much skilled the smelters of those days were. The other masterpiece iron pillars are reported from Dhar[32] (Central India). Mount Abu[33, 34] (Rajasthan) and beams from Konark[35] (Orissa) these were erected in 10th -11th Centuries, and 13th Century A.D., and 14th Century A. D. respectively.

Iron Technology in Uttar Pradesh

More than 200 sites have been excavated in Uttar Pradesh. These are Hastinaapur[36, 37] (650-350 B.C.), Atranjikhera[38, 39] (PGW - 1025

±100 B.C.), Hulas[40], [41] (PGW), Allahapur[42] (400-300 B.C.), Soron[43] (600 B.C. -100 A.D.), Alamgirpur[44, 45] (PGW), Mathura[46] (600 B.C.), Sonkh[47] (PGW), Ahichchatra[48, 49] (GW), Jakhera[50, 51] (PGW), Kausambi[52-53] (PGW and NBPW, 800 - 600 B.C), Rajghat[54, 55] (Early phase of NBP, 600 B.C), Ayodhya[56] (Late phase of NBP), Hulaskhera[57] (NBP 200 B.C-500 A.D.), Sohagnura[58] (NBP), Jajamau[59] (NBP- 600 B.C.), Parahaladpur[60], [61] (Early NBP), Sravasti[62, 63] (Early NBP, 600 B.C. - 300 B.C.) , Sringverpura[64, 65] (late NBP), Koladihawa[66] (Early Iron Age), Khairadhih[67, 68] (300 B.C. - 400 A.D), Bhardwaj Ashram[69, 70] (Gupta Period) and Narhan[71] (600-200 B.C.)

The evidence of local smelting is suggested by the occurrences of slags at Hastinapur[72], slags and ores at Atranjikhera[73], slags and bloom at Jakhera[74], slags and crucibles fragment at Hulas[75], lumps of slags at Sonkh[76], slags unfinished forging tools, series of furnaces at Khairadih[77], crucibles along with slag at Koladihawa[78] and the available radio carbon dates[79-80] from some of the sites revealed that the iron using culture appeared in Uttar Pradesh around 1000 - 600 B.C.

Most of the metals used in antiquity preserve evidence of their thermal and mechanical history in their microstructure. It is now well recognised that metallography for interpreting the internal microstructure of ancient metal artefacts with metallurgical microscope, scanning and transmission electron microscope can be used for understanding the extractive metallurgy and the steps adopted in fabrication of these objects. In some laboratories of Europe and America, such studies have now become a common routine. In India too, some studies have been done, but not as much as is desirable. In the past, archaeometallurgists have done metallographic and chemical analysis of iron antiquities from the excavation of Kausambi[81], Rajghat[82], Atranjikhera[83], Allahapur[84], Jajamu[85], Hulaskhera[86, 87], Sooron[88], Bhardwaj Ashram[89, 90], Srivgverpura[91] and Kheradih in Uttar Pradesh in order to know, how the Iron Age developed in Uttar Pradesh Bhardwaj[92] made a chemical and metallographic study of six iron artefacts and slags from the early historic levels at Rajghat (near Varanasi, Uttar Pradesh). All the artefacts are datable to 600-400 B.C. They comprised arrowheads, nails, blade an unidentified artefact and a rod. Bhardwaj found that the majority of these artefacts had a carbon content varying from 0.12-0.42% C. One artefact (bent nail) however, revealed a carbon content of 1.1%. Metallographic examination revealed equi-axed ferrite with slag inclusions. Only one artefact revealed the presence of cementite structure. Pearlitic structure was not traceable in any artefact. On the basis of this observation, he concluded that all these artefacts were of wrought iron and the black smith of Rajghat knew the process of carburisation around 600-400 B.C.

Prakash and Singh[93] have reported studies on six artefacts consisting of five arrowheads and an iron piece from Kausambi site (395 B.C -500 A.D., Uttar Pradesh). The metallographic studies done by them indicated that these artefacts were having pearlitic structure (steel structure) and the carbon content of steel was nearly eutectoid. The carbon content varied from 0.08-0.74% and phosphorous from 0.04-4.3%. Presence of manganese and nickel was detected by spectrographic analysis in all the iron artefacts.

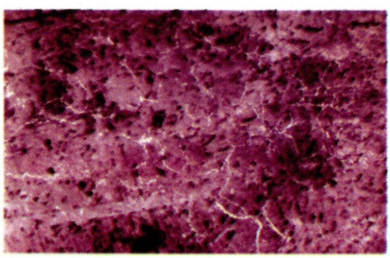


Figure.1. Photomicrograph showing pearlite with some streaks of ferrite in a residual metal in Celt from Attranjikhera, Etchant 2% Nital, 250 X (Medium carbon steel).

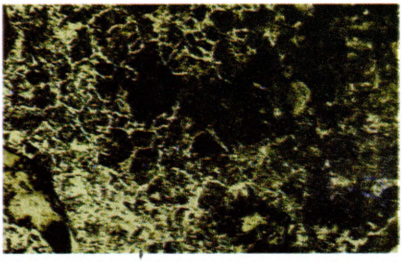


Figure.2.Photomicrograph of the section from arrowhead (Completely mineralized) showing traces of relic carbide at 250X, Etchant 2% Nital

Some examinations (Metallographic and analytical) were conducted in our laboratory on artefacts from Attranjikhera[94], Allahapur[95], Sooron [96], Jajamau [97], Hulaskhera[98, 99], Bhardwaj Ashram[100, 101], Sringverpura[102] and Khairadih to know how the iron technology developed in Uttar Pradesh. Earlier examination conducted on eight artefacts (1100 B.C. - 300 A.D. from Attranjikhera (District Etah) suggest including a celt, a chisel and two clamps that the extraction of wrought iron and smelting of iron ore with charcoal was known to the Atranjikhera smith around 1000 B.C., who later on developed their technology and were able to produce good quality steel (medium and high carbon steel) around 600 B.C.

Gaur[103] who excavated the Attaranjikhera site also writes that the main source of iron by the PGW people of Atranjikhera was most probably the region extending from south of Agra to Gwalior containing rocks in which iron content is quite high. Metallographic studies conducted on five completely mineralised artefacts (an arrowhead, a spearhead, a dagger, a knife and a nail (400-300 B.C.) from Allahapur[104], which is one of the early Iron Age sites situated near the village Surana, 103 kilometres west of Muradnagar in Uttar Pradesh indicated that they were fabricated from impure wrought iron and during the forging operations, some carbon particles were in advertently absorbed except in one case (Figure 2).

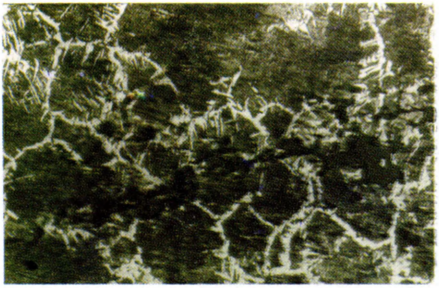
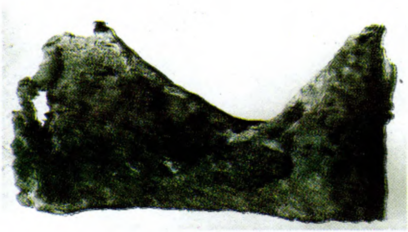


Figure.3. The residual metal in the section from an axe showing earlite with ferrite steaks (Hypo eutectoid steel), Etchant 2% Nital, 250X

The one exception was the nail, which was not having any traces of relic carbide. After imparting the desired shape, artefacts must have been allowed to cool in air. The studies indicate that the technology at that time was in a very preliminary stage.

Sooran[105] lies 25 km north east of Gwalior and is situated on a 15-meter high mound on the right bank of the Morar River. Atranjikhera is an early Iron Age site, which lies just about 25 km to its south. The studies conducted on artefacts (two axes, a knife, a weapon and spear) revealed that the art of smelting iron from its ores was quite familiar to this site during period 600 B.C. - 100 A.D. The art of making implements and weapons by getting carbon into wrought iron (cementation, Figure 3) has been achieved by these smiths but the technique of improving the mechanical properties of carburised wrought iron by heat treatment (quenching and tempering) and lamination technique was not known to them.

Figure.4. An Iron axe from Jajmau (600 -300 B.C.).



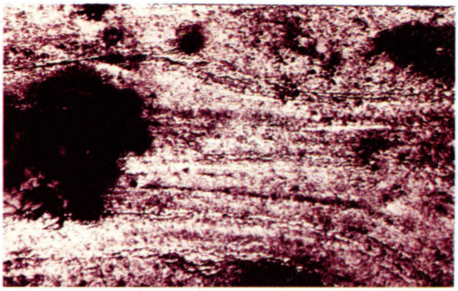
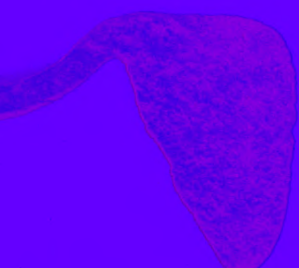


Figure.5. Photomicrograph showing laminated structure. Etchant 2% Nital, 250X.

Kanpur city and came to light while
nal High Way. The examination of
pearheads, nails, dagger blades and
aled that these smiths knew the
d heat treatment in 600 B.C. The
section from an axe indicated that
e axe was built up from two layers
f low carbon (Figure.4, 5) .The axe
cture was quenched, tempered and
investigations with other artefacts
that the lamination technique was
heat treatment was noticed only in



n Hulaskhera (200 B.C.-500 AD).

Jajamu[106, 107] sites is near the
digging for laying the Natio
iron artefacts (arrow heads,
sickles, 600-300 B.C.) reve
technique of lamination an
microstructure present in th
the metal used for forging th
of high carbon and another
in the final stages of manufa
allowed to cool in air. Our
from the same site indicated
widely used at this site, but
one axe.

Figure.6. An Iron chisel fro

Figure.7. Photomicrograph showing quenched and tempered structure, Etchant 2% Nital, and 250X

Raja Nala ka Tila[117] located between Latitude 83° 41" and 83° 19" E, Longitude 24° 42" and 24° 41" N, running just north of Son River extended in 50 acres over the adjoining areas of Mirjapur and Varanasi district. It is believed that once the capital of legendary king 'Nala' was settled here and later due to the havocs caused by the floods of the river Karmnasa migrated to Kashi. The site has revealed iron artefacts along with miscellaneous artefacts. The carbon dates of iron artefacts. Comprising socketed and tanged arrowheads, axe and chisels etc., from Raja Nala ka Tila have been placed between 1300-700 B.C. The preliminary examinations of artefacts indicated that they were made from low carburised wrought iron and detailed studies are under progress at National Research Laboratory for Conservation of Cultural Property, Lucknow. The detailed examinations may extend the period of iron technology in Uttar Pradesh beyond 1000 B.C. up to 1300 B.C.

Conservation and Authenticity

All the antiquities received from different institutions were conserved by following standard procedure of iron metal conservation. Determining the materials and techniques of metal objects may require not only stylistic and historical analysis, but also scientific analysis. There are many ways to categorize scientific analysis of objects. Objects can be characterized qualitatively and/or quantitatively by using destructive or non-destructive chemical or physical analysis of formation techniques or furnish materials (both organic and inorganic).Qualitative analysis reveals what materials (elements or compounds) are present. Quantitative analysis measures how much of the elements or compounds are present. The quantity can be measured numerically and the numbers can be organized into tables or graphs. Destructive analysis implies that a sample (removed from an object) is destroyed in the process of analysis, as oppose to non-destructive analysis, where the sample (either still on the object or even if removed from the object) is not destroyed but remains available for further testing. (Now these days non destructive analysis is done in metallographic and with portable XRF for detailed elemental analysis).The detailed study of scientific data obtained by doing metallographic examination along with stylistic and historical analysis gives clues about the authenticity of metal objects and any other artefacts from these sites with different metallographic structures may indicate the difference between the real and fake artefacts of that particular period.

Summary

Within the limits of our examinations of artefacts from Allahapur, Soron, Attranjikhera, Northern part of Uttar Pradesh indicates that iron technology was in preliminary stages at Attranjikhera and Allahapur in 1000 B.C. and 400-300 B.C. respectively but it developed around 600 B.C.-500 AD and smith was able to produce homogenous mild and medium carbon steel at Attranjikhera, Jajmau smith were quite advance even in 600 B.C., and were having good knowledge of lamination and heat treatment by this time. Hulaskhera smith developed their

iron and steel technology during 400 B.C. - 500 A.D. and attains the knowledge of lamination and heat treatment in 200 B.C. Present studies indicate that the Jajmau smith used heat treatment along with lamination around 600 B.C. And no other sites have shown this combination in any artefacts (Tools, implements, weapons etc.).

Blacksmith of Hulaskhera also deliberately added phosphorus for increasing the hardness of wrought iron and used this wrought iron metal with elevated phosphorus content in the fabrication of artefacts such as tools and weapons etc. Iron artefacts from Kausambi, Sringverpura, and Bhardwaj Ashram sites near Allahabad city revealed that iron technology was quite advanced at Kausambi right from 800 B.C. As they were able to produce low carbon, mild and medium carbon steel from wrought iron. Case carburisation technique was well known to these smiths around 600 B.C. and lamination process around 300 A.D. Sringverpura and Bhardwaj Ashram smiths in 250 B.C. knew lamination technique. Around 300-600 A.D. respectively. Khairadih smiths were having the knowledge of preparations of steel from wrought iron around 100 A.D.

The survey of the metallographic studies conducted on iron artefacts from Uttar Pradesh sites indicate that the Iron Age in Uttar Pradesh began around 1300 B.C. And later on around 600 B.C.-200 B.C. technological advances like lamination and heat treatment technology were made.

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14 Issues Related to Conservation of the Buried Underground Portion of the Delhi Iron Pillar

*R. Balasubramaniam**

Introduction

The Iron Pillar (Fig. 1) located in the courtyard of the Quwwat-ul-Islam Mosque, adjacent to the Qutub Minar in New Delhi, is famous for its exceptional resistance to atmospheric corrosion. All these monuments have been designated as world heritage site by UNESCO. The Delhi Iron Pillar has attracted the attention of metallurgists and corrosion scientists, eager to unravel the mysteries of the pillar. The pillar was built during the reign of Chandragupta II Vikramaditya (375-413 A.D.) and was originally installed in front of a Vishnu temple in Udayagiri in Central India. It was moved to its current location in Delhi in early 13th Century A.D. by Iltutmish. All historical, technical and scientific details related to the Iron Pillar can be found in references 1,2,3.

The pillar obtains its excellent atmospheric corrosion resistance due to the formation of a protective passive film on the surface. The excellent corrosion resistance is now well under stood on firm scientific grounds.

Figure 1.
The Delhi Iron Pillar Located at the Qutub Minar Complex in New Delhi

A detailed study of the Delhi Iron Pillar was undertaken in the 1950s and 1960s by the National Metallurgical Laboratory (NML), Jamshedpur in collaboration with the Archaeological Survey of India (ASI), during the period when Dr. B.B. Lal was the Chief Archaeological Chemist of the ASI. His studies on the pillar were significant because he was the first scientist to point out the deleterious effect of lead coating on the pillar in the buried underground on the pillar's soil corrosion and also provide concrete evidence that the Delhi iron pillar corroded like normal iron if subjected to immersed corrosion conditions[4]. The present communication will outline some issues related to conservation of the buried underground portion of the Delhi iron pillar, a topic that has not received serious attention of scholarsand conservators alike because "what is out of sight is usually out of mind."

Figure 2.

Excavation of Buried Underground Region

During the studies undertaken in 1950s and 1960s, it was realized that the iron in the region where the stone platform meets the ground was in a more severely corroded condition (Fig. 2). It was therefore decided to excavate the underground regions of the pillar in order to understand the state of iron in these regions and to undertake conservation activities, if required. The first detailed study of the underground region of the pillar was performed in 1961.

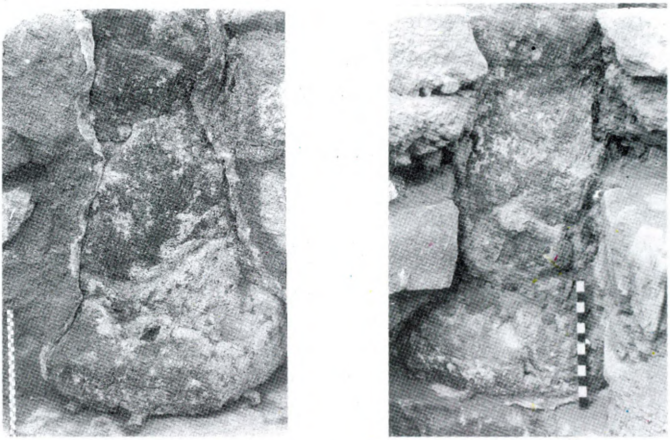

Figure 3: (a) and (b) Two Views of the Underground Portion of the Pillar below the Ground Level, before any Conservation Process was initiated.

Examination of the buried underground region revealed that a lead sheet of about 3 mm in thickness was wrapped around the bulbous end and to a height of 80 cm. This lead sheet was excellently preserved and possessed a superficial white layer (Fig. 3). This lead coating is also clearly noticed around the pillar's circumference in the region where the iron pillar protrudes out of the stone platform (arrowed in Fig. 2). This lead coating was provided around the pillar base in 1871 by Beglar, an assistant of the noted archaeologist and the founder of the Archaeological Survey of India, Alexander Cunningham. Beglar also laid the stone platform around the pillar's base.

Corrosion in the Buried Underground Region

When the lead coating was removed, significant corrosion (rusting) of the underlying iron was noticed (Fig. 3). The rust thickness ranged from a few millimeters to as much as 15 mm. Moreover, the base of the pillar (which was bulbous in shape) possessed several cavities and hollow holes caused by pitting corrosion. In fact, water poured into some of these cavities drained out at the bottom of the pillar[6], indicating the relatively deep nature of these corrosion pits. This was due to prolonged galvanic corrosion caused by contact of the lead coating and the iron base beneath. The pillar served as the sacrificial anode with the metallic lead sheet acting as the cathode. This resulted in the survival of the lead sheet while there was marked corrosion of the underlying iron metal[7]. Simulation experiments conducted at Indian Institute of Technology, Kanpur with lead coated mild steel in soil environments[8] have clearly established the deleterious nature of the lead coating as corrosion is intense in areas where coating defects exist. The soil samples in the nearby vicinity were found loaded with soluble sulfates and chlorides.

Figure 4(a) and (b)
Two Views of the Underground Portion of the Iron Pillar below the Ground Level, after the Rust Accretions on the surface were Removed.

The first cause of enhanced corrosion of metal at this location is due to the contact of the metal with moisture-containing soil. The residence time of moisture on the pillar surface in the buried underground region would be much more than the exposed portion

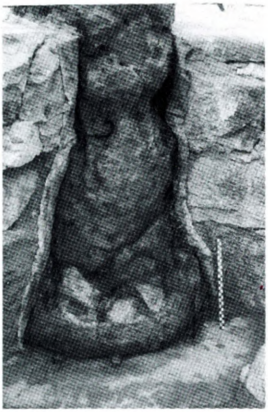

Figure 5 (a) and (b) Two Views of the Underground Portion of the Pillar below the Ground Level, after Conservation of the Surface.

of the pillar, because of the soil environment. Additionally, the presence of suphates and chlorides in the soil would lower soil resistivity, allowing for enhanced corrosion. The deleterious effect of chloride ions in accelerating corrosion of iron is, of course, well known and the dissolved chlorides will also aggravate coggravate corrosion attack.

In this regard, the role of the salt film (i.e. metal chloride) in stabilizing the localized corrosion front needs to be understood. The points discussed in this paragraph were brought to the notice of the author by a renowned corrosion engineer, Narasi Sridhar[9]. In localized corrosion process, chloride ions migrate into the pit region to balance the positive charges created by the iron dissolution and hydrolysis. Eventually, chloride concentration reaches a high value and ferrous chloride precipitates as a salt film. As the ferrous chloride is conductive and non-protective, unlike the oxide, it permits continued localized corrosion. Therefore, the process of localized corrosion is autocatalytic in nature. Localized corrosion stops only when the potential is decreased such that the flux of ferrous ion decreases and ferrous chloride can not be sustained any more.

Previous examination of pits in meteoritic iron revealed enhanced chloride content in pit (up to 5 weight percent), but not ferrous chloride[9]. The interesting fact about corrosion of meteoritic iron objects is that the meteorites contain significant amounts of phosphorus (up to 0.8 percent) and one of the most stable phases is iron phosphate. The phosphorus does not lend additional corrosion resistance to meteoric iron in buried soil. This indicates that there may be some similarities with corrosion of the Delhi iron pillar in the soil environments, because the iron pillar contains a significant amount of phosphorus. However, the examinations on meteoric irons were performed by bringing the samples from Antarctica to the laboratories in Europe, then cutting sections, and performing metallography, microprobe and X-ray analysis. Therefore, the iron chloride salt film could also have re-dissolved during these laboratory treatments, leaving behind remnants of chloride. *In-situ* analysis using Raman Spectroscopy may shed some light on this important issue. Of course, logistical challenges may have to be overcome to perform Raman Spectroscopy *in-situ.* However, if the samples, after digging them up, are preserved adequately (for example, kept in the freezer in a refrigerator) and they are examined, it will provide valuable clues to the role of chlorides in causing pitting of the Delhi iron pillar in the buried underground regions.

Conservation of the Buried Underground Region

It is therefore clear, based on the discussions above, that the pillar is subject to severe corrosion in the buried underground regions. Lal understood that the corroded buried portion of the pillar required conservation measures. The preliminary treatment of the pillar was provided after the base had been exposed to view by digging of the earth. This treatment consisted of elimination of the rust scale, earthy accretions and water-soluble salts (Fig. 4). Rust prevention treatments then followed and this consisted of consolidation of the holes, cracks and cavities. The pillar was then subjected to chemical cleaning for elimination of superficial accretions of sandy and clayey matter, greasy incrustations, corrosion residues and rust stains. Finally, this was followed by a rust prevention treatment. Lal, however, does not mention the actual rust prevention treatment used by him[4]. The condition of the pillar after these treatments is shown in Fig. 5.

When the pillar was again to be set up in the masonry, there was suggestion to use a new lead coating. As the deleterious effect of lead coating on the corrosion of the pillar in the underground region was well established, Lal suggested that if a zinc sheet be used to cover the bottom surface. Zinc would sacrificially corrode, thereby preventing corrosion of iron. With this view, he pleaded to use a zinc sheet in place of the lead sheet when the pillar was again to be reinstalled in the masonry pedestal. However, he could not convince the structural conservators and archaeological engineers who found the lead sheet handy for protecting the pillar from direct contact with mortar and the saline soil. Therefore, the base of the pillar, after conservation, was covered with a new lead sheet and installed in the masonry basement (Fig. 6). Lal painfully states that this was much against his wishes. The sad tale is that the advice of well-meaning scientists is not taken into account during decision-making processes in India is aptly reflected in this experience of Lal. Lal, therefore, requested that, in the future, if the pillar bottom is set in a new masonry basement, the lead coating should be replaced with a zinc coating. Therefore, it is imperative that the lead coating can be removed and replaced with another suitable corrosion protection scheme.

On the question of providing a suitable protective scheme for the pillar in the buried underground regions, several possibilities exist. Profecting the surface with a zinc coating, as suggested by Lal, may not be appropriate in the chloride-laden environment of the soil surrounding the pillar. Zinc will corrode at an extremely fast rate under these conditions and the sacrificial coating may have to be replaced at frequent intervals. The second possibility is coating with a polymer-based coating, like epoxy. This scheme is used for protecting buried iron pipelines. However, the degradation of the polymeric coating with time is of concern and therefore, this coating scheme will also call for periodic maintenance of the coating due to the limited life span of epoxy coatings. In this regard, provision of connecting the pillar bottom with a sacrificial anode can also be thought as a suitable measure. This is quite attractive because it need not be in direct contact with the bottom region of the pillar. It only needs to be electrically connected to the underground region. The sacrificial anode can be located such that it can be periodically inspected and replaced when consumed. Of course, it is important to ensure correct replacement of the anode and establish a maintenance schedule. The major drawback with this method will be that the material in the exposed portion of the pillar will also be protected against corrosion and therefore, people may attribute the excellent atmospheric corrosion to this sacrificial anodic protection. Therefore, the long term protection of the underground portion of the Delhi iron pillar calls for a serious debate among corrosion engineers and conservation specialists.

However, there are some immediate measures that can be taken to ensure that the buried region of the pillar does not suffer enhanced damage. As it is known that moisture is important for corrosion to take place, immediate steps can be taken to minimize water seepage into the soil, in the vicinity of the base of the pillar. By water is meant rainwater. The first step would be to provide a slope (gradient) to the stone platform such that water will flow away from the base. The second step that can be immediately implemented is in providing water resistant coatings on the surface of the stone platform and also on the courtyard in the near vicinity of the stone platform. This will ensure that water does not seep into the soil in the near vicinity of the base of the pillar. Of course, it would not be possible to completely eliminate moisture from the soil altogether, but, at least, the severity of corrosion in the buried underground region will be significantly reduced, if these immediate steps are taken.

The conservation of the pillar in the buried underground regions needs to be taken up urgently, after detailed discussions between archaeologists, conservators and corrosion experts.

Figure 6 (a) and (b) Two Views of the Underground Portion of the Pillar before the bottom region were again buried in the ground.

Conclusions

Optimum conditions exist for corrosion of the Delhi iron pillar in the buried underground region. The soil corrosion of the Delhi iron pillar is aggravated due to galvanic corrosion action in the presence of the lead sheet, which is currently surrounding the pillar in the buried underground region. Although scientific investigations have "shorn the Delhi iron pillar of the element of mystery and imagination", the conservation of the pillar in the buried region has not been addressed in a serious manner. The lead coating in the buried underground region has to be replaced with a suitable protection scheme after detailed consultation among experienced archaeological conservators and learned scientists. Some protection schemes have been suggested. Two immediate steps that can be readily implement are creating a slope on the stone platform such that rainwater flows away from the base of the pillar and provision of water resistant coatings on the stone platform as well as the courtyard in the vicinity of the stone platform.

Acknowledgement

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15 South Indian Bronzes and Coins and Their Authentication

V. Jeyaraj*

Introduction

The bronze images of South India have been the finest artistic treasures among all the metallurgical accomplishments of South India cherished by national, international and private antiquarians around the world. The South Indian bronzes are not only famous for their aesthetic beauty, iconometry and iconography and casting quality of high order but also are examples of the fusion technology with cultural traditions and are found in practically all the best museums in the world. The best pieces are always under threat and it is necessary to authenticate and protect these treasures for posterity. This involves the knowledge of their fabrication, composition and the metallurgical failures of the bronze icons. Iconographical, physical and chemical methods of authentications are dealt with in this paper.

History of Bronze Technology in South India

In the Near East, bronze technology seems to have preceded iron in human civilisation and had emerged as early as 3000 B.C. There are historical records of the prevalence of bronze casting technology in India even before 2500 B.C. This is evidenced from the excavated bronze image of the *dancing girl* from Mohan-jo-daro, which is currently preserved in the National Museum, New Delhi and the '*man-like*' figure found at the confluence of Ganges and Jamuna in North India, which has been dated to be about 100 B.C. Bronze technology in Tamil

Nadu dates back to 7th Century B.C. evidenced from the bronze objects especially the Mother Goddess obtained from excavations at Adichanallur, Tirunelveli district, Tamil Nadu; these objects are today preserved in the Government Museum, Chennai. The excavation by the Department of Epigraphy of Tamil University, Thanjavur at Kodumanal, Erode district, Tamil Nadu, has brought to light a *semi-precious stone-studded 'tiger'* bronze image belonging to circa 200 B.C.

Even though the bronze icon making was in vogue during the Pallava period (close of 3rd to 9th Century A.D.), the Pallavas have left too few of their icons to enable one to evaluate the full potential of the technological achievements prevalent in those periods. In spite of the existence of the bronze technology of the Pandyas (2nd Century B.C. to 17th Century A.D.), the remains of bronze icons of that period are not many. During the reign of the Cholas (9th to 13th Century A.D.), high quality bronze icons have been manufactured. Later, Vijayanagar kings encouraged the art of bronze icon making in the 15th and 16th Centuries A.D.

The bronze icons in the Government Museum, Chennai, acquired through the Treasure-trove Act of India 1878, are mainly from Thanjavur, Trichy, Pudukkottai etc., districts of Tamil Nadu. Scientific examinations of these objects have revealed that traditional casting was the techniques in vogue. Bronze icon-casting technology by the traditional method is practiced even to day at Swamimalai in Thanjavur district and also in few other places in Tamil Nadu.

Bronze is an alloy of copper (75-80%) and tin (25-20%). Ancient bronze icons are generally considered to be made out of *Panchaloha* connoting a *five-metal alloy* usually a composte alloy of metals - copper, tin, lead, silver and gold in varying proportions. But, analysis of South Indian bronzes reveals that they invariably consist of copper, tin, lead, zinc and iron. Trace quantities of arsenic, antimony, bismuth are also detected in a few of them.

Methods of Bronze-casting

Basically the two popular methods of bronze casting practiced in India are:

1. Solid casting (*cire-perdue* meaning *lost wax* process) and
2. Hollow casting.

There are methods like piece-mould casting, core metal solid casting etc., were available in the ancient South India.

Solid Casting

The solid casting process is otherwise called *cire-perdue*, a French term meaning *'lost wax'* process. The basic principle of the solid casting is that the image is first fashioned out of wax; then over it are laid in succession sufficiently thick, uniform layers of fine-grained clay (*'puthumann'*) followed by coarse sand with clay. The mould thus prepared is allowed to dry under shade, and then heated to about 80°C to let out the molten wax through opening in the clay layer. Finally molten bronze melt is poured into the hollow space thus created in the clay mould kept buried in the soil, taking care to fill every crevice and corner in the mould cast. The mould is allowed to cool and the clay layer is broken to bring out the cast bronze icon. This is then given the

finishing touches by the artisan with chisel and hammer to bring out the finer details of the image. The icon is then given a final polish with fine sea-shore sand. By this method, it is possible to cast only one icon at a time. The laborious mould preparation should be repeated for every individual casting of the icon. The famed bronze masterpieces from Tamil Nadu are solid cast pieces.

The cracked Chola period lamps because of advanced corrosion have revealed that iron rods are found in Chola Period Nataraj with the mould the centre as core. This reveals the fact that solid casting keeping iron rod as a core metal for strength made these lamps. This type of casting may be termed as core metal solid casting.

Hollow Casting

Since this type of casting of icon posses an inner core of clay, it is called hollow casting. They will be comparatively light in weight. In this process, a slightly smaller sized image is made out of clay. Thread like wax is extruded on to the clay mould and wrapped around it. The wrapped wax thread is flattened out evenly to the contours of the image. Finally the clay model is covered uniformly and completely with a thin layer of wax. Then the intricate details are worked out on the final wax layer. After the wax figure is fashioned to the required form and size, fine clay is applied over it. During the working of the clay mould, holes and inter connections (runners) are suitably provided to facilitate easy flow of the molten alloy in the hollow space around the inner clay

Hollow Cast Bronze

core and the escape of hot gases during the *pour process.* The mould is cooled, and broken up carefully to reveal the image. To get the artistic beauty the artisans effect details required for the image, finishing touches like chiseling, filing, polishing, etc. By this method also only one piece can be made from a mould. The technique of making a large sized bronze statue is to cast the image in pieces and assemble the separately cast fragments together by welding in the final stage. Several books on ancient technology on metallurgy detail this art. Work on the 10 feet bronze statue of Duplex of the 18th Century A.D. at Pondicherry is a classical example of the *piece mould hollow casting.*

Faking

Fakes are genuine works, which have been altered in character or added to, for the purpose of enhancing the value. Forgeries are copies of works of art or craft made for fraudulent purposes. Reproductions are copies made for honest purposes, which may subsequently be used by others for dishonest purposes, which may subsequently be used by others for dishonest reasons. Replicas are contemporary reproductions. Faking of art objects has increased in the last decade in India. There were famous forgeries like the Piltdown forgery during the current century, which rocked the art and archaeological world. Since then, many instances have come to light and are well known all over the world and India is no exception. On recent days, we have come across the faking and forgeries in respect of bronzes, coins, paintings, ivories and even stone objects. Scientific study has become more imperative in the field of art objects. Anyhow, scientific study takes more time for which the objects have to be subjected to detailed technical study.

Reproducing the masterpieces was an accepted fact and was widely practised for centuries by student artists to polish up their techniques in Europe. In India also it was the same. Lately a large number of instances have come to light where these simple craftsmen were being exploited by the people in the art trade to produce fakes and forgeries almost in all types of art works. The art works of recent origin were very cleverly camouflaged to look old and vice versa, which gave smuggling of art works a great boost and the illicit trade is rampant today.

Faker and Scientist

However clever the faker or the forger; however skilful in going into details for producing an art piece that would conform to its conferred antiquity, the fact remains that in some material detail, he slips up and his deception stands uncovered on thorough investigation. The criteria for recognition of authentic objects are fairly well established. Detection of forgery depends on the evidence of presence of discrepancy, if any, in the artefact. If the object so doubted is subjected to intensive scientific analysis for precise identification of the materials and techniques employed in it. The data so obtained has to be compared to the data bank already compiled on the type of objects in question and thus the possible presence of forger's hand emerges.

Authentication of Artefacts

There are various iconographycal, physical, chemical and instrumental methods of authentication. They are detailed below:

Iconography

There are many well-established methods of authentication. They are iconographic features in the case of sculptures, bronze icons etc. The style is another criteria for authentication of the artefacts.

At present the usual practice of authentication of objects, which are purchased for museums and galleries are based on stylistic, artistic considerations, which is described by the members of the Art Purchase Committee who are mostly Museum / Gallery Directors or Curators. It is not definite whether the objects purchased or objects returned from outside exhibitions are the originals or the faked ones.

Dimensions

Accurate dimensions of the bronzes such as height, breadth, thickness, weight are essential to authenticate the objects. Dimensions are a must when the objects are documented. But most of the museums do the documentation but the weight is not recorded. It is always a must that the weight also should be recorded for the authentication of the bronzes.

Photography

Finger printing of art objects and antiquities of all materials could be done if some documentation technique could be used such as precision macro-photography, Infrared Photography, Radiography. Now-a-days digital photography is of much use in documentation. The photographs should be numbered and suitably labelled.

Method of Making

The technique employed is yet another criteria. Materials used are also one of the criteria as the materials are characteristic of the provenance and date. Methods of fabrication differ from region to region and period to period. The composition varies from image to image. These characteristics can be utilised in the authentication of the bronzes.

Analytical Methods

Analysis of elements through classical as well as sophisticated instrumental methods will reveal the composition of the bronze icons. These records should be kept as secret. Other wise the culprits will use these data and faked objects will be produced in plenty.

Degradation Products

From the type of degradation also one can understand the type of the object and its authenticity. For example, the green patina is an authentic mark for ancient bronze icons. The colour of the bronzes is depending upon the corrosion products. If the corrosion product is copper oxide, the colour will be brown. If the corrosion product is basic copper carbonate, the colour will be bluish green. If the corrosion product is cuprous chloride, the colour will be pale-green and powdery. Always the brown copper oxide layer is the first layer. Then forms the basic copper carbonate, a bluish green corrosion layer, which is a transparent uni-molecular layer. This adds the aesthetic beauty of the bronze. The bronze disease erupts from the metallic surface and degrades the bronze. Fakers createae and artificial patina by coating with ammonium chloride, which destroys the bronze in due coarse. New bronzes are artificially aged to look like old. These should never be encouraged.

Metallography

Metallography is yet another boon, which characterises the internal structure of metallic objects. In case non-destructive testing should be done, then in-situ metallographic can be successfully carried out. The surface where the metallographic studies have to be done is polished by a hand polisher or by chemical etching and the microstructure is photographed. The microstructure is different for different bronze icons. The specific locality where the metallography was carried out should be recorded for authentication of the object.

X-radiography

The methods of authentication are subjective and aesthetic and objective and scientific. Radiology is one of the fundamental non-destructive methods of investigation and examination of works of art such as paintings, paper materials, wooden objects, ceramics, metal objects, etc. It has been used in the past and is used in the present in the detection of forgeries of the original works. When X-rays are allowed to fall on an X-ray film through the object to be examined, a shadow - graph is formed on film depending upon the structure the object. The latent image is developed, like photographic film to obtain the image of the inner structure of the object called radiograph. The radiography of bronze icons, coins, weapons etc., will give a radiograph showing the voids and discrepancies inside the metallographic structure. This information is used to conserve and to identify the paintings. Radiography could help in characterisation of these art works in order to finger print them for legal purposes.

Bronze Image and its Radiograph

Holography

Holography is a process of three-dimensional record of an art object. The hologram of an idol is taken with He-Ne laser beam. The hologram can be used as a convenient medium for displaying rare objects on exhibitions while the originals are kept under safe custody. Secondly, the hologram will be of use to authenticate the objects. Fringe spacing is made in the bronze icons of rarity, which characterises the object by forming contour lines, which are specific to each item. No two bronzes will have similar fringe pattern.

Other Physical Properties

The emf of the metal varies from metal to metal and the alloy has the emf of its own. The emf measurements can be made and recorded. This also adds to the authenticity of bronze icons. These values should be recorded for later reference.

Authentication of Coins

Copper coins before and after radiography. The radiograph shows the crack developed in one of the coins.

A Chola Coin before and after Radiography

Coins are the primary sources in reconstructing the history of the region in which the coins were issued. Different types of coins are available in museums, cultural institutions, with private collectors etc. Since many have started collecting coins as fashion, many have resorted into faking of coin too. In order to collect original coins and also to authenticate the original coins, one should be aware of certain scientific factors which will be of help to the person who is interested. Radiograph is shown here which indicates the authentication mark in one of the coins.

Conclusion

There are many examples of idol lifting in our country especially in Tamilnadu. The Hindu temples have always been repository of our great tradition and store houses of the cultural heritage of our people, continue to be under threat more than from criminals in our own society who are not ashamed to sell their heritage to foreigners than from any barbaric vandal. The thieves from inside are more dangerous than those from outside because they operate unnoticed posing like any other religious Hindu. We have to protect atleast what ever has been spared until now lest one should have to undertake foreign trips to destinations in America and Europe to find India, to understand our past and to know our own address.

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16 Revisiting an Exercise on Authentication of South Indian Metal Icons from Asian and Global Perspectives

*Sharada Srinivasan**

Introduction

South Indian metal icons are amongst the prized of Indian artistic creations, best represented by the famed 10th century Chola Nataraja icon, of the Hindu god Siva as cosmic dancer, which has drawn diverse responses from renowned sculptor Auguste Rodin (1921) to popular science writer Fritjof Capra (1976:258). Metal icons of Hindu deities were made in early medieval Tamil Nadu in southern India for being carried out in processional worship amongst devotees after being elaborately decorated. The worship of Siva was propagated by Tamil Saivite saints of the 6th-9th century, while Siva Nataraja was the family deity of the Cholas. A famous bronze Devi image in Freer Gallery of Art, USA is argued by Vidya Dehejia to represent the portrait of Chola queen Sembiyan Mahadevi (c. 940 AD), a great patron of Chola bronzes and temples. Under the 10th-11th centuries Chola rulers, technology came to the aid of religion with the prolific casting of Hindu metal icons. Several thousands of fine solid bronze images were cast by the lost wax process by skilled *sthapathis* or traditional icon makers, as still seen in Swamimalai.

There are problems in making attributions for these metal icons on stylistic grounds alone, with a few being inscribed and most recovered from buried hoards rather than excavated contexts, while continuing conventions of image casting over centuries into the present day have complicated the task of telling apart later from earlier images. Scores of icons and ritual metalware are stored poorly, if at all, documented or photographed in Indian temples and collections. It is thus relevant to look for objective scientific criteria or 'finger-prints' to provide tracer methods to assist 'dating', provenancing, stylistic authentication and conservation. The lost wax casting of metal icons is one of several surviving metal craft traditions in south India and the Indian sub-continent, with numerous fascinating aspects related to the technical accomplishments, ritual, historic and artistic dimensions and social organisation of such crafts.

From a study of the metal technology of South Indian '*pancha-loha*' metal icons, using finger-printing techniques such as lead isotope analysis and compositional and trace element analysis on well known representative images in collections such as Government Museum, Chennai, Victoria and Albert Museum, London and British Museum, London new insights were obtained into the problems of their chronology and provenance. Although the very existence of Pallava bronzes has sometimes been debated, the technical evidence helps in identifying Pallava bronzes and also suggests that the celebrated Nataraja icon, which has been regarded as a Chola artistic innovation, may have already been in vogue by the Pallava period. Sources of metal different from the earlier periods seem to have been used in the Vijayanagara/ Early Nayaka period, to which none of the sampled Nataraja images could be attributed. The study also seems to throw up supportive evidence for early historic images from South India, arguably including the *Sangam* era, and for identifying Nagapattinam-style South Indian Buddhist images. Taking the lead isotope investigations together with preliminary investigations on slags and ores from South India, there is also more preliminary supportive evidence than previously realised from exploring historical or epigraphical sources alone, for some local exploitation of metal sources including tin and zinc. Thus the study demonstrates how archaeometallurgy, as a branch of archaeology, can help to shed light on the historical record.

Some Global and Asian Perspectives on Authenticating Art and Bronze Statuary

The scientific authentication of art and antiquities is still a growing field wherein there have been some advances, however it is still a field which requires sustained support to realise its full potential. One of the pioneers in the field of scientific research in art and metal artefacts in terms of seeking out scientific information at large about an artefact in the manner of a forensic or diagnostic exercise which could throw light on problems of authenticity and conservation was Dr. Nigel Seeley, Head of Conservation, National Trust, UK (Barker 2004). According to Seeley, 'seeking out information from incomplete evidence applied to works of art just as it did to forensic science and precisely the same analytical techniques applied'. Notably, in 1972, Nigel Seeley planned the forensic tests that exposed Frederic Prokosch's forged first editions of modern authors which was collaboration between the Scotland Yard and the British Library. The Video Spectral Comparator (VSC), using the combination of ultra-violet and infra-red light was used to reveal obliterated or erased writing, which is a useful example of forensic science applied to cultural heritage.

Bronze statuary in antiquity were usually made of the lost wax casting process whereby a wax model is made of the statue to be cast, then covered with several layers of mould material to make a mould usually of clay in the past, and then the mould is heated to get rid of the wax and molten metal is poured into the mould. As observed by the author in 1991, a very accurate wax model replica of the famous 11th century Chola Vishabhavahana sculpture was being made at Swamimalai in Thanjavur district. As such there are two methods of lost wax casting, the solid lost wax casting process and the hollow lost wax casting process. In the latter process, the model is not made of a solid piece of wax, but a clay core is first made, sometimes with an iron armature, over which the wax model is made. This ensures that a thinner layer of metal and less weight of metal is required for the actual statue while the clay core is retained within.

For hollow cast statues, there can be more options for scientific authentication if some part of the clay core is exposed in a damaged part of the icon, which it very often is. Sometimes if charcoal residues from charred organic matter are present in the core, then C14 dating can be attempted. This could happen if material like jute husk has been used in the manufacture of the clay core. Thermoluminescence or TL dating of the clay core is an option for dating and authentication whereby the refractory material is dated from the time of firing. The thermoluminescence technique is the only physical means of determining the absolute age of pottery presently available. Most mineral materials, including the constituents of pottery, have the property of thermoluminescence (TL), where part of the energy from radioactive decay in and around the mineral is stored (in the form of trapped electrons) and later released as light upon strong heating. By calibrating this against the output with that produced by known doses of radiation, the amount of radiation absorbed by the material may be found and hence the age determined.

Though not as accurate as C^{14} dating, TL dating can be attempted to authenticate ceramics and broadly tell apart fakes from genuine antiques.

Even so, TL dating is more successful on fine refractories such as terracotta and Chinese porcelain rather coarse clay cores, as found in statuary, which tend to get contaminated. Attempts have been made to authenticate 'Chandraketadurgh' terracotta of the early historic period related to this site in Bengal by TL dating. Petrographic analysis has been used on the clay cores of hollow cast Southeast Asian bronzes to authenticate and stylistically characterize them. A study by Reedy (1997: 266-7) found that the mineral clinopyroxene is found in the core of hollow cast Khmer bronze statues from Cambodia rather than ones from Thailand. Newman (1997: 261-5) has undertaken petrographic analysis on the stone itself from some specimens of stone sculpture from Thailand which helped to characterize the detrital grains in specimens ranging from sandstone to calcitic quartoz wacke.

There are problems in authenticating and dating South Indian metal icons. Few Hindu images are inscribed, apart from some inscribed Buddhist and Jain icons. These are mostly solid cast images with no clay core which may be dated using C^{14} or TL dating etc. Most recovered from hoards buried later or temple collections rather than excavations. Continuing traditions of bronze casting compound dating and authenticating and the problems of pilferage of icons raise issues of forensic finger-printing. Such problems of authenticating due to continuing traditions are also found with the Benin bronzes of West Africa, where knock-offs and forgeries are a thriving industry (Nevadomsky 1997).

As far as authenticating of solid metal artefacts or icons for stylistic classification is concerned certain totally non-invasive techniques can be used but many have limited applications. Radiography is at best like a more sophisticated photographic record and is a cumbersome technique. X-ray fluorescence is a surface analytical technique and is not representative of bulk or interior composition and as a result the composition of tin measured in artefacts is often lower than the actual amount present in the bulk. Although Neutron Activation Analysis (NAA) can be used for non-destructive, it is more effective for ceramics and pottery. PIXE (proton induced x-ray emission) analysis and NAA have been used more effectively on small artefacts like gold and silver coins than on large corroded bronzes.

A technique that proved probably the most useful in characterizing and authenticating bronzes has been to undertake bulk chemical composition analysis on micro-drillings taken from the bronze, using spectro-chemical analytical techniques such as inductively coupled plasma atomic emission spectroscopy for major, minor and trace elements, and then used in combination with the finger-printing technique of lead isotope analysis. This technique has been successfully used in Jett and Douglas' (1992) study on Chinese bronzes and well as in the author, Sharada Srinivasan's (1996) doctoral research on South Indian metal icons.

The usefulness of technical studies in art historical discourse on bronzes can stem from the fact that metal artefacts may be grouped on the basis of chemical similarities resulting from shared sources of metal or metal processing and alloying which can be a useful diagnostic tool in the typological classification of the artefacts. Elemental composition analysis has frequently been used in archaeometallurgical literature to attempt to group together artefacts based on empirically observed similarities. For example, Reedy (1986) put together data from elemental and clay core analysis and art historical factors using statistical procedures to explore problems of provenance of Himalayan statuary bronzes. Numerous scientific studies have been undertaken on Chinese mirrors and other artefacts such as, by Chase and Franklin (1979). W.T. Chase (1979 a, b) of Freer Gallery of Art, Smithsonian Institution in particular developed useful techniques for the microscopic and metallographic examination and authentication of artefacts.

Compared to elemental analysis, lead isotope ratio analysis is a more powerful finger-printing technique since isotopic composition, unlike elemental composition, is not affected by chemical processes so that it is unchanged from ore source to processed metal. Furthermore lead is the only metal for which isotopic composition is unique and characteristic of different ore deposits due to geological factors (Gale and Stos-Gale 1982); so that the lead isotope ratios of artefacts with lead from the same source will tend to cluster together providing a finger-print for that group. Since south indian bronzes are of solid metal, there is no absolute method of dating them. However, by calibrating the metallurgical profile of different groups of bronzes a method of relative dating and stylistic authentication can be attempted, as done in Sharada Srinivasan's doctoral thesis from Institute of Archaeology, London (1996) which remains the most successful study to date to finger-print and stylistically authenticate south Indian bronzes and the most extensive application to date of lead isotope finger-printing in south Asian art or archaeology. Lead isotope investigations by Jett and Douglas (1992) proved useful in telling certain stylistic groups of Chinese Buddhist images, for example, Eastern Wei images could be distinguished thus from Northern Wei images.

As part of the afore finger-printing exercise on Chola and South Indian bronzes by Dr. Srinivasan, the sampling procedure used was of micro-drilling by using a drill bit of no more than 1mm thick in inconspicuous parts of the icon to retreive about 20-50 mg of sample and going to a depth of 1 cm from the main body of the icon, e.g. the armpit. The advantage of this technique had over the previous techniques is that it aided the analysis of bulk or interior composition while ensuring that sampling was undertaken with minimum damage to the artefact and the procedure was undertaken successfully even on very delicate artefacts in reputed collections including Victoria and Albert Museum (50), Government Museum, Chennai (70) and British Museum (10). Thereafter bulk compositional analysis was done using ICP-OES, i.e. inductively coupled plasma atomic emission spectroscopy with drilling in solution for analysis. Major, minor and trace elements were analysed for 18 elements of Cu, Zn, Pb, Sn, Fe, Ni, As, Sb, Bi, Co, P, S, Cr, Mn, V, Cd, Ag and Au. Lead isotope analysis was undertaken on about 60 analysed images.

ICP-OES and Lead Isotope Investigations on South Indian Bronzes

Archaeometallurgical investigations were undertaken on South Indian metal icons by the author with a view to mapping their art history and exploring sources of metal. Elemental analysis was undertaken using inductively coupled plasma optical emission spectroscopy (ICP-OES) on samples from 130 south indian images, overwhelmingly from the Tamil region, from the collections of Government Museum, Chennai, Victoria and Albert Museum, and British Museum, London for eighteen elements using facilities at Royal Holloway and Bedford New College, Egham. The full compositional analysis is reported in the author's doctoral thesis (Srinivasan 1996). Lead isotope ratio analysis was done on 60 selected images and miscellaneous artefacts using thermal ionisation mass spectroscopy facilities at Oxford Research Laboratory for Art and Archaeology, Oxford which is the most extensive application of lead isotope ratio archaeometry to South Asian artefacts to date.

The variations of the major elements of copper, tin, zinc and lead were found to be somewhat random, these being intentionally alloyed. However, significant patterns relating to dynastic chronology could be detected for about half of the analysed collection (which was better dated by art historical consensus) in the trace elements concentrations of arsenic (As), bismuth (Bi), nickel (Ni), cobalt (Co) and antimony (Sb) due to their being intrinsic to the metal smelted from the ore source. The lead isotope ratio plots such as of Pb 208/206 vs Pb 207/206 and Pb 206/204 vs Pb 207/206, also indicated certain discrete trends for different artefacts grouped by dynastic chronology, which for the most part complemented the trace element patterns. This can be explained if specific sources of metal were widely used at different periods. Thus the images including those of uncertain attribution, were re-assessed in the light of their lead isotope ratios and/or trace element composition (for As, Bi, Sb, Co, Ni) and resolved into the following stylistic groups as: Pre-Pallava, Early Pallava and Andhra group (*c.* 200-600 AD), Middle Pallava (*c.* 600-850 AD) and Later Pallava (*c.* 850-875 AD), Early and High Vijayalaya Chola period (*c.* 850-1070 AD), Early Chalukya-Chola (*c.* 1070-1125 AD), Later Chalukya-Chola (*c.* 1125-1279 AD), Later Pandya (*c.* 1279-1336 AD), Vijayanagara and Early Nayaka (*c.* 1336-1565 AD) and Later Nayaka and Maratha (*c.* 1565-1800 AD) periods. The technical details are already published by Srinivasan (1996) and Srinivasan

(1999a, b) and hence are not repeated here. The differences in the trace element trends for chalcophilic elements such as Ni and Co may perhaps be attributed to different sources of copper for the different groups of artefacts. For convenience, references to trace element trends further in the paper all pertain to this set of elements of Co, Ni, As, Bi, and Sb. Table 1 gives the average composition of analysed bronzes.

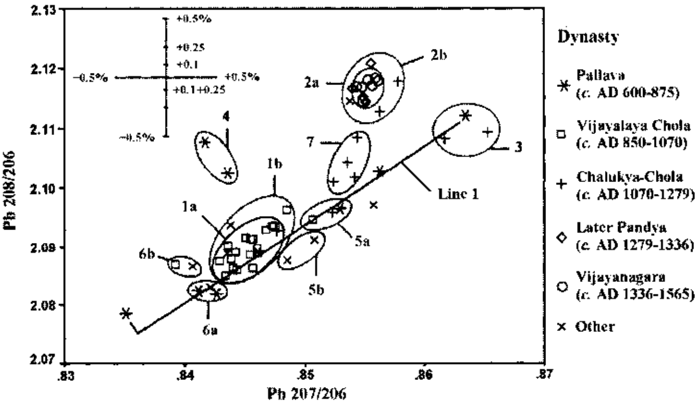


Figure 1

Lead isotope ratio plot of Pb 208/Pb 206 vs. Pb 207/206 for sampled south Indian bronzes with markers indicating dynastic chronology. The ellipses indicate groups of objects with similar sources of lead; the ellipse 1a consists mostly of early and high Chola bronzes (late 9th to mid 11th century). The objects lying close to the line would have lead mixed from two sources; these are found to be Pallava artefacts.

Fig. 1 is a plot of lead isotope ratios of Pb 208/206 vs Pb 207/206 for about 55 of the analysed South Indian images including a few other miscellaneous artefacts. The ellipses 1a, 2a, 3 and 7 have a sufficiently narrow spread with enough artefacts falling within them to suggest that they represent either discrete lead sources (or different mines in the same larger mining region). This may also be the case for the other minor groups and subgroups of three or less objects indicated on Fig. 1. However, since there are not enough artefacts in each of these groups, their isotopic matching could also have resulted from their having been made from the same batch of re-cycled metal (although it is not possible to say whether this metal contained lead from a single source or mixed from different sources.). In any case this does suggest that these artefacts are related by either metal processing or source. There is insufficient lead isotope data on Indian ore sources to pinpoint the exact ore sources although it appears from lead isotope ratio comparisons that known external sources from Western Europe, West Asia and China may generally be ruled out (Srinivasan 1996, Srinivasan 1999). The ellipses 1b and 2b are drawn to indicate objects for which lead from sources 1a and 1b prevailed with some mixing from other sources. On Fig. 1, the Groups 1a, 2a, and 7 are found to consist overwhelmingly of artefacts of the .Vijayalaya Chola group (*c.* 850-1070 AD), Vijayanagara and Early Nayaka period (*c.* 1336-1565 AD) and Chalukya-Chola period respectively (*c.* 1070-1279 AD). For Pallava bronzes the lead isotope ratios fall mostly along the line indicated on Fig. 1; this can be explained if lead from two sources was randomly mixed in these bronzes of which one would have been the source indicated by Group 3, resulting in a linear combination of lead isotope ratios. This is nevertheless a discrete trend serving to differentiate Pallava images from the others. Since the majority of the sampled images were leaded artefacts, it would be fair to say that the lead isotope ratio plots relate to the sources of alloyed lead.

On the Discrete Metallurgical Profile of Chola and Vijayanagara Bronzes

Perhaps the most marked result from this finger-printing study was the fact that Chola images, (i.e. bronzes attributed to the period of the direct lineage of Vijayalaya Chola, *c.* 850-1070 AD), show discrete technical finger-prints, both their trace element profiles and in their lead isotope ratios from bronzes which can be attributed to the Vijayanagara and Early Nayaka period (*c.* 1336-1565 AD). Fig. 2, an image of Nishumb-hasudhani, inscribed to the 10th century fitted trends for the early Chola group. The latter group consisted of some images which could be taken as typically Vijayanagara due to their stiffer and debased modeling, when compared to Chola images, which were predominantly Vaishnavite images such as Kaliya Krishna and Balasubramania, as indeed the Vijayanagara rulers were a strongly Vaishnavite dynasty. Furthermore, a couple of inscribed Nagapattinam Buddha images consistent with the style of the Vijayanagara period also had technical finger-prints matching this group which served to provide a chronological reference. In the case of lead isotope ratios, the fact that lead isotope ratios for bronzes of the two

Figure 2
Image of Nishumbhasudhani, Government Museum, Chennai, inscribed to the 10th century, analysed by Dr. Sharada Srinivasan for which the lead isotope ratio abd trace element trends authenticated the early Chola attribution

Figure 5
Balakrishna, Government Museum, Chennai Technically analysed by Dr. Sharada Srinivasan and autheticated to the Vijayanagara period (15th Century)

groups fall into discrete clusters suggests that their lead came either from different ore sources or from different mines within a larger mining area. This is a most useful observation since one of the problems in the art historical study of south indian bronzes has been the difficulties in telling apart bronzes of these groups due to the tendency in later periods to repeat earlier formulations. A typical image which fitted Vijayanagara trends and stylistically also fits this group is the Balakrishna image from Government Museum, Chennai (Fig. 5). However, none of the Nataraja images investigated from this study were found to belong to the Vijayanagara period.

Figure 3 Natesa from Kuram (Acc. No. 53/38), Chingleput district in the Government Museum, Chennai

'Cosmic Dance': Evidence for Nataraja Bronze by the Pallava Period (C. 850-875 AD)

Prior to the technical investigations made in this study, attributions of any bronzes at all to the Pallava period had been open to debate due to the lack of inscribed bronzes (Barrett 1965, R. Nagaswamy 1995). However the existence of a Pallava school of bronzes as distinct from Chola is supported by the fact that images studied here which share affinities. with Pallava sculpture generally have a reasonably discrete metallurgical profile from Chola ones especially in their Ni and Co values while their lead isotope ratios plot along the line indicated in Fig. 1.

It may be noted that the dated Pallava artefacts which tend to fit these trends include two seals and a copper plate charter with a bull emblem. As an example, the important Natesa from Kuram (Fig. 3) (Acc. No. 53/38), Chengalput district in the Government

Museum, Madras was dated by Dr. R. Nagaswamy (1988: 142) to the Pallava period (*c.* 700 AD) with copper plate grants of Paramesvaravarman I (*c.* 630-668 AD) mentioning metal images having been found at a Pallava temple at Kuram (Srinivasan 1963:68-70). Its lead isotope ratios fit the linear trend for the Pallava group confirming this attribution.

A surprise find from this study is that the famed Nataraja metal icon, depicting Siva dancing the anandatandava with the lifted leg extended in *bhujangatrasita karana* was very likely already in vogue by the Pallava period, predating its anticipated development in the Chola period. This is suggested by the fact that two 'Nataraja' images of Siva better fitted the lead isotope trends for the Pallava group although they had previously been classified as early Chola. One, a petit Nataraja from the British Museum, London (Acc. No. OA-1969-12-16-1), shows markedly Pallava features also shared by the Kuram Natesa such as the looped waist robe, the forward facing dwarf, the lanky form, and the right rear hand with the drum turned inwards. Thus this may well be the earliest known Nataraja bronze image, datable to the Pallava period, *c.* 800 AD. The second is a charming Nataraja image from Kunniyur in Government Museum, Chennai (Fig. 4), for which the lead isotope ratio trends fit to the Pallava group, also closely matching the ratios for the above

Figure 4
Nataraja, Kunniyur, Tanjavur District, attributed to Pallava period, c. 850 C.E. by author. Government Museum, Chennai (Acc. No. 752/75)

British Museum Pallava Nataraja. Indeed on closer examination, the features of this bronze are less

The idea that the Nataraja icon may have been formulated by the Pallava period is nevertheless somewhat consistent with the fact that the hymns of poets like Sambandar dating back to the 7th century refer to the worship of Nataraja at Chidambaram. The poems of Manickavachar, that the Nataraja was worshipped in the Pallava period at Chidambaram with underlying philosophical concepts of cosmic cycles of creation and destruction, is indicated in Tamil saint Manikkavachaka's Tiruvagagam, which says, 'let us praise the Dancer (*kuttan*) who in good Tillai's hall dances with fire, who sports (*vilaiyatu*), creating, destroying, this heaven and earth and all else' (Dehejia 2003: 103). Another moving mystical verse by Manikkavasaga echoing not only echoing the 'cosmic' sensibility and portraying his deep devotion is the following:

He who creates, protects,
and destroys the verdant world,
The primeval One…
Ah, When will I get to gaze upon
the unique One to whom no other compares

Him who is fire, water, wind, earth and ether,
Him whom others cannot understand…

-Manikkavachakka,
9th century (Mowry 1983: 53)

Evidence for Bronzes from South India of the Early Historic Period

In general little has been known about metal statuary from South India of the early historic period. Of course, some delicate examples of metal icons have been found from Satavahana or Andhra contexts of the early Christian era such as from Kolhapur, Amaravati and Nagarjunakonda, including Buddha images and secular bronzes. Even less has been known from the *Sangam* era, so called after the body of Tamil *Sangam* literature which is roughly dated to 3rd C. B.C. – 5th C AD. While a fine petit seated Buddha from Kaveripattinam has been attributed to this period, as such not much has been written on the metalware of this period. From this study it is found that some images and artefacts which can be attributed to the early historic period do have their own technical finger-print, being different from the Pallava artefacts especially in their antimony contents and for the purposes of this study these have been classified as Pre-Pallava. There is also reason to believe that this set of artefacts may include those which can be attributed to the Sangam era. This may be inferred from the fact that four coins panned from the river bed in Karur, the ancient *Sangam* capital, described as 'Indo-Roman', i.e. local coinage made in imitation of Roman coinage, also fitted the trace element trends of this group. An example is an image of a Yakshi with a goose from Victoria and Albert Museum, London, which was thought to be either Kushan from North India or from the Deccan of about the 2nd C. AD. However its trace element trends fitted those of the group of early historic period copper alloy images and artefacts from South India sampled in this study. Thus there is the possibility that it is a *Sangam* era bronze and indeed there is a similar depiction of a maiden, standing in a languid pose with leg crossed behind, in a well known gold signet ring with a mithuna couple panned from Karur.

On Nagapattinam-Style Buddhist Bronzes

A sequence of ten Nagapattinam-style bronzes from different periods were analysed for this study. These included three with Tamil or Grantha (i.e. Sanskrit in Tamil script) inscriptions datable to the 14^{th}-18^{th} centuries reported to have been found in Sri Lanka. Their technical finger-prints generally corresponded with those of the major groups of Tamil bronzes in chronological order, suggesting a South Indian provenance for them consistent with the style associated with the South Indian Buddhist centre of Nagapattinam on the Tamil Nadu coast. Some preliminary comparisons between the trace element trends of South Indian bronzes analysed in this study with those of a dozen or so analysed images from Sri Lanka (Von Schroeder 1990) suggest that Sri Lankan images in general have different trace element trends from South Indian ones. However, a curious exception is the well known fine 1.4 m high gilt 'Tara' image Lanka in the British Museum found of the sea coast of Sri Lanka which fitted the trace element trends detected for the Pallava group of South Indian images. More significantly, the lead isotope ratios of this image very closely matched those of a gilt Buddhist bronze of the Nagapattinam style analysed for this study from the Victoria and Albert Museum. This image had been described in the past as a Hindu goddess, Pattini Devi, and more recently identified as the goddess Tara. Stylistically, the slightly flexion of the hip or *bhanga* detected in the image shares affinities with South Indian goddesses whereas Sri Lankan images made before the Polonnaruva period of Chola occupation seldom show this feature. All of this lends credence to the idea that this image may have had a South Indian connection. It remains possible that images were shipped off to Sri Lanka following the decline of Buddhism, while the island may have also been viewed as a safe haven against the threats of iconoclasm, as seen with Muslim Sultanate and Portuguese forays, perceived within the Indian mainland.

On the Composition of 'Pancha-Loha' Icons

Nearly 80% of the sampled images were leaded bronzes and the rest 20% were leaded brasses with very few being unalloyed with lead. To highlight the salient metallurgical features of traditional image casting in South India, field observations made by author of lost wax casting techniques in 1990 and 1991 in Tamil Nadu and Kerala were correlated with textual prescriptions in the 12th century Manasollasa, the Gupta Manasara (5th C. AD) and other *silpasastras* and with the technical evidence (Srinivasan 1996: 93-134). A *sthapati* interviewed in 1990 by the author (Srinivasan 1990) indicated that the *'pancha-loha'* icons or 'five-metalled' icons were so called because they contained minor additions of gold and silver in addition to the other alloys of copper, tin or lead, which were added to the runner behind the face for added lustre. From the analysis it may be concluded from the random amounts of gold and silver detected that small amounts of these precious metals could indeed have been added (Srinivasan 1996). However, the levels of these additions do not exceed 1% and hence remain in the trace element category and there is no justification for the belief that the icons had a significant amount of precious metals in them.

Characterising Megalithic High-Tin Bronzes and Traditional Aranmula High-Tin Mirrors

Due to the scarcity of tin in the Indian sub-continent in general, and in south India, it has been believed with good reason that tin or bronze would have been important items of import from tin-rich regions of southeast Asia. However, metallurgical studies

Figure 6

Bowl from Iron Age Burials of Adichanallur, Tamil Nadu (800 B.C.), Government Museum, Chennai, analysed by author and found to be of wrought and quenched 23% high-tin bronze

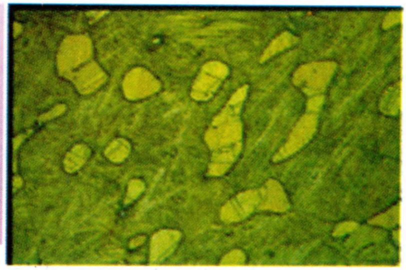


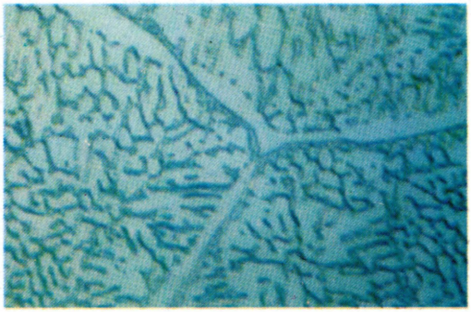
Figure 7

Micro-structure of wrought and quenched high-tin bronze jug from Adichanallur, Tamil Nadu, c. 800 B.C., (22.9% tin) showing predominant matrix of elongated martensitic needle-like beta phase and few islands of twinned alpha phase, indicating extensive hot forging and quenching between 650-750° C (400 x)

by the author reported in Srinivasan (1997) and Srinivasan and Glover (1995) and investigations suggest that right from the Megalithic and Iron Age period of the early to mid first millennium B.C. a class of alloys known as high-tin bronzes with a high content of tin of around 23% tin were already in vogue, ranking amongst the earliest such finds and continuing through the early historic and medieval period into the present day in South India. The metallographic study of a vessel from Adichanallur (Fig. 6) by the author showed it to be the rare alloy known as wrought and quenched high-tin beta bronze (23% tin) with presence of quenched martensitic beta phase (Fig. 7). The trace element impurities of some of these high-tin bronzes investigated by the author from the Adichanallur Iron Age burials and Nilgiri *Figure 9*

Megaliths were sufficiently different from those found at sites such as Ban Don Ta Phet in Thailand to suggest different ore

Figure 8
Dr. Sharada Srinivasan demonstrating the image in a metal mirror of cast high-tin delta bronze (33% tin) made at Aranmula, Kerala



Micro-structure of as-cast 33.4% tin-bronze mirror fragment from Malakkara showing a matrix of silvery-white delta phase with a fine network of bluish alpha plus delta eutectoid. (1000X)

sources, while the Indian material seems earlier. Some more unexpected and potentially exciting preliminary evidence for local tin came from slags that the author collected and investigated from slag heaps near the Kalyadi copper ore deposit in Karnataka, which investigations suggest were related to the co-smelting of copper and tin ores to yield a tin bronze of around 5-7% which is an exceptional finding of its kind from anywhere. There are indeed reported to be some minor placer tin deposits in north Karnataka and in Srinivasan (1998) references to tin from Karnataka going back to Solomon's times and in the medieval text the Mitakshara are pointed out.

Interestingly the delta bronze alloy of copper with 33% tin was used specifically traditionally for making mirrors in Aranmula Kerala (Fig. 8, 9), which is a hard highly reflective alloy which takes a very good polish and mirror effect and studies by the author have characterized and indicated how this particular delta phase of bronze was isolated and optimized to get the best possible mirror effect in what was one of the most remarkable Indian metallurgical traditions (Srinivasan 2004, 1995, 1998).

Some Evidence Supporting Exploitation of Local Metal Sources and Zinc

Historical studies on sources of metal in Indian antiquity, as also in the south indian context, have suffered from a paucity of historical documentation which is not only due the general lack of historicity within the Indian record but also due to the fact much that has yet to come to light from the epigraphical and inscriptional records. More information has been gleaned from Roman, Chinese or West Asian sources on maritime trade in metals; however these accounts by their nature may have tended to skew the record more in favour of external sources of metal. A significant outcome of this study is that it indicates that while maritime trade in metal would no doubt have had its place, the copper-bronze metallurgical traditions of the region and the Indian sub-continent as a whole were much more sophisticated than hitherto appreciated with new evidence for the local exploitation of tin, bronze, lead and zinc. The lead isotope ratio profiles of the analysed generally suggested that ore sources most likely Indian since they did not fit most lead isotope data from around the world including Chinese or European although more information is needed from other parts of the world and Indian ore sources to properly identify ore sources.

Since the grouping together of trace elements of artefacts is dependant on their having shared ore sources, the author undertook to make some preliminary investigations on copper slag and copper ore specimens from about seven sites of ancient mining in south india including Mamandur, Tintini, Somalaragada, Kalyadi and Ingaldhal (Srinivasan 1996). The slag specimens were investigated by electron probe micro-analysis with quantitative analysis of metallic remnants with ZAF correction. As ores have very heterogenous compositions, it is more significant to look for correspondences between the composition of metal remnants found in the slag as they would reflect the composition of the smelted metal when it was in the molten state. Some very preliminary comparisons were thus made between the trace metal composition of the metallic remains in the slag with that of the analysed South Indian bronzes. For example, it was found that the Ni/Co ratios of copper slags from Tintini related fairly well to that in images of the Vijayanagara period so that it is possible that this ore deposit could have been a source of metal for this period. This is indeed plausible given the proximity of this site in north Karnataka to the Vijayanagara capital of Hampi while there is also a legend of a 16th century metal working saint Moneshwara associated with Tintini. It may also be significant that the Ni/Co ratios of the metallic remnants in the bronze-smelting slags from Kalyadi were similar to those for the Vijayalaya Chola bronzes with both having a similar average tin content of 6-7% tin, suggesting Kalyadi as a possible source (Srinivasan 1998).

While the earliest known evidence for the production of metallic zinc comes from the Zawar area of Northwest India, Craddock (1995: 309), few early finds of metallic zinc have been previously reported. Lead isotope ratios for a zinc coin or ingot (sampled by the author from the collection of N.J. Seeley) with a Deccan Brahmi inscription of about the 4th century AD were nearly identical to those of a brass figurative vessel with 14% zinc panned from the Krishna delta in Andhra from the Victoria and Albert Museum, London (Acc. No. IM-9-1924) which in turn matched the trace element trends of an early historic period Avalokitesvara image also panned from the Krishna delta (for which lead isotope analysis could not be done due to small sample size). All of this corroborates an early historic period Deccan provenance for these artefacts, making the zinc coin/ingot one of the earliest known finds of metallic zinc. Intriguingly, the lead isotope ratios do not match the Zawar mine but falls on the periphery of the Group 1a of South Indian artefacts on Fig. 1. As mentioned before, the ore sources of the majority group of analysed South Indian bronzes has not yet been traced to inadequate data on ore sources, although an Indian ore source with a large isotopic spread of ±1% is not ruled out. Since zinc metal is not really reported elsewhere in the world in the pre-medieval period, this increases the likelihood of there having been another source of early zinc in India, apart from Zawar, probably near the Andhra region, which interestingly enough, a millennium later, was famed for the elegant *bidri* ware of zinc alloy known to have been made under the Deccan sultans. At the same time, the movement of metal over long distances is confirmed by lead isotope data compiled by the author, which indicates that both local Andhra and Mediterranean sources were used for different sets of silver coinage from the Satavahana period (2^{nd} century) (Srinivasan 1996).

Thus, while some literary accounts may point to external sources of metal these have to be viewed within the perspective of other Indian literary, geological and archaeological evidence which indicate that local sources of metal constituted a reasonably important of Indian metal supplies in antiquity, and while there may have been some supplementation from external or maritime sources, these two processes of local usage of metal and maritime trade in metal need not be viewed as having been mutually exclusive activities.

Acknowledgement

This paper is dedicated to the memory of late Dr. Nigel Seeley, former Head, Conservation, National Trust, UK, for his invaluable support in undertaking research related to scientific studies on bronzes and authentication of art and archaeological artefacts, his significant contributions are reflected in this paper in the findings related to bronzes, high-tin bronzes and metallic zinc. The author would also like to sincerely thank the Government Museum, Chennai and staff for their co-operation and encouragement in studies and in the presentation of this paper at the seminar on Authenticity in Art including Mr. M.A. Siddique, I.A.S., Dr. V. Jeyaraj and Mr. R. Balasubramanian; the support of the Victoria and Albert Museum and British Museum, London are also acknowledged.

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ARCHITECTURE

17 Authentication of Architectural Details of Pallava Monuments at Kanchipuram, Tamilnadu, India - A Perspective

D. Jayanthi and Ranee Vedamuthu***

Kanchipuram, one of the most ancient cities of South India, is located 71Km from Chennai, the capital city of Tamilnadu. There are more than 100 ancient temples in Kanchipuram town built by various rulers in different periods. The sandstone monuments built by the Pallava rulers from 6th century are the earliest. Seven of these earliest and important

sandstone monuments are under the Archaeological Survey of India (ASI), Chennai and have been declared as protected monuments. Only 3 monuments in Kanchipuram are taken care by the State Department of Archaeology, Tamilnadu and some are by the private trustees of the Kanchipuram town.

Map of Kanchipuram Town

This paper concentrates on the authenticated details pertaining to the Pallava monuments at Kanchipuram town. The paper analyzes the uniqueness of the Pallava monuments at Kanchipuram town in terms of

1. Architectural style of the Pallava monuments
2. Architectural character of the Pallava monuments
3. Used Building materials
4. Construction methodology

History of Pallava Architecture

The architectural style of the Pallavas can be generally distinguished by three distinct periods namely,

- Early period – Mahendra period
- Intermediate period – Mamalla period
- Late period – Rajasimha period

In the early period, the rock-cut cave temples were excavated during the reign of Mahendravarman-I from the natural rock, therefore it is said to belong to the Mahendra style.

Cave temples as well as free standing, monolithic rock-cut temples known as *rathas* built in the reign of Mamalla in the intermediate period, therefore be said to belong to the Mamalla style.

The late period possesses certain features, which are not found in the earlier cave temples and structural buildings built of stone or brick in the reign of Rajasimha and is said to belong to the Rajasimha style. The style of early period is quite crude and the intermediate style is little refined from the previous. The style developed during Rajasimha period is well refined and in this later period of the Pallavas, structural buildings were built for the first time in South India.

There is also a still later style than that of the Rajasimha, which may be called the style of Nandivarman. There are very few temples in this style as at this period we find the Pallava architecture was losing its identity and merging into the Chola style.

We may, therefore, adopt the following classification, and divide the history of the Pallava architecture into four styles.

1. Mahendra style - 610 – 640 A.D
2. Mamalla style - 640 - 674 A.D
3. Rajasimha style - 674 – 800 A.D
4. Nandivarman style - 800 – 900 A.D

Matengeswara Temple - ASI Monument

Most of the Pallava monuments found in Kanchipuram town are belonging to the Rajasimha style and purely of structural temples.

Till the beginning of the 7th century Jainism and Buddhism were the prevailing religions in Southern India.

In Kanchipuram town, there is an evidence of a Jain temple belonging to 5th century A.D. giving an authentic proof of the existence of Jainism as a religion before the establishment of Hinduism.

Patchi Vannar Temple
Non ASI Monument

In the beginning of the 7th century, Mahendravarman-I himself converted from Jainism to Saivism. After Mahendravarman-I, all the Pallava rulers were Hindus and great devotees of Siva and built a lot of temples dedicated to Siva. Almost all the monuments in the Kanchipuram town are dedicated to Lord Siva.

Architectural Character of the Pallava Monuments

The architectural character of the Pallava monuments found in Kanchipuram is of two types, viz Rajasimha Style & Nandhivarman Style.

1. Rajasimha Style

On plan the shrine has small square cells surrounded by a circumbulatory passage and faces the east. Externally a lofty tower rising in tiers which diminish in size as they approach the summit, is built over the central shrine, in front of which is a small porch which leads into a large pillared hall or ***mandapa.***

All Rajasimha temples are dedicated to Siva, presumably in the form of *Somaskanda,* since they all possess fluted basalt *lingas* and have the *Somaskanda* panel carved on the back wall of the shrine.

Mahendra Varma - I Period Temple

The *Somaskanda* panel is not only confined to the ***sanctum sanctorum*** but also continued as surface decoration on the body of the temple.

The *nandi,* another saivait symbol, is also widely represented as cultural forms around the temple.

2. Nandivarman Style

This style flourished during the second half of the 9th century and it is the intermediate style between the Rajasimha period and that of the early Chola. In general the lower portions of the temples were built of

Kailasanatha Temple
Typical of Rajasimha Style

stone; the upper portions were built of brick with ornamentation in plaster. The lingas are cylindrical and small. There is no *Somaskanda* panel in the sanctuary. The pillars and angles have no conventional lions.

Typical Architectural Features of the Pallava Monument

The salient features found in the protected monuments under the Archaeological Survey of India in Kanchipuram represent the authenticated architectural features of the Pallava style. This is applicable to all the monuments made of sandstone during the Pallava period from 674- 800 A.D.

The typical features are externally a lofty tower rising in tiers, which diminish in size as they approach the summit, is built over the central shrine, in front of which is a small porch which leads into a large pillared hall or *mandapa*[1].

Lion Sitting in Erect Position - Typical Pallava Feature

A very characteristic feature of these temples is the type of pillar found in them - The base of the pillar is carved in the shape of a conventional lion sitting in an erect position and carrying the shaft of the column on its head[2].

The lion in the sitting position and rearing position are seen as bases of structural elements like columns and pilasters and this is a peculiar architectural feature of the Dravidian style under the Pallavas.

Typical Tower of the Pallava Period

Sandstone is chosen as a prime building material for the Pallava monuments at Kanchipuram. Any monument made of sandstone in

Kanchipuram town gives authentic information that it was built during the Pallava period and between from 674 - 900 A.D.

Typical Pillar of the Pallava Period

The seven protected monuments under the Archaeological Survey of India, and most of the monuments under the State Department of Archaeology in Kanchipuram town are made of sandstone.

Typical Column Detail of the Pallava Architecture

The sandstone used in this region is of Gondwana Age. The brownish sandstone used in the monuments is pale, coarse and friable in nature and not of a very commendable quality[3].

Building Material (Sand Stone) used by the Pallavas at Kanchipuram

Construction Methodology Adopted

Since the building material chosen for construction is not of a very commendable quality, a granite slab was introduced at the plinth level of the monuments in order to bear the load of the structure.

This typical detail can be considered as an authenticated structural detail to identify a Pallava monument in Kanchipuram town.

Granite Slab at Plinth Level – Typical Construction Detail

Conclusion

The authenticated Pallava architectural characters and features mentioned in this paper are found in almost all the Pallava monuments built from 5th century to 9th century A.D. After the 9th century the typical architectural features of the Pallavas slowly started merging in to the early Chola style. The building material used for the construction of temples was switched over from sandstone to granite, brick and lime.

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18 Characterization of Gothic Church Architecture and Its Authentication

*A. Vijay Kiran**

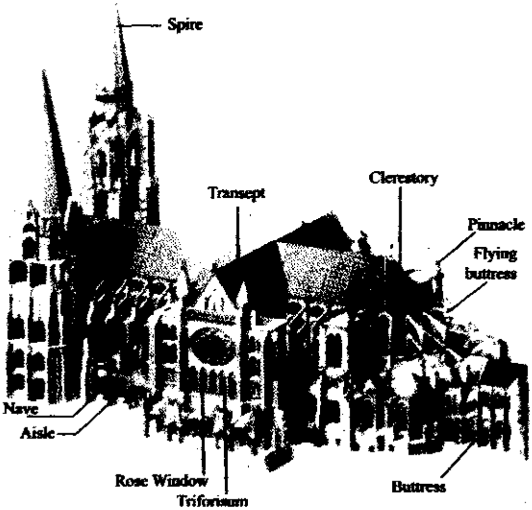
"A Church is a sacred building dedicated to divine worship primarily that it may be used by all the faithful for the public exercise of divine worship" — Canon Law Sec. 1161.

Introduction

A Church is "sacred" intrinsically, and not merely because sacred acts take place within it, but it is permanently and exclusively set aside by consecration or solemn blessing for divine worship, and so made "Sacred". Churches were built in second or third century, but larger churches with real art, decoration and style began in the fourth century by Constantine, the Emperor of Rome. Church architecture evolved according to time and development of art in the particular country or impo-rted and replicated from other count-ries. This brought about a variety of styles in the Church archit-ecture and one such style is the Gothic Archite-cture. Church

Characteristics of Gothic Architecture

The construction of Gothic buildings began in France and the first experiments of Gothic architecture were made, around 1140 A.D. and it was carried on from generation to generation. The place in the national life which the mediaeval Cathedrals occupied was an important one, and must be realized if we would understand how they were regarded. In the absence of books and of people able to read them, cathedrals were erected and decorated partly as a means of popular education, the sculpture and the painted glass reflecting the incidents of Bible history from the creation to the redemption of mankind, the sculptured forms and brilliant colouring rendering them easily understood by the people. The virtues and vices, with their symbols were also displayed, either in glass or statuary, along with their reward or punishment. Saints and angels told of the better life, and the various handicrafts, both of peace and war were mirrored in imperishable stone or coloured glass. They to a large extent took the place in our social state since occupied by such modern institutions as the Board School, Free Library, Museum, Picture Gallery and Concert Hall. They were the history books of the period. Architecture then as now was also the grand chronicle of secular history, past and present, in which kings, nobles and knights were represented.



Gothic Church Architecture – An Overview

Gothic architecture began in twelfth century in France and slowly developed itself through Europe as a necessary sequence of the Romanesque architecture or style. The Gothic masons were exhausting the possibilities of stone in small pieces as a building material. The masons started to cut the granular stone to the thinness of fibrous wood or iron and revelled in tricks of construction and marvelled world with their workmanship.

The Gothic builders often contented themselves with forming both the transverse and diagonal ribs of their new system of vaulting. In some cases, the diagonal ribs were kept semicircular. The pointed arches became permanent centres and gave a suggestion of height coinciding with the aspiring tendency of the style and its connection with religious enthusiasm. The columns and its capitals were real support to sustain the load. The capitals used variety of ornamentation. Buttresses were built to support the vertical walls for stability. In the case of the nave vaults, the collected pressure are counteracted by arches called flying buttresses, leaning against the nave wall and supported at some distance by massive piers, weighted with tall pinnacles. A considerable portion of the mere weight of wall even was therefore transmitted to a point outside the Cathedral, and opposed by buttresses which are in reality permanent shores preventing the vaults from spreading or falling out. The walls are occupied principally by windows of glass divided by stone mullions and the upper part formed with geometrical combinations of curves of immense variety of design. Most of the architectural features were founded primarily on structural necessity and others are the expression of artistic invention and of aesthetic requirements. The spire was evolved from no utilitarian requirements, but was an outward and visible sign of the communal spirit, an indication of municipal prosperity. The painted glass was an important factor in the development of the style for the windows, which exhibit painted transparent pictures of glass telling the incidents of Bible history. Since painted glass was the principal mode of decoration, the walls were kept internally as flat as possible, so as to allow the windows to be seen in every direction.

Types of Gothic Architecture

There are wide varieties of styles adopted by the different countries in Europe and the development of the architecture is named after that particular country with slight variations. The different types of Gothic architecture are listed below:

English Gothic

The English Gothic is marked by a more complete sequence of style than upon the continent. The Gothic style terminated in a very national phase called the "Perpendicular" style, not found elsewhere.

Anglo Saxon Style

This style was prevalent during 499-1066 A.D. The buildings are sometimes composed of Roman remains in Britain. The scanty remains of this period render it difficult to estimate the character possessed by the buildings. It is probable that timber was the material mostly employed in all classes of buildings, and we may believe that the great development in timber work of the later Gothic styles was due to this early use.

Norman Architecture

This is also known as English Romanesque or Twelfth Century Style, comprises the reigns of William I (1066-1087), William II (1087-1100), Henry I (1100-1135), Stephen (1135-1154) and Henry II (1154-1189). The general appearance of the architecture was bold and massive.

The Early English Style

This style was also known as Lancet, first pointed, early Plantagenet, or Thirteenth Century Style, comprises the reigns of Richard I (1189-1199), John (1199-1216), Henry III (1216-1272) and Edward I (1272-1307). Unlike Norman style which was massive, the tall and narrow Lancet openings were introduced to the design. The long trails of dog-tooth ornament lurking in the dark furrow of some channelled recess, the foliaged capitals and bosses intruding their luxuriance upon the mouldings and hollows, and the knots of pierced and hanging leaves, extending like some petrified garland or bower of filigree work round the arch, almost impart life and vegetation to the very stone of the door and window openings. Boldly projecting buttresses and pinnacles, and steeply pitched roofs, mark the exteriors. Internally, the slender groups of shafts occur connected by band to the piers. The pointed arch vaults have become more frequent bolder and more elegant.

The Decorative Style

This is known as the Geometrical and Curvilinear, middle pointed, Edwardian later, Plantagenet or Fourteenth Century Style comprises of Edward II (1307-1327) and Edward III (1327-1377). The general appearance is simple, from small number of parts, and magnificent, from the size of the windows filled in with the geometrical tracery. Increasing richness of ornamentation characterizes every part. Clerestories are enlarged at the expenses of the striforium. Vaulting ribs increase in number and complexity, the vault becoming a main feature in the effect of the interiors.

The Perpendicular Style

This is also known as the Rectilinear, late pointed, Lancastrian or fifteenth century style comprises the reigns of Richard II (1377-1399), Henry IV (1399-1413), Henry V (1413-1422), Henry VI (1422-1461), Edward IV (1461-1483), Richard III (1483-1485), Henry VII (1485-1509), Henry VIII (1509-1547), Edward VI (1547-1553) and Mary (1553-1558). The general appearance varies much in earlier and later work, the later being over laden with panelling, the main lines in a perpendicular direction.

French Gothic

France is the birthplace of Gothic architecture. The principle of Gothic architecture in France was the same as in all Europe, the vertical and aspiring tendency being accentuated by numerous spires, crockets, and pinnacles, by great internal height, high-pitched roofs and flying buttresses and the long lines of the tall traceried windows. The style has been divided into three groups viz.,

i) Primary (Gothique) or Thirteenth Century.
ii) Secondary (Rayonnant from the characteristic wheel tracery of the rose Windows) or Fourteenth Century.
iii) Tertiary (Flamboyant) or Fifteenth Century.

Scottish Architecture

Architecture in Scotland followed the flamboyant tracery of French Gothic in preference to the perpendicular of English's work. The "corbie" or "crow-stepped" gable was used and in vaulted roofs a continuous barrel vault with surface ribs was occasionally employed.

Irish Architecture

In Ireland, the architecture remains more of Celtic. The early churches were extremely small in length and used as oratories.

Belgian and Dutch Gothic

The Dutch character of simplicity is translated into their architecture; their churches are barn-like, and contrast with richly-treated buildings of Belgium.

German Gothic

Gothic was reluctantly adopted in Germany. In North Germany, brick architecture was developed. Bricks are the special character of German Gothic.

Italian Gothic

The influence of Roman tradition and classic forms of construction and decoration was so great that the verticality, which marks the Gothic architecture in the north does not pervade in other parts of Italy. In the exteriors of the churches, we notice especially the flatness of the roofs of tendency to mask the aisle roofs on the west façade, which was treated as a mere screen wall, without reference to the slope of the roofs behind the great central window in the west front lighting the nave; the flatness and comparative unimportance of the mouldings, their place being more than taken by the beautiful coloured marbles with which the façade were faced, and the broad surfaces covered with fresco decorations. The importance of the crowning cornice and the absence of pinnacles due to the unimportance of the buttresses should be remarked; also the employment of elaborately carved projecting porches at the west end the columns of which often rest on the backs of lions and the other animals. The Roman acanthus and Corinthian capitals of modified form were constantly used in Gothic buildings. The Italian use of brickwork was essentially the right one; the details were small and designed with taste, and the effect of variegated colour was relied on instead of depth of shadow a perfectly legitimate use of light and shade and warmth where small materials are used, and in which stone of different colour is carried systematically in patterns through the design, and gives a special character.

Spanish Gothic

In Spain, more of Moorish influence being felt in the architecture. The Saracenic features such as horse hoe arch, the pierced stonework tracery are of Moorish design. The early churches in Spain seem to have been executed by the aid of Moorish workmen. The Gothic style in Spain has a special character of single-span vaulted interiors. The exteriors are flat in appearance, owing to the space between buttresses being utilized internally for chapels. Excessive ornamentation without any regard for its constructive character is very apparent here.

Characters of Gothic Church Architecture

The characters of the Gothic churches are identified from their plans. They are generally in the form of a Latin cross, the short arms forming the transepts, the cruciform ground plan is considered by some as a development from the early Christian basilicas. A tower sometimes crowned with a spire is generally erected over the crossing or at the west end. As a rule the nave is the portion to the westward, and the choir containing the bishop and clergy is that to the eastward of the crossing.

The arms north and south are called the transepts. Each of these divisions is further divided into a central nave and side aisles, separated by columns or piers. The principal entrance, often richly ornamented, is at the west end, or by a porch on the south or north sides.

The columns to the nave support the arches, which carry the main walls of the church, rising above the aisle roof. Above the arcade, it will be seen there are a series of small arches, opening into a dark space caused by the height of the sloping roof of the aisle; this is called the triforium or blind storey. Above the triforium is a range of windows in the main wall, admitting light into the upper part of the nave; this division is called the clerestory or "clear storey" probably derived from the French word Clair or light here admitted by the many windows in this portion of the nave wall. The head of these windows is generally the level of the ridge of the stone vault of the nave, which is covered in by a high pitched wooden roof. The east ends or choirs usually square ended and in some cases circular, the floor is raised above the nave level by steps. The interior walls are decked with huge paintings and the colour schemes like purple, black, gold, dark red are used.

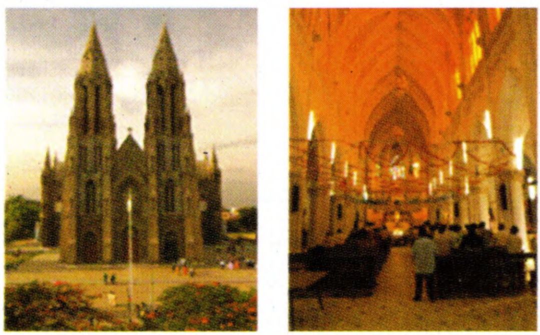
The cloisters are generally but not invariably, south and west of the transept, the warmest and most sheltered position. Besides being used for the studies, reading and writing of the monks, they are also the centre of the secular affairs of the community.

Such is the general distribution of the parts of a cathedral or large church from which naturally many deviations will be noticed.

Great length and central towers or western towers are features of Gothic cathedrals. Compared with such long, low and highly grouped Cathedrals in England, continental Cathedrals seem, short, high and often shapeless owing to the intricacy and profusion of their buttressing. In churches a single western tower is the characteristic of English work.

Gothic Church Architecture in India

The advent of Christianity in the very first century by the disciple of Jesus Christ, St. Thomas, the Apostle, marks the beginning of church buildings in India. Up to sixteenth century, not many churches were built. In the thirteenth and fourteenth centuries, the missionaries founded some churches, but without following any particular style of architecture. After discovering the sea route to India by Vasco da Gama in the fifteenth century, more and more Europeans extended their business activity with India in a great way. This paved the way for the European missionaries to come to India to spread Christianity. First the Portuguese, followed by the British, French, Dutch, German and many others.



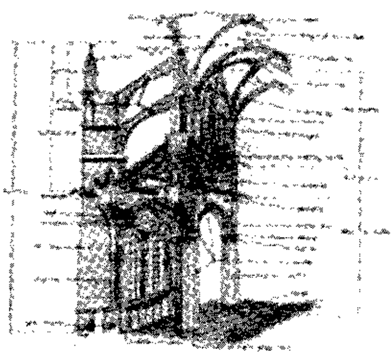
Exterior & Interior of St. Philomena's Church, Mysore

There were many attempts in the early churches to reproduce Gothic details. The missionaries saw it as their duty to convert the indige-nous population to Christianity, and as soon as finance became available churches were built to simulate as nearly as possible European prototypes. This aim was often only achieved in the facades of the buildings – the accommodation for the worshippers being constructed in cheap and easily available local materials and tech -niques.

There are number of Cathedrals and large churches built in Gothic style. Here one should observe that different Gothic styles depended on the nationality of the missionary or the architect. At large, the missionaries replicated some idea or style of their own country. Hence one can notice slight variations in different churches built at different period of time and the builder. To name a few of the Gothic churches in India, especially in South India – St. Joseph's Cathedral (St. Philomena's Church), Mysore; St. Mary's Basilica, Bangalore; San Thome Cathedral Basilica and St. George's Cathedral, Chennai; Shrine of Our Lady of Health, Velankanni, Thanjavur; Church of Our Lady of Dolorus, Trichur and so on.

Authentication of the Gothic Church Architecture

The authentication and identification of the Gothic architecture depend solely on the character of the architecture and styles. The Gothic church architectural designs introduced in India was cross-shaped plan, which became increasingly popular. One can easily authenticate the Gothic church architecture from its high rise altarpieces heavily ornamented, rose windows above the main archway, stained glass windows, high ribbed vaults, variety of arches specially pointed arches supported by columns with ornamented capitals, spires of great heights mostly served as belfries are the distinct characters of the Gothic church architecture.



Details of flying Buttresses Columns, Capital, Pointed Arches, Ribbed Vaults etc.

In order to authenticate the Gothic architecture, one should have the knowledge of the architecture and its styles; should be a keen observer and should have a critical mind to identify the variations, materials used and so on.

Conclusion

Churches are living buildings where the worshippers do visit on a regular basis. By this very act, the church buildings to an extent are conserved and conservation activity is undertaken on a continuous process. Churches seldom become redundant in India. Finally, the Gothic churches are to be identified, maintained, conserved, and restored wherever necessary for posterity.

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GENERAL

19 Identification of the Ethnic Indicators in Authenticating of Ethnographic Artefacts of a Culture Area

*C. Maheswaran**

Introduction

Realising the fact that the existing criteria in authenticating artefacts such as 'iconographic features', 'style', 'material used', 'technique employed', 'degradation status' are not useful in authenticating the ethnographic artefacts and as the methods of authentication are subjective and aesthetic, on the one hand, and objective and scientific, on the other hand an attempt is made in this paper to find an appropriate, alternative criterion. Consequently, it is realised that the ethnic indicators that are present and identified in the ethnographic artefacts alone could be taken into consideration as the apt criterion in authenticating them. The 'concept of culture area' is employed as a suitable approach in identifying those pertinent ethnic indicators. To illustrate this, the Nilgiris in Tamilnadu as the culture area is taken up for study, considering the wide spread presence and use of two indigenous ethnographic artefacts of aerophone category within this territory.

Historical Background of the Theory of Culture Area

Franz Boas and Clark Wissler while working as consultants in the American Natural History Museum and the Chicago Field Museum opposed the presentation of artefacts on the evolutionary sequence as that of Stone Age, Bronze Age and Iron Age. Further, they instruct to abandon the practice of presenting the artefacts on 'Comparative Method', which was prevailing at the European Museums. Ultimately, both of them adhered the presentation of the artefacts of the American Indian tribes on region-wise, having realised that the presentation of artefacts on the basis of linguistic family-wise became non-satisfactory.

Wissler who indulged in such presentation got inspiration that on how the culture traits of an area both unifies and differs with each other on certain lines. Consequently, he could propose the 'Theory of Culture Area'. According to him, "a region, which has a relatively similar way of living common to its component socio-economic systems and cultures, is referred to as a 'Culture Area'(Taylor, 1986:38). This concept is more relevant to deal with the material culture as it is based on the source of the artefacts and accordingly this concept is used primarily by the museum curators.[1]

The salient features of the concept of culture area are enlisted as follows:

i. The traits of a culture area whether they are of environ ment, religious beliefs or socioecon- omic systems or cultural materials always remain homogeneous and consequently that culture area becomes a distinctive culture area;

ii. The different ethnic groups occupying a culture area though differs slightly with one another will possess all the salient traits of that culture area and thus they form the 'typical culture' of all the ethnic groups that occupy the particular culture area;

iii. The ethnic groups, which occupy a culture area away from its 'culture centre' will possess a slightly lesser traits of that culture area; and

iv. The ethnic groups that occupy the periphery of the culture area will show impacts of the traits of the neighbouring culture area along with the traits of their own culture and thus exhibit a 'marginal culture'.[2]

The Nilgiris as a Culture Area

The Nilgiris popularly known as the 'Blue Mountain' occupies the prime portion in the Western Ghats of Indian sub-continent. This is designated as the 'Tribal District of Tamil Nadu' as it accommodates more tribal groups (viz. Todas, Kotas, Bettu Kurumbas/ Urali Kurumbas, Halu Kurumbas/ Alu Kurumbas, Jenu Kurumbas) Kattunaickas, Mullu Kurumbas, Irulas, Paniyas) than the other districts in the State. Apart from these indigenous tribal groups, there is yet another indigenous but non-tribal group known as the Badugas has been inhabiting the Nilgiris since 1603.

Each of the tribal groups of the Nilgiris exhibits an exclusive culture of their own, despite an underlying unity among them, fetching the status of culture area to the Nilgiris.[3]

Presenting of Case Studies in Identification of Ethnic Indicators

Government Museum, Udhagamandalam in the Nilgiris has acquired long flute like aerophones made out of a unique variety of bamboo known as 'Bugiri', from the indigenous ethnic groups such as Todas, Kurumbas, Irulas and Badugas during 1990-1997. On scrutiny, it became evident that the bugiri of these communities differ from each other, based on the presence or absence of certain traits in them and these traits are identified as the ethnic indicators, in authenticating these artefacts to one particular ethnic group over the other.

Likewise, the indigenous ethnic groups of the Nilgiris such as Kotas, Kattunaickas, Irulas and Paniyas are found to possess a shenai like aerophone known variedly as 'Koalu' (among the Kotas), 'Kolalu' (among the Kattunaickas), 'Kwaalu' (among the Irulas) and 'Cheemam' (among the Paniyas). As in the case of the bugiri, these shenai like aerophones of the above cited indigenous people differ from one another either in contour or in the method of performing them and consequently these tangible or intangible traits (as the case may be) are identified as the ethnic indicators, in authenticating these artefacts to a particular ethnic group over the other. Accordingly, two case studies are presented here in detail, in aiming at authentication of these ethnographic artefacts.

Case Study I: Bugiri [4]

To prepare a bugiri, in general, a long slender bamboo (about 75 cms in length) having oppositely faced curved inter nodes is selected. Six holes in equi-distances are made on this bamboo stem, by means of a sharp, pointed red hot iron rod. In fashioning the bugiri further the Nilgiri indigenous communities differ from one another. For instance, the Todas affix a slightly broader, hollow bamboo structure (known as 'hosaar' in their language) to its distal end in order to ensure a better performance; the Kurumbas cut the oppositely facing inter nodes in such a way, leaving the downwardly pointed projections of them in a slanting

Todas Playing Bugiri

manner; the Irulas shape the bugiri, by pruning away the inter nodes completely; the Badugas fashion their bugiri with inter nodes as lunately curved projections as the Badugas attribute this shape as the symbolic representation of the horns of the sacred buffalo belonging to their Mother Goddess, Hethai Amma. While performing with the bugiri, the Badugas plug the sixth hole of it permanently; contrary to this practice, all other indigenous communities make use of only the five holes, by blocking the sixth one with fingers while playing it. Further, while the Todas use this aerophone both to mesmerize their buffalo herd and to exhibit their individual talents in competitive spirits during their leisure time the Badugas have incorporated this musical instrument within their socio-religious observances. For example, to soothe on ailing patient or to console a large gathering of bereaved relatives who assembled near the corpse of their deceased kin or to make a restless baby to embrace sleep the Badugas play this instrument.

Case Study II: Koalu/Kolalu/Kwaalu/Cheeman [5]

This aerophone varies in appearance from one ethnic group to the other. For instance, the 'Koalu' of the Kotas is ornate in appearance with embellishments in metal over most of its body; contrary to this, the 'Kolalu' of the Kattunaickas is a drab artefact devoid of any such embellishments; 'Kwaalu' of the Irulas is fashioned in and out with indigenous materials such as wood, fibre, grass, beeswax and so looks ornate but simple; while the Paniyas attach a crescent shaped mouth guard of coconut shell so as to arrest any possible leakage of air while blowing the air stream.

In performance also this aerophone differs from one ethnic group to another. For example, the Irulas are able to play their ' Kwaalu' continuously for several hours while the Kotas perform with their 'Koalu' only intermittently by taking momentary intervals; the Paniyas could play their 'Cheemam' in a relatively longer duration; whereas the Kattunaickas perform with their ' Kolalu' for a comparatively shorter duration.

Conclusion

The variations so far observed, from the aforementioned discussions, such as 'presence or absence of embellishments', 'differences in contour', 'style, method and purpose of performing' could be identified as the differentiating traits and consequently they could be identified as the ethnic indicators for that particular ethnic group. And based on such identified ethnic indicators, one could authenticate the ethnographic artefacts, concerned. Thus, we could realise that the criterion of ethnic indicators could play a pivotal role in authentication of ethnographic artefacts within a culture area.

Foot Notes

[1]Based on the concept of culture area the major land territories of the world are divided into various culture areas for the purposes of study. For instance, 'Asia' as sub-divided into 'North Asia' and 'South Asia'.

[2]This concept of culture area is not free from shortcomings, observe the Anthropologists. For instance, (i) It is often difficult to distinguish a marginal area and (ii) Important ethnic groups in a culture area may not possess some of the supposedly distinctive traits of that culture area.

[3]Such underlying unity among these ethnic groups of the Nilgiris could be attributed either to 'Cultural Diffusion' or 'Parallel Evolution' or 'Psychic Unity of Mankind'. To pin point the

factor that binds them one has to carry out an extensive study in this 'Culture Area'.

[4] For details refer Maheswaran, C. 1997. (Cf. Select Bibliography of this paper)

[5]For details refer Maheswaran, C. 1997. (Cf. Select Bibliography of this paper)

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20 Authenticity and Conservation of Antiquities

*V. Jeyaraj**

Introduction

Authentication is a must in the case of all preserved antiquities in museums, temples, churches etc. Various methods of authentication are available in the behest of conservators and conservation scientists enabling them to prove the authenticity of the objects preserved in the museums. The authenticity of objects is very important at the time of purchase, loaning etc. Museums are practicing various traditional methods like iconography in the case of bronze icons, the appearance etc. But scientific methods are very much needed to authenticate objects of rarity and if infrastructure, time and money permit for all objects. While one authenticates the objects, he should conserve the objects also.

Authentication Procedures

Authentication procedures are physical, chemical and a combination of both. These procedures are sometimes destructive and at times non-destructive. Conservation is to increase the life of the object. Therefore any disfigurement to the object will be detrimental to the conservation of the object concerned. Therefore it is always mandatory that the authentication procedures should always follow non-destructive methods.

Conservation of Antiquities

Our cultural Heritage is superb but their preservation is neglected and there fore it is essential to safeguard them for posterity. In order to preserve them a rudimentary knowledge of conservation and related subject should be available to those who are in possession of such property or dealing with them.

All forms of direct and indirect actions aimed at increasing the life expectancy of (an) undamaged and or damaged element(s) of cultural property are termed as *conservation.*

All forms of direct action aimed at enhancing the message(s) carried out by (an) damaged element(s) of cultural property are termed as *restoration.*

There are three types of work in the museum. They are:

1. Preventive Conservation
2. Curative Conservation and
3. Restoration

Preventive Conservation

All the collection in a museum are sound, stable and some are damaged. What ever may be the condition of the objects preventive conservation is essential. A team of people in a museum may do this.

Curative Conservation

In a museum about 2% of the collection may be in need of curative conservation. When a unique piece is actively damaged, it needs curative conservation. It is an urgent and vital process to be carried out by a trained conservator/restorer.

Restoration

About 10% of the objects in the collection of a museum are in a damaged condition. The priority of the treatment is secondary. A trained conservator-restorer may do restoration. Some objects are in need of only conservation. Some objects are only in need of restoration. There are objects, which are in need of conservation and restoration.

Museum

Museum is a non-profit making permanent institution in the services of the society and of its development and open to the public, which acquires, conserves, researches, communicate and exhibits for purposes of material evidence of man and his enjoyment.

Aggressions of Cultural Property

The aggressions or the deteriorating factors of an object can be natural or man made. They may be by the environment, building and staff. The natural aggressions may be lead to immediate destruction or progressive destruction.

Immediate Destruction

Immediate destruction to the cultural property may be brought about overnight by flood, fire, earthquake etc.

Progressive Destruction

Progressive destruction is also natural one. This is brought about by environmental pollution due to air, dust, moisture, heat, light, micro organisms, wind, salt and intrinsic factors like chemical changes with in the material, physical changes etc.

The man made aggressions are classified as public aggression and professional aggressions.

Public Aggression

The public aggression is mostly due to unawareness. They are such as vandalism, encroachment of a declared monument or site, more tourism attraction, theft, war and terrorism, urbanisation, misusing the cultural property.

Professional Aggression

The aggression due to the professional mishandling of the antiquities and cultural objects is called professional aggression. This is due to the lack of awareness, planning, training, security, control and improper execution of curative conservation, restoration or, transport, storage, exhibition, support, lighting, handling, maintenance etc.

Strategy for Conservation

For better conservation of the cultural property, a systematic strategy is to be adopted. There are seven steps for the conservation measures to be taken. They are:

1. Know your collection
2. Categorise and identify the aggressors
3. Avoid the aggressors
4. Block the aggressors
5. Check or monitor the aggressors
6. React against the aggressors
7. Communicate.

The preventive conservation measures may be taken on the above lines.

Classification of Museum Objects

Any object representing art, culture etc., preserved in a museum qualifies itself to be a museum object. They vary from one to the other due to nature, type, property etc. their vulnerability to damage and their control measures also differ.

Depending upon the type of treatment to be given to the objects they can be classified as follows:

1. Metals
2. In-organic objects
3. Paintings

Metals

Metals and alloys form major portion of museum collections. They seem to be stronger but not durable. They are mostly archaeological collections and are exposed to air from ground and are found to be corroded mostly. In the ancient times objects made out of gold, silver, copper, lead, iron etc., were used and now are available in the museums, which have to be preserved for posterity. The corrosion products either should be removed or stabilised to extend the life expectancy of the objects as well as to provide maximum message from the objects.

Organic Objects

Materials derived from living organisms such as plants, animals etc., are called organic objects. Textiles, ropes, paper, palm leaves, wooden objects, leather, feather, bone, ivory, etc., are some of the examples. Organic objects are the weakest of all types of museum materials. A bad environment will very easily damage the objects. Therefore it is essential to give more attention towards these types of objects.

In-organic Objects

The objects, which are not organic, are called in-organic objects. Mostly they are earthen matters. They include stone objects, terracotta objects, glass objects, beads, stone implements, etc. They are composite in nature and are durable when compared to the other types of objects. Due to the long burial in the earth most of them weathered, absorbed salts, crumbled, and many have survived the ages.

Paintings

Paintings are complex in nature. There are different types of paintings. They are:

Cave paintings, wall paintings, oil paintings, miniatures etc. whatever may be the medium, type, and variety, the paintings are multi layered and therefore, they require special study.

Atmospheric Factors Affecting Museum Objects

Atmosphere plays a very important role in the deterioration of museum objects. Atmosphere consists of light, heat, pollutants, oxides of sulphur, nitrogen and carbon, ozone, etc.

Light

Light is a form of energy, which can change colours and bring about deterioration on the surface of delicate objects such as paintings, drawings, textiles and other organic objects. Light brings down the strength of the objects. The light can be divided into three divisions. They are ultra violet radiation (300-400 (m), visible radiation (400-700 (m) and infra red radiation (700 ηm and above). The light of wavelength up to 500 ηm brings about degradation on materials by photochemical reaction.

Heat

Heat is one of the factors, which affects the museum objects. Low temperature avoids the biological growth on museum objects. High temperature makes the objects to disfigure and increase the speed of chemical reaction. Textiles, paper, wood, etc., very easily get charred due to high temperature. The ideal condition of temperature will be 20 to 22° C.

Humidity

Humidity is nothing but the moisture present in air. This is measured in terms of Relative Humidity (RH). The high relative humidity will make the organic objects to swell there by encouraging biological activity and inorganic objects to absorb moisture into the pores present in the body along with salts and harmful salts. When the relative humidity is low, organic objects lose water and get shrunk. In the case of inorganic materials, the absorbed salts get crystallised and the surface scaling takes place. In general for any type of museum objects the RH should be in between 45% to 60%.

Air Pollution

The pollution due to the pollutants present in the air is called air pollution. The various pollutants, which are dangerous for the museum and archaeological objects are oxides of carbon, sulphur, nitrogen, ozone, salt spray and various organic gases. The various oxides combine with the moisture present in air and form acidic substances, which affect the objects at large. The salt sprays are absorbed by the stones, which result in the breaking of the surface layer.

Sound and Vibration

In the case of very weak archaeological objects such as unbaked terracotta objects highly mineralised metallic objects crumble due to the vibration due to sound and vehicular traffic.

Bio-deterioration

The deterioration brought out by biological agents such as fungi, moss, dry rot, liverworts, lichen, plants, bushes (botanical), insects, rodents, birds, animals (zoological) etc. almost all types of museum objects and archaeological objects are affected by these agencies. These agencies will bring about some symptoms on the objects. Stains, discolouration, disfigurement, pitting, tunnelling, firbillization, powder formation, development of odour, changes in the physical properties are some of the symptoms, which will be seen on the objects when they are affected by the organisms.

Control Measures for Bio-deterioration

All organic objects when brought to the museum should be fumigated in a fumigation chamber. Thymol, para-dichloro-benzene, carbon di sulphide, carbon tetra chloride, methyl bromide ethyl bromide, ethoxide are some of the common fumigants used.

General Treatment for Insects

There are two main methods of treatment for the insects in the museums. They are:

1. Fumigation with fumigants or insect repellents and
2. Dusting, spraying or fogging of the insecticides.

Fumigation

Fumigation is nothing but keeping the insect infested objects in an airtight chamber where volatile chemical like thymol, para-dichloro-benzene, carbondisulphide, methyl bromide, ethyl bromide, carbon tetrachloride, naphthalene, or ethoxide. In case the archival materials are affected by insects etc. it is better to fumigate with in a giant fumigation chamber under vacuum. The insect prone museum objects such as textiles, paper, leather etc. should be fumigated before the monsoon starts.

Application of Chemicals

When the application of insecticides either by spraying, dusting or brushing, care should be taken to avoid the health hazards. 5% solution of DDT, BH C, 0.01% solution of para-nitrophenol, mercuric chloride etc., are suitable for the eradication of insects.

General Treatment for Cryptogrammic Plants

Bacteria, fungi, algae, lichen, liverworts and mosses constitute the Cryptogrammic plants, which affect museum materials.

Among these, only fungi generally pose very high threat to museum objects. Organic objects like wood, paper, textiles, leather, proteinaceous materials, and paintings are damaged on account of the mould growth. Since moisture is the very important requirement for the growth of bacteria and fungi, humidity control is the best preventive measure. Air conditioning will serve this purpose but it will be out of the reach of most of the museums. Even if the air conditioning is done, it should be throughout the day and night.

Insect Trapping in Museums

Insect trapping is getting importance in the pest control in museums. Insect traps in general consist of the two components an attractant and the killing or retention part. There are various systems available and all systems can not be used in the museums. The best system is sticky type of insect traps. There are two simple traps. One is the window type and the other is the prism type. In both the systems the insects attracted to the traps are stuck to the sticky surface. Knowing the type of the insect suitable insecticide or insect repellents or fumigants can be used.

Non-toxic Pest Control in Museums

The toxicity of the chemicals used in the eradication of insects affects the persons who handle them and also the visitors to the museum. There fore in the recent days non-toxic methods of pest control have found place in the museums. Low nitrogen atmosphere is created to the objects, which kills the insects and also saves the objects of organic nature.

Freeze Drying

Freeze-drying is a very good method of treating the organic objects to save them from the biological agents. The organic objects are covered with polythene covers and deep-frozen at a temperature of about -22°C. This method keeps off all the biological agents from the museum and archaeological objects of organic nature. In the European countries this method is in vogue. The objects when treated in this way keep of the spores also from the objects. Once in a year the objects can go for deep freezing.

Mishandling, Neglect and Vandalism

Some times the damage caused by the handling of the objects both by the staff and the visitors. It is very essential that care should be taken in such a way not to damage the objects. Many damages to the museum and archaeological objects are attributed to the poor handling, lack of training to staff, neglect and vandalism.

Mishandling

Human factors such as improper handling, not having the basic knowledge about conservation may result in serious damage to the objects. This may occur in the gallery, laboratory, and storage or during transportation. Careless handling of object results in soiling, dents, scratches, abrasions etc. damage occurs when objects are dropped. They tear or break when outsized objects are hand-carried instead of being transported on trolleys. Objects break when they are lifted from the point of weakness. Surface of objects get damaged when surfaces of objects are dusted or cleaned with coarse or soiled cloths, brushes or vacuum cleaners carelessly.

Neglect

Neglect of museum objects results in various problems. Areas where any type of work on art objects is done must be kept absolutely clean. Very often it is noticed that perspiration and grease of hands stain art objects. The natural oils from hands deposited on objects attract dust, which is chemically harmful. It is advisable to wear clean cotton gloves when handling objects of art, or to use a clean cloth between hands and the objects. Hands should not touch painted surfaces as in the case of miniatures or manuscripts, photographs or slides and negatives.

Vandalism

Vandalism is a deliberate act by which damages are made on the objects of art and culture. Acts of true vandalism are fortunately few in India. The visiting public are generally respectful of the works of art and culture on display. But, it is noticed that the visitors used to scribble or write their names on the antiquities when the guars are not watchful. Other instances of willful damage can be attributed to political, religious or racial fanatism.

Vandalism can be controlled to a great extent by carefully guarding the objects in a gallery. Physical or psychological barriers, such as rope and stanchions, elevation of floor and total encasement of objects in showcases will avoid the vandalism. Electronic devices will give signal when objects are touched. In the British Museum, London electronic alarm based on the shadow caused on the objects makes the guard on duty to keep vigil on his duty so that such vandalism can be avoided.

Whether mishandling, neglect, carelessness or vandalism, the damages can be reduced to the minimum by the close monitoring and regular inspection of the objects. Training to the staff in the maintenance of the objects will keep the damages reduced considerably.

There are occasions in which the cultural heritage is damaged with out proper knowledge about them. For example in many temples wall paintings and inscriptions have been lost because of the renovation of the walls without knowing the importance of such information.

Examination of Objects

In order to decide on the strategy of conservation, the objects, which are affected, should be examined visually, instrumentally and chemically. Using a magnifier the condition of the objects should be studied. The surface should be watched for the presence of deposits. The alteration products may be studied by chemical analysis. If necessary instrumental analysis like X-ray diffraction, XRF Studies may also be done. After finding out the nature of defects, the type of conservation can be effected.

Chemical Conservation of Cultural Property

Chemical conservation is a subject, which has to be dealt with by a professional conservation chemist or conservator. Anyhow it is better for any one who is in charge of the cultural property or one who is interested in the conservation of the cultural property under one's charge.

Metals

Metallic objects, which are badly corroded, should be consolidated with the help of a consolidate like poly vinyl acetate.

Wooden Objects

Wooden objects normally take the stain by oils, dust, insects etc. They may be cleaned with the help of organic solvents like benzene, acetone, rectified spirit etc.

Stone Objects

Stone objects are affected by moss and algae and look like black painted objects. The black coating is removed by brushing with a dilute solution of ammonia and a dilute solution of calcium/ zinc silicon fluoride is coated on the objects.

Painting

Paintings are of different varieties and their care varies from painting to painting. Only an experienced restorer should carry out the restoration of the paintings.

Conclusion

It is better to have a basic knowledge about conservation. But it is advisable to avoid using chemicals, as the improper usage of chemicals will harm the cultural antiquities. In case of chemical treatment of antiquities experts should be consulted.

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21 Conservation of Art Objects with Special Reference to Their Authentication

*A.S.Bisht**

Introduction

The National Research Laboratory for Conservation, Luckow (NRLC) was advised by the Department of Culture, Government of India to organize a National Seminar on Authentication of Art Objects at Lucknow during the late eighties. This actually was on a suggestion from Late Dr. S. Paramasivan, a great Conservation Scientist who worked for the Archaeological Survey of India till his retirement and was earlier the founder Curator and Head of the Chemical Conservation and Research Laboratory of the Government Museum, Chennai, to the then Scientific Adviser to the Government of India. The NRLC accordingly invited scientists working in various institutions of the country namely the NRLC, Lucknow, Indira Gandhi Centre for Atomic Research, Kalpakkam, Central Forensic Science Laboratory, New Delhi and Kolkata, Science Branch of the Archaeological Survey of India, Dehradun, National Museum, New Delhi, and various other institutions and museums of India to participate.

The aspects of authenticity got a momentum after the two great exhibitions held in the Asia Society Galleries, New York on the subject "The Real, the Fake and the Masterpieces" (1988) and the exhibition on "Fake? The Art of Deception" (1990) held at the British Museum, London. It was further discussed at the conference on Authenticity (1994) organized by the UNESCO, ICOMOS, ICCROM and the Agency for Cultural Affairs, Japan at Nara. It was once more deliberated at a National Seminar (1997) on "Issues of Authenticity of Antiquities" held at the National Museum, New Delhi and was jointly organized by the National Museum, the NMI and the IGNCA, New Delhi. The subject was further discussed at the International Seminar (2005) held at the Government Museum, Chennai, which was jointly organized by the Government Museum, Chennai and the Indian Association for the Study of Conservation of Cultural Property, New Delhi. It looks that in India we were still debating whether Authenticity is a myth or reality. Incidentally, I have been a great supporter of studies on authenticity of art objects for some time now which is clearly seen in my writings ever since I was in USA and had seen the procedures of acquiring artefacts at the Metropolitan Museum of Art (M.M.A), New York. One of the interesting points related to this aspect in the procedure of acquiring art objects at the M.M.A., New York has been to study their authenticity issues prior to the acquisition for the museum. Unfortunately this aspect of study has not impressed the authorities of the country and I have not pursued it after my retirement in 1991.

Need for Authentication

The art objects, which were being acquired for museums a few decades back were mostly genuine but we may not be very sure of some of them these days. Fakes may enter the collections through the art dealers of disrepute. Before my retirement for about ten years, I got quite a few artefacts returned to their owners as per prevalent rules at that point of time and saved at least a few lakhs of rupees of the government. To me it looks that there are some valid reasons for it. One of the reasons may be that when we acquire artefacts we do not insist with sellers to disclose the source from which they got these before possessing them. The usual answer being that these are part of their family possessions. This is doubtful and gives rise to many questions. These may have been in their possession from the sources they do not think proper to disclose. Museums also do not insist to acquire only those artefacts which are registered with the Archaeological Survey of India under the Antiquities and Art Treasures Act 1972 or are covered under the Treasure Trove Act of 1878 or are not covered under any other relevant Act on the subject.

I am told by sources connected that the British Museum, London also did not know of the fake objects in its collection at the time of their entry. It is, therefore, a high time for us to amend our acquisition procedures before it is too late. Another point to consider, in this regards is the fact that many museums are not able to cope with the conservation of artefacts already in their collections themselves and are engaging private conservators/ restorers who undertake work on contract basis. Needless to say that they do not stop art acquisition even though they are not able to cope with the care of their collections already in house. On the one hand they always lament for more funds and on the other they can award contracts to private restorers very liberally or spent their total budget on other works of their choice. It has been my experience that most of our museums spend very nominal budget on the conservation of their collections or acquiring latest equipments for their own laboratory so that latest equipments and materials are used for conservation of artefacts in their collection. This would also encourage their own staff to be better equipped for their professional work. It is of importance that our artists and artisans are supported to keep their traditional art and crafts alive so as to preserve our ancient heritage for posterity. But it is also necessary to be true to the profession in reporting the period of creation. In no case they should try to artificially change their look. There should not be any exploitation of the artisans by the art dealers so as to pass them as antiques to our guests from abroad. This brings a bad name to the country. There should not be any objection in selling such works of art and crafts as of recent origin. We must, therefore, review the problem of fakes entering a collection and also authenticate our artefacts already in the collection and those have been purchased in the recent past. Traditional crafts are the authentic expressions of the traditional society and they can not be authentic of the present. No one should try to use the same materials for making crafts.

Authenticity - Definition and Meaning

This is very necessary to maintain the authenticity of an artefact for all times to come as a reference for future. We should also try to do proper conservation management and planning to save authenticity of an artefact by documenting the various peculiarities of it by way of fingerprinting them. Minute scientific examination and documentation should be completed of, at least of the objects of national importance so that they can not be copied or replaced in any way. This is also necessary to do before any conservation, which is sometimes termed as intervention with originality by some art historians, of an artefact especially when doing some replacements and strengthening, if it is felt absolutely unavoidable. We must keep these experts in confidence and we should have answers for their satisfaction. Publications of the faithful reports on replacements would never violate authenticity. Artefacts, which are original, having creative source and are unique in nature which can sustain and prove themselves. They are related to the historic continuity in the life of the heritage resource and can also show the same. They can prove the authority which is legally valid, are reliable, genuine, original and relates the work of art to itself, the place, the artist and the period attributed to it. It proves the form, material, aesthetic, artistic, historic and cultural values even though there is no witness of those days available at this point of time.

Problems in Authentication

It should be the endeavour of the conservators not to reconstruct a damaged artefact by introducing their own art in it. We should keep in mind the past documentation textual or graphic or on models or photographic and act very judiciously having respect for the sentiments of the artist foremost while taking the final decision as to what is best so as to respect the authenticity of this particular art work under the present circumstances. Young nationalism may advocate reconstruction of ancient monuments and artefacts with no respects for real values, which are inherent in authenticity of tradition, study them first and accordingly save their hidden values if they stand on reasoning. Conservation thus is a cultural problem first before being technical and scientific. It is also a policy matter without falling into trap of reconstruction and /or of faking.

We should also keep in mind that the reconstruction may conceal all the evidences of the past loss and betray the style, period and provenance of heritage resulting into falsification of authenticity and could thus be art historically misleading. It can betray the aesthetics and affect the past beauty of the original or it originality. Museums represent man's creative spirit and the museum objects are no more pieces of worship, as they might have been at one time, since these have now a new identity as works of artistic and historic importance. Accordingly, therefore, the losses if suffered by them in the past such as broken arms, legs, heads and all facial features such as nose, eyes, lips etc., have to be preserved as found at this point of time. There are many examples of such an action world over including India.

Suggested Measures

All museum personnel should insure that at any cost further damages do not occur to the artefacts while they are in a collection as the safety of artefacts, after their entry in the collection is the collective responsibility of every one working in the museum. We can understand that with the opening up of our economy selected effluents of our society are acquiring artefacts for their use or as a saving. On the other hand more and more people of our middle class of the society also want to have art works for their own use at home but can not afford artefacts and hence the demand for replicas has grown many folds. In order to safeguard the authenticity of our cultural relics of the past, museums have a great responsibility on their shoulders that they should not allow making of replicas of the same size as that of the original artefact to deter their possible replacement of originals from the collection and their replacement by replicas. This could indirectly promote genuine art pieces disappearing from India and ultimately landing in other countries. This has happened in many cases in the recent past e.g. Sivapuram Nataraja, a considerably large size bronze from Tamilnadu and Amin pillars from Haryana to cite a few examples.

As a possible deterrent to such illegal acts, it is high time that fingerprinting of our moveable heritage has to be undertaken without loosing much time as a national policy to be strictly adhered to by one and all. For this purpose we could take the help of the strides made by science and technology for scientific examination and recording of all possible details internally and externally. This could be taken up as special projects by museums in each State of India one by one for each category of artefacts. To begin with we can take up such a study covering the best of our treasures. I know it is a major task but sooner it is started earlier it would be completed. Another advantage of this project would be that the present state of their condition could also be recorded without much effort as a nation wide policy. Hopefully if this is adhered to, as a policy by one and all, it is going to help in the long run.

Conclusion

A few years back the Department of Science and Technology, Government of India undertook such a project with the help of (IGCAR) Indira Gandhi Centre for Atomic Research, Kalpakkam at the Government Museum, Chennai for the fingerprinting of bronzes in their collection very successfully. This could be further enlarged to cover many other museums of India by pooling all our resources, facilities and expertise together to achieve it as a national project for the preservation of authenticity of our cultural heritage.

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22 Cultural Heritage Conservation and Juridical Framework

*Stéphane Ipert**

Eurindia

EurIndia is developed in the framework of ECCP: European Union-India Cross Cultural Economics Programme. The aim of EurIndia project is to survey and preserve historical archives on textile trade between Europe and India. The Indian partners are the Delhi University and the Punjab State Archives

Artefacts Conservation Laws

It a strange and unusual combination. In Europe, legal aspects of conservation are becoming more accurate and evident. I will present a series of juridical questions to draw your attention on the legal basis of our common activities. Some of these may seem abusive or exaggerated; like the American way of treating everything with lawyers.

Different levels of laws must be considered: International conventions, national laws and rules, and in Europe, we have now European legislations, which are in reality above national laws. But this European legislation gets enforced with a very slow process of application.

International Conventions

The international conventions are:
Convention for cultural heritage protection in case of war and armed conflicts , The Hague, 14-05-54.

Convention on illegal exportation and importation of cultural heritage artefacts, Paris 5-02-86 and Rome 24-06-95.
WIPO conventions for intellectual property, which must be transferred into each national law system.

Artefacts Conservation and National / European Laws

Several juridical frameworks must be studied separately because they all must be respected.

Intellectual Property Laws

Author rights; derivate author rights
Property Bases and Laws

Intellectual Property Principles

Originality of the artistic and intellectual creation

→ Author rights, derivate rights
→ Financial advantages
→ Independence of the use, due as soon as a public presentation occurs
→ Moral eternal control (in Europe) creating in our job Regarding photography of artefacts objects: It depends on countries' jurisprudential decisions:
→ in the US, the reproduction of a painting is not an art but this is not clear for objects.
→ in Europe, most countries are also saying that it is not a creation, but it is always jurisprudential decisions with all its risks.

What about Partial Photography (like the detail of a painting)?

They may be protected by Author Rights for the photograph (or anybody who did the picture). For 70 years after the death of the photograph, money can be asked for, but there are some difficult cases like public servant photographs (employees of a museum) who have no financial advantage, but moral rights for ever.

Regarding conservation, some conservators had gone to justice courts in several countries since a few years! They argued that their work reveals a new art object or painting and they asked to be considered like 'derivate authors' like a pianist, who plays Mozart has an author right on its interpretation.

Considering conservation as an interpretation of art is a nice idea but till now none of the juridical courts has decided to follow conservators in their demand. Moreover, if conservation follows professional rules, it can not be considered as original. No author rights are available.

The legal basis for public institutions to ask for reproduction fees are for commercial or public purpose. No author rights can be argued unless for partial photography or representation of an art object still protected by author rights (20th century art and architecture… even modern changes by an architect in historical building).

When author rights are not possible, then the legal basis of reproduction fees disappeared while in most of the European countries these fees are quite high mainly for public presentation (publication, exhibition or virtual use on websites …)

→ More than 100 $ at the Victoria & Albert Museum, London for one Indian object photography in provincial city.

Some juridical courts did even consider that fees as illegal but public institutions continue their 'financial strategy'.

In France, Some Legal Basis Could Justify these Fees

The 'use for occupation of public domain':

It is an antique and Roman tradition in our 'Latin' law. For example, this is the argument of the Bibliothèque Nationale de France in Paris. The advantage is that the fees can be adjusted depending upon the eventual profit of the user, e.g. a picture of Taj Mahal should be 'sold' more than a small and unknown temple.

The problem of public domain arguments is that one should provide to the user exclusivity on the photography's use … it is not suitable for cultural institution who may 'sell' several reproductions of the same artefact.

'Specific Services' from the Administration and its Staff

It is not a tax (which should concern all citizens following voted rules), but a service offered like a museum entrance ticket (a service for a specific user) or a conservation treatment made by a public institution for a private collection. These specific services should be adapted to the real cost for the institution and not in reference with the profit of the user.

'Service fees' is legal, but offers small profit to the institutions (it is like photocopy fees in a public library; the price is adapted to the real cost for the library).

Therefore,: what should be done if the photography has not been done by the institution?

In France, an institution cannot ask for 'reproduction fees' if it has not done the picture.

Unless, if there is a specific work from the public institution staff derangement fees e.g., a Conservator or a Curator has to assist the private photograph; the photographer is doing its picture outside of the normal opening hours of a museum.

Can an Institution Forbid to Photographing Artefacts?

It is a difficult situation. Access to cultural heritage, which is a 'common' heritage, is a basic right in the constitution. In case of commercial profit, some European countries have some specific rules, which allow fees.

In the specific situation of new discovered artefacts, the owner has 25 years of 'authors protection'.

In the case of historical monuments, this is quite new, Cassation Court (High Court of Justice) just recognized the owner of a building isn't owner of the image of the building. If the institution takes itself the picture, photographic service can be charged; but no right of reproduction.

An institution cannot forbid doing photos of monuments, even if they do in some cases, it is illegal.

Property Right

Public commons are not concerned?
There are some specific cases of French artefacts where objects and monuments are owned by the Nation since the French Revolution (1789). Private collectors can restrict the reproduction and ask for fees (contract).

Conclusion

Juridical aspects are more and more present in museums and cultural institutions in Europe.

Conservators should know legal rules to preserve the specificity of their job and avoid excess of commercial management for cultural activities

Museums must accept the 'fair fees' and should not limit the access to collections.

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23 Digitization as a Way of Authentication: The Experience of Tamilnadu Archaeology Department

*T.S. Sridhar**

Introduction

The value of conserving our art treasure is an urgent need and has been stressed by those who are concerned with conserving and restoring them. There should be measures to protect art and cultural objects from theft and illegal trafficking. Hence the trafficking and faking of antiquities would be easily identified and kept under control and also made tougher for persons practicing illegal methods. There are both international and national Laws enacted and existing to stop these illegal actions. The word authenticity can be defined as genuineness of a thing. The authenticity depends on some parameters like the period, material, the location of the object, etc. The foremost necessity is to check the parameters mentioned above. Some equipments are necessary to study the parameters also. Before the advent of hi-tech in the field of archaeology, mostly the departmental staff were to rely on the personal judgment of the scholars, curators, epigraphists, archaeological officers etc., in documenting the art objects; they neither had the facility in their institutions, nor they were aware of its utility. Hence, there is a need for the creation of a master data bank. Even the soil adhered to the object while excavating should be analyzed and compared with the soil of the site from where it was recovered and the results should be included in the data bank. This could help in substantiating the claims of ownership when lost and recovered. Retrieval of the Nataraja bronze icon from Pathur, Thanjavur district, Tamilnadu, which was treated in the Conservation Laboratory, British Museum, London can be cited as an example for the above. This idol was exported to foreign land stealthily. During the legal battle many authentication proofs were produced. One among them was the report on the analysis of mud particle sticking to the inner part of the pedestal, which proved that it originated from Pathur. This legal battle was won by Dr. R. Nagasamy, former Director of the Department of Archaeology and Prof. P. Chandrasekaran, then Director of the Forensic Science Laboratory, Government of Tamilnadu, Chennai. There are several ways and means of establishing and identifying the original materials. Digitization is one such method.

This article discusses the authentication of art objects in general and digital photography, a way of authentication in particular. The most important, essential and fundamental activity for the identification of any art object is that it should be well documented. Various measures adopted by the Department of Archaeology with regard to digitization as one of the means for identifying the authenticity of an art object are discussed in this paper.

Department of Archaeology and its Activities

The State Department of Archaeology was started in the year 1961 with the prime intention of conservation and restoration of ancient monuments in Tamilnadu and to conduct excavations at historical sites. Later on, the activities were expanded to copying and deciphering of stone inscriptions; displaying the excavated antiquities in the site museums, chemically conserving the excavated objects, registering antiquities etc.

The department is carrying out digitalization of manuscripts, inscriptions, excavated antiquities etc. The Government of India has enacted the Antiquities and Art Treasures Act 1972 in order to curb the smuggling of art treasures from India. To enforce this Act effectively, Registering Officers were appointed to document the antiquities physically and with photographs. This is an authentication activity of the department. This scheme is being implemented in Tamilnadu from the year 1974. Tamilnadu stands first among the Indian States by registering 8,686 art objects in the prescribed format.

To preserve the history of Tamilnadu, the department of archaeology is protecting 87 monuments spread all over the State. These monuments, which have historical, inscriptional, architectural and artistic value, throw light on ancient heritage of Tamilnadu. They provide a wealth of information for the reconstruction of the State's history. The Central and the State Governments are allotting and spending huge amount of funds for the restoration of monuments and conserve them for posterity. This conservation work is being carried out as a joint venture by State Public works Department and Department of Archaeology. This work was possible by obtaining details from the data bank created by the archaeologists, epigraphists, conservation engineers, *sthapathis*, and artist of this department. Apart from adopting the modern documentation methods with sophisticated equipments, the manual registers should also be maintained simultaneously as a fall back measure.

This data bank is based on the several functions of the department such as conserving monuments, excavating historically important places, copying of inscriptions, exhibiting the excavated antiquities in the site museums, and conserving the art objects in the chemical conservation laboratory. At present this has been extended by modern digitization and is updated with all the details carried over during restoration.

Government Oriental Manuscripts Library, Chennai

The Government Oriental Manuscripts Library, the treasure house for ancient knowledge, housing more than 75,000 palm-leaf manuscripts, more than 22,000 paper manuscripts and more than 26,000 rare printed books, in various languages was started in the year 1896, and brought out under this department for maintenance. So far 454 publications have been brought in all South Indian languages and other Indian languages. At present the department has initiated action to digitize the entire manuscripts and rare books housed in this Library. The main objective of this digitization is to promote ready access of the documents for descriptive cataloguing, and publication. So far 1085 bundles of Siddha medical palm-leaf manuscripts have been digitized in the on going project of the National Mission for Manuscripts, Government of India, New Delhi. This department also has initiated digitization of manuscripts at GOML departmentally. Till date, 210 bundles of Tamil palm-leaf manuscripts have been digitized. It is proposed to digitize the entire collection of manuscripts and rare books housed in this Library.

Epigraphy as a Tool of Authentication

Epigraphy is the study of inscriptions on rocks, pillars, temple walls and other writing materials. It serves as the primary documentary evidence to establish legal, socio-cultural, literary, archaeological and historical antiquity on the basis of engraving of scripts. Epigraphs are themselves a valid document and serve for authentication. It has helped us in providing information for restoring many monuments and rewriting our original history. The inscriptions are transferred in to papers through estampaging and preserved in the State Department of Archaeology. These estampages are brought to the head office, catalogued, deciphered and transcribed by the epigraphists. The transcribed information are then brought out through publications. The estampages are preserved at the Ooty sub office exclusively, since this hill station naturally serves as friendly climate. It is estimated that there are 20,000 inscriptions in Tamil, which is roughly 40% of the total inscriptions found throughout the country. The department has so far copied 15,912 inscriptions. In the last 18 months 8079 have been copied and 3368 estampages have so far been digitized. It is an on going project of the department to digitize all the inscriptions present in Temples and monuments spread throughout Tamilnadu. Since many temples and monuments are not under the control of this department and as there are a number of renovation works carried out by the private organizations, knowingly or unknowingly the heritage value has been destroyed. Digitization will help in the easy access of inscriptions and decipherment, ready retrieval and wide dissemination to a large audience interested in epigraphy.

Excavations and Authentication

The department so far has carried out 27 excavations and brought to light hundreds of antiquities, which are displayed in the site museums located in different parts of Tamilnadu. The excavation has revealed structural remains, which are conserved *insitu.* All the details of the subjects during excavation are documented in the field notebook. Later, these details are discussed in workshops and seminars and finally the master documentation is done by way of publication. The department of Archaeology has brought out 21 publications of the 27 excavations done so far. Photography of antiquities by digital cameras helps in identifying the objects. The defects found on the objects are the finger print of the objects.

Site Museums

The site museums of the department of archaeology are located at the sites where the excavations were carried out with the objects acquired through the excavations. There are fourteen archaeological site museums of which one museum is exclusively for Under Water Archaeology at Poompuhar. All the antiquities displayed have been photographed and all the details of the antiquities have been documented in the Accession Registers, which contains information such as dimensions, aesthetic value, subject and excavation details. Conversion of these data in digital form is underway.

Merits of the Digitization

The above said documentation method has its own merits and demerits. The merits of handling the CD are well known. It is easily available as all can access the computerized materials. Moreover storage of documented material requires very little space when compared with physical storage of the paper estampages in almirahs and cupboards. It eliminates wear and tear by preventing the physical handling of the manuscripts. It also helps in increasing the life expectancy of the objects. In addition, a number of printouts can be taken in short time and distributed. The digitized information should be stored in CDs and not in floppies as CDs are free from virus attack.

Demerits

Unless multiple copies are had, there is a possibility of the data may be lost due to scratches and carelessness. If the CDs are not protected well, all the data will be lost. The "read and write" CDs are easily prone for illegal use. The life of a CD cannot be ascertained. Scratches and non-compatibility of different versions is also possible while copying the CD. The data put on the Internet may be subjected to hacking.

Safeguarding the Data

The data should be registered in the "read only" CD to prevent copying by unauthorized person. Hacking can be prevented by raising effective firewall measures. In order to prevent the illicit handling of the data, "Password" should be created. The documents in the computers, which are accessible to others, are to be in "read only" form. It has to be periodically updated adopting latest technology prevalent at that time.

Conclusion

At present almost all our departments and museums are provided with computers and digital cameras for generating computer-based documents. The retrieval of the same is very fast. This information can also be put on the Internet, which will be accessible to the users and the scholars. This will create awareness among the people in this field so that fake and illegal trafficking could be kept in check. Digitization is still in its infancy. It has to go a long way before all wings engaged in conserving art objects understand and adopt the principles of authentication. Further work has to be done to improve and refine the process and make it more acceptable to all art lovers. It is a tremendous task, which should be continued till the fruits of the efforts are fully achieved.

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24 Conservation of Art Objects with Special Reference to Lighting

*J.R.Asokan**

Introduction

Light is a form of electro-magnetic energy, having two types of radiations: visible and invisible. The unit of light is measured in nanometers. Our eyes are not sensitive to all portions of light, it can perceive only that portion of the light spectrum which lies between the wavelengths of 400 and 700 nanometers. The wavelength below 400 nanometers is ultra violet rays, and those of wavelengths longer than 700 nanometers are infra red radiations. Both these radiations are invisible to the eye.

Sources of Light

Museum point of view the light source may be divided in to two types. They are

1. Natural light
2. Artificial light.

Sun light is the natural source of light. Artificial lights have a wide variety of choice. Both have their own advantages and disadvantages.

Natural Light

Natural light has its own advantages. They are,

1. No electricity bill
2. More colour rendering
3. Accident proof

Natural light has its own disadvantages. They are,
1. More UV and IR radiations
2. Change of light intensity from morning to evening.
3. Seasonal changes in light intensity
4. More heat production

Artificial Light

Artificial light has its own advantages. They are,
1. Controlled lighting
2. Constant source
3. Preference to UV and IR radiations
4. Beauty or aesthetic appearance

Artificial light has its own disadvantages. They are,
1. Electrical consumption
2. More investment charges
3. UV and IR problems

Importance of Light in Museums

Light plays an important role in museums. The effect of display comes only through light. Even unattractive objects can be displayed attractively with the help of proper lighting method. Besides display, light is very important on conservation point of view. In museums both natural and artificial lights are being used.

Effects of Light on Museum Objects

Whatever may be the source of light, natural or artificial, light contains generally visible radiations, as well as other radiations to which the human eye is not sensitive. It has been observed that light with wavelengths shorter than 500 nanometers, the energy is sufficient to damage many of the organic compounds found in textiles, paper, leather, and similar materials. Paintings and dyed textiles fade because of the action of light. The colour fades and the materials also get disintegrate. Factors like humidity, temperature and oxygen level increases the effect of damage. But degradation depends on the following:

1. Intensity of Light
2. Duration of Exposure
3. Spectral Characteristic
4. Susceptibility of the Object

Preventive Measures

The following preventive measures may be taken to protect the museum objects from degradation due to light:

1. Intensity of light may be minimized.
2. Exposure to light should be a minimum.
3. UV Light absorbing films may be used to avoid degradation.
4. Light intensity should be maintained with in the advisable lux level.
5. Exhibits should be changed while displayed (periodic change of display)

Types of Light Used in Museums

Different type of lamps and fittings are used in museums. Whether it is an art gallery or a multipurpose museum there is no uniform pattern of lighting is followed. Generally, the lighting types used in museums may be classified in to the following types:

1. Lighting by Incandescent Lamps

This is an old type of lighting method. Still in many rural museums this lighting is being used. Heat production and UV light exposure is more in this case of lighting. The production of light in this is yellow in colour.

2. Lighting by Fluorescent Lamps

When compared to the incandescent bulbs, this type of lighting is more economical. Fluorescent lamps produces white light. Nowadays many coloured fluorescent lamps are available in the market. This is most commonly used lamps in many museums.

3. Lighting by Halogen Lamps (Ordinary / Dichroic)

This is a modified version of incandescent bulb. Uniform light is produced for longer hours in these bulbs. The light emitted is yellow in colour. This may be known as contemporary lighting method. Dichroic lighting is nowadays used in museums and commercial establishments. In the dichroic halogen type the produced heat is reflected back. 12 volts 50 wattage lamps are common in this type.

4. Lighting by Metal Halide Lamps

These are focusing lamps, which are commonly used for building purpose. This comes in different colours.

5. CFL (Compact Fluorescent Lamps)

Long length of the tube (fluorescent lamp) is restricted in a small area. These CFL bulbs have the advantage of space and wattage. These lamps are more economical and comes in low wattages but with good illumination capacity.

6. Fibre Optic Lighting

These are modern lighting methods, which are being used in many museums.

The advantages of fibre optic lightings are:
1. UV & IR free
2. Heat free (zero heat produced)
3. Minimum space required for fixing

4. One focusing light required for many points distribution
5. No need to open the showcases often for replacement of bulbs fittings etc.

The disadvantages are:
1. Costly to erect
2. More fixtures have to be placed for bright light

Principle of Fibre Optic System

The fibre optic system consists of a generator and a set of cables. Within the generator the light source is placed. Halogen or metal halide lamps are generally used for this purpose. From the generator a set of cables consisting of fibre glass fibres starts and this takes the light from the generator to the object by the principle called *total internal reflection.* Length of the cable, number of cables and the size of the cables are determined with our need. At the end of the cable different lens head can be placed according to the type of focusing we required.

7. LED Lighting System

This is the new introduction of lighting system in museums. These may be otherwise called as the high intensity LED lighting system. In this light comes from a group of lights. The lights are of front focusing and they are more economical than fibre optic lighting system.

The advantages are
1. UV & IR free
2. Heat Free
3. Minimum space required as in fibre optic lighting
4. Long distance focusing capacity
5. Very long life (1,00,000 hours)
6. Very low current consumption

The disadvantages are

1. The lighting system is costly
2. This system has colour rendering problem

Problems of Authentication with Lighting Systems

When objects are acquisitioned for the museum, they are documented. But due to the passage of time, the light used fade the colour of organic materials such as textiles, water colour paintings etc. The authentication will have a problem. Therefore, museum must have lighting system, which will not have any fading effect on the objects. Fibre optic lighting, LED lighting will be useful in this case. Use of the lights only at the time of visitors is advisable as this will prolong the life of the objects and also besides helping authentication.

Conclusion

It has been scientifically established that the maximum level of illumination for susceptible objects, like coloured textiles, Indian miniature paintings, water colour paintings, and similar works of art should not exceed 50 lux. Some other types of paintings, like oil paintings are not harmed even by more intense of light and 150 lux is the safe limit for them. The source of light, time of exposure and distance between the light and object are very important. If we are placing the light within the showcases (for art objects) means it is always advisable to use fibre optic lighting, or LED lighting. Depending upon the financial position, we may even use CFL lamps within the show cases. But we have to take care of UV lights by using UV filters. For open exhibits we my either use CFL lamps or dichroic halogen lamps depending upon the colour rendering we required.

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25 Treatment of a Discoloured Platinum Print – A Case Study

*S.Girikumar**

Platinum process or Platinotype process was invented by William Willis in 1873.It took him several years of to perfect the techniques and the chemistry. In this process platinum salts were used to form image rather than the commonly used silver. Unlike other processes, the image was formed by fine platinum particles deposited in the body of the paper. It gave subtle tonal qualities and fine velvety finish to the prints and was the most popular print process among the photographers from 1888 till the 1920s. By the beginning of World War-I, because of political reasons, the platinum metal became difficult to find in the open market and hence too expensive for the photographers to practice this process. One can imagine the popularity of the process from the fact that an early 20th Century photographer Frederick H Evans gave up photography when platinum paper ceased to be available.

Being a noble metal the image formed by platinum metal doesn't undergo any changes and the problems associated with these prints are those found in the works on paper.

This paper briefly discusses one of the treatment techniques developed for dealing with the most common problem; discolouration of the prints; and a case where the author has treated a platinum print using that technique.

Platinum Process

The paper is coated with a mixture of ferric oxalate and Potassium tetrachloroplatinate. During exposure, the light sensitive ferric oxalate is reduced to ferrous oxalate and thereby forming a latent image. The print is then developed using Potassium oxalate solution. Ferrous irons formed on exposure to light are strong enough to reduce platinum salts to metallic platinum. Fine particles of metal get deposited in the body of the paper to form the final image. The unreacted chemicals and the reaction by products are cleared using Hydrochloric acid.

$$UV + Fe_2(C_2O_4)_3 \rightarrow 2FeC_2O_4 + 2CO_2$$
$$2FeC_2O_4 + 4(C_2O_4)^{2-} + [PtCl_4]^{2-} \rightarrow 2[Fe(C_2O_4)_3]^{3-} + Pt\downarrow + 4Cl^-$$

The Fe^{3+} ions produced during the processing have to be removed from the paper. If the washing is improper or the paper is of poor quality, the residual Fe^{3+} will not be removed. In that case they will get hydrolyzed to form Ferric hydroxide which will get deposited on the surface of the paper.

Early studies on deterioration of paper had established the fact that direct contact with rusting iron caused reduction in strength of cellulose fibres and thereby weaken the paper.

Deterioration of Platinum Prints

Most common problems one encounters are dicolouration and brittleness of the paper support rather than any changes in the image.

When the highlight areas of the print yellow the appearance of the print becomes less pleasing as there is a reduction in tonal qualities.

Treatment Options

Absence of any emulsion layer and the stability of Platinum enable the platinum prints to be treated like any other stable objects on paper using aqueous methods.

Several treatments where suggested for removing the residual iron compounds using HCl bath, hypochlorite solutions etc. but these all found to cause further weakening of the paper fibres.

In 1994 Megan Gent and Jacqueline Rees of V&A explored the possibilities of reducing the insoluble Ferric complexes into soluble ferrous salts and then removing those using Chelating agents.

Their attempts were based on the results of previous studies of using sodium dithionite ($Na_2S_2O_4$) along with chelating agent Ethylene diamine tetra acetic acid (EDTA) for removal of metallic stains from paper artifacts.

They used a mixture solutions of EDTA disodium salt and dithionite with pH adjusted to 8.5 for optimum results. Prints were soaked in this bath for unto 22 hours to achieve the desired results.

The effectiveness of the treatment was evaluated using EDXRF analysis. During the analysis it was found that about 80% of the residual iron was removed from the prints and the appearance and strength of the prints were improved considerably. The yellowed highlights were cleared while the image areas remained unaltered.

Case study

In 2003 we received a Platinum Print from a private collection for treatment. It was a portrait of a gentle man, pasted on a core-board. An inscription on the board had dated the photograph to 1915.

Both the print and the board were extremely brittle and were torn at a few places. There was an overall discolouration of the print and some deeper stains on the face.

Treatment

Since the mount board was posing a threat to the physical safety of the print, it was decided to remove it from the board. It was soaked in water till the print was separated and floated off. The water bath was changed periodically as a lot of stains leached out of the board. Once the print and the facing sheet on which the inscriptions where written were separated they were washed in clean water and dried. It took about 4 hours of soaking to soften the adhesive and separate the print and the board. Even after the prolonged soaking the appearance of print did not improve. Therefore it was decided to treat the print using Gent and Rees's technique.

It was then soaked in a mixture of 0.1% Molar solution of EDTA disodium salt and 2% w/v solution of sodium dithionite. The pH of the solution was adjusted to 8.5 by adding sodium hydroxide. The print was initially soaked for about 12 hours and then washed repeatedly using tap water and dried. The appearance of the print had improved to a considerable degree during this treatment. How ever there was still certain amount of stains remained in the print. There fore it was soaked in the fresh bath for another 8 hours and washed and dried. With' this there was a satisfactory improvement in the appearance of the print.

It was then pasted on to a new board prepared by pasting 6 sheets of Whatman Grade Filter paper together. The surface layer from the original mount with the inscription was also pasted on to the new support.

It was then mounted with a window matt using mount boards prepared with 12 layers of Filter paper. Starch paste was used as the adhesive.

The whole assembly was then framed under glass.

Conclusions

The appearance and strength of the print has improved remarkably during this treatment. There hasn't been any further discolouration or brittleness observed in the last two and half years after keeping it in a humid warm condition. The print is still under observation so that the long term effectiveness of the treatment can be evaluated.

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INSTRUMENTATION

26 Lasers as a Tool for Art Conservation

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Historic preservation and conservation are complex fields, a blend of art, history and science. A multitude of materials and techniques has given rise to a wide variety of terms across the preservation and conservation disciplines. Cleaning is a critical part of the conservation process. It serves not only to improve the aesthetic appeal of an object or building but also to reveal its true condition so that appropriate action can be taken to ensure that it survives for many future generations to enjoy.

Conventional Methods of Cleaning of Art Works

Careless and inappropriate cleaning techniques, such as air-abrasive and steam cleaning, can lead to severe damage of the underlying surface of the art. The loss of surface detail by over thorough cleaning can reduce the visual appeal of a surface and in extreme cases can even lead to its accelerated decay. Even if cleaning is carried out very carefully, techniques such as air-abrasive cleaning will result in some loss of material from a surface, particularly from a decayed crumbling surface, simply because abrasive particles cannot discriminate between the soiling and the object surface. The removal of black encrustation from limestone sculpture is usually accompanied by removal of the patina, which develops on the surface over a period of time and within which the original surface relief is preserved.

Chemical-based cleaning techniques also have associated problems: chemicals often leave residues on the subject, which can cause problems later on, and once they have been applied their reaction cannot be suitably controlled.

Problems in Sculpture Cleaning

The main problems facing the stone conservator are stabilization, consolidation and further protection against pollutant gases and soluble salts. Stone is extraordinarily unstable in the modern environment. Once it has been attacked by pollutant gases, such as sulfur dioxide, or migrating salts, such as nitrates or chlorides, it is difficult to return the stone to a stable condition, even when it is placed in a museum environment. Although some temporary stability may be achieved by putting a damaged sculpture in a temperature-and humidity-controlled glass case, it is commonly found that degradation will continue and in certain instances, even accelerate.

To have any hope of halting salt action, the stone Conservator must interfere with the deep structure of the stone, sealing it against moisture movement and strengthening it against salt damage to the porous structure. Probably, the most popular means of stabilizing stone is the introduction of a consolidant. In the past, consolidants such as wax and shellac have been tried. These do not penetrate deeply into the stone and often aggravate the problem. Various synthetic resins, such as acrylics, epoxies, polyesters and silicones, have been used with greater success. By far the most successful, however, have been the alkoxy-silanes. These have several distinct advantages over other consolidants. They penetrate deeply into the stone (two to three inches in some limestone) and they deposit a hard, almost indestructible network of silica in the porous structure of the stone, which waterproofs and strengthens it.

There are many forms of alkoxy-silanes in use and many ways of applying them. The commonest methods are simple brushing, spraying and vacuum impregnation. Of these, the first is the most controllable and delicate approach, while the last is the least controllable and most potentially dangerous.

The full treatment of a sculpture must, of course, include cleaning. Any consolidation treatment or attempt to remove salts from stone must be carefully integrated with an appropriate cleaning system. In the past, the most common way to clean and desalinate stone was to immerse it in a tank of water for a period of weeks or months. This process can cause considerable damage because it loosens friable stone and pigment from the stone surface. A better method was developed in 1960s, by which a clay poultice (magnesium silicate and deionised water) is used to suspend a thin layer of water over the surface of the sculpture, like a cosmetic mudpack, sucking out both dirt and salts. This treatment minimizes the contact with water and also does less harm to the fragile surface of the sculpture. The use of sophisticated tools and techniques such as ultrasonic dental descalers and abrasion by air-blasted microscopic glass beads helps to give the Conservator much greater control over the cleaning process. Cleaning of metal sculptures to remove the oxide coat developed is also a very delicate issue. Rubbing abrasives, the entire surface cannot be reached. Also such rubbing may spoil the surface feature, particularly when the art is made of thin metallic sheets (foils). In such cases lasers are extremely useful. Lasers were first used for removing pollution deposits from stone in 1970. The development of laser-based techniques during the past few years has been a significant advance in making conservation methods less intrusive and more controllable. Improved laser technology, decreasing cost and the concurrent development of fibre optics suggests that it may soon be possible to produce a flexible precision tool that is capable of removing dirt and other encrustation from the surface of sculpture by vaporization, without harming the surface itself.

Laser as a New Tool

Since their invention in the early 1960s, lasers have found widespread application in metallurgy, medicine, telecommunications and entertainment. Less well known has been their application in the world of historic preservation, where lasers are just beginning to revolutionize the conservation of works of art. The term "laser" is an acronym for "light amplification by stimulated emission of radiation". A laser is the device that produces a highly directional beam of light in the infrared, visible or ultraviolet region (depending upon the type of laser) of the spectrum. The laser beam can be focused by a lens that concentrates the power on a very small region of the target. Depending upon the intensity of the light, it may be used to cut metal or to selectively remove a thin film of material layer by layer.

This technology has great potential for the cleaning of art works. Many works of art have been subjected to decades, if not centuries, of exposure to the elements, such as atmosphere pollution both inside and outside museums. This has led to a harmful accumulation of grime and other surface encrustation that obscure the underlying surface. Traditionally, art Conservators have cleaned paintings and other works of art with scalpels, abrasives and solvents applied as swabs or poultices. Recent advances in laser technology have yielded new tools for selectively removing unsightly or harmful surface accretions while preserving the underlying surface.

Advantages of Laser Cleaning

From a practical standpoint, the laser offers distinct advantages over traditional chemical cleaning methods:

Selectivity: The laser may be tuned to interact with specific substance.

Environmental Acceptability: No dependence on hazardous chemicals or solvents.

Non-contact: The process is amenable to automation and offers freedom from contact wear.

Preservation of Surface Relief: Photons do not distinguish between peaks and valleys. The material and profile are preserved. Even the arts made of thin metallic foils can be cleaned without damage to the surface structure.

Versatility: Optical flux intensities are achievable that can remove any material.

Localized Action: The laser action cleans only where directed.

Controlled Removal: A specific thickness of material can be removed.

These intriguing properties of lasers, coupled with recent reductions in size and costs of many commercial laser systems, have led to an increased interest in the potential benefits of laser technology to art conservation.

There is little evidence to begin assessing the long-term impact of laser cleaning, except on architectural stonework. Still, it is almost obvious that stone should be fairly resistant to the effects of lasers; after all, one seldom sees rapid deterioration of stone sculptures under the influence of light alone. Thus one would expect that any damage caused by a laser would be the result of secondary effects such as localized heating or plasma formation rather than by exposure to light. With careful control over the process, many of these secondary effects can be significantly moderated. But the potential of light to directly damage or alter other materials, especially organic materials, is well known. And while light damage is often seen in the immediate effects of bleaching, fading or yellowing of materials, the long-term effects, especially the breaking of chemical bonds, may not be easy to detect. Careful study of these factors is essential to build confidence in the feasibility of using lasers in art conservation.

Mechanism behind Cleaning of Stones and Metallic Surfaces by Lasers

The most common laser used in conservation at the moment is the Q-switched Nd:YAG laser, which provides short pulses (typically 5-10 ns long) of near infrared radiation at a wavelength of 1.064 micrometer (or 1.064×1^{-6} m). Their short pulse length prevents heat from being conducted beneath the soiling into the stone surface. The process of cleaning is self-limiting since once the dirt has been removed, further pulses will have no effect on the surface as insufficient energy is absorbed to cause any damage. The Nd:YAG laser is also extremely reliable, easy to maintain, relatively compact and robust.

One of the commercial lasers cleaning systems available is with jointed articulated arm in which the beam emerges through a pen-like hand-piece within which a lens is used to produce a diverging beam. The Conservator controls the cleaning effect through adjustments to the energy in each pulse, the number of pulses fired per second (repetition rate) and the distance between the tool and the surface (which controls the intensity or spread of the beam). In another system, instead of articulated arm an optical fibre is used to deliver the beam.

Cleaning Parameters

The most important cleaning parameter is the energy density, or fluence of the laser beam, which is defined as the energy per unit area incident on the surface (energy per pulse/beam size at the surface) and is usually measured in joules per square centimetre (J/cm^2).

At low fluence ($< 1\ J/cm^2$), strong absorption of energy leads to rapid heating and subsequent expansion of a dirt particle. Since the pulse length is so short the expansion happens so quickly that the resultant forces generated are sufficient to effect the particle from the surface. This is a very selective process. If the fluence is increased slightly, then some material will be heated to a sufficiently high temperature to cause vaporization. At higher fluences still (above approximately $1.5\ J/cm^2$; values depend on the properties of the soiling) the removal mechanisms become more complex and involve the formation of a plasma just above the surface and generation of a shock wave. This mechanism is less selective and can result in damage to the underlying substrate. Cleaning should therefore be carried out at the lower practical fluence so that the more selective mechanisms operate.

Enhancement of Cleaning by Water Coating

Water can sometimes be used to enhance the cleaning effect. By brushing or spraying a thin coating of water onto the dirt surface immediately prior to irradiation, stubborn deposits of dirt can be removed without having to increase the fluence to unacceptably high levels. Dirt particles become coated with a thin film of water, which is also able to penetrate into cracks and pores within the dirt layer. Absorption of the laser beam by the dirt layer occurs as normal and rapid heating at the dirt/

water interface leads to explosive vaporization of the water molecules, which exerts forces on and within the dirt layer sufficient to eject further material from the surface. The addition of water usually increases the cleaning rate significantly.

Some of the Disadvantages of Laser Based Cleaning

Laser cleaning does not work on everything. The cleaning of polychrome sculpture poses problems since different pigments absorb different amounts of radiation, certain types being very sensitive. For example, a single low-energy pulse will be sufficient to turn vermilion from red to black. In cases where there is evidence of pigment on a stone surface cleaning is usually carried out in such a way that the area is not exposed to laser radiation, unless it is known to be stable at the fluence being used.

Although laser cleaning of sculpture is usually much quicker than cleaning by the more sensitive conventional techniques, the large scale laser-cleaning of buildings cannot, at the moment, compete in terms of speed with techniques such as grit-blasting. It does however leave the stone surface intact.

The relatively high initial cost of purchasing a laser system is seen by some as a disadvantage. This should be set against the low cost of maintenance and the savings that are made on time taken to complete a job. The development of laser systems is so rapid that it might not be too long before large-scale laser cleaning systems become available. Purchasing a laser cleaning system is a long-term investment. In the short term it might make more sense to hire an appropriate system for a particular job.

Recent Developments

Ultra violet laser ablation is the result of the combined action of thermal, photochemical and mechanical processes. The laser light vaporizes a black crust but does not damage the underlying subject because it is almost completely reflected. When the laser is used in the Q-switched operation mode, with very short and intense pulses, it is necessary to take into account effects such as blocking of the laser light by the dust plume and the mechanical effects generated by the expanding plasma and the rapid heating of the target material. In the UV laser ablation photochemical effects also have to be considered. In this case energetic UV photons are able to break molecular bonds in the target material. Thickness of the layer removed is very small when UV lasers are used. Hence researchers are concentrating in the use of UV lasers to stone cleaning. The main problem of using laser ablation technique lies in the discoloration of the material beneath the layer removed and the long-term effects subsequent to laser action.

Conclusion

In a country like India, which houses a variety of precious sculptures and monuments, implementation of laser cleaning can prove to be promising in preserving and conserving our assets. Lasers are being widely used in many industries and research laboratories. Recent joint venture of laser scientists and conservators is likely to yield fruitful results in the near future.

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27 Infrared Thermography: An Aid for Conservation of Ancient Paintings

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Introduction

Art and architecture are marvels, which reflect the cultural heritage of a country. The south Indian bronzes, Aranmula mirrors, the rustle wonder - Delhi iron pillar, the historic Taj Mahal, wootz steel and many art and architectural wonders speak for itself about the rich cultural heritage of this country. This heritage needs to be preserved for posterity. The best way to preserve art and architecture is to understand the process of degradation, assess the degradation and develop methods to slow down this inevitable process while restoring the original piece. With better understanding of the basic sciences, and developments in the fields of sensors, electronics etc., we have today a number of scientific methods that can be used for characterisation of art objects and aid in their conservation. Scientific investigations on art objects are undertaken with a variety of objectives in mind. The most important of these include (i) assess the present condition so that restoration and conservation methods can be planned (ii) Understand the style, period and the process by which these objects had been produced and (iii) for comprehensive fingerprinting needed for documentation and authentic identification.

The most conventional approach, which can give a solution to all the requirements indicated above is through the use of Non-Destructive Testing (NDT) techniques. NDT as the name implies are techniques that have been developed to determine the quality of components without causing any harm to them. Right from the cradle to tomb of industrial plants or human beings NDT techniques play a vital role. A variety of NDT techniques are available today, which are being successfully employed in various industries to assess the quality and ensure the integrity, safety and reliability of plants and components. A few of these techniques have also been successfully applied for the investigation of objects of cultural heritage such as sculptures, paintings, monuments, etc., world wide. Ref 1 gives overview of NDE for art objects while ref. 2 and 3 give the results of the scientific investigations carried out by the authors on ancient south Indian bronzes and Delhi iron pillar.

Art can be three dimensional or two dimensional. 3-dimensional art refers to sculptures, ancient monuments and architecture while two dimensional art refers to ancient paintings, frescoes etc. NDT has been successfully used for characterisation of both 3-D and 2-D art. This paper focuses on the successful application of one of the advanced NDT techniques namely Infrared Thermography for detecting degraded areas in 2 D art objects - ancient Tanjore paintings and also judge the effectiveness of restoration.

It should be highlighted here that in the western world, infrared reflectography has been used for examining paintings and frescos. Infrared reflectography is a method of investigation using infrared radiation with low wavelength (0.8 to 2 microns) developed in the late 1960's specifically for the study of paintings. In this method near infrared radiation reflected from the painting or its underneath layers is captured by suitable photographic camera sensitive in near infrared radiation band. The captured IR images also referred to as infrared reflectograms is then analysed for under drawing or under painting and for authentication of the art work[4]. In this paper, the authors have used a novel and different approach. Emissivity variations have been used to map degraded areas and also judge the effectiveness of restoration in two 18th century Tanjore paintings. Such an approach has not been reported so far.

Infrared Thermography – A Brief Background

Infrared imaging or Thermal imaging or Thermography is the mapping of temperature profiles on the surface of the object or component. It makes use of the infrared band of the electromagnetic spectrum. Any body above absolute zero emits electromagnetic radiation. At ambient temperatures and above, these radiations are predominantly in the infrared band of the electromagnetic spectrum. Using an infrared detector it is possible to convert these infrared radiation into electrical signals, which can then be displayed on a monitor as a grey level image or colour image in which different grey levels or colours represent different temperature range. Thus a complete surface temperature map of the object can be obtained in a non-contact way. With appropriate calibration, it is also possible to get the absolute temperature values of any point on the surface of the object. Infrared refers to a region of the electromagnetic spectrum between the visible and microwave. The infrared spectrum extends from 0.75 μm to 1000 μm. However for practical applications, it is the 1-15 μm band, which is used. The properties of infrared radiations are similar to other electromagnetic radiations such as light. They travel in straight lines; propagate in vacuum as well as in liquids, solids and gases. They can be optically focused and directed by mirrors and lenses. The laws of geometrical optics are valid for these also. The energy and intensity of infrared radiation emitted by an object primarily depends on its temperature and can be calculated using the analytical tools such as Wein's Law, Planck's Law and Stefan Boltzmann Law. A detailed overview of the principles of infrared imaging is given in reference 5.

Infrared images are primarily due to variations in temperature and or emissivity within a scene or target. Emissivity is defined as the ratio of the total energy radiated by a given object surface at a particular temperature of object to the total energy that would be radiated by the surface of a black body at the same temperature and wavelength.

$$\varepsilon_{(\lambda,T)} = \frac{\text{Total emittance from the material surface}}{\text{Total emittance from the surface of a black body at the same temperature and wavelength}} \quad \text{.....} \ (1)$$

Black bodies have an emissivity of 1.0 while for all other bodies; the emissivity varies from 0-1. Emissivity is one of the most important factors affecting thermal measurements. It is a function of the surface condition of the object, wavelength of radiation, viewing angle and object temperature. Emissivity of materials can vary from 0.01 to 0.99. For opaque objects, Kirchoffs Law relates the emissivity e_o of the object surface to the reflectivity r_o. For an incident isotropic radiation,

.... (2)

Thus objects with low emissivity, such as highly polished metal surfaces, will have high reflectivity and vice versa. Emissivity is a parameter of importance in quantitative infrared. In the present experimental work, it is variations in emissivity that has been exploited to spot the areas of degradation and also study the effectiveness of restoration in ancient paintings.

Experimental Procedure

Tanjore Paintings

Tanjore paintings were originated in Tanjore. This type of art, which is famous for its ornamental relief work flourished under the patronage of the Nayak and Maratha princes during the 16^{th} - 18^{th} centuries. The process of making a Tanjore painting requires dedicated skilled labour. There are many stages during the making of this painting. The ground is made of a layer of cloth stretched over a wooden plank. Layers of paste made from glue and limestone are moulded and applied so as to create a three-dimensional effect. Trimmed with foil made of pure gold and embellished with gems, semiprecious stones or cut stones of various colours, the Tanjore paintings are true treasures. The early paintings were rendered with vegetable dyes for colours and shades. The present-day artists use chemical paints, which enhance the sharpness and provide better shade contrasts. Two Tanjore paintings belonging to the 18^{th} century had been received from the Government Museum, Chennai. The paintings were received in as and where condition. Figure 1 is the photograph of one of the paintings depicting a Tanjore (*Maratha*) Raja and Rani before restoration works were undertaken.

Experimental Arrangement

The paintings were investigated using a focal plane array based thermal imaging system with a thermal sensitivity better than 0.1°C. The salient features of this system is given in the Table 1. The experimental set up consisted of halogen lamp as the source of infrared radiation and the infrared system. The paintings were removed from the glass frame as infrared radiation gets attenuated by the glass cover. Thermal image of the painting before heating was recorded for the baseline information.

Thermal images during heating and after heating with halogen lamps were also recorded. The halogen lamp was placed at distance greater than 1m from the painting to safeguard the painting from any kind of damage due to over heat. Halogen lamp was flashed on the painting for 2-3 seconds. The field of view was so adjusted that the entire painting could be captured in a single frame. The thermal images were acquired using a flash card and subsequently analyzed using the IRWIN 5.2 software which has image processing tools such as spot temperature measurement, line profiling, area temperature measurement and isotherms for better results. Before examining the actual painting, the thermal images of natural and manmade pigments of different colours were also captured and analysed to understand the emissivity variations and also select the pigments that were blended well. The colours investigated were red, black and indigo. Different hues of the colour were exposed to heat radiations and the thermal images captured

Observations

Figure 2a and 2b shows the thermal image of the natural and man made pigments. It could be observed from the thermal profiles that both in the case of manmade pigments as well as natural pigments, the second row had better uniformity indicating a good blending of the pigments with their bases. In general it was observed that revealed that the gold colour pigments had a low emissivity (high reflectivity) (fig. 2b row 1) while black colour pigments absorbed infrared radiation to a large extent (high emissivity). The emissivity variation of hues of red, black and indigo colour varied between 0.5 – 0.9. Figure 3 (a) shows the thermal image of the painting on receipt from the museum condition after suitable image processing. The image was initially averaged to reduce the noise levels and then contrast stretched.

It can be observed that the thermal image before heating does not reveal much information. When a slight amount of heat input was given, areas of degradation became clearer. This was because, both the reflectivity and emissivity is a function of heat flux. It could be observed that apart from the facial and sari regions of the Rani, the background canvas and also certain areas on the Raja needed touching up. After identification of the regions and suitably marking them, the entire painting was retouched using a combination of manmade pigments as well natural pigments. Chemical treatments were also applied to the paint for conservation purposes. Fig. 4 (a) is the visual image (photograph) of the painting after retouching. It can be observed that the restored areas appeared to have blended well with the background. To check for the effectiveness of restoration, thermal imaging was again resorted to on the painting after heating it. Figure 4b is thermal image of the retouched painting. The retouched areas could be clearly visualised. It can be observed that the rani's sari area had been well retouched and the raja's face was also well defined thermally compared to the original painting indicating the effectiveness of the retouching procedure. The background canvas had also been touched. However, here the pigments appear to be at slight variance with the background though this is not apparent visually. Thus overall, thermal imaging clearly revealed that the pigments used had blended well with the background and also the image had been effectively restored.

Conclusion

A novel method of using the emissivity and reflectivity variations to identify the degraded areas and also study the effectiveness of restoration of ancient paintings has been presented. Thermal imaging could be effectively applied in the restoration of an ancient 18th century painting. Use of thermal imaging with a slight heating revealed the degraded areas, gave a pointer to which of the pigments would blend well and also provided the proof of restoration and also effectiveness of restoration. This study also clearly brings to fore the potential advantages in the use of non-destructive methods for scientific investigations on art objects.

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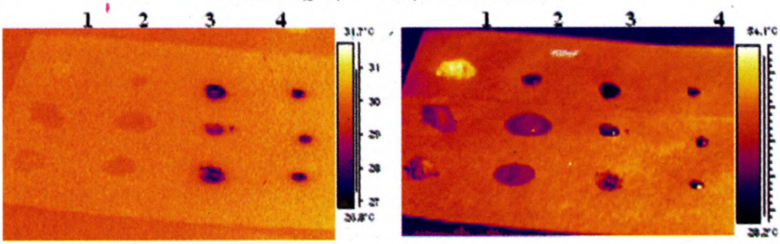
Table –1

Salient features of Thermal imaging camera

Model	Thermovision-550
Detector type	Focal Plane Array
Detector material	Platinium Silicide
Spectral Range	2 – 5.6 micrometers
Thermal sensitivity	<0.1K
Accuracy	2% over entire range
Temperature range	253 K to 1473 K
Cooling	Stirling
Image storage	12 bit digital
Image size	151 kB

Figures

Fig. 1. The Figure Shows the Photograph of the Original Tanjore Painting of 'Raja and Rani'.

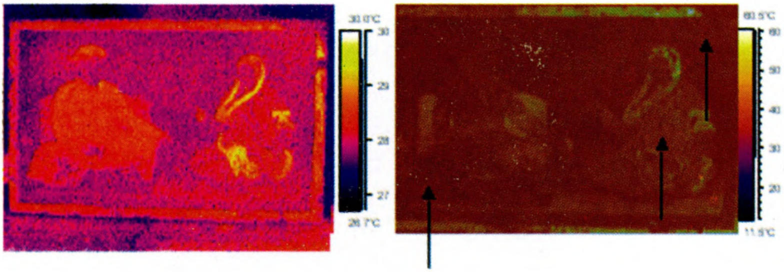


(a) **(b)**

Fig. 2 Typical Thermal Image of the Different Colours and with Natural and Synthetic Pigments.

(a) **(b)**

Fig. 3. Typical Thermal Images of the Painting (a) Before Heating and (b) After Heating. Areas of Degradation (indicated by arrows) Could be Clearly Seen After Slight Heating



(a) **(b)**

Fig. 4(a) Photograph of the Painting After Retouching and (b) Typical Thermal Image of the Retouched Painting

28 Conclusion - Golden Jubilee Celebrations of the Chemical Conservation and Research Laboratory and the International Seminar on Authenticity in Art with Special Reference to the Conservation of Art Objects

*V.Jeyaraj**

The International Seminar on Authenticity in Art was conducted in commemoration of the Platinum Jubilee Celebrations of the Chemical Conservation and Research Laboratory of the Government Museum, Chennai. The Indian Association for the Study of Conservation of Cultural Property, New Delhi, which is a forum of professional conservators, came forward to collaborate with the museum to conduct the international seminar. In order to conduct the international seminar, the Government of Tamil Nadu issued the G.O. No. dated and sanctioned the necessary funds.

An Organising Committee and a Technical Committee were formed to conduct the international Seminar. Mr. M. A. Siddique, I.A.S., Director of Museums, Government of Tamil Nadu was the Chairman of the Organising Committee. Dr. O. P. Agrawal, Director General, ICCI, INTACH, Lucknow was the Co-Chairman (Conservation) and Dr. Baldev Raj, Director, Indira Gandhi Centre for Atomic Research, Kalpakkam was the

Co-Chairman (Scientific), Dr. V. Jeyaraj, President, Indian Association for the Study of Conservation of Cultural Property and Curator of the Laboratory was the Member Secretary, Mr. N. Harinarayana, Former Director of Museums, Chennai, Dr. R. K. Sharma, Joint Director General, Archaeological Survey of India, New Delhi, Mr. Vinod Daniel, Australian Museum, Sydney, Australia, Prof. M. V. Nair, Director, National Research Laboratory for Conservation, Lucknow and Mr. R. C. Jain, Secretary, Indian Association for the Study of Conservation of Cultural Property, New Delhi were members. Dr. V. Jeyaraj, President, Indian Association for the Study of Conservation of Cultural Property, New Delhi and Curator of the Laboratory was the Chairman of the Technical Committee, Mr. S. P. Singh, Director (Conservation), National Museum, New Delhi was the Co-Chairman, Mr. B. V. Kharbade, Project Officer, Regional Conservation Laboratory, Mysore was the Member Secretary, Mr. A.S. Bisht, Former Chief Restorer, National Museum, New Delhi, Prof. I. K. Bhatnagar, Former, Head of Conservation, National Museum Institute, New Delhi, Prof. R. Balasubramaniam, Head, Department of Metallurgy, IIT, Kanpur, Prof. K. K. Jain, National Museum Institute, New Delhi and Mr. B. Venkataraman, Scientist, Indira Gandhi Centre for Atomic Research, Kalpakkam were the Committee Members.

The Chemical Conservation and Research Laboratory of the Government Museum, Chennai, established in 1930 celebrated its Platinum Jubilee Celebrations on the 14th December 2005. Dr. P. A. Ramiah, I.A.S., Secretary, Tamil Development-Culture and Religious Endowments Department, Government of Tamilnadu participated in the Platinum Jubilee Celebrations and honoured, Mr. N. Harinarayana, former Director of Museums, who served as Curator in the Laboratory in the past and

Dr. V. Jeyaraj, present Curator of the Laboratory and gave the inaugural address. He also released the book of abstracts of the papers and inaugurated the Exhibition on Authenticity in Art.

In the Inaugural Programme, Mr. M. A. Siddique, I.A.S., Director of Museums welcomed the gathering, Mr. R.C. Jain, Secretary, Indian Association for the Study of Conservation of Cultural Property, New Delhi felicitated and Dr. V. Jeyaraj proposed a vote of thanks.

The Exhibition on Authenticity in Art was arranged in the Centenary Exhibition Hall of the museum from 14th to 16th December 2005. The exhibition was a photographic exhibition on Authenticity in Art. The exhibition was on the methods of authentication such as holography, fringe pattern making, radiography, thermal imaging, metallography, authentication of wooden objects, bronzes, ivory objects, paintings, piltdown hoax, etc. In the hall, demonstration of marking identification marks in the paintings so that if they are lost and retrieved, they may be identified as original or fake. There was also a demonstration of lamination of printed paper by cold reversible lamination.

The Key-note address on Authentication and Conservation of Art Objects through Non-destructive Science and Technology was delivered by Prof. Dr. Placid Rodriguez, AICTE & INAE Professor, Indian Institute of Madras, Chennai and former Director of the Indira Gandhi Centre for Atomic Research, Kalpakkam.

The first technical session was on Architecture and was chaired by Mr. N. Harinarayana, Former Director of Museums, Government Museum, Chennai and rapporteurd by Dr. C. Maheswaran, Curator of Anthropology, Government

Museum, Chennai. Three papers were presented on Authenticaton of Architectural Details of the Pallava Monuments at Kanchipuram, Tamilnadu, India by D. Jayanthi and Ranee Vedamuthu, Characterisation of Gothic Architecture and its Authenticity by A. Vijay Kiran and Aesthetics in Conservation with Special Reference to Mandapa Sculptures of Madurai Temple by P. Sam Sathiaraj and T.S. Thangamuthu.

The second technical session was on Ethnographic Artefacts and Mr. B. V. Kharbade, Project Officer, Regional Conservation Laboratory, Mysore was the Chair Person and Mr. P. Rajamohan, Curator, Government Museum, Trichy was the Rapporteur. Dr. C. Maheswaran presented a paper on Identification of Ethnic Indicators in Authenticating of Ethnographic Artefacts of a Cultural Area and Mrs. R.D. Thulasi Brinda, Curator, Government Museum, Krishnagiri presented a paper on Conservation of Ethnological Objects with Special Reference to the Irula Tribes of Denkanikottain Region of Krishnagiri District.

The third technical session was on Ivory and Wooden Objects and Mr. S. P. Singh, Director (Conservation), National Museum, New Delhi was the Chair Person and Father Dr. A. Vijay Kiran, Research Scholar, Chemical Conservation and Research Laboratory of the Government Museum, Chennai was the Rapporteur. The following papers were presented:

Authentication of Ivory Art Work – A Case Study - *C. B. Gupta & Poonam Sehgal.*
Authentication of Ivory Artifacts - *Vajendra Joshi & Dr. R. S. Singh.*
Authentication of Ivory Bed - A Case Study -*R. C. Jain.*
Authentication of Wooden Objects: A Case Study - *Dr. V. Jeyaraj.*

The fourth technical session was on Metal Objects and Dr. V. Jeyaraj, President, IASC and Curator, Chemical Conservation and Research Laboratory of the Government Museum, Chennai was the Chair Person and Mr. R. Balasubramanian, Curator, Archaeology Section of the Government Museum, Chennai was the Rapporteur. The following papers were presented:

Revisiting Exercise on Authentication of South Indian Metal Icons from Asian and Global Perspectives - *Dr. Sharada Srinivasan*

Early Indian Coins with Architectural Symbols for Authenticating Analysis - *Raju Poundurai.*

The fourth technical session was on Paintings and Mr. C. B. Gupta, Former Technical Restorer of the National Museum, New Delhi was the Chair Person and Mr. Anil Risal Singh, Photographer, NRLC, Lucknow was the Rapporteur. The following papers were presented:

Authentication of Oil Paintings – Needs and Requirements - *Sreekumar Menon.*
Strategies of Authentication of Paintings - *K. K. Gupta.*
New Approach to Conservation of Oil Paintings - *Anand Kumar*
Authentication of Artifacts, Paintings and Manuscripts – *P. Sugunasekhar.*
Evaluation of Methods for Determining Authenticity of Paintings – *B. V. Kharbade.*

The fifth technical session was on Manuscripts, Paper and Photographs and Prof. M.V. Nair, Director, National Research Laboratory for Conservation, Lucknow was the Chair Person and Dr. R. S. Singh, Scientist, Central Institute of Science, New Delhi was the Rapporteur. The following papers were present:

Treatment of Discoloured Platinotype Print – A Case Study - *S. Giri Kumar.*

Differential Lighting – Photo-Documentation of Hidden Lacunae and Finger Printing of Paper, Painting and Manuscripts - *Anil Risal Singh.*

Preservation of Books and Paper Documents - *P. Renganathan*

Authentication of Palm-leaf Manuscripts -*P. Perumal.*

Thanjavur Marathas Modi Documents: Characteristics and Authenticity of Signatures - *S. Santhi.*

The sixth technical session was on Textiles and Dr. Stéphane Ipert, Managing Director, Centre de Conservation Du Livre, Paris, France and Ms. Sreelatha Rao, Assistant Superintending Archaeological Chemist, Hyderabad was the Rapporteur. The following papers were presented:

Authenticating Textiles of Indigenous Origin - *M. N. Pushpa*

Charactrization of Kodali Karuppur Saree - *Bessie Cecil & V. Jeyaraj*

The seventh technical session was on General topics and Mr. K. K. Gupta, Assistant Chemist, National Museum, New Delhi was the Chair Person and Mr. Qusay Mohammed Ali Hassan, Assistant Professor, Department of Physics, College of Education, Basra University, Iraq was the Rapporteur. The following papers were presented:

Cultural Heritage Reproduction: Judicial Aspects in Europe Museum and Libraries - *Dr. Stephene Ipert.*

Lasers as a Tool for Art Conservation - *P. K. Palanisamy*

Legal Protection of Art Objects – A Critical Review - *C. Paranthaman*

Improved Wheat Starch Adhesive for Conservation – *G.I.A. Prabaharan.*

Finger-Printing of Antiquities: Forensic Investigation Approach – *S. Thenmozhi*

Conservation of Art Objects with Special Reference to Light - *J. R. Asokan.*

The Valedictory function was organised in the evening in which Mr. M. A. Siddique, I.A.S., Director of Museums, Government Museum, Chennai presided over the function. Mr. R. C. Jain, Secretary, IASC welcomed the gathering and Dr. V. Jeyaraj proposed a vote of thanks. Mr. T. S. Sridhar, I.A.S., Commissioner Tamilnadu, Chennai delivered the Valedictory Address and also presented his paper on Digitisation as a Way of Authentication.

The Valedictory address was delivered by Thiru. T.S.Sridhar, IAS, Special Commissioner of Archaeology. He emphasized the urgent need for conservation of art objects and authentication of the same. However, for its proper upkeep and maintenance, a number of steps have to be taken both at the international and the national levels for preserving the cultural properties. Firstly, he suggested that there is a need for a sound and effective legal frame-work among all signatories to international organizations such as ICOMOS, UNESCO etc. in order to prevent smuggling and trafficking in works of art. He mentioned a few instances such as the sword of Tippu Sultan etc., which are now lying in foreign museums but which must be restored to their original community. Consensus among the nations is necessary so that the heritage property belonging to a particular community should be restored to that community. Secondly, he stressed the need to concentrate on technology and take advantage of the various advancements that have taken place for better preservation of heritage artifacts. To trace this end, a number of steps have been taken by the department of Archaeology with regard to digitization and authentication. Similar steps must be taken by other agencies also. Thirdly the management of heritage properties is a very important aspect which needs greater cooperation from all practitioners namely NGOs, Universities, departments and the common people. He suggested that an elaborate study may be made on conservation of cultural heritage for posterity. He appreciated the various steps taken by the organizers for the successful conduct of this seminar. Finally, he touched upon the issue of resource constraints in developing countries. In the western world sponsorship from business houses and other agencies has helped to fund cultural properties. However such support is not forthcoming in developing countries with the result many rare objects of art and heritage are left to decay, destruction and vandalism. It also encourages illegal trafficking. Cultural protection has to be strengthened by involving public private partnership. He also suggested that more and more agencies should take interest to preserve cultural properties. Our rare objects of heritage value should be kept in good shape, managed and maintained not only by the practitioners but also by general public who would like to appreciate this so that they can come and have an illuminating and aesthetic experience.

Cultural Programme was organised on the second day by the South Zone Cultural Centre, Thanjavur. The programme was inaugurated by Dr. A.C. Mohan Doss I.A.S., Director, South Zone Cultural Centre, Thanjavur. and the vote of thanks was proposed by Dr. V. Jeyaraj.

Field visit was organised for the delegates of the international seminar. The delegates were taken on tour to Indira Gandhi Centre for Atomic Research, Kalpakkam and had a panoramic view of the sophisticated instrumentation available for authenticity in art and other aspects of material science. The delegates had a feel of the arts of the Pallavas in Mahabalipuram. Towards the end, the delegates had a panoramic view of the various performing arts such as wheel thrown pottery making, kalamkari painting, puppet show, glass blowing besides having a close look of the various houses such as Chettinadu House, Andhra House, Karnataka House, Kerala House and the crafts street at Dakshinachitra.

The International Seminar was a grand sucess.

National Art Gallery
Inset - Chemical Conservation and Research Laboratory

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- Conserving museum objects under the Department of Museums.
- Research in conservation techniques and ancient technology.
- Training people in conserving the art, cultural and natural heritage for posterity.
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- Conservation consultancy services.

Publications of this Laboratory are Handbook on Conservation in Museums, Care of Museum Objects, Care of Archival Materials (Tamil), Introduction to the Chemical Conservation and Research Laboratory, Conservation of Cultural Property, Restoration of Paintings from Madras Christian College, Care of Paintings, Conservation Stone Objects, Metal Conservation etc and brochures.

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