COLLECTIONS CARE:
Staying Relevant in Changing Times, ASEAN & Beyond

CONFERENCE PROCEEDINGS

23-25 October 2019 | Singapore

Heritage Conservation Centre International Conference 2019

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Foreword

The international conference "Collections Care: Staying Relevant in Changing Times, ASEAN and Beyond" to be held from 23rd to 25th October 2019 is the first to be organised by the Heritage Conservation Centre (HCC), an institution of the National Heritage Board, Singapore – a one of a kind conference that primarily showcases care of Southeast Asia collections and practices in the Association of Southeast Asian Nations (ASEAN). It is with deep honour that I write this Foreword to the proceedings of this inaugural conference, as I took the helm of Director of the HCC from April 2019.

Collections matter to people and they are truly sources of knowledge, pride, inspiration and opportunity for us collection care professionals. Therefore, the HCC is committed to its leading role in collections care and heritage preservation in Singapore, with dedicated professionals working in a vibrant and professional environment. We aim to set and maintain high professional standards of collections care and heritage preservation, improve accessibility to our collections, and finally to disseminate and share with the public our knowledge of collections care. To advance our leading role, we strive to strengthen and deepen professional capabilities in the areas of collections management, conservation and conservation science. Together with partners and communities in the sector, we hope to expand our role in the heritage community beyond Singapore into the region, by leveraging on our expertise in collections management and conservation, and furthering our heritage science knowledge.

This conference attempts to initiate and continue a tradition of bringing together collection care professionals from the region and all over the world. There will be a rich and dynamic interchange of expertise and opportunities to engage in dialogue through shared experiences in collections care. The conference will particularly encourage interaction amongst participants in an informal setting to present and to discuss new and current work.

The organising team and I would like to thank all of the authors and presenters who have unreservedly contributed to this conference through their papers and posters presentations. Their contributions bring extensive knowledge and research to the conference and will help to make the conference as outstanding as it can be. I trust this will be an impetus to stimulate further research and exploration in collections care, now and beyond.

ONG Chiew Yen
Director
Heritage Conservation Centre

Introduction

When I first joined the Heritage Conservation Centre (HCC) about four years ago as Deputy Director of Collections Management and Conservation Services, one of the first few things I was tasked to do was to help grow the capability of the conservators. Coincidentally, there was also an interest to organise an international conference for HCC. It soon became clear that this was not only an opportunity for our conservators to showcase their knowledge but also for our other HCC colleagues who had been contributing to the care of our collection in different ways. These included our collection managers, cataloguers, photographers and estate colleagues, amongst many others.

In 2016, the organising committee for the international conference was officially formed. For the first few months, we discussed the theme of the conference. In the end, there was overwhelming consensus that it would carry a broad theme on collections care in Southeast Asia, in particular ASEAN. The conference would serve as a platform for all of us in the industry to come together and share our diverse experiences, successes and the lessons learnt. However, we also knew that that the conference would only be meaningful if we were to garner strong support and participation from the local and international community, especially our ASEAN partners.

Today, we are pleased to present the conference proceedings featuring 25 contributions from our local and international experts. Eight are from our ASEAN colleagues including Singapore. In addition, we also feature 15 abstracts from our poster presenters from HCC, including one from our Chinese partner, Shaanxi Institute for the Preservation of Cultural Heritage (SIPCH). Setting the tone and framework for the conference is our distinguished keynote speaker Professor Robyn Sloggett, Cripps Foundation Chair in Cultural Materials Conservation, Grimwade Centre, University of Melbourne. She shares with us her views on the future of collections care in Australia and Southeast Asia. The topics presented in this conference proceedings are as diverse as we could possibly get, featuring seven sub-themes: Rethinking Collections Care; Preservation Strategies and Solutions; Material and Methods; Technology in Collections Care; Science in Art and Heritage Materials; Library, Archives and Media Art Collection Management; and Storage and Environment.

We hope that you will find these specially curated themes in this publication useful. The published papers are not only meant to document our shared experiences and challenges in caring for our collections at the 3-day conference in Singapore, but we also hope that they serve as a starting point for us to build new relations and strengthen existing ones with a group of like-minded people who are not only committed to caring for the collections but more importantly, making them relevant for the many years to come.

CHUNG May Khuen
Chair of Conference Committee
Director
National Museum of Singapore

KEYNOTE

Simplicity in Complexity: Trends and Future Directions in Caring for Collections in Australia and Southeast Asia

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ABSTRACT
Southeast Asia and Australia are characterised by diversity in culture and custom, language, history, climate, religion and belief, methods of government, and economic capacity. Such diversity poses particular challenges for universal approaches to museum development and management, and in particular for practices, policies, and procedures relating to the care of collections. Conversely, diversity provides fertile ground for regional approaches, provided that decisions result from targeted research, the sharing of knowledge and resources, and the development of protocols and procedures that reflect the diversity and acknowledge the various capacities, including in economics, in literacy and language, and in law across the region. In this lecture, Professor Robyn Sloggett examines some of the pressing issues in collections care that need to be addressed across Australia and Southeast Asia, and explores current trends, initiatives and future directions for the care of the rich, diverse, and very important collections that exist in the region.

Introduction

The theme of the Heritage Conservation Centre's Conference *Collection Care: Staying Relevant in Changing Times, ASEAN & Beyond* encapsulates two critical issues that collection managers, conservators, curators, librarians, and archivists face in the 21st century – relevance and change. Over the past century the world has witnessed extraordinary social and political change, significant technological advancement, and unprecedented challenges. The human population has risen from 1.8 billion people in 1919 to 7.7 billion in 2019. We have watched, or been part of, the largest displacement of people in the history of our planet. We struggle with impacts of climate warming at all levels of decision-making. At no other time in the history of homo sapiens has it been so critical for us to be able to understand our past, and to be in a position to examine decisions that have impact on the future.

Two hundred years ago, the world was a very different place. Singapore, with a population of about 1,000 people, was just beginning to make its way in the world, attempting to understand its newfound status as a British settlement. In the opening chapter of his wonderful historical account of Singapore, *Singapore 1819: A Living Legacy*, Kennie Ting describes Singapore's founding document, the Treaty of Singapore, and the haste with which it was negotiated.[1] Signed on "6 February in the Year of Our Lord 1819 answering to the 11th day of the Month Rubbelakhir and the year of the Hujira 1234"[2], the 1819

Treaty of Singapore is a relatively simple document written in English and Jawi Malay, and embellished only with the seals of Tengku Hussein Mua'zzam Shah ibni Mahmud Shah Alam, resident Temenggong Abdul Rahman of Johor-Riau, and the East India Company. But through this simple object, it is possible to identify the play of colonial power that, tsunami-like, washed over Asia in the 19th century, destabilising dynastic allegiances, toppling governments, disrupting millennia-old cultural practices, and beginning the reorientation of the Western history of ideas.

In 1819, Britain was eager to thwart the dominance of Dutch trade in Southeast Asia. Colonel William Farquhar, representing the East India Company, and the then Lieutenant Governor of Bencoolen, Sir Stamford Raffles, representing the British government, were commissioned to obtain a treaty for strategic access to regional trade. By 28 January 1819, their two ships, along with six other vessels, were anchored near "a spot where a town and a strong fort could be built for the defence of the inhabitants and its trade."[3] Ting draws attention to how "Raffles' signature – a hasty scrawl in a not-so-elegant hand – evokes the tense circumstances surrounding the signing of the treaty". Raffles' signature stands in contrast to the beautifully calligraphic script of his Malay counterpart Tengku Hussein Shah, the elder brother of the Sultan of Johore, who arrived from Bulang on 1 February for the signing ceremony.

For Hussein Shah, the signing of the Treaty meant more than confirming a new trade relationship. It was validation of his claim to dynastic legitimacy. As the eldest son of Sultan Mahmud Shah III, Hussein Shah had expected to succeed to the Sultanate of Johore when his father died, but he was absent in Pahang and his younger half-brother Sultan Abdul Rahman, supported by political factions sympathetic to the Dutch, claimed the Sultanate.[4] The Sultanate had been fortified by the treaty with the Dutch East India Company that Sultan Mahmud Shah III had signed in 1784. The 1819 Treaty countered this, validating the claims of both Hussein Shah and the British Empire to the region. This relatively fragile document helps to better understand the British attempts to undermine Dutch trade dominance in Southeast Asia, and the individuals whose personal ambitions intersected with these global plays of power.

Objects like the Treaty of Singapore are, however, more than simply windows into the past. The objects held in public collecting institutions, in family collections, in small communities, and by individuals, help validate or contest received histories. They threaten comfortable assumptions by presenting unpalatable truths, taunt scholars with half-told stories, and provide the mechanisms that locate much broader issues that will impact the future. Access to objects enables stories to be told in ways that would not otherwise be possible, examine topics that would otherwise lack context, explore visual and material reference points with new insights, and test and validate theories and conjecture in new ways.

Materials and technology

The paper, wax seals, and ink of which the various copies of the Treaty of Singapore are comprised are part of a material tradition that stretches back centuries and which, by 1819, had crossed the globe. If the Treaty of Singapore had been signed in 1919, rather than 1819, it would have been part of a world where new manufacturing techniques were creating new materials and new products at a relentlessly rapid pace. By 1919, an event as significant as the signing of the Treaty of Singapore would be captured on film or in photographs. Such film would have been made from an unstable cellulose-derived material known as celluloid, comprised of nitrocellulose, camphor, ethyl alcohol, and a range of dyes, stabilisers, and other constituents. In 1919, this first modern plastic, cheap and highly ductile, was everywhere. Today it is a ubiquitous material in collections, found as audio recordings, moving image film, and simulated replacements for bone, ivory, tortoiseshell, and more. But celluloid is, literally, a time bomb. As camphor molecules shift their alignment, celluloid becomes brittle. Nitrates, accumulating in the presence of moisture, form nitric acid, resulting in sticky surface and a darkened, brittle mass. Celluloid is the undead of the collection, ready at any time to manufacture its own life force. Aged cellulose nitrate film is highly flammable and alarmingly unstable, with the capacity to spontaneously ignite. It burns at very high heat and produces large amounts of highly toxic nitrogen monoxide and dioxide, as well as oxygen, which makes nitrate fires impossible to extinguish. The "improved" version of celluloid, cellulose acetate, is only marginally better. It distorts, shrinks, and becomes brittle as it leaches acetic acid in a continuous chemical reaction known as “vinegar syndrome”.

Many modern materials such as these have created both practical and philosophical problems in collection care. Challenging ideas of material longevity, they have the potential to demand expensive solutions, create points of conflict between creators, curators, conservators and collection managers, and require vast amounts of time and ingenuity to solve the problems they pose. But there is no choice. If they are to properly represent human history, creativity, and endeavour, then institutions must collect modern materials. By the end of the 20th century, research into modern materials and modern technologies had become a significant priority in conservation and collections care, with large international collaborative research platforms examining the practical and philosophical issues raised by the collection of modern materials.[5] In 1996, the International Council of Museums – Committee for Conservation (ICOM-CC) established a working group dedicated to “Modern Materials”. In 1999, the International Network for the Conservation of Contemporary Art (INCCA) was established.[6] The beginning of the 21st century saw a raft of research initiatives in this area. Preservation of Plastics ARTefacts (POPART) developed a coordinated European-scale strategy that focused on identification and collection surveys, degradation studies, and active conservation.[7] Tate implemented its Modern Paints Project[8]; and the Getty Conservation Institute (GCI) began its Modern and Contemporary Art Initiative.[9] In Southeast Asia and Australia, two projects examined the behaviour of Western artists’ materials in tropical climates, and the 20th century in paint, bringing together partners across Singapore, Malaysia, The Philippines, Thailand, Australia, USA, and the UK.[10]

The digital age

If the Treaty of Singapore had been signed in 2019, the treaty document would probably still be paper-based, and photographs and a film would still be made of the ceremony, but digital versions of all these records would have been uploaded to a file sharing system and then downloaded into a digital archive. A digital version of the Treaty and images and the film of the signing ceremony would be posted on social media, and commentary shared on platforms such as Twitter, Facebook, QZone, WeChat, YouTube, Pinterest, WhatsApp, Tumblr, Instagram, or a myriad of others. Publicly accessible, these images and commentary would attract additional comments. In turn, some of this social media content would be uploaded into a digital archive, some downloaded into a range of devices, edited, and re-shared with new comments. With each new media platform, new content could be added. Each step requires a series of manufacturing, production, technological, planning, and decision-making ecosystems that are much more complicated than those involved in the production, use, and storage of the 1819 manuscript, or the 1919 version with its celluloid film and sound recordings. The democratisation of content production and distribution has created digital records that are more ubiquitous, and more difficult to manage than plastic. In 2003, to address the issues raised by digital records, The United Nations Educational, Scientific and Cultural Organization (UNESCO), in partnership with the National Library of Australia, produced *Guidelines for the preservation of digital heritage*.[11] By 2016, UNESCO saw the threat posed by digital technology as nothing less than a threat to the continuing function of national heritage institutions.

> Heritage institutions – libraries, archives, and museums – traditionally bear the responsibility of preserving the intellectual and cultural resources produced by all of society. This important mission is now in jeopardy around the world due to the sheer volume of information which is created and shared every day in digital form.[12]

UNESCO also noted:

> The long-term preservation of digital heritage is perhaps the most daunting challenge faced by heritage institutions today.[13]

By the beginning of the 21st century, and faced with a "digital dark age", most collecting institutions had established protocols and procedures in place for interoperability, emulation, simulation, archiving, and preservation. Much has been lost, however, for many individuals, communities, and organisations with less capacity to develop responses to this threat, and particularly those with limited financial and infrastructure resources,. The age of the democratisation of information has also led to significant inequity. On the one hand, almost anyone can own the means of production to create and to share digital content, and vast tracts of social, historical, cultural, and scientific records currently exist only in digital format. On the other, the ability to properly maintain and preserve this content sits with relatively few well-resourced and heavily invested organisations. For those who cannot afford to manage the technological obsolescence, and the maintenance of the ecosystems that support the continued access to the records, their history will, with the passage of time, slip from their grasp and from a wider shared heritage.

The sustainable museum

The internet access that the National Library Board (NLB) in Singapore provides to digitised copies of newspapers from 1831 made it possible to uncover an article in *The Singapore Free Press and Mercantile Advertiser* dated 6 February 1914 about the 1819 Treaty. Headed "Founding of Singapore", the article opens:

> Today, Feb 6th, is the anniversary of the signing of the Treaty of Singapore, and we may briefly recapitulate some of the circumstances of that memorable day which have all been carefully collected and gone into by the late Mr C. B. Buckley, in his admirable "Anecdotal History of Singapore."[14]

C. B. Buckley had been the owner of *The Singapore Free Press* as well as honorary adviser to the Shah of Johore, and an avid amateur historian. The article describes how the original 1819 Treaty disapped immediately after the signing ceremony, and copies of the 1824 Treaty were appended with the note that "no copy of these preliminary articles is to be found." C. B. Buckley, having searched Singapore for the original 1819 Treaty without success, assumed that the Treaty had been lost to "white ants, insects, and a damp climate … and mistakes or carelessness."[15]

> Then Mr Buckley went to Johore on the August Bank holiday of 1901. "The Dato Bintara Dalam … asked why so much trouble need be taken about it; why not look at the original?"… So a large safe was opened and the papers laid out on a big office table … Near the bottom …the treaty of 1819 itself was found among a bundle of old papers.[16]

The article noted Buckley mused that:

> The one copy, in the hands of English clerks, with secure safes, had not been forthcoming for many years, and the copies of it were incorrect, while the copy that had been handed to the Malay chief who had not a table, chair, envelope or safe, had been kept carefully wrapped up and preserved through four generations and nearly a century to the hands of his great grandson, now styled the Sultan of Johore.

A year after Buckley found the Treaty of Singapore in Johore, 25-year-old engineer Willis Carrier developed the first modern air-conditioning unit in New York. Two years later, air-conditioning was used for the St Louis World Fair, Missouri, USA. Gradually, the belief that air-conditioning was a valuable tool in collections management permeated collections care. In 1978, Garry Thomson, then Head of the Scientific Department at the National Gallery (London), in his book *The Museum Environment*, consolidated existing research and practices on and explored the "principles and techniques" for managing the museum environment. With collecting institutions invested in the idea of universal standards, Thomson's publication led an industry that was hungry for information and guidelines to endorse requirements for universal environmental standards. These were set at the generally accepted parameters of around 50 +/-5% relative humidity RH and 20 +/- 2 degrees Celsius.[17]

In the decades that followed, travelling international blockbuster exhibitions became a focus for institutions that were keen to demonstrate their commitment to accessibility and to showcase the relevance of their work in a global environment. Adherence to these universal environmental standards became a requirement for such programmes. Across non-temperate zones in Southeast Asia, India, Equatorial Africa, the Pacific Nations, South America, and Australia, institutions grappled with the costs of trying to create environments of 50 +/-5% RH and 20 +/- 2 degrees Celsius. Loan objects coming from local Indigenous, small rural, or regional communities were relocated from relatively high humidity and temperature into institutions which aimed at, but rarely achieved, a flatline of 50% RH and 20 degrees Celsius. For collections held in these communities, the cost of air-conditioning was not only prohibitive but the technology proved to be far from fail-safe. Research began to identify significant risks posed to objects from the failures and limitations of air-conditioning, and questions were raised as to whether the economic cost and impacts to the environment were justified.[18]

At the International Institute for Conservation of Historic and Artistic Works IIC 2014 Congress in Hong Kong, a joint IIC and ICOM-CC *Declaration on Environmental Guidelines* was announced. This Declaration sought to address a number of issues including: increased flexibility in guidelines for environmental conditions for collections and in the provision of environmental conditions for loans; better environmentally sustainable approaches to the management of museum environments; environmental conditions for permanent display and storage that were achievable for the local climate; and identification of different requirements for objects for loan and those held in permanent collections.

The Declaration also recommended that "existing interim guidelines" agreed by the American Institute for Conservation (AIC), the Australian Institute for the Conservation of Cultural Material (AICCM), and the Bizot Group, which proscribed acceptable tolerances of 40 – 60% RH and 15-25 degrees Celsius as standards for international loan exhibitions, should be confirmed as guidelines. Despite changes, these guidelines still reflect the concerns of institutions in temperate zones, the reliance on air-conditioning remains unchanged, and there is a failure to effect impact in the face of significant climate change. The recommendations in the guidelines remain as an adjustment of numbers, not as a change in practice.

A shifting global identity

The European protagonists engaged in the signing of the Treaty of Singapore – Sir Stamford Raffles and Major General William Farquhar – were quintessential early 19th century colonial military administrators. Both were avid collectors who built collections that record the natural history, and social customs, practices, and beliefs of the local population in the areas they administered. Collections such as these were assembled to support research and education programmes that were located "at home", thousands of miles away in the centres of colonial politics and ideas. In these metropoles, public institutions relied on cultural commodities from the colonies. In turn, these institutions valorised the great voyages of discovery, as well as the social, economic, and political theories that supported colonial conquest, trade, and government. In 1819, collections served to demonstrate the role and significance of emerging disciplines in contemporary European society. Collections were a record of the activities (and successes) of the colonial administrators, and served to entice the next generation of workers and entrepreneurs to serve in the colonies. Above all, the collections served as propaganda to justify Europe's colonial expansion. Collections of cultural material and human remains from Indigenous societies were the basis for self-serving theories about culture, society, and human development. Collections were also valuable assets, sold to raise money to support new colonial endeavours. For communities of origin, the result was often devastating, as cultural, religious, ceremonial, and educative objects were no longer available for cultural practice, study, or intergenerational knowledge development.

In 1812, seven years prior to signing the Treaty of Singapore, Sir Stamford Raffles, in a monumental act of aggression, ordered the sacking of the Keraton of Yogyakarta. Javanese manuscripts dating between 1772 and 1813 were looted, and ended up in the private collections of Raffles, Chief Engineer Colin Mackenzie, and Resident John Crawford. Only three manuscripts remained in the Keraton's Royal Library after the sacking: a Qur'an (copied in 1797), the *Serat Suryaraja* (1774), and a copy of the *Arjuna Wiwaha* (1778). In 1842, the British Museum purchased John Crawford's collection, known as the Archive of Yogyakarta, which is comprised of some 400 manuscripts and records. Bound in two volumes, this archive consisted of official reports, letters, accounts, and other documents, as well as the private papers of Sultan Hamengkubuwana II and his successor Sultan Hamengkubuwana III. The British Library describes these archives as a "highly important source for the political, economic, social, administrative and legal history of central Java in the late eighteenth and early nineteenth centuries". In 2016, in recognition of this significance, the library digitised the entire contents of the Archive of Yogyakarta and presented these records to His Excellency the Governor of Yogyakarta, H. M. Sri Sultan Hamengkubuwana.

Unfortunately, however, many items thus acquired were lost forever. During his service in Penang, Melaka, Java, and Sumatra, Raffles built an extensive personal collection of natural history, languages, literatures, and cultures of the region. Unfortunately, most of the Sumatran collections were lost when his ship the *Fame* caught fire in 1824. Raffles' secretary wrote:

> When I heard this news I was breathless … remembering all the Malay books of ancient date collected from various countries...The books could not be recovered for none of them were printed but in manuscript …[21]

The Javanese collections have survived with the Malay and Javanese manuscripts held in the Royal Asiatic Society of London; books and paintings in the British Library; and Javanese antiquities, archaeological drawings, textiles, weapons, shadow puppets, masks, and gamelan instruments held in the British Museum. While he served as British Resident and Commandant of Melaka between 1803 and 1818, William Farquhar commissioned local artists to produce 477 natural history drawings of local flora and fauna. Held by the Royal Asiatic Society from 1827, these drawings were purchased by Mr Goh Keok Khim in 1993, repatriated, and donated to Singapore's National Museum, where they are one of the most recognised components of the collection.

Repatriation, access, and the authentic cultural record

During the 20th century, as the colonial grip weakened and new nation states emerged with new needs for education and new remits for public institutions, moves to contest universal approaches to collection development and management strengthened. Emerging nation states reframed the purpose of their collecting institutions, defining these institutions as caretakers of new and very different national stories. These new and reimagined collecting institutions supported their constituent populations to find new voices for the new nations. For those keen to tell their own stories, it was obvious that, in many cases, overseas institutions were much better placed to tell these stories. They were aware that their country's objects and archives remained more easily accessible to scholars in Europe or North America, and that their country's history remained focused through the prism of colonisation. Across the globe, communities became increasingly aware that objects and archives held overseas could help fill significant gaps in their own history. By the end of the 20th century, repatriation had become a political lightning rod that periodically engaged Heads of State in awkward political manoeuvres that forced them to tiptoe between being seen as supportive of the needs of their local constituencies, and being seen as players on the international stage. For Indigenous communities in Australia and New Zealand, the refusal of institutions to return tens of thousands of human remains to families and communities provoked particularly intense responses. As recently as 1988, it was still necessary to mount a public campaign in order to halt a proposed auction in London of a *mokomokai*, which had been valued between £5,000 and £7,000. The campaign resulted in the head being withdrawn from the sale, and repatriated to New Zealand for reburial, but many communities and families are still engaged in this unequal battle. In 2000, having identified repatriation as a significant threat, the directors of 18 of the world's major museums in Great Britain, Europe, Russia, and USA signed the *Declaration of the Universal Museum*, claiming, with a certain amount of hyperbole, that of all the threats to museums in the 21st century:

> One of the most pressing of these is the threat to the integrity of universal collections posed by the demands for restitution of objects to their countries of origin.

New philosophies, however, were challenging the systems that had built these "universal" museums. In 1982, UNESCO established its Working Group on Indigenous Populations, and in 1985, work on the draft *Declaration on the Rights of Indigenous Peoples* began. The Declaration was formally adopted on 13 September 2007, and the United Nations Permanent Forum on Indigenous Issues asserted that:

> Many of the rights in the Declaration require new approaches to global issues, such as development, decentralization and multicultural democracy. In order to achieve full respect for diversity, countries will need to adopt participatory approaches to Indigenous issues, which will require effective consultations and the building of partnerships with Indigenous peoples.

Around the same time, The Nara Document on Authenticity Conference (1994) focused the global heritage sector's interest on what constituted authenticity in conservation by arguing that:

> 11. All judgements about values attributed to cultural properties as well as the credibility of related information sources may differ from culture to culture, and even within the same culture. It is thus not possible to base judgements of values and authenticity within fixed criteria. On the contrary, the respect due to all cultures requires that heritage properties must be considered and judged within the cultural contexts to which they belong.[26]

Other statements followed. The African Cultural Heritage and The World Heritage Convention (1995) expressed concern that the under-representation of African sites on the World Heritage List demonstrated a Eurocentric "monumentalist" conception of cultural heritage.[27] In 1996, the Council on Monuments and Sites (ICOMOS) in the US prepared The Declaration of San Antonio that asked "whether the American point of view is fully represented in the [Nara] document", noting the plurality of community interests, and that "the identification of 'fundamental cultural values' is not possible or desirable in this context."[28]

Rethinking the museum

Two decades into the 21st century, philosophies and practices relating to decision-making and documentation now form a considerable part of collections care, and informed advocacy is central to any objectives aimed at the preservation of cultural material. Unsurprisingly, the increased interest in pluralist approaches to conservation and collection management opens up new challenges. In Australia, for centuries prior to colonisation, Indigenous communities were part of the great north-south trade route that stretched from northern Australia, past Timor, to Macassar and on to Macau. This trade was based on treaties, but unlike the Treaty of Singapore, these were performative and not textual; enacted through cultural practice and protocols. The crews of the Macassan *prau*s that traded along the coastline of northern Australia raised flags in order to seek permission to access landing sites and were, similarly, granted permission. Today, documentation of these treaties is preserved in contemporary performance, though the trade was banned in 1907. For institutions holding ceremonial material that relates to these treaties, the question of how to preserve the performance that is the treaty is a significant one. Similar questions are being asked about the preservation of conceptual performance art as institutions grapple with questions of how best to collect performance, rather than just a record of the performance. The bringing together of senior cultural knowledge holders, practitioners with collection managers, and conservators, in dialogue, to examine these difficult questions of preservation and access, provides a much broader and more effective constituency to guide consultation and decision-making.

Collection managers and conservators worked hard in the 20th century to build professional frameworks for the care of cultural collections. But challenges remain, and the political and economic realities that are part of the history of the region impact on the care of collections across Australia and Southeast Asia. In Australia, many regional and remote Indigenous communities have amassed highly significant collections of audio-visual materials that are housed in conditions with poor environmental control, and that lack staff dedicated to, or trained in, collections care.[29] In the Tiwi Islands off the coast of northern Australia, community art centres experienced annual mean fluctuations between 66 and 73% RH from 1979 to 2009, rising from between 74.5 to 80.5% RH in the Wet Season, and falling to between 57 and 67% RH in the Dry Season. Objects coming from such communities will be under stress in environments between 40 and 60% RH.[30] So, despite significant work done to date, much evidence-based research is still needed in order to understand the impacts of climate change and museum environmental standards for collections in tropical environments, or in small, less well-resourced communities. In many centres in Southeast Asia, the aftermaths of war, regime change, and environmental disasters have left governments without the resources to properly manage and conserve large parts of their country's significant cultural audio-visual heritage. For the Asia-Pacific region, the issue of how to best provide fit-for-purpose conservation and collection management responses in depleted economic environments is a pressing one.

Conclusion

Eric Thompson, who examines the historical narratives developed in museums across Southeast Asia, discusses the shift that had occurred by 2012 from colonial museums to museums that simultaneously demonstrate national narratives and perspectives, with "extra-national narratives … with particular thoughts to an emergent international and regional ASEAN consciousness".[31]

Towards the end of second decade of the 21st century, rethinking the definition of what it meant to be a museum as:

> … a non-profit, permanent institution in the service of society and its development, open to the public, which acquires, conserves, researches, communicates and exhibits the tangible and intangible heritage of humanity and its environment for the purposes of education, study and enjoyment[32]

has become a focus for the International Council of Museums (ICOM). In September 2019, at ICOM's Extraordinary General Assembly in Kyoto, the ICOM membership were asked to vote on a proposed new definition of a museum that acknowledges that:

> Museums are democratising, inclusive and polyphonic spaces for critical dialogue about the pasts and the futures. Acknowledging and addressing the conflicts and challenges of the present, they hold artefacts and specimens in trust for society, safeguard diverse memories for future generations and guarantee equal rights and equal access to heritage for all people.

> Museums are not for profit. They are participatory and transparent, and work in active partnership with and for diverse communities to collect, preserve, research, interpret, exhibit, and enhance understandings of the world, aiming to contribute to human dignity and social justice, global equality and planetary wellbeing.[33]

After much discussion the Extraordinary General Assembly of ICOM decided to postpone the vote, and the debate will, no doubt, continue to be active for some time into the future.

As objects were brought together to build collections, and as collections were brought together to form museums, guiding models of best practice and effective decision-making were crafted to suit the requirements at the time. But times change. New challenges propel new enquiries. New enquiries effect new solutions. Some of these are technological, some are philosophical, some are sociological, but all need to be practical.

This story of the Treaty of Singapore started 200 years ago when the materials on which the treaty was written were purchased and prepared. As each milestone is reached in its history – 50 years, 100 years, and now, 200 years – a document with the social and historical weight of the Treaty of Singapore attracts additional content in different contexts. Along the way, new materials and new technologies challenge accepted methodologies for collections care, while new sociologies reframe the aims of public institutions, and rebalances occur as history is examined and its impacts recalibrated. There is no doubt that the 21st century will present new major challenges for the care of collections.

For collecting institutions across the globe, staying relevant in changing times means being engaged with, and contributing to the big issues they face in the 21st century, including the challenges posed by new technologies, social inequity, climate change, changing needs in education, and the displacement of people across the globe. Times change, but the commitment of people with passion for and understanding of the value of collections has been a constant over time. It is this simple belief, more than anything else, that will drive the care of collections into the future.

Author's biography

Professor Robyn Sloggett is the Cripps Foundation Chair and Director of the Grimwade Centre for Cultural Materials Conservation at the University of Melbourne. Her research interests include: the investigation of the materials and techniques of artists, attribution and authentication of paintings, the development of the art market in the twentieth century, collection development and history, and the preservation of cultural materials held in Australian Indigenous communities. She holds qualifications in art history, philosophy, and cultural materials conservation. Robyn has been honoured to receive the Bathurst Macquarie Heritage Medal (2016), the International Council of Museums Australia Award for International Relations (2013), the AICCM Award for Outstanding Research in the Field of Material Conservation (2012), and the AICCM Conservator of the Year Award (2004). In 2015, she was made a Member of the Order of Australia. She is passionate about conservation and its importance for the future of our region.

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CONFERENCE PAPERS

Looking to the Future: Collection Care at the British Museum

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KEYWORDS
collection care, conservation, collection management, photography

ABSTRACT

The British Museum is constantly changing the way it interacts with audiences, creating a wider range of exhibitions that attract not only the traditional visitors but also draw in new, younger people. Globalisation, combined with need to generate income, has led to an increase in international touring exhibitions and loans. Initiatives which encourage national lending are taking the Museum's collection out of London, and to other areas of the UK. The development of new storage facilities, which will be accessible to student and researchers at the university, will further increase access to the Museum's collection. All these initiatives impact on collection care, increasing the workload, and extending and challenging traditional processes and practices.

In March 2019, a centralised Collection Care Department was created in the British Museum. The paper will discuss this recent change in structure, which is intended to increase capacity and flexibility in order to deliver on both collection-related activities and income, as well as audience-generating "business developments". The paper will also discuss the historical approach to collection care, its pros and cons, and the evaluation that led to the creation of the new Department. Combining Loans & Exhibition Registration, Collection and Documentation Registration, Collection Management of Loans and Displays, and (separately) Care and Access, Photography and Imaging, and Conservation teams, this new group is comprised of 150 staff.

Setting the direction and vision, and developing shared, standardised, and integrated practices for the Collection Care Department requires both discussion within the Collection Care Department, and careful and open exploration of best practices with other museum teams such as Exhibitions, International Engagement, and Collection Projects and Resources Department. Prioritising work according to the Museum's strategic plan, and meeting exhibition and touring deadlines, underpins all developments.

Introduction

The British Museum (BM), which was opened to the public in 1759, is one of the world's greatest museums. With 80 galleries and 8 million objects, it attracts 5.8 million physical visitors per year and 38 million hits on its web site annually . There are approximately 900 BM staff and 500 volunteers. As a "museum of the world", it has eight collection departments that represent geographical regions (Africa, Oceania and the Americas; Middle East, Egypt and Sudan; Greek and Roman Collections; Asia; and Britain, Europe and Prehistory), and materials (Coins and Medals, and Prints and Drawings). The Museum makes its collection freely available to the public through its permanent galleries and through a regional UK loans programme. The combined total of national and international loans in 2018/19 was 5,248 objects to 240 venues, making the museum one of the largest lending museums in the UK. Collections are being displayed in local museums and small venues across the UK, or incorporated into larger exhibitions across the world.

The Museum annually receives £40 million of grant-in-aid from the government to support and underpin its activities. Most of this money is used for staff salaries and care of the building. An additional £40 million, which is needed to maintain the building, preserve the collection, and ensure that the Museum meets its strategic objectives to increase knowledge of, and access to, the collection, is funded through charitable donations (£21 million), commercial activities (£13 million), and legacies (£10 million) (1).

An annual rolling programme of ticketed exhibitions contributes to this income target. Some exhibitions are focused on the BM's collection. For example, in 2018/2019, the museum presented *I am Ashurbanipal*; *King of the World, King of Assyria* (2), a carefully curated display which captured Assyria's position as an ancient military through wall reliefs, metallurgy, and clay tablets, and contextualised this collection in relation to today's society and political landscape. Other exhibitions, such as *Munch*; *Love and Angst* (3) Exhibition and *Manga* (4) are a combination of the BM's collection, and loans from other museums and organisations. Through careful design, these exhibitions are given a modern relevance which attracts new audiences to the museum. The visitor profile for *Manga*, for example, is predominantly teenagers and those in their early twenties. These visitors are our audiences of the future. Ticket sales, together with associated revenue from the café, restaurant, and gift shop, also contribute to annual income.

The Museum's International Engagement Department, which includes the International Touring Exhibitions (ITE) team, creates bespoke, income-generating International Touring Exhibitions (5). These, often blockbuster, multi-material shows focus on popular themes such as Egypt or ancient Greece. Borrowing venues are charged a fee which covers the loaning of the collection, their transportation, and installation as well as a profit margin. In 2019/2020, 16 ITE exhibitions were concurrently touring venues in America, Europe, Asia and Australia, with each exhibition visiting three or more venues. Opportunities to expand the current offer from ITE are under development.

Amid the development of new and expanding income-generating activities, day-to-day collection-based activities, that underpin the care of the collection, continue. The BM has 12 study rooms where scholars and researchers come to investigate the collection for personal research and private study. Gallery rotations of light-sensitive items, maintenance of stores, management of the environment, location control, and documentation of new acquisitions, are a few examples of "business-as-usual" activities.

The completion of the World Conservation and Exhibition Centre (WCEC) in 2014 was the fulfilment of the first stage of the Museum's ambition to develop the Bloomsbury estate to create more functional spaces, make possible the consolidation of activities, improve collection facilities and staff working conditions, and enhance the visitor experience. 6,000sqm of collections storage, conditioned for organic objects, is included as part of the build, and collections are being moved from outstations to these improved storage facilities.

The Museum also holds a significant proportion of its collection at Blythe House - a government owned store that is earmarked for closure in 2023. The BM's collection in this building is being prepared for moving either to the main Bloomsbury site or to a newly built facility outside London, i.e. the British Museum Archaeological Research Centre (BM ARC) (6). The collections housed in the new facility will be accessible for research and are available for UK and international loan. BM_ARC will house archaeological collections, large stone sculptures and provide flexible space for the temporary storage of a broad range of collection material to support storage moves and other capital projects elsewhere across the estate. It will be delivered in partnership with the University of Reading which not only has an excellent international reputation for research in Archaeology, Classics and History, but is also an important research partner of the Museum.

Care of BM's collection is fundamental to all museum activities, both income-generating and otherwise. A review was undertaken of the existing structure of collection care in the BM, with a view to identify more efficient and effective ways of working that could deliver on the expanding work programme within the existing staff capacity.

Review and restructure of collection care in BM

In the past, collection care was dissipated across the Museum. Each curatorial team had its own conservators, collection managers, and administrators.

A central Conservation Department was created in 1975 with its own Head of Department. This brought together the conservators who had previously worked within curatorial teams. The Department structure was formed around the deep understanding that conservators have of the deterioration, care, conservation and preservation of materials, rather than focusing on geographical regions or historical periods. This correlated well with the scale of the collection and the nature of conservation training, allowing the Conservation Department to develop expertise in Metalwork, Stone, Wall-paintings, Ceramic and Glass, Organics and Western and Eastern Paper. More recently a Preventive conservation team has been established.

Collection Management practice was organised around teams of Museum Assistants (MAs) led by a Senior Museum Assistant (SMA) (or an equivalent) based in individual curatorial departments. The processes, procedures, and tasks of these teams were largely autonomously managed by curatorial teams whose cross-departmental work were limited. In 2015, the structure was reorganised (7) to create three teams of Assistant Collection Managers, each led by a Collection Manager who works across the Museum to deliver its progammes. The primary drivers behind this restructuring were the increasingly ambitious, income-generating, international touring loan programme, and the completion of the WCEC. This restructuring allowed resources to be flexibly allocated to projects whilst delivering business as usual. Greater streamlining of process and the development of a more responsive team increased efficiency and encouraged best practices. With improved strategic planning, programming, and resource management, financially realistic and sustainable public-programme delivery could be embedded into the museum's higher aims and objectives. This structure meant that experienced MAs and SMAs (responsible for the care of the collection remained distributed across the curatorial departments, maintaining familiarity with the collection and their specific care needs.

In 2017, a review of departmental administration, which included specialist tasks relating to collection, such as loans administration and documentation, was undertaken (8). As the administrative structure was distributed across curatorial departments, administration teams were focused solely on the needs of a particular curatorial department, and locally managed. Whilst this structure allowed the administration teams to have good knowledge and understanding of a particular part of a collection, there were significant differences in the way each department administered collection-based activities. In the case of a multi-departmental loan, for example, the borrower had to deal with two or more individual departments with different processes and practices. This was time consuming for the borrower, with no lead person to communicate with. The levels of administrative activity did not directly correlate with resource provision within each curatorial department. Loans, acquisitions and other collection-related administration operate in a complex environment, and require expert knowledge of international legislation and standards covering due diligence *Spectrum* (9), indemnity, import and export law, management of human remains (10), fire arms (11), the Convention on International Trade in Endangered species of wild fauna and flora (Cites) (12).

Reviews of collection management and collection administration had recommended the centralisation of these activities.

Collection Care Department: the new structure

On 1 March 2019, the Collection Care Department (CCD) was established, drawing into one team the Conservation, Collection Management, and Photography Sections (Figure 1). The new team comprised of over 150 staff. The majority of the staff are based within the WCEC, though Collection Managers tended to be based within the curatorial teams or in workshops dissipated across the Museum estate.

The Collection Care Department is responsible for the conservation care, storage, display, and photography of the Museum collection, ensuring that best practices are maintained throughout all these activities. CCD focuses on all aspects of collection management, from acquisition to access and display within and beyond the BM, both in physical form and virtually through contributions to museum publications and the website. The Department is actively engaged in all collection-related activities championed by the museum: galleries, exhibitions, and loans, together with national initiatives such as the Portable Antiquities Scheme, and in compliance with the Treasure Act. (13).

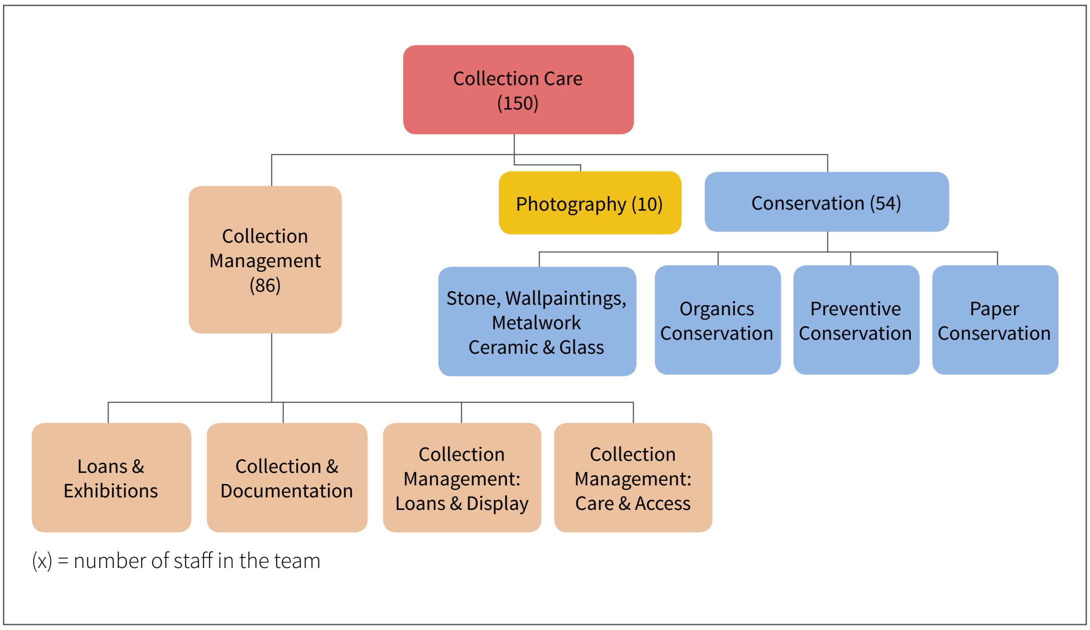

Figure 1. Structure of the BM Collection Care Department.

Roles and responsibilities

The Collection Care Department is led by the Head of Collection Care. This senior post was established to ensure that collection care is considered in all major decisions made by the Museum. As a member of the Senior Management Group, the post-holder is responsible for creating and delivering strategic and operational collection-based objectives, and for advising the Director and Deputy Director of Collection on aspects of collection care. Collection-focused standards and guidelines are championed and ratified at the monthly Collection Group meetings, which includes curatorial keepers, the Head of Collection Care and the Head of Collection Projects and Resources. Managing risks to the collection, including their salvage and recovery in the event of a disaster, is a collaborative role, led by the Head of Security and including Head of Collection Care, Head of Facilities Management and others who are responsible for the visitors to the museum and museum retail. The Head of Collection Care leads the team in ensuring best practices and legal compliance with national and international law and codes of conduct, and anticipates and prepares for changes to ensure that the team remains fit for its purpose. The individual teams within the Department have specific responsibilities. Continually exploring opportunities to break down boundaries and increase collaboration within a team will increase its flexibility.

Conservation

The Conservation Section is responsible for the preservation of the BM collection through preventive and interventive treatment. The Preventive Conservation section ensures that risk to the collection is reduced or removed. The Interventive Conservation teams clean, reconstruct, consolidate, and prepare the collection for display or loan. The conservators' deep understanding of how materials change over time allows them to interpret deteriorated surfaces, increasing understanding and interpretation of the Collection. The Head of Conservation is responsible for the strategic priorities for the conservation of the BM collection, and delivering work to deadline for loans, exhibitions and gallery refurbishments museum activities. The post-holder also ensures that the team is future-proofed in terms of expertise, techniques, and equipment. Section/Studio Heads lead specialist teams of conservators, who are experts on organic and inorganic materials and papers. The Conservation Section has a core staff of 55, with additional contract staff supplementing some projects.

Collection Management

The Head of Collection Management Section oversees four teams: Care & Access, Collection & Documentation, Loans & Display, and Loans & Exhibitions.

The Care & Access Team focuses on the day-to-day care of the collection, and enables business-as-usual activities, which include access to the collection, maintenance of stores, movement of the collection within and beyond the Museum, and collection documentation. The Team is responsible for managing departmental study rooms, permanent galleries, and stores across all BM sites. It is led by a Senior Collection Manager, and comprises of eight Collection Managers and 28 Assistant Collection Managers.

The Loans & Display Team leads, organises, schedules, and documents practical installation of objects for the public programme of temporary exhibitions at Bloomsbury. It advises on best practices for packing and transportation, creates mounts and bespoke packing solutions for travel crates, and couriers and installs the collection at borrowing venues in the UK and internationally. The Team is led by the Senior Collection Manager of Loans & Display, who oversees six Collection Managers, 19 Assistant Collection Managers, and the teams that specialise in heavy objects, framed works, and textiles.

The Collection & Documentation Team is responsible for maintaining and coordinating the BM's long-term loans and supporting the acquisition process. It coordinates the collection management aspects of compliance with the The Treasure Act. It also ensures inventory standards, safeguards data integrity, manages documentation for all aspects of collection management including collection audit, and is responsible for the maintenance of the Museum's database (Museum Index +), including training staff on the use of MI+. The Team is led by the Registrar of Collection & Documentation, and is supported by an Inventory Manager, a Project Coordinator, and two Collection Coordinators. The Registrars are responsible for the inventory of the Museum's collection on the Museum Index + (MI+) collection management system.

The Loans & Exhibitions Team is responsible for managing the logistical aspects of the Museum's national and international loans, including UK partnerships, ITE loans, and the Bloomsbury exhibitions programme that includes loans coming into the museum from external organisations (museums, galleries, private collections etc.). It ensures compliance with national and international law on the care and movement of collections and materials. The Team is led by the Registrar of Loans and Exhibitions, and supported by seven Project Coordinators and five Loans Coordinators.

Photography and imaging

Working from a well-equipped central studio, the Chief Photographer manages nine photographers producing 2D and 3D high-resolution images of items from the BM permanent collection, for the public as well as all departments in the Museum. The team will work on location-recording excavations, architecture, landscapes, and portraits in support of exhibitions and events within the Museum, within the UK and abroad. The Team undertakes specialist-led time-lapses and scientific imaging, and offers photographic training. In-house, the team's images are used for publicity posters, labels and publications, and as archival records of key events and activities.

What will success look like?

The creation of the Collection Care Department is recent, and recruitment into some of the teams is ongoing. The centralisation of collection care activities has many benefits that will be realised as the Department continues to form, traditional barriers relax, and new relationships and loyalties develop.

Success in the long term (five to ten years) will be measured by the Department's strategy to deliver on future museum objectives. Whilst the movement of the collection from Blythe House to BM_ARC will be undertaken by an independent storage move team managed by the Collection Projects and Resources Department (CPR), the CCD will be responsible for managing and making accessible this remote collection once the transfer has been completed. Similarly, the Department must anticipate and plan for increased international activity and a more demanding exhibition programme. The Museum is currently developing a plan to address essential repairs of the main museum building. This will provide the opportunity for major refurbishment of the permanent galleries. The Department's ability to secure resources to support these activities, and to provide sound and pragmatic advice in a timely way to help the delivery of the museums strategic aims and objectives will be considered signs of long-term success.

A balance has to be struck between delivering on the primary purpose of the Museum, caring for its collection, and the need for income generation and attraction of future audiences. Achieving this with finite staff resources requires strategic planning and prioritisation of activities. Forward planning of departmental resources, and input into the future planning of exhibitions, ITE, and gallery development, can potentially optimise staff time and avoid log jams and clashes in programmes that will otherwise occur. The Collection Care Department can open up and improve cross departmental working with other teams across the Museum that are focused on delivering the same strategic objectives.

Short term (five years) success will be increasing effectiveness and efficiency of collection care related processes by bringing teams together to review and revise traditional practices. Success can also be achieved by providing clear guidance to the staff in Collection Care and the other museum teams with whom they collaborate and delivering training to manage the risks to the collection, as well as defining new ways of working. The new structure offers the Assistant Collection Managers opportunities for career development, and success will be in seeing individuals grow and take on more responsibilities.

Creating a standardised process that is applicable to all curatorial teams, for example, in the way loans are managed, would ensure that borrowers have a named museum contact to work with. This improves the Museum's reputation for professionalism, which in turn increases the BM's contribution to UK's soft power through international and national initiatives. Within the Museum, this standardised process will ensure that decisions made by the Loans Committee are objective, and consider resource costs. It will also avoid creep of the scope of the agreed loan, where additional items are added at a later date, compromising both the cost and the safety of the collection being loaned.

The Conservation, Collection Management, and (to a lesser extent) Photography Teams are all involved in the process of delivering collection-based activities for the Museum. For example, during the acquisition of new items for the collection, the Documentation Section would review and record item details, the Conservation Team would assess item condition, and the Storage Section would review the long-term implications and cost of storage. By working together to create a single collection care process that incorporates all the individual parts while eliminating redundant or repetitive activities, greater efficiency is achieved.

Developing the Department and changing traditional processes and practices will take time, good planning, and positive energy on behalf of all the individuals involved. Not everything can happen at once, and in some instances, the need to pilot change before full implementation will draw out the differences in practices across the Museum. Creating trust and respect within the Department is also part of success, and opportunities to develop cross-departmental single-issue working groups to look at, for example, health and safety compliance or inter-team communication, will highlight commonalities rather than emphasise differences.

Author's biography

Sandra Smith is Head of Collection Care at BM. Prior to taking up this post in February 2019, she was Head of Conservation and Technical Services at the V&A, with an overview for the long-term care of the V&A collection. Sandra has taken a leading role in the development of the conservation profession as the Coordinator of the Ceramics and Glass working group of ICOM-CC, participating in working groups within Institute for Conservation (Icon) to develop career opportunities and education strategies in conservation. She was Senior Judge of the Nigel Williams Award, Treasurer of The International Institute for Conservation (IIC) and Icon and is currently a Trustee of the Gabo Trust and Vice-President of IIC. Sandra is an accredited conservator of Icon (ACR) and Fellow of International Institute of Conservation (FIIC) and the Society of Antiquaries (FSA). She was awarded Honorary Fellow by the City and Guilds Art School in July 2019.

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Creativity Within Institutional Structure

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KEYWORDS
collection care,
institutional structure

ABSTRACT
This paper considers "collection care", a key part of the heritage sector, as challenges identified at certain times that might be thought of as "punctuations". These punctuations are analysed in terms of constraints that affect the making of changes. It is argued that constraints, when openly explored, can generate options for future phases of collection care; and, that museums and archives can use the concept of "punctuation" to facilitate creativity in discussion of caring for collections.

Introduction

"Collection care" is a key part of the heritage sector. This paper suggests that the concept of "punctuation" can be used to keep collection care relevant by creating opportunities offered by multiple constraints. Each object, or set of objects, has different histories of use and care prior to entering collections, and afterwards, acquisitions of similar objects or records gain different histories of use. Standards in "collection care" and methodologies have been developed (Mason, 2002). Alongside this process of standardisation, there has been an interest in diversity and localism (Brennan & Moreau, in press), which shows differences within a single culture or region.

"Collection care" is a continuous process punctuated by periods of review and possible intervention. Thus an object's care history is episodic. The term "collection care" uses a passive form of the noun ("care"), while "collection caring" suggests a more active process. As soon as "collection care" is talked about as a verb, guidelines and standards become fluid to meet specific circumstances, and increasing flexibility is important in changing times. The process of collection care can be seen as a series of "silences" in store, reviews, distinct decision-making, interventions, and further reviews. At a series of points in time, here called "punctuation", there are opportunities to review collection care. These punctuations may be due to standard institutional practices, external stimuli such as loan requests, or unplanned contingencies such as fire or water leakage (Pedersoli et al., 2016). Three case examples, based on the author's conservation practice and research, are introduced. These examples are chosen because each is anomalous in some way, and each highlights different aspects of collection care.

"Staying relevant" is essential for collection care. Three case studies, based on the author's conservation practice and research, will be introduced as examples of collection care. The first example concerns historic garments found deliberately concealed within the structure of buildings, the second is a design archive containing hundreds of thousands of designs, and the third focuses on string figures, or the "cat's cradles".

1. A design archive

1.1 Punctuation

The first example focuses on how to improve public access to a huge collection of design records while ensuring their long-term preservation. These records are the Board of Trade Representations and Registers of Designs, 1839-1991 (often referred to as the BT Design Register). The BT Design Register consists of 11,122 volumes and boxes, estimated to approximately three million unique, ornamental designs, that are registered for copyright protection. The designs are presented in many forms, including samples of textiles, lace, straw plaits, and linoleum, lengths of wallpaper, and photographs of many kinds (e.g. glass plate negatives). The volumes also include complete artefacts (e.g. straw bonnets, printed cotton kerchiefs, and leather gloves).

This extraordinary resource is held by The National Archives (TNA) in London, UK. TNA's mandate means that the public has the right to access the records. A project was initiated in order to see whether the collection management of the BT Design Register could be changed so as to enhance both public access and collection care.

1.2 Constraints

Several challenges were identified, including limited textile and textile conservation expertise within TNA, the huge range of materials and products preserved as design representations, the large size of leather-bound volumes into which many of the earlier samples were pasted, the great weight of the volumes (some weigh more than 25kg), many volumes had weak bindings, and some volumes were so full that they could not be closed properly. Also, readers often needed to consult several volumes.

It soon became clear that TNA needed to know more about what users wanted of the BT Design Register. Four consultation events were held with various stakeholders, including historians, curators, and designers. Opinions and ideas were noted and a questionnaire was circulated. In summary, the richness of resource and challenges of searching were noted by everyone. Also, it appeared that archivists tended to prioritise access to the written records, i.e. the registers, while museum curators, makers, and designers tended to prioritise access to the representations, stressing the importance of colour and texture.

1.3 Next phase

The results of the consultation led to two streams of work: improving access to the written records, and considering ways to provide access to colour and texture (Eastop, Buelow & Brokerhof, 2012). One series of records (BT43 and BT44), dated between 1842 and 1883/4, was prioritised because it posed a particular finding challenge: although each registered design had a unique number, the designs were not put into a single, numbered series, but were arranged according to 14 classes or categories. In order to find a design easily, both the design number and the class of design needed to be known. If the reader knew only the design number, s/he might have to order 14 volumes before the required design was identified. Besides being frustrating for the reader, such searching might result in unnecessary handling of the volumes in the repository, in transit, and in the reading rooms.

The registers in the selected series were transcribed. To aid further searching, spelling errors were corrected, and "London" was added to some addresses. The category "female proprietor" was added, as it was thought to be useful to current researchers. This series of registers is now available online, free of charge, via the Discovery catalogue on the TNA website. In the long term, subject to resources and priorities, all the registers could be transcribed and made available online[1].

[1] http://www.nationalarchives.gov.uk/help-with-your-research/research-guides/registered-designs-1839-1991/

Online access to the representations is much more challenging. It was clear that searching by pattern would be welcomed, and image-based searching was investigated during the pilot study. Online delivery of textured designs by polynomial texture mapping (PTM, which is one application of RTI, Reflectance Transformation Imaging) was investigated. It provides very high quality images that can be viewed online with zoom and raking light effects, both operated by the user/reader (Eastop, 2016). Haptic technology, which enables the user to "feel" the online artefact, was also investigated, and attracted a lot of interest. In the future, such technologies may enable access for the visually impaired, and also "hands-on" access to vulnerable or contaminated surfaces.

2. An anomalous "collection"

2.1 Punctuation

Worn garments and other things such as bottles are sometimes found, apparently deliberately concealed, within the structure of buildings in the UK, northern Europe, and North America. Common sites of concealment include near chimneys, beneath floorboards, and by doors and windows. These caches have preserved rare garments, e.g. doublets made in the early 1600s (Eastop, 2006; Eastop & Dew, 2006), and thousands of boots and shoes (Swann, 1996). Such finds are seldom discovered in systematic "archaeological-type" investigations, but are uncovered, often by builders, during house repairs or alterations. Examples include a pair of early 17th century stays (i.e. corsets) discovered during the demolition of an old building in Sittingbourne, Kent, UK, and a fragmentary boy's doublet of c. 1625 found under attic floorboards by builders working in an attic room in Eynsham, Oxfordshire, UK (Hayward, 2010).

2.2 Constraints

Caches sometimes contained an odd mixture of objects, e.g. bottles, garments, scraps of paper, and may contain plant materials such as dry flowers. When accessioned, they can present a categorical problem: to which collection should they be assigned – archaeology, dress, or social history? The garment finds are often in poor condition: heavily worn, creased, and soiled. A few finds appear to have been deliberately damaged before they were concealed. Should such finds be accessioned into a museum collection, or should they be documented and then re-concealed? As caches are usually uncovered in domestic settings, it is often the occupier of the house or the builder who makes the discovery and the decision on what to do. Some finds are viewed as rubbish and are thrown away. Some are viewed as interesting historical evidence and are brought to a museum. Others are examined, perhaps photographed, and re-concealed. The constraints are both the distribution of the objects and the lack of a single institutional base.

For these finds, appropriate "collection care" depends initially on how the artefacts are viewed by their finders. Some finders donate the finds to their local museum. Others document the objects before re-concealing them because they believe the object "belongs to the house", and hiding them again is important. In rare cases, finds are sent for "conservation", which might encompass examination, documentation, cleaning, re-shaping, and mounting for storage and display. For the Deliberately Concealed Garment Project (DCGP), which I initiated as a research project, we aimed to document finds, find-sites, and the views of finders and (re-)concealers, in order to preserve evidence of the practice of concealment, as well as what was concealed.

2.3 Next phase

A website was developed for DCGP, thereby creating an e-collection of finds in the form of images and written documentation (Eastop & Dew, 2006). The e-collection enables records of the finds to be made and shared, while leaving finders/custodians to decide what to do with the finds. Some finds were donated to local museums, some were re-hidden, and some were thrown away. The project website[2] includes records of many caches, a bibliography, and access to PDFs, and provides advice on what to do if you uncover a cache. The e-collection seems appropriate for these unusual and widely dispersed artefacts.

[2] www.concealedgarments.org

3. Anomalous artefacts – "cat's cradles"

3.1 Punctuation

As part of a project for a Master's course on "material culture" at University College London, I was required to make an "object-based study". I selected an anomalous object. This was a set of eight string figures "collected" in 1888 by a famous British anthropologist, AC Haddon, during his expedition to the Torres Strait Islands, which lie between Australia and Papua New Guinea. The string figures were acquired by the British Museum in 1889. The collection consisted of six sheets of card, with one or two string figures secured (tied/sewn) to each card. Haddon catalogued them, and his record cards are preserved at the museum.

3.2 Constraints

Haddon's string figures have come to epitomise a particular era in the development in British anthropology: "if you collect string figures, you'll collect anything." The string figures are anomalous as they were created as exemplars and potential exhibits. String figures, once the subject of elite, academic study, are now generally viewed as a child's game. The 100th anniversary of the first expedition of 1888 and of the second expedition of 1898 generated interest in the two expeditions and the resulting collections, which are held at the British Museum and at the Museum of Archaeology and Anthropology, Cambridge, UK, respectively. The playing of string figures is linked to the history of the British Empire, as string-figure playing was employed by ship passengers to relieve the tedium of long journeys by sea.

3.3 Next phase

The current phase of interest in string figures focuses on their performative properties, and their link with practices of making (McKenzie, 2013), and in cognition and embodied knowledge (Eastop, 2012; 2014). String-figure making is recognised as useful in teaching mathematics, particularly algorithms, where a repeated sequence of moves results in predictable outcomes (Murphy, 2008). The making of string figures provides a useful model for intangible cultural heritage, linking museum artefacts to play and performance.

Discussion

These three examples come from my experience of the UK's "heritage industry". How far the ideas generated in this context are relevant to ASEAN and beyond is unclear. Recognising that persons coming from different traditions may hear the processes described differently, the principles described may be of interest. In the examples, "collection care" is described as a process. There are times when there is no discussion within the institution that is related to a specific object/collection, and other times when the care of the object/collection is under review. The author uses the term "punctuation" to denote the time when object care is questioned.

A "punctuation" is initiated when people in an institution are faced with a problem, and when the routine practice of the institution does not meet the problem faced. The National Archives wants to meet its mandate for archiving and access; the finders of objects hidden within buildings did not know where to go for advice; and the users of collections at the British Museum want to understand the relevance of patterns of string from the Torres Strait tied onto sheets of card. In each case, there was not an automatic process to follow, especially when the needs of stakeholders outside the institutions were considered. Discussion ensued to find a solution. These discussions needed to be wider than usual, both within the institution and beyond. A sequence of time-limited institutional structures needed to be created, including consultations, surveys, visits, and trials of novel technology. Each set of formal and informal meetings generated ideas that needed to be tested through further action. The creativity within these meetings needed to be constrained by the institutional ideology and mission statement.

The examples showed that each object generates its own constraints: the design archive by the vast quantity and diversity of material; the once-concealed garments by their often very damaged condition and wide dispersal; the mundane form of the card-mounted string figures, contrasting with the dynamic performance, for which they were "collected". The striking lesson of these case studies is that the very constraint posed by the objects was the stimulus to find the next solution.

Other constraints include those of each "host institution": The National Archives, keeping to its mandate for both preservation and access; DCGP by its non-custodianship of finds; and the British Museum by its post-colonial relationship with the Torres Strait communities. Exploration of constraints can generate possible solutions. The essential factor is that in each case, the institution was mobilised to allow for time, physical space, and permission to explore a range of suggestions. Thus the punctuation allows for a pause for discussion within institutions and across parts of wider society. Punctuation, in the examples, leads to solutions that will enable the caring of collection for the next phase.

Conclusion

This paper considers "collection care" as challenges identified at certain times, i.e. times that might be thought of as "punctuations". These punctuations can be analysed in terms of constraints: what are the constraints that affect the making of changes at this punctuation of time? The third stage is to consider the next phase: what can we do now, within the resource constraints and the prevailing willingness for change? For the purpose of effective decision-making about collection care in changing times, constraints can be identified and openly explored (say, within an institution) in order to generate options for the next phase of collection care. Staying relevant in changing times requires an openness to ways of working, and for optimum effect, this requires giving time for possibilities to be thought about and discussed. If time is given for discussion and exploration, constraints can prove to be opportunities. Museums, archives, and other institutions can use the concept of "punctuation" to facilitate creativity in discussion of caring for collections. Articulating the constraints in an institution can facilitate the generation of solutions rather than hindering them. Creativity in structuring the pattern of discussion is essential.

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Author's biography

Dinah Eastop, PhD, MA, FIIC, ACR is a London-based Consultant in Material Culture and Conservation, with 40 years' experience spanning conservation practice, higher education, and research, within the UK, Australia, mainland Europe and Southeast Asia. She worked for the Textile Conservation Centre [UK], The National Archives [UK], and ICCROM, notably for CollAsia. Her research links the physical nature of objects to their cultural dynamics, e.g. the changing roles of collections, and their effects on conservation and custodial decisions. Her publications include *Chemical principles of textile conservation*, co-authored with Ágnes Timár-Balázsy (1998), *Upholstery conservation: Principles and practice* co-edited with Kathryn Gill (2001), *Changing views of textile conservation* (2011), and *Refashioning and redress. Conserving and displaying dress* (2016), co-edited with Mary M. Brooks for the Getty Conservation Institute. Dinah initiated and leads the Deliberately Concealed Garments Project (see www.concealedgarments.org).

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Innovative Care for Classical and Contemporary Cultural Movable Heritage: Ideas, Valuation, New Technologies & Materials, Research and Methods

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KEYWORDS
holistic preservation of cultural heritage, contemporary theory of conservation, new art technologies and materials, research for conservation, methodology of conservation

ABSTRACT

The growing awareness of changes resulting from the current cultural breakthrough has implications for conservation, both in relation to the traditional disciplines of art, and in preserving the other provenance heritages of the world, including the $20^{th}/21^{st}$ century legacies. The general perspective of conservation can be an expression of collective wisdom on "why heritage is preserved". The contemporary holistic perspective of tangible, intangible, and digital-born heritage is a new understanding of legacies and knowledge built in the complex way, using complex evaluation of cultural heritage, and without reducing it to components. The new theory of complex preservation of movable art legacy in relation to contemporary art involves identifying the essence of the work of art and its context, idea, material, as well as new technologies.

To avoid the risk of losing precious heritage, the author suggests

(i) expanding the range of protection and conservation strategies on the basis of heritage evaluation, and using broad terminology for new strategies of preservation

(ii) a broad program of identification for holistic object recognition.

In conclusion, the author tries to anticipate the challenges of transformation in future civilisation, the need for identity, and creation of a reflexive society in museums, including education of the younger generations and on sustainable conservation.

Introduction

In this dissertation, the general inquiry is on why (ideas) and how (practice) contemporary cultural heritage is preserved. It seems to be the time to consider how changes in current civilisation would affect the future of cultural heritage. This paper is devoted to a new understanding of cultural heritage in a holistic way, and of new approaches in atypical material artworks that range from atypical synthetic sculptures embedded in other materials, to environments, assemblages, installations with light, conceptual art, and many others. In short, I am presenting the following approaches:

- The need for broadening contemporary theory and practice.
- Methodology and controversy: classical art vs atypical artworks.
- Case studies about preservation of iconic Szapocznikow artworks.
- Final considerations: the strategy of decision-making in preservation; replacement of a destroyed ready-made element; overall remarks on innovative preservation–conservation; the problem of integrity of artworks; how to preserve the utilitarian function of objects; controversial arrangement and exhibition; ethical issues; towards a new philosophy and methodology in the care of contemporary art; extending the theory on the care and preservation of cultural heritage.
- Final conclusion.

Contemporary theory and practice

We are witnessing a time of civilisational breakthrough, as Smith & Natsuko (2006) suggest that "heritage becomes the heritage when it is recognisable within a given cultural set or social values, which in themselves are 'intangible'".

The objects earmarked for protection and preservation were recognised as material (Butler, 2006), and at the same time a "tangible manifestation of intangible cultural heritage" or strictly intangible heritage (Boylan, 2006). Conceptualising new elements in the modern theory of conservation and restoration of cultural heritage in a holistic way is a complex task, which the author considered based on the fruitful practice (presented in case studies below) and elements of the new theory (Szmelter, 2010; 2012; 2018). To avoid repetition, the author draws attention to the convergence of the new theory with theories from other authors.

Accordingly to Hölling (2017), "Today, conservation no longer aims simply to prolong its objects' material lives into the future. It is seen as an engagement with materiality, rather than material—that is, with the many specific factors determining how objects' identity and meaning are entangled with the aspects of time, environment, ruling values, politics, economy, conventions, and culture."

Latour and Lowe (2011) proposed the metaphor of a river's complex catchment area to explain that artworks have not only one original entity, but their trajectory includes copies and other manifestations. Without new methods and technologies that are integrated with science, we cannot imagine our life *per se*, or trans-disciplinary care and conservation.

Methodology and controversy: classical art vs. atypical artworks

The richness of the artistic expression of classical art seems to be well known, but modern art exists also in strictly conceptual areas, or with use of atypical materials that the conservator has to know how to preserve for future generations. Looking for innovative preservation of avant-garde cultural heritage, we have to consider methodologies including:

- Problems of identification, character of object, biography of artwork, and results of analytical research
- Ethical considerations in decision-making in conservation
- Maintenance of ephemeral art and the eventual role of simulacra
- Questioning the need for replacement of destroyed ready-made elements
- Preservation of the utilitarian function of objects
- Choice of scope and strategy for conservation in all stages including passive, preventive, and active/restoration/reconstructions/emulation/restaging
- Re-installation and presentation, arrangement and exhibitions

In this light, it is obvious that the preservation of contemporary visual art heritage is trans-disciplinary and based on collaboration across disciplines

Case studies: iconic artworks of the 20th century

The iconic artworks presented below are the legacy of Alina Szapocznikow (1926-1973), an outstanding sculptor and multidisciplinary artist. They are associated with the desire to overcome the tragic life of her youth as a Polish-Jewish girl who survived in ghettoes and three German Nazi concentration camps during World War II. After the liberation of the camps, she left for Prague in Czech Republic, where she began studying at the Faculty of Fine Arts, and later continuing her studies in Paris. In 1951, she returned to Poland. In 1963, Szapocznikow moved permanently to France, and established contacts with artists of the Nouveau Réalisme movement that developed around critic Pierre Restany, and other artists like César, Arman, and Niki de Saint-Phalle. In 1965, for her sculpture *Goldfinger*, she became a laureate of the prestigious Copley Foundation award, selected by an esteemed jury of artists Marcel Duchamp, Jean Arp, Max Ernst, and Roberto Matta. Problems started to sprout in curatorial-conservation projects associated with collecting, displaying, and preserving contemporary works that include plastics and other materials, such as cigarettes, grass, plants, clothes, bodily casts, etc.

In Szapocznikow's sculptures made between 1956 and 1973, synthetic plastic was used as the main matter to bind elements of so-called "found-lost" ready-made objects. The artist's personal objects were immersed in complex compositions of plasmatic polyester matter. These include photographs, women's underwear, men's shirts, women's skirts, and shreds of gauze. In the *Tumours* cycle created before she died, atypical materials were immersed deep in polyester as an abstract artwork. Szapocznikow used casts of her illness-ridden body as well as the ironic compositions with ready-made objects in this dramatic iconology of cancer. She also included photographs wrapped in bandages, and added grass and fibres as impermanent materials that do not belong to the classical art world. She wanted to give them an eternal life.

Case studies on Szapocznikow's work explore how the initial intention for the work might conflict with old-fashioned museum policies. Condition reports revealed that Szapocznikow's artworks were inherently impermanent, as over 180 objects were found in a state of decomposition, akin to pieces of a jigsaw puzzle. The state of the plastic works varied according to the technique of creation, the means of "renewal", and the place of storage of each work (Shashoua, 2009). The darkened layers on certain works, and the dark tone in the case of polyesters, were due to the repeated preparation of these objects for expositions by periodically rubbing them with oil. Destruction, cracks, and holes, which in some cases involved missing pieces, were caused as much by mechanical damage as by the actual technique applied in the works, that had been deep-dyed in mass resins, illuminated pieces, kinetic pieces, assemblages, and environmental and ephemeral objects.

Museum and gallery staff, including conservators, were shocked that the techniques Szapocznikow used were numerous and diverse. The techniques and materials used ranged from plaster, bronze, and marble, to dyed polyesters, polyurethane, and compositions of artificial materials linked with non-permanent organic ones, such as grass and newspaper.

Searching for the ideas and values behind atypical artworks is obligatory before the conservation-restoration of Szapocznikow's works.

The acceptance of any preservation procedure depended on the understanding of the argument devoted to the artist's intentions and motives, that were learned from archives and her public interviews. On the basis of Szapocznikow's personal archives in Paris, spanning 1957 to 1972, some receipts for art supplies and a list of resins and other materials were drawn up. These receipts bore the artist's signature, address, and personal data. These receipts as well as her co-workers' comments revealed the type of artificial resins she used.

Author of this chapter was head of conservation in long term project of the care of Alina Szapocznikow heritage, including design and all stages of conservation programme. I was responsible for proper identification of artwork, methodology I step-by-step realisation as a leader of team of researchers and co-operators. The type of synthetic materials used was identified and confirmed by chemists Dr Irmina Zadrozna and Dr Joanna Kurkowska. This data created the basis for verification of a description of the technique and technology used in Szapocznikow's work.

Szapocznikow's legacy (152 artworks) was identified and preserved in a long-term protection project that began in 1994. Due to the extremely individual character of her legacy, it was necessary to first preserve the intentions and ideas of the artist (immaterial), before the matter (tangible). This approach required the creation of a new conceptual framework for the complete care of the recently created visual artworks, both tangible and intangible, with a focus on the importance of interdisciplinary approaches in the preservation-conservation of cultural heritage.

Figure 1. State of weightlessness – Homage to Komarow*, Alina Szapocznikow, 1967. Polyester, gauze, photographs, and metal base. Dimensions: 235 cm x 70 cm x 40 cm.*

Technical problems with conserving Szapocznikow's legacy resulted not only from mechanical destruction, but also from the altering of the plastic materials and technologies by natural causes.

The principles and stages of conservation activity led to the halting of external damaging processes, cleaning of the objects, removing amateurs' over-painting and additional layers, consolidating of the layers of work, reinforcing or changing constructions, filling in missing pieces, retouching, care of use (e.g., lighting, and function like kinetic or utilitarian), protecting the surface of works from further degradation, and using, among other things stabilisation coating, which protected works from UV rays.

State of weightlessness – Homage to Komarow by Alina Szapocznikow looks like a mummy held in a vertical position, slightly at an angle, presented in a so-called "anti-gravity" effect. It was a strange sculpture, which occupied a separate place like a long silhouette, unstable on its feet. Szapocznikow played on zero gravity in her homage to Komarow, an astronaut who died during space flight. This was her personal tribute to the epicness of space exploration. In this case, the artist's intention was very important to the arrangement and exhibition of the piece, but it also posed a great technical problem. The plastic sculpture was constructed with a weak metal base wrapped in gauze, bandages and fibreglass, which were then dipped in polyester resin several times. The membranes of the synthetic material separated and crumbled in raised blisters around the neck, breast, and feet of the figure.

Following results of research, a hardening substance with a catalyst was applied to the polyester resin that had not been soaked. Holes in the fibreglass enforcement were filled with fragments from the original pieces. The holes that could not be replaced with original materials were filled with casting patches, into which gauze and bandage were melted. These patches imitated the original. The bandages used had a weave similar to bandages available in the 60s, and the colour of the patches matched up with the colour of aged resins by adding pigmentation of burnt ochre and green umber. Unfortunately, limiting the reconstruction to the holes was impossible in terms of construction. This operation, though conflicting with the classic European theory on conservation, was absolutely necessary to preserve the object. The sculpture was still liable to crack in three places, and was as fragile as eggshell. The most fragile places were laminated with clear polyester resin mixed with a catalytic hardening solution. This drastic reconstruction was necessary because it involved replacement of the internal structure, the function of which was to carry the sculpture.

Author of this chapter and co-operators created a new construction for the object. The metal stand with a rod that went into the portable construction of the sculpture was sanded, corrosion pits were removed, and the sculpture was covered with high quality acrylic resin isolation. The hollow space within the sculpture was filled with polyurethane mounting foam that was prepared in a laboratory, which reinforced sculpture construction and its statics. The entire polyester composition was covered with a protective layer of matte varnish with UV blocker, and with a coating of colloidal silica. Finally, the main problems of the *State of weightlessness – Homage to Komarow* were related to the care for the sculpture's state of "anti-gravity" – an unconventional intention of the artist. To preserve Szapocznikow's idea, it was necessary to reconsider ethical issues devoted to the reconstruction of the object's inner structure, and to recover the effect that suggests independence from the law of gravity.

Figure 2. Headless torso*, Alina Szapocznikow, 1968. Polyester resin and polyurethane foam.*

Headless torso by Szapocznikow was a type of transgression in the field of sculpturing. It was left in an extremely bad condition before conservation. The polyurethane element of the cushion did not powder or peel. Due to the very dark colour used, it was difficult to tell if there had been any changes in colour. The surface was covered with a thin layer of dirt.

The polyester part of the woman's body had been preserved and was in good condition. The whole surface is visible though air bubbles were embedded in the mass, as a result of a not very careful technological process. The bubbles located close to the surface are small holes that accumulated dust. Unfortunately, unprofessional transportation and lack of space and support in the box had caused 28 deep cracks in the soft polyurethane material. So an element (a kind of metal rack welded from two parts) was introduced to support the structure from behind, transferring the weight bearing function of the object onto it. The stand is connected to a wooden element suited to the shape of the sculpture on which the original sculpture stands. After cleaning, the polyurethane was reinforced. Finally, the surface of the sculpture was covered with a thin layer of varnish for protection.

Figure 3. Pollution I*, Alina Szapocznikow, 1968. Polyurethane and natural grass on a jute belt. Dimensions: 11 cm x 87 cm x 170 cm.*

Pollution I is one of the sculpture series mentioned in the author's write-up on mixed techniques by Szapocznikow. The sculpture's support was made of highly degraded hard polyurethane, which was cracked, stained, dull, and had numerous pits. The grass was brown and dirty, and the leaves were broken. With each exhibition, the commissioned curators and conservator considered the possibility of replacing the elements of degraded grass but curators preferred original degraded grass. The object's surface had been cleansed both mechanically and chemically, and the cracks in the polyurethane, in danger of further degradation, had been glued closed with Impranil. The grass had been washed and reinforced, and as a result part of its green colour and natural character, could be seen. The entire work had been secured with art-matt aerosol varnish with UV blockade. Our inability to halt the destruction of the polyurethane sculpture base and the obvious neglect of its liability to further degradation is analogous to the acceptance of cracks in paintings, which are not retouched as evidence of natural ageing of the material.

Figure 4. Personified tumours*, Alina Szapocznikow, 1971. Environment: a set of 14 self-portraits cast and modelled in polyester resin on the basis of a gypsum cast of her own head. Dimensions close to real life.*

Personified tumours by Alina Szapocznikow (1971) is a type of proto-installation. It is a set of 14 self-portraits cast in polyester resin on the basis of gypsum. These are in fact deformed casts of her own head. The objects were filled with glass wool, gauze, and newspapers. Finally, this proto-installation was presented by the artist on small stones.

Most of the works had polyester walls measuring between 0.5 mm and 80 mm in thickness, and different degrees of pigment saturation. Conservation began with the identification of the essence of installation and the artist's intent. The interior of the objects, accessible through existing openings, was de-acidified to prevent further degradation of the paper. In those fragments that had an additional construction carrying function, fibreglass was added to the resin in order to improve mechanical strength. The treatments given were de-acidification, cleaning, consolidation, and reconstruction. Finally, in order to prevent divergent rates of polymer photo-degradation, the objects were coated with a protective layer and UV blockade. Other problems were related to the integrity of art works, proper presentation, and exhibitions of installation according to the intent of Szapocznikow.

Final considerations

Overall remarks on innovative preservation–conservation issues and methods

In every case study, the conservator, together with the research team, undertook research of the individual artist's biography and context of their work. There was no fixed technological configuration, theoretical framework, or know-how, which was universal to the entire diversified cultural legacy of Szapocznikow. The great lesson in understanding the artist's creative process came from analyses of Szapocznikow's motivation, ideas, and intentions, alongside her methods and use of technology. The broad range of conservation issues in the preservation of Szapocznikow's artwork was based on the care for integrity of her artwork. In this long-term project, the author of the project experienced many problems with unconventional approaches and practical know-how, some of which were presented by the author (Szmelter, 2010). Let us, therefore, take a closer look at these problems, and attempt to categorise them according to several approaches.

The problems of integrity of artworks

The integrity of artworks is crucial in the process of restoration (Brandi, 2006) as well as during their re-installation, presentation, and exhibition (Szmelter, 2012). The cycles *Tumours* and *Herbarium* were Szapocznikow's last works before she died. In addition to their value as human testimony, these works illustrated the naked truth of the impermanence of modern artworks made from plastics. The works were made using polyester and polystyrene along with added elements, and their conservation-restoration and reconstruction were properly done according to ethics.

However, the project author and cooperators had observed many times the discrepancy between the integrity of the original set of artworks as compared to when the pieces underwent re-installations and exhibitions. Many times, curators came up with new interpretations of the artworks, and they would make their own material composition for many elements in the installation. These are forbidden for many reasons, including law, conservation ethic and copyright. In the ethics of conservation the objects would have lost an aspect of their value, which results from the relationship between its parts and the entire installation, which is consistent with the artist's intention. In conclusion, "life after life" of artworks during exhibition is a very important issue for conservatorship-curatorship in relation to the integrity of artworks. Very often, well-trained conservators are not only the advocate of the artist and his/her intent, but also the orchestrator of all activities in the care for the legacy of artist and the role of his/her artworks in cultural heritage.

Replacement of a destroyed ready-made element

Szapocznikow experimented with materials in order to achieve an aesthetic contrast between the effect of the black polyurethane volcanic resins and living matter, i.e., the fresh green grass. The support made for *Pollutions* was made of extremely degraded hard and soft polyurethane sponges, which gradually cracked, became stained and dull, and developed numerous pits. The grass was wilted, brown, and dirty, and the leaves were broken and crushed. After cleaning, the sculpture became more colourful, but was still far from fulfilling the artist's intention to contrast fresh grass with the harsh post-industrial surface of volcanic black polyurethane. The conservation programme was presented with complete objectivity and without preference for specific solutions. The first conservation work only included preservation of the substance, cleaning, and reinforcing. Authors of conservation design and all stages of the conservation project (including programme, methodology and realisation) nevertheless thought that for subsequent exhibitions of the piece, one should consider many scenarios. For example replacing the old grass, which was hardly recognisable, with a strip of fresh lawn grass, and putting it in the crack in the polyurethane base, thus reclaiming the object so that it was able to communicate the artist's intention, namely drawing the viewer's attention to the contrast between the green grass and the black, dangerous "pollution". While making her assemblages and experimenting with living matter and plastics, Szapocznikow also made casts as body impressions, in polyester and polyurethane, mostly of herself or her friends. By duplicating particular themes, she approached Pop Art and New Realism. The complex care of the legacies of visual art included among others: recognition, contextualisation, and treatments like cleaning, consolidation, and re-integration.

How to preserve the utilitarian function of objects

A different strategy was employed in Szapocznikow's *Lamps* cycle (1968), in which lights played an active role in the artistic process. They had to stay active after reconstruction in a very colourful way. The artist used only a few elements in different configurations: female breasts and lips, and a sculpture of a phallus, all made with polyester or polyurethane. Witty plastic artworks served as a prototype for a lighting device. In the late 1960s, artists developed works with a strong undertone of vital self-irony. These objects were quasi-"utilitarian", or design prototypes, as if decorative in funny way.

Szapocznikow's artworks constituted mixed media that were unique in the field of museum collections conservation. An atypical art work's were born rapid pace of work of quick dried synthetic resin and the tension, destructions are implied in the sculpture's layers of plastic (Szmelter, 2012). It is not easy to combine polyesters and polyurethanes with appropriate activators, fillers, or accidental materials like lighting device.

A particular "artist's code" is given to works by each artist. It meant using his/her own materials, techniques, and technologies, which played in the author's opinion a role like "DNA in creating a human genome".

Reconstructed objects must have the same function of the original artworks. The artist had intended to use them not only in exhibitions, but also in popular museums' shops. We are deciding whether it is legal and ethical to make an emulation or reproduction of these utilitarian artworks. If yes, it must be confirmed by the son of the artist, or other heirs. Singular challenges should aim at preserving specific vitality effects, which critic Pierre Restany picturesquely rendered as "the decadent splendour of a new Jugendstil, incarnated in a festival of sumptuous bodies, put into relief by the flickering of their internal lighting" (Restany, 1998).

Controversial arrangement and exhibition: ethical issues

Alina Szapocznikow's legacy remains a specific phenomenon of the art world as she was a pioneer in creating plastic sculptures and the application of kinetic and light effects in art. Her works of art are still widely discussed and exhibited in ways that sometimes provoke controversy. Therefore, complications were started in the preservation of her legacy, including theoretical-conceptual and ethical, as well as practical, in terms of identification and conservation methods.

In many similar situations, we need long-term conservation-curatorial preservation that abides by re-installation guidelines. Preservation was a kind of advocacy of the artist's intention in the course of conservation and reconstruction, and is strictly related to respect for the law, the work's integrity, and its copyright. In restoring and conserving presented artworks and legacy, the final goal was to exhibit the artworks in the form that would be most representative of the artist's intentions. The complex preservation process transformed Szapocznikow's avant-garde legacy into a new cultural phenomena, which was exhibited widely in the world, including the Museum of Modern Art (MoMA) in New York in 2012, and Centre Pompidou in Paris in 2013. The best arrangement and exhibition was seen in Hepworth Wakefield, UK in 2017/2018 (Szapocznikow: Human Landscapes, 2018).

Towards a new philosophy and methodology in the care of contemporary of art

A situation where mental inertia keeps "old ideas" alive after they are obsolete, as in the care and conservation of Szapocznikow's visual art legacy, must be avoided. First of all, "do no harm", as in the medical motto "*primum non nocere*". Principles, which originate from a traditional way of thinking, develop and evolve in every conservation decision. Based on interdisciplinary art, science, technology, research, diagnostics and identification, we tried to achieve maximum respect for the authentic substance of an object. In light of this proposition, and with regard to the highest degree of singularity found in contemporary artwork, theories must be flexible and the concept of conservation must be tailored to the needs of every object. In the process of conservation-restoration-reconstruction, it is necessary to return to the artist's intention and ideas in order to preserve the integrity of the artwork and its so called potential unity – using a term from the theory of restoration (Brandi, 2006). We have observed a turning point in cross-disciplinary research devoted to the conservation of modern and contemporary cultural heritage in the field of visual art. This is a symptom of a changed philosophy of conservation for diverse cultural legacies based on new ideas, and atypical and impermanent materials "that do not belong to the art world". As a consequence, a new understanding of the processes of structural changes in systems of knowledge in conservation-restoration of modern and contemporary art has arisen. Current civilisational and cultural breakthroughs implied the broadening of the notion of cultural heritage within the theory, heritage studies, and changed practice of complex conservation-restoration-reconstruction, which are presented in case studies. Finally, author of this chapter after thirty years of the care and conservation of many modern and contemporary art objects is considering the need of extending the theory of preservation for holistic interpretations.

Extending theory of the care and preservation of cultural heritage

The time is ripe for the definition of a new theoretical paradigm for the care of the cultural legacy of the most recent artistic heritage including movable art works, so as to enable the continued preservation of these witnesses to contemporary culture. Although a new theoretical paradigm will be based on existing doctrine and theories, the new elements of theory should extend beyond classical doctrine limitations. The beginning of this modern approach to conservation was in the spirit of historical relativism (Riegl, 1903), and the esthetical theory (Brandi, 1963), to arrive at the modern theories of sustainable conservation for the "common good" in the early 21st century, and that were propagated by many authors. However, globalisation is not a linear process that homogenises different societies into a single identity.

According to Appandurai (1996), it is a multidirectional wave that stimulates localities to respond to growing global trends. In Wharton's (2012) debates about multiculturalism and ethnic violence in a broad global perspective, specific problems are devoted to the authentication of ethnography works, and identification of different social groups. Very open-minded is Hölling's (2017) definition that "conservation is a complex techno-cultural practice with a strong, retroactive impact on its objects and subjects. Conservation offers an invaluably rich context to study a man-made world. Simultaneously, it allows us to pursue fundamental epistemic questions related to what, when and how artworks exist in the world and how our engagement with them is contingent upon the prevailing cultural-historical conditions". It is really a universal point of view in the similar light presented in the author's propositions (Szmelter, 2010; 2018).

Conclusion

The answer to the question "why and how cultural heritage is preserved" is based on the new holistic understanding of cultural heritage in the world. The author extended the understanding of the term "conservation" to a broader idea of "preservation", with cultural heritage as a set of materials, care for the complex tangible and intangible and digital legacies, which are to people-centred.

The correct preservation process for movable works of art implies the need to evaluate the individual work of art, recognition of the role of material remains, the context, idea, and intent of the artist, the artwork's condition, identification of material and technology, and the aim for conservation. Then, it is time for the care by diagnosis and concept for conservation, and the design of conservation, including possible restoration, various forms of reconstruction, emulation, reconstruction, restaging, and finally considering arrangement and exhibition.

Shedding new light on the contemporary theory of care or preservation is related to the holistic approaches according to the conservation ethic and is similar to the medicine ethic. Visual art heritage is faced with an entirely new set of atypical materials, technologies, and new problems in comparison with classical art. There are difficulties in adapting to new strategies in decision-making, especially for classical European museums. But changes are underway and more obvious for institutions in the world devoted to “unstable” contemporary art. As well as, I hope, are close to broader meaning of authenticity based on Nara Document (1994).

The holistic extension of contemporary theory together with the values of visual art heritage from the 20th to the 21st century is becoming increasingly necessary. The extended theory is coherent and presents new approaches and needs for a new art preservation methodology based on trans-disciplinary science, knowledge, and practice. It is based on research combined with a new approach to the mixed character of culture, diffusion of visual art disciplines, and a man-made world, including education of the younger generation.

Author's biography

Professor Iwona Szmelter PhD is a researcher and academic teacher who has been a conservator too at the Faculty of Conservation Academy of Fine Art in Warsaw since 1981, and at the Postgraduate Museums Studies at University of Warsaw since 1997. She was a scholar at La Sapienza University in Rome in 1981. She is also the co-founder of networks in conservation like ENCoRE (European Network for Conservation Restoration Education), and INCCA (International Network for the Conservation of Contemporary Art). She led one Polish project in The European Research Area (ERA) in 2005, and was a scholar professor at GRI Getty Los Angeles in 2007. She was a researcher of The Joint Programming Initiative on Cultural Heritage and Global Change: A new challenge for *Europe* (JPI CH EU 2010-2014), and promoter of PhD during international project NACCA (New Approaches in the Conservation of Contemporary Art), which was in the frame of EU program Horison 2020 (Marie Curie-Sklodowska Innovative Training Programme, 2016-2019). Thus far, she has authored many publications, and led 750 preservation projects, including 152 preservation-conservation projects on multidisciplinary artworks by Alina Szapocznikow, as well as many other classic and contemporary artworks.

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Sustainable Preservation of Analogue Photographs in a Hot and Humid Climate

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ABSTRACT
In the past, many large collections of negatives were overlooked, due to financial and technical constraints or lack of interest. Those photographic archives have been kept without special care and are at risk today. With the move into the digital age, there is renewed interest in collections of negatives, that can benefit from new technologies to enhance dissemination and access. There is also a real concern by the cultural heritage community to improve the preservation of photographs, wherever they are in the world, for their intrinsic value. The United Nations Educational, Scientific and Cultural Organization's (UNESCO) Memory of the World programme, in particular the 2015 *Recommendation concerning the Preservation of, and Access to, Documentary Heritage Including in Digital Form* (UNESCO, 2015), provides the framework to address these challenges and develop a sustainable policy for the long-term preservation of documentary heritage. Indeed, analogue photographs can be easily damaged or destroyed due to inappropriate environmental conditions. However, there is often a significant gap between the standardised storage recommendations for photographic records and the actual conditions. Unfortunately, the implementation of preservation standards is often a challenging, if not impossible, task. Compromises must be found, but they require a technical study of the collection that takes into account its context, uses, history, local resources, and sustainability, among other factors. This paper describes the methodology in the study of a collection of valuable glass plate negatives that was kept in a hot and humid environment in Myanmar. The results of this study made it possible to propose a strategy to improve, in a sustainable manner, the conservation of this collection while facilitating access to it through digitisation.

Introduction

The Memory of the World (MoW) programme was launched by UNESCO in 1992 as an international cooperation strategy aimed at safeguarding, protecting, and facilitating access to documentary heritage, especially heritage that is of world significance and endangered. The vision of this programme is that the world's documentary heritage belongs to all, and should be fully preserved and made permanently accessible to all without hindrance. Since 1998, the Memory of the World Committee for Asia and the Pacific (MOWCAP), or the so-called "regional forum" for the MoW programme, has been working to assist preservation of and access to documentary heritage of the Asia-Pacific region, and to increase awareness of the existence and significance of that heritage. This includes the important collection of glass plate negatives held at the Department of Archaeology and National Museum (DoA) under the Ministry of Religious Affairs and Culture in Myanmar. The adoption by UNESCO Member States in 2015 of the *Recommendation concerning the Preservation of, and Access to, Documentary*

Heritage Including in Digital Form was a significant opportunity for the safeguarding of this collection. By recognising the fragility of the world's documentary heritage and establishing its importance as a primary means of knowledge creation and expression for the greater understanding of the world, *Recommendation* provides the framework for addressing the challenges of safeguarding the glass plate negatives, and for developing a sustainable strategy for their long-term preservation and access. This paper reflects some aspects of the project launched by UNESCO in 2018 under the MoW programme. This project aims to define more precisely the condition of the collection, improve its preservation, and perform digitisation to aid further dissemination of the collection.

Risk assessment for the collection

The collection and its environment

The collection holds over 5,000 glass plate negatives depicting monuments, reliefs, objects, and paintings associated with Bagan and other sites across Myanmar. These are silver gelatine dry glass plate negatives. This technology was introduced during the last quarter of the 19th century, and was commonly used between the 1880s and the late 1950s. The structure of the negatives is simple: a glass plate is covered with a thin layer of gelatine that contains an image-forming material made of metallic silver grains. Plates were sometimes varnished to protect the image surface against abrasions and humidity. These photographs were taken during the first half of the 20th century, to document Bagan sites as well as other monuments and archaeological sites across Myanmar. Around 4,000 plates were produced by the Office of the Superintendent, in Myanmar, between 1903 and 1941. Around 1,000 plates were created between 1948 and the 1950s by the Office of the Director, Archaeological Survey, Burma (today Myanmar). The collection is now located in Yangon, in the administration building of DoA.

The value placed on this collection of glass plate negatives is very high, especially as it depicts monuments and interiors that have since been damaged or destroyed. This is a rare and unique collection that needs to be preserved and made accessible to the public for its intrinsic aesthetic, historic, and documentary value. Preservation of these photographs may contribute in particular to the restoration of the monuments of Bagan that have suffered from major damage or destructions due to the 1975 and 2016 earthquakes. However, this collection of glass plates is at risk due to photographs' constituents reacting to the inadequate storage conditions that are not matching international conservation standards (Fig.1). For instance, it is likely that the indoor climatic conditions, with temperature being frequently over 25°C and relative humidity (RH) over 65%, have had a great impact on the negatives' condition. Furthermore, the plates were housed in low quality paper envelopes on a wooden shelf in five wooden cabinets. Most of the plates were stored vertically. However, large format plates were kept flat, and in stacks. Such an environment might cause image oxidation, mould growth, breakage of the glass support, and delamination of the gelatine layer due to climate fluctuations. A closer inspection was necessary to assess the main the frequency of those possible damages.

Collection survey

Archival collections, such as photograph collections, encompass a large number of items – from a few thousand to a few hundred thousand – that cannot undergo exhaustive examination and therefore require the implementation of a statistical survey. To achieve this goal, a proper survey methodology is followed. A representative sample of the collection is selected and examined. If properly done, this survey would provide an idea of the conservation condition of the entire collection.

Samples are selected by systematic sampling (i.e. selecting items at regular intervals) or by random sampling. Computer programmes such as random number generators provide a list of random numbers that can be used to pick images to be examined (Random Lists, 2013). Many collections contain artefacts of different provenances and types. To prevent over- or under-representation of specific holdings during random sampling, a technique called stratified sampling is used. Each holding is handled separately, and the number of samples taken is proportional to the size of the holding. By applying statistical laws, the percentage of deteriorated artefacts can be estimated within a certain margin of error (see Creative Research Systems, 2012). The main clues for identifying chemical decay are image fading or discolouration, gelatine degradation, and base degradation (Fig. 2). For all these degradation types, a scale of damage is set – for instance, from zero to three – to better represent the degradation intensity. Such an assessment requires some expertise to spot relevant decay that might be unnoticeable to someone not familiar with historical photographs, and also adequately rate the decay intensity. For this project, the statistical survey of the glass plate collection was carried out by eight people within three days, through evaluation of 10% of the collection using systematic sampling (i.e. picking one glass plate negative from every 10 plates on the shelves). The results (Figs. 3-5) are expressed by a confidence level of 95%, meaning that if the same sampling is repeated 100 times, the results would still be within the margin of error for 95 times.

The results of the survey indicate that 13.5% of the collection (741 glass plate negatives) were too deteriorated to produce a readable image (Fig. 3). The 4,749 remaining glass plate negatives could still produce a fair or good image through printing or digitisation. The most common degradation for the non-varnished plates is silver mirroring; almost all of photographs exhibited this degradation. It is due to a combination of pollutants and high humidity. The pollutants were obviously emitted by the low quality paper or the board enclosure housing the plates. The varnished negatives did not exhibit silver mirroring because the varnish protected the image from the pollutants, but the varnish itself had aged badly (e.g. yellowing, blistering) in the presence of high humidity, contributing to the depreciation of the image quality to, at times, the point of substantial degradation of the image. Other frequently found damages include mould residue, binder degradation, and image losses.

Reference	Title
ISO 18902	Imaging materials – Processed imaging materials – Albums, framing, and storage materials
ISO 18911	Imaging materials – Processed safety photographic films – Storage practices
ISO 18916	Imaging materials – Processed imaging materials – Photographic activity test for enclosure materials
ISO 18918	Imaging materials – Processed photographic plates – Storage practices
ISO 18920	Imaging materials – Processed photographic reflection prints – Storage practices
ISO 18929	Imaging materials – Wet-processed silver-gelatine type black-and-white photographic reflection prints – Specifications for dark storage
ISO 18934	Imaging materials – Multiple media archives – Storage environment

Fig. 1. Selection of international standards relating to the preservation of photographs.

Degradation symptoms	Description
Image oxidation/fading	Local or overall yellow or brownish staining of the silver image
Silver mirroring	Presence of a metallic bluish layer when observed via reflection, and slightly yellow when seen in transmitted light on the image surface
Varnish degradation	Strong yellowing of the varnish, formation of cracks, blistering
Dirt, dust	Particle deposit, residue of biological activity such as mould, insect droppings
Binder/gelatine degradation	Water-related damage: partial dissolution or disappearance of the gelatine layer due to an excess of humidity, mould
Image losses	Localised parts of the image missing due to mechanical abrasion, insect groves, rodents
Flaking/delamination	Delamination of the image layer from the glass plate
Broken plate/cracks	Plates having cracks or breaks

Fig. 2. Description of the degradation symptoms for glass plate negatives.

Distribution of GPNs by damage types		Margin of error
% of GPNs with none or negligible damage	2.4%	±1.3%
% of GPNs with little damage	61.0%	±4%
% of GPNs with significant damage	23.1%	±3.5%
% of GPNs with extreme damage	13.5%	±2.9%

Fig. 3. Survey of a glass plate negative collection in a tropical climate (Southeast Asia).

Degradation symptoms	% of photographs damaged	Margin of error
Silver mirroring	95%	+2,8
Varnish degradation	90%	+5,0
Mold, dirt, dust	80%	+3,2
Water damage	62%	+3,9
Image losses	61%	+3,9
Flaking/delamination	6%	+1,9
Image oxidation	5%	+1,7
Broken plate	3%	+1,3
Cracks	2%	+1,1

Fig. 4. Percentage of glass plate negatives damaged, according to degradation type.

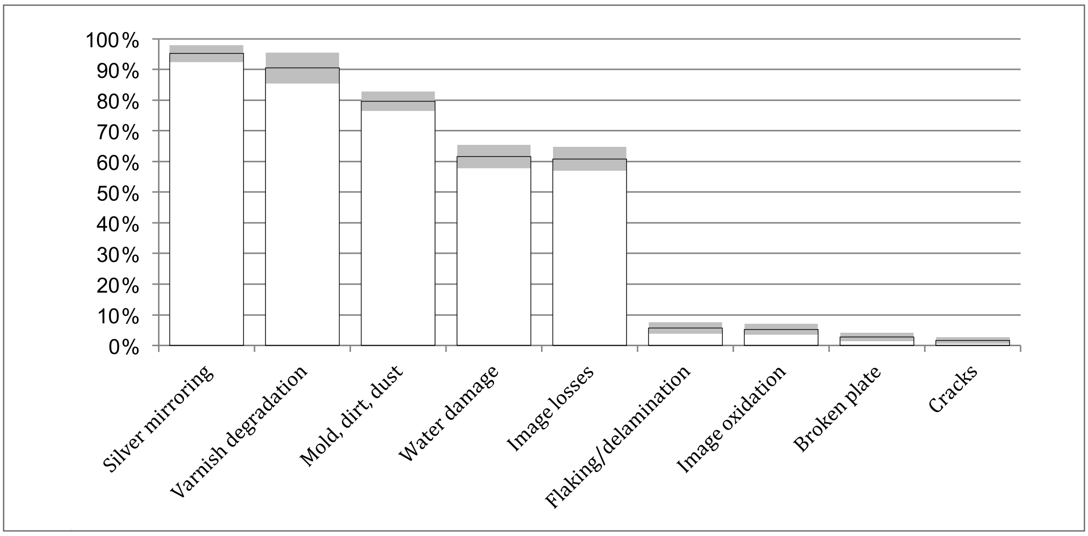

Fig. 5. Percentage of glass plate negatives damaged, according to degradation type (margin of error in grey).

Conclusion: priority for action

This survey was a convenient tool to assess the condition of the collection as it allowed to identify frequency and intensity of damages. The degradation of the negatives is related to an excess of moisture that has induced the bio-degradation of the gelatine layer through mould, binder dissolution, and speed up the degradation of the poor quality enclosures that results in pollutants emission. The immediate action needed to stop the collection's decay was to decrease humidity surrounding the negatives to a safe level. Reducing the RH would slow down or stop the degradation process, and would therefore contribute to improving the life expectancy of the collection drastically. Another important action was to replace the old acidic enclosures with better quality enclosures to avoid further development of silver mirroring.

Alternative solution for long-term preservation

Environmental conditions

The ISO standard (2000) stipulates a temperature of 18°C and 30%–40% RH for extended storage of glass plate photographs (Fig. 6). However, after the survey, it was clear that the damage was mainly moisture-related: the high humidity weakened the gelatine binder. The high temperature had been less of an issue, although it certainly contributed to speeding up some of the processes of decay. Cool storage, at 18°C, may not solve the issue of high RH, and might instead induce other issues such as condensation, power failure risks, and high cost maintenance. To set up a drier environment, dehumidification units can be used in the storage room. However, besides the energy consumption cost, this option may not be very effective considering the water contained in the building structure, the frequent air exchanges through the doors and windows openings, the lack of water vapour tightness of the room, as well as the presence of staff.

	Medium-term storage (a)		**Extended-term storage (b)**	
	Maximum temperature	Relative humidity range	Maximum temperature	Relative humidity range
Silver gelatine glass plate negatives	25°C	20–50	18°C	30–40
a) For medium-term storage, the cycling of temperature and relative humidity (RH) shall be no greater than ±5°C or ±10% RH, respectively, over a 24h period. The moisture content of plates shall not be greater than the moisture equilibrium with these RH parameters.				
b) For extended-term storage, a set of temperature and RH levels should be chosen. The cycling of temperature and RH shall not be greater than ±2°C or ±5% RH, respectively, over a 24h period. The moisture content of plates shall not be greater than the moisture equilibrium with these RH parameters.				

Fig. 6. Maximum temperatures and average humidity ranges for the storage of glass plate negatives from ISO 18918 Imaging Materials – Processed Photographic Plates – Storage Practices*.*

Dry cabinet

Another option was to create a microenvironment for the collection using smaller, secured containers. It was decided the collection would be moved into airtight door-type metal cabinets where the RH can be adjusted. The airtightness would prevent the collection of dust, pollutants, insects, or rodents, as the internal source of pollutants, such as the old acidic enclosures, had been removed. Airtightness could be ensured as all of the low-quality materials (e.g. acidic envelopes) emitting volatile organic compounds would be replaced, and the negatives themselves do not produce much harmful chemicals (unlike plastic-based photographs). In the cabinet, dry silica gel can be used to maintain a stable low-humidity condition; however, the silica gel would need to be replaced regularly. To avoid this tedious but necessary task, the use of dry cabinets was proposed. These cabinets are manufactured for the pharmaceutical industry to store humidity-sensitive chemicals, but are also used for storing electronic components, entomological collections, or photographic materials, such as lenses and cameras, in humid environments. They are available in different sizes (30 to 600 litres), made from metal, and have glass doors, airtight seals, and a small built-in dehumidification unit. The dehumidification system is either a Peltier cooler system, which removes moisture from the air by condensing it out, or an automatic regeneration desiccant (zeolites) unit. Some dry cabinets have additional functions such as air filtration (Goodsgood, n.d.). The structures are made of painted metal, and the cabinets have glass doors. Those materials are compatible with photographic material, although special attention had to be given to any synthetic polymer inside the cabinets, such as foam pads or gaskets, to ensure they do not emit sulphur or any other compounds that could be damaging to photographs. Such cabinets have a low energy consumption and yet can ensure the appropriate relative humidity (from 20% to 60%), and maintain this humidity level for many hours even during power failure. Adding a data logger inside the cabinet such as a Preservation Environmental Monitor - PEM - (IPI, 2019) will ensure the monitoring of the humidity.

Paper enclosures

Sleeves protect photographs from dust, abrasions, and careless handling, but the closer the materials come into contact with the photograph, the more carefully they must be selected. The old acidic envelopes originally used to store the negatives were inappropriate for long term storage and needed to be replaced with photo-safe enclosures, as the negatives would be stored as historical evidence of the collection past. Paper is preferred for the new housing, instead of polyester. Paper is water vapour permeable and carries less risk of adhesion, ferrotyping, and mould growth resulting from trapped moisture. A range of models was deemed suitable, depending on the format of the photographs and their fragility, but four-flap envelopes seemed to be the most appropriate for the glass plate negatives. The thickness of the paper layers of the four-flap envelopes not only served as a humidity buffer but also acted as cushioning, which would mitigate uneven pressure between plates and eventually absorb shocks. Four-flap envelopes are easy to manufacture. It only involved cutting a piece of photo-safe paper in the shape of a cross, and did not require any adhesives. A potential, interesting resource of good quality paper was identified in Myanmar. In the Shan state of north Myanmar, south east of Mandalay in the mountains near Inle Lake, the tradition of mulberry paper production (*Broussonetia papyrifera)* still exists (see Watkins, 1992). This kind of paper is also still being produced in many Asian countries, including China, Japan, Korea and Thailand, and is often used for conservation purposes due to its excellent long term behaviour. However, the possibility of using this Shan paper for glass plate enclosures required some investigation. A batch of Shan papers was provided to evaluate their suitability for photograph conservation. Although these papers exhibited a pretty tough structure suitable for making umbrellas or accessories, they were not smooth enough for storing photographs. They may create local pressure on the surface of the image, and result in abrasions. A batch of Chronos® photo-safe paper was acquired and used for making the four-flap envelopes.

Storage boxes

Originally, the plates were stored without boxes. It was then decided that small containers would offer extra protection and allow safe retrieval and handling of the plates. Cardboard boxes are a common container for photographs and glass plates, although glass plate negatives are heavy, and the cardboard could be weakened in the event of water damage or a high-humidity event. Cardboard is also susceptible to damage from fungus and insects. In the context of this collection, the use of polypropylene (PP) corrugated folding boxes was considered an appropriate option (Fig. 7). Although PP does not play a humidity-buffering role, PP corrugated boxes are very resistant to handling, have a long life expectancy, and are suitable for holding heavy glass plates. Moreover, they absorb shock well, and their cost is low compared to quality conservation cardboard boxes. Furthermore, they are less susceptible to biological damage, mould, or pests, and are not water-sensitive (Seo, Shin & Kim, 2009). The glass plates were to be stored vertically in the boxes, along the long edge. The inside width of the boxes measured 10 cm. Selecting wider boxes for storing the plates was inadvisable because the plates are heavy and, depending on their size, could result in the boxes becoming difficult or even dangerous to handle. Around 20 small size glass plate negatives of different sizes would be stored in a box (24.5 × 19 × 9.5 cm). Large glass plate negatives (25 × 30.5 cm) could be stored vertically in similar boxes. This would, however, increase the risk of the box tipping over when used. Partitions with rigid vertical dividers would therefore be required to keep the boxes upright during retrieval and refilling. The option of storing the large glass plates flat in small quantities (around 12 glass plates per box) was adopted.

Fig. 7. *Fluted polypropylene boxes for vertical storage of glass plate negatives (Image from Art Doctor, n.d.).*

Conservation treatment and digitisation

The reconditioning of the collection is currently being carried out. The change of enclosures is an opportunity to perform basic conservation treatment on the glass plate negatives by removing all the dust, dirt, and mould residue. These on-going interventions are being documented. After cleaning, the negatives will be ready to be digitised. The ultimate goal of digitisation is to capture the clearest, highest-quality image possible for dissemination, and which may possibly serve as surrogate artefacts. There are two options for digitising glass plate negatives: a flatbed scanner or a digital single-lens reflex (DSLR) camera. Both are currently being used for digitisation in photography collections, and have their own advantages and disadvantages (Kyle, 2018). The workflow has to keep the object as safe as possible. A DSLR camera and light box equipment set-up offers flexibility. Because there is no contact with the plates, the risk of breakage is limited. Capturing images with a DSLR over a light box is faster than using a flatbed scanner. Although use of a flatbed scanner may be easier for image capture, it offers less versatility in terms of format. A camera can be used to capture larger formats while the flatbed scanner is limited by its own flatbed size. In a flatbed scanner, the plate is sandwiched between the scanner bed and the cover, which acts like a light box. The risk of excessive pressure and breakage when using a scanner is higher compared to the use of a DSLR camera. The challenge in capturing a non-transparent image with a DSLR camera is to ensure even lighting. This might be particularly difficult to achieve if the print is very glossy. A flatbed scanner is more convenient in this sense, because its internal lighting source allows this issue to be minimised. Both pieces of equipment are suitable for this collection and required a similar budget. The last aspect to take into consideration was the after-sale service of these devices. Repairing, replacing, or upgrading a DSLR camera might be easier than doing so for a professional flatbed scanner. The process of the production of the master files also needed to be determined, including the optimum resolution, black-and-white or colour digitisation, bit depth (e.g. 16 bits, 24 bits, etc.), file formats, International Color Consortium (ICC) profile, and other imaging quality assessment factors. The software for managing the database also needed to be addressed. This software must allow the retrieval of image files as well as documentation of the image's history, treatment, and storage.

Conclusion

The preservation of cultural heritage is a dynamic discipline that evolves with the times. More attention is paid to the collections of photographic negatives and their preservation, not only to preserve the visual content, but also to preserve their materiality. International preservation standards exist for storage of photographic material, but it is difficut to master the technical and financial implication of standardised conservation conditions in tropical climates as, most of the time, compromises with local and low cost solutions have to be conceived. However, the implementation of such a sustainable strategy requires a thorough review of the collection, its context, and its environment. An appropriate analysis allows conservators to identify the risks, after which priority actions and needs can be better defined.

In this project, such an assessment was undertaken for a historic collection of glass plate negatives kept in the 20th century, in the hot and humid environment of Myanmar. The rates and types of damage were different from expected: the main, and most critical, factor was the moisture and air quality, and not the temperature or the storage cabinet. Solutions were proposed, but they were tailored to local needs and with input from stakeholders. In the future, appropriate training covering collection care, digitisation, and documentation, and a database will be provided with UNESCO support. Such a preservation plan implements the UNESCO *Recommendation concerning the Preservation of, and Access to, Documentary Heritage Including in Digital Form* which encourages Member States "to consider their documentary heritage as an invaluable asset" and continue to evolve to further recognise the need for investment in the preservation, in digital infrastructure, and skills. As a long-term outcome, a photo preservation studio could be set up and serve as a model for best practices in conservation in hot and humid climates, including cataloguing and digitising to meet future needs.

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Authors' biographies

Bertrand Lavédrine received his doctoral degree from the Faculty of Humanities, University of Paris I Panthéon-Sorbonne, with a thesis in Art and Archaeology. He also received a Master's degree in organic chemistry. He is a professor at the National Museum of Natural History in Paris, and was Director of the Centre de Recherche sur la Conservation from 1998 to 2018. Past professional responsibilities include being head of the Master Conservation Programme at the University of Paris I Panthéon-Sorbonne, a member of the International Council of Museums - Conservation Committee (ICOM-CC) board, and coordinator of the ICOM-CC Photographic record group. He has authored papers and books on preservation topics with particular focus on photographic collections. Some of those books are available in French, English, Spanish, Russian, Japanese, and Vietnamese. Bertrand Lavédrine has received the European prize for conservation innovation, the Kraszna-Krauz Photography Book award, and has been awarded a Knighthood in the Order of Arts and Letters of France.

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[1] http://isdp.eu/publication/eu-myanmar-relations-toward-greater-engagement/

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Preservation and Survey Strategies of Paper Based Records at the National Archives of the Philippines

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KEYWORDS
archives, records, preservation, repair techniques, collection survey

ABSTRACT

The National Archives of the Philippines has more than 60 million pieces of archival records. These records are paper-based and have been subjected to deterioration brought about by time, weather condition, pets, disasters and improper handling by those who have access to them.

This paper relates how the National Archives of The Philippines employs measures to take care of the records. The causes of deterioration of records are identified, the procedures for preservation are elaborated upon, and the appraisal strategies to enhance the protective measures are enumerated. Altogether, this paper provides a microscopic survey of how to protect the records and make them accessible to meet the research purposes of today's and future generations.

Introduction

Archives provide information and evidence of activities which happened in the past. They have value to nations and regions, organizations, societies and individual people. They state stories, document persons and identity and are valuable sources of data and research. They are our recorded memory and form a significant part of our community, and cultural history.

They are collection of documents or records which have been selected for permanent preservation because of their value or as a basis for historical or other research. Records are created by the activities of organizations and people; they serve an active purpose while in current use and some of them are later chosen and preserved as part of the archival collection.

With this I believe that it is only vital for all records being archived to be given an utmost care to ensure its existence all the time. This is really one of the most significant things we could ever stretch to the coming generation.

Everyone is entitled to know their rights about their roots and where they came from, how their ancestors lived their lives before and how meek people transformed into a modern man, how things evolved and adopted to the current world.

Southeast Asia used to be a literate and yet generally non-writing society, but with the coming of foreign colonizers like the Spaniards, Dutch, and British, paper was introduced to keep records permanent and easy for access. Since the 16th century, Southeast Asian peoples began inscribing their thoughts, opinions and words on paper.

The paper and inks that they used were normally acidic, making the records vulnerable to deterioration as they aged.

At the National Archives of the Philippines, our records are exposed to such susceptibility. We are faced with the enormous mission of protecting and prolonging the life of more than 60 million pieces of records that have been accumulated since the 16th century. Our prized possession is the documents created during the Spanish rule of the Philippines (1565-1898), which number to more than 18 million pieces. These are government reports, legal papers, ecclesiastic and church chronicles, engineering plans, maps, and statistical data. But we also nourish records made during the American rule of the Philippines (1898-1946), Japanese invasion of the Philippines (1941-45), and since we became an independent nation in 1946.

We follow a number of systematic procedures for describing and understanding the properties of our records.

At the National Archives of the Philippines, it is the policy of the state to preserve, conserve, protect, and promote our Cultural Heritage. We can only do so much in implementing all of these by ensuring security in terms of physical and intellectual aspects of all our holdings.

We monitor all activities in our archives, from acquisition, to rehabilitation up to proper storage of these records.

Present condition

The current state of the records is another important thing that we always take into consideration, for the records may still be in good condition or are already worsening.

The first thing that we notice with damaged records is discoloration. They may be darkening or yellowing, fading, or foxing because of time. Or they may have gotten stains because of contact with poor quality material, mold growth, stains, tidelines or water and liquid stains, flyspecks, accretions, surface soiling, fingerprints, or blanching.

With regard to structural condition, the records may have suffered from embrittlement or flexibility, tears or breaks, losses, pin or tack holes, abrasion, thinning, cockling, folds, wrinkles, attachment to support, flattened platemark, scratches, trimmed edges, creases, cracking, pages sticking together because of exposure to water damage, damages because of fire or smoke, damages caused by insects, and marks from staples, paper clips, rubber bands.

The inks also sustain damages. They may have blotted, diffused, or been erased. They may also have attained discoloration or corrosion, and they may have skipped areas.

Past treatments

Through the years, people attempt to repair any damages that the records get. But in the past, the treatments applied to the damaged records had not yet been scientifically proven to really repair the damages. What happened was instead of repairing, the records were rather damaged more. The past treatments included adhesive tapes, frames, patches, glue, lining, retouching, and others. These treatments can hardly be removed now, or acidic and therefore add more damage to the records.

Preservation

The National Archives of the Philippines has taken measures to preserve its records.

Preservation has something to do with the acquisition, distribution and organization to ensure suitable protection and access to its cultural and historical information for the current and future use of the public or the coming generation.

It is the totality of processes and operations involved in the protection of records and archives against damage or deterioration. It encompasses the activities which prolong the usable life of archival records.

When we say preservation, it includes examination of records, regular maintenance of storage facilities, and conservation and restoration of damaged records.

In preservation program, we mean that we are to engage in the following activities; examine and improve the environment; examine the materials and establish priorities for treatment; separate newly acquired materials from your existing archives; establish work rooms for restoration; coordination with some professional conservator from different state (exchanging knowledge and skills); monitoring and supervision of in-house repair and rehabilitation

Principles of preservation

The principles of preservation are documentation, rule of reversibility, compatibility of the problem and the solution and restoration.

Documentation comprises of narrative description of the records to be treated, the checklist and the photographic record.

In Rule of Reversibility, no procedure or treatment should be undertaken that cannot be undone, the technique undertaken can be reversed.

The Compatibility of the Problem and solution means the treatment to be applied should not be greater than the problem. Its better to do nothing at all if there's no acceptable treatment or solution compatible to the problem.

Restoration means that the process must be done with great care to ensure its integrity and authenticity are not put into doubt.

Causes of deterioration

We need to remember that our materials can easily be damaged by many different factors. Our manner of securing them from these damages is very crucial. Acid, which affects the quality of the paper, light, ultraviolet rays in sunlight and fluorescent light can cause chemical changes and speed up the process of fading.

Temperature and humidity are another thing they accelerate the growth of molds and contributes to the internal disintegration of the paper, whereas air pollution caused embrittlement and discoloration and breakdown of the paper fibers. Insects and pets are too dangerous to archives, they can consume the entire information content of your holdings if not detected early, the whole archives would really be at stake.

Disaster impact to records

A great impact of damage to records may be obtained from disaster, if you are caught unguarded and unprepared, most likely, you might lose everything. Records affected by a disaster and not addressed immediately could lead to a much serious problem in just a matter of time.

This is one of our huge concerns in our country. We as the National Archives of the Philippines is mandated to disseminate and implement a government wide program on counter disaster program to prevent or at least mitigate the impact of catastrophe.

By conducting regional and in-house training, we are gradually publicizing the importance of having a disaster preparedness plan for each and every agency in the Philippine government.

However, some disasters cannot be prevented and the least thing that we can do is to educate and train all personnel specially records officers on how to handle situations and response quickly and recover damaged records properly during and after the emergency. By saying so, the National Archives of the Philippines is conducting a regular free seminar to disaster prone areas all over the country twice a year.

Identifying the risks, knowing the past history of the region regarding disaster experiences and determining all preventive actions needed to circumvent devastating impact before the disaster strikes are just some of those matters that we address in the seminar proper. Precise actions in an emergency situation must be observed at all times.

Preservation procedures

Identity of records

First, we establish the identity of a records. We assign a name or title to each bundle according to its contents. If a bundle contains records of Spanish Records, Creation of Towns in the years 1757-1887, the bundle is named *Ereccion de Pueblos 1757-1887*. The length, width, and thickness of the pages are measured. We also verify where the records were created. The technique used for the records created during the Spanish rule was manuscript, while during American rule, typewriting was used starting in the 1920s. Before the introduction of typewriters, there was no other way to make records but to write them with hands. The total number of pages of the bundle is also recorded.

Photo documentation

This is to record the physical appearance of the document. It needs to be photographed to evaluate the difference before and after the restoration procedure and to appreciate the importance of applying techniques/treatment on documents.

Pagination and dismantling

Assign number on every page from the first leaf until the last. Page number shall be in incremental sequence. Dismantling on the hand is the removal of fasteners, clips, staples, thread, binding tapes and cover and unbinding the bound by hand. In dismantling records into loose sheets, we make sure that pages will be kept intact.

Materials description

After establishing the identity of records, we go to their material description. We classify if the support used is paper, cloth or parchment. The paper could be made of cotton or pulp. Cloth might be similar to canvasses used as medium for paintings. Parchments might be made of animal skins or vellum.

The inks used were iron gall or carbon. Iron gall is a pigment type of ink, which means that it becomes indelible once it is inscribed on paper. With this type of ink, the ink and the paper become one item. They become inseparable. But iron gall has intrinsic properties which are acidic, and which therefore gradually corrode the paper over time. Iron gall is usually used for manuscript technique of writing. Nearly all of our Spanish documents have this type of ink.

Carbon ink is a type of ink that is delible and therefore does not hold on to paper permanently. It can be removed from the paper, and if it comes into contact with water or other liquids, it smears or smudges. The information within the paper is damaged or destroyed.

Our Spanish documents have colorants like water colors, oil paint, and crayon. These colorants were used in making community maps, geographical settings, and plans for roads, bridges, churches, schools, and government buildings. They could be indelible or not. And so, during restoration, we are very careful not to cause any damage to them. Any little mistake could render the document ugly or unreadable.

At the last stage of describing the materials, we may find that the records may also bear seals inscribed by Spanish Kings, Popes of the Roman Catholic Church, and government and church officials. The records may also have covers or bindings.

Then we conduct the pH test. It determines the potential of hydrogen of records, or the degree of acidity or alkalinity of the records. Using the gauge that ranges from 0 to 14, the paper can be known to be neutral if it is 7, acidic if it is 6.5 and below, and alkaline if it is 7.5 and up.

The ink solubility test is also performed to know if the ink of the records can or cannot stand exposure to water. If it passes this test, the records go through the wet cleaning steps. The records are washed and de-acidified with the use of a chemical solution called calcium hydroxide. This solution is a mixture of tap water and calcium. It removes the acid present in the records.

If the records cannot be washed because of their soluble inks, they go through the dry-cleaning process. The records are cleaned through brushes, cotton swabs/balls, scalpel, rags, erasers, or vacuum cleaners.

Conservation

It is the intrusive protection of archival material, by the minimal physical and chemical treatments necessary to resist further deterioration, which will not adversely affect the integrity of the original. It refers to the treatment and repair of individual item to retard record's aging or restore them to a usable condition.

Restoration

It is the full or partial treatment of damaged records. It is the repair of an item when aesthetics and reproduction of the original appearance is more important than the preservation of the integrity of the item.

In restoring the damaged records, we use four techniques: tissue repair, leaf casting, encapsulation, and lamination.

In a full tissue repair, the record is pasted onto a tissue paper and covered with another similar tissue to attain structural strength. In partial tissue repair, mending, infilling, framing, and backing can be used depending on the needs of the record. Very thin tissue papers are used. This is not to affect the clarity of the information of the record.

In leafcasting, fibers in suspension are poured into the damaged records to fill the holes and other damaged parts.

In encapsulation, the damaged record is sealed between two pre-cut sheets of polyester films. This technique is resorted to if the record has darkened that a tissue paper pasted on it would make it unreadable. The film sheets are transparent and make the records clearly readable.

In lamination, the damaged record is attached to an archival or a lamination cloth, and the two are pasted together using a laminating machine.

Preservation surveys/survey strategies

Environmental survey

Assessment of suitability of the building and its facilities for storage of records.

The building where the collections are stored is thoroughly inspected to ensure the safety of both the collections and the employees.

Security is another priority of the organization. Security guards are present 24/7, and CCTVs are installed in the entrance, exit points and inside the storage areas as an effective measure against thefts of documents. Fire alarms, extinguishers and water sprinkle system are also put in place to check any obvious emergency in case it happens.

Proper ventilation is a must for storage areas, while rooms where employees work are air conditioned. Open steel shelves in the storage area are preferred, since they are stable and sturdy to accommodate the records. Regular fumigation and pest control should also be applied.

Collection survey

This is designed to determine the present condition of the collection, to appraise the extent of damage that the collection has obtained and to make recommendations on what should properly be applied.

This is one way of knowing how many were heavily damaged, partially or if still intact or in good condition.

This survey begins with a review of the policies, procedures and programs of the agency with regard to preservation. Then the spot checking or actual inspection of the buildings, offices, storage areas and the collection follows.

The results of the ocular inspection are detailed in a Spot-Checking Report. This include the recommendations that should be taken. A follow-up culminates the survey, this is a strict checking if the recommendation has been followed and implemented.

Condition survey

It assesses the physical condition and status of repair of our collections.

Condition survey is gathering of data needed to evaluate treatment priorities. At the National Archives of the Philippines, we have provided a form which we called as the “Condition Report Form” where we enumerated all the information needed to identify the damage obtained by the records caused by different damaging factors, be it from a natural or human negligence, and what kind of treatment shall be done to the said records.

Caring for the records

In caring for the records, proper storage must be prioritized. The temperature and humidity play great factors in maintaining the good physical condition of the collection, said factors must be well controlled to its best level to ensure the best state of the records.

The processes that we do at the National Archives of the Philippines are all labors of love. We love the records. We have jobs because of these records. We exist as government professionals and public servants because of the records. And most important of all, we have these records whenever we want to know how we were in the past, what our ancestors did, and what they can serve for us in the present and the future.

We will continue to produce new knowledge, techniques, and practical know how to further preserve these treasures of our nation.

Conclusion

In conclusion, archival records are there to prove and attest the history of every nation. That it is our duty and responsibility to uphold the intention to promote and preserve these documents.

We must provide the most efficient approach and method to ensure its protection and existence.

Furthermore, knowledge and techniques for new strategies to improve the record’s condition must be sustained. One must stretch its cordial dedication to guarantee its safety for the use of the coming generations.

Author's biography

Virginia has devoted 90% of her career to the Archives Preservation Division for the last seven years. She has experience in performing different techniques in preservation of records. Her recent activities include assessment of potential records to be declared as part of National Cultural Treasure, inspection of damage records affected by different types of calamities in dissimilar areas in their country, Resource Speaker to government agencies regarding Records Management and restores brittle archival record in their laboratory. Virginia also renders technical assistance to government offices who need support with regard to their records management concerns and damage records affected by wreaking factors. She had also attended various seminars and tours local and abroad. Among them are; Preservation Development and Cultural Summit, in Pasay City, Philippines in 2016, Training Tour in Media and Conservation Laboratory, National Archives here in Singapore in 2016 and Documentary Heritage Preservation and Management, by KOICA in Korea in 2014. Virginia's passion also includes pop jazz music and she loves playing badminton in her spare time.

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Preserving and Promoting the Value of the Han-Nôm Document Store at the National Library of Vietnam

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KEYWORDS
NLV, Nôm preservation, Han-Nôm heritage, Dó paper, Nôm digitalization project

ABSTRACT

Nôm script is an old Vietnamese writing system, and a valuable heritage of Vietnamese culture. The Han-Nôm document store at the National Library of Vietnam (NLV) was started in the 1960s. It now consists of over 4,000 books, many of which are highly valuable. This collection authentically reflects aspects of social life, history, education, and geographical science in Vietnam during the historical process from XIIV to XX century. Time, climate, and limitations of material facilities and preservation techniques have resulted in the store being gradually damaged. Subsequently, the library implemented the repair, restoration, and digitalization of the entire Nôm document store with the support of the Vietnamese Nôm Preservation Foundation in USA, North Carolina University, and the Preservation Center of Cornell University, USA.

This paper analyzes the characteristics of Dó paper (a traditional paper used to publish Han-Nôm documents); the objective and subjective factors that increase the risk of damage to historical documents; the preservation measures implemented on Han-Nôm documents stored in NLV; and the materials used in restoration of Han-Nôm documents.

This paper also introduces storage and service methods, explains the digitalization project, and proposes ways to enhance the effectiveness of introducing these archives as a method of preserving and promoting the value of Vietnamese cultural identity.

Introduction

Han-Nôm heritage is an important part of Vietnam's culture. It connects the past and present, and preserves cultural and historical values as well as national character. It is a comprehensive and honest reflection of all aspects of Vietnamese social life, and has great significance in the building and defending of the Vietnamese Fatherland.

At present, Han-Nôm heritage collections are scattered across Vietnam. The collections can be found in public, university, and research institute libraries, as well as archives centering on Vietnam and its people. The Han-Nôm collection stored at NLV's store of valuable and rare documents was started in the 1960s, and now consists of more than 4,000 copies – many of which are highly valuable. These works were either handwritten or printed using woodblock or modern methods, and contained either

Han script, Nôm script, both Han and Nôm scripts, as well as Han or Nôm scripts which have been transferred to the modern Vietnemese language. This archive of documents in NLV can be classified into four types: Kinh, Su, Tu, and Tap. It includes anthology, biographies, mandarinate examinations, drama, educational and scientific materials, special issues, family annals, historical accounts, woodblocks, books on linguistics, literature, medicine and pharmacy, stories written in Nôm script, poems and rhythmical prose, and books on religion, Chinese studies, court affairs, village custom, and family law.

Time, climate, and limitations of material facilities and preservation techniques have resulted in the store being gradually damaged, and at risk of falling into oblivion.

In this paper, I present the actual state of the ancient Han-Nôm document store at NLV before it underwent repairs and restoration. I also present the nature of the preservation work, the methods of organizing the use of Han-Nôm documents to promote its value to the public, and introduce the advanced cultural character of the Vietnamese nation in the period of international integration today.

1. State of the Han-Nôm document store before repair & restoration

The Han-Nôm document store at NLV currently contains more than 4,000 books produced between 1667 and 1989. All Han-Nôm documents from the 13th century to the 20th century were made using rhamnoneuron paper (Dó paper), which is a type of handcrafted traditional paper developed during this period. Learning about the method of production and characteristics of rhamnoneuron paper will help us to understand more about causes of damage to the Han-Nôm document store.

1.1. Physiochemical properties of Dó paper

Dó paper is made from Dó bark. Dó is a type of tree that can be found in the northern region of Vietnam. Studies of Dó paper production facilities in Vietnam show that Dó paper is produced manually, and has not undergone any chemical process that creates acid in paper. Long Dó fibers are tied to create a sheet of Dó paper. Such a method makes Dó paper porous and, subsequently, very light. Dó paper is half as heavy as industrially-produced papers.

The ingredients for producing Dó paper are bamboo, wood, and natural light. The light is needed to dry the paper, making the paper acid-free. Therefore, Dó paper has a long useful life if preserved in a standard environment. Reality shows that Dó paper has a useful life of up to 500 years, typically the types of ordinations in Vietnamese temples and shrines which are still being kept at the National Archives Center in good condition. These documents were made from Dó paper, since the preservation facilities have not developed.

1.2. Damaged state of the documents

Because the Han-Nôm documents did not contain chemicals, acidification of paper was little. Thus, the damage to the documents was mainly due to subjective and objective factors.

The physical damage of archival documents in general directly affects the level of providing information of the documents and the ability to allow readers contact directly to the documents. Therefore, archival documents in general must be in a good physical state, which may be understood to be undamaged, untorn, uncrumpled, containing clearly legible words, and easy to read. If the physical state of archival documents does not meet these requirements, the documents must be repaired or restored before putting into storage mode and serving the users.

A survey of the Han-Nôm document store at NLV shows that the most common damages include:

- Tears, crumpling, decay, and friability as the Dó paper was too thin. Moisture in the environment also caused many documents to stick onto each other for a long time, leading to gradual decay and tears (Fig. 1, Fig. 4).
- Large yellow or brown stains appearing due to the desiccation process of paper. When paper dries, it creates smears that cannot be repaired, and this affects the aesthetics of the documents (Fig. 1).

- Dust and dirt contamination. Insect attacks caused a lot of holes to be formed on the document surface, leading to information loss (Fig. 2 - 4).
- Loss of protective covers, causing documents to fall apart. The cotton thread used for sewing the books have also decayed and broken off (Fig. 1 - 3).

Below are some pictures showing the damaged state of the Han-Nôm documents in the NLV document store.

Fig. 1. Document is torn and has yellow stains. Information has been lost.

Fig. 2. Document was attacked by insects, and cover has been lost.

Fig. 3. Document was attacked by insects and thread has broken.

Fig. 4. Document pages stuck together.

2. Factors affecting the preservation of Han-Nôm documents

2.1. Objective factors

Weather impacting the state of Han-Nôm documents

The hot and damp weather that regularly appears in Hanoi is very favorable for the development of mould, microorganisms, and insects. Almost all insects and mould develop and reproduce well in damp temperatures and a high moisture environment. Many documents were also damaged by attacks from insects such as worms, cockroaches and termites, and rodents such as rats.

Lack of preservation means and techniques

Most Han-Nôm documents stored at NLV were collected by the people. Before being archived at NLV, the documents were preserved and conserved by the people mainly by experience and their own abilities, therefore many documents were preserved in good condition with little damage or integrity (approximately 1/3 of the documents in the Han-Nôm achives store of NLV). However, most of the documents (2/3 of the total) regrettably were in a deteriorated state with different levels of damage as mentioned in section 1.2. At 1960s to 1990s, the library only acted as a collection and storage agency that served readers interested in the documents; NLV had not many investments to promote the role of the preservation work

Due to historical incidents in the past, especially the Indochina War or change in repository location, the documents needed to be packed, transported for rapid evacuation; thus, the bad influence on physical state of the documents is unavoidable.

2.2. *Subjective factors*

Archival method and preservation conditions

The Han-Nôm documents were placed in thick paper cartons that were unsuitable for preservation because they contained acid. Such an unstable environment leads the protective boxes to absorb moisture, directly affecting the documents inside to some extent (Fig. 5).

Method of service

Librarians' manual way of serving readers leads readers to come into direct contact with the original documents. As the documents are already in a damaged state, the direct contact caused further damage.

Awareness of proper handling methods

The Han-Nôm documents were written or printed on Dó paper, which is very thin. Therefore, when handling the documents, the slightest carelessness (taking/holding documents without using gloves, dirtying the documents, using pens, glue, or pins near the documents, transporting documents carelessly, eating while reading the documents, tearing documents) may cause damages. Carelessness not only came from document users, but library archivists who were unaware of the importance of document preservation, especially for the ancient, valuable and rare Han-Nôm documents.

Fig. 5. The Han-Nôm documents in NLV were stored in boxes.

3. Methods of repair and restoration implemented to Han-Nôm documents at NLV

In 2008, NLV leaders called on VNPF for support to repair, restore, and digitalize the Han-Nôm document store in order to build the first ancient Han-Nôm digital library. Thanks to the mobilization of the VNPF, University of North Carolina sponsored NLV with a large quantity of equipment and materials needed to effectively preserve the store. NLV and the United States Embassy also conducted training courses teaching library staff how to repair and restore documents, and make protective boxes for storage of Han-Nôm documents. These courses, taught by paper conservator and Director of Cornell University's Preservation Center Mr John Francis Dean, increased the preservation capacity of valuable and rare document cadres at NLV and some provincial libraries.

3.1. Repair materials

Vietnamese traditional paper

Dó paper

Because Dó paper is very "clean" and durable, trade villages in Vietnam also produce it for the folk painting market. Dó paper is also used for preservation, repair, and restoration work of paper documents at archival agencies and libraries.

However, there is the fact that bleaching agents are not used during the production of Vietnamese Dó paper, thus, Dó paper is always a specific shade of yellow which comes from the Dó paper fiber. This is good for conservation paper requirements but it limits the documents' aesthetics when the documents needing renovation are bright.

"Cậy" cover

A "Cậy" cover is used to protect Han-Nôm documents. It is produced by pressing many layers of thin Dó paper together to produce a thick book cover, and then painted with "Cậy" water – a natural glue made from the resin of young Cậy fruit – to ensure hardness and prevent the document from insect bites or absorption of moisture.

Fig. 6. Vietnamese Dó paper.

Fig. 7. "Cậy" paint water.

Materials imported from foreign countries

Restoring tissue paper

NLV also seeks more types of specialized tissue paper for the preservation of paper documents. *Kizuko Kozo* 6g/m^2, *Maruishi MM* 9g/m^2, and *Mino Tengojo* 8.6g/m^2 from Japan, and some repair paper types from Taiwan, are used to obtain higher quality restoration and ensure document aesthetics (color, thickness, etc.) are maintained.

Acid-free materials

Acid-free materials are used to make the protective enclosure: lining paper, hard covers to make the box, and plastic cloths. All these materials are used in the field of preservation.

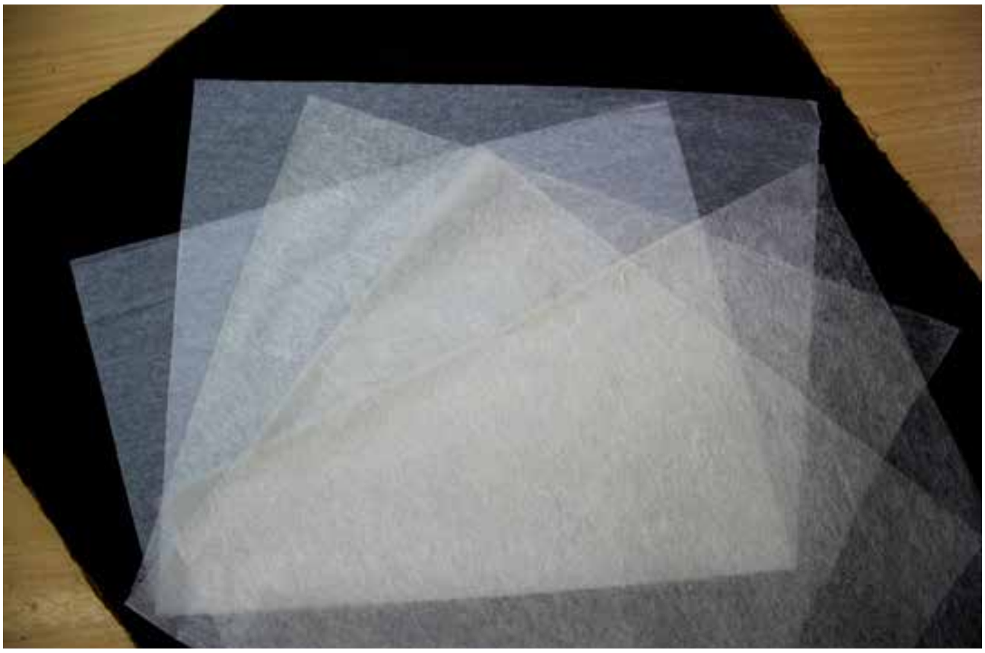

Fig. 8. Tissue paper from Japan.

Adhesive

NLV uses two types of adhesive in preservation work:

- Mending and gluing pastes like methylcellulose (MC) and wheat starch (for mending and inlaying of damaged documents). These types of glue with neutral pH are used by local and foreign preservation centers due to their high adhesive capacity and can be removed in the necessary case.
- White pastes like polyvinyl acetate (PVA) and ethylene vinyl acetate (EVA). These have high adhesive capacities suitable for gluing enamel cloth material and paper covers used to bind books and make the protective boxes.

3.2. Repairing method

Manual methods: Mending, gluing, inlaying

Conservation technicians adhere to the ongoing conservation process at NLV, where mending, gluing, and inlaying are the basic techniques used. However, maintaining as much of the documents' initial shape also depends on the cleverness and meticulous handiwork of the individual technician.

Use of leaf caster to strengthen and mend documents

Paper document conservator John F. Dean tested this method in the course he taught on repairing and restoring the Han-Nôm documents. Leaf caster fills the holes or large tears in the papers without causing the thickness of the documents to increase, as would have happened with the inlaying method.

Conservation technicians in NLV were worried that the documents would be further damaged since they needed to be immersed in a tank of leaf caster to be fixed, and the Dó paper was very thin and soft. However, the result was very satisfactory because the paper fibers ended up firmly bonded to each other. This result may affirm that strengthening the Han-Nôm documents using machines ensured about technical and aesthetic aspects for conservation work as required.

4. Storage method

Making protective boxes for the documents is one way to create an acid-free standard protection environment and prevent the external environment from affecting the documents.

Making protective boxes with acid-free covers

Each document is contained in a box that has an acid-free cover and fits the document exactly. These covers prevent damage caused by the external environment. All documents are also labeled.

Making large boxed enclosures for storing a group of documents

A standard-sized large box suitable to the shelf was designed to enhance the aesthetics of display materials. After being placed in their individual protective boxes, all documents were then grouped according to the continuous identification number and placed into the large box. The label on the large boxes indicate the box serial numbers and identification number of the documents inside.

Fig. 9. Protective box.

Fig. 10. Protective enclosure.

NLV's Han-Nôm document store shared the same storage space as other valuable and rare documents such as maps, photos, and documents from the Indochinese era. The establishment and control of the store's environmental conditions is favorable and economical.

Repair and restoration, the making of protective boxes, and storing of the Han-Nôm documents in a standard environment shows the NLV Director is interested in preserving valuable and rare documents at NLV.

5. Digitalizing the documents and serving the readers

5.1. Project to digitalize Han-Nôm documents

The project to digitalize NLV's Han-Nôm books was a cooperation with VNPF that began in April 2006. The aim of the project was to preserve and promote the highly valuable cultural heritage of Vietnam through building a digital library, which combined modern techniques on digitalization with library and information science. It was the first digital library in Vietnam built for such ancient documents.

After nearly two years of implementation, several important achievements were attained, such as:

- Creation of a book catalogue
- Photographing and processing of 1,158 Han-Nôm books and 78,536 image files
- Creation of a database containing the digitalized books, and publishing them on the internet
- Training a group of experts on how to preserve and digitalize documents so they are able to process the remaining Han-Nôm documents

The project has helped NLV protect a valuable and rare heritage source of Vietnamese culture, and helped many readers worldwide access and utilise this source. It also changed the way NLV served readers.

Fig. 11. Digitalization of Han-Nôm documents at the National Library of Vietnam (Source: http://www.nomfoundation.org/About-the-Foundation/Photos).

5.2. Form of serving the readers: Traditional and electronic

NLV has taken much interest in promoting the value of Han-Nôm documents through organizing ways for people to use this document store. At present, Han-Nôm documents at NLV are made available through exhibitions, displays, document presentation seminars, and document supply services, which includes allowing documents to be read on the spot, and providing copies of the documents, and access to full-text in the electronic database.

5.2.1. Traditional service method by request form

The reading room in NLV is where readers can submit a request form in order to be served the Han-Nôm documents, just like how they would request for other types of documents. Due to the lack of necessary equipment and a serving standard process for rare documents in general, NLV has not enforced principles for serving such documents. For example, librarians and readers have not been required to wear gloves when handling the documents or placing the document on specialized equipment to flip because the Han-Nôm documents are very thin and prone to tearing if they are not handled carefully.

5.2.2. Online service method

After the digitalization project was completed, readers could fully access the entire database of Han-Nôm books online via the NLV website (http://hannom.nlv.gov.vn/). This online reading method helps the library to promote the use of Han-Nôm documents without needing to expand the size of or upgrade the Han-Nôm document reading room. This method also helps the library to promote the value of the Han Nôm documents, as well as the contents of the other documents it preserves and stores. At the same time, the library can manage the documents and users better as illegal photocopying and deterioration of the documents due to physical contact with the originals can be prevented, while the library promotes the modernization of document preservation and conservation.

Conclusion

At present, the Han-Nôm documents are the same as a kind of historical tangible heritage and "shaped" in the materials. Very few people can read the ancient Han and Nôm scripts. Thus, the need to enhance the preservation and conservation of this document source (both physical and digital) must be coupled with the study of Han-Nôm heritage in order to mitigate the risks of losing Han-Nôm documents. Besides the solutions presented above, the continued translation and transcription of Han-Nôm documents are also needed to promote the value of these valuable documents, and store the valuable heritage and national assets of the Vietnamese nation in a scientific and sustainable way.

Author's biography

Mrs Phạm Thị Kiều Giang received a bachelor's degree in Information – Library Science from University of Social Sciences and Humanities – a member university of Vietnam National University, Hanoi – in 2001. In 2002, she started working at the National Library of Vietnam as a librarian for the Reading Book Division. In 2006, she moved to the Preservation Division due to the division's expansion and development. She has attended courses and workshops, domestically and overseas, on preserving paper documents. In 2010, she was appointed Deputy Head of the Preservation Division in NLV, where she was put in charge of the document repair and restoration departments.

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Engaging Museum Audiences through Protection and Promotion of Collections at the National Museum of the Philippines

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ABSTRACT

The National Museum of the Philippines (NMP), the primary institution given the task by law to manage the national art, anthropological, and natural historical collections of the country, is also mandated to foster scholarly study and to make available the art, anthropological, and natural historical collections to the public through exhibitions and publications.

Through the NMP complex in Manila, and its various regional, area, and site museums strategically located all over the country, NMP is continuously redeveloping, redesigning, reconceptualising and re-evaluating its organizational structure, human resources, facilities, exhibitions, collections policies, programs, partnerships, and engagements, primarily to improve its collections management and public accessibility to stay relevant in changing times.

Overview of the National Museum of the Philippines

The National Museum of the Philippines, a Trust of the Philippine government, is an educational, scientific, and cultural institution. Its primary mission is to acquire, document, preserve, exhibit, and foster scholarly study and public appreciation of works of art, specimens, and cultural and historical artefacts representative of or unique to the cultural heritage of the Filipino people and the natural history of the Philippines.

NMP is also mandated to establish, manage, and develop a central museum complex located in the centre of Manila, as well as regional museums in key locations in the country. The NMP complex in Manila is composed of four buildings housing specific national collections and conducting specialised researches. The NM of Fine Arts houses fine and applied arts and art history, built heritage, and movable and immovable cultural properties; the NM of Anthropology is dedicated to human origins, prehistoric and historic archaeology, maritime and underwater cultural heritage, and ethnology; the NM of Natural History, launched in 2016, is devoted to ancient life, geological history, and flora and fauna biodiversity; and the National Planetarium is for the indigenous astronomy of the different groups and communities in the country. Rather than referring to them as departments, NMP uses the historical civil service term "divisions". There are also 16 regional, area, and site museums, and satellite offices strategically located from Batanes, the northernmost province in Luzon, to Zamboanga and Jolo, in southwest Mindanao.

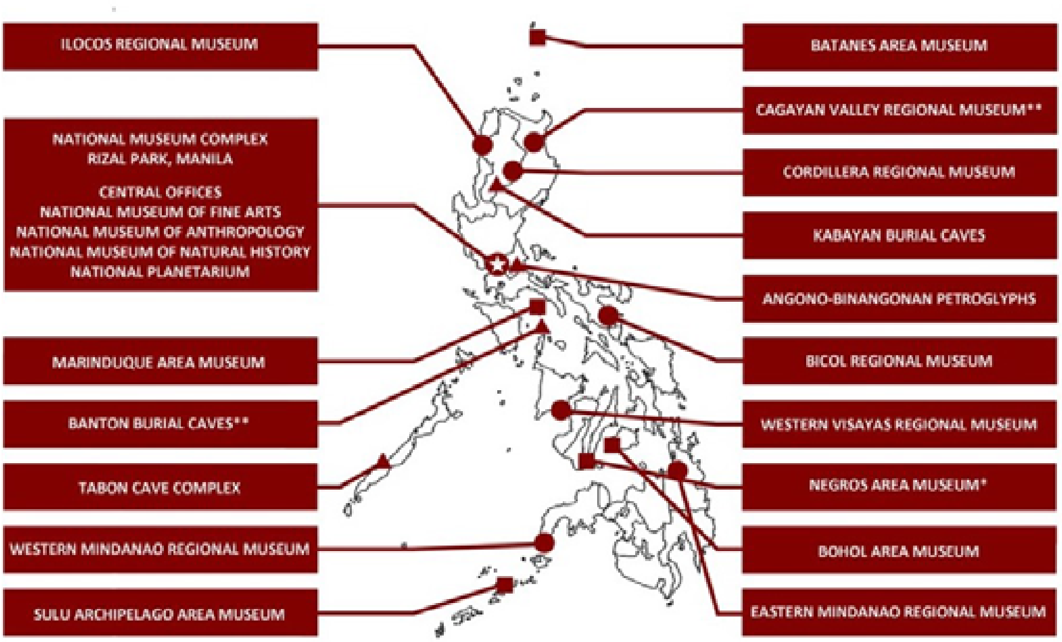

Figure 1. Philippines map showing the location of the NMP Complex in Manila and the 16 regional, area, and site museums all over the country.

The general charter of NMP is Republic Act No. 8492, also known as the *National Museum Act of 1998*. A new law, Republic Act No. 11333, has been enacted on 26 April 2019, superseding the general charter and meant to fill the gaps of the earlier Act, as well as strengthen the NMP. It has also meant that the regulatory functions of the museum will be transferred to another agency to remove conflicts of interest. This new law will also replace the regulatory function of the museum, but it is worth mentioning here Republic Act No. 4846, or the *Cultural Properties Protection and Preservation Act of 1966*. Protection, preservation, conservation, and promotion of the nation's cultural heritage, the mandate of the different cultural institutions which includes NMP, and the protection and professional development of cultural workers, were further strengthened by Republic Act No. 10066, otherwise known as the *National Cultural Heritage Act of 2009*.

NMP is distinct from any other agency of the Philippine government due to its primary responsibility as custodian of, and its vital function as manager and developer of, the national collections. Its annual calendar of activities is anchored on a series of mandated commemorations established by various presidential proclamations, including Proclamation No. 913 *Declaring the Period from October 1 to 7 of Every Year as National Museum Week* effected in 1971; Proclamation No. 683 *Declaring the Month of February of Every Year as National Arts Month* and Proclamation No. 798 *Declaring the Month of October of Every Year as Museums and Galleries Month* in 1991; and Proclamation No. 439 *Declaring the Month of May of Every Year as National Heritage Month* in 2003.

Starting in 2014, general admission to NMP buildings in Manila and NMP regional museums is free during the months of February, May, and October, in observance of the above national celebrations, and free to government employees in the month of September, which is Civil Service Month. On 1 July 2016, NMP's Board of Trustees finally abolished admission fees to NMP buildings all over the country. This resulted in a significant increase in museum visitorship, and enhanced Filipinos' access to their heritage.

In 2015, the number of visitors at NMP buildings in Manila was 534,820. 62.78% was composed of primary, secondary, and tertiary students from schools, colleges, and universities across the country, and 37.22% was composed of local and foreign tourists. In 2016, visitorship numbers increased slightly to 651,017, due to the free admission policy beginning in the second half of the year. Still, 60% of the visitors were composed of students and the other 40% were local and foreign tourists. The dramatic increase in the number of museum visitors started in 2017, where there were 826,463 visitors. Numbers doubled in 2018, where there were 1,689,007 visitors. In 2019, for the first quarter alone, we have already surpassed the total number of visitors recorded in 2016.

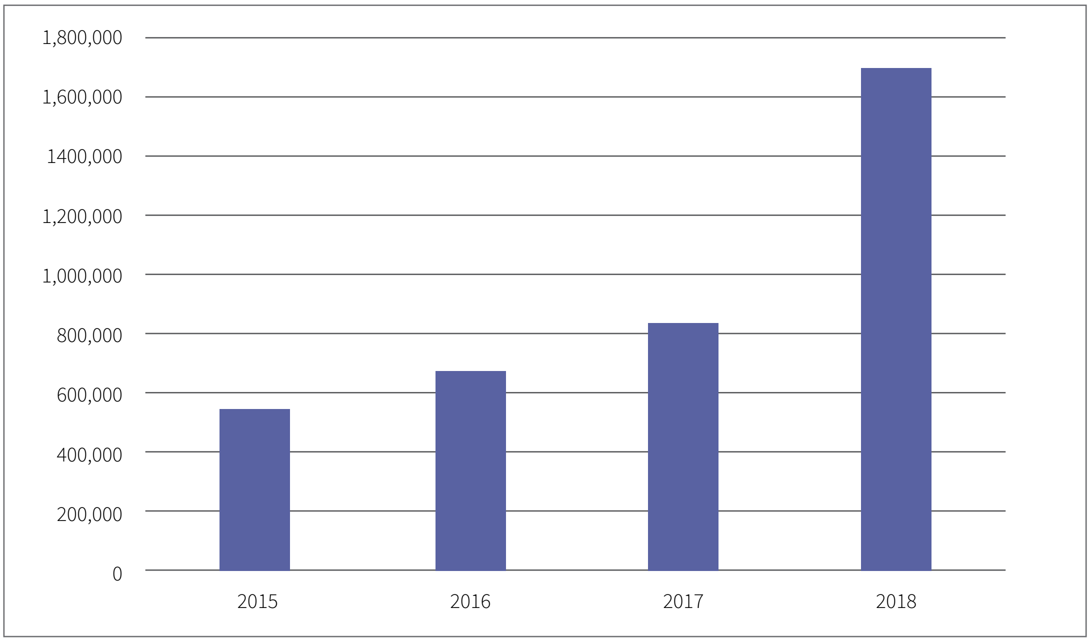

Figure 2. Number of visitors at NMP Buildings in Manila from 2015 to 2018.

The significant increase in the number of viewers in NMP buildings in the central office can be attributed to:

(1) free admission;
(2) opening of the first National Museum of Natural History in the country, and the continuous development of the galleries and facilities;
(3) conducting of educational and public programs such as lectures, seminars, trainings, workshops, and outreach activities; and
(4) promotions through social media.

Proactive and engaging collections care in the NMP of the Philippines

As the primary institution responsible for the care and development of the national collections that provide physical evidence of the cultural and natural heritage of the Filipino people, and true to its mandate of providing the general public access to the collections through exhibitions, publications, educational, and public programs, NMP designs and implements different strategies addressing the increasing number of visitors while ensuring the safety and security of its collections.

During the orientation and re-orientation of new and old employees of the museum, the primary mandate of the museum was introduced and re-introduced, instilling in all staff that the museum has flourished since its establishment in 1901, that the proper care of the national collections will be the legacy of the management and staff to future generations as NMP was merely a custodian, and that the museum and collections must live on for generations.

All programs and activities of NMP, from its reorganization and staffing pattern in 2014 to the development, expansion, and upgrading of its facilities; from the re-conceptualisation and reinstallation of exhibitions to the development of public and outreach programs, were geared towards preventive conservation of the national collections without sacrificing public access.

Reorganization of the agency

In 2011, the newly appointed NMP Director Jeremy Barns, and Assistant Director for Museums Ana Labrador, identified the need to revise the Organizational Structure and Staffing Pattern (OSSP) of the agency. This was a result of recognising NMP's organizational gaps: it was functioning as an ordinary government office but not as a proper museum. After consulting senior staff and having several meetings with different clusters of the NMP, the management drafted a proposal that went through many revisions, including reducing the number of additional staff members from 600 to 350. The proposal was eventually approved by the Board of Trustees and endorsed to the Department of Budget and Management in 2014. The latter approved the revised OSSP, and NMP management finally implemented it in 2016.

The approved OSSP comprised a total of 568 positions, of which 235 were newly created, mostly requiring a higher entry level requirements. This paved the way for expansion, conversion, and creation of divisions, thereby strengthening NMP's core mandate, and addressing the weaknesses and gaps in the organization as well as the development of NMP's human resources.

Development of technical and scientific personnel

NMP encourages employees to apply for, attend, and participate in international trainings and conferences, and endorses and supports the staff in exchange programs or further studies in their respective fields.

Upon returning, the staff are required to share and evoke the knowledge, skills, and insights they gained with their respective divisions, other divisions within their cluster, and the general public. *Seminars in Museum Practice Series* and *From Field to Museum* are some of the programs where the central office served as a venue for knowledge sharing.

Other programs were also designed to develop the capacity of staff in regional museums and satellite offices, together with other museum and heritage workers in the local areas. *Running A Museum Workshop*, which was inspired by the practical handbook by the International Council of Museums (ICOM) and *Tuklas Kalikasan* ("Discover Nature"), was a seminar-workshop on the collection, documentation, and installation of natural and cultural specimens that was organized and conducted by NMP's various research and technical divisions in collaboration with the local government and college or university in the region. *Running A Museum Workshop* and *Tuklas Kalikasan* were designed to advance the skills of NMP employees in a particular region, and to prepare them to conceptualise and install exhibitions in the upgraded and expanded facilities and assist other museums in the area that request for technical assistance of the museum.

These programs strengthened and expanded cross-institutional and professional ties nationally and internationally, and facilitated the exchange and sharing of experiences and best practices. At NMP, this was a progressive shift as its new managers found that staff did not talk professionally to each other. While communication gaps remain an issue, especially among divisions, the staff are provided with opportunities for collaborations through interdisciplinary agendas such as exhibitions and public programs.

Upgrading, maintenance, and management of facilities

After the establishment of the Insular Museum of Ethnology, Commerce and Natural History by the Philippine Commission on 29 October 1901 (the officially observed foundation day of NMP), the institution was reorganized, renamed, transferred, reintegrated, and finally granted three permanent buildings in 1996. Planning for the improvement and establishment of museum guidelines was initiated in 1984, but the *National Museum Act of 1998* was only signed into law on 12 February 1998, in the midst of the Asian Financial Crisis.

The Museum of the Filipino People (now NM of Anthropology) was inaugurated in 1998 for the Philippine Centennial Celebration on 12 June, but it took more than a decade for the two other buildings, namely the NM of Fine Arts (formerly the Old Legislative Building) and the NM of Natural History (formerly the Department of Tourism) to be converted into exhibition spaces, collection holdings, and curatorial offices under a new management.

Extensive improvements in the physical facilities, such as curatorial offices, exhibition spaces, storage rooms, and security and control rooms at the NM of Fine Arts began in 2010, and the opening of the first NM of Natural History took place in 2016.

The existing regional, area, and site museums, and satellite offices in the country, were also expanded and upgraded. Some were built in areas that were considered key locations, and/or where significant cultural sites are found.

Included in the upgrading of facilities and identification of the different spaces were the purchase of scientific and technical equipment units, compactor shelves, storage cabinets and racks, anti-UV window screens and shades, LED lights, and archival supplies and materials; repair and maintenance of the heating, ventilation, and air conditioning system; and installation of surveillance and security cameras.

Re-conceptualisation and installation of exhibitions and conduct of corollary activities

With the improvements and upgrading of the facilities, exhibitions were also re-conceptualised and re-installed. National collections that were in storage for decades were shown to the public for the first time. In the case of the NM of Anthropology, the dismantling of the exhibitions installed in 1998 started in 2014, and the re-conceptualisation of new exhibitions was based on the new management's master plan. In this exercise, the curatorial team engaged the indigenous communities, or culture-bearers, as the main source of information, from the conceptualisation of the exhibition to the development and conduct of the educational and corollary activities. Roundtable discussions and consultative meetings were organized during the conceptualisation stage, and field research was conducted on-site. Walking through of the exhibitions were conducted, and attendance and participation of the members of the indigenous community during the launching and corollary activities took place.

Other exhibitions were multi-disciplinary in nature, involving the different technical and curatorial divisions of the museum, and organized in partnership with other government and non-government organizations.

Representatives from the local communities also took part in lectures, demonstrations, and workshops in relation to the exhibitions. They also interacted with visitors and shared their experiences and insights.

During the selection of collections for exhibition, the condition of an artefact was considered. Conservators and technicians assessed the condition of the artefact, applied necessary conservation measures, and discussed with the curatorial team about recommended installation materials and systems in order to reduce the risk on the objects while on exhibition. Aside from the collections' condition, the material, size, orientation, parts, significance, and location of the artefacts in the exhibition were also considered.

Monitoring and maintenance of collections and gallery duty

Based on the OSSP of the agency, there was to be three general clusters per organization: the financial and administrative cluster, the visitors and museum services cluster, and the research or technical divisions cluster. The Central Museum Visitors Operations Division and the Museum Services Division were directly in charge of visitorship and public programs, while the monitoring and maintenance of collections and galleries was undertaken by the research and technical divisions, together with the Facilities Management Division and security and maintenance service providers.

In the NM of Anthropology, a researcher or technician was put in charge of monitoring a particular gallery, including its collections, showcases, texts, captions, lights, temperature, relative humidity, and other exhibition considerations before and after gallery hours. A monitoring form was devised to record the staff member's observations on the different parts of the exhibition, and actions taken, such as replacement of captions and coordination with the responsible individual or division. Based on the daily monitoring form, the collections to be pulled out for conservation, and the gallery to be scheduled for maintenance, were identified and prioritised.

Aside from monitoring galleries at all times, personnel from the technical divisions were also required to be on duty during opening hours. They also monitor the collections, exhibition collaterals, facilities, visitors, and other NMP staff, and report to or coordinate with the division concerned if there are problems in the information and communication equipment, temperature of the gallery, and if visitors have questions regarding the exhibition. The staff on duty is also required to submit a gallery duty report to ensure the proper maintenance and stable condition of the collections on display.

The monitoring responsibilities and duties of the technical staff also served to orient security, maintenance, and front-line services staff on the basics of preventive conservation and the overview of the exhibition. Visitors were also encouraged to write their comments, observations, suggestions, and recommendations in the guestbook provided in each gallery. The comments were reviewed and considered towards immediate improvement or upgrading works of the gallery.

Orientation of visitors

In order to control the number and flow of visitors, designated entrances were built for regular visitors, visitors with special needs, and NMP staff. Every visitor, or a representative from a large group, was required to register themselves since NMP no longer collected admission fees. Bags are inspected, and bags larger than A4-sized paper were deposited in the checked bag area.

In the interest of the safety and security of national collections on exhibit, NMP's front-line staff gave a brief orientation to visitors and tour operators before proceeding to the different galleries. Visitors were reminded of actions, materials, and equipment units that were not allowed inside the galleries. For large groups composed of students and their parents or guardians, a guide was assigned to provide an overview of the exhibitions, while members of the curatorial or technical team provided details on the collections, concept, building, and maintenance of the galleries.

Figure 3. (a) Visitor guidelines in NMP buildings. (b) and (c) NMP guides orienting visitors at the Marble Hall of the NM of Anthropology.

Creation of committees and task forces

Due to the vast and varied national collections in the fields of Art History, Built Heritage, Anthropology, and Natural History, NMP created a committee to draft, revise, and update Collections Management policies, guidelines, and manuals. An Emergency Preparedness Committee was also created for the protection and safety of NMP employees, visitors, and collections during armed conflict and other man-made or natural disasters and emergencies, with a team specifically in charge of collections registry, conservation, and recovery. The Collections Registry team was tasked to complete registration and inventory of collections, identify a collection's location and vulnerability to hazards and risks, prioritize objects to evacuate first through significance assessments (if necessary), and formulate basic conservation procedures.

All NMP staff members also undergo regular emergency preparedness training sessions and participate in nationwide emergency drills such as fire prevention seminars. An Integrated Pest Management Committee was also created as part of the preventive conservation measures of the NMP.

On-the-job training for students

Pursuant with the Department of Education Order No. 30 series of 2017, senior high school students are required to undergo an 80-hour work immersion. NMP, having an educational mandate, accommodates Grade 12 students in addition to third- and fourth-year college students for their on-the-job training (OJT) program. In 2018, 71 senior high school students from different schools in Metro Manila and southern Luzon completed their OJT. Currently, NMP has a memorandum of agreement with 26 universities and colleges all over the country for the OJT program.

Since 2010, more NMP employees have occupied senior and managerial positions, and many employees with technical skills have retired. The Human Resources and Management Division, together with its Promotions and Selections Board, experienced difficulties in the hiring of new staff because of the specialised nature of museum work, and the strict minimum qualifications set by the

Civil Service Commission.

Through the OJT program, NMP aimed to identify and recruit potential museum staff. The museum opened its doors for secondary and tertiary students to experience and be immersed in the different tasks of museum staff. Students were oriented with the vision, mission, and goals of the museum, and the organizational structure and tasks of each cluster, before they were assigned to different divisions to assist in the documentation and organization of the collections, monitoring of galleries, guiding of visitors, development and design of educational materials, and conduct of corollary activities. The trainees were also required to submit a daily journal as part of the evaluation, assessment, and improvement of the program.

Educational and outreach programs

Various educational and outreach programs have been designed by the NMP in Manila and its regional museums for different visitors, in relation to international and national celebrations and exhibitions. *Batang Pambansang Museo,* a docent training for teens and kids, exposes participants to the different guides' trails or exhibition themes. Participants are also given free art materials, and taught the basics of sketching or printmaking by partner artists to process their experience and enhance their visual literacy. Professional photographers would also share their inspirations and insights on portrait or landscape photography, and provide free lessons to participants. Artists, photographers, and curators are given the opportunity to talk about their work, in a program dubbed *Artist's/Curator's Talk and Tour*.

At the NM of Anthropology, photography, film screenings and Artists' or Filmmakers' Talks are scheduled as part of the museum's Visual Anthropology Program. There are also lectures, weaving demonstrations, and embroidery workshops conducted by invited textile, mat, and basket weavers, and embroiderers from the different regions of the country. Similar programs are being conducted in regional textile galleries through the Gender and Development Program, and during NMP's textile international traveling exhibition, as part of the cultural and diplomacy program organized by the different Philippine Service Posts in the Department of Foreign Affairs, and in partnership with the Office of Senator Loren Legarda. Games, activity sheets, quizzes, and similar educational materials are also distributed to students visiting a particular gallery, as part of the interactive aspect of the exhibitions.

Figure 4. *[Left] Ms Nelia Rogano, a master piña-seda weaver from Kalibo, Aklan, Philippines, demonstrating the weaving of piña-seda cloth on a* tanhaga *(wooden foot loom) at the Philippine Embassy in London in October 2017, during the launch of the first international traveling exhibition of the NMP. [Right] Embroidery workshop facilitated by Ms Joan Monedo, master embroiderer from Lumban, Laguna, at The Textile Museum of the George Washington University Museum, in Washington, DC, as part of the piña-seda international traveling exhibition in the US in 2018.*

At the NM of Natural History, leaf art workshops were organized for visually-impaired students and facilitated by the Botany and National Herbarium Division. A painting workshop on using stones for storytelling was also conducted by the Geology and Palaeontology Division.

Community engagement in the protection and management of immovable heritage

Aside from the movable tangible objects exhibited and stored in NMP buildings, there are also immovable objects and built heritage that are monitored, managed, and developed by NMP as part of the Cultural Properties Preservation and Protection Act of 1966. The act was amended in 1974, through Presidential Decree No. 374, to include the management of declared National Cultural Treasures, Important Cultural Treasures, and Cultural Properties all over the country. Through NMP's Cultural Properties and Regulation Division (CPRD), officials and law enforcers in local government units and communities are capacitated to assist in the regulatory function of the NMP. Soon this function will move to the policy-making and grant giving body, the National Commission for Culture and the Arts, as part of the NMP's streamlining process and its new law, Republic Act 11333.

Roundtable discussions on cultural property identification, documentation, and registration were organized for government cultural agencies and those involved in the protection of natural and cultural specimens, to establish institutional linkages, improve synergy, and strengthen inter-agency cooperation to achieve more effective protection and preservation of the country's heritage. Regular information dissemination on the pertinent laws, as well as seminars and trainings, are conducted by the CPRD all over the country.

The rehabilitation of damaged churches and ecclesiastical collections, declared National and Important Cultural Treasures, in the island of Bohol in central Visayas after the earthquake of 2013, and in Guiuan of Eastern Samar after Typhoon Haiyan, also in 2013, are the best examples of how different government and private sector agencies were engaged in recovery and rehabilitation efforts. The on-going documentation, conservation measures, and site development plans of mummies and associated material culture in the province of Benguet in Cordillera is another project that illustrates the need for involvement and participation of, and decision-making by the community.

Digitization and social media

Development of NMP's central database and migration of the research divisions' existing systems is on-going to widen accessibility to the national collections on display and in storage. Digitization of catalogues, field site reports, and research papers, is also taking place. These materials will be made available at the NMP Library or accessed through its website.

NMP also has an active following on Facebook, Twitter, and Instagram. For instance, in August 2019, the NMP's Facebook account was being followed and viewed by more than 200,000 users. Information on upcoming, continuing, and completed activities, programs, and exhibitions of the museum are posted on its social media pages. Registration for museum activities and programs is also done online. Comments, suggestions, and recommendations posted on NMP's social media pages are collected, collated, reviewed, and considered for the next scheduled maintenance and upgrading of the exhibitions.

Challenges to staying relevant in changing times

NMP recognises that sustaining the museum and the national collections requires the support and engagement of partners from other cultural agencies, national and local governments and community groups, academia, students, researchers and specialists, and culture-bearers. But as Tse *et al.* (2018: 274) argued in their recent paper, a more balanced recognition of the inter-related contexts of people, objects, place, and time encompasses an inclusive and sustainable preventive approach to conservation applicable to the Philippines.

In 2011, NMP's new management allowed visitors to take photographs in galleries although it was previously forbidden. This move acknowledged the existence of digital cameras in handheld phones, as well as the growing power of social media. Museum visitors increasingly posted images of their museum visits on their social media pages, influencing others to also visit the NMP. NMP's challenges in marketing the museum and in encouraging more audiences to visit the museum were somewhat overcome through the museum's eventual popularity on social media and by word of mouth. As mentioned above, free admission also resulted in an increase in visitor numbers.

The NMP's next step is to go beyond the numbers and ensure that the quality of visits is also assured. Besides the programs listed previously, the staff are now focusing on developing education programs that would introduce school teachers to the idea of using NMP as an alternative classroom, and include NMP into the subjects' curricula. Based on NMP's survey, Filipino teachers preferred to assign their hired tour operators the task of taking their students around in museums, as they were afraid to lose their preeminent position should they fail to authoritatively answer their students' questions. To address this issue, NMP's Museum Services Division provided programs such as Science Orientation for teachers in 2018. Forthcoming are workshops on Social Science and Art Appreciation for teachers, using the collections and exhibitions of the NMP.

The main challenge for a national museum is to retool civil servants into becoming true public servants, and shift their "gears" towards making the museum relevant and as universally accessible as possible to its primarily Filipino audience. This is quite a task as the demographics of NMP's target visitors indicate that their income brackets are wide, and their educational backgrounds vary, along with different levels of learning capacities. Besides, a largely young population seems to be more demanding, as social media dictates more novel experiences.

While NMP's newer recruits seem eager, many of them have yet to acquire skills and the attention to detail required for management of exhibitions, research, and public programs. One weakness is their lack of communication proficiency, perhaps brought about by gaps in their education, or lack of confidence in expressing themselves. By contrast, older staff members are struggling to upgrade their capabilities despite the many workshops, training seminars, and other mentorship programs aimed at enabling them to contribute towards turning the museum into a heritage and leisure facility truly responsive to the needs of 21st century clients and stakeholders. We have included in our target audience the Filipinos living outside the Philippines.

This would require a culture change in staff members' attitude about working for the NMP, which involves promoting and preserving local heritage through the NMP's collections as larger than all of us. A sense of humility, fortitude, and diligence must be developed to underscore that the work at the museum is the management and staff's legacy to the next generation, and not about us. The NMP management hopes that the new law, once implemented will address that concern.

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Determining the Archaeological Collection

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ABSTRACT
An archaeology investigation comprises of multiple phases and processes. What are the decisions made at each stage of a project in creating the archaeological collection? From surveys, preliminary inspections, chance finds, evaluations, to large-scale rescue excavations, each segment of fieldwork will indubitably yield artifacts and other finds – what is the decision matrix for selecting items to record and collect? Beyond fieldwork during post-excavation procedures, the archaeologist is again faced with the conundrum of determining how the artifact assemblage is classified, cataloged, stored and archived. The decisions at each juncture in the field, the laboratory, and storage facility ultimately shape the archaeological collection's preservation for posterity. This paper examines the practices employed by archaeologists in Singapore and discusses future directions for assimilating the archaeological materials into a national collection.

Introduction

'Determining the archaeological collection' is an ambitious phrase to define. Ask any two archaeologists and one is likely to receive three different responses. Nonetheless an 'archaeological collection' is universally understood to be the assemblage of artifacts, ecofacts and other materials (such as soil, geological samples, and ecological specimens) recovered from an archaeological context. Defining how an archaeological collection is formed is as disparate as the varying organizations and entities involved with the acquisition and care of the artifacts. It may be an exercise highly regulated by collecting agencies and depositories, such as city museums, that serve as the legal depository for archaeological materials. Or where guidelines are lax or non-existent, it becomes the ethical responsibility, and often, whim, of the individual archaeologist managing the project.

Setting standards or guidelines on the recovery and collection of archaeological materials is crucial for archaeological work's multifarious processes – from preliminary planning to fieldwork, post-excavation and long-term storage. In other parts of the world, particularly in Western Europe, North America and East Asia, where archaeology as disciplines are long established, each stage of the archaeological process is typically undertaken by separate groups of professionals (field workers, laboratory assistants, conservators, archivists, collection managers etc.). This is not to propagate that all foreign institutions and organizations adhere to high standards of handling their archaeological collections. Archaeologists worldwide whether in advanced, developed countries or otherwise, are faced with the same concerns of funding and availability of resources to enable the execution of their work.

The United Kingdom has perhaps one of the more mature and developed archaeological infrastructures and frameworks in place, with multiple specialized professional bodies dedicated to a distinct aspect of the discipline. Foremost is the Chartered Institute for Archaeologists (CIfA), which serves as the leading professional body representing career archaeologists. The organization's members are professionally accredited and observe a rigorous code of conduct, undergo professional development schemes, and abide by a complaints procedure to uphold competence and standards in archaeology. Pertaining to archaeological collections, the CIfA establishes the *Standard and Guidance for the Collection, Documentation, Conservation and Research of Archaeological Materials* (CIfA 2014).

While CIfA addressed collection of archaeological materials on the ethical level, the Museum of London's *Archaeological Site Manual* (MOLAS 1994) is the standard field bible for archaeologists working on specific concerns for field collection of finds in the United Kingdom. It includes a section on 'General finds collection policy', which details guidelines on retrieval of various categories of archaeological remains. Beyond the field, there are several more nuanced and specialized interest groups and organizations dealing explicitly with archaeological collections in permanent storage and care, such as the Society for Museum Archaeologists (SMA) and the Archaeological Archives Forum (AAF). Both SMA and AAF represent archaeological professionals in collection management, and work on establishing standards and practices to be adopted by their members. The AAF publication *Archives: A Guide to Best Practice in Creation, Compilation, Transfer and Curation* sets the standards for collating the entirety of an archaeological archive, which includes not only the excavated artifacts, but also all documentary formats (photographs, drawings, plans etc.) created as part of the excavation record (Brown 2011). SMA periodically reviews and reports on the status of archaeological collections held in museums. SMA's *Archaeological Archives and Museums* monitors developments, progress, and highlights challenges and issues faced by these collections (Edwards 2012).

The organizational examples highlighted above certainly did not materialize overnight. The United Kingdom's archaeological ecosystem underwent over a century of evolution through a combination of interests and public debates from local grassroots-led historical societies, university archaeology departments, commercial archaeological firms, museums, local government councils, and national agencies (Schofield et. al. 2011). In contrast, archaeology as a discipline in Singapore is still very much in its infancy. Up to the mid 20th century, interest in archaeology was largely antiquarian, with collectors musing over the occasional chance finds associated with the island's past. Emphasis and perceptions by European archaeologists based at the Raffles Museum in Singapore then, was on a historically richer neighboring Malaya. Only in the final quarter of the last century was systematic archaeological investigation on the history of Singapore island initiated, through a ten-day excavation of Fort Canning in 1984. Since then, investigations have occurred more frequently, particularly for impact assessments and development-led excavations. Despite the 35 years of archaeological presence, the discipline remains dominated by a handful of trained archaeologists, and this limited number of individuals essentially drive all the related work in the country (Lim 2019).

Creating an archaeological collection is a diverse process and begins as soon as an anomaly in the ground is identified and the action of physically picking up an object has taken place. An item is deemed an artifact if it is manufactured or modified by human hands, and represents part of past human culture. A stone that has been worked or carved is an artifact; so is an unworked stone removed from its natural environment and transported miles away and set up as art installation or to line a garden path – as long as human intervention and thought is behind the modification of the object, it is objectified as an artifact. Most archaeological materials are collected through excavations and the process of retrieving the objects from the ground. However excavation alone does not make up the entirety of how an archaeological collection is assembled. Other phases in the investigation, from preliminary planning to post-excavation, contribute to the collection mantra. In the United Kingdom, these collection processes undergo many stages involving different archaeological specialists from inspectors on watch, field archaeologists, laboratory technicians, artifact specialists, material scientists, conservators, curators and archivists.

Evidently, Singapore does not have the multitude and diversity in specialist support as practiced in the United Kingdom. Here, the same small pool of archaeologists who work in the field, sees the artifacts through all the processes leading up to long-term storage. This does enable the streamlining of standards from the start of a project until the packing away of the finds. Singapore also benefits from the British corpus of established standards, guidelines, and best practices to model and adopt. The phases and processes presented here are the practices developed and employed by the author since 2006, and this methodology continues to be implemented at the Archaeology Unit in the ISEAS Yusof-Ishak Institute.

Expected and unexpected occurrences

This early phase typifies the identification of a potential archaeological reservoir or site, and this process may be deliberate by design, or by chance. Archaeology is the study of the human past through material culture. Broadly, any site or landscape with evidence of any past human activity or occupation will potentially yield archaeological remains. Many sites in Singapore are recognized for their historical value or architectural heritage traditions, with some preserved as National Monuments or awarded Conservation status. While these sites are accorded a level of protection for their historical and social significance, they are limited to above-ground architectural structures and features. It will be no surprise that these protected sites may also yield potential below-ground historical and archaeological remains. Aside from the preserved monuments or conserved sites, there are innumerable landscapes throughout the country with rich localized history that certainly enlarges the potential archaeological pool. This pool may be as diverse as an early 20th century school campus, a World War II battlefield site, or a prominent landmark in the neighborhood recognized by several generations of residents – or perhaps a site that encompasses all the three examples above.

Although infrequent, occasional chance finds do come to the attention of archaeologists. Chance finds are accidental occurrences where the public, during the course of their routine activities such as gardening, walking the dog, etc. uncovers artifacts. For example, in the 1990s, a bronze head of possibly a Buddha figurine was picked up on Punggol beach by a jogger. Chance finds also occur during development work by construction crews who alert the National Heritage Board or other government agencies that manage land assets (such as the National Parks Board or the Urban Redevelopment Authority). The discovery of a cache of Chinese stoneware jars at the old Parliament House during redevelopment which prompted a brief archaeological excavation in 2002 is one such instance (Miksic 2013).

Some of the chance finds by well-meaning individuals are eventually deposited with the archaeologists. In the earlier days of archaeology in Singapore, data collection surrounding the provenience and context of these finds are frequently inadequate. As these finds are uncovered fortuitously, these occasions are often fleeting, and the finder did not have at hand available tools for recording basic information – it is unlikely someone out walking the dog carried his 35mm film camera, map and note pad along for the outing. Over the past decade, circumstances have changed tremendously. The rise of ubiquitous mobile phone technology with built-in camera and global positioning satellite mapping functions, as well as note taking abilities, enabled a lot of detailed information surrounding the nature and location of the finds to be collected, least to mention the ease and pace of which these information are shared. Archaeologists certainly have better data and provenience of the finds, enhancing the interpretation and analysis for potential reservoirs. At present, the Archaeology Unit in ISEAS has implemented a basic recording process including artifact forms and tags when alerted of chance finds.

Archaeologists do not hold a monopoly on deliberate attempts at locating buried artifacts. There is also the growing number of metal detector hobbyists in the country whose activities and removal of artifacts do affect the below-ground cultural heritage environment. Currently, metal detecting at large operates within existing regulatory and legal framework in Singapore, and some enthusiasts embark on their pursuits to the extent of seeking permissions from landowners and tenants. Unfortunately, the finds by these hobbyists are not reported and their activities do impact archaeological reservoirs and sites. Most information pertaining to detectorists are obtained through often difficult to verify online forums, and other less opaque sources such as dealers in antiques/collectables, and pawnbrokerages, where some of the recovered finds are allegedly disposed. This is indubitably an area that needs further monitoring and possibly engagement.

Preliminary field investigations

Fieldwork and excavations are the mainstays of any archaeological endeavor. Archaeologists are often imagined excavating networks of trenches over vast tracts of land, removing mounds of dirt to reveal precious and valuable buried artifacts from lost civilizations. While such romantic visions do have some semblance of truth, however, before a project reaches the excavation phase, much preliminary fieldwork is conducted to identify and determine existing and potential pockets of archaeological remains. Such preliminary investigations or studies are in the form of inspections and surveys. Inspections are site visits to ascertain visually the nature of a site. These include pedestrian ground truthing, walking and examining the topography of the landscape, review of cartographic materials and aerial imaging through the employment of aerial reconnaissance drones. At this stage, it is a non-intrusive assessment of the site, and only surface finds are usually collected. Hence artifacts yielded from such investigations are few and frequently absent.

Surveys are the next step up the archaeological process. During surveys, the documentation, mapping and possibly shovel testing are undertaken. Shovel test pits allow a quick sub-surface probe to appraise the stratigraphic sequencing and seek out any archaeological pockets. As the name implies, a shallow excavation is dug with the aid of a shovel limited to the width and depth of the spade face. The number of shovel tests depends on the sampling strategy devised by the archaeologist. These may be entirely random and conducted where surface finds provide evidence of deposits, or depressions in the lay of the land suggesting past landscape transformations. It can also be systematic with gridded transect lines erected over the site and dug at arbitrary distanced intervals. Shovel testing generally collects 100% of all materials uncovered, in order to demonstrate existence of cultural materials and an archaeological reservoir. Collections are also made from any standing architectural remains and features, and surface finds. These artifacts enable the approximate spot dating and a preliminary chronological range of a site to be estimated. Consequently, this latter group of materials is selectively biased towards artifacts with diagnostics such as manufacturer's mark, identifiable typological or decorative motifs.

Excavations

The completion of the preliminary field inspections and surveys will determine the necessity for any additional archaeological intervention or mitigation. Should there be a successful identification of archaeological deposits and remains, excavations may then take place. Most excavations in Singapore are development-led, which are mitigation measures to identify and rescue as much archaeology data and materials from the threat of development. To which, two principle forms of excavations are practiced in Singapore: evaluations and large-scale rescue excavations.

Evaluations are small-scale excavations to assess the extent and significance of a site's archaeological deposits. It is typically undertaken as part of an impact assessment where future construction will occur. The test trenches employed are modest, and measure 1m x 1m or 1m x 2m, which enables statistical enlargement or reduction within the sampling strategy. The artifacts recovered serve as a preliminary interpretation of past cultural activities, and collection at this phase is more comprehensive with the large majority of artifact yields being bagged. The excavations are systematic and horizontally controlled by either stratigraphic layers or arbitrary levels. Some recent evaluations were done at the Singapore Art Museum (April 2018), which closed for the construction of a new annex and refurbishment, and at Fort Canning Park (July 2018–January 2019), where large-scale landscaping works and public access to the hill are underway.

Rescue excavations represent the epitome of the archaeological collection process. By this stage, sufficient pockets of archaeological deposits have been positively identified and require active intervention and mitigation to recover as much data and materials as possible, which will otherwise be lost to construction work. Rescue digs are planned around the construction and impact footprint. The excavation units vary considerably and are usually constrained by available time and resources. The National Gallery Singapore site (October 2010) employed units measuring 250cm x 200cm, while the Victoria Concert Hall site (September 2011) utilized 400cm x 400cm squares, and the excavations at Empress Place lawn (January-April 2015) were 500cm x 500cm in size. Next, the archaeologist will need to determine how to maintain a documentable relationship which the finds and archaeological context is found. Horizontal controls, or how to dig in a systematic and controlled fashion, essentially governs the collection of materials and corresponding data. This is achieved either by following the natural stratigraphic layers (the way the soil is deposited), or to dig arbitrarily through impositions of an artificial level by excavating at set depths, for instance of 5cm or 10cm per level. Consequently, horizontal controls for the excavations will affect how the artifacts and finds are collected and eventually inventoried and stored.

Contingent on the availability of field personnel, the project archaeologist decides the necessity for screening the excavated spoil through a system of mesh screens. Due to the urgency and pace of a rescue dig, screening or sieving enabled objects especially smaller items to be recovered. Screening is particularly effective for the retrieval of beads, glass fragments, coins, shell and faunal remains, metal work (e.g. fishing hooks, clasps, buckets, etc.) botanical remains and charcoal. Screens employed vary from ¼ inch (6mm) and ⅛ inch (3mm). Typically, for layers with undisturbed deposits, a 100% screening of finds are made, but there are circumstances where a reduced screening of spoil dirt have been made. This is statistically reflected as 50% (one in two buckets), 30% (one in three buckets), or 20% (one of five buckets) collection rates.

During both evaluations and rescue excavations, should personnel and time permit, finds are rudimentarily sorted into their material categories (ceramics, metal, glass, etc.) bagged and tagged according to the horizontal controls and excavated provenience. Otherwise, all artifacts are collectively bagged and set aside for processing off-site at a later date back at the office facility. Small unique finds such as coins, glass beads, rare items, or objects requiring special care and conservation are packed separately.

Over the last 15 years, between 2006 and 2019, development-led excavations dominated the field, accounting for 17 out of 19 archaeological projects. The pace and window of opportunity are extremely challenging and limited for these rescue projects are driven by the construction schedule (Lim 2016). While a systematic excavation plan was devised, none of the investigations achieved 100% coverage of the construction impact zones within the development sites. The excavation at the National Gallery Singapore site was restricted to the 1,260sqm car park located between the Supreme Court and Municipal Building. The excavations only amounted to 12.36% of this car park space, and did not include the other impacted areas within the sprawling compounds of the two buildings. Still, some 375kg of artifacts was recovered, but indubitably more were lost to the construction (Lim 2017). Nearby at the Victoria Concert Hall site, the 116sqm rescue excavation area represented only 9.61% of the 1,170sqm construction impact zone along Old Parliament Lane. This did not account for the other affected construction zones within the concert hall and theatre development. Despite the restricted areas excavated, about 654kg of artifacts was rescued (Lim 2018). The more recent 2015 Empress Place rescue excavation saw an approximate 2,273sqm impacted by redevelopment. Only 19.2% of the site was systematically excavated yielding approximately 3,000kg of finds; the rest of the site was unfortunately destroyed (Lim 2015).

Watching briefs

Not all development sites require extensive archaeological investigations or excavations. A watching brief is monitoring of work during the construction or development process. It involves an archaeologist conducting periodical inspection of the site during crucial phases of the construction (for example laying of foundations or earthworks). There is little interference by the archaeologist whose presence on-site is simply to mitigate the 'unknowns', serving in an advisory capacity to alert the developer should any important finds be uncovered during the construction. Watching briefs are usually determined as a precautionary measure. Processes involve documentation of soil stratigraphy, collection of soil samples and retrieval of any significant artifact remains. Over the past year, watching briefs have been conducted at Kampong Gelam, the Singapore Cricket Club, Fort Canning Park, Armenian Street, and Bukit Chandu.

Archaeological materials collected

Since 2006, guidelines developed by the author for the collection of artifacts and ecofacts in the field have been devised, and are presented briefly in the table below. The list is not exhaustive, but addresses the most frequently encountered material types in Singapore, and serves as an outline on what to collect and how much to collect.

Artifacts & ecofacts collected			
S/No.	**Artifact category**	**Collection**	**Remarks**
1.	Ceramic building materials (CBM) Brick Roof, wall and floor tiles	Items with diagnostics and a reference sample only.	Volume and weight record in field.
2.	Ceramics Pottery Vessels Ornamental	100%	-
3.	Glass Beads, Bangles Vessels Bottles	100%	-
4.	Glass (modern) Bottles body shards Pane	Sample only. Bulk finds not collected.	Volume and weight record in field.
5.	Metal Coins	100%	-
6.	Metal Buckles Cutlery Other household	100%	-
7.	Metal Tin cans Containers Nails (modern)	Sample only. Bulk finds not collected.	Volume and weight record in field.
8.	Metal scrap	Not collected.	Volume and weight record in field.
9.	Textile and leather	100%	-
10.	Faunal Bone Shell	100%	-

11.	<u>Floral</u> Seed Wood	Sample only.	Contingent on nature of item.
12.	<u>Charcoal</u>	Sample only.	Contingent on nature of item (e.g. hearth, midden, etc.).
13.	Plastics/synthetics	Sample only. Bulk finds not collected.	-
14.	<u>Other building materials</u> Concrete Plaster Masonry (granite, marble etc)	Items with diagnostics and a reference sample only.	Volume and weight record in field.
15.	Worked stone	100%	-
16.	Other geologicals	Sample only.	Volume and weight record in field.
17.	Soil samples	Sample only.	-

Traditionally, archaeologists focus on recovering deposits from an undisturbed context that will permit the analysis and interpretation of the site's past activities and functions. Archaeologists typically collect 100% of the finds from such in-situ deposits. However in a highly urbanized environment such as Singapore, large volumes of materials with little diagnostic features are frequently encountered, such as roof, floor and bathroom tiles, bricks, scrap metal, nails, and pane window glass. These common non-diagnostic bulk finds are not collected. Similarly, artifacts identified as modern and deposited in well-defined contemporary construction fills may also be exempted from the collection process. A small sample is retained for reference, unless the artifact serves as useful chronological markers or features unique analytical elements, while the bulk finds are described, measured, weighed and recorded into field notes (excavation forms or field journals), and disposed.

Classification, sorting and inventory

At the completion of the fieldwork, all recovered materials are transported to the processing facility and office for post-excavation work. Here, the archaeological assemblage is cleaned, washed, sorted and classified as part of the lengthy and tedious inventorying process (Lim et. al. 2017). Non-dialogistic bulk finds, such as ceramic building materials and other undesired items like asbestos and cement debris etc., undoubtedly still find their way into the assemblage. These items are not processed further, but are duly recorded, removed from the collection and discarded. For the purpose of simplifying the subsequent discussion, this paper shall limit the illustration of the post-excavation phase to the ceramic finds as a broad representation on the processing of archaeological materials in Singapore.

Ceramics make up the majority of archaeological finds from Singapore. For example, at the Victoria Concert Hall site, 85% (totaling 382kg) of the artifacts are ceramics from the pre-modern medieval period (Lim 2018). Therefore it is not surprising that compared with the other artifacts, archaeologists have developed a more nuanced sorting and classification protocols for this class of materials. Inevitably, as a large proportion of ceramics recovered from Singapore sites date back to the pre-modern port settlement (c.1300s-1600s), archaeological researchers over the past three decades have demonstrated much partiality towards ceramics as their main focus and study to understand early life and trade prior to the arrival of European colonization. Ceramics are sorted into a combination of production types, and functions as an identification class, followed by distinct typologies and vessel parts.

<table>
<tr><th colspan="4">Sorting and classification for ceramic artifacts</th></tr>
<tr><th>S/No.</th><th>Ceramic class</th><th>Ceramic type</th><th>Vessel part</th></tr>
<tr><td>1.</td><td>Porcelain</td><td>Whiteware.
Blue and White.</td><td rowspan="4">Rim,
Neck,
Shoulder,
Carination,
Body,
Base,
Profile,
Lid,
Spout,
Handle,
Lug,
Ornamental,
Token.</td></tr>
<tr><td>2.</td><td>Stoneware</td><td>Greenware.
Storage.
European.</td></tr>
<tr><td>3.</td><td>Earthenware</td><td>Fine paste.
Tempered.</td></tr>
<tr><td>4.</td><td>White earthenware</td><td>European.
Japanese.</td></tr>
<tr><td>5.</td><td>Ceramic building materials (CBM)</td><td>Bricks, roof tiles, wall tiles, floor tiles, architectural fixtures, bathroom fittings.</td><td>-</td></tr>
</table>

The classification of the ceramic artifacts relies on existing technological and art historical observations, and is augmented by ceramic data from past archaeological excavations in Singapore and elsewhere. The ceramic classes are determined from the firing production's extent of sintering and vitrification of the wares: porcelain fired at highest temperature from 1,200 degrees Celsius; stoneware from 1,000 degrees Celsius; and earthenware between 800 and 900 degrees Celsius. A basic typology is next formulated, and the ceramics are visually sorted into different wares. The sherds are then identified into part(s) of the vessel they represent: rim, neck, shoulder, carination, body, lug, body, base, profile, handle, lid, token, etc. This is further sorted to reflect if the item is glazed and decorated (painted, printed, stamped, etc.). The only exception applies to ceramic building materials, which are identified by their function rather than production technology. The items are subsequently counted, weighed and packed into bags with a maximum capacity of 10 sherds. Bags are stored according to the provenience of the find by excavation unit and stratigraphic depth (horizontal control). Beyond the sorting and classification system, work is underway to mark and label the artifacts, each with a unique identification number to create an inventory for collection management. In the near future, an electronic database is planned to catalog these finds.

Conservation of finds

Archaeological conservation is a very different subset from current museum-centric conservation practices in Singapore. Archaeological artifacts possess a distinctive set of challenges, and the immediate issues are emergency treatment to arrest and stabilize the decay of the finds once removed from a relatively stable buried environment. Metals and organic materials are items that require most urgent attention, and irrefutably will continue to deteriorate over time. Adequate storage of such finds is challenging for these materials, particularly corroding metal objects. Presently, only rudimentary measures and facilities that address basic housekeeping, pest control, and periodic monitoring, are in place. Aside from the metals and organics that require further care, fortunately, the bulk of the archaeological collection composing of ceramics are generally passive once cleaned and stored in a stable environment.

Special attention should be drawn to a small but growing collection of waterlogged materials. Several pre-modern wooden planks and stakes have been recovered from the Empress Place site in 2015. These well-preserved timber frames were found beneath the water table and were carefully recorded and extracted. The planks with lugs and dowels demonstrate evidence of medieval Southeast Asian shipbuilding knowledge, and may have been recycled timber from a hull of a boat (Lim 2016). Radiocarbon dating of one sample yielded a late 13th century date, and the ecofact was certainly worked sometime during the 14th century, when Singapore was an active port settlement. These wooden planks, some as large as 75cm in length, have been kept submerged in tanks of water and kept out of sunlight with a monthly change of fresh tap water. The planks and stakes are an important ecofact of pre-modern Singapore's maritime heritage, and are retained for potential future analysis. Long-term preservation expertise and assistance is urgently needed, and help is required for the removal of water and replacement of the damaged cellulose structure with conservation polymers.

Another category of waterlogged objects is finds from a marine environment. These artifacts require a long period of desalination to reduce and stabilize the level of absorbed salinity, as well as removal of marine encrustations. Currently, the desalination process of these archaeological materials is still ongoing. While professional advice has been sought from leading specialists and archaeological conservators in the United Kingdom (Museum of London, Norwich Museum, Heritage England, and Institute of Archaeology University College London), the long-term care and storage of these waterlogged items represents a challenge for the archaeologists, and adequate local resources are sought.

Summary of decision points and recommendations

Illustrated briefly above are key decision points faced by the archaeologist that will inevitably affect and determine the volume and nature of the archaeological collection. The two underlying considerations in the field are how much to collect and what to collect. Off-site and back in the processing facility, the archaeologist is confronted with how to segregate, conserve and store the collection. The table below summarizes the crucial points and considerations outlined in this paper.

Summary			
S/No.	**Event**	**Decision point**	**Considerations**
1.	Chance finds	Collected/reported specimens	All items surrendered by finder
2.	Inspection	Sample area	How large
		Surface collection	Percentage to collect
3.	Survey	Sample area	How large
		Surface collection	Percentage to collect
		No. of shovel test pits	Percentage to collect
4.	Evaluation	Sample area	How large
		Size of test units	How large
		No. of test units	What to collect. Percentage to collect.
		Horizontal controls	Excavation strategy by arbitrary or stratigraphic layers

5.	Rescue excavation	Size of impact zone	How large
		Size of excavation units	How large
		No. of excavation units	What to collect. Percentage to collect.
		Horizontal controls	Excavation strategy by arbitrary or stratigraphic layers
		Screen of spoil	Percentage to screen
		Non-diagnostic bulk finds	Recorded but not collected in bulk are CBM, plane glass, scrap metal, geological etc.
		Collection of soil samples	Percentage to collect
		Elimination of undesirable items	Exclude modern/contemporary synthetics such as plastic cling wrap, drinking straws and hazardous materials (asbestos)
6.	Post-excavation	Classification and sorting	How to distribute
		Inventory marking	On items > 2cm, tagging for metals and rare materials
		Conservation	What is selected
		Packing and sorting	How to distribute

One of the more immediate assistance required by archaeologists in Singapore is support for field conservation, and the stabilization and treatment of finds. Conservation support is also needed for long-term monitoring and care, specifically in the areas of metal, organic, and waterlogged materials. An initiative that could potentially leverage on the existing conservation facilities of the National Heritage Board for collection condition checks, advisory, and fundamental training practicums on artifact handling and treatment, would be beneficial for archaeologists.

The archaeological collection in Singapore is modestly growing with each new investigation. Presently this archive is distributed and under the care of several institutions, with the two largest custodians being the Archaeology Unit in ISEAS, and the Department of Southeast Asian Studies, National University of Singapore. Smaller collections can be found with the National Parks Board, Sentosa Development Corporation, the National Museum of Singapore, and elsewhere. The care and long-term maintenance of these materials are certainly of concern. The collections under the custodianship of these organizations are currently the result of well-meaning personalities and management who are sympathetic for their retention. However their fates beyond the immediate future is uncertain, for managers change and individuals have their attention called to other areas – empathy alone is not a permanent solution. Over the years, there were members of management or policy committees who thought best to discard the collections rather than preserve and archive them (Lim et. al. 2017). Ultimately, the creation of a centralized depository to bring together the disparate collections in Singapore by a national agency such as the National Heritage Board is most ideal and should be given serious consideration. This depository should not be a mere storage facility and needs to be staffed by professional archaeologists or archaeologically trained personnel to ensure that aside from their care and long-term preservation, analysis and research data can be generated from the collection.

Author's biography

Lim Chen Sian is an Associate Fellow at the Archaeology Unit, ISEAS-Yusof Ishak Institute, Singapore. He is a historical archaeologist interested in the transitional period between pre- and post-European contact in Southeast Asia and the development of port settlements, military fortifications, and the material culture of trade. He has been involved in Singapore archaeology since 2002. As of 2006, he has led all major archaeological investigations in the country, and works extensively on lobbying for legislative changes pertaining to the necessity for impact assessments, protection of archaeological sites, and artifact ownership.

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Experience in the Preservation of Documents and Objects at Ho Chi Minh's Working and Living Spaces in the Presidential Palace Compound

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ABSTRACT
The late President Ho Chi Minh's working and living spaces in the Presidential Palace compound are a precious historical and cultural heritage of Vietnam. It was where the beloved leader of the Vietnamese nation lived and worked during the last 15 years of his life (1954-1969). From this space, he led the Vietnamese people to overcome difficulties by successfully implementing two important revolutionary tasks: building up the socialist North, and fighting for the liberation of the South. A system of vestiges and materials exists in the presidential palace compound and is divided into three categories: real estate vestiges, movable vestiges, and landscape environment. 160 original documents and objects, or movable vestiges, are currently being displayed. Although many of these documents and objects are replicas, they are displayed at the same position like the time when the late President was still alive, because these replicas have contributed greatly to the research and promotion of propaganda and education about the late President. Hence, they are preserved as original documents and objects. As preservation work is carried out in the vestiges area there needs to be a balance between carrying out preservation work, as well as continuing to promote daily receiving and propagating to visitors. The objects and documents displayed at the Presidential Palace are constantly subjected to direct pressures from the environment, as well as the indirect effects of human activities, hence are at risk of being damaged. This paper shall cover the preventive and restorative methods that are being used to preserve the integrity of the documents and objects in the late President's living and working spaces in the Presidential Palace compound. Future plans to enhance the preservation works shall also be presented.

Historical and cultural value

The late President's living and working spaces in the Presidential Palace compound are where he lived and worked during the last 15 years of his life (12/1954-9/1969). During those 15 years, the late President, the government, and the Party Central Committee set out the right guidelines and strategies for the Vietnamese revolution and the people by conducting two strategic tasks: building the socialist North and fighting for the liberation of the South. These tasks positively contributed to national independence, democracy, peace, and social progress.

The compound is a special national monument that carries great historical, political, and cultural significance. Every year, it attracts millions of domestic and foreign visitors who visit, study, and express their admiration for a great leader who had a profound influence on Vietnam's history and the movement for independence of oppressed people in the world in the 20th century.

Among the memorial monuments across the country dedicated to the late President, the living and working spaces in the Presidential Palace compound are the only original monuments, showing moral example of the great leader who devoted his life to the country, the people, and the progress of humanity in the world. It is considered the channel to propagate the Party's and State's lines and policies, and promoting the image of the country and people of Vietnam to international friends. At the same time, it also acts as a friendship bridge, contributing to international cooperation efforts and the building of a peaceful, stable, and cooperative environment for national development.

The Presidential Palace compound is system of real estate, movable property, and environment containing thousands of documents and objects associated with the activities and daily life of the late President. The compound includes the following major monuments:

- Presidential Palace: Where the late President used to work (his office).
- House 54: His living place from 1954-1958.
- Car garage.
- House on stilts: His living place from 1958-1969.
- House 67: The place where he died.

Figure 1. The Presidential Palace.

Figure 2. House 54, where the late President lived from 1954 to 1958.

Figure 3. House 54.

Figure 4. *Car garage.*

Figure 5. *House on stilts, where the late President lived from 1958 to 1969.*

Figure 6. The basement of the house on stilts.

Figure 7. The late President's working room, on the upper floor of the house on stilts.

Figure 8. House 67, where the late President passed away.

Figure 9. Inside House 67.

All relics, documents, and objects belonging to the late President were preserved and kept intact. Right after his death, the work of protecting and preserving the monuments and exhibits in the compound was defined as the most important task. The preservation of documents and objects must comply with the principles to maintain the same status, so that they are not changed, deformed, corrupted, or deteriorated over time. It was also essential to protect the living and working spaces in the strictest way so as to preserve them. This was a big challenge that the officials and employees who worked here wanted to solve.

Preservation of documents and objects

Current status of documents and objects at the compound

1,340 original documents and objects had been found in the late President's living and working spaces after Ho Chi Minh died in 1969. By 1982, an additional 2,304 kitchen relics had been found. These original documents and objects are testimonies to the events, historical phenomena, and activities of the late President during the time he lived and worked here. Therefore, such documents and objects strongly stir deep feelings in visitors. It is also the basis of scientific research and propaganda - Ho Chi Minh's living and working space in the Presidential Palace compound.

However, due to the requirement for a long-term preservation, most of these original items were put into storage at Ho Chi Minh Museum's storehouse. The items have been preserved using modern equipments and following very strict regimes that are suitable for each type and kind of material. Some of the original items were then replaced with replicas. Currently, only 746 exhibits are on display at the Presidential Palace compound.

Among the documents and objects exhibited at the compound, 160 are originals. Although many of the documents and objects being displayed are replicas, these items have contributed greatly to the research and promotion of multi-faceted propaganda and education about President Ho Chi Minh. Hence, our preservators are preserving them as original documents and objects.

Difficulties in preservation

Unlike storage in museums, where items are arranged according to materials, and left in different storage rooms with appropriate scientific and technical facilities, the documents and objects displayed at the compound have not been separated in a similar way, even though they are made of different materials. Furthermore, the compound is open daily to serve a large number of visitors, making it a completely opened storehouse. Some monuments that are fully opened to the public, including the house on stilts and House 67, cannot be fitted with preventive equipment such as air conditioners, dehumidifiers, automatic control and monitoring systems, etc. The documents and objects displayed in these monuments are subjected to the direct impact of harsh climate and heavy rain in a low land of ponds and lakes, a lot of trees, high humidity, many kinds of insects, harmful organisms, etc.

In addition, the funds allocated to the renovation and preservation of these monuments, documents, and objects are very limited, making preservation and restoration difficult.

The number of people well-trained in preservation methods is limited. They are not yet fluent in foreign languages, making it difficult to access the advanced preservation technologies practiced in museums in the region and around the world.

All of these difficulties pose great challenges for managers and those who are directly involved in preservation work in Vietnam.

Main preservation methods

Preventive preservation

Preventive preservation is a method of preservation that ensures documents and objects are stored, displayed, or transported without damage or degradation to the extent that repair is required. Preventive preservation, if done scientifically and planned well, can contribute significantly to the preservation of artefacts.

Ensure air, temperature, humidity and light in environment are suitable

Removing dirt

Maintenance staff dust and wipe the surface of the documents and objects with a soft cloth daily. As dusty documents and objects must be cleaned regularly, cleaning might cause damage, so some documents and exhibits are protected by mica boxes to minimise the impact of dust, dirt, and insect attacks. At noonbreak, windows, doors, and sun blinds are closed or rolled down. In addition, the maintenance of the ceiling, and the cleaning of the trough and the roof of the houses, is done once a week to limit the artefacts' exposure to dust and dirt. When heads of state and high-ranking delegations from other countries visit the upper floor of the house on stilts, they are required to wear canvas shoes to reduce the objects' exposure to dirt, and to avoid scratching the floor.

Ensuring proper lighting

For relics such as House 67 and the house on stilts, preservators used simple measures, such as reducing the brightness of light bulbs at closing time, and closing the windows and doors, to prevent the documents and objects from discolouring or deforming under the influence of light.

During normal hours, lighting is adjusted so that it meets the preservation needs of the objects (to be kept in complete darkness) and the needs of the visitors (to see the objects clearly with enough light). Therefore, after visitors have left, the lights will be switched off, and windows and doors closed or shuttered to maintain indoor light vibrancy of between 50 Lux and 200 Lux.

Controlling temperature and humidity

The buildings in Ho Chi Minh's living and working space in the compound are affected by the surrounding environment's relatively high humidity. Condensation happens easily on these old monuments.

In 1999, dry gas technology was introduced, and a Munters device was installed in closed buildings or rooms, such as House 54, the car garage, and the Politburo meeting room.

The Munters device is an advanced technology that has been used quite extensively in industrialised countries. The device operates based on the principle of moisture exchange, to create a preservation environment similar to the inherent living environment of the objects. It performs moisture exchange between the environment and the indoor conditions, using dry and adaptive processes to maintain proper moisture levels of 50% RH.

Dehumidification was also done using the Munters equipment, based on the principle of using hygroscopic materials, which does not cause "frosting", and does not affect the state of the artefacts. At the same time, this device allows temperature changes to take place at a low frequency, thereby avoiding potential negative impacts caused by sudden temperature changes.

The Munters device can be turned on and off automatically according to the environmental humidity quite accurately. The operation and maintenance of the device is also simple and convenient.

In 2011, a Supervisory Control and Data Acquisition (SCADA) monitoring system was installed at the living and working spaces to automatically control the temperature and humidity in closed monuments such as House 54, the Politburo meeting house, car garage, medical equipment showroom, and kitchen.

The system is a software interface program that can perform data collection, parameter monitoring, and actuator control functions for the entire circuit of closed monuments. The program is written on Win CCv7 platform, a famous Siemens tool specialised in creating human-machine interface (HMI) applications which is widely used in industries related to automation.

Thanks to this monitoring system, the air environment in the monuments is maintained in the standardised mode. The modern technical system is highly reliable and specific indicators for temperature and humidity were set within the following range:

- Temperature within the permitted range of 18^0 C to 25^0 C
- Relative humidity within the permitted range: 55% (+ -5%)

Through the automatic control monitoring system, technicians could monitor and adjust the temperature, humidity compatible with the external environment. This monitoring system can even store statistics, analyse data, and report them to the centre.

However, this system can only be installed at the closed monuments mentioned above, so this technology cannot be applied to opened monuments such as the house on stilts and House 67. We had to apply normal preservation methods for the house on stilts and House 67.

Figure 10. The monitoring system.

Dealing with insects and pests

The Presidential Palace is located in a wooded area (previously a botanical garden, so many tall trees obscure sunlight, causing high humidity in the area). Therefore, it is an ideal environment for insects and pests to multiply, especially termites, ants, and cockroaches.

Among the harmful insects found here, termites are the biggest risk to preservation of the documents and objects, which are mostly made of materials such as cellulose, wood, and fabrics that are susceptible and attractive to termites. Documents and objects have been quite old so they are easily attacked by termites. Therefore, it is necessary to visually check for termites regularly.

In recent years, the palace compound has collaborated with Vietnam Sterilisation Company to implement termite control measures using advanced US technology that is not harmful to the environment and humans. Termite control measures are implemented regularly to prevent them from attacking buildings, old trees and ground areas and damaging the documents and objects.

Staffs also clean the objects daily to rid them of insects, rodents, and mould.

Dealing with natural disasters

During the rainy season, preventive measures such as pruning the branches of big trees around the monuments, especially the opened monuments, are taken to prevent the weather from affecting the relics. Sun blinds are rolled down and to avoid the rain and wind from affecting the monuments' wooden floors and pillars.

Dealing with fire

In order to prevent fires, visitors are not allowed to smoke in the area near the monuments, especially the house on stilts, under strict supervision of the security team. Fire alarms, fire resistant equipment, and fire extinguishers have also been installed. The outdoor area is installed with water sockets, with fire extinguishers placed next to them. High pressure pumps have also been installed. In order to carry out fire prevention work well, a fire prevention and fighting committee was established, consisting of members of the bureaus of the palace compound. Every year, we also work closely with the fire protection police force in the area to hold training for the whole commitee. At least once every two or three years, we coordinate with Ba Dinh District's Fireman Department to train firefighters, and regularly check water hydrants and fire extinguishers to ensure that they would work well when needed.

Dealing with vandalism

The Presidential Palace compound is located in the central administrative complex, where the highest authorities of Vietnam (including the national assembly, government, and Party's Central Committee) are concentrated, so this place is of high political significance. As a result, the complex may also be the target of troublemakers and anti-state fighters, so protection and preservation work that prevents such acts of sabotage is the top priority.

The authorities work closely with relevant agencies such as the State Office, the Government Office, the Guard Command, and the Management Board of Ho Chi Minh Mausoleum, to be ready to respond to any such situations that may occur. The compound has also been equipped with radios and cameras, and security stops and machines for monitoring people and bags going in and out of the area.

Restorative preservation

Although all precautionary measures have been applied, the artefacts can still be damaged as the monuments are open to visitors 365 days a year, including stormy days. Over time, sun blinds have been stained and torn, lights have been broken, and patterns on the glass windows have become brittle and peeled off. Books, newspapers, and newsletters on the tables and bookshelves have also been tarnished and torn.

In order to restore these artefacts, the preservation team had to carry out restorative preservation while complying with the following principles:

- Restoration must be based on actual experience.
- Restoration must not change the original characteristics, such as shape, size, information, and aesthetics, of the documents and objects.

The preservation team has since restored some documents and objects using cloth, paper, and carpentry techniques. The team utilised different methods according to the specific material used, but all methods had to comply with the above-mentioned principles.

Torn fabrics were stitched up and keep the original characteristics of the artefact as much as possible. If an artefact had been broken, it must be restored using the right material, colour, and size as the original.

For rattan objects that were punctured, flaky, or cracked, restoration was made using materials of similar shape, colour, and size.

The compound has been preserved according to short-term, long-term, and anti-degradation preservation regimes. This is a difficult job that requires high technical expertise and regular innovation. We have implemented a timely repair and restoration plan with a consistent view to always choose small repairs, if that is enough, prioritise saving the artefacts in their original states, and avoid changes or distortions to the artefacts. Annual maintenance and restoration is also being carried out as planned. In the process of repair and restoration, the preservation department assigns scientific personnel to monitor, regularly follow up on, supervise, and record each case in a logbook.

Solutions to improve preservation work

The preservation of documents and objects in these living and working spaces has seen many remarkable achievements in recent years, preserving the priceless heritage that the late President Ho Chi Minh left for future generations. To further improve, and especially to catch up with developments in preservation work in museums and monuments in other parts of the world, much more needs to be done, specifically:

1. Investing in equipment and facilities needed for preservation work, giving priority to the application of scientific and technical advances in the preservation of documents and objects.
2. Actively mobilising the help and support of professional agencies on relic preservation, and promote cooperation and exchange of experience in the preservation of monuments with museums in and out of the country.
3. Improving the professional qualifications of staff doing preservation work by training them further. These staff should have a deep expertise in specific areas of preservation, including preservation techniques for each material, repair or restoration techniques, etc. Staffs also need to be proficient in informatics and foreign languages to be able to stay updated on information and technical advances of the countries around the world.
4. Implementing a plan to restore and replicate the books, newspapers, and newsletters in case the original ones are damaged or lost or needed to preserved in the storage with the best preserving conditions.

Conclusion

We can say that we have effectively preserved the monuments, documents, and objects at the late President Ho Chi Minh's working and living spaces. In doing so, visitors are able to feel Uncle Ho's presence. Every house, object, and tree still retains his warmth and presence. To date, more than 70 million visitors have seen these spaces and paid tribute to the late President. With the above achievements, it can be said that preservation of this relic site has contributed significantly to the course of preserving and embellishing the cultural and historical heritage of the country.

Author's biography

Le Thi Thanh Loan graduated from Hanoi University of Foreign Studies and Ho Chi Minh National Academy of Politics and Administration. She has been a member of the Propaganda and Education Bureau of Ho Chi Minh's vestiges in the Presidential Palace area for 12 years. Her work includes introducing visitors to the historical values of the vestiges in the area as well as the late Ho Chi Minh's activities during his 15 years living there. The vestiges are of great historical and cultural importance to the nation, and receive about 3 million visitors from inside and outside Vietnam every year. She enjoys her work and has opportunities to meet people and statesmen from many countries, who share the same admiration for the late President Ho as the great father of the nation by Vietnamese as well as peace-loving people all over the world.

Conservation of a Large Ambrotype (Collodion Positive) Portrait by Woodbury & Page: A Case Study

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KEYWORDS
collodion positive, ambrotype, Woodbury & Page, cover glass, image glass

ABSTRACT
The subject of this case study is the conservation of a collodion positive portrait of Hamengkubuwono VI, who was the sultan of Yogyakarta (reign 1855-1877). It was produced circa 1857-1858 by the photography studio Woodbury & Page. Walter Bentley Woodbury (1834–1885) and James Page (1833–1865) were itinerant photographers who were born in England but met in Beechworth, Australia, eventually establishing their studio in the Dutch East Indies (now Indonesia) in 1857. They became one of the most important studios in 19th century Southeast Asia, creating portraits of many prominent people.

With the arrival of early photography in Southeast Asia, daguerreotypes and collodion positives played an important role in documenting both the landscape and the people. Collodion positives, commonly known as ambrotypes, are photographic images on glass supports that were popular between 1850 and 1880, particularly for capturing portraits.

This portrait was part of a large photograph collection that was on display at the *Amek Gambar: Taking Pictures - Peranakan and Photography* exhibition at the Asian Civilisations Museum, Singapore, in 2018. It was considered to be one of the most significant early pieces dated in 19th century planned for exhibition rotation. During pre-exhibition examination, the artefact's original window mat and the backing of the ambrotype were noted to have been damaged. The seal around the edges of the ambrotype was also inadequate, which compromised the structure. Therefore, conservation of the housing was necessary.

The ambrotype was disassembled and documented. The cover and image glass were cleaned, and the degraded backing board was replaced with a museum-quality board. The original "Woodbury & Page – Photographic Artist" label was transferred to the new backing board, and the ambrotype was resealed and framed back into its original frame.

This historically important artefact belongs to the collection of Mr and Mrs Lee Kip Lee.

Steven Wachlin, *Woodbury & Page Photographers Java* (Leiden: KITLV press, 1994), 11.[1]

Steven Wachlin, *Woodbury & Page Photographers Java* (Leiden: KITLV press, 1994), 15.[2]

Historical background

The ambrotype portrait of Hamengkubuwono VI in the collection of Mr and Mrs Lee Kip Lee carries great historical significance because it is an image of the sultan. It also has a high intrinsic value as it is one of very few surviving ambrotypes of this large plate size from the Woodbury & Page studio (Fig. 1). Under the ownership of Woodbury & Page, the studio was in existence in the Dutch East Indies from 1857 to 1864, when it was sold. The new owners maintained the name of the studio until it closed in the early 20th century. Prior to his business venture in Java, Woodbury was employed as "the best glass artist" by photographer Perez Batchelder in Melbourne , but he is perhaps best well known for the invention of the Woodburytype process, together with Joseph Wilson Swan, in 1864. Though the Woodbury & Page studio was not the first photographic studio to be established in Southeast Asia, it became one of the most successful.

The ambrotype of Sultan Hamengkubuwono VI was produced during Woodbury & Page's early establishment in Java, in the early years of the Sultan's reign. The royal family was noted to have their own official photographers in the 1860s. However, Woodbury & Page also produced an ambrotype of the sultan's consort, Ratu Kencana during that period. It is not known if written records about the ownership of this pair of ambrotypes exist. In addition to these portraits, a stereoscopic glass plate produced by the studio, which shows a slightly different exposure than the ambrotype, was also likely done around the same time (Fig. 2).

The biographical literature on Walter Woodbury references his writings, which includes the following: "to the eastward of Java to Samarang, a Dutch settlement about 900 miles from here, from there we shall visit the Princes Lands where all the native princes live..."[2] Yogyakarta was referred to as Princes Land.

Fig. 1. Before treatment: ambrotype of Sultan Hamengkubuwono VI (Courtesy of Mr and Mrs Lee Kip Lee).

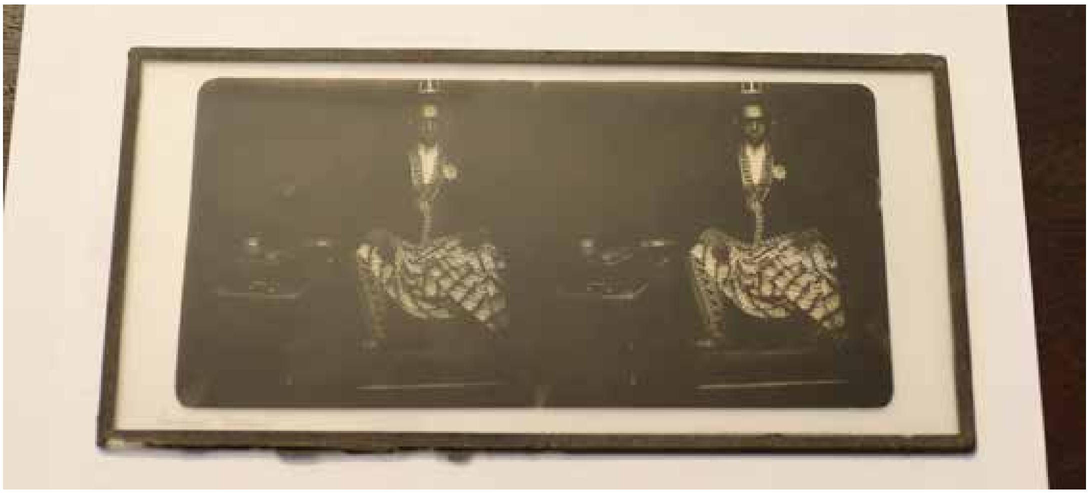


Fig. 2. Stereoscopic plate of Sultan Hamengkubuwono VI by Woodbury & Page (Courtesy of Mr and Mrs Lee Kip Lee).

[3] Susie Clark, "The Conservation of Wet Collodion Positives," *Studies in Conservation*, Vol. 43, No. 4 (1998): 231.

[4] Jens Gold, *The Ambrotype/Wet Collodion Positives on Glass: Treatment Challenges on Complex Nineteenth-Century Photographic Objects* (Norway: Preus Museum, 2018), 49.

The ambrotype of Sultan Hamengkubuwono VI

The wet collodion process, invented by Frederick Scott Archer, refers to production of both wet collodion negatives and collodion positives. He first published his findings of using collodion on glass support in 1851. After capturing and fixing of the image, the ambrotype and the wet collodion negative were negative images when placed on a white background. However, when both are placed on a black background, they become positive images as the collodion colour was much lighter in tone. Collodion positives are commonly known as ambrotypes, whereas the black background is usually black lacquer painted onto glass, or a piece of black paper or cloth installed in the frame behind the image. Ambrotypes were commonly presented either inside a case, or framed with an often ornate mat.

"…The first used a folding, velvet lined case, covered in leather, cloth, paper or sometimes thermoplastic resin…The plate, a gilt mount and a cover glass were held together by a bent strip of decorative metal foil, known as the 'preserver'…The other method of presenting wet collodion positives, commonly employed for larger plates, was in a 'passe-partout'. These bindings typically consisted of a painted cover glass with various painted paper and board mounts between the cover glass and the photographic plate. Behind the photographic plate is a pulp-board backing and the binding is sealed with paper. These passe-partouts are usually presented in frames, rather than cases."[1]

The dimensions of the Sultan Hamengkubuwono VI ambrotype are 32.5cm (H) x 25.7cm (W) x 0.2cm (T) (12 ¾ in. x 10 1/8 in.), which is considered a large plate. It is in a frame which is more in keeping with the European tradition. The ambrotype also closely matches the established oversized plate format of European 19th century image plate sizes[2]. It is known that Woodbury & Page had established contacts with photographic suppliers in Europe.

The housing style of this ambrotype, however, differs from the typical European decorative design. This ambrotype has a simple gold paper window mat, in contrast with the more decorative and thicker paper or brass mats usually found in cased and framed ambrotypes in Europe and America. The gold on this window mat matches the decorative frame. The picture frame itself is gilded and ornate – very much in line with 19th century European design.

The original label advertising the photography studio was produced by Wiemans lithography, and was still attached to the original backing during condition assessment. It reads "Woodbury & Page, Photographic Artists. Portraits, Stereoscopes and Views on Glass and Paper" (Fig. 3). Besides producing fine quality photographic prints, it appears that the studio was also very attentive to their label design, which remained artistic throughout the firm's existence.

Condition and proposed treatments

The objective of this project was to provide long term preservation for the ambrotype by keeping it in safe housing while preserving its original look as much as possible. The window mat and gilded frame were found to be original and dating back to the 1860s. They appear to be consistent to this period in terms of materials and design.

During condition assessment, the artefact was kept separate from its frame. The structure of the seal was not stable as the sealing paper had lifted along the sides from the ambrotype package. Sealing appeared inadequate as the corners were not fully covered. The image glass was also noted to be slightly smaller than the cover glass. The original paper window mat was sandwiched between the cover glass and image glass, and was damaged, with torn edges projecting into the image area. A loss at the bottom right corner of the window mat had previously been repaired. However, the repair was inappropriate because the weight of the repair paper was heavier than the original window mat, and did not match the colour of the original well. The backing board was degraded and encrustations were noted on its inner side. The black paper at the back had also severely degraded.

The collodion positive image was in relatively good condition. Some scattered irregular-sized black spots and faint cloudiness in the background areas were noted. These blemishes are quite possibly inherent to the processing steps during the production of the ambrotype. The hand-applied gold and coloured pigments was noted on the surface of image and are discussed in detail below.

Based on the needs of the ambrotype, the following treatment steps were proposed:

- Assess and document the ambrotype.
- Disassemble the plates.
- Remove the tape residue from the cover glass.
- Clean the cover glass and collodion positive.
- Repair the original paper window mat.
- Compensate for different plate sizes during resealing.
- Assemble and seal the cover glass, collodion positive, and cardboard backing.
- Frame back the ambrotype in its original frame.
- Add final backing for extra protection.

Fig. 3. Original "Woodbury & Page" label (Courtesy of Mr and Mrs Lee Kip Lee).

[5] Ian Moor, "The Ambrotype-Research into Its Restoration and Conservation-Part 2," *The Paper Conservator*, 2:1 (2010): 36-43,, https://doi.org/10.1080/03094227.1977.9638496.

Observations

Single and double glass process

There are various types of glass processes for ambrotypes, with both the single and double glass processes being common[5]. The Sultan Hamengkubuwono VI ambrotype was produced using the single glass process, whereby black varnish is applied on the collodion image. The image was reversed and viewed through the glass side. Constituents such as hand colouring media and varnish were applied on the same image side. However, the addition of the front cover glass and the window mat (sandwiched between 2 glasses) also resembles the double glass process (without cementing). The double glass technique typically does not involve reversing the image, and involves applying the varnish on the opposite side of the image. Fig. 4 illustrates the components of the Hamengkubuwono VI ambrotype.

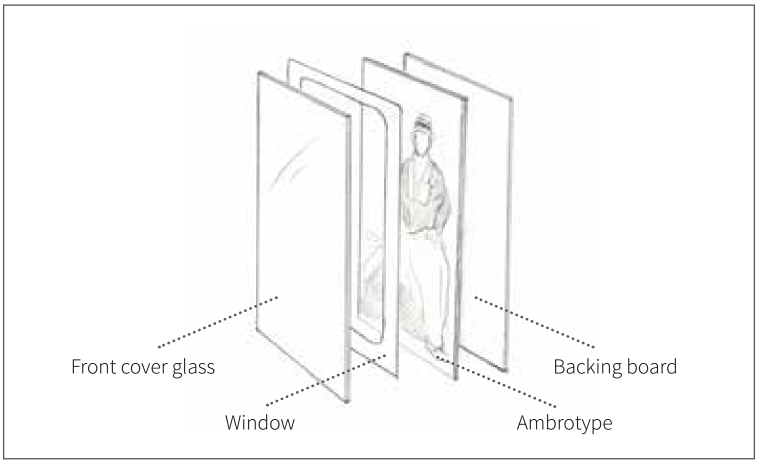


Fig. 4. Diagram of the Sultan Hamengkubuwono VI ambrotype.

[6] Steven Wachlin, *Woodbury & Page Photographers Java* (Leiden: KITLV press, 1994), 13.

Hand colouring

Hand colouring on photographs was common in the 19th century as photographs were monochrome at that time. This technique was similarly applied to daguerreotypes. Colouring could be applied by artists rather than the photographer. According to Walter Woodbury: "Those we charge £10 for are done on paper and afterwards coloured by an Artist here to whom we pay one half the amount for colouring them"[6]. This suggests that an artist could have been engaged to hand colour this ambrotype as well. The application of colour was usually done by breathing lightly on the plate, and then lightly brushing on the pigment using a fine brush. Pigments mixed with binder were also painted directly onto the surface of the image. Hand colouring was usually executed on certain areas of the image, to create skin tone and enhance jewellery and clothing. In the Sultan Hamengkubuwono VI ambrotype, soft subtle touches of red and green were noted on the face and side table respectively. But most of the areas were executed with brush application technique as evidenced by the well-defined brush strokes in several areas. In some areas, including the button and brooch (white and turquoise), some bubbling was observed. Under visual examination, the colour palette was noted to be confined mostly to gold, red, white, turquoise, green. Table 1 highlights some of the areas and colours being used.

Table 1. Colour palette.

Area on the ambrotype	Colour
Face	Red
Head gear	Gold
Ear accessories	Gold, white, turquoise
Brooch	White
Buttons	White, turquoise
Decorative border	Gold
Foot wear	Gold with white dots
Side table and trays	Gold with white dots and green

Using a handheld magnifier (x25) and a portable digital microscope camera onsite, the gold was observed to have a powdery appearance with well-defined particle edges, suggesting gold powder paint had been applied with a brush. This was consistent across the image wherever gold appeared. Some of the gold paint appeared to be on top of other paint layers, such as the whites.

Fig. 5. Close-up details of the gold powder paint.

Window mat

Window mats were commonly made of paper or metal. This window paper mat was unusual as it was made of simple, thin, light-weight paper. Under magnification, the front side of the window mat was noted to have a gilt appearance (Fig. 6). The shape and aperture of the window is irregular. Some straight score marks were noted along the border of the gilt window. The cutting of the gilt window could possibly have been done entirely by hand without use of a template.

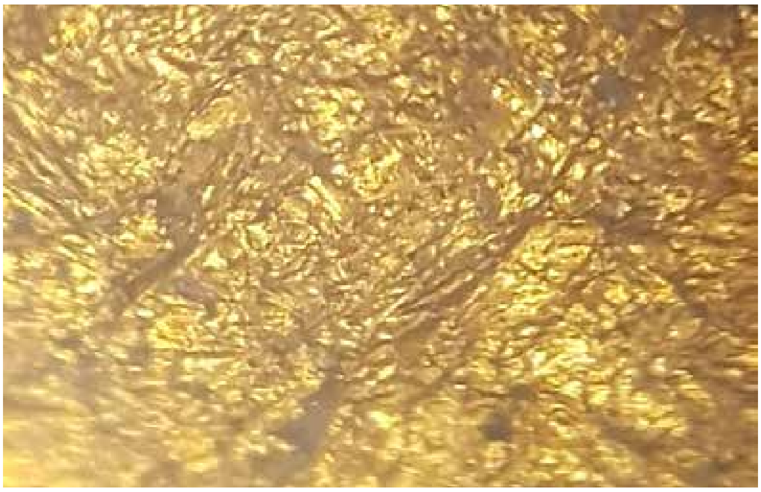


Fig. 6. Window mat (x25 magnification).

Conservation treatments

Cover glass and image glass

After removal of the sealing tape from the edges of the cover glass, the adhesive residue was removed using ethanol and a cotton swab. For general cleaning, a mixture of distilled water and ethanol (50:50) was used.

The constituents of the black lacquer on the image glass could be asphalt, shellac-based materials, as well as soot or lamp black pigment, as these were some of the common ingredients being used. No scientific analysis of this lacquer was possible onsite. However, during assessment, minor losses, crazing patterns, white spots, and abrasions were noted on the lacquer. The white spots and bloom could have possibly been caused by glass deterioration resulting from long term exposure to high humidity and temperature. The leaching of alkali from the glass support could appear as white spots on the lacquer. It was decided that an aqueous cleaning treatment of the surface would not be undertaken, as it could result in unknown consequences, and as the varnish layer was still intact and showed no signs of lifting. The surface of the image glass was cleaned with a soft mop brush (squirrel hair) only.

Fig. 7. Close up view of black varnish on the back of the ambrotype.

Window mat

The adhesive on the previous repair was very weak, and was removed mechanically. Some areas of gold were noted to be slightly friable. Therefore, the window was gently humidified on verso and flattened (Fig. 9). This was carried out for crushed areas of the window mat. After flattening, the mat was mended using a compatible light-weight Japanese paper and wheat starch paste. For losses, the Japanese paper was toned with acrylic paint. In order to match the window appearance as much as possible, in-painting was carried out. A dry brush stipple technique was used to achieve the surface quality (Fig. 11) of the original mat.

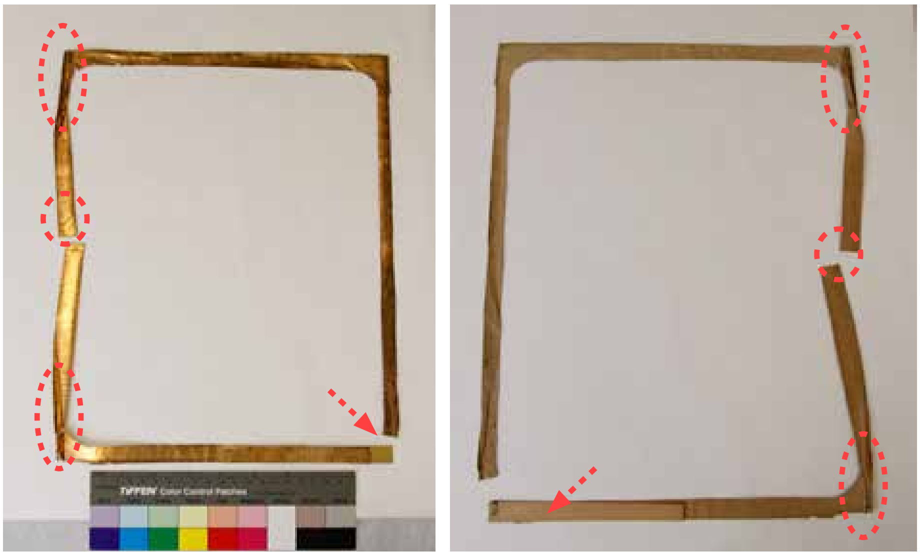


Fig. 8. Window mat before treatment. Damage and previous loss repair are indicated.

Fig. 9. Author carrying out localized humidification on the window mat.

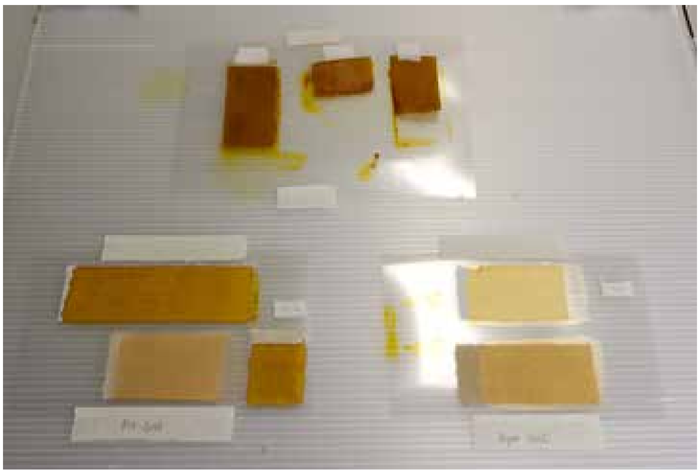
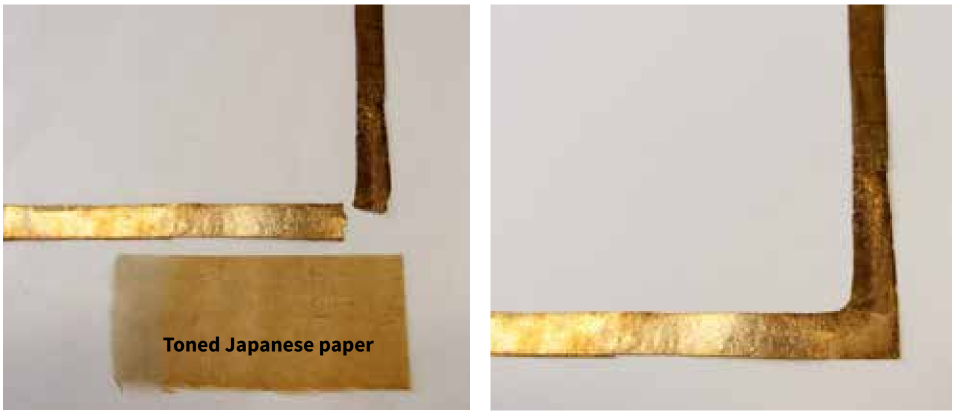


Fig. 10. Small toned sampling was carried out to match the Japanese paper to the base colour of the window mat.



Before treatment **After treatment**

Fig. 11. Close up image of window corner before and after treatment.

"Woodbury & Page" label

As the label is an integral part of the object, it was important to keep it. However, encrustations were noted on the inner side of the original backing board, and the board was degraded and badly stained. In order to prevent further deterioration, the label was removed from the backing board and transferred to a new, better quality museum mat board. The original board was kept separated.

The label was removed mechanically with the aid of a preservation pencil (Fig. 12). Due to the project treatment schedule, stain removal was not an option. However, the label was surface cleaned before encapsulation in a Mylar envelope.

During removal **After removal**

Fig. 12. Removal of the label.

Assembling the ambrotype

The original cover glass is slightly larger than the image glass. It is approximately 5-6mm larger on the left and right sides. This size difference will cause a "hollow" or gap on the sides, which could lead to tape breakages resulting from mishandling after resealing. Replacing the cover glass with a new and smaller one to match the image glass size was not an option as the frame's opening (rabbet) would be too wide to accommodate the ambrotype package. Therefore, it was decided that the plate size differences could be compensated by increasing the size of the backing board, and adhering strips of mat board to the sides of the backing board to stabilize the image glass. This was done by adhering strips of mat board to the left and right sides of the new backing board using 3M #415 double sided tape. The strips were made of 4-ply museum mat board matching the thickness of the image glass as closely as possible (Fig. 13).

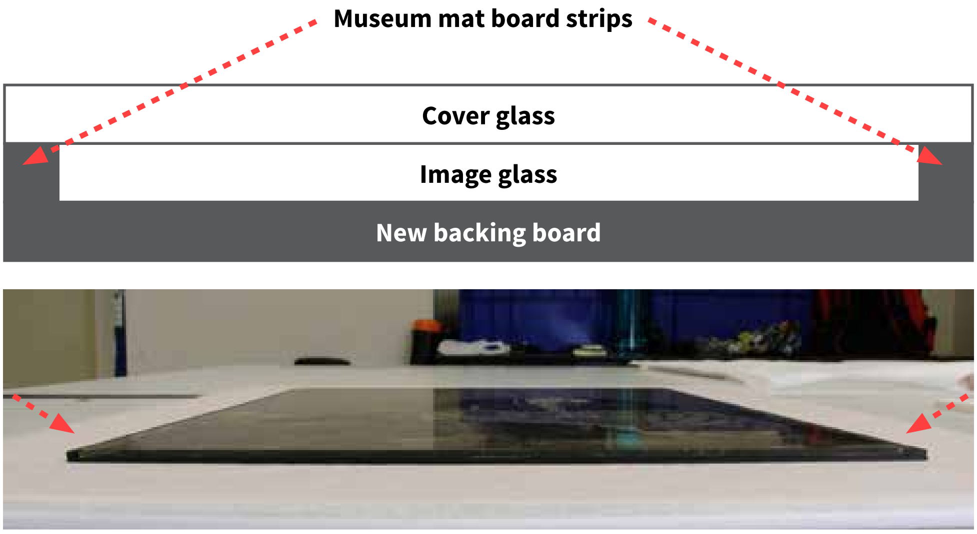


Fig. 13. Side profile of the ambrotype package.

Sealing the ambrotype

Photographic materials are sensitive to oxidizing gases from unstable materials and therefore using inert materials are essential. Japanese paper strips and Filmoplast P90 pressure sensitive tape have been used and recommended as sealing materials for ambrotypes as they are considered chemically stable. In order to ensure this large ambrotype is adequately sealed, the author carried out a test with both Filmoplast P90 and Japanese paper with wheat starch paste (thick consistency) to test their adhesion strength on glass. Both had good adhesion and were adequate for sealing. However, Japanese paper with starch paste had better strength and slightly more resistance to peeling. Its removal could be easily carried out with a moist cotton swab in the future, if necessary. A good alternative to the Japanese paper is Silversafe photo paper. It is a type of unbuffered cotton rag paper which was created in 1982 to meet the conservation and preservation needs of photographic materials. However, readily available standard-sized sheets would not cover the entire perimeter of the ambrotype, making a joint necessary. Therefore, Japanese paper (Kozo, 30g/m^2) was selected as the sealing strip paper.

In order to match the overall aesthetic of the ambrotype, the Japanese paper strip was toned a solid neutral black. Toning was carried out prior to sealing, and using an airbrush so that the process could be done with ease. Though hand brushing was an option, it was not used (Fig. 14).

Fig. 14. Toning the Japanese paper strips using an airbrush spray.

Sealing the ambrotype along its perimeter was done traditionally. Comparing to smaller plates, large plates require a considerably larger amount of material and time to prepare, together with manual dexterity and care on behalf of the handler, as oversized plates are very fragile. Before sealing the plate, the binding strip was gently humidified with a light spray (distilled water) in order to relax the support. After humidification, wheat starch paste was evenly applied to the sealing paper. The ambrotype package was positioned on top of the pasted strip before being wrapped around the perimeter (Fig. 15). After adhering the strip to the perimeter, excess paper at the corners were pinched, cut, and adhered in place (Fig. 16). The border of the sealing paper overlapped the front and back by approximately 5mm. After sealing, the ambrotype was air dried.

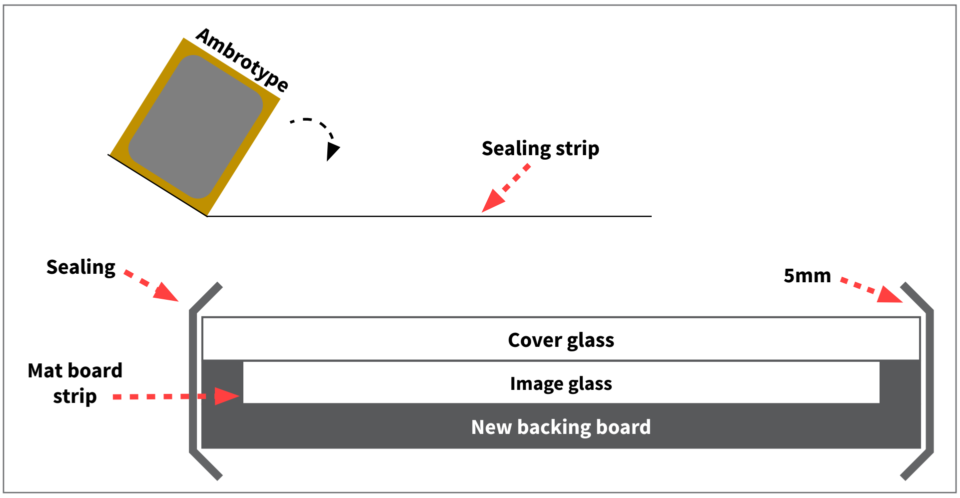


Fig. 15. Diagram showing the sealing process, and the ambrotype side profile.

Fig. 16. Close up image of a corner after sealing.

Framing

The opening of the frame was noted to be slightly wider than the ambrotype package, particularly on the left and right sides. In order to prevent the ambrotype from shifting sideways inside the frame, inert polyethylene foam tape was adhered along the lip of the frame. A mat board spacer was also added as filler on both sides of the rabbet. After framing, a final inert backing was added as extra protection. The frame is structurally stable and so no conservation work was carried out. After the treatment and framing (Fig. 18), the artefact was returned to the Asian Civilisations Museum storage facilities.

Fig. 17. Close up image of the polyethylene foam tape and mat board strip on the frame rabbet and lip respectively.

Fig. 18. Front and back of the ambrotype, after treatment and sealing.

Conclusion

Understanding the materials and the historical context of this ambrotype was key to its conservation. It is a continuous learning journey to understand the photographic techniques, process, material components and the framing materials, in order to conserve and preserve the ambrotype to the largest extent possible.

Conserving this ambrotype, in particular the resealing process, has been a challenging journey as the ambrotype is very fragile. Advanced planning of the working procedures and materials accessibility was crucial.

Further research and possible conservation of other Woodbury & Page ambrotypes will be important to aid in developing a better understanding of the materials and techniques they used. It has been a privilege to conserve this important piece of history.

Fig. 18. Hamengkubuwono VI and his consort, by Woodbury & Page (Courtesy of Mr and Mrs Lee Kip Lee).

Acknowledgements

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Author's biography

Tay Jam Meng specializes in the conservation of paper and photographic materials at Global Specialised Services Pte Ltd (GSS) in Singapore. Prior to joining GSS in 2014, he worked on paper and photographic materials in the Heritage Conservation Centre (National Heritage Board) and the private sector for 14 years. Jam Meng graduated with a Diploma in Fine Arts from the Nanyang Academy of Fine Arts in Singapore. He trained in photographic materials conservation under Ian and Angela Moor at The Centre for Photographic Conservation (London) in 2004. He also completed an internship at The British Library in 2005 and the Canadian Conservation Institute in 2010.

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10. Wachlin, Steven, '*Indonesia (Netherlands, East Indies)'* in John Hannavy (ed) Encyclopedia of Nineteenth-Century Photography Volume 1, A-I index. Routledge, Taylor and Francis Group, New York. London. 2007
11. AIC (PMG), *Photographic Materials Conservation Catalog – Chapter 2 Cased Photographs, Including Daguerreotypes, Ambrotypes and Tintypes*, First Edition. September 1998

Suppliers of materials

1. Acrylic colours (Winsor & Newton Professional Acrylic, Liquitex Professional Acrylic) : Art Friend Blk 231 Bain Street, #03-033, Singapore (180231)
2. Aero Color® Acrylic Ink (brand: Schmincke): Art Friend Blk 231 Bain Street, #03-033, Singapore (180231)
3. Japanese paper: Paper Nao 4-37-28 Hakusan Bunkyo-ku Tokyo JAPAN 112-0001
4. Museum mat board (brand: Rising): Framehub 61 Kaki Bukit Ave #05-05 Shun Li Industrial Park S(417943)
5. Mylar film, Zen (Jin) Shofu Japanese Wheat Paste (powder), Volara polyethylene foam tape, 3M #415 tape: TALAS https://www.talasonline.com/

Materials, Methods and Ethics: An Investigation on the Repairs of an Alms Bowl from Cambodia

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KEYWORDS
alms bowl, Cambodian monk, gap-filling, plant fibres, rice husk ash

ABSTRACT

This paper investigates repairs found on an alms bowl with a cover (Accession No. 1995-01628) from Cambodia. This artefact belongs to the National Heritage Board (NHB) collection and is exhibited at the Asian Civilisations Museum (ACM) in Singapore.

This studied alms bowl, created 1930s, is a rare surviving example of an alms bowl constructed out of plant material. The alms bowl is a container monks use to collect their daily rations of food. During the civil war in Cambodia, the destruction of temples and execution of monks led to the loss of generations of monastic lineage, practice, teachings and documents. It is, therefore, vital to understand the circumstances that led to the repair of this bowl by its previous owner who was a Cambodian monk.

Information on Buddhism, its philosophies and practices on the care of objects was derived from both literature and interviews. The findings from this research provide insights on how utilitarian artefacts are repaired by users within the culture and the types of filler and resins used for repairs in Cambodia.

Introduction

This paper presents the study of repairs found on an alms bowl with a cover (Accession No. 1995-01628) from Cambodia. This alms bowl bears evidence of repair in five areas. The repairs are composed of either a patch, resinous putty, paste or a combination of these materials. The composition of the repairs and original materials are visually studied and examined using an array of analytical methods. The religious approach to the care and treatment of the Alms bowl is reported based on consultation with the Cambodian monks and existing literature on the subject. The research uncovers the ideas, intention and thinking behind the selection of repair materials and techniques by the maker or user, in this case, the monk who owned the bowl.

Buddhism in Cambodia - the survivor's tale

Coggan (2015, p.16) observes that Cambodian religion is a complex blend of Hinduism, Buddhism and Animism. Hinduism provides the Khmer with gods; Buddhism an ethical framework; and Animism a rich world of spirits. All three together make up the mandala of Cambodian spiritual life. Powers (2018, xvi-xix) further describes that Buddhism was spread to Burma, Cambodia, Laos and Indonesia in the third century. In 1327, King Jayavarman Paramesvara established Theravada Buddhism in Cambodia. In 1975, Khmer Rouge brought about the "killing fields" period leading to the decimation of Buddhism in Cambodia. During the Khmer Rouge civil war in Cambodia, the monks were disrobed and sent to labour camps or work brigades and worked to exhaustion without adequate food and rest. They were sometimes also killed. Temples were turned into warehouses and made into other facilities or destroyed altogether. Buddhist festivals, rituals, observances and objects such as alms giving, sacred books, respectful language and religious calendars, were banned. (Coggan 2015, p.141-142). This wiping out of generations of monastic lineage, was a tragedy as many teachings and documents were lost. Traditional knowledge was not passed on and Buddhism practices could not be maintained to thrive.

This alms bowl dates to the 1930s and is a container used by the monk for their daily collection of food. This alms bowl is a rare surviving example of a bowl made of plant material. Sentence (2001, p. 12) informs that "very little ancient basketry remains. Humble, workaday objects such as baskets have always been thrown away when they are no longer serviceable. As basketry involves the use of perishable materials, they will normally disintegrate and only survive the passage of centuries under exceptional circumstances".

Fig. 1. Alms bowl with cover and selected views of repairs found.

When the studied bowl was presented to the monk in Wat Bo temple in Siem Reap Cambodia, the monk remarked "This rice bowl is an ancient version and type of bowl that was used in Buddha's time. My generation uses a rice bowl that is made of metal." (Theana and group of monks, 2018, personal communication, 6 September).

Alms Bowl: *Pindapata*

"As a bird takes his wings whithersoever it flies, so the *bhikkhu* (monk) goes with robes and bowl". (Khantipalo 2010, p.204).

Each monk has his own alms bowl which functions as a vessel or container for food. The bowl is one of the eight essential possessions of a monk. He should not have any worldly possession beyond these eight items. The other seven possessions are: three robes (waist cloth, upper robe, double robe), a waist band to secure the waist cloth, a needle and thread, a razor and a water strainer. Besides these essentials, there might be additional things a monk will have such as a bowl stand, a crot (umbrella mosquito net), a sitting rug, a bathing cloth and a bag.

Pindapata is the Pali language description for a Buddhist monk's alms food gathering, and literally means "the food- morsel's fall into the alms-bowl" (Khantipalo 1964, p. 4). The alms bowl is often referred to as a "begging bowl" or "rice bowl". Chodron (2018, p. 9) stated: "The practice of going on alms round in the Buddha's time meant that monastics could not prepare or ask for food they liked. We are to eat whatever we receive with gratitude. To do this, the monks have to work with their attachment to certain foods and shift their attention from liking to disliking the taste and texture of particular foods to awareness of the kindness of others for sustaining our lives. Not preparing food also prevented monastics from killing worms in fruit and vegetables when washing or cooking them". The alms bowl is not merely a dish but is regarded as an important vessel that helps to support a monk's life physically, as well as his spiritual development.

In Cambodia, during the Khmer Rouge period, the Government placed severe restriction and did not allow monks to leave the monastery. Alms collection continues to be a common practice in today's monastics lives in Cambodia. The climate, as well as monks' residences being close to villages or households makes it conducive for maintaining the tradition of alms rounds in Southeast Asia. In cities and towns, this tradition requires some planning and modification due to modern living. Town councils at times require monks to get a parade permit to do it. (Chodron 2018, p. 4).

Maintenance and condition

"We are also instructed to treat our alms bowl respectfully and to care for it so that it is not broken." (Chodron 2018, p. 113). "This commitment to treasure objects until they can no longer be used or repurposed is at the heart of Buddhism" (Matsumoto 2018, p. 27).

After use, the bowl has to be cleaned, returned to its sling carrier and tied to its stand, ready to be taken anywhere. During alms collecting, when the bowl becomes heavy with offered food or if the monk has tired hands, the bowl is placed on its stand and secured by its sling carrier to prevent it from falling to the ground.

Knowing the living conditions of the monk gives us clues as to how the bowl got damaged. The damages found on this bowl are mainly holes in the structure. The unusual number of repairs reveals to us that the damages are beyond ordinary wear and tear. A monk walking through jungles or forests, where thorns and branches could have pierced into the bowl may be a possible scenario.

In the past, the bowls are made in a variety of shapes and materials as Bhikkhu Khantipalo (1964, p. 287) highlighted: "… an earthen bowl, shaped melonwise…". The alms bowl is bigger than the typical household bowl. Bhikku Khantipalo (1986, p. 306) explained, "Firstly, a *bhikkhu*'s bowl has to be reasonably large to accommodate all the food that people wish to give him. Secondly a bowl may be really large if the *bhikkhu* to whom it belongs goes wandering on foot and stay in caves, a mountain or forest. His bowl is then his suitcase… ."

The newer versions of alms bowls are made of stainless steel for convenient maintenance, hygiene and durability and are no longer so easily damaged.

Repairs – Buddhist ethics and philosophies

"Sometimes repairs provide an eloquent mute witness to the history of a damaged object. The circumstances that led to the repair or the person who applied it, can be linked with notable historic moments. Even when the origin of an old repair is uncertain, it can attain the status of an essential attribute" (Portell 2003, p. 365).

The repairs on this bowl signalled that this artefact was well-used and had been in long service and this is in keeping with the principles of the Buddhist lifestyle to use it diligently and repair it only when it was a dire necessity. This level of care and sensitivity extended beyond the physical act of caring for the bowl to embodying the human spirit of compassion, resilience and adaptation - in the way the monk related to relationships and the environment.

"The repair and maintenance of household or mundane objects is another of the roots of conservation." (Pye 2001, p. 38). The repairs applied by the monk onto this alms bowl can be seen as an early example of domestic craft or conservation repair practice. The monks have basic stitching skills as it is expected for monks to sew their own robes or keep their robes mended, probably aware of the saying "a stitch in time saves nine". A needle and thread are one of the essential eight belongings of a monk. Having very few things and no money, the monk strives to be self-sufficient and practical in sourcing the materials for repairs. The monk could repair the bowl by using the materials available locally or familiar to him and his surroundings, such as his robe, waist cloth or sitting rug.

Research aim

This research was three fold:

1. Material characterisation and finding out the composition of the original materials and repair materials and how these materials relate to one another.
2. Learning about the religious based approach to the care of the alms bowl by the monk.
3. Discussing the ethical aspects of repairs, as well as repair materials and techniques used by a monk and conservator.

Materials

The materials selected for analysis were extracted from both the original parts of the bowl's body and lid - from the exterior and interior areas of each repair. The locations of samples are reported in Table 1.

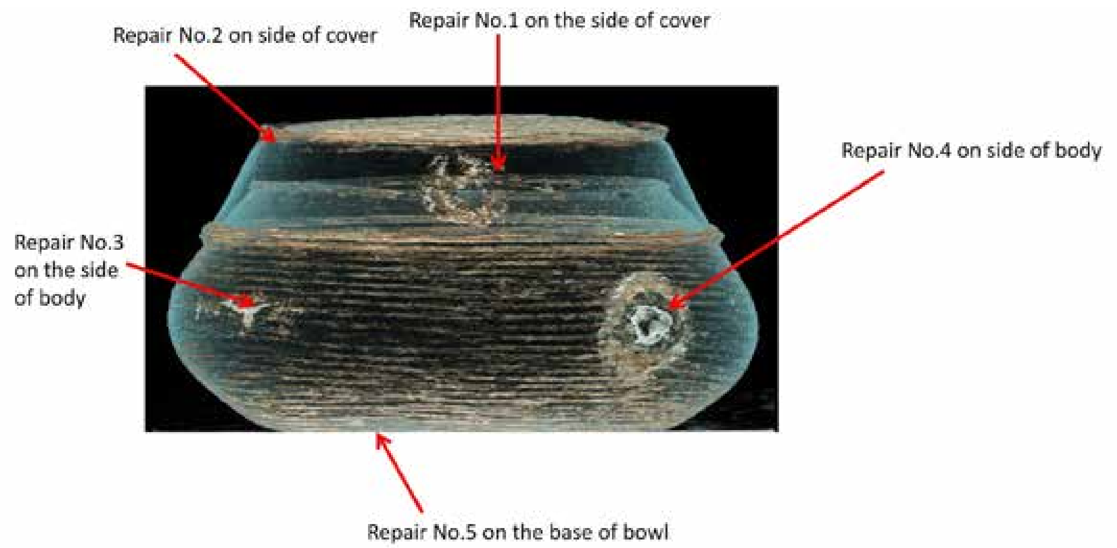


Fig. 2. Location of five repairs on the alms bowl as seen in computed tomography scan.

Table 1. Typology and labelling of samples.

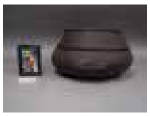
Sampling location on artefact	Overall view of repair	Exterior	Interior	Samples	Designations O = Original R = Repair C or B = Cover or Body/Base I or E = Interior or Exterior of the bowl
Original Cover				1. Stem 2. Binding 4. Surface coating	O.C.1 O.C.2 O.C.E.4
Original Body/Base				3.Weaving strand 5. Surface coating	O.B.I.3 O.B.E.5
Repair 1 Cover				6. Weaving strand 7. Patch Fibres 8. Surface coating 9. Surface coating	R1.C. I.6 R1.C.I.7 R1.C.I.8 R1.C.E.9
Repair 2 Cover				10. Weaving strand 11. Filler	R2.C.I.10 R2.C.I.11
Repair 3 Body				12. Surface coating 13. Surface coating 14. Patch Fibres 15. Weaving strand 16. Surface coating	R3.B.E.12 R3.B.E.13 R3.B.E.14 R3.B.I.15 R3.B.I.16
Repair 4 Body				17. Surface coating. 18. Patch. 19.Filler. 20.White deposit.	R4.B.E.17 R4.B.E.18 R4.B.I.19 R4.B.I.20
Repair 5 Base				21. Fibres 22. Red deposit	R5.B.E.21 R5.B.I.22

Fig. 3. Samples were taken from selected areas of losses on the body of the bowl.

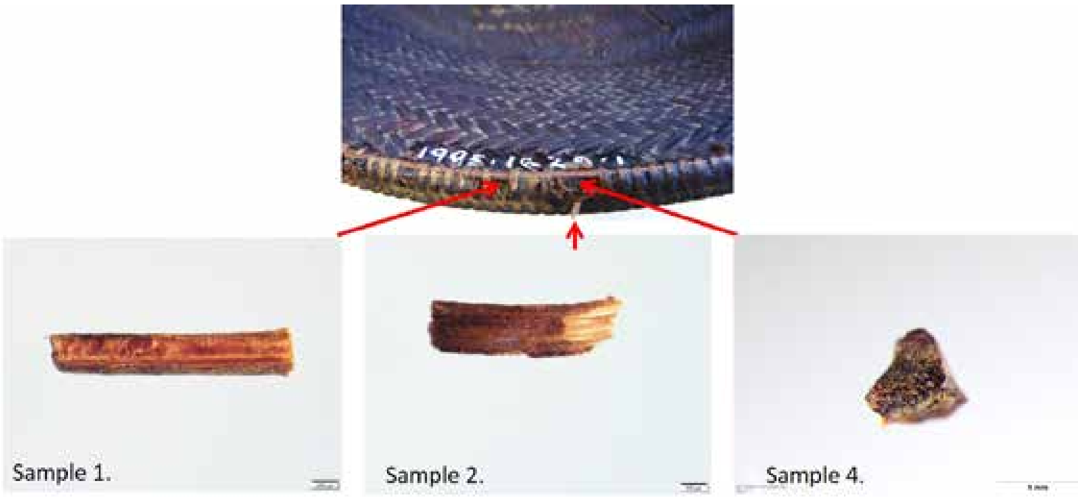


Fig. 4. Samples taken from selected areas of losses on the cover's rim.

The samples of the original materials were primarily taken from areas where there was loss or breakage as it allowed the least invasive interaction with the object as seen in Fig. 3 and Fig. 4.

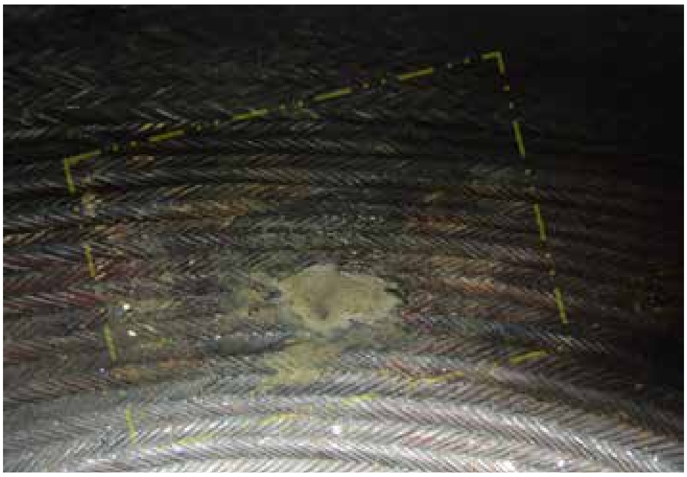


Fig. 5. A close examination under raking light showed a ghost image of a rectangle which suggested that there was a patch attached on top of filler.

Methods

The sample material, both original and from repair areas was examined in respect to its morphology and chemical composition, using complementary analytical techniques.

Protocol of examination

1. Visual
   a. The artefact was examined visually in its entirety with the aid of visors, ultra-violet light and optical microscopes in reflected and transmitted light.
   b. X-radiography machine Siemens Ysio Digital Radiography system. X-radiographs were taken of the bowl at an exposure time of 5sec, 40 kV, 2.1 mAs.
   c. Computed Tomography machine Siemes Somaton Definition Flash. CT scans were taken of the bowl at 120 kV and 15 mAs.

2. Microscopy with focus on surface morphology
    a. The samples taken of the original and repair materials were examined in digital surface analysis with microscopy using Keyence VHS Digital microscope, Olympus SZX7 digital stereo microscope, Confocal Laser Scanning Microscope and Olympus LEXT OLS4100 (CLSM).
    b. Field emission scanning electron microscope (FESEM) Hitachi SU5000 coupled with energy dispersive X-ray spectroscopy (EDS) Bruker XFlash 6/60 were used for imaging surface morphology and determination of chemical composition. In FESEM the back scattered electron mode (BSE) was used in 60Pa vacuum, with 20kV beam acceleration, at 50-60 intensity spot and working distance of 6-10mm.
3. Analysis with focus on chemical composition
    a. The chemical composition of the filler materials in repairs was detected with X-ray dispersion spectroscopy, (EDS coupled with FESEM) and mapped using Bruker's processing software.
    b. For identification of the surface coatings on the original material, the samples were pyrolyzed with a Frontier Auto-Shot AS-1020E pyrolyzer system interfaced to a gas chromatography/mass spectrometer (Shimadzu gas chromatograph GCMS-QP2020 quadrupole mass spectrometer), following a method of analysis developed for organic polymers. This GC protocol, recommended by Schilling (et al., 2016) for Asian lacquer analysis was selected based on the initial evaluation that the coating and some filler materials appeared to be lacquer.

Results

Ultra-violet induces visible fluorescence examination

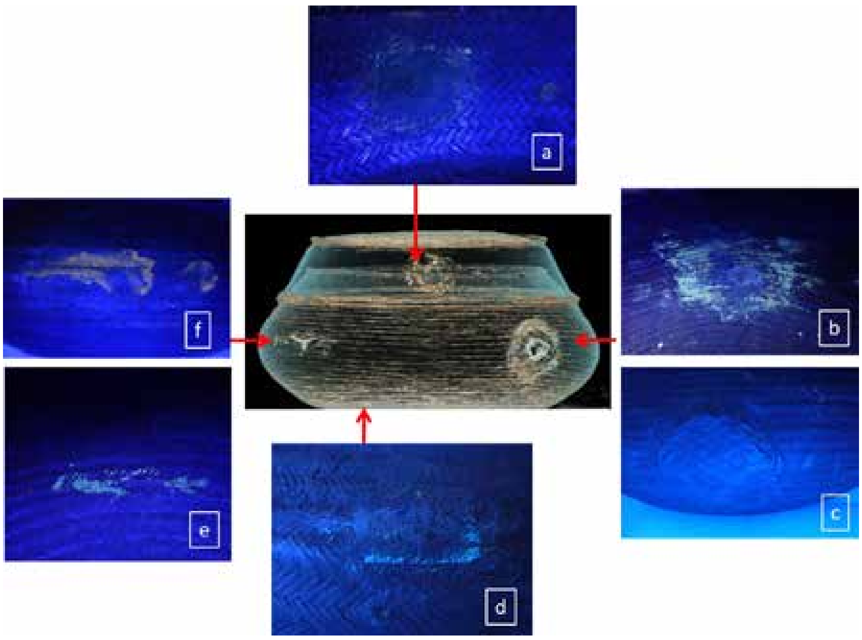


Fig. 6. A different degree of fluorescence was exhibited when exposed to UV light.

In Fig. 6 (a) and (d), the exposed fibres on outer edges of the patch fluoresce in blue-white is indicative of wool. In Fig. 6 (b), (e), and (f), the samples showed fluorescence ranging from orange to yellow indicating added adhesive used in the repair area. In Fig. 6 (c), the material did not fluoresce and had a homogeneous surface indicating the material to be of plant origin. Coating also appeared similar to original.

X-radiograph

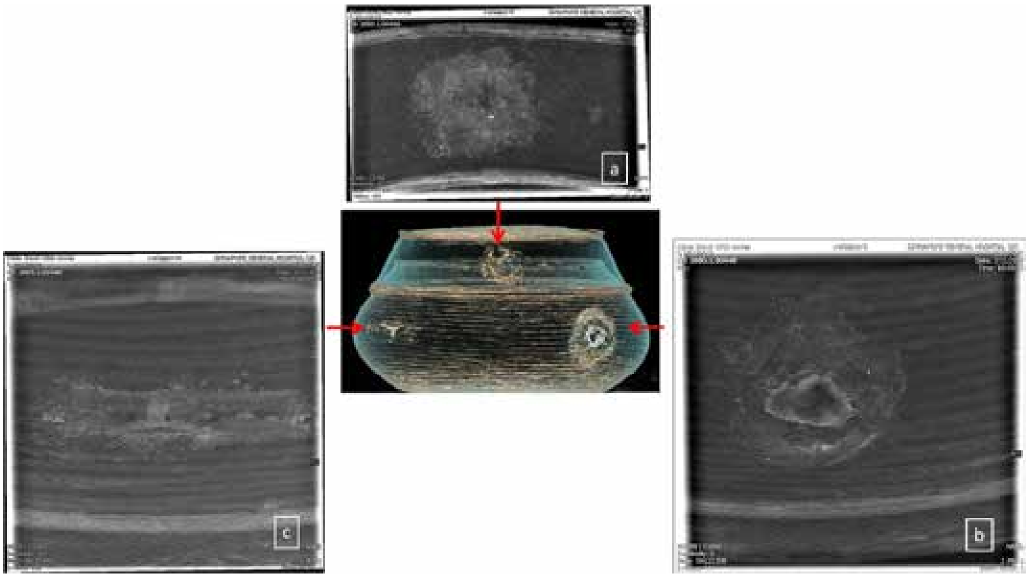


Fig. 7. X-radiography of selected repairs.

X-radiographies revealed the difference in textures and densities between original and repair materials. It was found that the visible patch is larger than the loss area in b and c.

Computed tomography scan

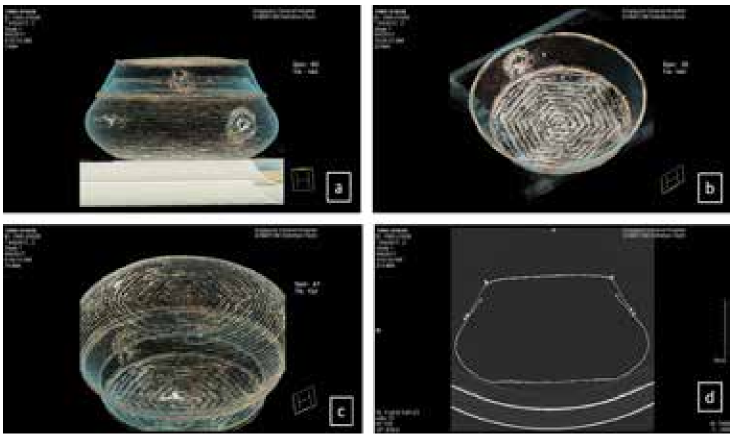


Fig. 8. CT scan shows the weaving directionality, and vessel profile of the alms bowl.

The CT Scan allowed us to observe details of the thickness of repairs in comparison to the original structure of the bowl in Fig. 8 (a) and 8 (c). The weaving pattern and directionality of plaiting in basket is more defined, for example in the cover in b. This line rendering of the alms bowl shows the typical vessel profile associated with the alms bowl having a wide body and mouth opening in Fig. 8 (c). The proportions and manner of placement of the cover to the body is clearly defined in Fig. 8 (c). CT scans findings complemented the results obtained from X-radiography.

Stereo microscopy examination

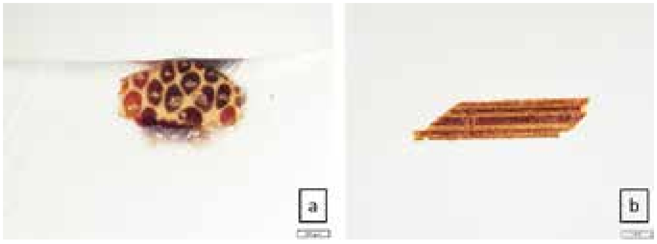


Fig. 9. Sample O.B.I.3 of weaving strand. (a) Cross section view, magnification: 2.5x. (b) Longitudinal view, magnification: 1.25x. Both showed cellular structure pointing to bamboo.

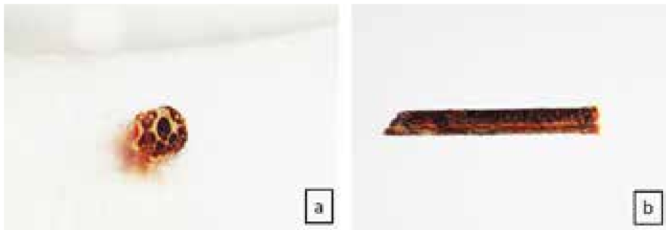


Fig. 10. Sample O.C.1 of stem. (a) Cross section view, magnification: 2.5x. (b) Longitudinal view, magnification: 1.25x.

Microscopy examination was carried out to identify the plant type based on the cellular and physical features of the original structure of the bowl. Plaiting, a type of weaving technique was used to create the bowl. Weaving strands (warp and weft) of the bowl is bamboo. The cross sections showed vascular bundles and pith cavities. Furthermore, the longitudinal view of fibres showed parallel stripe colouration. Rattan was also found but only in the binding on the rim of cover.

Confocal Laser Scanning Microscopy (CLSM)

Fig. 11. (a) CLSM Image of a mixture of resinous from the rim of cover sample #4. (b) Macrograph of surface coating sample #4.

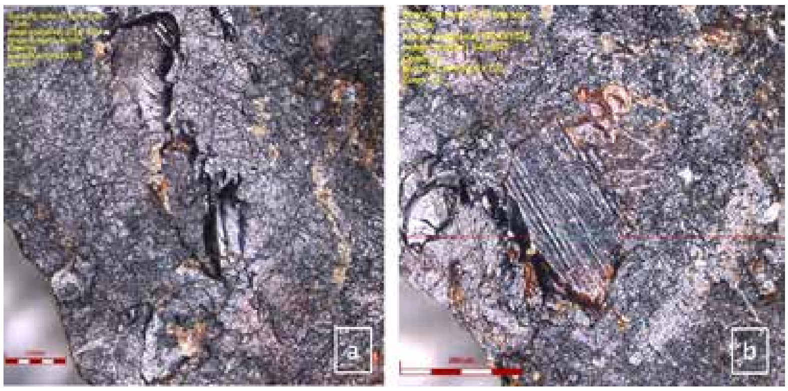


Fig. 12. (a) CLSM image showing general view of topography of surface coating on the body of bowl. (b) CLSM image showing bamboo fibre fragment revealed in the area of coating loss.

The bowl is coated inside and outside with a type of lacquer or natural resin. The resins which are natural polymers are difficult to analyse because they are complex mixtures of many compounds, in particular aged material may show evidence of food residues from past use. In this alms bowl there was no evidence of food residues but there were many cockroach casings.

Scanning Electron Microscopy (SEM), Energy Dispersive X-ray Analysis (EDX)

Fibre materials

The visual examination indicated that there are two types of fibres used as a patch support material in repair areas.

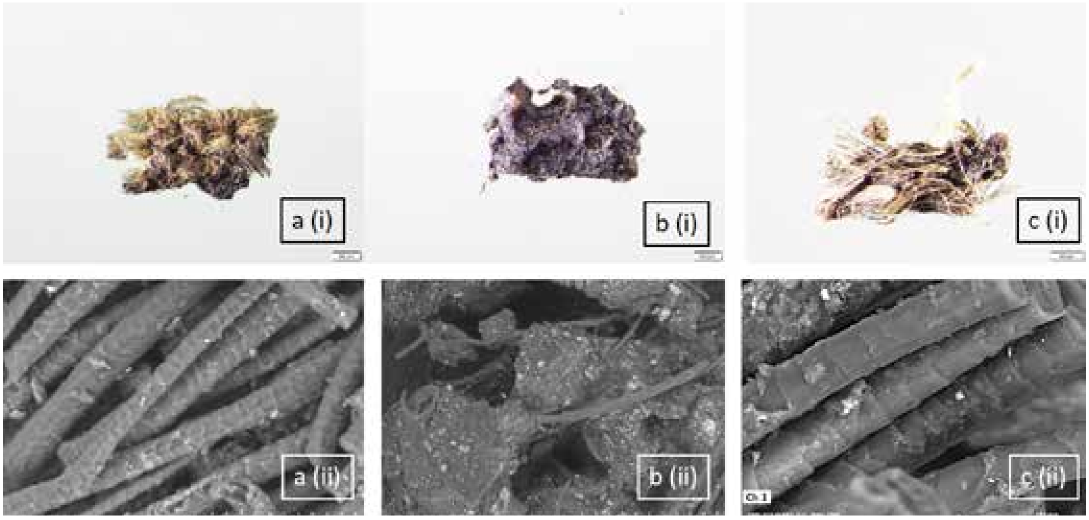


Fig. 13. (a (i)) Macrograph of repair #1 patch. (a (ii)) Scales on fibres indicating wool. (b (i)) Macrograph of repair #3 patch. (b (ii)) Morphological contrast of filler. (c (i)) Macrograph of repair #5 patch. (c (ii)) Scales on fibres indicating wool.

Fig. 14. (a) SEM micrograph of repair #1 patch: a close up of wool fibre showing overlapping scales; scale 50 μm. (b) Macrograph of weaving pattern and colour of the same repair area; scale 100 μm.

SEM-micrographs confirmed presence of wool fibres inside the fill of three patches, as illustrated in Fig. 13. The physical characteristics of wool fibres such as its crimped and wavy behaviour and colouration ranges from off-white to light cream is seen in Fig. 14 (b).

Fig. 15. (a) Macrograph of repair #4 patch. (b) and (c) SEM micrograph showing plant material and directionality of weaving in repair#4, scale 500 μm.

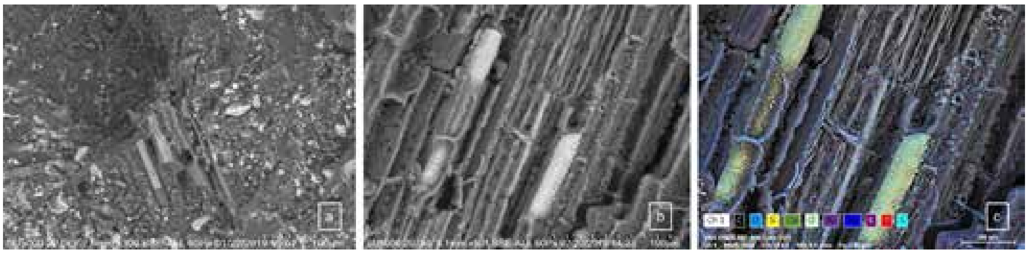


Fig. 16. *(a) SEM micrograph showing pith cavity in repair#4, scale 100 µm. (b) SEM micrograph showing silica deposits, scale 100 µm. (c) Chemical mapping confirming silica element present in deposits.*

One of the repair patches contained plant fibres. This sample was compared with known samples of rattan, palm leaf and bamboo. The closest and possible match seen was bamboo stem. That conclusion was derived based on the elongated cells and silica deposit (in cylindrical rods) inside the cells. Identification of silica bodies or unique cellular structure of a stem are features relied on in identifications reported in the study of rattan in (Szczepanowska, 2018).

Filler materials

The visual examination indicated that several different types of filling materials were used in repair and none in the original body of object. The main filling materials found were rice husk ash and clay. The features were compared with known reference samples.

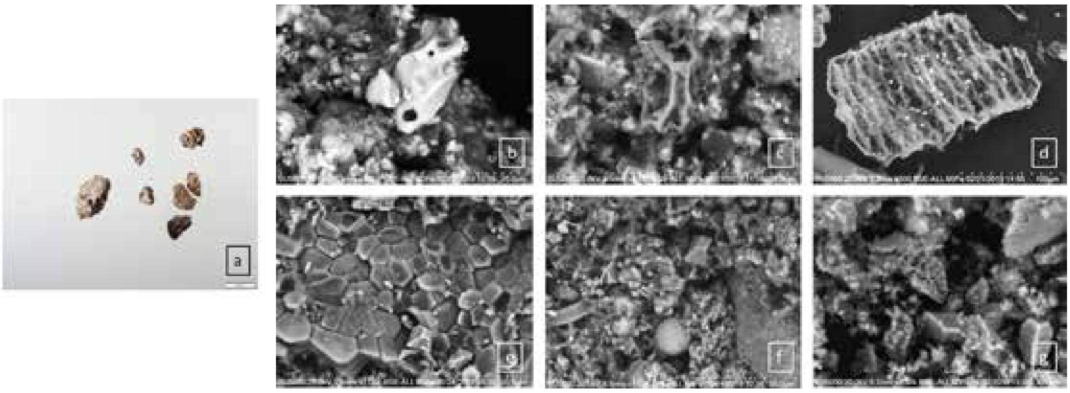


Fig. 17. *(a) Macrograph of a filler material from repair#4. (b) – (d) SEM micrograph of same sample showing fragments of rice husk ash in filler, scale 20 µm and 100 µm. (e) – (g) SEM micrograph of same sample showing fragments of clay and inclusions in filler, scale 50 µm and 30 µm.*

The rice husk ash and clay particles were found in the composition of the filler of repair #4. A paste made of raw lacquer, rice husk ash and white talc is commonly used in Cambodia for filling losses in basketry. This was confirmed during a visit to Angkor Art Studio, Cambodia (E. Stocker, 2018, personal communication, 4 September). The rice husk is burnt at a relatively low temperature thus retaining some features of the husk. A close up of the clay mass revealed distinct particles of rice husk ash in Fig. 17 (b) – (d). The different morphologies of rice husk ash fragments– fibrous flakes (Fig. 17 (d)) and geometric shell particle with circular openings (Fig. 17 (b)) matched bibliographic references (Ziegler et. Al., 2016, Bondioli et. Al., 2007). A small number of sheeting which is characteristic for clay was detected in Fig. 17 (e). Spheres and crystalline features were seen in Fig. 17 (f). The spatial positioning of the sphere inclusions shown in Fig. 17 (g).

Fig. 18. *SEM-EDS chemical mapping.*

Table 2. Chemical composition of rice husk ash showing a large percentage of silica as its main mineral element.

Element	Mass Norm %
Carbon	42.37
Oxygen	39.42
Silicon	16.98
Aluminum	0.16
Potassium	1.08
Sum	**100**

The chemical composition of rice husk ash, determined by SEM EDS, is reported in Table 2. The ash is characterised by high percentage of Si followed by Al and K.

GCMS-Pyrolysis

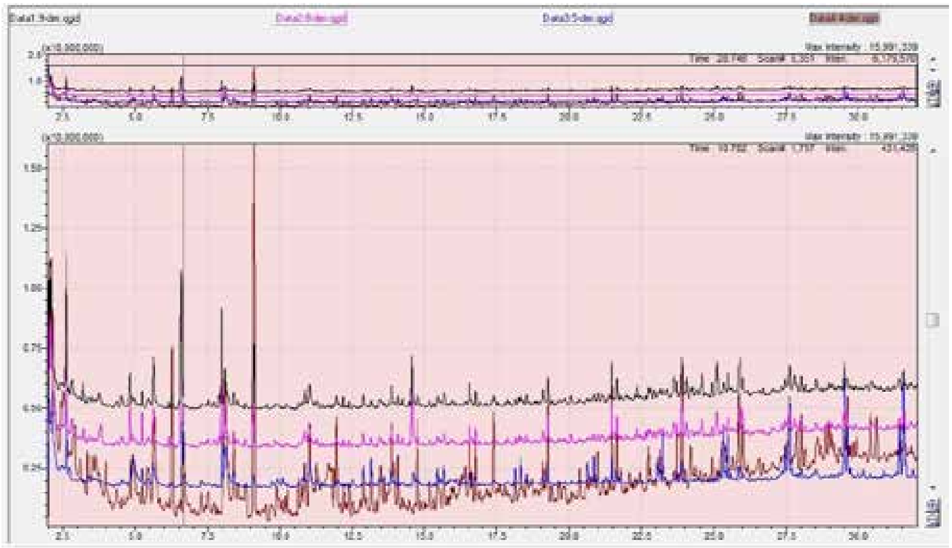


Fig. 19. *Py-GC Pyrogram of four samples extracted from surface coatings, three of which showed strong spectral similarities.*

Sample #16 was compared with pure lacquer collected in Myanmar, indicating great similarities, to thisiol lacquer, which is a type of lacquer used in Myanmar and Cambodia.

Conclusion

Visual examination such as X-radiography and CT scan provided information about the internal structure of the artefact and repairs without the need to disassemble it or sample the repairs, which was especially important because repairs were still intact. Analytical examination with SEM provided more detailed information about the surface morphology of the fibres and particles used in the filler.

Based on analytical examination, the following materials were identified both in the original and repairs:

1. The original body was constructed primarily using bamboo for structure of body and cover and rattan for fastening.
2. Coating that was applied on the original body and repaired areas were most likely lacquer. More analysis required on lacquer.
3. The repair patches were made of wool fibres and bamboo fibres. The filler materials were made of rice husk ash, clay and lacquer.

The known composition and techniques of the repairs in this studied bowl contained valuable information concerning the cultural biography, changes in context and use of this artefact, allowing the conservator to make an informed decision to retain all repairs and to select materials for a treatment if needed.

Conservators are accustomed to wool or plant fibres or natural resins as repair material but using rice husk ash in a filler mixture has not been mentioned in key texts on the topic of repair materials and gap-fill (Thornton, 1998, Webb, 1998, Florian, 1990, Pearlstein, 1994, Portell, 2003). Rice husk is a waste by-product from the milling process and can be tested further for treatment application as an inert filler. Research is widely available for rice husk ash in industrial applications such as a filler in cement (Bondioli et al., 2007, Kartini, 2011, Nagrale et. Al., 2012, Ziegler et. Al., 2016). Some areas for further study may include exploring the relationship between working properties of rice husk ash and different temperatures of burning. By studying rice husk ash, conservators get a chance to consider using ecological materials in their treatments.

The shared perspectives of a conservator and monk, from an ethical standpoint, is respect towards an artefact, not harming or destroying the artefact and following respective codes of conduct whether in the conservation field or Buddhist religion. A Monk may employ different ethics when repairing an artefact compared to a conservator, such as refraining from selecting or creating animal based adhesives or fillers, which may be directly in conflict with the Buddhist principles and disciplines of no-killing (Hsu 2014, p.1, Hsu 2016, p.129).

The monk did not pay much attention to the purity of the materials and resorted to using recycled or repurposed materials locally available. An example would be the repair patches made of wool fibres. They were most likely derived from the monk's siting rug, robe cloth or discarded textiles scraps found in temples. Like-wise with the bamboo fibres patch which appears to be repurposed fragment from a finished woven mat product possibly found in the temple grounds.

A conservator considers the re-treatability or reversibility of the treatment and would select materials which are stable, of conservation grade and literature-reviewed. Given the visible character of the coarse repairs, it may be argued that aesthetic considerations were of minor concern for the monk and the repairs were purely functional. The monk intended for the repairs to be permanent and aspired for it to last until there is new damages.

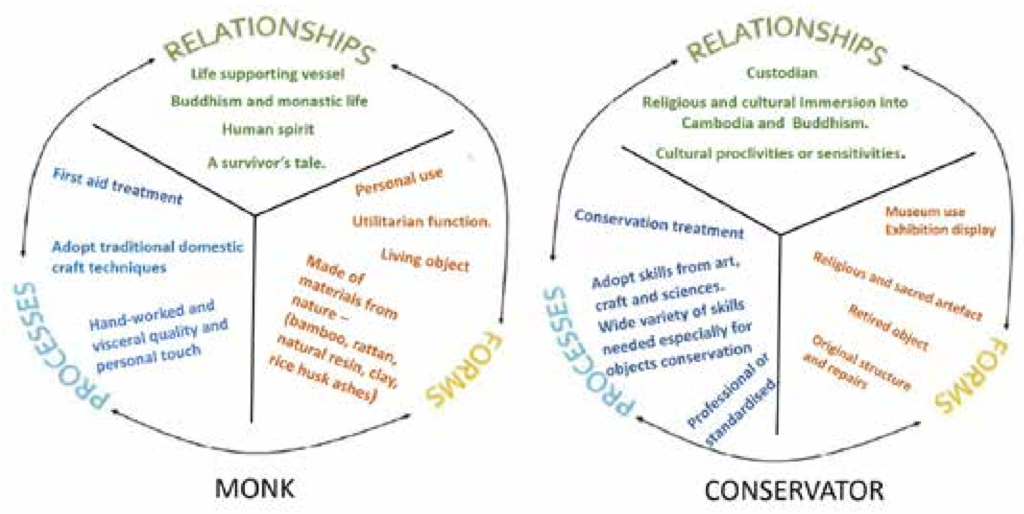


Fig. 20. The diagrammatic illustration of inter-connectedness of forms, processes and relations was featured in Cutajar (et. al., 2016) and originally based on Janet Setphenson's 2016 Cultural Values Model. Fig. 18 is adopted and adapted to show the reciprocity between intangible (processes and relationships) and tangible (physical form) framework by a monk and conservator.

The repairs on this studied bowl shows the monk's good empirical knowledge of the behaviour and properties of materials, mending techniques, ingenuity and resourcefulness when having little or scarce materials. This investigation and reflection of the repairs on this alms bowl offers teachings, ethics and lessons of Buddhism for readers and is a testimony of the monk's way of life, discipline and religious practice. The modern generation of monks own bowls made of metal. As such, repair methods or techniques will no longer be thought of, applied and needed. Therefore, repair skills may disappear or be forgotten as well.

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Author's biography

Sylvia Haliman holds an MSc in Conservation in Archaeology and Museums and an MA in Principles of Conservation from University College London (UCL), UK. Trained as an objects conservator, she has worked in museums in UK, Hong Kong and Singapore. She joined the objects conservation team at Heritage Conservation Centre (HCC) Singapore in 2013.

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Wax On... Wax Off? Investigating Nd:YAG Laser Cleaning as a Method of Removing Wax Coatings from Iron Alloy Surfaces

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KEYWORDS
Renaissance wax,
laser cleaning,
iron alloy surfaces

ABSTRACT
Renaissance microcrystalline wax is commonly applied as a protective coating to various objects, particularly metal objects, as part of conservation treatments. Subsequently, it may be desirable to remove the wax as part of cleaning processes in future treatments. However, it can be difficult to completely remove wax from metal surfaces. Laser cleaning has been explored as a method for removing wax coatings from metal surfaces, but available information remains scant. This paper investigates the use of laser cleaning with a Q-switched Compact Phoenix Nd:YAG (1064nm) Laser for removing Renaissance wax coatings from non-archaeological iron alloy surfaces. Uncorroded and corroded mild steel coupons coated with Renaissance wax were laser-cleaned, and the results evaluated to determine damage to the substrate surface and completeness of coating removal through visual observation, mass measurements, Fourier-transform Infrared Spectroscopy (FTIR), and Scanning Electron Microscopy (SEM). Various cleaning parameters tested on uncorroded coupons caused changes to the substrate surfaces, but wet laser cleaning with white spirit at a fluence of 0.48 J/cm^2 appeared to effectively remove the wax coating. On corroded coupon surfaces, the parameters tested caused significant damage and were found to be unsuitable as a cleaning method for the coupons. More extensive investigations of laser cleaning to remove wax coatings would be helpful in furthering our understanding of this cleaning method. This study was conducted as part of a dissertation submitted for the degree of MSc in Conservation for Archaeology and Museums of University College London in 2018.

Introduction

Renaissance microcrystalline wax is commonly used within the field of conservation and is frequently applied to various objects, particularly metal objects, as a protective coating. Renaissance wax is the brand name for a particular blend of waxes, first formulated in the 1950s, marketed for museum and conservation use, and produced by Picreator Enterprises Ltd (Picreator Enterprises Ltd 2017). It is a mixture of Cosmolloid 80H (a microcrystalline wax) and Wax A (a polyethylene wax produced by BASF), in the ratio 100g to 25g in 300ml of white spirit (Plenderleith & Werner 1971, p. 374).

Microcrystalline wax is a petroleum wax with relatively low crystallinity, while polyethylene wax is a hydrocarbon wax made by polymerising ethene monomers. Its physical properties depend on its level of crystallinity and molecular weight (Horie 2010, p. 125). These waxes are tough and relatively inert, and their films are water-white and clear, resistant to moisture and gases (Rivers & Umney 2003, p. 167), and "self-healing" (Scott & Eggert 2009, p. 146), making them favourable for use as coatings in conservation treatments. They are commonly applied on metals to protect them from corrosion. They have been used to coat furniture fittings (Rivers & Umney 2003), ethnographic objects (Moffett 1996), and archaeological objects (Keene 1984), among others. In Singapore, at the Heritage Conservation Centre (HCC), a protective layer of Renaissance wax is often applied to metal objects, functioning as a barrier layer against the humidity of a tropical environment.

However, studies have shown that corrosion can still occur underneath the wax layer (Keene 1984; Scott & Eggert 2009, p. 146-147). Other drawbacks to wax coatings are that they can attract and retain dirt, and complicate the application of other materials for future conservation treatment (Johnson 1984). Compounding these problems, wax coatings can be difficult to remove once applied, especially from porous corroded surfaces (Horie 2010, p. 128; Johnson 1984; Moffett 1996). Boiling water has been suggested but was not found to be effective (Johnson 1984). Commercial solvent cleaning systems have also been proposed but may not be practical since industrial equipment is required (Johnson 1984). Renaissance wax, because of its polyethylene wax component, requires the use of hot xylene to be removed, which poses health and safety risks (Moffett 1996).

At Knole House, a historic house under the care of the National Trust, a layer of Renaissance wax is applied to many metal objects on display in the house by the house conservation team once a year as a protective coating (C. Vida, pers comm., 27 October 2017). This is in line with recommendations for housekeeping practice for metal objects in the Trust's *Manual of Housekeeping* (Harris 2006). During my internship at Knole (September 2017 - February 2018), I assisted in the treatment of a pair of steel andirons. The Renaissance wax coating on the andirons had retained dust and dirt, and some corrosion had taken place under the wax layer. As part of the treatment, the object would be cleaned by removing the wax coating and the corrosion products under it. The objects conservator carrying out the treatment found that conventional solvent cleaning was tedious and time-consuming, as repeated and extensive swabbing was required to reduce the wax layer with white spirit. Furthermore, it was unclear if the Renaissance wax coating had been completely removed, and it was suspected that some wax still remained on the object.

This experience prompted the question of whether there was another, better way to remove a Renaissance wax coating from the surface of an iron alloy. The frequent use of Renaissance wax to coat iron alloy objects in HCC made this a particularly relevant question to conservation practice in Singapore.

Laser cleaning was considered a potential alternative, as an Nd:YAG laser cleaning system was available at Birmingham Museum and Art Gallery (where this study was conducted) and at HCC. This technique utilises a laser to focus energy on a small area of a material. Absorption of this energy may cause material to be ejected, or ablated, from the substrate surface by thermal and chemical processes (Cooper 1998, p. 40; Fotakis *et al.* 2007, p. 25-32). Laser systems can be categorised by the type of medium used in the system to produce the laser beam. An Nd:YAG laser (fundamental wavelength of 1.06μm) uses a neodymium-doped yttrium aluminium garnet crystal as the lasing medium. Apart from wavelength, other parameters of a laser include, but are not limited to, pulse duration, pulse repetition rate, and fluence (energy per unit area). These factors affect the amount of energy in the laser that interacts with a substrate, so parameter choices are highly influential on the results of this interaction. The outcomes of this interaction also depend on the properties of the material, as well as the ambient environment (Cooper 1998, p. 59-60; Fotakis *et al.* 2007, p. 5). In conservation treatments, laser cleaning would ideally be self-limiting, where the undesired dirt layer absorbs the energy from the laser pulse and gets ablated, while the substrate surface is not. Otherwise, the substrate may be damaged by the laser pulse (Cooper 1998, p. 55).

While laser cleaning has been used to remove coatings from various substrates, a large proportion of studies published on the laser cleaning of metals are concerned with corrosion removal. There have been fewer publications about using laser cleaning to remove organic coatings from metals, though some studies have shown that it is possible to do so without damaging the substrate surface (Lee *et al* 2013; Mateo *et al.* 2009).

The use of laser cleaning to remove hydrocarbon waxes in particular has not been extensively explored, and few studies can be found. Madden *et al.* (2005) investigated the effect of different laser systems on a microcrystalline wax, Multiwax W-445, that had been applied to glass, red/black granite, and white plaster substrates. They found that, with the parameters tested, the microcrystalline wax was only affected by the KrF excimer laser (operating at 248nm). The other lasers, including the Q-switched Nd:YAG laser (1064nm, 532nm and 355nm) did not have any observable effect on the wax. However, they suggest that different experimental variables, such as sample preparation and laser parameters, may produce different results. In investigating laser cleaning for removing a hydrocarbon wax coating from a metal surface, Koh & Sarady (2001) carried out tests on uncorroded mild steel plates and on samples from a corroded cast iron object, using a TEA CO_2 laser (10600nm), and an Nd:YAG laser (1064nm and 532nm). They found that the TEA CO_2 laser produced the best cleaning results and was able to completely remove Ter Hell 5495 microcrystalline wax coatings from the corroded surfaces. In contrast, the Nd:YAG laser was much less effective at removing the coating and carried a higher risk of damage in the form of surface melting and darkening of the corroded surface.

As Nd:YAG lasers are the most commonly used type of laser cleaning systems in conservation (Koh & Sárady 2005), this paper aims to investigate the use of Nd:YAG laser cleaning at 1064nm as an effective and non-damaging method of removing Renaissance wax coatings from iron alloy surfaces. It presents the methodology and results of experiments with various parameters on coated iron alloy coupons.

Materials and methods

Uncorroded and corroded iron alloy coupons were used for comparative tests of different cleaning parameters. The corroded coupons were obtained by subjecting coupons to an accelerated corrosion process. Renaissance wax coatings were first applied to both types of coupons, then coating removal by conventional solvent cleaning and by laser cleaning was attempted. The laser cleaning parameters used had been selected based on the most promising results from preliminary trials. The results of the cleaning tests were evaluated based on the identification of any damage to the substrate surface, and on the completeness of wax coating removal. Assessment of changes to the substrate surfaces was aided by visual observation and a selection of coupons was imaged by SEM to document changes in surface morphology. Assessment of the completeness of coating removal was aided by visual observation, changes in mass, and FTIR-ATR.

Sample preparation

5cm x 2.5cm x 0.1cm mild steel coupons with a matte finish (supplied by The Metal Store, pre-cut to size) were used. Each coupon was cleaned in the following series of steps:

1. Immersion for about one minute in white spirit and periodically agitated.

2. Cleaned with fresh white spirit on a cotton swab.

3. Thoroughly cleaned with industrial methylated spirit (IMS) on a cotton swab, until the surface appeared streak-free.

The corroded coupons were prepared by abrading cleaned coupons with a glass bristle brush twice on each side using moderate pressure, then rinsed in acetone and air-dried on clean tissue. They were immersed in 5% w/v NaCl solution for five minutes, then removed from the solution and exposed to a humid-dry cycle of 60ºC and 100% RH in a laboratory oven for 20 hours, followed by room temperature and RH for 4 hours. This humid-dry cycle was repeated three times. The corroded coupon surfaces were then swabbed with IMS on cotton swabs to remove most of the loose corrosion product.

A thin layer of Renaissance wax was applied to the centre of one side of each coupon, in an area of about 2.5cm x 2.5cm, with a lintless microfibre cloth. This layer of wax was allowed to dry for about half a minute, then buffed to an even finish with a microfibre cloth. Three coats of buffed wax were applied on each coupon.

Cleaning tests

Laser cleaning was carried out with a Q-switched Nd:YAG Compact Phoenix Laser. Each coupon was positioned vertically on a white foam board that was moved to change the distance between the coupon surface and the laser handpiece, and hence the fluence used. A rigid piece of board was attached to the handpiece to function as a tactile guide to maintain a constant and relatively accurate working distance during the cleaning process (Fig. 1).

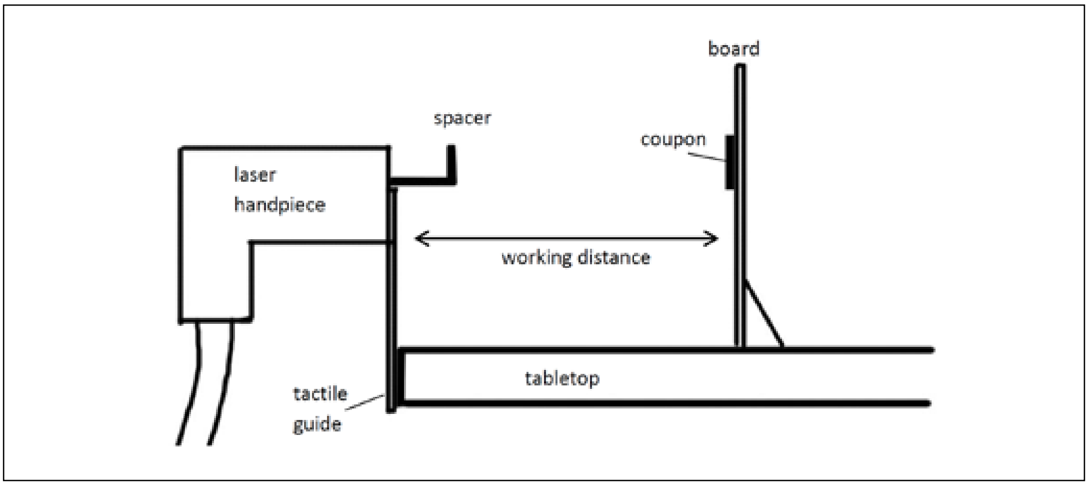


Fig. 1. Diagram of the laser cleaning set-up used (side view).

All tests were conducted at a wavelength of 1064nm, single-pulse with a pulse width of 10ns and a frequency of 2Hz. Adjacent laser spots were placed so that they partially overlapped to obtain complete coverage of the coupon surface. Fluence was calculated using the following formula:

Fluence (J/cm^2) = energy per pulse (J) / area of laser beam on surface (cm^2) (Cooper 1998, 59)

The parameters used on the uncorroded and corroded coupons are presented in Tables 1 and 2. Each set of parameters was tested in triplicate and with control coupons, which were unwaxed coupons that were subjected to the same cleaning process as the waxed coupons.

Documentation and analyses

The coupons were photographed with a Canon EOS 1100D digital SLR camera. Optical microscopy was carried out using a Keyence VHX-1000 digital microscope, at 50x and 100x magnification, in full and partial illumination modes. Examination by ultraviolet-induced visible fluorescence was also attempted, but the Renaissance wax coatings on the coupons were too thin to produce fluorescence visible to the naked eye.

The coupons were weighed using a Mettler AT261 DeltaRange analytical mass balance. Mass measurements were made to five significant figures. To obtain images of the surface morphology of the coupons, a Hitachi S-3400N SEM with an INCA X-Sight EDS detector was used in the secondary electron mode with an accelerating voltage of 5.0kV.

Table 1. Cleaning parameters used in cleaning tests on the uncorroded coupons.

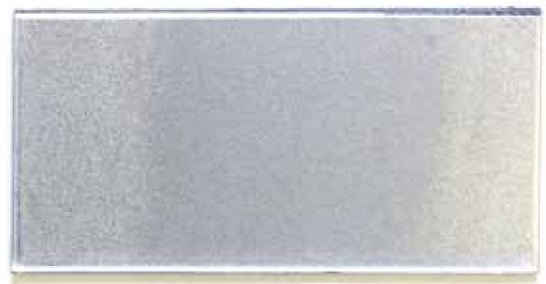
Test set	Energy (mJ)	Working distance (cm)	Fluence (J/cm^2)	Solvent used	Application method	Image of a representative coupon
U1	-	-	-	White spirit	Coupon swabbed till no further change in surface observed.	
U2	90	20	0.46	-	Coupon surface was cleaned twice.	
U3	95	20	0.48	White spirit	Surface was first dampened with solvent on a cotton swab, then cleaned by laser. This process was repeated once.	
U4	95	25	0.25	White spirit	Surface was first dampened with solvent on a cotton swab then cleaned by laser. This process was repeated once.	

Table 2. Cleaning parameters used in cleaning tests on the corroded coupons.

Test set	Energy (mJ)	Working distance (cm)	Fluence (J/cm^2)	Solvent used	Application method	Image of a representative coupon
C1	-	-	-	White spirit	Coupon swabbed till no further change in surface observed.	
C2	95	25	0.25	-	Coupon surface was cleaned twice.	
C3	95	30	0.15	-	Coupon surface was cleaned twice.	

For FTIR analyses, a PerkinElmer Spectrum Two FTIR Spectrometer with data collected by ATR was used with a data collection range of 4000 to 450cm^{-1}. 120 scans and a resolution of 4cm^{-1} were used. Reference spectra of unwaxed and waxed coupons were collected and characteristic wax absorption bands identified with reference to an FTIR spectrum of Renaissance wax from the Infrared and Raman Users Group (IRUG) spectral database (IRUG 2018). Sample coupons were analysed in three different spots by preview mode and one representative spectrum was collected for each set of cleaning parameters.

Results

The two main criteria used to evaluate the results of the cleaning processes on the coupons were:

1. Damage to substrate surface, defined as any change to the surfaces of the coupons after the cleaning process, relative to the initial appearance of the unwaxed coupon surfaces. With the corroded coupons, removal of any corrosion product was considered a form of damage; and
2. Completeness of wax coating removal.

Table 3 summarises the cleaning results suggested by each method of assessment, which are elaborated on in this section.

Table 3. Summary of cleaning results suggested by visual observation, mass measurements, FTIR, and SEM.

Set	Visual observation	Mass measurements	FTIR	SEM
U1	Wax residue present; no change in substrate	Wax residue present	No wax remaining	Changes in substrate surface
U2	No wax remaining; change in substrate on one coupon	No wax remaining	No wax remaining	Changes in substrate surface
U3	No wax remaining; no change in substrate	No wax remaining	No wax remaining	Changes in substrate surface
U4	No wax remaining; no change in substrate	Wax residue present	No wax remaining	Changes in substrate surface
C1	Presence of wax residue inconclusive; substantial changes in substrate	-	No wax remaining	-
C2	Presence of wax residue inconclusive; substantial changes in substrate	-	-	-
C3	Presence of wax residue inconclusive; substantial changes in substrate	-	-	-

Uncorroded coupons

Damage to substrate surface

Observation by the naked eye and by optical microscopy did not detect changes to the substrate surfaces, except for a faint, brown discoloured patch visible on one of the coupons after cleaning by U2 (Fig. 2).

This could have been a result of accidentally exposing that area of the coupon surface to too many overlapping laser pulses during the cleaning process – a similar but more severe discolouration was observed in preliminary trials when a coupon surface was deliberately exposed to multiple laser pulses at a lower fluence.

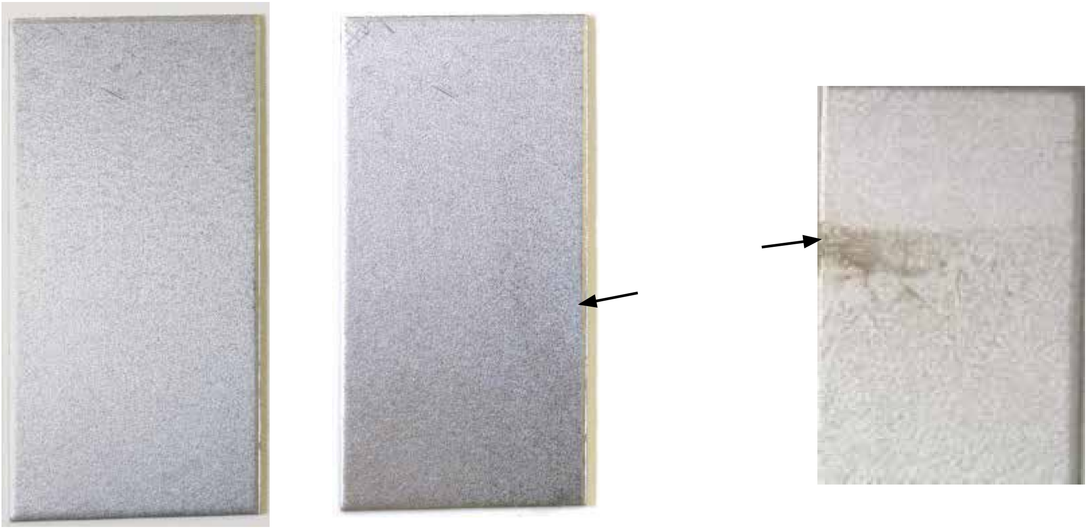


Fig. 2. One of the coupons in U2 before waxing or cleaning (far left) and after cleaning (right), with part of a coupon from a preliminary trial (far right). The arrows indicate the locations of the brown discoloured patches that appeared during cleaning.

SEM images of cleaned areas on selected coupons showed varying degrees of change to the surface morphologies of the cleaned coupons. Generally, grooves and edges on the substrate surfaces appeared more rounded and less defined, and a wrinkled appearance appeared after cleaning (Fig. 3).

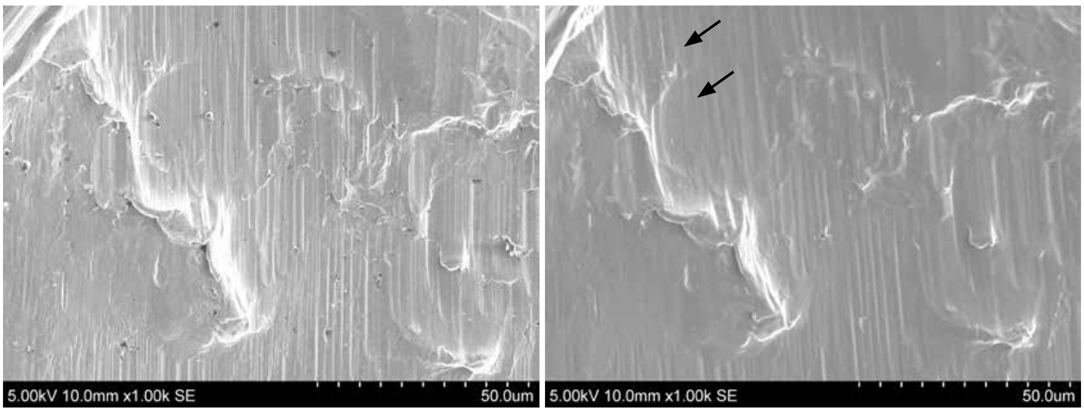


Fig. 3. SEM image of the control coupon of U3, before laser cleaning (left) and after laser cleaning (right). A wrinkled appearance to the surface appeared in the areas indicated by the arrows.

Completeness of coating removal

Application of the Renaissance wax coating imparted a dull, matt appearance to the coupon surface. This was used as a visual indicator as to the presence of a wax layer. Swabbing with white spirit (U1) appeared to remove most of the wax coating. However, a faint haziness remained after cleaning (Fig. 4), suggesting that some wax still remained. With laser cleaning (U2, U3, U4), the wax coating on each coupon appeared to be removed completely in each of the parameter sets tested. The coupon surfaces also appeared to be free of visible wax residue when examined under magnification.

Fig. 4. Selected coupon from U1 before waxing, after waxing, and after cleaning.

A comparison of mass measurements of the coupons before waxing and after cleaning showed that cleaned coupons in test sets U2 and U3 generally had no measurable difference in mass as compared to their initial unwaxed masses. However, the U1 and U4 coupons consistently showed an increase in mass. This suggests that no measurable wax residue remained after cleaning on U2 and U3 coupons, while some residue remained on U1 and U4 coupons after cleaning.

The FTIR spectra obtained of the cleaned coupons showed poor signal strength in the regions of interest. In comparing them against the reference spectrum of Renaissance wax generated, none of the characteristic absorption bands for the wax was visible, implying the absence of wax residue from the cleaned coupons. Unexpectedly, this is inconsistent with the visual observations and mass measurements for U1 and U4 coupons, which had suggested that wax residue was still present on these sets of coupons after cleaning.

Corroded coupons

Damage to substrate surface

The cleaning processes caused significant changes to the substrate surfaces that were observable with the naked eye. The mechanical action of swabbing with white spirit (C1) removed loose corrosion. However, most of the corrosion product was retained. With laser cleaning (C2 and C3), the coupons looked drastically different after cleaning (Fig. 5). The laser pulses ejected large, loose patches of corrosion products from the surface. They also removed much of the lighter corrosion layers and caused some darkening of the remaining corrosion products. Because the damage to the coupons was substantial even at the macroscopic level, SEM imaging was not carried out.

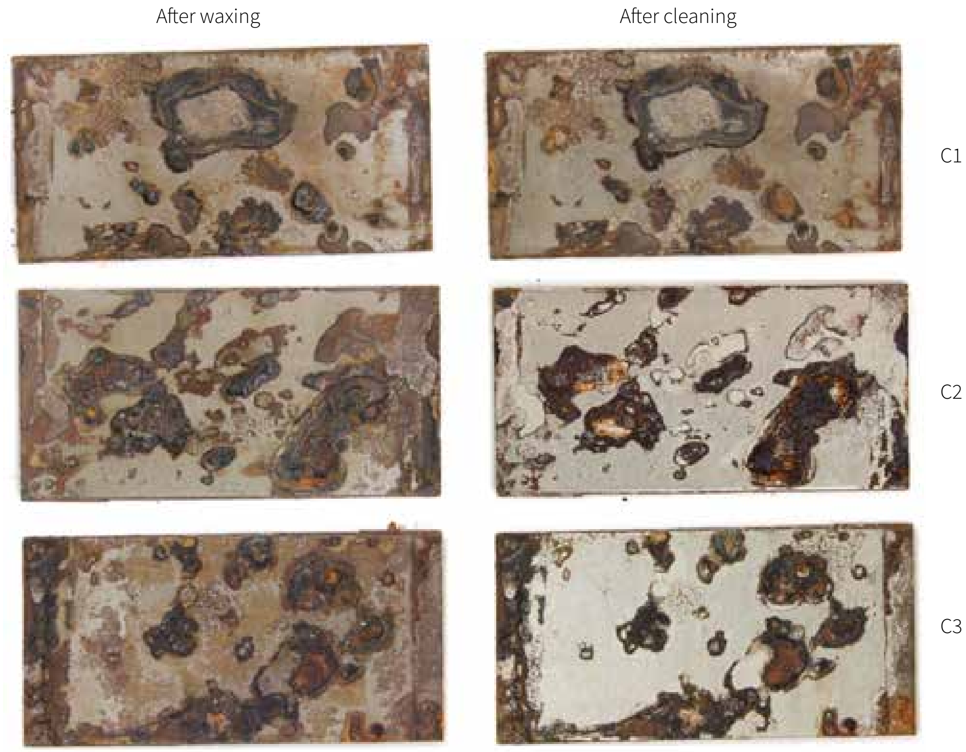


Fig. 5. Images of selected coupons in each test set, after waxing and before cleaning (left), and after cleaning (right).

Completeness of coating removal

Application of Renaissance wax coatings imparted a gloss to some corroded areas, which was used as a visual indicator of change to the wax coating. However, in other areas, the mottled appearance of the surface made changes in colour or gloss difficult to detect.

A reduction in gloss of corroded areas of C1 coupons and in some smaller areas of more adherent corrosion in C2 and C3 coupons suggested that some of the wax had been removed. However, so much of the corrosion had been ejected from the laser-cleaned coupon surfaces that it was difficult to evaluate wax coating removal separately from the removal of the corrosion layer, whether visually or by mass measurements. Any decrease in mass due to wax removal would be indiscernible against that resulting from the substantial loss of corrosion products. FTIR analysis was only carried out on the C1 coupons and the spectrum suggested that no wax residue remained after cleaning.

Discussion

Uncorroded coupons

In terms of wax removal efficacy, laser cleaning appeared to generally clean the coupons more effectively than conventional cleaning with white spirit. However, results were inconclusive as to whether complete coating removal had been achieved for each of the cleaning parameters because of inconsistencies between the different methods of observation and analyses used. These inconsistencies in results suggest that some inaccuracies arise from the limitations of one or more of these methods. It is possible that macroscopic visual examination could not detect wax residues that remained on the coupons in low quantities or that FTIR analyses may have showed false negatives if the small amounts of any wax residue on the cleaned coupons did not produce a strong enough signal to be detected. The rigidity of the coupons may also have made it difficult to achieve good contact between the coupons and the FTIR detector window. More precise mass measurements could also be useful in cases where the mass of wax residue is smaller than the error of a less precise mass balance.

With all the laser cleaning parameters tested, changes to the substrate surfaces observed in the SEM images could possibly be attributed to surface melting of the substrate. This phenomenon has been observed in previous studies (Dajnowski & Dajnowski 2013; Koh & Sárady 2001; Korenberg *et al*. 2008; Lee *et al* 2013). It is also called "micro-melting" (Dajnowski & Dajnowski 2013) because it is only observable under high magnification with an SEM. It has been attributed to the localised high temperatures generated when laser energy absorbed by the surface is converted into heat, and can be minimised by reducing pulse duration or pulse repetition rate (Korenberg *et al*. 2008; Fotakis *et al*. 2007, p. 36-37). Because the substrate surface is altered by melting, it is generally considered an undesirable effect and a form of damage. However, it has also been observed to increase the corrosion resistance of cast iron and in some cases could be considered a beneficial effect instead (Dajnowski & Dajnowski 2013).

Taking these into account, the parameters that seemed to give the most effective and least damaging results of those tested were those used in U3: wet laser cleaning with white spirit and a fluence of 0.48 J/cm^2. The results also demonstrate the advantage of wet laser cleaning over dry laser cleaning: at similar fluences, wet cleaning with one pass of the laser (U3) was able to clean the coupons to a similar level as dry laser cleaning with two passes of the laser (U2), thereby reducing the risk of discolouration by multiple pulses as was observed with one U2 coupon.

Corroded coupons

Both sets of laser cleaning parameters tested resulted in significant damage to the coupons by discolouration and corrosion removal.

Darkening of corrosion products was observed with each of the fluences used (0.25 J/cm^2 and 0.15 J/cm^2). This effect of laser cleaning on iron corrosion products has previously been reported in the literature and it has been suggested that the change in colour is due to the conversion of lighter-coloured corrosion products to black magnetite by the absorbed energy of the laser pulse (Koh & Sarady 2001; Koh & Sárady 2003; Korenberg *et al*. 2008).

Conventional solvent cleaning caused far less damage to the coupon surface. It also appeared to have been able to remove the Renaissance wax coating based on visual observation and FTIR analysis. This is unexpected as it is inconsistent with the reported difficulty of removing Renaissance wax. This result is also inconsistent with the inability of conventional solvent cleaning to remove all wax residue from the uncorroded coupons. It may be that the mottled surface of the corroded coupons impeded accurate visual evaluation of the presence of wax residues. The limitations of the methods of observation and analyses, identified above with the uncorroded coupons, may also apply to these tests with the corroded coupons.

Based on these results, neither set of laser cleaning parameters tested can be considered suitable for removing Renaissance wax coatings from a corroded surface when corrosion layers are to be retained unaltered.

The results of this study suggest that Nd:YAG laser cleaning with white spirit could be a potentially effective method for removing Renaissance wax coatings from an uncorroded iron alloy surface with minimal visible damage. However, the parameters tested were not self-limiting as multiple passes of the laser appeared to have the potential to cause damage to the substrate surface. On the other hand, the laser cleaning tests on corroded coupons caused significant undesirable changes to the corroded substrate, suggesting that the parameters used were unsuitable as a non-damaging cleaning method.

The actual efficacy of this cleaning method remains inconclusive because of some inconsistencies between the results of different post-cleaning evaluation methods. This study is a preliminary step in evaluating the suitability of this cleaning method in a real-world context. Our understanding of this cleaning method and the possibilities for its real-world applications would benefit from further investigation, including changing variables such as fluence, laser wavelength, types of corroded surfaces, coating application methods, etc. How this translates to a practical application of laser cleaning to the treatment of an actual object is beyond the scope of this study and has not been addressed. Apart from experimental data, it will be important to consider the needs of the object and the treatment, as well as the level of damage that is acceptable.

Conclusion

Nd:YAG (1064nm) laser cleaning was tested on waxed iron alloy coupons as a method for removing Renaissance wax coatings. Evaluation by visual observation and microscopy, mass measurements, SEM and FTIR-ATR suggested that wet laser cleaning with white spirit and a fluence of 0.48 J/cm^2 could be a potentially effective and minimally damaging set of cleaning parameters for uncorroded surfaces, but actual efficacy remains inconclusive. None of the parameters tested on waxed corroded coupons was considered suitable as a cleaning method as they caused significant changes to the corroded substrate surfaces. Further studies of laser cleaning for Renaissance wax coating removal from iron alloy surfaces would expand the range of available methods for treatments where wax removal is desired.

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Fig. 1. Diagram of the laser cleaning set-up used (side view).

Table 1. Cleaning parameters used in cleaning tests on the uncorroded coupons.

Table 2. Cleaning parameters used in cleaning tests on the corroded coupons.

Table 3. Summary of cleaning results suggested by visual observation, mass measurements, FTIR, and SEM.

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Fig. 5. Images of selected coupons in each test set, after waxing and before cleaning, and after cleaning.

Reconstructing the Lost: Technical Analysis and Digital Reconstruction Supporting the Treatment of a Portrait of Sir Song Ong Siang

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KEYWORDS
Song Ong Siang, digital reconstruction, visible retouching, painting conservation ethics

ABSTRACT

In preparation for the 50th Celebration of the National Museum of Singapore (NMS) in 2015, a portrait painting of Sir Song Ong Siang (1871 - 1941), the first Chinese in Singapore to be knighted by the British, was selected by the NMS curatorial team to be the key exhibit at the NMS Modern Colony gallery. The figure was recognised for his contributions to the development of Singapore's civil society during his lifetime and was a prominent member of the Straits Chinese community in Singapore.

Painted in 1936 by the German artist Julius Wentscher (1881 - 1961), the portrait had arrived at the laboratory of the Heritage Conservation Centre (HCC) in poor condition, with diminished visual aesthetics. The varnish was severely discoloured and many areas of the paint layer were inexpertly overpainted, resulting in disfiguration.

Complex restoration treatments were carried out on the painting at the HCC between August 2014 and January 2015. A non-invasive examination of the painting, with normal light, ultraviolet fluorescence and X-ray radiography identified the extent of losses in the original paint layers underneath later overpainting. The examination also revealed extensive damage to the subject's facial features. To gain further insights into the original painting technique, better differentiate it from the overpaints and plan the conservation treatments, additional analytical techniques were employed, such as polarised light microscopy (PLM) and scanning electron microscopy with energy-dispersive x-ray spectroscopy (SEM-EDS).

The final appearance of the reconstructed facial features was a result of many anatomical drawings coupled with digital projections tested within the composition, until the unity of the form matched the whole of the painting. Features such as specific perspective, lighting angles and brushstrokes were considered in reconstructing the ear.

This paper presents an in-depth conservation analysis and the decision-making process, with a focus on the removal of all non-original layers and the process of chromatic reintegration of the subject's facial features.

[1] By verbal communication with the author in October 2014.

[2] The HCC Painting Examination & Treatment Report, created on 15 September 2005 (Conservation ID 10115), contains information about previous two restorations.

Introduction

The portrait painting of Sir Song Ong Siang was created in 1936 by the German artist Julius Wentscher (1881 - 1961). It was painted on a large canvas support measuring 213 x 145cm (Fig. 1). The painting was originally displayed at Victoria Memorial Hall in Singapore until 1959. There is no record of the painting's transfer to NMS but NMS curator Daniel Tham believes it probably occurred in the 1960s[1]. Due to its drastically deteriorating condition, the painting had undergone three restoration campaigns between 1971 and 2005.

In early 2014, the portrait was selected by the curatorial team to be the key exhibit at the Modern Colony gallery, when the NMS reopened in September 2015 after renovation. As the previous restoration interventions had resulted in an overall degradation of the original paint layer and compromised the proper reading of the artwork, complex restoration treatments were carried out on the painting at the HCC between August 2014 and January 2015. Due to extensive losses in the paint layer, especially in the critical anatomical details, the retouching process turned out to be the most complicated part of the restoration treatment.

In order to understand the decisions made during the treatment, the restoration history of the painting and its condition before treatment will be discussed briefly. The choice of the retouching method will be explained and substantiated. As a joint curator–conservator effort was vital in finding the best possible aesthetical outcome, the role of the curatorial input will also be presented.

Earlier interventions

The past restoration records of the portrait, although fragmentary, documented the core treatments and their dates. The first documented intervention was conducted in 1971 and encompassed extensive overpainting and varnish application. The second treatment campaign was conducted between 1991 to 1993. Probably dealing with severe paint delamination and loss, the treatment was focused on the improvement of the structural condition of the artwork. The paint layer was consolidated and the whole painting lined with wax-resin adhesive on cotton canvas, and the minor losses were retouched.

The third restoration was done in 2005 at HCC and it reversed many of the previous treatments.[2] Varnish and selected overpaints were removed. The back of the painting was cleared off from the lining canvas and adhesive. The painting was strip-lined with cotton canvas and Beva film and loose-lined, varnished with Talens varnish and retouched with an unknown brand of acrylic colours.

Fig. 1. Portrait of Sir Song Ong Siang before treatment. Courtesy of the National Museum of Singapore, National Heritage Board.

Condition assessment

The image that emerges from the previous records is that the restoration campaigns in 1991 and 2005 did not meet one key objective – improve the painting's aesthetics through addressing the issue of disfiguring overpaint.

When the painting arrived at the HCC laboratory in 2014, its condition was found to be unsatisfactory and this was partially attributed to previous restoration procedures. The portrait was severely compromised by inadequate and darkened overpaints, retouchings and yellowed varnish. The raking light photography (Fig. 2 (a)) and X-ray radiogram (Fig. 2 (c)) provided evidence that the purpose of overpaints and retouchings were to cover the losses in the original paint layer. The texture and level of the overpaints and the retouchings did not match the surrounding original paint layer as the

[3] Samples of the paint were embedded in fast-curing acrylic resin ClaroCit (supplied by Struers) and polished with abrasives down to grade 4000. Optical microscopy was then carried out in visible and ultraviolet reflected light on the Leica DMRX polarising microscope at magnifications of x40, x100 and x200. PLM was carried out using the methodology developed by Peter and Ann Mactaggart. See Peter Mactaggart and Ann Mactaggart, *A Pigment Microscopist's Notebook*, 7th rev. (Somerset, 1998). The mounting medium for pigment dispersions was Cargille Meltmount nD=1.662. Scanning electron microscope (SEM) Hitachi SU5000 coupled with energy dispersive X-ray spectroscopy (EDS) Bruker XFlash 6/60 were used for imaging morphology of additives and their chemical composition. In SEM, the backscattered electron mode (BSE) was used in 60Pa vacuum, with 20kV beam acceleration, at 50 - 60 intensity spot and working distance of 10mm. The distribution of chemical elements was mapped using Bruker's processing software.

amendments were laid over the original canvas support. The ultraviolet fluorescence photography (Fig. 2 (b)) compared with the X-ray radiogram showed that many of the overpainted areas were greater than the actual losses and consequently covered the original paint layer.

Among the many affected areas, Song Ong Siang's face was the most disfigured due to unnecessary overpaint and the poorly executed reconstruction of the left ear, probably the result of the 1971 restoration campaign. The reconstruction, conducted without an understanding of the principles of perspective and anatomy, was responsible for very negative visual impact. In a 3/4 facial view, the exposed ear, affected by perspective, should appear smaller and narrower than when seen at profile view. The reconstructed ear, by comparison, lacked perspective and related more to a profile view in its greater width. Another issue was the low position of the reconstructed ear in relation to other anatomical details, which revealed an unawareness of facial trisection theory, which proposes that the lengths of the nose and ear are identical, and that each constitutes approximately a third of the facial height.

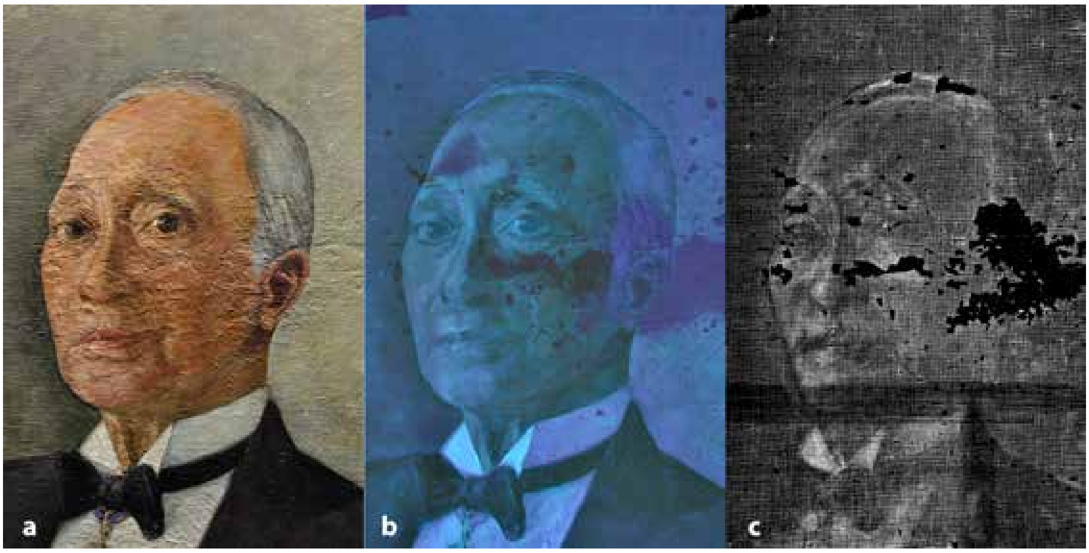


Fig. 2. Close-up of the face. (a) Visible raking light photography. (b) Ultraviolet fluorescence photography. (c) X-ray radiogram.

Technical examination

In determining a treatment course, it was of utmost importance to first establish what the original and non-original paints are, and to clarify the structure of the layers, especially in the area of the reconstructed ear.

Three paint samples were taken for optical microscopy stratigraphic analysis, polarised light microscopy and SEM-EDS elemental analysis.[3] In view of the planned reconstruction of the ear, it was also interesting to confirm the pigment composition used by the artist for the flesh colour.

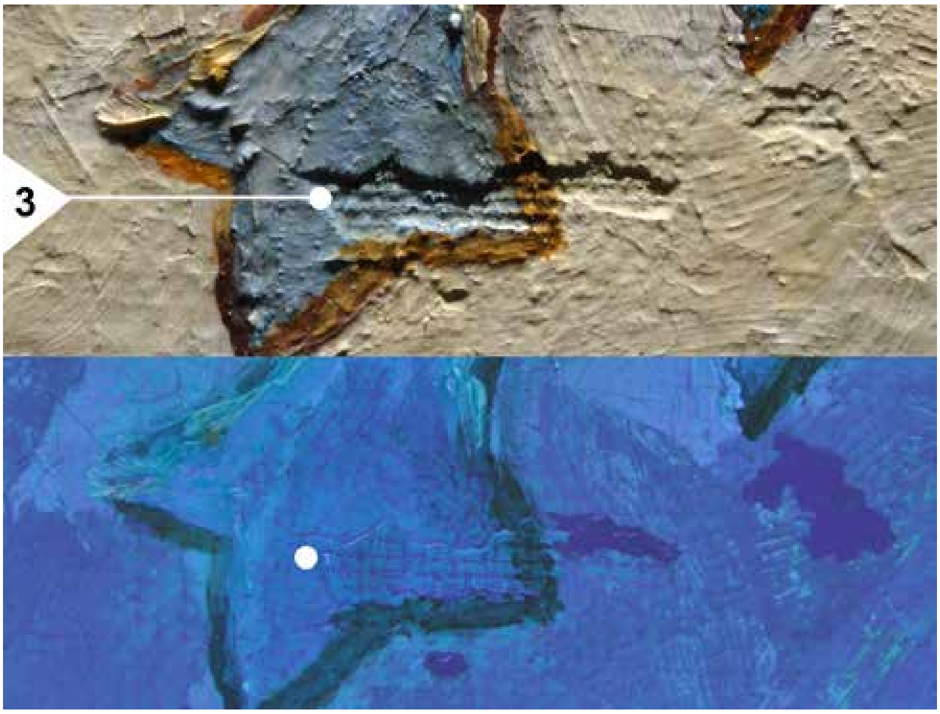


Fig. 3. Detail of the Order with indicated sampling area. The adjacent ultraviolet fluorescence image shows the areas of overpaint.

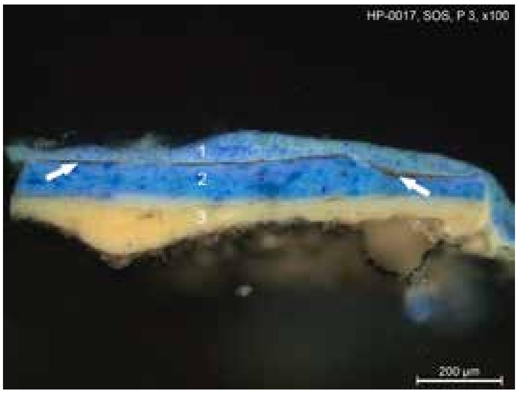


Fig. 4. Paint cross-section of a sample taken from the blue enamel of the Order, showing a separation between the two blue layers.

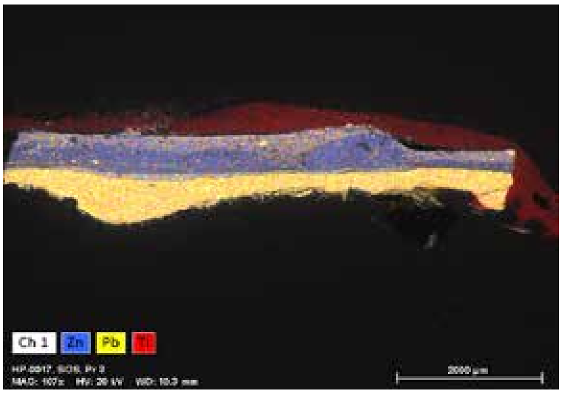


Fig. 5. SEM-EDS distribution map of Zn, Pb and Ti. Layer 2 has different amount of Zn along the upper and bottom areas.

An optical microscopy of the paint cross-section with the blue enamel of the Order near the loss area (Fig. 3) revealed two layers of blue with a distinctive gap between them (Fig. 4), suggesting that the top layer was applied after the lower layer had dried. It is noted that the top layer surrounds the other blue and white layer at the sides as well. In addition, the PLM and SEM-EDS measurement showed that the top layer is a mixture of ultramarine with titanium white (and probably lithophone) (Figs. 5 and 6) applied over the mixture of cerulean, lead and zinc white (Figs. 5 and 7). This finding confirmed that the top layer is an overpaint.

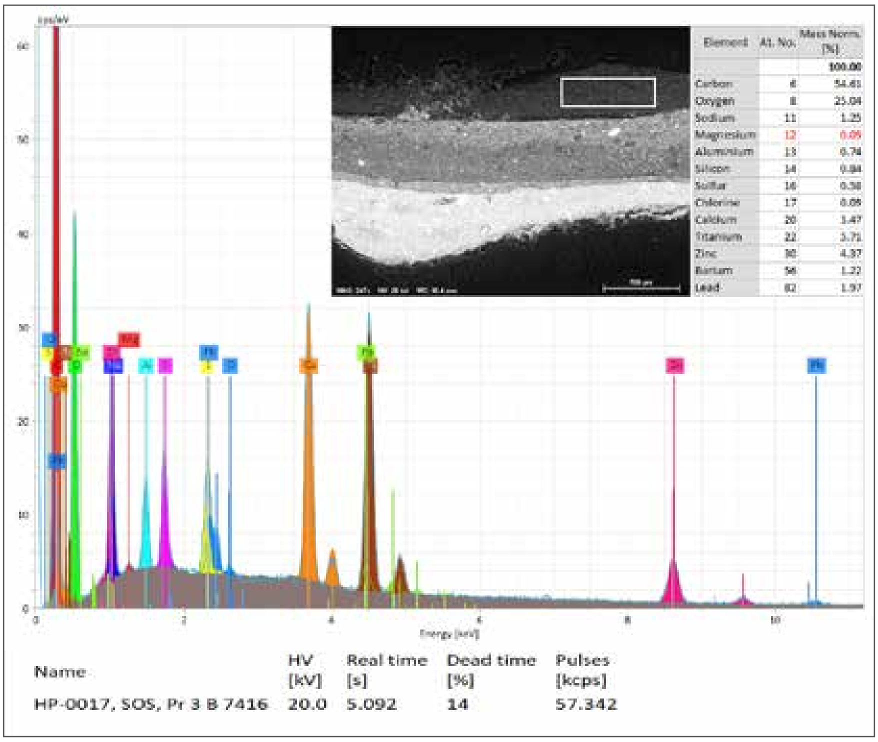


Fig. 6. SEM-EDS quantitative elemental analysis of top blue layer (overpaint). The insert SEM-BSE image shows the paint cross-section with the selected area used for the EDS measurement. The layer is a mixture of ultramarine with titanium white and probably a small addition of lithophone.

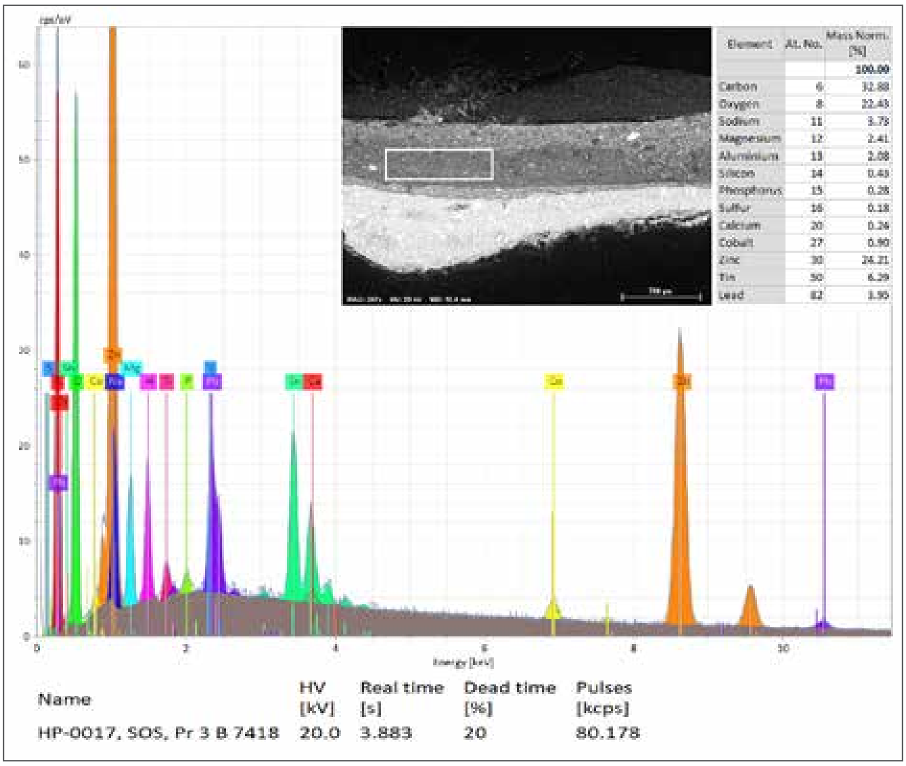


Fig. 7. SEM-EDS quantitative elemental analysis of original blue layer. The insert SEM-BSE image shows the paint cross-section with the selected area used for the EDS measurement. The measurement was taken from the bottom part of the layer, where the higher concentration of Co and Sn gave a stronger signal. The layer is probably a mixture of cerulean, ultramarine, lead and zinc white.

Two cross-sections from the restored area of the ear and the adjacent original paint (Fig. 8) reveal the differences between the structure of their layers. The restored ear was painted directly over the area of loss without priming, confirming the earlier visual observation with the raking light. The sample shows multiple and complex paint layers, suggesting that the restorer struggled to find the correct shape and flesh colour of the ear (Fig. 9). The main component of the overpaints is a mixture of a high amount of titanium white with a small addition of zinc white, which was confirmed by the SEM-EDS (Fig. 10). The flesh colour was achieved by adding iron red, umbra and organic red, as confirmed in the SEM-EDS elemental analysis (Fig. 11) and PLM.

In contrast, the sample from the adjacent original paint layer has a fundamentally simple structure (Fig. 12). The white ground is present and composed of a high amount of lead white with a small addition of zinc white, similar to the sample taken from the blue enamel. The flesh colour above the ground was achieved by an application of three layers of mixtures containing lead and zinc whites with cadmium yellow and sienna, as confirmed in the SEM-EDS elemental analysis (Figs. 13 and 14) and PLM. Although the optical microscopic image of the sample showed a uniformity of the flesh colour layer, the SEM-BSE mode revealed that the artist painted using a layering system with different Pb–Zn and Cd–Fe ratios, perhaps in an attempt to find a satisfactory hue (Fig. 14).

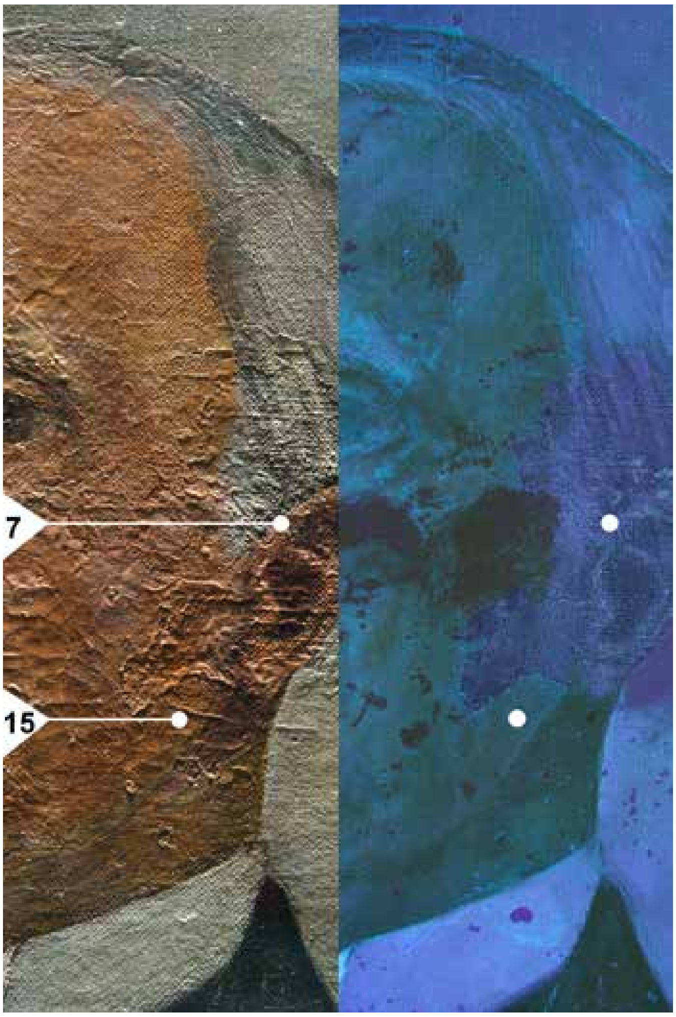


Fig. 8. Detail of the face with indicated sampling areas. (7) Reconstructed ear. (15) Original paint. The adjacent ultraviolet fluorescence image shows the areas of overpaint.

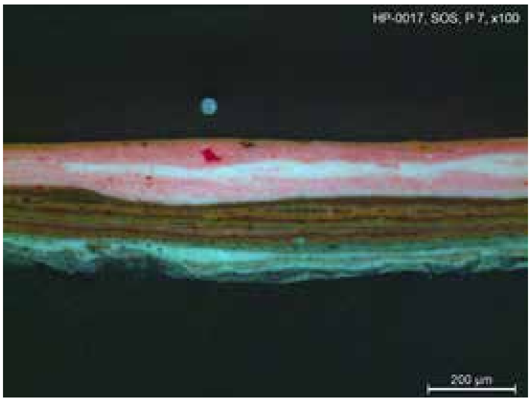
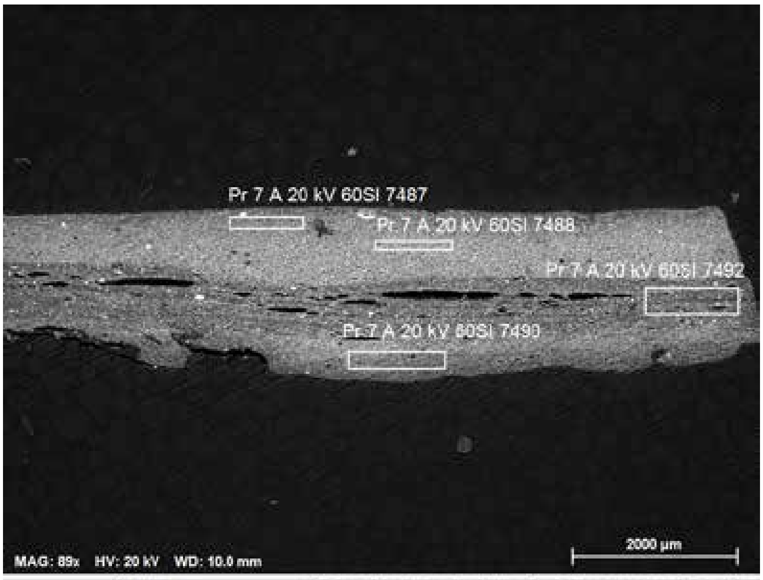


Fig. 9. Paint cross-section of sample 7, taken from the reconstructed ear.

Fig. 10. SEM-EDS distribution map of Ti.



Spectrum	C	O	Na	Al	Si	S	Ca	Ti	Mn	Fe	Zn
HP-0017, SOS, Pr 7A 20 kV 60SI 7487	55.05	27.66	0.45	0.24	0.13		4.29	7.06		1.34	3.78
HP-0017, SOS, Pr 7A 20 kV 60SI 7488	52.45	24.32	0.52	0.29	0.16		5.64	11.38		0.52	4.73
HP-0017, SOS, Pr 7A 20 kV 60SI 7492	54.62	28.64	0.21	0.35	0.39	0.11	5.58	3.92	0.37	3.99	1.81
HP-0017, SOS, Pr 7A 20 kV 60SI 7490	51.91	27.52	0.38	0.54	0.44	0.14	3.18	12.05		1.67	2.17

Fig. 11. SEM-BSE image of the paint cross-section of sample 7, with selected areas of the EDS measurements and result table of quantitative elemental analysis.

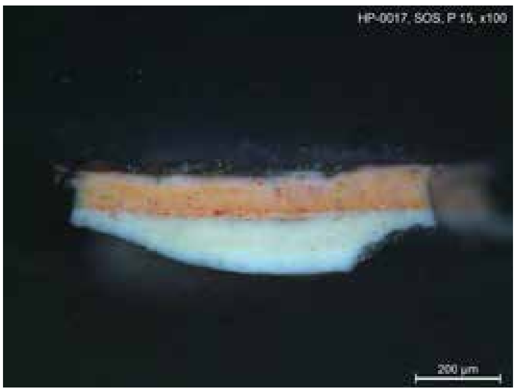


Fig. 12. Paint cross-section of sample 15, taken from the original paint near the reconstructed ear.

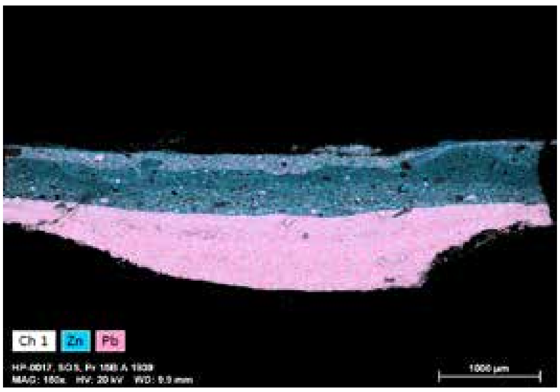
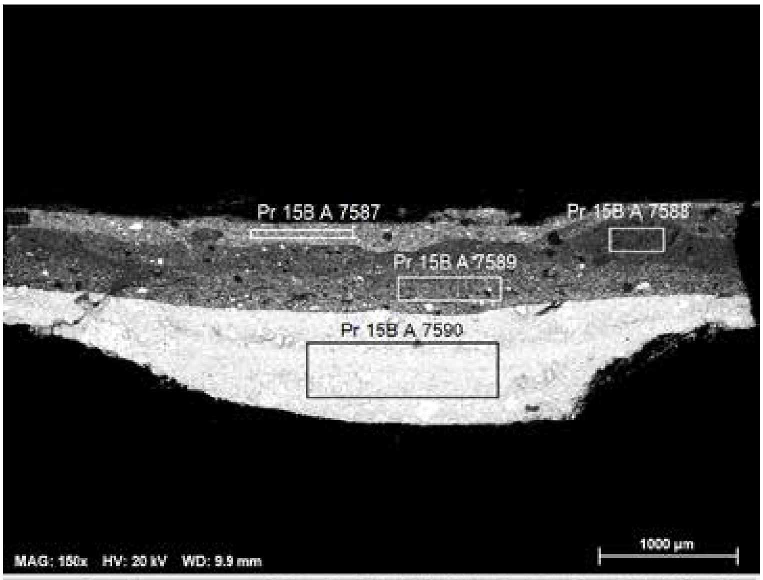


Fig. 13. SEM-EDS distribution map of Zn, Pb.



Spectrum	C	O	Na	Al	Si	S	Ca	Fe	Zn	Cd	Pb
HP-0014, SOS, Pr 15B A 7587	28.85	17.13	1.83	0.44	0.23			0.23	14.99	0.92	35.39
HP-0014, SOS, Pr 15B A 7588	35.91	20.42	3.88	0.48	1.50	0.22	0.45	0.44	29.83	0.54	6.34
HP-0014, SOS, Pr 15B A 7589	29.08	19.58	2.63	0.93	1.41		0.16	1.24	23.11		21.87
HP-0014, SOS, Pr 15B A 7590	19.47	13.73	0.31	0.21					0.62		65.66

Fig. 14. SEM-BSE image of the paint cross-section of sample 15, with selected areas of the EDS measurements and result table of quantitative elemental analysis.

Additional observations of the painting style of the anatomical details revealed a few crucial details that would be useful in the reconstruction phase. It became apparent that the painter had used dark brown for shadows, light brown for light areas, pink for highlights and light green for middle tones. He also used dark brown contour to enhance the form and isolate it from the background (Fig. 15).

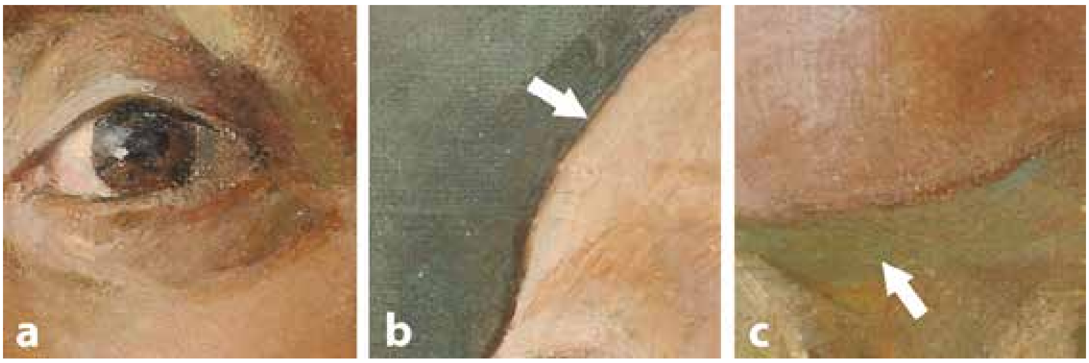


Fig. 15. Detail photographs showing: (a) Dark brown used in shadows, light brown for light areas and pink for highlights. (b) Dark brown contour. (c) Light green.

Treatment decision

Once the condition of the painting and full extent of the losses were known, a decision on how the painting should be treated was paramount. The input from the curator[4] was essential to ensure the success of the project. The curator-conservator discussions and a mutually-reached agreement on a cohesive treatment strategy were required, including well-thought-out decisions regarding how to treat the previous reconstruction of the left ear, overpaints and retouchings.

According to ethical conservation principles, any previous treatment of the artwork forms part of its history and should be taken into consideration during conservation treatment. This triggers a question if overpaint or improper reconstruction that is visually disturbing should still be preserved. Art historian Maximiliaan Martens suggests that, a conservator can consider two treatment options: improving the integration or removing it.[5] As the state of the materials used in the portrait of Song Ong Siang and the quality of the previous treatments were unsatisfactory and could not be sufficiently corrected and integrated, the removal of all the obtrusive materials followed by the reconstruction of lost paint was justified.

Another challenge was the reintegration of losses. Small and medium losses presented no problem and could be retouched using the original paint as a reference. On the other hand, the integration of major compositional losses while respecting the painting's authenticity was considered one of the fundamental issues of the restoration process. Hence, the question of how to address this issue in the portrait of Song Ong Siang was raised during one of the many conservator–curator meetings. As the painting was chosen to be the key exhibit, it was clear that leaving the untreated complex damage in the facial area would interrupt the continuity of the form and hence degrade its artistic and aesthetic value.

From an aesthetic viewpoint, a work of art is not composed of individual parts[6] but characterised by the unity of the form as a whole.[7] Therefore, reconstruction as a critical interpretation is aesthetically justifiable as long as it aims only at making it easier for one to see the potential formal unity of the work existing within the fragments.[8] According to art historian Umberto Baldini, if the intervention should happen, "it cannot be avoided by appealing to that kind of alibi that a convenient interpretation of the 'charter of restoration' allows those who do not wish to face issues or formulate problems with no easy solutions".[9] Barbara Appelbaum similarly feels that the conservator in such a situation has a great responsibility and should face the challenge.

"To refuse to bring an object much closer to its ideal state because we cannot be sure of the one-hundred-percent correspondence of our work with the lost original cuts against our responsibility as conservators to restore the usefulness and meaning of objects to their custodians."[10]

The decison for the reconstruction of the left ear was supported by the obvious anatomic evidence; however, there was a need for more sources to inform the reconstruction treatment. Thus, the curator obtained archival photographs for close examination and the creation of a digital reconstruction prior to the actual painted reconstruction.

Another challenge was choosing between minimal, imitative or visible retouching methods[11] as a technical solution for recovering the artistic integrity in the critical area of the face. Minimal retouching was ruled out because the conservator and curator both expressed concerns over how members of the public would respond to the display of "unrestored work". This retouching method risked drawing the viewers' attention to the flaw, disrupt the flow of the image, and undermine the artist's intention.

While the imitative retouching method could perfectly have served the concept of reconstruction, the visible retouching method was ultimately favoured as it aimed to blend the reconstructed parts seamlessly with the original, in such a way that the reinstated areas would be invisible to normal viewing, but discernible up-close.

[4] May Khuen Chung, former NMS curator.

[5] Martens, Maximiliaan P. J., (2015). "'Leave it or take it away': ethical considerations on the removal of overpaintings", *CeROArt* (HS), 4. Retrieved from: https://journals.openedition.org/ceroart/4765.

[6] Philippot, A. & Philippot, P. (1996). "The problem of the integration of lacunae in the restoration of paintings". In (Eds.), Stanley, N. Talley, Jr., M. K. & Vaccaro, A. M. *Historical and Philosophical Issues in the Conservation of Cultural Heritage*, p. 335. Los Angeles: Getty Conservation Institute. Retrieved from: https://trove.nla.gov.au/work/21678149?selectedversion=NBD12008809.

[7] Mora, P., Mora, L. & Philippot, P. (1996). "Problems of presentation". In (Eds.), Price, N. S., Talley Jr., M. K. & Vaccaro, A. M. *Historical and Philosophical Issues in the Conservation of Cultural Heritage*, p. 345. Los Angeles: Getty Conservation Institute.

[8] Mora, P., Mora, L. & Philippot, P. (1996). "Problems of presentation".In (Eds.), Price, N.S., Talley. Jr., M. K., & Vaccaro, A. M. *Historical and Philosophical Issues in the Conservation of Cultural Heritage*, p. 345. Los Angeles: Getty Conservation Institute.

[9] Baldini, U. (1996). "Theory of restoration and methodological unity". In (Eds.), Price, N. S., Talley Jr., M. K. & Vaccaro, A. M. *Historical and Philosophical Issues in the Conservation of Cultural Heritage*, p. 356. Los Angeles: Getty Conservation Institute.

[10] Appelbaum, B. (2007). *Conservation Treatment Methodology*, p. 253. Oxford: Butterworth-Heinemann.

[11] Muir, K. (2009). "Approaches to the reintegration of paint loss: theory and practice in the conservation of easel paintings", *Reviews in Conservation* 10, pp. 19 - 28.

[12] Siang, S. O. (1984). *One Hundred Years' History of the Chinese in Singapore* (Reprint). Singapore: Oxford University Press.

[13] Siang, S. O. (1923). *One Hundred Years' History of the Chinese in Singapore*, 4. London: John Murray. Retrieved from: http://www.nas.gov.sg/citizenarchivist/annotate/transcribe?itemid=33548&collectionid=134.

Digital reconstruction

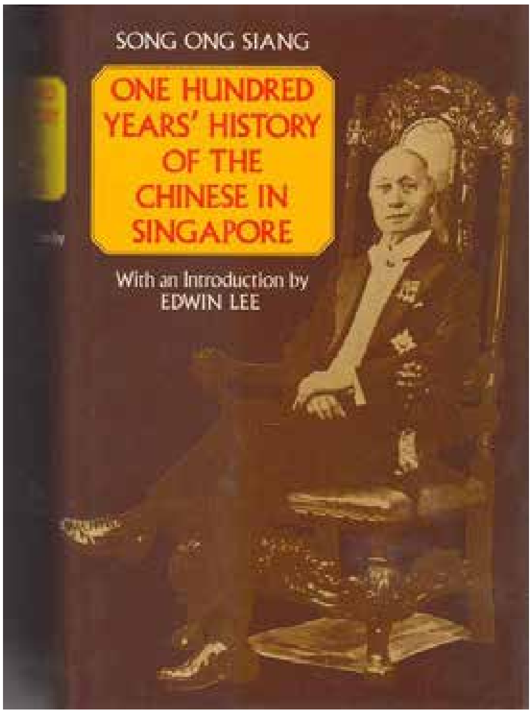


Fig. 16. Photograph of Song Ong Siang, from the front cover of the 1984 edition of One Hundred Years' History of the Chinese in Singapore *by Song Ong Siang.*

There are a few photographic references however, not a single alone offers sufficient information on which to reliably base an accurate reconstruction of the ear.

The first reference is a photograph from the book *One Hundred Years' History of the Chinese in Singapore*, published by Song Ong Siang in 1923 (Fig. 16).[12] There are many similarities between this photograph and the portrait however, in the photograph, the man's head is turned more towards the camera and viewer, hence the visibility of his left ear is reduced. In the painting, the head is angled straight, towards a point in the distance; hence, the left ear is well exposed and well defined to the viewer.

Fig. 17. Photograph of Mr & Mrs Song Ong Siang, from the 1923 edition of One Hundred Years' History of the Chinese in Singapore *by Song Ong Siang.*

The second photograph used for consideration is from the original 1923 edition of the same book (Fig. 17).[13] In this photograph, the man's pose is quite similar to the portrait. The direction of his head in the photograph is similar to that in the painting, with the visible left ear. Unfortunately, the size of the photograph and the quality of the book printing made anatomical study very difficult.

A third photograph, from c. 1920,[14] presenting Song Ong Siang as a much younger man and showing the right side of his face, provided several essential details for the reconstruction process (Fig. 18). We could see in this photograph that his earlobe is a detached type with distinctive helix (Fig.18 (a)), anti-helix (Fig. 18 (b)) and lobule (Fig. 18 (c)).

Fig. 18. Photograph of Song Ong Siang, c. 1920, from the Lee Brothers Studio Collection, courtesy of National Archives of Singapore. Arrows indicate: (a) Helix. (b) Anti-helix. (c) Lobule.

[14] From Lee Brothers Studio Collection, courtesy of National Archives of Singapore (accession no.: 2008_004971_LHM). Retrieved from: http://www.nas.gov.sg/archivesonline/photographs/record-details/a8a8259f-1162-11e3-83d5-0050568939add

Next, preliminary drawing studies were carried out. Facial trisection principles were kept firmly in mind – the length of the nose and ear are identical and each constitutes approximately one-third of the facial height. In addition, as the view of the portraited face is 3/4, the exposed ear's size would be affected by the perspective, and thus appear smaller. If the face had been drawn from a 2/3 view, the ear would be turned more towards the viewer and thus appear bigger. The anatomical drawings were made and tested within an enlarged photocopy of the face until the unity of the form matched the original.

In the next phase, paints were used on mock-ups to observe the changing impact of light and shadow in the definition of the form, and how the reconstructed ear integrates with the face. The most satisfactory results were scanned and, using Adobe Photoshop CC, pasted, and transformed with scale, perspective and distortion tools; this was followed by merging, employing the system of layers, and manipulating with opacity and fill. Finally, the fill was colour-corrected with levels and colour balance tools. The final draft was presented to the curator for consultation (Fig. 19).

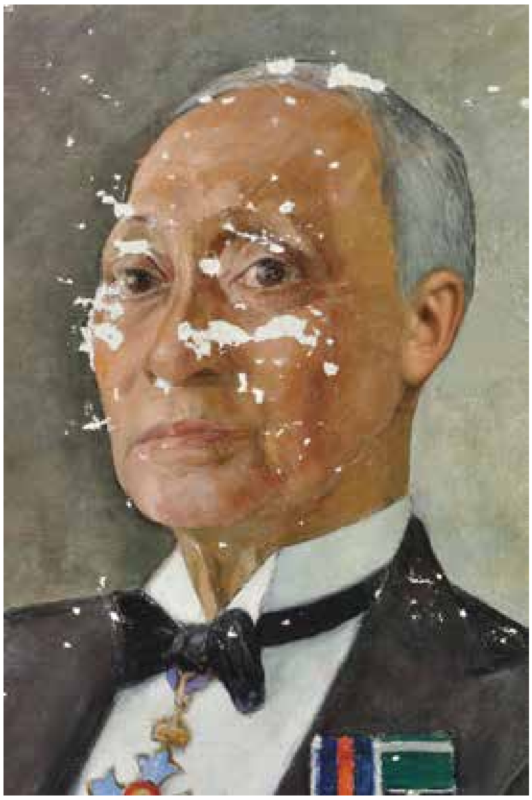


Fig. 19. The result image of digital reconstruction of the left ear and surrounding area.

Retouching

Although the previous phases of restoration, such as the complex cleaning process and structural work, constituted the bulk of the treatment time and greatly contributed to the final outcome, those phases will not be discussed here as they are outside of the main focus of this paper. The paint loss reconstruction was the ethically sensitive phase of the treatment and it determined the aesthetic consistency of the painting; thus, it was the focal point of this paper.

For infilling, a white putty – 12% weight ratio of calcium carbonate and Mowiol 4-88 (a polyvinyl alcohol) – was prepared by hand. Imitating the texture of the surrounding paint layer was key for the integration of fills with the original paint layer and for further retouching. To achieve the correct texture, the putty was applied wet by means of dots and modelled strokes to mimic the original texture (Fig. 20).

Fig. 20. Close-up view of the area of paint loss after infilling and texturing.

The painting was stretched onto the stretcher and brush-varnished with 10% Paraloid B-72 in 1-methoxy-2 propanol, followed by a coat of Larapol A81 at 12% in Shellsol A100. Due to the large number of losses (Fig. 21), first, smaller and peripheral areas were retouched; then, the larger and more central areas were approached, until the various nuances became apparent; in this way the damaged areas that were harder to treat could be better assessed.[15]

Fig. 21. View of the painting after infilling.

For most of the small and medium-size losses, Schmincke gouache was used to preliminarily integrate the losses with plain colours. Next, the retouching was executed with Gamblin Conservation Colours.

The painted reconstruction of the ear was a multi-step process. First, an image of the digital reconstruction was printed to the actual size and mounted in the vicinity of the damaged paint, so the latter could be constantly referred to and copied from. Next, a freehand pencil drawing of the ear was executed (Fig. 22(a)) and protected with a coat of 10% Regalrez 1094 varnish in Stoddard. The gouache underpainting was used more freely to recreate the anatomical details; it was also made a few shades brighter than the original

[15] Mora, P., Mora, L. & Philippot, P. (1996). "Problems of presentation". In (eds.) Price, N. S., Talley Jr., M. K. & Vaccaro, A. M. *Historical and Philosophical Issues in the Conservation of Cultural Heritage*. Los Angeles: Getty Conservation Institute, 349.

paint layer in order to retain the maximum intensity of the surface for the upcoming visible retouching executed with Gamblin Colours. With this technique, the reconstructed areas are imperceptible when observed from a distance, but distinguishable upon closer observation. An earlier identification of cadmium yellow and sienna in the flesh colour significantly helped with colour matching. It is interesting to note that both pigments are relatively opaque and have good tinting strength, which make them a perfect choice for an artist and conservator. To enhance the final visual effect, some dark, brown contours and light green middle tones were applied; these tones are similar to the ones found on other parts of the face (Figs. 22(b), 23 and 24).

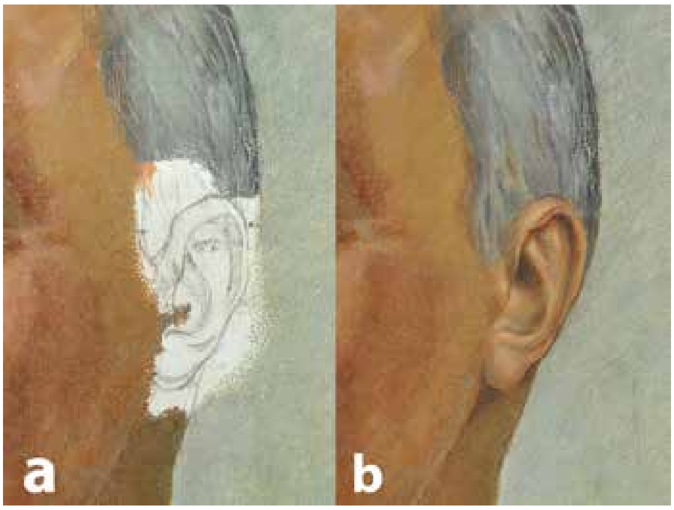


Fig. 22. Painted reconstruction of the ear. (a) Freehand pencil drawing. (b) Fully reconstructed ear.

Fig. 23. Close-up view of the face after retouching.

Fig. 24. View of the painting after restoration. Courtesy of the National Museum of Singapore, National Heritage Board.

Conclusion

This case demonstrates that in conservation practice, there are no default decisions; they should instead be derived from a complex assessment process. A study of the paint layer with different types of light and x-ray imaging, combined with microscopic and spectroscopic examination of the paint samples, supplemented with past treatment records provided an exhaustive knowledge of the condition, nature and impact of the past interventions on the painting. The information gained from the assessment process allowed for a thorough evaluation of the possible treatment scenarios, made in accordance with conservation ethics.

Knowledge of anatomy and perspective principles combined with freehand drawing and an understanding of the painting style helped the conservator to achieve viable reconstruction. Digital tools greatly enriched the reconstruction process as it allowed manipulation and preview before actual application to the painting. The digital reconstruction was key to allowing the conservator to reach a decision confidently. The visible retouching method minimised losses and restored the painting's functionality.

The reinstated area looks invisible to the casual observer, but it is evident with closer observation, and when illuminated with UV light. The reversibility of the reconstruction was one of the main concerns during this project and it impacted the choice of materials used. In addition, the chosen retouching methodology allowed the conservator to work by the layer, so that each layer can be removed by using different solvents if necessary.

This intricate conservation project was captured on a short film, *Restoring the Lost*. Produced by the NMS, the video clip is permanently installed in the NMS gallery next to the painting to increase public awareness of the complexities of the conservation process of this particular painting and the profession as a whole, and the role that HCC plays in the preservation of the national heritage of Singapore.

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Author's biography

Damian Lizun received his Master of Arts in Conservation and Restoration of Paintings and Polychrome Sculpture from Nicholas Copernicus University, Torun, Poland, in 2001. During his studies and after graduation, he worked in his family's conservation business, where he gained practical and analytical skills from his father, conservator Zenon Lizun. In 2006, he was appointed Conservator (Paintings) at Tipperary County Museum, Ireland. He moved to Singapore in 2013 when he was appointed Conservator (Paintings) at the Heritage Conservation Centre.

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Use of Technology in Collections Management: HCC's RFID Experience

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ABSTRACT

This paper discusses the use of technology in collections management, specifically in the area of tracking the movement of artefacts and artworks. As the size of a museum collection and the frequency of its access grow over time, maintaining accurate movement and location records becomes increasingly challenging without the aid of technology. However, what technology to employ is not an easy question to answer considering the resource constrains that museums face and the unique challenges of automating the tracking of cultural materials.

Radio frequency identification (RFID) technology is used in many industries to automatically identify and track tags attached to objects. It is an upgrade from manual tracking systems or barcode technology that requires a line of sight and one-at-a-time only reading. The reliability and performance of RFID technology has matured over the years and its usage around the world has proliferated due to decreasing cost of equipment and tags.

However, there are few examples of RFID technology use in museum collections management. What are the challenges or limitations in applying this technology to manage artefacts and artworks? This paper will discuss the unique difficulties in tagging cultural materials, drawing on the Heritage Conservation Centre's (HCC) experience in implementing and using RFID to manage location and movement records, and carry out regular stocktake. It will cover the infrastructure setup required, the deliberation on the types of RFID tags to use, and the inherent complexities involved in attempting to tag cultural materials. The results and outcome of HCC's RFID tagging project will be shared, as well as the key learning points to note for other institutions considering the adoption of this technology.

Introduction

As the size of a collection grows and the frequency of its access increases, data accuracy and reliability becomes an issue when manual processes that are prone to errors becomes overwhelmed and difficult to maintain. Against the backdrop of rapid technological advancements in the last two decades, expectations of how we can utilise technology to improve our work has increased tremendously, as well as a steadfast belief that technology will create greater efficiency and solve our ever-increasing resource constrains. This paper discusses the use of technology in collections management and shares HCC's experience in implementing RFID technology to improve the accuracy, ease and efficiency of tracking and stocktaking artefacts and artworks.

The number of items in the Singapore National Collection (NC) have grown rapidly from around 25,000 objects in the 1990s to over 200,000 objects today. The number of museums that HCC supports has also increased from two museums in the late 1990s to five museums[1] and three heritage institutions[2] today. The frequency of access to the collection has, therefore, increased tremendously with the centre now supporting approximately 50 exhibitions, rotation and loan projects each year, as well as accessioning between 2,000 to 3,000 new acquisitions every year. The number of researchers that visits the centre to view and study the collection has also increased steadily.

It was clear that technology was needed to improve work efficiency and replace many of our manual work processes, such as the tracking of artefact and artwork movements in and out of collection stores using logbooks, manual updating of storage locations to the database, issuing of handwritten receipts and use of manually prepared lists for stocktake. The accuracy of location records in our database has also become increasingly unreliable over time. This has resulted in precious time wasted on searching for misplaced items, and a troubling situation of being unable to know whether an item was lost or misplaced whenever we could not find it. One of our primary responsibilities in managing the collection is to ensure that all items under our care are properly accounted for, but the manual stock-take process we used was extremely onerous and the large volume of paper records generated were difficult to maintain and retrieve for reference.

Knowing that the situation will only get worse with time, a process review was carried out in 2011 where RFID was identified to be a suitable technology to improve the tracking of artefacts and artworks. HCC embarked on the RFID technology project in 2013 with the focus to improve the tracking and updating of artefacts and artworks movements and the process of performing stocktake. The central idea is to employ RFID technology to automate the existing manual work processes.

Background of RFID technology

RFID is one of the automatic identification and data capture (AIDC) technologies which identifies objects and automatically collects data about the objects and updates them to a computer system without human intervention[3]. It uses wireless radio waves to transmit, identify, trace, sequence and confirm objects[4].

Many museums around the world are still using traditional manual handwritten methods that are time-consuming and prone to error to manage and record the movement of artefacts and artworks[5]. Some have made the step up to employ barcode systems, but barcode technology has its limitations with the most pertinent being the need to have a line of sight to scan and read the barcode labels. This means there is a need to handle the artefact or artwork in order to read the barcode, which results in higher risk of damage due to repeated handling or mishandling. RFID technology, on the other hand, does not have this limitation as it does not require a line of sight for a tag to be scanned and read.

RFID is also a mature technology used for tracking object movements with proven application in many industries such as pharmaceutical, retail and logistics. The use of RFID around the world has proliferated over the years due to the decreasing cost of RFID tags and the communication equipment used. However, there are hardly any examples of successful large-scale implementation of RFID for managing museum collections. Why is this so and what are the challenges in applying this technology to manage artefacts and artworks?

Inherent challenges in tagging artefacts and artworks

There are some unique difficulties in tagging artefacts and artworks that explain why RFID technology is not actively adopted in managing museum collections. Every object in a museum collection is unique and irreplaceable. They are made of different material, of different shapes and sizes, and in different stages of deterioration – some are in stable condition, while others could be so fragile that any mistakes in handling would cause irreversible damage. The risk of damage to the collection in the process of tagging could be a reason why many museums are reluctant to adopt RFID technology. The task of implementing RFID is even more daunting for institutions looking after a large number of

[1] The five museums are National Museum of Singapore (NMS), Asian Civilization Museum (ACM), Peranakan Museum (TPM), Singapore Art Museum (SAM), and National Gallery Singapore (NGS).

[2] The three heritage institutions are Indian Heritage Centre (IHC), Malay Heritage Centre (MHC) and Sun Yat Sen Nanyang Memorial Hall (SYSNMH).

[3] Mohd, K. Y. and Md., Y. S. (2016). The Adoption and Implementation of RFID: A Literature Survey. *Libres* 6, no. 1, p. 32.

[4] Mohd. and Md. The Adoption and Implementation of RFID, p. 32.

[5] Xiao, C., Chen, N., Li, D., You, Lv. & Gong, J. (2017). SCRMS: An RFID and Sensor Web-Enabled Smart Cultural Relics Management System. Sensors 17, no. 1, p. 1.

artefacts and artworks. It is natural to wonder if it is possible to tag hundreds of thousands (or even over a million) objects in a safe, efficient and timely manner.

Apart from the risk of damage, there is also the problem of how to attach RFID tags onto the artefacts and artworks. It is difficult to imagine how this can be done easily given that every object is different. The method to attach the RFID tags will need to be secure enough and yet safe and reversible (i.e., can be undone without damage to the object). Directly adhering RFID tags onto the objects is not an option due to the risk of damage. If you are unable to attach the RFID tags directly, does it still make sense to implement RFID technology?

There are no comparable high-value assets managed in other industries using RFID technology that have similar characteristics to artefacts and artworks. Similarly, there are no readily available solutions in the market that can be bought off-the-shelf and implemented easily. To undertake RFID tagging, the museum will have to invest resources and efforts to study and develop customised RFID tags that can be applied across a wide range of museum objects and devise attachment methods that are simple enough for efficient implementation.

HCC's RFID journey

Despite the challenges in implementing RFID for managing collections, HCC made the decision to forge ahead as the existing manual processes in use were severely overwhelmed and strained. It was clearly not tenable to continue practising them. The first critical step for the project was to set clearly the objectives to meet and the timeline to implement the project. This section of the paper will outline the RFID solution implemented by HCC and explain the reasoning behind the decisions made.

HCC is a custom-built specialised storage and conservation facility. The building is located away from the museums and heritage institutions and serves as the centralised storage repository for all the artefacts and artworks that are not on display. With this context in mind, the scope of the project was set to tag all the items that are physically in storage within a period of one year. There were four main objectives[6] set for the RFID project:

1. Automate or eliminate most if not all manual work processes.
2. Improve the ease and accuracy of managing object movements.
3. Improve the ease and accuracy of performing stock-take.
4. Improve the collection of data for management reporting and future planning.

Setting the objectives and defining the scope and limit of the project is a vital step that must be undertaken carefully. RFID technology cannot solve every single problem, so the solution implemented will need to be tailored to the objectives set. It can be easy to be over-ambitious to attempt too many different objectives at once and end up failing. Due to the high volume of artefact and artwork movements generated by supporting the acquisition and exhibition activities of eight museums and heritage institutions, the primary focus for HCC was to ensure that we are able to use RFID to accurately and reliably track the movements of the items in the building. Accounting for the collection is another primary objective, so emphasis is also placed on how we can use RFID technology to aid us in carrying out regular stocktake[7].

The project timeline of one year to tag over 200,000 items might seem ambitious and difficult to achieve. However, setting this challenging timeline was necessary to achieve focus to complete the tagging of the objects. We were of the view that setting a longer timeline will actually create more difficulties as we will have to maintain additional and overlapping work processes for a longer period of time. Having a longer implementation period will also mean the project will be "in progress" for such a long time that staff may lose focus and start to doubt if it can ever be finished.

It was also made very clear that the focus of the RFID system is managing artefact and artwork movements and performing stock-take, so other objectives such as theft prevention (typically associated with RFID technology) was not included for the project. Tracking of artefacts and artworks while they are on display (as opposed to being in storage) also were not implemented as objects on display required different types of RFID tags to be developed.

[6] Lee, Sean H. H. and Wong, D. (2016). "Retooling Collections Management: Tagging and Tracking Singapore's National Collection with Radio Frequency Identification (RFID) Tags. *Cultural Connections* 1, no. 1, pp. 64 - 65.

[7] HCC has to conduct stocktake at regular intervals based on the collections classification: 100% of National Treasure (NT) and High-Value (HV) Collections every year, 100% of Permanent Collection (PC) every two years, and 100% of Community Collections (CC) every five years.

Fig. 1 below illustrates the various components of the RFID system implemented at HCC. The sections to follow will elaborate on the different components of the solution implemented.

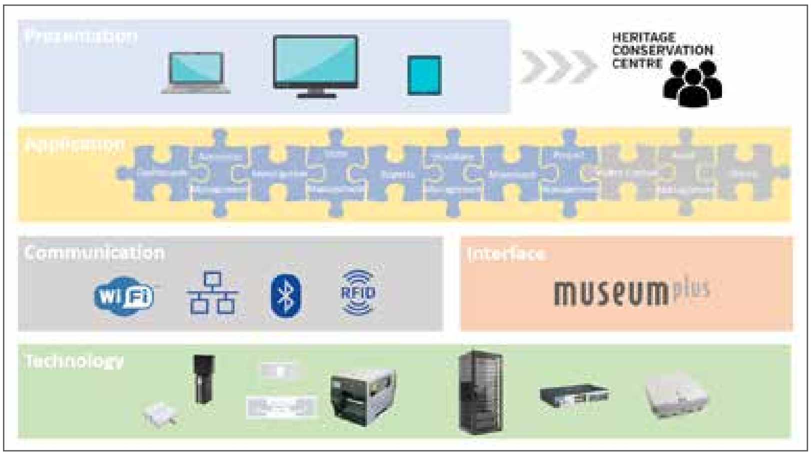

Fig. 1. Components of HCC's RFID solution.

Infrastructure and hardware setup for RFID use

The use of RFID technology requires a Wi-Fi network for real-time retrieval and update of data through handheld devices and readers. The HCC building structure was studied and the installation of access points throughout the building and in the collections stores was carried out using existing trunking (see Fig. 2) to avoid the need for renovation works. This was an important consideration to avoid any risk of damage to the collection due to drilling or hacking of the walls. It also minimised disruptions to day-to-day operations. The network coverage in the collection stores was augmented by Power over Ethernet (PoE) access points (Fig. 3) deployed with range extenders.

For the RFID system to work well, it was vital to setup the infrastructure properly to overcome any communication interference caused by metal storage equipment[8]. The approach taken was to make use of existing IT infrastructure to minimise the need for extensive cabling and renovation works.

[8] Mohd. and Md., The Adoption and Implementation of RFID, p. 41.

Android handheld device and RFID readers (Fig. 4) are used to scan RFID tags to retrieve data from the server and collections database, and real-time updates can be made to update changes in the location of artefacts and artworks. The same handheld device is also used to perform stock-take of the collection through different kinds of readers with different reading ranges (e.g., for reading individual tags or wide-area scanning of tags).

Fig. 2. Cabling installation using existing trunking to avoid intrusive renovation works.

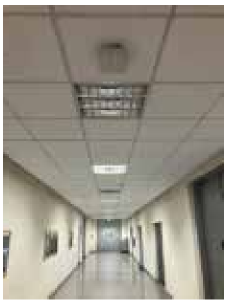

Fig. 3. Wireless network coverage in corridors and collections stores using PoE access points .

Fig. 4. Handheld tablet with short range audio jack RFID reader.

Selection and customization of RFID tags

Given the inherent difficulties of tagging artefacts and artworks, passive UHF RFID technology was assessed to be suitable for tagging the collections housed at HCC. It does not require a line of sight for reading and would therefore minimise the need to handle the artefacts and artworks. The reading range can be also adjusted according to the type of reader used. From a cost perspective, passive RFID tags were without a doubt more practical compared to active RFID tags. The cost of using active RFID tags would be astronomical, even without considering the need to install additional hardware and the need to replace the batteries of the active tags every 3-5 years. Passive RFID tags are expected to last up to 20 years, which is more than sufficient to cover the life cycle of the RFID system.

Although the technology was assessed to be suitable, there were no readily available passive UHF tags in the market that are designed for use on artefacts and artworks. In other words, there were no RFID tags that could be procured and used immediately. When the project started, the direction was to design brand new types of passive UHF RFID tags that could be used on our collections. Efforts were made to test all sorts of commercially available materials that could possibly be used to construct the tags. There were also plans to make RFID tags using only conservation grade material (e.g., archival paper and ink), but that quickly proved to be impractical from a cost perspective.

After a few rounds of testing materials (Fig. 5), which took up quite a bit of time, the idea to design and make new type of tags was abandoned due to the lengthy research time and cost involved. The approach taken then changed to sourcing for commercially available tags that could be customised for use on our collections. Fortunately, the tag form factor for passive RFID tags is versatile and could be customised to meet the project needs.

After much deliberations and experimentations, three different tag types were finalised – two tags of the same design with different sizes (larger one with better reading range) that can be used across the different types of objects in the collection and a third sticker version customised specially for tagging bulk archival collection (Fig. 6). The tags were encapsulated with biaxially oriented polypropylene (BOPP) (which was evaluated to be a safe material) to ensure the they were safe for direct contact with the artefacts and artworks.

A special requirement was implemented to print accession numbers onto the RFID tags (Figs. 7 and 8). The RFID tag itself has its own unique identifier, but having the accession number printed onto the tag is important as we want to easily know (without scanning the RFID tag) which item the tag belongs to – in the event that tags that are unable to be attached onto the objects get mixed up. This is a unique requirement for tagging museum collections as each object tagged also has its own unique number (accession number) and there is no need to ever reuse the tag made for an object.

Fig. 5. Material testing carried out to select suitable material for making tags.

Fig. 6. Three different types of tags finalised (two of same design with different reading range and one sticker version).

Fig. 7. On demand printing of accession number onto RFID tag.

Fig. 8. Accession number on RFID tag allow for easy identification to prevent mix-up.

Tagging implementation

The final number of types of tags to use was deliberately kept small in order to allow for the tagging implementation to be carried out efficiently. It would be complicated and difficult to use and maintain a large number of different types of tags. The final three tags were meant to be versatile and practical enough for application across a spectrum of objects. It was also accepted that it would be impossible to attach the tags with the objects in some cases (e.g., for tiny objects like small buttons and coins). For such cases, the tag would be placed near the object (e.g., in a sleeve or folder) or with its storage encapsulation.

With the RFID tag customised and ready for use, the next challenge was to carry out the tagging. This was one of the most challenging parts of the project as the timeline set was one year. Tagging the collection involves handling and there is risk of damage. The method of attaching the tags must not cause any detriment to the artefacts and artworks. As such, direct adhesion of the tag to the object was ruled out due to the high risk and difficult implementation.

The primary method for tagging 3-dimensional objects was using a cotton string to tie the RFID tag to the object in a stable area that is easily visible without too much slack on the string to avoid accidental hooking (Figs. 9, 10 and 11). For framed artworks like paintings and prints, the RFID tag was tied onto the hanging hooks of the frame (Fig. 12). For 2-dimensional objects (mainly paper, photos and documents), the storage encapsulation (e.g., sleeves, folders and covers) was used to tag the object (e.g., by placing the tag in a pocket attached to the encapsulation) (Figs. 13 and 14). For objects that are too fragile, too small or have no logical spot for tag attachment, the tags were simply placed beside the object or in folders within the storage cabinets, shelves, trays or boxes (Figs.15, 16 and 17).


Fig. 9. Attaching tag onto stable part of 3D object.


Fig. 10. Attaching tag onto rolled textiles.


Fig. 11. Attaching tag onto scrolls.

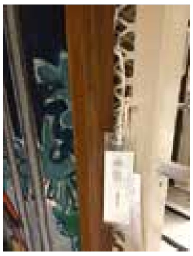
Fig. 12. Attaching tag onto hanging hook of framed artworks.


Fig. 13. Placing tag into a specially made pocket attached to Mylar sheet holding maps.


Fig. 14. Placing tag into a specially-made pocket attached to Mylar folder holding a document.


Fig. 15. Tag placed in front of ceramic jars with no suitable place for attachment.


Fig. 16. Tag placed inside a ceramic bowl with no suitable place for attachment.


Fig. 17. Folder holding tags that could not be attached to prints stored in a cabinet drawer.

The tagging implementation was carried out by staff hired by the vendor. As much as it was preferable to use our staff who are experienced in handling, it was not possible to take them away from their day-to-day duties. On top of that, tagging implementation was carried out in 2015, the year when Singapore celebrated her 50th year of independence with major exhibitions and museum revamps, so the department could afford to assign only a few staff to oversee the entire tagging process. Special training was provided to the group of staff hired by the vendor and the tagging work was carried out in two teams using a store-by-store approach.

This was not an easy process as the staff hired by the implementing vendor had limited handling experience and it took a while before the team was trained, stabilised and up-to-speed. Along the way, many of the staff who were not able to follow instructions properly or demonstrate sufficient care and awareness when handling the artefacts and artworks were dropped from the project. The tagging implementation was made more difficult by the large volume of collections movement as many objects were de-installed and returned to storage due to museum revamp projects.

The tagging process was taken seriously as it was a way for us to carry out a 100% stocktake of the collection. To ensure that the items were not tagged wrongly, the tagging process required multiple layers of checks: verifying the physical accession number on an item, ensuring the image in the collections database is correct, and ensuring the accession number printed on the RFID tag is correct. Fig. 18[9] below illustrates the five sub-processes involved in the tagging implementation and the multiple rounds of checks carried out.

[9] Lee and Wong. Retooling Collections Management, p. 67.

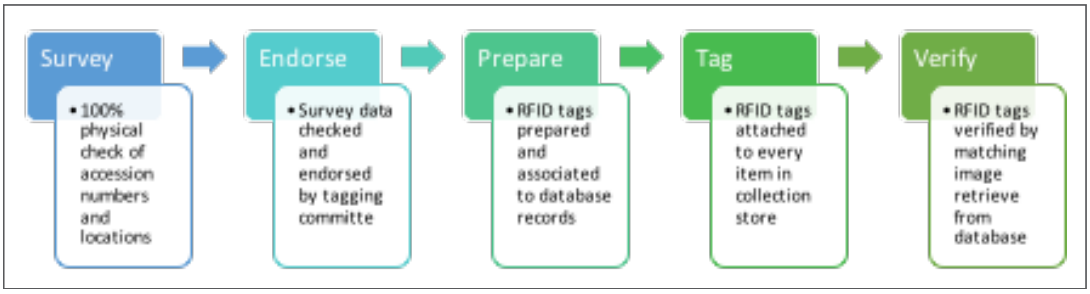

Fig. 18. Multiple layers of verification before RFID tagging.

Software functions and capabilities developed

The software developed for the RFID system provided the ability to perform real-time data retrieval and updates. A data exchange interface was built to link the RFID system to the existing collections database, which remained the primary database for holding information relating to the artefacts and artworks. The new RFID system keeps operations data pertaining to movement of objects and records of stock-take.

The development of the software took place concurrently with the tagging implementation and followed the general principles of agile project management[10] where an iterative and incremental design and build model was used. Each module of the software was built incrementally giving users a chance to test and feedback before more features and functions were built. Training was conducted regularly to allow users to learn and familiarise with the new system.

Apart from the primary functions built to allow real-time location updates and stock-take confirmation through handheld readers, many new functions and capabilities were also developed to improve or replace existing manual work processes, such as the issuing of receipts, tracking the progress of new acquisitions accessioning, generation of stocktake list and tracking of stocktake progress through the system.

Results and outcomes achieved

The project took approximately 15 months to complete from award of the tender to the vendor to the completion of tagging of the artefacts in storage. Over 200,000 objects were tagged safely despite having to use external staff with limited handling experience. This was achieved through training and close supervision of the tagging process.

The tagging exercise has essentially allowed HCC to conduct a 100% stocktake of its collection and as a result achieve greater clarity on the state of the collection. All tagged items with previously inaccurate locations were updated, and a system-controlled standardised location naming system was implemented to ensure that the accuracy of the location data can be maintained. The uncertainty surrounding objects that previously could not be found was lifted – they were either found misplaced somewhere or it could now actually be confirmed with better certainty that they were really missing. Many legacy issues were also resolved in the process of tagging the collection, such as correcting data errors in the system, uploading missing photos, accessioning parts that were missed out, etc. Some improvements to housekeeping was achieved through improving storage methods and replacing old storage materials in the process of tagging the collection.

Productivity gains were achieved with the elimination of many manual processes such as issuing receipt and tracking movement of objects in and out of collections stores using physical logbooks. With now accurate locations, lesser time is wasted on locating misplaced items. Better data is now captured in the system (e.g., precise number of objects at each location, the estimated storage utilisation rate, the amount of time an object has been at a temporary or permanent location, which collection stores have the highest frequency of movements, etc.) for management reporting and future planning.

The greatest time-saving and productivity gains were achieved in the area of stocktaking. With the entire collection tagged, the benefits of RFID technology could now be fully utilised for stocktaking.

[10] Lee and Wong. Retooling Collections Management, pp. 65 - 66.

The previously time-consuming, tedious and error-prone manual process of generating the stocktake list, preparing the printouts for sighting with witnesses, and reconciling the paper records were now eliminated and replaced by the system software which generates the stocktake list, keeps track of stocktake progress, and generates reports for management reporting automatically. Multiple modes of stocktake were developed for use (e.g., individual object sighting without witness, individual object sighting through an independent witness authentication, and rapid stocktake using wide-area scanning reader) and the possibility of fraud or human errors in the stocktake process was greatly reduced.

Reflections and key learning points

One of the biggest challenges in undertaking RFID tagging is the need for collections data to be accurate. In order to tag an item, there is a minimal need to ensure that the physical accession number on the object, the image in the database, and the accession number printed on the RFID tag matches. While this may seem straightforward, any inconsistency will prevent you from tagging an object. As you go through the objects in your collections, you will inevitably come across many items with various legacy issues such as incomplete or inaccurate data, items without accession number, items with wrong accession numbers, items with wrong images, items with parts not accessioned, items with unknown accession numbers, etc. All these affect the progress of the tagging work and decisions will need to be made quickly on whether to investigate and resolve the issues on the spot or consolidate them for later investigation.

It is vital that there is a procedure in place on how to deal with these issues, or tagging work will not be completed. HCC's approach was to tag items that could not be resolved easily with a red-coloured RFID tag and record some basic details into the database for a later follow-up. After tagging the collection, it was also found that there were a lot of records remaining in the database with no associated RFID tags. This data would need to be investigated and data-cleansed. HCC moved the data to a separate "folder" in the database for further investigation, so that they did not get mixed up with live and active records verified through the RFID tagging project. It should be worthwhile to note that even after a few years of follow-up work, there remain a large number of red-tagged items to be resolved and database records to be cleansed, so resources will need to be committed continuously to tackle them.

Tagging of the collection presented a great opportunity for housekeeping, improving the existing storage methods for the objects. However, it must be noted that whatever additional tasks you decide to do apart from tagging the object will have an impact on the progress of the tagging work. Therefore, it is important to strike a balance and set clear guidelines and limits from the onset with regards to the extent of additional work to be carried out as part of the tagging.

Setting a challenging timeline and focusing resources to complete the tagging work turned to be a positive approach. Initially there were doubts on whether the timeline was viable, considering the number of items to be tagged. However, it did not take long for staff to become frustrated and impatient with the additional and concurrent processes that were put in place during the tagging implementation. If the tagging period was to be extended, it was highly possible that staff would become increasingly frustrated. The team involved in the tagging work could also lose focus if the implementation work is done over an extended period of time.

The selection of a suitable vendor is crucial. You will need a partner who is flexible and willing to learn and understand the business of managing artefacts and artworks. It is unlikely that you can easily find vendors with experience in tagging museum collections. Appointing a wrong partner can lead to severe consequences and may even cause the project to fail, so it is best to invest the time to closely scrutinize and select the right partner[11].

[11] Mohd. and Md. The Adoption and Implementation of RFID, p. 44.

Passive RFID tags should theoretically be able to last for a very long time, especially in a stable storage environment. However, HCC has encountered instances (although in only a very small percentage) where tags were found to be defective. Investigation by the vendor revealed that a batch of tags used had quality problems. It would, therefore, be worthwhile to make sure that RFID tags supplied by the vendor is consistently tested and confirmed to be of good quality. It would be a nightmare if a large number of tags start failing after only a few years.

Finally, it is also important that you scope the necessary resources to continue to improve the system, particularly in the initial years where a lot of adjustments and changes to your software can be expected as the users start to use the system and provide feedback. You would also need to cater for resources to periodically upgrade the peripheral hardware such as the handheld devices and readers. Training is also an area that cannot be neglected as some staff will continue to face difficulties in adopting the new technology and workflows, especially when more and more software changes are implemented.

Conclusion

The expectation to leverage and capitalise on improving technology to manage museum collections is a reasonable and fair one. We have no excuse to remain with backwards and inefficient methods as other industries and sectors make continuous efforts to adapt and improve. Failure to invest in use of technology will inevitably end up costing us more in the future. The introduction of technology is best done in an incremental manner by building up of the necessary skills, capabilities and acceptance within the organisation on the need to embrace technology in day-to-day work. Technology is not a solution in itself, but a tool for us to utilise to improve our work. And it is important not to forget that any system is only as good as the people using it, so continuous investment is needed to ensure that people are trained and on-board in using technology to improve their work.

HCC's experience in RFID tagging has shown that it is possible to tag a large and varied collection and make use of the technology to maintain accurate locations and perform stocktake. Every institution will have its own set of challenges and whether and how much technology will help to solve the problems will really depend. It is important to carefully scope the objectives to be achieved and allocate the necessary resources. The cost of investing in technology need not be prohibitive as practical solutions can always be found. It is hoped that HCC's experience can serve as a useful reference for other institutions who are interested in implementing RFID technology for collections management.

Acknowledgements

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Author's biography

Darren Wong joined the Heritage Conservation Centre in 2009 and is currently the Assistant Director of the Collections Management Department and Head of the Preventive Conservation Workgroup. He graduated from the University of Winnipeg with a Bachelor of Arts (Hons) in Anthropology and International Development Studies.

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Streamlining Processes: The Singapore Collections Management System Story

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KEYWORDS
systems, business process, information management

ABSTRACT

This paper aims to share the Heritage Conservation Centre's (HCC) experience on the upgrading of the National Heritage Board's (NHB) collections management system to improve information capture processes for the National Collection (NC). Through this, NHB also builds necessary structures to ensure data publishing of the NC is simplified for ease of sharing on public platforms such as Roots.sg and the National Library Board's (NLB) OneSearch.

NHB first implemented its collections management system, the Museum Collections System (MCS), in 2006. The new system, the Singapore Collections Management System (SCMS), was launched in 2016, after more than a year of work and contributions from the working committee. The working committee comprised colleagues across NHB, and Singapore Art Museum and National Gallery Singapore staff ranging from curators to collections managers and conservators.

SCMS is the central database for NC-related information, and is used by NHB, Singapore Art Museum, and National Gallery Singapore. A subset of the NC information stored in SCMS is made available to the public through Roots.sg and other platforms. SCMS also serves as an information repository of the NC. Basic information can be retrieved from the system without needing to refer to subject matter experts such as curators or conservators. As such, one key objective identified by the working committee is the streamlining of NC information capture processes across institutions following a review of existing business processes.

This paper also shares the challenges faced during the implementation phase of the project – for example, the government-wide policy to unlink all Intranet systems (SCMS is an Intranet system) from the Internet. This policy created several challenges which the team worked with different partners to overcome.

The revamp project, from consultancy to implementation, took approximately 1.5 years to complete.

[1] The national museums and institutions are National Museum of Singapore (NMS), Asian Civilisations Museum (ACM), Peranakan Museum (TPM), Heritage Institutions (HIs) – Indian Heritage Centre (IHC), Malay Heritage Centre (MHC) and Sun Yat Sen Nanyang Memorial Hall (SYSNMH)

[2] Heritage Conservation Centre, ISO Quality Manual 9001:2015 (Singapore: HCC, 2015), 7

Aim

This paper discusses how system revamps give organisations opportunities for business process reviews and chances to engineer changes to improve information management for future use through a case study of the SCMS revamp.

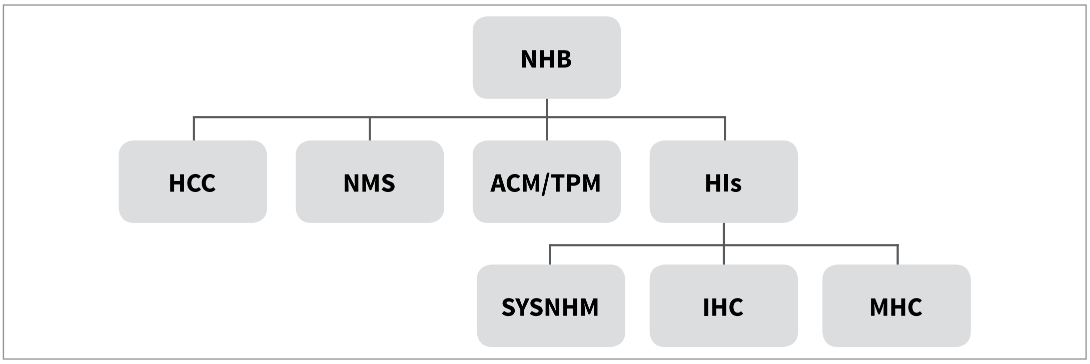

Figure 1.

Background

NHB is a statutory board under the Ministry of Culture, Community and Youth (MCCY). HCC and the national museums and institutions[1] are NHB divisions (Figure 1). HCC's mission is "…to manage, care for and facilitate access to our National Collection (NC)[2]". This includes managing storage, providing preventive and interventive conservation, and facilitating physical and digital access to the NC.

Since 2006, the NC has been made publicly available digitally via the now defunct Singapore Collections Online (SGCOOL), with the aim of promoting NHB cultural heritage materials to the general public. Currently, the NC records are available on Roots.sg, NHB's resource portal for information and articles about culture and heritage (Image 1).

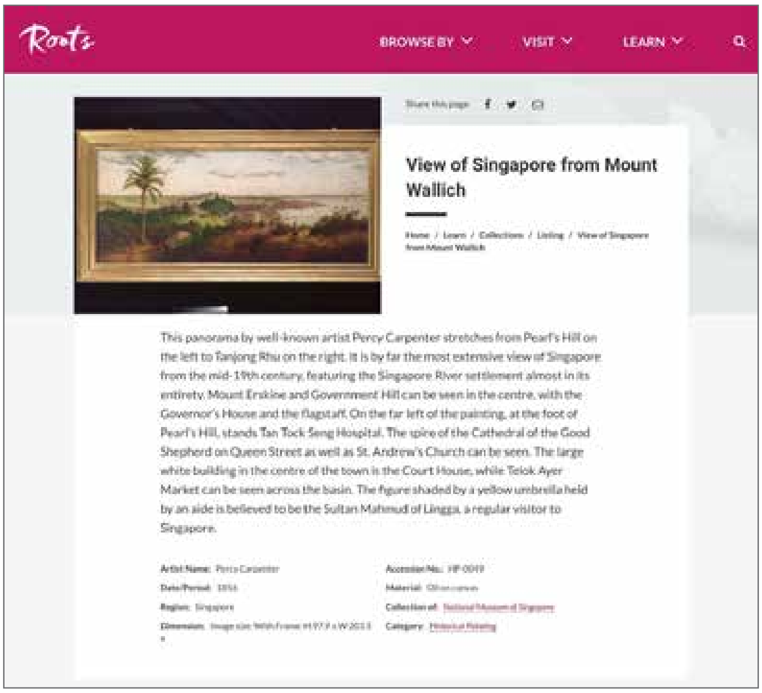

Image 1

Requests to share NHB NC data also increased over the years. In 2012, NHB joined the Google Art Project[3]. In 2014, NHB made the NC searchable through OneSearch, a search aggregator by NLB. In the cultural heritage industry, a successful collection aggregator is the Europeana Collection, which is managed by the Europeana Foundation. Set up by the European Commission in 2008, a key task of Europeana Collection is to develop a cultural heritage platform for Europe and the world[4]. As of 2018, the Europeana Foundation works with more than 3,500 galleries, libraries, archives and museums to provide access to over 50 million digitized items in their collections. International work groups, such as the CIDOC Conceptual Reference[5] Model working group, are also establishing standards to facilitate data exchange.

The previous collections management system, MCS, had become technologically obsolete, hence limiting the options for data exchange with various parties, including NHB's own websites. In 2015, NHB decided to upgrade MCS to a system that is more agile and comes with more options for data sharing functions. The decision also provided a good opportunity for NHB to review its existing processes in information capture, and explore other functionalities to better improve information management of the NC.

While HCC is in charge of the collections management system, more than half of system contributors are curators and collections managers in the respective museums and heritage institutions. In addition, staff in NHB, museums and heritage institutions often require reports regarding NC; for example, the percentage of NC records available for public access and NCs acquired through donations. Hence it is important for HCC to understand the expectations of all relevant parties prior to the start of the project to better manage it. HCC did this by having small group discussions with key stakeholders prior to the start of the project.

[3] "Google Art Has More Than 150 Artworks From NHB", Today, April 15, 2012

[4] "History", Europeana Pro, July 25, 2017, https://pro.europeana.eu/our-mission/history

[5] CIDOC Conceptual Reference Model is an International Organization for Standardization (ISO) guideline for exchange of information between cultural heritage institutions (ISO 21127:2014). This is the cumulative work of a group of museum professionals in CIDOC Documentation Standards Working Group since 1996, before it was accepted as a standard in 2006 by ISO. The group continues to refine the standards to improve data exchange for the cultural heritage industry.

Methodology & project structure

Prior to the start of the project, preliminary requirement-gathering sessions were conducted to determine the scope of the project. Key stakeholders from the collecting institutions, as well as policy and corporate divisions in NHB, were involved in these sessions to ensure information needs from all areas were considered. From these sessions, it was clear that besides the technological upgrade, key stakeholders were also keen to streamline processes, explore ways to better manage information capture processes, and investigate the possibility of reusing existing information within MCS. The project officially started in May 2015 and ended in November 2016. The product chosen to implement was MuseumPlus, which complies with several industries' standards including Spectrum, the UK Museum Collections Management Standard.

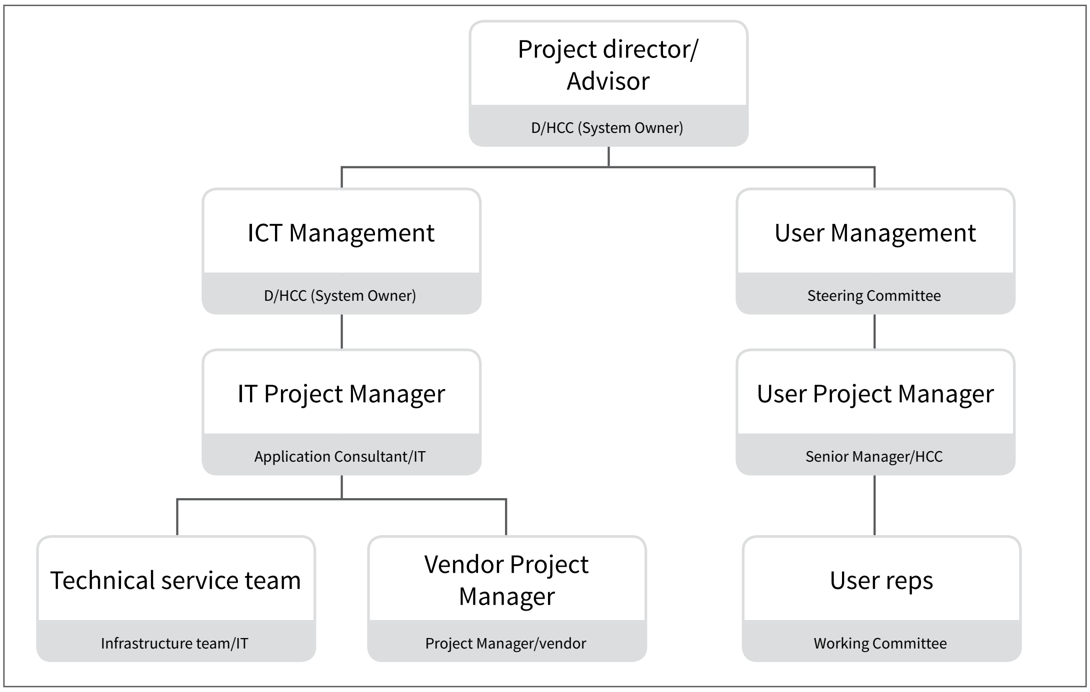

Figure 2.

The project team consisted of representatives from collecting institutions under NHB, the NHB IT department, and two external collecting institutions, Singapore Art Museum (SAM) and National Gallery Singapore (Gallery), who are collecting on behalf of the State. The project structure (Figure 2 in previous page), steering committee (Figure 3) and working committee composition (Figure 4) are shown below.

The steering committee comprised of other key stakeholders besides the collecting institutions. Besides IT, the National Collection Division (NCD), which manages the policies within NHB, was also invited to be part of it.

The working committee comprised mainly of representatives from the collecting institutions and HCC, as they would be key users interacting with the system on a daily basis.

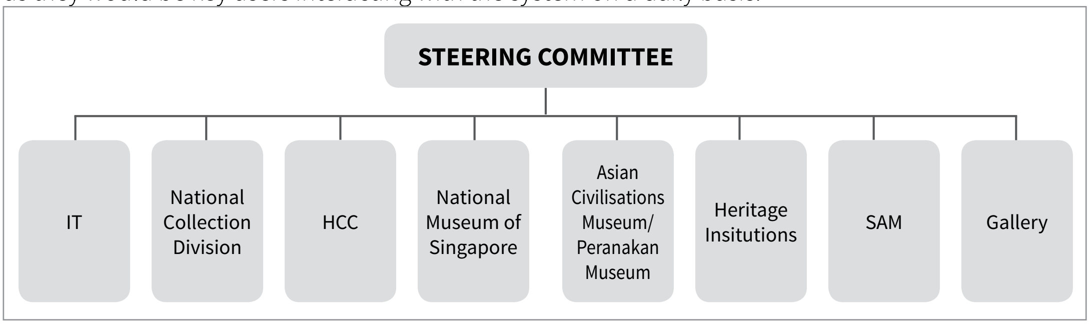

Figure 3.

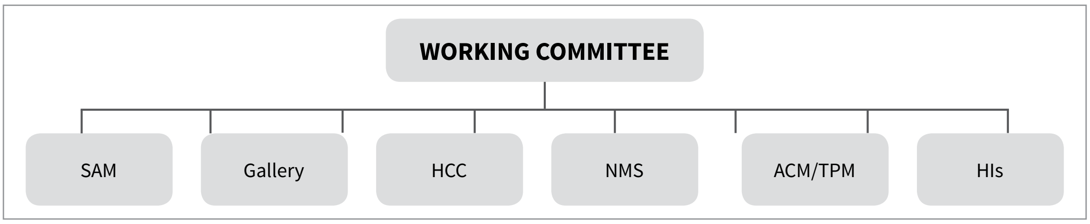

Figure 4.

The consultancy took place from May to October 2015, where detailed requirements were gathered from different groups of stakeholders, mainly collections managers (from both HCC and collecting institutions), conservators and curators. The sessions were planned according to different modules in the system and corresponded to the processes that were stated to be reviewed.

Eventually, the project team took a phased approach to roll out SCMS, focusing on ensuring existing functions in MCS were working well in SCMS. SCMS was launched on 17 March 2016, and its additional functionalities were rolled out by 26 November 2017.

The working committee held in-depth discussions on the five processes listed below. Two processes have been successfully implemented, while the others are being considered for future implementation.

1. Acquisition & accessioning
2. Data exchange
3. Conservation
4. Loans management
5. Exhibition management

Results

Acquisition & accessioning

NHB has an acquisition policy in place. It is applicable to all collecting institutions, including SAM and Gallery. The policy states the process, as well as information required for the process. MCS was unable to accommodate all the information requirements, resulting in acquisition information residing in different places, digitally and physically.

Feedback on MCS was gathered during the consultancy. The proposed workflows were also shared with the working committee. The previous acquisition process within the system is shown below (Figure 5).

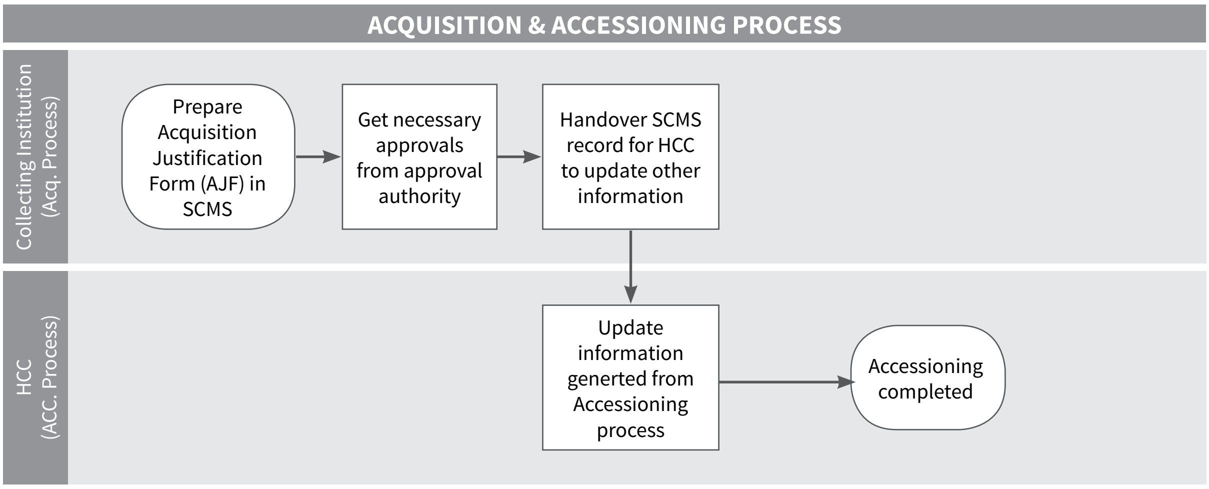

Figure 5. Acquisition and accessioning process (before).

One key concern raised was the lack of checks on information stored in the system, resulting in concerns that MCS did not contain updated information. This led to staff constantly needing to refer to physical acquisition documents stored at HCC. Staff found the process of requesting, physically retrieving, scanning and emailing the documents to the requester tedious. A summarised workflow on responsibility of information between collecting institutions and HCC, in use currently, is shown below (Figure 6).

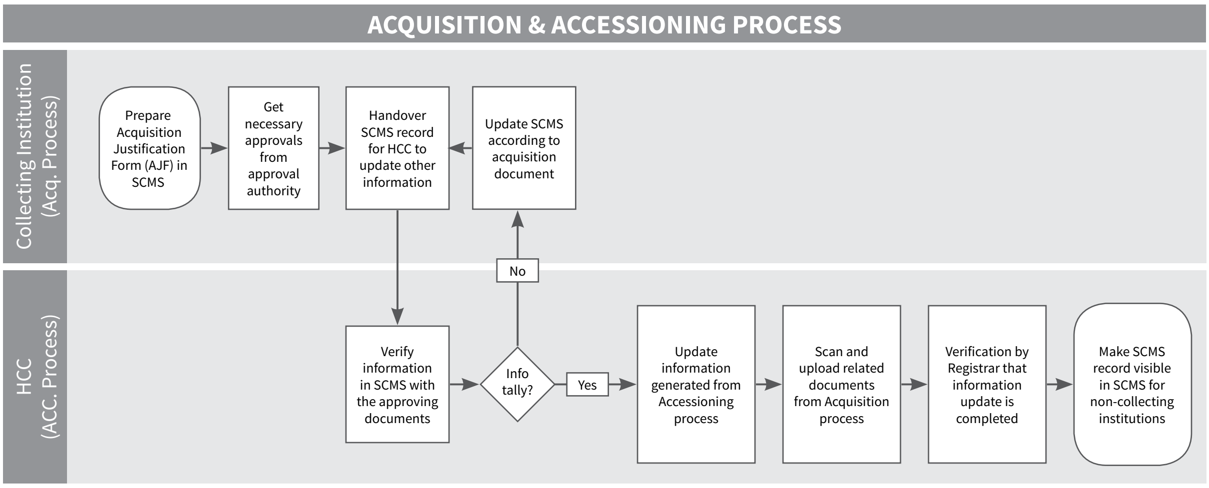

Figure 6. Acquisition and accessioning process (after).

In the new workflow, HCC would acquire the additional role of verifying the information entered by collecting institutions. Several levels of checks would help to ensure information captured in the system is the most updated at the point of acquisition.

Data exchange

Improvements were also made to the data exchange process. One key weakness of MCS was its inability to export data in XML format, which is a common data exchange standard currently. The system was also unable to carry out web service calls, where data exchange takes place between machines, without human intervention. This limited the ways NHB could exchange data with its partners, such as Google and NLB. NHB would often pay the system vendor to extract data, then physically pass the data to the requesters of NC data. These were areas NHB was keen to improve.

Initially, the project team planned for data exchanges to be executed via web service calls only, especially data exchange between NHB systems. This would reduce the need for a man-in-the-loop, as systems would be able to "call" each other to get the data required. The frequency for exchanging data to facilitate this process can be changed by NHB. However, during the implementation of web service calls in 2015, a policy disallowing Internet connection for Intranet systems was implemented across Singapore's public sector. As SCMS is an Intranet system, the new policy did not affect the plans for data exchange between SCMS and the Automated Collections Tagging System (ACTS), which is an Intranet system HCC uses to track artefact movement within HCC. The data exchange process between SCMS and ACTS was therefore established with the launch of SCMS in March 2016.

The policy, however, had a great impact on data exchange between SCMS and NHB resource portal Roots.sg, which is hosted on the Internet. Hence, NHB had to continue exchanging data offline, manually. Vendors passed data to each other via encrypted storage disks. Data updates were also limited to every quarter, as additional operational costs and resources were required to update the database. However, data could be exported in XML format, allowing staff to export smaller datasets directly from SCMS. NHB did not need to engage a vendor in such instances, reducing delays and cost.

Another functionality that was greatly affected by this policy is the cataloguing function within SCMS. The Cataloguing team in HCC was set up in 2014, with the aim of increasing digital access to NC records through attributing descriptive metadata (such as subject terms related to an artefact) to NC records, disambiguating name authorities and proposing local terms to be used as controlled terms across the heritage sector. The terms used in the attribution of metadata are mainly from internationally and regionally established controlled terms. Getty's Art and Architecture Thesaurus (AAT) and Library of Congress Name Authorities (LCNA) are some key standards used by the Cataloguing team. The initial plan was to access the authority term records hosted on the Getty Research Institute and Library of Congress websites directly. With the policy change, this plan was no longer possible, and new solutions had to be explored. As a result, additional time and effort was spent to overcome this challenge and make the terms available through SCMS. Meanwhile, the Cataloguing team continued cataloguing using spreadsheets, which was not ideal. As the catalogued records were not in SCMS, Roots.sg was also unable to get the enhanced information needed to make NC records more accessible. Manual linking of resources was done. Staff searched different databases using keywords, selected resources that were related, and manually linked these resources on a page, resulting in more effort from staff. For catalogued records where structured metadata was available, the linking would be automatic and dynamic.

In April 2019, HCC completed the deployment of an offline system which stores authority names and controlled terms from AAT and LCNA. SCMS can access it via the intranet system. The Cataloguing team now works on this offline system directly.

Conservation

During the consultancy, information capture for conservation information was identified as one area that can be improved. There are four conservation sections, set up according to material types, within HCC's Conservation Services department. These sections are Paper, Painting, Textiles and Objects. Each section had a representative in the project team to discuss and streamline practices across the sections. Previously, each section made separate requests to customise the Conservation module, resulting in mixed practices of using MCS. Furthermore, some sections updated each field in the Conservation module, while others just keyed in the bare minimum, i.e. object conserved, date of treatment and conservators' names. While planning for data migration, the project team also realised each section had used same fields for different purposes. For example, the Remarks field was used by one section purely to contain follow-up remarks. It was used by another section to record time spent on conserving an object. Hence, section representatives expressed their wish to streamline documentation needs across sections, and to have reporting functions, so that they do not need to manually compute the Key Performance Indicator (KPI).

As the sections shared the same condition report format, it became the basis of discussion. The four section representatives discussed it at length with each other, facilitated discussions within their sections and reached the consensus of streamlining different segments in the condition report. They also agreed that fields would remain different across sections due to the sections' varying needs.

The project team also considered the need for reporting functionalities, such as total time spent on conserving, and number of objects conserved within a certain time frame. These elements were subsequently built into SCMS, ready to be used when data is available.

While the above functionalities are available, Conservation Services (CS) had not put them to use as operational changes were required prior to full implementation. HCC's Knowledge and Information Management (KIM) section will be working closely with CS in the coming years to understand the latter's needs and concerns, suggest workflow improvements and make changes to SCMS when needed.

Loans management

One area for improvement the committee identified was information management for loaned items. There are two types of incoming loans in the NHB context – short term and long term loans. Short term loans usually comprise objects borrowed for exhibition purposes, and which usually go on display for a specific exhibition after arriving on NHB grounds. They are often returned immediately after the exhibition ends. Hence, the quantity of information needed to manage short term loans is relatively low, and information management can be handled by the project in-charge and the immediate team.

However, long term loan objects could be kept at NHB premises for long term display or research purposes. Long term loans range from three years to more than a decade. The loaned objects can be moved between exhibition galleries, as well as NHB facilities – for example, from a museum to HCC. Due to the length of these loans, there are concerns about information gaps, such as whereabouts of the objects, contractual terms, renewal of the loan contract. Currently, such information is listed in spreadsheets, with the museums and HCC maintaining separate lists. As such, managing the information requires many resources. There are also concerns about information discrepancies between the different lists.

During the consultancy, generic loan workflows, including terminating a loan prior to end date and extending a loan contract, were discussed and built in to the SCMS Contracts module. These enabled SCMS to capture mandatory information such as lender, person in-charge of the loan at NHB and loan expiry date, helping staff with the necessary follow-ups for loaned items.

HCC and ACM will pilot this module, and start with reconciling lists of loaned items before adding the data into SCMS. Of all the NHB institutions, ACM has the most number of lenders and long term loan objects. Hence, it expressed the wish to manage loaned objects better using a system accessible to others in NHB. More system or workflow changes can be made to this module before rolling it out to the entire NHB.

Exhibition management

Exhibition management is a manual process within NHB as the museums and HCC communicate via emails and spreadsheets for updates on artefact lists. Hence, the working committee identified this as a process to be streamlined. Several rounds of discussions took place between the museums, Collections Management (CM) and CS representatives during the consultancy period. During the discussion, key information to be captured, such as artefact lists, exhibition titles, exhibition periods and names of people working on the exhibitions, were identified. The workflow was subsequently built based on the NHB Exhibition Standard Operating Procedure (SOP). Built-in system reminders were also added, enabling persons in-charge to receive system generated emails and effect action. The proposed workflow for use within SCMS is shown below (Figure 7).

One key issue was that the current workflow did not address the issue of having multiple artefact lists. Currently, updates on artefacts to be exhibited for a particular exhibition is done on spreadsheets, using colours to indicate if an artefact is newly added to the list or will not be required for the exhibition. HCC and museum staff often compare the latest version with the previous version to ensure there is no miscommunication, which is tedious and laborious. Hence, during the consultancy, the project team agreed that this is one key area of improvement to better exhibition planning.

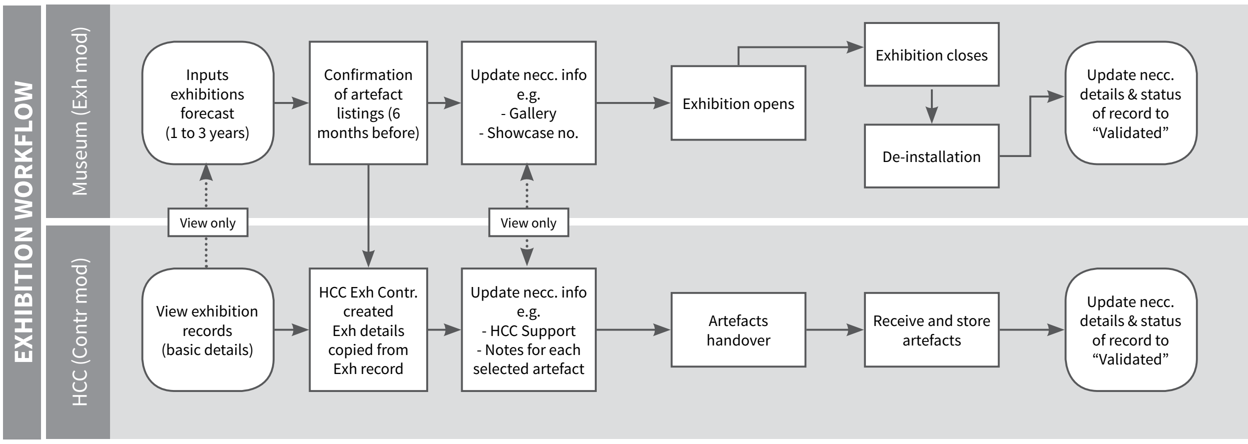

Figure 7. Proposed exhibition management workflow.

HCC and ACM colleagues were the pilot users for the Exhibitions module. Due to business requirements and access rights configurations, SCMS did not allow museum and HCC system users both to edit records in the Exhibitions module directly. Hence HCC's users have to maintain the artefact list in the Contracts module while museums' users maintain a separate list in Exhibitions module. Any changes made by museums' users will have to be manually added by HCC's users to the artefact list in Contracts module. As a result, the new workflow did not solve the initial concern as there will always be two lists, the museum list and the HCC list, which may result in both parties working on different artefacts for an exhibition.

In addition, the project team also realised that the organisation structure within each institution affected how each institution accorded resources for managing exhibitions. For example, museums such as ACM each have a dedicated team working on different aspects of an exhibition. However, curators in smaller institutions such as the heritage institutions (HIs), have to manage all aspects on their own. As such, working arrangements between HCC and each of the institutions varied, complicating the use of the Exhibitions module. This meant SCMS could not fulfil its purpose of being a centralised platform where all information regarding objects selected for exhibitions are made available to all users. Observations made after the pilot trial highlighted the need for much enhancement and workflow changes, which would then enable SCMS to function as a centralised communication platform for museums and HCC. There is also another NHB project looking at managing exhibition-related information[6]. After discussions with stakeholders, NHB decided to pursue this project at a later stage.

[6] There is another knowledge management project looking into archiving exhibition-related information. As such, the decision was not to focus on enhancing SCMS' Exhibitions module first.

Challenges faced

Government-wide Internet separation policy

Tighter IT security in the public sector was a major challenge for the project team. As mentioned earlier, there was a policy change restricting the public sector's access to the Internet. This had a domino effect on the project timeline, as additional time was required to redesign the system architecture so it complied with government-wide policies, yet could also provide access to key users outside of NHB, i.e. SAM and Gallery's curatorial and collections teams. System architecture is integral to the deployment and implementation of SCMS, especially for workflows involving key business processes and web service calls. The team also took a longer time to confirm the system architecture as it involved seeking and receiving approval of the proposed methods from relevant authorities.

Another impact brought on by this government-wide policy is the delayed implementation of web services for Internet-based systems, like Roots.sg and Getty's thesauri. As shared above, NHB planned for Roots.sg to get updates from SCMS via web service calls. However, due to the new policy, there was no direct network access from the SCMS hosting environment (Intranet) to the Roots.sg hosting environment (Internet). As such, NHB still has to continue to engage its vendor to manually extract and update data in the two systems quarterly.

Getty's AAT is one of the key standards used by the Cataloguing team, and it is accessible via Internet. However, being an Intranet system, SCMS cannot connect directly to AAT. As a result, access to this important resource had to be reassessed, which required additional time and resources. The inability of SCMS to connect to AAT resulted in users being unable to use SCMS in the way it was originally intended. They also had to find a workflow outside of SCMS to continue their work.

Complex requirements due to different practices amongst institutions

Complex requirements arising from varied business needs resulted in more time required to complete the stages (requirements gathering, development, testing and documentation) of the project, impacting the workflow process that the application developer created specifically for NHB. The workflow process is a customised functionality, effected for seven SCMS modules, that ensure business processes are adhered to. In doing so, key information is captured in SCMS from the beginning. The process reduces the need for patching information at latter stages, which may delay related tasks. It can also track different stages of the process, making outstanding tasks and their responsible parties known to all. The requirements gathering stage subsequently took a considerably longer time, and involved many clarification sessions, as a change in requirement for any business process required a thorough review of all other business processes. Similarly, a bug fix for one business process required the other processes to be re-tested. Much time and effort was needed for the testing process.

Inconsistent data structure in previous system

Inconsistent data structure in MCS led to multiple data patching sessions, increasing the amount of time and effort required to investigate and fix problems and test solutions. Inconsistent data structure could be attributed to previously requested functionalities and unclear instructions on how to input information in MCS. Multiple enhancement projects had taken place since NHB started to use MCS in 2005. These included addition of new fields and functionalities, which helped facilitate the work of users then. However, there was no clear documentation of what type of information was to be contained in each field, and what functionalities were developed specially for NHB. This posed a problem during the mapping of fields for data migration, as no data migration logic could fit all MCS records. For example, the project team discovered that some fields were repurposed during enhancements. As a result, additional time was spent on finding a suitable mapping model to migrate all information from the different versions of MCS into the current system. Most of the information has been migrated. However, minor data patches may still be needed if missing information types are discovered.

Learning points

Conduct pre-consultation with key stakeholders to determine project scope

Pre-consultation sessions with stakeholders were held, and proved useful in shaping the scope of the project. The stakeholders consulted include collections and curatorial staff from museums and heritage institutions, HCC and NHB HQ's National Collection, Finance and Procurement and Internal Audit divisions. External collecting institutions' collections and curatorial staff were also included in these sessions. Majority of these stakeholders from NHB and external collecting institutions are frequent users of the MCS who would continue to have regular interactions with SCMS. The other stakeholders, such as National Collection division, may not use SCMS, but rely on it to provide information. These sessions were their only avenue to raise requests as they are unlikely to be part of the core working committee.

These sessions provided a platform for the system owner (HCC) to explain the rationale for upgrading the system and the intended outcomes while giving stakeholders the opportunity to prepare themselves for participation in the post-tender award consultation sessions. Stakeholders could therefore plot their schedule to include participation in the exercise and also think of possible improvements prior to the sessions.

The sessions also gave stakeholders an opportunity to voice their needs with regards to NC data and information collection. This two-way conversation, which started before and lasted throughout the project, created a sense of ownership in everyone involved. The outcome of these sessions translated into system specifications and became the basis for review of existing work processes.

Cultivate sense of collective ownership to ensure longevity of the system

While HCC owns and manages SCMS, it is not the only party deciding on system requirements. SCMS is a system that is accessed and maintained by all entities that handle, manage, care for and display the NC. Hence, it is essential for key stakeholders to understand that any changes to the system are likely to result in workflow changes for their respective organisations. Very often, committee members are the champions for SCMS within their own institutions. As such, they need to know they have a part to play in ensuring smooth operations too.

Both the pre-consultancy sessions and the consultancy process with vendors aimed to create a collective sense of ownership of the system in all participants. The working committee is directly responsible for the revamped system, as they gave the specifications to the vendor. They also invested a lot of time and effort on discussing possible workflow improvements for the system. Even after the system was launched, HCC continued to receive feedback on how to make SCMS better.

Continual engagement with key stakeholders and users on a regular basis is important. They need to know that there are plans for improvement, and that their views and feedback will be considered for system changes. HCC conducts annual engagement sessions with all museums and galleries to conduct training and update system users on the key changes made to and future plans for SCMS.

Emphasise on and communicate IT security importance to users and vendors

With the rise in frequency and threat of cyberattacks, IT policies and security will constantly be reviewed so as to protect the government's IT network. Throughout this project, more security conditions were added to ensure SCMS would not become the single point of weakness to compromise the government IT network. This caused frustrations and inconvenience to all involved, including users and vendors. For example, users could not use the developed web service call function for AAT and LCNA after its implementation, and vendors could not access the NHB testing environment for problem analysis. The latter resulted in longer turnaround time for fixes. Alternatives had to be explored to overcome these issues. Therefore, it is important to emphasise to participants that IT security of the civil service cannot be compromised just to provide convenience to a small group of people. Vendors also need to understand that their solutions must be flexible and changes are inevitable when national interests are being protected.

Conclusion

The revamp of NHB's collections management system provided the project team with a chance to relook the way information has been collected thus far, and assess the necessity of the information collected. It also provided an opportunity for stakeholders to voice their information needs, and for NHB to incorporate these needs into the new system to ease stakeholders' workload while ensuring organisational knowledge is captured in a centralised database.

The exercise also created a space for stakeholders to evaluate existing business processes, examine gaps and identify areas for future improvements. The key message for the project team is the importance of aligning information capturing with organisational information needs, improving work efficiency and reducing confusion over data accuracy.

Last but not least, while it is important to emphasise on system changes, it is equally important to plan for and manage changes in work processes that happen outside of the system. It is important to assure key stakeholders that the changes will benefit them and their organisation in the long run. Hence, change management is important to ensure the intended outcomes are achieved. This project creates a platform for future discussions on continued refinement of both system and work processes between key users and system owners.

Acknowledgements

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Author's biography

Tan Pei Qi holds a Bachelor of Arts (History) from National University of Singapore and a Master of Science (Knowledge Management) from Nanyang Technological University. She joined NHB in 2007 as a researcher in the Singapore Art Museum. She implemented the NHB collections management system upgrade in 2015 and is currently overseeing the Knowledge and Information Management section in HCC.

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Research on Classification of Red Paint Layer on Ban Chiang Pottery using Non-Destructive Techniques

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KEYWORDS
Ban Chiang pottery, non-destructive technique, FTIR, pXRF, Colorimeter, paint layer

ABSTRACT
Ban Chiang pottery is a significant evidence of art objects that presents the prehistoric social networks and technological method that produced it. These artefacts were excavated in 1970 by the Fine Arts Department of Thailand and the University of Pennsylvania. This find is one of the most significant archaeological discoveries in Southeast Asia.

According to archaeological research, these ancient artefacts date back to more than 3,500 years, whereas the famous painted red pottery dates back to around 2,300 to 3,000 years ago. There are many replicas in markets all around the world, and as a result, it is difficult work for people who deal with the classification of these artefacts. Thus, various studies on authenticity of these objects in order to approve the original Ban Chiang pottery are performed such as in the field of art history, archaeological materials, etc.

In the analysis of archaeological materials, a piece of pottery is defined by a combination of characteristics related to materials used, shape, size, and decoration. The decoration of Ban Chiang pottery is very unique thanks to its decorative motifs and painted layer. The red colour painted on the pottery surface is a natural clay earth pigment.

This research paper aims to analyse the red painted layer on original Ban Chiang pottery, and also its replicas, in order to compare the materials used. Scientific analysis is a non-destructive analytical technique that identifies the materials used for the red painted layer. The equipment used for analysis in this project include Fourier Transform Infrared Spectroscopy (FTIR), Portable X-Ray Fluorescence (pXRF), and Colorimeter.

The results can help in differentiating between original Ban Chiang poetry and a replica although they appear to be quite similar.

Introduction

The Ban Chiang archaeological site in northeastern Thailand was designated a world heritage site by the United Nations Educational, Scientific and Cultural Organization (UNESCO) in 1992. This site dates back to between 2100 B.C. and A.D. 200, and spans the Pre-metal, Bronze, and Iron Ages (Penelope, 1973). A team from the University of Pennsylvania and the Thai Fine Arts Department suggested that Ban Chiang pottery represents the world's oldest bronze-casting and iron-working civilisation. The recovered pottery can be categorised into: Pre-metal Age pottery, dating back to 3,000 to 5,000 years ago, and characterised as black vessels decorated with a cord mark design; Bronze Age pottery, dating back to 2,300 to 3,000 years ago, and identified as carinated pots of greyish-white clay and plain surface, with a painted incision under the rims; and Iron Age pottery, dating back to 1,800 to

2,300 years ago, the most beautiful collection among all, distinguished by their painted red geometric patterns on dark clay and buff slip coating. The unique style of the pottery from each period suggests that different fabrication processes and firing temperatures were used (Tanthanuch *et al*., 2011).

The chemical composition of materials used to design Ban Chiang pottery is crucial information. Materials for art production change with time and production place. Various studies on chemical composition of Ban Chiang pottery, including McGovern *et al.* (1985) and Bubpha (2003), found that plant material was the major ingredient in the Bronze Age pottery, but rarely found in the Iron Age pottery. McGovern *et al.* and Bubpha also investigated the slips that coated the Iron Age pottery, and found that the chemical composition of the slips was almost the same as that of the pottery interior. The difference was that the slip contained slightly more iron (Fe) and slightly less calcium (Ca) than the interior of the ware. McGovern *et al.* (1985) and Bubpha (2003) also stated that the composition of Ban Chiang pottery generally included silica (SiO_2) and a mixture of other minerals, such as quartz, carbonate, aluminium oxides, and iron oxides. The ratio of SiO_2 to other clay minerals within the clay determined the type of clay, such as kaolinite ($Al_2Si_2O_5(OH)_4$), illite ((K, H_3O) Al_2(Si, Al)$_4O_{10}(OH)_2$), etc. Investigation of the chemical composition of Ban Chiang pottery using XRF also revealed the artefacts' SiO_2/Al_2O_3 ratio. All the samples were found to contain a high amount of SiO_2 and a low amount of Al_2O_3. The SiO_2/Al_2O_3 ratio varied between 3.27 and 4.76. The amount of alkaline oxides (K_2O and Na_2O) in Pre-metal Age pottery shards was lower than that found in the Bronze Age and Iron Age pottery shards. The amounts of alkaline-earth oxides (CaO and MgO), which are auxiliary fluxes, were also low. In contrast, the amount of Fe oxide in Pre-metal Age pottery shards was higher than in the Bronze Age and Iron Age pottery shards. It is known that iron oxide contributes to the reddish colour of clay-based products fired at low temperature (Tanthanuch *et al.,* 2011). The studies conducted by Glanzman *et al*. (1985) revealed that the red paint on Iron Age pottery had a similar chemical composition to that of the slip. The difference was that the red paint contained more Fe and less Ca (Glanzman *et al*., 1985). In addition, Na Nakhornphanom *et al*. (2011) mentioned that the original Ban Chiang pottery had higher water stability than its replicas.

Sample preparation

In the authors' study, two sample pottery groups were defined.

Group 1: Forty samples of pottery and potsherds, excavated from the Ban Chiang archaeological site in northeastern Thailand, and which were given to the Fine Arts Department by Silpakorn University.

Group 2: Twenty samples of replica pottery, obtained from the market and the central storage of the Fine Arts Department.

Figure 1. Original and replica samples were both analysed.

Results and discussions

The analyses were obtained through the following methods.

Reflectance spectroscopy

To carry out analysis using a non-destructive technique, the reflectance spectroscopy technique was utilised. This technique carries the underlying assumption that each material displays a specific spectral signature in the ultraviolet (UV), visible (Vis), and infrared (IR) regions, and that this spectral signature contains more information about the quality and quantity of the red pigment than the eye can capture. Measurements were performed using a Gorgias Reflectance Spectroscopy system equipped with a 10W halogen lamp, Toshiba TCD1304DG linear array detector with spectral range of 300 to 1000 nm (100 microns slit), and a charged coupled device (CCD) linear sensor of 3468 pixels. The spectral resolution is 16 bits. The authors illuminated the samples at an angle of 45°. The recorded light spectrum corresponds to human vision sensitivity, which ranges from 380 to 720 nm.

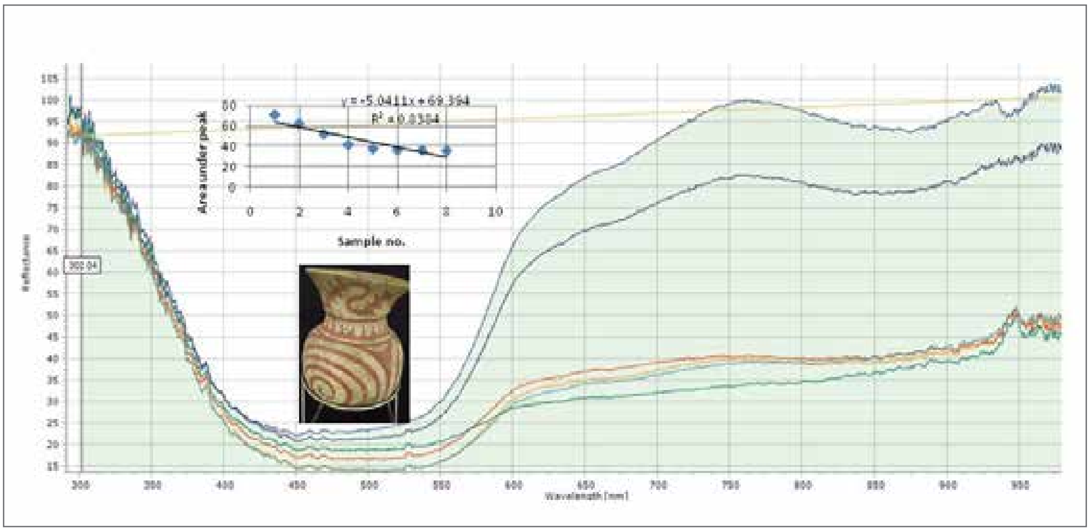


Figure 2. Reflectance spectra for eight points of one original Ban Chiang pottery sample.

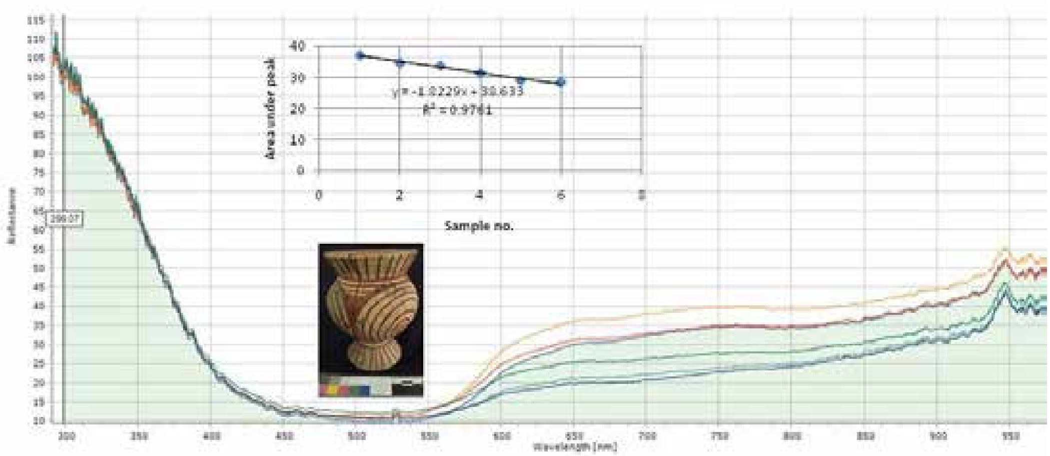


Figure 3. Reflectance spectra for six points of one replica sample.

Figures 2 and 3 show the reflectance spectra of red paint samples taken from the original and the replica sample respectively. All samples were mixtures of a variety of elements such as Si, Al, Ca, and Fe. The chemical composition of the red paint in visible light showed it was an Fe compound. The red paint also displayed a reflection wavelength range of 300 to 1000 nm. The peak in the UV region, which lies between 300 to 400 nm, is hardly visible to the eye. In the wavelength range of 470 to 500 nm, the original Ban Chiang samples showed an absorption rate that was lower than that of the replica samples. This meant that the red paint on the originals had less red hue than that of the replicas. This was because the interference of the green-blue wavelength of the replica sample was very low compared to the original sample. Moreover, the average area under the graph for the wavelength range of 470 to 500 nm, showed that the replica is 11.49 when the highest average area under the graph is 12.65 and the lowest average area under the graph is 10.47 and the variant is 9.7%. The original is 19.21 when the highest average area under the graph is 24.4 and the lowest average area under the graph is 14.56 and the variant is 31.93%. These results showed that the difference of reflectance in the red paint on the originals was not constant whereas that of the red paint on the replica sample was more constant and closer to each other.

PXRF

PXRF is one of the methods used for chemical analysis of archaeological pottery and other cultural heritage artefacts. Chemical characterisation of the samples was obtained by analysing the major element content. Preliminary analyses were carried out in some of the samples to check whether this type of element was valid as a suitable proxy for in the study of red paint samples. The major element content was measured using pXRF, which is commonly used in pigment studies. Measurements were taken using the Thermo Scientific Niton XL3t 970 analyser (serial 945633) with the aperture for 8 mm for 40 seconds. The mode is Mining Cu/Zn.

Table 1. Major element content analysis of original Ban Chiang samples and replica samples. Values are expressed in normalised percentages with respect to the total weight of detected elements.

Sample	**Fe**	**Mn**	**Ti**	Ca	K	Al	P	Si	Cl	S	Ratio Si/Al
No.1	3.33	0.063	0.322	5.265	0.932	2.718	0.172	13.699	0.033	9.631	5.04
No.2	2.941	0.053	0.313	5.077	0.902	2.214	0.145	12.205	0.037	9.152	5.513
No.3	3.31	0.099	0.347	4.389	1.002	3.125	0.211	15.636	0.024	8.143	5.003
No.4	2.71	0.08	0.376	3.375	1.065	3.468	0.274	18.328	0.022	4.906	5.285
No.5	2.683	0.055	0.31	4.99	0.907	1.984	0.139	11.835	0.025	7.549	5.965
No.6	3.603	0.116	0.274	4.118	0.882	2.315	0.194	13.167	0.037	7.743	5.688
No.7	5.967	0.104	0.239	4.365	0.943	2.144	0.294	12.041	0.047	7.176	6.153
No.8	2.359	0.088	0.35	4.806	0.83	1.957	0.108	14.642	0.035	7.497	7.482
No.9	2.972	0.118	0.333	5.517	0.857	2.482	0.39	13.551	0.039	9.734	5.459
No.10	4.007	0.097	0.275	4.947	0.861	1.784	0.16	10.185	0.03	8.007	5.709
No.11	4.83	0.127	0.23	4.681	1.001	2.663	0.277	12.374	0.028	8.337	4.647
No.12	3.271	0.068	0.307	5.19	0.951	2.969	0.189	15.61	0.046	7.982	5.257
No.13	3.423	0.071	0.256	5.466	0.792	2.791	0.152	14.962	0.09	8.946	5.361
No.14	2.008	0.056	0.199	2.436	0.68	2.14	0.17	13.527	0.03	4.329	6.321
No.15	2.777	0.176	0.285	6.422	0.846	2.401	0.206	12.068	0.048	11.956	5.026
No.16	4.109	0.098	0.412	4.581	0.879	2.197	0.721	11.285	0.108	5.454	5.136
No.17	4.078	0.046	0.361	5.087	1.011	2.909	0.305	13.826	0.116	8.86	4.753
No.18	3.124	0.07	0.381	4.009	1.188	4.171	0.237	18.765	0.066	6.527	4.498
No.19	3.855	0.107	0.357	4.274	1.09	3.465	0.237	14.939	0.061	9.015	4.311
No.20	3.184	0.184	0.37	3.69	1.134	4.168	0.221	17.775	0.035	7.922	4.265
No.21	2.727	0.052	0.27	7.234	1.278	2.197	0.149	10.542	0.03	12.071	4.798
No.22	2.693	0.06	0.298	5.845	1.137	2.775	0.102	13.538	0.016	9.902	4.878
No.23	2.669	0.04	0.219	8.274	1.159	2.207	0.178	9.338	0.025	12.156	4.231

No.24	2.015	0.025	0.231	8.255	1.056	1.54	0.07	8.278	0.019	11.695	5.375
No.25	2	0.032	0.225	7.986	3.271	1.887	0	8.406	0.024	16.973	4.454
No.26	2.189	0.027	0.245	8.779	1.012	2.405	0	10.885	0.02	13.737	4.526
No.27	1.304	0	0.331	8.818	0.877	2.73	0	16.776	0.028	13.359	6.145
No.28	2.43	0	0.207	9.169	1.093	1.967	0.109	8.974	0.034	13.054	4.562
No.29	2.652	0.077	0.241	3.986	6.043	1.998	0.186	10.373	0.014	16.63	5.192
No.30	3.652	0.053	0.296	4.912	2.096	2.139	0.141	11.14	0.031	12.026	5.208
No.31	3.23	0	0.242	7.673	1.388	2.282	0	9.629	0.03	12.55	4.219
No.32	2.69	0.025	0.297	6.743	1.559	2.795	0.092	11.797	0.031	12.962	4.221
No.33	3.09	0.033	0.247	8.121	1.371	1.611	0.078	8.429	0.023	12.786	5.232
No.34	2.75	0.061	0.237	8.129	1.187	1.715	0.091	8.164	0.026	13.608	4.76
No.35	2.85	0.114	0.304	4.64	3.714	1.557	0	8.932	0.014	15.54	5.737
No.36	3.993	0.061	0.366	1.897	3.971	4.17	0.092	14.534	0.018	9.836	3.511
No.37	2.981	0	0.254	5.718	2.932	2.183	0.092	11.388	0.035	13.423	5.217
No.38	3.1	0.027	0.326	5.197	1.618	2.628	0.118	12.869	0.042	10.394	4.897
No.39	3.068	0.052	0.226	7.659	1.261	1.707	0.075	8.042	0.022	13.116	4.711
No.40	2.276	0.03	0.247	6.862	1.226	1.621	0.076	8.592	0.018	12.073	5.3
Mean	3.072	0.066	0.290	5.714	1.450	2.454	0.161	12.276	0.036	10.419	
Max.	5.967	0.184	0.412	9.169	6.043	4.171	0.721	18.765	0.116	16.973	
Min.	1.304	0	0.199	1.897	0.68	1.54	0	8.042	0.014	4.329	
	Replica Sample										
No.41	2.954	0	0.499	1.296	0.963	2.535	0.122	13.04	0.274	1.683	5.144
No.42	2.691	0	0.528	0.796	0.887	4.667	0.088	18.297	0.104	0.989	3.92
No.43	2.473	0	0.456	0.942	0.822	3.275	0.133	14.58	0.193	2.127	4.452
No.44	1.585	0	0.544	0.848	0.699	5.624	0.064	21.292	0.053	2.401	3.786
No.45	2.22	0	0.551	0.574	0.952	4.808	0.06	19.332	0.163	1.38	4.021
No.46	1.911	0	0.567	0.807	0.838	5.428	0.069	20.589	0.061	1.98	3.793
No.47	2.311	0	0.534	0.692	0.885	5.267	0.077	19.965	0.112	1.533	3.791
No.48	1.632	0	0.505	1.064	0.786	6.434	0.077	21.795	0.12	4.076	3.387
No.49	1.861	0	0.491	0.626	0.706	4.632	0.098	20.998	0.054	0.738	4.533
No.50	1.589	0	0.505	0.476	0.553	5.019	0.087	22.046	0.069	0.474	4.392
No.51	3.317	0	0.213	9.181	0.986	2.706	0.072	11.643	0.022	1.362	4.303
No.52	2.731	0	0.431	2.143	0.851	3.714	0.269	16.103	0.021	1.533	4.336
No.53	3.025	0	0.364	2.665	0.955	3.116	0.313	13.492	0.032	1.752	4.33
No.54	2.918	0	0.408	1.572	0.958	3.951	0.313	16.35	0.024	1.39	4.138
No.55	2.506	0	0.487	0.795	0.951	5.419	0.375	20.348	0.009	0.71	3.755
No.56	4.662	0.025	0.363	1.2	1.172	4.824	0.291	18.149	0.023	1.522	3.762
No.57	3.586	0	0.421	0.594	1.163	5.178	0.238	19.201	0.017	0.426	3.708
No.58	2.192	0	0.484	3.437	0.695	4.96	0.44	19.026	0.007	1.406	3.836
No.59	2.56	0	0.48	1.152	0.94	4.968	0.38	19.073	0.015	0.626	3.839
No.60	2.718	0	0.419	3.278	0.898	4.53	0.444	17.326	0.029	1.408	3.825
Mean	2.572	0.001	0.4625	1.707	0.883	4.552	0.200	18.132	0.0701	1.476	
Max.	4.662	0.025	0.567	9.181	1.172	6.434	0.375	22.046	0.274	4.076	
Min.	1.585	0	0.213	0.466	0.553	2.535	0.06	11.643	0.007	0.474	

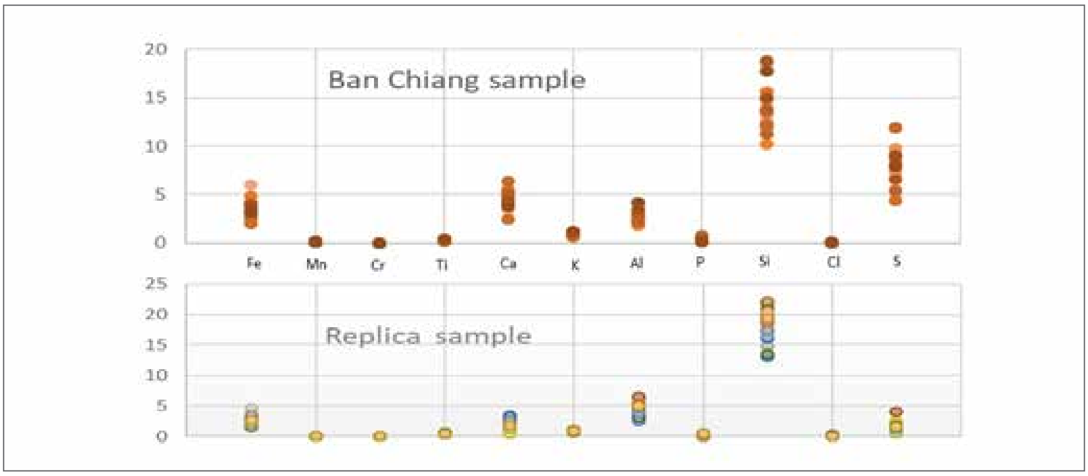
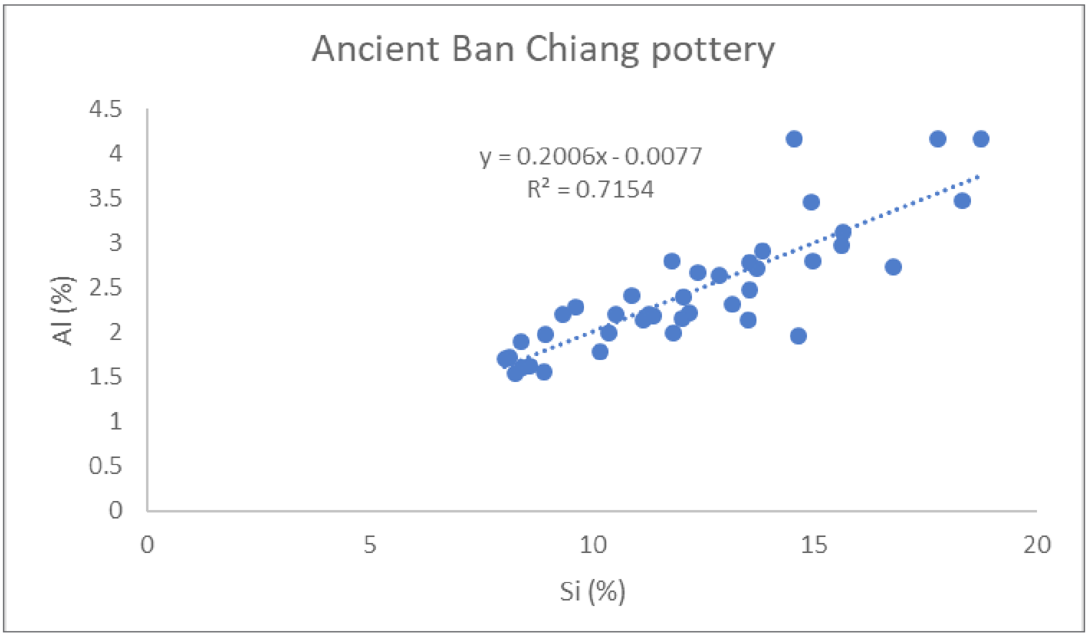


Figure 4. Major element content analysis of original Ban Chiang samples and replica samples.

The results showed a clear difference between the red paint on the original Ban Chiang pottery samples and that on the replica samples, and highlighted the most significant differences between them (Figure 4).

Characteristically, the red paint from the original samples had high Si, S, Ca, and Fe content, and low Al content. Si was the most abundant element. The content of other detected elements (K, P, Cl, Ti, and Mn) was near to the detection limit (1%) and considered insignificant (Figure 4 and Table 1). In Table 1, Si content varied from 18.765% to 8.042%. S was the second most abundant element, with a mean value of 10.419%. The minimum content value measured was 4.329%, and the maximum value 16.973%. Meanwhile, the mean for Ca content was 5.714%, the minimum content value 1.897%, and the maximum value 9.169%. The Fe content in the red paint from the original samples was low (less than 6%). The mean Fe content value was 3.072%, the minimum 1.034%, and the maximum 5.967%. The Si/Al ratio was nearly constant, with values of ~5 (Table 1).

The red paint from the replica samples had high Si and Al content, and lower Ca content. The content of other detected elements (K, P, Cl, Ti, and Mn) was considered insignificant. The Si content varied from 22.046% to 11.643%. Al was the second most abundant element, with a mean value of 4.552%, minimum value of 2.535%, and maximum value of 6.434%. The mean Ca content was 1.707%, the minimum value 0.466%, and the maximum value 9.181%. The Fe content in the red paint from the replica samples was low (less than 5%). The mean Fe content was 2.572%, the minimum 1.585%, and the maximum 4.662%. The Si/Al ratio was nearly constant, with values of ~4.



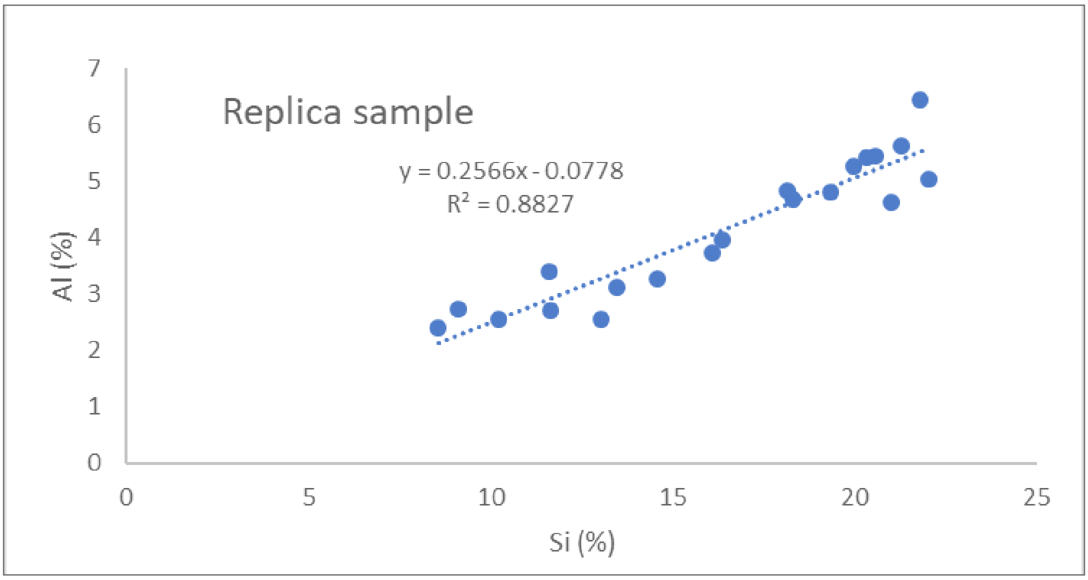


Figure 5. Relative percentage between Si and Al in original Ban Chiang samples and replica samples.

The relative percentage between Si and Al (R^2) in the red paint on the Ban Chiang samples and the replica samples was 0.7154 and 0.8827 respectively. The covariance of Si and Al content indicated that both elements were part of the red clay mineral phase, and that the clay minerals in the replica sample had lower covariance than the minerals on the original Ban Chiang samples. The results also indicated that the red paint on the replica samples most likely went through machine production, whereas the red paint on the original Ban Chiang samples was produced by man.

Generally, the Ca found on the pottery existed either as $CaSO_4$ or in calcite form. Calcite in archaeological pottery appears in the form of coarse granules or fine particles, and can be primary or secondary calcite. Coarse calcite granules could be polycrystalline or monocrystalline. Primary calcite is the initial calcite preserved in low-fired pottery. Secondary calcite, formed after the pottery firing process, is reformed (re-carbonated) calcite, precipitated calcite, or calcite produced from alteration. Therefore, the high content of Ca found in the red paint might have come from the soil and in the form of a carbonate or oxide compound, depending on the paint's elemental composition and the site the pottery comes from. With this information, we can begin to compare the red paint from the original Ban Chiang sample and the replica sample.

The authors found that the original Ban Chiang samples had three times more Ca content than the replica samples. This indicates that the high Ca content in original Ban Chiang pottery might be the result of long-term deterioration in the soil. Soil consists of various elements and moisture, including aqueous calcium hydroxide and Ca solution. These compounds may have seeped into the paint layer of the pottery and remained on the artefact's surface. In contrast, the red paint on the replica samples, which are produced in present day, had a constant quantity and ratio of chemical compounds such as Fe, Si, and Al. High Ca content may reduce the vibrant colour of the red pigmentation, thus the replicas were produced with low Ca content. The replica samples had low Ca content because Ca cannot accumulate onto the pottery in such a short time. However, if the soil used to make the pottery contained a high concentration of Ca, the pottery may show an abnormally high content of Ca.

When the Ca content decreases, in the case of the replica sample, it is due to carbonate not affecting contamination from the archaeological site. Figure 4 and Table 1 show that Fe content was not related to variations in Si and Al content, indicating that the Fe had formed a distinct mineralogical phase (iron oxides). The Fe content in both the original Ban Chiang samples and the replica samples had similar mean values, and measured 3.072% and 2.572% respectively.

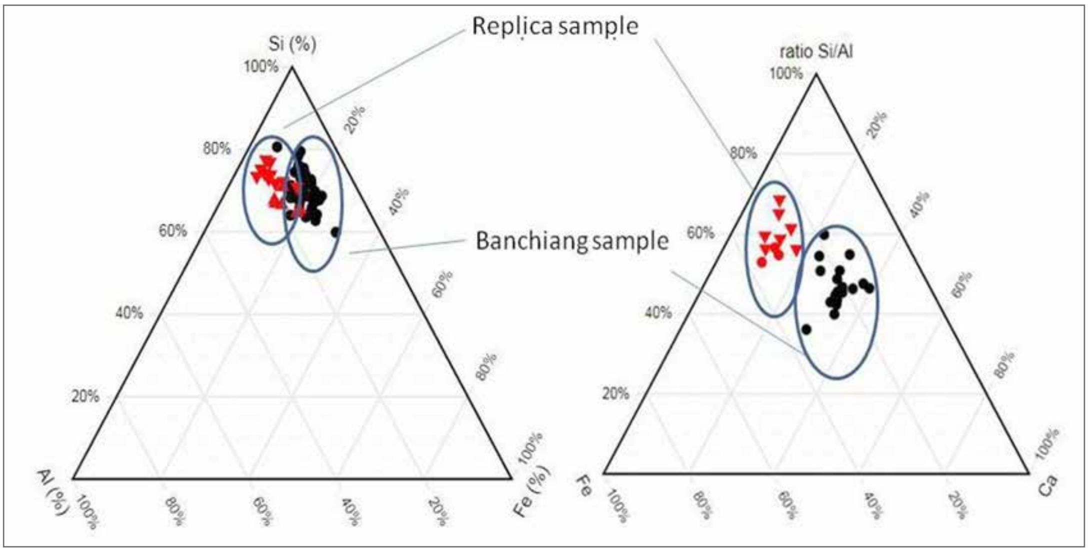


Figure 6. Ternary diagram of Si/Al/Fe content (left) and ternary diagram of (Si/Al)/Fe/Ca ratio (right).

In Figure 6, the ternary diagram of Si/Al/Fe content shows the results from the original Ban Chiang samples and the replica samples. As shown, the black and red spots are closer together, and some even overlap with each other. However, the diagram of Si/Al, Fe, and Ca ratio shows that the red and black are clearly separate from each other.

Colorimeter

Sixteen samples of red paint on eight original Ban Chiang samples and eight replica samples were analysed using the Colorimeter (NR110, 3nh).

Table 2. Colour coefficients a*, b*, and L*.

Sample No.	Colour coefficients (Ban Chiang samples)			Colour coefficients (Replica samples)		
	L*	a*	b*	L*	a*	b*
1	60.86	12.87	16.81	35.62	21.74	22.12
2	52.13	17.12	16.69	60.29	14.85	23.79
3	46.02	20.98	19.81	38.94	28.70	27.47
4	46.06	21.27	20.04	32.60	30.19	26.78
5	54.20	17.89	20.75	44.89	18.26	23.15
6	52.62	18.04	19.76	48.41	19.29	23.15
7	48.38	22.53	23.78	32.70	26.76	24.45
8	49.17	21.26	24.74	36.47	30.88	26.65

Red paint contains varying amounts of octahedral iron oxides, namely hematite (Fe_2O_3) or/and goethite (FeOOH), and white pigments from either aluminosilicates, such as kaolinite and illite, or calcites, such as quartz and Ca compounds. When hematite dominates as the main iron oxide, a red colour is observed; when goethite dominates, the red paint shows yellowish hues. These colours are results of the ion Fe^{3+} that is contained in both oxides, or more precisely, of the charge transfer between Fe^{3+} and its ligands O^{2-} or OH^-.

The L*a*b* space, coordinates are reduced from the formers: the achromatic lightness L* and the two chromatic components a* (green–red axis), and b* (blue–yellow axis). The colorimetric L*a*b* coordinates are given in Table 2 for all the red paint measured from original Ban Chiang and replica samples. The a* coordinate for the original samples stood between 12.87 and 22.53 with a relative variation of 75%. The b* coordinate stood between 16.69 and 24.74 with a smaller relative variation of 48.2%. Achromatic lightness L* varied by 32.2%. The same results were seen in the eight replica samples. By comparing chromatic coordinates of both types of samples, it was found that a* varied 1.43 times more than b* for the replica samples, and 4.2 times more than b* for the original samples. To differentiate the red paint using colorimetric parameters, the a* coordinates for both groups of samples appeared more significant, and were thus more related than b*. The positive a* values corresponded to the redness that was already qualitatively reported as characteristic of the red paint as seen by the eyes. This property is emphasised by the size of the L*a*b* space. Figure 7 indicates that L* of the Ban Chiang sample was higher than that of the replica sample. This result is tied to the influence of the relative amount of white pigments (carbonate and sulphate of Ca) contained in the Ban Chiang samples. Figure 7 also points out that the nature of the white pigments does influence the relationship between lightness and redness.

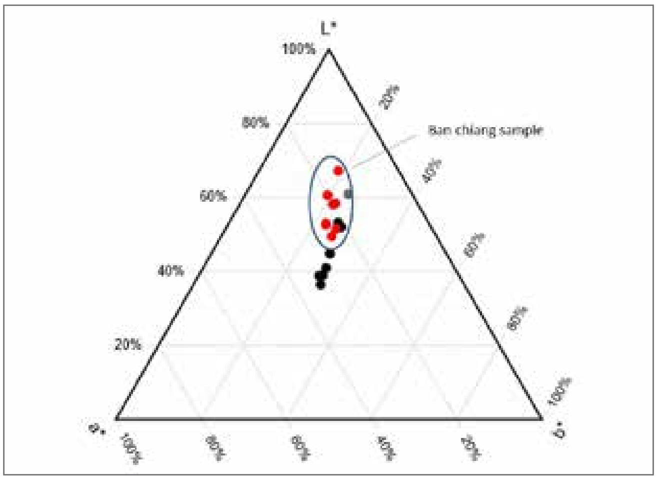


Figure 7. *Relationship between colorimetric coordinates a*, b*, and L*.*

FTIR analysis

Four samples of red paint on two original samples and two replica samples were analysed using FTIR spectroscopic analysis. Measurements were taken using FTIR equipment (NICOlet iS10). The spectral solution is 0.4 cm^{-1}, and scan for 16 seconds. The spectra obtained are presented in Figure 8.

The FTIR spectra for both types of samples were very similar to each other, with all peaks showing the FTIR spectrum of peak the red paint on pottery also found peak of SiO_2, which is related to the result of XRF that found the amount of Si in main composition of red paint. The IR band at 3383.57 cm^{-1} could be due to the stretching vibrations of Si-OH groups in amorphous SiO_2. Correspondingly, the IR band at 1640 cm^{-1} could be due to the bending vibration of H_2O molecules. Maximums of both spectra (in the 900-1200 cm^{-1} range) could have been caused by stretching C-O or Si-O vibrations. However, a wide band is present in this area indicates that it is more probable that the maximums come from Si-O vibrations because silicon is present in the samples, in the form of kaolinite-derived aluminosilicate ($Al_2 O_3$ *SiO_2 *$2H_2O$). The very strong and broad IR band at 1003.61 cm^{-1} is usually attributed to Si-O-Si asymmetric stretching vibrations. The IR band at 956 cm^{-1} can be attributed to silanol groups.

The main peak in the replica sample reading was similar to the peak of the Ban Chiang sample reading. However, the authors found that characteristic peaks of aliphatic carbon-carbons (C=C and C-C) were also observed, which means that binder was used in the creation and preparation of the paint colour. The presence of organic material in both of the replica samples was characterised by the frequencies of C-H stretching bands at 2986 cm^{-1} and 2955 cm^{-1}, the overall profile of the C-H stretching region, C=O stretching at 1732 cm^{-1}, and skeletal vibrations at 1179 cm^{-1}. In Figure 8, the presence of a carbonyl group with a maximum value of 1731.65 cm^{-1} was observed in the FTIR spectrum of replica sample (A). In replica sample (B), the presence of this group was characterised by a maximum value of 1720.06 cm^{-1}. These values of maximum absorption for both groups of samples corresponded to the area of absorption of ester-bound C=O groups. The absorption for sample (B), measuring 1637 cm^{-1}, refers to the presence of C=C bond in the molecule, and the presence in IR spectra at approximately 1435 cm^{-1} and 1374 cm^{-1} originate from deformational C-H vibrations (asymmetrical and symmetrical vibration).

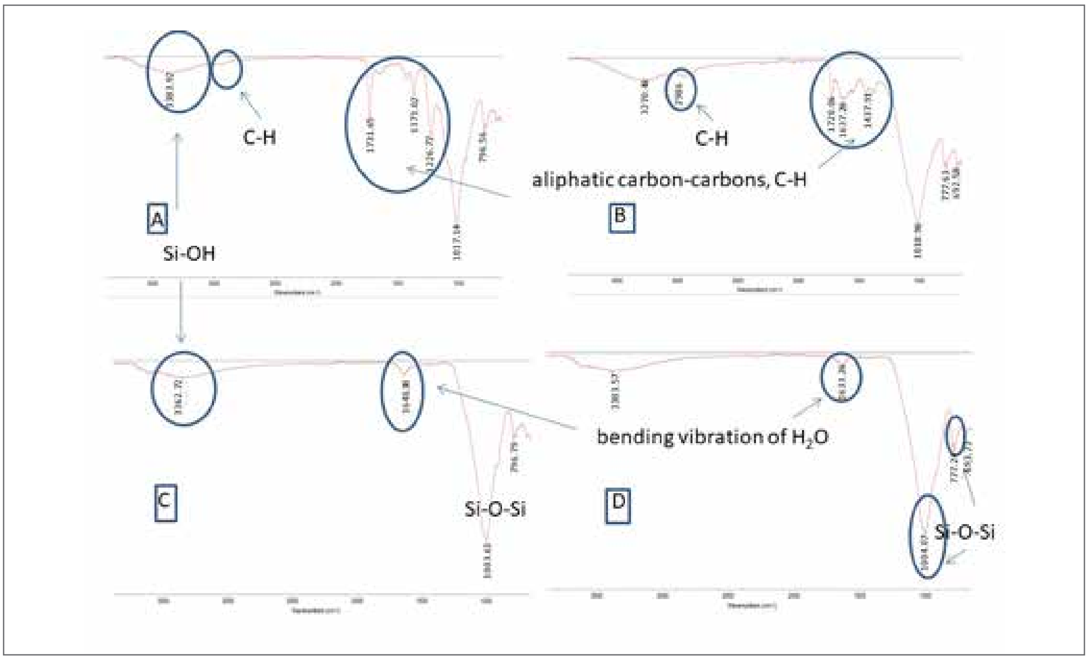


Figure 8. FTIR spectra samples (A, B: the replica samples; C, D: the Ban Chiang samples).

Conclusion

This paper studied the red paint found on original Ban Chiang pottery and its replicas via scientific techniques in order to compare the differences between these objects. The XRF technique showed that the main chemical elements of red paint were Si, Al, and Fe, and that there was significant difference in the amount of Ca between the original pottery and the replicas. The original pottery had higher amounts of Ca than the replicas. If finding out the origin of the $CaSO_4$ and $CaCO_3$ groups that remained on the original samples' surfaces was necessary, XRD technique could be applied. The reflectance spectroscopy in the wavelength of 300 to 1000 nm indicated presence of red earth. It was found that at the wavelength of 450 to 850 nm, the data of the original samples was spread out and far from the line R^2, whereas the data of the replica samples was close to R^2. The Colorimetric coordinates showed that the variants of a*, b*, and L* derived from the original samples were more than the variants of a*, b*, and L* derived from the replica samples. It means that the red paint material of the replica sample is exactly proportionate to the mineral amount, which is different from the Ban Chiang sample. The FTIR also confirmed the results of the functional group of chemical composition of the elements by XRF technique. Si-OH and Si-O-Si were found on the red paint from both types of samples, but the functional organic group was only found on the replica samples. This indicates that the organic material (binder) of the original pottery had degraded, but it is still found on the replica sample because this binder is in paint products available in present day. Thus, the authors can conclude that the scientific techniques utilised in this research successfully differentiated original Ban Chiang pottery from replicas without destroying any samples.

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A Brief Introduction to Gold Coating Craft on Painted Earthen Sculptures from Ancient China

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KEYWORDS
painted earthen sculpture,
surface decoration,
gold coating

ABSTRACT
Painted earthen sculptures are an important physical carrier of ancient Chinese history and culture. This paper takes the production of these sculptures and their surface makeup process as an entry point to focus on the gold coating craft that is part of the sculptures' make-up process. Gold coating is an important decorative method that includes gold depicting, gold brushing, gold pasting, etc. Gold coating is also an important embodiment of the grade, structure, and the value of an earthen sculpture, and shows off the sculptor's superb craftsmanship and technical abilities.

Introduction

Making painted earthen sculptures is a traditional craft that uses clay as the main material for shaping, and involves colours and patterns drawn on the sculpture surface after the clay dries. Plenty of pottery pigs, sheep, chickens, fishes, birds, and faces of people were found on the relics unearthed at Hemudu Site in Yuyao, Zhejiang Province; Qujialing Site in Jingshan, Hubei Province; Dawenkou Site in Shandong Province; and Banpo Site in Xi'an, Shaanxi Province. These ancient and precious works of art prove that the history of Chinese earthen sculptures can be traced back to the Neolithic Age more than 7,000 years ago.

The development of painted earthen sculptures

During the Wei, Jin, Southern and Northern Dynasties where Buddhism prevailed, the rapid development of Buddhist statue-making directly promoted the development of painted earthen sculpture art. With the continuous deepening of Buddhism and Taoism in the Sui and Tang Dynasties, painted earthen sculptures were gradually popularised among the people due to the craftsmanship associated with the sculptures and rich modelling, and availability of materials. In the Song Dynasty, painted earthen sculptures were a part of local religion and customs, and widely used in temples, ancestral halls, or as various types of earthen toys. By the Yuan Dynasty, the court had a special institution to manage the craftsmen who were dedicated to the creation of Buddha statues. After the Ming and Qing Dynasties, painted earthen sculpture art flourished and became an indispensable part of the people's cultural life. Painted earthen sculpture art has been passed down to contemporary society and remains an important physical carrier of religion, folklore, and humanities.

The craftsmanship of painted earthen sculptures

Painted earthen sculptures can be classified according to size. Large-scale painted earthen sculptures mostly exist in temples, ancestral halls, caves, etc. The themes of these sculptures involve religion, mythology, legendary figures, etc. Small-scale painted earthen sculptures mainly included ornaments, toys, and so on.

The production process of large-scale painted earthen sculptures is relatively complicated (Fig. 1). These are the steps commonly used to make these sculptures:

1. Make the sculpture's skeleton using thick wood for the main column. Nail a wood strip or sheet onto the column to create the general frame of the sculpture.
2. Make the main body of the sculpture. Wrap the body with wheat straw, rice straw, and coarse linen, in order to cover the main body with the coarse slurry. It is also beneficial to reduce the weight of the final earthen sculpture,because of the wheat straw, rice straw, and coarse linen, not the Paste coarse clay.
3. Paste coarse clay onto the body to form the sculpture's posture, including its general shape and clothing pattern.
4. Apply fine clay after the coarse clay has dried. Cotton, fine linen, cotton paper, and other reinforced materials are also added into the fine clay to prevent the sculpture surface from cracking after drying. The main details of the sculpture, such as the face, headwear, hair accessories, crowns, hands, feet, costumes, etc., are added using layers of fine clay.
5. Polish the surface of the fine clay. After the fine clay has dried, the cracks on the surface of the earthen sculptures are pasted together repeatedly. Pasting stickers and patches, or polishing the surface until it becomes flat and smooth, also helps to fix cracks.
6. Strengthen the surface of the fine clay by applying a layer of glue, and alum water or tung oil. This mixture strengthens the earthen surface and prevents colour penetration.
7. The final step is surface painting. Patterns and colours befitting the figure, sculpture shape, and are in accordance with temple requirements, craft requirements, funding availability, etc., are drawn and applied to the surface of sculpture. Full painting of the surface, partial gold coating, and whole-body gold coating may also take place.

Fig. 1. Production process of a painted earthen sculpture.

The production process of small-scale painted earthen sculptures involves clay beating, drafting, kneading (moulding and printing), refurbishing, drying the sculpture in the shade, applying background powder, colouring, carving facial expressions, waxing, and more. The main raw material used is still clay, and a small amount of cotton wool or silk tissue paper is added to the clay to increase the strength of the final sculpture.

The surface decoration process

After applying fine clay to the sculpture, the sculpture's surface is decorated according to the traditional make-up process. The fine clay layer can be treated with hemp paper, white ash, large lacquer, tung oil, and other materials, mainly to prevent the fine clay layer from cracking, but also to increase surface flatness, and strengthen surface strength.

The materials used for make-up in ancient China are mainly natural minerals and plant pigments. For example, red pigments generally come from hematite, cinnabar, lead oxide, etc.; green pigments from green copper ore, turquoise, malachite, etc.; blue pigments from blue copper ore, lapis lazuli, etc.; yellow pigments from stone yellow, orpiment, etc.; and white pigments from chalk, gypsum, lime, talc, etc. Sculptures can also be decorated with gold, either in the form of partial small area gold coating, partial large area gold coating, or whole-body gold coating.

Fig. 2. Earthen sculpture in Sichuan Xinjin Guanyin Temple.

Fig. 3. Earthen sculpture in Dule Temple, Yinzhou District, Tianjin.

Fig. 4 and Fig. 5. Earthen sculptures in Shuiluyan Temple, Lantian County, Shaanxi Province.

The surface gold coating process

Gold coating is an important way of sculpture decoration, and also indicates the high value of an earthen sculpture. Normally, gold coating is applied onto the earthen sculptures in high-level temples. Gold coating decoration methods mainly include gold depicting, gold painting, and gold pasting.

Gold depicting

Gold depicting is mostly used for fine decoration of earthen sculptures. A brush is dipped into gold powder, and then used to draw patterns and write characters on the sculpture surface. The patterns drawn would usually complement other decorations such as gold-edged lines (Fig. 6 and Fig. 7). The gold powder is usually made from a mixture of high-purity gold powder, large lacquer, and tung oil.

Fig. 6 and Fig. 7. Gold-depicted areas of a sculpture.

Gold brushing

Fig. 8 and Fig. 9. Gold-brushed areas of a sculpture.

It is easy to understand gold brushing as it literally involves brushing gold powder onto the surface of an earthen sculpture using a brush or a pen (Fig. 8 and Fig. 9). The gold powder is usually mixed with high-purity gold powder, large lacquer, and tung oil. Generally, the area of the gold brushing is relatively large, and brush strokes can be seen with the naked eye.

Fig. 10. Micro-image showing a section of a gold-brushed sculpture.

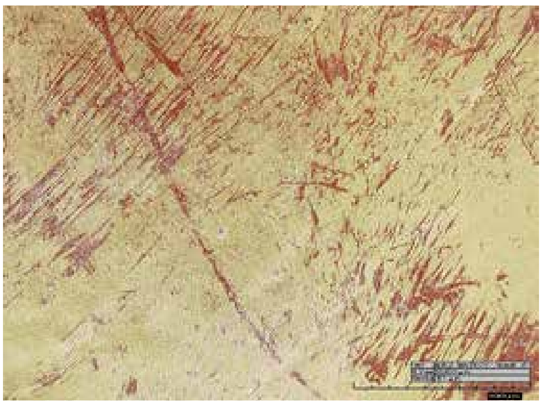


Fig. 11. Micro-image of a gold-brushed surface.

Fig. 10 shows a micro-image cross-section of a gold-brushed surface, while Fig. 11 shows a micro-image of a gold-brushed surface. In Fig. 11, pen or brush strokes can be seen on the surface.

Gold pasting

Gold pasting is a gold coating technique used for surface decoration of painted earthen sculptures. The requirements for material technology and methods are numerous, and the cost of gold pasting is relatively high.

Ancient gold foil processing technology

Due to the good ductility and malleability of gold, gold foil is made by beating a thin gold sheet. One gram of gold can be made into 0.5 square metres of pure gold foil with a thickness of 0.12 μm. In China, gold foil manufacturing started in the Eastern Jin Dynasty, matured in the Southern Dynasties, and was popularised in the Song, Qi, Liang, and Chen Dynasties. Nanjing is the birthplace of Chinese gold foil.

Gold foil can be classified into "red gold" or "yellow gold", depending on the colour of the final product. Gold foil has also been called *Kujin* Foil, *Su Da Chi*, and *Tian Chi Jin* since the late Qing Dynasty. The production of gold foil generally involves many steps, including material selection, gold melting, gold smashing, making Gold *Nianzi*, heating Jin *Kaizi*, pounding Jin *Kaizi*, wrapping *Kaizi*, and gold foil cutting. The steps are as follows:

8. Material selection. This involves selecting gold raw materials.
9. Gold melting. Gold is placed in a crucible and melted at high temperature to become gold water. Micro amounts of silver and copper are added, and the residue filtered. The gold water is then poured into an iron sink trough to cool down and form a gold bar.
10. Gold smashing. After the thick gold bars have been manually flattened into thin gold strips, they are cut into thin gold leaves.
11. Making Gold *Nianzi*. The big golden leaves are cut into one square centimetre of gold leaves using a bamboo knife. A gold leaf of this size is called a Gold *Nianzi*.
12. Heating Gold *Kaizi*. 10 square centimetres of black gold paper is heated in an incubator.
13. Dipping Gold *Nianzi*. Embed the Gold *Nianzi* in between two pieces of upper and lower heated black gold paper. The Gold *Nianzi* should be placed in the centre of the black gold paper.
14. Pounding Gold *Kaizi*. The embedded Gold *Nianzi* paper is placed on a foil machine and pounded to make it thinner and larger. Now, the Gold *Nianzi* becomes Gold *Kaizi*.
15. Wrapping Gold *Kaizi*. The Gold *Kaizi* is pounded continuously to make a thinner foil. This Gold *Kaizi* is then picked up using a goose feather and placed onto 20 square centimetres of black gold paper.
16. Cutting gold foil. A gold foil is cut into a specific shape using a bamboo knife.

Adhesives commonly used in gold pasting during ancient times

<u>Tung oil</u>

Tung oil is dry oil extracted from the fruit of the Tung tree (Vernicia fordii). It is a special product made in China, and is mainly produced in the southern provinces. The widely used tung oil is an excellent dry vegetable oil that is fast-drying, light-weight, and has good gloss, strong adhesion, is resistant to heat, acid, alkali, corrosion, and rust, and is non-conductive. Good quality tung oil is yellowish gold in colour, weakly acidic, and has good infiltration properties. It forms a film that is firm and dense. One disadvantage of tung oil, though, is its poor resistance to oxidation, and hence it should be sealed during storage. The main uses of tung oil in ancient painted earthen sculptures are as follows:

1. It works as an infiltration and reinforcement material to the fine clay layer.
2. Making gold horns. Tung oil is mixed with additive materials and cooked to six medium to make gold horns.
3. Making gold lacquer by mixing tung oil with gold powder.
4. Becoming a binder used in the gold pasting process, after being mixed with large lacquer.

Large lacquer

Large lacquer is one of China's famous specialties. The discovery and use of natural lacquer in China can be traced back to more than 7,000 years ago. The lacquer relics unearthed in China have a history of more than 2,000 years.

The composition of natural lacquer is very complicated. Lacquer is mainly composed of high molecular urushiol, laccase, gum, and water. Urushiol is the main component of painting solutions. Generally speaking, the higher the content of urushiol in the painting solution, the better the quality of the painting solution.

Large lacquer is only soluble in organic solvents such as alcohol, acetone, xylene, and gasoline. Raw lacquer is toxic, but the painting film formed by it is non-toxic and non-polluting. However, large lacquer also has certain limitations. The quality of large lacquer varies with the origin, variety, climate, etc., so controlling its quality is difficult. The filming process of lacquer is closely related to temperature, humidity, wind, and other environmental conditions. It requires a warm and humid condition, so it is not suitable to be made in winter. The viscosity of large paint is large, the production period long, the technology requirement high, and the process complex. Lacquer film is dark, deteriorates readily, and is not resistant to direct sunlight. Sometimes, large lacquer could even cause skin irritation to the operator.

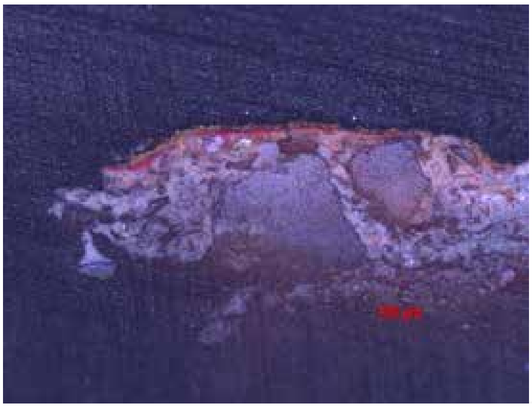
Large lacquer is used for a wide range of applications. In addition to the lacquerware that most people are familiar with, lacquer is also widely used in the construction, furniture, earthen sculpture production industries, and more. In large-scale earthen sculptures, it is famous for its large lacquer putty, together with gold adhesive and earthen sculpture production craftsmanship of Chinese unique "Fetal Lacquer Painted Sculpture". In the process of gold coating a painted earthen sculpture, putty powder is added to large lacquer, and large lacquer and tung oil can be mixed to form a binder.

Gold coating

The normal gold pasting process

Fig. 12 and Fig. 13. Gold-pasted sculptures.

The traditional gold pasting process is very simple. An adhesive is applied to the surface of the fine clay layer, and the surface is then coated with gold foil (Fig. 12 and Fig. 13). The size of ancient small gold foil is generally about 3cm x 3cm (in ancient times, it was called "inch gold"), and the big gold foil is about 9cm x 9cm in size. However, in practice, there is a great relationship between gold coating and gold foil quality, adhesives, and techniques. It can be directly observed that the gold foil on the surface of an earthen sculpture is in the form of a block, and there are traces of glue leakage in the middle.



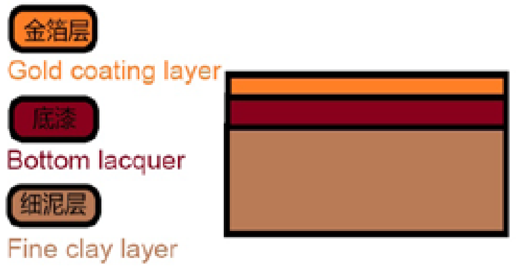
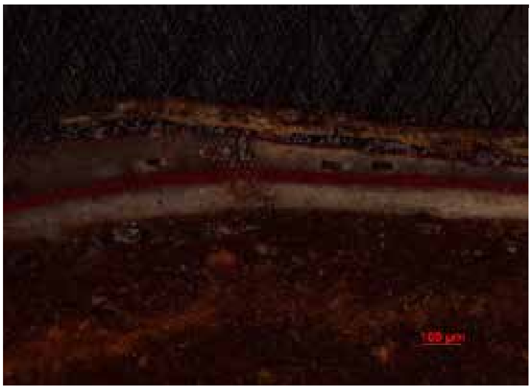


Fig. 14. Micro-image showing the cross-section of a gold-pasted sculpture.

Fig. 15. Diagram showing the layers in gold pasting.



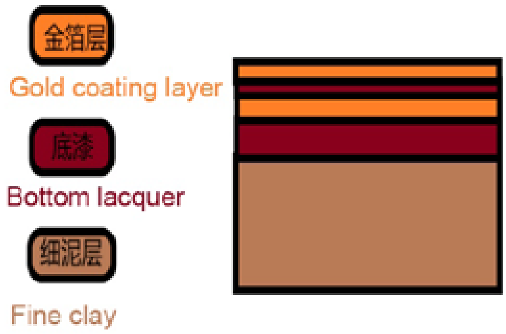


Fig. 16. Micro-image showing the multi-layered cross-section of a gold-pasted sculpture.

Fig. 17. Diagram showing the multiple layers in gold pasting.

From the micro-images of the cross-section and the layers in gold pasting, the relationship between gold foil, primer lacquer, and the fine clay layer can be clearly observed (Fig. 14 and Fig. 15). Multi-layered gold pasting, a result of past maintenance works, can also often be found (Fig. 16 and Fig. 17). When this phenomenon occurs, the gold foil becomes susceptible to environment influences, and will curl, be lifted from the sculpture surface, crack, and peel. These damages make restoration and treatment during the conservation and repair processes difficult.

Decorated gold pasting

Fig. 18 and Fig. 19. Sculptures with decorated gold pasting.

Decorated gold pasting is a relatively high-level gold pasting method. It is often used on key decorative parts, patterns, etc., in order to highlight the three-dimensional features of the part or pattern and reflects the higher level of the earthen sculpture, which enhances the sculpture's finishing touches. For example, decorated gold pasting is mostly used on a figure's collar, sleeves, skirts, or on the edges of the main patterns, the dividing lines, etc. (see Fig. 18 and Fig. 19).

Fig. 20 and Fig. 21. Parts enhanced by decorated gold pasting.

Gold pasting first starts with making a sketch with a pencil or charcoal indicating the area where the powder needs to be applied, and then mixing a certain amount of glue (e.g. bean glue, bone glue, peach glue, etc.) to white ash or gypsum to make a paste. The grey paste is placed inside a cone-shaped bag made of kraft paper or similar materials. The tip of the cone bag is then cut to form an opening the same thickness the decoration is required to be in, and the cone bag is hand-squeezed, the same way a pastry bag is squeezed during the modern cake-making process. The grey paste is squeezed onto the surface of the sculpture according to the shape of the pattern and, after the paste has dried naturally, the adhesive and gold foil are applied.

Fig. 22. Micro-image showing the cross-section of a sculpture with decorated gold pasting.

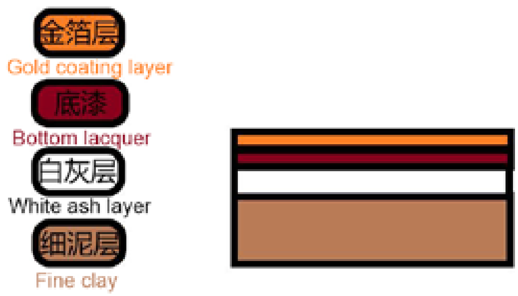


Fig. 23. Diagram showing the layers in decorated gold pasting.

The white substance under the decorated gold pasting (Fig. 22 and Fig. 23) is the grey paste layer. The surface of the decorated gold coating is semicircular.

Gold dialling process

Fig. 24 and Fig. 25. Gold-dialled sculptures.

Fig. 26 and Fig. 27. Parts of gold-dialled sculptures.

Gold dialling is the most complicated process in gold pasting. The gold production method and steps required for gold dialling are very demanding. Gold dialling is a traditional skill that is on the verge of being lost. In ancient times, many skills were passed on via word of mouth, and no accurate, detailed written records existed. According to the research and detection analysis of the gold-receiving parts, the process of gold dialling is roughly as follows: make a fine clay layer, apply a binder, apply gold foil, dial the gold foil according to the pattern, then add the top coat.

Fig. 28. Micro-image showing the cross-section of a gold-dialled sculpture.

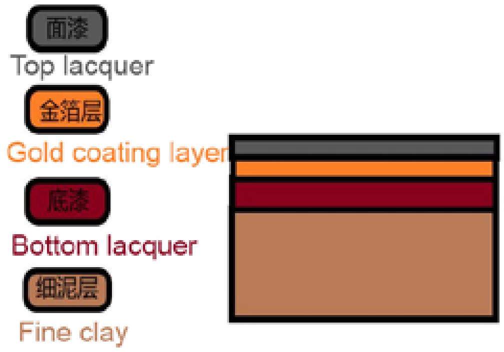


Fig. 29. Diagram showing the layers in gold-dialling.

The micro-images of a gold-dialled sculpture (Fig. 28 and Fig. 29) show the hierarchical relationship of the gold plating process, in which a black top coat is lacquered onto the surface gold foil.

Through conservation and restoration of the Luohantang Song Dynasty painted earthen sculptures in Qinglian Temple in Jincheng, Shanxi Province, the gold dialling process was ascertained to be as follows:

1. Make a fine clay layer. After 80% of the clay layer has dried, reinforcement is conducted using tung oil that has been simmered and mixed with large lacquer.
2. Make the bottom layer. The main material of this layer of the Qinglian Temple sculpture is *kaolin*. Craft rubber is added to the *kaolin*, and evenly blended and spread onto the fine clay layer.
3. Reinforcement of the bottom layer. The *kaolin* soil is reinforced with a layer of cooked tung oil and large lacquer.
4. Paste the gold foil. The binder used is 10% tung oil and large lacquer.
5. After the gold foil is 80% dry, a mineral pigment is added to the gold foil layer.
6. After the pigment is 50% dry, a bone needle is used to dial the gold.
7. After the gold layer has completely dried, a layer of tung oil is added.


Fig. 30 and Fig. 31. Recovery of gold-dialled sculptures.

Conclusion

Painted earthen sculptures have a long history, vivid shape, rich content, and bright colours. They are an important part of ancient Chinese cultural relics. Most earthen sculptures were created to promote the spread of Buddhism, but were based on real humans and absorbed a large number of folk craftsmanship. They are recognised by a wide range of people as an art form that condenses the wisdom and creative talents of the ancient Chinese people. The production of painted earthen sculptures is very complicated and ingenious, reflecting the advanced scientific and technological level of the times. However, because of the characteristics of the sculpture's materials, the sculptures are susceptible to environmental factors, and their preservation condition is not good, so the need for repairs and conservation are prominent. Prior to carrying out restoration works, cultural relic conservators must fully understand the ancient earthen sculpture production process, the methods and materials associated with the process, as well as the craftsmanship of the time, in order to scientifically and effectively protect each sculpture, and contribute to the inheritance of human cultural heritage.

Author's biography

Zhou Ping graduated from the Northwest University with a major in conservation of cultural heritage. She is the Deputy Director of Shaanxi Institute for the Preservation of Cultural Heritage (SIPCH). She has undertaken a number of scientific research projects organised by MOST and the National Cultural Heritage Administration (NCHA). She has drafted five national and industry standards. She has presided over conservation and restoration projects of many national cultural relic conservation units and museum collections, such as the research into painted clay sculptures in Tianjin Dule Temple, stability assessment of stone tablets and other precious cultural relics in Xi'an Beilin Museum, and conservation and restoration of architectural paintings and coloured drawings in Gongshutang. In 2010, she volunteered at Museum of University of Pennsylvania to restore two steeds belonging to Zhao Ling Mausoleum. From 2012 to 2016, she was a main member of the Shaanxi Provincial Tri-Qin Scholars of the conservation of cultural heritage. In 2013, she became one of the Cultural Heritage Conservation experts of NCHA. In 2016, she became one of the Cultural Heritage Conservation Experts of Shaanxi Provincial Development and Reform Commission. In 2017, she was awarded the "Advanced Worker in Shaanxi Province".

Analysis and Cleaning Tests of Zinc-type Haze on Oil-based Portrait Paintings of the Peranakans Mr And Mrs Tan Beng Wan

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KEYWORDS
zinc oxalate, gordaite, zinc chlorosulfate, haze, efflorescence, cleaning

ABSTRACT
Insoluble and stable crusts, haze, and efflorescence that have developed on the surface of paintings can be visually disturbing and are generally difficult to remove during conservation. Highlighted here are a pair of oil-based portrait paintings of the Peranakans Mr and Mrs Tan Beng Wan, dating to the late 19th to early 20th century, that presents an interesting case study of various zinc-type hazes on paint surfaces. The thin whitish films and unsightly patches were analysed using a digital microscope, scanning electron microscopy with energy dispersive spectroscopy (SEM-EDS), and Fourier-transform infrared (FTIR) micro-spectroscopy, and were identified as different mixtures of zinc oxalate, carbonate (hydrozincite), hydroxychlorides, and sulfates. Gordaite ($NaZn_4Cl(OH)_6SO_4.6H_2O$) and zinc chlorosulfate ($Zn_4Cl_2(OH)_4SO_4.5H_2O$), also known to occur in marine or urban/industrial atmospheric corrosion of zinc, were characterised probably for the first time as surface efflorescence on oil paintings. Zinc soaps migrating from the ground and paint layers were postulated as precursors to the formation of the zinc-type haze localised in micrometer scale layers at the paint surface. Removal of these zinc-type salts is challenging as they are insoluble in water and resistant to organic solvents used in conservation. Mechanical removal of the thin haze has the risk of disrupting the underlying paint layers. The efficacy of cleaning the whitish haze on *Portrait of Mr Tan Beng Wan* using chelating solutions was tested, and treatment considerations are discussed.

[1] The authors use the term Peranakan here to denote early Chinese immigrants who married indigenous women from the Malay Archipelago in Southeast Asia, and are therefore, of mixed ethnic origins.

[2] In 1871, Mr Tan Kim Tian and his son Mr Tan Beng Wan founded Tan Kim Tian and Son Steamship Company, one of the first Chinese firms in Singapore to buy and build ships.

Introduction

Surface haze reported in painted works of art has been attributed to various sources, including mould, pollutants, migration of free fatty acids and wax, physical disintegration of surface coatings, saponification, and complex salt formation (Gridley 2019). Similar terms like efflorescence, encrustations, whitening, blanching, and blooming are also often used in the conservation field (Ordonez & Twilley 1998; Van Loon 2008). Although not all hazes on affected artworks are visible, some can be visually impactful and compromise the artwork's aesthetics (Burnstock et al. 2011; Puglieri et al. 2016; Van Loon, Noble & Boon, 2011). In the case of mould, if not treated immediately, it could propagate deep into the paint layers, and the damage caused may become irreversible in future. In some instances, the haze reappears even after its removal (Puglieri et al. 2016). Hence, even the slightest occurrence would be a cause for concern in conservation.

A pair of portrait paintings in the Peranakan[1] (Chong, Teo, Yoong & Joseph 2015) collection of the National Heritage Board of Singapore (NHB) was brought to the authors' attention, as the painted surfaces showed an unusual haze that appeared to have effloresced to differing degrees (Fig. 1). These paintings, dating to the late 19th to early 20th century, are important portraits of Mr Tan Beng Wan (1850-1891) and his wife Madam Lim Imm Neo (1851-1925), who were highly respected pioneers in the shipping industry of early Singapore[2]. It was suggested that the portrait paintings were created using photographs as reference, and commissioned to a studio (Chong et al. 2015; Lee et al. 2015).

During the initial assessment of the paintings, it was uncertain if the whitish haze was part of the artist's technique or due to natural degradation, though the latter seemed to be a more plausible reason since portrait paintings of this genre were usually painted with a background executed in one uniform chroma. To return the paintings to their original appearance, it was desirable for the haze to be removed. Despite several condition assessments made in the past, the nature of the haze had not been analysed and identified chemically. Although a few attempts to clean the haze were tested in the past, the tests were unsuccessful, leaving the haze mainly unimproved. Mechanical scraping of the haze was possible, but this approach put the paint layer underneath at risk, whereas rolling cotton swabs with deionised water was effective in some areas of *Portrait of Mr Tan Beng Wan*, but not in others. Selected for a potential upcoming exhibition following renovation of The Peranakan Museum (TPM), these portrait paintings were again brought to the conservation lab, providing an opportunity to re-investigate the surface haze.

Fig. 1. *Paintings affected by zinc-type haze:* Portrait of Mr Tan Beng Wan *and* Portrait of Mrs Tan Beng Wan *by an unknown artist, donated to TPM by Mr and Mrs Tan Choon Hoe. Yellow arrows show locations of haze being sampled.*

[3] Record in the National Archives of Singapore

[4] Record in the National Heritage Board's Roots.SG platform.

Background of the paintings

Both paintings were assessed for the first time at the Heritage Conservation Centre (HCC) in 1996, and several times subsequently, over a span of two decades. Other than the haze, the condition of the paintings was fair, and the pair mainly underwent treatments that improved their structural stability, for example strip lining and repairs on the primary support. The paintings were executed thinly on a thin cotton canvas (84.6cm x 63.1cm) with no tacking margin present. The information provided in the condition report in 1996 described *Portrait of Mr Tan Beng Wan* as "framed and glazed, having an excess moisture causing the paint layer to be disintegrated and the paint layer being directly in contact with the glass plate."

Understanding the media is important to comprehend the possible mechanisms for forming the hazy degradation on the paintings. However, previous inspections had led to confusion regarding the type of binding medium used. This doubt was highlighted in previous conservation reports, in which the paint medium was recorded as pastel, tempera, gouache, and oil paint separately. To the authors' surprise, this discrepancy was repeated in books, newsletters, and archival records that featured the portraits. These sources have described the paintings using different media and support, such as "tempera on cotton"[3], "tempera on wood" (Tan 2003), "gouache on paper" (Chong et al. 2015), and "oil"[4]. In 2012, analysis using FTIR spectroscopy affirmed the binding media in *Portrait of Mrs Tan Beng Wan* as oil (Chaplin 2012) and in 2017, *Portrait of Mr Tan Beng Wan* was similarly identified as an oil binder with zinc soaps (Chua & Dominguez 2018). These results verified that the paintings are best represented as "oil on cotton."

It is difficult to accurately attribute the haze solely by visual observation. Taking reference from past condition reports, the haze on the paintings examined by different conservators had been described differently. For *Portrait of Mr Tan Beng Wan*, the haze was listed as "severe media discoloration especially at the upper part of greyish colour," "extensive blanching in background appearing to be degradation of top layer of paint," and "fungi growth being covered by the varnish". In contrast, for *Portrait of Mrs Tan Beng Wan*, terms relating to "haze" were not mentioned; instead, the condition of the painting was assessed as "discoloration especially at the top and bottom parts of the painting". The discrepancy in the description of haze shows the importance to conduct a scientific analysis to determine the nature of the haze.

It was unclear what caused the haze and when it began to occur. One of the rare records was a photograph taken in 1968 showing *Portrait of Mr Tan Beng Wan* displayed in the reception hall of the Botan house (Fig. 2(a)-2(c)). At that time, the house was located at Neil Road, close to the shipping area for which the family was well-known. *Portrait of Mrs Tan Beng Wan* was assumed to be hung on the opposite wall. It is not evident from the photograph whether the haze existed in the paintings at that time. From HCC's records, the earliest retrievable images of the paintings were taken in 2012, and those photos showed that the haze was already present. Combined with previous condition reports from 1996, it could be postulated that the haze on the paintings was already present at the point of donation.

(a)

(b)

(c)

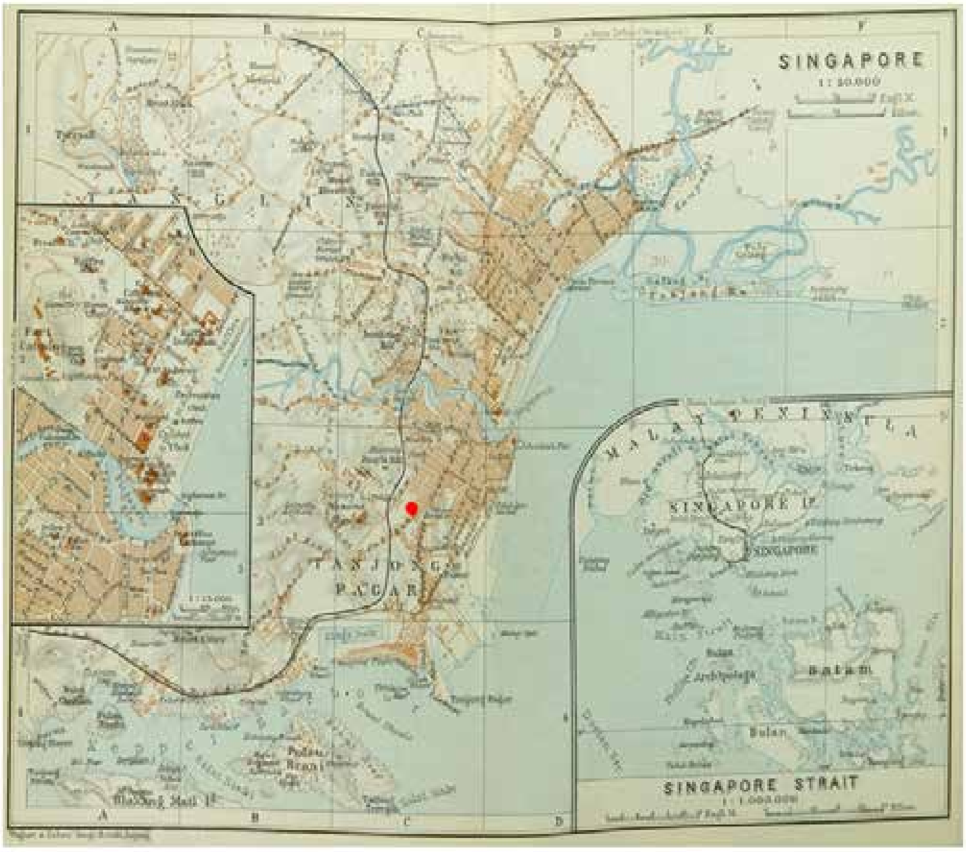

Fig. 2. (a) Reception hall at the Botan House, 1968. The red arrow points to the Portrait of Mr Tan Beng Wan *painting. It is likely that the wife's portrait was located on the opposite wall (Lee 2019). (b) Exterior of Botan House, 1968 (Lee 2019). (c) Map of the Singapore city and environs, c. 1914 (Baedeker 1914). The red dot refers to the Botan House at Neil Road.*

Results and discussion

Assessment of the haze

Portrait of Mr Tan Beng Wan was most visually affected by the haze. Almost the entire grey background was covered with a whitish haze. Other affected localised areas were the whitish patches on the black jacket *ma gua* (馬褂), and whitish haze and violet haze along the cracks on the blue robe *chang pao* (長袍). Haze on the paintings was observed directly using a digital microscope lens mounted to a z-motor unit. The latter enables 3D images to be collected over an extended depth of focus. As seen in Fig. 3, the haze was very thinly formed on the paint surface (the thickness measured between 2 to 6 μm), implying that mechanical removal using tools without risking damage of the underlying paint would be inevitable. The fact that both portraits were created using very thin paint, and with a uniform and flat painting technique, makes cleaning even more challenging, since any attempt to alter the surface would be easily noticeable. The haze on *Portrait of Mrs Tan Beng Wan* was less apparent (Fig. 4), but when viewed along the plane of the painting, the whitish haze could be seen tracing the painting's craquelure on the paint layer.

(a) (b) (c) (d)

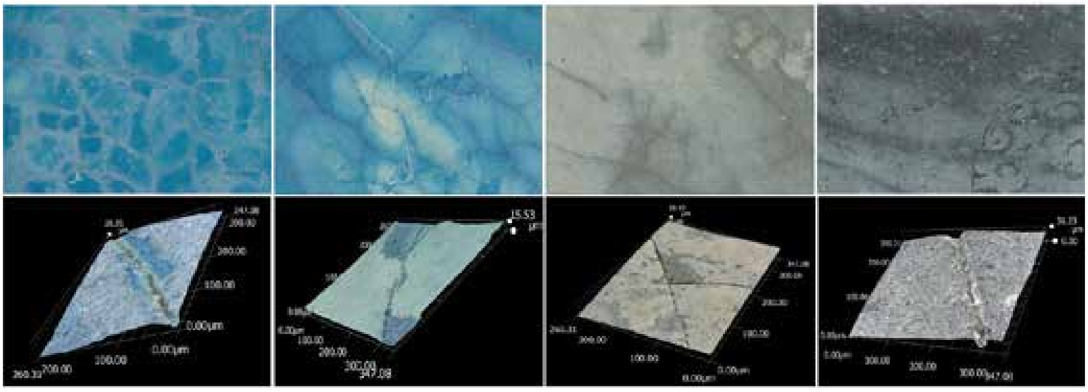

Fig. 3. Close-up images of the haze on Portrait of Mr Tan Beng Wan*. (a) 1- Violet haze on blue cracks. (b) 2- White haze on blue. (c) 3- White haze on grey. (d) 4- White haze on black. Upper row shows camera images. Bottom row shows digital microscopic images at 1000x magnification.*

(a) (b)

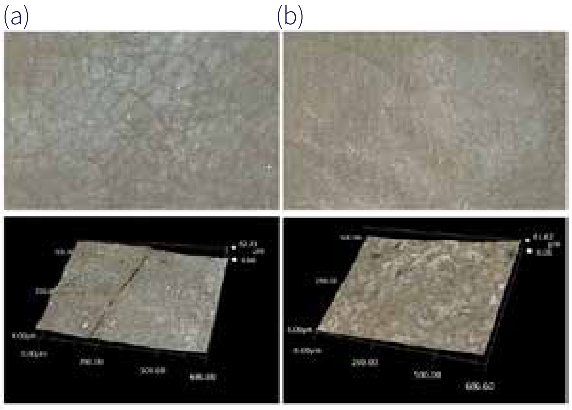

Fig. 4. Close-up images of the haze on Portrait of Mrs Tan Beng Wan*. (a) 5- White haze at top left corner in background. (b) 6- White haze at left of chair. Upper row shows camera images. Bottom row shows digital microscopic images at 500x magnification.*

Characterisation of the haze

A microsample of the haze was collected from the paintings and characterised using SEM-EDS and micro-FTIR spectroscopy. Table 1 summarises the FTIR results and indicates the compositions of the haze.

Table 1. Summary of FTIR and SEM-EDS results of haze samples on the portraits.

[5] **Major**, minor, (trace) intensities

Painting	No	Haze	FTIR	EDS[5]
Portrait of Mr Tan Beng Wan	1	Violet haze on blue cracks	Zinc oxalate, zinc chlorosulfate ($Zn_4Cl_2(OH)_4SO_4.5H_2O$)	**Zn,** S, Cl (Na, Fe, K, Mg, Al, Si)
	2	White haze on blue	Gordaite ($NaZn_4Cl(OH)_6SO_4.6H_2O$)	**Zn**, S, Cl, (Na, Fe)
	3	White haze on grey	Zinc oxalate, hydrozincite	**Zn,** (Na, Al, Si, S, Cl, Mn, Fe, Ca, P)
	4	White haze on black	Zinc oxalate	**Zn,** Ca, P, (Na, S, Cl, Mg, Al, Si, K)
Portrait of Mrs Tan Beng Wan	5	White haze at top left corner in background	Gordaite ($NaZn_4Cl(OH)_6SO_4.6H_2O$), zinc oxalate	**Zn**, S, Cl, (Na, Al, Si, Ca, Cu)
	6	White haze at left of chair	Zinc chlorosulfate ($Zn_4Cl_2(OH)_4SO_4.5H_2O$), zinc oxalate	**Zn**, S, Cl, (Na, Al, Si, Ca, Cu)

Zinc oxalate salts

Oxalate salts were indicated by the strong marker peaks in the FTIR spectrum at 1630-1640 cm^{-1}, 1362 cm^{-1}, and 1320 cm^{-1}. These peaks were observed in almost all the haze samples taken from both portraits (Fig. 5). The additional sharp band observed at 825 cm^{-1} is a good marker peak for zinc oxalate specifically. This band differentiated zinc oxalate from calcium oxalate – a common degradation product on painted artworks which would otherwise show a sharp band at 782 cm^{-1} in the FTIR spectrum. In some samples, the band at 825 cm^{-1} was masked by spectral bands of other compounds, hence elemental verification with SEM-EDS was necessary. SEM-EDS of the haze showed major intensity for zinc, and only trace intensity for calcium, confirming the presence of zinc oxalate. The white haze sample taken from the black jacket of the man's portrait showed small amounts of calcium (Ca) and phosphorus (P) in SEM-EDS, which could be due to a whitening phenomenon of bone black in the underlying black paint (Van Loon 2008).

The occurrence of zinc oxalate on painted surfaces is far less common compared to that of calcium oxalates, with only a handful of the former mentioned so far (Dunkerton et al. 2013; Frøysaker, Liu & Miliani 2013; Monico et al. 2013; Rosi et al. 2019). None of these studies included treatment strategies for paintings affected by zinc oxalate efflorescence. Although some cleaning tests were done on Edvard Munch's unvarnished oil paintings containing zinc oxalates, the main purpose of these tests was to remove dirt and dust, rather than zinc oxalates (Frøysaker, Liu & Miliani 2013).

Although frequently found on artworks, the origin of metal oxalates remains unclear, and various reasons have been postulated for the occurrence of metal oxalates on artworks. Biological activity of microorganisms is capable of secreting oxalic acid (Gridley 2019), whereas chemical formation of oxalates has been attributed to oxidative degradation of the organic binder or resinous coating, catalysed by the presence of zinc white (Colombini et al. 2002). Recently, oxalic acid was reported as the most abundant dicarboxylic acid (DCA) in organic atmospheric aerosols (Martinelango, Dasgupta & Al-Horr 2007). It constitutes up to 50% of total atmospheric DCAs, especially in non-urban and marine atmospheres.

Zinc hydroxychloride and sulphate salts

SEM-EDS analyses of the haze from all sampled areas on both portraits consistently showed major amounts of zinc, along with small to trace levels of sulphur and chlorine. A haze sample carefully taken without mechanical disruption of morphology showed crystalline platelets in SEM. These results suggest efflorescence formation of zinc hydroxychloride and sulphate salts (Nasdala 1998; Odnevall & Leygraf 1993; Odnevall & Leygraf 1994). To determine the type of zinc-coordinated salt with chloride and sulphate, FTIR microscopy was used. It is interesting to highlight the lack of FTIR reference spectra for zinc hydroxychloride and sulphate salts in conservation science literature, despite the prominence of zinc-related products (e.g. zinc white pigment, zinc sulfide (in lithopone), zinc stearate additive) used in artworks. The literature on atmospheric corrosion of zinc metal, however, was more forthcoming. Zinc-derived salts of chlorides and sulphates are commonly encountered in zinc metalworks used in the marine and automotive industries (Leygraf et al. 2016). Such zinc-derived corrosion products commonly contain oxides and hydroxides (ZnO, $Zn(OH)_2$), carbonates (hydrozincite $Zn_5(CO3)_2$ $(OH)_6$), chlorides (simonkolleite $Zn_5(OH)_8Cl_2{\cdot}H_2O$), sulfates (zinc sulphate $ZnSO_4{\cdot}nH_2O$ and zinc hydroxysulfate $Zn_4SO_4(OH)_6{\cdot}nH_2O$), and chlorosulfates (gordaite $NaZn_4Cl(OH)_6SO_4.6H_2O$ and zinc chlorosulfate $Zn_4Cl_2(OH)_4SO_4.5H_2O$) (Zhu et al. 2000).

In the FTIR spectra (Fig. 5), gordaite ($NaZn_4Cl(OH)_6SO_4.6H_2O$) was identified on the white haze on blue (*Portrait of Mr Tan Beng Wan*) and also on the top left corner in background (*Portrait of Mrs Tan Beng Wan*). Marker peaks diagnostic of gordaite were in agreement with literature values: two peaks at 1120 and 990 cm^{-1} (SO_4 stretching modes), 1670 cm^{-1}, and 1639 cm^{-1} (HOH bending), and three distinct peaks at 3347 cm^{-1}, 3401 cm^{-1}, and 3505 cm^{-1} (OH stretching in the metal hydroxide layer, or structurally bound water) (Jayasree et al. 2006; Nasdala 1998). As the X-ray emission energy of Na (Ka^{-1}.04 kV) is very close to Zn (La^{-1}.01 kV) in the EDS spectrum, the detection of Na can easily be missed in the presence of high Zn levels. In all the haze samples from both portraits, traces of sodium were likely present as the X-ray line shifted slightly to 1.02 kV, supporting the presence of gordaite.

Zinc chlorosulfate ($Zn_4Cl_2(OH)_4SO_4.5H_2O$) was identified on the violet haze on blue cracks (*Portrait of Mr Tan Beng Wan*) and also on the white haze at left of the chair (*Portrait of Mrs Tan Beng Wan*). In the FTIR spectra containing zinc chlorosulfate, spectral bands attributed to oxalate were also apparent. The strong oxalate stretching band and broad OH stretching of zinc oxalate overlap with some diagnostic bands of zinc chlorosulfate (Jonsson 2012). Hence, other spectral bands were used to identify zinc chlorosulfate; these include a strong band around 1000 cm^{-1}, along with 1058 cm^{-1}, 956 cm^{-1} (symmetric SO_4 stretching), a strong band at 1138 cm^{-1} (asymmetric SO_4 stretching), a sharp band at 611 cm^{-1} (asymmetric SO_4 deformation), and a weak band at 3601-3605 cm^{-1} (OH stretch) (Jayasree et al. 2006; Jonsson 2012).

The ground and paint layers deep below the haze contained zinc carboxylate agglomerates. Zinc soaps from the ground have likely migrated to the surface and remineralised as zinc carbonate or hydrozincite (Van Loon 2008), which subsequently interacted with the environment (e.g. dirt, pollutants, organic debris) to produce zinc hydroxychloride and sulphate. According to the atmospheric corrosion sequence of zinc, gordaite and zinc chlorosulfate (identified on the portrait paintings) are corrosion products of zinc in the final stages, which suggests that efflorescence on the paintings have reached stability, and are unlikely to undergo further chemical changes (Jonsson 2012). Given that gordaite and zinc chlorosulfate on zinc metal are commonly found in marine (high Cl- to SO_4^{2-} concentration) and urban/industrial environments (high SO_4^{2-} to Cl^- concentration) (Jonsson 2012; Odnevall & Leygraf 1993; Odnevall & Leygraf 1994), the authors postulate that the origin of the zinc hydroxychloride and sulphate haze characterised on the paintings could be traced to their historical location in the family house at an urban area near the seaside (Fig. 2).

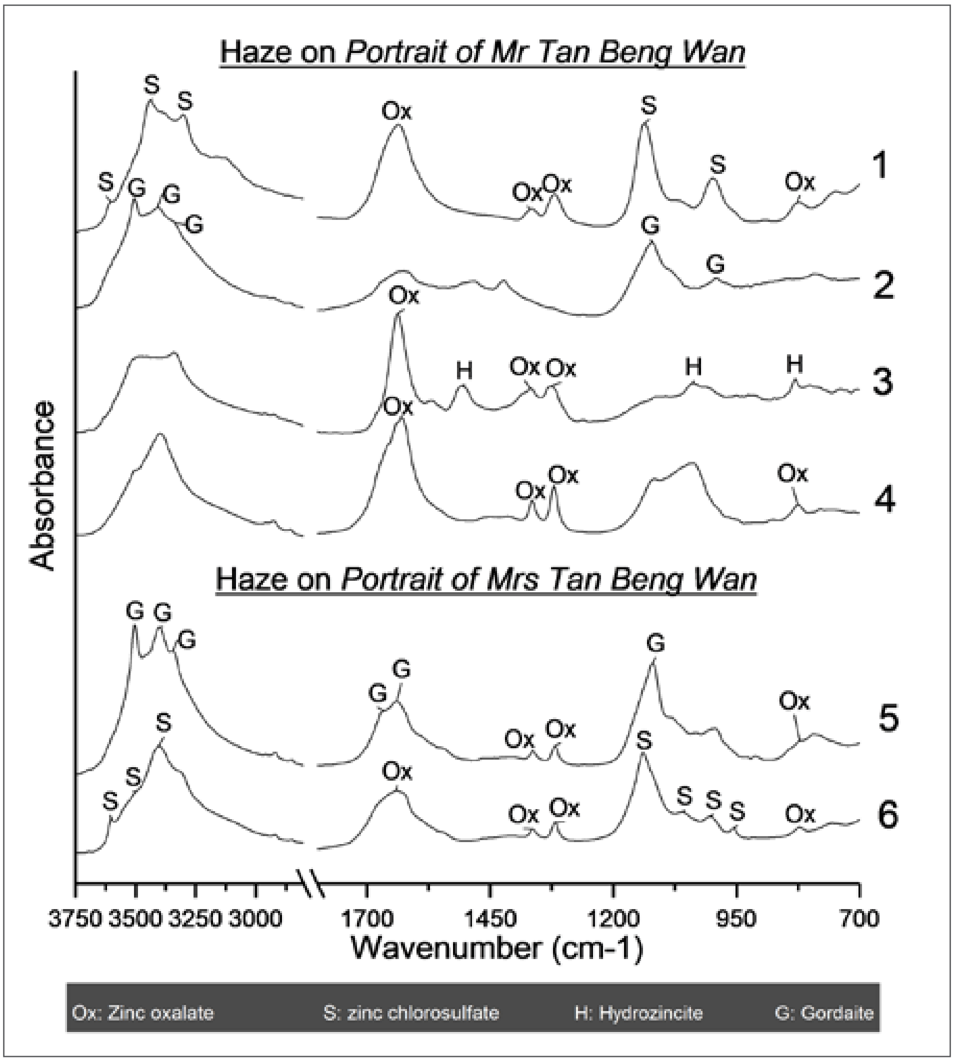

Fig. 5. FTIR spectra of haze from Portrait of Mr Tan Beng Wan*: (a) 1- Violet haze on blue cracks. (b) 2- White haze on blue. (c) 3- White haze on grey. (d) 4- White haze on black; and from* Portrait of Mrs Tan Beng Wan*: (e) 5- White haze at top left corner in background. (f) 6- White haze at left of chair. Marker peaks are annotated.*

Cleaning tests of zinc-type haze

Inorganic salt deposits on paintings that are water-insoluble, resistant to organic solvents, and intimately connected to the paint could not be removed by traditional methods (Burnstock 2011; Sutherland et al. 2013; Van Loon, Noble & Boon 2011). For salt removal, the use of soluble chelating agents, which can bind to cations in a salt and encourage the salt's dissolution, appeared a viable option (Van Loon, Noble & Boon 2011). Ethylenediaminetetraacetic acid (EDTA) was studied in the removal of lead soap efflorescence and calcium salts on paintings (Sawicka et al. 2014; Selva Bonino et al. 2015), while triammonium citrate (TAC) has been used effectively to remove surface dirt on Turner's oil sketches (Carlyle, Townsend & Hackney 1990). Although removal of zinc salts on paintings using chelating agents has not been published to the authors' knowledge, this method seemed a promising option for further testing.

[6] Preparation of zinc-type haze on zinc foil involved polishing zinc foil with SiC paper and immersing it in separate solutions of 1M oxalic acid and 0.9% NaCl solution over three days. The corrosion films were confirmed with FTIR spectroscopy as zinc oxalate and hydrozincite respectively.

[7] Zinc oxalate was purchased from Sigma Aldrich. Hydrozincite salt was prepared using the synthesis method by Hales & Frost.

Out of all of the hazy patches observed on the two paintings, the whitish haze on the grey background of *Portrait of Mr Tan Beng Wan*, identified as a composite of zinc oxalate and hydrozincite, is the most prominent, and therefore was the subject of testing for its removal. Before conducting the actual cleaning tests on the painting, the solubility of these zinc salts was tested in chelating agents and also using a simulated cleaning on sample mock-ups. TAC and EDTA in both 1% and 5% concentrations were selected as potential chelating agents for removing the white deposits. In this case, the formation of zinc-type haze on polished zinc metal foil as sample mock-ups for the cleaning tests[6] was simulated. Taking into account that the haze is very thin (measuring on the micrometre scale) and is attached to the surface of the paint layer, the method of applying the chelating agent needs to be as least disruptive to the paint layer as possible. In this case, the use of a rigid agarose gel was tested simply by placing it over the area, to be cleaned without mechanical movement. This approach was preferred as a gentler method of application.

Solubility test of zinc salt powder

Table 2 lists the solubility results for zinc oxalate and hydrozincite powders[7] (Hales & Frost 2007) tested in 1% and 5% TAC and EDTA solutions. The results clearly indicate that hydrozincite is soluble in both chelating agents. The dissolution of zinc oxalate in the chelating agents is poorer, though it is possible for a clear solution to result as time and concentration of chelating agent increases. As expected, EDTA with an additional chelating site was found to be a stronger reagent than TAC in chelating the zinc cations.

Table 2. Solubility of zinc oxalate and hydrozincite salts in chelating solutions.

	1% EDTA (1mL)	1% TAC (1mL)	5% EDTA (1mL)	5% TAC (1mL)
Zinc oxalate (4mg)	Insoluble	Insoluble	After vortex, dissolves in half hour	Almost dissolves after a few hours
Hydrozincite (4mg)	Slow dissolution	Slow dissolution	Immediate dissolution	Immediate dissolution

Cleaning tests of zinc-type haze simulated on zinc foil mock-ups

Table 3 lists the results of the cleaning tests of zinc-type haze simulated on the surface of zinc foil mock-ups using 1% and 5% TAC and EDTA in an agarose gel. From the results, it is clear that hydrozincite can be removed with chelating agents in agarose. This proved more effective at the higher concentrations of 5%, and the results indicate that EDTA was stronger than TAC in this regard. However, for the removal of zinc oxalate, more time and higher concentration was required to see a clear removal. These results support the findings for the dissolution of the powder samples presented in Table 2.

Table 3. Cleaning tests of zinc-type haze simulated on the surface of zinc foil mock-ups.

	1% TAC (in 3% agarose)	1% EDTA (in 3% agarose)	5% TAC (in 3% agarose)	5% EDTA (in 3% agarose)
Zinc oxalate on Zn foil	No immediate change. After 3 hours, partial removal was observed.	No immediate change. After 3 hours, partial removal was observed.	No immediate change. After 3 hours, complete removal was observed	No immediate change. After 3 hours, complete removal was observed
Hydrozincite on Zn foil	Partial removal.	Partial removal.	Immediate removal.	Immediate removal.

[8] Blanching here refers to whitening of a paint surface arising from Rayleigh scattering, commonly associated with humidity and porosity.

Cleaning tests on actual painting

From the results of the previous two tests (Tables 2 and 3), the authors confirmed that the selected chelating agents (TAC and EDTA) and the agarose gel method of application can be effective in dissolution and removal of the specific zinc-type haze of interest (zinc oxalate and hydrozincite). For cleaning tests done on the *Portrait of Mr Tan Beng Wan* painting, the authors decided to start with the lower concentration (1%) and weaker chelating agent (TAC). The objective of the in-situ cleaning tests on the painting was to determine if the chelating action can be limited to the haze without affecting the underlying paint layer. A 3 mm diameter cylindrical agarose gel with 1% TAC was placed over the test area on the painting. The images before and after cleaning were recorded with the digital microscope. The agarose gel was left at 1s to 30s intervals for up to a few minutes, or until the area of interest showed a visible change. At the end of each test, a fresh agarose gel without chelating agent was placed over the area of interest to clear off residual chelating agents on the paint surface.

An unobtrusive area with substantial amounts of white haze on the grey background of *Portrait of Mr Tan Beng Wan* was selected for the cleaning test. 1% TAC in 3% agarose gel was applied to different spots using different application methods (Table 4). Quite unexpectedly, the agarose gel showed the tendency to cause whitening of the dark grey paint layer below the haze, similar to "blanching"[8] (Genty-Vincent et al. 2015), and this effect worsened the longer the gel was in contact with the paint surface (Fig. 6). This whitening phenomenon could be a result of more soluble components leaching from the lower layers to the upper layers due to poulticing. Tests using a higher concentration chelating agent consisting 5% TAC in 3% agarose gel reduced the haze further, but these also showed blanching and was undesirable. In addition, these caused some areas of the paint layer to be removed, revealing the white ground.

Table 4. Cleaning tests of painted surface with TAC in agarose gel.

Spot	Application method (1% TAC in 3% agarose gel)	Result
1	Tapping 1s interval up to 10s	No change
2	Leave 30s interval up to 30s	Causes "blanching"
2	Leave 30s interval up to 180s	Partial removal of haze. Causes "blanching"

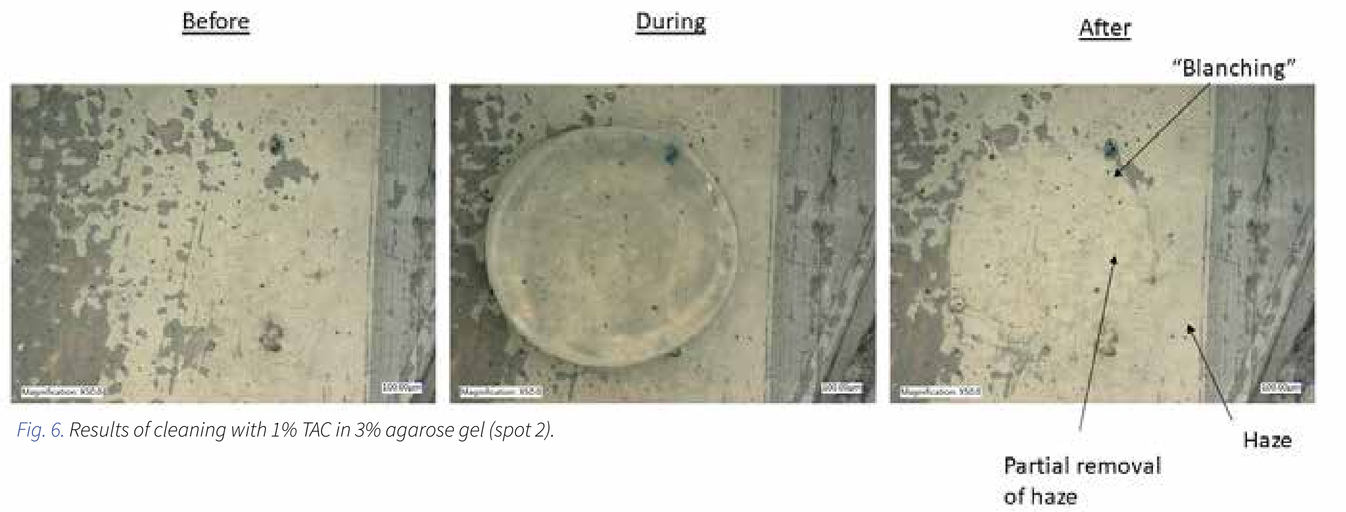

Fig. 6. Results of cleaning with 1% TAC in 3% agarose gel (spot 2).

A cleaning test using cotton swabs with 1% TAC solution turned out to be more effective than the agarose gel method (Fig. 7). The rate of cleaning was controllable, reaching the point of revealing the original dark grey paint below the haze. No blanching was seen with this method. However, the cleaning was uneven; the haze was not completely removed even after four passes of swab rolling with 1% TAC. It was observed that the swabs had picked up some of the dark grey paint, hence the cleaning tests did not continue using TAC at a higher concentration.

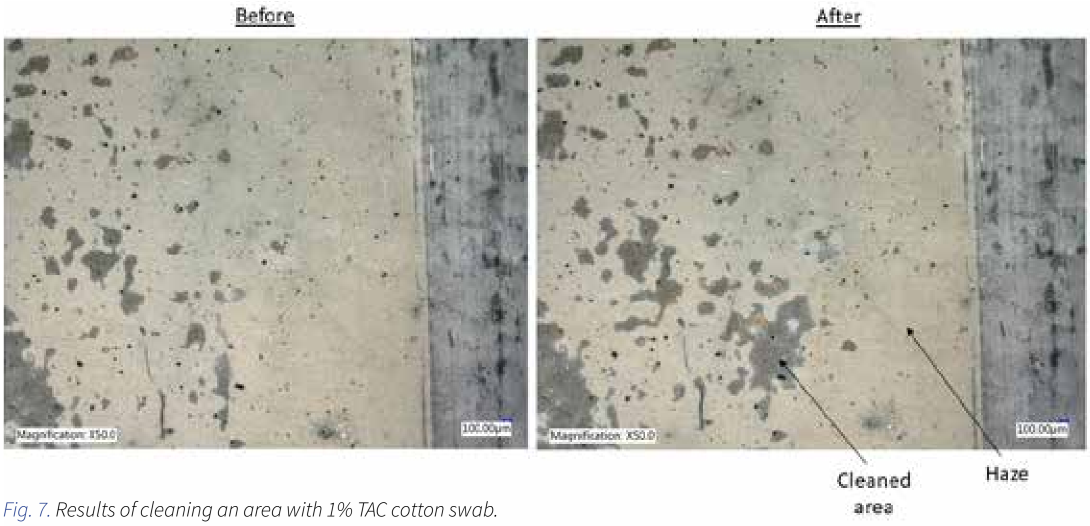

Fig. 7. Results of cleaning an area with 1% TAC cotton swab.

Conservation considerations

The results obtained from the tests provided an overview of the cleaning possibilities that chelating agents can offer when cleaning a haze composed of zinc oxalates and hydrozincite. While it is possible to clear the haze with 1% TAC using cotton swabs, the authors have reservations about carrying out this treatment. The action of using TAC to remove the haze has resulted in portions of the original paint being removed, and the paint system inevitably aggravated. Considering that the treatment is an extensive area that occupies almost one third of the whole painting, it is unlikely that the intended cleaning can safely achieve a uniform background without causing further paint damage. Moreover, the test cleaning spots appeared exceptionally matte and do not match the slight glossiness exhibited in the rest of the original dark grey paint that had been unaffected by the haze. There is also concern that removal of the haze would encourage migration of more zinc soaps to the surface, thereby regenerating the haze. On account of above reasons, it was decided the haze would not be removed.

Conclusion

The analysis and cleaning tests of zinc-type haze on the two oil-based portraits were carried out. Different parts of the haze were characterised as primarily zinc oxalate, hydroxychloride, and sulphates, as well as hydrozincite, which were likely formed at the paint's surface upon migration of zinc soaps from the thick ground. The presence of gordaite and zinc chlorosulfate on the portrait paintings, identified as surface efflorescence probably for the first time on oil paintings, could be traced to the historical location of the house in an urban/ industrial area close to the sea.

The white haze on the grey background of *Portrait of Mr Tan Beng Wan,* characterised as a mixture of zinc oxalate and hydrozincite, was the most disfiguring, and therefore the most desirable for removal. As previous attempts to remove this haze using mechanical scraping, organic solvents, and water, showed little success, the use of the chelating agents TAC and EDTA was studied. The cleaning tests on zinc oxalate and hydrozincite, in powder form and simulated on zinc foil, showed that both chelating agents (EDTA stronger than TAC) in a rigid agarose gel achieved gentle removal for a positive outcome. However, when tested on the actual painting, the agarose gel with 1% TAC caused unacceptable blanching of the paint surface and could only partially remove the haze. The agarose gel with 5% TAC reduced the haze further, however, it led to paint loss and blanching. On the contrary, removal of the haze with 1% TAC using cotton swabs was better than expected, although this method also picked up some paint and caused uneven cleaning. Due to the difficulty in predicting cleaning efficacy without causing paint damage, removal of the white haze using the above mentioned methods was considered unacceptable for this painting. Nevertheless, the results of this study significantly improved the authors' understanding of the observed surface haze and justified the conservation treatment decision.

Materials and methods

Materials used:

Agarose (low gelling temperature), EDTA (ethylenediaminetetraacetic acid disodium salt dihydrate), TAC (ammonium citrate tri-basic, 97%), zinc oxalate, Zn foil.

Equipment used:

Keyence VHX6000 digital microscope mounted on a mobile stand, Agilent micro-FTIR spectrometer, and Hitachi SU5000 SEM coupled with a Bruker EDS.

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Evolving to Transform

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ABSTRACT
The digital format provides ease and convenience for filmmakers and content producers. However, the digital era universally presents challenges to archivists in all aspects of their work, from preservation to access. The discussion on how the digital era has operationally changed the functions and the functioning of archives is an on-going one.

This paper will make observations and pose considerations on how film preservation – its philosophy, principles and practices – have evolved in response to the digital era. This evolution was born out of necessity. This paper proposes that rather than merely considering the issue of survival, this evolution can perhaps create sustainable organisations, and grow a more vibrant creative industry.

Actual scenarios and case studies encountered within the Asian Film Archive will be explored to illustrate how operational strategies have developed, positively transforming the Archive in more ways than one.

Introduction

As the second decade of the 21st century draws to an end, it seems fitting to reflect on how the evolution of the digital era has affected the work of film archives, especially in the years between 2009 and 2019. This decade in question has seen some of the most tumultuous changes for archives as they have attempted to catch up with technological advances. Archivists have had to be (re)trained, and digital workflows have had to be created, adopted, and integrated into archiving systems. Most significantly, archivists have had to transform their archiving philosophies and change the mindsets of their stakeholders and embark on advocating for funding support for the expensive digital journey ahead.

Mention the word "archive" and two images spring into the minds of many people – an antiquated place where all things old, faded and in some physical form are kept; or, in recent times, an online platform where research can be conducted by browsing different primary sources in various mediums. These two notions of the "archive" aptly describe the evolution that has descended on archives, and signify the impending (for some) or on-going (for others) transformation that archives around the world are experiencing. There is a struggle to make the analogue collections of a bygone era and the digital formats of the current era accessible. Included in this complexity is that these struggles with formats affect the gamut of archival operations, bringing the interrogation right to the core of an archive's existence. It requires a re-examination of archival philosophy, the principles and concept of preservation, and to the operative functions of selection, acquisition, documentation, cataloguing and access for public reference and long-term utilisation.

The Asian Film Archive (AFA) came into existence on 1 Jan 2005. It was established as a Pan-Asian institution that aspired to be a repository for Asian films that have yet to be archived in their own countries. Getting the fledgling AFA organised and functioning took a staggering amount of work, as its original two man team grappled to shape the ethos and practices that would drive the archive. Within the first year of AFA's Reel Emergency Project's open call for the deposit of films for preservation in 2006, hundreds of Southeast Asian films and their related materials, such as photographs and publicity kits, were submitted. The huge response from Southeast Asian filmmakers was evidence that they recognised the need to take immediate action especially if there were no preservation facilities in their own countries since this meant their films were at high risk of deteriorating and possibly being lost forever. To handle these immediate needs, AFA made the conscious decision then that it would, within its first decade of operations, focus its preservation efforts on films made within Southeast Asia.

As more Southeast Asian countries began to develop film archives, film centres and councils to gradually meet some of their own needs related to film acquisition and preservation, AFA, since 2015, started to widen its acquisition purview to accept titles from wider Asia, including but not limited to China, Korea, Japan, Taiwan, Sri Lanka and Iran. By responding to the changing film landscape of Southeast Asia and providing assistance when required or requested, AFA has stayed relevant. Over the years, when film laboratories and post-production companies closed, AFA would be one of the first points of contact to save the film prints and negatives stored in such facilities, that would otherwise be thrown away.

In July 2015, the Union Film Lab in Hong Kong was slated to close when its lease was terminated. It was due to leave behind over 300 picture reels and negatives. Staff from the Hong Kong Film Archive, the Film Archive (Public Organization) in Thailand, L'Immagine Ritrovata in Hong Kong (a restoration lab), an independent Indonesian film researcher, and AFA were activated, poring through hand-written lists of the film titles and, within five days, had decided on which titles would be preserved, and how the materials were to be split between the three archives before the laboratory permanently closed its doors. The closing down of the Yangtze Cinema in Singapore's Chinatown was another instance when AFA, together with a handful of volunteers and some film enthusiasts, salvaged hundreds of cans of films the night before the building was demolished.

Fig. 1. Documenting picture reels and negatives from Thailand. Image courtesy of AFA.

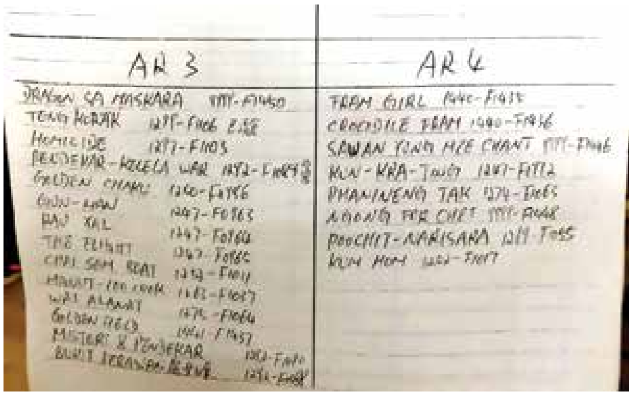

Fig. 2. Example of hand-written lists of film titles from Union Film Lab (Hong Kong). Image courtesy of AFA.

Archivists must look backwards and forwards in time, acquiring material and assessing if someone in the future may find the material significant and useful[1]. The serendipity of when such films land in an archive require archival staff to respond quickly and apply their policies to determine what to do with the films. Mutual co-operation between archives help to save many films that would otherwise have been lost. Eventually, some of the films from the examples above have found their way back to their home countries, if there was an archive to take them. In most cases, AFA continued to provide the films with a home, and will gradually digitise these films to enable them to be accessible for research and screening.

[1] Janna Jones, *The Past is a Moving Picture: Preserving the Twentieth Century on Film* (Florida: University Press of Florida, 2012), 126.

Janna Jones observed the complexity of the organisational practices involved in managing a moving image archive, and succinctly expressed that there is a certain "dialectic of creation and destruction, control and chaos… logic and ingenuity, order and disruption" that define the "discovery, interpretation, representation, and accessing"[2] of the visual experience of cinema. An archive is a space managed by rational and disciplined logic. Decisions made in AFA's early years were based on this "disciplined logic", but also a sense of reasonable intuition that relied on using personal relations to develop professional ones. AFA's survival depended on how it would balance creating a sustainable archive that could serve its stakeholders effectively, even as it brings together accessible and meaningful programmes for its users.

However, embarking on digital preservation threw the archive's organisational practices into further upheaval than Jones' description could have imagined, because much of the logic used for analogue format preservation could not be utilised for the digital format. With filmmakers adopting digital as their shooting format, and born-digital materials being the norm, AFA has had to consider how to equip itself to be able to start preserving born-digital content. As hundreds of Asian films were being made monthly and the number of enquiries on depositing files were increasing, DCPs (digital content packages) and hard drives required as short-term storage of these materials have been increasingly deposited. Such common deposits have led to urgent and vital considerations on how the archive can achieve long term sustainability because of the huge investment in hardware, software, new skills acquisition, content management system upgrade and other infrastructural considerations that had to be envisioned, developed, purchased, adopted, converted, taught and implemented.

It has only been 14 years since AFA was established and it has already conducted several rounds of reassessments and reviews of its acquisition, selection, and cataloguing policies since digital born content became a staple film output. The move in format from analogue to digital has also impacted how AFA has had to balance between its core business of preservation and outreach, from determining budget allocations to staff deployment.

In treading into the environment of digital information and responsibilities, AFA, like other archives embarking on digital preservation, has had to establish a digital repository. The *Trustworthy Repositories Audit & Certification: Criteria and Checklist*, a document accomplished through working groups in Europe and the United States, posits that setting up a trusted digital repository involves not just a preservation system for and management of the repository, but for the entire archive. An archive's governance, organisational structure and staffing, policies and procedures, financial fitness and sustainability, digital object management practices, technological infrastructure and data security all become an integral part of the repository. Potential risks such as failures in media, hardware, software, communication, networks, obsolescence, operator error, natural disasters, external and internal hacks, all become part of the constant monitoring and maintenance that make digital preservation a complex and expensive undertaking[3]. As the basic criteria and checklist show, a digital repository that can be trusted to preserve an immense amount of data for the future will need the collaborative efforts of depositors, stakeholders, funders, and communities related to the greater digital preservation ecosystem.

The speed at which technology is evolving means that no concrete long-term preservation solution has been developed for born-digital and digitised content. Archivists have been scrambling to make their analogue collections available by digitising, migrating and creating descriptive metadata to enable the collections to be searchable online. However, there is also the race to keep up with technological advances in order to preserve born-digital material. Amongst organisations, public and private, and content generators like filmmakers, there is a growing realisation that "…without preservation, there will be no access, open or otherwise."[4] The responsibility of ensuring analogue and digital content are preserved and consequently made accessible has fallen hard upon libraries, museums and archives that Guy Pessach defines as "memory institutions… social entities that select, document, contextualise, preserve, index, and thus canonise elements of humanity's culture, historical narratives, individual and collective memories."[5]

This brings us to the important topic of selection and acquisition. Sam Kula, former director of the National Film, Television and Sound division of the National Archives of Canada, once stated that "[i]n archives, the only thing that really matters is the quality of the collections; all the rest is housekeeping."[6] Kula's quote then was made in reference to how vital the process of selection was in order for the archives to not be inundated with materials. In the current digital environment, archives can no longer make do with an ad hoc policy to "acquire everything, just in case". Born-digital moving image content is storage intensive, and industry formats that are constantly evolving mean that curatorial decisions must invariably be made on how much additional material beyond the final release version is to be retained.[7]

AFA has always adhered to a selection policy that is tied to access, placing the Archive in good stead, in the digital age, to review its policy when required. This policy articulates that the rights owner must allow the film to be publicly accessed, unless the motivations for restricted access conditions are necessary and/or reasonable. For example, an embargo may be placed on a film until after its premiere; or, the film

[2] *ibid*, 9.

[3] Online Computer Library Center, Inc. (OCIC) and the Center for Research Libraries (CRL), *Trustworthy Repositories Audit & Certification: Criteria and Checklist* (Chicago and Dublin: 2007), 3. http://www.crl.edu/sites/default/files/d6/attachments/pages/trac_0.pdf.

[4] Blue Ribbon Task Force on Sustainable Digital Preservation and Access (BRTF-SDPA), *Sustainable Economics for a Digital Planet: Ensuring Long Term Access to Digital Information* (San Diego: San Diego Supercomputer Center, 2010), 23, http://brtf.3dsc.edu/biblio/BRTF_Final_Report.pdf.

[5] Guy Pessach, "Memory Institutions: Social Remembering, Privatization, and its Discontents," *Cardozo Arts & Entertainment Law Journal* (2008): 73, http://papers.ssrn.com/sol3/papers.cfm?abstract_id=1085267.

[6] Janna Jones, *The Past is a Moving Picture: Preserving the Twentieth Century on Film* (Florida: University Press of Florida, 2012), 126.thi

cannot be viewed due to the deteriorating condition of the sole surviving film copy, unless an access copy has been made. Access is just one of many practical guidelines to enforce selection.

AFA's collection is relatively young by archive standards. 70 percent of its films are considered contemporary, and date back an average of 25 years, because AFA decided to focus on acquiring the works of living filmmakers. Film selection criteria are determined by a list of priorities which include considering the condition of the films' formats and the "Asian-ness" and significance of the films on the cultural landscapes of both its country of origin and internationally. Independently produced films that are not preserved in the home country of the filmmaker or by any other archive, would receive prioritised attention. These guidelines are detailed on AFA's website, and the mechanics of how films can be submitted for assessment and preservation are elaborated on the website's Frequently Asked Questions (FAQ) section.[8]

With the adoption of the digital shooting format, the practice of acquiring current films has worked out well for AFA. Not only are present works being preserved, this practice gives AFA the opportunity to constantly remind filmmakers and producers to consistently archive their work and not leave preservation on the backburner. Through AFA's constant contact with the film community, it has become obvious that the community generally does not really understand what digital preservation entails. For instance, many filmmakers do not practise proper file naming conventions and often cannot recall the differences between multiple versions of the same film. This creates challenges when the archive needs accurate information to accession and catalogue the materials. Some filmmakers think that having a DCP, or a ProRes file with burned-in subtitles, or uploading a film on a content-sharing platform is enough to "archive" the film for posterity. On the other end of the spectrum are filmmakers who mistakenly assume that every single item related to their creation must be kept, including the numerous files containing rushes and ambient sound takes. To dispel such misconceptions and more, and to generate better understanding on how to manage the longevity of digitally made content, AFA conducts film preservation talks to filmmakers and film schools. The information delivered at these talks can be equally useful and applicable for library and museum colleagues who may not be equipped yet to handle the complexities related to moving image digital preservation.

So much content and data from the 20th century alone has either been lost or cannot be accessed due to being stored in obsolete technology. This is a concern observed by archivists like Dr Anna Sobczak (Poland/France), who are advocating for archives to communicate to big global IT market players that aside from storage and technological developments, these companies should be mindful that issues about accessing content in the future are of priority to users, so that they are aware that problems of access are areas that need to be addressed in digital preservation.[9] This is in line with the collaborative efforts amongst various preservation communities and stakeholders that the *Trustworthy Repositories* document is recommending.

The cross-sharing of information, expertise, equipment and even development of systems, between libraries, archives, and museums (LAMs) is an illustration of how it is best to not re-invent the wheel. Incurring high costs (the cost of digital preservation infrastructure is astronomical) and collaborative efforts should be advocated to capitalise on existing preservation and infrastructure development efforts. Technological skills once thought to be the sole purview of IT and technical personnel, are now required of staff overseeing digital preservation. This makes it difficult to recruit staff with the appropriate preservation and technological training, especially in Southeast Asia where few have formal preservation education.

It has been argued that digital technology has erased many distinctions between custodians of information and custodians of artefacts – museum curators, librarians, archivists, and information technology specialists – and there is some truth to this argument. Parameters for practices and collections are blurred in the digital world, and this invariably means that the metacommunity of information professionals must adopt, adapt, develop and shed certain practices and principles to address issues forced onto the LAM communities by digital technology.[10]

Apart from the practical concerns of what hardware and software infrastructure must be acquired to support digital preservation, there is the very real issue that once preservation of born-digital content has been embarked upon, there must be a commitment of funding to support on-going

[7] Anne Gant, Chew Tee Pao, and Laura Drake Davis, "Collecting Born-Digital Material at the Source: Acquisition Strategies and Lessons Learned," *Journal of Digital Media Management* 7, no. 4 (2019): 347.

[8] AFA's collection guidelines and FAQ section can be found on AFA's website http://www.asianfilmarchive.org.

[9] Moys Schuttert, "Archives in the Digital Era – An Interview with Anna Sobczak," *EU Screen Blog*, June 26, 2017, http://blog.euscreen.eu/2017/06/archives-in-the-digital-era-an-interview-with-anna-sobczak/.

digital preservation. A one-time investment would not be able to support the various work processes, like digitisation and transcoding of older formats. Migrating digital assets from obsolete formats has become the norm. Digital archives must be worked on endlessly in order to be operational. Such work processes include "paying for server space, processing submissions, archivists have to oversee, debug, respond to queries, migrate data, advocate."[11] Analogue assets like film negatives and positives, if cared for in appropriate conditions, have proven to be able to last for a century. Digital technologies "tend toward loss and disappearance"[12], and Robert Darnton's description of the digital evolution, where "hardware and software become obsolete so rapidly as to condemn all digital texts to belong to an endangered species"[13], makes for a truly distressing analogy to anyone working in the field of digital preservation. Around the world, governments and funders seem willing to provide funding for digitisation and access initiatives. However, institutions are finding it difficult to secure long-term funding for continued and sustainable digital storage and cataloguing[14].

An example from the Academy of Motion Picture Arts and Sciences shows the enormity of the digital file sizes for feature length films and the quantifiable cost of digital preservation. Digital files required to match the visual quality of a film made on 35mm and presented on a 4K digital cinema would entail more than 50 megabytes per frame (24 frames produced per second), more than 8 terabytes per master version of a two-hour film, and more than 2 petabytes for an entire film's production[15]. The estimated cost (in 2007) of preserving film archival master material per title annually was USD1,059, while digital preservation of the same material was estimated at USD12,514[16]. Factoring inflation together with the exponential number of digital films produced yearly, the cost of digital preservation is, and will continue to be staggering.

With these sums clearly laid out, the reality of what digital preservation entails can be a major deterrent to embarking on the digital preservation journey – especially for smaller institutions. However, given the avalanche of born-digital materials being created daily, digital preservation is not an issue that can be swept aside or ignored for long. Institutions, agencies, interest groups and even individuals, need to work together in some way to tackle the looming cloud of how to prevent the loss of cultural and heritage in this generation, which looks to be much more than all that has been lost in previous generations put together.

Conclusion

Every archiving conference, panel discussion, forum or workshop in the last decade has had digital preservation as its theme or as a key focus. It was (and still is) universally a topic that archivists struggle with, are sometimes stumped by, and that has created complexities from selection to access. It has been particularly difficult for smaller institutions with limited resources, whether it be manpower or budgets, to deal with the digital materials that have come into collections. However, most archives have evolved to incorporate digital preservation as part and parcel of their work with the recognition that the exponential amount and speed at which digital content is being generated and lost must be dealt with.

The digital format presents many unknowns – what new formats will come about, how can we ensure continued accessibility, how can loss of content be reduced – and has upended the once stable and routine archiving environment. Yet the digital format undeniably provides an ease and convenience to content producers, including filmmakers. This paper has highlighted some of the challenges that the digital form poses for preservation and the "solutions" are by no means easy. Not only must archiving professionals be willing to try something different from what they may have been doing for a long time, they must acquire new skills from different sectors, and advocate to stakeholders and funders to continue supporting a seemingly ever rising preservation cost.

The digital future is here, and some would even regard the current era as a post-digital world, shaped by artificial intelligence, blockchain and extended reality. These technological trends and digital transformations will eventually descend on the LAM industry, and it would be up to preservation professionals to work together to craft methodologies that will save our moving images and cinematic heritage for the future.

[10] Anne Gilliland-Swetland, *Enduring Paradigm, New Opportunities: The Value of the Archival Perspective in the Digital Environment*, (Washington D.C.: Council on Library and Information Resources, 2000), http://clir.wordpress.clir.org/wp-content/uploads/sites/6/pub89.pdf.

[11] Abigail De Kosnik, *Rouge Archives: Digital Cultural Memory and Media Fandom*, (Cambridge, MA: MIT Press, 2016), 6-7.

[12] *Ibid*, 29.

[13] Robert Darnton, "The Library in the New Age," last modified 12 June 2008. http://nybooks.com/articles/2008/06/12/the-library-in-the-new-age/

[14] Anne Gant, Chew Tee Pao, and Laura Drake Davis, "Collecting Born-Digital Material at the Source: Acquisition Strategies and Lessons Learned," *Journal of Digital Media Management* 7, no. 4 (2019): 346.

[15] Andy Maltz and Shefter Milt, *The Digital Dilemma: Strategic Issues in Archiving and Accessing Digital Motion Pictures Materials*, (Los Angeles: Science & Technology Council, Academy of Motion Picture Arts and Sciences, 2008). http://cosmo-diital.com/cd2015/digital_dilemma.pdf.

[16] Randall Davis, *Digital Dilemma: Strategic Issues in Archiving and Accessing Digital Motion Picture Materials*, (Los Angeles: Academy of Motion Picture Arts and Sciences, 2007), 2.

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Karen Chan has been with the Asian Film Archive (AFA) since 2006. She oversees the AFA's development, from preservation and restoration initiatives, to the curation of programmes and publications. She advocates for film literacy and preservation, running classes for educators and students. Karen contributes to archiving and library publications and has jointly written a chapter on "Independent digital filmmaking in Singapore" for the book *Singapore Cinema*. She presents at industry conferences, most recently at the 2019 International Film Restoration Forum in Xiamen University, Tokyo International Film Festival's CROSSCUT ASIA 2019, and 2018 EYE International Conference in Amsterdam. Karen has served on the Executive Council of the Southeast Asia-Pacific Audiovisual Archives Association and is a member of the Advisory Committee of the Singapore Film Commission. Her past experiences include being a teacher, working at the National Archives of Singapore, and the Natural History Museum in New York City.

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Preservation of Audio-visual & Time-based Media Assets for the Future

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ABSTRACT

The National Library Board of Singapore (NLB) manages the National Library, the National Archives of Singapore (NAS) and the network of 26 Public Libraries in Singapore. It holds a collection of oral history interviews, music tracks/scores/lyrics, and audio-visual (AV) and sound recordings, which are valuable to Singapore as a nation.

This paper explores and shares NLB's experience in the end-to-end management of its growing audio-visual collections for access and preservation, focusing on the technical issues involved in the long-term survival and accessibility of these time-based media and audio-visual collections, which require the careful management of these materials, and may pose significant challenges to museums, libraries, and archives.

Time-based media, particularly the analogue media formats, requires urgent migration and digitization to minimize risk of media obsolescence. Sound and Moving Image Laboratory (SMIL) at NAS implemented a hierarchical storage strategy to effectively and efficiently manage the huge storage requirement for these audio-visual contents. Ingest systems were set up to ingest new formats in High Definition (HD) and 2K resolutions in 2015, and 4K resolutions in 2018. The constant need to migrate digital files into newer formats is systematically done to ensure that nothing is lost to technological obsolescence.

Introduction

NAS joined NLB in November 2012. Both NAS and the National Library have been actively digitizing Singapore content for many years. This coming together created a catalyst to synergize an NL-NAS Digital Preservation and Delivery Strategy to serve as a critical pillar for its digital collections and services. This strategy provides comprehensive digitization and digital acquisition plans to enrich our National Collection. It hopes to ensure that current and future generations of Singaporeans will have access to Singapore's past, and be inspired by such historical moments. They can also cherish the parts they played in creating such shared memories, and weaving the fabric of the nation. This forms NLB's to move into four strategic thrusts for 2020 and beyond, with one overarching digital strategy. It is also mandated that any public records of national or historical significance shall be transferred to the care and control of the National Archives especially when it has value to the government, nation, community, and citizens.

NLB's L2020 Strategic Thrusts			
Delivering Rich SG Content	Delivering Effective Services	Building Libraries of the Future	Nurturing High Performance

1. Based on the NLB Act:
   "any public records...of ***national or historical significance*** *shall be transferred to the care and control of the National Archives..."*
2. Categories of public records that NAS preserves as stipulated under IM4L:

	Categories	Scope
1	Value to the Government	Document thinking behind policies, achievements and contributions of agencies towards national developments
2	Value to the Nation	Illustrate Singapore as a sovereign nation and the international agreements which Singapore is party to
3	Value to the Community	Provide markers to Singapore's milestones and achievements; promote understanding and appreciation of Singapore's history
4	Value to the Individual Citizen	Contain vital documentation of identity, rights and responsibilities of individuals and organisations

My role was to create a media framework and workflow, test, and implement the analogue-digital staging design, and to work with the development of scripting language to integrate different metadata from different computer management systems (CMS) into one seamless preservation system. We looked at how best to utilise our limited resources and knowledge expertise within our archival ecosystem to provide access to uniquely Singapore content for future Singapore in a sustainable manner. A future-oriented and future-ready NLB needs to be a custodian of Singapore-related audio-visual contents to inspire Singaporeans to participate in the nation's past, present, and future.

The audio-visual collections play an increasingly important role in libraries and archives. Audio-visual experience is a useful tool to create a vibrant reading culture in Singapore, and develop a nation of active readers of all ages.

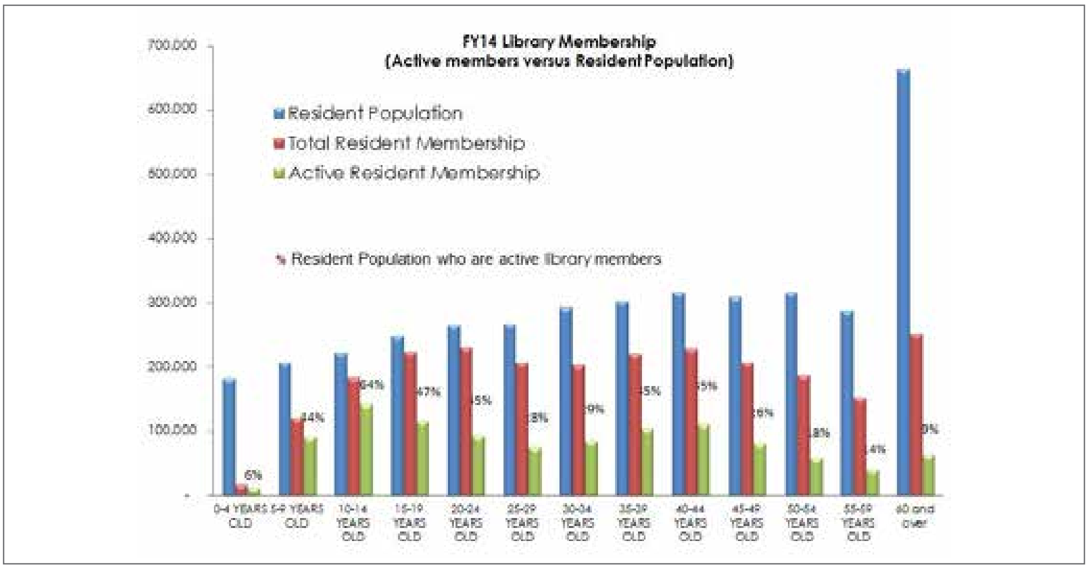
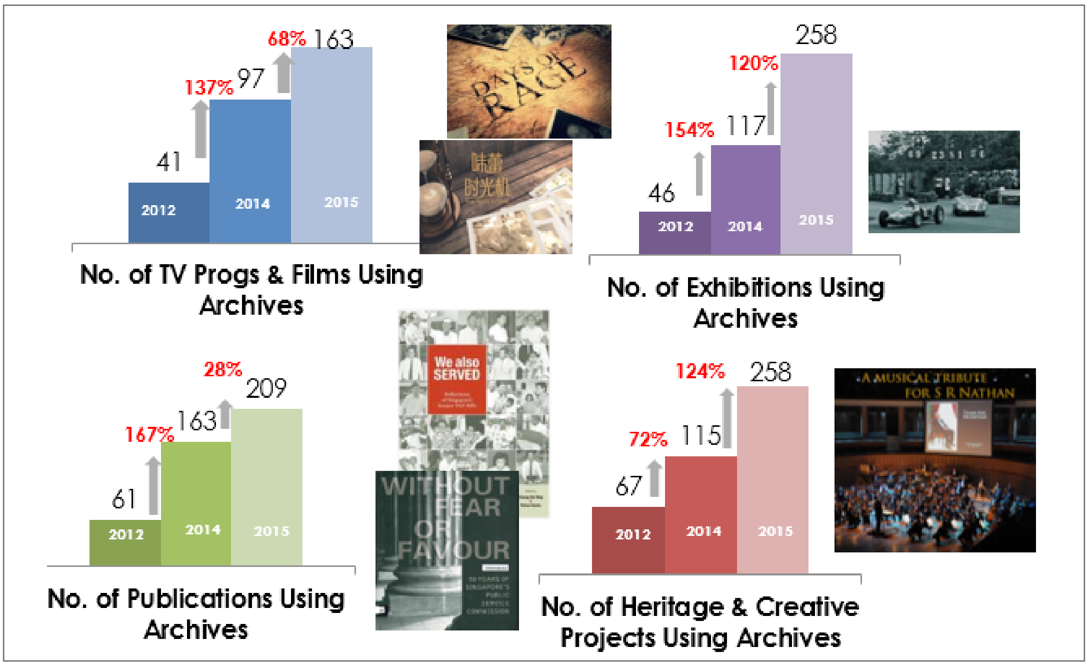


Figure 1. FY14 library membership[1] & delivering effective services.

[1] 2015 Nation of Readers National Library Board



NLB's strategies since then have been to use multimedia contents on social media, starting with the Singapore Memories Project and Read@School (Early Read & kidsREAD), where we immerse different spaces for young readers with inspiring collections and arts & culture programs, where collaborations and mentoring created opportunities for the communities.

Sustainable workflow and quality digitization

The NL-NAS Masterplans envision a future where Singaporeans are inspired by our past, and participate in our history. We strive to build collections for the nation, revamp spaces to better serve the public, preserve and enhance discovery to our collections in a digital era, and bringing our collections to life through exhibitions and programs. Figure 2a shows the revamped NAS 132-seater Oldham Theatre where both analogue 8, 16, 35mm film and 2K/4K digital DCI laser projector with Dolby Atmos surround enables both past and future collections to be showcased through events such as Archives Invites and Archives Unlocked in Figure 2b.

Figure 2a. Revamped NAS Oldham Theatre in 2019.

Figure 2b. Archives Invites and Archives Unlocked Events in Oldham for 2019.

Figure 2c. Preserving and enhancing discovery.

Preserving and enhancing discovery for our multi-format audio-visual collections in a digital era requires a robust IT infrastructure and bandwidth for end-to-end archival management with the ability to do multiple and simultaneous recordings, digitize, view, ingest, perform quality checks, and generate access copies while managing classified or restricted access in the most seamless integration possible.

Figure 2d. Preserving & enhancing discovery.

Over the last five years, digitization work has evolved rapidly. As a policy, we keep the analogue tapes or film after digitization. The tapes are kept in repositories, and the digitized master files now become the master copy. It is therefore critical that the digitized master files are of the best quality possible. Comprehensive quality checks (QCs) are integral to this media workflow.

2 Sparenberg, H. & S. Foessel. 2016. *A Concept for File-Based Content Exchange Using Scalable Media.*

3 Interra Systems Inc. 2015. *Auto QC in the Digitization Workflow.* Digital Media Group.

Figure 3a. Digital preservation storage and tape library.

Today, NAS manages about two petabytes (PB) of AV files. Besides, about 50 terabytes (TB) of AV contents are digitized and added to the collection every month. The digitized files include a preservation copy (in lossless compression JPEG2000 OP1a codec wrapped in MXF format for video and BWF for audio), a working copy (in XDCAM or IMX30 lossy file wrapped in MXF format for video and BWF for audio), and an access copy (in H.264 wrapped in MP4 format for video and MP3 for audio).

The analogue records/materials that are digitized go through a complex broadcast, and industry standard file-based and baseband QC process. SMIL's QC system uses tools and applications to test for video and audio compliance with in-house policy formats. The QC system also checks for dropouts of the generated contents, updates our Digital Audio-visual Preservation (DAP) system with timecodes and technical metadata, and checks for quality in audio and video. Most importantly, it checks for encoding/transcoding errors in files that will end up as our master files for the original records. Checksums and file integrity are included from the start of file creation as a point of reference and these checks are done every time when files are transfered to different media to keep the integrity of the file in check.

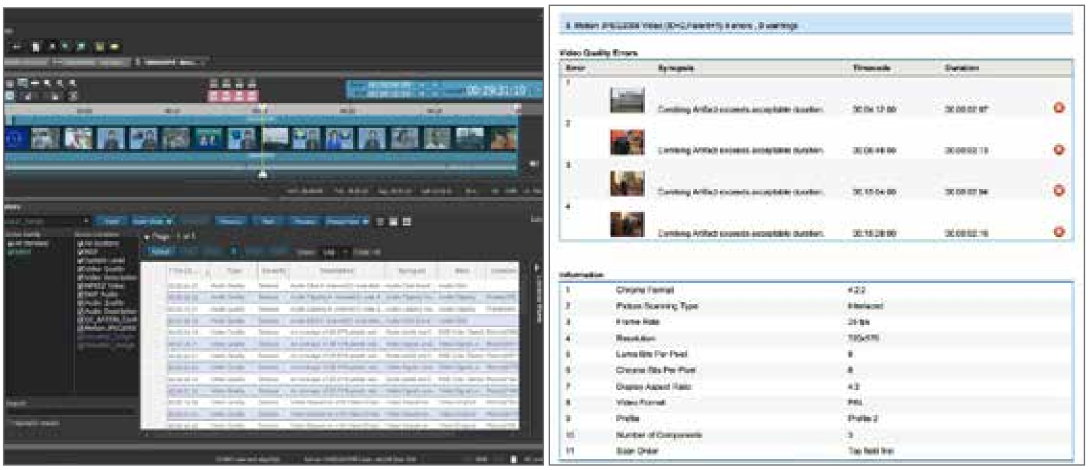


Figure 3b. File base quality check system.

We handle quality checks of about 1,000 hours of AV records every month at 24 hours and seven days a week. This is achieved through a combination of file-based automated QCs and selective manual QCs.

These QCed files are then archived in an LTO Tape Library (Linear Tape-Open is a magnetic tape data storage technology developed in the late 1990s as an open source standard with two preservation copies. One working copy is stored in a high-speed 10GbE near line network attached storage. The Tape Library manages about 400 LTO 6 & 8 tapes, which are externalized and placed into repositories with controlled humidity and temperatures. SMIL's SAN-storage servers have been 75% utilized since it was commissioned on 1 October 2014 and refreshed in 2017. That currently averages to 750 TB of digital contents every year, and it has been increasing as NAS race to digitize the obsolete AV formats by 2023.

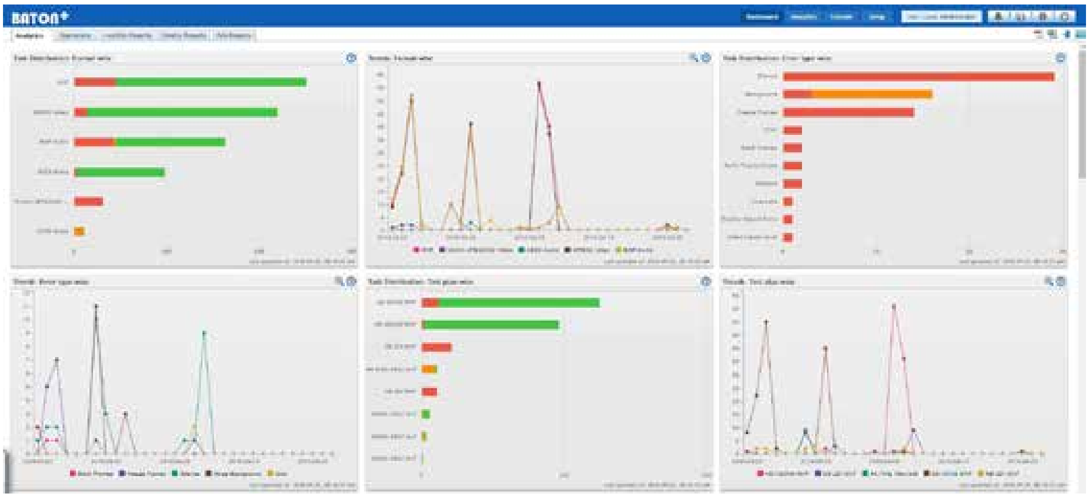


Figure 3c. Quality check system report.

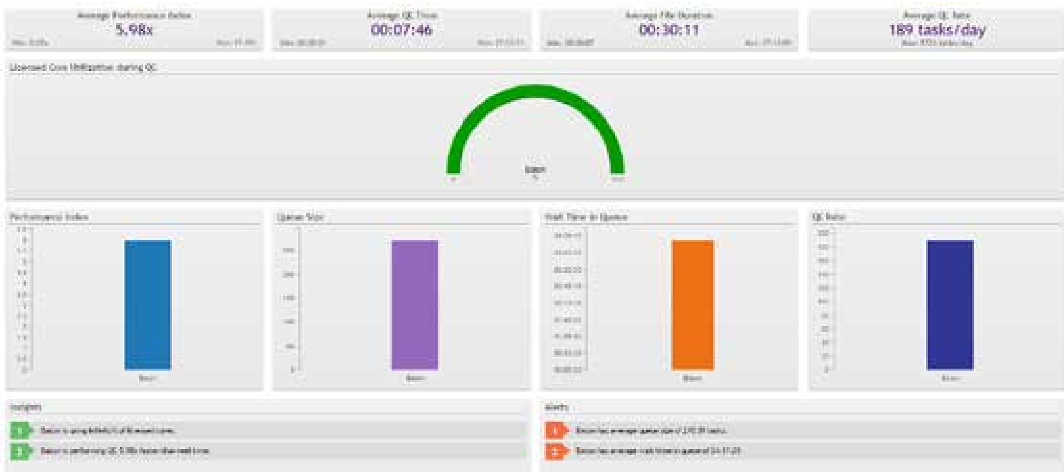


Figure 3d. Quality check system report.

Quality checks, which form a major part of the DAP system, keep data and reporting capabilities that give an overview of errors management, performance, and utilization of resources. With these, SMIL could also monitor the type of files, type of errors, and time taken to process these digital files, and create benchmarks for our AV services to meet community demands. Strategic planning can then take place with a better-informed decision-making.

For this reason, SMIL made enhancements to our DAP system, which allows AV records created by these public offices to be viewed, tracked, and archived in various storage media. This was set up to mitigate the risk of obsolescence for the high volume of digital files. Our hierarchical risk-management strategy is to have placeholders for different levels of files for the same record at different storage point, and our DAP system tracks and indexes these records.

When a piece of music is recorded and digitized, there is a high chance of preserving that piece of recording. But if you have a time-based performance that is playing in an exhibition with multiple musical instruments, how do you capture this intimate transfer of energy that is poured out from the musician into this little piece of violin made of wood, and is heard and then translated into music? How do you capture that same experience of marvelling at the symphonic sound that the whole orchestra was making, which was beautiful and powerful, and more than anything that one musician would have ever managed on his or her own? In an exhibition or event, curators and producers are always seeking to create the most articulated sculpture, or display the most poetic instrument of communication to an audience. A language at its most condensed is like a song lyric or a poetic puzzle that needs to be unlocked and unpacked. What TV or audio-visual can do is to transmit that vision and transform it into a "monumental exhibition" that can be broadcasted to the audience and travel back or forth in time. That is the beauty of time-based media - it could be used as a tool to be immersive, if preserved properly.

Changing needs and flexible requirements

Today's collaborative workflows for preservation, conservation, and access sees the need for a faster turnaround for content digitization, creation, and distribution. Faster throughput (bandwidth) means more works can be accomplished by the same number of curators, producers, artists, archivists, and other professionals, allowing them to be more productive. Greater flexibility and capability will provide these professionals with a greater field of expression within the modern digital workflows, which are capable of delivering these different services by utilizing faster connectivity, processing power, and digital storage. An exhibition, whether online or onsite, is both a physical and digital space that becomes a mass congregation. It is a temporary collective of population of hundreds or thousands of people who have gathered to view and experience the moment. They have also come seeking for information or research on a particular topic, and many desire to have that one-to-one intimacy with the creator, curator, producer, or artist.

This requires a digital storage platform that can adapt to quickly changing requirements, whether for higher performance, higher density, greater cost efficiency, or long-term asset protection, while greatly enhancing the control and capability of the primary content creation, finishing, deployment, and management solutions. The hierarchical storage with this combination of digital storage can adapt to changing needs, while enhancing the value of content creation and management solutions. This requires a workflow using optimized storage platform that a hierarchical storage[4] can achieve.

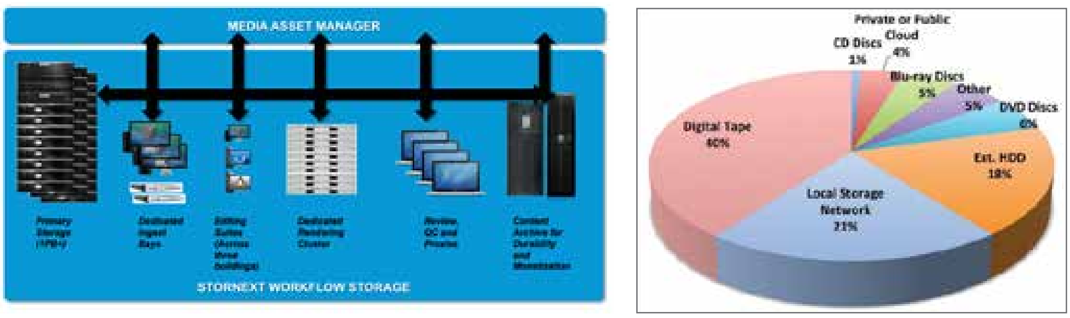


Figure 4. Hierarchical workflow & percentage of digital long-term archives on various media.

Digital storage that is optimized[5] for video workflows is different from general-purpose IT files. This is because the demands of moving and streaming large, high-resolution media files are quite different from the demands of storing and accessing photos, database records, or documents. Similarly, the file

[4] SMPTE 124-08: 2015 Coughlin, T.M. 2014. *Survey summary for storage in professional media and entertainment.* Retrieved on [DATE] from http://tomcoughlin.com/techpapers.htm

[5] Coughlin, T.M. 2011. *Making a robust media archive.* Atascadero, CA: Coughlin Associates.

movement demands of a general business or IT environment are very different from the needs of AV content movement throughout AV production workflow[6].

Files in a general business or IT environment are quickly moved from a primary, active storage to a more static archive. AV records or content-centric workflows require contents to move from primary storage to different storage archives, and back several times within the ingestion, QC, reproduction, distribution, and archiving workflow. An intelligent hierarchical storage platform allows asset management or workflow automation solutions to address the entire end-to-end workflow.

Value in hierarchical storage for different needs

The key difference is its ability to customise the type of storage to be used depending on the application's needs, in terms of speed, performance, and cost. The needs of one workflow may be very different from the next, and great efficiencies can be gained by segregating workflows using different types of storage, rather than using the same class of storage for all workflows or contents. How can NAS sculpt this experience of use and re-use of our archival material? And as curators, archivists, librarians, conservators, preservation specialists, or designers and artists, each have to take responsibility on how the patron spends using our collection or viewing our exhibitions. One could say that we are like airplane pilots who navigate a flight path for passengers everyday.

Having these "flight paths" or workflows adds value to various technologies for the same application where the important component of the workflow-optimized storage is in the automatic migration and recall of AV record and contents from one storage to another, based on the life cycle of that AV file. As these contents age, they may not have the same access requirements, and can thus be stored more economically in less expensive storage.

With this improved workflow and optimized storage[7], records and collections can be automatically moved from faster, but more expensive storage to cheaper secondary storage, or even back to cost-effective tape or optical base storage. This can dramatically reduce the cost of storing the contents. This application manages, optimizes, and unites the different tiers of storage that we have, and uses the same interface and tools for managing the storage to automatically restore older contents for immediate reuse.

With network attached storage (nas-storage), there is often only a single storage, and it may require third-party data management applications, and even third party storage systems to enable a multi-tiered storage that may not work when new versions of software or hardware emerge.

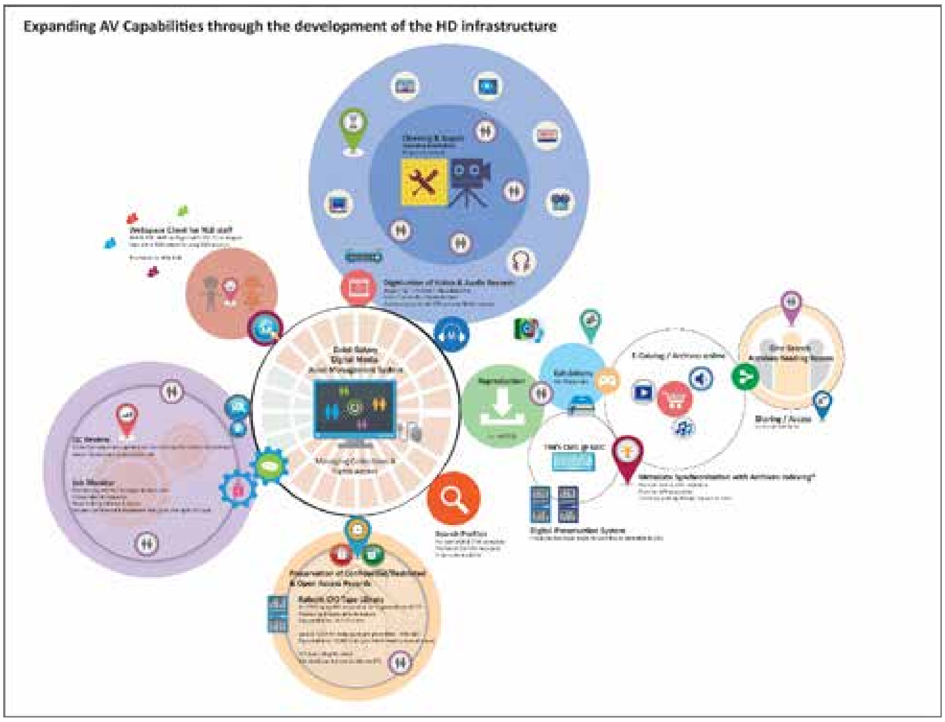


Figure 5a. NL-NAS end to end workflow overview.

6 Coughlin, T.M. 2011. *Maximizing process, creative and content lifecycle value with workflow-optimized storage.* Atascadero, CA: Coughlin Associates.

7 Coughlin, T.M. 2011. *Making a robust media archive.* Atascadero, CA: Coughlin Associates.

Over the last three years, NL-NAS has been evaluating the use of optical disc and cloud based solutions for its archival library. We are at the infancy of the digital preservation. Time is however not on our side, and the entire collection of audio-visual and oral history materials needs to be fully digitized within the next few years.

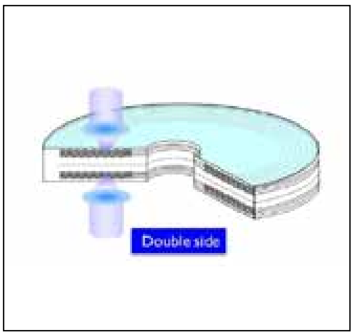
Figure 5b. Audio-visual & oral history materials are placed online upon digitization.

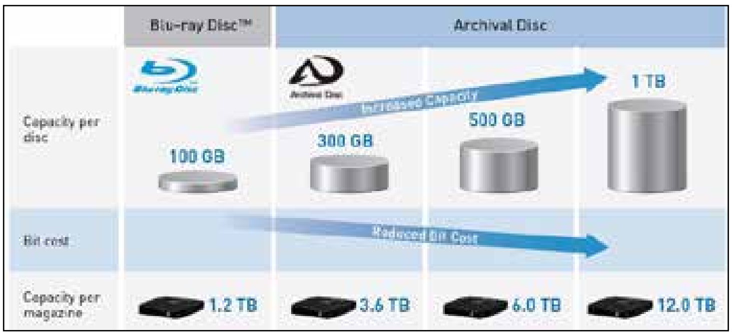
This hierarchical capability of the system is implemented to manage and preserve both SD/HD AV records and 2K/4K film contents, which are of national and historical significance, to mitigate the risk of loss of contents. What NLB hopes to achieve is to fulfill its national patrimonial role of making contents accessible through 4-ABLES : PreservABLE*, FindABLE, ExpandABLE, DeliverABLE. (*The essence of this paper focuses on "PreservABLE")

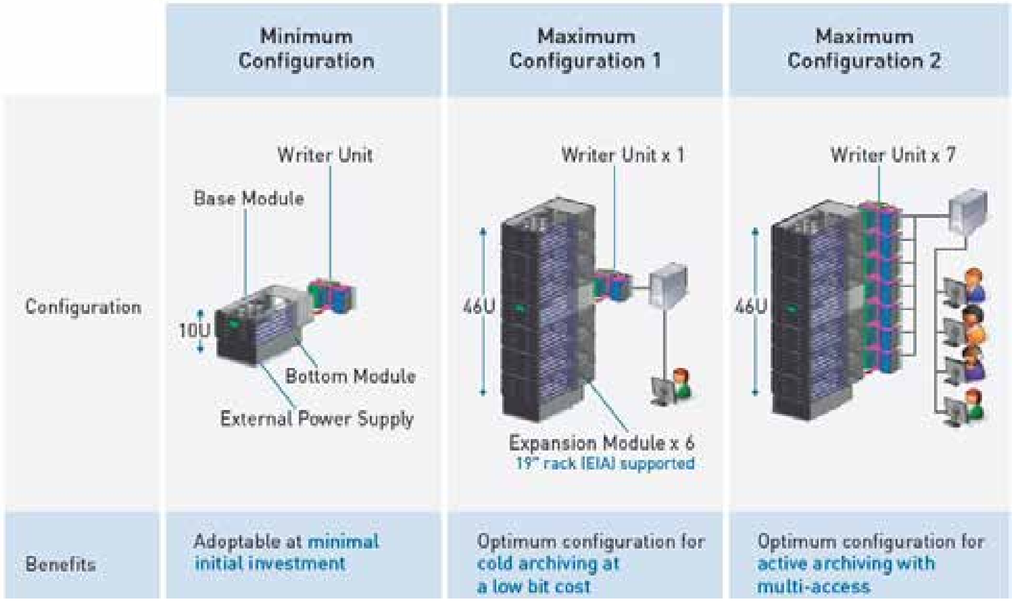
Making memories accessible and preservABLE for future Singapore

"I can rest assured that everything in the National Collection that is precious will last beyond this generation."

Like any flight, the most delicate part is the takeoff. The beginning; because when you design a system to manage preservation and conservation work, the prime material that you are working with is something that will take a lot of time to prepare and test. The more we manage the user acceptance test, the better the system will be. It will cost every staff dedication, to fill every atom of air in that space before the exhibition can take place. It will also take the audience's anticipation. Everyone brings with them the story of how they got there, the distances they travelled, the months they had to work to get that film to screen, or for that exhibition to work. It is a walk through cinema that allows producers to become protagonists in their own poetry, and share their own stories. Like many translations from music to mechanics, what was initially deemed as technically impossible, is now possible and achievable by putting together a collective system to manage these collections.







[8] Panasonic Corporation. 2015. A long-Term data archiving strategy for more sustainable business. AVC Networks Company

Figure 6. Archival disc from Panasonic & Sony[8].

Preservation of the National Collection is of paramount importance to us. We see digitization as the key to preserving the National Collection digitally, and enabling NLB to provide access to current and future generations. Whilst digital files can offer quick onsite and offsite access to our contents, digital file formats require specific needs for preservation as they can become obsolescent at a faster rate than paper materials, due to technological evolution and physical deterioration.

The digital content stored in a digital archive is subject to a number of threats that endanger the ability to preserve this content for the future. These threats relate to various types of technology obsolescence. The media itself can become obsolete, and a machine to read the file may no longer be found. Digital materials are machine-dependent in order to be accessed. The speed of change in technology means that the time frame available to take action to preserve the digital materials is short. An analogue audio-visual record stored in an office environment or storage space that lacks appropriate environmental control will need to be migrated regularly, or there will be a possibility of catastrophic loss through deterioration over time.

The phasing out of old analogue audio-visual players is certain. Many players are either already extinct, or they will soon be. Certain players like the vinyl are making a comeback. So digitization from such formats would need to be completed within this generation. Accessibility to the contents may be lost completely if we do not make it preservABLE now.

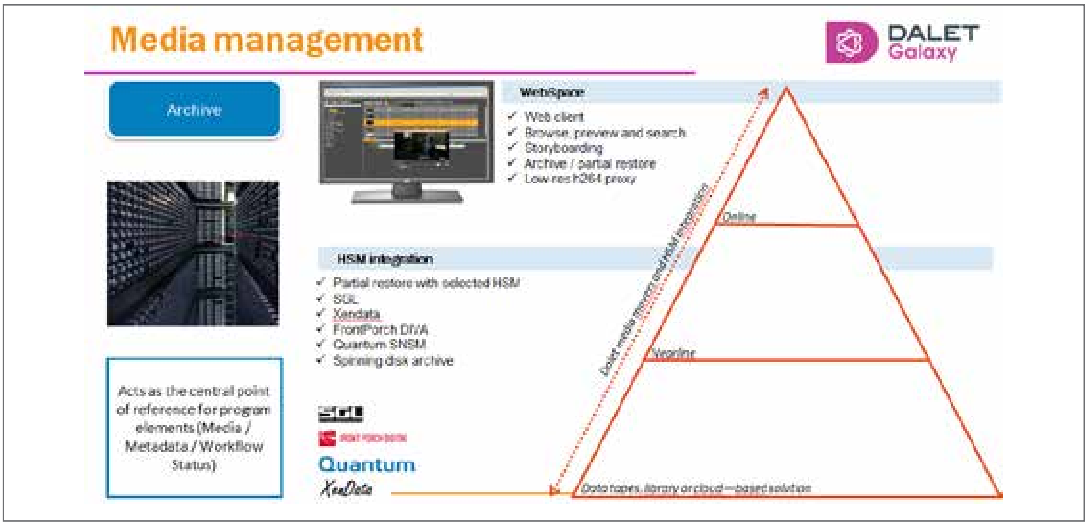


Figure 7. Integration to digital media asset management.

9 National Archives of Singapore. 2015. *NL-NAS Masterplan.* National Library Board.

Part of our preservation works includes the migration of our collection of audio-visual records created by public offices and private organizations covering 60 years of our broadcasting history that captures defining moments such as the momentous self-government victory rally speech of 1959[9]. The past will continue to inspire us, but as Singapore continues to develop, new events become part of the memory of the nation. All these are indexed and managed in our database and media management system, which also generates reports via data analytics that give us an overview to make better strategic decisions.

The Singapore broadcast industry has moved into full HD digital transmission in 2015, and there has been a corresponding rapid phasing out of analogue equipment. NAS has to step up the pace of migration and digitization of AV records so as to reduce the risk of loss due to format obsolescence. The migration and digitization of about 80,000 to 100,000 analogue AV recordings currently preserved at NAS and a projected 10,000 recordings yet to be transferred to NAS by public agencies will be our focus for the next three to five years[6]. NHK – Japan's National Broadcaster has been preparing its 8K broadcast for the 2020 Olympics, and have been offering 4K colorization services for black and white films, which is something we might need to consider for the future of time-based media.

The conversion to digital file-based AV records will facilitate and allow for the simultaneous access of recordings through all NLB libraries, and not just at the Archives Reading Room. The current plan is for digitized AV recordings to have immediate access at NAS and extended access in all libraries across Singapore for viewing where copyrights permit.

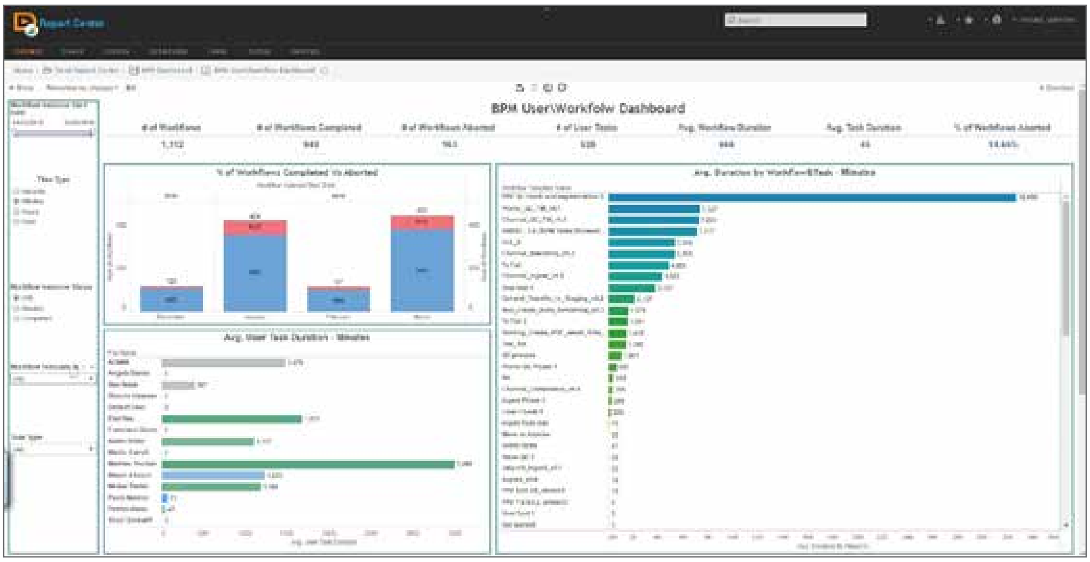


Figure 8a. Workflow dashboard.

NAS has also been transcribing and translating oral history interviews after digitization to facilitate greater and easier use of the contents. Transcribing and translation work is vital as it provides easier access to the oral history recordings through searches and shorter research time. Transcripts are also useful when quotes need to be extracted quickly for use in publications and exhibitions. Therefore, there will be a corresponding wider usage of rich oral history contents for programming and exhibitions. With more translated interviews, language will no longer be a barrier to the dissemination of stories and information in the oral history collection.

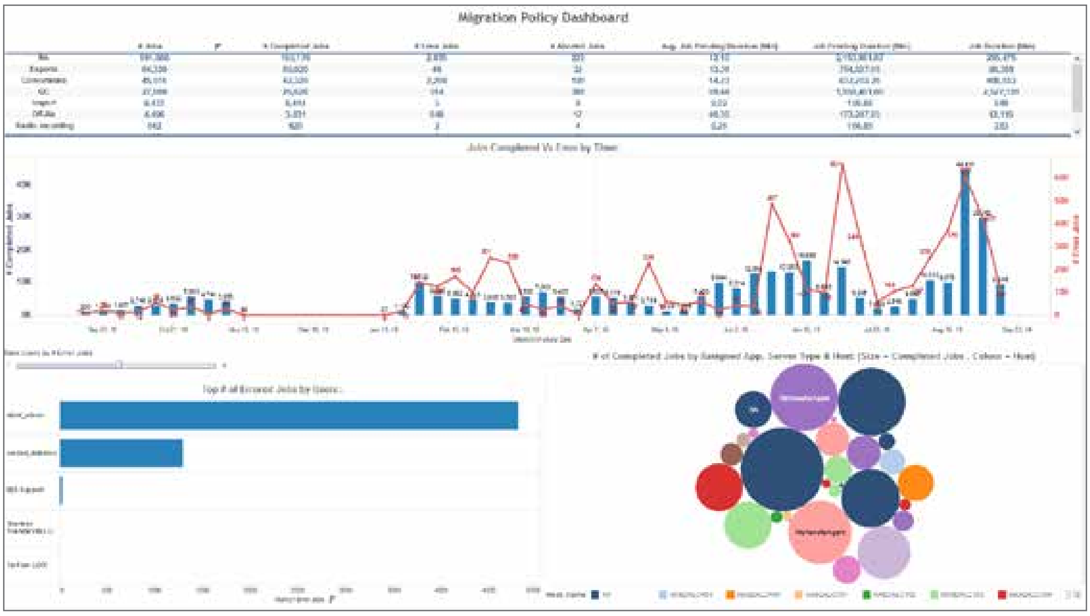


Figure 8b. Migration policy dashboard.

Figure 8c. Job activity dashboard.

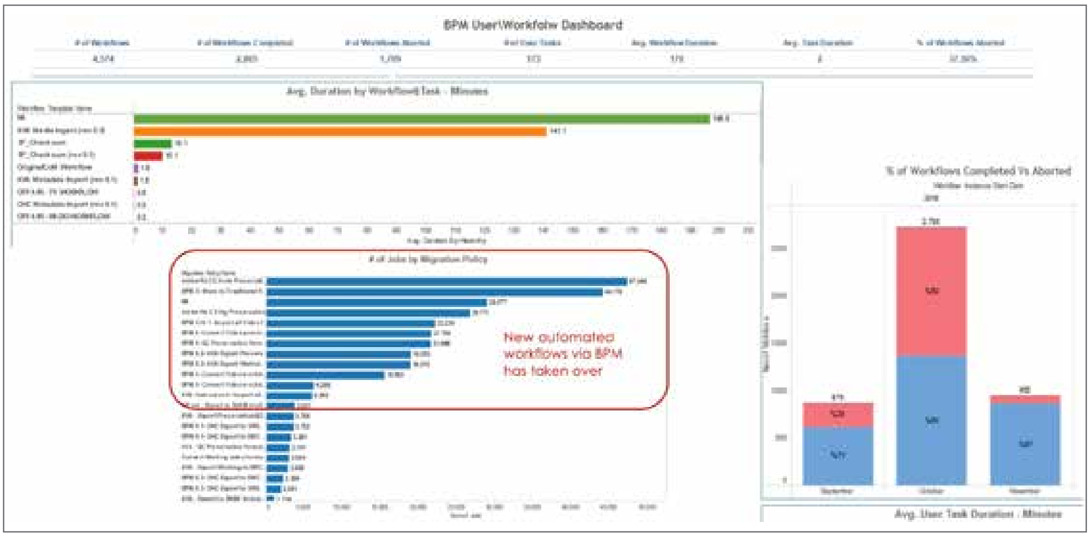


Figure 8d. BPM User Workflow dashboard.

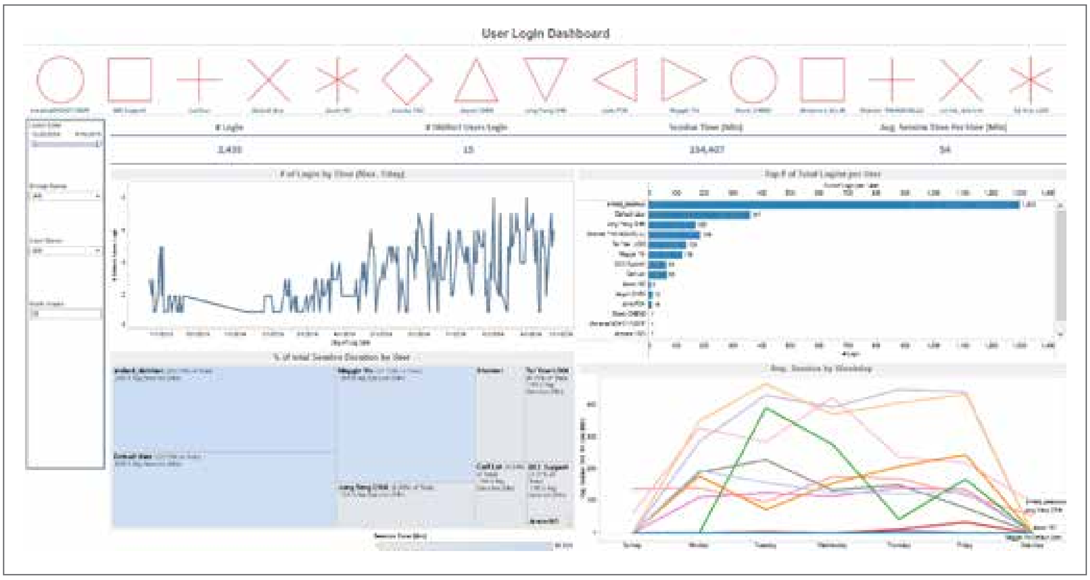


Figure 8e. Staff activity dashboard.

How the story ends

With so many valuable memories, we no longer have to depend on a one-size, one-storage-fits-all solution. The intelligent hierarchical storage platform provides us with a cost-effective and scalable solution to meet the blazing pace of AV digitization. Our story should not end, but memories must continue into future generations. And for this to happen, we need to continue to architect and put in place a comprehensive suite of well-integrated systems.

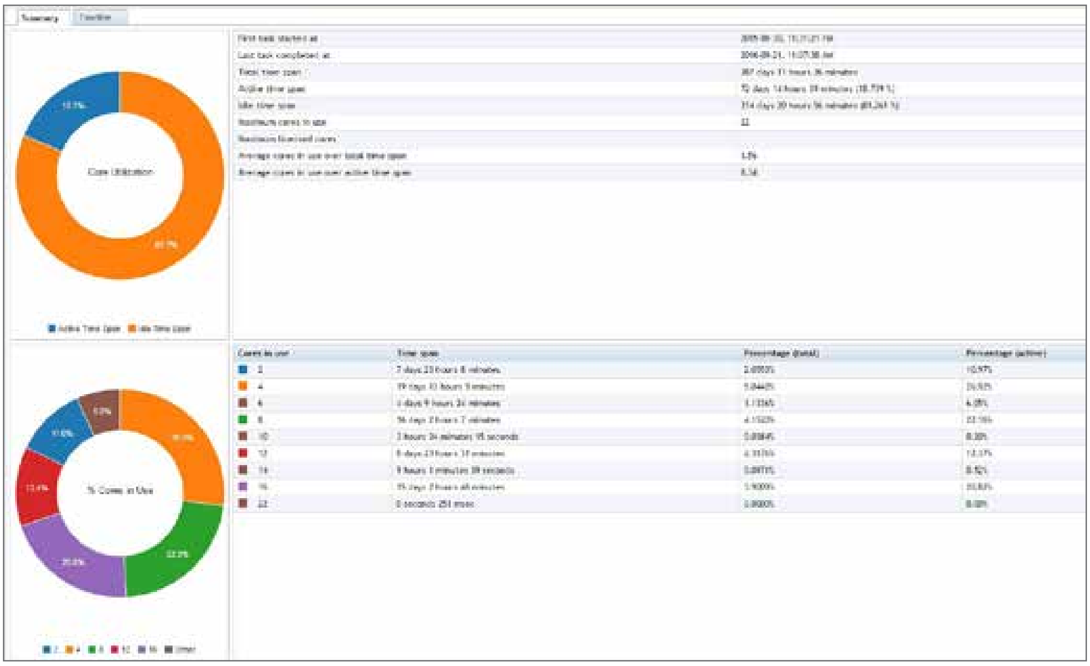
One of which is the DAP system for AV, which handles over ½ PB or 500 TB of preservation materials annually. The other key system is the Ex Libris Rosetta Digital Preservation System (DPS). Rosetta is one of the leading digital preservation solutions used by libraries and archives in the world. Back in December 2015, over 140 TB of preservation materials were managed in the Rosetta DPS. NAS has also started to use the Rosetta DPS for its photograph collection.

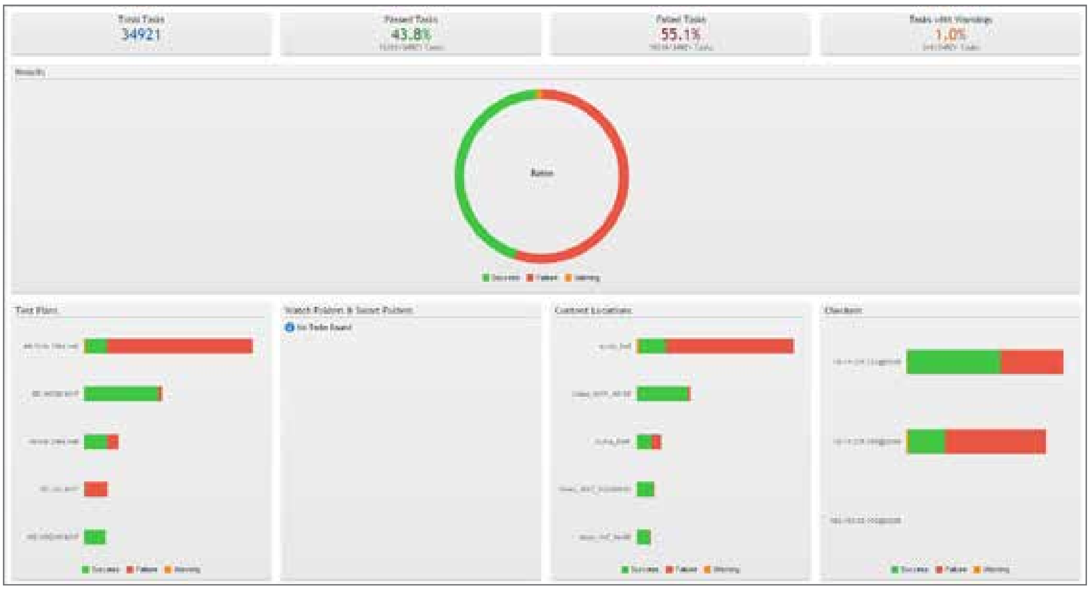
The NAS AV contents can be accessed through the one-stop NAS Archives Online portal. Archives Online streams the AV contents, and is designed to be mobile-friendly. It also manages the access

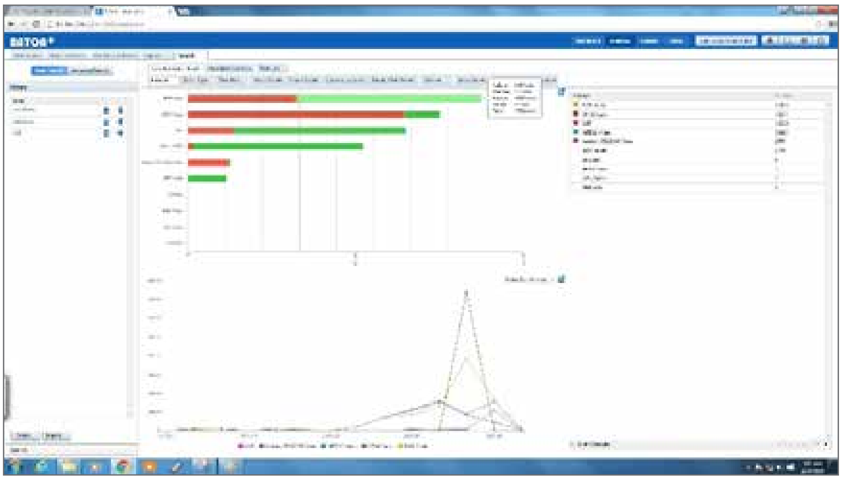
[10] Siang, H.K., Chan, A., Pak, P. & J. Phang. 2015. *End-to-end management of audiovisual and multimedia content and services - the NLB experience*. National Library Board.

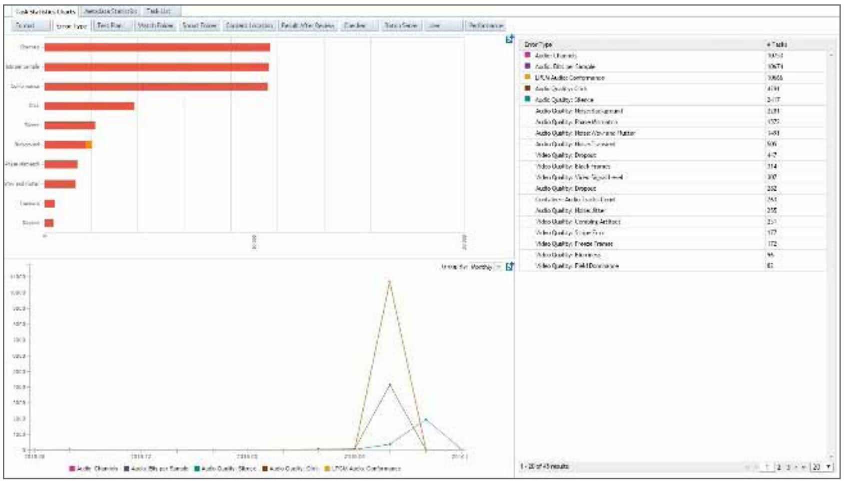
levels, including onsite and offsite access.

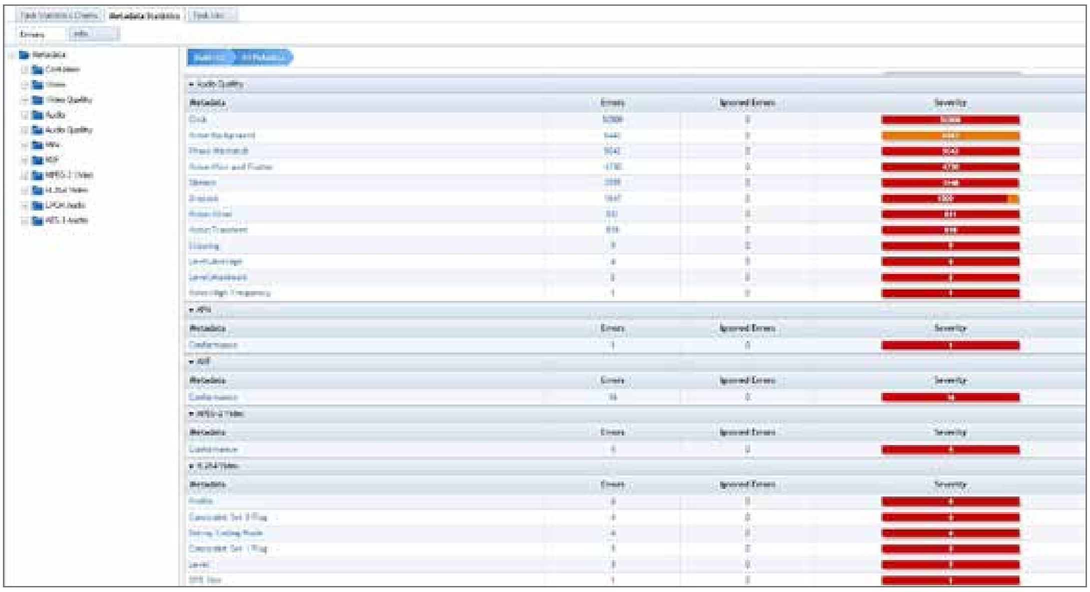
AV materials are much larger in file size. We are currently managing these AV files with one integrated Digital Audio-visual Preservation (DAP) system consisting of a Digital Media Asset Management System from Dalet, which includes Brio and Amberfin ingest servers, Baton file-based QC system from InterraSystems, Dell's Isilon Storage, Netapp's near line solutions, and Quantum Hierarchical StorNext. There are always new challenges that arise with the digital system, which we quickly realized are in the perimeters and settings within the QC itself. Many of the settings for broadcast cannot work with old archival footage. Hence, many preset settings have to be created for specific records.











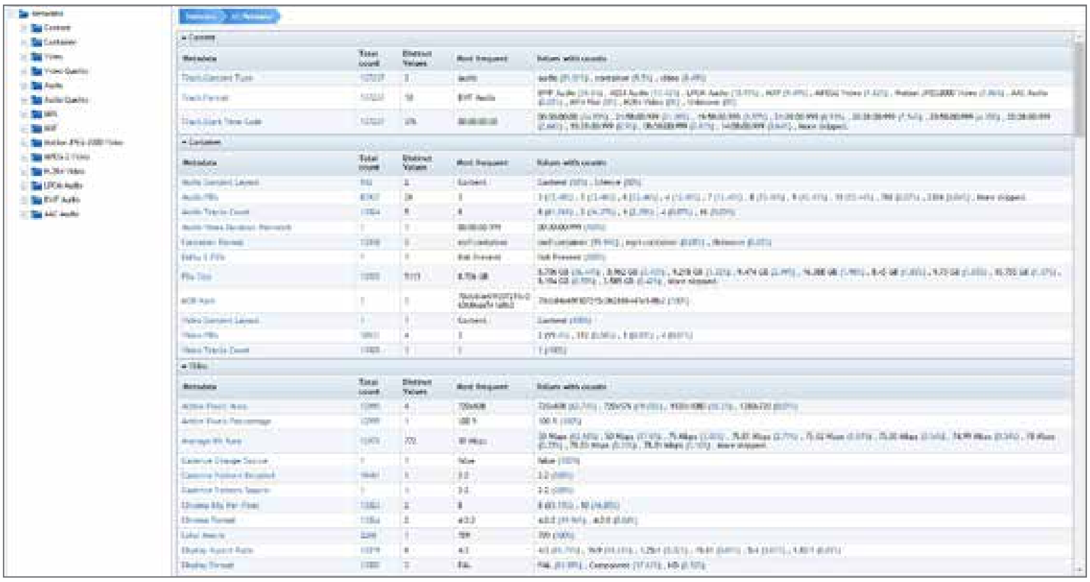


Figure 9. New challenges.

The beauty of the hierarchical storage system is that once it is populated, it can be externalized and put it in a new storage at a lower cost, so storage space will not be used up. NLB is working on enhancements for storage options for our working and access copies within the hierarchical storage setup. The two options we have now is either the scale-out nas-storage or the object storage WAN. From a technological perspective, our goal is to support existing workflows, and make them more efficient while enabling new business opportunities. We would like to eliminate silos of storage, and at the same time deliver production needs and share our media assets across different content management systems.

The scale-out NAS gives us the ability to move contents through different kinds of storage solutions, and have an optimized data flow for media content based on demands of its nodes option. When we need a fast storage for production, we add a high-speed node, and when we require a long-term solution, we deploy a cheaper but not as fast node. This gives us the capability to stay on top of our requirements where performance, capacity, or workflows can be adapted quickly and easily without downtime as we can scale out at any given time.

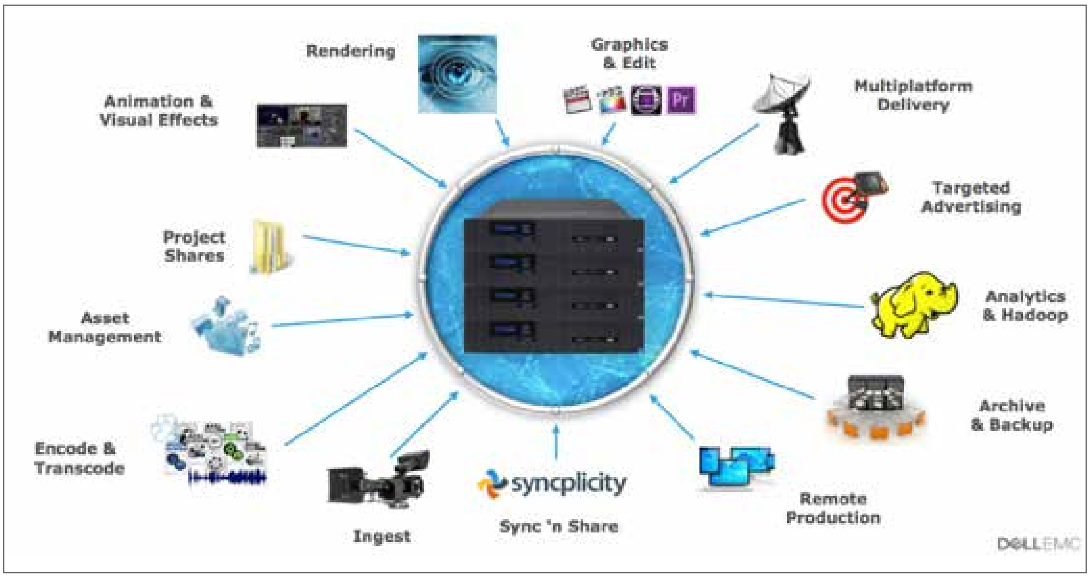


Figure 10a. Scale out nas-storage & object storage technology for scalability and flexibility.

The object storage-based systems offer more flexibility in how and where contents are stored and preserved. Because object storage leverages the scale-out capabilities of IP networks, this addressing allows digital data sets to scale indefinitely. Object storage controller breaks data into data objects, and distributes them over multiple independent nodes, disks, and sites according to policy. If one of the data objects is lost because of disk failure, the object storage will rebuild that data object on another storage node.

The goal is for us to be forward-looking, and future-proof our collection, and yet spend less. We pay only for what we need and when we need it. With this, we hope to deliver more by managing contents and media, rather than managing storage.

This purpose-built workflow-optimized storage saves time. It eliminates costly human errors, and allows the creative users to focus their valuable time on core creative pursuits that yield more for the organization, rather than spending their time on manual and unpredictable content workflow steps. It delivers values throughout the entire archival and production workflow. Purpose-built workflow storage extracts more values in the processes, creating values from content with the same staff and facility, and over the entire managed lifecycle of the content produced, to yield long-term benefits.

Professional media has also been dependent upon a variety of digital storage technologies to carry on the various operations. It starts from content capture, goes through post-production, content distribution, and finally archiving. The shift to digital technologies has highlighted the role of digital storage in every aspect of video production and use. Its characteristics of various storage technologies have led to their use in different applications.

[11] SMPTE 124-08: 2015 Coughlin, T.M. 2014. *Survey summary for storage in professional media and entertainment.* Retrieved on [DATE] from http://tomcoughlin.com/techpapers.htm

[11]Flash memory has become the dominant storage technology in modern professional video cameras, and is playing an increasing role in content distribution, and perhaps in post-production, as the price declines, due to its high performance. Reflecting the move to information technology networking in many production facilities, network storage and cloud-based storage are assuming an important and growing role in post-production, content distribution, and archiving. These cloud storage systems use HDDs, flash memory, optical discs, and magnetic tape to allow for trade-offs of cost and performance.

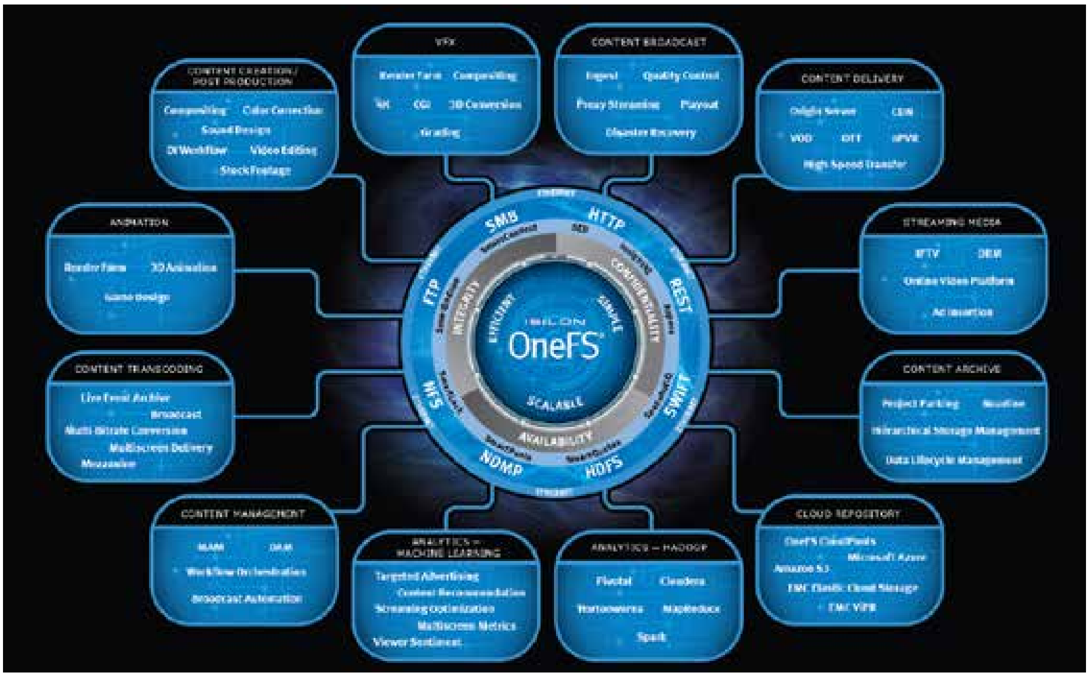


Figure 10b. *Scale out nas-storage & object storage technology for scalability and flexibility.*

It is NAS hope that SMIL's DAP system acts as an "instrument". A bit like that violin that will create a place and space where people can play and enter their worlds at one end, and emerge at the other end of the building, and find that their worlds have joined in a collective poem, voice and story. Facial and voice recognition can help with automated metadata collection but as in all machine learning, the algorithm that generates the collective poem has to be simple. It is like a predictive text that has to be trained on millions of keywords. So it will become a sort of convergence of intelligence, past and present, and organic and inorganic.

I am inspired by the words of Stephen Hawking. Towards the end of his life, he asked an interesting question: If we as a species were ever to come across another advanced life-form, an advanced civilization, how would we speak to them? What collective language would we speak as a planet? The language of light, audio, and vision reaches every audience. All of us are touched by it. None of us can hold it. And in that theatre, that exhibition, that black or white space, we can begin each work in a dark place, devoid of light. We might have to stay up all night to focus and program the lights, and find new ways to sculpt and carve light, and mix it with sound and vision.

Ultimately, what we preserved and conserved will always be seeking new ways to shape and reshape a piece of history, identity, and the Singapore story. Each of us will always find the words for things that we no longer need to say. One day, everything that you and I have done may no longer exists in physical form. In fact, most of what NAS has tried to preserve made over the previous decades might be in formats that no longer exist today. But all of our work endures in memories, in synaptic sculptures, in exhibitions, within digital and physical spaces only in the minds of those who were once present in the audience.

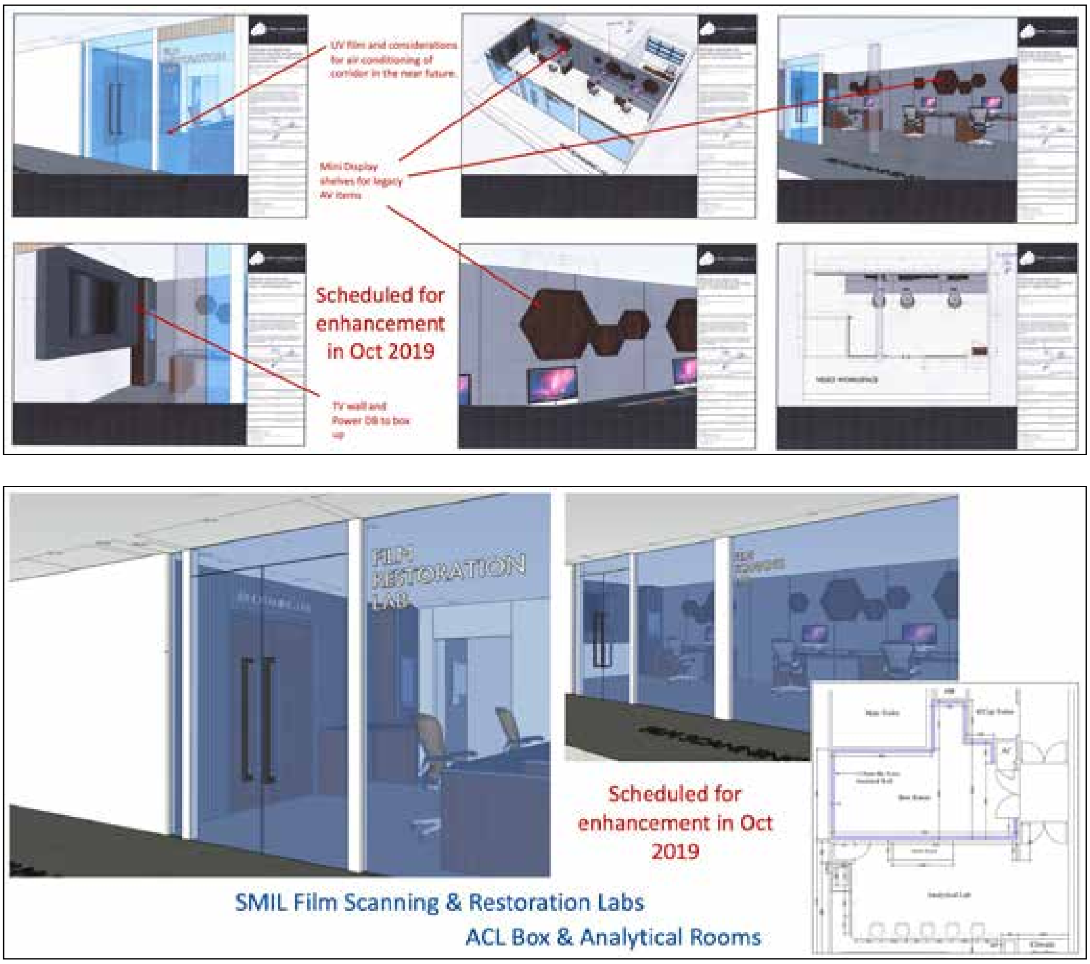


Figure 10c. Enhancement to improve preservation and conservation workspaces.

Implementing a hierarchical storage workflow together with a digital media asset management is probably the best sustainable option for NAS and to have to scale-out high performance primary storage system, in order to enable specialized ingest stations such as the Amberfins and Quadrigga systems across multiple buildings, and simultaneously dedicate high performance to any rendering bay, or transcoders, which can help to speed up priority records within the comprehensive workflow while focusing on the archival and production process at the same time. This allows us to have higher efficiencies from limited resources to preserve and provide access of our memories, our stories, and our legacies to future Singaporeans.

Author's biography

Mr Adrian Chan currently heads the Archives Laboratories that consist of the Sound and Moving Image Lab (SMIL) and Archives Conservation Lab (ACL) at NAS. He and his team manage the conservation, preservation, migration, and archiving of paper records (photos, maps, posters, and books) and analogue or digital AV records (audio, video, and films) for Audio Visual Archives, Oral History Centre and the National Library. This involves identifying, organizing, and preserving the records according to medium, carrier type, format, and media, by a system of migration or conservation and exploring new technologies and proven methods. The Archive Laboratories also recommends and implements appropriate technologies relating to the preservation of records and its condition via a risk management strategy.

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Heritage Cataloguing: The HCC Experience

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KEYWORDS
heritage cataloguing, controlled vocabulary, taxonomy, Heritage Conservation Centre

ABSTRACT
Modern technology has evolved to a sophisticated level. The National Heritage Board (NHB), Singapore, like other prominent international museums, is leveraging on this modern technology to present her collections and heritage resources through educational and user-friendly online platforms. Today, there is increasing public awareness of Singapore's heritage, as well as moves to increase public engagement. Cataloguing the Singapore National Collection (NC) is one of the steps undertaken by the Cataloguing Team at Heritage Conservation Centre (HCC), an institution of the NHB, to further promote this.

The objective of these efforts by the Cataloguing Team is to enhance the digital records so as to increase the online search-ability of the records. This will facilitate a broader use of and access to the NC for research, education and personal enrichment.

The development of the cataloguing system takes place in stages and includes: the process of descriptive cataloguing, subject cataloguing, metadata creation, incorporation of metadata schemas and controlled vocabulary standards, development of local terms, NHB controlled vocabulary and taxonomy. This article shares the journey of the cataloguing work at HCC through the aspects of the benefits of the collections' metadata cataloguing; development of the collections' cataloguing capabilities; concerns raised in the past; and challenges, achievements, and future plans.

Introduction

Presently, search engines retrieve search results linked to concepts and entities such as people, locations, events, organisations, etc. These concepts or entities, which are stored in organised knowledge bases are structured information about the objects or things (Balog, 2007). Relationships can be established amongst the entities which link the data and in doing so, enrich the information and give context to the searched matter. These entities and relationships can be shared across institutions and platforms, thereby linking together and enriching more information.

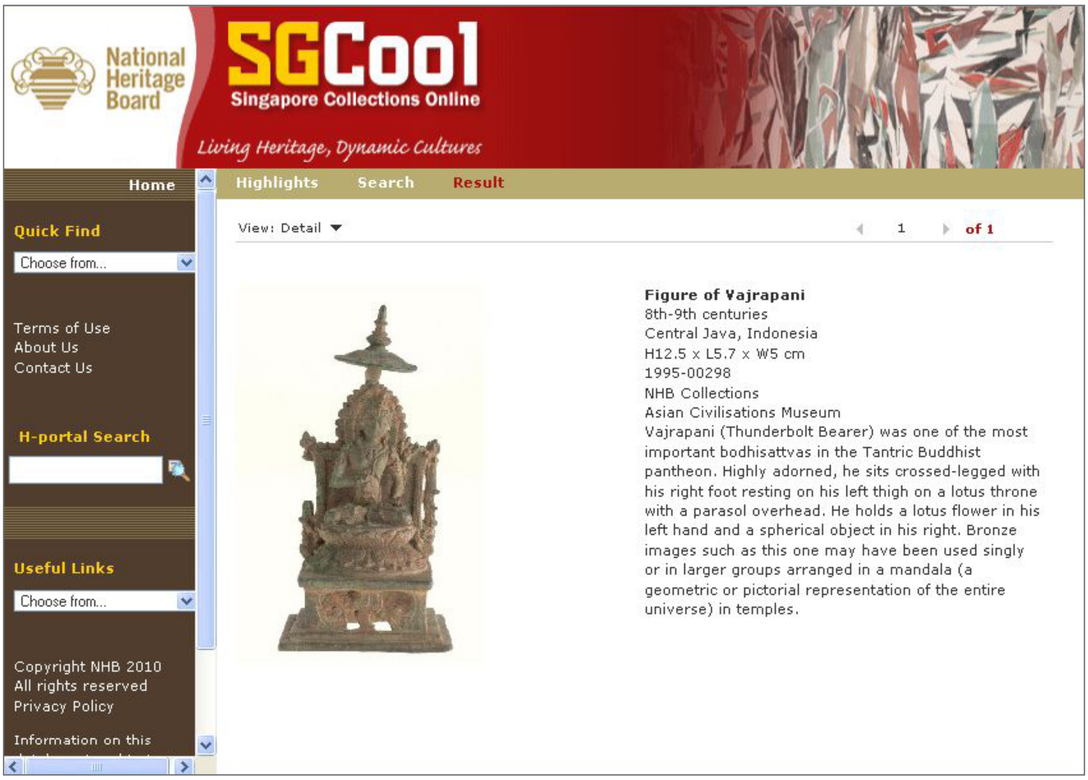
The NHB is tapping on this advent to also display the NC and heritage resources through educational and user-friendly online platforms. The HCC is an institution of the NHB, which cares for, manages, conserves and makes the NC accessible both physically and digitally; and it was tasked to enhance the search-ability and accessibility of the NC records online.

This paper takes readers through HCC's journey between 2014 to early 2019 to enhance the metadata of the NC records by employing the sophisticated information retrieval technology which NHB is deploying. It has long been the aspiration of yesteryear's HCC colleagues to enable quality retrieval of records from both online and the old Collections Management System (CMS). The setbacks then were specialised skills and time. These aspirations were expressed in two papers presented at the International Committee of Documentation (ICOM), CIDOC Annual Conferences in 2005 and 2010 by former HCC Registrars: *A Custodian's Challenge: A Museum Documentation Standard for All? Experience from Heritage Conservation Centre (HCC), Singapore* (Teh 2005) and *A Postcard is Not a Building: Why We Need Museum Information Curators* (Low & Doerr 2010).

Development of digitisation of the NC records

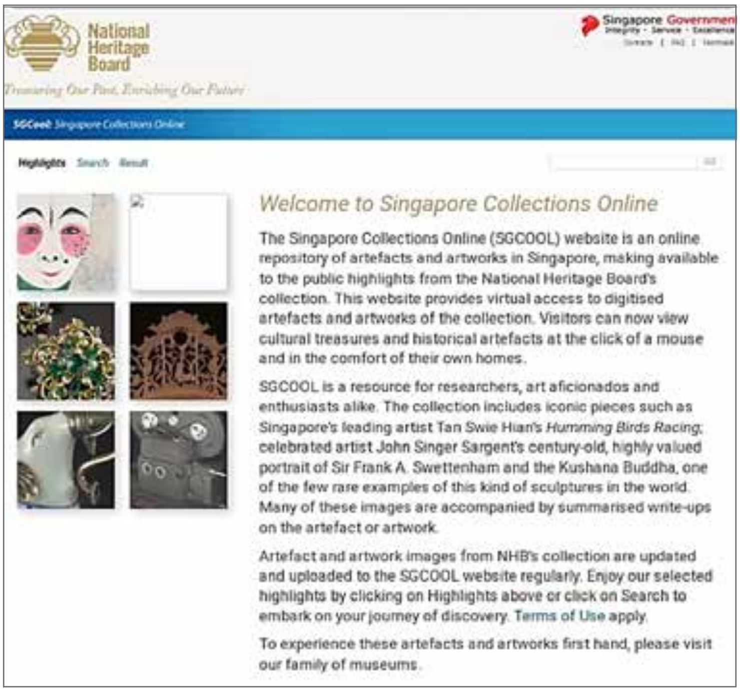
In 2005, NHB embarked on efforts to digitise the NC and an NHB-wide digital CMS was launched. Presently known as Singapore Collections Management System (SCMS), it housed the inventory data and research information of the objects, and was (and still is) managed by HCC.

Together with the implementation of a centralised database, the NC records were also made available to the public via the Singapore Collections Online (SGCool), which was launched in 2007. Besides increasing public awareness of the NC, this move of displaying the growing volume of NC records online enabled NHB to display more NCs than it physically could during exhibitions. However, the online records were very simple and static. See Fig. 1 and 2.



(Collection of the Asian Civilisations Museum)

Fig. 1. An NC online record on SGCool Generation 1.

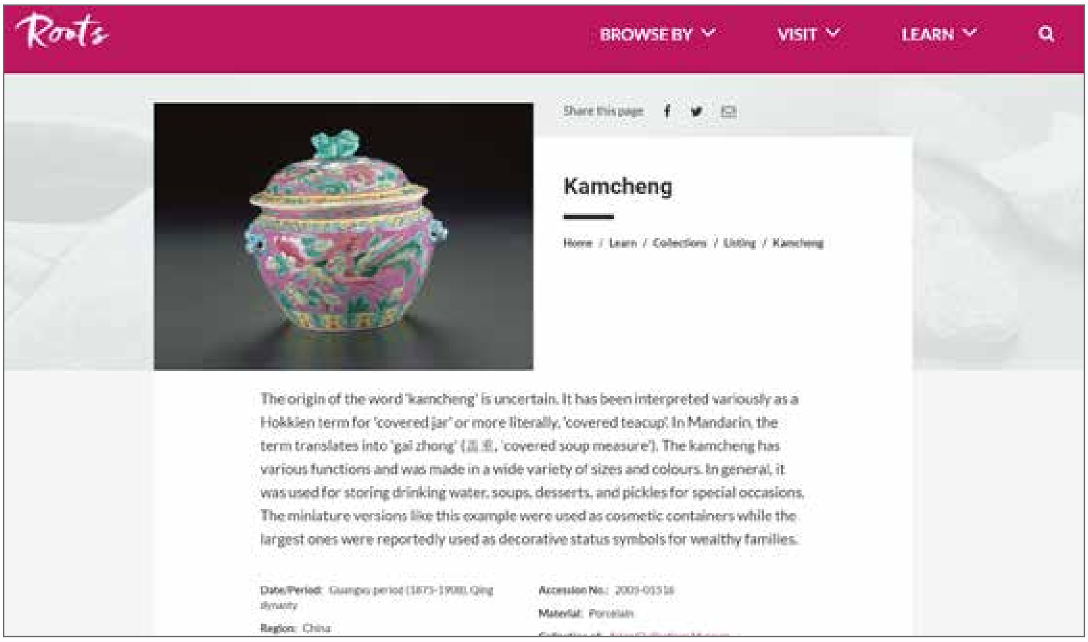


(Collection of Singapore Art Museum)

Fig. 2. An NC online record on SGCool Generation 2.

Nevertheless, it was reported that from 2014 to 2015, online visitorship to SGCool increased by 56%, which was an indication of interest not only in the NC (Wong, Liu & Koh 2016) but also in accessing the NC online.

NHB later proposed a Digital Engagement Framework in 2014 to better engage the public digitally. One of the projects was Roots.sg launched in 2016. Roots.sg is the NHB resource portal, which hosts NHB content related pages on a single platform. See Fig. 3 for a NC online record on Roots.sg. It was in this Digital Engagement Framework that HCC was tasked with the mission of increasing the search-ability and accessibility of the NC records.



(Collection of the Asian Civilisations Museum)

Fig. 3. An NC online record on Roots.sg.

Documentation challenges faced in the yesteryears

The need to enhance the data in the then CMS for better record search and retrieval had been recognised by HCC colleagues for many years. Teh (2005) in her paper discussed the inconsistent documentation standards used for the NC. Amongst the challenges she raised, was the lack of terminology control. She noted the inadequacy of using English terms to describe Asian artefacts that had native terms such as "*keris*" and "*cheongsam*". At the same time, she was concerned that using native terms would greatly limit the digital retrieval of the records, as such terms would only be used by people who knew the local language, rather than the larger public. Besides that, variant spellings of the same word could exist due to different dialects or ethnic groups. This would pose a challenge for record retrieval due to lack of vocabulary control. Teh's concern was not unfounded as a search for creators/artists would be the same as those who have aliases and pen names which they could use interchangeably.

Teh's concern was echoed in Low & Doerr (2010). Low discussed the need for controlled vocabularies. However, due to the specialised skill, effort and time required then, a thesaurus for NHB was not developed. They also highlighted the challenge of standardising documentation "horizontally" across museum collections and suggested the need for "Museum Information Curators" to carry out these tasks, which Cameron & Robinson in *Digital Knowledgescapes* (as cited in Low and Doerr, 2010) noted:

> *With a universe of applications for new digital technologies opening up for museums, as well as the need to effectively draw together existing information resources, museums will need to consider the creation of new staff roles responsible for the digitization and linking of related data. These new information brokers will be responsible for identifying documentary sources and creating relationships between data in previously unrelated fields or disparate media categories.* (Cameron & Robinson 2007, p.184)

The core of the challenges discussed by Teh (2005) and Low & Doerr (2010) can be summarised as the need for controlled vocabulary, local terms, and research content to enhance the quality of the metadata of the artefact records in the CMS to aid more efficient record/information retrieval both internally and online. Understanding the huge amount of work needed to do this for the ever-growing NC, Low & Doerr (2010) suggested a team specifically dedicated to carry out these tasks. These tasks are a form of cataloguing work, which HCC termed **heritage cataloguing –** unlike library cataloguing done by Librarians and inventory cataloguing by Collections Managers.

The HCC cataloguing journey and experience

Cataloguing is the structured process of organising information about artefacts in a collection. Information is categorised into a set of "fields" or "elements"; each distinct information in a specific field to make them retrievable and accessible (Joudrey, Taylor & Miller 2015). Cataloguing work, which encompasses the different processes of subject description, creation of metadata, controlled vocabularies, taxonomy classification, and ontological analysis is an organised means for resource description and access. Using the terms of Library Science, HCC does subject and descriptive cataloguing for the NC.

Subject cataloguing is the process of describing what the object is *about*. It entails the intellectual process of identifying the subject matter/context of an artefact. This usually classifies the artefact by using controlled vocabulary from a recognised thesaurus. For HCC, subject cataloguing is carried out based on content submitted by the Curators and research done by the Cataloguers.

Descriptive cataloguing entails *describing* an object according to a set of elements, such as dimensions, dating or creator. Descriptive cataloguing results in descriptive metadata, which is used for identification and searching for an artefact record by its title, creator, date, and other keywords. At HCC, descriptive cataloguing is done based on content submitted by both Curators and the Registrars.

The value of cataloguing the NC

Heritage cataloguing adds value to a digital collection and for its users. Besides enhancing retrieval of records within our internal databases, cataloguing also enables a user with a device (mobile or otherwise) and internet facility to search and browse the NC. In future, linked data would make online records accessible on multiple systems and applications.

The outcome of cataloguing the NC using controlled vocabulary would enhance the organisation of records in SCMS and enhance precision in search retrievals, which saves users' time. This adds value to research work, as well as information seekers on-the-go. Subject cataloguing value-adds to the records, which only have descriptive metadata. The richer information in the metadata would benefit users in the area of education and research, and enable all a more in-depth discovery of Singapore's heritage. Being able to browse the collection, filter the search results and click on suggested related items enrich the digital experience. These records accompanied by high resolution images, which provide aesthetic value and visual details of the objects, would bring enjoyment to users, especially those who are physically disabled and unable to visit the museums.

Heritage cataloguing would provide greater meaning to the artefacts and enlarge their access by creating relationships between the artefacts and other entities. Artefacts can be better understood and appreciated when their value is derived from their association with a person, a historical location or an event, instead of just basing it on their intrinsic value as artefacts. (FPAN North Central 2012)

The HCC Heritage Cataloguing Team

Three Cataloguers, all trained in Information Studies (the equivalent of Library Science) were hired by December 2014. This qualification was essential at the initial stages as the task required the understanding of and skills in library cataloguing. However, once the foundation of the cataloguing work was established and later progressed beyond basic cataloguing work, the skills and qualifications required were excellent research skills, training and a background in History or Social Sciences (with an interest in the arts and heritage field), as well as knowledge management. Coincidentally, these positions had tasks similar to those that were suggested by Low & Doerr (2010) for Museum Information Curators.

As of December 2018, we presently have 14,326 catalogue records created from 14, 304 objects. With these, the HCC Cataloguers are presently working with our colleagues in the Strategic Communications & Digital Department (SCD) and Information Technology Department (ITD) on the deployment and use of metadata created for the NC into an ontology for the search database for Roots.sg, as part of the NHB Cultural Ontology Project. The search functions we are working toward are semantic, contextual, facetted and multi-source searches with additional advanced features such as relationship viewer and tag clouds. These features will run on an integrated search across all the pages on Roots.sg, which would aid in retrieving related artefacts and other topics on the same subject matter. This project is still a work-in-progress and the present Roots.sg revamp is expected to be completed in 2020.

Developing the cataloguing framework

Establishing a framework is the foundation for cataloguing. The Cataloguing Team studied the existing tools and resources, the international standards and thesauri available and the online collections of museums worldwide. Over the years, many metadata schemas have been developed and they are used for different types of collections. For example, Categories for the Description of Works of Art (CDWA) is used for art objects; CDWA Lite version, Visual Resources Association Core is used for visual surrogates of works of art and architecture; and Dublin Core for Web resources.

As the NC consists of a variety of cultural objects and artworks, the CDWA was selected because it is comprehensive, user-friendly and suitable to be used for both artefact types. The elements (also known as fields) are comprehensive enough to cast the net over the variety of cultural objects and artworks in the NC. The availability to adapt and customise the elements to suit NHB's needs is another advantage of the CDWA. The Cataloguing Team scanned the cultural objects and artworks in the NC via the SCMS and selected, as well as adapted elements that could best describe these artefacts.

See Table 1 below for examples of the selected elements.

Table 1. Selected metadata elements and the corresponding controlled vocabulary/thesaurus to be used.

Elements (Fields)	**Controlled Vocabulary/Thesaurus (source of the metadata used)**
Object/Work Type	AAT, NHB Controlled Vocabulary
Creator	LCNA, TTE
Creator Role	AAT- Agents Facet
Creation Date	ISO 8601 format
Creation Place/ Original Location	TGN and local terms
Place Qualifier	AAT
Styles/Periods Indexing Terms	AAT - Styles and Periods Facet
Materials Name	AAT- Materials Facet
Object colour	AAT - Colour (Physical Attributes Facet)
Subject	AAT, LCSH, TTE, NHB Controlled Vocabulary

On hindsight, this framework is also broad enough to capture "transdisciplinary information" mentioned in Low & Doerr's (2010) paper. Their concern was on loss of information if an institution only captured data according to a specific discipline. Citing their example (Low & Doerr 2010):

> *a postcard with a picture of a building was documented only as "building" by one institution, while another institution documented a painting with a building only by its artistic style*.

This framework selected by HCC not only gives consistency to the type of information captured "horizontally" across the NC, but it also has elements to capture related context of the object such as historical/cultural event, archaeology and architectural context and historical location etc.

Using the example of a postcard with an image of a building with the location in Singapore, the selected elements of how the postcard would be catalogued is shown in Table 2 below:

Table 2. Example of selected elements and metadata in cataloguing.

Elements	**Metadata**
Object type	postcard
Subject	buildings
	National Museum of Singapore
Place	Singapore

If it were an abstract painting of a building by an artist who painted it in Singapore, the selected elements of how the painting would be catalogued is shown in Table 3 below:

Table 3. Example of selected elements and metadata in cataloguing.

Elements	Metadata
Object type	paintings
Creator	*Samad bin Sahur, 1950 -
Subject	buildings
	abstraction
	art, abstract
Place	Singapore

*Fictitious name

Hence, the different disciplines can be captured in this framework in a standardised manner.

Selecting controlled vocabulary and thesauri

The next task was ensuring the standardised use of terms when assigning metadata to the artefacts for consistency in the organisation of objects and retrieval. The team explored a number of well-established controlled vocabularies and thesauri available. The suitability of the terms in the thesauri – the scope of usage of the terms and the words forming the term were some of the aspects considered during the assessment of the thesauri.

The controlled vocabularies and thesauri assessed were Library of Congress Subject Headings (LCSH), Library of Congress Name Authority (LCNA), Art & Architecture Thesaurus (AAT), Union List of Artist Names (ULAN), Thesaurus of Geographic Names (TGN), and Thesaurus for Graphic Materials (TGM), and ICONCLASS for art, architecture, and material culture.

AAT and LCNA were the only selected sources for the controlled vocabulary at the initial stage. AAT was selected as its controlled vocabulary is used for describing items relating to fine art, architecture, decorative arts, archival materials and material culture (The Getty Research Institute, n.d.), which is suitable for the NC. However, AAT does not contain proper nouns. LCNA was selected for proper nouns – names of places and people, and it contains many Southeast Asian creators' names. Further into the work, to better describe the context of the artefacts for subject element, Library of Congress Subject Headings (LCSH) was added to the list of controlled vocabularies. TGN was later added to the list as its context for locations aided geographical association.

In 2016, the National Library Board (NLB) shared the controlled vocabularies from their Knowledge Organisation Systems (KOS) with NHB. The controlled vocabularies facilitates consistent indexing/tagging of resources/information and enables the effective search and retrieval of resources/information across partner agencies. As the controlled vocabularies are predominantly Singapore-centric, it was particularly relevant for the tagging of NHB's artefacts.

Moving on, 130 different object types in the NC were selected from the NC as a sample set to be tested for the actual cataloguing work. The different object types were made up of sculptures, jewelleries, musical instruments, printed materials and contemporary art works etc. This was to test if the selected elements and controlled vocabularies would work well with the various types of artefacts in the NC. Based on the sample catalogue records, these proved to be sufficiently comprehensive to catalogue the collection.

Table 1 shows examples of metadata elements (fields) and the corresponding controlled vocabularies/thesauri used when assigning metadata (terms) to them. Fig. 4 shows a section of the metadata records of two artefacts.

Accession number	Image	Record Type	Object/Work Type	Title Text	Creator Identity	Creation Date	Creation Place	Physical Appearance	Subject Terms
2016-00573		item	military uniforms	WWII British Army soldier's cotton shirt	Not indicated	1942 - 1946	Malaya	A second World War British Army soldier's cotton shirt is displayed. The collared shirt has long sleeves which can be folded at the elbows. There is a breast pocket with one pocket button exposed, on both sides of the cotton shirt. A first field dressing pocket is present on one sleeve. The shirt is khaki in colour, for purposes of camouflage.	world wars
									shirts (main garments)
									Great Britain. Army
									1942-1945 Japanese
2016-00578		item	military uniforms	WWII British Army soldier's cotton shorts	Not indicated	1942 - 1945	Malaya	A Second World War British Army soldier's cotton shorts are displayed. The hem front fly contains 2 buttons. There are belt loops around the waistband of the shorts, accompanied with a couple of buckles at the centre. The hems of the cotton shorts are uncuffed. The short trousers are khaki in colour, chiefly for the purpose of camouflage.	world wars
									shorts (garments)
									trousers
									Great Britain. Army
									1942-1945 Japanese

(Courtesy of the National Museum of Singapore, National Heritage Board)

Fig. 4. A section of a metadata list on MS Excel.

Developing the cataloguing guidelines concurrently with cataloguing work

The SG50 exhibitions and the New Acquisitions artefacts acquired from 2014 onward were the first lists of artefacts catalogued using MS Excel as our template while waiting for the Cataloguing Module in the SCMS to be ready.

An essential item we developed concurrently with our cataloguing work was the HCC Cataloguing Guidelines. The *HCC Cataloguing Guideline v.1* was developed with the aim to standardise cataloguing work and as a guide for those who need to catalogue artefacts at HCC but are not trained in cataloguing. It is a documentation of how the cataloguing work is done at HCC.

This guide outlines:

1. Standards used;
2. How to catalogue;
3. Free text versus controlled vocabulary;
4. Organisation of objects to be catalogued; and
5. Definitions, research resources, and others.

Version 2 included a section on writing physical descriptions of artefacts. *Version 3* is in progress and expected to be completed in mid-2019. It includes new guidelines for the standardisation of terms used to catalogue specific artefacts for better consistency.

Developing the NHB controlled vocabularies and local terms

In the process of cataloguing, the Cataloguing Team found that there were specific terms which were needed to describe our Southeast Asian artefacts, which were not found in established international controlled vocabularies and thesauri. Hence, it was essential to develop our own local terms in order to accurately describe the artefacts. This was also raised by Teh and Low & Doerr. Teh (2005) had noted that HCC had plans to set up a working group comprising Curators, Registrars and academics to develop a thesaurus and this has today materialised as the Cataloguing Team.

Development of local terms is still a work-in-progress. We plan to reference the format based on AAT's. See Fig. 5 for an example of a term from AAT with its scope note. A guide that includes the criteria of creating local terms, the use of authorised sources for the writing of scope notes and other rules is being developed. The NHB Controlled Vocabulary will include a scope note which will give the definition of the term and the scope of use. A plan to set up a committee of subject matter experts to review the scope notes is also in discussion. These terms will be created in the Vocabulary Module in

SCMS when the module is ready for use and attributed to the records as well. We also hope to share this thesaurus with other institutions when it is properly established.

Examples of local terms which are needed for our Peranakan items are "*chupu*" and "*kamcheng*", which would otherwise be generally tagged with the term "pots".

Teh (2005) raised a concern: will native descriptors limit the retrieval of the Southeast Asian artefacts if the objects were described using them? This would not happen as native descriptors can be linked to the preferred term, which is the term that will be displayed on the front end, for example – "daggers". Hence, the weapon can still be described as "*keris*" and yet be searchable by non-native users using the term "daggers" because "*keris*" will also be retrieved when "daggers" are being searched. Also, variant spellings of a term can also be linked to the term itself. These linking are done to aid search at the backend and will cast a wider yet accurate net during retrieval. See Fig. 6: An example of object type taxonomy development in MS Excel.

Fig. 5. A term with a scope note from AAT.

Weapons and Accessories (20)			
TOPIC LABEL	**SYNONYM**	**RELATED TERM (RT)**	**RT CATEGORY**
dagger		keris	Weapons and Accessories
handgun	pistol revolver		
keris	kris	dagger	Weapons and Accessories
machete		parang	Weapons and Accessories
parang		machete	Weapons and Accessories

Fig. 6. An example of object type taxonomy development in MS Excel.

"Dagger" and "*keris*" are linked to each other as related terms. "*Kris*", a variant spelling is linked to "*keris*" as a synonym.

In 2017, NHB also started contributing to the creation of names authorities to NLB's KOS. In particular, NHB contributed the names of local and Southeast Asian artists, prominent personalities, and organisations related to objects in the NC. The monthly contribution includes a well-researched summary biodata of the entities. This effort further contributes to building a consistent, controlled names bank for use by both NHB and NLB.

It is undeniable that the processes of developing controlled vocabulary and taxonomy are time consuming but they are a fruitful effort as they increase the search-ability and accessibility of the NC records, as well as raise the precision and accuracy of retrieval. This intellectual process needs human intervention, which presently cannot be replaced by a machine.

Developing an object type taxonomy for the NC

The artefact records in SCMS are categorised according to material type for storage purposes, whereas in heritage cataloguing, artefacts are described purely by the objects' significance. In order to improve user experience during search and enhance accuracy of retrieval though better organisation of NC, the HCC Cataloguers started developing an object type taxonomy for the NC. Besides better organisation, a taxonomy also supports retrieval via the relationship of terms, faceted search, filtering of search results and browsing of a collection using hierarchies (Hedden 2016). As developing the taxonomy is new to the Cataloguers, we acquired the services of a knowledge management consultancy company to conduct a workshop for us on taxonomy development and run a consultancy alongside us for a few sessions periodically when we started developing the NC object type taxonomy hands-on.

A considerable amount of time was spent by the Cataloguing Team going through lists after lists of artefacts generated from the SCMS and grouping the objects before the consultancy. We learnt about and worked on:

1. Hierarchy levels required;
2. Categorising, sorting and grouping the artefacts by open card sorting method;
3. Labelling categories;
4. Testing the suitability of the categories by close and open card sorting;
5. Linking preferred terms with synonyms and related terms;
6. Non-preferred terms; and
7. Creating of scope notes and others.

See Fig. 6 above for an example of our taxonomy creation. We worked with our colleagues from Collections Management, the Conservation department and Curators from the museums to test the suitability of the terms and categories. These categories and labels (terms) created for the taxonomy will also be tagged to the artefact records.

To see the taxonomy in its hierarchical form for browsing a collection or filtering search results online on the new NHB website, the Cataloguers will work with SCD and vendors during the Roots.sg revamp.

Developing a cataloguing module in the SCMS and administrative matters

As there was no cataloguing software at HCC when the work commenced, the Cataloguers depended heavily on MS Excel as the framework template. In 2017, the planning for the development of the Cataloguing Module began. The module was to be built into the SCMS as the cataloguing work draws data from the artefact records in the Objects Module in the SCMS. The SCMS team, Cataloguing Team and the vendor, discussed the fields, the linking of records for grouped and item records, ingestion of AAT and LC thesauri into the system, capturing of administrative data and generating of reports/statistics. The module went live for use in April 2019. See Fig. 7 for image of cataloguing module.

The key performance index (KPI) for the work done was tracked using a pivot table in Excel while waiting for the system to be set up for cataloguing in the SCMS. This KPI tracker tracks the number of items catalogued and catalogue records created in total by Cataloguer and museum.

The Cataloguing Team also conducts cataloguing training for contract staff and vets their work. Due to the constant exchange of metadata lists, naming conventions for the lists are important to avoid mix-ups.

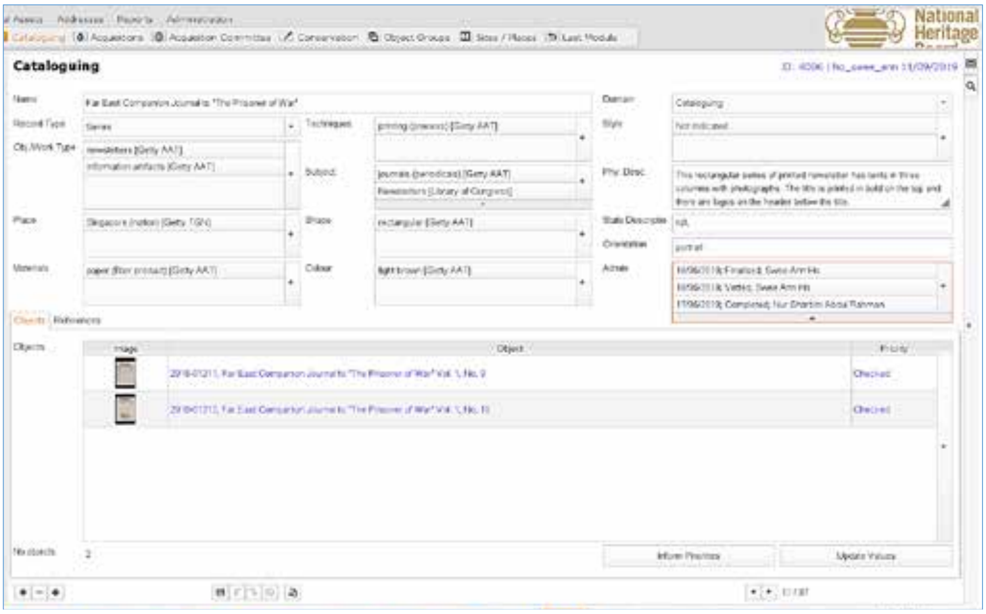


Fig. 7. Print screen of Cataloguing Module in SCMS.

Challenges and recommendations

The learning curve was steep in the initial years, and not being able to visualise how the product would be digitally was a challenge. Nevertheless, each step made it easier, especially when the cataloguing work itself stabilised. Below, we share some of the challenges faced and the recommendations that might help.

Importance of pre-project preparation

Heritage cataloguing is new in Singapore and so too was the initial team. Much of the learning during development of the framework and the system for cataloguing was through research (reading up on) and trial and error. Although the Cataloguing Team did occasionally have the kind input from NLB, the NC consists of heritage objects and artwork; and the framework used is different from that of the libraries. The Cataloguers started on the work quickly due to the SG50 project. Much of 2014 to mid-2017 was spent adjusting and refining the framework and controlled vocabularies to find the best match for the NC.

In March to April 2018, the Knowledge and Information Management (KIM) section at HCC conducted a work trip to the Netherlands and London where they observed cataloguing and controlled vocabulary work carried out by the museums they visited. The presentations of the Netherlands and London teams affirmed that HCC was also applying the same best practices as our foreign counterparts.

It would be recommended that prior to the commencement of a cataloguing project, sufficient time be given to conduct substantial research, study and planning. A study trip would be helpful in the early milestones of the project for better understanding, visualisation, planning and network sharing.

Use of MS Excel for cataloguing work

The Cataloguers depended heavily on MS Excel when the project commenced because the Cataloguing Module was not yet developed. The MS Excel was used for several tasks such as the cataloguing template, the KPI tracker and as database for local terms creation. It was a challenge to sort the records with images in MS Excel as that had to be done individually, which was time consuming.

Tracking of the KPI was a challenge as errors in formulated cells would take place causing discrepancies in the statistics. Nevertheless, the upgraded system (SCMS) which has cataloguing features will be ready for use and metadata for the new records will be keyed into the database in April 2019. Statistics and the generation of reports are also features which are included.

The Cataloguers also uses MS Excel to create and manage local terms and controlled vocabulary. It is not an easy task with the hierarchical structure. Furthermore, as the number of terms grew, it became too cumbersome to manage the many tabs needed on one file. Hence, it will help when the Vocabulary Module in the SCMS is ready.

Evolving standards in information capturing

Due to evolving standards in information capturing since the collection started in the late 19th century, (during the days of the Raffles Library and Museum – presently the National Museum of Singapore (NMS)), there are records which need much research on the artefacts for cataloguing; mainly the older records. Steps were taken to outsource these items for research and also engage contract cataloguing/ research assistants to research on and assist in cataloguing these artefacts while the Cataloguers focused on developing the cataloguing system.

Lack of vocabulary control for information capturing

As mentioned above, controlled vocabulary was not used in the then and present SCMS. Data was entered using free text which resulted in different spellings and terms used. This caused the data to be disorganised, which affected the search-ability of items. For example, "Singapore" could have been input as "SG", S'pore", "Singapore" or "Singpore" (error). When searching "Singapore", the records with "SG", S'pore", "Singpore" would not be retrieved. This challenge took the Team a long time to retrieve objects for the taxonomy development. Finally, the Cataloguers just generated all the categories available in the SCMS and matched the object manually.

Lack of local training opportunities in cataloguing, taxonomy and ontology

Training opportunities for these areas are scarce in Singapore. The Cataloguing Team read up on these, did an online taxonomy course and then learnt on-the-job. We were fortunate to be able to acquire the services of the consultant to guide us early this year. We hope to also be able to send one of our team members for an internship overseas to acquire skills on development and management of controlled vocabulary.

Internet separation

The internet separation for government agencies (due to tightening of IT security) was a challenge faced. The separation affected the use of controlled vocabulary thesauri which are updated automatically on the internet. The thesauri are ingested into the SCMS, which sits on the NHB intranet; and with the internet separation, the thesauri would not be updated automatically. Nevertheless, this challenge is being worked-on and it is suggested that ingested thesauri be updated periodically each year.

Conclusion

The 2014 to 2019 heritage catologuing journey of the HCC Cataloguing Team has been one with a steep learning curve. Not only was it new to us, it also includes a vast variety of artworks and heritage objects, and ever advancing technology. Although HCC is presently able to train external vendors to catalogue the objects in order to grow this ecosystem for the arts and heritage industry, there is still much to learn in developing the cataloguing capability for online output purposes, due to the fast advancing and ever changing technology. Nevertheless, it has been a fruitful journey witnessing metadata created and used in the NHB Cultural Ontology Project and to observe object type taxonomy developed and controlled vocabulary in progress. It is an exciting time as we await to see the efforts for information retrieval online materialise in the very near future.

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Author's biography

Ho Swee Ann is a Senior Manager in the Cataloguing section at HCC. She has been on the team from the onset in 2014 and presently leads the team. She has a BA (Hons) in Malay Letters from Universiti Kebangsaan Malaysia, LLB from University of London and MSc. Information Studies from National Technological University (NTU), Singapore.

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The National Museum Storage of Thailand: The Change of Past to Present and the Future

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ABSTRACT

Originally, the museum storage was located within the Bangkok National Museum area where the Front Palace was. At that time, the artifacts were kept in various buildings such as the attic of the exhibition buildings and so on. Later, the antiques increased in inordinate numbers every year; however, there is limited space. Furthermore, there is also no environmental control, for example, humidity monitoring and temperature calculating. As a result, the museum storage was crowded, disorderly, and difficult to secure as well as check or search for objects.

Then, the Fine Arts Department has adopted the two buildings of the Kanchanaphisek National Museum, which is planned to be an ethnological museum in Khlong Ha sub-district, Khlong Luang district, Pathum Thani province. In 1995 and 1998, both buildings were completed, respectively, to be used as the Central Museum Storage. At this point, more than 30,000 artifacts were relocated from the Bangkok National Museum's storage, the Chandrakasem National Museum's storage, as well as artifacts obtained from archaeological excavations, acquired from government agencies inside and outside the country, as well as presented by the people. Regarding the environmental control, the objects were classified in two main materials; firstly is the objects made of organic material and secondly is objects made from inorganic material.

For the past 20 years, the two former buildings have been unable to accommodate the increasing number of objects every year, which currently has 80,000 items of antiques, art objects and imitation art objects. In addition, the limitations in the form of buildings are not appropriate for the actual utility of storing stone artifacts that have a large amount of weight. Therefore, the Fine Arts Department has a plan to build new national museum storage that has been designed to meet the standards of conservation with modern technology to secure antiques, which will be a prototype and first international standard national museum storage of the Fine Arts Department.

Preparing to move antiques, nearly a hundred thousand pieces, needed cleaning and pest control. This consists of removing the fungus that may lie in the objects such as cloth, wood, paper and terracotta, before relocating to new storage. The Fine Arts Department made a cooperation agreement with the National Institute of Nuclear Technology (a public organization) to create innovative projects to conserve Thai cultural heritage with radiation technology. The goal of using nuclear energy is to exterminate fungus and insect removal in place of the previous method of freezing to stop the insect life cycle for strengthening collections care.

Background

The museum storage is a collection site for maintaining antiques and artifacts which are cultural heritage and national wisdom, which cannot be taken out to exhibit at all permanent exhibitions, and the newly added antiquities for the benefit of studying, researching and rotating the exhibition both permanently and temporarily. The museum storage is important and necessary, especially for the museum affairs. The museum store has to have a way to manage the systemic regulation and classifications of objects clearly to easily search for antiques, easily maintain security and control the suitable environment well.

Originally, the museum storage is located within the Bangkok National Museum area where the Front Palace was. At that time, the artifacts were kept in various buildings such as the attic of the exhibition buildings and so on. Later, the antiques increased in inordinate numbers every year; however, there is limited space. Furthermore, there is also no environmental control, for example, humidity monitoring and temperature calculating. As a result, the museum storage was crowded, disorderly, and difficult to secure as well as check or search for objects.

The condition of museum storage in the 1980s that was crowded and difficult to find objects.

Her Royal Highness Princess Maha Chakri Sirindhorn was highly interested in the storage of national museums. When the princess was a student at Chulalongkorn University, she went to the museum storage to study Prasat Phanom Rung Inscriptions that the Fine Arts Department unearthed during the building restoration. Later on, she gave numerous advices according to museum storage improvement in many occasions, for example;

“We should improve the development of warehouses to have a more useful regulatory system.” (1989)

"The Fine Arts Department does not have enough places to store artifacts and National museums have crowded and disordered storage. Some artifacts have never been put on display. Then, collecting the objects could be a choice of preservation. The Fine Arts Department should construct a large museum storage for systematic organization and studying of artifacts." (1991)

Her Royal Highness Princess Maha Chakri Sirindhorn studied Prasat Phanom Rung Inscriptions in the museum storage.

From the initiation of Her Royal Highness Princess Maha Chakri Sirindhorn, the Fine Arts Department adapted two buildings at Pathum Thani province that are prepared for the ethnic museum as the National Museum Storage which was completed in 1995 and 1998 by relocating artifacts from the Bangkok National Museum, the Chantharakasem National Museum, Phra Nakhon Si Ayutthaya province. Including the collection of stolen or illegally exported artifacts, and donation objects from various domestic and international organizations. More than 30,000 artifacts were collected and classified by materials, for example, organic and inorganic, for easily environment control.

The National Museum Storage of the National Museum now consists of two buildings, divided by the collection of artifacts.

The Museum Storage No. 1

This is the building of museum storage No. 1 .

Stone storage room, collecting antique type prehistoric stone tools, religious sculptures, parts of archaeology site or inscriptions.

Stucco storage room, collecting antiques, sculptures, idols in religion, and architectural decorative pieces.

Bronze room, storing tools, weapons, and jewels, from the prehistoric era onwards and religious sculptures.

Shadow puppet storage room, storing puppets of over 1,100 characters, especially puppets in the reign of King Rama II at the beginning of 18th century, which have been dubbed "the earthquake". Moreover, there are more than 400 characters of the shadow play craftsmanship.

Education center, the artifacts for the benefit of comparative study between the genuine and the reproduction according to production techniques, art forms, etc.

Central storage for case exhibits, storing antique and art objects that were confiscated from illegal trade and which are under legal proceedings.

The Museum Storage No. 2

This is the building of museum storage No.2.

Pottery store room, storing antique type tools, and prehistoric pottery found in Thailand. Includes containers from the source of the ship sinking in the Gulf of Thailand, and sculptures of idols in religion, decorative jewels, and ancient sites.

Fabric warehouse and paper storage, like costume type items used in religions as an embroidery fabric, talipot fans, bags including homespun woven, sewing machines, and paper storage, such as the Thai text book showing auspicious animals, and ancient Thai herbs including the ancient palm leaf manuscripts carrying Buddhist scriptures.

Musical instrument room, storing antique type string instruments, woodwind instruments, and percussion instruments both in Thailand and abroad.

Metal warehouses and technology rooms, collecting objects of folk tools used in agriculture and daily use, such as yokes, ploughs, chisels, coconut graters as well as tools and equipment in industrial technology such as drug grinders, telephone exchanges, typewriters, cameras and so on.

Armoury room, mainly collecting artifacts of traditional Thai weapons.

Room for religious object, store antiques like wood carvings, primarily in religions such as Buddha images and scripture cabinets.

Exquisite art gallery, storing art objects made of carved wood types of architectural decoration for temples and palaces, such as windows, doors, air ventilation wood carving, and ancient furniture like howdahs, beds, and palanquins.

Wickerwork room, mainly storing objects made of bamboo and rattan types of household appliances used in daily life and occupations such as land and aquatic animal capture tools.

Current collection of antiquities

The Central Storage of the National Museum is classified by type of material, except the musical instrument group. Fabrics and weapons are stored as related categories, which have material others mixed in the storehouse. In the musical instrument room, there are materials made of wood, leather, metal. In the fabric store room, there are both fabric and metal together because they are arranged in the same category. The number of objects stored in the storage are mostly bronze and metal (more than 34,000 items), followed by clay, that amounts to more than 15,000 items. The next is stone, which amounts to almost 4,000 items. The leather group has about 1,600 items.

Current security system

1. The opening and closing of the storage room still uses the old system, namely the key, with the seal on the clay cube. Each entry and exit is recorded in the daily event log which has many limitations or deficiencies in the matter of security, such as the key cabinet being not secure enough, as it was just a little cabinet that was easy to break.

Here is the old system to lock the storage doors, use the keys and stamp the seal on clay cube. There are three stamp seals which are different patterns like lotus, Ganesha, and flower.

2. CCTVs both inside and outside the buildings total 70, but do not cover all areas within the warehouse. So there are many rooms and many angles without cameras to record images and which are counted as one blind spot. The CCTVs must work 24 hours a day, so the life of the device and uninterruptible power supplies quickly deteriorate, which involves limited maintenance costs in each fiscal year.
3. Fire extinguishing systems with carbon dioxide, with a total of 30 tanks, a kind of volatile liquid with 15 pounds of 15 tanks, and dry chemical powder with 15 pounds of 15 tanks are organized in the areas at risk. It is close enough to be easily accessible if there is a fire, but there is no installation of fire extinguishing systems with water in the stone storage room or even the office.
4. Security officers guard the buildings 24 hours a day.
5. The exterminator for termites and insects uses chemical sprays to get rid of termites by spraying on the ground and on the floor. But this cannot 100 percent prevent termites, because under the building there is high humidity and the paths of termites are not easily visible. In addition, the termite injection in this way causes stains on the floor, and also a bad smell that is harmful to the staff.

The current system records database registration antiquities and art objects

1. The temporary register papers are the first record of an antique register with a pencil. They can be deleted, modified, and changed details before actually recording the data, and is considered the original registration of artifacts, therefore must be collected for checking of information later.
2. The register of antiquities books are detailed records of each artifact written in elaborate handwriting, is easy to read, and had no unnecessary scratchings, deletions or modifications.
3. The index card is an account of each piece of antiquity that contains both information and photographs for use in the search of antiquities. It can be made into an annual index card or a specific category.
4. Database management by Microsoft Access is the database system that has been used for 10 years – easy to use but has limitations on database updates. The database cannot connect to online data if there are multiple backups on multiple computers or officers take turns updating information, causing confusion as it is not known which data set was the last to be updated. Moreover, saving photos to the database in the application process can be cut down to just one; when there is a lot of information to make the machine work harder, data loads so slowly.
5. The antique and artifacts online database of the Fine Arts Department is the creation of the Information Technology Center of Cultural Heritage so that all national museums use the same standard. They can update information at any time or work from any area with internet access, can save unlimited data, can add multiple photos, and moreover, can immediately know the amount of artifacts recorded in the online database and also find information about the antiques of other national museums throughout the country. However, there are currently limitations on centralized servers that may make the hunting slower than usual. Staff are continuing to solve these problems to increase efficiency and make convenient work faster.

Future plans and arrangements for the National Museum Storage

For the past 20 years, the two former buildings have been unable to accommodate the increasing number of objects every year, which currently totals 80,000 items consisting of antiques, art objects and imitation art objects. In addition, the limitations of the buildings are not appropriate for the actual utility of storing stone artifacts that have a large amount of weight. Therefore, the Fine Arts Department has a plan to build a new national museum storage facility that has been designed to meet the standards of conservation with modern technology to secure antiques, which will be a prototype and first international standard national museum storage of the Fine Arts Department.

The budget committee had approved the amount of 462.5 million baht to finance the construction of a new museum storage facility designed to suit the operations of a storage building with an additional living space of 7,000 to 25,000 square meters, capable of storing up to 200,000 items or antiques. The stone and stucco rooms can accommodate up to 3 tons per square meter and have security systems. It is the first central museum storage of Thailand with museum standard. The goal is to act as a storehouse for antiques research, which will be a model for the construction of a central warehouse for regional projects, namely the National Museum Storage building, which took three years to build. At present, the building has been completed and installed with a security system. Currently, the second phase is ongoing in the installation of the base system and fire protection system. More additions to the whole archive room including educational services for visitors, as well as packing and moving more than 80,000 artifacts from old warehouses to install and store in the new warehouse for a period of three years during the years 2019–2021, will be done with a budget of 310 million baht.

Here is the first National Museum Storage in Thailand that is located in Pathum Thani province, 80km away from Bangkok.

The concept of designing a new central museum storage building

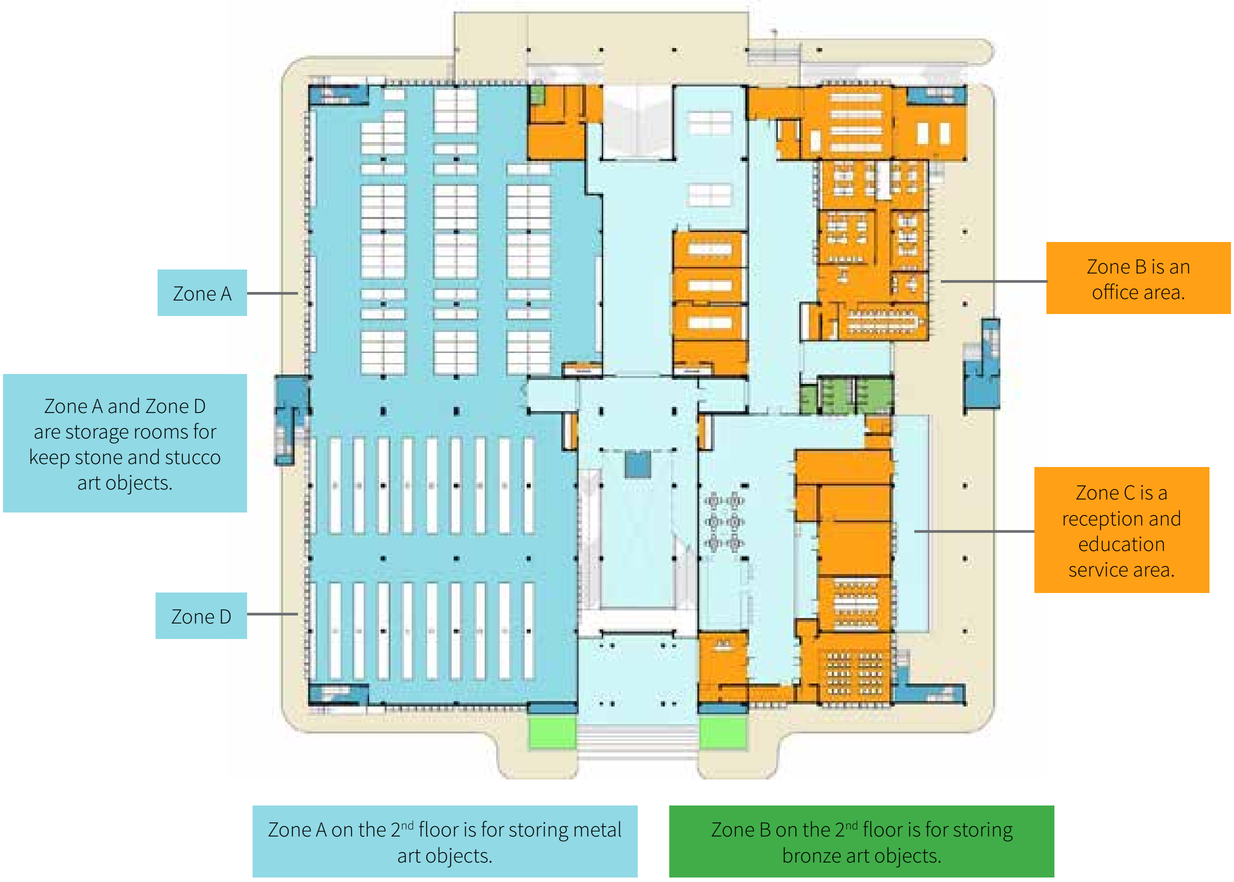
The Fine Arts Department assigned the Office of Architecture to design the building. The National Museum Storage located in Pathum Thani province about 60 km far away from Bangkok. In order to prevent floor settlement problems, the National Museum Storage is a reinforced concrete building with extra-large steel. The building has a pillar and beam structure system combined with a four-layer compressive floor system. A roof covering the shape of the building using lotus patterns in Thai architecture as a frame decorated exterior building walls. To create Thai identity with modern construction materials, the building wall is designed in two layers to prevent heat from outside. The real wall, an inner layer made of lightweight brick, has fire-resistant properties, keeping heat less. The outer wall is an aluminum wall with holes to filter direct sunlight from the wall and ventilate the heat or humidity from the building, which will reduce the electricity cost from air conditioning system.

Interior materials like steel, aluminum and concrete were used as the primary materials to prevent insects from destroying objects stored inside the building.

Determining the usable area of the National Museum Storage building

The interior area is approximately 25,000 sqm, divided into four zones, namely, A B C D. The division of the storeroom space due to size and weight of each category of artifact. Therefore, Zone A's 1st floor, is the office area and the registration office. Zone B's 1st floor, provides a space for educational services to those who come to visit, and includes libraries, search database rooms, a briefing room and a reception hall. Zone C's and D's 1st floor has a space of up to 3,500 sqm, and are a collection of antique stone and stucco with the heaviest weight among the artifacts. These areas have load capacity up to 3 tons per sqm. On the 2nd floor, Zone A and Zone D are storage for metal, bronze, brass, iron, gold, silver, tin and lead. Zones B and C are storehouses for pottery. Section 3 in Zones A and D are antique cabinets, wood carvings and basketry. Zone B is a storehouse for leather, bone, horn, ivory. Zone C is a storehouse for fabrics, palm leaf and paper.

Plan 1st floor



Plan 2nd floor

Future security system

The National Museum Storage building is designed to have two separate entrances between the staff and the outsiders. The entrance to the storage room is clearly proportional, in order to achieve maximum security for artifacts. The museum storage uses technology to monitor security systems in real time, uses software to analyze event images from various situations, and then automatically log into digital system that can be traced immediately.

1. The Door Monitoring System. All doors connected to different sections within a storage will be installed to show the status of the door, and can be checked all the time to see if any door was opened or closed, with a warning signal given to the 24-hour security center. When any door is opened, the system will record the information into the digital system, which will work alongside the CCTV systems.

The CCTV monitoring room.

2. The Access Control System is a monitoring system about through in – out of the staff by limiting certain rights, such as identification, officials confirming their identity for entry and exit areas in the office, and educational services. The identity verification system with individual characteristics uses fingerprint scanning for entry/exit areas within the antique archives room, which will only reserve access to the space in the warehouse to certain personnel. The system will automatically record digital data stored in the database and can be checked back at any time.
3. A fire extinguishing system with a clean substance will be installed in the chamber of the leather, ivory, paper, palm leaf, and fabric warehouse, which is located on the third floor, because these types of antiques are most susceptible to damage. The Animal Archive Room and the fabric store room are designed to have a full building management system, which cannot be installed in every room, since it requires a high budget.

This storage room uses a fire extinguishing system with a clean substance for protecting the paper and leather antiques.

The NOVEC 1230 Cleaning System used in the building is considered to be the most environmentally friendly substance compared to other clean substances used worldwide. It has the ability to put out fire 100% in 10 seconds without using a lot of space to set up the tank, and is safe because the pressure in the tank is low compared to other clean substances. In addition, firefighters can enter the room immediately because the substance does not affect breathing. It has the least impact on the human body and can degrade in the atmosphere of the earth in less than 24 hours.

The carbon dioxide fire extinguishing system (CO_2) installed in the area of the remaining seven warehouse rooms are manual fire extinguishing systems. Although CO_2 is not a good extinguishing gas, it is effective enough for use, and cheaper than other gases.

Temperature and humidity monitoring system in the warehouse

A sensor system of temperature and humidity in every room will be displayed real-time to the Office of the National Museum Storage without opening the room. It will also connect to the software to operate air conditioning and humidity control systems if the temperature or humidity exceeds the values set for each type of artifact to maintain the most suitable humidity and temperature conditions.

Air conditioning and humidity control systems

There is an air conditioning and humidity control system installed for every storeroom except the stone room (which is stored in natural temperature and humidity conditions), using software that works with various monitor systems to quickly operate and in time. The various control systems can be adjusted to the flexibility of the building management. Security systems have a control center in the area of the building where security officers are present 24 hours a day, while the internal environment monitoring system will be centered in the office building with a retrospective system in the event of any occurrence, all of which are integrated with backup power systems to supply power for various control systems in the case of the Provincial Electricity Authority stopping electricity service as well.

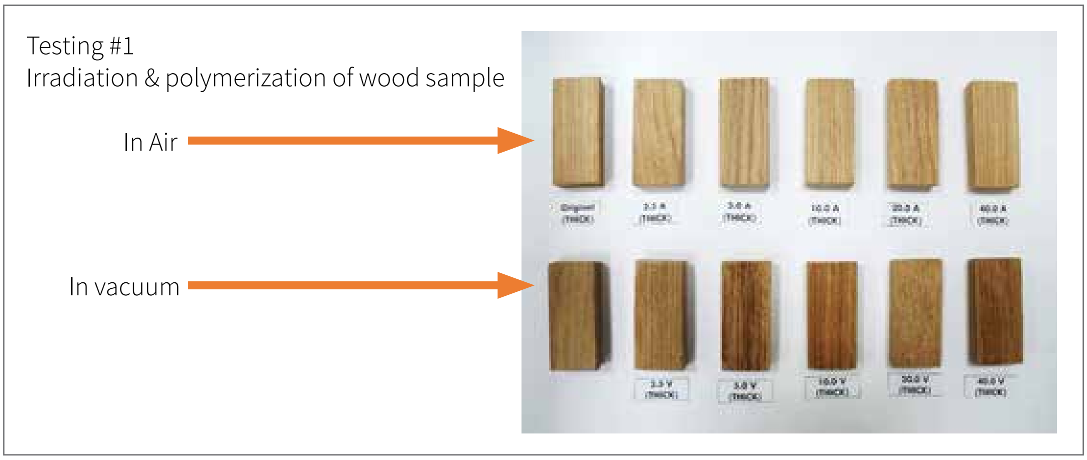
Old Storage Buildings	**New Storage Building**
1. Total usable area of 7,000 sqm.	1. Usable area of 25,000 sqm.
2. Only collect of 50,000 artifacts.	2. Support for up to 200,000 items.
3. The structure can load 500 kg per sqm.	3. The structure can support 3,000 kg per sqm.
4. There is no space for registration, packaging, lifting and moving large artifacts.	4. There is an area for registration, packaging, lifting, and moving all sizes of antiques easily.
5. There are not enough CCTVs for the entire storage area. There are many blind spots that CCTVs cannot record.	5. Installed CCTV in all areas, both inside and outside the warehouse building. There are no blind spots.
6. Has 30 tanks of fire extinguisher with carbon dioxide (CO_2).	6. Has a fire extinguishing system using clean, environmentally friendly substances. Has a Fire Alarm System, a fire extinguishing system with water, and fire extinguishers with carbon dioxide.
7. Close and open doors using keys.	7. Close and open doors using a pass for the office area, and using the fingerprint scanning system for only the relevant personnel at the storage area.

Preparing to move antiques, nearly a hundred thousand pieces, needed cleaning and pest control. This consists of removing the fungus that may lie in the objects such as cloth, wood, paper and terracotta, before relocating to new storage. The Fine Arts Department made a cooperation agreement with the National Institute of Nuclear Technology (a public organization) to create innovative projects to conserve Thai cultural heritage with radiation technology.

The conservation basketry art works by freezing under -20 degrees Celsius.

Freezing was used to control growth of fungi and exterminate insects in wooden art objects under -20 degrees Celsius, but could only stop the growth of fungus, not kill it. After research and testing, nuclear technology will be implemented for permanent extermination of fungi, and this method will be used in the conservation of antiquities for strengthening collections care.

In the context of the peaceful use of nuclear and radiation technologies, nuclear techniques, with special emphasis on gamma radiation treatment, are suggested for the characterization and preservation of cultural heritage artifacts including eradication of insects, disinfection of microorganisms, and consolidation of degraded materials with radiation-curing resins. In the last few decades, it was demonstrated that nuclear techniques are exceptionally suitable not only for non-destructive characterization of cultural heritage artifacts, but also in support of their conservation and restoration.



The insects that live in wood will die after Gamma irradiation of only 5 kGy, but the wood will change a little in condition.

The example test before and after Gamma irradiation 5 kGy, where the pathogen has decreased clearly.

The National Institute of Nuclear Technology and the Registrar of the Museum Storage and Information Division initiated a research project for preservation of cultural heritage artifacts using gamma irradiation and radiation processing technologies for the first time in Thailand in 2018. The project includes the determination of dose rate optimization, eradication of molds and insects, polymerization of coating agents, and physical property evaluation for long lasting conservation. As Thai cultural heritage is unique, the method of conservation using radiation and nuclear technologies should be developed to meet standard practices for the sustainability of Thai cultural heritage.

By means of the goal of using nuclear energy to exterminate fungus and insect removal from the original method of freezing to stop the insect life cycle to the first time that will start using nuclear technology in the conservation of antiquities for strengthening collections care.

Conclusion

The five-year (2015-2020) Strategy Plan of the Fine Arts Department aims to develop conservation and strengthen exhibition standards for 40 national museums so as to preserve cultural heritage in their current state and pass it down to future generations. This improves museum experience and the image of the national museums. The construction of this National Museum Storage building will be the starting point for the renovation and development of these museums in times to come. There will be a project to construct storage for three regional national museums, namely the northern regional Sawankhalok National Museum Storage at Sukhothai province; the northeastern regional Khon Kaen National Museum Storage at Khon Kaen province; and the southern regional Songkhla National Museum Storage at Songkhla province, to accommodate the number of antiques and art objects that is increasing every year. They aim to be storage centers and preserve artifacts to better serve the public as the country's lifelong learning places.

Author’s biography

Kannasamon Kamuta is a curator under the Office of National Museums, Fine Arts Department. She works in education, analyzing and detecting art objects to consider allowing import or export for the Kingdom of Thailand, and inspecting antique shops to stop if there are objects that have been illegally obtained for sale. She works in the management of the largest museum storage in Thailand, therefore is responsible for the selection of antiques to be kept in the central collection of the National Museum for educational benefits research for the public.

An Evaluation of Hanging Storage for Garments in Heritage Conservation Centre

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KEYWORDS
garment storage, hanging storage, space optimisation, collections management, preventive conservation

ABSTRACT
Storage space optimisation is an ever-present concern for institutions managing collections of cultural heritage and art. Faced with finite space for storage and an increasing number of new artefacts and artworks, these institutions have to consistently review options to maximise storage space. This paper will highlight one example of storage space optimisation, the hanging storage of garments in the Heritage Conservation Centre (HCC), that had taken place in three phases:

- 2003: Introduction and feasibility study
- 2010: Development and implementation
- 2018: Evaluation and future planning

This paper will introduce the hanging storage system undertaken by HCC, detail the decision-making processes behind the undertaking, and evaluate the methods and materials used during the implementation of hanging storage almost a decade ago. Based on the findings, recommendations on whether to continue the use of hanging storage system were made. This project illustrates how HCC experiments with solutions to storage space challenges, and stays relevant and practical while meeting the changing needs of the Singapore National Collection (NC).

[1] In the Indonesian and Malaysian region: a member of a people locally born but of Chinese or mixed Chinese and Malay descent; especially in Java, a member of a Chinese family long settled and acculturised in the area (Oxford Dictionaries)

[2] A garment consisting of a single length of fabric draped around the body worn by women in South Asia (Singapore Infopedia)

An introduction to garment storage at HCC

HCC is an institution of the National Heritage Board (NHB), and a repository and conservation facility for the management and preservation of the NC. It houses conservation laboratories and climate-controlled storage spaces, and is home to more than 200,000 artefacts and artworks. Being the first of its kind in the region, HCC aims to play a leading role in collections care and conservation through managing, caring for and providing access to the NC.

One of the main categories of objects in the NC is the garment collection, which consists of approximately 9,000 garments. This mainly heritage-based collection spans ethnic costumes like Peranakan[1] wedding robes and prized artefacts such as an imperial dragon robe dating to the 17th Century Qing Dynasty in China. The growing contemporary collection includes the works of Singaporean and overseas fashion designers such as Benny Ong and Alexander McQueen, and artists like Jompet Kuswidananto and Eng Tow.

Initially, HCC only had one collections store outfitted specifically for garments, and the storage systems were designed and built with two storage methods in mind – flat storage and rolled storage. For flat storage (Fig. 1), the garment is laid out horizontally and may be buffered with acid-free tissue to better support the garment's construction. According to the Canadian Conservation Institute (CCI), flat storage is considered the ideal storage method for garments as the garments experience the least amount of stress in this state (Canadian Conservation Institute, 2008).

Rolled storage is used for storage of two-dimensional garments, like shoulder cloths and saris[2], on rollers (Fig. 2). Though rolled storage is considered a space-saving method, there are limitations. As rolling places physical stress on garments, garments in poor condition or with certain surface decorations, like paint, sequins and beadwork, cannot be rolled.

Fig. 1. Flat storage.

Introduction of hanging storage to HCC (2003)

The idea of hanging garments as an alternative storage method was first mooted in 2003 when 111 Chinese opera costumes were acquired by the National Museum of Singapore and brought to HCC. Chinese opera costumes are very large, with long sleeves (called "water sleeves") and heavy embellishments that would have taken up a lot of storage space if stored flat. This collection prompted a team of collections managers and textile conservators to conduct a study on the feasibility of hanging storage on selected costumes.

The study concluded that hanging storage was indeed a viable option for future garment storage, although then-textile conservator Loh Boon Nee also highlighted that this method is dependent on meeting "stringent selection criteria" and used alongside "a regular, thorough maintenance and checking programme" for collections care (Loh et al., 2003). However, a hanging storage system was not undertaken in 2003 due to space, manpower, budget and time constraints.

Fig. 2. Rolled storage in the HCC garment store.

Development and implementation of hanging storage (2010)

The opportunity to implement hanging storage across a wider variety of garments arose in 2010, with HCC's expansion during a period of additions and alterations. This saw the addition of two garment stores, increasing the storage capacity for garments by more than three times, from 565m^2 to 1,791m^2. Following the expansion, a team of collections managers and textile conservators revisited the possibility of implementing a hanging storage system in an effort to optimise storage space.

Criteria for hanging storage

Conservators began by determining which pieces in the collection would be suitable for permanent hanging storage. 1,088 garments awaiting permanent storage were surveyed. Of these, 134 pieces were chosen for hanging storage based on the following criteria set out in the 2003 feasibility study by Loh Boon Nee (Loh et al., 2003):

- Strength: Fibre strength and weave strength had to be substantial. The shoulder area must be able to support its own weight. Garments with narrow shoulder straps or containing flimsy fabric or lace at the shoulder area would not be hung.
- Weight: The garment must be lightweight, without heavy embroidery and embellishments. Bottom-heavy garments would not be hung.
- Structural stability: Garments where the fabric has extensive areas of weakness or widespread damage, or are coming apart at the seams, would not be hung.
- Construction: Knitted or bias-cut garments would not be hung as gravity would cause distortion.

Designing the hanging storage system

Having identified the garments for hanging storage, the team then looked into the design of the hanging storage system. This included determining store infrastructure and procuring furniture, hangers, and hanger add-ons.

Store infrastructure and furniture

Mobile storage systems were procured and installed in two of the new garment stores (Fig. 3). An important criterion for selecting suitable storage cabinets was their adaptability; for example, whether the space could be converted to flat storage should the need for hanging storage in the future change.

Fig. 3. Some sections of the mobile storage system with drawers at the bottom.

Hangers

The team had a choice between procuring ready-made standard-sized padded hangers for the tops and dresses from overseas conservation materials suppliers, and making customised ones in-house. As the cost of purchasing, shipping and customising ready-made hangers was considerably higher, the team opted to make customised padded hangers in-house. This afforded the team some flexibility regarding hanger design, whilst ensuring that materials used met conservation requirements for structural and chemical stability (Loh, personal communications, 2019).

Tracings of the shoulder seam shape were taken. This shape extends slightly beyond the seam line as it was felt that this extension would provide better support to the shoulder seams, which is a potential area of weakness (Fig. 4). Each padded hanger was made according to their individual tracings, ensuring a high level of customisation and support (Fig. 5). However, hangers for skirts, shorts and pants did not have to be customised as these were uniform in shape at the waistband i.e. straight across. As such, only minor modifications were made to standard clamp hangers (Fig. 6).

Fig. 4. Illustration outlining where tracing would be taken for a dress. (2007-53386). Image courtesy of the National Museum of Singapore, National Heritage Board.

Figure 5. Diagram of a padded hanger for tops and dresses, made by a trained seamstress (Zhuo Shiya, 2019).

- Aluminum hanger
- Ethafoam™
- Adhesive
- Polyester wadding
- Cotton fabric cover
- Outer cotton fabric cover

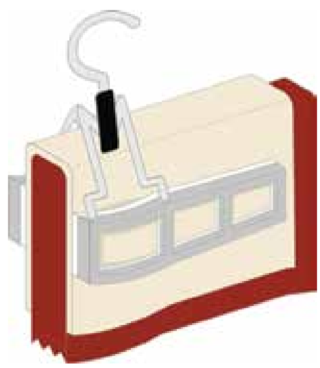

Figure 6. Diagram of a clamp hanger for skirts, shorts and pants, made by art handlers (Zhuo Shiya, 2019).

- Aluminum hanger
- Plastic portion of hanger
- Polyethylene foam
- Cotton fabric
- Garment

[3] A straight, close-fitting silk dress with a high neck and slit skirt, worn by Chinese and Indonesian women (Oxford Dictionaries)

[4] Tyvek® is a non-woven, spun bond olefin fibre. It was discovered in 1955 by DuPont.

Hanger add-ons

Two modifications to the design of the hangers were undertaken for specific types of garments. Long sleeves on garments were secured to limit their movement in storage, particularly when the compactor was being moved. A length of cotton twill tape was stitched onto each end of the padded hanger, which ran through the sleeves of the garment, allowing the sleeves to be secured (Fig. 7).

Garments with high collars, like cheongsams[3], needed support to prevent sagging or distortion. Polyethylene foam (Fig. 8) was hence used because of its ability to bend into the collars' shapes, and its material strength, which provided support.

To reduce the amount of dust accumulating on the garments, dust covers were constructed from Tvyek®[4] (Fig. 9 and Fig. 10). This material was chosen due to its high breathability, which would reduce the risk of mould growth, and its resistance to liquids, which provided further protection from water damage.

With these preparations in place, the 134 garments chosen for hanging were then moved into hanging storage.

Fig. 7. Padded hanger with additional cotton tape to support long sleeves.

Fig. 8. Collar support made for a shirt (2004-00649) using polyethylene foam. Image courtesy of the National Museum of Singapore, National Heritage Board.

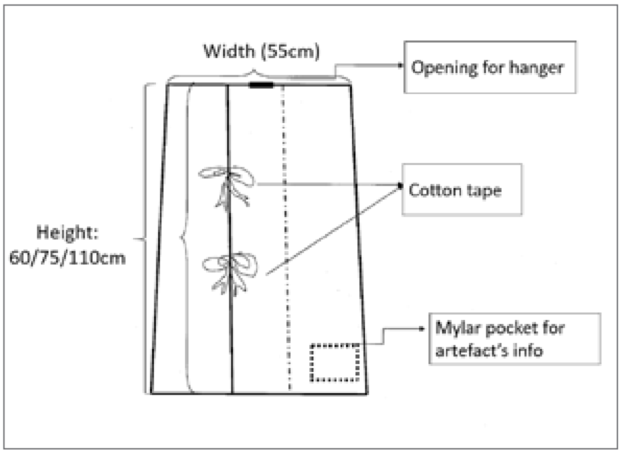

Fig. 9. Design of the dust cover for garments in hanging storage (Cheng Tan, drawing, 2012).

Fig. 10. The dust cover when opened. Artefact pictured is a shirt (2004-00649). Image courtesy of the National Museum of Singapore, National Heritage Board.

Evaluation of hanging storage in HCC (2018)

With a hanging storage system in place, the next stage was to improve it. Noting that there were aspects of the hanging system to streamline, an evaluation of the effectiveness of hanging storage since 2011 was first conducted.

In 2018, a new team of collections managers and textile conservators came together to evaluate the system's effectiveness. The aim of this evaluation was to determine the effectiveness of hanging storage, and if it could and should be more widely used. The results of this evaluation would also benefit collections managers in planning the allocation of space within the garment store; for example, in determining how much space should be dedicated for hanging garment storage.

Five factors important to storage of the NC were identified, and used as parameters for evaluation:

- Storage space optimisation
- Cost effectiveness
- Amount of time required to prepare garments for storage
- Accessibility of artefacts
- Impact of storage method on condition of garments

Hanging storage was compared to flat storage against each evaluation parameter, as they are the two main options for storage of garments. Rolled storage was not part of the comparison as only flat items could be rolled, which excluded majority of the garment collections.

Storage space optimisation

Based on garment size and how they were arranged in storage, the maximum quantity of garments which could fit in a drawer for flat storage was estimated and compared against the estimated maximum quantity of garments which could fit in a cabinet for hanging storage. The results were as follows.

Table 1. Storage capacity of short garments and long garments.

Type of garment	Storage description	Flat storage	Hanging storage
Short garments (shirts, blouses and short bottoms)	Number of drawers or sections in a full cupboard	16 drawers	2 sections
	Storage capacity within each drawer or section	2 to 4 pieces	23 pieces
	Capacity range	32 to 64 pieces	46 pieces
Long garments (full-length items – dresses, pants, long skirts)	Number of drawers or sections in a full cupboard	16 drawers	1 section
	Storage capacity within each drawer or section	1 piece	23 pieces
	Capacity range	16 pieces	23 pieces
Total Capacity Range		**16 to 64 pieces**	**23 to 46 pieces**

The team concluded that more short garments could potentially be stored flat in a drawer than in hanging storage (up to 64 pieces compared to 46 pieces). However, more long garments could be hung compared to being stored flat (23 pieces compared to 16 pieces). It is difficult to conclude which storage method would optimise storage space as it is dependent on the type of garments acquired and their condition. In general, most garments can be stored flat, but there are stricter selection criteria for selecting garments to be hung, thus making flat storage the better space-optimising choice for the institution.

Cost effectiveness

In order to determine the cost effectiveness of both hanging and flat storage options, the team looked at the unit cost of each method of storage. This includes the cost of:

- Storage infrastructure
- Labour required to store garments
- Materials

As one flat storage cabinet can store 16 to 64 pieces, and one hanging storage cabinet can store 23 to 46 pieces, the cost of storage for one piece of garment for a particular storage type was derived by taking the total cost of building the storage system, including materials and manpower, and dividing it by the number of garments it can store.

$$\textbf{\textit{Cost of storage for one garment}} = \frac{\textbf{\textit{Infrastructure cost + Labour cost + Material cost}}}{\textbf{\textit{Number of garments stored}}}$$

The unit cost of storage for long garments is consistently lower for hanging storage, as compared to flat storage (Fig. 11). This is mainly attributed to differences in the infrastructure cost; a cabinet for flat storage can be up to three times bigger than the cabinet for hanging storage because the latter only has two metal bars, whereas the former required up to 16 drawers.

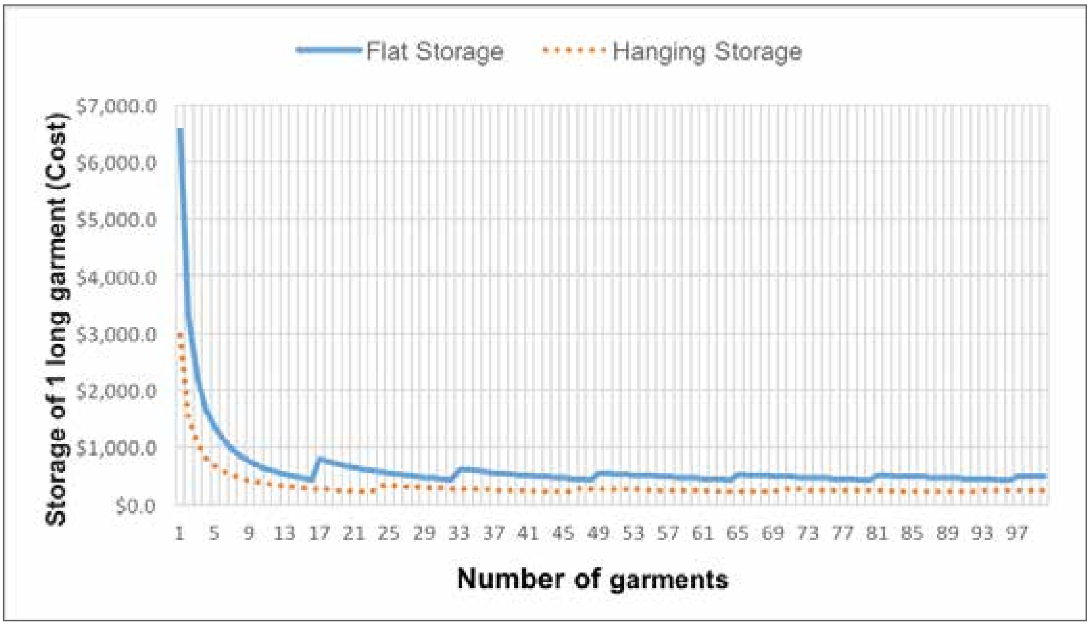

Fig. 11. Unit cost of storage for long garments (1 to 100 pieces).

The trend holds true for storage of short garments too, but only when it involves storage of up to 13 pieces of garments (Fig. 12). However, as the number of pieces stored increases, there is a variation in cost effectiveness between the two storage methods (Fig. 13). Even though the unit storage cost would typically decrease as more garments are stored, due to economies of scale, the number of variables involved in the costings resulted in small spikes across the graph, affecting the unit cost of each storage method. As such, there is difficulty in determining which storage method is more cost effective.

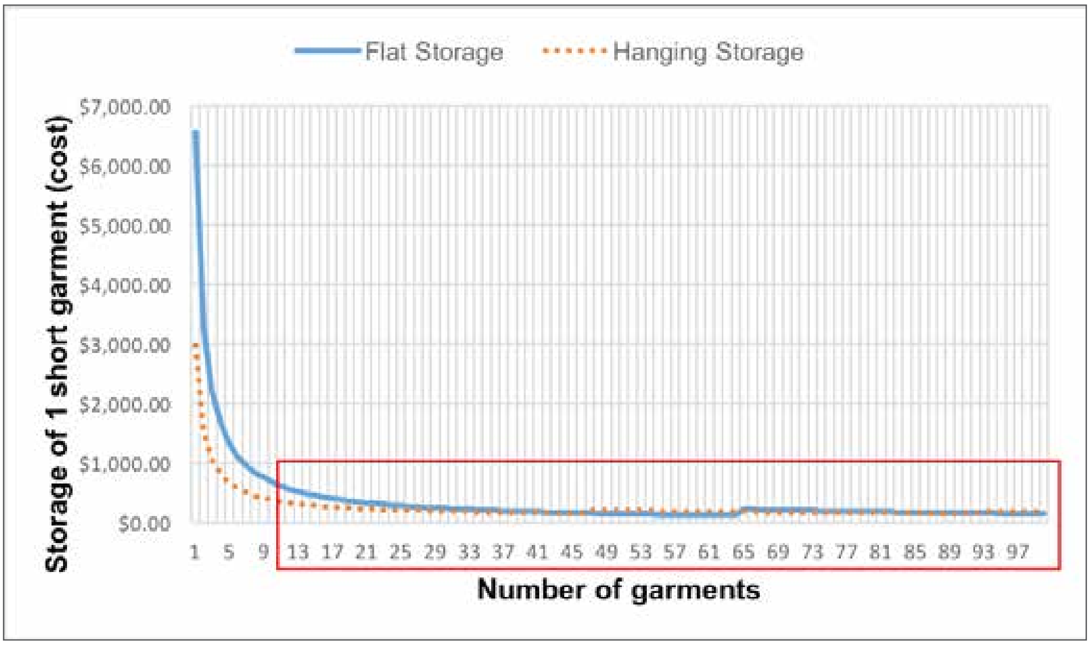

Fig. 12. Unit cost of storage for short garments (1 to 100 pieces).

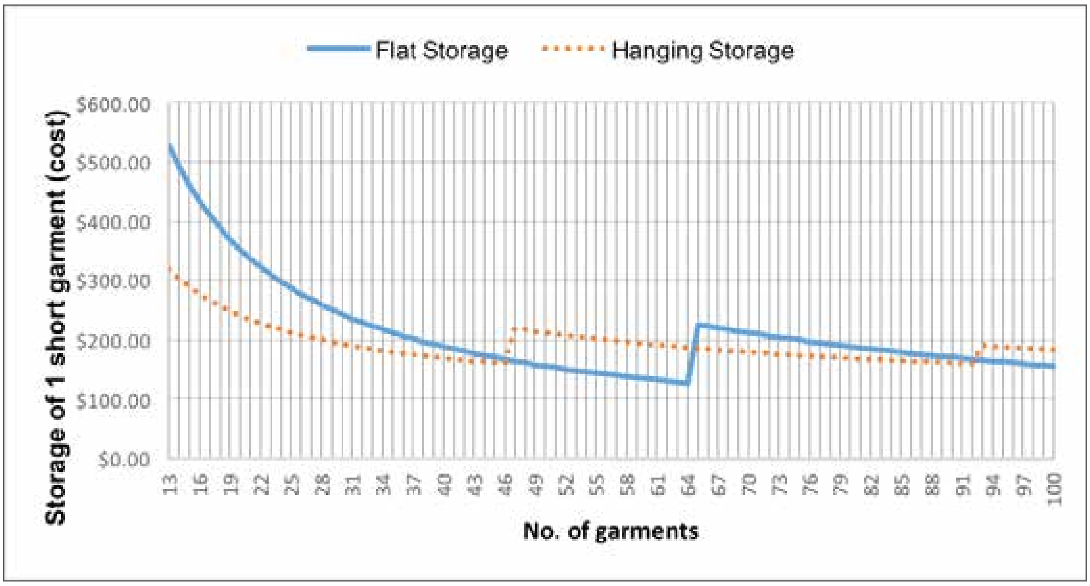

Fig. 13. Unit cost of storage for short garments (13 to 100 pieces).

Taking into account the storage costs of both long and short garments, hanging storage emerged the overall better cost-saving option. Flat storage is more cost-effective for short garments in certain situations.

Amount of time required to prepare garments for storage

All garments that enter the NC go through a New Acquisitions Condition Assessment (NACA) that is conducted by conservators. The preferred storage option is accessed and communicated to the collections managers before the garments are moved into storage (Fig. 14). For garments using hanging storage, a sizeable amount of at least 100 pieces needs to be accumulated before a trained seamstress is hired to make the hangers. The hangers have to be hand-made according to the measurements of the garments. This entire process can take months depending on the rate of acquisition, and how fast the necessary materials can be procured. Flat storage, on the other hand, is more straightforward — the garment can be stored immediately without much delay after the NACA is conducted.

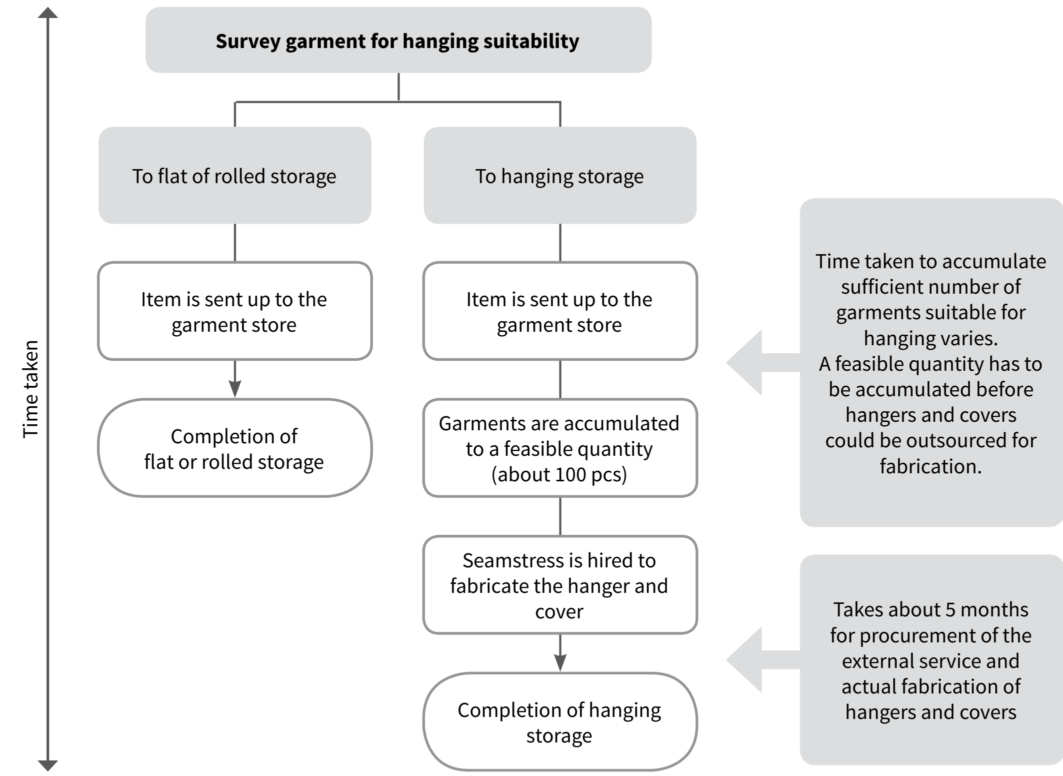

Fig. 14. Simplified workflow for storage of garments at HCC.

Accessibility of artefacts

As the collection is regularly accessed for purposes such as exhibitions and annual stocktake exercises, ease of accessibility is important to facilitate storage and retrieval processes. Retrieval of garments in hanging storage is more efficient than that for flat storage, as the garments only need to be removed from the rod they are hung on. In flat storage, an entire drawer may need to be taken out by hired art handlers in order to safely remove large garments, garments stored further inside a drawer, or garments in drawers which were high and out of reach.

In addition, the dust cover for a hanging garment includes a large opening that facilitates ease of access. The cover also has a Mylar® pocket, with a photo of the garment and its accession number, which allows for easy identification.

In this respect, hanging storage outperformed flat storage.

Impact of storage method on condition of garments

A complete condition survey of all 134 garments was conducted in order to determine the impact of hanging on their condition, and therefore assessing the performance of the hangers. Condition reports for these garments in their original condition were retrieved to provide conservators with a basis for comparison. Conservators looked out for creasing, stress along seam lines and vertical distortion as indicators of the effect of gravity on garments whilst in hanging storage.

Table 2. Hanger performance overview.

Hanger Performance	Number	Percentage
Well (No modification required for hanger)	49	36.5%
Moderately well (Minor modification required)	45	33.5%
Did not perform as required (Major modification required)	36	27.0%
Did not perform at all (Needs to be moved to flat storage)	4	3.0%
Total	**134**	**100%**

While evaluating the condition of the garments, textile conservators divided follow-up actions into four categories. "No modification required for hanger" meant that hangers had performed well (36.5% or 49 garments), causing no observable change to the garment's overall physical condition.

"Minor modification required" meant that hangers had performed moderately well (33.5% or 45 garments) but required some modifications to their auxiliary support. Modifications included making better-fitting collar supports and removing cotton twill tapes from hangers, as the latter caused minor creasing where the sleeves were folded.

Some of the garments in hanging storage required "major modification", which meant that the hangers did not perform as required (27.0% or 36 garments) (Fig. 15). There were signs of deepening sharp creasing with the potential for distortion. The reason for this was the hangers' overall design or shape. The initial design of the hangers saw their maximum width go beyond the shoulder seam in an effort to support the seam. However, this caused more overall stress to the garment, as it was not draping in the way it was constructed to.

Fig. 15. A cheongsam (above left, 2007-53386) and a blouse (above right, 2004-00869-001) were on hangers that required major modification as the hangers were causing stress to areas across the garment – in this case, around the base of the collar. Image courtesy of the National Museum of Singapore, National Heritage Board.

Lastly, the team observed strain and possible structural changes in a small percentage of hangers that did not perform at all (3% or 4 garments), particularly at areas that would affect the garment's structural integrity, like along the shoulder and collar seams. These garments were moved to flat storage after the survey was over (Fig. 16).

Even though studying the impact of flat storage on these garments was not possible unless these 134 pieces were moved into flat storage, and a comparative analysis was also conducted after seven years, it is known that there is a lower risk of damages to textile artefacts if they are in flat storage. For example, hanging a garment exposes it to stress strain brought about by gravity and ill-fitting hangers, as compared to resting it on a flat surface. And overall, out of the 134 garments hung, a majority of them (85, or 63.5%) needed to have modifications made to the hangers or moved to flat storage, thus incurring additional work for the team in the future.

Fig. 16. A Singapore Airlines air stewardess uniform (2005-01238-001) from the late 1970s is one of four garments in which change in structural condition was observed. The garment has since been moved into flat storage. Image courtesy of the National Museum of Singapore, National Heritage Board.

It is also worth noting that there might be garments that would fare better in hanging storage. In the process of evaluating hanging storage, the team noted that an installation artwork by Indonesian contemporary artist Jompet Kuswidananto, which had to be hung due to an internal metal structure, performed relatively well (Fig. 17).

Fig. 17. Part of an artwork entitled "Java's Machine: Phantasmagoria" (2011-00733-005), by Indonesian contemporary artist Jompet Kuswidananto, which had to be hung due to an internal metal structure. Image courtesy of the Singapore Art Museum.

Conclusion

The effectiveness of both storage methods, based on the five objectives, is shown below.

Table 3. Comparison of objectives for both storage methods.

Objective	Hanging storage preferred	Flat storage preferred
Storage space optimisation		√
Cost effectiveness	√	
Amount of time required to prepare garments for storage		√
Accessibility to artefacts	√	
Impact of storage method on condition of garments		√

As mentioned above, there is difficulty in concluding the ideal storage method for storage space optimisation, as it is largely dependent on the type of garments acquired by the different NHB museums and their condition. However, as there are stricter selection criteria for choosing garments to be hung, and flat storage is suitable for most garments, the latter is still the most appropriate choice for HCC.

Even though hanging storage fared better than flat storage for accessibility and cost effectiveness, the amount of time required to implement the entire hanging storage process -- from identifying a garment as suitable for hanging, to making the hangers for it, and storing it -- made it a much less practical choice for HCC. With the increasing number of new acquisitions coming in to HCC, it is critical that garments be stored as efficiently as possible.

Evaluation of the condition of garments currently in hanging storage showed that this storage method did not cause major changes to garment condition over the last seven years, although modifications are required for most of the hangers to provide more support, or prevent future damage. In this aspect, flat storage is still the option which presents lower risk of damage to garments because of the inherent stability of a flat-laying item. Nonetheless, it was noted that specific garments would require hanging storage to best suit their structural requirements.

Most importantly, as caretakers of the NC, HCC's main priority is the needs of the collection. Given that majority of the garments in the collection at this point are not suitable for hanging due to their age, material or construction, dedicating a large portion of storage space to hanging storage is not an optimal use of space. The condition of the garments when they are hung is also at risk, as seen in the condition survey results, where hangers were found to be causing strain or damage to some garments.

Through this evaluation, future planning of space allocation within garment stores would be easier and better suited to the needs of the collection. As such, following the evaluation, some furniture for hanging storage was converted to flat storage.

However, HCC has not totally ruled out use of hanging storage, as it can be undertaken for specific collections in the future. It would be suitable for three-dimensional contemporary garments, textile pieces and artworks which have internal structures, like metal wires or crinolines, which prevent them from being laid flat. In these cases, collections managers and conservators will continue to work together, as in this and previous iterations of the hanging storage project, to come up with the best solution for the artefacts and artworks.

Acknowledgements

This paper would not have been possible without the collaboration of many colleagues and friends over many years, whose help and support we acknowledge with much gratitude.

Hanging storage was first proposed by a team in 2003. The team included collections management staff Agnes Sing, Cheng Tan, Yuen Boon Pin (former Museum Assistant), and textile conservators Elsie Wong and Jacinta Loh (former Textile Conservator).

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Xue Miao graduated with a Bachelor of Engineering (Hons) in Chemical and Biomolecular Engineering from the Nanyang Technological University. Passionate about preserving Singapore's history and heritage, she joined HCC in 2016 as an Assistant Collections Manager. She is working towards specialising in the storage of garments, and currently oversees the garment stores in the centre.

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Geraldine joined HCC's Conservation Services (Textiles) Department in 2011. She graduated with a Bachelor of Art (Egyptian Archaeology) from the University of Liverpool, and holds a Master of Philosophy in Textile Conservation from the Centre of Textile Conservation and Technical Art History at the University of Glasgow. She has a keen interest in archaeological and ethnographic textiles, as well as collection storage strategies.

Cheng Tan

Cheng Tan has been with HCC for 19 years as a Collections Manager. She was part of the hanging storage feasibility study done in 2003, and the first hanging storage project in 2011. She was in charge of the garments stores and storage of garments at HCC.

Vanessa Liew

Vanessa joined HCC's Conservation Service (Textiles) Department in 2013. She graduated with a *Bachelor of Art (English Language) from the National University of Singapore. She is in charge of mould management at HCC.*

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[5] The plain washed cotton fabric was prepared by scouring it in temperatures above 90˚C. Scouring removed hydrophobic impurities in fabrics made out of natural fibres (S. Wijayapala, 2013).

Annex A
Full list of materials used for hangers

Material	Rationale	Top hanger For tops and dresses	Clamp hanger for bottoms
Aluminium	Aluminium hangers were chosen to be the base mainly due to the metal's durability. It is strong, does not rust, and unlike wooden hangers, also does not off-gas. The emission of any volatile organic compounds (eg: urea formaldehyde) may be damaging to textile fibers (Hatchfield, 2005) (Tímár-Balázsy & Eastop, 1998).	✓	✓
Ethafoam™	Ethafoam™, a polyethylene foam, was chosen as the first layer around the aluminium hanger because it could be cut to any shape and was sturdy. The foam was then cut according to the tracing taken of the garment.	✓	
Hot-melt adhesive	This archival grade adhesive holds two Ethafoam™ cut-outs together.	✓	✓
Polyester wadding	As the foam's surface is stiff, polyester wadding was layered over it to buffer the edges of the hanger.	✓	
Cotton cover	A layer of plain washed cotton fabric[5] was wrapped around the hanger to seal the polyester wadding, keeping it from shifting. It also prevented the wadding from transferring onto the garment's surface.	✓	
Outer cover	A final outer cover of the same cotton fabric can be removed for washing to enable cleaning of these hangers for routine housekeeping purposes (Caple, 2012).	✓	
Polyethylene (PE)	Hangers for bottoms utilised a simple clamp mechanism. Whilst they had aluminium frames, their clamps were made of PE. The convex shape in the centre allowed for space for buttons and other closures.		✓
PE Foam and cotton interleaf	Attached with hot melt adhesive, PE foam was used to line the inner aspect of the clamp hangers. Together, both materials served as protection from creasing or harsh folds (Fig. 6). Both acted as a protective layer between the PE foam and the garment, and provided grip.		✓

Annex B
Estimated cost of materials per hanger in 2011

Material	Cost (per hanger) in 2011
Aluminium Hanger	S$1.76
Ethafoam	S$3.33
Polyester wadding	S$3.44
Plain cotton fabric	S$2
Tyvek®	S$4.69
Cotton tape	S$0.75
Mylar®	Negligible cost
Cotton thread	Negligible cost
Total cost	**S$15.97**

Sustainable Approach for Humidity Control in the Tropics

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KEYWORDS
humidity control, microclimate, climate responsive buildings, containers/enclosures

ABSTRACT
This paper focuses on a sustainable approach to humidity control in the tropics. The problems with conservation of cultural materials being kept in a hot and humid climate are very complex. Environmental conditions play an important role in controlling the deterioration factors to which artifact materials are susceptible. Standards developed for temperature and humidity levels are difficult to attain in a tropical climate unless sophisticated and costly air-conditioning equipment is used, and the equipment can run 24 hours a day, 365 days a year. Collections are suffering from outdoor as well as indoor-generated air pollutants derived from unstable materials.

At present, most buildings often have few openings, and are without adequate air movements. Air-conditioners are used in service areas for human comfort during working hours only. It was observed that large scale outbreaks of fungi have caused serious problems in many air-conditioned buildings. A group of xerophilic fungi can grow and reproduce in conditions with a low availability of water.

Therefore, thoughtful consideration should be given to the overall building design, exterior walls and windows, insulation and vapor barriers, building materials, storage and display materials, as well as containers and enclosures. Each container and/or enclosure contains a microclimate which only slowly interchanges with the room environment. When environmental conditions in an exhibition or storage area are not optimal, an appropriate container/enclosure can shield the object from fluctuating or harmful environmental conditions. To avoid trapping moisture, an enclosure should be assembled under recommended conditions of relative humidity. Storage conditions and the quality of housing materials constantly affect the condition of collections. Enclosure materials for making sleeves, boxes, shelves, cabinets etc., should be carefully selected. Each object should have its own protective housing and packaging to protect it from dust, damage caused by handling, and rapid changes in environmental conditions.

Introduction

Countless numbers of cultural materials are preserved in museums, libraries, temples, churches, palaces, traditional houses, organizations/institutions, and private collections. The problems with conservation of these materials in hot and humid conditions are very complex. A harsh climate, excessive light, insects, microorganisms, rodents, salts, and pollutants are some common causes of damage to artifacts in the tropics.

Environmental conditions play an important role in controlling the deterioration factors to which artifact materials are susceptible. Standards developed for temperature and humidity levels are difficult to attain in a tropical climate unless sophisticated and costly air-conditioning equipment is used, and the equipment can run 24 hours a day, 365 days a year. The cost of such operations is so high that museums, archives, libraries, and private collectors cannot afford to keep funding it. The building's energy saving policy is another obstruction to controlling temperature and humidity. Most buildings have therefore been designed or modified to achieve temperatures suitable for human comfort only. Old buildings with adequate natural ventilation have been fitted with air-conditioning systems. After such modifications, these buildings become almost airtight because all their windows and vents are made of glass. The air-conditioning systems are usually operated during working hours. These climatic conditions accelerate the rate of deterioration of many cultural materials.

Therefore, well-trained, experienced museum staff, architects, and engineers, who understand the implications of these requirements, are needed. Ideally, these people must be involved in the building design process so as to achieve full environmental control. Thoughtful consideration must be given to the overall building design, the exterior walls and windows, the insulation and vapor barriers, building materials, storage and display materials, as well as the detailed engineering of the mechanical environment control systems. There is a need for many of those responsible for the management of cultural materials to change their perceptions and gain a deeper understanding of preventive conservation.

Problems encountered with the collection environment

Long term observation revealed that most cultural materials have long been damaged by purposeful alteration and inappropriate building modification carried out by unqualified personnel. It was also observed that severe damages often resulted from prolonged neglect of protective measures.

High temperature and high humidity combined make one of the worst environments for preservation of cultural materials. Different objects have different temperature and humidity requirements. The effects of fluctuations in temperature and humidity on artifacts are damaging. Fluctuating relative humidity causes stress on materials. A change in relative humidity causes dimensional alteration in hygroscopic materials, for example, wood, ivory paper, skins, and other organic materials, resulting in warping, splitting, and delamination of sensitive materials. Rapid humidity fluctuation damages a wider range of materials than temperature changes. In a wet climate, it may not even be possible to maintain ideal relative humidity levels. Although no single relative humidity range is ideal for all objects, high relative humidity (over 65%) is inadvisable as it often causes mold growth and metal corrosion.

Inappropriate building modification is one of the biggest obstacles to achieving environmental control. Rather than having passive conservation environments, many buildings rely more and more on air-conditioning systems to provide human comfort. Most new buildings and restored old buildings often have few openings, or are without adequate air movements. Air-conditioners are used in service areas for human comfort during working hours only. Most storage areas are non air-conditioned, while some have air-conditioners which are operated for brief periods due to the building's energy saving policy. Many storage areas have only one door, and no window, making them tightly sealed. As a result, unwanted vapor inside the rooms has less opportunity to escape. Some display areas and storage areas have sufficient windows and vents, but they can only be opened occasionally due to security reasons and the need to prevent rain from entering.

Serious damage to buildings as a result of condensation is increasingly common as more buildings are being tightened, and thermal insulation is installed to increase energy efficiency. Sometimes, problems can be traced to poor construction with cracking, setting foundation. Moisture sometimes comes from plumbing leaks, drain line that removes water from the indoor part of central air conditioner. In many cases, inadequate insulation of air-conditioning ducts are also potential sources for condensation in buildings. High indoor humidity caused by human activities can also be a source of problems. Condensation can happen when air is cooled to its dew point, or it becomes so saturated with water vapor that it cannot hold any more water. Expensive operating costs and energy saving policy are the main obstructions. Some display and storage areas are air-conditioned to reduce the heat. Unfortunately, according to the energy saving policy, most air-conditioning systems are operated only for staff's and visitors' comfort only. At present, it was found that more serious problems occur on cultural materials housed in modern air-conditioned buildings.

Some museums, libraries, and archives are located at the basements of buildings, some of which situated on river banks. Basements often contain higher amounts of moisture or humidity than other areas because they are usually not well ventilated. They are also colder, meaning more condensation occurs there, which leads to dampness and humidity. Water vapor in the air condenses on any cold surfaces like glass, ceramics, metals, polished stones, plastics, as well as porous materials. Water from leaks in the building will also often run down to the basement. Meanwhile, water building up in the yard and ground around the base of the building can cause frequent water problems in the foundation of the building. Airborne moisture will move to equalize distribution throughout the environment. The effect of this movement of moisture within buildings, particularly where humidity - controlled areas abut uncontrolled spaces, is often difficult to control or overcome. For example, open doors that lead people from galleries to uncontrolled public areas can cause severe migration of moisture in or out of controlled spaces.

Figure 1. Temperature and relative humidity in a room where the air-conditioner was in use during working hours in the rainy season.

During the last 40 years, it was observed that large scale outbreaks of fungi have caused serious problems in many air-conditioned buildings such as museums, libraries, archives, galleries, hospitals, banks, universities, temples, offices, and private houses. In very moist atmospheres, fungal growth is very common. Outdoor air is often the source of spores. If high moisture conditions exist for a sufficient time in a building, fungal growth and sporulation may occur. Spores of most fungi do not survive significant periods in air because of the absence of energy. Those that survive have specific mechanisms to prevent damage from desiccation and irradiation. Anytime moisture is available, spores can germinate and fungi can grow and produce thousands of new spores, utilizing organic materials in the substrates.

During rainy season, under conditions of high humidity and poor ventilation (when the rooms are closed after working hours and during the weekend) profuse growth of certain fungi is very common. Furthermore, due to security reasons, most museums, libraries, and archives are well sealed and do not have adequate ventilation.

It has been observed that a group of xerophilic fungi can grow and reproduce in conditions with low availability of water. These microorganisms have developed physiological mechanisms that enable their biochemical pathways to function in environments where little water is available. These xerophilic fungi were identified as the *Penicillium, Aspergillus,* and *Eurotium* species. The sexual states of these fungi are present if growth has been long term, and the nutrients of the substrate are conducive for the conversion to sexual phase. Ascospores are produced in the sexual stage of many fungi in these species, for example *Eurotium halophilicum, Eurotium amstelodami, Emericella variecolor,* and *Emericella nidulans.* Some of these fungi find suitable living conditions even on relatively dry surface, e.g. glass, ceramics, metals etc. They are well adapted to a warm, low water activity environment, and they are thermotolerant. *Eurotium halophilicum* in particular is a xerophilic fungus with a high tolerance to water stress. The minimum observed water activity (Aw) for germination and growth of *E. halophilicum* is 0.675, one of the lowest for the *Eurotium* species (Christensen et al., 1959). This group of fungi is commonly observed in stagnant areas all over the country.

The occurrence of these fungi is also associated with dust. Some of these fungi have a preference for salts and sugar substrates. They are very common on textiles, leather, paper, paintings, wood, glass, plastics, ceramics, and inorganic materials coated with resins and lacquers. Many species of these fungi are common contaminants that feed on various substrates and are known as potential mycotoxin producers.

The occurrence of these fungi in indoor environments is often underestimated due to inadequacy of classical methods in measuring their presence, and the fungi's very slow growth on typical media. In many cases, microbiologists were not able to easily identify this group of fungi. Since 1990, the author has investigated fungal surface features and morphological characteristics using several types of microscopes, including the scanning electron microscope, to directly examine the fungi occurring on the substrates and the processes associated with its deterioration. Fungal species can be distinguished by their sporophore morphology and spore surface characteristics. It is also possible to determine whether the fungus is growing on the substrate or on impurities present on the substrate. The results of the author's investigation showed the presence of several xerophilic fungi on relatively dry substrates.

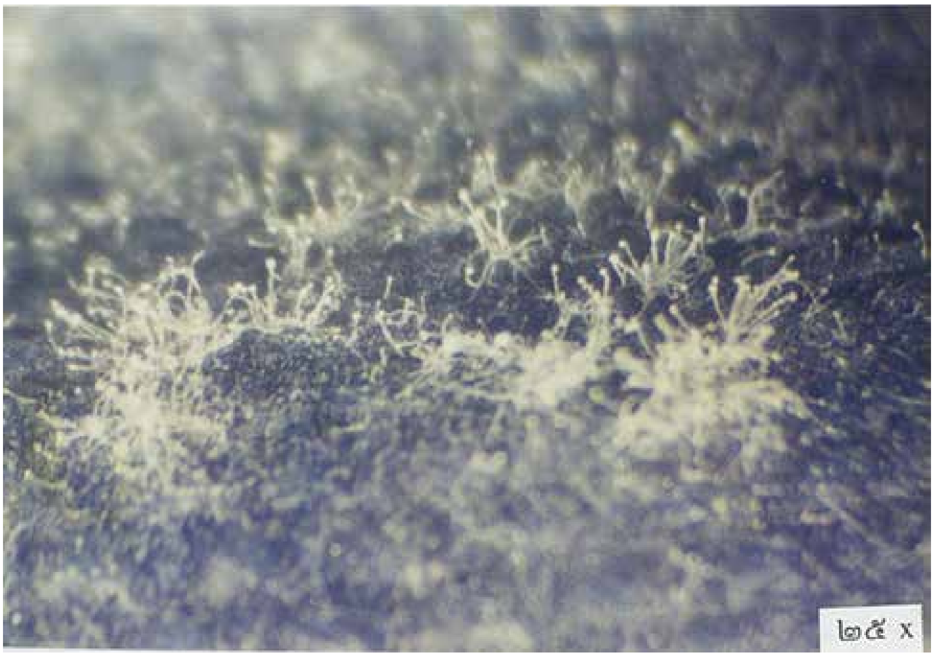

Figure 2. Colony of Aspergillus halophilicus on paper (25x).

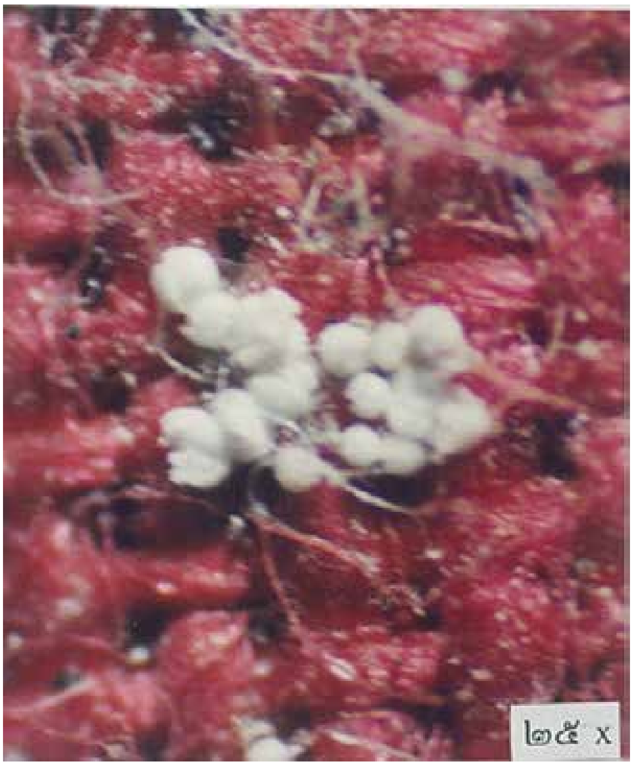

Figure 3. Cleistothecium of Eurotium halophilicum (25x).

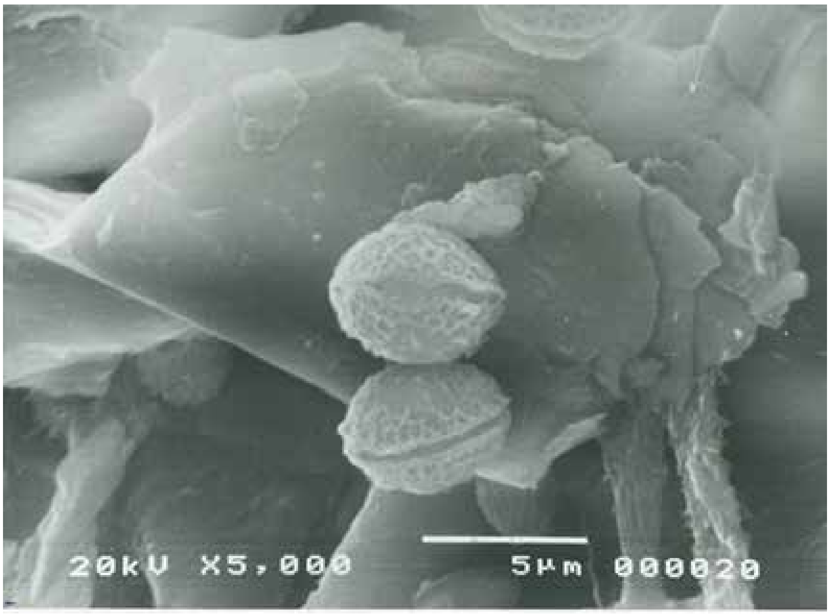

Figure 4. Ascospores of Eurotium halophilicum (5000x).

In damp rooms, and especially on wet substrates, visible growth of molds from the genus *Penicillium, Aspergillus, Cladosporium, Curvularia, Alternaria, Mucor, Fusarium, Aureobasidium, Paecilomyces, Trichoderma, Memnoniella, Stachybotrys, Drechslera, Gliomastix,* etc., are observed. These molds grow on damp or wet materials containing cellulose, protein, and other materials which are sources of nutrients. Fungi are ubiquitous, and fungal spores are a common component of household and workplace dust. In large amounts, they can be a health hazard to humans, potentially causing allergic reactions and respiratory problems.

If fungal growth has occurred, it is important to understand the factors that have allowed the growth to occur so that remediation recommendations can be made. In general, the recommendation is to remove the growth and reduce humidity. The buildings should be re-designed or modified to allow adequate ventilation whenever necessary. In practice, it is difficult to maintain a stable temperature and relative humidity level, even with the benefit of air-conditioning. It was observed that temperature and humidity in normal air-conditioned storage spaces operated 24 hours a day and 365 days a year were not constant.

During rainy season, certain fungi can grow. Poor ventilation and surface temperature dynamics can produce foci of water condensation and local micro-climates with localized peaks of Aw greater than the surrounding indoor environment. Tight construction, combined with poor choices in design, building materials or operations, can increase the probability of fungal growth. The tighter the building construction, the less air exchange there is between the inside air and the outside air. Moisture, pollutants, dust, and fungal spores stay in the building longer. If the building is not well ventilated, then the humidity will stay high for a long time. Tight building construction, when combined with moisture source control (exhaust fans) and controlled ventilation (intentional introduction of outside air), reduces the probability of fungal growth in a building. Conventional control of temperature and relative humidity in conformity with recommended standards may be insufficient to prevent material colonization, especially if the buildings are enclosed systems with low ventilation rate.

Environmental control requires intense concern from the very beginning of the planning process, through to design and construction, and to the final installation of the equipment and the objects. Architects, engineers, conservators, and museum staff must be involved in the design process so as to achieve proper climate control. Thoughtful consideration must be given to overall building design, the exterior walls and windows, the insulation and vapor barriers, as well as the detailed engineering of the mechanical climate control systems. The right building design and fabric contribute to a better indoor environment for both collections and visitors. A combination of passive control (building design and fabric) and active control (air circulation and dehumidification) is necessary to prevent microbial deterioration. The building should be designed to benefit from natural ventilation. External thermal insulation, coupled with internal vapor barriers and shading devices, should be used. Ventilation is one of the most important factors for maintaining acceptable indoor air quality in buildings. Windows should be open during the day, especially when it is hot, since this is when humidity is usually lowest outside. When it is raining, all windows must be closed. Staff must take an active role in the operation of such buildings, for example, by opening and closing windows at appropriate times of the day or of the season, or by using movable shading devices.

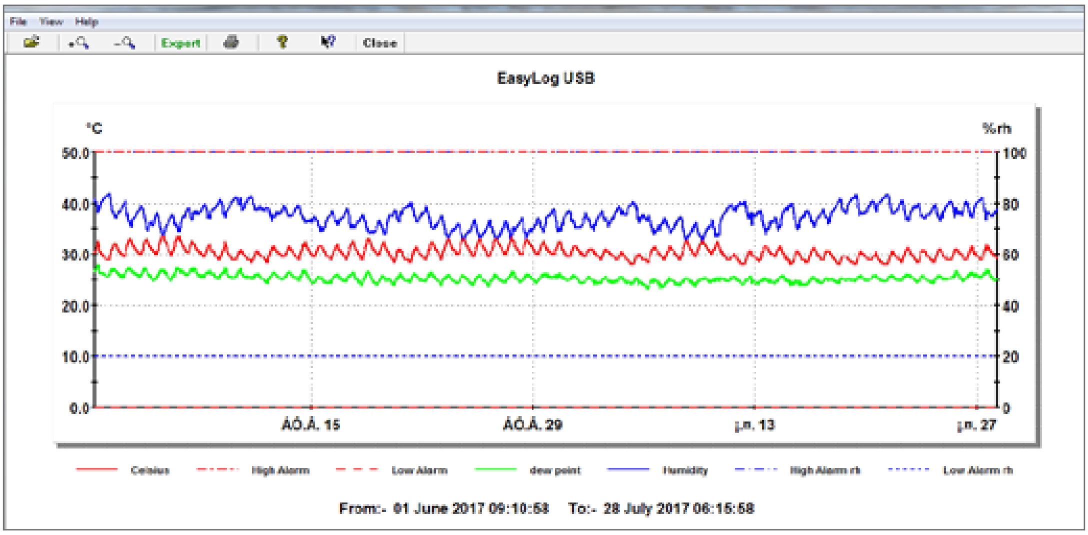

Figure 5. Temperature and humidity in a well-ventilated space during rainy season.

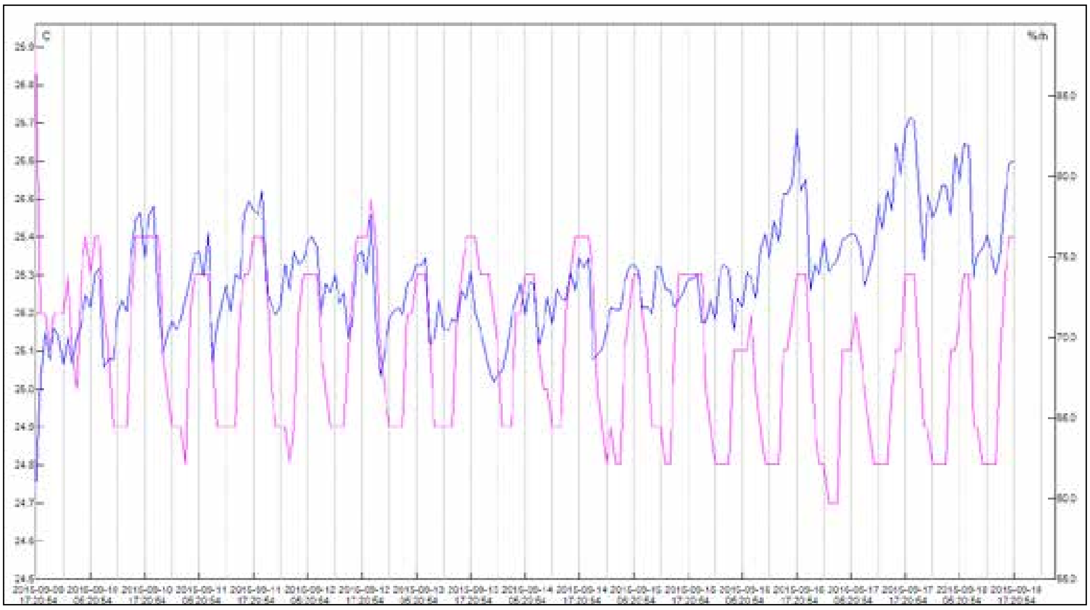

Figure 6. Temperature and relative humidity levels in a normal air-conditioned storage facility operated 24 hours a day, 365 days a year.

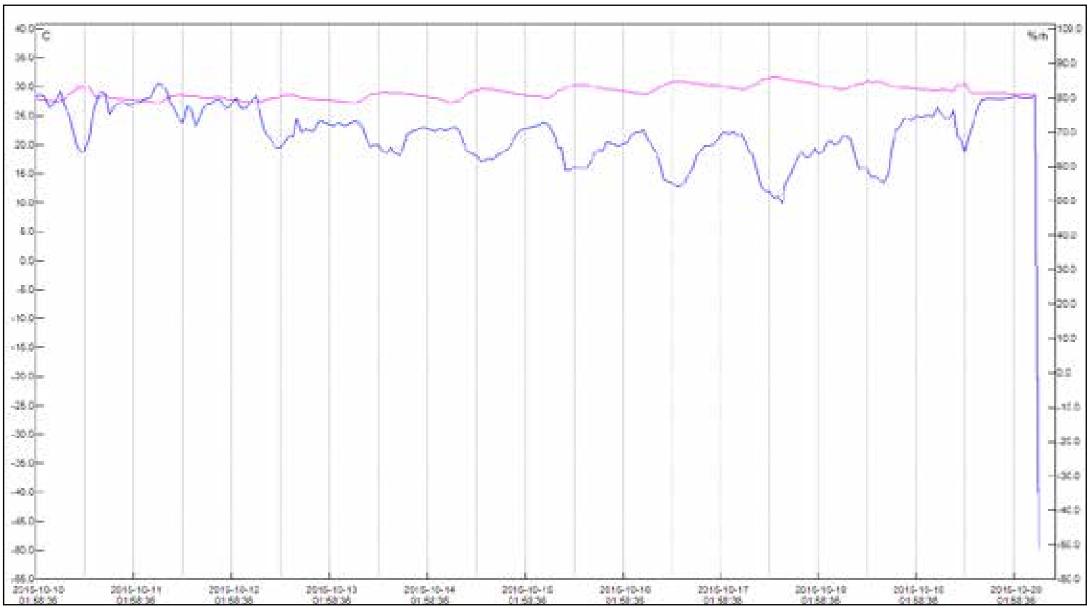

Figure 7. Temperature and relative humidity levels in a naturally ventilated room (non air-conditioned) during rainy days.

Sustainable approach for humidity control

Most design solutions to environmental control are too costly and architecturally inappropriate for a tropical climate. In many cases, dehumidifiers are used in conjunction with air-conditioners. However, these equipment need a lot of energy to power and lead to high maintenance costs. When these systems fail, the resultant environment is more damaging to the artifacts than the natural conditions would have been. Condensation and fungal outbreaks on surfaces are the most common risks.

The key solution is to use ventilation to reduce heat and moisture gains indoors. Buildings in warm, humid regions should have ventilated pitched roofs, long eaves, openings on all facades, external downspouts, over-sized gutters, above grade basements, and stilts separating the constructions from the humid ground. Some important architectural features, i.e. the placement of the building with respect to the sun path, prevailing winds and driving rains, and careful location of the openings, can lead to a comfortable indoor space. Drainage systems are also important features. The use of materials with high thermal resistance, such as mineral wool, glass fiber, expanded clay, and cellulose, can reduce heat gains and losses indoors, and minimize daily climate fluctuations. In addition, buildings should be designed in a way to maximize human comfort while minimally utilizing mechanical humidity control systems. It is extremely difficult and costly to solve the humidity problem after a building has been constructed or renovated.

If it is not possible to achieve relative humidity levels, try to achieve a reasonable level that does not fluctuate. If this level is above 65%, try to improve air circulation and regular inspections for mold growth. The adoption of passive building design to create conservation environments should be developed and applied. Another method is to use forced and filtered ventilation, creating positive pressure inside the rooms, and thus avoiding dust and insect penetration through gaps. In many cases, it is really necessary to improve ventilation and air circulation through the use of low-tech fan and filters. Ceiling fans and table/floor fans can be used to circulate air within a room for the purpose of reducing the perceived temperature because of evaporation of perspiration on the skin of the occupants and visitors. Warm air can be allowed to rise and flow out upper openings to the outside (the stack effect), thus forcing cool outside air to be drawn in through openings in the lower areas. It is important to remove unpleasant smells and excess moisture, introduce outside air, and prevent stagnation of interior air. The room must be well ventilated whenever moisture builds up. Increasing air circulation by switching on a circulating fan for a few hours each day can help. Preference should be given to louvre windows, which allow air flow at all times, instead of glass window panes.

Natural climate control with low energy consumption, and low operation and maintenance efforts, seems to be more appropriate for collections in the tropics. It was observed that temperature and humidity in a naturally ventilated room (non air-conditioned) fluctuated less during rainy days, and no sign of fungal growth was apparent.

Ventilation is one of the most important factors for maintaining acceptable indoor air quality in a building. Oscillating fans should be installed in the center of the room to provide air movement. The process of "changing" or replacing air in any space to provide high indoor air quality is used to remove unpleasant smell and excessive moisture, introduce outside air, keep air circulating in the interior of the building, and prevent stagnation of indoor air. Cooling is achieved only if ventilation and shading mechanisms are added to the building. Light structures and open shallow spaces are recommended, along with the interior environment closely following the exterior environment. It is also important to equalize humidity distribution throughout the environment. If it is dry outside, interior moisture will move to external areas, and vice versa. The effect of this movement of moisture within buildings, particularly where humidity-controlled areas abut uncontrolled spaces, is often difficult to control or overcome. It is also necessary to prevent the entry of insects by using forced and filtered ventilation. Climatic conditions vary from place to place, which causes localized environmental problems. There can even be temperature and humidity gradients within each room.

It is desirable to maintain a low temperature in storage, but practical difficulties arise. Cooling the air increases its relative humidity so that greatest dehumidification capacity is needed. There is also the danger of condensation. Relative humidity problems can be analyzed and dealt with, either by installing apparatus to control humidity, or by finding a new storage situation for collection materials

In many cases, air-conditioning systems have accelerated damage to cultural materials due to the greater frequency and rapidity of cyclic environmental changes. The results of long term observation suggest that cyclic environmental changes are more damaging to most materials than larger but gradual changes in temperature or relative humidity, which would occur in buildings without air-conditioners. Repeated variations in temperature and relative humidity, e.g. during the day and the night, or due to thermostatically controlled devices such as a short cycling air-conditioner, lead to the accumulation of non-recoverable dimensional changes. The display environment is more rigorous than the storage environment because it has the potential to contain light, which would negate all other environment circumstances.

Storage conditions and storage materials are at the heart of all efforts to reduce the rate of deterioration. Storage conditions and the quality of housing materials affect all of the collection all the time. The most successful attempts to limit deterioration from environmental causes are based on the creation of a storage space with temperature and humidity control, coupled with filtration equipment to remove oxidants, and acidic and sulfide gases. Such an integrated approach to environmental control is initially costly, but in the long term, is the most efficient way to maintain stable humidity conditions in storage.

A simpler and less expensive alternative is to protect the objects inside protective enclosures, such as showcases, microclimate frames, storage boxes, envelopes, folders, and transport cases. Thoughtful consideration must be given to create a suitable microclimate for each object. The materials and design of an enclosure create a self-buffering microclimate. The moisture exchange between air trapped in the enclosure and hygroscopic materials remains balanced. A well-sealed case/enclosure can prolong the usefulness of a passive buffer and more effectively block external airborne pollutants and insects from entering the enclosure.

In addition to outdoor pollutants, collections also suffer from indoor-generated air pollutants liberated from unstable materials like plywood, wood products, adhesives, paints, and plastics. Long term observation revealed that appropriate enclosures can stabilize relative humidity and protect artifacts against insects and external pollutants. Each enclosure contains a microclimate which only slowly interchanges with the room environment. When environmental conditions in an exhibition and storage area are not optimal, a sealed enclosure can shield the objects from fluctuating or harmful environmental conditions.

Vulnerable materials should have their own protective housing and enclosure to protect them from dust, damages from handling, and fast changes in environmental condition. The materials for housing and enclosures should be carefully selected and designed. Appropriate buffering materials can also be added to the enclosures. Further studies to monitor the effectiveness of various enclosures and buffering materials will be necessary.

Conclusion

Environmental control of buildings in a tropical climate requires intense concern from the very beginning of the planning process, through to design and construction to the final installation of the equipment and objects. Design and construction of museum climate control systems is a complex undertaking. These systems require the highest quality design skills, construction expertise, and mechanical components. A climate controlled building that functions imperfectly and erratically is much more harmful for the collections than if no climate control at all is used. It was observed that when the climate control systems failed, the resultant environment was more damaging than the natural conditions, and fungal outbreaks on object surfaces was the most common risk.

For preventive conservation to be effective for a particular collection, technical knowledge must be matched with administrative commitment to integrate preventive conservation into the operation of an institution. A solution has to be found to improve the environmental stability for the collection, as well as provide healthy and comfortable environmental conditions for visitors and staff. High ranking administrators should understand the reasons and the procedures for implementing such a solution. It is also very important to educate more conservation personnel to satisfy the growing demand for conservation skills. In the long term, it is the most efficient form of conservation, not only for museums, but also for libraries, archives, and collections of ethnographic, natural history and geological materials.

A natural climate control approach involving low energy consumption and low operation and maintenance efforts, seems to be more appropriate for collections in the tropics. Thoughtful consideration must also be given to create a microclimate for each object. Various forms of microclimate enclosures should be utilized whenever possible, and must be carefully designed to offer additional protection for the objects and at the same time reduce the energy consumption needed for air-conditioning in buildings. Vulnerable objects should have their own protective housing and enclosures to protect them from dust, damages caused by handling, and rapid changes in environmental conditions. At present, multiple experiments are being designed to evaluate the impact of adding various buffering materials to enclosures.

Author's biography

Chiraporn Aranyanark has had a long and distinguished career in conservation. Her career began in 1972, after she graduated with a degree in Chemistry from Chulalongkorn University, where she later also earned an M. Eng. in Nuclear Technology. She also attended several international training courses on conservation and scientific examination of cultural property. In 2013, the Thai Senate awarded her for her distinguished achievements in the field of applied science. In 2018, Silpakorn University awarded her an honorary doctorate in fine arts conservation.

For over 36 years, Chiraporn served the Conservation Science Division, of the Fine Arts Department in Thailand's Ministry of Culture. She has been involved with several international organizations such as ICCROM, in which she was a council member (2003-2007). She was also a member of the Scientific Committee for Conservation of Stone (ICOMOS), and a member of the International Council for Biodeterioration of Cultural Property (ICBCP).

After her retirement from the Fine Arts Department in September 2008, she continued her career as an expert in conservation. She has developed numerous training courses/workshops and publications to increase the competence of museum staff all over the country. She is also a visiting lecturer for the M. A. in Conservation of Fine Arts and M. A. in Architectural History at Silpakorn University.

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POSTER ABSTRACTS

Controlled Vocabulary and Taxonomy: A Cataloguing Capability Development at HCC

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ABSTRACT
This poster seeks to illustrate the development of an National Heritage Board (NHB) controlled vocabulary and taxonomy. It will highlight the NHB-controlled vocabulary and taxonomy, the purpose of developing them, tools used to develop the taxonomy, the process of creating the taxonomy, and how they will add value to the industry.

Controlled vocabulary is an ordered arrangement of words used to catalogue items or subjects of interest, in order to accurately retrieve records by browsing or searching. The Heritage Conservation Centre (HCC) has been cataloguing the National Collection (NC) using controlled vocabularies from thesauri such as Getty's Art and Architecture Thesaurus (AAT), the Library of Congress Authorities (LC), and the National Library Board's Taxonomy and Thesaurus Editor (TTE). However, regionally- or culturally-specific terms, which are commonly used to classify some of the artefacts in the NC, are not published in these thesauri. HCC is creating a controlled vocabulary for NHB in order to attribute these terms to the NC and aid searchability.

HCC is also working on creating a local taxonomy that is tailored to the NC by referencing the controlled vocabulary terms from international thesauri. Taxonomy is a structure that organises categorised concepts or things to reflect associative relationships between them – like parent-child relationships, for example. The taxonomy will aid the browsing and filtering of search results.

The creation of NHB-controlled vocabulary and taxonomy adds value to the industry as it standardises terms, organises artefacts, and aids in search and retrieval of NC records online. These will benefit industry professionals, researchers, students, as well as other parties who are interested in searching the NC online.

Standardisation of Photography for the National Collection of Singapore

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ABSTRACT

This poster aims to share the current practices of the Heritage Conservation Centre (HCC) in photographing the National Collection of Singapore, and the colour management process adopted by the Visual Resource (VR) team of HCC to ensure colour accuracy of photographs.

Photography of the National Collection of Singapore began in the 1970s, and was performed using film and transparencies. In 2001, the National Heritage Board (NHB) began to use digital photography. The VR team has since developed photographic guidelines for up to six object types, including 2-dimensional (2D) artefacts (e.g. paper artefacts, and artefacts with a flat decorative surface) and 3-dimensional (3D) artefacts (e.g. sculptures and furniture). The guidelines specify camera angles; artefact positioning; and colour management procedures, and are adhered to by the VR team.

To ensure best practice in colour management, the VR team has also developed procedures to ensure consistency in the photo documentation process. The standardisation of photography ensures the consistency in photo documentation for the National Collection. Indirectly, this makes it easier for any stakeholder to specify the camera views needed.

Management and Enhancement of Transit Spaces at the Heritage Conservation Centre

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ABSTRACT

This poster aims to showcase the workflow of artefact transit spaces at the Heritage Conservation Centre (HCC). Transit spaces consist of the Loading Bay, Artefact Examination Room, Crate and Crating Store, New Acquisitions Transit Stores, and the Fumigation Room. Presently, these spaces are managed by a Collections Manager assisted by a team of dedicated outsourced personnel. This arrangement, set up by the Collections Management Department, has been in place for some years and has proven effective in alleviating the workload of HCC staff. The outsourced personnel are responsible for managing the spaces according to the department's standard operating procedures. In doing so, they ensure the spaces can be efficiently managed, use of the spaces is tracked, and that there are enough transit spaces to store or hold newly acquired artefacts.

Transit spaces are mainly used for the receiving of new artefacts acquired by the national museums and heritage centres under the management of the National Heritage Board, as well as the National Gallery Singapore and the Singapore Art Museum; as temporary storage for artefacts which are un-accessioned; as holding areas for accessioned artefacts being returned to storage after being displayed, or those that have been newly acquired; as areas for RFID (Radio Frequency Identification) tagging; as holding areas for crates undergoing acclimatisation; as work space for accessioning; as work space for new acquisition condition assessment; and as holding areas for infested artefacts awaiting pest eradication treatment.

Due to the many and varied uses of these spaces, both accessioned artefacts and artefacts awaiting accessioning are usually kept in the same space, making the tracking of these artefacts challenging. The problem is compounded by the many varied activities happening at these spaces at the same time.

This poster examines past practices as well as strategies that could clarify and better define the uses of these spaces, such as tracking improvement of work processes and introducing technologies like an active RFID system.

Behind the Accessioning and Storage of a Chinese Letterpress Collection

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ABSTRACT
At the Heritage Conservation Centre (HCC), the repository and conservation facility for the National Collection (NC), the methodology for accessioning and storing bulk acquisitions involving large, complex, and multi-part artefacts often depends on several criteria. Using Sun Yat Sen Nanyang Memorial Hall's (SYSNMH) recent bulk acquisition of a Chinese letterpress as case study, this poster explores what these criteria are, and the complexities of balancing them.

The new SYSNMH collection, featuring the first letterpress machine powered by an electric motor, and a complete set of moveable Chinese typesets, has been added to the NC and is under the custodianship of HCC. Amounting to an estimated 48,500 pieces, the collection consists of a wide variety of artefacts with differing physical traits and compositions.

Managing the letterpress acquisition was thus no easy feat. Each different type of artefact required a unique set of care and repository methods specific to their physical characteristics. Other than satisfying an artefact's care requirements, the selected collection care methodology also had to preserve the collection's cultural significance in its entirety, as well as the curator's future exhibition display intentions.

Balancing and fulfilling all these key considerations can be a complex and challenging task, as was the case with this Chinese letterpress acquisition. This poster examines some of the challenges the acquisition team encountered, and what the accessioning and storage methodology is adopted by HCC eventually. It also illustrates how each of the selected approaches was carefully devised to fulfil most, if not all, of the important criteria mentioned above.

Odd Shapes and Peculiarities: Storing Contemporary Artworks

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ABSTRACT

The Heritage Conservation Centre (HCC) is the repository and conservation facility preserving and managing over 200,000 artefacts/artworks from museums of the National Heritage Board, the National Gallery of Singapore (Gallery), and the Singapore Art Museum (SAM). As museums acquire more contemporary artworks, coming across characteristics such as large odd shapes and peculiar mediums poses challenges to their storage needs. For instance, large odd shapes can be a storage problem for a space-starved facility and peculiar mediums for their preservation given that their deterioration rates and durability are unpredictable.

This poster features the journeys of HCC Collection Managers who deal with storage of odd-shaped and peculiar artworks, and illustrates the storage considerations and methods these managers employed. Since odd shapes and bizarre mediums are more prevalent in contemporary artworks, this poster highlights two artworks from SAM's collection: David Chan's *Utama's Cat*, due to its large odd shapes, and Ezzam Rahman's *Here's Who I Am, I Am What You See*, for its peculiar medium.

Ezzam Rahman uses bodily matter, such as dead skins and fingernails, to sculpt 34 pieces of "human skin flowers". As the "flowers" were extremely fragile, a storage box was designed to ensure they were housed safely and to eliminate possible vibrations, caused by movement of the artwork, during retrieval. Interestingly, the storage method mirrored the packing of the *Tang Shipwreck Collection*'s overseas loan to Asia Society Museum in 2017, proving that similar storage or packing methods can be adopted for artefacts that are worlds apart.

David Chan's *Utama's Cat* is a large outdoor sculpture comprising a large wooden cat sculpture and four large origami-like metal encasements. The cat sculpture is more than 3 metres long and 2 metres high, while each metal encasement is 2 metres long and 2.1 metres high. Apart from its large size, the sculpture's fragility also had to be considered in storage deliberations. For instance, the cat sculpture was assembled upon a solid wooden core and recycled chair legs, which created an extremely heavyweight yet delicate structure. The metal encasements were delicate as well, because their shiny coated paint surfaces were susceptible to scratches. As a result, five crates were custom-built to protect the artwork from external damages. This method has certainly eased the handling of large sculptures, and has since been used for storage of other large contemporary artefacts in the SAM collection.

The two case studies illustrate that contemporary artwork storage is not as straightforward as it seems. They also show the level of considerations and efforts taken to ensure each artwork, big or small, is housed safely. Additionally, with contemporary artists becoming more explorative in their artistry these days, collection managers have to flow in parallel with the artists by staying inventive, open-minded and adaptive, to understand the needs of artworks with odd shapes and peculiar mediums.

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The Tang Shipwreck Collection: Its Journey to HCC

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ABSTRACT
This poster illustrates the transfer of over 53,000 artefacts in the Tang Shipwreck collection from the Singapore Tourism Board to the National Heritage Board. More than 1,000 of these artefacts were subsequently displayed at the Asian Civilisations Museum, and the rest are stored and cared for at the Heritage Conservation Centre (HCC). It also examines the important considerations and outcomes of managing such large-scale relocation of artefacts.

HCC is a purpose-built facility for storage and conservation of artefacts and artworks. It has a state-of-the-art custom-built repository system designed to accommodate the widest range of collections. The Tang Shipwreck is one of the most important underwater archaeological discoveries within the region, as it provides some of the earliest evidence indicating that Southeast Asia was involved in the ancient Maritime Silk Road.

Found in 1998 near Belitung Island, Indonesia, this remarkable collection comprises mainly ceramics that were manufactured during the Tang dynasty. The collection also includes luxurious gold and silver items and a handful of organic products. The sheer number and broad material range of this collection, along with the different shapes and sizes of the artefacts, posed a tremendous storage challenge for HCC. Having stayed underwater for centuries, many of these artefacts have unique encrustations formed by corals on their surfaces. These encrustations added to the complexities in packing and transporting the collection from one location to another.

To overcome these challenges, a team from the Collections Management Department developed a robust and comprehensive tracking and inventory system. The team also researched and experimented with new storage methodologies, taking into consideration the need to optimise storage space and facilitate easy access to the collection in the future.

The unique difficulties and constraints the team faced when transferring this collection, and the solutions they adopted will be shared. The deliberation on the suitable infrastructural setup required to accommodate this massive collection, and other key learning points, will serve as useful reference for other heritage institutions which may undertake similar large-scale collections move.

First-time Application of Adjustable Aluminium Stretchers for Oversized Paintings from National Gallery Singapore

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ABSTRACT

This poster presentation discusses the first-time application of two different types of aluminium stretchers for oversized paintings from the National Gallery Singapore's (NGS) collection. Two oil canvas paintings, *Spain and Philippines* by Juan Luna and *Forest fire* by Raden Saleh, were selected for NGS' inaugural permanent display in 2015. The paintings measured 230 cm (H) x 81 cm (W) and 298 cm (H) by 396 cm (W) respectively. Due to their sizes and advanced deterioration of their original auxiliary supports, the paintings required new and adjustable stretchers. As aluminium profiles do not react to variations in humidity or temperature, a stretcher made of this material would not warp or twist, even in unfavourable display or storage conditions. Mounting and stapling of the canvas during stretching was simple thanks to the laminated plywood strips attached to the aluminium bars. Uniform tension was achieved either through a system of screws located at each corner and the ends of each cross-bar, or a system of tensioning units that contained springs. This poster focuses on the construction and function of the manually adjustable and self-expandable aluminium stretchers. It will also present practical steps for assembling, stretching, tensioning these stretchers, and critically evaluate the two applied construction systems.

Conservation Case Study of a Polychrome Wooden Sculpture – Adapting a Preservation Strategy for Open Display

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ABSTRACT
A polychrome wooden sculpture of the deity Guangong from the Ming Dynasty in Shanxi Province, China, is being preserved in the National Collection Singapore. The sculpture is chosen for permanent display in the Asian Civilisations Museum's (ACM) gallery "Ancient Religion" in November 2017. There are no historical records about the origin of the sculpture and its conservation history is only fragmentarily documented. However, signs of different campaigns of early interventions are clearly evident on the sculpture. The preparation for the new display appeared to be an opportune moment to carry out in-depth technical examination to achieve a better understanding of the sculpture's materials. With the gained knowledge conservators can adapt the preservation strategy to support the new concept of open display, instead of encasing the artefact in vitrines. This poster highlights the findings of surface and structure analyses and illustrates main interventions of the current conservation treatment. It illustrates how the treatments, which were applied to the sculpture after its entrance into the National Collection in 1995, are respected and integrated into the conservation process. It also demonstrates the synergy among the conservation science and other conservation sections of the Heritage Conservation Centre.

Insights and Exchanges into Material, Techniques, and Historical Origins of a Bodhisattva Sculpture

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ABSTRACT
This poster features the conservation of the sculpture *Standing Bodhisattva*, and the project's involvement in the collaboration between Shaanxi Institute for the Preservation of Cultural Heritage (SIPCH) in China, and the Heritage Conservation Centre (HCC).

The sculpture originated from Shanxi province, and had been restored over time while it was located at the temple it was originally placed. In the 1990s, the sculpture entered the National Collection. Since then, it has been treated by conservators at HCC in 1997 and 2006. The latest conservation treatment was carried out for the opening of the new permanent gallery *Ancient Religions*, at the Asian Civilisations Museum (ACM), Singapore, in 2017.

The sculpture was in poor condition because of an accident that happened during its transportation. The accident resulted in breakages and losses, primarily in the areas of the face and lotus base areas. Furthermore, conservators' close examination of the sculpture revealed the mount at the sculpture's base to be a complex mix of original materials, and materials added during the sculpture's later years.

As part of the cooperation between HCC and SIPCH, a team of conservators and conservation scientists from both institutions participated in a field trip to Shanxi province, China, in September 2017.

The conservators' exchanges with the SIPCH team and observations from the field work provided essential technological insight about how a wooden skeleton and distinctive layers of clay form the sculpture. This information was vital to making an informed decision on what areas of the sculpture and its base are important to preserve. The findings from this treatment and collaboration provide the basis for further research into the area of polychrome clay sculptures in the future.

A Technical Examination of a Balinese Painting by D. G. Soberat

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ABSTRACT
Technical examination was carried out on a painting by D. G. Soberat from the National Gallery Singapore collection.

Scarce scientific material research has been done on Balinese paintings. The only research of such nature is a research article, published in the journal *Raman Spectroscopy*, which focuses mainly on the analysis of pigments in contemporary works (Marcelino, M.D. R., Muralha, V.S.F., 2012).

This poster aims to contribute to the material study of early Balinese paintings, and provide clues that aid in understanding the choice and use of materials and their technical application.

Different scientific analysis were undertaken to complement the results with the literary description of the materials used by Balinese artists. The painting surface was examined using 3D digital microscopy, and the paint materials were analysed using X-ray fluorescence spectroscopy (XRF), Raman microscopy, and Fourier Transform Infrared Spectroscopy (FTIR). Microscopic images revealed an absence of ground on sized cloth and thin black outlines. The paint materials were characterised as a mixed palette of colours including bone white, iron ochre, vermilion, Prussian blue, and yellow synthetic organic pigment, combined with proteinaceous binder.

The detailed examination of this Balinese painting has allowed us to better understand the painting technique and the materials used by the artist. These data will be extremely valuable for future research on other Balinese paintings from the National Gallery Singapore collection.

Capturing Moments in Time: Experiences from the Time Capsule Project

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ABSTRACT

This multi-agency time capsule project involved the preparation and burial of a time capsule for the 50th Anniversary of Singapore's Independence (SG50), with the team from Heritage Conservation Centre (HCC) looking into the preservation aspects of the time capsule contents. The contents of the time capsule – 50 sets of items consisting paper, objects and textile materials – were selected via a public vote. The time capsule will be unearthed in 2065.

Improvements to the preservation of the time capsule items were made based on information obtained from an unearthed time capsule that had been buried in 1990, during the 25th Anniversary of Singapore's Independence (SG25). Soil and rainwater, stacking of the items, pollution, and high humidity were risk factors observed in the SG25 time capsule or identified in project planning of the packing. Strategies for better packing and other preventive measures for the new time capsule were devised to control these risks. Documentation, which was lacking in the previous time capsule, was carried out for the SG50 time capsule to record the description of the items, images, packing methods, and materials used in packing the items. The SG25 time capsule served as a precedent from which learning lessons and improvisations could be drawn and devisde. In turn, the SG50 time capsule, which captures current preservation approaches and technology, will provide future generations with sources for research and innovation during its opening 50 years later in which they can continually improve on for the burial of the next time capsule, in the form of preservation relay.

Conserving a Mid-20th century Cambodian Painting: A Cross-disciplinary Treatment Approach

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ABSTRACT
Buddha descending from Tavatimsa Heaven, a mid-20th century Cambodian painting by Som Lin, was selected for the Faith and Belief gallery at the Asian Civilisations Museum in 2016. The conservation of this painted textile provided an excellent opportunity for the paintings conservation section to embrace, adapt, and apply various conservation approaches from different specialisms.

During the selection of treatment methodologies and materials, introduced after discussion with colleagues from the paper and textile conservation sections, arose an interesting reflection which focused on a respectful intervention and preservation of the intrinsic characteristics of the painting. While minimal treatment was chosen for the paint layer, a more interventive approach was required to address structural damages to the textile support, which was the main focus of the project. Natural materials commonly used in paper, such as Japanese paper and wheat starch paste, were selected for use in treatments, which included reinforcement of holes and strip lining. Textile stitching techniques, a humidification method, and a patch support, were carried out or applied on different areas of the painting. Paintings conservation knowledge was applied not just onto the previous treatments, but also on the conservation of tears, and localised infilling and inpainting. Projects of this nature have become more common, demonstrating collaborative effort across conservation disciplines to find the best solution for the preservation of our heritage.

Mixed Reality for Making Conservation Decisions

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ABSTRACT
A Mixed-Reality (MR) museum experience has been developed for National Museum of Singapore (NMS) "Digimuse Project Insight: Art Conservation in Mixed Reality" for understanding the behind-the-scenes of conservation work. Using technology, a museum visitor's experience is enhanced through the Holo-lens. Holo-lens is an MR tool providing audio and visual "interaction" between user and artefact, and takes a user through the steps of carrying out conservation treatment.

This digital engagement can enhance conservation training, and understanding of treatment decisions and priorities. It facilitates learning and acquisition of knowledge for future or existing conservators. The use of MR can help junior conservators to consider, or reconsider, the approaches and treatment priorities to the care of an artefact in the "Trainer-Trainee" platform.

Using this technology, a Trainee can visually communicate with the trainer to understand the decision-making matrix and treatment priorities being proposed. The Trainer-Trainee portion is carried out using a painting that had been conserved for the MR engagement. Discussions and communications are crucial in conserving an artefact; and so are decision-making, treatments prioritisation, understanding, and finding the best solution out of all possible proposals. Digital technology can perform an educational and public outreach role on issues of conservation, and raise awareness of the care required for artefacts in institutional collections. It has tremendously enriching contents that can be used to reach out to sponsors and donors well-placed to support conservation of heritage and the arts, and can also be further developed for conservation training and public education.

Analytical and Terminological Contribution to a Database of Commercial Western and Asian Blue Pigments

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ABSTRACT

Through professional dialogue between the Shaanxi Institute for the Preservation of Cultural Heritage (SIPCH) in China and the Heritage Conservation Centre (HCC) in Singapore, the problem of ambiguity in matching a pigment's vernacular term to the pigment's chemical content has been recognised as an important gap in conservation work. Pigments are an integral part of painted cultural artefacts and their identification aids in accurate attribution, dating, and the predicting of their degradation behaviour. While pigment databases have been developed in different parts of the world, none have linked chemical correlation and nomenclature of Western and Asian pigments. The accessibility of Western pigments in Singapore, and Asian pigments in China, led to a collaborative effort: developing a unified chemical pigment database.

Starting with blue pigments as a pilot study, over 100 powder pigments used for artistic or preservative purposes were acquired from various contemporary commercial suppliers. The selection of blue pigments focused on inorganic and synthetic organic pigments that were less likely to undergo chemical changes over time. Their chemical contents were verified and analysed using complementary identification techniques such as spectroscopy, microscopy, and elemental analysis. The results were then compiled in a shared database, which enabled the nomenclature of pigments native to a country to be interpreted objectively based on chemical content. Interestingly, the chemical content of half of the pigments studied were found to deviate from the pigment's vernacular term. Chemical modifications such as addition of fillers and variation in particle sizes were observed. Such formative research hopes to plug the nomenclature gaps in globally supplied pigments, which is useful for the heritage conservation community, particularly conservators, conservation scientists, and artists.

Investigation and Research on the Bio-deterioration in Outdoor Stone Cultural Heritage, Shaanxi Province, China

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ABSTRACT
This poster is a follow-up from my earlier published research. An investigation was conducted on bio-deterioration of 19 outdoor stone heritage sites in Shaanxi Province, China. The survey included the type and species of the organisms and their distribution patterns. The type of bio-deterioration that had occurred included algae, lichen, moss, animal and advanced plant. Lichen was found to have grown in 16 sampling points, algae in 11 and moss in 6. Conclusion from correlation analysis that feldspar and hold time of the stone have significant effects ($P<0.05$) on the distribution of bio-deterioration in the stone cultural heritage.

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