
conservation

CONTRIBUTORS
Agnes Sing
Cindy Lau
Chuance Chen
Damian Lizun
David Chew
Derek Lu
Elsie Wong
Esther Ng
Ishak bin Ahamad
Khairuddin Hori
Lynn Chua
Phyllis Koh
Sarah Chui
Siti Suhailah Salim
Tan Pei Qi
Zuraidah Ehsan

PROJECT MANAGER
Janice Teng

EDITORS
Timothy Hayes
Loh Heng Noi
Sean Lee

COPYEDITORS
Sunda Press Pte Ltd

***ON CONSERVATION* ISSUE 3**
Published in 2015 by
Heritage Conservation Centre
32 Jurong Port Road
Singapore 619104

ABOUT *ON CONSERVATION*

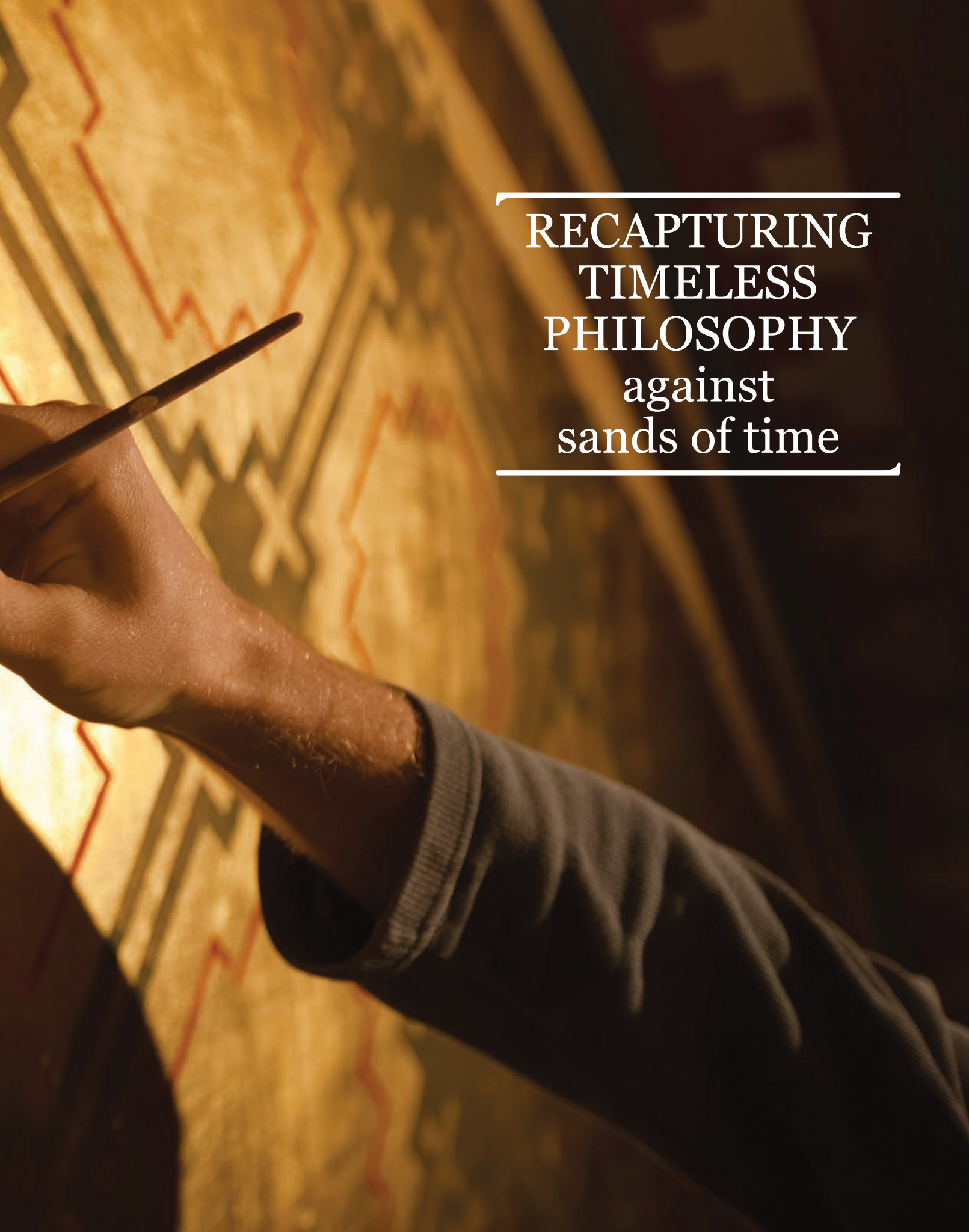
On Conservation is a biennial series published by the Heritage Conservation Centre (HCC). It is aimed at sharing with the local and international communities the techniques, methodologies and processes employed by its collections management and conservation practitioners. This journal presents their approaches undertaken for various exhibitions and case studies, and the rationales behind their thinking and applications of cross-disciplinary skills. This publication is a cumulation of learning experiences from salient and meaningful projects.

HCC is constantly building relationships with practitioners from Singapore and beyond. Our collaboration with overseas partners is shown in some of the articles in this series. Their wisdom and generous sharing of their skills, knowledge and experience have helped us towards our goal of continuous improvement and vision of excellence.

DESIGNED BY Verztec Consulting Pte Ltd
Printed in Singapore

ISSN 2010-3123

CONTENTS


RECAPTURING
TIMELESS
PHILOSOPHY
against
sands of time

FOREWORD

The Heritage Conservation Centre (HCC) is entrusted with the task of caring for and preserving our national heritage materials, known collectively as the National Collection, for posterity.

HCC staff are constantly challenged to think critically about their work. They need to update their professional skills, whether for handling scientific equipment and chemicals or exercising care when they work on heritage objects. They have to keep abreast of new tools, technologies and ideas to achieve higher productivity and new levels of excellence. They also need to devote time to research and strategic planning to ensure sustainability, continuity and improvement. Just as importantly, they need to improve access to their work in order to enable more people to understand and appreciate what our rich National Collection has to offer.

I would like to take this opportunity to express my appreciation to my HCC colleagues for their dedication and diligence, and congratulate HCC on the third issue of the biennial series. I am sure readers will make many interesting discoveries in this edition.

MRS ROSA DANIEL
Chief Executive Officer, National Heritage Board

PREFACE

When we start a good thing, the right thing to do is to keep at it; along the way, we improve it and maintain its relevance. The *On Conservation* series is a worthy initiative that encourages learning, promotes discussions and facilitates sharing. It is therefore definitely a good thing that the Heritage Conservation Centre (HCC) continues to nurture and grow it.

Our aim for *On Conservation 3* is to adaptively capture and reflect HCC's conservation and collections management developments for the purposes of learning and broad sharing. Our strategy for this issue had to be calibrated against our operational commitments to projects for SG50, the celebrations of Singapore's Golden Jubilee. Such considerations led us to select relevant projects that were completed and meaningful projects that were undertaken for SG50. We have also included other projects that document significant developments, so as to capture knowledge from HCC's journey as well as to share our experiences, challenges and lessons learnt before valuable tacit knowledge perishes.

I offer my heartfelt gratitude to all the contributors for *On Conservation 3*. Their dedication to their jobs and their passion for learning have made it possible for HCC to produce this third issue despite their SG50 work schedule.

Loh Heng Noi and Timothy Hayes generously served on the Editorial Panel for this issue. Their rich experience and wide perspectives have enriched the articles. To Heng Noi and Timothy, I gratefully extend my sincere appreciation and thanks.

To you, our reader, I wish you pleasure in going through the pages. Please feel free to email us at NHB_HCC@nhb.gov.sg if you have recommendations, feedback or suggestions to help us improve. Thank you!

SEAN LEE
Director, Heritage Conservation Centre


OUR
DEDICATION
IS ENGRAVED
into our efforts of
restoring the past

DREAM OF THE PERFECT CHAMBER – Textile Conservation For A Peranakan Bed

By

Chuance Chen, Assistant Conservator (Textiles) and Elsie Wong, Conservator (Textiles)

Figure 1. **The Penang-style bed set up as a wedding chamber at the National Museum of Korea, South Korea, in 2013.** From the collection of the Peranakan Museum

Figure 2. **The Malacca-style bed has two tiers and acts as a night bed (left) and day bed (right)** Wedding bed, (2011-01742 & 2011-01741). Courtesy of the Peranakan Museum

INTRODUCTION

For many years, the Peranakan Museum showcased a Penang-style Peranakan wedding bed. This bed was a hard worker and had travelled widely to places such as Musée du quai Branly in France in 2010 and the National Museum of Korea in South Korea in 2013 (Figure 1). The bed could finally take a break when the Peranakan Museum acquired a Malacca-style two-tier bed to replace it in 2013 (Figure 2).

The Malacca-style Peranakan bed, circa early to mid 20th century, features raised, openwork gilt carvings. They depict fertility, auspicious and sacred symbols like phoenixes, peonies and the Eight Immortals of the Taoist religion. The bed also comes with an intricate hand-embroidered set of 17 textiles made of vivid silk threads. The Textiles Conservation Section of the Heritage Conservation Centre (HCC) was tasked to carry out conservation treatment for these fabrics and to dress the bed according to Peranakan wedding chamber traditions. In this article, we discuss two challenging parts in the conservation project: mounting the night bed's curtain and securing a pair of window covers to the day bed's frame.

BACKGROUND

THE MALACCA-STYLE PERANAKAN BED

Jackie Yoong, Curator at the Peranakan Museum, shared valuable insights into the history of the Peranakan wedding chamber and bed, which informed our work. Since the late 15th century, the wedding chamber had played a significant role in Peranakan Chinese weddings. It was a room set aside – usually in the bride's house – for the couple. In Singapore and Malacca, Peranakan Chinese families had two beds for weddings: one was a double bed and the other a single, and they usually had matching designs. The use of the single bed varied across families. The wedding beds occupied a central space and role in the chamber as they were perceived to be the site where descendents for the family are conceived. Rituals are performed to bless the beds and the chamber before and during a wedding.

The acquired Malacca-style double-tier bed, set of 17 textiles and two chair covers belonged to the family of Sharron Chee, an 11th-generation Peranakan. According to Yoong, it is extremely rare

to find such a bed today with its original accompanying textiles and provenance. The Chee family had used the set for at least five weddings over three generations since the early 20th century (Figure 3). The family is one of the oldest documented Peranakan families in Singapore and Malacca, with their roots dating to the early 18th century.

Figure 3. **Actual set-up of the wedding chamber at the Chee family home in 1994**
Photo courtesy of Sharron Chee

CONDITION ASSESSMENT

We received the Peranakan artefacts in October 2011. The set comprises bed curtains, curtain wraps, window covers, bed spreads and mattress runners, among other decorative pieces. The textiles are all heavily embroidered or embellished (Figure 4). For example, two red plain silk chair covers are embroidered with gold metal-wrapped threads. Every piece of this recent acquisition is delicate because of its intricate details, and requires careful and minimal handling. Our conservation approach was to treat all the textiles consistently in terms of their aesthetics, as they would later be showcased as a set.

Beds belonging to both Malacca and Penang Peranakans are exported Chinese furniture made of nam wood. They also have intricately carved auspicious Chinese motifs. But while the Penang wedding chamber comprises just one bed, the Malacca chamber has two – a double bed and a single bed with matching textiles. Malacca and Penang Peranakan beds use Chinese export textiles. However, some collectors believe that there are variations in their border designs. The bed accessories also differ. The Malacca versions usually have intricate silver hangings and a rectangular wooden *sireh* box.[1] On the other hand, Penang *sireh* boxes come in different shapes and are embellished with embroidered hangings.

To facilitate the conservation and set-up process, we first collated vital information, including images of comparable textiles and bed structures. However, the resources were limited. Most of them were archival photographs, and we depended on them for clues on

Figure 4. **Dark blue horizontal bed or door hanging,** (2011-01954-002).
Courtesy of Peranakan Museum

> "The Chee family is one of the oldest documented Peranakan families in Singapore and Malacca, with their roots dating back to the early 18th century."

[1] *Sireh* or betel nut boxes are containers for storing betel leaves, gambier, lime, cloves and chalk needed for chewing. The exchange of betel nut was of great significance at the prenuptial ceremonies of Peranakan weddings.

"Mylar polyester film lining for 3D artefacts; and polyethylene mattresses. These were chosen because they were light enough to support the bed spreads and beaded pillow covers without weighing down the bed structure."

Figure 5. **Embroidery of a deer on the bed curtain**
Detail from bed curtain, (2011-01745).
Courtesy of Peranakan Museum

the overall presentation of a dressed-up bed. Eventually, the pictures were still insufficient, providing only a fraction of the information our textile conservation work required. For example, we could not gather adequate information from the photographs on the mounting of the 8.5m-wide night-bed curtain and a set of day-bed window covers.

Meanwhile, we did a preliminary assessment on the condition of the artefacts to obtain an estimated treatment time, which would be 650 hours, and to determine the mounting methods. The assessment took into consideration interventive conservation treatment, which constituted stabilising the structure, deterioration, deformation, as well as the sequence of the installation. The assessment was also an opportunity to explore possible solutions to the mounting issues we had. Some of the mounting methods eventually adopted for this installation included the use of support fabric with a combination of herringbone/tunnel stitches to mount a pair of curtain catchers; cotton fabric to secure hangings; fabric lining to support flat displays; Mylar polyester film lining for 3D artefacts; and polyethylene mattresses. These were chosen because they were light enough to support the bed spreads and beaded pillow covers without weighing down the bed structure.

CONSERVATION

MOUNTING THE LARGE NIGHT BED CURTAIN

We began the set-up by installing the curtain to the Malacca night bed as it makes up the biggest part of the bed and is to be wrapped around it. The curtain is also the largest textile in the set, measuring 8.5m in width and 2.2m in length, with 11 panels of plain silk embroidery (Figure 5). For this particular curtain, there was neither a string for fastening it to the frame, nor a sewn loop typically found in curtains. It was simply like a piece of *kain panjang* (wrap cloth), except it was longer and much wider (Figures 6 and 7).

The challenge was mounting the large and heavy fabric on the bed frame in the most secure way. Our earlier research yielded no information on this; neither were there any tips on presenting the curtain. Eventually, we decided to utilise a header cloth, which is a common and secure stitch-mount method of vertically presenting a flat textile. In this method, a piece of fabric of similar thickness is sewn on the top border of the textile, acting as a header which the piece hangs from (Figure 8).

We adopted this method because the header cloth would wrap the bed curtain well around the three-dimensional bed structure: the header cloth distributes the

Figure 6. **Rolling out the bed curtain**

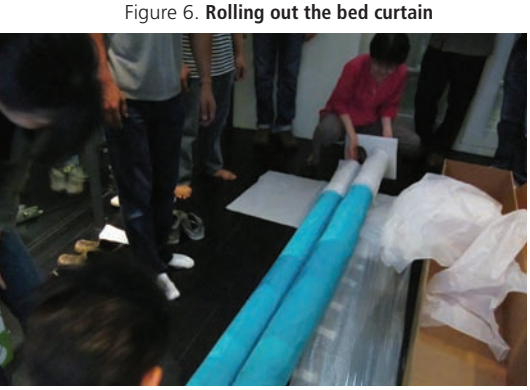


Figure 7. **Treating the bed curtain**

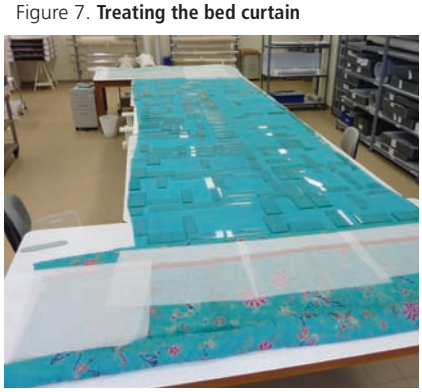


Figure 8. **Bed curtain stitched to a header cloth**

Figure 11. **The front (left) and back (right) of a window cover**
Gold window cover for the side of the front bed with 3 phoenixes and 1 deer, (2011-01943-001). Image Courtesy of Peranakan Museum

weight of the textile evenly while securing the piece firmly to the bed frame ceiling. We also added cotton ties to the header cloth to help secure it to the bed frame (Figure 9).

After much snipping of the header cloth and pinning, and countless repositioning of the embroidered panels, the curtain was successfully mounted (Figure 10). Removing excess header cloth was a tedious process, but it was necessary in order to obtain the best fit for the bed curtain and to mount it securely at various points. After the bed curtain was installed, the remaining textiles for the night bed were put up quickly and easily.

SECURING A PAIR OF WINDOW COVERS

The other challenge was securing a pair of gold window covers to the day bed (Figure 11). Yoong said that both sides of the hand-embroidered covers should be visible since this would help to better present their workmanship. This could be done by mounting them on the bed's pair of detachable carved wooden frames, which act like windows (Figure 12).

Earlier, the owners had glued the gold window covers to the bed's detachable wooden frames. Adhesive residues were spotted on the edges of the window

Figure 12. **The bed's detachable wooden frames that act like windows**
Part of wedding bed, (2011-01741-010 & 2011-01741012). Image Courtesy of Peranakan Museum

Figure 9. **Cotton ties added to the header cloth**

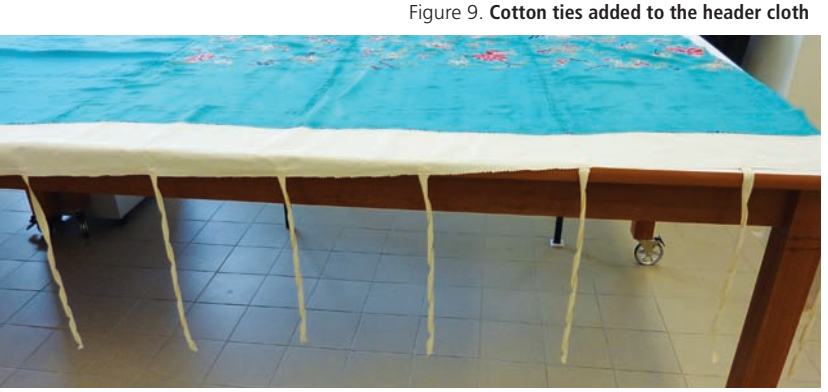


Figure 10.
The conservator and art handlers dressing the bed with the large curtain

Figure 13. **The edges of a gold window cover turned brown due to adhesive remains**
Detail from Gold window cover for the side of the front bed with 3 phoenixes and 1 deer, (2011-01943-001).
Image Courtesy of Peranakan Museum

Figure 14. **Conservators applying mounting stitch to the artefact**

covers. The adhesive had caused the edges to turn brown and become rigid (Figure 13). The challenge was selecting a conservation method that could secure the covers without tarnishing them. The previous method of using adhesives was not an option.

After much exploration and weighing the visual importance of the covers against their condition, we decided to apply the mounting stitch method without the use of a support fabric. The idea was to have the covers support themselves evenly on all sides of the wooden frames. The mounting stitch method utilises 100% polyester thread. We also took advantage of the inner part of the wooden frame by applying another set of mounting stitches there. In total, it took an afternoon with four pairs of hands to complete the task (Figure 14).

In addition, a piece of 0.3mm-thick acrylic sheet – cut slightly smaller by 0.05mm – was added to the front of each frame to better support the window covers. Holes were then drilled at strategic parts of the window covers. Nylon string insulated with polyethylene tubing was sewn through these holes to further secure the covers to the frames.

The result is pleasing. The pair of gold window covers is now supported evenly on all four sides of each wooden frame and also backed by an acrylic sheet.

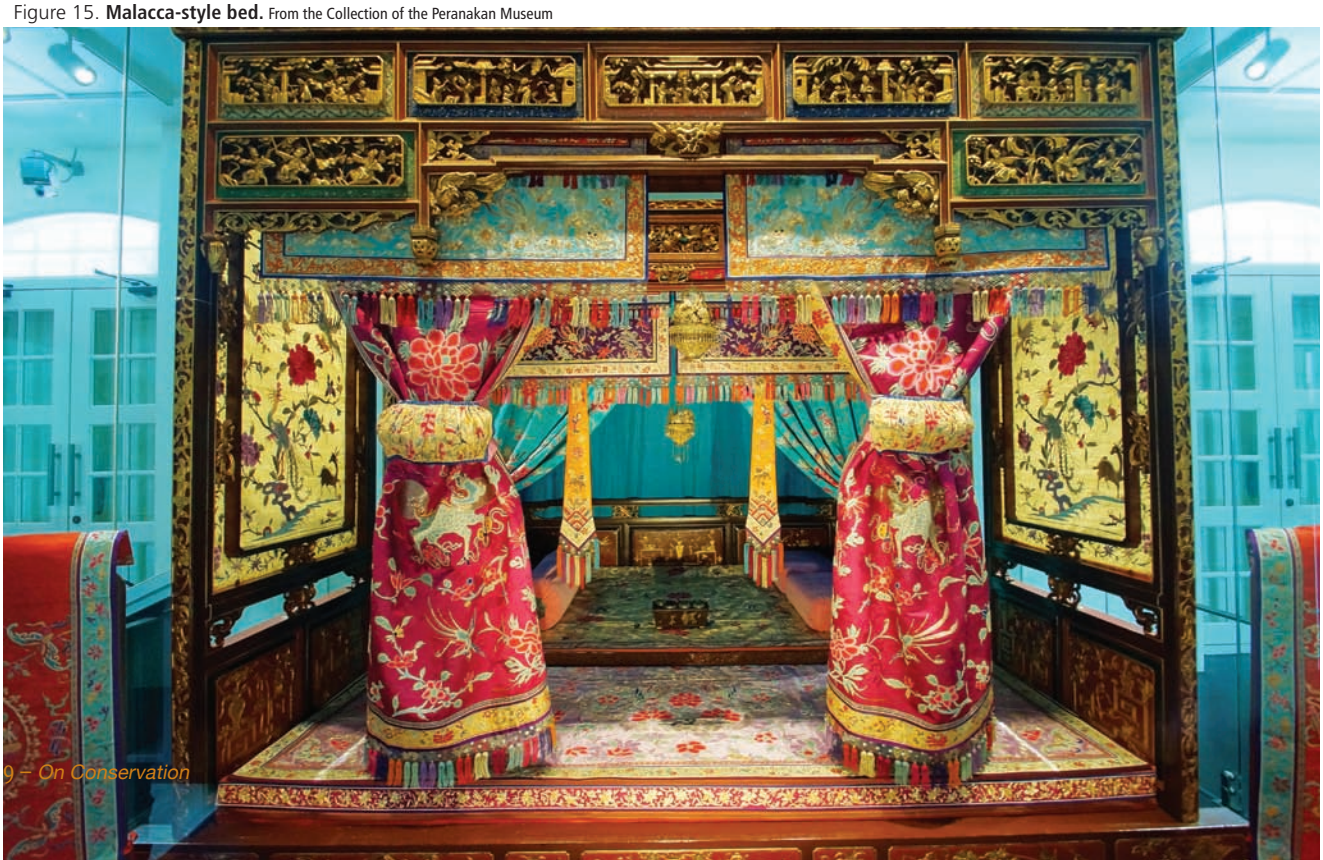
CONCLUSION

The final touches to the bed ensemble include pillows and a silver *sireh* set (Figure 15). If you have the opportunity, we recommend that you get up-close and personal with this exhibition at the Peranakan Museum to witness the beauty of this culture, the intricacies of the bed set-up, and the efforts behind textile conservation treatment.

ACKNOWLEDGEMENTS

The installation of the wedding chamber was made possible by the Peranakan Bed Project Team comprising HCC Conservators (Textiles); Mr Konstantinos Chatziantoniou, HCC's external conservator who assisted in the interventive conservation work; and Ms Jackie Yoong, who gave her invaluable advice on the proper usage of the Peranakan artefacts featured in this article.

Figure 15. **Malacca-style bed.** From the Collection of the Peranakan Museum



17 TEXTILES FROM THE PERANAKAN WEDDING CHAMBER

Night bed curtain *(Klambu ranjang blakang)*
(2011-01745)

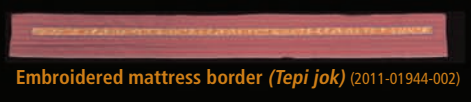
Dark blue horizontal bed or door hanging *(Kain bee)*
(2011-01945-002)

Dark blue horizontal bed or door hanging *(Kain bee)*
(2011-01945-001)

Night bed spread *(Kain jok)* (2011-01744)

Orange bed hanging *(Kain necktie ranjang)*
(2011-01947-002)

Orange bed hanging *(Kain necktie ranjang)*
(2011-01947-001)



Embroidered mattress border *(Tepi jok)* (2011-01944-002)

Gold window cover for the side of the front bed with 3 phonixes and 1 deer *(Kain pin)*
2011-01943-001

Gold window cover for the side of the front bed with 3 phonixes and 1 deer *(Kain pin)*
(2011-01943-002)

Purple vertical curtain for the front bed *(Langsir ranjang depan)*
(2011-01746-002)

Light blue horizontal hanging for the front bed *(Kain bee)* (2011-01747-001)

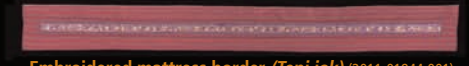
Light blue horizontal hanging for the front bed *(Kain bee)* (2011-01747-002)

Purple vertical curtain for the front bed *(Langsir ranjang depan)*
(2011-01746-001)

Cream ground bed curtain tie *(Kain chengkam langsir ranjang)*
(2011-01940-002)

Bed spread *(Kain jok)* (2011-01743)

Cream ground bed curtain tie *(Kain chengkam langsir ranjang)*
(2011-01940-001)



Embroidered mattress border *(Tepi jok)* (2011-01944-001)

Courtesy of Peranakan Museum

CSI: CONSERVATION SCENE INVESTIGATION – Investigating Mercury Presence in a Chinese Opera Troupe Collection

By

Ishak Ahamad, Assistant Conservator (Objects) and Cindy Lau, Assistant Conservator (Objects)

INTRODUCTION

In 2009, a conservator discovered an abnormal phenomenon happening to a Chinese opera troupe collection stored in the Heritage Conservation Centre (HCC): silvery droplets were dripping from the painted surface of a wooden ruler and a decorative opera sword. A qualitative chemical spot test was carried out on the droplets, revealing the presence of mercury.

Mercury is highly toxic. It has a low melting point and quickly turns into liquid and vapour at room temperature. This heightens the risk of mercury entering the body by inhalation or through epidermal contact.

Our investigation on detecting mercury in objects would be the first of its kind done in HCC. A preliminary plan was laid out in 2010.[1] Our research aimed to reveal the risks that practitioners face when dealing with hazardous objects – in this case, items with mercury – and to put in place safety measures for them.

The process of our investigation primarily comprised surveying the entire opera troupe collection to identify and segregate objects suspected of containing mercury. This was done in two ways: through a chemical identification method, and via qualitative analysis using a handheld X-ray fluorescence (XRF) machine.

BACKGROUND

THE CHINESE OPERA TROUPE COLLECTION

The collection was acquired by the National Museum of Singapore, National Heritage Board (NHB). From 1996 to 2003, the items in the collection were either purchased from or donated by opera doyens and collectors, who had bought or commissioned them for various opera troupes that performed in Singapore and Southeast Asia. The objects are dated from the 19th to 20th century and were most likely made in China or Hong Kong; however, their manufacturers are unknown.[2] Of the 126 items in this collection, 22 of them displayed a shiny coat and were suspected to contain mercury. Most of these objects are spears; a few are sabres and swords, and one is a stool.

All mercury-suspected pieces in the collection have their surfaces, sharp ends or blades constructed from wood and coated with a silvery paint. In the past, mercury or its compounds were added to paint to achieve the commonly seen shiny appearance of Chinese opera props. Mercury also acts as a fungicide to prevent the growth of bacteria, mildew and mould. In addition, lead was used with mercury to increase the paint's drying rate, durability and resistance to moisture.

MERCURY: A DANGER ZONE

Mercury is a highly toxic metal. A person exposed to it risks mercury poisoning, the extent of which is dependent on the duration and intensity of the exposure. Mercury can enter the body through ingestion, inhalation or direct dermal contact, the last being especially lethal. Mercury poisoning results in a loss of vision, sensation, mobility and taste, and causes numbness and tunnel vision. Chronic exposure results in brain, heart, spinal cord, kidney and liver damage, and a weakening of the body's immune system.[3] Long-term exposure leads to worse symptoms such as personality changes, stupor, coma and death.[4] The severity of mercury poisoning depends on the route of exposure and the concentration and form of the mercury compounds.

Mercury compounds are generally neurotoxins that damage the brain and central nervous system. Organic mercury compounds such as phenylmercuric acetate and phenylmercuric nitrate were used in indoor water-based latex paints as a preservative against mould and mildew. When cases of toxicity from long-term inhalation were discovered, these compounds were removed in paints in 1990.[5]

Methylmercury, an alkyl mercury compound, is one of the most toxic mercury compounds. When a mother is exposed to it, her fetus' learning ability and neurodevelopment can be affected. Mercury's bioaccumulation ability causes it to be stored in the kidneys and brain, and pregnant mothers can pass it to their babies.[6] Ecologically, mercury can be transferred up the food chain from crops to animals in a process known as bio-magnification. The entire food web risks being poisoned and contaminated even if some of its links have no direct contact or interaction with mercury.[7]

In the museum and storage context, the sources of mercury include mercuric salts in mineralogical collections; artists' materials such as cinnabar and vermillion (commonly used as paint pigments in old paintings); insecticides in taxidermy and ethnology collections; and organic mercury in phenylmercuric acetate and phenylmercuric nitrate, which are common in pharmaceutical, medical and dental equipment collections.

The entry of mercury or its compounds from the collection into the body by ingestion or dermal contact is minimal. The danger lies in inhaling mercury vapour – this is often difficult to detect. The partial pressure of mercury in the air at 25°c is quite low (0.0018mmHg). Partial pressure is the hypothetical vapour pressure for mercury vapour in equilibrium with its solid or liquid state at a given temperature in a closed system.[8] In other words, the amount of mercury vapour produced from the solid or liquid states of mercury compound is small. But in an unventilated space, mercury vapour can easily exceed the recommended maximum amount (0.025 mg/m^3) and become a health hazard.[9] Thus, objects containing liquid mercury or that have undergone mercury spill present risks.

MERCURY EXPOSURE LEVEL RESTRICTIONS IN SINGAPORE

The Occupational Safety and Health Division under the Ministry of Manpower states that the Biological Threshold Limit Values for inorganic mercury presence in human urine should not be more than 35ug/l.[10] In the Workplace Safety and Health Act, the long-term Permissible Exposure Level (PEL) for contaminated air assigned to inorganic mercury forms – including metallic mercury and mercury vapour – is $0.025mg/m^3$; for aryl mercury compounds it is 0.1 mg/m^3; and for alkyl mercury compounds it is $0.01mg/m^3$. Due to the high toxicity of alkyl mercury compounds, a short-term PEL of $0.03mg/m^3$ is specifically assigned to it.[11] It is important to note that globally, there is no legal safe value for mercury absorption through dermal exposure from the handling of artefacts containing mercury.

METHODS OF DETECTING MERCURY

Our examination of objects suspected of containing mercury involved two steps. First, a mercury-testing form was developed for documenting and compiling the results collected from examining each object. It would also be used for the documentation of such tests in the future.

Second, we engaged two types of methods to detect and identify mercury. The chemical testing method utilises Diphenylcarbazone and is a common method for detecting mercury.[12] The alternative testing method is done with a handheld XRF machine. Because it utilises advanced technology and precision, the X-ray fluorescence analysis method has become increasingly popular in the arts and archaeology fields. It is used for a range of purposes including elemental analysis and hazardous substances detection.[13]

[1] The plan was halted in 2011 due to HCC's Addition and Alteration Project to expand storage capacity. The mercury investigation project resumed in 2012.

[2] "Museum Collection System," National Heritage Board, accessed March 4, 2014.

[3] "ToxFAQs™ for Mercury," Agency for Toxic Substances and Disease Registry, accessed October 2, 2013, http://www.atsdr.cdc.gov/toxfaqs/tf.asp?id=1195&tid=24; John F. Risher, *Elemental Mercury and Inorganic Mercury Compounds: Human Health Aspects* (Geneva: World Health Organization, 2003), 21–26.

[4] Ibid.

[5] Nancy Odegaard and Alyce Sadongei, *Old Poisons, New Problems: A Museum Resource for Managing Contaminated Cultural Materials* (Walnut Creek: Altamira Press, 2005), 74–76.

[6] "Mercury and the Environment," Canadian Conservation Institute, accessed July 4, 2013, http://www.ec.gc.ca/mercure-mercury/Default.asp?lang=En&n=DB6D2996-1; "Toxicological Profile for Mercury," Agency for Toxic Substances and Disease Registry, accessed July 4, 2013, http://www.atsdr.cdc.gov/toxprofiles/tp46.pdf; Risher, *Elemental Mercury,* 220–478.

[7] Ibid.

[8] Donald J. DeCoste and Steven S. Zumdahl, *Chemical Principles* (Australia: Cengage Learning, 2012), 827.

[9] Canadian Conservation Institute, "Mercury in Museum Collections," *CCI Notes 1/7* (2002), accessed July 4, 2013, http://www.cci-icc.gc.ca/resources-ressources/ccinotesicc/1-7-eng.aspx.

[10] Occupational Safety and Health Division, Ministry of Manpower Singapore, *OSH Guidelines on Toxic Industrial Waste Treatment* (Singapore: Ministry of Manpower Singapore, 2003), accessed July 4, 2013, http://www.mom.gov.sg/Documents/safety-health/factsheets-circulars/OSH%20Guidelines%20on%20Toxic%20Industrial%20Waste%20Treatment.pdf.

[11] Ministry of Manpower Singapore, *Workplace Safety and Health (General Provisions) Regulations, September 8, 2011,* accessed July 4, 2013, http://www.mom.gov.sg/Documents/safety-health/WSH%20(General%20Provisions)%20Rgs.pdf.

[12] Nancy Odegaard et al., *Materials Characterization Tests for Objects of Art and Archaeology* (London: Archetype Books, 2000), 74.

[13] Aaron N. Shugar and Jennifer L. Mass, eds., *Handheld XRF for Art and Archaeology* (Leuven: Leuven University Press, 2012), 17–36.

Figure 1. **Preparing the Diphenylcarbazone solution to be added to samples**

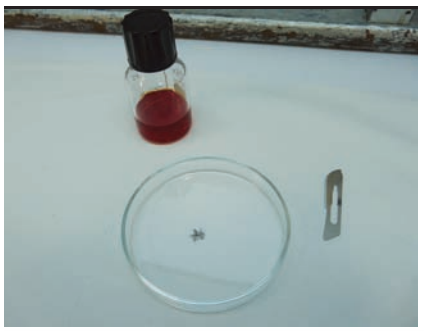


Figure 2. **Removing a small sample from the surface of a suspected object for testing**

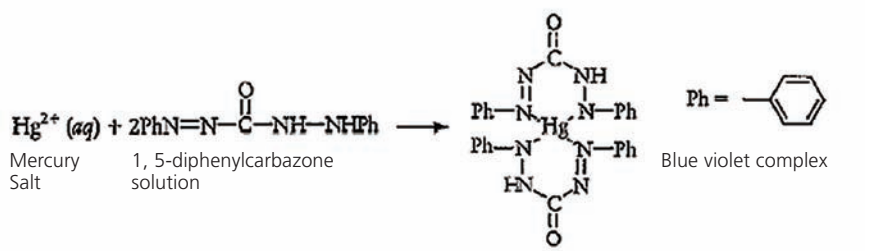


Figure 3. **Chemical equation of the reaction between mercury salt and 1,5-Diphenylcarbazone to form blue violet complex. Source: Diagram from Nancy Odegaard et al., *Materials Characterization Tests for Objects of Art and Archaeology* (London: Archetype Books, 2000), 74**

CHEMICAL TESTING WITH DIPHENYLCARBAZONE

A Diphenylcarbazone solution was made by dissolving 0.05g of 1,5-Diphenylcarbazone in 5ml of ethanol (analar grade) in a small 50ml beaker (Figure 1). Small samples, suspected to contain mercury, were extracted from the surface of the objects with a surgical scalpel and placed in a spot test plate (Figure 2). Two to three drops of the reddish 1,5-Diphenylcarbazone solution were added to the sample with a disposable pipette to test for a reaction (Figure 3). The formation of a blue violet complex indicated the presence of soluble mercuric salts (Figure 4). If there was no presence of mercury, no blue violet complex appeared (Figure 5).

The mercury test results were analysed and assigned three different ratings:

TABLE 1. MERCURY TEST RESULTS AND RATINGS

Result	Rating
Blue violet complex appeared	Positive
Slight tint of purple complex	Possibility
No blue violet complex appeared	Negative

Figure 4. ***Sample* shows the formation of a blue violet complex, which indicates the presence of mercury in the object; there is no such complex in *Control***

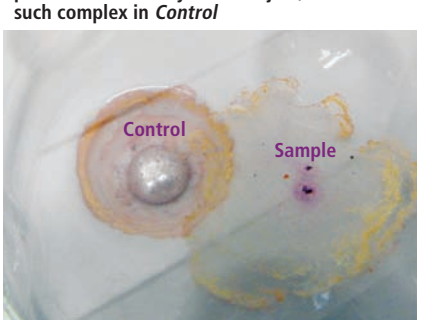


Figure 5. **If there is no presence of mercury, no blue violet complex will appear**

X-RAY FLORESCENCE ANALYSIS WITH XRF

A Handheld X-ray florescence machine, the Thermo Scientific Niton XL3t GOLDD XRF Analyser, was used in the electronic metal mode to detect and analyse mercury. The Restriction of Hazardous Substances Directive (RoHS) provided a guide to the permitted level of mercury in each object.[14]

XRF makes use of a primary X-ray source via an X-ray tube to excite and eject electrons from their inner atomic shells. This creates a vacancy in the inner shells and causes the atom to be unstable. For the atoms to be stable again, electrons from the outer shells will have to be transferred to the inner shells to fill up the vacancy. During the transition, a characteristic secondary X-ray is given off with energy levels indicating the energy difference between the two corresponding shells. The energy levels for each element are unique and this reading allows for a non-destructive analysis of the elemental composition of an object.[15]

Safety remained a priority – in particular, we were conscious about our exposure to electromagnetic radiation from the XRF machine. The project supervisor and team member took turns to use the machine. Before each user handled the device, he had to attend proper health and safety radiation training and must be licensed by the Radiation Protection and Nuclear Science Department under the National Environment Agency. They each wore the Thermoluminescent Dosimeter (TLD) badge at all times during XRF testing to monitor the accumulated dosage of radiation they were being exposed to. This also ensured they would abide by the legal total dosage per year (less than 20mSv per person). In addition, they attached a lead shield to the head of the XRF machine to mitigate the effects of scattering radiation that might affect the user (Figure 6).

RESULTS

Chemical spot testing identified six objects with the mercury rating "Positive", 12 objects with the rating "Possibility" and four objects with the rating "Negative". The results from the Handheld X-ray florescence machine indicated 13 objects having mercury levels higher than the RoHS-permitted amount, which gave them the "Positive" rating, two objects suspected of negligible mercury presence and with the mercury rating "Possibility"; and seven objects with no mercury detected.

We gathered a few observations on our methodology from our investigation. First, there were slight discrepancies between the results obtained by chemical testing and by XRF testing. Only two objects yielded different results after being tested by the two methods. The discrepancy could be due to zinc, as the two objects had zinc in their compounds.[16] Zinc reacts with 1,5-Diphenylcarbazone to form other coloured compounds, leading to a faulty result.[17]

We eventually found the handheld XRF to be of higher accuracy. In the chemical test, there were different degrees of colour saturation in the blue violet complex, but this had no relation to the percentage of mercury in the sample. The XRF eventually provided a non-destructive and simpler detection method.

Finally, we found that lead is usually present in the objects with mercury. Although lead also poses a health hazard to handlers, its risks are of lower severity compared to mercury. This is because it does not vaporise into gaseous form, and so, cannot be inhaled.

NEW PROCEDURE

We created an SOP detailing guidelines on handling and storing objects containing mercury. We hope this will help collections officers and conservators with managing artworks and artefacts suspected of containing mercury, and better protect the handlers' health and safety.

The SOP works like an alert system. It encompasses visual detection guidelines for new acquisition or artefacts in the National Collection, which includes principles on immediate response, point of contact and subsequent measures relating to objects suspected of containing mercury. Once the alert is raised, the objects would undergo qualitative testing with the handheld XRF. To ensure that mercury-confirmed objects are clearly communicated as hazardous, instructions and procedures have been specified for their packing and labelling.

The method of transporting these objects is also stated. It is especially necessary to don the appropriate Personal Protective Equipment (PPE) when handling the objects. An N95 face mask, nitrile gloves and disposable lab coats are recommended.[18] Procedures to dispose these pieces of equipment have also been outlined to prevent the cross-contamination of mercury between handlers.[19]

Figure 6. **A user wearing TLD Badge while using the Thermo Scientific Niton XL3t GOLDD XRF Analyser that comes attached with a lead shield**
Detail of Sabre - Puppet Prop, (2000-01376). From the Collection of National Museum of Singapore

[14] "RoHS Restricted Substances," Restriction of Hazardous Substances Guide, accessed July 4, 2013, http://www.rohsguide.com/rohs-substances.htm.

[15] M. Steven Shackley, X-Ray *Fluorescence Spectrometry* (XRF) in *Geoarchaeology* (New York: Springer, 2011), 17; Philip J. Potts and Margaret West, *Portable X-Ray Fluorescence Spectrometry: Capabilities for In Situ Analysis* (Cambridge, U.K.: RSC Publishing, 2008), 1–12.

[16] The two objects are 2001-05694 and 2001-05695 in the Museum Collection System.

[17] Christine Found and Kate Helwig, "The Reliability of Spot Tests for the Detection of Arsenic and Mercury in Natural History Collections: A Case Study," *Collection Forum* 11, no. 1 (1995): 6–15; Fritz Feigl, *Spot Test in Inorganic Analysis* (New York: Elsevier Publishing Company, 1972), 669.

[18] The N95 mask, manufactured by 3M Singapore, is clinically proven to provide at least 95% filtration efficiency against solid and liquid aerosols.

[19] Deborah Cane, "Safe Handling of Museum Collections Containing Arsenic," *ICON Newsletter* 19 (2012): 18–20.

In the SOP, we also provide specific recommendations on opening bagged objects. Both handlers and viewers are to equip themselves with the proper PPE and to only carry out the opening under a fume extractor. This is to ensure the complete dissipation of mercury vapours. The priority is to minimise the inhalation of mercury vapour, which may have accumulated in the sealed bags during the handling and transport period. A sharing session was conducted for all staff on the SOP and the health hazards of mercury in July 2013. Refresher courses will also be conducted upon request.

PACKING AND STORING OBJECTS WITH MERCURY

Previously, objects containing mercury were stored uncovered and indiscriminately with HCC's other collections in Mixed Media Store 2. We eventually created new packing methods and a centralised storage area for them.[20]

We had four key considerations when it came to planning the packing and storage procedure for these items. One, the process must deter the spread of mercury compounds or vapour. Second, the package design must allow for easy handling and access to the objects in the future. Third, the packing materials must be chemically stable, cost effective and widely available. Fourth, clear and simple mercury hazard labels should be placed on the packed objects.

The new packing method involves the use of a polyethylene sheet. Besides its low cost, the sheet's transparent property also enables the objects to be viewed easily after packing (Figures 7 and 8). It is also widely available. The packed bags are sealed with a heat sealer and taped with a pressure-sensitive tape. They are then clearly labelled with the mercury warning labels (Figure 9). The final step segregates and stores them in a specially allocated area in Mixed Media Store 2 (Figure 10). The concern about microclimates in the bags is addressed in the SOP. There are detailed instructions on opening the bagged objects, which may contain mercury vapour due to the elimination of air circulation, and ways of preventing inhalation of the vapour.

Figure 7. **Packing normal objects**

Figure 8. **Packing large objects**

"Besides its low cost, the sheet's transparent property also enables the objects to be viewed easily after packing"

DISSEMINATING INFORMATION

NHB's object database, the Museum Collection System (MCS), will be updated. For the record of each object found with mercury, comments will be added under the "HCC Remarks" column of the "Acquisition/Inventory" function. This ensures proper dissemination of information to HCC personnel, curatorial staff and researchers.

CONCLUSION

Of the 22 pieces in the opera troupe collection, more than half have a high amount of mercury compounds, which poses a health hazard to handlers. Globally, there is still insufficient research to establish the toxicity values (or reference concentrations) for inhalation exposure to mercury compounds. Thus, it is safer to be extremely careful when dealing with any amount of mercury vapour.

Nonetheless, our investigation was done not so much to prevent contact with objects containing mercury, or to call for the removal of these items from the nation's heritage collection. Rather, we aimed to raise the awareness of mercury presence in objects and suggest ways to manage them as carefully as possible. The SOP addresses the handling, storage and transport of these items in the best way possible, and most importantly, proposes health and safety guidelines for handlers.

To further enhance safety measures for staff, it has been proposed that we could develop our project for other collections in HCC – including investigating different types of hazardous substances – and plan for more specialised storage areas for these challenging objects.

ACKNOWLEDGEMENTS

We would like to express our sincere thanks to Polly Tan, Assistant Collections Manager, HCC, for her kind assistance and support in carrying out the project.

Figure 9. **Labelling the packed object with the mercury warning label**

Figure 10. **Storing them together in a specially allocated area**

[20] Laura Ratcliffe, "Rationalising Hazardous Collections," *ICON Newsletter* 17 (2012): 14–18.

"Globally, there is still insufficient research to establish the toxicity values (or reference concentrations) for inhalation exposure to mercury compounds. Thus, it is safer to be extremely careful when dealing with any amount of mercury vapour."

FURRY NO MORE – Mould Assessment and Remediation

By
Phyllis Koh, Conservator (Paper)

INTRODUCTION

The Heritage Conservation Centre's (HCC) Mould Management Team (MMT) was created in 2009 to manage the risk of mould in the National Collection and its impact on staff who are working in the repository. The idea was initiated by Loh Heng Noi, then HCC's Director, who suggested for a team to develop an integrated approach to mould detection, risk assessment, and the impact and management of mould infestation in HCC.[1] As there are no formalised groups or institutions to model after in the local heritage sector, it has been a long learning journey for MMT.

First led by former HCC Conservator Loh Boon Nee with five team members, MMT has been developing its knowledge from available research readings and courses, running small study projects, training staff to handle mouldy artefacts, leading indoor air quality (IAQ) surveys, and carrying out mould remediation in affected stores.

METHOD

MEASURING INDOOR AIR QUALITY

An integral part of HCC's mould management strategy is assessing the air quality in the building by measuring mould levels. The mould level in the air – in air-conditioned buildings – is typically quantified via IAQ surveys. From these surveys, we assess if the air quality is suitable for human comfort and health. The amount of viable mould is expressed as Colony Forming Units (CFU). This measurement has been applied in the manufacturing and medical industries to ensure acceptable levels of microbes in the environment.[2] The cultural heritage sector has also increasingly adopted the use of IAQ testing as a means of monitoring quantitative amounts of microbes that could cause deterioration of cultural objects.[3]

MMT first conducted a small study in 2010 on the use of IAQ in selected areas of HCC.[4] The results suggested that there was a relationship between higher levels of mould count and the sighted phenomenon of mould growth in some stores. Thus, it was decided that a more extensive round of IAQ survey could be conducted in all of HCC's stores and laboratories in 2011 before the mould remediation began. A local vendor was appointed to carry out the testing while the design of the survey was planned by MMT.

Another round of IAQ was then carried out in 2013 after the mould remediation. It was a good opportunity to gauge the effectiveness of the mould remediation measures in the affected stores, where HCC could compare the mould levels before and after the cleaning. Having additional rounds of IAQ surveys would also allow HCC to establish a baseline reference for mould levels in the National Collection in the future. This would determine mould levels that are safe or unsafe for the collection. Previously, there were no established limits on healthy or unhealthy mould levels.

2011 AND 2013 IAQ SURVEY DESIGN

The design of the 2011 survey included 213 air samples and 169 surface samples from all stores and laboratories in HCC. For air sampling, samples were taken at ground level (1m above the

ground and away from the walls) and at the air vent supply (AVS) and return grilles (AVR).[5] The surface samplings were acquired with the use of sterile swabs and surface contact plates. For each store, the air samples at ground level were taken from the front, centre and back of the room.[6]

In 2013, there were some changes made to the design of the survey with recommendations from various industries. Previously, three plates for air sampling were used in each room in the 2011 test. In 2013, this number changed according to the room's size, which allowed for better accuracy. Also, while both surface contact plates and swabs were used for surface sampling in 2011, this was changed to swabs only in 2013 for consistency.

The types of agar used by the same vendor were different in 2011 and 2013. Sabouraud Dextrose Agar (SDA) was used in 2011 and Rose Bengal Agar (RBA) was used in 2013. However, studies have shown that these two types of agar have no significant differences in terms of mould count and species recovery.[7] Meanwhile, 18 plates of Dichloran glycerol-18 (DG-18) agar were utilised alongside the RBA plates to gauge if there would be any significant differences. DG-18 agar is a selective medium for Xerophilic fungi, which can grow in conditions with low water activity. The Aspergillus and Penicillium genera, which contain the Xerophilic species, commonly infest library materials.[8] Results from the IAQ survey showed that in the 16 indoor locations, there were no significant differences between RBA and DG-18 plate counts.

TABLE 1. SUMMARY OF CHANGES IN THE 2013 IAQ SURVEY DESIGN

Elements	2011	2013
Air sampling at ground level	Regardless of room size, three plates were placed in each room at the front, centre and back of the room.	Dependent on room size. One plate was placed for every 100m^2 of the room.[9]
Surface sampling	Both surface contact plates and swabs were used.	Only swabs were used on all surfaces.
Agar plate media	Media used was *Sabouraud Dextrose Agar.*	Media used was *Rose Bengal Agar.* An additional 18 plates of Dichloran glycerol-18 agar were tested alongside the RBA plates.

[1] Jacinta Loh Boon Nee, I*nternal Report: Analysis of Setsco Report on the Findings of Air Velocity, Mould and Yeast Count in HCC* (Singapore: Heritage Conservation Centre, 2010), 1.

[2] The World Health Organization recommends a maximum level of 50 CFU/m^3 in hospitals.

[3] Sofia Borrego et al., "Determination of Indoor Air Quality in Archives and Biodeterioration of the Documentary Heritage," *ISRN Microbiology* 2012 (2012), accessed March 12, 2014, http://dx.doi.org/10.5402/2012/680598; Lalchand Dalal, Mousumi Bhowal, and Swapna Kalbende, "The Monitoring of Airborne Mycoflora in the Indoor Air Quality of Library," *Journal of Natural Product and Plant Resources* 2, no. 6 (2012): 675–79; Aleksander Harkawy et al., "Bioaerosol Assessment in Naturally Ventilated Historical Library Building with Restricted Personnel Access," *Annals of Agricultural and Environmental Medicine* 18, no. 2 (2011): 323–29; Cesira Pasquarella et al. "Proposal for a Biological Environmental Monitoring Approach to be Used in Libraries and Archives," *Annals of Agricultural and Environmental Medicine* 19, no. 2 (2012): 209–12; Cristina Sabbioni, Giulia Caneva and Paolo Mandriol, *Cultural Heritage and Aerobiology: Methods and Measurement Techniques for Biodeterioration Monitoring* (Dordrecht; Boston: Kluwer Academic Publishers, 2003).

[4] A total of 58 sampling points were taken by a vendor.

[5] Samples were taken at ground and air vent levels to account for spores that might be lighter or more abundant at greater heights.

[6] Measurements from these three positions would provide a good overview of the mould levels in different areas of the store.

[7] Anne Meriaux, Caroline Duchaine and Paul Comtois, "Usefulness of Using Three Different Culture Media for Mold Recovery in Exposure Assessment Studies," *Aerobiologia* 18, no. 3–4 (2002): 245–51.

[8] Flavia Pinzari and Mariasanta Montanari, "Mould Growth on Library Materials Stored in Compactus Type Shelving Units," in S*ick Building Syndrome: in Public Buildings and Workplaces*, ed. Sabah A. Abdul-Wahab (Burlington: Elsevier, 2011), 199–201.

[9] Chin S. Yang et al. recommends one sample for every 500 ft^2 of floor space, while the ISO 14644-1 standard recommends the number of samples via the square root – or m^2 – measurement of the floor space. Chin S. Yang et al., *Business Legal Reports Guide – Mold Management*, 2nd ed. (United States: Business & Legal Reports, Inc., 2006).

RESULTS

COMPARISON OF IAQ RESULTS IN 2011 AND 2013

The overall health of the rooms in 2013 improved from 2011. The improvement ranged from 69% to 92% among the various rooms, as seen in Table 2. There was a marked improvement in the air quality as seen from the AVR's air sampling and the other stores' surface swabs. These two parameters are strong indicators that the mould cleaning was successful.

TABLE 2. COMPARISON OF MAXIMUM READINGS

	Air sampling at ground level, maximum CFU/m^3	Air sampling at AVR, maximum CFU/m^3	Air sampling at AVS, maximum CFU/m^3	Surface swab, maximum CFU/25m^2
2011	850	850	1300[10]	6800
2013	120	240	110	2100
% improvement in room health	85	72	92	69

MOULD LEVEL STANDARDS

While the mould counts in HCC have reduced markedly in 2013, there is still a need to set a standard. There are numerous standards set by various industries for air-conditioned buildings.[11] They range from 500 to 1000 CFU/m^3. However, a mould count baseline reference standard for cultural materials has not been well established yet. A possible reference would be a set of empirical figures for air assessment from Integrated Control of Mould in Archives, published by the Instituut Collectie Nederlan (Tables 3 and 4).[12]

TABLE 3. AIR SAMPLING ASSESSMENT BY THE INSTITUUT COLLECTIE NEDERLAN[13]

CFU/m3	Air Assessment
0 – 25	No expected problems
25 – 100	Possible presence of source, further testing needed
100 – 1000	Source present, mould often observed on objects
< 1000	Active mould growth in area

TABLE 4. SURFACE SAMPLING ASSESSMENT BY THE INSTITUUT COLLECTIE NEDERLAN[14]

CFU	Assessment
0 – 15	Good
15 – 50	Moderate
50 – 150	Bad

MMT recommended setting a standard of 100 CFU/m^3 after evaluating the results from both surveys and the reference obtained. However, it was later deemed more practical to set a range of values. Having a range of values would allow us to evaluate which stores may require more attention in terms of inspection and housekeeping.

The current practice follows the assessment guidelines by the Instituut Collectie Nederlan. The surface sampling standards are presented in Table 4, but the units would be set at CFU/25cm^2 instead. These values are more relevant as 91.5% of the surface sampling results from the 2013 IAQ survey were less than 30 CFU/25cm^2. When future rounds of IAQ surveys are conducted, these standards will be reviewed accordingly to gauge if they are still relevant to the overall climate of the collection.

INTEGRITY OF RESULTS AND METHODOLOGY

The 2013 IAQ survey has a detailed methodology so it would be reproducible in the future. However, there was variability in both the 2011 and 2013 surveys. First, the surveys were carried out over several days due to the large number of samples. Ideally, the sampling should take place within the day to decrease the variability of conditions. Second, different people carried out and guided the surveys at HCC. Different staff also tested the agar plates at the vendor's laboratory.

Finally, different models of air sampling equipment were used, which might have resulted in a variability of the results. In 2011 the Biotest Reuter Centrifugal Sampler was used. In 2013 the IDEA 3P Tractability Air Sampler was used even though the same vendor was hired. This was beyond HCC's control as the vendor decided to change their air sampler

"While the mould counts in HCC have reduced markedly in 2013, there is still a need to set a standard. There are numerous standards set by various industries for air-conditioned buildings."

models over time. It is often difficult to compare data obtained from different models of air samplers. However, some of the IAQ data collected by HCC over the span of three years gave consistent readings of the CFU levels.[15] Thus, though it is likely that different air sampling models give slightly different results, the variability of results is minimal in the case of HCC's usage. In order to decrease such variability, MMT has plans of conducting in-house IAQ surveys by procuring our own set of air sampling equipment.

MOULD REMEDIATION IN MM2 STORE

In 2010 the MM2 store was found to be affected by mould. This store contains a mixture of ethnographic and folk life materials, mostly stored on open shelf, powder-coated metal racks. During one of the routine store checks, we discovered the shelving and racks to be mould infested. A subsequent assessment revealed that 80% of the racks were infested, with most of the mould located on the underside of the metal racks (Figures 1 and 2). An investigation conducted in August 2010 suggested several reasons for the infestation.[16] The dust covers attached to the racks during an earlier addition and alteration project in HCC could have resulted in a microclimate that encouraged mould growth. Furthermore, analysis of the store revealed rapid fluctuations in relative humidity that could have exacerbated the situation. It was also noted that the older batches of shelves had more grime, rust and mould growth on them. However, all these had minimal impact on the collection, with only several objects being affected by mould.

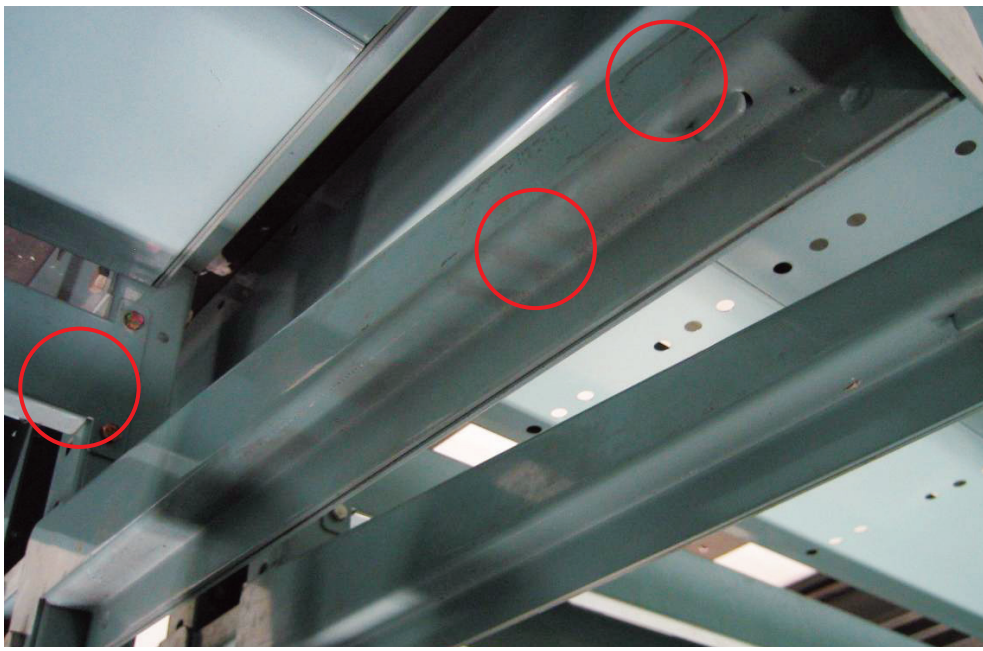


Figure 1. **Racks with mould, dirt and rust.** Photo courtesy of Alvin Tee

Figure 2. **Rusted shelves.** Photo courtesy of Alvin Tee

"A subsequent assessment revealed that 80% of the racks were infested, with most of the mould located on the underside of the metal racks "

[10] It is likely that the filters in the air vent supply grilles were soiled, thus contributing to the higher mould count.

[11] The World Health Organization recommends 500 CFU/m³ air; the *Singapore Standard 554: Code of Practice for Indoor Air Quality for Air-conditioned Buildings* recommends a concentration of less than 500 CFU/m³ air; the Healthy Building International recommends a concentration less than 750 CFU/m³ air; and the National Institute of Occupational Safety and Healthy up to 1000 CFU/m³ air; Claudia Ross et al., "Studies on Fungal and Bacterial Population of Air-conditioned Environments," *Brazilian Archives of Biology and Technology* 47, no. 5 (2004), accessed 15 March, 2014, http://www.scielo.br/scielo.php?script=sci_arttext&pid=S1516-89132004000500020.

[12] The Dutch National Archives has been practising the air assessment guidelines for years, but no standard has been established; Arnold Den Teuling, Agnes W. Brokerhof and Bert Van Zanen, *Fluffy Stuff: Integrated Control of Mould in Archives* (Amsterdam: Netherlands Institute for Cultural Heritage, 1999), 27.

[13] The DG-18 agar plate with a Reuter Centrifugal Sampler was used. Samples were taken diagonally at 20, 90 and 240cm above the ground.

[14] The RODAC™ 65mm plate was used.

[15] A. Savino, C. Pasquarella and O. Pitzurra, "The Index Of Microbial Air Contamination," *Journal of Hospital Infection* 46, no. 4 (2000): 241–56.

[16] The survey was conducted by two conservators, Selina Halim and Ikuko Takeyama, who were working in HCC then.

The remediation for MM2 store took two months, which involved nine conservators and five collections officers. As this was a large-scale project that needed quick attention, external manpower consisting of art handlers and cleaners was also hired for the cleaning and moving.[17] The logistics in the remediation exercise required good planning. It involved moving and documenting objects; dismantling and cleaning the shelving; and managing staff movement and duties. For protection against any health effects from the mould, all personnel involved in the remediation exercise used Personal Protection Equipment (PPE) such as lab coats, gloves and N95 masks.[18]

Before the shelves were dismantled, all the objects in the store were documented and moved out to a clean holding area (Figure 3). The objects were assessed to see if they required any treatment before moving. The shelves were then dismantled and cleaned with a 50/50 or 70/30 ethanol/water solution (Figure 4). Any rusted shelves were discarded along with the foam that was used to cushion the artefacts. These shelves were then replaced. Lastly, the filters in the air vents were replaced as well (Figures 5 and 6).

"Lessons learnt from the exercise have led us to develop an integrated approach to preventing mould growth.

COST OF MOULD REMEDIATION EXERCISE

Approximately S$10,400 was spent on hiring external help and S$1,000 went to the cost of the materials. However, this did not take into account the cost of time spent by HCC staff for the remediation exercise, the investigation survey and the IAQ surveys. A reference case study from the National Library Scotland showed that the cost of a mould remediation exercise after a flooding case in 2009 was £250,000 (approximately S$519,674), excluding the cost of staff time. This exorbitant cost stemmed from replacing the flooring, procuring the equipment, consultancy, remedial works, closure of exhibition and legal costs.[19]

PREVENTION

Lessons learnt from the exercise have led us to develop an integrated approach to preventing mould growth. Our strategy comprises three key approaches: *Monitor, Manage and Maintain*. The *Monitor* aspect includes carrying out annual IAQ surveys to check mould levels in the air and surfaces. This includes ad-hoc store surveys of the storage compartments and randomly selected artefacts. We will look at relative humidity, ventilation and dust levels in the stores. *Manage* entails crafting standard operating procedures so staff can respond to mould outbreaks in the best way possible and heed a chain of commands. *Maintain* largely comprises housekeeping, where rolling schedules for storage cleaning and materials replacement are developed. Methods of proper storage would also fall under this category.

CONCLUSION

The IAQ survey has been a useful quantitative tool for evaluating the environment. Nonetheless, it should be supplemented with other preventive measures to achieve an integrated approach to mould management.

A comparison between the 2011 and 2013 IAQ survey results shows that the risk of bio-deterioration has reduced greatly. This is likely due to the mould remediation exercises conducted. Mould remediation remains a costly exercise requiring significant resources, which serves as a reminder for us to be rigorous in our preventive measures.

ACKNOWLEDGEMENTS

Special thanks to the MMT members for their help in the IAQ surveys and colleagues who were involved the mould remediation exercise. In addition, I would like to thank Alvin Tee, former Head of Objects, HCC, and Jacinta Loh Boon Nee, former Senior Conservator (Textiles), HCC, for their inputs for this article.

Figure 3. **Moving the artefacts and removing the shelves.** Photo courtesy of Alvin Tee

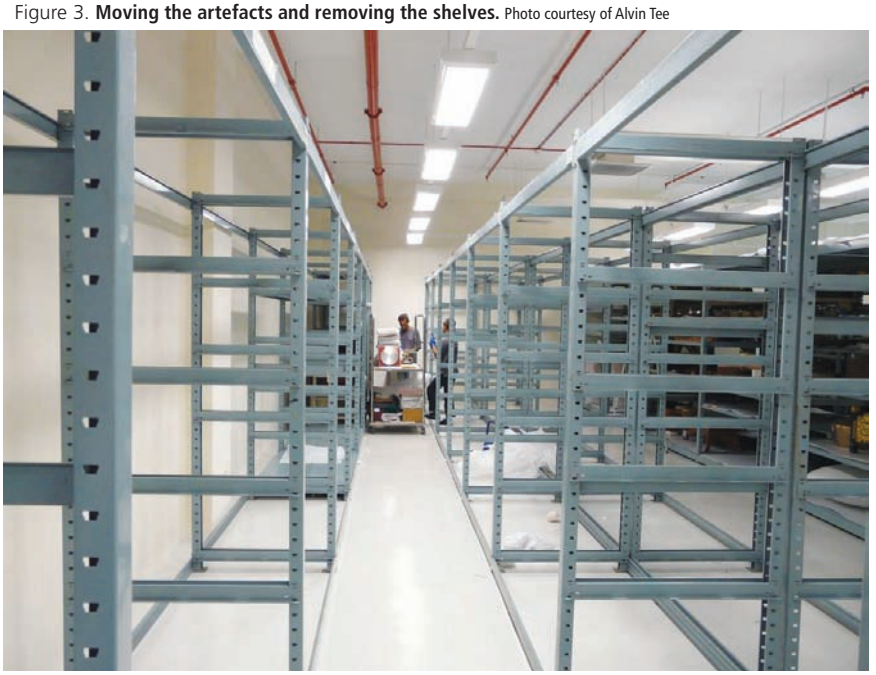
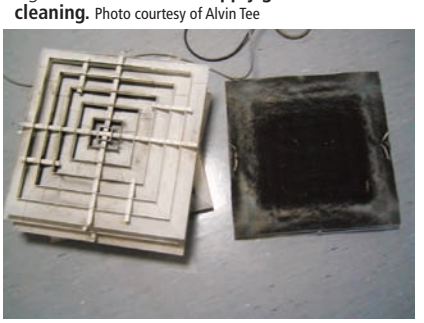


Figure 4. **Cleaning the shelves.** Photo courtesy of Alvin Tee

Figure 5. **The air vent supply grille before cleaning.** Photo courtesy of Alvin Tee



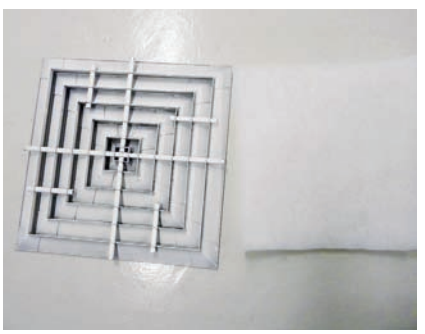


Figure 6. **The air vent supply grille after cleaning and the fitting of a new filter**
Photo courtesy of Alvin Tee

[17] There were attempts to engage companies dealing with mould to manage the remediation project. However, they declined the invitation as they could not ascertain the type of mould present.

[18] Information on the full logistics of the remediation exercise would be detailed in another paper.

[19] Robert Jackson, "Lessons Learnt: Case Studies on the National Library of Scotland" (paper presented at Moulds & Health in Libraries, Archives & Museums Conservation, Health & Legal Implications, Edinburgh, Scotland, December 5, 2011).

FROM BOOK TO BUILDING – A History of Collections Management in Singapore

By
Zuraidah Ehsan, Registrar/Collections Management

INTRODUCTION

Collections management – the physical care and documentation of collections – plays an important role in a museum. It encompasses a variety of activities including collections development, providing access to the physical artefacts and information associated with them, and ensuring proper storage and care for collections.

At the Heritage Conservation Centre (HCC), collections management team strives towards best practices for the physical care and management of the National Collection. The scope of HCC's Collections Management Department includes organisational policy-setting, building and security maintenance, storage management of artefacts, conservation and scientific investigation of materials, environmental monitoring and control, exhibition and loan support, and emergency preparedness and response planning.

This article charts the history and development of collections management in Singapore from early methods of documentation to current practices in preventive conservation.

RAFFLES LIBRARY AND MUSEUM

EARLY METHODS OF DOCUMENTATION AND STORAGE

The present facility, HCC, and its current collections management standards might give the impression that holistic collections management has been practised in Singapore for some time. However, this is not the case. Even though some forms of documentation did exist in the past, standards were inconsistent and quite unreliable back then.

The beginnings of collections management in Singapore can be traced back to 1849, with the establishment of Raffles Library and Museum by the Singapore Institution Committee. The Museum was known for its natural history collection, which was stored in the museum's vicinity and managed by curators.

The 1919 Raffles Library and Museum Annual Report offers information on how artefact documentation was carried out during this time. The report states that accessioning books had been kept in the Museum since 1877 to document the movements of artefacts. However, entries in these books were too scanty to render proper identification of artefacts. To rectify the problem, a more permanent and complete Accession Register was instituted on 1 January 1921. Unfortunately, no information is available on how effective the new system was.

An assistant curator, H.D. Collings, was hired in 1934. He developed a new system to catalogue the ethnographical and archaeological artefacts in the Museum. His efforts are evident in an accessioning book known as the *Z book*. In this book, Collings attempted a retrospective accessioning exercise of collections acquired before 1934. All these artefacts were accessioned in the book and given the prefix "Z". Artefacts acquired after 1934 were given year prefixes.

Collings' year numbering system was used up to 1942 before the Japanese Occupation of Singapore. Although there were no entries in the accessioning ledger of artefacts in the years of the Occupation, it is known that these artefacts were kept safe from being looted.[1] Evidence from the accession books then showed that Collings' documentation method continued after the Japanese Occupation. More methods of accessioning had also begun to appear. For example, there are artefacts labelled with new category prefixes such as "WD", which is suspected to mean "woodcarving". Information about artefacts was now captured by writing them on cards, very much like the library catalogue system. This information was transferred to museum catalogue record books as well as year number record books for further classification.[2] However, it is difficult to determine exactly how and when the card system,

the catalogue record books and the year number record books started and stopped as no information about them is currently available.

MUSEUM CONDITION AND EXPANSION

Karl Richard Hanitsch arrived in Singapore in 1895 to assume the curator position. He found the Museum in a deplorable state. Mould, dust, poor display cases, and pests contributed to the erosion of many of the collection's pieces. Dr Hanitsch set out to correct the situation and although he managed to rectify it, the problem of space persisted.[3]

In the early 20th century, the Museum underwent several building expansions to accommodate its growing collection. Not much was recorded about the storage of the Museum's collection then. One can only speculate that the expansions included more storage areas, as it would have been impossible for the entire collection to be exhibited.

NATIONAL MUSEUM

AFTER INDEPENDENCE

In 1955, the Raffles Library and Museum separated. After Singapore's independence in 1965, the Museum was renamed the National Museum and began focusing its collection on Singapore's history and nation-building efforts. Thereafter, more attention was given to restructuring and developing the new museum. Several surveys and investigations concerning museum activities were carried out, and reports on observations and recommendations towards the Museum's improvements were submitted. Some of these observations noted the poor standards of storage facilities and documentation of artefacts.

BEGINNINGS OF A COLLECTIONS MANAGEMENT PLAN

Two documents in the 1980s explicitly recommended that a central registry be established, and that one person, a registrar, be appointed to manage the collection.[4] A later audit report also reflected a concern for better artefact management for accountability and accessibility.[5] It therefore became more pertinent to incorporate a structured procedure, in which information on artefacts could be captured more accurately and systematically. A comprehensive collections management plan had to be established, and this would not be effective if the old, decentralised system of documentation and collections management persisted.

In 1991, a registrar was appointed and the Collections Unit was formed to focus on developing a proper inventory and reviewing documentation procedures. This introduced a more centralised system that enabled the collections management plan to be carried out cohesively, which would lead to an improved standard of artefact documentation. One of the initial steps taken was carrying out a basic inventory exercise and reviewing probable procedures. Other new measures were also taken. The year accession system was used to better communicate each inventory's acquisition time. A manual of documentation procedures was drafted to include important information such as the item's description, dimensions, period, provenance, material, and other acquisition-related details. Artefact categories were also created to facilitate the artefact classification process, and the photo documentation of artefacts – which had begun earlier – expanded to include images in 35mm-slide format.[6]

DOCUMENTATION DATABASE

The adoption of computer technology for collections documentation was officially recognised in 1991 by the then Ministry of Information and the Arts in its feasibility study of computerisation projects for all its departments.[7]

The first system used was a customised Australian text retrieval software called AWAIRS. The design was record management-oriented and supported navigation between related records. Some of the features included accessioning, cataloguing locations,

[1] The safety of the collection is attributed to Edred John Henry Corner, Director of the Singapore Botanic Gardens at the time of the Japanese Occupation, who considered it his responsibility to safeguard Singapore's scientific and cultural heritage. He and a newly arrived Japanese botanist secured the Botanic Gardens and the Raffles Library and Museum. Corner, E. J. H. The marquis: A tale of Syonan-to. (1981) Singapore: Heinemann Asia: 23-24

[2] Loh Heng Noi, interview by author, June 15, 2012.

[3] Megan S. Osborne, "Early Collectors and Their Impact on the Raffles Museum and Library," *The Heritage Journal*, 3 (2008): 1–15.

[4] The two documents are "Collections Management at the Singapore National Museum," a report by Ann Davis, PhD, 13 April 1983, and "Task Force on the Long-term Development Plan for the National Museum," a report by a task force appointed by the Ministry of Community Development, July 16, 1987.

[5] Loh Heng Noi, "Collection Documentation: The Experience of the National Museum of Singapore" (paper presented at the Conference on Comparative Museology and Museography in ASEAN, Manila, Philippines, April 9–12, 1997); no other information is available on this audit report.

[6] Faith Teh Eng Eng, "A Custodian's Challenge: A Museum Documentation Standard for All? Experience from Heritage Conservation Centre, Singapore" (proceedings of the Annual CIDOC Conference, Zagreb, Croatia, 24–27 May, 2005); Photo documentation in the 35mm-slide format started in 1994.

[7] Loh Heng Noi, "Collection Documentation."

external movements, loans, authority file maintenance, security and back-up recovery functions, and enquiries and report generation. The system, however, had its limitations such as the lack of an imaging component.

In 1997, the ARTS database was created to provide basic information on artefacts, artists, and acquisitions and their sources. However, due to technical issues, the system was never fully adopted and all the museums' data were subsequently exported to Microsoft Access. The Artifact Image Library, or AIL system, was then developed after the onset of digital photography and the start of the digitisation of existing images, which were in the 35mm slide format. This project also sought to replace the old practice of taking black and white photographs, and of developing them and pasting them onto the accessioning forms. Furthermore, AIL worked in parallel with the Microsoft Access database that managed the collections data.

In 2004 the Integrated Museum Collections Management System – also known as IMCMS and later renamed MCS – was introduced, and it was a more encompassing system. The system brought together the various databases that were used and enabled different departments and sections in the museums and HCC to share a common platform for their work. Currently, MCS is built on a client-server technology, which requires an installation of a third-party software on users' computers. HCC is now looking to upgrade its system infrastructure to support the increasing complexities in collections management work. The move will be towards a web-based system, allowing MCS users to access information from major web browsers such as Google Chrome and Internet Explorer, without the need to install any other software.[8]

As part of HCC's continuous improvement in managing the National Collection, it has embarked on adopting ACTS, or Automated Collections Tagging System, which uses Radio Frequency Identification technology (RFID) to automatically track artefacts. The movement of RFID-tagged artefacts can be monitored, and their information, such as location data, can be synced to MCS for easy reference. ACTS replaces the current manual system of recording the movements of artefacts in store logbooks and thus improves productivity.

CHALLENGES IN STORAGE

GROWTH OF THE NATIONAL COLLECTION

In 1993 the National Heritage Board (NHB) was formed, and the Museum's collection was separated into three new museums: Singapore Art Museum, Asian Civilisations Museum and National Museum of Singapore. The challenges of documenting different types of collections of the three museums were now greater. However, these challenges were made more manageable with the new standards implemented earlier.

The three museums also signified a growing National Collection. This called for a larger storage facility. The idea for a new storage facility had been in the pipeline since the eighties. By offering storage and conservation facilities of an international standard, NHB sought to encourage more loans and donations of historically and culturally significant artefacts to the National Collection as well.[9]

Building a new repository signalled the importance of better managing and storing the National Collection for current and future generations. The outcome was the building and establishment of HCC, a purpose-built state-of-the-art artefact repository complete with a central conservation laboratory. It was fully operational from 1997 and officially opened in 2000. Some of the unique features of the new building are temperature and humidity control mechanisms, concrete-reinforced and aluminium-clad walls to ensure maximum security and insulation for the artefacts, and a security vault for high-value artefacts.

With a new repository, the National Collection can now be kept in an ideal environment with controlled climates and conditions. This also meant that the collection is taken care of collectively rather than individually, ensuring effective overall management.

PREVENTIVE CONSERVATION

As noted earlier, the rapid growth of the National Collection led to space constraints, which limited the quality of Singapore's collections management. One way to remedy this was the incorporation of preventive conservation principles when planning for the new repository.

Preventive conservation is marked by the integration of science and technology into the museum world and prioritises efficient and effective collections management solutions. It has its origins in Europe, specifically Great Britain. The benefits of preventive conservation materialised during the two World Wars, where safeguarding cultural heritage from the enemy became more important than ever. After the wars, conservation was strengthened by new experiences in large-scale coordination and technical knowledge, and international collaboration.[10]

"To ensure a regulated environment that prevents such occurrences, one of HCC's primary goals is the provision of a fully air-conditioned storage facility that functions round the clock."

Preventive conservation entails storing, displaying, handling and maintaining a museum's collection in ways that promote long-term stability, and which would not lead to deterioration. This includes monitoring temperatures, humidity and light in museum galleries and storage areas, developing methods for secure display and storage, and working with a wide range of staff to ensure the safety of artworks during their transport and loan to other museums. Preventive conservation relies immensely on controlling the museum or storage environment.

HCC was essentially designed with the preventive conservation philosophy in mind. By regulating the environment, preventive conservation acts as the first gatekeeper in a collections management plan – it helps to prevent, reduce and mitigate the effects of factors threatening an artefact's survival.

In the case of Singapore, fluctuating temperatures and high humidity levels are two key factors that speed up an artefact's deterioration. The presence of moisture and irregular temperature settings can accelerate chemical reactions such as corrosion, as well as biological deterioration like mould growth and insect activity. To ensure a regulated environment that prevents such occurrences, one of HCC's primary goals is the provision of a fully air-conditioned storage facility that functions round the clock.

As each artefact is made of various materials and responds differently to a host of environmental factors, it is necessary that HCC's storage rooms are equipped with the appropriate temperature and relative humidity levels. In addition, the floors of the storage areas are coated with epoxy to reduce dust accumulation and other pollutants that can harm the objects.

Another aspect of preventive conservation concerns the security of the collection. HCC is equipped with a stringent security system that involves the use of closed-circuit television cameras, intrusion detection mechanisms, card access controls and unique keys for accessing individual stores.

CONCLUSION

Even though documentation standards have improved, some challenges remain.

As far as space is concerned, new locations are currently being sourced. The aim is to turn them into off-site storage spaces to accommodate the ever-growing National Collection. As the museums and the National Collection expand, demands on the collections management system and space will become more challenging. Thus, current systems must have room to develop and evolve.

Nonetheless, the goals of collections management remain to preserve each artefact and the information accompanying it in the best way possible, and to facilitate its sound storage. These protect the invaluable quality of heritage materials. Most importantly, future generations must have access to these artefacts, which tell important stories about history, culture and identity. ⧗

[8] Tan Pei Qi, Manager, Knowledge and Information Management, HCC, conversation with author, (December 16, 2014).

[9] Heritage Conservation Centre, "Introduction to Heritage Conservation Centre," in *HCC Resource Kit* (Singapore: Heritage Conservation Centre, 2000), 1.

[10] Simon Lambert, "The Early History of Preventive Conservation in Great Britain and the United States (1850–1950)," CeROART 9 (2014), accessed June 21, 2014, http://ceroart.revues.org/3765.

EXAMINATION AND CONSERVATION TREATMENT Of Raden Saleh's *Ship In Distress*

By
Damian Lizun, Conservator (Paintings)

INTRODUCTION

In 2000, the Singapore Art Museum purchased *Ship in Distress,* a painting in oil on canvas by Raden Saleh Syarief Bustaman, who is considered one of the best known 19th-century Indonesian painters and one of Southeast Asia's most recognised artists. The painting had presented deterioration such as severe varnish discolouration, cupping paint and isolated canvas undulation. In preparation for its display at the National Gallery Singapore in 2015 when the museum opens, complex conservation treatments to improve the painting's aesthetic values and technical condition were carried out in 2013.

The conservation activity also provided the opportunity to carry out technical examination on the painting, which has led to greater understanding of the artist's techniques and materials. Besides discussing the painting's technical condition and its conservation treatment, this paper also describes the results of its near-infrared examination and the stylistic comparisons with the artist's other similar works.

LIFE HISTORY

Raden Saleh was born in 1811 in Semarang, Central Java, Indonesia, to a family of the ruling elite. Widely regarded as the first modern painter in Indonesia (then known as the Dutch East Indies), he is known for his historical paintings such as *Capture of Prince Diponegoro* (1857) and *Flood on Java* (1865–1876), and scenes of animal fights and oriental hunting. Over his lifetime, he developed many multidisciplinary interests including ethnography, archaeology, architecture, palaeontology and gardening.

Raden Saleh spent 25 years in Europe and became a part of European art history.[1] He arrived in the Netherlands in 1829, where he studied drawing and oil painting under portrait painter Cornelis Kruseman and landscape painter Andreas Schelfhout. He quickly gained the Dutch king's patronage and soon began to receive portrait commissions.[2] In 1839, he travelled to Dusseldorf, Germany, home at that time to the German Romantic painting movement.[3] Then, he visited Frankfurt and Berlin, and finally moved to Dresden, where he initially planned to train his artistic eye on the pictures in the Gemäldegalerie, the city's famous art gallery which had Germany's leading collection of art. Dresden proved to be more than a stopover in his European educational journey. He stayed in Dresden for four years, which were among the happiest in his life.[4] There, he experienced the new cultural peak of the Romantic period and acquired a new social status, quickly noticed by Dresden society, which expressed great interest and curiosity towards this talented artist from the Far East. On Raden Saleh's part, he was impressed by Dresden's intellectual and cultural life.[5]

It was in Dresden that Raden Saleh decided to make animal fights and oriental hunting leitmotifs in his art. He believed that as an Asian, he was better capable of capturing the emotional qualities of such scenes than Europeans. It was also there that he produced many of his maritime paintings. Scenes of hunting and sea storms became characteristic of his paintings and were enthusiastically received at the 1840 Academy Exhibition in Dresden.[6] In 1844, Raden Saleh left Dresden and moved to Paris. He returned to Java in 1851. His second stay in Europe was from 1875 to 1878. He died in Java in 1880.

ICONOGRAPHY

During the Romantic era of the 19th century, shipwrecks and distressed vessels in seascapes were key motifs in art. They alluded to a distressed humanity isolated in a menacing or malignant universe. Paintings became the platforms to show the conflicts between human will, elemental forces of nature and fate symbolically through these motifs.[7] Artists continued to use the imagery of the drifting boat—sometimes helplessly becalmed, sometimes thrown about by tremendous waves—until the end of the century to carry moral or religious messages concerning the fate of man.[8]

Seascapes are rooted in 17th-century Dutch marine art. Dutch artists painted seascapes just as the Dutch Republic was expanding into a world power dominating maritime trade and holding

vast cultural influence.[9] English and later American artists adopted seascapes in their paintings. In the 19th century, such works contained a variety of subjects, ranging from maritime events and political relations to the private emotions of individual artists.[10] When describing the Romantic fascination with the ship and storm at sea, we observe a characteristic difference between these two dramatic subjects: the shipwreck emphasises the occupants' plight; the storm, the frightfulness of the elements.[11] It is however unlikely that all 19th-century artists consciously intended their shipwreck pictures to be symbolic. Some interpreted them to be so; others appeared to have been drawn to the subjects spontaneously. Either consciously or intuitively, the artists chose these subjects because they gave visual form to feelings otherwise vague and inexpressible, and to feelings that were part of the general emotional climate at the time.[12]

During his four years in Dresden, Raden Saleh produced many seascape paintings and eventually developed an individualistic style of expressing the Romantic fascination with forces of nature. Among these seascape paintings is *Ship in Distress,* which depicts a single-mast vessel amidst violent storm waters (Figure 1). In the central plane of the painting is a powerless vessel that has lost its sails but still flies a British flag. A closer look reveals a few helpless crew members struggling for survival. The figures are so small and sketchy that they are almost insignificant. In the third plane, another ship is battling raging waves, trying to escape. Both ships are at nature's mercy, tossed around in the vast ocean. A prominent barrel is floating in the right foreground, probably thrown off the ship to distract whales and dangerous marine creatures from the ship and its crew.

Another painting, *Storm on Sea,* is a dramatic painting in oil on canvas, measuring 41 x 57.5cm (Figure 2). It is signed and dated 1840, and depicts two ships trapped among crashing waves, lost in the turbulent sea. The main vessel is in the central plane, heading left towards a brighter scene where there may be some hope of rescue; another ship is in the third plane, close to the painting's right edge, trying to escape its fate. The main ship flies the American flag that was in official use between 14 June 1777 and 1 May 1795; it was no longer used when Raden Saleh created this painting.[13] A barrel is floating in the bottom right foreground.

[1] Werner Kraus and Irina Vogelsang, *Raden Saleh: The Beginning of Modern Indonesian Painting* (Jakarta: Goethe Institute, 2012), 26.

[2] Ibid., 34.

[3] Ibid., 40.

[4] Ibid., 41.

[5] Ibid., 42.

[6] Ibid., 49–50.

[7] Eitner Lorenz, "The Open Window and the Storm-Tossed Boat: An Essay on the Iconography of Romanticism", *The Art Bulletin* 37, no. 4 (1955): 287–88.

[8] Ibid., 287.

[9] Victor Domin, "Rough Seas—Shipwrecks of the Romantic Era: The Evolution of the Dutch Tradition", 2, accessed February 10, 2014, https://www.academia.edu/4086992/Rough_Seas--Shipwrecks_of_the_Romantic_Era_the_Evolution_of_the_Dutch_Tradition.

[10] Ibid.

[11] Gerald Eager, "The Iconography of the Boat in the 19th-Century American Painting", *Art Journal 35,* no. 3, (1976): 224.

[12] Lorenz, "The Open Window", 290.

[13] Kraus and Vogelsang, *Raden Saleh,* 254.

Figure 1. ***Ship in Distress*** **before conservation**
Collection of National Gallery Singapore. Image courtesy of National Heritage Board

Figure 2. ***Storm on Sea,*** **private collection, Indonesia**
Image courtesy of Dr. Werner Kraus, Centre for Southeast Asian Art

The positions of the three main compositional elements (two ships and a barrel) are similar in both *Ship in Distress* and *Storm on Sea*. But the composition of the latter painting relies on the stark contrast between the two sides of the sky, light on the left and dark on the right. The ships are depicted to be in the midst of a receding storm, and a clear and bright patch of sunlight is breaking through the clouds. The light illuminates the main ship, metaphorically representing man's salvation and deliverance, primarily by God, while the second vessel is still engulfed in darkness symbolising inevitable fate.[14]

We find a similar scene in *Shipwreck in Storm* (Figure 3). The oil painting on canvas measures 40 x 50cm and is signed and dated 1840. In its first plane a Dutch vessel is heading towards the right, while a second ship is engulfed by waves. A barrel is again present, near the bottom left of the canvas. The positions of these three main compositional elements appear to mirror those in the aforementioned works. The main ship is trying to escape the stormy weather. We can see the crew struggling with ropes and torn sails, but not their individual reactions, from where we are.

An increase in drama is evident in the fourth painting entitled *Shipwreck in Storm* (Figure 4). This 1840 work in oil on canvas measuring 50 x 65.5cm is also dominated by a turbulent sea and a dark sky. But it is more dramatic and foreboding than the other paintings because there is more contrast between its compositional elements. The ship in the foreground is already shattered on the rocky coast and is being thrown about by merciless giant waves. In contrast, the fate of the second vessel on the left is hanging in the balance as strong winds stretch its sails till they are nearly bursting. Nonetheless, it has a small chance of survival, demonstrated by the little piece of blue sky in the painting's top left corner.

Coastal Landscape is another of Raden Saleh's shipwreck scenes. It was painted in Indonesia in 1854 with oils on a panel and measures 27 x 37.5cm (Figure 5). In the painting the wrecked ship lies on the beach with the recurrent motif of a barrel; the storm has died down and the wind has dropped. The drama of the battle against the wind and the waves has come to an end.[15]

This short overview of selected seascapes demonstrates that Raden Saleh chose to represent in his paintings the struggles with the elements rather than the occupants of the ships. Distinct human figures are absent from his paintings; viewers are left to confront nature's power on their own terms. The sea and the sky—not people—dominate the works. To Raden Saleh, who travelled across the Indian and Atlantic Oceans on a sailing ship from Java to Europe in 1829, such images were not merely complacent depictions of disasters; instead, they were derived from his personal experiences of being caught in storms at sea on several occasions. He was well able to reproduce the specific conditions of air and light.[16] We can assume then that Raden Saleh believed that he was capable of capturing the emotional qualities of such scenes. This short analysis also proves that the artist could indeed effortlessly manipulate the dramatic tension in his paintings.

TECHNICAL EXAMINATION

The conservation treatments of *Ship in Distress* provided an opportunity to carry out technical examination of the painting, which would help identify the artist's techniques and materials used.

CANVAS

The canvas structure was analysed according to Bogumila Rouba's model.[17] *Ship in Distress,* measuring 39 x 45cm, is executed on fine plain-weave linen fabric with a thread count of 13 threads for the weft and 16 threads for the warp in $1cm^2$.[18] Even though there are no selvedges[19], it was possible to differentiate the weft and the warp, and determine the warp's direction, because the number of warp threads is always greater than the number of weft threads.[20] The warp's direction corresponds to the painting's vertical orientation. Both the weft and warp threads have irregular but similar widths (from 0.3 to 0.8mm; mean 0.55mm) and weak "Z" twists (more than 45º). The degree of the combined weft and warp filling is high (88.97%), but the

Figure 3. ***Shipwreck in Storm,*** **private collection, Indonesia**
Image courtesy of Dr. Werner Kraus, Centre for Southeast Asian Art

Figure 4. ***Shipwreck in Storm,*** **collection of the National Gallery, Indonesia**
Image courtesy of Dr. Werner Kraus, Centre for Southeast Asian Art

Figure 5. ***Coastal Landscape,*** **private collection, Indonesia**
Image courtesy of Dr. Werner Kraus, Centre for Southeast Asian Art

Figure 6. **Back of the painting *Ship in Distress* before conservation. A paper label was attached with natural glue to the backing board**

Figure 7. **Detail from *Ship in Distress*. The label features handwritten inscriptions in four languages**

[14] Domin, "Rough Seas—Shipwrecks", 2.

[15] Kraus and Vogelsang, *Raden Saleh*, 260.

[16] Ibid, 256.

[17] Bogumila Rouba, "Płótna jako podobrazia malarskie [Canvases as painting supports]", *Ochrona Zabytków* 38, (1985): 222–45.

[18] Linen fibres were identified by nodes present at intervals along fibre length in the form of X.

[19] A selvedge is a self-finished edge of fabric that runs parallel to the warp (the longitudinal threads that run the entire length of the fabric); it keeps the fabric from fraying.

[20] Rouba, "Płótna jako podobrazia malarskie", 225.

[21] Werner Kraus, Centre for South Asian Art, Passau, Germany, email message to author, January 23, 2014.

[22] The examination was conducted by the author.

canvas structure is considered to be very irregular, characterised by a difference of 19.3% between the weft filling (55.9%) and the warp filling (75.2%).

The painting's left and right margins are covered in paint that continues from the main composition. The top and bottom tacking margins are covered with a white paint and have a second set of nail holes. This suggests that the painting had originally been stretched over a temporary, slightly wider structure; when it was finished it had been transferred to the strainer. The strainer was visually identified to be made of pine, and its four 12mm thick members were half-lap-joined. The width of the top and bottom members was 3.8cm and the width of the left and right members was 2.5cm. The strainer had a 4mm thick paper board at the top probably to provide additional support for the canvas, which had been glued and nailed to the strainer. Upon transfer, the painting had been first glued to the board and then mounted with iron nails along the sides. The left and right margins had been folded over the strainer and then cut, which explains why they are covered in paint. The nail holes in the left and right margins corresponded to the nail holes in the strainer.

A paper label measuring 12.5 x 9.5cm was attached with natural glue to the bottom right of the backing board (Figure 6). The label has handwritten inscriptions in four languages, likely written by artist himself (Figure 7). The first three inscriptions from the top convey the same information—"Raden Saleh from Java"—in three languages: old Javanese (Raden Saleh's native language), Arabic and Latin.[21] The bottommost script is in German and indicates that the painting was created in Dresden on 25 February 1842. The label is decorated in the top right corner with a small painted image of a blue patera with fruits.

PAINT LAYER

The paint layer was analysed with the help of non-invasive multispectral imaging on the full-spectrum Nikon D90 with a set of filters for visible light, ultraviolet and near-infrared photography.[22] To analyse the paint layer in the cross section, samples of the paint were embedded in self-curing acrylic resin Estetic S (supplied by Wiedent) and polished with abrasives down to grade 3000. 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.

For pigment identification, X-ray fluorescence spectroscopy (XRF) and

Figures 8. **Paint cross section of the sky taken from the margin of the painting *Ship in Distress* showing the structure of the ground and paint layers – 1) brown ground; 2) white imprimatura; 3) blue paint – at microscopy magnification of 100x**

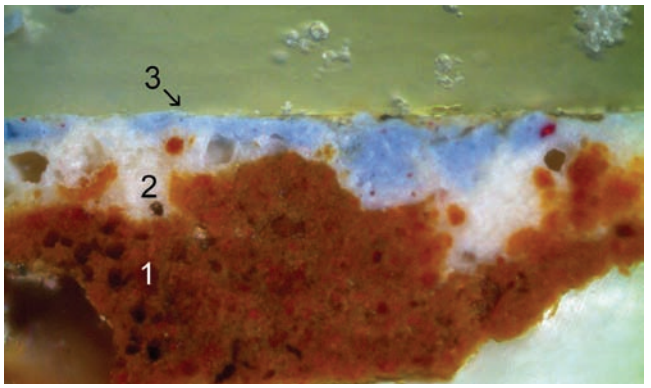
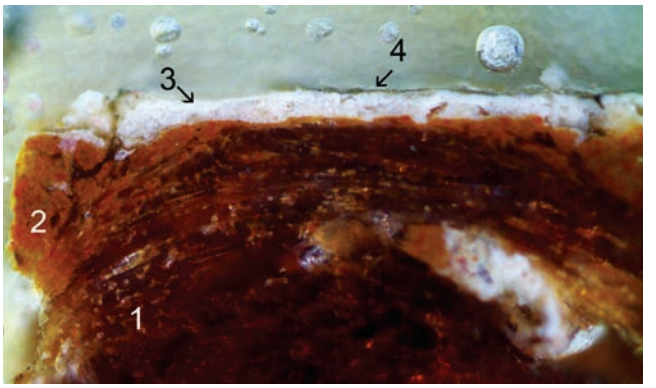


Figure 9. **Paint cross section of the white imprimatura taken from the top margin of the painting *Ship in Distress* showing the structure of the ground and paint layers – 1) textile fibres; 2) brown ground; 3) white imprimatur; 4) varnish – at microscopy magnification of 100x**



polarised light microscopy (PLM) were used.[23] XRF was conducted with a Thermo Scientific Niton XL3T EDXRF, and PLM was carried out by means of the same Leica DMRX polarising microscope.[24] Samples for the cross-section analysis and pigment identification were taken only from the margins.

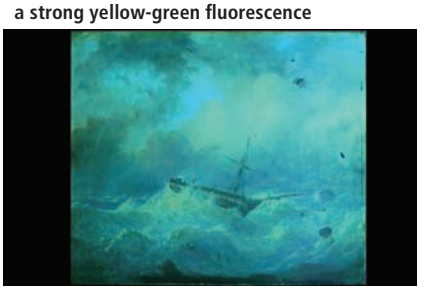
The paint layer cross section indicated that a thin layer of brown ground had been applied on the canvas (Figures 8 and 9). XRF analysis taken from the back of the painting as well as from the margin detected the presence of iron in the ground. Further PLM observation identified yellow ochre as isotropic particles with n>1.66. An amido black staining test confirmed the presence of proteins in the ground.[25]

The next layer is a coat of lead white imprimatura.[26] XRF detected lead on a white margin. Spot tests with 5% sodium sulphide on the imprimatura layer in cross section taken from the margin also revealed the presence of lead white. The application of a white or grey imprimatura layer on top of brown or red ground was a common technique during the seventeenth and eighteenth centuries not only in southern and northern Netherlands but also France and Italy. It is possible that such a layer build-up was dictated by economic reasons. The first layer, consisting of cheap earth pigment, was used to fill the interstices in the canvas wave, whereas the grey ground, containing the more expensive lead white, was applied to provide an even surface and a base colour for the painting.[27] The final paint layer had been applied thinly over the white imprimatura but impasto was evident for the clouds and waves.[28] XRF confirmed that lead white is a major component of the white paint used for the clouds. XRF also detected the presence of lead in high intensity and that of cobalt in low intensity in the blue sky area. The high intensity of lead in the measurement was due to its presence in the imprimatura lying beneath.[29] PLM observations of the pigment particles taken from the blue sky area identified the cobalt blue as isotropic particles with n>1.66. Spot tests with 5% sodium sulphide on the paint layer in cross section from the same area also revealed the presence of lead white; this further proved that the blue paint is a mixture of cobalt blue and lead white.

Mercury, detected by XRF in the warm reddish tone of the clouds, is attributed to vermillion pigment. The artist had signed his full name in red, at the bottom left of the painting (Figure 10), as he characteristically did in bold colours on most of his paintings.[30] Additional XRF testing of the red paint of the signature revealed a concentration of mercury, along with a high level of lead relating to the imprimatura. It was thus concluded that the red paint must be vermillion pigment. The Sudan black test, Rhodamine B staining test and saponification test with 10% sodium hydroxide determined that the imprimatura and final paint layers are bound in oil.[31] The paint surface was covered with a very thick, yellowed varnish, probably composed of natural resin; it was revealed under ultraviolet examination as a strong and characteristically yellow-green fluorescence (Figure 11). The varnish was most likely original, although there was no definite proof.

Figure 10. **Detail from *Ship in Distress*. The artist's signature in vermillion pigment at the bottom left of the painting**

Figure 11. **The paint surface of the painting *Ship in Distress* was covered with a very thick, yellowed varnish, probably composed of natural resin, revealed under ultraviolet as a strong yellow-green fluorescence**



UNDERDRAWING

Near-infrared examination of the paint layer confirmed that the artist had made a compositional underdrawing before painting.[32] The sketch, mainly of the waves and the central ship, is free and fairly expressive, but literal in some places. The artist had drawn it linearly, most likely with a sharp graphite pencil, whose marks absorbed the infrared radiation and were therefore clearly visible in near-infrared. The near-infrared examination also uncovered an initial double-mast main ship (Figures 12 and 13) and a silhouette of a second ship close to the painting's right edge (Figures 14 and 15). In the final painting the artist had painted this second ship on the other side; the compositional arrangement had changed during the painting process (Figures 16 and 17). Waves expressively outlined with fluent lines had not been repeated literally during painting. The entire underdrawing had been made freely at one go and its function was to determine the contours of the whole scene. The examination also revealed compositional development and new insights into artist's working style and practice.

Figures 12 & 13. **Detail from *Ship in Distress*. The near-infrared examination uncovered an initial double-mast main ship**

Figures 14 & 15. **Detail from *Ship in Distress*. The near-infrared examination uncovered the silhouette of a second ship close to the painting's right edge**

Figures 16 & 17. **Detail from *Ship in Distress*. The artist painted the second ship on the other side in the final painting**

[23] The XRF analyses were conducted by Lynn Chua Hui Ru from the Heritage Conservation Centre, Singapore. Polarised light microscopy of pigment dispersions was carried out by author.

[24] The Thermo Scientific Niton XL3T EDXRF contains an X-ray tube of silver anode running at 6–50kV and 0–200μA. A small spot of 3mm or 8mm internal collimation was used, depending on the test area of interest. The measurements were taken in 8 points and a time of spectre accumulation was 100 seconds; 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: Published by authors, 1998); The mounting medium for pigment dispersions was Cargille Meltmount nD=1.662.

[25] The protein stains were prepared and applied according to Elisabeth Martin's methods. See Elisabeth Martin, "Some Improvements in Techniques of Analysis of Paint Media", *Studies in Conservation* 22 (1977): 63–67.

[26] Imprimatura is a semi-transparent coloured insulation layer placed directly on the ground before painting, in whatever tone desired. It provides an overall tonal optical unity in a painting and helps the painter establish value relations from dark to light in the initial stages of the work.

[27] Jim Dimond and Christina Young, "Reducing Cupping Without Lining" in *Alternatives to Lining: The Structural Treatment of Paintings on Canvas Without Lining,* ed. Mary Bustin and Tom Caley (London: United Kingdom Institute for Conservation of Historic and Artistic Works, 2003), 29–30; Maartje Witlox, "Many Hands Make Light Work: The Seventeenth-Century Antwerp Interior with Figures Before a Picture Collection", in *Art Matters, Netherlands Technical Studies in Art 3* (2005): 87.

[28] Impasto is a thick and opaque textured area resulting from the application of heavily bodied paint where brush or painting-knife strokes are visible.

[29] XRF analysis typically probes paint layers in totality, making it sometimes difficult to discern the exact layers from which emissions for different elements are detected.

[30] Kraus and Vogelsang, *Raden Saleh,* 64.

[31] The lipid stains were prepared and applied according to the methods of Meryl Johnson, Elizabeth Packard and Richard Wolbers, and the saponification test was conducted according to the methods of Elzbieta Mirowska, Maria Poksinska and Irena Wisniewska. See Meryl Johnson and Elizabeth Packard, "Methods Used for the Identification of Binding Media in Italian Paintings of the 15th and 16th Centuries", *Studies in Conservation* 16 (1971): 145–64; Richard Wolbers, *Cleaning Painted Surface: Aqueous Methods* (London: Archetype Publications, 2000), 177; Elzbieta Mirowska, Maria Poksinska and Irena *Wisniewska, Identyfikacja podobrazi i spoiw malarskich w zabytkowych dzielach sztuki* [Identification of painting supports and binding media in works of art] (Torun: Uniwersytet Mikolaja Kopernika, 1986), 150.

[32] For infrared examination, a Heliopan RG 1000 filter with visible light cut-off point around 1000 nm was attached to the camera lens.

Figure 18. **The painting *Ship in Distress* before conservation had suffered severe cupping. The painting was photographed in raking light to reveal the cupping**

Figure 19. **Varnish removal treatment significantly improved the colours and clarity of the underlying paint layer of the painting *Ship in Distress***

CONDITION ASSESSMENT

The painting's main problems were severe cupping of the paint layers (Figure 18) and varnish discolouration; these were detrimental to the painting's visual appearance. Cupping formation is a complex process called stress alignment and describes differential shrinkage of various layers. The cupping in *Ship in Distress* had occurred due to contact with moisture during the aqueous gluing of the canvas to the cardboard. The moisture had caused the development of stress, which had resulted in shrinkage and stiffening along poorly filled weft arrangement.[33] Additional stress had developed when the glue size contracted during drying. The trapped moisture between the canvas and backing could evaporate only through the aging cracks and the newly developed cracks caused by shrinkage of the canvas. Subsequently, as the paint layer contracted during drying, the edges of the cracks had become raised, leading to cupping. All these factors had resulted in pulling the canvas upwards and lifting the paint and ground layers.

The irregular canvas structure (19.3% difference between weft and warp fillings) had also contributed to the scale and orientation of the cupping. The warp's vertical arrangement (75.2% warp filling) dominates the weft's horizontal arrangement (55.9% weft filling); therefore, the canvas had shrunk along the poorly filled weft arrangement, and hence the lines of cracks and cupping formation were vertical. However, the cupping had been mitigated probably by the almost equal width of the weft and warp threads and their weak "Z" twists. There were also a few planar deformations along the edges and air pockets between the painting and the paper board.

A yellowed and irregularly glossy natural resin coating covered the paint surface. There were also some minor faded retouchings over the varnish in the sky area. This suggests that the painting had been retouched in preparation for its auction sale in 2000. The painting was mounted on an unstable original strainer that exhibited splits and loose joints, and was framed in a non-original contemporary frame with a highly reflective glazing.

CONSERVATION TREATMENT

The goals for the conservation treatment were to stop the deterioration of the original materials, improve the painting's appearance and stabilise its structural condition.

First, the yellowed varnish was removed in order to re-establish the composition's legibility. A solvent solution of isopropanol and Stoddard (2:1 ratio) removed the varnish along with the retouchings on the surface. The treatment significantly improved the colours and clarity of the underlying paint layer (Figure 19).

Next, with the painting taken off from the strainer, the paper label was removed from the backing board using a sharp scalpel. This was relatively easy to do as the natural adhesive was brittle. After the label was cleaned with a soft sponge and the excess adhesive scraped off with a scalpel, it was encapsulated in a Melinex envelope.

The next stage was separating the painting from the paper backing board. The paint layer was protected by facing a Japanese tissue adhered with 3%

methylcellulose, laid face down and secured with two clamps to prevent any movement. The paper board was locally wetted with water and removed with a chisel and a scalpel (Figure 20). In order to prevent moisture from causing any local distortions of the original canvas, blotting paper was placed on the cleaned areas and pressed with glass plates and weights.

After the paper board was removed, the back of the canvas could be fully seen (Figure 21). Next, the problem of cupping paint had to be addressed. Cupped paint may not be successfully brought into the plane by lining; conservation literature has documented multiple failures.[34] Moisture treatment combined with pre-stretching on the adjustable working frame and local consolidation of the affected areas was opted for as a suitable technique. The Japanese tissue facing was first removed with wet cotton swabs. The painting was then temporarily strip-lined with 2.5µm thick Beva film and linen canvas, and fixed face down to a Lascaux adjustable working frame. The work area was then covered with polyethylene foil, on top of which a piece of wet fabric with dimensions similar to the frame's internal dimensions was placed. Four foam blocks were placed on the fabric's corners. The frame, along with the painting's paint layer facing up, was suspended on the four foam blocks over the source of moisture. The whole structure was covered with polyethylene foil to create a climate envelope. The aim was to plasticise the paint layers and canvas with moisture so that the painting could be tensioned by expanding the adjustable frame. The pressure was increased gradually every 30 minutes by precisely adjusting the screws. This process was repeated four times until sufficient tension was achieved. The canvas planar deformations were completely eliminated.

Then, the frame with the painting was removed from the climate envelope and the paint layer was put face up on a working surface. Consolidation tests were carried out with 5% weight per volume (w/v) solution of Aquazol 500 in isopropanol and 5% weight per volume (w/v) solution of Plexisol P550 in xylene. Consolidants were applied by brush to the localised areas of cupped paint. The affected areas were pressed and heated with a tacking iron through a layer of Melinex. However, most of the cupped paint was only minimally reduced.

Another treatment was thus considered: consolidation through impregnation of the painting.[35] Current research has found the impregnation method to be effective in the long term whereas less invasive treatments have been unsuccessful.[36] The deep penetration of the adhesive during impregnation enables contact between the canvas

[33] The analysis was based on the Mecklenburg model for the generation of cupping in canvas paintings. See Paul Ackroyd, "The Structural Conservation of Canvas Paintings: Changes in Attitude and Practice Since the Early 1970s", *Reviews in Conservation*, no. 3 (2002): 9.

[34] Jim Dimond and Christina Young, "Reducing Cupping Without Lining" in *Alternatives to Lining: The Structural Treatment of Paintings on Canvas Without Lining*, ed. Mary Bustin and Tom Caley (London: United Kingdom Institute for Conservation of Historic and Artistic Works, 2003), 29–30.

[35] Gustav Berger, "Lining of a Torn Painting with Beva 371", in *Lining Paintings: Papers from the Greenwich Conference on Comparative Lining Techniques*, ed. Caroline Villers (London: Archetype Publications, 2003), 56; Michael von der Goltz, et al., "Consolidation of Flaking Paint and Ground", in *Conservation of Easel Paintings*, ed. Joyce Hill Stoner and Rebeca Rushfield (London: Routledge, 2012), 377.

[36] Dariusz Markowski, "Nowe, bezpieczne sposoby ochrony impastowej warstwy malarskiej obrazow olejnych na plotnie podczas zabiegow konsolidacji i dublazu na stole prozniowym [New safe methods of protecting the impasto paint layers of oil paintings on canvas during the consolidation and relining on a vacuum table]", in *Problemy dublowania obrazow na plotnie*, ed. Maria Roznerska and Joanna Arszynska (Torun: Uniwersytet Mikolaja Kopernika, 2005), 21, 24, 33; Jadwiga Wyszynska, Metody dublowania w procesie konserwacji malowidel sztalugowych na plotnie [Lining methods in the restoration of easel paintings on canvas] (Krakow: Akademia Sztuk Pieknych, 2003), 66.

Figure 20. **The paper material of the cardboard of the painting *Ship in Distress* was locally wetted with water and removed with a chisel and a scalpel**

Figure 21. **The back of the canvas was fully visible after the paper board was removed**

Figure 22. ***Portrait of Raden Saleh*** **by Friedrich Carl Albert Schreuel, collection of the Rijksmuseum, Holland**

and the paint layer to be re-established. Therefore, if the consolidant could be introduced from the painting's front and back, firm adhesion could be achieved.[37] Hence, the painting was taken off from the frame, the strip-lining was removed, and a warm 12% Beva 371 solution in Stoddard was applied by brush on the painting's front and back. The application was repeated. After the Beva had dried, the painting was put face up on a vacuum hot-table under uniform heat and treated for 15 minutes at 65°C and a pressure of 300mb. This treatment was successful and the cupping was thoroughly eliminated.

The tacking margins had rust damage and were unequal in width, so a strip-lining was added to the margins. Losses to the paint surface were filled using white putty prepared by hand (12% weight ratio of calcium carbonate and polyvinyl alcohol). The painting was stretched on a new strainer and brush-varnished with Larapol A81 at 12% in turpentine. Retouchings were executed with gouache colours combined with MAIMERI ketonic resin colours. Finally, a protective coat of semi-glossy varnish (Larapol A81 at 12% in xylene with Cosmolloid 80H microcrystalline wax added in the ratio of 10 parts of resin to 1 part of wax) sprayed over the painting's surface. As a preventive conservation measure, the painting's back was supported with a foam core backing board. The encapsulated label was attached to the backboard with double-side tape.

FRAMING AND ETHICAL CONSIDERATIONS

The original frame was not preserved and was replaced with a contemporary frame likely to have been introduced when the painting was being prepared for its auction sale in 2000. From both historical and aesthetic perspectives, the contemporary frame is unsuitable for the painting. The search for an appropriate frame is a subject for separate study, but I would like to highlight the issue of the painting's original presentation here and initiate a thorough, systematic research in the future.

As Malgorzata Sawicki states, many factors should be taken into account when selecting an appropriate period frame or designing a reproduction frame. These include the artist's intentions, influences, year of production, circumstances associated with the creation, subject of the painting, as well as its palette and style.[38] Much of this information often remains undetermined; therefore, if there is little evidence on the original frame of a particular painting, a conservator often researches frames used by the same artist to find the most appropriate design. We can speculate that a comparable frame may exist in other collections, but we must take into account that picture frames have for a long time been seen as transitory, dispensable and subject to fashion and taste.

Looking for an appropriate design for the frame of *Ship in Distress,* I came across a painting entitled P*ortrait of Raden Saleh* by Friedrich Carl Albert Schreuel.[39] This painting in oil on canvas, measuring 106.7 x 85.3cm, presents Raden Saleh painting one of his seascapes (Figure 22). The portrait was created in 1840, the year Raden Saleh was living in Dresden and produced many maritime paintings. Schreuel painted a very detailed seascape in this painting, showing the distressed ship with a prominent barrel floating in the sea, which is characteristic of Raden Saleh's maritime scenes. This suggests that Schreuel might have been equally accurate in his representation of the painting's frame.

The frame in Schreuel's painting has simple scrollwork corners and curved outer edges hinting at the Rococo influence. These features are typical of Biedermeier frames, used in Germany, Austria and Scandinavia from 1815 to 1849.[40] Thus, we can assume that the seascape that is portrayed together with Raden Saleh in *Portrait of Raden Saleh* was originally decorated with such a frame, available in Germany at the time.

Portrait of Raden Saleh is hence a source that should be considered

[37] Larisa Yashkina, "Adhesive Method of Consolidating Oil Paintings with Cuppings and Hard Craquelure", in *Lining Paintings: Papers from the Greenwich Conference on Comparative Lining Techniques,* ed. Caroline Villers, (London: Archetype Publications, 2003), 106.

[38] Malgorzata Sawicki, "From Lady in Black to Art Students: The Story Behind Changing a Frame", *AICCM Bulletin* 30 (2007), 45.

[39] Friedrich Carl Albert Schreuel, Portrait of Raden Saleh, 1840, oil on canvas, Rijksmuseum, Amsterdam, Painting, accessed February 2014, http://hdl.handle.net/10934/RM0001.COLLECT.5363.

[40] Paul Mitchell and Lynn Roberts, *A History of European Picture Frames* (London: Merrell Publishers, 1998), 97.

Figure 23.
After conservation treatment, the painting *Ship in Distress* was framed back into its non-original, contemporary frame

when seeking a suitable frame for *Ship in Distress*. The Biedermeier frame seems to be a good choice as it was in use when the painting was created. Meanwhile, the painting, after its conservation treatment, was framed back in its non-original, contemporary frame, but with the frame's highly reflective glazing removed (Figure 23). I hope that the current frame will serve only as a temporary solution and that thorough research on a suitable period frame for the painting will be conducted in the near future.

CONCLUSION

To our knowledge, there has been no previous technical study of Raden Saleh's seascapes. Hopefully, this paper will help contribute to the research on the artist's techniques.

Comparing the artist's styles for *Ship in Distress* and other similar works, we can surmise that he chose his representations of ships in storms consciously as he believed that he would be able to capture the emotional qualities of such scenes.

The technical examination of the painting helped further understanding of the artist's techniques and materials, while the non-invasive near-infrared examination revealed the characteristics of his preparatory drawing, which allowed for comparisons with the final paint layer. XRF and PLM analyses identified the major pigments used by the artist. For a more comprehensive study of the artist's techniques, further near-infrared examination combined with detailed material analysis of Raden Saleh's other seascapes will be required.

The technical examination also pinpointed the causes of the painting's deterioration. Although the conservation of the painting was a challenging project, the final result is satisfactory as the painting is now in a presentable condition for display. The conservation treatment greatly improved the painting's appearance and stabilised its structural condition. To enhance the artwork and present it appropriately, further research on a suitable period frame will be needed. ⧗

ACKNOWLEDGEMENTS

I would like to thank Dr Werner Kraus, Director, Centre for South Asian Art, Passau, Germany, for his translation of the inscriptions and permission for the reproduction of the images in this publication, and to Lynn Chua, Assistant Conservator (Paintings), HCC, for conducting the XRF analyses.

FUTURE PROOFING – Challenges In Contemporary Art Conservation

By

David Chew, Senior Assistant Director and Curator, National Heritage Board; Sarah Chui, Senior Conservation Officer (Objects), HCC; Khairuddin Hori, Senior Curator, Singapore Art Museum; and Derek Lu, Senior Collections Officer, HCC[1]

INTRODUCTION

Artists continue to experiment with methods and materials to express their concepts, concerns and emotions. This is most apparent in contemporary art. For instance, the use of ephemeral materials and time-based media is now the norm. No one can tell which methods and materials will be involved in future art-making. In the process, conservation and documentation methods also evolve alongside the experimental nature of contemporary art.

In this article, we explore some of contemporary art's new methods and materiality. Our discussion draws from the artworks of the *Future Proof* contemporary art exhibition by the Singapore Art Museum (SAM) which was held in 2012. We examine some of the challenges of conserving and documenting these works. In particular, our case studies are Robert Zhao's *If a Tree Falls in the Forest* and Vertical Submarine's *A View with a Room*. Our emphasis is on the importance of collaboration between conservator, artist, curator and collections manager in preserving contemporary art.

BACKGROUND

Art in Singapore till the fifties was deeply anchored in traditional forms and styles such as Chinese ink painting and Western oil painting and representation. Artists such as Chen Chong Swee, Georgette Chen, Cheong Soo Pieng and Chen Wen Hsi melded local subject matter strongly rooted in Chinese techniques with Western stylistic influences, striving to create what became known as the Nanyang style (or Chinese migrant art).[2]

Thomas Yeo, Anthony Poon and Goh Beng Kwan departed from the Nanyang style to assert a formalistic enquiry into art itself, similar to the international art discourses of the sixties and seventies, which were characterised by European and American modernist abstraction and formalism.[3] Artworks by Singapore artists during this time ranged from oil paintings to collages and installations, and remained object- and artefact-based.

In 1979, artist Tan Teng Kee organised a picnic on his premises, an exhibition of his paintings and sculptural works presented in an informal manner. He would eventually burn these works of art. The act sought to undermine and obliterate the existence of an artwork as an object, and emphasised the artwork as a process.[4] This event marked a seismic shift in the Singapore art scene in the early eighties. It was now largely influenced by movements such as the Fluxus. Tang Da Wu and Amanda Heng moved towards conceptual art and adopted engaged attitudes towards the everyday world as a resource for materials, subject matter and methods of making.[5]

Singapore's artists today continue to expand on the possibilities in creating and rethinking the meaning of art production and consumption. This translates to a similar paradigm shift for art conservation, where the focus is no longer just on the object and medium of the art, but also on the concept, ideas and processes behind it.

UNCONVENTIONAL METHODS AND MATERIALITY

Painting and sculpting are no longer necessary skills attached to popular artists of our times. The American artist Jeff Koons and the British artist Damien Hirst are known for having assistants to paint and sculpt. Koons and Hirst then put their signatures on the works, for the concepts are what matter. Such art-making happens in Southeast Asia as well, and this can be observed in the studios of Navin Rawanchaikul and

[1] Sarah Chui and Khairuddin Hori assumed these positions at the time of writing, but have since left the National Heritage Board.

[2] Gunalan Nadarajan, Russell Storer and Eugene Tan, *Contemporary Art In Singapore* (Singapore: Institute of Contemporary Arts Singapore, LASALLE-SIA College of the Arts, 2007), 9–10.

[3] Kwok Kian Chow, *Channels & Confluences: A History of Singapore Art* (Singapore: Singapore Art Museum, 1996), 8.

[4] Tay Swee Lin, T*rimurti and Ten Years After: Trimurti and Dimensions of Performance Art* (Singapore: Singapore Art Museum, 1998), 44.

[5] T. K. Sabapathy and Cecily Briggs, *Cheo Chai-Hiang, Thoughts and Processes: Rethinking the Singapore River* (Singapore: Nanyang Academy of Fine Arts and Singapore Art Museum, 2000), 27.

Figure 1. **Before activation of mousetraps**
Detail from Robert Zhao, 2009, *If a Tree Falls in the Forest,* installation, dimensions variable. Singapore Art Museum collection.
Image courtesy of the artist

Asmudjo Jono Irianto. Singapore artists also adopt this method of engaging assistants in executing their concepts.

Materials used in contemporary art have also evolved. Besides the use of traditional materials, artists today also incorporate everyday, readymade materials for their intrinsic and symbolic values. Marcel Duchamp, who presented a urinal as a sculpture work, most famously propagated this.

In 2012, SAM presented an exhibition of young and emerging Singapore artists titled *Future Proof* at the SAM at 8Q museum. This exhibition was curated by then SAM curators David Chew and Khairuddin Hori, and featured contemporary artworks that were either predominantly new commissions or from the artists' own collections. The exhibition demonstrated a shift in methods and materials. Concepts took centrestage and materials used included the consumable, reproducible, recycled and organic.

This Is Home by Shah Rizzal was made primarily of industrial paper bags that formerly contained 40kg of flour and recycled PVC pipes. These were constructed into a small, mobile tent that was part of a durational performance. The tent was hung by a string in SAM at 8Q as a sculpture. The artist also created a broom from dried coconut fibres and a backpack utilising synthetic, industrial packing materials.

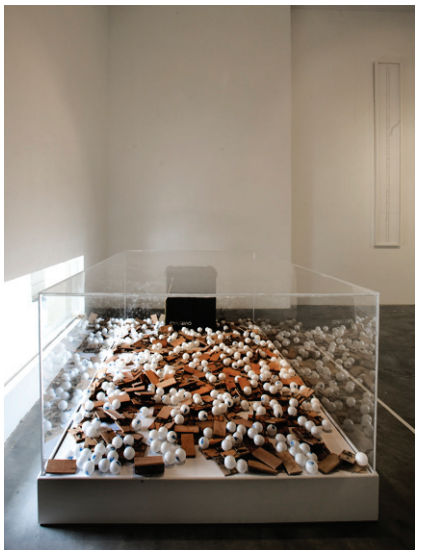
In Your Love is Like a Chunk of Gold by Sookoon Ang, six loaves of bread were drenched in tinted monoammonium phosphate and infused with crystals of various colours to encourage the growth of larger crystals on the loaves. These pieces of bread sculptures were designed with an intention for them to decay and were thus unfit for conservation.

Building as Body, a collaborative and site-specific installation by Grace Tan and Randy Chan, used industrial tarpaulin. The tarpaulin was woven onto The Substation building and exposed to the elements. This façade is reconstructible following detailed technical drawings and instructions by the artists. However, the materials used are not reusable because they have a short shelf life and degrade easily. New materials have to be used for each instalment of the artwork.

The final example is *If a Tree Falls in the Forest* by Robert Zhao (Figure 1). A part of the installation comprises ping-pong balls set off by vibrations caused by noise and mousetraps. This work now belongs to the National Collection. The ping-pong balls are not accessioned, hence new ones can be used in each event if existing ping-pong balls are damaged or lost.

Impermanent materials are common and deliberate in contemporary art today. At times, it is the remnants of these materials that are conserved. These remnants become documentation for the moment, place and event of a work, such as a performance art piece. Where parts of or an entire artwork can be replaced, curators and conservators typically rely on instructions from and agreements with artists. In some cases, such as Ang's bread-crystal sculptures, accurate reconstruction is an impossible undertaking.

Figure 2. **After activation of mousetraps**
Robert Zhao, 2009, *If a Tree Falls in the Forest,* installation, dimensions variable. Singapore Art Museum collection. Image courtesy of the artist



[6] Monika Jadzinska, "The Lifespan of Installation Art," in *Inside Installations: Theory and Practice in the Care of Complex Artworks,* eds. Tatja Scholte and Glenn Wharton (Amsterdam: Amsterdam University Press, 2011), 21

[7] Patricia Levasseur, "If A Tree Falls in the Forest" Stylistic Significance, National Heritage Board Museum Collections System, 2011.

[8] Robert Zhao, "Mission, Institute of Critical Zoologists, Singapore," accessed March 28, 2014, http://www.criticalzoologists.org/mission/mission.html.

[19] Tatja Scholte, introduction to *Inside Installations: Theory and Practice in the Care of Complex Artworks,* eds. Tatja Scholte and Glenn Wharton (Amsterdam: Amsterdam University Press, 2011), 11.

[10] Ibid.

[11] Ibid., 22.

[12] Jadzinska, "The Lifespan of Installation Art," 21.

CONSERVATION

At the Heritage Conservation Centre (HCC), special documentation is carried out when an artwork meets any of the following four conditions:

1. It is interactive
2. It is easily degradable, leading to physical and chemical changes
3. It requires specific criteria during set-up
4. It involves multiple projections and specific programming

THE CONCEPT AS EXPERIENCE

The objective of conserving contemporary art is to preserve the artist's original intention. More often than not, contemporary artists emphasise concepts and ideas rather than the objects' aesthetics, and installation art has become common for such expressions.[6]

Zhao's *If a Tree Falls in the Forest* is one such example. It is an installation piece of 706 parts comprising photographs, mousetraps and ping-pong balls, and is aided by technology. The artist's intention is to allow audiences an experience in a "scientific institute".[7] Zhao's practice often examines the relationship between humans and animals.[8] In this piece, he expresses the unspoken pressures in the relationship between mice and humans.

The installation's mechanics involve activating one of the mousetraps that has a ping-pong ball on it in an acrylic case while customised music is being played. The activation of the mousetrap creates a domino reaction on the rest of the mousetraps and ping-pong balls (figure 2). The activation symbolises "a moment of both shock and enlightenment".[10] The installation was activated at the opening of the *Future Proof* exhibition, and 30 mousetraps were damaged as a result. The ping-pong balls remained structurally stable and in good condition. During the post-exhibition discussion between the stakeholders, additional mousetraps were bought as replacements and as contingency for the installation to be displayed in five more future exhibitions.

The other conservation concern was the lifespan of the taxidermy components and the maintenance of the multimedia equipment. If these materials show obvious physical deterioration, which affects the artist's intention, the conservators would have to turn to consulting other professionals for their respective knowledge. For Zhao's work, conservators consulted an entomology expert on handling the translucent taxidermy cockroaches that were suspended in test-tubes filled with white spirit (Figure 3 and 4). They also had to seek an electrician's advice about the functionality of the MP3 player that came with a customised music piece and an amplifier. The considerations included the format of the music piece and its future archival as technology changes.

Conserving *If a Tree Falls in the Forest* signalled that today's conservation process requires the consideration of future audiences' participation, collaborating innovatively with different professionals, using substitutable materials, and accepting the limited lifespan of artwork components.[9]

THE CONCEPT AS MATERIAL

One other feature in contemporary art is the incorporation of synthetic materials and industrially produced commercial products. These modern materials are commonly found in installation artworks, where the artists aim to create a unity of

Figure 3. **Translucent taxidermy cockroaches**
Detail from Robert Zhao, 2009, *If a Tree Falls in the Forest,* installation, dimensions variable. Singapore Art Museum collection. Image courtesy of the artist

Figure 4. **Close-up of a taxidermy white cockroach**
Detail from Robert Zhao, 2009, *If a Tree Falls in the Forest,* installation, dimensions variable. Singapore Art Museum collection.
Image courtesy of the artist

Figure 5. **Everyday products were placed in a monochrome room**
Vertical Submarine, 2009, *A View with a Room,* installation, dimensions variable. Singapore Art Museum collection. Image courtesy of the artist

these different media and technologies to allow the audience to "exercise all of his senses".[12] Often, artists create these works without much or no awareness of material degradation and failure.[11]

In A View with a Room by Vertical Submarine, everyday products such as Milo tins, canned food, mothballs, a sofa, cupboards and cigarette butts are placed in a monochrome room (Figure 5). These items are either painted grey or covered with a monochrome version of the actual product label. The installation has a total of 351 parts. Different materials of these varied items have their unique properties. With a wide range of materials in this installation, conservators from HCC's four sections – objects, paintings, paper, and textiles – had to collaborate to conduct a condition assessment. After the completion of the condition assessment, the conservators identified the rate of degradation of modern materials such as plastics as the artwork's prime preservation concern.

Odour from the mothballs was a telltale sign of its rate of degradation. Further, the plastic packaging of the mothballs was air-permeable. Thus, the mothballs would sublimate into the air and affect other artworks stored in the same location. The main challenge was preserving the original mothball packaging, which was made of degradable plastic. It would be difficult to find an exact replacement in the future, since the manufacturer would change and update the packaging design over time. One of the possibilities considered was scanning the original label on the object. Another idea was to enable longevity of the artwork by replacing the original material with new material.

The conservators also noticed paint flaking at some parts of the work. The artist advised that areas of flaking revealing colours other than grey should be touched up. Artist interviews were therefore important during the process, and artists' inputs were required to ensure informed decisions on the work's conservation.

DOCUMENTATION

The standard practice of a museum inventory is to register and document all components of an artwork to maintain accountability. Once the components are accepted, the accession registry will assign a unique number to every object acquired. The challenge lies in documenting an artwork's replaceable components, such as those that can be reproduced or changed during every installation. There is a need to track these replaceable components as they have

been accessioned in the registry. One way of simplifying the process is to skip the accessioning of these replaceable components. However, how then can these replaceable components be kept accountable?

To address this, HCC's collections staff revised the inventory list to include information on all irreplaceable and replaceable components of an artwork. This works as a record with detailed descriptions of each component and its function in the artwork. Discussions among conservators, artists and curators help to identify the ephemeral components, and strategies are conceived to ensure the accurate display of these components based on the agreed artwork specifications. For time-based media components, technical evaluations and monitoring mechanisms help develop the best methods to store and handle the digital assets. For Zhao's *If a Tree Falls in the Forest,* the specifications of the replaceable mousetraps and ping-pong balls – such as the presentation format and manufacturers' contact details – have been recorded.

With the inventory list, conservators can also access and understand the artworks easily. Artists play an important role in facilitating the process. For example, Zhao was willing to explain the process of how he had created the translucent taxidermy cockroaches in his work. This helped in the documentation and allows for future reproductions should the current components become unpresentable. The media items in Zhao's installation have been evaluated as well, and technical data of the digital assets were documented.

From our observation, what has been most useful in devising these strategies are open collaboration between conservators, artists and curators, and for all to be focused on the goal of maintaining the authenticity in the re-creation of ephemeral and time-based media components; and flexibility in the planning of preservation strategies, especially in ensuring that they are scalable and adaptable.

ETHICS

Conservation is another way of appreciating contemporary art.[10] Preserving contemporary art entails realising the importance of retaining the conceptual value and the artist's intent. The process of preserving an artwork is subjected to continual changes over time influenced by the viewpoints of various stakeholders, for example, the living artists and curators. As a result, any alteration will implicate the conservation decision-making process.

One known trait about contemporary art is the experimentation with new materials and unconventional techniques by artists. Challenges arise when the preservation of these works defy standard conservation ethics. In traditional conservation, every part of an artwork is irreplaceable and should be regarded as invaluable. During the treatment of heritage materials, there are also clear signs on the parts of the artwork requiring treatment or stabilisation. On the contrary, this may not be the case for the conservation of contemporary artworks as material degradation can be part of the artist's intention. As a result, conservators sometimes have to approach the conservation of contemporary art differently from the conservation of traditional art and cultural heritage materials. However, understanding on the behaviour of modern materials, such as degradation mechanisms, remains fundamental.[12]

Chiantore and Rava note that "the search for knowledge about the artwork is more important than the actual conservation

"Chiantore and Rava note that 'the search for knowledge about the artwork is more important than the actual conservation practice'. In order to better understand the artwork, conservators have to conduct artist interviews to capture crucial information. "

"Carrying out interviews with artists and crafting detailed documentation are important parts of the process. Active communication among the stakeholders and capturing key information – such as the creative process, artist's intent, materials and techniques used – are important to preserve the integrity of the artwork."

practice". In order to better understand the artwork, conservators have to conduct artist interviews to capture crucial information. Greater emphasis is placed on the documentation process of the artwork, and "the search" is regarded as part of a well-informed conservation strategy.

The above explains three key principles that form the basis of contemporary art conservation in HCC:

1. Identification of materials used and the methods of construction
2. Collaboration and collation of information concerning the characteristics and the behaviour of synthetic, new or unconventional materials
3. Thorough documentation of the artwork

CONCLUSION

Four parties were significant in meeting the challenges of conserving the above contemporary artworks: conservators, artists, curators and collections staff. In other instances, other specialists such as multimedia and digital expertise may be needed to address specific technicalities.

To ensure the artist's intention within the artwork is well preserved, conservators have to be mindful of the conservation approach.[13] Carrying out interviews with artists and crafting detailed documentation are important parts of the process. Active communication among the stakeholders and capturing key information – such as the creative process, artist's intent, materials and techniques used – are important to preserve the integrity of the artwork.

Artists furnish conservators and collections managers with information on their art-making techniques and instructions on managing dedicated and non-dedicated components.[14]

Artist discussions between conservators and collections managers offer effective and productive ways to allocate the required resources and work out the appropriate preservation strategies.

A curator's primary role is to establish the collection with the objective of the institution in mind. Curators also help ensure the intentions of artworks are conveyed accurately to the public. This role has evolved over the years to include exhibition making and has even spilled over to specialised roles such as collections management.

For collections managers, accountability is a priority. Documentation for more complex works that use ephemeral objects or time-based media is best done in consultation with the artist and the curator. In our experience interviewing several installation artists, we have discovered that they are comfortable with replacing or reproducing components in their works as long as the intended viewer experience is not altered.

Each stakeholder has his own perspective when it comes to an artwork, and these individual contributions are significant to the documentation and preservation process. Art may evolve, but the mission of curators, collections managers and conservators remains to preserve the artists' legacies and the works' contemporary artistic values for future generations.

[10] Alexandra Trone, "The Emergence of Modern Conservation Theory," in *Historical and Philosophical Issues in the Conservation of Cultural Heritage*, eds. Nicholas Stanley-Price, Mansfield Kirby Talley, and Alessandra Melucco Vaccaro (Los Angeles: Getty Conservation Institute, 1996), 202–11.

[11] Oscar Chiantore and Antonio Rava, "Conserving Installation Art," in *Conserving Contemporary Art: Issues, Methods, Materials, and Research*, eds. Oscar Chiantore and Antonio Rava (Los Angeles: Getty Conservation Institute, 2013), 154–65; Standard conservation ethics can refer to preserving the integrity of the artefact or valuing its original intention for future generations. A summary of the code of ethics from the American Institute for Conservation of Historic and Artistic Works (AIC) can be found here: http://www.conservation-us.org/about-us/core-documents/code-of-ethics.

[12] Oscar Chiantore and Antonio Rava, "Aesthetics of the Contemporary Era," in *Conserving Contemporary Art: Issues, Methods, Materials, and Research*, eds. Oscar Chiantore and Antonio Rava (Los Angeles: Getty Conservation Institute), 14–19.

[13] Oscar Chiantore and Antonio Rava, "Awareness of the Issues," *Conserving Contemporary Art: Issues, Methods, Materials, and Research*, eds. Oscar Chiantore and Antonio Rava (Los Angeles: Getty Conservation Institute), 34.

[13] Jadzinska, "The Lifespan of Installation Art," 26.

[14] Dedicated components are items constituting the artwork. Non-dedicated components are appendages necessary for the display of the artwork, but do not constitute the work.

FROM EXPERIENCE TO LESSONS – Sharing Our Museum Collections System Journey

By
Tan Pei Qi, Manager (Knowledge and Information Management)

INTRODUCTION

The Museum Collections System (MCS) is the National Heritage Board's (NHB) consolidated artefact database that stores and makes accessible information and media files related to the artefacts in the National Collection (NC). The MCS also provides a structured workflow for capturing and updating NC records, thus helping to align work processes.

The MCS was implemented in 2005 and enhanced in 2011. It will be upgraded again and a review of the lessons learnt so far is timely. This paper highlights four such lessons: engaging users; catering for growth; reviewing periodically; and securing support. These lessons also bring to attention some possible obstacles, useful for other institutions converting from manual to electronic systems.

BACKGROUND

Previously, NHB institutions, namely the National Museum of Singapore, Asian Civilisations Museum, Singapore Art Museum and Heritage Conservation Centre (HCC), used a manual system to record and update information on the NC. They were each responsible for their own sets of NC records, which existed in only spreadsheets and simple databases. These records were created for targeted users and specific purposes. For example, HCC's records contained only information of interest to itself, such as the artefacts' dimensions and locations. Consequently, the entire range of information on a single artefact was spread over different NHB institutions, and staff from one institution could not readily access the information kept by another. Furthermore, as the NC grew in size and went on to be utilised more, the manual system began to manifest its shortcomings in inaccurate, conflicting and outdated records.

Since the NC belongs to the nation, there were also expectations for it to be available to the public. As only a small percentage of the artefacts could be physically displayed at any one time, the Internet was seen as the next best alternative where the public could enjoy easy access to the NC. The NC information was, however, trapped in the spreadsheets.

It thus became evident that the manual system would not be viable in the long run. NHB needed a centralised electronic platform that could hold all the NC records, rationalise them and publish relevant information for the public. Based on the above needs, NHB chose Zetcom's MuseumPlus as its integrated museum collection management system.

A benefit of the MCS is the consolidation of information. Staff no longer need to look for isolated information in different places and can access all the available information on one platform. Staff located at various NHB locations can access the database. They can now generate all the information they require into a single document on the MCS, which relieved them of the laborious task of manually pulling data from different sources. The MCS can also generate standard templates that juxtapose visuals and text information for easy referencing. In addition, staff can now update information more easily as they only need to make changes once on the centralised platform instead of multiple times on various spreadsheets. They can also refer to the MCS for

"With all artefact records on a centralised platform, NHB has been able to publish information and images of the NC online. Since 2007, more than 120,000 records have been made available for public access on Singapore Collections Online (SGCOOL)"

additional information such as stylistic and historical significance, which was previously available in only hard copy documents held in repositories.

With all artefact records on a centralised platform, NHB has been able to publish information and images of the NC online. Since 2007, more than 120,000 records have been made available for public access on Singapore Collections Online (SGCOOL) <www.sgcool.sg>.

LESSONS LEARNT

Useful lessons were learnt from the experiences of implementing and enhancing the MCS, from engaging key users early to catering resources for continuous improvements, and from conducting periodical reviews to ensuring all-round support for the system.

LESSON 1: ENGAGE THE USERS

A system such as the MCS extensively changes the ways its users work. It is essential to engage its users early on from the specification phase so that they have ownership in creating a system that will work for them.

User engagement helps a project team foster a sense of ownership among user representatives so that they are more likely to adopt the system, be its champions and influence their colleagues to use it actively in the future. Discussions also demonstrate to the users that their feedback and views are important and taken into consideration.

The project team can also understand the ground situation better and get a sense of the possible enhancements in the future through consultation with user representatives. Additionally, through such consultation, user representatives can understand if their issues are related to technology, policies or processes so that the right actions could be taken.

We thus convened a working committee of MCS user representatives from each institution for the MCS implementation. The user representatives discussed the best solutions for their requests with the vendor, who also streamlined certain key processes such as acquisition. The user representatives were also entrusted with the responsibility of testing the system before live implementation; the scope included making sure that the vendor had delivered on the specifications and that processes flowed well within the system. Thus, the user representatives put in a lot of effort to ensure that the MCS would work for their colleagues.

Learning Points

The engagement of users is crucial, but even more critical is engaging the right users. The working committee was mainly made up of managers who had used the system for non-operational purposes. While they tried their best to convey the issues faced by operational staff using the manual system, they did not have hands-on knowledge of what worked on the ground. If we had involved operational staff in the committee, the discussions would have been more expeditious.

We also need to assure users that future system enhancements are possible. This is so that we can gather useful ideas even if we cannot include them in the current scope. Furthermore, we should continue to get user feedback after implementation as users begin

to interact more with the system. For example, a committee of user representatives can be set up to discuss user requests quarterly. This ensures continuity, and users are aware that a feedback channel exists. Harnessing engaged users can help to initiate and effect the agreed changes.

LESSON 2: CATER FOR GROWTH AND IMPROVEMENTS

The MCS was enhanced in 2011. This was followed by two additional phases to complete the improvements that could not be included in the scheduled implementation. Some of these supplementary improvements were new suggestions that took time and effort to be assessed. Others were processes that had to be streamlined internally, such as tracking the loans of artefacts using the MCS. As such process changes affected every institution using the centralised system, they were possible only after in-depth, long-drawn discussions with all stakeholders.

Learning Points

If users' good suggestions cannot be implemented due to technical, budgetary or manpower constraints, it may lead to their unwillingness to give feedback on the system in the long run. We need to ensure that manpower, expertise and budget are readily available so that improvements for user experience, workflow and efficiency can continue to be implemented during a system's lifetime.

LESSON 3: REVIEW THE SYSTEM PERIODICALLY

The MCS was enhanced six years after it was implemented. Before the enhancement, we had made small improvements along the way. However, we did not have any holistic review of the MCS's effectiveness, and neither did we have any formal channel for users to voice their feedback and concerns.

The MuseumPlus system was one of the best museum database systems available in the market when it was procured eight years ago, but changes and breakthroughs in IT were making it outdated and obsolete. One example was its user interface; users commented that it was unintuitive, although it was considered to be user-friendly in 2003.

Over time, users became frustrated with the system and lost confidence in it.

Learning Points

Nothing remains the best without improvement. If we do not make improvements, some key processes may have to take place outside the system. It is thus important that we review the system periodically to see if it continues to support its users' changing needs. This ensures that it remains relevant even as policies, workflows and IT trends change. When resources permit, major system upgrades and even migration to new platforms should be considered, as it may eventually be more costly to maintain the old system, and the technical support for it may be discontinued. If there are resource constraints, smaller improvements on the existing system may be required and the decisions on them ought to be duly communicated to users.

LESSON 4: SECURE ADEQUATE SUPPORT

For the MCS enhancement in 2012, a working committee comprising representatives from HCC and NHB museums was formed. The working committee was able to highlight less apparent issues as well as specify what was required. A steering committee was also formed so that decisions could be made when the working committee could not come to resolutions for certain matters.

A staff member from the IT department was also a key member of the working committee to give inputs and alternative suggestions that would serve users' needs. However, there were times when technological issues beyond the project scope were not addressed. This led to unrealistic expectations, such as the request for an increase in network speed as part of the enhancement.

At the same time, while a structure was put in place, some of the original user representatives had other duties and had to be substituted by other members from their institutions during the consultancy sessions. There were occasions when the new members gave differing and sometimes even opposing suggestions, leading to confusion within the project team.

Learning Points

All-round consistent support – from the management, users and technical staff – is critical so that the system can continue to grow, evolve and remain relevant to the institution's mission.

The management's support helps to ensure that budget and manpower

are readily available to continuously improve the system. With an adequate budget allocated by the management, the system can be maintained at optimal efficiency. By recognising user representatives' participation in the project as a part of their job scope – for example, a curator may be in the working committee on top of his or her curatorial duties – the management provides legitimacy to the system and sends a clear message that the system is the organisation's asset and everyone is expected to contribute to it.

With the management's endorsement of the system, user representatives are then more likely to support it more strongly. They are also more likely to remain committed even after the system has been implemented and to continue to offer feedback.

Vendors can advise if their systems are able to meet users' needs, but only in-house technical staff are able to advise if the existing hardware can support the requirements or if there is a need to upgrade it. It is hence essential that we have technical expertise at hand to ensure that the system works well and can be continuously improved.

CONCLUSION

It has been some ten years since NHB has implemented its centralised electronic collections system. While the MCS has served NHB's needs adequately so far, there is still room for improvement in the areas of user engagement, review, feedback, and support, as discussed in the lessons from the experience. If we engage the right users from the start to register their needs, we can better develop a system that truly works for them. Meanwhile, if the management demonstrates to users its endorsement of the system, the MCS will then continue to receive users' support and commitment. Additionally, if we review the MCS from time to time and keep the feedback channels open, we will be able to ensure that it remains relevant to changing needs.

"Vendors can advise if their systems are able to meet users' needs, but only in-house technical staff are able to advise if the existing hardware can support the requirements or if there is a need to upgrade it."

WHAT LIES BENEATH – The Safe Display Of Textiles And Garments

By
Siti Suhailah Salim, Senior Conservation Officer (Textiles)

INTRODUCTION

National Heritage Board (NHB) museums have been using mounts for textile artefacts for more than a decade. Earlier on, mounts were fabricated by the Heritage Conservation Centre's (HCC) textiles conservators, as they constituted part of conservation treatment. The demand for them was still manageable then. However, with the reopening of the National Museum of Singapore (NMS) in 2006 and the inauguration of the Peranakan Museum in 2008, the use of mounts increased significantly. Eventually, due to the greater demand for mounts and time constraints, it became challenging for the textiles conservators to work on both conservation treatment and the fabrication of mounts.

To cope with the challenge, HCC launched a programme in 2009 to train non-conservators in the production of mounts. The trained mounters proved to be an asset to the textiles conservation team, especially for later exhibitions such as the Peranakan Museum's *Sarong Kebaya: Peranakan Fashion and Its International Sources exhibition* in April 2011 (Figure 1) and NMS's *In the Mood for Cheongsam: Modernity and Singapore Women* exhibition in March 2012. These two major exhibitions featured mainly textile and garment artefacts. The former showcased 131 kebayas (traditional blouses) and batik cloths worn by Peranakan women; the latter, 150 cheongsams (one-piece dresses with mandarin collars) (Figure 2).

Various types of mounts are used for the display of textile and garment artefacts. Mounts help to contextualise visual presentations in exhibitions and make displays more interesting and relatable to museum visitors. But there are other important reasons why mounts are specially made for textile and garment artefacts. This paper gives insights into HCC's use and fabrication of mounts as part of textiles conservation.

MOUNTING FOR SAFE DISPLAY

All organic materials are inherently unstable, and it is impossible to stop their ageing and deterioration. But these processes can be slowed down with interventive and preventive conservation, and mounting constitutes part of textiles conservation.

After artefacts have been selected for display in exhibitions, textiles conservators have to physically examine them and/or refer to past condition records to determine the types of treatments needed to stabilise their condition.

The conservators and curators will decide on the suitable mounts and display methods that may be used based on the artefacts' condition, curatorial content, exhibition design, display duration, and resources such as time and budget.

The artefacts' condition is the foremost consideration when determining the

Figure 1. **Garment mounted on soft sculpture with T-bar in the *Sarong Kebaya* exhibition at the Peranakan Museum**
Long tunic, (2011-00111).
Courtesy of Asian Civilisations Museum.
Gift of Mr. and Mrs. Lee Kip Lee

Figure 2.
Garments mounted on mannequins in the *In the Mood for Cheongsam* exhibition at the National Museum of Singapore
White Floral Cheongsam with cap sleeves, (2010-04856); Purple Cotton Cheongsam, (2010-04858), Black Cheongsam with red embroidery and piping, (2010-04860); Blue and white cheongsam with cap sleeves, (2010-04855); Floral Cheongsam with cap sleeves, (2010-04859). From the Collection of National Museum of Singapore

mounts and display methods. This is especially so for fragile textile artefacts. These artefacts are generally weak and unstable, and may still be vulnerable even after treatment. Therefore, choosing the right mounts, display methods and methods of securing the textiles to the mounts is crucial. For example, fragile textiles should be mounted on strainer mounts, instead of rollers, for full support (Figure 3). Displaying textiles flat in showcases is a better option than hanging them or displaying them vertically. Mounts have to provide the additional support needed to further stabilise the artefacts for the display duration. Mounting then forms an important part of conservation treatment.

Mounts serve not only the purpose of display; they can also be used during handling and transport and in storage (Figure 4). These mounts serving different purposes must be well designed so that artefacts are stable and supported at all times. The use of such mounts can also lead to cost and time savings as a single mount can serve various purposes.

MAKING MOUNTS

Textiles are among the more sensitive artefacts in museum collections. As they are organic, they absorb gases, moisture, pollutants and light from their environments easily, and these can accelerate deterioration. Materials for making mounts thus have to be carefully selected. Emissions of volatile compounds from the materials of mounts may weaken textiles, cause colours to change and corrode metals. If the colours of the mount fabrics run easily when they come into contact with water, their dyes will be transferred to the artefacts. Therefore, to ensure safe display, mounts need to be made of inert materials of conservation standards. If any new material is being considered for use, HCC's Material Testing Workgroup will first test it using the Accelerated Corrosion Testing method.[1]

Badly made or ill-fitting mounts can easily cause damage to textiles and garments too. Good mounts are able to support the weak areas, not stress the artefacts and allow the artefacts to fit accurately and unobtrusively. Their assembly cannot be too complicated as well so as not to cause over-handling. There is no fixed fabrication method or material to use, as each one is unique and customised to its artefact's special needs. Fibre-glass mannequins are usually padded with polyester wadding and wrapped with cotton or silk fabric for the closest fits possible (Figure 5). Padding is also necessary to protect artefacts against rough edges and unevenness on the surfaces of the mannequins and other core materials such as acrylic rollers, wooden strainers and corrugated boards

Figure 5. **Covering a padded mannequin with cotton fabric**

Figure 3. **This piece of textile was stitched to the strainer on all four sides and horizontally on the upper half to ensure that it was fully supported**
Textile fragment, (2009-01850).
Courtesy of Asian Civilisations Museum.
Previously in the Roger Hollander Collection

Figure 4. **Inserts for shoes provide support, yet they are unobtrusive. They are used as mounts for display as well as storage**
Child's shoes, (2011-01871).
Courtesy of Peranakan Museum

[1] For more on Accelerated Corrosion Testing, see Jacinta Loh Boon Nee, "Safe Materials Save – An Alternative 3-in-1 Methodology for Accelerated Corrosion Testing for Materials," *On Conservation* 1 (2010): 45–47.

Figure 6. **A conservator getting the completed mannequins ready for an exhibition and giving them a final inspection**

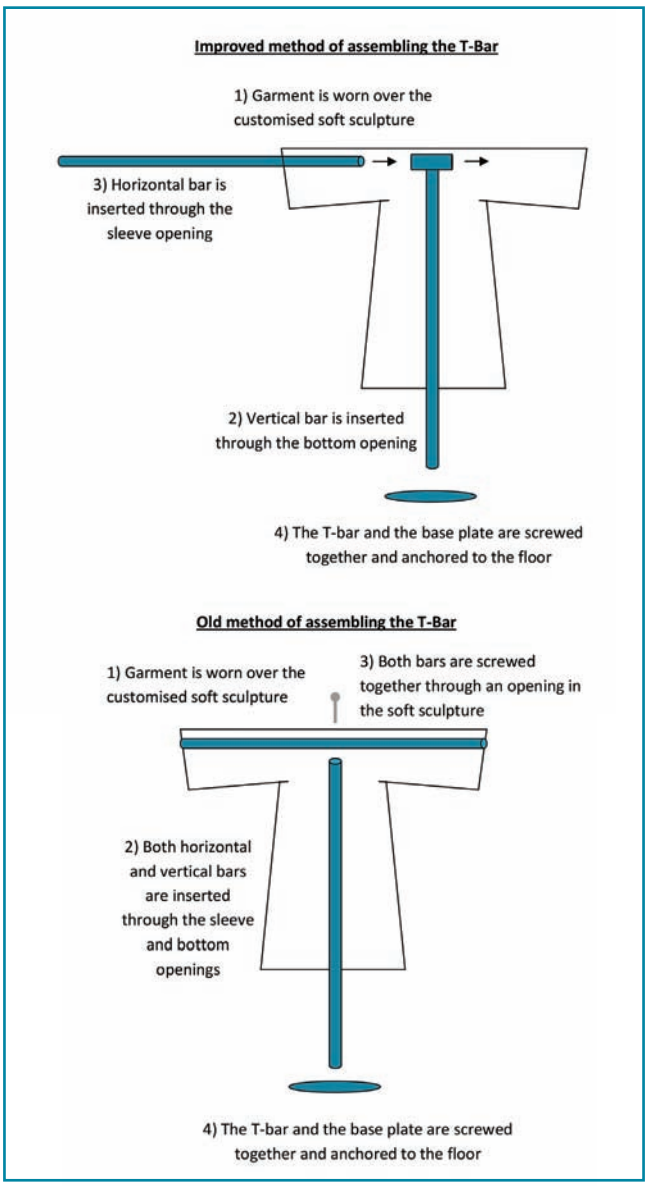


Figure 7. **This diagram shows the old and improved methods of assembling the T-bar in the soft sculpture**

used for the display of flat textiles, as uneven surfaces may impress on the textile and cause damages such as distortion and tears.

Conservators treating the artefacts usually design and fabricate the mounts as they know the artefacts' condition best. Mounting time is always factored into the conservation treatment and may take up a considerable amount of the conservators' time. It takes about one to five days (or more) to construct a mount, depending on type, design and complexity. Even though most of the fabrication is now done by trained mounters, conservators are still involved in the design and fabrication process together with them (Figure 6).

TYPES OF TEXTILE MOUNTS

Soft sculptures, mannequins, rollers, strainers and boards are some of the commonly used textile mounts in NHB museums and HCC.

SOFT SCULPTURES

Garments can be dressed on soft sculptures, away from the human body form. A soft sculpture is a cushion-like padding. When a garment is worn over a soft sculpture that has been customised to its shape, it is presented in three-dimensional form. The garment is also subjected to less stress as the customised soft sculpture gives it full support.

Soft sculptures are held in place with horizontal bars or T-bars. When a garment is worn over a soft sculpture inserted with a horizontal bar, it can be suspended from above with wires. When

"A soft sculpture is a cushion-like padding. When a garment is worn over a soft sculpture that has been customised to its shape, it is presented in three-dimensional form."

Figure 8. **Mannequins are modified before they are padded to the correct sizes**

"The fits on mannequins in store windows always seem to be perfect; this is because the excess clothing material is tapered to the back with darts. The same method cannot be used on garment artefacts as it may cause damage to them."

it is worn over a soft sculpture supported and anchored to the floor by T-bars, it can be presented upright. For the I*n the Mood for Cheongsam* exhibition, the T-bar mounting method was improved. There were about 50 customised soft sculptures to be fabricated, and the T-bars had to be assembled within the day of installation itself. The old mounting method, whereby the horizontal bar had to be screwed into the vertical bar, was time-consuming and strenuous. The tight preparation schedule necessitated the improvement of the old method for higher work efficiency. With the new method, the horizontal bar could easily be slotted into the vertical bar and secured (Figure 7). This improvement reduced the time taken to assemble the mount by half, and, importantly, helped minimise handling of the artefacts. This assembly method of the T-bars was used subsequently for exhibitions at the Peranakan Museum and has proven to be the most suitable method so far.

MANNEQUINS

Garments can also be dressed on mannequins. With the reopening of NMS and the inauguration of the Peranakan Museum, the use of mannequins for displaying garment artefacts became prevalent. This display method helps contextualise visual presentations and makes them more appealing. However, it is not suitable for all garments. When garments are being dressed on mannequins, some areas of the garments may be subjected to stress, and severe handling can be detrimental to the garments' condition. Therefore, conservators have to ensure that the garments are in stable condition first.

The mannequins used in NHB museums are torsos on stands and full-body mannequins with detachable body parts. Those used in window displays come with modern, stylistic poses and are not suitable for museum exhibitions showcasing ethnic costumes. In addition, the fits on mannequins in store windows always seem to be perfect; this is because the excess clothing material is tapered to the back with darts. The same method cannot be used on garment artefacts as it may cause damage to them.

To achieve accurate fits, mannequins are either padded up or customised. Padding mannequins is the most challenging part of mounting displays. The sizes of these mannequins are smaller than the garments they support so that they can be padded up to the correct sizes easily. Sometimes, when even the smallest mannequin available is not suitable, certain body parts, such as the bust and shoulders, have to be modified (Figure 8).

Other than type and size, shape is another important consideration when padding mannequins. Conservators have to work closely with curators to understand the clothing styles of the owners, periods and cultures from which the garments

Figure 9. **Textiles mounted on padded rollers**
Batik, (2004-01017). Courtesy of Asian Civilisations Museum. Gift of Nora Gunawan.
Shoulder cloth, (T-0809, T-0733, T-0959), Courtesy of Asian Civilisations Museum.
Sarong, (T-0538). From the Collection of National Museum of Singapore

Figure 10. **Batik textiles on soft sculpture mounts suspended from above**
Skirtcloth, (2007-55856). Batik skirt cloth with bird of paradise motif, (2010-00708).
Batik skirtcloth with birds, boats and aeroplanes motifs, (2010-03486).
Courtesy of Asian Civilisations Museum

originated so as to achieve accurate silhouettes. This is especially important if the garment belonged to a prominent person. For example, if the garment was worn loosely, the conservator needs to take care not to pad its mannequin up to the garment's fullest measurements in order to reflect the original wearer's true silhouette.

ROLLERS, STRAINERS AND BOARDS

Flat and tubular textiles are usually displayed on rollers (Figure 9), soft sculptures (Figure 10), strainers and boards. Depending on size, weight and other requirements, light, small-sized flat textiles may be mounted on suitable sturdy boards instead of wooden-framed strainers. Tubular textiles are inserted with soft sculptures, which support them as three-dimensional forms. There are a few ways of mounting a textile: stitching it directly to the mount; attaching it to the mount with Velcro; and attaching it to the mount with a header cloth which acts like an extension of the textile (Figures 11 and 12). Whichever method is employed, adequate but not overly excessive stitching is necessary to support and secure the textile such that its weight is distributed evenly, especially if it is displayed in an upright manner. The display duration also has implications on the treatment: artefacts on short-term display of a few months can be secured to the mount using insect pins or magnets, but this way is not advised for artefacts on longer display.

TEXTILE MOUNTING PROGRAMME

The Textile Mounting Programme was initiated by HCC's textiles conservation

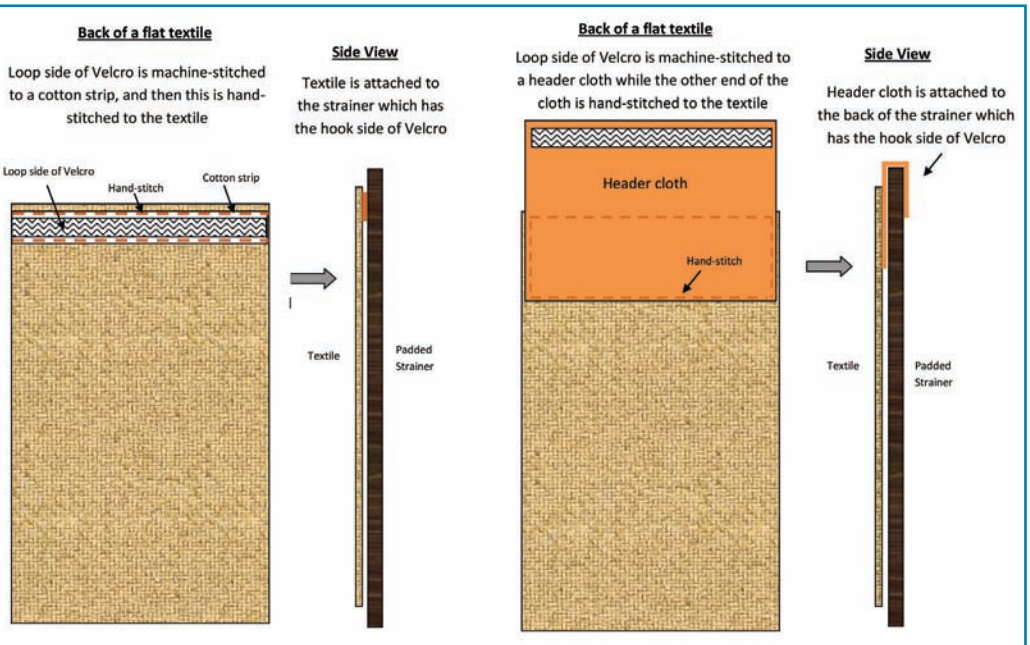


Figure 11. **This diagram shows two different methods of securing a piece of textile to a strainer**

team to support the conservators in fabricating mounts. Two to three people are usually trained in each round. Applicants are tested on basic skills such as sewing, wrapping and cutting (Figure 13). Successful applicants then attend a six-week programme where they learn how to make different types of mounts for display and storage. They also learn how to handle textile and garment artefacts as they need to take measurements of artefacts and assist conservators in testing how well garments fit on mounts. Skilled and efficient mounters are also expected to find innovative methods of constructing high-quality mounts that require as few fittings as possible so as to minimise handling of the artefacts.

Mount fabrication is time-consuming as every mount is customised and may require a few trial fabrications before the perfect fit is achieved. Thanks to the Textile Mounting Programme, trained mounters are able to undertake the fabrication under the direction and supervision of conservators. This allows conservators to focus on higher-skill tasks such as interventive treatment.

CONCLUSION

The textiles conservation team was faced with a challenging situation when the demand for textile mounts increased and resources were limited. The Textile Mounting Programme was developed to cope with this. The programme has proved to be an asset not only to the textiles conservation team but also to NHB, as the trained mounters have been able to provide their services to other conservation teams and the museums. The public has also become aware of HCC as an institution and its conservation work through the programme.

The textile mounts used in NHB museums have evolved over the years. The design and quality of mounts produced now are of higher standards. The improvement made to the T-bar mount has successfully reduced assembly time and helped minimise the handling of artefacts. It is the best solution for now, but there may be better ones in the future. The textiles conservation team is constantly on the lookout for new materials and the latest mounting techniques and technologies, to produce more engaging displays, higher-quality mounts and, importantly, to prolong the lifespans of the textiles and garments in NHB's collection.

ACKNOWLEDGEMENTS

I would like to thank the following for their involvement in the two aforementioned exhibitions: HCC's textiles conservation team; Islizah Asmon, Cao Ling and Joanne Ng (trained mounters); Chung May Khuen, Senior Curator, National Museum of Singapore; and Jackie Yoong, Curator, Peranakan Museum. Special thanks also to Jacinta Loh Boon Nee, former Senior Conservator (Textiles), HCC, who initiated the Textile Mounting Programme.

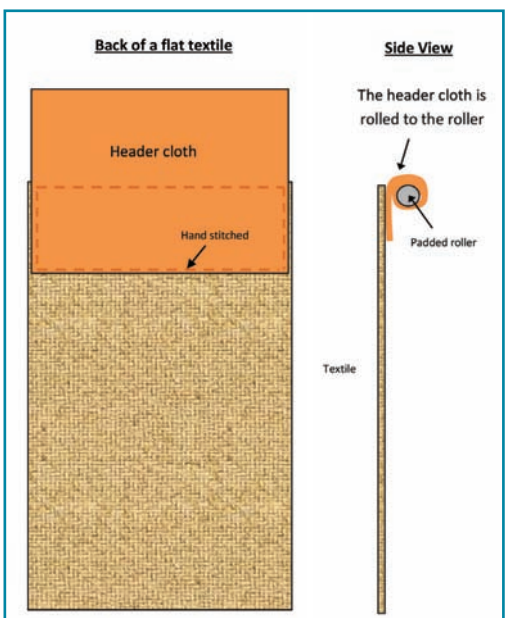


Figure 12. **This diagram shows how a textile is mounted to a roller**

Figure 13. **A practical test for the Textile Mounting Programme**

DECIPHERING THE ORIGINS – Conservation Of A 19th-Century Siamese Fortune-Telling Manuscript

By
Esther Ng, Senior Conservator (Paper) and Lynn Chua, Assistant Conservator (Paintings)

INTRODUCTION

Manuscripts are an important part of Thailand's material heritage. Those written and illustrated by hand are rarer and especially valued; their production had ceased around 1925 with the advent of printing in Siam (Thailand's former name).[1] One such handcrafted work in the National Heritage Board's collection – a 19th-century fortune-telling manuscript from southern Thailand – was conserved and then exhibited in the *Enlightened Ways – The Many Streams of Buddhist Art in Thailand* exhibition at the Asian Civilisations Museum from November 2012 to April 2013.

This paper discusses the treatment of the said manuscript, which had media damage, losses and tears in the paper support, and distortion due to previous repairs. Dirt and insect frass had also disfigured its surfaces. In developing the treatment, we considered the manuscript's history as well as its original use. In the end, we preserved some of the damage as it was evidence of use and limited the treatment to the consolidation of media and the mending of tears and losses in the paper support. We also examined the media and support using polarised light microscopy (PLM), X-ray fluorescence (XRF) and Raman spectroscopy to aid its placement and dating.

Figure 1. **Manuscript Cover Fortune Telling Book,** (XXXX-02864). From the Collection of National Museum of Singapore

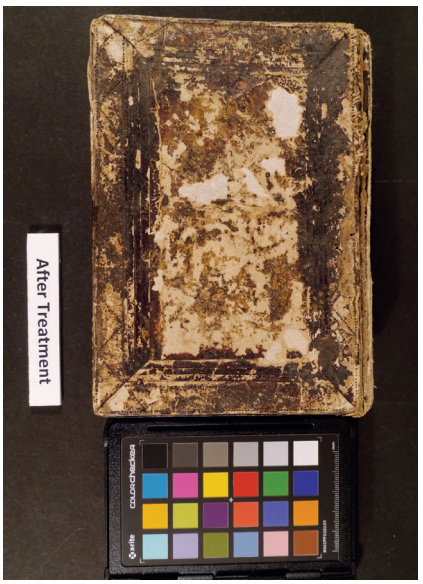


Figure 2. **Illustrated and text pages. Detail of Fortune Telling Book**

BACKGROUND

The fortune-telling manuscript is surmised to be of southern Thailand origin and is dated to the 19th century, given its style of language as well as the presence of pigments such as ultramarine, which has been found to be a typical pigment used by artists during that period in Thailand.[2]

The concertina manuscript, measuring 12.5 x 18 x 4cm, consists of black-painted front and back covers (Figure 1), and 41 pages of hand-executed illustrations and text in Thai script. The illustrations and text (Figure 2), presented on alternate pages, are drawn from a variety of sources, notably stories from the Buddha's past lives, the epic *Ramakien* and folk tales such as *Suthon Manora*.

Fortune-telling manuscripts were consulted for important activities and occasions such as marriage, house building and farming. The person seeking divination would tack a pin or another sharp object on a page at random and the fortune teller would interpret the tacked section.[3]

TECHNICAL EXAMINATION

METHOD

We conducted initial in-situ XRF analysis before determining where the micro-samples for the other analysis techniques would be taken from. The other techniques were Raman spectroscopy, PLM and scanning electron microscopy-energy dispersive spectroscopy (SEM-EDS) analysis, depending on the specific material in question.

In-situ analyses of the pigments were first carried out with a Thermo Scientific Niton XL3T EDXRF containing an X-ray tube of silver (Ag) anode running at 6–50kV and 0–200μA. A small spot of 3mm internal collimation was focused on the areas of interest. We took care to support the manuscript well with cushions and weights. To prevent the pigment analyses from being complicated by different colour pigments overleaf, only areas with the same colours on both sides of the paper were selected.

Raman analyses were performed at Victoria and Albert Museum, London, on a Horiba Xplora equipped with a high-sensitivity air-cooled charge-coupled device, using a laser wavelength of 638nm. The laser was focused on the sample via a microscope lens. Its laser power, starting from a low <1mW, was progressively increased so as to obtain a spectrum without burning the sample.

A Leica DMRX optical light microscope with transmission and reflection modes was used. Paint samples scraped onto individual glass slides were mounted with a Meltmount that had a refractive index of 1.66 and were viewed under optical magnifications of 100x, 200x and 400x.

A Hitachi SU3500 VPSEM scanning electron microscope (SEM) coupled with energy dispersive spectroscopy (EDS), operated by an analyst from Hi-Tech Instruments, analysed a micro-sample that was gently scraped from the white paint. Powdered samples do not require further sample preparation, and the sample's surface morphology was acquired using an ultra variable pressure detector. EDS was used for the elemental analysis.

RESULTS

PAINT IDENTIFICATION

Raman spectroscopy confirmed the presence of ultramarine (a blue pigment) and vermilion (a red pigment) (Figures 3 and 4). These findings are compatible with previous research done on manuscripts from the 18th to the 20th century.[4] Vermilion was also confirmed by the detection of mercury in the red paint using XRF. The white, purple and yellow pigments were not identifiable by Raman spectroscopy; the samples exuded strong fluorescence that obscured the weaker Raman bands, and, as a result, useful spectral information on the pigments could not be detected. These pigments appeared as extremely round particles under light microscopy. When viewed under cross-polarised light at a magnification of 200x, some of them exhibited black crosses, which

Figure 3. **Page with blue and white pigments, which were extracted for analysis. Detail of Fortune Telling Book**

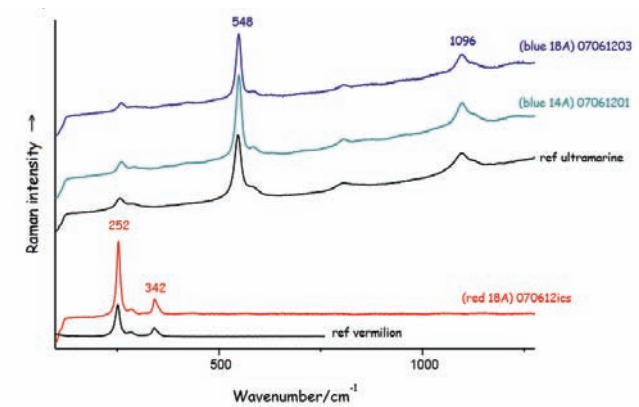


Figure 4. **Raman analysis at 1% power and 638nm laser shows the blue to be lapis/ultramarine and the red used for outlining the figures to be vermillion**

[1] Thailand was known as Siam until 1939, so both names will be referred to wherever relevant in this paper; Horace Geoffrey Quaritch Wales, *Divination in Thailand: The Hopes and Fears of a Southeast Asian People* (Thailand: Suphanit Publish House, 1983), n.p., quoted in Wajuppa Tossa (lecture on Thai fortune-telling manuscripts, Asian Civilisations Museum, Singapore, March 25, 2013).

[2] Wajuppa Tossa, lecture on Thai fortune-telling manuscripts, Asian Civilisations Museum, Singapore, March 25, 2013). Tossa, Associate Professor at the Mahasarakham University in Thailand, confirmed the origin of the manuscript to be southern Thailand. One indication is the costumes of the *kinnari* (half-woman, half-bird creature in Siamese mythology) depicted in the manuscript. She also ascertained the style of language in the manuscript to be 19th century; For more on typical pigments used by artists in 19th-century Thailand, see Jo-Fan Huang, "A Technical Examination of 7 Thai Manuscripts in the 18th, 19th and 20th Centuries," in *ANAGPIC 2006 Student Papers* (Winterthur, Del.: University of Delaware / Winterthur Art Conservation Department, 2006), 10, accessed May 1, 2013, https://pacer.ischool.utexas.edu/bitstream/2081/3222/2/2006ANAGPIC_Huang.pdf

[3] Patamakorn Bullstaporn, "The Knowledge of the Phrommachat" (Chiang Mai University, 1986), n.p., quoted in Wajuppa Tossa (lecture on Thai fortune-telling manuscripts, Asian Civilisations Museum, Singapore, March 25, 2013).

[4] Huang, "A Technical Examination," 10.

Figure 5. **Particles exhibit distinct black crosses under cross-polarised light at a magnification of 200x**

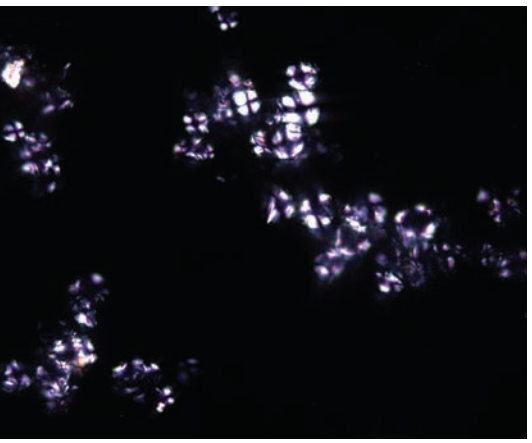


Figure 6.
SEM image of a white particle at 4500x

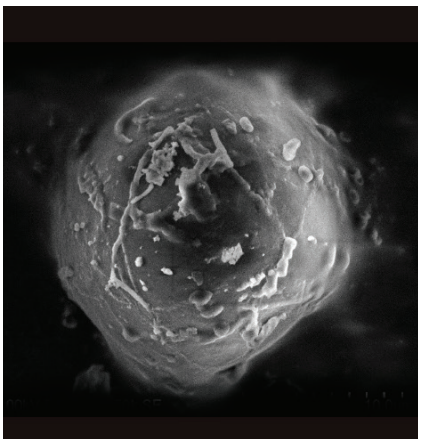
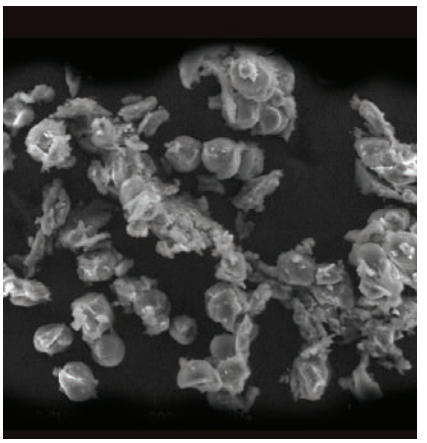


Figure 7.
SEM image of white particles at 600x



suggest the presence of almost spherical material (Figure 5). Initially, we thought these particles were coccoliths, a calcium carbonate chalk derived from fossil remains, mixed together with the pigments to form the paints. Gettens reports that coccoliths are found in calcareous rocks formed during various geological ages.[5] Futhermore, XRF analysis of the white paint detected the presence of calcium. However, SEM examination at higher magnifications of 600x and 4500x confirmed otherwise.

Under SEM, the particles appeared like round globules coated with some minerals and a binding medium (Figures 6 and 7). Upon further elemental analysis using EDS (Figure 8), three different substances were found in the agglomerate. The EDS results suggest that the mineral calcium carbonate is present, but not in the form of coccoliths. Coccoliths would have displayed a characteristic platelet structure under SEM, but this was not observed in the SEM image. Calcium occurs in only small amounts, spread randomly throughout the sample; this may be deduced as contamination from other layers. The elemental analysis showed mainly the presence of carbon and oxygen; this suggests that the white paint agglomerate is primarily organic.

FIBRE IDENTIFICATION

We examined the paper support under fibre microscopy (Figure 9) to see if it is made from *khoi (Streblus asper)* bark, the traditional source for such manuscripts, or mulberry *(Broussonetia papyrifera)* bark. Both are used in traditional papermaking in Thailand, although literature suggests that *khoi* was strictly used for early manuscripts and royal records.[6] Both trees belong to the family *Moraceae,* order *Rosales.* We were unable to obtain a sample of the actual *khoi* fibre for comparison. In comparing the slide of our sample to the image of a modern *khoi* fibre there is a good similarity.[7] Under examination and comparison, the fibre in question is certainly long and has certain characteristics that are similar to those of mulberry, such as the cross striations along the length of the fibre. To solve the identity of this fibre, we will attempt to obtain a sample of the *khoi* fibre to investigate and clarify this matter in the future.

CONDITION ASSESSMENT

The manuscript was in fragile condition and could not be exhibited or studied safely. It had suffered severe insect damage and had significant losses of media and support. In addition, a number of folds between the concertina pages were torn, and many had previous repairs.

The paper support shows a coarse wove pattern (Figures 10 and 11) as it was made in accordance with the traditional papermaking method. Pulp is first placed on fabric stretched over a frame, then rolled over with a stick to even out the fibre distribution and left to dry.[8] The next step in the traditional papermaking process is burnishing, which involves applying a thin paste of rice flour on the paper surface and rubbing it with a smooth stone.[9] The paste also acts as sizing, which would prevent the ink from bleeding.

The paper support, aside from the losses from insect damage and handling, was still strong and stable with a pH of 6.5–7. This was likely because the lime used for preparing the bark for pulping and in

"Carrying out interviews with artists and crafting detailed documentation are important parts of the process. Active communication among the stakeholders and capturing key information – such as the creative process, artist's intent, materials and techniques used – are important to preserve the integrity of the artwork."

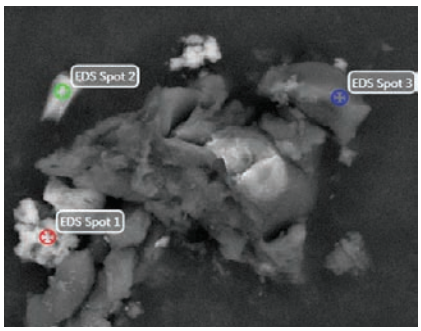


Figure 8. **Elemental analysis of three spots in white ground sample – Spot 1: calcium, oxygen, carbon and traces of aluminum and silicon; Spot 2: carbon, oxygen, silicon, aluminium, sodium and traces of iron, chlorine, potassium; Spot 3: carbon and oxygen only**

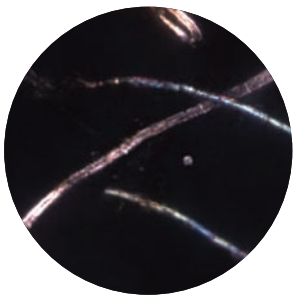


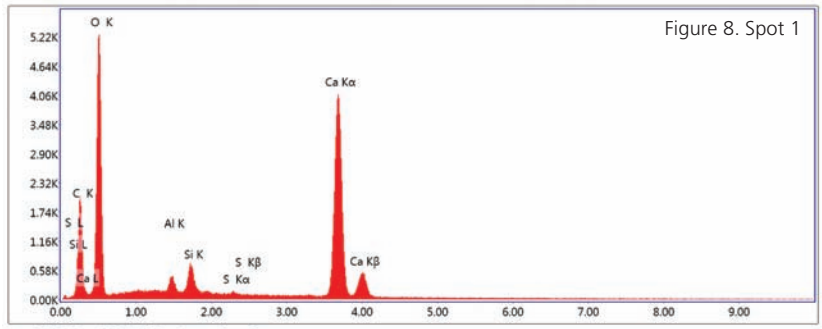
Figure 9. **Fibres from the manuscript under PLM at a magnification of 100x**

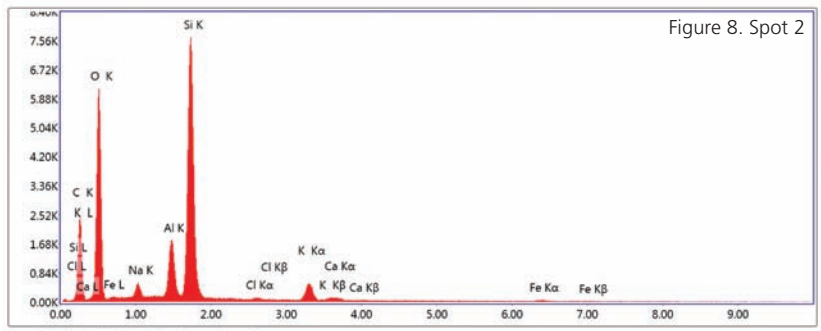
the starch solution for layering the paper support had rendered it fairly alkaline. Besides being sized with starch, the paper support had also been prepared with thick white ground for both the text and the illustrations.

The media of the manuscript are black ink, gold leaf, gold paint as well as white, blue, red, yellow, green, and purple pigments. The media on the text pages are stable. However, on the illustrated pages, many painted areas were friable and cracked (Figure 12) due to the thickness of their paints and prolonged handling over the years. These areas were in need of consolidation.

CONSERVATION TREATMENT

Together with the curator of the exhibition, we decided on the three priorities of conservation treatment: remove surface dirt and accretions due to insect damage; consolidate cracked





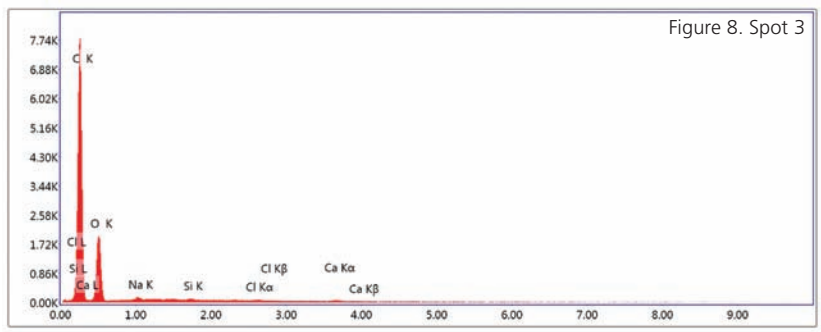


Figure 10. **Wove pattern on paper support. Detail of Fortune Telling Book**

[5] Rutherford J. Gettens, Elisabeth West Fitzhugh and Robert L. Feller, "Calcium Carbonate Whites" in *Artists' Pigments: A Handbook of their History and Characteristics Vol.2*, ed. Ashok Roy (Washington D.C.: National Gallery of Art, 1983), 203–26.

[6] Huang, "A Technical Examination," 7.

[7] Ibid., 15. The slide of our sample was compared with the image of a modern *khoi* fibre on this page.

[8] Om Prakash Agrawal, *Conservation of Manuscripts and Paintings of Southeast Asia* (London; Boston: Butterworths, 1984), 137–38; Elaine Koretsky, *Sheet Formation Around the World 1976–2002*, DVD (Boston: Research Institute of Paper History and Technology, 2002); Royal Botanic Gardens, Kew, "XXXVI Streblus Paper," *Bulletin of Miscellaneous Information* 15 (1888): 81–84, accessed May 1, 2013, http://www.jstor.org/discover/10.2307/4114843?uid=3738992&uid=2129&uid=2&uid=70&uid=4&sid=21104562951767.

[9] Agrawal, *Conservation of Manuscripts*, 137–38; Royal Botanic Gardens, Kew, "XXXVI Streblus Paper," 81–84.

Figure 11. **Brush marks on paper support. Detail of Fortune Telling Book**

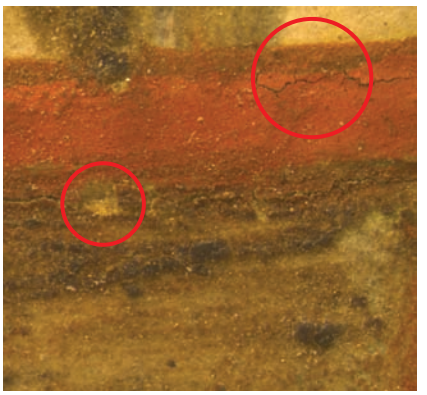


Figure 12. **Friable and cracked media. Detail of Fortune Telling Book**

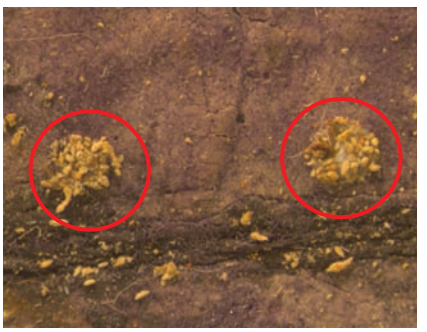


Figure 13. **Insect frass. Detail of Fortune Telling Book**

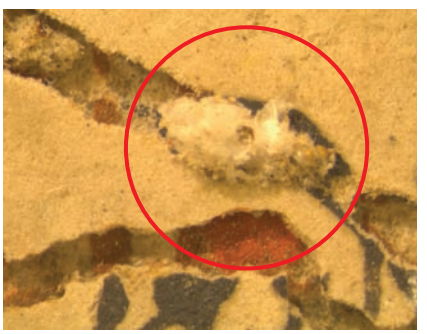


Figure 14. **Insect casing. Detail of Fortune Telling Book**

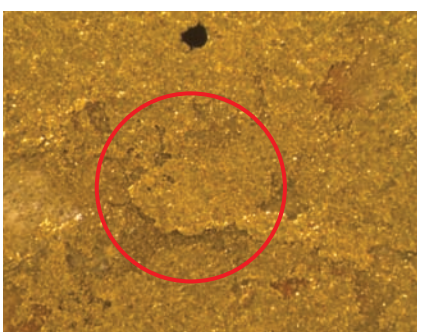


Figure 15. **Friable gold paint. Detail of Fortune Telling Book**

and friable media; and mend larger tears, holes and losses in the support. Our aim was to stabilise the manuscript without compromising its integrity and evidence of use.

Given the friable media, we removed the dirt and accretions from only the support's unpainted areas, using a small soft brush and under microscopic magnification; the insect frass and casings (Figures 13 and 14) were picked up with tweezers.

After each page was cleaned, the media on it were consolidated. Our initial plan was to test both gelatine and hydroxypropylcellulose (also known as Klucel G). However, according to the curator, it was likely that the manuscripts were produced by monk fortune-tellers whose beliefs forbade the killing of living beings and voluntary use of meat products. This piece of knowledge about the manuscript's origins contributed to our understanding of its intrinsic values. To preserve the manuscript's attributes, we decided not to use gelatine. Instead, we tested Klucel G dissolved in deionised water.[10] Results confirmed that it worked well in terms of adhesive strength and, at the same time, it did not alter the surface characteristics of the adjacent part of the support.

We applied Klucel G at a concentration of 0.5% using a nebuliser on the areas with cracked media. As for the areas that were much more friable or were flaking, such as the gold paint (Figure 15), we applied Klucel G at a concentration of 1% using a brush. After application, we left the consolidated areas to dry before testing to see whether a second coat was needed.

The next step was to mend the significant tears and holes in the manuscript. Before treatment, a number of pages were torn at the folds and previously repaired in a variety of ways. Some pages had been sewn at the folds with thread (Figure 16); others were held together and reattached with a strip of cloth or paper

Figure 16. **Two pages sewn together in a previous mend. Detail of Fortune Telling Book**

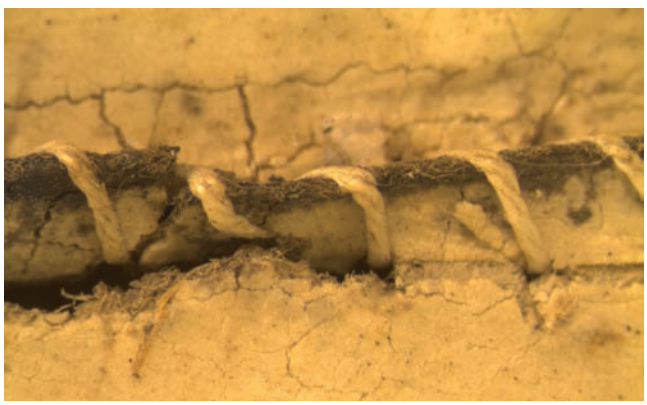


Figure 18. **Tears in the paper support as a result of stress from previous restoration and use. Detail of Fortune Telling Book**

Figure 17. **Two pages reattached with a strip of cloth in a previous mend. Detail of Fortune Telling Book**

"We came to the conclusion that within the context of Southeast Asian cultures and traditions, it is very important to consider the religious and social aspects of artefacts in collections since the same types of objects are still held in awe today."

(Figure 17). Some of these previous mends had caused stress to the support, which over time resulted in further tears and breakages in the support (Figure 18).

We decided that we could mend some of the major tears and losses but would retain other previous restorations as evidence of use. The mending was done with Japanese *kozo* fibre paper and wheat starch paste. These materials were chosen because of their strength, ageing properties and close proximity to the original materials of the manuscript. For the previous restorations that we had decided not to alter, we would alleviate the stress caused by the distortions by handling and supporting the pages carefully during exhibition and use so that the tears and breakages would not worsen. In addition, to avoid unnecessary handling, we photographed the manuscript so that curators and researchers would be able to use the photographs, instead of the physical manuscript, for reference in the future.

CONCLUSION

When the manuscript was first presented to the paper conservation team at HCC, very little information was known about it. By working with the curator of the collection, consulting with other experts and drawing on historical texts, we were able to develop treatments that were appropriate to the object and its history. We came to the conclusion that within the context of Southeast Asian cultures and traditions, it is very important to consider the religious and social aspects of artefacts in collections since the same types of objects are still held in awe today. As we gain more insights and concrete information about the historical use of the artefacts and their material compositions, we will be better able to preserve the material evidence of our cultures. ⧗

ACKNOWLEDGEMENTS

Special thanks to Heidi Tan, Principal Curator of the Asian Civilisations Museum, for initiating the project and her invaluable inputs; Wajuppa Tossa, Associate Professor at Mahasarakham University, for her insights into Thai fortune-telling and manuscripts; Lucia Burgio, Senior Scientist at the Victoria and Albert Museum, who carried out the Raman testing; Hi-Tech Instruments Pte Ltd for the SEM-EDS analysis; Phyllis Koh, for her assistance in the fibre analysis; Konstanze Bachmann, for her advice on this paper; and colleagues at HCC for their support throughout this project.

[10] Different concentrations of Klucel G were tested before we concluded that 0.5% was the most efficient and effective consistency. Results showed that only one coat of Klucel G at 0.5% was needed to stabilise most of the cracked and slightly friable paint areas.

ADAPT AND INNOVATE – Preventive Conservation Of The Leo Haks Opera Collection

By
Agnes Sing, Senior Collections Officer

INTRODUCTION

The National Museum of Singapore (NMS) acquired its largest collection of Chinese opera artefacts from Leonardus Haks in 2006. Also known as Leo Haks, the Dutchman lived and worked in Singapore in the 1970s.[1] In an interview with Mary Lee, he recounted that he was intrigued by Chinese culture and heritage, particularly Chinese funerals, and he started collecting related paraphernalia.[2] His interest grew, and in 1975 he left his managerial position at Cold Storage, a leading food supplier in Singapore. Since then, he has been a private collector, art dealer and author.[3]

Named the Leo Haks Collection, the comprehensive collection consists of 3,192 artefacts, including traditional opera costumes, scripts, musical instruments, banners, backdrops, props, headdresses and accessories. It also comes with a large number of beautiful hand-painted paper garments, which were collected from 1973 to 1979 from local paper offering shops by Haks.[4] As for the opera items, they were collected from 1975 to 1984 in Singapore.[5]

For such a huge collection of artefacts in varying sizes, materials and conditions, what were the challenges of handling and storage? How did the Heritage Conservation Centre (HCC) overcome these challenges? This paper discusses HCC's customised workflow for accessioning the collection as well as its innovative methods of adhering to preventive conservation principles, reducing the use of storage materials and optimising storage space.

BACKGROUND

In the early 1980s Haks bought the bulk of the opera collection from Liew Seng Wah, its original owner who had retired from his performing career.[6] Liew was a local Chinese opera artiste who had started Kwong Wah Dramatic Troupe with his wife, Pek Choy Yok, in the late 1920s. The troupe had performed in Singapore and around the region during the heyday of Chinese opera from the 1930s to 1950s. This acquisition is thus important as it presents opportunities to study the history of Chinese opera in Southeast Asia through the lens of a troupe that had travelled extensively around the region.

The collection includes 365 sets, or 1,561 parts, of traditional hand-painted paper garments. The larger ones, measuring up to 3.7 x 5m and featuring dazzling designs, are meant as offerings to be burnt for deities; the smaller, human-sized ones are less elaborate and meant for ancestors.[7]

Although paper garments may not have a direct connection with Chinese opera, the two do share a common function as ceremonial tools. During calendrical festivities and deities' birthdays, some Chinese pay their respect to deities and ancestors. They perform prayers and rituals, including burning paper garments as offerings. Chinese opera, on the other hand, is presented at temples as a form of entertainment for the deities and ancestors.[8]

Hand-painted paper garments, such as the ones in the Leo Haks Collection, are regarded as especially valuable now because of their rarity. Considered outmoded in Singapore now, they have been replaced by machine-printed paper garments from Bangkok.[9] Furthermore, gifts to deities and ancestors now are usually in practical forms, such as food and drinks that can be distributed to followers after ceremonies.

Very few paper garments of the same type as that in the Leo Haks Collection exist outside of Singapore today; they are scarce even in China, their original place of production. Paper garments were originally made in Guangdong, China, between 1930 and 1960.[10] In 1949 when China adopted communism, religious worship in every form was banned and severely censured. According to Haks' research, paper garments were being destroyed during the Great Leap Forward campaign from 1958 to 1961. Retailers in Singapore had to send paper to China for paper garments to be made when materials became scarce, before their production for export eventually came to a complete halt during the Cultural Revolution (1966–76). The paper garments collected by Haks from shops in Singapore could be the largest remaining collection of this traditional craft and are thus considered especially rare and valuable.[11]

CHALLENGES

A team, comprising staff from NMS's curatorial and HCC's collections management and conservation services departments, was formed for the project to accession the Leo Haks Collection. Broadly speaking, there are three types of

artefacts in the collection, namely two-dimensional (2D) items (opera garments, banners and backdrops); three-dimensional (3D) items (headdresses, accessories and props); and paper items (scripts and paper garments).

The artefacts had arrived at HCC crammed in three large wooden crates at random without proper packing. Most of them had either been loosely packed or stuffed into any available space in the boxes. The opera garments had been folded without proper support and were creased. They were also dirty and emitted mouldy odour.

Limited storage space was another challenge: HCC's crating store, allocated for the temporary storage of the artefacts, was only 132.2m², and its four racks and shelves were occupied by large artefacts that could not be shifted elsewhere.

STRATEGY

Our top priority was thus to provide reasonable care to the artefacts while managing the space limitation. The strategy involved the 3R principles (reduce handling; reduce repetitive processes; and reduce cycle time) and an adapted workflow.

We employed an adapted workflow that began with artefact identification, number assignment, condition check and temporary storage. It then progressed to photography, which was carried out concurrently with accessioning, before documentation and permanent storage. Despite the large quantity, we were able to execute related tasks in succession within the same processes.

EXECUTION

A five-phase plan was developed and executed accordingly.

PHASE ONE: IDENTIFICATION, NUMBER ASSIGNMENT, CONDITION CHECK AND TEMPORARY STORAGE

We started with identifying the opera costumes, headdresses and accessories because they were the largest in terms of size and number. Related artefacts were grouped as units based on motifs and functions for meaningful reference in the future. For instance, a robe was grouped with matching accessories such as a skirt, belt, headgear and shoes. After a garment had been identified, we wrote its assigned accession number on a piece of acid-free paper and attach it with a fine pin to the bottom proper left of the garment. In this way, everyone would know where to look for the number instead of having to flip through the opera garments. As for the 3D items, the assigned numbers were secured with strings. Each item was immediately checked by the conservators after identification and number assignment. The pieces awaiting their matching pieces were temporarily stored on large stackable hardboards, while those without matching pieces were put away in temporary boxes.

Paper garments, scripts, props, banners and backdrops were not included in the identification stage because they had been grouped consistently and we could accession them straight away. All items except the paper items were condition-checked; the paper conservators selected pieces at random to assess their condition.

For the opera garments, we tracked them by dividing the garments into groupings of functions, colours and craftwork (embroidered or sequinned), and noting their details meticulously on paper. This was a manual method but it was still more effective than referring to photo images that had no descriptions. Moreover, it was easier to take notes on location for pieces that had been stored away.

We completed the identification, number assignment, condition assessment and temporary storage of 1,291 sets, or 1,631 parts, of garments, headdresses and accessories in 20 days. If we had

[1] Mary Lee, "Letter From Singapore," *Far Eastern Economic Review,* June 13, 1980, accessed August 16, 2014, http://www.leohaks.com/2010/other_items/reviews/19%20CC_FEER_Inverview_Mary_Lee_1980.jpg.

[2] Ibid.

[3] Ibid.

[4] Leo Haks, "The Great Bazaar: Chinese Votive Costumes," FMR 2 (August–September 2004), 98.

[5] Coen Pepplinkhuizen et al., *Celestial Art: Paper Offerings and Textiles from China Collected by Leo Haks* (Gent: Snoeck Ducaju en Zoon, 1997), n.p.

[6] Ibid.

[7] Leo Haks, "The Great Bazaar," 88; Baihao Wulong and Guiyu, "Buddhism," accessed March 23, 2014, http://angelcity.idv.tw/world/fo.htm. In the Agama Sutra, one of Sakaymuni Buddha's discourses, humans who are skilful in their actions, words and thoughts are said to be reborn in celestial realms as large, tall and beautiful beings with mighty power. These celestial beings are regarded as deities in folklore and calendrical ceremonies.

[8] *Wayang – Amusement for the Gods,* produced by Mona Loh (1989), accessed February 25, 2014, http://vimeo.com/22506702.

[9] International Institute of Asian Studies, "Celestial Treasures from China: Gifts for the Gods and the Deads," *IIAS Newsletter* no. 11 (Winter 1997): 50, accessed Aug 16, 2014, http://www.leohaks.com/2010/other_items/17%20-%20ILLA.jpg.

[10] Ibid.

[11] Ming-Yeung Lu, "Collecting for Life: Book Review of Silk for Thrones and Altars and Celestial Art," *Textile Society of Hong Kong* 12, no. 1 (Spring 2004): 12, accessed Aug 16, 2014, http://www.leohaks.com/2010/other_items/reviews/20%20CC_spring2004_collectingforlife.pdf.

used the conventional way, with each task done individually, we could have taken up to three months. By carrying out these related tasks successively within the same stages, we were able to shorten the time taken for this phase, not to mention minimise artefact handling.

Temporary Storage

To maximise the space available, we devised an innovative technique. Thick polyethylene (PE) blocks were glued several centimetres apart from one another along the edges of large hardboard trays. The costumes were laid on the hardboard trays, which were then stacked one on top of another, supported by the PE blocks underneath. The trays with lighter load were placed on top, and the ones with heavier load below. The openings between the PE blocks allowed us to easily identify what was stored within each storage unit when we needed to group the costumes with their matching pieces and accessories as sets.

Some garments were stored in temporary boxes immediately after they had been identified without their matching pieces so as to quicken the project pace and make room. Subsequently, when their matching pieces had been found, the stored-away pieces were retrieved to be reassigned the necessary "part of" numbers. This backtracking process was inevitable as there was simply not enough space in the crating store for all three crates to be emptied at one go.

PHASE TWO: ACCESSIONING

Accessioning involves the marking or labelling of numbers on the artefacts. The accession numbers are typically written on cotton tape and sewn on garments. The process should be reversible, so no knots must be used in the sewing. The sewing was done with the garments in their storage units. We did not have to search through the garments and were able to easily replace the pieces of acid-free paper (on which the numbers were earlier written) with cotton tape, as every piece was pinned to the bottom proper left of the garments. The garments were also placed such that their bottom proper left sat at both proper lefthand corners of a storage unit's narrow ends. The numbers assigned to the garments during identification were first written on the cotton tape; we could thus know which garments had yet to be accessioned just by checking the unused tapes.

For the 3D items, we applied a layer of paraloid (varnish) on solid surfaces before writing the accession numbers, followed by another layer of paraloid as the sealing topcoat. For paper items, the numbers were written with a soft tip 2B pencil.

PHASE THREE: PHOTOGRAPHY

Different materials required different exposures for photography. Generally, sequinned garments reflect light easily while embroidered ones absorb light. The costumes were hence sorted into these two groups. On photography day, we were able to photograph the two sets of artefacts in a concerted manner without interruption from frequent exposure setting changes. When the garments were laid flat during the photography, we also took the opportunity to take their measurements.

Family Pictures

We grouped the costumes with their accessories such as shoes, boots and headdresses to facilitate quick retrieval when photographing the artefacts in their "families". The accessories had to be stored away from the costumes in separate boxes and locations due to their 3D forms. "Part of" numbers – "x over the total number of boxes" – were indicated on the box labels. If there were five boxes, "1/5", "2/5" and so on were written next to the accession numbers on both the costume and accessory boxes, to help staff know that there were other "parts" with the same accession numbers in other locations. This was so that we could seek the other "parts" out and group them efficiently for the "family pictures".

Backdrops

Four or five staff worked together to spread out these large pieces of backdrops with intricate designs and set up the required lighting. After the photography was completed, the backdrops were measured and folded properly.

Paper Garments

The paper garments are made of rice paper or paper mache, both of which are fragile in nature. Their elaborate motifs and coloured paints also made them the most challenging artefacts to be photographed. The elaborate motifs on the smaller pieces made of foil, which are pasted on the costumes, and the paints flaked whenever the costumes were being folded and unfolded. To photograph the larger paper costumes, some measuring up to 3.7 x 5m, we had to unfold the sleeves (Figure 1) and then fold them back to how they had been folded before so as to reduce the stress on them. Only three staff members were needed so as to synchronise movements without tearing the artefacts.

PHASE FOUR: DOCUMENTATION

The documentation stage captured information about the artefacts for future reference and research. Records are created in hard copy documents as well as in soft copy in NHB's Museum

"To maximise the space available, we devised an innovative technique. Thick polyethylene (PE) blocks were glued several centimetres apart from one another along the edges of large hardboard trays."

Collections System (MCS). The notes taken during identification, such as on the functions, colours and craftwork of the artefacts, were used as a reference to ensure that the images in the MCS records were correctly uploaded.

PHASE FIVE: PERMANENT STORAGE

A room of 56.61m² in HCC was allocated for the permanent storage of 1,045 garments and 586 accessories, props and backdrops. The permanent storage phase was the most intensive part of the project because we had to carry out comprehensive research to devise an extensive range of storage methods, plan the use of the limited space and observe preventive conservation practices.

For this storage project, although non-archival boxes were eventually used, archival materials were introduced to mitigate the transfer of acidity from non-archival materials to the artefacts. Years later, the non-archival materials may need to be replaced, but this is a usual practice for storage projects using archival materials as well. Therefore, while the storage strategy for the Leo Haks Collection might not have been a perfect one, it was nonetheless adopted given the situation and resources available at that time.

Garments

If the costumes were to be stored in archival garment boxes, they would have to be folded extensively. Folding would have stressed and creased the materials, which would lead to microscopic and subsequently larger, irremediable tears after some time.

The costumes were instead stored in customised boxes made of non-archival corrugated hardboard, each measuring 16 x 148 x 78cm. These boxes were large enough to accommodate the length of all the opera robes; we could lay the robes flat in the boxes by folding only the sleeves. As the non-archival hardboard contained lignin and sulfur, which would degas acidity, acid-free paper was thus lined on all internal surfaces of the boxes. The layers within each garment were interleaved with acid-free paper to prevent material abrasion, absorb the acidity degassed by the garments and prevent layers of garments from sticking to one another as a result of electrostatic force. Holes were also punctured at the four corners of the boxes to allow ventilation and prevent mould, which thrives in still-air environments (Figure 2).

Figure 1. **A paper costume unfolded for photography. Its elaborate motifs and flaking paints made it vulnerable to the stress of folding and unfolding**
A paper robe, (2007-56575).
From the Collection of National Museum of Singapore

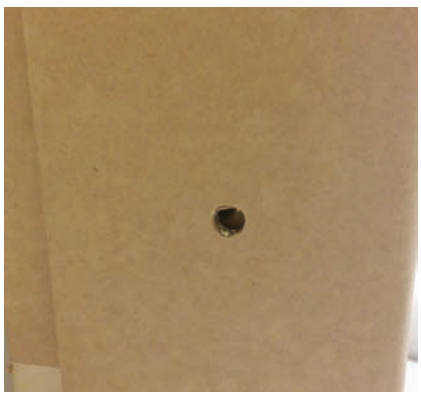
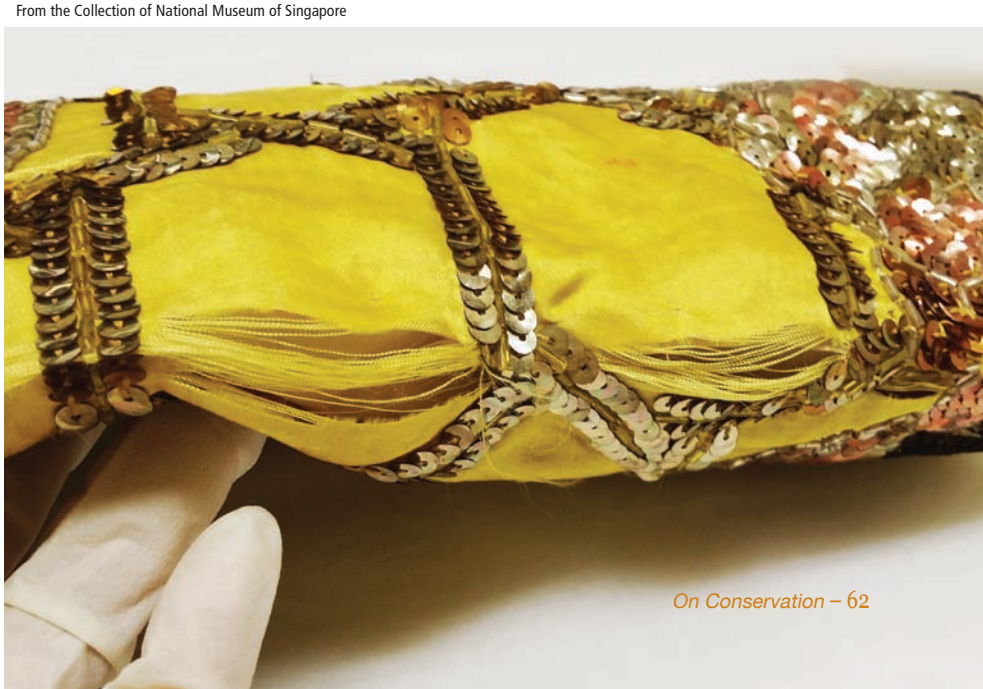


Figure 2. **Holes were punctured in the four corners of the boxes to allow ventilation; this would prevent mould, which thrives in still-air environments**

Figure 3. **A horizontal tear running across the back of the shirt below the collar. It is a common tear due to gravitational force and stress exerted at the collar**
Detail of a red robe embroidered with golden carps and floral motifs worn by a court official in a Chinese opera, (2007-51518).
From the Collection of National Museum of Singapore

Figure 4. **A tear in a sleeve, especially common for sequinned satin. Stuffing the sleeve with acid-free paper is an art: If the sleeve is understuffed, the sequins will weigh down and cause stress on the satin; if it is overstuffed, the tear line will be aggravated**
Detail of Costume-Opera: Lady embroidered yellow dress (top blouse) (2001-06149-001).
From the Collection of National Museum of Singapore



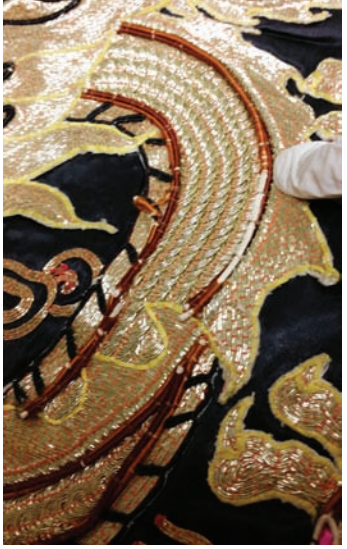


Figure 5. **The embroidery shown here is made of paper coiled thread curled with gold thread. It is suspected previous folding has caused the paper lining to break and the elements to disintegrate**
Detail of a black robe embroidered with cranes and a gold dragon motif worn by a court official in a Chinese opera, (2007-53067).
From the Collection of National Museum of Singapore

Figure 6. **The yellow dotted lines show the recommended lines for folding over areas that contain lesser embroidery**
A yellow robe embroidered with floral designs and a gold dragon motif worn by a court official in a Chinese opera, (2007-53068-001).
From the Collection of National Museum of Singapore

Craftwork

Opera costumes are embroidered and sequined with symbols such as dragons, phoenixes and floral motifs. The more details an opera costume has, the heavier it is. We inserted appropriate stuffing as support for the craftwork and joint lines (side seams and inseams) of garments, to maintain the artefacts' constitution in 3D shapes. Stuffing is made of unbuffered sheets of acid-free paper with neutral pH, crushed and rolled into cylinders ("sausages") or rounds ("buns"). It prevents abrasion between garment surfaces, buffers the weight of craftwork when garments in flat storage are stacked, and prevents electrostatic forces from causing the pieces to stick together.

It is important not to overstuff an artefact to avoid stressing its fabric too much. We assessed the fragile parts, which were usually the sleeve, shoulder and neck areas where movements and gravitational stress occurred (Figures 3 and 4), before determining where to add the stuffing and how much stuffing to use.

Wadding to Support Folding

Folding stresses the fabric, distorts the threads and decorative elements, and subsequently weakens these areas (Figure 5). However, it is often inevitable given limited space. Generally, we limited folding to the sleeves and where the fabric was lighter (Figure 6).

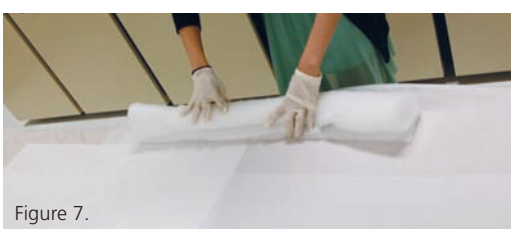


Figure 7.

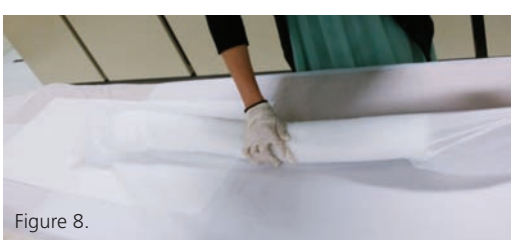


Figure 8.

Figure 9.

Figures 7, 8 and 9. **Strips of wadding are wrapped in acid-free paper, forming elongated cylinders that are secured with cotton tape. They are used for supporting fold lines that need sturdier support than that from stuffing made of only acid-free paper**

Figure 10. **PE foam blocks were glued along the edges of PE trays, serving as pillars that supported the tier above. 3D accessories and props secured on smaller PE boards were placed within the space created by the height of the PE foam blocks, which were glued strategically beside the outlines to hold the smaller PE boards**
Headwear (2007-51995) & (2007-51996).
From the Collection of National Museum of Singapore

Where folding was necessary, we used cylindrical rolls made of wadding wrapped in acid-free paper (Figures 7, 8 and 9) to prop up the fold lines. Made of polyester fibre, wadding is cushion-like padding that can uphold the weight of the garments quite well and maintain the volume needed as support. The acid-free paper wrapping prevents the polyester fibre of the wadding from getting onto the garments.

3D Accessories and Props

Non-archival boxes recycled from a travelling exhibition were modified by introducing archival-quality corrugated PE trays and thick PE foam blocks for the storage of headdresses and props. Each box contained two to five tiers, and each tier was underpinned by a tray. Thick PE foam blocks were glued strategically at the edges of each tray, serving as pillars that supported the tier above. 3D accessories and props, each secured on individual trays customised to its size, were placed on the larger trays within the spaces created by the height of the PE foam blocks (Figure 10).

Inventory Tracking and Minimising Handling

Although accession numbers had been written discreetly at the back of the artefacts, we also indicated them on both the smaller and larger trays. If the objects had been taken out, we would

know which artefacts to track for from the accession numbers on the trays. The accession numbers written on the smaller trays allowed us to easily check for them without directly handling the objects.

Ease of Storage

The smaller trays were created as supporting trays for the artefacts, and their outlines were drawn on the larger trays. With these outlines, staff would be able to return the objects to their original locations and in the correct orientation. Words such as "top", "head", "tail" and "bottom" written down on the trays (Figure 11) also helped to mark the artefacts' orientation. The outlines of the artefacts themselves were also faintly drawn on their supporting smaller trays to ensure that staff would know how to store the objects back to their trays, in cases where the objects and their trays were separated.

Cushioning and Shock Protection

Stored in boxes stacked one on top of another, the objects were subjected to movement during retrieval. The design of the storage must hence help cushion any possible stress and divert it away from the objects. With the help of the empty areas, which facilitated easy retrieval, we were able to glue 1- to 3-inch PE foam blocks (the thickness depended on the height of the props or accessories) along the outlines, a few centimetres apart from one another. The smaller trays could then be fitted snugly into their positions with no void areas that could lead to localised stress to objects. In addition, the foam blocks also helped to divert shock or vibrations away from the objects.

Backdrops

Generally, backdrops are made of three types of materials: velvet, satin and canvas. The first two types of backdrops in the Leo Haks Collection were folded, with pasted characters or embroidery avoided as bending would cause the glue or needlework to disintegrate (Figure 12).

Canvas backdrops painted with watercolours were rolled with large cylindrical hardboard tubes wrapped in Mylar sheets and silicone release paper so that the acidity from the hardboard would not transfer to the backdrops. When rolled, the painted side of the canvas in contact with the back of the canvas was faced with silicone release paper to prevent the watercolour paints from rubbing off. Each rolled backdrop was then propped up on four to six PE foam blocks placed at intervals across its length, away from the horizontal solid surface on which the foam blocks stand. Each PE foam block had a flat base for standing on the horizontal solid surface and a concave depression to hold the rolled backdrop (Figure 13). By minimising the surface areas on which the rolled backdrop rested, we were able to minimise the pull of gravity and prevent the down-facing surfaces from being crushed or compromised.

CONCLUSION

The project to accession the Leo Haks Collection was completed in 18 months. This timeframe would not have been possible if we had employed a conventional approach. By adopting an adapted workflow, we were able to execute related tasks within the same processes. This allowed us to avoid repeating processes, and reduce the cycle time to accession and store the artefacts while minimising handling of the artefacts and adhering to preventive conservation principles. At the same time, the accessioning project also gave us the opportunity to creatively improvise effective ways to economise storage materials and to optimise storage space.

Figure 11. **To ensure that items would be returned correctly to their original places, their accession numbers were indicated on the larger PE trays. Words such as "top", "head", "tail" and "bottom" were also indicated to help ensure the correct orientation**

Figure 12. **A wadding cylinder placed at the fold line to reduce the stress of folding on the garment. Pasted characters were not folded, as bending would cause the glue to disintegrate**
Detail of Backdrop, (2007-52217).
From the Collection of National Museum of Singapore

Figure 13. **Each rolled backdrop was then propped up on four to six PE foam blocks placed at intervals across its length, away from the horizontal solid surface on which the foam blocks stand. Each PE foam block had a flat base to stand on the solid surface and a concave depression to hold the rolled backdrop**

ACKNOWLEDGEMENTS

I would like to express my appreciation to Loh Heng Noi, former Director, HCC, and current Director, National Collection, NHB, for initiating this paper; to Sean Lee, Director, HCC, for his critique and opinions on this paper; and to Darren Wong, Assistant Director, Collections Management, for penning the opening of this paper. Special thanks to my former HCC colleagues, including the following, for their support throughout this project: Teh Eng Eng, Registrar, for entrusting me with the Leo Haks Collection; Chng Mun Wye, Assistant Registrar, for his help and encouragement; Lee Chee Keong, Photographer, for photographing the artefacts; and Jacinta Loh Boon Nee, Senior Conservator (Textiles), for her guidance and sharing. My thanks also go to Raj Prithivi and Cheng Tan, both currently managers of collections management at HCC for their suggestions, HCC's contract staff and the art handlers of Global Specialist Service.


PRESERVING
OUR PAST
to inspire the
future.

BIBLIOGRAPHY

CSI: CONSERVATION SCENE INVESTIGATION – INVESTIGATING MERCURY PRESENCE IN A CHINESE OPERA TROUPE COLLECTION

Agency for Toxic Substances and Disease Registry. "ToxFAQs™ for Mercury." Accessed October 2, 2013. http://www.atsdr.cdc.gov/toxfaqs/tf.asp?id=1195&tid=24.

Agency for Toxic Substances and Disease Registry. "Toxicological Profile for Mercury." Accessed July 4, 2013. http://www.atsdr.cdc.gov/toxprofiles/tp46.pdf.

Canadian Conservation Institute. "Mercury and the Environment." Accessed July 4, 2013. http://www.ec.gc.ca/mercure-mercury/Default.asp?lang=En&n=DB6D2996-1.

Canadian Conservation Institute. "Mercury in Museum Collections." *CCI Notes 1/7* (2002). Accessed July 4, 2013. http://www.cci-icc.gc.ca/resources-ressources/ccinotesicc/1-7-eng.aspx.

Cane, Deborah. "Safe Handling of Museum Collections Containing Arsenic." *ICON Newsletter* 19 (2012): 18–20.

DeCoste, Donald J., and Steven S. Zumdahl. *Chemical Principles.* Australia: Cengage Learning, 2012.

Feigl, Fritz. *Spot Test in Inorganic Analysis.* New York: Elsevier Publishing Company, 1972.

Found, Christine, and Kate Helwig. "The Reliability of Spot Tests for the Detection of Arsenic and Mercury in Natural History Collections: A Case Study." *Collection Forum* 11, no. 1 (1995): 6–15.

Ministry of Manpower Singapore. *OSH Guidelines on Toxic Industrial Waste Treatment.* Singapore: Ministry of Manpower Singapore, 2003. Accessed July 4, 2013. http://www.mom.gov.sg/Documents/safety-health/factsheets-circulars/OSH%20Guidelines%20on%20Toxic%20Industrial%20Waste%20Treatment.pdf.

Ministry of Manpower Singapore. *Workplace Safety and Health (General Provisions) Regulations, September 8, 2011.* Accessed July 4, 2013. http://www.mom.gov.sg/Documents/safety-health/WSH%20(General%20Provisions)%20Rgs.pdf.

Odegaard, Nancy, and Alyce Sadongei. *Old Poisons, New Problems: A Museum Resource for Managing Contaminated Cultural Materials.* Walnut Creek: Altamira Press, 2005.

Odegaard, Nancy, Scott Carroll, Werner S. Zimmt, David Spurgeon, and Stacey K. Lane. *Materials Characterization Tests for Objects of Art and Archaeology.* London: Archetype Books, 2000.

Potts, Philip J., and Margaret West. *Portable X-Ray Fluorescence Spectrometry: Capabilities for In Situ Analysis.* Cambridge, U.K.: RSC Publishing, 2008.

Ratcliffe, Laura. "Rationalising Hazardous Collections." *ICON Newsletter 17 (2012): 14–18.*

Restriction of Hazardous Substances Guide. "RoHS Restricted Substances." Accessed July 4, 2013. http://www.rohsguide.com/rohs-substances.htm.

Risher, John F. *Elemental Mercury and Inorganic Mercury Compounds: Human Health Aspects.* Geneva: World Health Organization, 2003.

Shackley, M. Steven. *X-Ray Fluorescence Spectrometry (XRF) in Geoarchaeology.* New York: Springer, 2011.

Shugar, Aaron N., and Jennifer L. Mass, eds. *Handheld XRF for Art and Archaeology.* Leuven: Leuven University Press, 2012.

FURRY NO MORE – MOULD ASSESSMENT AND REMEDIATION

Borrego, Sofia, Paola Lavin, Ivette Perdomo, Sandra Gómez de Saravia, and Patricia Guiamet. "Determination of Indoor Air Quality in Archives and Biodeterioration of the Documentary Heritage," *ISRN Microbiology* 2012 (2012). Accessed March 12, 2014. http://dx.doi.org/10.5402/2012/680598.

Dalal, Lalchand, Mousumi Bhowal, and Swapna Kalbende. "The Monitoring of Airborne Mycoflora in the Indoor Air Quality of Library." *Journal of Natural Product and Plant Resources* 2, no. 6 (2012): 675–79.

Harkawy, Aleksander, Rafał L. Górny, Leonard Ogierman, Agnieszka Wlazło, Anna Ławniczek-Wałczyk, and Anna Niesler. "Bioaerosol Assessment in Naturally Ventilated Historical Library Building with Restricted Personnel Access." *Annals of Agricultural and Environmental Medicine* 18, no. 2 (2011): 323–29.

Jackson, Robert. "Lessons Learnt: Case Studies on the National Library of Scotland" (paper presented at Moulds & Health in Libraries, Archives & Museums Conservation, Health & Legal Implications, Edinburgh, Scotland, December 5, 2011.

Loh, Jacinta Boon Nee. *Internal Report: Analysis of Setsco Report on the Findings of Air Velocity, Mould and Yeast Count in HCC*. Singapore: Heritage Conservation Centre, 2010.

Meriaux, Anne, Caroline Duchaine, and Paul Comtois. "Usefulness of Using Three Different Culture Media for Mold Recovery in Exposure Assessment Studies." *Aerobiologia* 18, no. 3–4 (2002): 245–51.

Pasquarella, Cesira, Elisa Saccani, Giuliano Ezio Sansebastiano, Manuela Ugolotti, Giovanna Pasquariello, and Roberto Albertini. "Proposal for a Biological Environmental Monitoring Approach to be Used in Libraries and Archives." *Annals of Agricultural and Environmental Medicine* 19, no. 2 (2012): 209–12.

Pinzari, Flavia, and Mariasanta Montanari. "Mould Growth on Library Materials Stored in Compactus Type Shelving Units." In *Sick Building Syndrome: in Public Buildings and Workplaces,* edited by Sabah A. Abdul-Wahab, 199¬–201. Burlington: Elsevier, 2011.

Ross, Claudia, Jose Roberto de Menezes, Terezinha Inez Estivalet Svidzinski, Ulisses Albino, and Galdino Andrade. "Studies on Fungal and Bacterial Population of Air-conditioned Environments." *Brazilian Archives of Biology and Technology* 47, no. 5 (2004). Accessed 15 March, 2014. http://www.scielo.br/scielo.php?script=sci_arttext&pid=S1516-89132004000500020.

Sabbioni, Cristina, Giulia Caneva, and Paolo Mandriol. *Cultural Heritage and Aerobiology: Methods and Measurement Techniques for Biodeterioration Monitoring.* Dordrecht; Boston: Kluwer Academic Publishers, 2003.

Teuling, Arnold Den, Agnes W. Brokerhof, and Bert Van Zanen. *Fluffy Stuff: Integrated Control of Mould in Archives.* Amsterdam: Netherlands Institute for Cultural Heritage, 1999.

Yang, Chin S., Li De-Wei, Diane Miskowski, Patricia Heinsohn, Paul Ellringer, and Christopher C. Gunther. *Business Legal Reports Guide – Mold Management,* 2nd ed. United States: Business & Legal Reports, Inc., 2006.

FROM BOOK TO BUILDING – A HISTORY OF COLLECTIONS MANAGEMENT IN SINGAPORE

Heritage Conservation Centre. *HCC Resource Kit.* Singapore: Heritage Conservation Centre, 2000.

Lambert, Simon. "The Early History of Preventive Conservation in Great Britain and the United States (1850–1950)." *CeROART 9* (2014). Accessed June 21, 2014. http://ceroart.revues.org/3765.

Loh, Heng Noi. "Collection Documentation: The Experience of the National Museum of Singapore" (paper presented at the Conference on Comparative Museology and Museography in ASEAN, Manila, Philippines, April 9–12, 1997).

Ministry of Community Development. "Task Force on the Long-term Development Plan for the National Museum" (Report, 1987).

Osborne, Megan S. "Early Collectors and Their Impact on the Raffles Museum and Library." *The Heritage Journal,* 3 (2008): 1–15.

Teh, Faith Eng Eng. "A Custodian's Challenge: A Museum Documentation Standard for All? Experience from Heritage Conservation Centre, Singapore" (proceedings of the Annual CIDOC Conference, Zagreb, Croatia, 24–27 May, 2005); Photo documentation in the 35mm-slide format started in 1994.

EXAMINATION AND CONSERVATION TREATMENT OF RADEN SALEH'S SHIP IN DISTRESS

Ackroyd, Paul. "The Structural Conservation of Canvas Paintings: Changes in Attitude and Practice Since the Early 1970s." *Reviews in Conservation,* no. 3 (2002): 9.

Berger, Gustav. "Lining of a Torn Painting with Beva 371." In *Lining Paintings: Papers from the Greenwich Conference on Comparative Lining Techniques,* edited by Caroline Villers, 56. London: Archetype Publications, 2003.

Dimond, Jim, and Christina Young. "Reducing Cupping Without Lining." I*n Alternatives to Lining: The Structural Treatment of Paintings on Canvas Without Lining,* edited by Mary Bustin and Tom Caley, 29–30. London: United Kingdom Institute for Conservation of Historic and Artistic Works, 2003.

Domin, Victor. "Rough Seas—Shipwrecks of the Romantic Era: The Evolution of the Dutch Tradition." Accessed February 10, 2014. https://www.academia.edu/4086992/Rough_Seas--Shipwrecks_of_the_Romantic_Era_the_Evolution_of_the_Dutch_Tradition.

Eager, Gerald. "The Iconography of the Boat in the 19th-Century American Painting." *Art Journal* 35, no. 3 (1976): 224.

Johnson, Meryl, and Elizabeth Packard. "Methods Used for the Identification of Binding Media in Italian Paintings of the 15th and 16th Centuries." *Studies in Conservation* 16 (1971): 145–64.

Kraus, Werner, and Irina Vogelsang. *Raden Saleh: The Beginning of Modern Indonesian Painting.* Jakarta: Goethe Institute, 2012.

Lorenz, Eitner. "The Open Window and the Storm-Tossed Boat: An Essay on the Iconography of Romanticism." *The Art Bulletin* 37, no. 4 (1955): 287–88.

Mactaggart, Peter, and Ann Mactaggart. *A Pigment Microscopist's Notebook,* 7th rev. Somerset: Published by authors, 1998.

Markowski, Dariusz. "Nowe, bezpieczne sposoby ochrony impastowej warstwy malarskiej obrazow olejnych na plotnie podczas zabiegow konsolidacji i dublazu na stole prozniowym [New safe methods of protecting the impasto paint layers of oil paintings on canvas during the consolidation and relining on a vacuum table]." In *Problemy dublowania obrazow na plotnie,* edited by Maria Roznerska and Joanna Arszynska, 21, 24, 33. Torun: Uniwersytet Mikolaja Kopernika, 2005.

Martin, Elisabeth. "Some Improvements in Techniques of Analysis of Paint Media." *Studies in Conservation* 22 (1977): 63–67.

Mirowska, Elzbieta, Maria Poksinska, and Irena Wisniewska. *Identyfikacja podobrazi i spoiw malarskich w zabytkowych dzielach sztuki [Identification of painting supports and binding media in works of art].* Torun: Uniwersytet Mikolaja Kopernika, 1986.

Mitchell, Paul, and Lynn Roberts. *A History of European Picture Frames.* London: Merrell Publishers, 1998.

Rouba, Bogumila. "Płótna jako podobrazia malarskie [Canvases as painting supports]." *Ochrona Zabytków* 38 (1985): 222–45.

Sawicki, Malgorzata. "From Lady in Black to Art Students: The Story Behind Changing a Frame." *AICCM Bulletin* 30 (2007): 45.

Von der Goltz, Michael, Ina Birkenbeul, Isabel Horovitz, Morwenna Blewett, and Irina Dolgikh. "Consolidation of Flaking Paint and Ground." In *Conservation of Easel Paintings,* edited by Joyce Hill Stoner and Rebeca Rushfield, 377. London: Routledge, 2012.

Witlox, Maartje. "Many Hands Make Light Work: The Seventeenth-Century Antwerp Interior with Figures Before a Picture Collection." *Art Matters, Netherlands Technical Studies in Art* 3 (2005): 87.

Wolbers, Richard. *Cleaning Painted Surface: Aqueous Methods.* London: Archetype Publications, 2000.

Wyszynska, Jadwiga. *Metody dublowania w procesie konserwacji malowidel sztalugowych na plotnie [Lining methods in the restoration of easel paintings on canvas].* Krakow: Akademia Sztuk Pieknych, 2003.

Yashkina, Larisa. "Adhesive Method of Consolidating Oil Paintings with Cuppings and Hard Craquelure." In *Lining Paintings: Papers from the Greenwich Conference on Comparative Lining Techniques,* edited by Caroline Villers, 106. London: Archetype Publications, 2003.

FUTURE PROOFING – CHALLENGES IN CONTEMPORARY ART CONSERVATION

Chiantore, Oscar, and Antonio Rava. "Conserving Installation Art." In *Conserving Contemporary Art: Issues, Methods, Materials, and Research,* edited by Oscar Chiantore and Antonio Rava, 154–65. Los Angeles: Getty Conservation Institute, 2013.

---. "Aesthetics of the Contemporary Era." In *Conserving Contemporary Art: Issues, Methods, Materials, and Research,* edited by Oscar Chiantore and Antonio Rava, 14–19. Los Angeles: Getty Conservation Institute, 2013.

---. "Awareness of the Issues." In *Conserving Contemporary Art: Issues, Methods, Materials, and Research,* edited by Oscar Chiantore and Antonio Rava, 34. Los Angeles: Getty Conservation Institute, 2013.

Jadzinska, Monika. "The Lifespan of Installation Art." In I*nside Installations: Theory and Practice in the Care of Complex Artworks,* edited by Tatja Scholte and Glenn Wharton. Amsterdam: Amsterdam University Press, 2011.

Kwok, Kian Chow. *Channels & Confluences: A History of Singapore Art.* Singapore: Singapore Art Museum, 1996.

Nadarajan, Gunalan, Russell Storer, and Eugene Tan, *Contemporary Art In Singapore.* Singapore: Institute of Contemporary Arts Singapore, LASALLE-SIA College of the Arts, 2007.

Sabapathy, T. K., and Cecily Briggs. *Cheo Chai-Hiang, Thoughts and Processes: Rethinking the Singapore River.* Singapore: Nanyang Academy of Fine Arts and Singapore Art Museum, 2000).

Scholte, Tatja. Introduction to *Inside Installations: Theory and Practice in the Care of Complex Artworks,* edited by Tatja Scholte and Glenn Wharton, 11–20. Amsterdam: Amsterdam University Press, 2011.

Tay, Swee Lin. *Trimurti and Ten Years After: Trimurti and Dimensions of Performance Art.* Singapore: Singapore Art Museum, 1998.

Trone, Alexandra. "The Emergence of Modern Conservation Theory." In *Historical and Philosophical Issues in the Conservation of Cultural Heritage,* edited by Nicholas Stanley-Price, Mansfield Kirby Talley, and Alessandra Melucco Vaccaro, 202–11. Los Angeles: Getty Conservation Institute, 1996.

Zhao, Robert. "Mission, Institute of Critical Zoologists, Singapore." Accessed March 28, 2014. http://www.criticalzoologists.org/mission/mission.html.

WHAT LIES BENEATH – THE SAFE DISPLAY OF TEXTILES AND GARMENTS

Loh, Jacinta Boon Nee. "Safe Materials Save – An Alternative 3-in-1 Methodology for Accelerated Corrosion Testing for Materials." *On Conservation* 1 (2010): 45–47.

DECIPHERING THE ORIGINS – CONSERVATION OF A 19TH-CENTURY SIAMESE FORTUNE-TELLING MANUSCRIPT

Agrawal, Om Prakash. *Conservation of Manuscripts and Paintings of Southeast Asia.* London; Boston: Butterworths, 1984.

Bullstaporn, Patamakorn. "The Knowledge of the Phrommachat". Chiang Mai: Chiang Mai University, 1986. Quoted in Wajuppa Tossa, Lecture on Thai fortune-telling manuscripts, Asian Civilisations Museum, Singapore, March 25, 2013.

Gettens, Rutherford J., Elisabeth West Fitzhugh, and Robert L. Feller, "Calcium Carbonate Whites." In *Artists' Pigments: A Handbook of their History and Characteristics* Vol.2, edited by Ashok Roy, 203–26. Washington D.C.: National Gallery of Art, 1983.

Huang, Jo-Fan. "A Technical Examination of 7 Thai Manuscripts in the 18th, 19th and 20th Centuries." *ANAGPIC 2006 Student Papers* (2006): 10. https://pacer.ischool.utexas.edu/bitstream/2081/3222/2/2006ANAGPIC_Huang.pdf

Koretsky, Elaine. Sheet Formation Around the World 1976–2002, DVD. Boston: Research Institute of Paper History and Technology, 2002.

Royal Botanic Gardens, Kew, "XXXVI Streblus Paper", *Bulletin of Miscellaneous Information* 15 (1888): 81–84. http://www.jstor.org/discover/10.2307/4114843?uid=3738992&uid=2129&uid=2&uid=70&uid=4&sid=21104562951767

Tossa, Wajuppa. Lecture on Thai fortune-telling manuscripts, Asian Civilisations Museum, Singapore, March 25, 2013.

Wales, Horace Geoffrey Quaritch. *Divination in Thailand: The Hopes and Fears of a Southeast Asian People.* Thailand: Suphanit Publish House, 1983.

ADAPT AND INNOVATE – PREVENTIVE CONSERVATION OF THE LEO HAKS OPERA COLLECTION

Baihao Wulong and Guiyu. "Buddhism." Accessed March 23, 2014. http://angelcity.idv.tw/world/fo.htm.

Haks, Leo. "The Great Bazaar: Chinese Votive Costumes." *FMR 2* (August–September 2004): 98.

International Institute of Asian Studies. "Celestial Treasures from China: Gifts for the Gods and the Deads." *IIAS Newsletter* no. 11 (Winter 1997): 50. Accessed Aug 16, 2014. http://www.leohaks.com/2010/other_items/17%20-%20ILLA.jpg.

Lee, Mary. "Letter From Singapore." *Far Eastern Economic Review,* June 13, 1980. Accessed Aug 16, 2014. http://www.leohaks.com/2010/other_items/reviews/19%20CC_FEER_Inverview_Mary_Lee_1980.jpg.

Lu, Ming-Yeung. "Collecting for Life: Book Review of Silk for Thrones and Altars and Celestial Art." *Textile Society of Hong Kong* 12, no. 1 (Spring 2004): 12. Accessed Aug 16, 2014. http://www.leohaks.com/2010/other_items/reviews/20%20CC_spring2004_collectingforlife.pdf.

Pepplinkhuizen, Coen, Leo Haks, Willem Velema, and Kunsthal Rotterdam. *Celestial Art: Paper Offerings and Textiles from China Collected by Leo Haks.* Gent: Snoeck Ducaju en Zoon, 1997.

Wayang – Amusement for the Gods, 1989. Produced by Mona Loh. Accessed February 25, 2014. http://vimeo.com/22506702.

BIOGRAPHIES

AGNES SING...
joined HCC as a Museum Assistant in 1999. She takes care of HCC's Furniture and Chinese Opera Collections. As child, she liked to follow her grandma to temples to watch opera performances. She never knew what the performances meant until she began managing Chinese opera artefacts and researched on collections management in her professional life. Then, she began to appreciate the ancient performing art form more deeply. Agnes has a Diploma in Technology (Logistics) from Ngee Ann Polytechnic. There, she received an award for Most Outstanding Academic Performance from ST Logistics. She also has a Bachelor of Arts (Translation and Interpretation) from SIM University.

CINDY LAU...
obtained her Bachelor of Science (Honours) in Materials Science from the National University of Singapore, followed by a Master of Arts in Conservation from the University College of London. She joined HCC in 2010 as an assistant conservator, and has worked on projects such as *Terracotta Warriors: The First Emperor and His Legacy* and *Enlightened Ways: The Many Streams of Buddhist Art in Thailand*.

CHUANCE CHEN...
enrolled in Apparel Design at Temasek Polytechnic, Singapore, in 2001, and worked on womenswear after graduation. In 2008, he studied Marketing at the Singapore Institute of Management. He joined HCC's Conservation Services (Textiles) Department in 2009. A large part of his training and practice is on interventive treatment and methods of display. His projects predominantly comprise costume and fashion conservation projects, and he was involved in the National Museum of Singapore's *Beauty in Black* (2010) and *In the Mood for Cheongsam* (2012) exhibitions.

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. Over the last 13 years, he has worked on the conservation of easel paintings, frames and polychrome sculptures in private and public collections in Poland and Ireland. He moved to Singapore in 2013 when he was appointed Conservator (Paintings) at HCC.

DAVID CHEW...
is a curator and senior assistant director with the Community, Institutions and Outreach division at the National Heritage Board (NHB). Previously, he managed the Singapore, Malaysia and China collections and exhibitions at the Singapore Art Museum (SAM), and was also part of NHB's Policy and Strategic Planning division. He has a Master's in Contemporary Art Theory from Goldsmiths, University of London. His past exhibitions at SAM include *The Singapore Show: Future Proof* and *Panorama: Recent Art from Contemporary Asia*. He was also one of the curators of the Singapore Biennale 2013.

DEREK LU...
is Senior Collections Officer at HCC. He started his training in paper conservation before moving to collections management, where he now coordinates local and overseas exhibitions. These include In *Memory of Wu Guanzhong, Seeing the Kites Again, Negotiating Home, History* and *Nation, Panorama: Recent Art from Contemporary Asia* and *The Singapore Show: Future Proof*. He is actively working on the accessioning guide and documentation practice for contemporary art in the National Collection.

ELSIE WONG...
has over thirty years of experience in conservation treatment and is skilled in dealing with a wide variety of materials. She began her career in 1976 in the National Museum of Singapore's Curatorial Department. In 1981, she joined the Museum's Conservation Department, and moved to HCC's Objects Conservation Department in 1993. In 2006, Wong joined HCC's Conservation Services (Textiles) Department.

ESTHER NG...
joined HCC's paper conservation team in 2001. Since then, she has been actively involved in the preventive and interventive conservation of Singapore's National Collection. She has trained with Morgan Library and Museum in New York, University of Delaware-Winterthur's art conservation programme, and the Library of Congress in Washington DC. She attained professional accreditation status as a conservator with ICON (UK) in 2012.

ISHAK BIN AHAMAD...
has a background in precision engineering, where he specialised in the study of metals, metals science and metals fabrication. He joined the National Heritage Board in 1994 as a conservation officer, and gained experience in basic objects, painting, paper and textiles conservation before specialising in ceramics and metals conservation. Ishak did a six-month internship in metals and ceramics conservation at the British Museum, London, U.K., and attended a two-week metals conservation programme in Worcester, Massachusetts, U.S.A. He has also travelled to France, Korea and Kuwait for various conservation projects. Recent projects he worked on include *Enlightened Ways: The Many Streams of Buddhist Art in Thailand.*

KHAIRUDDIN HORI...
is Deputy Programming Director at Palais de Tokyo, Paris. He was formerly Senior Curator at the Singapore Art Museum. He spearheaded numerous Southeast Asian art exhibits, notably Lee Wen's 2012 retrospective, *Lucid Dreams in the Reverie of the Real.* Khairuddin graduated from the Nanyang Academy of Fine Arts and LASALLE College of the Arts. Other hats he wore include associate artist at the Substation; actor, director and associate director at local Malay theatre company Teater Ekamatra; and poet and arts manager at the Singapore Management University.

LYNN CHUA...
joined HCC's paintings conservation team upon graduation from the National University of Singapore with a bachelor's honours degree in chemistry in 2009. She completed an internship at Victoria and Albert Museum, Science Section, concentrating on the examination of artworks using X-ray fluorescence, Raman and optical microscopy. Lynn, now undertaking a Master of Science with a research focus on art material characterisation, is assisting with the setting up of a scientific unit in HCC.

PHYLLIS KOH...
has been a conservator at HCC for seven years. She specialises in paper conservation. She is currently leading the Mould Management Team, which is under the centre's Preventive Conservation Working Group. Koh graduated with a Bachelor of Science (Life Sciences) from the National University of Singapore, and a Masters of Conservation in Fine Art from Northumbria University, Newcastle.

SARAH CHUI...
is a former staff of the HCC. She joined in 2010, where she was Senior Conservation Officer (Objects). Chui enjoyed working with contemporary artworks because of their experimental nature. She treated works for various exhibitions such as *Negotiating Home, History and Nation, Panorama: Recent Art from Contemporary Asia* and *The Singapore Show: Future Proof*.

SITI SUHAILAH SALIM...
has worked on several mounting and preventive conservation projects with HCC and National Heritage Board museums before joining HCC fulltime in 2009. Since then, she has conducted workshops under the Textile Mounting Programme to train colleagues and non-conservators on textile mounting. She has a Diploma in Fashion Design from Nanyang Academy of Fine Arts and a Diploma in Electronic Engineering from Temasek Polytechnic.

TAN PEI QI...
holds a Bachelor of Arts (History) from the National University of Singapore and is currently pursuing a Master of Science (Knowledge Management) at the Nanyang Technological University. She manages the National Heritage Board's Museum Collections System and will be working on its upgrade in the upcoming months.

ZURAIDAH EHSAN...
began work as Collections Officer at the National Heritage Board (NHB) in 1995. In 2007 she furthered her studies at the National University of Singapore. She returned to NHB in 2009 as Assistant Researcher for the SGCool portal. When it ended in 2013, she was re-designated as Collections Manager at HCC, and in 2014, became Registrar.

HCC extends our appreciation to the Directors of National Museum of Singapore, Asian Civilisations Museum, Singapore Art Museum and Director (Curatorial & Collections) of National Gallery Singapore for approving the use of the images; and staff of these museums and institutions, who provided their assistance on the use of these images.


National
Heritage
Board