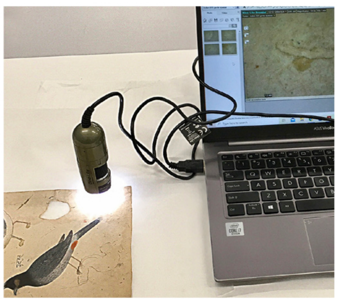
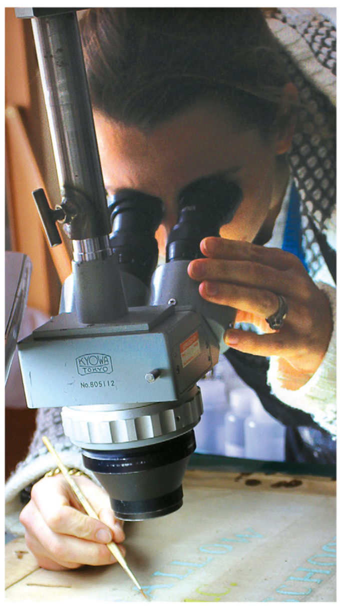
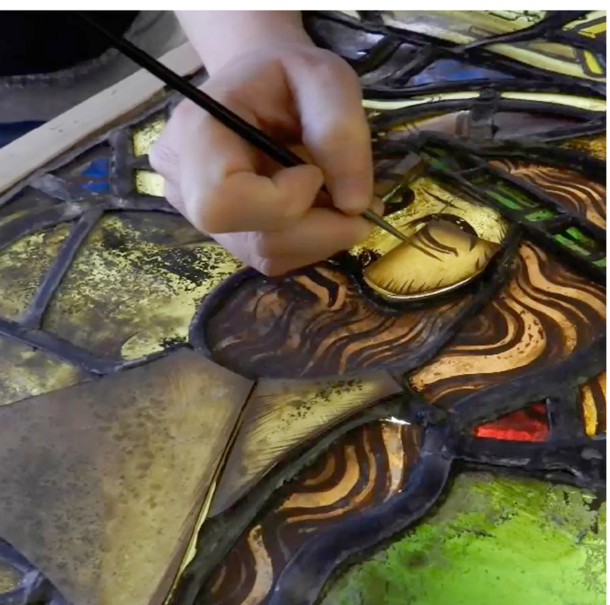
CONSERVATION INSIGHTS 2020

Lectures







INTACH

CONSERVATION INSIGHTS 2020

Lectures

INTACH
Indian National Trust for Art and Cultural Heritage
INTACH CONSERVATION INSTITUTES

Acknowledgements

INTACH Conservation Institutes would like to thank first and foremost all the authors for contributing the papers, reviewing and making this publication a reality. We are grateful to each one of you for sharing your experience and knowledge.

We would like to take this opportunity to look back on the past year when everyone came together for the 'Conservation Insights 2020' Lecture Series and thank all those who were involved and contributed.

We would like to thank Maj. Gen (Retd.), L.K. Gupta, AVSM, Chairman INTACH and Dr. (Mrs) Chuden Tshering Misra, Member Secretary, INTACH for their continued support and encouragement that made the online lectures and this publication possible.

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Contents

Foreword

The INTACH Conservation Institutes works to advance conservation practices in art and material heritage which includes objects, collections, architecture and sites. It serves the field of conservation through promoting best conservation practices, research, training, capacity building, field projects and the dissemination of its work and that of others, in the field. The aim is to create awareness of cultural heritage management issues and dissemination of knowledge, that will benefit professionals and organisations, working in the field.

The COVID-19 pandemic has resulted in a paradigm shift in the functioning of organisations. INTACH too, is adapting and strengthening its online capacity building, in heritage conservation. Many programmes and events were started to increase online sharing of knowledge resources for the benefit of the heritage conservation professional community. The 'Conservation Insights 2020' lecture series was one such initiative. Its aim was to promote networking of conservation professionals through an online platform.

The 'Conservation Insights 2020' lecture series, which was organised by INTACH Conservation Institutes during June-December 2020, provided valuable insights, as the name suggests, for conservation practice. It throws light on a variety of conservation practices and is a valuable tool for learning in its own right. This publication includes selected papers based on the lectures. The papers on various subjects related to cultural heritage conservation, are specifically intended for conservators, conservation scientists, researchers and students in related fields. I thank all the authors who contributed to this publication and shared their knowledge so willingly.

I hope this scholarly publication, and its dissemination, will help in knowledge creation for the conservation community and for the curious layperson as well.

Dr. (Mrs) Chuden Tshering Misra
Member Secretary, INTACH

Preface

The COVID-19 pandemic disrupted our normal way of life and led to lockdowns of institutions globally. During this period, INTACH also shifted to remote learning by using online platforms and resources, in order to continue dissemination of knowledge. The INTACH Conservation Institutes organised the online 'Conservation Insights 2020' lecture series from June to December 2020. There were in all seventy-eight lectures given by experts from India and other countries including Italy, Germany, Spain, Malta, Egypt, Netherlands, Ireland, Hawai'i, United Kingdom and the USA. The participants included students from more than fifty institutions, fellow colleagues, scholars and researchers from around the world.

As a result of these lectures it was possible not only to link with individuals but many institutions, specializing in the field of heritage conservation. The lectures provided invaluable opportunities for networking and exchanging expertise. The selected topics varied from conservation of objects to understanding material, technology and research projects developing in the field of conservation. The success of this event was entirely due to the speakers, who took time to prepare and deliver these online talks. We owe them a debt of gratitude.

This publication, a compilation of selected lectures from the 'Conservation Insights 2020' series, represents another step towards sharing and dissemination of knowledge. The lectures cover a wide range of issues related to philosophy of conservation, preventive conservation, building conservation and the tools and techniques used in examination and conservation of different materials. The subject matter is an invaluable contribution to the field and useful to practising professionals, researchers and students in the field of heritage management.

I take this opportunity to thank all the authors who contributed these papers, and for sharing their knowledge and experience. I hope that this open access e-publication makes for an interesting and informative resource and leads to better understanding of heritage management.

Maj. Gen. (Retd.) L.K. Gupta, AVSM
Chairman, INTACH

Gaël de Guichen
Advisor to the Director General,
ICCROM, Rome, Italy

6 July 2020

Natural Causes of Deterioration … NO … Error of Diagnosis

GAËL DE GUICHEN is French. He began his career as the engineer in charge at the prehistoric cave of Lascaux. In 1969, he joined ICCROM where he completed his entire career. He launched three major programs: one on preventive conservation, one on the development of African museums, one involving the public. As member of ICOM-CC he lead the taskforce on terminology. Since his retirement in 2001, he serves as Advisor to the Director General of ICCROM and has been applying the program on storage Reorganisation RE-org in 21 countries. Since his first mission in India in 1972 he often came back to lecture or run projects.

Preventive conservation[1] requires anticipating all type of possible causes of deterioration on a specific element of tangible cultural heritage, in a specific context.

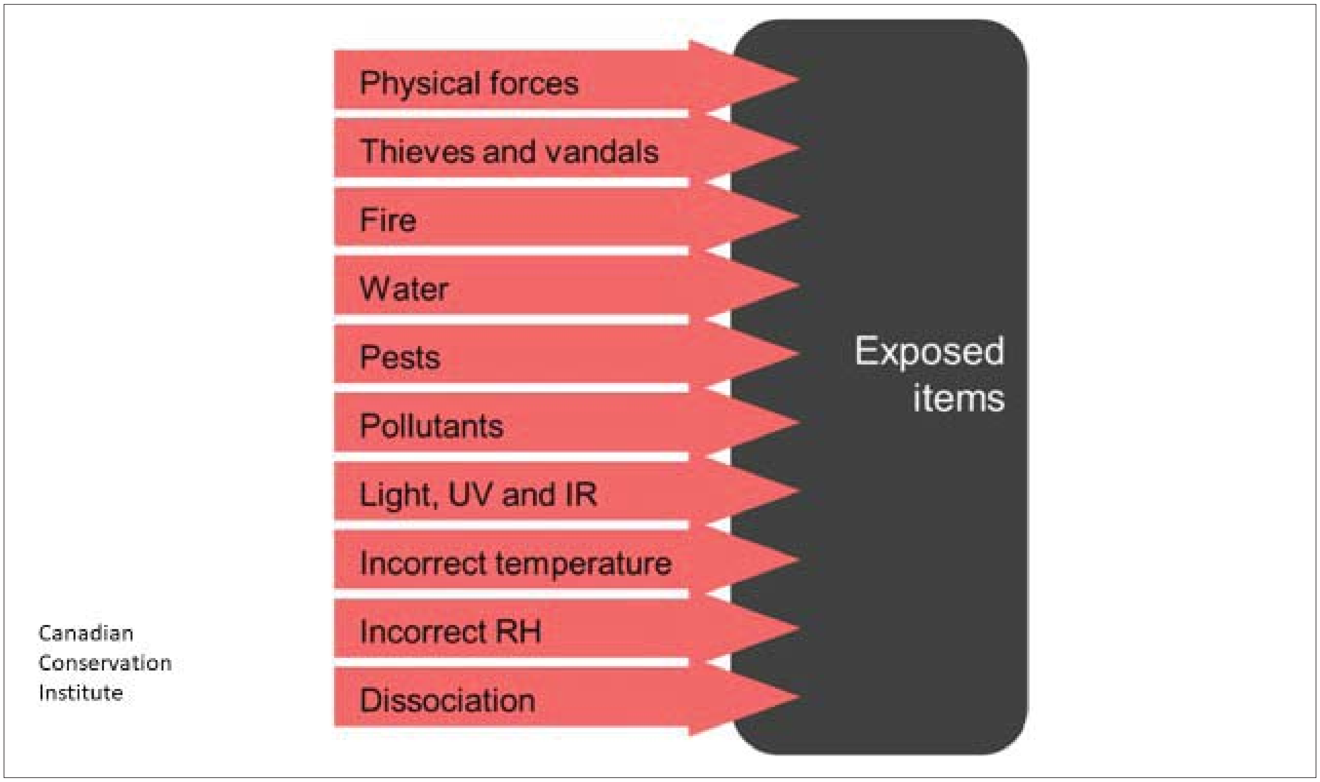
In 1994 CCI proposed 10 agents of deterioration which are principally applied to Museum collections

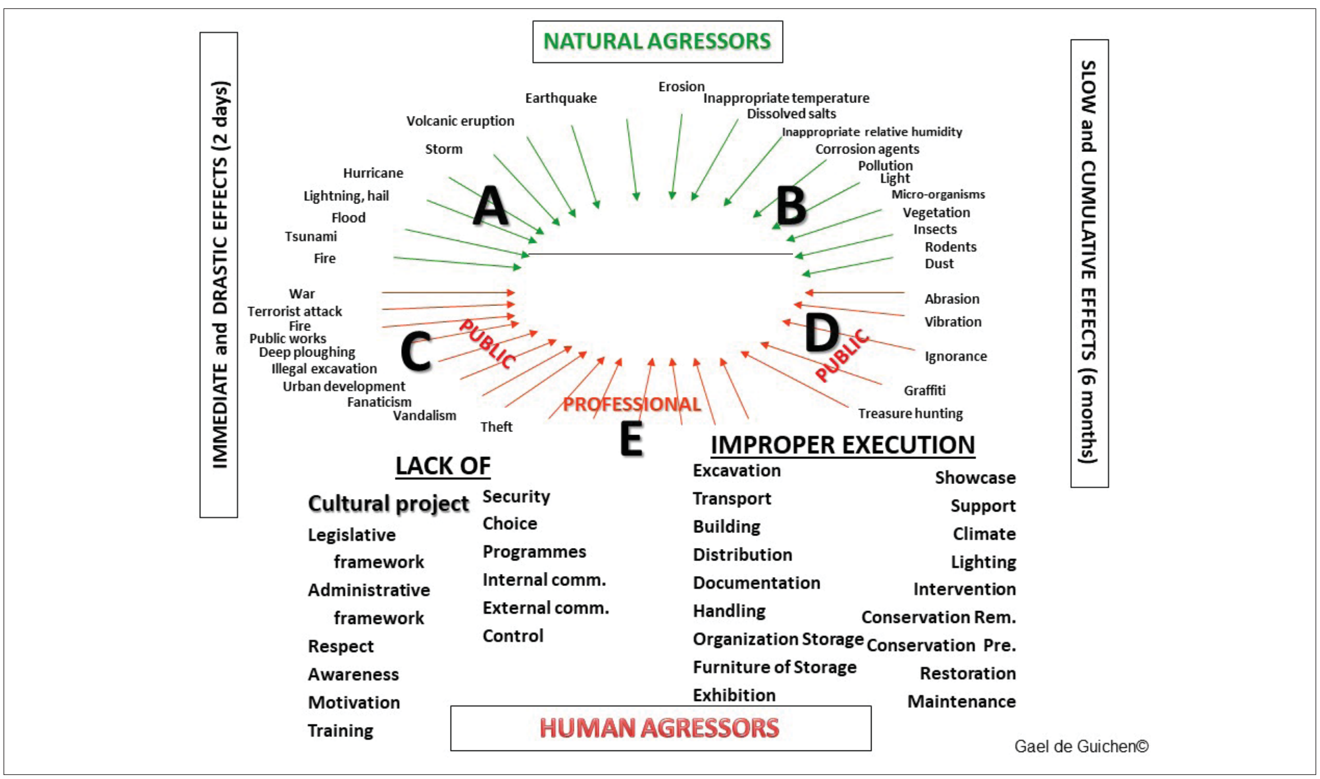
At ICCROM since 1978 I have developed a table which proposes 50 agents and can be applied to all types of cultural heritage, both movable and immovable.

What so ever is the approach it is possible to see that in both these cases the so-called "natural causes" are identical.

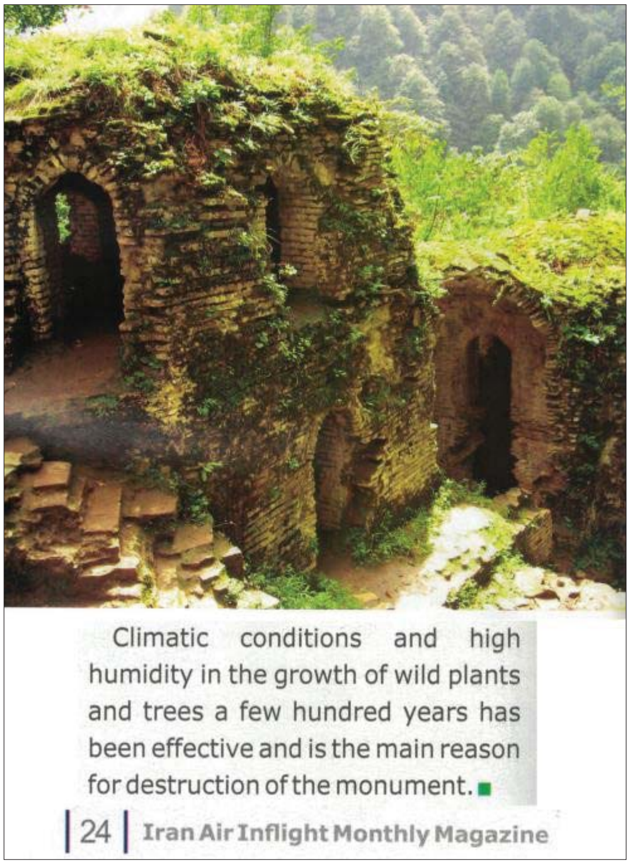
In conclusion, it seems that man is not responsible and that it is mother nature (water, relative humidity, temperature, insects, etc.)

1 Official definition by ICOM and CEN





- **Preventive conservation** - all measures and actions aimed at avoiding and minimizing future deterioration or loss. They are carried out within the context or on the surroundings of an item, but more often a group of items, whatever their age and condition. These measures and actions are indirect – they do not interfere with the materials and structures of the items. They do not modify their appearance.



Climatic conditions and high humidity in the growth of wild plants and trees a few hundred years has been effective and is the main reason for destruction of the monument.

| 24 | Iran Air Inflight Monthly Magazine

which is destroying what humans have created with love, patience and art.

Four years ago, flying from Rome to Teheran, I was reading the inflight magazine and saw the image of a brick construction built 600 hundred years ago, in the middle of the forest, today in ruins. As you can see the caption was:

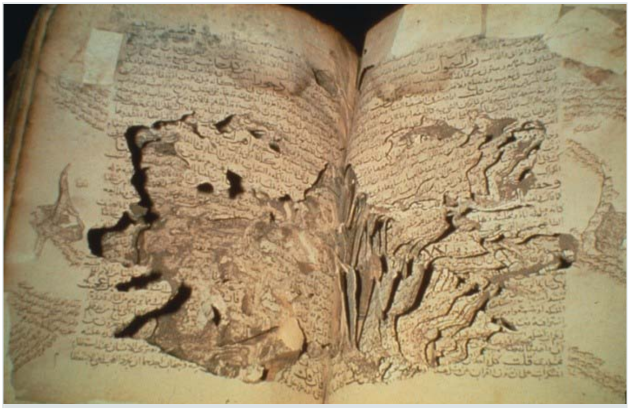
> "Climatic conditions and high humidity
> in the growth of wild plants and trees
> a few hundred years has been effective
> and is the main reason for destruction of the
> monument"

It came as a shock to me. The ones responsible for the slow destruction of this palace have never been the trees and wild plants but the abandonment of this construction by man, leaving the nature to reinvade the place abandoned by the owner. If this building had been properly maintained, it would have been perfect despite its age.

From this moment, I opened my eyes, changed my mind totally. I modified the way I have been teaching for 45 years in more than 50 countries. I realized that the diagnosis I had been proposing during my teaching was simply wrong. It is not easy to admit, I can assure you!

(*Left*)**: NO**, nature is not responsible for this wooden polychrome head of King Tutankhamun (which was found in good condition in 1922 in the tomb in the Valley of the Kings) that has been damaged seriously in last 70 years.

In the museum, the damage is not due to climatic conditions but by human errors of museum staff who have not been able to create in the museum the climatic conditions identical to those existing in the chamber for 3300 years allowing this sculpture to reach us in a sound state.



(***Above***)**: NO**, termites were not responsible for the destruction of this book. The museum staff who has not done regular monitoring, control and discovered too late that termites were very active and greedy are responsible.

(***Above***)**: NO**, it is not heat that has been bending this candle! The person responsible is the staff who had placed the candle near a radiator.

(***Above***)**: NO**, it is not these lovely flower bearing plants which are breaking those roman marbles slabs but the person in charge of this archaeological site who has not done his job of regular maintenance

(***Above***)**: NO**, dust is not responsible for the damage on this panel of paper screen. The staff or the person who had not covered it with a simple piece of newspaper (it was stored in horizontal position) is responsible.

(***Above***)**: NO**, it is not artificial light which has faded this textile from Madagascar, it is the human staff of the museum who have exhibited it directly under artificial fluorescent tubes with no protection during its 70 years in the museum

1970 *2000* *TODAY*

(***Above***)**: NO**, it is not natural light that has destroyed, in front of the eyes of millions of visitors, the ostrich fan of Tutankhamun but the museum warden who had not pulled the curtain on the adjacent window.

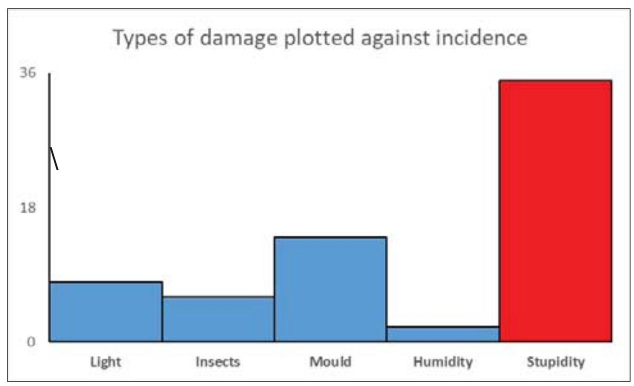
(***Above***)**: NO**, this museum has not been destroyed by fire. Those responsible are the administrator and his staff who has created the conditions for a fire to develop. …. No fire extinguishers… no special door … no one trained to handle the situation, etc.!

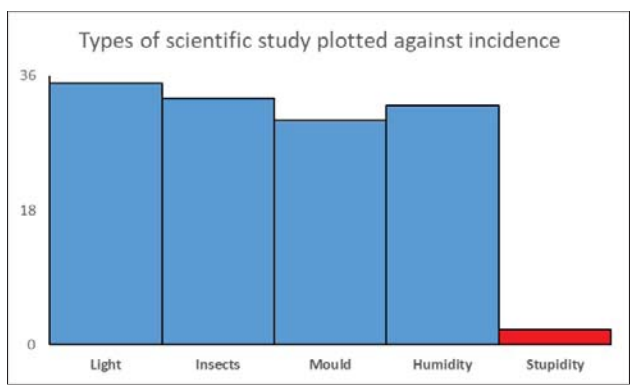
I could continue forever to illustrate that damages that I have attributed for years to "natural causes of deterioration" when in fact they were always due to "man".

It is a combination of abandon, disinterest, lack of common sense, amateurism, lack of adequate training, stupidity, and big professional errors.

As man is destroying, every day, under our eyes his natural environment, man is destroying, every day, his cultural environment.

In an excellent article published in 1986 in "Recent setbacks in Conservation" volume 2, with his amazing sense of humour, Bob Barclay has anticipated those errors of diagnosis with 2 illustrative graphs:





However, 35 years later, we still refuse to call a cat, a cat!

Please be honest.

10 & 13 July 2020

Annalaura Casanova M.
Conservation Scientist, Rome, Italy

Flavia Bartoli
Department of Science,
Roma Tre University, Rome, Italy

Biology and Cultural Heritage: Concepts, Definitions and Diagnostic Approach

ANNALAURA CASANOVA MUNICCHIA is a conservation scientist with a PhD in Biology and Post-doc in the Nanosciences and Nano-technologies section. Previously, she worked as a conservation scientist for Superintendence Monuments and Fine Arts Office of Venice. She graduated with honours from the University of Bologna with a degree in "Science and Technology for Conservation and Restoration of Cultural Heritage", Faculty of Mathematical and Physical Sciences, Ravenna Campus (RA).

FLAVIA BARTOLI has a PhD in Biology and a Post-doctoral in Biology applied to conservation and valorisation of cultural heritage. She has worked on several national and international projects such as the conservation and valorisation of Pompeii and Ercolano, Crypt of Original Sin (Matera, Italy), lodge of Cupid and Psyche (Rome), Angkor Wat (Cambodia), Capadocian Site, etc. She was also a visiting teacher for ACRA foundation project '*Zanzibar Built Heritage Job Creation*' and Professor for the International Master '*BioHeritage: Biology for the Knowledge and Conservation of Cultural Heritage*'. She graduated with honours in Biology from the Roma Tre University.

The cultural heritage, whether of organic or inorganic material, is subject to alteration and deterioration over time, linked to physical, chemical or biological processes. In particular, the stone monuments are a large part of our outdoor cultural heritage and their conservation by biological affection is one of the most profoundly studied topic in conservation's science of 20th century (Caneva et al. 1991, 2008; Morton & Surman 1994; Warscheid & Braams 2000; Chen et al. 2000; Tiano 2002; Clair & Seaward 2004; Herrera & Videla 2004; Crispim & Gaylarde 2005; Macedo et al. 2009; Mohammadi & Krumbeine 2008).

The biological colonisation is a complex process that involves several time-spatial elements, due to the interrelationship among organisms, substrate and atmosphere. Indeed, each monument or artwork must be considered as a habitat where different parts can be considered as microniches, and several types of organisms (lichens, fungi, algae, ferns, mosses, higher plants) can find good conditions for development (Lisci & Pacini 1993; Jennings & Stewart 2000; Nimis 2001; Lisci et al. 2003; Gorbushina 2007; Francis 2010).

The presence of organisms on stone monuments (i.e. biodeteriogens), in the outdoor environment, has been associated, for a long time, to substrate degradation (i.e. biodeterioration). However, in recent time, a new idea regarding the possible positive role (i.e. bioprotection) performed by the organisms on stonework is coming up (Viles et al. 2011, 2012; Garcia-Vallès 2003; Carter & Viles 2005; Sternberg et al. 2011a,b; Pinna 2014).

Actually, in the modern science, the microorganism able to grow on the monument surface are also studied to understand if their presence, ecology and physiology can be a useful tool for the conservation of the artworks (i.e. bioremediation) (Ranalli et al. 2000; Webster and May 2006; Parulekar-Berde et al. 2020; Fernandes 2006; Yadav et al. 2020).

Biodeteriogens

The artefacts, ruins and monuments exposed to outdoor conditions, are affected by biological colonisation (see fig. 1). Many organisms can use the substrate only as support (i.e. phototroph organisms); however, they can favour more complex colonisation, with possible biodeterioration effects. Consequently, when the colonisation cause biological decay effects are called biodeteriogens. (Caneva et al. 2008; Cuzman et al. 2011).

Therefore, the study and the knowledge of the biodiversity, ecology and physiology of biological colonisation on artworks is essential to maintain and preserve the stone cultural heritage for further generations.

The microclimate and the biodiversity degree of the opportunistic airfora/airfauna, such as the reliant environmental factors, among which water, temperature, light, and nutrients influence positive or negative the colonisation process (Caneva et al. 2008).

In the case of stone artefacts, monuments and ruins the biological contamination and the intensity of the biodeterioration processes are strongly influenced by water availability as limiting factor that control, with the light the trigger of colonisation process (Caneva et al. 2008; Warscheid & Braams 2000, Cuzman et al. 2011). The first colonisers of stone surface are autotrophic microorganisms, followed by heterotrophic as associated consumers. Indeed, the last can growth on stone only after the primary enrichment of substrate by organic material, thus starting an ecological succession with the development and the death of successive organism generations (Tiano 2002;

Fig 1: *Angkor UNESCO site (Cambodia), biodeteriogens flora*

Bellinzoni et al. 2003; Caneva et al. 2008).

The development of pioneer microorganisms depends on the combinations of environmental conditions, the chemical-physical properties of stone, and microorganisms’ intrinsic properties (Tiano 2002; Bellinzoni et al. 2003; Caneva et al. 2008). Successfully, when the substrate was eutrophicated, the stone’s chemical composition became less critical, organisms as microfungi, heterotrophic bacteria, and nitrophilus lichens can compare (Nimis et al. 1992; Cuzman et al. 2011).

Terrestrial algae and cyanobacteria have been reported as biofilms on solid substrata’ exposed surfaces in almost all climatic zones. The previous studies demonstrated that green algae have major Mediterranean-Temperate distribution, whereas cyanobacteria are dominant in tropics environments. This difference is due primarily to humidity request and moderate light intensity by green algae, and the capability to withstand high temperature, desiccation and protecting themselves from intense solar insolence on the part of cyanobacteria (Samad & Adhikary 2008).

Bioreceptivity

The whole substrate properties, defined as “Bioreceptivity”, contribute to biological colonisation (Guillite 1995; Miller et al. 2012) and concur to the establishment, anchorage and development of flora and/or fauna. Finally, the organisms’ ability to colonise and transform a substrate is closely linked to suitable adhesion trough species-specific structures (Caneva et al. 2008). Hence, in this habitat water, temperature, light, and nutrients, often operate a primary role in the colonisation of stone surfaces, limiting environmental factors for the genesis and the development of each organism (see fig. 2). As a result, the presence and the variability of potential biodeteriogens depend on the environmental and climatic conditions surrounding the surface to colonise (Ortega-Calvo et al. 1995; Barberousse et al. 2006; Caneva et al. 2008).

Fig. 2: *Different bioreceptivity of stone, Angkor site (Cambodia)*

It must be related to the totality of material properties that contribute to the establishment, anchorage and development of flora and/or fauna. Relating to the stone materials, the bioreceptivity mainly comprises surface roughness, moisture content, the chemical composition of the outer layer, and the rock’s structure-texture. The biofilms formation is related with the primary bioreceptivity or “Intrinsic Bioreceptivity”, whereas the next colonisation phases are connected with the “Secondary, Tertiary or Extrinsic Bioreceptivity”, because the chemical composition and the physical characteristics change, during the exposure to weather (Tiano 2002). Subsequently, the ability of organisms and microorganisms to colonise a substrate and to transform it is closely linked to a good adhesion trough species-specific structure (Caneva et al. 2008). The biodeteriogens arranged in a structurally and functionally complex ecosystem which is essentially “an heterogeneous matrix of microorganisms held together and tryingly bound the underlying surfaces by extracellular polymeric substance (EPS) that develop when nutrient the surrounding environment are available” (Rosenberg 1989).

The exopolymeric polysaccharide matrix (EPS) contains about 98% water, so it "cements" them to the surface, retaining water for a long periods and it transforms rock surfaces into highly adhesive aeolian catchments which accumulate dust and volatile material (Gorbushina 2007).

Biodeterioration

The biodeterioration is known and studied for a long time, which was defined as "any undesirable change in the properties of a material caused by the vital activities of organisms" by H.J. Hueck (1965, 1968). The complex process of stone biodeterioration is a consequence of several types of operations: aesthetical, chemical and physical, always related to the variability of the biodeterioration patterns morphology, depending to the coloniser species, their physiological conditions, the substrate's nature and the climate (Warscheid & Braams 2000; Herrera & Videla 2004; Caneva et al. 2008).

The aesthetical damage is related to the new aspect assumed by the artwork in consequence of the biological colonisation, acting in different ways (Kumar, Kumar 1999; Tiano 2002; Caneva et al. 2008; Viles 2012):

(1) forming coloured patches or patinas and crusts;
(2) greenery surface;
(3) vegetation growing up monuments and ruins.

Regarding the first point, some of the biodeteriogens (as lichen, cyanobacteria, algae and fungi), in specific conditions, can produce pigments like chlorophyll, carotenoid, and melanin, staining the underlying substrate (Imperi et al. 2007, Jehlička et al. 2014). The pigment production by microorganism depends on both genetic and environmental factor. Examples are the production of UV-protective pigments (carotenoids, scytonemin) by endolithic microorganism in adverse conditions such as high UV radiation (Edwards et al. 2003, Vitek et al. 2014). Endolithic growth is characteristic of microorganisms that to survive at the extreme state began to penetrate inside the rock (Walker & Pace 2007). Another example is the melanin pigment, product by fungi as a tool against UV-radiation, desiccation, and temperature excursion (Casanova Municchia et al. 2014).

The final colour can range from black, green, orange, red, and pink, which depends exclusively on the microorganism and environmental factors (Caneva et al. 2008). Especially high saline content (due to efflorescence phenomena), specific lighting conditions, substantial variations in humidity and temperature, are important factors to the colour patina origin (Garcia-Vallès et al. 1998, Polikreti & Maniatis 2003, Tescari et al. 2016, Tescari et al. 2018).

An example is the case of study in the Angkor archaeological area (see Fig. 3), wherein on Phnom Krom temple surface occurs an unusual pink layer (Tescari et al. 2016).

Fig 3: *Pnom Krom Temple, detail of the pink encrustation*

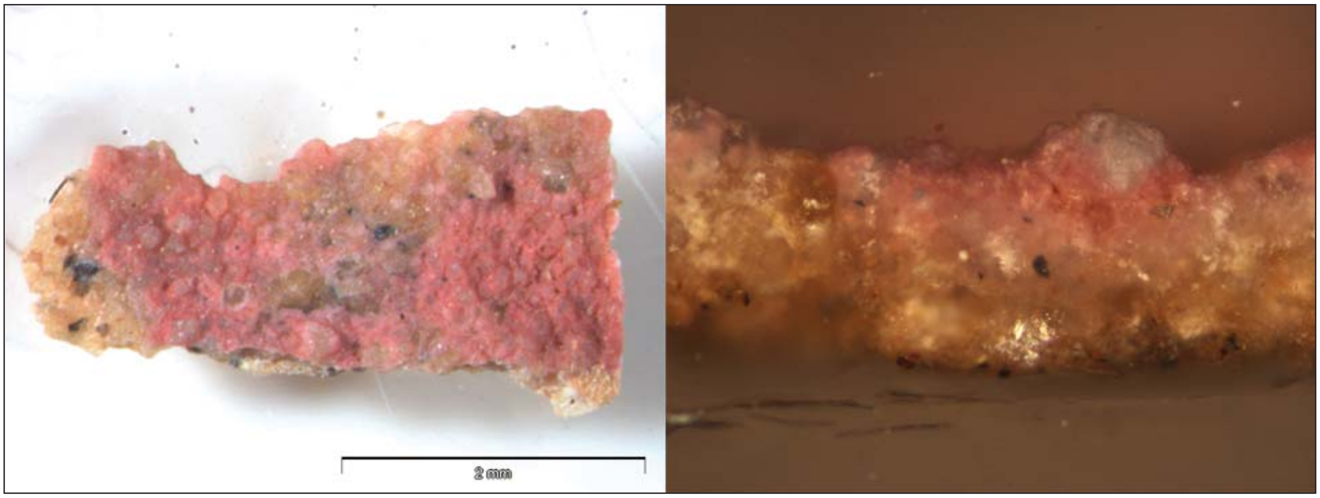


Fig. 4: Stone sample observed by stereoscope (left image) and a cross-section investigated by optical microscope (right image)

Its thickness and compactness is resistant, similar to an encrustation (see Fig.3), and appears only on surfaces exposed to direct sunlight and winds and protected from incident rainfall by wooden scaffolding.

Tescari et al. 2016 supposed that this unusual pink discolouration could be due to colonisation of pigmented microorganisms. Indeed, the SEM images underlined the presence of coccoid shaped cells, comparable in size to small prokaryote. Also, in correspondence to the pink encrustation, the authors identified a phosphorous accumulation. Its presence is associable to the bat guano deposits inside the temple that afterwards to evaporation cycles deposits phosphorous on the external surface. The existence of salt efflorescence (phosphorous) could be favour halophilic and Xerotolerant bacteria colonisation. Another interesting study (Tescari et al. 2018) pointed out the presence of bacterial species (Arthrobacter agilis) in correspondence to the pink patina at "Terme del Foro" (Pompeii, Italy). In this case, the authors were good at identifying a bacterial carotenoid pigment by spectroscopic analysis, responsible for the rosy discolouration.

Main biodeterioration processes involved in the artefacts are due to chemical and physical mechanisms.

The physical damage refers to the organisms' penetration through species-specific attachment structures and strategies, causing mechanical damage that leads to substrate crack and loss of cohesion (Caneva et al. 2008; Mohammadi & Krumbeine 2008).

In the end, the chemical alteration is due to the secretion of several acids and other chemical compounds, as intermediate metabolic products or chemicals needed for adhesive strategies, that reacting with the stone leads to surface alteration (Caneva et al. 2008). An essential intermediate metabolic product is oxalic acid (Adamo & Violante 2000). In the presence of a substrate rich of calcium, this acid can form a chemical complex with calcium ion and become calcium oxalate. It has two mineralogic forms: monohydrate (whewellite) and dihydrate (weddelite) (Conti et al. 2012). The calcium oxalate occurrence is amply reported in the literature on different art object as stones, frescos, canvas, glass and wood (Del Monte & Sabbioni 1987, Maravelaki-Kalaitzaki 2005, Aliatis 2009, Salvadori & Casanova Municchia 2016). In addition to the biological origin, calcium oxalate also derives from chemical processes due to previous conservation treatments. Discriminate one process respect to another is not always straightforward, and it is the object of scientific debate, as reported in the literature (Sabbioni & Zappia 1991; Rampazzi 2004; Otero 2018).

About the biodeterioration processes, due to its origin (binding its with calcium ions of the substrate), calcium oxalate causes a deterioration process. However, the calcium oxalate's lesser solubility than calcium carbonate creates a layer comparable to a "crust" on the artefact surface. Especially, on stone monuments, the development of a superficial crust, based on oxalate, could give a bioprotection function (De la Rosa et al. 2012). This "crust" and its protective action from weathering processes (rainfall and wind) reduce water penetration, preventing deterioration processes.

An example of this bioprotection rule is reported in the case studies (see Fig. 5), regarding the impact of lichen growth, on the Cappadocian monuments, also known as "fairy chimneys" (Garcia-Valles et al. 2003, Casanova Municchia et al. 2018).

The majority of external surfaces of these monuments are colonised by black-grey crusts mainly consisting of lichens. The colonised rock is affected both by physical and chemical processes, looking it deteriorated strongly. Fungal hyphae (in the lichen structure besides the algal zone there is the medulla, which consists of loosely interwoven hyphae) penetrate between and inside the rock grain into the depth, producing structural detaching and perforation (see Fig. 6).

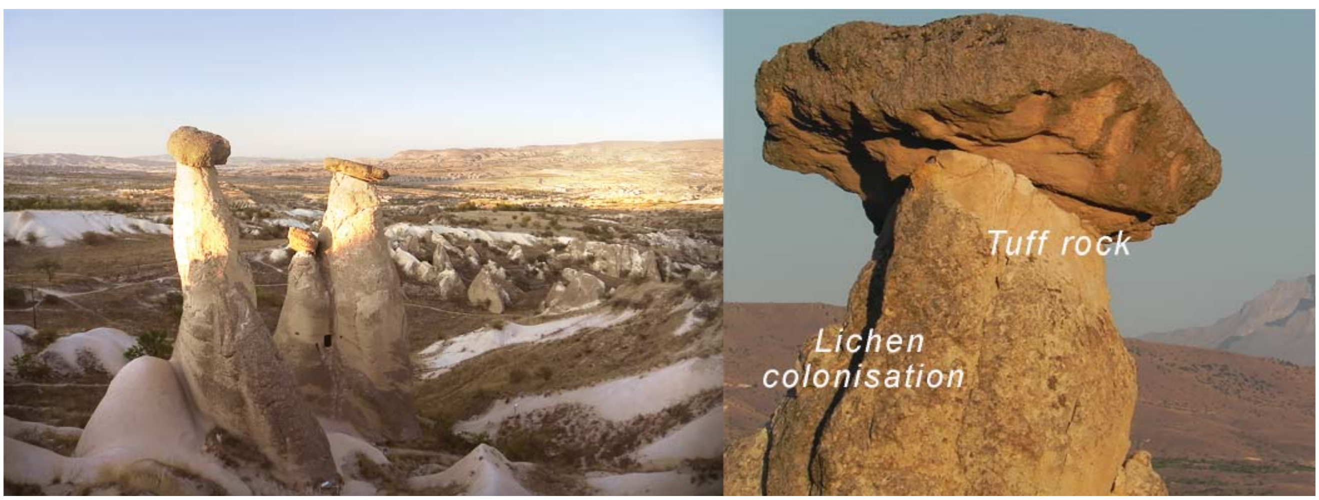


Fig. 5: *Cappadocian monuments "Fairy Chimneys", detail of lichen colonisation*

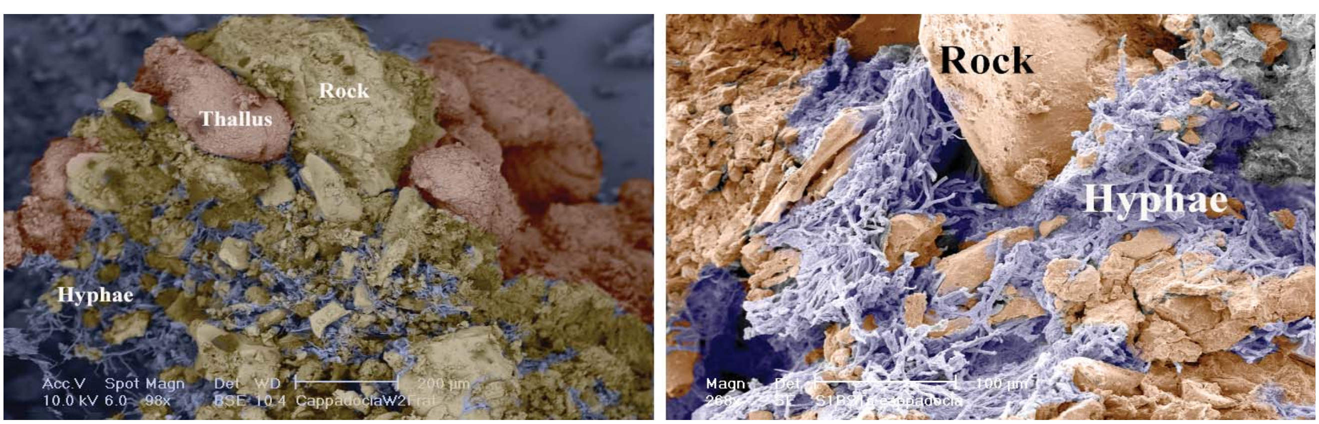


Fig. 6: *False SEM images. Detail of lichen penetration*

Between lichen thallus area and rock is also detect a calcium accumulation, probably calcium oxalate. This superficial crusts' protective action against water penetration and the wind action plays an essential rule in a so dangerous and uncertain conservative state. For this reason, the removal of lichen is not entirely recommended (Casanova Municchia et al. 2018).

Finally, the genesis and the development of each organism are always reliant on environmental factors, among which water, temperature, light, and nutrients, which often operate a primary role in the colonisation of stone surfaces. As a result, the presence and the variability of biodeterioration potential depend on the environmental and climatic conditions surrounding the surface to colonise.

Biodeterioration identification

Not always microorganism takes characteristic shape on the art objects surface, which is simple to confuse biodeterioration with chemical and physical phenomena (Caneva et al. 2014). For example, a geological process, or a pollution situation, or a biological attack can be all the possible solution to clarify the presence of a blackish patina on a stone surface (see Fig.7) (Caneva et al. 1995, Bellinzoni et al. 2003, Maravelaki-Kalaitzaki et al. 2005, Casanova Municchia et al. 2016, Antonelli et al., 2020).

At this purpose, there are different methodologies useful to detect and quantify the microorganism presence on the art object and their possible damage. In addition to the standard microscope techniques (transmitted light biology microscopy, microscopy fluorescence illumination, stereoscopic and molecular techniques) other essential instruments to investigate the samples are used (Wierzchos et al. 2004, De los Ríos et al. 2005, Dakal et al. 2012).

It is also possible to obtain new information about penetration, the volume occupied, and distribution by microorganisms. Confocal laser scanning microscope combined with specific fluorochromes permit to provides 3-D images of specific biological structure (as extrapolymeric substances (EPS), nucleic acid, chlorophyll a, phycobiliproteins) distinguishing it from the substrate (Casanova Municchia et al. 2014, Kamjunke et al. 2012, Macedo et al. 2009). This aspect is useful for evaluating the true extent of colonisation and its impact on the artwork.

Fig. 7: *The different origin for the black/grey patina. a) The four fountain "Giunone" (Rome): car pollution; b) Tiber embankment (Rome): biological colonisation; c) Khmau temple (Cambodia): geological processes*

The presence of carbohydrates and carbohydrate compounds such as polysaccharides, mucin, glycogen, and fungal cell wall components is also quickly revealed by The Periodic Acid Shiff (PAS) staining (Gorbushina 2007, Bartoli et al. 2014). Generally, a polished cross-section is stained by Schiff's periodic acid and after observed by a reflecting microscope. The reaction between PAS staining and carbohydrates produce an aldehyde. Aldehydes are identified in pink colouration due to the fixation of the Schiff's fuchsin. This technique is amply used to visualise hyphae penetration to quantify how much the lichen has affected the conservation of a stone substratum.

Scanning Electron Microscope (SEM) coupled to an energy dispersive spectrometer (EDS) identifies physical and chemical processes induced by microorganism on the substrate. It gives information both on microorganism morphology and deterioration phenomenon (De los Rios et al. 2005). The microanalysis permit to map chemical elements in order to monitor changes on the substrata (Wierzchos et al. 1996). These techniques make an essential contribution to the deterioration of cultural heritage, simulating the real implications that certain microorganisms have on the substrate and attributing the biological origin in particular cases of damage.

Microorganisms with endolithic growth, capable of penetrating inside the rock, left the stone surface not colonised. These aspects make the hardest to recognise of the biodeterioration forms. Molecular spectroscopic technique as Raman spectroscopy can be an efficient tool for identifying organic and inorganic compounds left by the microorganism, like "footprint" on stone (Casanova Municchia et al. 2014). This technique determines the organic compounds released (as carotenoids, scytonemin, calcium oxalate, phycocyanin or phycoerythrin) in the rock matrix, and use them as a marker for a clear identification of biological colonisation in the substrate when this is not evident or visible (Edwards 2010, Jehlička et al. 2014). Also, to point out the cause of "colour patina", molecular spectroscopy can easily distinguish a chemical origin from biological.

Bioprotection

The bioprotection is one of the processes that link biotic and geomorphic system and includes a whole host of plant, animal and microorganisms interacting with rock surfaces. Geikie (1893) defined "Bioprotection" as "the formation of a stratum of turf protects soil and rocks from being rapidly removed by rain or wind. Hence, the surface of a district so protected is denuded with extreme slowness, except along its watercourses. A crust of lichens doubtless on the whole protects the rock underneath it from atmospheric agents". Rodriguez-Navarro et al. (2011), concerning the monument conservation, also defined it as "the active or passive microbially induced or mediated consolidation, cleaning, and/or protection of (stone) artworks affected by chemical, physical, and/or biological weathering phenomena".

Various authors affirm that in some cases the biodeterioration is lower than physic-chemical process, so they sustain that microorganisms, especially lichens, in certain conditions must not be removed from the stone surfaces. As other, these authors state that some organisms, such as lichens, act as an umbrella-like protective layer. Then, the role of organisms in preventing or retarding the action of other weathering processes may provide a physical barrier to erosion, thermal and water blanketing, decreasing the wet-dry cycle trough the stone (Carter & Viles 2005; Viles 2012; Coombes et al. 2013). Therefore, this concept generically referred to those organisms acting like an umbrella protecting the underlying substrate from the mechanical effects of raindrop impacts, acid attack, airborne pollutants and salt deposition; it means “umbrella effect” (Garcia-Vallès 2003; Carter & Viles 2005).

The role of organisms in preventing or retarding other earth surface processes, is both active (e.g., by producing a protective patina or crust on a rock surface) and passive (e.g., by providing an umbrella-like effect). They may give thermal blanketing, absorb aggressive chemicals through interception, keep surfaces hot and dry more constantly, reduce boundary layer wind speed, provide a physical barrier to erosion and bind grains together (Carter & Viles 2005).

Bioprotection can be a dominant process in environments where abiotic weathering processes are aggressive. In such case, organisms may actively or passively contrast the weathering of their underlying substrate relative to surrounding exposed rock (Fiol et al. 1992; Arinõ et al. 1995; Mottershead & Lucas 2000; Favero-Longo et al. 2009; Concha-Lozano et al. 2012; de la Rosa et al. 2012). Conversely, organisms-induced deterioration tends to be associated with biogeochemically or biogeophysical aggressive species, and/or moderate weathering environments (Adamo et al. 1993; Moses & Smith 1993; Paradise 1997; Adamo & Violante 2000; Chen et al. 2000; de la Rosa et al. 2012).

The debate concerning the biodeterioration vs bioprotection is ongoing because the overall results of all studies suggest that a single species may acts bioprotectively in one environmental context, but biodeterioratively in another.

Bioremediation

In the term Bioremediation was included several processes that concern the conservation and restoration event using microorganisms as a restorative tool to come back at the original condition of the substrate (Webster & May 2006; Ranalli et al. 2000; Yadav et al. 2020; Fernandez et al. 2006).

Weathering of the calcareous matrix of stone results in increased porosity. This leads to a decay of its mechanical stability. Biomediated approaches to reverse this process, and thus promote the stone’s consolidation can supply rather than replace traditional restoration technologies, which can often be ineffective or toxic for restorers or the environment (Fernandez et al. 2006; Webster & May 2006). Hence, in the conservation and restoration science, the controlled use of microorganisms as bioremediation agents offers new approaches to help preserve, protect and restore the monument and artworks.

In particular, the ability and potential of some microorganisms to remove and manage undesired chemical compounds like sulphates, nitrates and organic matter, makes them a useful tool to clear out pollution (i.e., spilled oil, solvents, pesticides and other environmentally toxic compounds) (Yadav et al. 2020), but also to graffiti removal (Sanmartín et al. 2014). Moreover, others identify microorganisms as able to produce and release calcium carbonate in the environment, developing a biomineralisation process that can be a capable alternative to the chemical generation of this salt. The researches results demonstrate that bio-calcifying bacteria can load to calcite precipitation as natural metabolic activity, either by passive or active bioprecipitation (Fernandez et al. 2006). Moreover, it has shown that deposition of a calcite layer can be achieved without significantly reducing porosity or growth of contaminating microorganisms (Webster and May 2006). Subsequently, after identifying useful microorganisms’ ability, a simple and effective technique for applying bacteria to the substrate needs to be developed (Fernandez et al. 2006). It was recognised that bioremediation treatment could be performed by spray, brush or compress application techniques, and the choice depends on the type of alteration, the artwork material, the areas location and the metabolic activity of the selected microflora (aerobic and anaerobic). (Ranalli et al. 2000).

At last, it is very important that, monitor the microbial activity during the growth and at the end of the metabolic activity to prevent undesirable effect on the substrate due to the microorganism physiology. In this way, in all cases, a final cleaning of the applied organisms was carried out to avoid the continuing of undesired metabolic processes (Ranalli et al. 2000).

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Conservation of a Recent Conservation Based on Ethyl Silicate and Silica Sol

During the last decades conservation based on Ethyl Silicate as a consolidant for sandtone was very popular in Germany. The material was not only applied in situations where no problems were to be expected, but also when such were expected on the long term. Two reasons were decisive: it was possible to preserve historic, if not original parts of the structure and it was less expensive, than labor intense replacement of sandstone parts. So in the end consolidation with Ethyl Silicate was applied to sandstones as the molasse sandstone, showing a considerable hygric dilation, even foreseeing problems, that would occur in the region where consolidation met the unconsolidated core of the stone. One of these monuments was the Minster of Salem Abbey, having a somewhat curious restoration history.

ALBERT KIEFERLE, Restorer at AeDis AG, Germany. After having completed school in different parts of Asia and in Germany, he took an apprenticeship as a stone cutter, eventually drifting more toward stone conservation. In 1983 he took up studies of art history and European anthropology at the Eberhard-Karls-University in Tübingen, Germany. Since 1988 he has worked as a freelance restorer. In 2002 he founded AeDis together with Georg Schmid as restorer and Peter Reiner as Architect, focusing mainly on planning of restoration and practical restoration of high-quality historic buildings, mainly Gothic churches from the 13 th century in the southwest of Germany, closely linking planning and conservation.

Building and restoration history

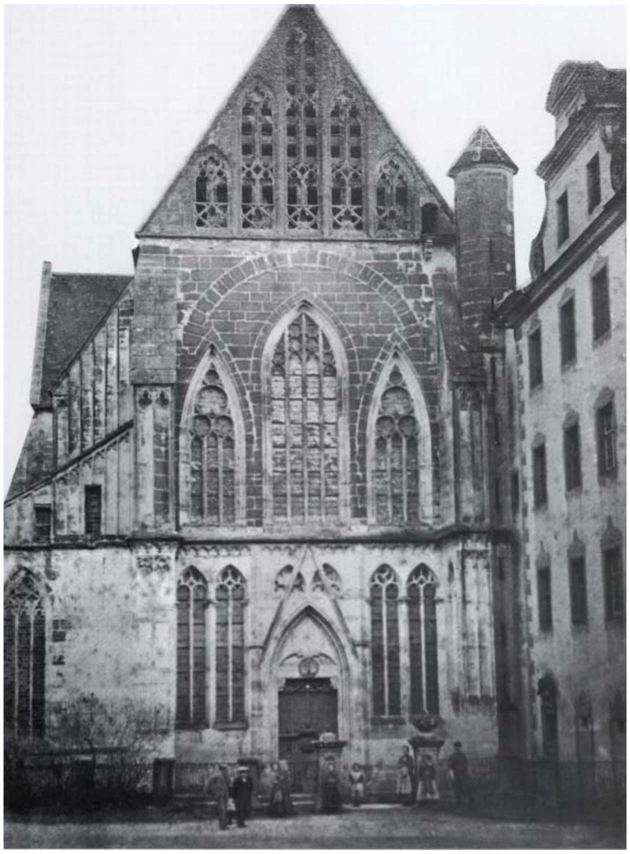

Fig. 1: Facade of the Minster before 1885

Salem Abbey, located in southern Germany, some 6 km from the Lake of Constance, was founded in 1134 and settled by Cistercian monks within the following years. The abbey quickly managed to escape local disturbances and rivalries. It became directly subordinate to the Emperor in 1142, and to the Pope in 1178, giving it a good chance for economic success. By the late 13th century the abbey could afford to replace its romanesque minster by a then modern, large gothic minster. In the early 15th century the construction had come to an end, adding a further case bay, forming the current west façade.

Several modernisations of the interior and repair on exterior parts were carried out during the 18th century, after the adjoining monastry buildings had been destroyed by fire in 1697 and, which had been rebuilt almost immediately. (Knapp 2004).

In 1803 the monastry was closed down and handed over to the Margrave of Baden, who in the 1880s undertook a large scale overhaul, replacing large quantities of the original rather soft, yellowish sandstone of local origin with Rorschach Sandstone.

Soon new damages were to be seen as large size delaminations at a vast extent on the new Rorschach Sandstone parts. These results must have been somewhat discouraging. No more repairs were done until the end of the 20th century. Stone replacements, which are usually regarded as a very robust way of repairing the damaged areas, were now looked at sceptically, and new paths were considered.

Research and proof of concept before 1997

Research on conservation of the molasse-sandstone at Salem began in 1971. Josef Riederer, from the Doerner-Institut in Munich, attempted first tests on stone consolidation with silicic-acid-esther. Unfortunately, he poorly documented where he had applied this material, making later re-examinations close to impossible. No further steps were taken at that time (Wendler et al 1993).

Fig. 2: Multiple layers of delamination in 1998

In the early to mid-1990s research was finally intensified, first within the project ‘Steinzerfall/ Steinkonservierung’ (‘Stone Decay/ Stone Conservation’) through the German Ministry for Research and Technology and was later continued within the Franco-German research project.

Within this parts basic and parts applied research, there were three groups of studies that had a larger impact on the future conservation of the Minster:

> Ettl, Munich and Zehnder from the ETH Zürich had undertaken a rough survey and mapping of the Minster’s damages (Ettl 2002, Zehnder and Ettl 1993).

From a restorer’s view – a more basic part, which was never the less very important for the following works, was published by Gabriele Grassegger, summarzing a large number of surveys by herself and her colleagues:

“Within this project the role of humidity was examined from various points of view, and its effects were observed. The detailed emission measurement and the meteorological data shows, that the deposition of pollutants are strongly reduced in the lower parts of the building... Sulphur-dioxide is the main deposition. … hydrological and geological research show, that the portion facing the west is constantly in contact with ground water, the portion facing the east only occasionally. For the first time moisture from the underground could be observed without damages to the building by spontaneous potential logging … Microwave-reflection and transmission give us a (semi-quantified) image of the spreading of humidity. The mortar in the joints plays an important role as water conductor. … All surveys show that relatively high concentrations of salts (mainly sulphate) are present in the stone, but reduced towards the interior. The chemical and mineralogical degradation of the stone material are carbonate and mineral solutions by acid, the creation of gypsum in solution pores and cracks. Especially severe damages occur in constantly moist and periodically moist areas, protected from rain (i.e. bottom sides of cornices). The different kinds of molasse-sandstone have slightly different cementation and contain different types and concentrations of rock fragments, influencing the resistance against weathering.” (Grassegger 2002). At the time a strong emphasis was put on the pollution. In course of these large research campaigns a set of conservation materials based on silicic-acid-and silica sol had been developed and thoroughly tested. It proved that the main damages, especially the delamination and ruptures could be treated with these, at that time, advanced conservation techniques. So finally a treatment trial was applied to a limited area by Egon Kaiser and examined by Hans Ettl (Ettl 2002).

Conservation in 1997-2002

In 1996 scaffolds were put up for urgent repairs of the roofs woodwork and tiles. It immediately became evident, that the damages on the sandstone façade was an imminent risk to visitors, making of repair inevitable. The severe damages were almost completely restricted to the areas with the Rorschach Sandstone from the 1880s. The main damage was delamination, sometimes in several layers, one on top of the other, and to some extent they had fallen off.

As repairs on the façade were originally not intented at that time, there was no budget for these works, which estimated at a double digit millions sum of Marks. Together with Otto Wölbert from the Heritage Authorities we developed a plan that did not include any stone replacement, based only on the conservation methods tested during the research phase.

Fig. 3: *Grouting around 2000*

Fig. 4: *Newly opened gaps in 2013*

Endangering delaminations were simply taken off and an edging repair applied. Replacment of these severely damaged stones should be done some time within the next 10 years (Wölbert and Kieferle 2002). In the course of 4 years between 1998 and 2002 the conservation was applied to the main portions of the Minster, however not to some areas such as the naves clerestory and the aisles. The traceries in the pediments were given the most attention, as they were most severely damaged, because they are extremely slender - often no wider than 13 cm with concave fillets along the edges.

Revision 2009 and 2013

After the Magrave of Baden had sold large parts of the monastry including the Minster to the state, work on the façade was eventually resumed.

A first look at the façade in the winter of 2009 showed no new damages. This was to change at our next revision in the summer of 2013. This time cracks had reopended and to a small extent new hairline cracks had shown.

During the following year work on the façade was resumed first on the north side of the nave in areas not touched during the previous overhaul. Together with the owner and the heritage authorities we decided to continue with the original treatment, at the same time investigating the cause for the newly appeared gaps and their treatment.

Research after 2015

New gaps quite regularily appeared in locations, where there had been older gaps, primarily on slender edges and tips of traceries and more seldom of cornices. To a smaller extent new

Sample / Parameter	Traceries exterior zone	Traceries interior zone	Block exterior zone Consolidated	Block interior zone Unconsolidted
Hygr. Dilation µm/m parallel to bedding	1170	1130	330	980
Hygr. Dilation µm/m at right angle to bedding	1000	970	620	0.77
Adhesive tensile strength dry parallel to bedding N/mm²	0.70	0.31	1.22	1.60
Adhesive tensile strength wet parallel to bedding N/mm²	0.18	0.26	1.70	0.90
Adhesive tensile strength dry at right angle to bedding N/mm²			0.66	0.64
Adhesive tensile strength wet at right angle to bedding N/mm²			0.72	0.42

hairline cracks had appeared, primarily on the somewhat more massive pillars of the pediment.

Scaffolds on the northside of the nave had been put up in a way to give access to smaller portions of the west façade, which had been treated in 1997/98 giving access for examination and areas with severe damages before 1997.

The focus was layed on hygric dilation, which at this point had not been of a larger concern in the research of the 1990s. Matthias Kocher's thesis about measurements of pressures caused by hygric and thermic dilation (Munich 2004) was a first anchor. In this work he did not only examine the amount but also the pressures, these effects amounted to on different sorts of sandstone, known to be having problems related to hygric and thermic dilation. Rorschach Sandstone was included in some of the series of measurement, but not in every one.

Hygric dilation of Rorschach sandstone is known to be in the area of 650 and 1200 µm/m, that is up to 1.2 mm/m. Thermic expansion for this sandstone lies arround 9 – 10 µm/°K, amounting on a mild summer day to a expansion with temperatures of the stone between 15 and 50°C to 300 - 400µm/m, in a years scope between – 20 and 60 or even 70°C, this amounts to almost another mm/m, allthough they most likely cannot simply be added to each other (Kocher 2005)

Kohler measured the swelling pressures of Rorschach Sandstone with values of between 0.30 and 0.50 MPa. The pressures caused by temperature gave results between 0.3 and 0.41 MPa, exceeding hygric effects. Measurements were made with cubes of 5 cm edge length.

The problem to be analyzed occurred in areas which had been consolidated, so we had to examine consolidated and unconsolidated weathered material. The research was done by Dr. Hans Ettl, Munich. We decided to measure hygric dilation of consolidated and unconsolidated material, together with pressures and the adhesive tensile strength.

Two blocks of different origins and conditions were examined: One was a very slender part of the traceries with severe damages where intense conservation had been carried out in 1998, the other was a part from a regular building block with a normal amount of damage. Samples were in both cases taken from the surface area, which had been reached by the Ethyl Silicate consolidation and material from the interior of the stone, we assumed had stayed untreated.

The hygric dilation of the traceries showed unexpected if not contradictory results We had assumed, that consolidation had only been applied to the exterior zone (from the surface to 3 cm depth). Hygric dilation turned out to be a bit larger in exterior probes, but did not differ significantly compared to the interior. Hans Ettl measured 970µm/m and 1130µm/mm in average versus 1000µm/m and 1170µm/m. Adhesive tensile strength differed significantly. Probes taken from the exterior zone showed to have 0.70 N/mm² compared to 0.31 N/mm² with the probes taken frome the core. The measurement was repeated with water saturated probes, giving 0.26 N/mm² for the probes from the core regions and only 0.18 N/mm² for the probes taken from the surface zone. So the adhesive tensile strength of consolidated wet sandstone was strongly reduced compared to the untreated interior. We were not able to interpret the results in a fully conclusive way. We assumed, the part had been treated to some extent with Ethyl Silicate beyond the depth we had epected. On the other side, the surface zone had weathered, altering the properties in a to now not fully understood way, leaving questions to be investigated in the future.

Measurements taken from the building block showed clear results. Hygric dilation was strongly reduced by consolidation, especially parallel to its bedding (0.98 to 0.33 N/mm²). The swelling orthogonal to the bedding was only slightly reduced (0.77 versus 0.62 N/mm²). The adhesive tensile strength of the warer saturated probes was reduced to 40-50% i.e. at a significantly higher level, compared to the slender sample from the traceries.

Dr. Hans Ettl concluded that this strongly reduced adhesive tensile strength under water saturation was the main cause of damage to the molasse sandstone. He concluded that consolidation still had mostly positive effects on key values of the stone.

The plan for further conservation was to apply Ethyl Silicate through the gaps, in order to push the edge beween consolidated surface and unconsolidated core further back from the surface with its constantly repeating wet dry cycles and into less extreme teperature ranges. Application of the Ethyl Silicate should be done using packers glued on top of the gap with hot melt adhesive. After the reaction of the Ethyl Silicate had come to an end, the gaps should be refilled as before, using silica sol grouting mainly with fine quarz powder and sands, as well as sands from the surrounding stone material as aggregate. Application and formulation of these materials had not changed fundamentally since 1997.

Additional examination was done on the application of further Ethyl Silicate to the surface of the molasse sandstone, showing it was not necessary, alltough it did not seem to do harm at first sight, but nevertheless restricted to areas where it was inevitable, especially to further strengthen material with a silica sol binding. The testing areas were only evaluated using drilling resistance measurement.

Refining the process and application

During winter 2016/17 recording of findings and detailed planing was done and the bids were filed, so testing would be done by the people who would do the actual conservation. Riccardo Itta from Überlingen, located quite close to Salem, took the challenge very passionately. In spring the following year trials were undertaken, beginning with the consolidation, which could be easily applied. A few weeks later, when the water repelling surface was gone, grouting was tested. It turned out, that this material would not fill the gaps, narrowed by the previous grouting, so we had to look for alternatives.

Using regular mortars for grouting was not considered a good choice, as gypsum

Fig. 5: Preparation for consolidation and grouting

was a major cause for the delaminations and it was feared, that the lime would cause new delaminations. Research in the 1990s had come to the result, that here the delaminations were mainly caused by a deposition of gypsum in the layers near the stone surface.

Epoxy resin was also considered counter-productive, as it would create a barrier for moisture.

So we tested a product originally developed by Stephan Busch arround 2005 based on Ethyl Silicate (silicic-stone-adhesive, in German: Steinsilikatkleber). It was originally intended as adhesive for dutchmans repairs. It consists mainly of quarz, calcium hydroxide and Ethyl Silicate. This material had been formulated to give moisture diffusion, adjusted to sandstone and adhesive tensile strength had been adjusted to values of 1 to 1.5 N/mm², being in the range of an aged Molasse Sandstone. Although it contained lime, no white veil, that would indicate lime on the surface was observed until now. The material had been thoroughly examined around 2005, mainly by Hans Ettl and has been in use since then. The main objection to the material was, that the person applying it needed some experience in doing so, as the fluid quickly spreads into the stone and reaction sets in fast, giving almost no time for adjustments.

The conservation was now planned to be the following:

Ethyl Silicate was applied to the gaps through packers until the surrounding stone material was saturated. The packers had been glued onto the surface with hot melt adhesive, also closing the opening of the cracks.

The silicic-stone-adhesive was applied through the same packers, that had been used for consolidation. The application of the grouting was done right after consolidation, further improving the bond between the gouting and the surrounding sandstone.

Results

Samples were made using this technique and evaluated by extracting drill cores. The cracks showed to be filled to a point where a crack could barely be seen with the naked eye. This procedure of consolidation and grouting did not turn out to be more laborious than the originally intended process.

As in the previous restoration at the turn of the millennium long turn observation will have to show if this treatment can be considered successful, or will it be the cause of new problems.

Fig. 6: Gap refilled with silicic-stone-adhesive. Diameter of hole 28 mm.

Fig. 7: Facade of the minster in 2018

This treatment will most likely not be a standard technique, as the conditions, leading to it were – hopefully – quite unique. Whereas treating sandstones of very diverse character and quality, which have been consolidated using Ethyl Silicate, will be a regular challenge to future collegues.

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A Procession of Banners: Improving the Preservation and Interpretation of Flags and Banners in Devon and Cornwall, England, UK

MORWENA trained at the Textile Conservation Centre, when it was part of the University of London and based at Hampton Court Palace. While training she had placements and contracts at LP3 Conservation and Musée de l'Armée in France, and at the Fitzwilliam Museum, Cambridge. After a short contract at the Museum of Welsh Life she was a Museums & Galleries Commission intern in Ethnographic Conservation at the Royal Albert Memorial Museum, Exeter. Since then Morwena has worked as a freelance conservator working for the National Trust, other heritage organisations, museums and private clients, with a 2002 fellowship at the National Museum of the American Indian, Smithsonian Institution, USA. She carries out interventive conservation treatments alongside collections care consultancy and training, specializing in World Cultures Costume and Textiles.

HELENA JAESCHKE is an accredited conservator specialising in the treatment of museum and archaeological objects. She trained at University College Cardiff, Wales and the Institute of Archaeology, London. She is the Conservation Development Officer for South West Museum Development, providing practical advice and support to more than 200 Accredited museums in south west England. Resources from her most recent project Pest Partners can be seen at https://southwestmuseums.org.uk/what-we-do/projects/pest-partners/

Introduction

Banners and flags are often large colourful objects that express an identity for groups of people, around nationality, community organisation, cause or belief. These objects are used to draw attention to and celebrate that identity; for example, outside buildings, in parades or even in battle. Many communities in the South West of England have traditional processions at which different community groups parade their banner or flag, and the coastal nature of the Devon and Cornwall peninsula means that many flags are associated with maritime history.

This paper describes a project for targeted improvements in the preservation of a specific type of object, in this case flags and banners, across several museums, which can in turn lead to better understanding and use in community engagement.

In the early 2010s it became apparent that many of the museums in the South West of England were struggling to care for banners and flags in their collections. As the evidence was haphazard, a survey was carried out to ascertain the extent of the problem in Devon and Cornwall. The results led to a programme being devised to improve the collection care of flags and banners and subsequently to a project of community engagement that included research into and conservation of some of them. This paper describes the different elements of the overall programme and illustrates the stages, with case studies.

Museums and conservation in South West England

The South West of England (SW) is a largely coastal and rural region with many small, independent museums as well as larger, urban, local government museums and National Trust historic houses. There are over 210 accredited museums in the region, which includes the historic counties of Cornwall, Devon, Dorset, Gloucestershire, Somerset, Wiltshire and Bristol, Bath and North East Somerset (BANES). Many of the smaller museums have few, or no, paid staff and rely on the dedication of their volunteer workforce to care for the collections, create displays and engage their communities. Museums in the SW are supported by the SW Museums Development team (SWMD) that offers resources and training for all museum activities. A key aspect of SWMD's work is the conservation and collections care support and advice provided by the Conservation Development Officer (CDO), Helena Jaeschke.

While some of the larger museums, such as Bristol City Museums, The Box at Plymouth and Exeter's Royal Albert Memorial Museum (RAMM), have conservation departments, most conservation and collection care improvements are provided by private conservation practices. The CDO supports an informal network of independent conservators across the region.

The scale of the challenge posed to museums in caring for flags and banners

Banners and flags have been generally used outside on flag poles or masts, carried in processions, or even in battle. This exposes them to wind, rain, sunlight and ultraviolet radiation as well as to environmental soiling, including mud. They may have been packed away while damp and stored in outbuildings or churches with poor environments. The SW of England has moderate temperatures and high rainfall and buildings are often damp. These conditions can accelerate chemical deterioration and encourage thriving insect and fungal colonies.

One object in particular was the catalyst for the programme. A large painted silk banner, with extensive splits and repairs, was found draped over other objects in a museum store, covered in thick fungal growth and shedding paint and textile fragments. It was at risk from further serious damage or complete loss. Both authors had encountered similarly vulnerable flags and banners in museum collections during site visits across Devon and Cornwall. This led to a discussion about the need to support museums in the region with targeted collection care advice for banners and flags. In order to ascertain the scale of the problem a survey was carried out.

Initially, SWMD's Museum Development Officers (MDOs) for Devon and Cornwall, partly funded by local authorities, were asked about the flag and banner collections in the museums they support. In 2012 all museums in Devon and Cornwall were encouraged to complete a survey, digitally via www.

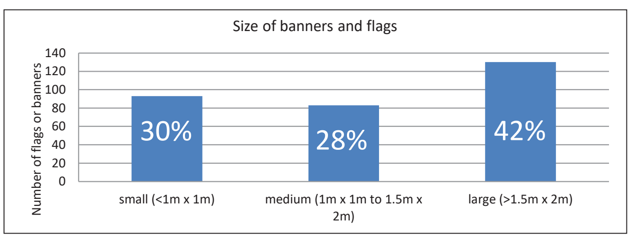
surveymonkey.com, email or by printed form. 26 museums and historic houses in Devon and Cornwall responded that they had banners and flags: 15 were independent trusts, 3 were National Trust properties.

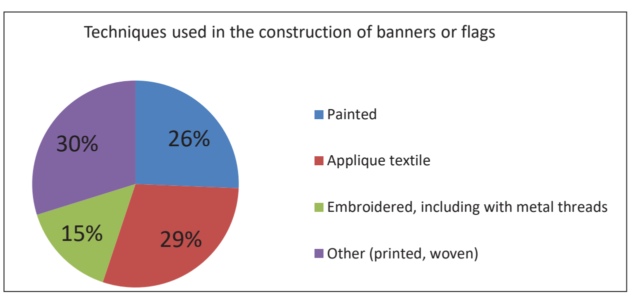
The majority of collections in the survey hold 1-5 flags and/or banners and four collections hold 21-50 items. The survey total was 118 banners and 253 flags.

The vast majority are military, naval or maritime. Others relate to industry (e.g. railways, telegraph, and china clay companies) and community or religious groups. There are also fairground banners, national flags and family crests.

The survey also asked about the size and construction of the objects:

Respondents may have described the condition of items and their storage as being better than they actually are, as the vast majority have no specialist knowledge or training in condition assessment. The majority (approximately 179) of flags and banners were assigned to the 'fair condition' category, requiring 'minor structural conservation and/ or cleaning for display.' Approximately 25% were described as 'excellent or good condition, no structural damage, safe for display.' Approximately 22% were listed as 'poor condition'.





Approximately 45% of the banners and flags were described as being 'properly stored flat in a box or on a wide diameter roller… in good environmental conditions', 45% were 'stored in a good environment but not properly supported, e.g. folded or wrapped around its pole,' while the remaining 15% were listed as 'poorly supported and in a poor environment'.

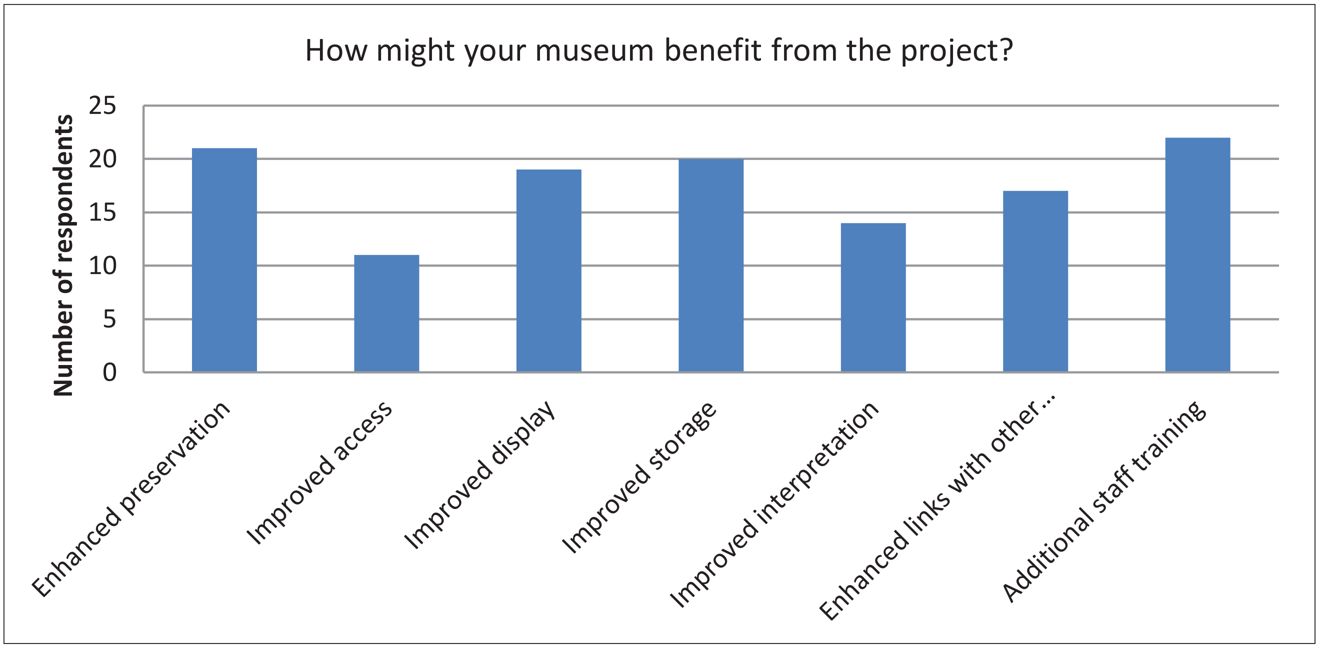
These results suggested that over half of the flags and banners would benefit from a project to improve storage, particularly physical support, and also that 75% require some conservation to be made safe and suitable for display. 73% of respondents stated that the display of these objects posed a challenge to their museum and 58% felt that their storage was also challenging while 35% found their interpretation challenging.

Over 70% of respondents identified one or more of the following as potential benefits of the proposed project:

- additional staff training in collection care
- enhanced preservation of the banners and/ or flags collection
- improved storage of the collection
- improved display of the collection.

Other significant perceived benefits for over 50% of respondents were: 'enhanced links with other museums that have similar objects' and 'improved interpretation of the collection', while 'improved access to the collection' was seen as a potential benefit by 42% of the museums.

The survey results confirmed that banners and flags posed significant challenges for museums in Devon and Cornwall, in both display and storage. As well providing enhanced preservation of the banners and



flags through improved storage, the proposed project would have wider benefits identified by the museums, such as additional staff training in collection care, enhanced links with other museum that have similar objects and improved interpretation of the collection.

Fig. 2: A thickly painted fairground stall banner, Dingles Fairground Heritage Centre

Fig. 1: *A painted silk community banner of the Devonport Women's Co-op Guild, The Box Plymouth*

Fig. 3: *A double-sided painted silk Ancient Order of Foresters banner made by George Tutill's company, Sidmouth Museum*

Fig. 4: *Appliqué and painted Scouts flag, Whimple Heritage Centre*

Fig. 5: *Appliqué and embroidered Toc H banner, Exmouth Museum*

Fig. 6: *Pieced wool bunting Customs Flag, National Maritime Museum Cornwall*

Collection care programmes for groups of museums

There is an established practice of working with groups of museums, in the UK, to support their activities through collection care training and survey projects. These activities were provided by Area Museum Councils until the end of the 20th century and from 2003 'Hub' museums in the regions through the 'Renaissance in the Regions' programme. The SW Conservation Development Officer role was created through this scheme which has since evolved into the Museum Development Programme, SWMD, funded partly by Arts Council England.

The authors have provided collections care training, collections surveys and conservation plans for groups of museums through the Devon Ethnography Project (1996-8), Renaissance at Work for the West Midlands, SW Federation of Museums & Art Galleries, and since 2006, SW Museum Development.

Flying the Flag: Collections Care programme to support museums to improve conditions for their flags and banners

Once the survey had delineated the need, a project: 'Flying the Flag' was developed to include condition assessments at 'surgeries', local training sessions, distribution of materials and equipment to improve storage and follow-up site visits to help museums implement collection care improvements. The Pilgrim Trust granted £24,000 to cover the surgeries, training sessions, materials, and the follow-up site visits by a conservator. SW Museum Development funded the CDO's activities. Participants signed a Charter on behalf of their museum which committed them to best practice in caring for their flag and banner collection.

The six half-day surgery sessions were held in local town halls, community centres and museums across the two counties. Each surgery was local to a group of four or five museums who were invited to bring two banners or flags to be condition assessed and photographed for the museum's records. It was important to select sizeable rooms for the surgeries to accommodate the large textiles from several museums and allow the different activities to be carried out simultaneously.

Each flag was assessed by the Textile Conservator and professionally photographed by Gary Young. All painted flags and banners were further assessed by Sophie Brummitt, Paintings Conservator. The CDO and a Textile Conservation intern provided invaluable help throughout the sessions, liaising with museum staff, helping to unpack, handle and repack the flags and banners and assist with data collection. An assessment was made of the condition of each object, and a treatment proposal developed for stabilisation for display, including recommendations for mounting and display. The surgeries provided greater insight into the condition of the objects and the challenges that the museums faced in caring for their flags and banners. 43 condition reports were produced for the participating museums.

A pattern began to emerge of the range of banner and flag types that the museums were particularly interested in, and concerned about: naval and military, including company flags from the Battle of Waterloo; 'Toc H' appliqué banners made for the First World War soldiers' support organisation; industrial and maritime flags; Wolf Scout and Cub flags; Sunday School banners; large commercially produced (Gorman 1976), painted silk banners for friendly societies, and campaigning banners for the women's Suffrage movement and the Cornish language.

Fig. 7: *Unrolling a fragile silk banner for assessment, Bodmin surgery*

Fig. 8: *Gary Young photographing a banner*

Fig. 9: *Discussing a flag with Curator Gordon Kane, Mevagissey Museum*

***Fig. 10:** Getting out a banner for photography at the surgery*

***Fig. 11:** Condition assessment of a China Clay industrial flag, Bodmin surgery*

***Fig. 12:** Sophie Brummitt examining the painted inscription on Porthallow Sunday school banner*

Condition

Flags and banners are generally constructed with a flat field, usually rectangular, with images and inscriptions created through piecing, painting, printing, embroidery or appliqué, or a combination of these. Damage can occur as a consequence of construction with differential tension between adjacent areas, for example on painted flags and banners where splits can form in the flexible silk ground around stiffer painted areas. Other damage occurred during use outside, through exposure to daylight and ultraviolet radiation, rain and wind. This can be seen on some naval and industrial flags where the fly end is completely shredded. Other forms of damage occurred during storage in non-optimal conditions either before or after acquisition by a museum.

In order to make consistent assessments of the flags and banners a condition assessment form was developed, using criteria published by Keene (2002):

- Major structural damage: detached parts, large areas of loss, splits or tears, severe creasing or distortion. An example might be large splits around painted motifs on double-sided silk banners, or the loss of the fly end of a flag
- Minor structural damage: smaller areas of loss, splits and tears, moderate creasing and distortions, severely abraded
- Surface damage to painted textiles: paint loss, flaking, cupping, delamination
- Disfigurement: damage to the visual integrity of the object through fading, soiling, loss, staining or deterioration
- Chemical deterioration: fading, embrittlement of fibres, corrosion, powdering, sticky areas
- Biological damage: damage by insects, especially clothes moth and carpet beetle larvae or damage caused by microbial infestation or vermin

- Accretions: generalised loose particulate soiling, including fungal and insect debris and more ingrained and encrusted soiling
- Damaging old repairs: repairs causing distortion or other physical damage and repairs using adhesive tapes that cause staining

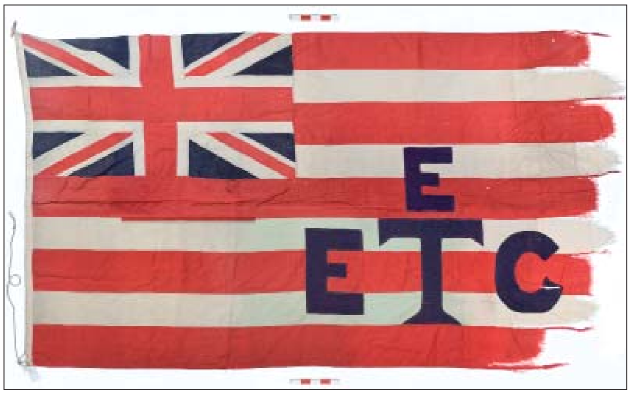


Fig. 13: *Major structural damage to the fly end of the flag from its commercial use outside, Porthcurno Telegraph Museum*

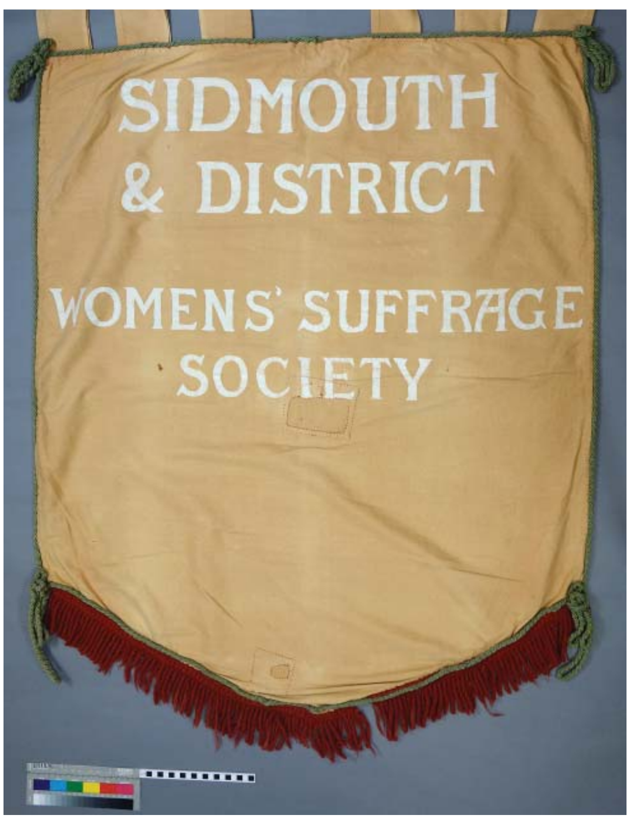


Fig. 14: *Minor structural damage – small holes and creasing, Sidmouth Museum*

Fig. 15: *Surface damage – loss of paint layer from being rolled during working life*

Fig. 16: *Disfigurement – staining and fading from display on a pole, Penlee Museum*

Fig. 17: *Chemical deterioration – embrittled silk and tarnished metal threads*

Fig. 18: *Biological deterioration -clothes moth damage to wool bunting ground*

Fig. 19: *Accretions - dust and encrusted corrosion products*

Fig. 20: *Damaging repairs - adhesive tapes used on a painted silk banner*

Training Sessions

Museums in the South West are very appreciative of training opportunities for their paid and volunteer workforce, many of which are offered by SWMD. Flying the Flag training sessions were carried out at 4 sites across Devon and Cornwall. Each session was attended by 12-20 people who were given a 'Caring for Flags and Banners' handbook and materials to improve the storage of their collection. The six-hour training combined presentations with practical activities. The topics covered were:

- Documenting banners and flags
- Deterioration: damage and possible causes
- Environmental requirements for storage and display
- Rolling large flags and banners for storage
- Display – making padded boards and using rare earth magnets for mounting (Spicer 2019)

The training days were also important for enabling participants to share experiences and build networks with colleagues working in nearby museums.

Fig. 21: *Workshop participants preparing to roll banners*

Fig. 22: Workshop participants preparing a pad to accommodate a fixed pole on a banner before rolling it

Fig. 23: Workshop participants preparing padded boards to display their flag or banner

Fig. 24: Some of the materials provided to participating museums during the workshops

Materials and Equipment

Each participating museum was supplied with materials and equipment to help them improve the storage and display of their flags and banners. These included materials for rolled storage and to make padded boards for display. The use of the materials was described and demonstrated in the training sessions.

Materials for storage	Materials for display
Acid-free card tubes 152mm and 254mm Ø x 4mm thick	Rare earth magnets and steel strips
Rolls of unbuffered acid-free tissue	Acid-free card honeycomb board
Tyvek non-woven roll	Gummed paper tape for edging boards
Silicon release paper	Scoured unbleached calico and brushed cotton
Cotton tape 16mm and cotton webbing	Polyester wadding
Archival pens and Tyvek labels	Polyester sewing thread and curved needles
Melinex polyester film 12µ	Velcro hook & loop fastener
Nitrile gloves	Evacon R adhesive

Follow-up site visits

Each participating museum was offered a follow-up site visit by the Textile Conservator in order to ensure that the momentum of the project was maintained, despite the many commitments of the museums, to allow for consolidation of knowledge by staff after the training, and to ensure that there was a marked improvement in the collection care of the flags and banners. Nine museums received follow-up visits, primarily to help with rolling large flags or banners onto the acid-free wide diameter tubes, including Sidmouth Museum, Plymouth Museum & Art Gallery (now 'The Box'), PK Porthcurno, Wheal Martyn China Clay Museum, National Maritime Museum Cornwall and St Ives Museum.

***Fig. 25:** Rolling a flag between two layers of unbuffered acid free tissue, site visit to Wheal Martyn China Clay Museum*

***Fig. 26:** A string of 14 pennants from a sailing boat after packing during a site visit to the National Maritime Museum Cornwall*

***Fig. 27:** Extending an acid-free tube to roll a large flag, Porthcurno Telegraph Museum site visit*

***Fig. 28:** Applying the Tyvek dustcover to a rolled flag, Porthcurno Telegraph Museum*

***Fig. 29:** Large painted wool banner taken down from display, St Ives Museum*

***Fig. 30:** Flags on display in St Ives Museum, 2017 during winter closed season*

St Ives Museum is in a historic building that previously housed a pilchard curing cellar and a laundry. It has a large collection of maritime flags, many of which are displayed on the first floor. The museum is staffed by a dynamic group of volunteers with a passion for and knowledge of their local history and a wide range of practical skills. As with many SW museums in historic buildings, there is little room for collection storage. The team identified an internal space between the low ceiling of the education room and the first floor which was being used to store props and discarded equipment. They cleared and cleaned the space, repaired damage to the walls and ceiling and created a pulley system to raise the large, rolled banners to the door. During the site visit several large flags and banners were rolled onto the wide diameter acid-free tubes, interleaved between two layers of unbuffered acid-free tissue. These were then wrapped in an outer protective layer of Tyvek (non-woven, high density polyethylene fabric). These were transported to the store, with the ends of the rollers supported on chocks made by the team. One of the banners on display, with a painted design on wool bunting, was identified as at risk from mechanical deterioration and light damage and was taken down by the volunteers for condition assessment and rolled storage. Recommendations were made to apply UV filters to the lighting fixtures; this was later implemented with support from the CDO.

Raising the Standard: research, conservation, community engagement and display

Flying the Flag had led to marked improvements in the collection care of the banners and flags in the participating museums and, importantly, had raised awareness of the collections and their potential to engage audiences. Thanks to a Jonathan Ruffer Curatorial Grant from the Art Fund, a historical research specialist helped the participating museums with further research and interpretation of their objects.

Many of the objects required conservation for display and wider access but the museums lacked the capacity and confidence to seek grant funding and commission a conservator themselves. The CDO with other SWMD colleagues developed a further project, 'Raising the Standard': funded by the National Heritage Lottery (NHLF) and co-ordinated by SWMD across 10 museums and community heritage organisations in Devon and Cornwall, involving the conservation, display and interpretation of 15 banners.' (SWMD 2017).

Following a tendering process, the selected flags and banners were conserved at two textile conservation studios and a paintings conservation studio (Textile Conservation Limited, Bristol; Morwena Stephens Conservation, Exeter; Sophie Brummitt Studio – Paintings, North Devon). A case study is presented below. The project also funded an Events Co-ordinator who helped the museums develop 18 events and 53 activities around their objects to engage new and existing audiences and to welcome the conserved banners back into their communities.

For example, Sidmouth Museum worked with local Girl Guides to make dolls and bags inspired by their Women's Suffrage banner to mark the centenary of women's suffrage in the UK. Saltash Museum hosted an event for members of Toc H while Whimple and Penlee Museums worked with local Scout groups. More information about these events can be seen in films at SWMD "Raising the Standard" (2017) https://southwestmuseums.org.uk/what-we-do/projects/raising-the-standard/.

Conservation case study: Mevagissey Wesleyan Sunday School Banner, Mevagissey Museum

The double-sided, professionally painted, navy silk banner depicts Christ with sheep in large central areas on each face, painted in greater detail on face 1, with inscriptions and foliage motif borders. The banner is trimmed with yellow silk and cotton braid, also used for hanging tabs along the top edge. It measures 1.94 x 1.52m. Fragments of paper which had been adhered over the especially damaged inscription 'Wesleyan', could date from the

Methodist Union in 1932, when this part of the inscription may have been covered up.

The banner had severe splits around the borders of the central painted area, and a full width horizontal split across the centre. There was loss to the border, hanging tabs and fringing, and generalised creasing. There was extensive damage to the paint layer from flexing, failed adhesive tape repairs and damp, with loss, abrasion and staining. Some structural damage was due to severe black fungal infestations, especially on the hygroscopic braid; and webbing clothes moth (*Tineola bisselliella*) damage to the wool fringing. Further accretions included vegetable matter, dust and peeling adhesive tape. Various adhesive tapes had been used across the splits and were failing, having deposited thick, discoloured and embrittled adhesive residue onto the silk and painted surfaces.

The fungal debris was removed in a quarantine room using a HEPA (high efficiency particulate air) filter vacuum and artists’ brushes, with the conservator wearing a FFP3 half mask respirator. The banner was then taken to the textile conservation laboratory for further treatment. The banner textiles were cleaned using Smoke Sponge (vulcanized natural rubber cleaning sponge) to remove more ingrained soiling.

Before treatment of the painted areas, the Paintings Conservator made a detailed inspection of the banner using ultra violet (UV) light, raking light, and the microscope. Loose adhesive tape was mechanically removed. Other remnants of adhesive residue were removed using acetone. The painted surface was then cleaned using swabs of saliva, cleared with swabs of deionised water. This removed a very thick, black surface dirt. Paint losses were consolidated using 10% w/v Aquazol 200 (Poly (2-ethyl-2-oxazoline)) dissolved in deionised water.

After consultation with the Curator, it was decided face 1 would be displayed, so any restoration treatment to the painted areas, such as retouching, would be limited to this side. Losses in the paint layers were brushed with a layer of 10% Sodium carboxy-methyl cellulose (SCMC) in deionised water to act as an isolating layer for the retouching. It was agreed that retouching should be minimal; since the banner is an important piece of social history any retouching should enable the viewer to read the object better rather than concealing old damages. The damages in the paint layers were blocked out with flat colour so that they could still be seen but were less disfiguring. It was agreed that the ‘WESLEYAN’ inscription was not retouched since the damage to this section of the banner was part of its history. Retouching was carried out using dry pigments bound in ‘Paraloid B72’ acrylic resin in 1 Methoxypropan-2-ol.

Heavyweight silk habutai and fine nylon bobbin net were dyed with Huntsman Lanaset (1:2 metal complex and reactive) dyes to colour-match the brocade ribbon border and to match the navy ground. In order to fully support the areas of damage without obscuring the painted areas on Side 2 of the banner a painted semi-transparent support was prepared. Silk crepeline was dyed to blend with the yellow/gold/cream of the painted areas. The outline of the painted areas was traced onto ‘Melinex’ (polyester film) which was then placed face down over white paper and covered with polyethylene. The dyed silk crepeline was placed over this and painted dark blue in the areas corresponding to the ground with a 0.25% Lanaset dye and 3% sodium carboxymethyl cellulose mixture, as described by Zagorska-Thomas (2009).

Given the size of the banner, the usual steaming-on-a-frame technique for setting the painted dye had to be adapted. Following research into techniques used by silk artists, tests were carried out by rolling painted crepeline in scoured unbleached cotton calico and steaming it in an adapted catering water boiler. The tests proved successful and the dyed and painted crepeline was steamed.

The banner was humidified, using 'Sympatex' (semi-permeable membrane) to realign creased and distorted loose areas around the splits.

The dyed and painted crepeline was brushed with adhesive (15% Lascaux 303HV: 498HV (1:2) (thermoplastic copolymer butyl-methacrylate dispersion thickened with acrylic butyl-ester) in deionised water) over polyethylene. The adhesive was applied over the Melinex tracing of the design to ensure that the support fabric remained aligned with the banner's design. The crepeline was positioned over the banner and the adhesive was reactivated using acetone-brushed archival blotting paper over a layer of 'Sympatex' for five minutes (Karsten & Down 2005), then weighted with glass plates to dry.

Damaged areas in the braid were supported by inserting yellow heavyweight silk habutai under the areas of loss and applying an overlay of colour-matched fine nylon bobbin net, secured with fine polyester Gutermann Skala thread.

An aluminium honeycomb display board was prepared by sealing the edges of the board with aluminium adhesive tape and covering with scoured brushed cotton and a layer of scoured, undyed cotton. Blue heavyweight habutai silk was stitched to the board in the areas that correspond to the bottom quarter of the banner in order to visually infill areas of loss. The banner was then stitched to the board.

When the banner was returned to the museum, it was welcomed by the community including its last superintendent during its working life, George Hunkin, who explained the covering up of the word "Wesleyan" using toffee wrappers, to avoid offending a new minister. Conserving the banner enabled this link with its history to be retained by the museum.

Fig. 31: *Mevagissey Wesleyan Sunday School banner, obverse before conservation*

Fig. 32: *Mevagissey Wesleyan Sunday School banner, reverse before conservation*

***Fig. 33:** Obverse bottom left before conservation - splits, loss, adhesive tape damage, paint loss*

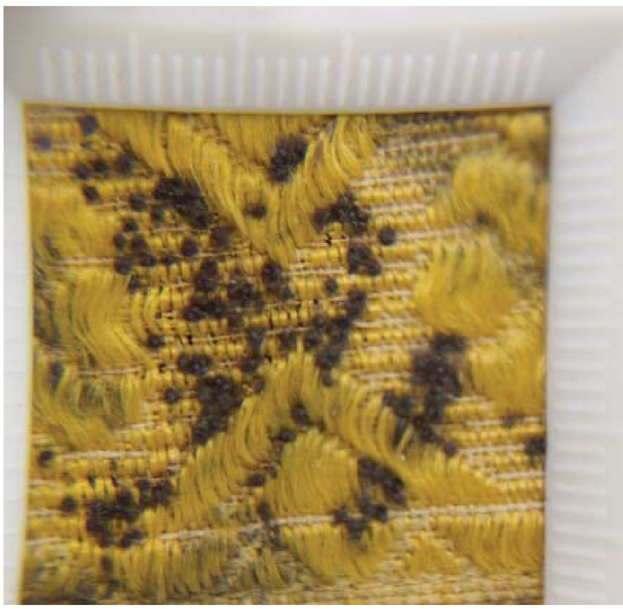


***Fig. 34:** Braid border with fungal colonies*

***Fig. 35:** Removing adhesive residue*

*(Right) **Fig. 38:** Mevagissey Wesleyan Sunday School Banner obverse after conservation*

***Fig. 36:** Painting dyed silk crepeline with dye paste to support reverse*

***Fig. 37:** Sophie Brummitt consolidating paint on the Porthallow Sunday School banner*

Fig. 39: *Mevagissey Wesleyan Sunday School Banner reverse after conservation*

Conclusions

Focussing on a specific type of objects which presented similar challenges to a large number of museums enabled a co-ordinated response with shared resources, providing much greater improvements than any of the museums could have managed alone. The regional museum development team supplied co-ordination, administration and leadership whilst conservators provided specialised skills and knowledge.

The museums' involvement with SWMD brought the problem to light, and their determination to improve the care of this fragile part of their collection enabled the project to develop through 4 different phases; from the initial scoping survey, through the first condition assessments of selected objects, historical research and the joint grant application for conservation, redisplay and improved storage. Their mutual support and development during the project have resulted in an increased confidence that even with limited resources and largely volunteer workforce they can aspire to and achieve significant improvements in the care and use of their collections for the benefit of their present and future communities.

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Acknowledgements

We would like to thank all the participating museums, heritage organisations and their workforce for their commitment to the project. Thank you to the Pilgrim Trust, the Art Fund, National Lottery Heritage Fund and SWMD for funding the project and to Sophie Brummitt, Gary Young, Nicki Chard and colleagues at Textile Conservation Ltd for their work and expertise.

31 July 2020

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Burn Out: Case Studies in Conserving Printed Textiles

Presented at Colonial Williamsburg's annual conference symposium in 2017, "Printed Fashions: Textiles for clothing and the home" and for INTACH "Conservation Insights 2020"

JULIA M BRENNAN has BA from Columbia University, and a Masters in art crime from The Association for Research in Crimes Against Art. She has worked extensively in the field of textile conservation since 1985. Her company, Caring For Textiles, founded in 1996, is based in Washington DC. She offers a range of textile treatments, display, installations, storage, assessments, and survey work for institutions, historical sites, and private clients. She is committed to conservation outreach and the protection of cultural property, and providing stakeholders with sustainable skills. Since 2000, she has led multiple conservation workshops in Bhutan, Madagascar, Algeria, Indonesia, Laos and Thailand, Cambodia, Taiwan, and Rwanda in museums, monasteries, genocide memorials, and community-based collections. www.caringfortextiles.com

KAITLYN MUNRO joined Caring for Textiles in 2014. After earning her BAA in Fashion Design and Museum Studies from Central Michigan University, she received an MFA in Costume Design and Technology from University of Cincinnati CCM. In the summers, she is a costume maker for the Santa Fe Opera. Kaitlyn specializes in historic clothing conservation. In her spare time, she enjoys researching and sewing period costumes and accessories using historical hand sewing techniques, especially 18th century ones.

Over the years, Caring for Textiles has treated and examined many printed textiles including some high profile and famously owned pieces. Conservators have always dealt with a variety of problems when treating printed textiles from inherent vice and dye burn out from metal mordant's, to thin cotton from wear, or splitting along pattern and dye lines. In these five case studies, we look at this inherent vice of burn out as well as previous attempts to conserve, repair, and preserve and we will look to the future for further conservation treatment options.

The burn-out, or primary inherent vice of many old printed textiles often happens because of the use of iron tannate dyes to achieve dark rich colors. Tannins are inherently very acidic due to phenolic hydroxyl and carboxyl groups in their chemical structure. On top of this, the sulphate ions originating from the iron mordants form sulpheric acid with environmental humidity[1].

The acidity of the dyes and the printing process can cause accelerated breakdown of cellulose fibers. Which is why we often see these patterns of loss along dark design and pattern lines in these printed textiles. There is currently no method used by the textile conservation community to slow the burn out or prevent it from happening in the future. We can only use methods to stabilize and secure damaged areas.

The first among these case studies is a John Hewson Textile that Caring for textiles treated in 2010 (Figure 1). A young private client brought in the studio and was very excited to care for her heirloom piece, as she is a descendant of John Hewson. John Hewson was a prolific American textile artist during the late 18th century. Born in London and trained in a cotton-printing factory, he moved to the United States and set up a calico printing company of his own in Philadelphia Pennsylvania.

Fig. 1: *Textile attributed to John Hewson. Block-printed plain weave cotton. 1780-1810. Private collection*

This piece owned by the client is related to other John Hewson textiles in the Philadelphia Museum of Art, the Metropolitan Museum of Art, and others. In the pursuit of good treatment protocol, and with a piece of this importance, we reviewed other conservation treatments of John Hewson textiles as well as other similar and notable printed textiles from the period, including a treatment performed by Sara Riter on a Oremerod bedcover at the Philadelphia Museum of art.

It came into the studio previously framed and in need of treatment. Upon un-framing, it was discovered that the textile was adhered in each corner to an extremely acidic backing board. Luckily, it was safely though painstakingly removed. Though it did not have any complete areas of burn out, some of the black or brown elements of the design were very brittle and showed a slight amount of powdering. Because of this and other color testing for dyefastness, it was determined that the textile could not be safely wet cleaned without further loss to the black and brown areas, though it would have been a great benefit to de-acidify. The textile was instead surface cleaned with latex-free polyurethane foam sponges in areas of the cream ground, which managed to remove a considerable amount of surface soiling. About 10 areas along the bottom of the textile were damaged due to wear and were repaired using fine cotton thread and careful hand stitching. An archival mount was prepared and the textile was cautiously secured. With the treatment and new mount, our client can now enjoy her cherished family heirloom for years to come.

The second treasured textile that Caring for Textiles treated came into the studio from a private client in 2014. A large and commanding piece, at five feet by six feet our client was interested in getting her beautiful quilted kalamkari conserved and mounted for

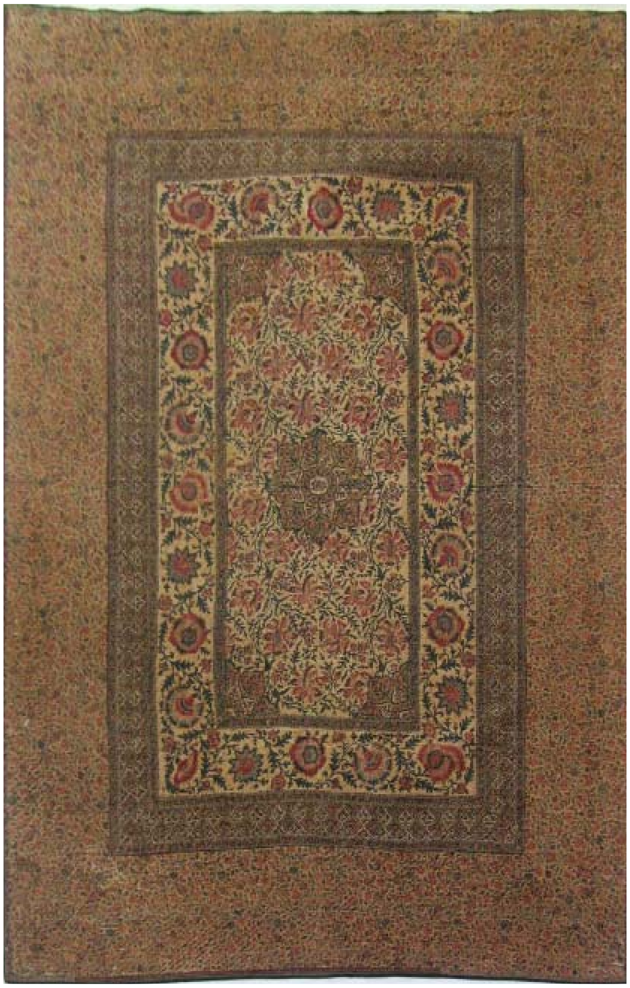

Fig. 2: Quilted Kalamkari Textile. Possibly 18th c. (unconfirmed). Private Client

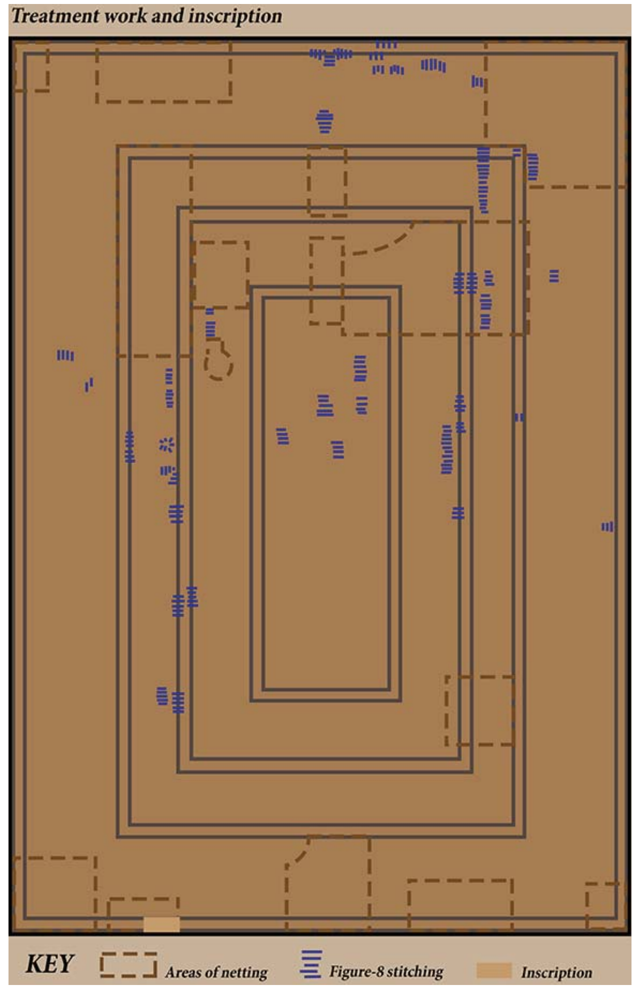

Fig. 3: Kalamkari textile stitch/repair graphic

framed display in their home (Figure 2). Little is known about this piece's specific origin, though it was most likely made in India. The face is one large hand painted panel of fine cotton, with a pieced outer border. The backing fabric has a cream ground and small repeated pattern of red bunches of tulips, most likely block printed. On first appearance, the kalamkari looked to be in remarkable condition, but on closer inspection, the stunning patterns that make up the face of the textile disguised many areas of wear and loss scattered throughout the piece.

This graphic shows all the areas that were treated (Figure 3). In order to be prepared for display, the main stabilization treatment focused on the protection and encapsulation of the damaged/split/torn and holed areas on the face of the textile. The technique to preserve these areas was the application of sheer beige polyester netting, in a dyed shade close to the color tone of the textile. Because of the sheer quality of the netting, it will only minimally mask the clarity of the patterns. It is not noticeable from a distance and will effectively support damages. This netting was attached by hand with fine back-stitching and Skala, a mono filament polyester thread in 15 areas of the kalamkari. In many of these areas of application, we were able to use lines of the quilting pattern to further disguise our treatments and stitching (Figure 4). 44 other areas throughout the pieces did not require such encompassing treatment

Fig. 4: Before and after treatment, fine nylon netting is applied to encapsulate and protect areas of loss

but were carefully repaired using fine hand stitching and Skala thread to draw splits and tears back together. After treatment it, was stable enough to be mounted for display.

In 2013, Caring for Textiles conserved and prepared this bodice worn by Martha Washington for display at Mount Vernon. It is dated to the late 18th century and made from a cream colored cotton with a brown and pink block-print pattern, and lined with plain cream-colored linen (Figure 5). There were many areas of damage throughout which required

Fig. 5: Bodice. Block printed cotton. 1790-1800. (W-1525) Photo © George Washington's Mount Vernon

stabilization, especially along the vertical brown stripes which were opening to show the linen lining beneath. All areas of damage were stabilized using overlays of fine monofilament nylon net. The sheer net allows for visibility of the printed fabric, and will best protect all the damages from developing overtime (Figure 6). Part of the treatment was mounting on a customized mannequin for display. Mounting a fragile printed garment can be very challenging, the wrong tug, no matter how gentle can potentially create new splits in weak areas that are not visible to the eye.

In the collection at Tudor Place Historic House and Gardens in Washington D.C. is a banyan that also belonged to Martha Washington, as far as we know it currently in need of treatment (Figure 7). Caring for Textiles examined the Banyan in 2008 and was tasked with preparing a conservation assessment, treatment proposal, and proposal for creating a reproduction. It is dated to the 1780's or 90's. It is made from a soft and fine printed cotton with a motif or red flowers within scalloped circles. The banyan has scattered areas of historical repair, and the cotton is very worn in places (Figure 8). The banyan was clearly

Fig. 6: Before and after treatment, fine nylon netting is applied to encapsulate and protect areas of loss

Fig. 7: Banyan. Block printed cotton. 1780-1790. Photo © Tudor Place Historic House and Gardens

Fig. 8: Examples of damages and previous repairs on the banyan

a garment that was very well used and loved. There are scattered stains and foxing throughout. It also of course, has many damages throughout, many are clearly due to the burn out of the print, areas of complete loss where the print is missing or where new areas of loss are beginning It is unknown whether or not this printed cotton was imported from India but it is visually similar to other floral motifs produced there for English and American market.

Mary Doering, notable collector of 18th century costume, graciously loaned this lovely jacket dated to the 1790's to us for research (Figure 9). We were fortunate to examine it in person, the jacket is an excellent case study of repair techniques over time. Caring for Textiles examined this jacket in 2016, we were able to take microscopic photos of many of the damaged "burn out areas" so we could understand the edges up close. The jacket is made from a lovely lightweight cotton with a striped and floral printed motif, it is lined in linen. Here are some of the image, really good examples of this type of burn out damage up close. On the left, you can see the individual threads and their breaking points. On the right you can see an area where an area of the brown printed motif is gone. More good examples, the left, the area of brown is actively degrading, there is a possibility of full loss of the area in the

***Fig. 9:** Jacket. Block printed cotton. 1790s. Private collection*

future. In the right image, you can see that the right spring is lost, but the others still remain.

This jacket was also an interesting case study because it is a veritable feast of previous repairs, many campaigns, darning, netting, and other types of stitch repair over possibly 100 years (Figure 10). Quite a visual glossary of repairs, some so lightly and lovingly stitched, yet strong and still survive. Many areas of the jacket have re-weaving darning repairs from early in the jacket's life and other areas have netting encapsulation, clearly a modern conservation technique. In a way, these previous darning repairs are a testament to women's skills, how we study chronicle and learn from our predecessors. It makes us think about methods and approaches for repair and fill – then and now. The darning repair remains strong and protective. A close up of the repairs, the darning was meticulously executed. It was a pleasure to explore this jacket in the studio, and learn from these stabilization techniques.

In the future, we may have chemical processes available as treatment options to slow the degradation process in textiles that test positive for iron-tannate dyes. Standard conservation methods such as encapsulation, darning, stitch repair painted in fills, and adhesive backings will still be employed, but options that change the chemistry of the fibers of textile and slow down the degradation process may become viable options. In the world of paper conservation where iron-gal ink has caused similar burn out damages, an aqueous treament is often used with great success to slow the rate of degradation. Since this treatment requires water, it is unsuitable for use with textiles with weakened fibers and issues of dyefastness, which is an issue for many printed textiles.

Dr. Helen Wilson who now works as a conservator at The National Archives in England, competed her Dissertation in 2012

Fig. 10: Examples of previous repairs in jacket, re-weaving and net encapsulation

doing research on non-aqueous conservation treatments for textiles testing positive for iron-tannate dyes[2]. Her research found several promising solutions but no conclusive results, some of the issues being further research needed in the application process.

After Conversing with Dr. Wilson over e-mail, she explained that she has not undergone any further research since the conclusion of her dissertation and no other conclusions have been made, but she believes her research has laid a great foundation and would be thrilled for others to take her findings further.

Since presenting this at Williamsburg in 2017, we have learned that Nicoletta Palladino completed her Masters thesis “Nanomaterials for the consolidation of iron-tannate dyed textiles” at the Polytechnic University of Milan in 2019[3]. Her research builds upon the findings of Dr. Helen Wilson, and Dr Wilson aided in her research. As a part of her thesis Palladino “used $CaCO_3$ calcium carbonate nanoparticles to neutralize the acidity, while the stabilization was addressed by a combination of nanocellulose, and silica nanoparticles, to truly tackle the complexity of the hierarchical nature of cotton textiles.”

It is very exiting for me to see that Dr. Wilson’s research is being built upon, and hope a viable and simple treatment will be discovered and frequently used in the future.

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3 August 2020

Pavithra Muddaya
Managing Trustee, Vimor Handloom Foundation Bengaluru, India

Conservation Impacting Livelihoods

PAVITHRA MUDDAYYA founded Vimor in Bengaluru in 1974, a home store specialising in reviving and creating handloom sarees. Vimor is involved with design work and training free of cost for weavers and is a NGO for livelihood opportunities. Vimor also participated in the festival of India in Britain, France and many other textiles related events. Pavithra's journey has allowed her to be part of many state and central Government organisations promoting handlooms and design development. She was awarded a Certificate of Merit by Ministry of Textiles in 1997 for revival of Molkalmuru Design and also awarded by Ashoka Innovators for the Public 'A Recognition for Contribution to Society for creating new avenues for the weaving communities of India through design and marketing interventions 2002-2003'. She established Vimor Museum of living textiles in Bengaluru as a space to celebrate the weaver and the common man's contribution to India's textile legacy in the last 120 years. She has been part of creating financial success for 80 percent of its weavers to function independently.

Introduction

I will be sharing the revival journey of Vimor which has been documenting and reviving traditional methods and designs, motifs etc. Saree conservation becomes more meaningful if apart from conserving the original product, we could impact weavers and the continuity of the craft and also make the tactile cultural heritage available to a larger audience through reproductions of original antique designs.

Conservation according to me, is preserving the tangible and intangible cultural legacy for posterity.I do not have an academic background in textiles or conservation, but I have been working with handloom weavers for 45 years, mentoring many of them.

I run a home-based store, Vimor, where we sold antique sarees which we got from temple auctions when we began in 1974. This gave me the opportunity to study, repair, restore strengthen by reinforcing the textile. This was done so that we could create a saleable saree for our customers, collectors, businesses, and museums like the Calico.

We noticed a shift in the type of sarees that were offered to deities as the old sarees with traditional designs were replaced by sarees that had modern designs, polyester, and tested zari. We felt a need to preserve these beautiful saree designs thus we embarked on a revival journey working with handloom weavers. We had great support and appreciation from the stalwarts of Indian handicrafts – Mrs. Kamala Devi Chattopadya and Mrs. Pupul Jayakar.

Why Revival?

Taking up the revival of an antique saree design was very uncommon, an unchartered territory that was not lucrative unlike nowadays. Now I am able to clearly present the entire process of recreating an original textile or being inspired by it to create a near look alike.

The original saree pieces were woven with pure zari and had exquisite workmanship.

Many were bought by Mrs. Pupul Jaykar for the Calico Museum and other organizations

When the quality of the original sarees started dwindling, that is the designs and fabric were not as superior as the earlier years, Vimor undertook a reproduction of the original. The first attempt was a plain Pooja silk saree woven at Dharmavaram. The original saree designs were painstakingly hand-painted and the original saree was sold, to generate income. At that point, we did not have the luxury of retaining a saree, and also in 1974 the color xeroxing was not economically viable. Actually doing this documentation by painting the original was a first step in conserving the design. This was a record that serves as material to revive the design.

Now, what were the criteria to undertake the revival? Maybe it was the hope of ultimately recreating an identical replica?

Our Indian textiles legacy I believe belongs to every Indian. When I say this —I should work towards making a close replica while impacting weavers' livelihood. To do this the weaver was central. Pavithra's experience and aesthetics to guide the entire process was the main advantage between the original, its inspiration, techniques and innovations.

The Vimor Story

Late Mrs Chimmy Nanjappa, Founder of Vimor

Vimor began as a small home business in 1974 selling handloom sarees established by late Mother Chimmy Nanjappa and her daughter, Pavithra.

The sarees auctioned at the South Indian temples were supplied to us in bundles. These sarees were anywhere between 80 to 120 years old. These were antique sarees by age but not sourced from any family or royalty. Mr. Bhandari, our antique saree supplier, traveled across different centers, bought the consignment, and sold it to Vimor.

This is Pavithra's and Vimor's journey of the revival of sarees and textiles. It involves documenting, mentoring along the revival of traditional techniques and designs. Saree Conservation becomes more meaningful when, apart from conserving the original product, we are able to impact weavers and help preserve the craft. Enabling a larger audience to experience our textile heritage through re-productions of the original antique designs.

We study old samples which are then used to recreate the sarees while keeping the techniques, the designs, and the economic factors in mind. We also learn cultural aspects attached to the textiles which range from stories, meanings of motifs and colors, etc, giving us a larger picture. This knowledge can create financial success and stimulate creativity. It can be used to educate and create a sense of pride amongst weavers and the public. The fabulous range of textiles that we have inherited helps to re-create and re-invent textiles creatively for the future, essentially inspiring weavers through conservation.

Criteria to undertake the revival

We noticed a shift in the type of sarees that were offered to deities as the old sarees with traditional designs were replaced by sarees that had modern designs, polyester, and tested zari.

Pavithra addressing women weavers in North Karnataka

We felt a need to preserve these beautiful saree designs and thus we embarked on a revival journey working with handloom weavers.

How did we go about conserving design?

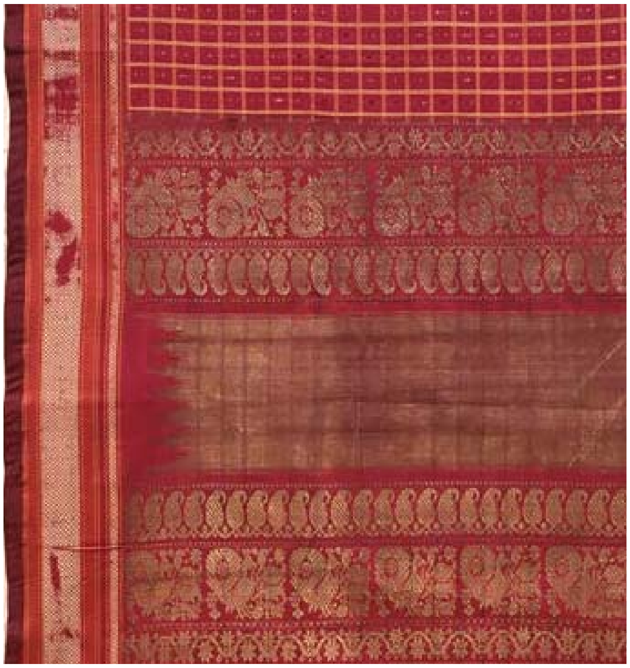
The original was studied in detail, regarding the yarn, structure, technique, and motifs. Once all the relevant details were studied, I would choose a weaver. This process was always to get a small time weaver with determination to succeed.

Determination to overcome his odds was the only spark we needed to see, irrespective of his current status. Finding the positives in his work gave him confidence and built pride in his work. Money and financial security are the most important among other things for any craftsman The advance payment and a buy-back agreement allow the weavers to work in a risk-free environment, with every detailed guidance.

Rags to Riches – The Pooja Saree

I am now going to give you an example of textile design impacting livelihood, i.e. the story of Pooja saree.

Story:
The 'Pooja saree' was given as a reference name for this particular type of saree as its borders resembled that of the Angavastra (shoulder cloth worn with the dhoti). These sarees were offered by the devotees to the deities in the temples once a wish was fulfilled or for festivals. Once the temple had accumulated a large number it was auctioned locally. Even today devotees donate in this way. Hence the name temple sarees came to be associated with sarees draped on a deity.



Original Pooja saree (almost 100 years old)

Speciality:
On studying the original textile we realised that the yarn had natural dyes and was not highly twisted. The body has double Muthu lines [dotted lines] in perfect squares. The centre of each square had a tiny Ikkat design, which resembled a dash/hyphen. The border had a “navillu kannu” (peacock eye), the pallu is elaborate with the “khalasha” motif which is a coconut sitting on mango leaves atop a small pot of water used in Hindu ceremonies. The last part of the Pallu has minute birds in the Jamdhani technique.

Vimor’s Input:
Ikkat was substituted by threads to replicate the dash/hyphen inside the squares. The number of white threads was reduced to be subtle and the border was maintained. The bird motif at the end of the pallu was altered slightly as no weaver was willing to use the original technique.

This innovative ‘Pooja saree’ became a must have across the generations of our customers and is Vimor’s pride and joy.

Journey:
So the Pooja saree was acquired by Vimor 1974/75, in silk with zari work and also in cotton. At that time, we did not know where the saree was woven, because as per our knowledge at that point “ikkat” work and Jamdhani technique were not prevalent anywhere in the states of Karnataka and Tamil Nadu. Many years latter due to Pavithra’s research on Molkalmuru region of Karnataka, we were enlightened on many aspects of this saree and were able to replicate it, as close to the original.

The first reproduction was done in 1976. We began a small production of recreating a simple design of the Pooja saree with Mr. Kondanna in Dharmavaram in undivided Andhra Pradesh. The outcome was a huge success as it was pocket-friendly, aesthetic, lighter silk, and easy maintenance compared to the heavier, more expensive Kancheepuram silks. Central Cottage Industries Delhi was our largest buyer.

When the weaver weaving these sarees suddenly passed away leaving a very young son to manage his family. Vimor stepped in to design a different version of the same Pooja but with an added surface Karnataka embroidery called Kasuti. Now looking back this was a great plan to support the son’s production, and introduce a traditional technique into a huge market hungry for the design.

The saree design intrigued us to experiment and innovate based on the original antique saree. Over time we had many in our collection which is housed in the Museum of living textiles. The design was tailor-made according to the weaver’s skill and his determination to succeed that we recognized as the most important factor, We would mentor and build his confidence, which would go a long way to positively impact his life.

The design soon spread across their village and many other regions as well with weavers making other variations of the design and adding their own influence. It has been central to the continuous production for 45 years in different regions of South India. It has been woven in silk with zari, cotton, cotton silk, polyester to suit all kinds of price points. They are available in sarees, dupattas, stoles, and yardage. The entire cross-section of weavers, dyers, ancillary workers, businessmen, boutiques, and exporters have all been benefited.

Weaver:
The weaver's growth was measured from him owning one house to 12 houses, one-two looms to 100 looms. They were now masterweavers managing many smaller weavers under them. Today their sons join the business, expand the operation and I am honored and humbled when they bring their sons to me to guide them.

Amongst the many, two weavers stand out who were trained with this design. One Mr. Ranganathan, the other, late Mr. Govindhan, who became the biggest saree manufacturers. Even now their financial year's business begins with their first bill made out to Vimor. They believed we are a good luck charm.

This to me is conservation impacting livelihood.

Examples of inspired design interventions in Pooja Saree

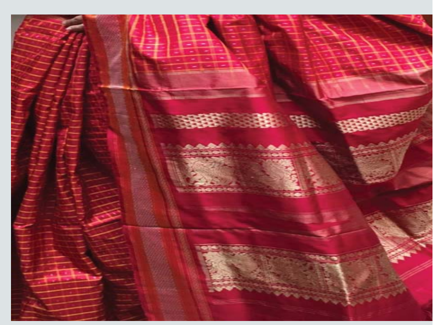
Pooja plain saree in silk (1978): *Vimor started production of this design with weavers from Dharmavaram.*

Pooja plain saree in cotton (1982): *This Vimor design was produced with weavers from Rasipuram, Salem, Chirala, and small villages in Karnataka, Tamil Nadu, Andhra Pradesh and Telangana.*

Pooja checks with Manipuri Pallu saree in cotton (1980): *Vimor started production of this design with weavers from Kanchipuram, Salem, Gumundipondi, Chirala and Vadamanapakkam.*

Pooja checks saree in silk – Molkalmuru design with zari pallu (mid 70s): *Weavers from Arni and Kanchipuram produced this Vimor design*

Pooja checks saree in silk – Molkalmuru design with plain pallu (mid 70s): *Vimor design without zari and a plain pallu with weavers from Sevur and Cheyyar*



Pooja silk saree in Ikkat – recreated in 2010/2019: *Pooja saree comes back to its original ikkat design – finally creating a near look alike!*

Vimor Handloom Foundation

The Vimor Handloom Foundation is an extension of Vimor, was set up in 2004. Established with a vision to empower weavers, to research, document as well as create sustainable products and practices.

The foundation aims to add value to the existing knowledge banks and help conserve India's textile heritage. Educating people about our textile inheritance is also an important aspect of the foundation.

The objective of the museum is to preserve and showcase heirloom textiles from our vast private collection and those donated by people across the country. The space facilitates the interaction between weavers as well as important people in the handloom sector through talks.

The Urban Weavers Workshop is one such workshop where people are taught the basics of handloom weaving by a master weaver on our museum looms.

- Vimor Museum textiles are not Historical or Royal- these are all donated by people all across India
- Written in non-technical language- so that it is easy to understand for everyone
- Showcases design assimilation and integration as India's Strength- to showcase and make people aware that this is India's strength.
- Conduct an Urban weavers workshop to spread the joy of Handweaving and to appreciate the complexity behind the weavers' skills.

Vimor museum of living textiles

Why do we need to preserve design?

We need to preserve these techniques and designs as this is our inheritance. These are positive memories that we want to bring back into people's awareness and appreciate the huge contribution that the common man and the weaver, together have contributed. In the absence of Royal patronage, the community becomes the patron and the weavers are the custodians of textiles. This also serves as a personal archive or family heirloom documentation. Pavithra's experience and aesthetics provide guidance between the original and its reproduction to benefit all.

How creating designs today become tomorrow's antiques?

Society needs to include the creative, Interpretation of textile which allows growth. The market was driven for the local community

Antique cummerband worn by kodava men at family function

Car, gramaphone and biplane motifs

first, and then for traders. There are multiple variations of the same design found in one Village. External Factors like climate, social norm, wearing style, festivities – influenced design development. Oral history allows the study of the trends when the textile was woven. By recreating the original textiles in design we are safeguarding and creating antiques for tomorrow.

How do we authenticate origin in the absence of written records?

The problem of authentication is very real as nothing has been written about since it didn't belong to royalty or a certain historical period. Attributing place of origin to a particular design based on its oral stories. Trade and Migration allowed integration in design is how we undertook documentation. This knowledge was based on talking to weavers above the age of 70 as they are the only ones who can recall or have heard stories from their grandparents.

Reconstructing design based on these stories is a slow and tedious process which represents the essence of design in a local area.

An example of this is the car and biplane motif saree.

Why is sharing our common textile legacy important?

Indian textile heritage belongs to every Indian. Access to see heritage textiles is very rare for our general public. This is the reason the Vimor Museum of Living Textiles was set up, to showcase textiles to the weavers and the public.

How many Indians know about Museums and conservation? By creating handwoven sarees of traditional, heirloom sarees, we believe more people can wear and they can earn while preserving our textile cultural heritage.

Textiles have always been a living craft attracting the entire world to our exotic textiles. We have no competition from any other country.

B.B. Paul
Former Director, Weavers' Service Centre Ministry of Textiles, India

7 August 2020

Materials & Weaves of Some Important Indian Textiles

BIJAN BEHARI PAUL, born on 11th February 1955, hails from a weaver's family in Anandapur, West Midnapur in West Bengal. He studied Handloom Technology course in Indian Institute of Handloom Technology, Varanasi and Project Planning & Infrastructure Management in Rajasthan University, Jaipur. Later he taught at Indian Institute of Handloom Technology, Varanasi for 3 years and then joined the Weavers' Service Centre as Designer and finally retired as Zonal Director in February 2015 after serving for 40 years. During his tenure, he formulated the India Handloom Brand Scheme, brought out two collections of exclusive handloom products under Tantavi project, deputed to Nepal as Handloom Expert twice under Colombo Plan and ITEC for development of the handloom sector there, deputed to Cambodia for establishment of Asian Textile Museum under Mekong Ganga Co-operation, developed shade cards of natural dyes and eco-friendly dyes and implemented many R & D projects on design documentation, loom development. He received the National Award from the President of India in 1991 for his innovative designs for handloom products. After retirement, he was engaged as Consultant in the office of the Development Commissioner for Handlooms, Ministry of Textiles for 3 years. Presently he works as Consultant in Taneira, a Titan Group of Companies.

Introduction

The art of handloom weaving is an age-old tradition in India that has been practiced over centuries. A piece of madder dyed cotton cloth has been found during excavation in Mohenjo-Daro and Harappa site. It proves that our countrymen were having high skill of spinning, weaving and dyeing of cotton even before 5000 years ago. Various written treatise pertaining to *Rig Veda*, *Ramayana*, *Mahabharata*, *Thalia* (by Greek historian Herodotus) and Kautilya have mentioned not only spinning and weaving but also the high quality of silk and cotton. Export of handloom products, as early as fifteenth century was reported, followed by Vasco da Gama's visit to India thereby opening of trade routes to Europe. Further, it is said that by the end of seventeenth century, 83% of the East India Company's trade accounted for clothing exports.

With the advent of the industrial revolution, the British began executing a protectionist policy in order to restrict import of handwoven cloth from India (to Britain) while dumping their machine-made cheap cloth to India from Lancashire. Towards the end of the nineteenth century, the cotton textile sector suffered from a range of challenges from economic recessions to natural calamities. In fact, for the period ranging end of the nineteenth century and the first three decades of the twentieth century, there was an ongoing tussle between dumping of British mill products versus Indian hand-woven textiles with the rising call of Swadeshi goods.

Despite such adversity, Indian artisans have stood the test of time and have kept this great tradition alive. Over the centuries, handlooms have come to be associated with excellence in India's artistry in fabrics. Fabrics and designs

were influenced by geographic, religious and social customs of a region. Even today, handloom weaving constitutes one of the finest and most vibrant aspects of Indian cultural heritage. Different parts of India have distinct styles of products – Brocades of Gujarat and Banaras, Jamdanis and Balucharis from Bengal, Kancheevarams of Tamil Nadu, Ikats from Odisha, Gujarat and Telangana, Chanderis and Maheshwaris from Madhya Pradesh, Khes of Punjab and Haryana, Muga of Assam, wild silks of Bihar, Tasar of Chhattisgarh and Jharkhand, Woolen shawls of Himachal and Nagaland, Pashmina from Kashmir, Phanek from Manipur, Dorias of Rajasthan and Paithanis of Maharashtra.

Handloom is known for flexibility, versality and innovativeness. The level of artistry and intricacy achieved in the handloom fabric is unparalleled and certain weaves/designs are well beyond the scope of modern machines.

According to the Fourth All India Handloom Census 2019-20, the total number of households in India engaged in handloom activities (weaving and allied activities) is 31.45 lakhs. Across India, 28.2 lakhs handlooms were reported in the Census, out of which 25.2 lakhs were in rural areas and 2.9 lakhs were located in urban areas. Handlooms are mostly located in handloom weaver households (95.6%) which clearly signify that weaving on handlooms is primarily a household-based activity. This sector contributes nearly 15% of the cloth production in the country and also contributes to the export earnings of the country. 95% of the world's hand-woven fabric comes from India.

Textile fibres/ yarns used

Fibres form the raw material from which yarns and fabrics are made. Until recently (before the introduction of rayon in 1910), fabrics were primarily produced from fibres of natural origin like cotton, silk, wool, jute, linen, hemp etc. These fibres have special inherent properties that make them suitable for conversion into yarns and then to fabrics. Considering their origin, fibres may be classified into two groups:

A) Natural fibres – these fibres may again be sub-divided into three groups

   1. Vegetable – these can be further classified into four groups:
      - i) Seed fibre – cotton, kapok
      - ii) Bast fibre – jute, flax, hemp.
      - iii) Ramie, banana etc.
      - iv) Leaf fibre – sisal, pine apple etc.
      - v) Fruit fibre – coir
   2. Animal fibres are obtained from silk (Mulberry, Tasar, Eri, Muga), wool (sheep) and hair (goat, camel, rabbit, alpaca etc.). India is the only country in the world where all four varieties of silk is available.

3. Mineral fibre is made from Asbestos.

B) Man-made fibres - these may be divided into following four broad categories:
1. Re-generated fibres are manufactured from raw materials of natural origin. These may sub-grouped into four as below:
    - i) Cellulosic – viscose rayon
    - ii) Cellulose esters – acetate rayon
    - iii) Protein – casein
    - iv) Others – alginate, rubber
2. Synthetic fibres are those that are manufactured by synthesis of simple polymer-forming materials. These may be divided into following six sub-groups:
    - i) Polyamides
    - ii) Polyesters
    - iii) Polyvinyl derivatives
    - iv) Polyurethanes
    - v) Polymerized hydrocarbons
    - vi) Synthetic rubbers
3. Metallic – zari
4. Others – glass

Types of zari

Zari is a combination of yarn (silk/cotton/rayon/polyester) and some metals like gold, silver or copper which is used by the textile, handicraft and other industries in the country. The zari craft has been developed in the country over centuries and produced mainly in Surat and Banaras. *Real* zari is made by electroplating gold over a silk or cotton core yarn coiled with flattened silver wire. These days in place of flattened silver wire (*Badla*), an alloy made of silver and copper is used to cut down the cost of zari. In case if *Imitation* zari, the alloy is made of copper and a little quantity of silver. The core yarn may be artificial silk or polyester. Lacquering or fast gilding is done over the coiled yarn to give a look of gold. This is very cheap compared to Real zari. Now-a-days, there is one more class of zari called *Plastic* zari which is made of thin plastic strip coiled over core yarn.

Zari making

Properties of some natural fibres

	Cotton	Linen	Jute	Mulberry	Tasar	Muga	Eri	Wool
Density	1.54	1.50	1.52	1.33	1.32	1.80	1.38	1.30
Tenacity (g/d)	3.40	6.00	5.50	3.60	3.40	3.60	3.10	1.70
Elongation (%)	6	3	2	29	16	29	24	30
Moisture regain (%)	8	12	12	18	10	13	15	18
Susceptible to insect/mildew	Silver fish damages	Silver fish damages	Silver fish damages	Mildew Silver fish damages	Mildew Silver fish damages	Mildew Silver fish damages	Mildew Silver fish damages	Yes
Effect on acid	Weakens	Weakens	Weakens	Resists dilute acid	Resists dilute acid	Resists dilute acid	Resists dilute acid	Resists dilute acid
Effect on alkali	Resists	Resists	Resists	Strong alkali dissolves	Strong alkali dissolves	Strong alkali dissolves	Strong alkali dissolves	Strong alkali dissolves

Fibres have been defined by the textile Institute as "units of matter characterized by flexibility, fineness and a high ratio of length to thickness". Some additional characteristics, such as stability at high temperature, a certain minimum strength and extensibility, might be included if the fibre is to be used for textile end uses. Fibre length, fineness, colour, lustre, density, moisture absorption ability, resistance to heat, acid, alkali etc. are very important properties that decide the usefulness of the fabrics made out of the fibres. Basic properties of some natural fibres are given in the table.

Cotton

Types of yarn

There are two types of yarns based on their raw material's character – staples or filament. When the yarn is made by twisting of short staple fibres, it is called Spun yarns. All natural fibres are spun into yarns. Man-made fibres are manufactured both in staple and filament characters, hence spun as well as filament yarns are available in this category. Of course, silk yarn is manufactured both in spun and filament form.

In cotton, there are varieties of yarns like carded, combed, mercerized, gassed & mercerized depending upon the processes undertaken and each of these varieties has special significance on the ultimate character

Mulberry silk

of the fabric made out of it. Similarly, different varieties of yarns such as *reeled silk, spun silk, dupion, matka, fesua, noil* etc. are manufactured from mulberry silk. Tasar yields *reeled silk, spun silk, ketia, ghicha, matka, jhuri* etc. Muga yields both reeled and spun yarns whereas Eri silk is only spun into yarn since it cannot be reeled due to the inherent structure of the cocoon.

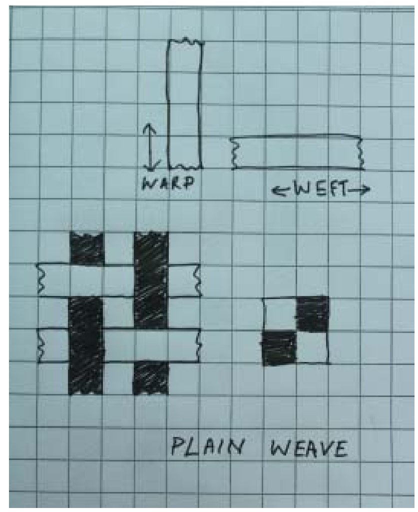
Woven fabrics may be classified broadly into two groups – (1) Basic fabrics in various weaves like plain, rib, mat, twill, satin, sateen, textural and combination of such weaves. These basic fabrics are used extensively for surface embellishments and other decorations for value addition. (2) Patterned fabrics are woven with various techniques like extra warp designing, extra weft designing, brocading etc. with the help of *jala, adai*, dobby and jacquards.

Types of weaves

Fabrics are woven with the interlacement of at least one series of vertical yarns, called warp and one series of horizontal yarns called weft, in right angle. Individual warp and weft yarn are termed as end and pick respectively. The style of interlacement of warp and weft yarns is known as weave. There are three basic weaves – plain, twill and satin.

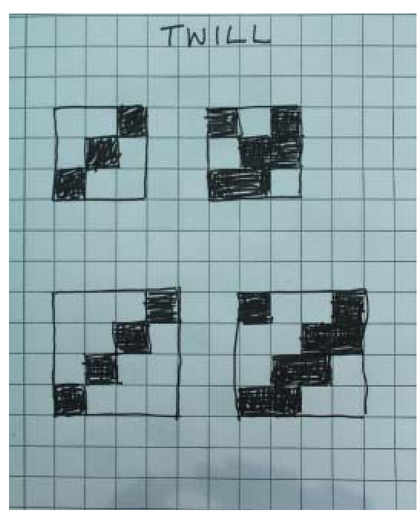
1. Plain weave

Plain weave repeats on 2 ends and 2 picks. Each end interlaces with each pick in alternate order like 1 up 1 down and then 1 down 1 up. It gives the toughest/strongest fabric since all threads interlace alternately. Almost 80% fabrics are woven in plain weave.



2. Twill weave

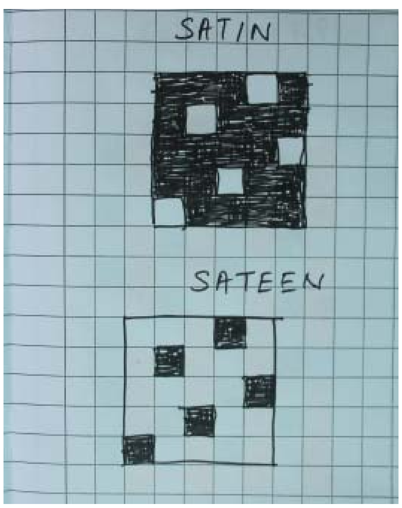
Twill weave repeats in minimum 3 ends and 3 picks. Interlacement occurs in more than 1 end or 1 pick at a time like 2 up 1 down (3 thread twill), 2 up 2 down or 3 up 1 down (4 thread twill). 2/2 twill is mostly used. The fabric has a diagonal line appearance on the surface. It gives closer texture and results in relatively heavier fabric.



3. Satin/ Sateen weaves

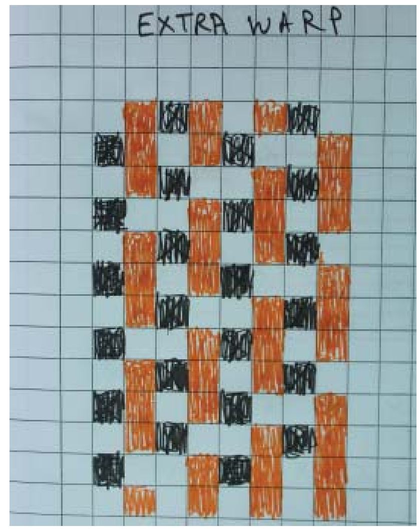
Satin weave repeats in minimum 4 ends and 4 picks but true weave repeats on 5 end and 5 picks. Here each end interlaces only once with a pick in a repeat not in diagonal manner as in the case of twills but in a skipped manner. Because of long floats of threads, the fabric surface is very smooth. When the surface is entirely with warp, the fabric is Satin and when it is with weft then it is Sateen.

In traditional Indian hand-woven textiles such as sari, dhoti, dress-material, shawls, stoles, furnishing etc., patterns or designs are primarily woven in three different weaves - extra warp, extra weft and tapestry.



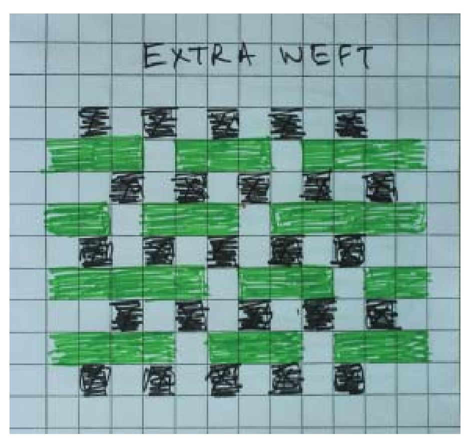
4. Extra warp designing

Extra warp design is made by inserting extra design threads in the warp direction. These threads lie in between base or ground warp threads in various proportions such as 1:1 (1 ground 1 design), 1:2 (1 ground 2 design), 2:1 (2 ground 1 design), 2:2 (2 ground 2 design) etc. as per requirement. Therefore, there are two series of warp and one series of weft in this weave. Design threads interlace with weft threads in a particular fashion as suitable for the pattern to come up on the surface of the fabric. If these extra design threads are taken out, ground fabric remains intact. They are manipulated directly with the help of a designing device like, *adai*, dobby, jacquard, in a particular fashion. This arrangement results in faster production and mostly used in sari borders.



5. Extra weft designing

Similarly, Extra weft design is made by inserting extra design threads in the weft direction. These threads lie in between base or ground weft threads in various proportions such as 1:1 (1 ground 1 design), 2:1 (2 ground 1 design) etc. as per requirement. There are two series of weft and one series of warp in this weave. Design threads interlace with warp threads in a particular fashion as suitable for the pattern to come up on the surface of the fabric. If these extra design threads are taken out, ground fabric remains



intact. They are manipulated directly with the help of a designing device like *jala,* jacquard etc. in a particular fashion. This arrangement results in slower rate of production and mostly used in all important traditional in saris such as *Banarasi, Kancheevaram, Dharmavaram, Molkalmuru, Jamdani, Bomkoi, Venkatgiri, Gadwal, Chanderi, Kosa, Ashawali* etc. this is the most versatile method of designing of a patterned fabric.

6. Tapestry designing

Tapestry technique is the most unique, complicated and time-consuming method of designing. This technique is applied in weaving of very coarse material like durrie (*cut-shuttle durrie*) as well the *finest Pashmina Shawl, Kullu Shawl, Kinnori Shawl* and silk saris such as *Paithani*. There is neither extra series of warp nor weft. Design is made by inserting different colours of weft of small lengths, one after another following the contour of the pattern across the width of the fabric by hand with the help of small shuttles or weft package locally called as *tili or kani*. All such small lengths of design threads jointly make one pick.

Types of materials

Cotton is one of the principal crops of the country and is the major raw material for domestic textile industry. It provides sustenance to millions of farmers as also the workers involved in cotton industry, right from processing to trading of cotton. In the raw material consumption of the textile industry in India, the ratio of the use of the cotton to man-made fibres and filament yarn is 59:41.

However, handloom sector in our country has been consuming primarily natural fibres/yarns like cotton, silk, wool, jute, linen etc. of all format since ancient times. Even today when all kinds of man-made fibres are manufactured and available in plenty in the country, almost 90% natural fibres/yarns (cotton – 67.2%, silk 12.6%), wool – 7.9%, linen – 1.4%, jute – 0.5%) are used in our handloom products. Zari (2.5%) is used for designing of the fabrics as per handloom census 2019-20.

Broad information on materials and weaves of some important traditional Indian hand-woven textiles are tabulated in the following pages. Information on materials and weaves given in the tables against the fabrics is based on pure traditional form. Present status may vary.

Jamdani of West Bengal, Uttar Pradesh & Andhra Pradesh

Item	Details
Base warp	Cotton
Base weft	Cotton
Design warp	Cotton
Design weft	Cotton, zari, muga
Base weave	Plain
Design weave	Extra weft (plain)

Baluchari

Items	Details
Base warp	Mulberry silk
Base weft	Mulberry silk
Design warp	Mulberry silk
Design weft	Mulberry silk
Base weave	Plain
Design weave	Extra weft (twill/satin)

Banarasi Kimkhab Brocade

Items	Details
Base warp	Mulberry Silk
Base weft	Mulberry Silk
Design warp	-
Design weft	Silk, zari
Base weave	Satin
Design weave	Extra weft Twill/sateen

Banarasi Butidar/ Jangla

Items	Details
Base warp	Mulberry silk
Base weft	Mulberry silk
Design warp	-
Design weft	Mulberry silk, zari, art silk
Base weave	Plain
Design weave	Extra weft Twill/sateen

Ashawali

Items	Details
Base warp	Mulberry silk,
Base weft	Mulberry silk
Design warp	-
Design weft	Silk, zari
Base weave	Plain, satin
Design weave	Extra weft Twill

Banarasi Tanchoi

Items	Details
Base warp	Mulberry silk
Base weft	Mulberry silk
Design warp	-
Design weft	Mulberry silk
Base weave	Satin
Design weave	Twill/sateen

Paithani

Items	Details
Base warp	Mulberry silk, cotton
Base weft	Mulberry silk, cotton
Design warp	-
Design weft	Mulberry silk, zari
Base weave	Plain
Design weave	Tapestry (plain)

Chanderi

Items	Details
Base warp	Mulberry silk
Base weft	Cotton
Design warp	Cotton, zari
Design weft	Cotton, zari
Base weave	Plain
Design weave	Extra warp and extra weft (twill/sateen)

Patan patola

Items	Details
Base warp	Mulberry silk, zari
Base weft	Mulberry silk, zari
Design warp	-
Design weft	-
Base weave	Plain
Design weave	Double Ikat - resist dyeing

Kancheevaram

Items	Details
Base warp	Mulberry silk
Base weft	Mulberry silk
Design warp	Mulberry silk, zari
Design weft	Mulberry silk, zari
Base weave	Plain
Design weave	Extra warp, extra weft (twill/satin/sateen)

Dharmavaram

Items	Details
Base warp	Mulberry Silk
Base weft	Mulberry Silk
Design warp	Zari
Design weft	Zari
Base weave	Plain
Design weave	Extra warp, extra weft (twill/satin/sateen)

Maheswari

Items	Details
Base warp	Mulberry Silk
Base weft	Cotton
Design warp	Cotton, Zari
Design weft	-
Base weave	Plain
Design weave	Extra warp (twill/satin)

Himru

Items	Details
Base warp	Mulberry Silk, cotton
Base weft	Cotton
Design warp	-
Design weft	Mulberry Silk, cotton, zari
Base weave	Twill
Design weave	Extra weft (floats)

Mushru

Items	Details
Base warp	Mulberry silk
Base weft	Cotton
Design warp	Mulberry silk
Design weft	-
Base weave	Satin
Design weave	Twill, Tiny floats

Backstrap loom products of North Eastern States

Items	Details
Base warp	Cotton
Base weft	Cotton
Design warp	Cotton
Design weft	Cotton
Base weave	Plain
Design weave	Extra weft (floats)

Pashmina Kani shawl

Items	Details
Base warp	Pashmina
Base weft	Pashmina
Design warp	-
Design weft	Pashmina
Base weave	Twill
Design weave	Tapestry (twill)

Kullu, Kinnori shawl

Items	Details
Base warp	Wool
Base weft	Wool
Design warp	-
Design weft	Wool
Base weave	Twill
Design weave	Tapestry (plain)

Conclusions

Our centuries-old hand-woven traditional textile products have not changed their course of production in terms of materials and weaves in spite of onslaught of industrial revolution happening in the world during last 150 years. Many man-made fibres are available in the market today but our consumers and weavers are comfortable with natural fibres. It may be due to the climatic condition of the country, easy availability of natural fibres and of course love and respect of our consumers for traditional craft. However, gradual and slow consumption of acrylics, nylon and polyester yarns have been noticed now.

The weaves of the huge range of traditional products are limited to simple and basics such as plain, twill, satin, extra warp, extra weft and tapestry, except *Gyasar* and *Himroo* where compound weaves are used. Further, there is inter-cluster pattern and design manipulation happening now. Traditional motif of one region is being copied in other regions. Even manipulation in technique is also happening in the sector. Printing patterns are woven in the fabric and vice-versa. Basic patterns after weaving or printing are super imposed with embroidery. Even two techniques of designing such as weaving and printing are clubbed together in the same fabric to give it a different look in the name of innovation. Purists of the craft may not agree with such manipulation.

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Textile Yarns – Technology, Structure and Applications by B.C. Goswami *et al.*

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Indian Metallurgical Heritage and Archaeometallurgical Approaches

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Introduction

Archaeometallurgy pertains to the technological study of metallic archaeological artefacts and art objects to gain insights into the manufacturing techniques and history of technology and to also the provenance and sources of metal which could help in their classification. Archaeometallurgy is increasing becoming a widely inclusive discipline of archaeology which attempt to trace the history of ancient metal production, distribution and usage in antiquity and the related socio-cultural and economic ramifications (Srinivasan 1996, Srinivasan 2017). Metals have played a crucial role ever since post-Neolithic societies being used progressively through the Copper Ages, Bronze Ages and Iron Ages across different regions. The early metals to be exploited were those which were found in the native state, followed by those which could be smelted or reduced easily from ores, while those which were more difficult to smelt were discovered last. The commonly used metals in antiquity include gold, silver, copper, iron, tin, lead, zinc and mercury (Srinivasan and Ranganathan 1997). Many modern developments in metallurgy draw from in ancient practices that pre-date the Industrial Revolution. The earliest usage of copper seems be around the 8th millennium BCE in Turkey or Anatolia (Rehren and Pernicka 2008). The use of non-ferrous metals is seen in the river valley cultures of Mesopotamia, Egypt; and also the coeval Harappan civilisation of the Indian subcontinent (*c.* 2500 BCE) (Possehl and Rissman 1992, Kenoyer 1998).

The trajectory of some of the metals used in antiquity is traced in this paper with some archaeometallurgical insights, field studies and technical investigations by the author, particularly from southern India. Various techniques of scientific examination find increasing use in archaeometallurgical and archaeometric study, including microscopy, spectro-chemical and elemental analysis, x-ray fluorescence and others. Investigations of archaeometallurgical debris such as slags, crucible and furnace remnants can be made using SEM-EDAX, EPMA-WDS and so on. Lead isotope ratio analysis can be a useful technique for identifying the source of lead alloyed in an artefact since the lead isotope ratios remain unchanged through smelting processes (Srinivasan 1999a), which has been attempted by the author on some artefacts as reported here.

The use of native copper, tin bronze and arsenical bronze was known in antiquity. Copper alloys come into vogue in the Bronze Age civilisations in Egypt, Mesopotamia and the Indus Valley as well as in China. The making of statuary figurines in received an impetus in the Indian subcontinent following the Hellenistic incursions in northwest India. Metal icons of bronze and brass, including gilt images, were cast of Buddhist, Jaina and Hindu affiliations especially from about the 5th century CE in different parts of the subcontinent with ramifications in East Asia and Southeast Asia. The making of metal icons for processional worship by the lost wax process still continues in parts of Thanjavur district in southern India, harking back to the great medieval Chola bronzes such as the celebrated Nataraja bronze. Although there are often problems in making stylistic attributions for south Indian bronzes due to longstanding continuing traditions, archaeometric techniques are useful in the classification of metal artefacts apart from gaining insights into history of technology (Srinivasan 1996, 1999a, 2016a-f).

Gold in antiquity

The noble metal of gold is found in nature in the native state. Gold has been used to make jewelry not only due to its golden lustre but also due to its great ductility which facilitated forging it into sheet metal and a range of shapes. The most spectacular gold artefact is the Egyptian artefact of the enigmatic mask of the young Pharaoh Tutenkhamen (*c.* 1300B CE) made by hammering sheet metal. Early gold and silver ornaments from the Indian subcontinent are found from Indus Valley sites such as Mohenjodaro (*c.*3000 BCE). Gold and copper usage is reported from Neolithic Merhgarh in Baluchistan, Pakistan (*c.* 6000 BCE). Diadems and belts of gold are reported from Mohenjodaro. Harappan silver artefacts are reported from Kunal, in north-western India (Agrawal 2000: 6). The lighter colour of some gold artefacts from Mohenjodaro suggests the use of naturally occurring gold with silver impurities. Skilled practices of goldworking are noted in the Harappan period

Fig. 1: Micro-beads from Harappan site, National Museum, Delhi (2500 BCE)

such as the use of gold micro-beads (figure 1).

Gold mining seems to have had a long history in parts of southern India such as in Karnataka. It has been speculated that gold from the Karnataka region collected from the surface by Neolithic cultures of the mid third millennium BC might even have supplied the Indus regions (Allchin and Allchin 1982: 337, More recent studies have also pointed to other probable nearer minerals sourced for the Indus period (Law 2011). The author had made preliminary field surveys in north Karnataka in the Hutti-Maski region in 1991 where she noted extensive old workings for gold. Most outcrops

Fig. 2: Neolithic Ashmound, Wandalli, Karnataka; with mullackers or grinding stones related to gold extraction found near old gold mine workings

had open cast mines with old mining galleries with large mullacker fragments scattered about indicating ore crushing activity in antiquity (figure 2). Old timber from a 200 metres deep mine shaft was carbon dated the mid 4th century BC (Radhakrishna and Curtis 1991: 23-4), ranking amongt the deepest known old gold mines. The Jalagarus were a traditional community in the Dambal region who undertook alluvial washing and panning for gold (Foote 1874: 140).

The Nilgiri hills and Wynad bordering, Tamil Nadu, Kerala and Karnataka host some sparse hard rock and alluvial gold deposits. Roman Pliny's account (1st century) of gold from the country of Naris might well refer to the land of the Nairs, ie the region of the alluvial gold tracts of the Nilambur valley below the Wyand hills (Radhakrishna and Curtis 1991: 23). While they are currently uneconomical, it is interesting they have been illegally mined/panned by local Kurumba tribes as observed by the author. In 1990 the author and Digvijay Mallah had identified some old gold workings in Gudalur, and observed children from the local Kurumba community engaged in hard rock mining for gold and panning for gold from the streams for alluvial gold using large wooden pans, whereby the heavier particles of gold would segregate into the pan while the lighter sand grains would wash away (Srinivasan 2018, Srinivasan 2016a). The Kurumba tribe was traditionally believed to have had magical powers apart from knowledge of mining and metallurgy according to Thurston (1909). There are also accounts that Hoysalas used gold from the region.

The rich finds of gold jewellery from the Nilgiri cairns, now housed in the British Museum, London may date from the early or mid 1st millennium BC to AD by some commentators (Knox 1985). The gold granulation technique seen in some of the ear-rings, whereby tiny spheres of gold were formed, may relate to Hellenistic influences, although the use of gold micro-beads was also noted at Harappan sites such as Lothal. Other early Tamil examples of gold jewellery include an ear-ring from Souttoukeny of the 2nd century BCE from Tamil Nadu depicting a prickly fruit, now in the Musee Guimet in Paris (Postel 1989: 130). These bring to mind the rich poetry of the classical Tamil Sangam era (*c.* 3rd century BCE to CE) which evoke local fruits and flowers such as *kurinji*.

Silver

Silver was extracted in the Old World using the method of cupellation, by the smelting and refining of silver rich lead ores. The old mines and working in Dariba and Agucha in the region of Rajasthan indicate production of silver from argentiferous lead in antiquity. These mines were found to be comparable in extent to the mines of Rio Tinto in Spain used in the Classical and Hellenistic World (Craddock *et al.* 2017). Silver anklets were also found from the Harappan site of Mandi. Use of silver is seen in punch-marked Mauryan coins from the 4th century BCE onwards. From the Satavahana period, (1st-2nd century CE), lead isotope finger-printing suggested the Agnigundala mine in Andhra Pradesh as one source of silver for coins, while Sardinia seemed likely to be another source, indicative of maritime trade (Srinivasan 1999b, 2016b). The largest cast silver urns are seen in the Jaipur palace and museum which would made of alloyed metal since pure silver is too soft for such large castings.

Cast copper-bronze icons and icons

The use of copper-bronze tools is seen from Harappan times, ranging from utilitarian artefacts such as chisels, nails, hooks and axes to cast miniature figurines. Several examples of

Fig. 3: *Dancing girl, Mohenjodaro, 2500 BCE (courtesy John Marr)*

low tin bronze with less than about 10% tin are found, whereby tin would have been added to harden the softer copper metal and to improve its castability. The fine miniature bronze of the Mohenjodaro dancing girl, *c* 2500 BCE is about 10 cm in height (figure 3). Cast in the round, it was very likely made of the lost wax/resin casting process where a model would have been made of wax/resin, invested with clay to make the mould and the wax melted out and metal poured into the hollow. Mortimer Wheeler in a TV programme of 1973 described the image as, ‘a girl, perfectly confident, there is nothing like her in the world’ (Possehl 2002). There are aspects of the figurine that connect to folk or indigenous practices such as the sideways hair bun still worn by Gond women of Central India and Kota women of the Nilgiris in southern India. In figure 4, a wax model for the casting of a metal figurine by the Gond community of Bastar (akin to Dhokra work) is seen with a tripartite headgear which brings to mind the

Fig. 4: Wax model for image being made by Gond community of Bastar

kinds of headgears worn by figures depicted in Indus seals.

The casting of copper alloy icons came widely in vogue from the early historic period onwards. Spectacular bronzes were also cast under the Cholas in southern India. The celebrated Nataraja bronze of the Chola period (figure 6), was hailed as 'poetry but nonetheless science' by Ananda Coomaraswamy in 1912. The connections to surviving South Indian dance practices of Bharata Natyam derived from Sadir, the temple dance tradition of Thanjavur area are still to be seen (figure 5). Excellent examples of Gupta statuary are known such as the life-size Sultangunj Buddha now in the Birmingham Museum, which was found to be of predominantly of copper and standing at 2.28m (figure 7). Bronzes continue to the cast by the lost wax process even in the present day at Swamimalai, in Tanjavur district. In this process an image was made of wax and invested

Fig. 5: Bharata Natyam dance pose of Nataraja by Sharada Srinivasan

Fig. 6: Nataraja, Kankoduvanithavam, Government Museum, Chennai

Fig. 7: *Sultanganj Buddha, 6th century, Birmingham Museum*

Fig. 8: *Metal icon casting at Swamimalai, Thanjavur district, Tamil Nadu*

with clay to form the mould. The mould was then heated to melt and get rid of the wax and then metal poured in which solidified to give the final metal icon. At Swamimalai the images are first minutely carved in wax and then covered in layers of clay to form the mould, using the fine alluvial clay of the Kaveri, the vandal munn, and then the wax expelled by heating the mould and then metal poured in to form the castings (figure 8). The hollow casting process used a clay core and was used more in the north of India for casting. In this the final icon was made of a thin layer of metal with the clay core retained inside. Hollow cast icons can appear damaged due to the thinner layer of metal being prone to damage.

Harle (1992: 302) memorably commented that the early Chola bronzes represent the finest representations of godhood, unsurpassed in any place or age. These bronzes were made by the lost wax process or investment casting process. The image was cast by first making a model in wax, and then invested with moulding material to form a mould and thereafter the mould is heated to expel the wax and the molten metal is poured into the hollow to generate the metal icon. The Sanskrit phrase *'madhuchchehistavidhanam'* refers to the lost wax process and is described in the artistic treatise of the Manasara of about the 4^{th}-5^{th} century (Reeves 1962: 29-31, Srinivasan 2016 *c*). That the lost wax process is also invoked in a poem by the Tamil women poet-saint Andal (*c.* 800) who compares dark rain clouds to the mould holding liquid wax, entreating them to rain on the Lord Visnu (Srinivasan 2016 *c*).

Investigations by the author as previously reported in Srinivasan (1996, 2016 b) indicate that a majority of the South Indian medieval bronzes were of leaded tin bronze. About 80% of 130 south Indian images from the early historic to late medieval period were leaded bronzes with tin contents not exceeding 15% and keeping within the limit of solid solubility of tin in copper. Beyond this limit as-cast bronzes become increasingly brittle due to the increasing presence of delta phase. The Chola bronzes (10^{th}-12^{th} century) in general had an average composition of about 6% tin and 6% lead (Srinivasan 2015). The 11^{th} century Chola Nataraja from Kankoduvanithavam in figure 5 analysed by the author by ICP-OES analysis had 8% tin and 8% lead as leaded bronze (Srinivasan 1998a). Of the total number of images only 15% were leaded brass images with more brass being used in the post-Chola period. Figure 9 shows the micro-structure of a cast predominantly copper image of the late Chola period studied by the author. Although south Indian icons are often described as 'pancha-loha' or five-metalled icons, the analyses by the author indicated rather they are largely leaded bronzes or leaded brasses. Such nomenclatures of pancha-loha and ashtadhatu (eight elements) more symbolic since it is not practically possible to make alloys with a significant content of so many metals. Archaeometallurgical investigations by the author on slag specimens recovered near the Ingaldhal copper mines in Karnataka confirmed that they were from copper smelting, likely of the Satavahana period from associated finds of early historic russet coated pottery (Srinivasan 2016d).

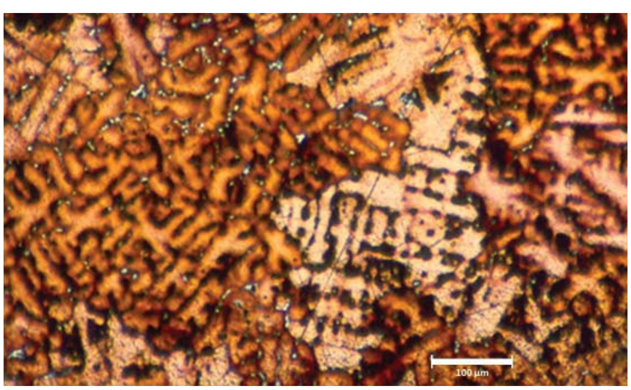

Fig. 9: *Micro-structure of cast predominantly copper alloy of late Chola era (200X)*

Fig. 10: *Making of mould for bell casting at Nacharkoil, Tamil Nadu (Bell maker late Govindrajan with Sharada Srinivasan)*

The lost wax casting of bronze bells has been practiced in the Thanjavur region of Tamil Nadu, which is another declining tradition Nacharkoil, a small village located four kilometres from Kumbakonam, has traditionally been renowned for the making of temple bells and temple lamps. In the past it had a sizeable community of Kammalar or bronze and bell metal workers. The *Kammalar* community have also been involved in making lost wax castings of large and medium sized temple bells by the lost wax process. Here the mould and wax model were build up using hand lathes in ingenious ways (figure 10), although the traditional lost wax casting of bells is declining and giving way to other industrial processes.

Binary high-tin bronze vessels and mirrors

As-cast binary copper-tin alloys with over 15% were not widely used in the ancient world as they are embrittled due to the presence of the delta phase component. Previously, the Indian subcontinent had not been regarded as a significant region in the exploitation of tin and bronze. However, metallurgical investigations by the author on artefacts from megalithic contexts and early historic contexts, continuing into medieval to modern south India demonstrated longstanding familiarity with the exploitation of the intermetallic properties of binary high-tin bronzes, as seen in the manufacture of vessels, coins and musical instruments of wrought and quenched beta bronze with 22-5% tin, and the manufacture of mirrors of delta bronze with about 33% tin (Srinivasan 1994, Srinivasan and Glover 1995, Srinivasan 2016e), which are also the last surviving crafts of their kind in the world.

Astonishingly, highly sophisticated and thin-rimmed bronze vessels have been uncovered from the megalithic cairns and burials of the Nilgiris (figure 11) and Adichanallur, Tamil Nadu (*c.* 1000-500 BC), while metallurgical investigations on some of these by the author confirmed that they were of hot forged and quenched binary unleaded high-tin beta (23% tin) bronze (Srinivasan 1994, Srinivasan and Glover 1995, Srinivasan 2010). Such an alloy of copper and tin with around 23% tin can be forged greatly at high temperatures due to the presence of a high temperature plastic beta phase which when quenched gives additionally

Fig. 11: *Vessel from Nilgiri Cairns, Tamil Nadu, Government Museum, Chennai (early to mid 1st mill BCE)*

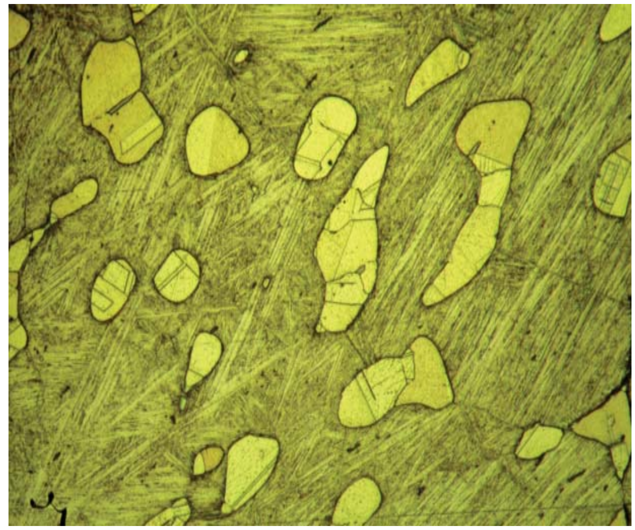

Fig. 12: *Micro-structure of vessel from Adichanallur, Government Museum, Chennai, hot forged/wrought and quenched high-tin beta bronze structure of 23.9 % tin bronze, 400 X*

properties of strength and lustre to the alloy. These extraordinarily thin-rimmed vessels were fabricated by extensively hammering out such an alloy between 586-798^0 C when a plastic beta intermetallic compound (Cu_5Sn) of equilibrium composition of 22.9% tin forms. This was followed by quenching which resulted in the retention of needle-like beta phase, as seen in the microstructure of a vessel from Adichanallur in figure 12, and which prevents the formation of brittle delta phase and also gives a golden polish. Low-tin bronzes have limited workability in comparison. Indian influences were also discerned in examples of high-tin bronze vessels found in Thailand in southeast Asia (Bennett and Glover 1992).

Such high-tin bronze vessels have continued to be used among the local communities of the Nilgiris such as the Todas. Such high-tin beta bronze vessels also show high corrosion resistance due to the retention of the beta intermetallic compound phase as also seen in the Nilgiri vessel in figure 11. The making of such high-tin bronze vessels by similar processes survived in many places till recently, such as in Kerala and in Nacharkoil in Tamil

Nadu. The author observed large vessels being made in parts of Kerala especially in Palghat district in the 1990s of 23% beta bronze, 25 cm in diameter and 1mm rim thickness, being wrought and hot forged from ingots of 15cm diameter and 1.5 cm thick followed by quenching. However this tradition has virtually died out today.

Although tin is scarce in India compared to other regions such as southeast Asia, it is possible that some minor local tin deposits were accessible in antiquity. Eastern India has tin deposits in the Hazaribagh region (Chakrabarti 1979, 1985-6), where Mallet observed the pre-industrial smelting of tin by local tribals in furnaces resembling shaft furnaces for iron smelting. Investigations by the author on slags from the ancient mining region of Kalyadi within Hassan district of Karnataka indicate that these are bronze smelting slags with up to 7% tin from co-smelting copper and tin ores due to the presence of metallic iron, rather than casting slags from alloying copper and tin (Srinivasan 1997), which might suggest the exploitation of minor local sources of tin.

The making of reflective mirrors of a composition of high-tin delta bronze is a rare artisanal tradition which survives in Aranmula in Kerala (figure 13). Studies by the author

Fig. 13: *Polished metal mirror blank at Aranmula (with reflection of Sharada Srinivasan)*

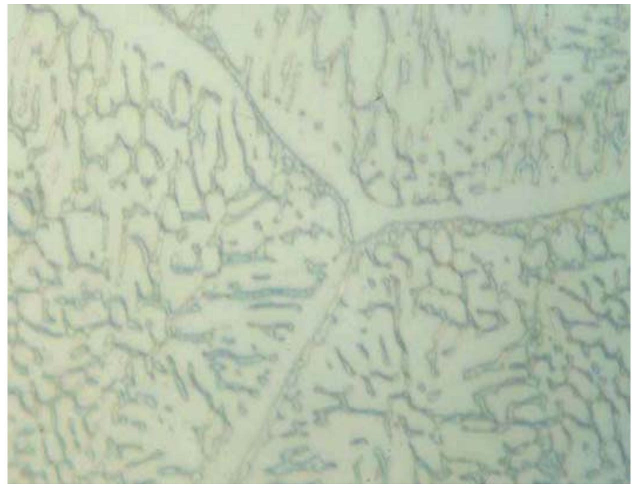

Fig. 14: *Micro-structure of Aranmula mirror of high-tin delta bronze (400X)*

have documented the making of unique highly reflective specular metal mirrors of a composition of around 32% delta tin bronze, optimising the presence of a hard, silvery and reflective alloy which can be highly polished to get the best mirror effect. Her studies showed that the specular intermetallic delta phase which formed in 33% high-tin bronze was skilfully optimised and exploited to make traditional mirrors in Aranmula as indicated in the micro-structure in figure 14. Using low-cost methods and organic materials, an innovative closed-crucible-cum mould casting process was used to cast the blank which was then skilfully polished to get the reflective mirror (figure 13). Its reflective properties can be compared very favourably with those of the glass mirrors that are manufactured in modern day factories with mercury coating. This ancient tradition with its technological and ritualistic significance is, however, greatly in decline. The traditional weddings of the Nairs included the ashtamangalyam comprising of eight auspicious articles that were to be part of the wedding trousseau the brides. These included the Aranmula mirror (valkannadi in Tamil and Malayalam) as reported even from the early 20th century by Thurston (1909).

Iron, steel and wootz steel

The Indian subcontinent has a vibrant iron and steel in antiquity. The celebrated Iron Pillar (figure 14) is renowned as the 'rustless wonder' for its relative corrosion resistance. It is about 7.375 m high and 41.6 m in diameter and is the earliest surviving massive iron forging. The Sanskrit inscription on the pillar of the late 4th century to early 5th century CE is attributed to the Gupta king Chandragupta II, alluding to the erection of a *dhwaja* or pillar by Chandra, as a devotee of the Hindu deity Vishnu, on the hill of Vishnupadagiri. A sample studied by Sir Robert Hadfield was found to be iron of high purity with about 0.1% phosphorus and 0.04% carbon (Hadfield 1912). The formation of a protective passive film on the surface and an amorphous oxyhydroxide layer next to the metal-rust surface of the phosphoric iron may have aided the corrosion resistance (Balasubramiam 2008). Ultrasound investigations suggested that the pillar was built up by forge-welding cakes of wrought iron in a perpendicular and radial fashion (IGCAR).

Fig. 15: *Delhi Iron Pillar, Gupta, 400 CE, upper portion*

India has also been famed for the legendary Indian wootz steel, or *ukku* in south Indian languages, a high-grade high-carbon steel, especially produced in southern India according to several European travelers' accounts from the about 16th to 17th centuries (Srinivasan 2016f). As indicated in accounts of 17th century traveler Tavernier, tens of thousands of shipments of wootz steel from sent from the kingdom of Golconda (in modern Telangana) to Persia and West Asia to make the fabled Damascus blades. The Damascus steel blade, believed to have been forged of Indian wootz steel of a high carbon content of 1.5-2%, was reputed for its cutting edge (Smith 1982, Srinivasan 1994, Srinivasan and Ranganathan 2014). The attempts to characterize wootz by scientists of the caliber of Michael Faraday spurred many developments in 19th century metallurgy and contributing to the Industrial Revolution. Vast amounts of archaeometallurgical debris related to the production of wootz steel are still found in the region of northern Telangana. Wootz steel production sites with crucible debris were also uncovered in the region of Mel-siruvalur (figure 16) and Tiruvannamalai in Tamil Nadu by the author (Srinivasan 2016f, Srinivasan 2007).

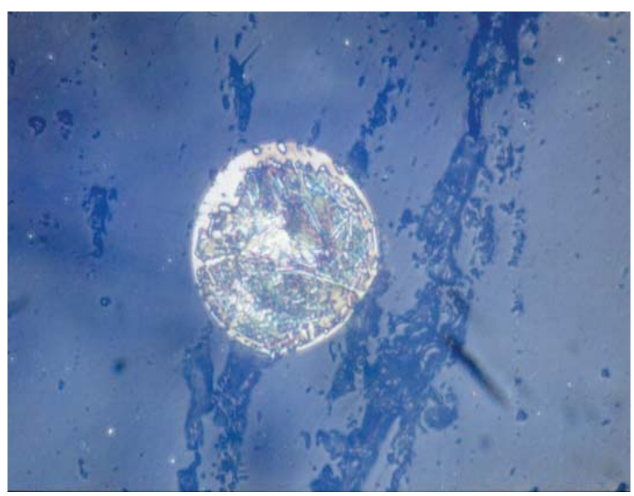

Fig. 16: *Micro-structure of wootz steel making crucible debris from Mel-siruvalur showing remnants of ultra-high carbon steel (400X)*

As far as the archaeological evidence is concerned, three specimens of ferrous blades had high carbon contents of 1.2-1.7% C of the composition of wootz steel from the Bhir mound of Taxila (*c.* 3rd century BCE (Marshall 1951: 534). Greek alchemist Zosimos in the 3rd *c*, AD mentioned that the Indians made steel for sword by melting soft iron in crucibles recalling to the wootz process Srinivasan (2016f). Kadebakele is an Iron Age site near the World Heritage site of Hampi in Karnataka. A small iron ring (acc. no. 900, 22E-28 N, Level 7) radiocarbon dated to 800-440 BCE yielded a through pearlitic structure of at least 08% carbon steel, suggesting it could have been cast steel produced from crucible processes (Srinivasan *et al.* 2009).

Excavations at an iron age megalithic site at Kodumanal, Tamil Nadu (3rd *c.* BCE), near Karur, the Chera capital of the Sangam era (3rd *c.* BCE-3rd *c.* AD) revealed furnaces with vitrified crucibles (figure 17) and iron slag (Rajan 1990). A vitrified crucible fragment from Kodumanal showed ferrous metal processing remains (Srinivasan and Griffiths 1997, Srinivasan 2007). Figure 18 is an elemental distribution map of a crucible fragment from Kodumanal, examined using EPMA-WDS by the author which shows the presence of ferrous remnants. The bardic poems of the Sangam Tamil poetess (3rd *c.* BCE-3rd *c.* AD evoke warring chieftains and their spears (*ekku*).

Fig. 17: *Crucible and tuyere fragments, Kodumanal, 3rd century BCE*

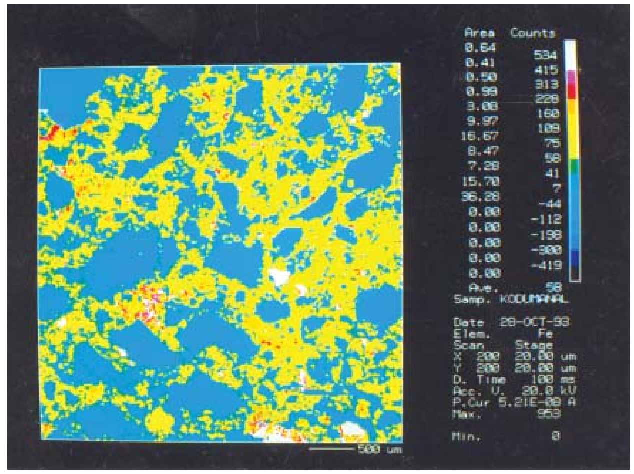

Fig. 18: *Elemental distribution map by EPMA-WDS on cross-section of crucible from Kodumanal, 3rd century BCE, Tamil Nadu*

Ukku may derive from the Sangam Tamil word *uruku*, meaning boiling over. The Sanskrit Arthasasthra (3rd *c.* BCE) refers to *vaikruntaka* which might possible allude to steel. Pliny's 'Natural History' mentions the import into the Roman world of iron from the 'Seres', which might be identified with the ancient Southern Indian kingdom of the Cheras. Roman accounts of the 'Periplus of the Erythrean Sea' refer to the flourishing port of Muziris or Muciri on the Malabar coast. Interestingly, an iron nail from Pattanam, identified with the Muziris revealed a microstructure typically associated with ultra-high carbon wootz steel containing about 1.5% C (Srinivasan 2007).

Early production of metallic zinc

The earliest firm evidence for pre-industrial extraction of metallic zinc seems to comes from India. Zinc is one of the most difficult of metals to isolate since zinc metal oxidizes and volatalises readily around the same temperature of about 1000°C as is needed to smelt zinc ore. Hence it forms as a vapour in the furnace which would immediately get re-oxidised. Therefore finds of metallic zinc are not very common from early antiquity.

There is remarkable evidence for the semi-industrial extraction of metallic zinc by the 12th century CE from the Zawar area of Rajasthan (Craddock et. al. 1998). Zinc was smelted by downward distillation of the zinc vapour formed after the reduction of zinc ore. The *Rasaratnakara,* a Sanskrit text ascribed to the great Indian scientist Nagarjuna, of the early Christian era describes the process of downward distillation or *tiryakpatana* (ibid.) Using retorts with condensers and specially designed perforated furnaces, the zinc vapour could be drastically cooled down to about 500^0 to collect at the bottom of the furnace to get a melt that could solidify into zinc metal. Remnants of perforated furnaces with zinc smelting retorts have been found from Zawar, whereby more than 30 retorts seen to have been packed in each furnace (Craddock *et al.* 1998, Craddock *et al.* 2017). The remains suggest that production of Zawar was almost on semi-industrial scale in an era preceding the Industrial Revolution and continued on a large scale during the Moghul era until the 17th century. A sample with 34% zinc was excavated from the Buddhist site of Taxila (ca 4th *c.* BC) or Takshashila, now in Pakistan (Marshall 1951) which may have been made by alloying metallic zinc.

The remarkable artistic innovation of Bidri ware (figure 17), inspired by Persian inlaying traditions, developed under the late medieval Muslim Sultanate rulers of the Bidar region of Karnakata. The use of metallic zinc was made to make highly elegant metalware, of a patinated high-zinc alloy with 2-10% copper inlayed in silver (La Niece 2015), which was used to make hukka bases, ewers and other artefacts. The Bidri ware sample in figure 19 investigated by surface XRF analysis by the author had 90% zinc and 6% copper.

A metallic zinc ingot with a reported Deccan Brahmi inscription was studied by the author using lead isotope ratio finger-printing and was found to fit a 5th *c.* AD attribution from the Andhra region (Srinivasan 1998, 2016a). The shape of the ingot/coin was also interesting akin to a solidified globular droplet with a flat bottom as it could have been collected at the bottom of the furnace by downward distillation. One of the important polymetallic deposits in southern India is in Agnigundala, Andhra Pradesh which lead isotope ratio studies by the author indicated was exploited at least by the early historic Satavahana period (Srinivasan 1996, 1999b, 2016b). Figure 20 is a view of one of the old copper mine workings.

Fig 19: *Bidriware vessel of zinc alloy of Persian influence*

Fig 20: *Agnigundala, Andhra Pradesh, old copper mine workings (Sharada Srinivasan visit of 1991)*

In Europe, commercial zinc smelting operations were established by William Champion in Bristol in Britain in the 1740’s using downward distillation suggesting its inspiration from the Zawar process (Craddock et. al. 1989). Thus Indian metallurgists can justifiably be regarded as inventors of the process of zinc smelting.

Archaeometallurgy and Conservation Science: Challenges and Scope

In the Indian context there are several challenges in developing the fledgeling area of archaeometallurgy. Sadly, many of the surviving crafts traditions linked to ageold practices are rapidly declining with livelihoods increasingly marginalised. Several of the archaeometallurgical production sites and old mining areas are also disrupted by infrastructure development, agriculture and so on, so that the records of these activities are rapidly being effaced. Concerted action is needed to retrieve what is left of the remnants of a rich pre-industrial legacy. The area of conservation research is also one that needs more impetus in terms of scientific research. Even though the Delhi Iron Pillar, has been hailed as the rustless wonder, a closer look (figure 15) suggests that in recent times rust has perhaps indeed been forming perhaps exacerbated by industrial pollution and other factors. Thus there is a need for working concertedly for the scientific documentation and preservation of artefacts and materials heritage.

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Conservation is About People

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Introduction

When asked by INTACH to deliver an online lecture, I decided to discuss this subject because it is broad and appeals to all conservation sectors. Of course being a book and paper conservator, I will discuss projects related to my area of specialisation.

Before getting into the treatment of the six projects discussed in this essay, it would be appropriate to present the reasons why we treat objects and what conservation means to people. I tried to view conservation through the eyes of a keeper or owner of an object because the significance of ownership is completely different to that of a conservator who remains detached from the object's worth (emotional worth). From my work and experience in book and paper conservation I have reached the conclusion that conservation is about people and this is because objects are conserved for what they are valued by people, and for the effect they have on them.

This essay has been inspired from having read and reread, the book by Salvador Muñoz Viñas entitled 'Contemporary Theory of Conservation.'[1] It has the most readable text, is very comprehensible, and addresses conservation issues and classical theories of conservation with much clarity. It also makes excellent arguments about truth, objectivity, conservation ethics and common sense. In 2013 I had attended a Summer School in Rome organised by ICCROM and for the two weeks Salvador Muñoz Viñas formed part of the lecturing team. I was fortunate to follow his lectures, discuss issues outside the classroom and also become good friends with him. There are some points in this presentation that are in fact inspired from his lectures which have triggered much thought on the projects I was working on or had worked on already.

This essay is divided into two parts: the first discusses what it means to preserve works of art. The questions that come to mind are: How much do we clean? What do we clean? And for whom do we treat works of art? Other related issues concern damage and its assessment as well the meaning and effects of patina on an object.

In the second part of this essay I discuss how the role of the conservator changes in different cultures and contexts depending on the expectations of people. Through the projects I have worked on in different countries, I will explain how I have had to make a range of conservation decisions that have depended largely on the choices of people within the cultural context I was working in.

1 Salvador Muñoz Viñas, Contemporary Theory of Conservation, Oxford: Elsevier – Butterworth Heinemann, 2005.

PART ONE

The Oxford English Dictionary defines conservation as 'to keep in safety, or from harm, decay, or loss; to preserve with care'. It further states 'now usually to preserve in its existing state from destruction or change'. The use of the words 'now usually' evoke a sense of change in definition from what it meant before.

Conservation is not just about practice, it is also a concept and an attitude. It is about choices and therefore involves much thought. Decisions as to what to treat, how to treat, and whom to involve in conservation treatment, are rooted in the relationship conservators perceive between the object and its social context.

Conservation is a complex and continual process that involves determining what heritage is, how it is cared for, how it is used, by whom, and for whom. Conservation is not only concerned with definitions of best practice (Florentine or Roman, Anglo-Saxon or European, American or Japanese etc), but also in assessing the application of new approaches to changing situations. Conservation is not merely a process where damage is arrested from further decay but also a process of understanding and managing change, or sometimes the lack of it.

There are three reasons why we treat artworks: for individuals (private owners, collectors, those who have inherited something sentimental that has meaning), for institutions (museums, churches, universities including exhibitions for educational purposes), and for posterity (we feel responsible citizens to share what we have with future generations).

Conservators are normally contacted for one reason – damage. Damage is a crucial notion in conservation. It is a prerequisite for conservation itself to even exist. If no actual or potential damage existed, no conservation act would ever be performed.

Conservation should attempt to preserve or restore the true nature of objects. This is considered to be the most important principle which is common to all classical theories of conservation. In understanding damage and dirt a number of questions are raised as to whether the true nature of an object depends only on its material integrity. Are we only concerned with what it is made of and how it is damaged? Are we alarmed by the extent of the material damage? What about the meaning of the object? What does it represent? Why was it made? What is its story? At which stage in an object’s life are we conserving it?

Decisions about cleaning (or not cleaning) are influenced by what is considered meaningful. And of course this refers to its meaning to people and their understanding and expectations of a work of art. Albert France-Lanord states ‘we can see how much the choice of working methods is determined by essentially human considerations.’[2]

The question that always arises is: which imprints of the history of an object should be retained? As conservators we always wonder which layer should be cleaned or which binding layer should be saved or which varnish layer should be removed. In making these decisions we are also deciding which imprints of the history of an object should be sacrificed.

Damage may be caused by a number of factors namely chemical, physical or biological factors such as mould growth, insect damage, corrosion, humidity. It can also be created through natural disasters such as earthquakes and floods as well as human disasters – war, accidents, vandalism, carelessness, negligence and mishandling.[3]

Linked to the extent of damage is the notion of patina. Patina is a form of non-deliberate damage. It can be called ‘alteration’ rather than damage *per se*. Patina may create technical change: where material and textural changes occur on the surface of an object, and or axiological change: where there is a superficial change that increases the value of the object.

Patina is the kind of alteration which is unwanted yet it adds to the value of an object. Patina does not seem to have negative connotations, even though it may cause damage.[4]

Paul Philippot in his chapter on patina and its effects on paintings states that ‘the veil that an ancient varnish carries will generally be quite valuable when there is a question of offsetting heightened contrasts of balancing worn areas with those that are intact, yet cleaning can usually be taken much further when alteration due to patina is minimal. In this case, however, one must also take into account the fact that radical exposure of the original pictorial layer almost always accentuates its materiality to the detriment of the image, and that bestowing a new appearance on an ancient object can create discord within the work of art that is a kind of falsification. It emphasizes the material to the detriment of form, and indicates the predominance of a hygienic interest in the object over an aesthetic interest in the image.’[5]

2 Albert France-Lanord, ‘The emergency of Modern Contemporary Theory’ in Historical and Philosophical Issues in the Conservation of Cultural Heritage, ed. Stanley Price Nicholas, M. Kirby Talley JR. and Alessandra Melucco Vaccaro, The Getty Conservation Institute, Los Angeles, 247.

3 See Chapter 4, Les facteurs externs de l’altération du papier, in De Tutela Librorum, La Conservation des libres et des Documents d’Archives, Andrea Giovannini, verlag für Kultur und Geschischte, Baden, 2010.

4 See Salvador Muñoz Viñas, Contemporary Theory of Conservation,101-102.

5 Paul Philippot ‘The Idea of Patina and the Cleaning of Paintings’ in Historical and Philosophical Issues in the Conservation of Cultural Heritage, ed. Stanley Price Nicholas, M. Kirby Talley JR. and Alessandra Melucco Vaccaro, The Getty Conservation Institute, Los Angeles, 375.

Apart from improving and or stabilizing the condition of an object, conservation also contributes to its value. The difference is that conservation is a deliberate alteration because it involves making decisions and choices, while patina is not. It simply is there on exposure over time.

Patina and conservation are the alterations that normally increase the value of an object. But the reverse may occur where the alternations that occur with patina and conservation may reduce the value of an object. For example if treatment is not carried out by professionals or using inferior quality materials, or if the patina is causing more than just superficial damage, then this would certainly reduce the value of an object.

While decay and disaster are the alternations that reduce the value of an object, on the other hand, decay and disaster can also provide an alteration that increases the value of an object if for example through an extreme state of deterioration there is an increase in the aesthetic appreciation of an artwork. This may occur where the damage becomes so fascinating that it adds to the visual qualities and historicity of an object.[6]

PART TWO

This section discuss six conservation projects I have been involved in. The works of art illustrated here vary from ancient to 20 century art. As conservators, our specialization is divided according to materials so anything made of paper, parchment or leather would fall within the remit of a book and paper conservator, irrespective of date. The range of objects is enormous and commonly include manuscripts, printed books, maps, drawings, prints and watercolours. But there are more rare artefacts that one comes across such as playing cards, posters, globes, hand held fans, paper sculptures, wall paper, folding screens and even paper money.

The artefacts discussed are not presented in chronological order. The number of years is not relevant to the discourse of this paper which is the reason why I shall be leaping back and forth between book and paper projects of different periods. The projects are in fact as diverse as can be. The main message I want to come across with is that objects are conserved because they are valued for the effect they have on people and decisions that are made for their treatment depend precisely on that.

Project 1 – A Coloured Lithograph

I start by discussing an object I worked on in Malta some years back. It is a coloured lithograph depicting Our Lady of Sorrows – the Virgin Mary who was in deep sorrow as she was experiencing the passion of her son Jesus Christ. This lithograph has suffered quite extensively (Figure 1). Firstly it has been given a black boarder around the figure of the Virgin

Fig. 1: *Detail of the lithography showing insect damage, stains and aluminium foil stars*

6 Parallel Existences, The Notarial Archives A Photographer's Inspiration – Alex Attard, eds. Joan Abela and Emanuel Buttigieg, Kite Group, Malta, 2018 and The Fragment – An Incomplete History, ed. William Tronzo, Getty Research Institute, Los Angeles, 2009.

Mary, presumably to cover up some previous damage; it has suffered damage from silverfish, it has large water stains to the left, and to top it all someone had added silver starts using cooking aluminium foil at a later stage. Owned by a couple in their seventies, I was told that they wanted it to 'look good' because it had great sentimental value and had also been passed down to them in the family for a couple of generations or so. I knew the image could be enhanced with basic cleaning and retouching techniques but to what extent was I supposed to treat it?

My major concern were the stars. The owners wanted new stars, and not only did they want them new, they wanted them made of solid silver and for them to be three dimensional. I was at a loss how to go about this. The owners argued that that's how they always knew the print and there was no way the appearance would be changed.

The work was very interventive and a great deal of retouching was required especially after the black colour in the background was removed. The removal of the colour incidentally revealed the names of the artist and printer which means that in cleaning, I was able to discover new information about the object (Figures 2 and 3).

As for the dilemma about the stars, new silver stars were ordered. Upon ordering them I ensured that they would be hollow on the inside and light weight as much as possible. I also ensured that in pinning them to the artwork their very weight would not damage or cut through the paper. Special supports beneath each star were inserted to act as a cushion on the recto and verso of the print. The print was then mounted and framed and later delivered to the client (Figure 4). The client had tears in her eyes with joy. Until that moment I had never imagined that a treated work of art could have such an effect on its owner.

Fig. 2: *Detail after cleaning showing the names of the artist and lithographer*

Fig. 3: *Detail of the face of the Virgin before and after treatment*

Fig. 4: *'Our Lady of Sorrows' lithography before and after treatment*

What is the conclusion about this artwork? As a conservator offering a service to others, I was compelled to follow the client's instructions on how to treat this artwork. Although the print was surface cleaned, a certain amount of patina was also retained. Of course I ensured that conservation grade materials were used throughout and that treatments were reversible as much as possible but ultimately conservation is about people and it was the owner's decision that I had to follow. The end result was ultimately a balanced one and was to the satisfaction and reward of both the client and myself.

Project 2 – A Printed Antiphonal

This project took place while in Switzerland and the book in question forms part of the music library collection of the Benedictine Abbey of St Andrew in Sarnen, near Luzern.[7] The abbey was flooded in August 2005 leaving the library underwater for 72 hours.[8] One of the books I was working on was a printed antiphonal dating 1757 (Figure 5). As seen in the images the binding was covered in mud from the flood, the leather was distorted and the front board and cover were missing (Figure 6). In spite of the severe damage, the nuns in the abbey decided that basic treatment would be sufficient. Owing to the large number of books that had to be treated because of the flood, funds were tight and only 15 hours were allotted to repair this particular volume. Furthermore, another two exact examples of this printed book form part of their collection, therefore treating this book was not considered top priority given the urgency of the flood material that needed to be dealt with.

The text was superficially cleaned, tears and losses were fixed, the spine was reinforced and reshaped and the leather cleaned from mud deposits. A protective cover made from acid free board was used instead of a full leather cover (Figure 7).

Fig. 5: *Printed antiphonal, 1757, showing the leaver cover before and after cleaning*

7 This project was carried out in the studio of my former employer Maya Stein in Zurich, Switzerland.

8 https://rism.digital/rism-ch/cataloging/sarnen.html [Accessed 30 January 2021).

Fig. 6: *The anitphonal showing distortions in the spine and the front board and cover that are missing*

Fig. 7: *The missing cover was replaced with a protective manila board instead of leather*

Conclusion: minimal treatment was required to fulfil our client's request. The binding would have looked more attractive had it had a full leather cover but we had no budget and therefore no time to do this. Our decision for minimal treatment was ultimately based on what the monastery required. It was also based on the purpose and use that this book has within the context of a monastic collection, where another two copies already exist.

Project 3 – Cyril Power's linocuts

This third project belonged to a private collector.[9] It involved work on three linocut prints by Cyril Power who was a British futurist artist who was active in the 1930s. He is famous for capturing sport events such as rowers, runners and ice skaters. Cyril Power's works of art fetch a great deal of money. After doing some research on these prints, I discovered that they were fetching around 20-30,000 Euro each at auction.[10] Since the client wanted to sell them, that meant of course that he was planning on making a profit and that treatment had to be 'invisible'.

At first glance they did not appear to be damaged but upon close inspection it was clear that there was extensive damage from old repairs (Figure 8). These repairs were carried

Fig. 8: *Detail of linocut by Cyril Power showing old repairs using red adhesive tape*

Fig. 9: *Details of linocut showing irregularities and planar distortions from the incorrect mounting methods used in the past*

out using a kind of shiny red tape that almost looks like duct tape which left a white adhesive deposit on the surface of the paper. Owing to the very fragile nature of their thin material, the prints had pulls and irregularities which were caused by the tension created from the old adhesive during mounting that was far stronger than it should have been resulting to planar distortions and undulations (Figure 9).

Utmost care was taken to conserve Cyril Power's prints not only because of their worth in terms of artistic and monetary value but also because of their fragile and delicate nature. The removal of creases and cockling was carried out by applying a very light mist of water which

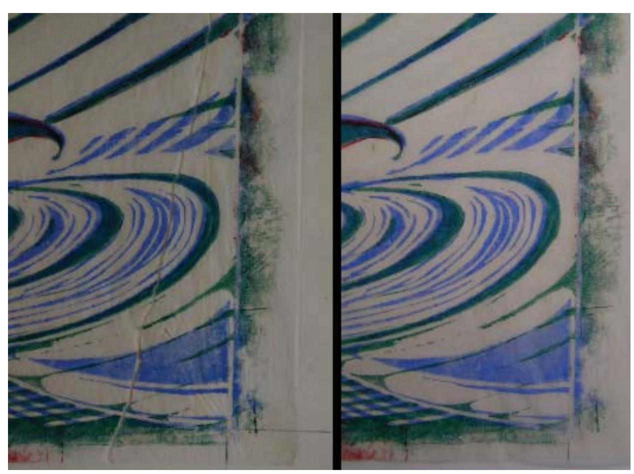

Fig. 10: *Showing details of paper repairs before and after treatment*

9 Treatment was carried out while I worked for Museum Conservation Services in Duxford, Cambridge, United Kingdom.

10 https://www.bonhams.com/auctions/25438/lot/89/ [Accessed 30 January 2021].

Fig. 11: Detail showing the smoothening out and flattening of distorted areas

Fig. 12: Monastery of St Catherine on Mount Sinai, Egypt

was then flattened with a large heated spatula. Paper repairs were effected with very fine Japanese tissue in minute pieces using tweezers so that the joins were almost impossible to detect (Figures 10 and 11).

Conclusion about this project: My treatments not only had to be reversible and up to conservation standards (which is a given), they also had to be perfect and completely invisible. The conservation treatment on such a valuable set of prints now means that the prints are worth more than before. Alteration here has meant increase in value.

Project 4 – The Monastery of St Catherine, Mount Sinai, Eygpt

This project concerns the survey and storage of the collection of manuscripts and early printed books in the Monastery of St Catherine (Figure 12). My work at the monastery involved surveying the collection together with a team of conservators through the Ligatus Research Centre of the University of the Arts London.[11] Being a Greek Orthodox monastery, it was rather difficult for the monks to accept the idea that women would be working on a daily basis in their library. The first few rounds of conservators who worked there were Greek men, eventually they accepted men who were not Greek. After some time, they began to run out of male conservators so they inevitably had to revert to women!

Greek women first of course, and finally came those in the fourth division, like myself, who are not Greek!

The regulations for working in such an austere monastery are quite rigid. For women it meant that you wore only loose clothing, no arms or neck or legs or feet could be revealed in any way. No make-up, no perfume, no jewellery. The men would sleep within the monastery walls, but women would sleep in a little guest house normally reserved for Greek Orthodox nuns visiting the monastery on pilgrimage. Working times for us in the library had to conform to the monastic duties of the fathers.

The St Catherine's project has involved a survey of all its manuscripts and early printed books. This project had been on-going through the St Catherine's Foundation and the University of the Arts in London for a number of years with intermittent periods because of the political instability in Egypt. A total of 3,306

11 This project was lead by Professor Nicholas Pickwoad. For more information see: https://www.ligatus.org.uk/stcatherines/ [Accessed 30 January 2021].

Fig. 13: A typcially beautiful Byzantine illuminated manuscript from the St Catherine collection which will be boxed

books were surveyed to assess their codicology and condition. About 10% of the collection (310 volumes) will not be treated whatsoever because of their uniqueness (Figure 13). And precisely because they are so unique, a decision has been made for them not be touched but to be boxed for protection.

The criteria for boxing the manuscripts include the rarest manuscripts that includes all those written on parchment which amount to about to 10% of the collection. Furthermore it includes all manuscripts bound in Byzantine or Greek style bindings and other manuscripts of particular importance which are vulnerable without protection and need to be shelved horizontally.

The protective box is made from stainless steel.[12] The corner seams are welded by hand and electro polished. The finish obtained by this process is highly impressive. The box is designed with a fitted handle to offer a clean uncluttered appearance when shelved. The base tray and lid of the box are made the same height, so that it opens fully to 180° and no further, and when open, the entire box lies on a flat surface without the risk of tipping. The books are placed in the boxes with their spines against the side opposite to the handle, so that when the box is carried by the handle, the weight of the book is taken on the spine without creating damage to the book. This allows the boxes to be carried vertically in one hand when in transit from shelf to desk and back. The handle is also designed to bear the shelfmark of the manuscript and other information as required.

The box is designed to provide chemical stability, impact and crush resistance, durability, fire protection, water resistance and insect resistance. The inside of the boxes is lined with Plastazote. Acid-free millboard is placed between the Plasazote and the steel walls of the box to provide effective short-term heat insulation in the event of a fire. The gap between the trays is sealed against dust with silicone which will be specially manufactured for this purpose. Furthermore the manuscripts are given custom-made internal wrappers made of acid-free card which are designed around the shape of the metal fittings of the bindings.[13] Essentially, the thought behind the design of this box is phenomenal.

The conclusion is: when manuscripts are of extreme value, they are put on another level completely. They become untouchable objects, almost sacred. Why? Because here we are dealing with the Monastery of St Catherine on Mount Sinai and the standing it has as the oldest library in the world with an incredibly rich collection of volumes. Out of fear of losing any form of historic evidence that these books may provide, the value and meaning of this collection as a UNESCO world Heritage site,

12 See https://stories.worldsteel.org/innovation/stainless-steel-cases-safeguard-ancient-manuscripts/, [Accessed 1 February 2021].

13 See https://www.ligatus.org.uk/stcatherines/node/7, [Accessed 1 February, 2021] and Velios A, Pickwood N and Honey A. Manuscript Boxing: a Technique for Objective Spatial Arrangement’ in Journal of Paper Conservation, Vol.12, Issue 4, 16-25.

is given a different dimension that goes beyond any conservation treatment.

Project 5 – Working on Manuscripts in Mekele, the Tigrey Region, Ethiopia

The following example is probably on the other end of the spectrum from that of the Monastery of St Catherine. That's not because the manuscripts are not as precious. Far from it. But in an environment where religious texts are used on a regular basis in their churches, the manuscripts we were working on in Mekele had a different meaning and function for their owners.

This project was headed by the Hiob Ludolf Centre for Ethiopian Studies, University of Hamburg by a team of scholars having different backgrounds, mainly linguists, philologists, historians and conservators.[14]

In a strongly Christian environment, Ethiopia has a long-standing tradition for the production of religious texts. While visiting some rock-cut churches in the countryside we were invited to see some manuscripts kept in a library that is composed of one room. Inside the library there are a total of about 20 manuscripts: some stored in their leather satchels and others stored in a wooden chest and cupboard or simply covered in cloth.

Their manuscripts are rather heavy and large in format. They are all made of parchment (Figure 14). There are no manuscripts made of paper. Paper only came into Ethiopia with the introduction of printing which was as late as the 19th century when the first missionaries began to settle there. Besides to produce paper you would need fresh water which is quite difficult in a country which has always suffered from great drought. On the other hand farming has always been one of the main activities in Ethiopia which means that animal skins have always been available to be turned into parchment as a material for writing.

Fig. 14: *Ethopian manuscript, Tigray region*

We were totally in awe at what we saw and were able to handle while visiting this library. And what is even more amazing is that these manuscripts from the 16th and 17th century, are used for the liturgy on most Sundays in their churches. People handle these volumes, they touch them in veneration, kiss the faces of saints and holy figures, they hold them and carry them around in procession. And precisely because they are prestigious, they are considered more worthy of use in their eyes.

These Ethiopian liturgical manuscripts are objects of everyday use. As a consequence they also get worn and repaired quite often by members of the local communities (Figure 15).

The manuscript we were working on was a hagiographical text containing The Acts of Martyrs and forms part of the collection of the Monastery of Ura Masqal. It is written in Gez which is old Amharic and dates to the 15th century. The major problem with this manuscript is that it was attacked by rodents and has large areas of parchment missing. A great deal of the sewing was also lost leading

14 Ethio-SPaRe: Cultural Heritage of Christian Ethiopia – Salvation, Preservation, and Research, funded by the European Research Council under the 7th Research Framework Programme IDEAS (Independent Researcher Starting Grant 240720, December 2009 – May 2015).

Fig. 15: *Ethopian liturgical manuscript showing several repairs made by its owner*

to detached leaves. The leaves also have several undulations which make it even more difficult to carry out repairs as it is very awkward and complex to flatten them.

Very oddly Ethiopic manuscripts do not have folio numbers. This means that the sequence of putting together a dismantled volume can only be done if one can read the text. We therefore had a team of philologists working with us who could read Amharic and make sense of the text and help us put the correct leaves together for repair. At one point we needed to look at the skins using transmitted light to see if the blood vessel patterns in the skin matched together. The only light source available was the use of natural light by placing the manuscript leaves up against the window panes. This worked perfectly well considering we had no equipment to do otherwise.

There are no conservation laboratories in the Tigray region so we had to create a working space for the time we were there. We were given a room in the Ministry of Tourism in Mekele on the seventh floor which was not ideal but with some planning in advance we managed to work well enough. Compromise, creativity and spontaneity were the order of the day.

To be able to flatten the undulations in the parchment, we required a humidification chamber to moisten the leaves. So we called in a local carpenter. We had four pieces of wood cut for us, covered them with a large piece of plastic sheeting, inserted a hygrometer to regulate the humidity levels and there goes the cheapest humidification chamber one can think of!

Throughout the time we were working there we also had full time supervision from the owner of the manuscripts – a lovely priest in his seventies or so who travelled several kilometres every week to come and stay with us. He spoke no English. Us conservators on the other hand, spoke no Amharic so it was all about smiles, shaking of hands and the crossing his hands across his chest in gratitude as the work progressed.

Being in Ethiopia was a learning experience about working with people and for people. The urgency to get the manuscript ready for the people to use was imminent. The manuscript needed to be functional again. It needed to be handled, carried in the church, leafed through and ultimately prayed from. Museums, showcases and specially monitored storage systems do not form part of the cultural set-up because they are unnecessary in this context. Furthermore, this manuscript is meant for use by the faithful. The purpose of this manuscript here is one: for the local community and for the meaning it has to the people who use it.

Project 6 – The Cantilena

My project examples started with Malta, and shall end with Malta. For these last 7 years I have been working at the Notarial Archives in Valletta. It houses a fascinating collection, a wonderful team of people and a number of challenging issues to cope with. One of the projects we have been working on involves sorting out unidentified and heavily damaged material that has been stored away for decades. The job involves superficial cleaning, identifying the notary and date, creating a protective wrapper or folder for the documents, and boxing them all systematically.

We are having to deal with a large amount of World War II damage, mostly heavily bombed material with some that still have bits of schrapnel amongst the leaves. In one instance a manuscript has been sliced through and cut in half with the impact of the blast. The question that arises is "if one were to find the other half of the manuscript, would one restore it?" isn't this part of its history and its biography? Should it be altered? Would you piece it together and make it whole again? Objects change over time in their material form and in their conceptual form. Decisions about cleaning (or not cleaning), or repairing (and not repairing) are choices that are influenced by what is considered meaningful.

But the Notarial Archives does not only have fragments and fragmented volumes. Amongst its most important documents is a manuscript that contains the oldest poem written in Maltese that predates 1480. The poem is known as the Cantilena and was discovered in 1966 by two scholars (Figure 16).

The Cantilena is written on just one leaf of this manuscript. The entire manuscript contains 280 leaves which contain legal contracts that are written in Latin. The manuscript was not in the best of shape before it was treated. It had a broken spine, acidic boards that were affecting the leaves, several tears and breakages in the paper, ink degradation and several losses. Thankfully the folio on which the Cantilena was written is in good condition. The leaves were repaired and the text resewn. Furthermore a new conservation grade binding and a protective box were made.[15]

But the whole point of mentioning this project is that because of this one single leaf and its precious text, the remaining 280 leaves had to be treated with the utmost attention and care in the interest of safeguarding that very one special leaf that belongs to it. We do not only do this for the scholars of tomorrow but for all those who are simply responsible to protect and appreciate all that is part of Maltese identity and history. This is a case in point where conservation increases the value of an object because it is done for people.

The aim of my talk has been to stimulate ideas, broaden horizons and question why we make decisions. Raising awareness of the importance of works of art is important not only in order to inspire the present generation to look at them in a wider way, but also to encourage the development of a groundwork of cultural values against taking wrong decisions in the future.

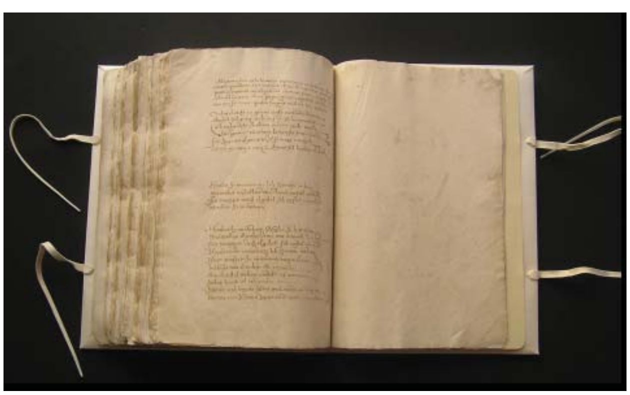

Fig. 16: *'The Cantilena' – the oldest poem written in Maltese, The Notarial Archives, Valletta, Malta*

Conclusion

I conclude by presenting a work of art by a contemporary Italian artist, Pietro Ruffo which was on display in 2013 at the Museum of Contemporary Art in Rome. This artwork entitled 'Youth of the Hills' is a construction of a World War II German panzer reproduced

15 See Zammit Lupi, Theresa, 'Codicological Analysis and Conservation Treatment of the Cantilena manuscript' in Journal of Maltese Studies, 2014, 91-118.

Fig. 17: *Detail of 'Youth of the Hills' by Pietro Ruffo, on display in July 2013 at the Museum of Contemporary Art Rome*

to scale (Figure 17). It strongly expresses the contradiction that one breathes in the territories of the Middle East conflict. The panzer is covered in beetles that are carved on the pages of the Jewish Torah. Attention has been given not to destroy the integrity of the text which is considerd sacred in Jewish culture. The beetles emerge from the work as if they were released from the sand, their natural habitat. The beetle is a symbol of strong religious affiliation of the people because of the dramatic territorial dispute. It is a tremendously powerful work of art – socially, religiously and politically.[16] Objects matter because they are powerful visual metaphors that can bypass language and this panzer is truly a case in point.

I visited this museum with a group of friends, all conservators. We thought for a moment that if this artwork were to be damaged, this would be a proper nightmare for any paper conservator. It would not only be a technical challenge but would also be a conceptual and ethical challenge as it is immensely thought-provoking. Where does one begin? What would be the extent of treatment when the sacred text is such a delicate issue? Should it be treated or should it be left as it is and left to decay as part of its history? What was the artist's intention? And should the artist's intention matter now that the work is completed? As a group of practising conservators we had a lively discussion together.

Value is socially determined: an object can only have value insofar as people give it value. Conservation is about refreshing and renewing culture and heritage in ways that reflect and contribute to society's values, thereby making a statement about value to others, and a statement about the present to the future.

I conclude with two human values which I feel are essential for us all, more so for practicing conservators: humility and prudence. Humility to negotiate, discuss and lead to treatments only by way of keeping our values central. Prudence by way of using treatments that reversible, using materials that are scientifically tested, being respectable towards others and intervening as least as possible. This reflects and allows for a future where 'viewers may have aesthetic preferences or scientific needs that might differ from ours.[17]

16 See http://www.pietroruffo.com/works/beetles_flags/, and http://www.almostcurators.org/en/lui-chi-e-pietro-ruffo/, Accessed 2 February 2021.

17 Muñoz Viñas Salvador, On the Ethics of Cultural Heritage Conservation, Archetype Publications Limited, London, 2020, 44.

Barbara Beckett
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26 August 2020

The Value of Maintenance –
The Important Role of Regular Maintenance in the Conservation Process

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The title, The Value of Maintenance,[1] borrowed from a research publication from Historic England, summarizes the various aspects of regular maintenance, which will be disclosed in this article:

> The Value of Maintenance for the historic objects and sites and the Value of Maintenance in the Conservation Process and consequently for the community.

Everyone, from the expert conservation community to the general public would agree that regular maintenance is important. In general, if we value and care about something, someone then we look after it as circumstances allow, thereby prolonging the life.

1 https://historicengland.org.uk/advice/caring-for-heritage/places-of-worship/maintenance/

So why, despite a common agreement about the importance of regular maintenance, is it so difficult to implement it in our conservation-restoration projects and obtain funding for it?

The examples and case studies to illustrate the topic are taken from over thirty years working in heritage conservation in field work, teaching, research and as an employee of national offices for the care of monuments.

The observations and case studies are taken from a variety of locations – Europe, Asia, Africa and illustrates the topic is global. The wide timeframe indicates that this common lack of maintenance is not a new task; we need to finally address and implement! It is important that the following is not intended to assign blame or see failures – the examples, case studies are just to illustrate that examples are everywhere around us and the need for improvements is universal.

This paper on the presentation is part of a series of online talks organised by INTACH; examining conservation topics from all over the world covering a wide range of materials, objects, sites and challenges. Most of the talks imply the importance and unfortunate lack of regular maintenance.

This short article does not claim to cover the vast topic of maintenance comprehensively. Nevertheless, the aim is to remind us of the importance of maintenance and will demonstrate that there is a change for the future to advocate maintenance to a wider professional and lay audience. The topic is included in various current discussions and global challenges from sustainable protection of cultural and natural heritage, reducing the carbon footprint, responding to climate change and community engagement.

Maintenance in historic writings and international charters

Nearly 200 years ago the English art critic **John Ruskin** (**1819 -1900**) writes in chapter VI §19 of the **Lamp of Memory from the Seven Lamps of Architecture** this often-quoted sentence: "Take proper care of your monuments, and you will not need to restore them. A few sheets of lead put in time upon the roof, a few dead leaves and sticks swept in time out of a water-course, will save both roof and walls from ruin. Watch an old building with an anxious care; guard it as best you may, and at any cost from every influence of dilapidation. Count its stones as you would jewels of a crown; set watches about it as if at the gates of a besieged city; bind it together with iron where it loosens; stay it with timber where it declines; do not care about the unsightliness of the aid; better a crutch than a lost limb; and do this tenderly, and reverently, and continually, and many a generation will still be born and pass away beneath its shadow".[2]

His contemporary countryman **William Morris** (**1834 -1896**), also known as the founder of the Arts and Crafts movement in the United Kingdom writes with further founders 1877 the **"Manifesto" for the founding of the Society for the Protection of Ancient Building** (**SPAB**). In this he voices the idea of regular Maintenance which is still a key element of the SPAB.

"It is for all these buildings, therefore, of all times and styles, that we plead, and call upon those who have to deal with them, to put Protection in the place of Restoration, to stave off decay by daily care, to prop a perilous wall or mend a leaky roof by such means as are obviously meant for support or covering".[3]

2 http://www.victorianweb.org/authors/ruskin/7lamps/6.html

3 https://www.spab.org.uk/about-us/spab-manifesto

The SPAB plays, in the United Kingdom, still an important role in protection of historic building with the main focus on maintenance and regular small repairs. In the paragraph about community engagement, I will give further details about some of their activities.

Following these historic manifests, the importance of regular maintenance, one of the most vital parts in safeguarding our built heritage, is incorporated in most of the renowned international conventions:

Venice Charter (1964)[4] Article 4
"It is essential to the conservation of monuments that they be maintained on a permanent basis"

The ICOMOS Principles for the preservation and conservation/ restoration of wall paintings 2003 combines in Article 4: Preventive Conservation, Maintenance and Site Management. Here it is pointed out, the close synergy between regular maintenance and regular monitoring to detect and address defects in an early stage.

"The aim of preventive conservation is to create favourable conditions minimising decay, and to avoid unnecessary remedial treatments, thus prolonging the life span of wall paintings. Appropriate monitoring and the control of the environment are both essential components of preventive conservation. Inappropriate climatic conditions and moisture problems can cause deterioration and biological attacks. Monitoring can detect initial processes of decay of the painting or the supporting structure, thus preventing further damage. Deformation and structural failure leading even to possible collapse of the supporting structure, can be recognised at an early stage. Regular maintenance of the building or the structure is the best guarantee for the safeguard of the wall paintings".[5]

In the Burra Charter (first adapted 1979, reviewed 2013)[6] the Australia ICOMOS Charter for Places of Cultural Significance we find several references to Maintenance. Article 1.5 defines Maintenance as: "Maintenance means the continuous protective care of a place, and its setting. Maintenance is to be distinguished from repair which involves restoration or reconstruction".

Article 16. Maintenance: "Maintenance is fundamental to conservation. Maintenance should be undertaken where fabric is of cultural significance and its maintenance is necessary to retain that cultural significance".

An important new factor in the Burra Charter is the important role of maintenance is given for the communities and community engagement. The explanatory notes point out, that maintaining a place may be important to the fulfilment of traditional laws and customs in some Indigenous communities and other cultural groups. Later in Article 12 there is further reference to the possibility of community engagement through maintenance. Article 12. "Participation Conservation, interpretation and management of a place should provide for the participation of people for whom the place has significant associations and meanings, or who have social, spiritual or other cultural responsibilities for the place."

4 https://www.icomos.org/charters/venice_e.pdf

5 https://www.icomos.org/en/what-we-do/focus/179-articles-en-francais/ressources/charters-and-standards/166-icomosprinciples-for-the-preservation-and-conservationrestoration-of-wall-paintings

6 https://australia.icomos.org/wp-content/uploads/The-Burra-Charter-2013-Adopted-31.10.2013.pdf

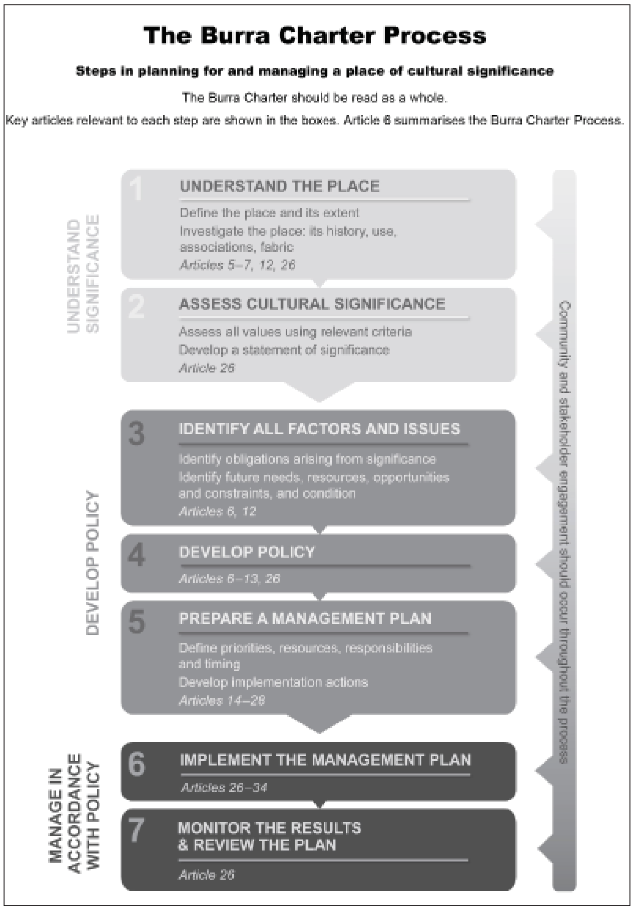

***Image 1:** The Burra Charter Process, Flowchart 2013 (Image from https://australia.icomos.org/wp-content/uploads/The-Burra-Charter-2013-Adopted-31.10.2013.pdf, p 10.)*

The flow chart of the Burra Charter shows how clearly how Maintenance is embedded as an integral part of the Conservation – the Conservation Process.

Martha Demas, 2003[7] adapted this plan for the conservation of archaeological sites. She asserts the critical importance of including the regular Maintenance and Monitoring in the Management Plan as a preventive measure to slow down deterioration.

But she also warns that repetitive small repairs such as repointing, that are carried out as part of the routine Maintenance can lead to gradual loss of historic fabric.

In the approach to sustainable preservation of Stone Monuments **Fitzner 2004** describes in the publication **“Documentation and Evaluation of Stone Damage on Monuments”**[8] the three main parts of the conservation process as anamnesis, diagnosis and therapy. Monitoring and maintenance are an integral part at the end of the therapy.

Francesca Pique changes the linear models into a circular diagram. Based on the flow chart of the Burra Charter **“The steps of**

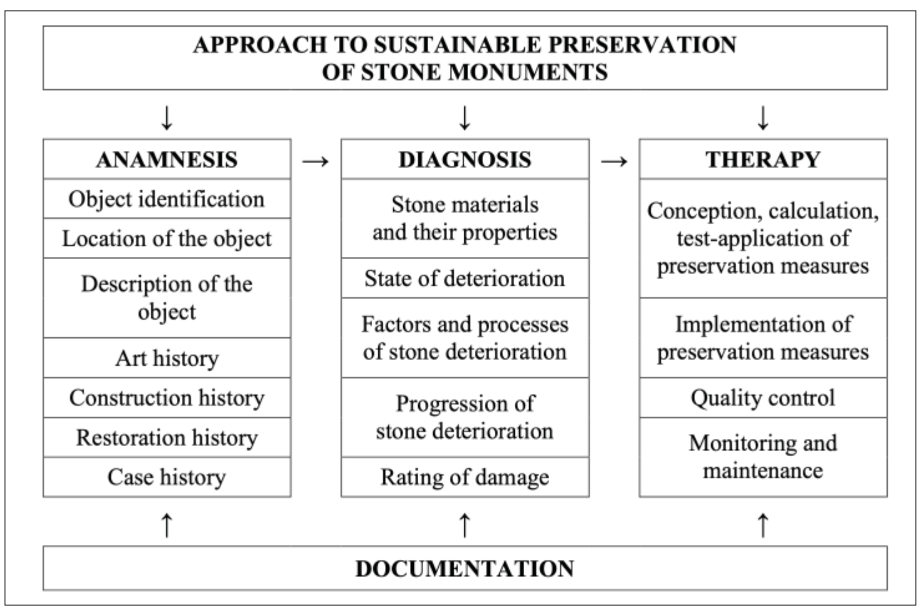

***Image 2:** Approach to monument preservation Fitzner, 2004 (http://www.stone.rwth-aachen.de/stockholm2004.pdf p. 678*

7 https://www.getty.edu/conservation/publications_resources/pdf_publications/pdf/mgt_plan_arch_sites_vl_opt.pdf p.27-54

8 http://www.stone.rwth-aachen.de/stockholm2004.pdf 10th International Congress on Deterioration of Stone Stockholm, 2004 p.677-690

the Conservation Process"[9] are illustrated as a circular diagram to emphasize that the conservation process is a repeating cycle in which monitoring and maintenance following the intervention.

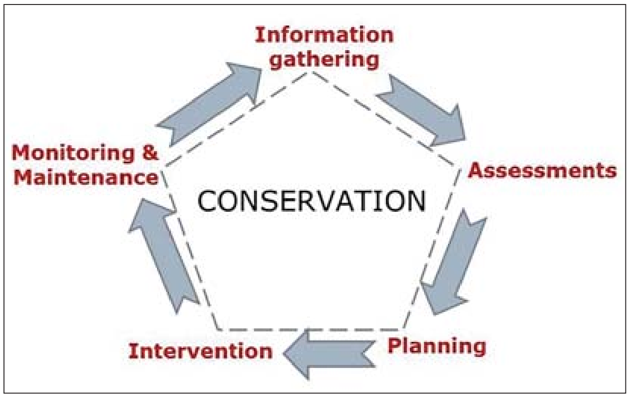

Image 3: *The Steps of the Conservation Process from Pique, James 2017*[10]

The completion of remedial conservation interventions is the starting point for regular maintenance and monitoring. Our cultural heritage needs ongoing care to preserve it for the future.

So, despite repeatedly including maintenance into international charters and acknowledging it as an integral part of the conservation process is it still not extensively applied in the common practise and part of every conservation project? Why is it easier to acquire funding for conservation - restoration projects than lower funds for regular maintenance? Don't we value it enough?

9 Francesca Piqué and Julian James, 'Learning to give clients what they don't want: Conservation education and post-treatment monitoring and maintenance'. In Proceedings of the International Conference Preventive and Planned Conservation Monza, Mantova (5-9 May 2014). Ed. Stefano della Torre, Nardini 2017

10 Francesca Piqué and Julian James, 'Learning to give clients what they don't want: Conservation education and post-treatment monitoring and maintenance'. In Proceedings of the International Conference Preventive and Planned Conservation Monza, Mantova (5-9 May 2014). Ed. Stefano della Torre, Nardini 2017 p.11-p25

Harmful impact of lack of maintenance

The following case studies show the harmful impact of the lack of maintenance on the deterioration process. The examples shall raise awareness and encourage to make a common effort to implement regular maintenance as an integral part of heritage conservation in every conservation practise, as it is already integrated and approved in the theory of conservation.

The examples are from my own personal observations during site visits and within my various professional roles. Everyone can make the same observations in their own area and find similar examples in the lack of maintenance; but it should also be seen that in a few areas the objects show regular care and maintenance.

The most common images associated with the lack of maintenance are leaking rain gutters and downpipes, blocked hoppers and gullies which lead to water overflow; displaced, lost roof tiles allow water infiltration; woody biological growth, where the roots growing into the joints and cause tension, which finally can lead to material loss; exposed ironwork once corroded causing strain, cracking and loss of material; lost glass pains and blocked vents preventing essential ventilation inside the building.

To care includes to exclude any possible harm, therefore it is important to avoid storing any potential harmful or just moist material, such as sacks with waste, with for example salt contaminated plaster that had to be removed, next to the site. The next rainfall would undoubtably distribute the soluble salts.

Cleaning is one of the main tasks of regular maintenance, removing leaves, harmful vegetation, waste, bird excrement, to list some of the most common ones.

Well meant protective temporary structures need constant maintenance and repair, otherwise they not only loose their positive protective

Image 4: *Slipped, displaced and lost roof tiles (Beckett 2020)*

Image 5: *Buddleia growing in rain gutter (Beckett 2020)*

Image 6: *Defect, overflowing downpipe (Beckett 2016)*

Image 7: *Corrosion of reinforced early concreate pillars. (Beckett 2016)*

Image 8: *Storage of bags with waste and contaminated building material against the historic wall (Beckett 2016)*

Image 9: *Dried moss is blocking the water drainage (Beckett 2019)*

function, but they can even cause harm.

In countries with high rainfall during rainy seasons, such as the example here from Stone Town, Zanzibar, showing protected roofs over the wooden doors and windows. If they are dislodged or broken, then instead of leading the water away from the building it can lead instead to water infiltration. Unfortunately, in densely built historic towns, it is often not enough to only look after your own property, because as the image from the Hamamni Persian Bath show, the broken cover over the entrance door from the neighbouring property, leads the water directly into the historic wall of the Hamamni Baths.

Poor maintenance leads primarily to moisture related defects; therefore, the inspection should be best carried out also during rain. As important it is to watch the water distribution during the rain, it is equally important to observe the capacity and speed of the evaporation and drying time. This can reveal areas with poor ventilation and vapour blockages. Moisture occurs in various forms, from rainwater infiltration to condensation on the historic surfaces. The growing number of air condition units are an increasing source of condensation water in our built historic environment.

Therefore, an important task of maintenance is additional to prevent water infiltration, is to allow ventilation inside and outside the building. This includes clearing vents to enable airflow and outside it can mean to cut of some branches from a tree close to the building, or remove items such as old water tanks, boards, chairs, building material, leaning against the walls which hinders ventilation.

Historic buildings create over a long period of time "equilibrium" with its environment and consequently any changes need to be closely monitored and managed. Due to the inert heavy mass of most of the historic buildings, changes,

Image 10: *Broken protective roof leads the water in the plaster of Hamamni Baths, Stone Town (Beckett 2016)*

Image 11: *Broken protective roof leads the water in the plaster of the "Upendo House", Stone Town and activates soluble salts. (Beckett 2016)*

Image 12: *Heavy rain during the rain season in Stone Town, Zanzibar (Beckett 2016)*

Image 14: *Tree close to a historic building can hinder ventilation and cause mechanical damages (Beckett 2019)*

Image 13: *Condensation moisture on the inside of the roof windows Hamamni Bath, Stone Town, Zanzibar (Beckett 2016)*

Image 15: *Tree is casting a shadow on the historic walls (Beckett 2019)*

defects, but also positive impacts occur slowly, so the evaluation of any measures requires time. Actions not always have a clear positive or negative impact on the historic fabric; in most cases the potential effects have to be assessed.

Coming back to the example of the tree or branch close to a structure; this can hinder ventilation but at the same time the shadow can reduce extreme temperature fluctuations which could cause material stress. These observations, to see and evaluate any changes, require consistency and continuity over a long period of time. Only then it is possible to determine the rate of any deterioration process. This can only be achieved by community involvement, volunteers who are able to watch, monitor their building and object regularly.

Case Studies

Four case studies, taken from fieldwork projects I was involved from several regions, illustrate the unnecessarily loss of irretrievable historic fabric caused by lack of maintenance. In these case studies I only present the aspects that are related to maintenance.

Between 1445- 1452 the large **West Portal of St. Martins Church in Landshut in the South of Germany** had been created mainly out of Sandstone, including terracotta sculptures and painted plastered areas. The portal is part of the highest brick church tower (130m) of the world. Lack of cohesion and adhesion, crusts, discoloration and salt efflorescence indicate during the condition assessment (2011) that these deterioration processes are possible related to soluble salt mechanism. Drill flour sampling is required, which allows depth profile with characterization and quantity of soluble salts. The location and the predominance of Nitrates and Sulphates lead to the identification of one of main source of soluble salts – a high amount of pigeon droppings which accumulate on the roof above the Portal. The slightly acid,

***Image 16:** St Martins Church, Landshut, Germany (Image from Knesch, St. Martin Landshut, Regensburg 2009, p. 15)*

***Image 17:** St Martins Church, Landshut, West Portal (Beckett, 2011)*

***Image 18:** The composed image shows the location of the bird dropping and water ingress (Beckett 2011).*

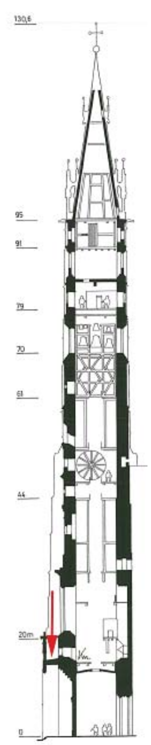

***Image 19:** The red arrow in the section drawing of the Tower shows the location of the bird dropping and water ingress (Beckett 2011).*

high concentrated salt solution is distributed in the vaulted ceiling below by water infiltration.

This damage source can be reduced by inhibiting the birds to rest on the roof and regular cleaning of any droppings. Together with the repair and maintenance of the roof and water goods it will stop water infiltration and enables to transport the water controlled away from the precious portal.

In January 2018 as part of INDO Swiss workshop[11] in collaboration between INTACH and the University of Applied Sciences in Bern, Switzerland we carried out a condition assessment on the wallpaintings in the **Kirti Mandir in Vadodara, India.** Built between 1926 – 1936 it was commissioned by Maharaja Sayajirao Gaekwad III for the memorial of their ancestors. The architect V.R. Talwalkar used the local Limestone (Kota Stone). In the main hall, the four walls are decorated with wallpaintings from the artist Nanadlal Bose (1882 – 1966)

The protein bond paint was applied on lime plaster. The main deterioration phenomena had been the loss of adhesion and cohesion of the paintlayer. The presence of salt efflorescence indicate that the damages are imposed or enhanced by soluble salt mechanism. All four images show enhanced damages towards the corners.

With the inspection of the damaged areas from outside the building and the roof area, the source of the moisture and one source of soluble salts was clear. Similar to the previous example of St. Martins Church in Landshut, here the source of the water infiltration was caused by the leaking cast iron down downpipes and the pigeons which rest and contaminate the rain gutter inlet boxes. With regular maintenance these damages to the wallpaintings could have been avoided, reduced or at the very least slowed down.

Image 20: *Kirti Mandir, Front of the Main Hall. Vadodara (Beckett 2018)*

Image 21: *Kirti Mandir, Vadodara. Interior with students during the workshop. (Beckett 2018)*

Image 22: *Kirti Mandir, wallpainting Battle of Kurukshetra- (25ft x 5ft = 125sq. ft.)*

Image 23: *Kirti Mandir: On the exterior there are two historic cast iron downpipes on the areas where the wallpaintings inside show defects.*

Image 24: *Kirti Mandir: Cast iron downpipe. The biological growth indicates that water leaks out. Birds, here a pigeon is resting in the hoppers and contaminate the water and block the hopper.*

Stone Town, Zanzibar Hamamni Persian Baths

From 2015 to 2016, as the conservation expert for the Italian NGO Fondazione ACRA,[11] I was involved in the capacity building for the EU funded Zanzibar Built Heritage Job creation project, ZANHER research project.[12]

A wide variety of courses were conducted to train local craftspeople to carry out regular maintenance and repairs on historic masonry and woodwork. The fieldwork education combined theory and practise on real case studies. At the same time these projects, carried out on location, contributed to the preservation of the World Heritage Site Stone Town.[13]

Amongst other buildings, we restored during several training courses, was the Hamamni Persian Bath, using traditional techniques and local materials.

The Grade 1 listed Hamamni Persian Baths was built between 1870 and 1888 under the Sultan Barghash bin Said as a public bath. The large complex architecture was erected, like most of the historic buildings in Stone Town, with the local coralline ragstone and mangrove timber. The irregular stones are bond with thick lime mortar and were traditionally covered with a two layered plaster system and a final limewash in white, yellow or blue. As we often discovered in historic buildings, the main issues are related to soluble salt mechanism and moisture which enable the salt related deterioration processes. The condition assessment identified that the main source for the sulphate was the inappropriate subsequent repairs with cementious plaster. For the areas with a high content of nitrate the source was

11 https://www.acra.it/it/?lang=en

12 https://www.facebook.com/zanzibarheritage/

13 https://whc.unesco.org/en/list/173/

Image 25: *Hamamni Persian Baths, Stone Town; Front façade after restoration (Beckett 2016)*

Image 26: *Hamamni Persian Baths roof area after restoration (Beckett 2016)*

discovered outside of the west wall. This, at that time undeveloped building plot, was used as a waste dump and cat litter box. This contaminated and damp earth reached a height of 1.5 metre against the historic wall of the Hamamni Baths.

The source of the damp derived from several sources; all are related to the lack of maintenance. The wall top of the two-scale wall was lost, and water and loose material could infiltrate deep into the cavity wall. Due to the closure of two previously open windows, and subsequently stopping the airflow and ventilation inside the different rooms led to raised humidity levels in the building and formed condensation on the glass panels of the small roof lights. The broken glass sheets added to the water ingress problem.

(Left) Image 27: *Hamamni Baths, East wall exterior before clearing, waste and contaminated standing earth (Beckett 2016)*
(Right) Image 28: *Hamamni Baths, East wall before repair. Lost cover of the two-scale wall allows water ingress (Beckett 2016)*

Image 29: *Hamamni Baths, Interior. After rain the East wall is getting in one area. (Beckett 2016)*

Image 30: *Hamamni Baths. The downpipe from the neighbouring house drains the water into the east wall of the Hamamni Baths. (Beckett 2016)*

At the north end of the west side of the building, the walls were frequently wet after rainfall. An investigation into the adjoining neighbour courtyard revealed, that a well-meant maintenance measure of the neighbour caused this damage. The new downpipe of the neighbouring house discharge directly into the wall of the Hamamni Baths.

A new threat to the preservation of the Hamamni Baths comes from a new construction, using low-cost cement mortar on, an empty plot on the west side, a source for further soluble salts.

Historic buildings, with high number of soluble salts in the historic walls, require regular maintenance to reduce water infiltration and allow ventilation. The monitoring will give an understanding of the complex salt mechanism we often have to live with. With regular maintenance we can create constructive conditions to control, reduce and slow down the deterioration processes.

Part of the maintenance at the Hamamni Baths included the clearance of the undeveloped building plot and removing of the standing earth to allow the walls to dry out. It is also important to clean regularly the vast roof space from waste and dust, that hinders the water run-off and controlled drainage.

Between 2007-2011 I was given the opportunity to establish an inaugural post-graduate course in the conservation of wallpaintings at the Tainan National University of the Arts, in Taiwan.

The practise of the three-year course was carried out in fieldwork projects in varies Temples.

For this last case study, I have chosen the **Shuixian Temple in Beigang**. The first temple dates back to 1739. Due to the destruction caused by flooding of the nearby Beigang river, it has been rebuilt several times. The now visible structure dates from the 19th Century. The wallpaintings that decorate all the walls, were completed by Chen Yufeng (1900-1964).

The "ink like" painting is carried out in fresco technique on a thin final intonaco. This highly polished lime plaster consists of lime, traditionally burnt from oyster shells and hemp as the filler.

Incense soot leads to the dark brown staining layer on the surface of this wall painting. The regular flooding has saturated the plastered brick walls with soluble salts from the surroundings, which included agricultural land rich in fertiliser products.

Image 31: *Shuixian Temple in Beigang, Interior; the temple is open to the enviroment (Beckett 2009)*

Image 32: *Shuixian Temple, small. Protective temporary roof over the wall-painting stops direct rain. The later storage of the tables enables nevertheless the rain to to bounce back onto the painting. (Beckett 2009)*

Image 34: *Shuixian Temple in Beigang. Students from the TNNUA are carrying out regular monitoring and maintenance (Beckett 2010)*

Image 33: *Shuixian Temple in Beigang. Wallpainting, from Chen Yufeng (1900-1964) after restoration. (Beckett 2009)*

It is a difficult task to preserve structures such as Temples, that are exposed to the environment, especially in the extreme climate, with varying temperatures and a monsoon season. Infuriatingly, the temples are built traditionally with no rain goods, to lead water away from the walls. This important task can only be achieved with constant maintenance and monitoring.

I would like to end with my last case study with a positive and an optimistic note.

For all our fieldwork projects in Taiwan, we managed to achieve and implement a maintenance contract. This 5-year maintenance contract after the conservation-restoration is a lasting legacy to the work in restoration process and was negotiated within the project budget. Additionally, this maintenance and monitoring created the first working contracts for the students after graduation. Regular inspections include any maintenance and any small interventions, such as consolidation of few flaking paintlayer, avoided any larger damages and finally loss of the historic fabric. This is a very successful conservation/business model, that could be implemented for all conservation-restoration projects.

Biology in Conservation and Maintenance “protective” and “harmful” biological growth

Maintenance can often be seen in the context of removing of any vegetation. With wider research and stricter protection of the natural environment this maintenance task is now applied in a much wider, holistic and sustainable approach. Any potential harm of biological growth is further differentiated and evaluated against any protective properties. It is general acknowledged that historic buildings create important habitats for endangered wildlife[14] and plants – therefore rare, endangered plants can add to the value of the historic building and as the example from the church tower covered with wallflowers shows, can add to the beauty.

Historic walls are often covered with algae, lichens and moss[15]. While some of the biological growth can be harmful, through chemical or physical processes, research show that most in contrary protect the historic stonework[16]. Moss often found on roofs and horizontal stonework can shelter stonework against temperature fluctuations and frost, but on the other hand it can block rain goods and drainages and this can cause water damage. This means, that the remove of the vegetation should be selective. Some of the biological growth can be also used as an environmental indicator for example for areas with high moisture or sun irradiation. Therefore, before any biological growth will be removed during maintenance, it should be decided on a case-by-case basis and if required in cooperation with a biologist. This information will be part of the maintenance plan.

Any plants with woody roots such as ivy, buddleia, or even trees can cause physical stress to the historic masonry and should be controlled, managed and if necessary, removed to prevent any damages.[17]

The protective function of biological growth is, for example, used to cover exposed ruined walls with a green cover of grass with

14 https://historicengland.org.uk/images-books/publications/bats-in-traditional-buildings/

15 Caneva Nugari and Salvadori (ed.): Plant Biology for Cultural Heritage: Biodeterioration and Conservation, 2009

16 Beierkuhnlein, Drewello, Snethlage and Töpfer (ed): Zwischen Denkmalschutz und Naturschutz Leitfaden zur naturverträglichen Instandhaltung von Mauerwerk in der Denkmalpflege, Berlin 2011. Siegesmund: Die ‘Drei Gleichen’. Baudenkmäler und Naturraum: Faszination einer Kulturlandschaft 2013

17 https://historicengland.org.uk/advice/technical-advice/parks-gardens-and-landscapes/landscape-management-of-monuments/

Image 35: *Wallflowers add to the beauty of the church tower. (Beckett 2020)*

Image 36: *Historic Stone wall with a variety of protective and harmful biological growth. (Beckett 2020)*

Image 37: *Large trees on the historic castle ruin wall top causes stress through wind movements (Beckett 2018)*

Image 38: *The roots of Ivy an penetrate any voids and cause stress to the historic fabric (Beckett 2019)*

Image 39: *Soft capping training to protect ruined wall top (Harvey 2019)*

local succulents, called soft capping[18]. These green cover needs also regular maintenance – weeding. Controlling vegetation, soft capping as part of regular maintenance are definitely good activities for Community engagement.

Taylor Review Pilot[19]

The Taylor Review Pilot was funded by the Department for Digital, Culture, Media and Sport (DCMS) and managed by Historic England. Between September 2018 and March 2020 some recommendations from the 2017 Taylor Review: Sustainability of English Churches and Cathedrals were tested in a rural and urban environment. With the support of two Fabric Support Officers (FSO) and two Community Development Advisors (CDA), a series of 16 workshops and a small grant fund for regular maintenance and minor repairs, the pilot examined ways to support places of worship to preserve their historic building fabric in a sustainable way for the future. The key elements for the preservation of the historic fabric are the focus on regular maintenance and to carry out small repairs using a "stich in time" approach before they develop to larger problems. These will be more costly and can lead to the loss of historic fabric. Especially the lack of maintenance and neglect of urgent small repairs to the rain goods lead to large costly defects. This was one of the out-comes from the research "The Value of Maintenance?"[20] In my title to this article "The Value of Maintenance" I removed the question mark and stated it as a fact.

18 https://historicengland.org.uk/research/current/conservation-research/care-of-buildings/#Section9Text

19 https://historicengland.org.uk/advice/caring-for-heritage/places-of-worship/churches-sustainability-review/

20 https://historicengland.org.uk/advice/caring-for-heritage/places-of-worship/maintenance/

Regular maintenance[21] and monitoring often includes small repairs such as stabilizing an open plaster edge with some mortar fillet, re-pointing[22] or replacing a damaged and missing roof tile. Regular maintenance and monitoring offer the opportunity to engage the wider community.

While most of the regular maintenance such as clearing gutters, drains and ventilation can be carried out by volunteers, the small repairs need to be carried out by skilled craftsmen, although it can be surprising what a range variety of skill sets can be found in a volunteer group. During the Pilot we had some cases where professional masons offered their time to contribute to the community.

Part of my task as a FSO was to support Places of Worship to develop, with the help of volunteers, a maintenance plan checklist[23] which reflected their building and capacity. I recommended that regular maintenance inspections were carried out periodically with additional inspections after (or even during) extreme weather conditions, such as a heavy storm.[24]

To make this easier to do and record we refined further an existing maintenance checklist. It was important that the observations made during the regular maintenance and as a result of regular monitoring were both recorded in the maintenance checklist. These important observations will help to inform later conservation or repair work.

21 https://historicengland.org.uk/advice/technical-advice/buildings/maintenance-and-repair-of-older-buildings/

22 https://historicengland.org.uk/images-books/publications/repointing-brick-and-stone-walls/heag144-repointing-brick-and-stone-walls/

23 https://historicengland.org.uk/content/docs/caring-for-heritage/trp-intro-maintenance-checklist/
https://historicengland.org.uk/advice/caring-for-heritage/places-of-worship/churches-sustainability-review/#advice

24 https://historicengland.org.uk/advice/technical-advice/buildings/maintenance-plans-for-older-buildings/

This record will help to evaluate the velocity of deterioration processes and also to assess the effect of previous interventions. It is helpful to support these observations with photos or drawings. An easy effective tool is also marking, mapping observations in a plan or copy of an overview photograph.

This maintenance list is free to download[25] and can be adapted to the architecture and situation of any historic building and site. It will help to organize, budget and share the important task of maintenance and monitoring.

Maintenance and minor repairs – Value to reduce carbon footprint

With the increasingly urgent and challenging task to reduce or carbon footprint and reduce climate change, the idea of maintenance and minor repairs is more and more valued as an important tool to support this aim. This is also necessary for the preservation of our heritage, which is under the threat from the effects of the climate change, with more severe environmental impact.[26]

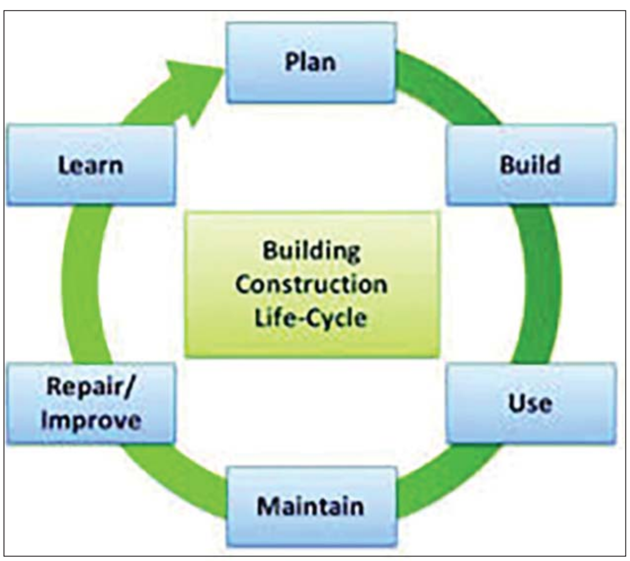

Image 40: *Building Construction Life-Cycle graphic (http://www.builtconstructions.in/OnlineMagazine/BuiltConstructions/Pages/Life-Cycle-Analysis-Methods-in-Buildings-0231.asp)*

The following graphic shows the "Building construction life cycle", again the important role maintenance and repair plays to prolong the historic fabric and therefore the imbodied carbon footprint.

Connecting our historic building to the ideas and demands of the conservation of the environment adds value to our task to preserve these precious historic buildings. This can help to engage a wider community and achieve more public interest.

NGOs Promoting Maintenance

Public engagement and raising awareness for the preservation of the historic building is carried out by several NGOs. Amongst others I want to mention two in particular, who from the beginning had a strong focus on the importance of regular maintenance.

Monumentenwacht (Monument Watch) is an organization that specializes in the periodic inspection of built heritage. It originated in the Netherlands in 1973. It promotes the idea that "prevention is better than cure" by offering periodic inspection, monitoring, and minor urgent repair and writing independent professional inspection reports, which serves as a reference for owners and users for further maintenance and conservation activities to raise their awareness of the importance of proper maintenance and preventive conservation[27].

At the beginning of this presentation, I citied the well know founders of the Society for the protection of ancient buildings SPAB. For over 100 years they have promoted regular

25 https://historicengland.org.uk/advice/caring-for-heritage/places-of-worship/churches-sustainability-review/#advice

26 https://historicengland.org.uk/whats-new/news/recycle-buildings-tackle-climate-change/

27 https://www.sciencedirect.com/science/article/pii/S209526352030056X

maintenance and constant care for the historic buildings as the only way to preserve them. They raise public awareness and engage a larger number of volunteers for carrying out maintenance work on their local historic local environment. Every year they promote the National Maintenance week[28]. A wonderful idea to promote and engage the value of regular maintenance.

This can be an important public event and brings together local communities.

Everybody can contribute and bring in special skills from gardening, to cleaning, trimming trees, taking photos, the catering of the volunteers – all generations can take part. An opportunity to engage with the next generation of custodians for our cultural heritage.

With this contribution, which has given a short overview on several aspects of the value of maintenance, that are acknowledged and published in the conservation community, my main aim is that we feel empowered to continue to campaign for a higher value of regular maintenance – that the value that it has in theory will be embedded into every conservation project and therefore get the necessary awareness and funding. With a growing awareness for the protection of our natural environment we have the chance to engage with a wider community, to fight for our aim to preserve our cultural and natural environment – with regular care and maintenance at the heart.

28 https://www.spab.org.uk/campaigning/national-maintenance-week

4 September 2020

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Injection Grouting for Delaminated Wall Paintings: Approach, Design, Challenges

Born in Italy in 1986, **DR CHIARA PASIAN** is a wall painting conservator and currently Lecturer in the Department of Conservation and Built Heritage at the University of Malta, where she teaches at the MSc course in the Conservation of Decorative Architectural Surfaces, and supervises students in field projects. Pasian is strongly interested in applied scientific research and holds a PhD from the Courtauld Institute of Art, London. Before joining the University of Malta, she has been a visiting lecturer at the University of Applied Sciences and Arts of Southern Switzerland (SUPSI) and at the University of Tsukuba, Japan. She is currently member of international committees related to conservation, including Assistant Coordinator of the ICOM-CC *Murals, Stone, and Rock Art Working Group* and member of the RILEM Technical Committee *Specifications for Testing and Evaluation of Lime-based Repair Materials for Historic Structures*. Beside academic research, she also works as an on-site conservator. She has being involved in projects in collaboration with different private and academic institutions (such as University of Tuscia, Italy and the Courtauld Institute of Art, London) in several countries, including Malta, Italy, Switzerland, France, Turkey, India.

Introduction

A decorative architectural surface is any decoration for which the support is the structure itself. Such decoration is therefore part of an immovable support, 'completely and unavoidably physically dependent' on it (Cather, 2010). This is therefore the case of wall paintings, among other decorative architectural surfaces, such as reliefs and mosaics. Wall paintings are particularly complex systems, composed of multiple layers of materials, connected through porosity one to the other and to the external environment. Such physical open system is hardly controllable, and often causes of degradation cannot be removed. In addition to this, wall paintings are potentially very vast, often reaching hundreds of square meters, and extremely heterogeneous, both topographically and stratigraphically, i.e.

their original materials and condition may significantly vary from one area to another. All these factors make the conservation of wall paintings extremely challenging (Cather, 2010).

Among the deterioration phenomena which may be encountered, delamination – a lack of adhesion between plaster layers, or support and plaster –, when unstable, is particularly dangerous for the integrity of wall paintings, and challenging to address.

Delamination: definition of the problem

When a delamination is present, there is loss of *adhesion* at the interface between two layers. In the case of wall paintings, such layers can be two layers of plaster, or plaster and underlying support. Therefore two separate *cohesive* layers are not bound at the interface anymore. This is different from a situation in which there is loss of cohesion; this regards a single layer (for instance a plaster or a paint layer), in which its particles are not bound together anymore.

Delamination can manifest in different forms: it can be quite obvious to detect, for instance associated with deformation of the plaster, cracking and/or loss of plaster exposing the pocket between the two layers, or more subtle and difficult to detect, with no clear sign on the surface.

It is important to underline that delaminated areas of a wall painting do not necessarily need a remedial intervention – they do when they are unstable, i.e. if there is risk of loss of original material.

As we will see in the following sections, the assessment of the problem and of the intervention itself, during and after, present difficulties due to the concealed nature of both the problem and its treatment (Rickerby et al. 2010, p. 472).

Injection grouting: aim and definition of the intervention

The detachment of a wall painting and its subsequent transfer to a movable support 'affects its entire identity' (Brajer, 1999), and this regards both its values and original materials. The wall painting existence itself, its value and significance are strictly interrelated to the one of the building/structure it belongs to, and that is why 'conserving a wall painting without ensuring the state of conservation of its support would be irresponsible' (Cather, 2010). Detachment is therefore to be considered as *extrema ratio*, and stabilisation of the delamination is always preferred.

Injection grouting is a remedial intervention which aims to address a failure of adhesion between layers by introducing a compatible adhesive material with bulking properties (Griffin, 2004). The pocket where the grout is going to be injected is pre-wet with water, or a solution of water and ethanol; this is performed in order to clear the cavity and to wet the plaster/support, with the aim of reducing the absorption of the water contained in the grout mixture, therefore reducing the chances of shrinkage of the grout. The grout in its fluid state is then injected in the pocket, typically through a syringe with the aid of a needle or a catheter (according to the size of the delamination, the access point and the fluidity of the grout); the material then sets, filling the void and re-addressing adhesion between the layers. It is to be noticed that to stabilise a delamination, the grout does not necessarily have to fill the entire gap. In some cases anchoring points are sufficient to ensure stability.

Injection grouting is critically important because potentially saving wall paintings at risk of collapse.

It is also a very complex intervention. First of all it is performed on extremely fragile wall paintings; secondly, the assessment of the problem (Del Vescovo and Fregolent, 2005; de Freitas et al., 2014, among others) may present difficulties, as well as the assessment of the intervention, which is inherently inaccurate because concealed. Lastly, and importantly, grouting is irreversible, i.e. the set grout becomes part of the wall painting stratigraphy, and it is hardly re-treatable (Rickerby et al., 2010, p. 472).

Therefore physico-chemical compatibility with the original materials present is fundamental, and the grout design should be tailored to the specific painting and the specific deterioration phenomena encountered.

Injection grouts composition

Injection grouts are typically composed of a binder, aggregates or fillers and a suspension medium (liquid, typically water). The suspension medium allows the solid components to mix and stay in suspension, and the overall mixture to be fluid and injectable. Grouts may often contain additives in limited amounts to modify certain properties (ex. plasticisers to modify the flow, air-entrainers to increase porosity etc.) (Biçer-Şimşir et al. 2009). Table 1 summarises the grout typical components and their function in the overall mixture.

Approach and Methodology

The design of a grouting intervention, like any appropriate methodology in conservation, involves an incremental and iterative approach to problem solving (Cather, 2006). 'An iterative method attempts to address a problem by finding *successive approximations* to obtain *more accurate* solutions' (Cather, 2006).

A rigorous and methodological approach for a grouting intervention includes the following phases:

Study of original materials and Definition of the problem

It is crucial to begin with a knowledge of the original materials and techniques of the painting. This starts on site, with observation of the plaster(s) and support in areas of losses, or where they are exposed. Once the

Table 1: Grout components and their function in the mixture

Component	Function	Examples
Binder	• Binds all the components when the grout is set • Results in the matrix of the grout	Lime (slaked lime/hydrated lime), NHL, earth, etc.
Aggregates	• Give the bulk • May help reducing shrinkage and/or increasing flow	Inert fillers vs. pozzolanic fillers
Additives	• May be used to improve certain properties of the grout (ex. injectability, adhesion, porosity, etc.)	Synthetic vs. natural (fluidisers, air entrainers, adhesives, etc.)
Suspension medium	• Allows the grout to be liquid and injectable • Keeps the components in suspension	Typically water; water-ethanol (Pasian et al., 2018; 2020)

stratigraphy is understood, the use of relatively simple magnification tools, such as a portable microscope, can provide useful information about the single layers, in a non-invasive way – ex. matrix, aggregates (quality, size, shape) and their relative amount, porosity, cohesion. This can be just an estimation, though, as just the surface is visible with a portable microscope. If a sample can be taken, micro-chemical tests can be carried out – even on site – to try to characterise the binder and the aggregates (Odegaard et al., 2005). If sampling is allowed and laboratory facilities are available, the study of the plaster can be deepened, and petrographic analysis (via optical microscopy) can be performed on a thin section; this allows to identify the crystalline phases, including morphology, size, texture, relationship among them (Artioli, 2010, p. 48). The investigation can be then expanded with the use of other techniques (ex. SEM-EDS, XRPD, EPMA, TGA/DSC, Raman spectroscopy, physico-mechanical tests etc.) (Artioli 2010, p. 48; Hayen et al., 2016; Izzo et al., 2016; Miriello et al., 2018, among others).

Of course paint layers, and their condition, cannot be overlooked, as they are extremely important and what aesthetically defines a wall painting. For instance, one should pay attention if they are sensitive to water (typically present in grouts in high amounts, Pasian et al., 2018) and if they may be sensitive to/possibly damaged by some of the potential grout components.

After the understanding of the original materials, in order to plan the grouting intervention, it is fundamental to understand and define the problem encountered. The delamination needs to be observed, if partially visible, and assessed. The assessment is often difficult, because the delamination is concealed – partially or totally –, being located under the surface between plaster layers and/or plaster and support. Few fundamental points can be defined though:

- Is the delamination vertical (wall) or horizontal/semi-horizontal (ex. ceiling, vault)?
- Where is it located in the stratigraphy, if visible from a loss (between what layers? Is it in multiple locations in the stratigraphy)?
- How thick is it, if visible from a loss (it can well vary between few millimeters and several centimeters)?
- Is it flat or deformed (is the plaster deformed)?

A very simple acoustic tapping technique can be used to have an idea of the topographic extension of the delamination; the depth and width are more difficult to assess, and the sound may just roughly suggest if the delamination is rather thick or shallow. More sophisticated non-invasive techniques may be adopted, such as thermal imaging (de Freitas et al., 2014; Daffara et al., 2015), acoustic techniques (Calicchia and Cannelli, 2005; Del Vescovo and Fregolent, 2005; Quagliarini et al., 2014), Electronic Speckle Pattern Interferometry (ESPI) (Hinsch et al., 2009; Boaglio et al., 2012), but the assessment, often, may still be complex and not definite.

Definition of the performance criteria (general and site-specific)

In order to design a successful intervention, performance criteria need to be set, i.e. what the intervention and the conservation material (grout) aim to achieve. Performance criteria exist that are general for the grouting intervention and site-specific, i.e. tailoring the specific problem encountered on site (Cather, 2006). Performance criteria include working properties, which are the properties of the material in its fluid state during the intervention, and performance characteristics, which relate to the set grout and its long-term behaviour

Table 2: Examples of performance criteria for the grouting intervention (general and site-specific)

General performance criteria for grouting (Griffin, 2004; Pasian et al., 2020)		Site-specific performance criteria (ex. thick delamination on a ceiling)	
Working properties	**Performance characteristics**	**Working properties**	**Performance characteristics**
• good injectability	• minimal shrinkage after setting	• low wet density	• low dry density
• good flow	• porosity, water vapour permeability and hygrothermal behaviour similar to those of the original plasters	• good tackiness	• good adhesion
• low water content and release	• mechanical strength similar to or lower than that of the original plasters		• bulking properties
	• good adhesion		

within the structure of the wall painting (Griffin, 2004; Biçer-Şimşir et al., 2009). Examples of performance criteria are found in Table 2.

Formulation of the grout

Grout components (binders, aggregates) are selected according to their physico-chemical compatibility with the original materials (Pasian et al., 2020). The final mixture, when set, will need to have properties similar to those of the original materials. Grouts components and their ratios are balanced in the formulation so that the desired properties (previously set with the definition of the performance criteria) are fulfilled. In order to check that the properties of the grout are suitable for the intervention, they need to be tested. This is why grout formulation and testing need to go hand in hand, and the formulation is progressively refined according to the testing results (see next section). It is crucial that the grout undergoes testing in order to predict its behaviour in the stratigraphy, since, as stated, once injected the grout becomes a non-extractable part of the wall painting and its long-term behaviour may affect the integrity of the wall painting itself.

It is important to remember that grouts are suspension, i.e. particles (binder particles, aggregates) are suspended in a liquid (*suspension medium*, typically water). Therefore the behaviour of the overall mixture will depend on such particles, both regarding working properties and performance characteristics. Particles will have an influence on working properties acting on the rheology of the mixture (i.e. how the materials behaves in the fluid state), and on performance characteristics, according to the packing density and geometry they will produce in the set grout.

The following variables in the mixture design can be considered:

- **Solid: liquid ratio in the suspension**
  the amount of solid in the suspension is called *volume fraction* (Duffy, 2015) – this has an influence on shrinkage, cohesion and flow; ex. the more the solid in the mixture the less the shrinkage of the grout, but also the worse the flow
- **Particle shape**
  This regards particularly the aggregates. Round shapes help to enhance working properties such as injectability and flow (Pasian, 2017a, p. 79; Pasian et al., 2020), while angular shapes improve packing geometry (Fig. 1)
- **Particle size distribution**
  Also this regards particularly the aggregates. A wide distribution of particle sizes

(*polydispersity*) improves packing density and geometry (Fig. 1) and at the same time decreases viscosity (Fig. 2), therefore enhancing flow (Duffy, 2015). In turn, packing density and geometry have an influence on cohesion and therefore mechanical strength; at the same time, packing density and geometry influence porosity, which in turn has an impact on mechanical strength, water vapour permeability and capillary water absorption (Pasian et al., 2016)

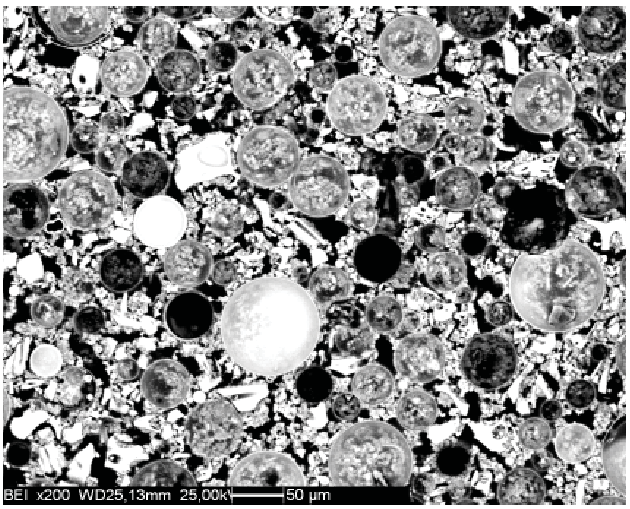

Fig. 1: SEM image (BSE, 200X) of thin section of grout with a good packing density and geometry (Pasian-Secco 2015©)

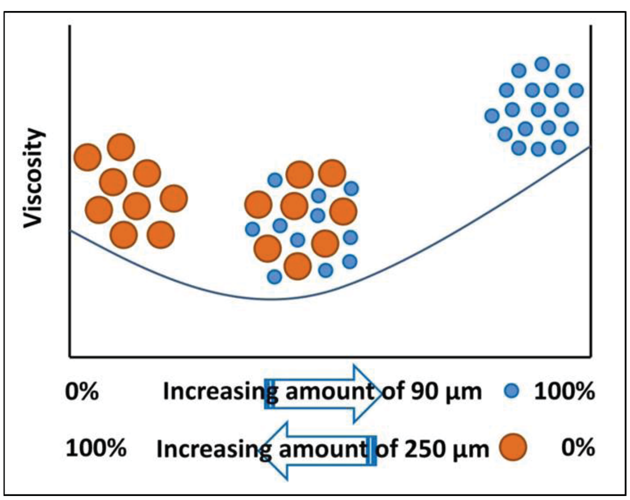

Fig. 2: Graph showing how a variety of particle sizes (orange and blue together in the picture) decreases viscosity, and therefore enhances flow (Pasian 2017©)

- **Water absorption**
  How much water particles absorb has an influence particularly on the working properties of the grout; the more the absorption the poorer the injectability and flow, and the higher the viscosity.

In addition to this, it is very important to tailor the

- **Amount of suspension medium, and type**
  This is interrelated to the solid:liquid ratio in the suspension. As previously stated, the typical suspension medium for grouts is water. Water allows the solid to be in suspension and the mixture to be injectable. Importantly, it plays a role in the setting of the grout when the binder is lime (Cizer et al., 2012), an hydraulic binder (ex. hydraulic lime, lime + pozzolan; Pecchioni et al. 2008:, p.58), or gypsum (Lewry and Williamson, 1994). Water is often used in large amounts in grout formulations, as it improves working properties, but its excessive presence can be problematic: it may lead to segregation and bleeding of the grout, and to its shrinkage upon setting (Biçer-Şimşir et al., 2009). In addition to this, water in the porous system of the wall painting can cause the dissolution of soluble salts, leading to their migration and harmful re-crystallisation when water evaporates. This is a very common deterioration mechanism for porous building materials (Arnold and Zehnder, 1991, p. 114). Lime-pozzolan-based grouts with a water-ethanol suspension medium have been studied to limit the problems mentioned above, being ethanol a worse solvent for ionic substances such as soluble salts (Kolker et al., 1996; Pinho et al., 2005; Pasian et al., 2017b). Water could be reduced up to 85% (water 15%:ethanol 85% in the suspension medium, Pasian et al., 2018). Chemical reactions have shown to occur in such grouts also in the presence of ethanol (Pasian et al., 2018). Moreover, such water-ethanol grouts have suitable

physico-machanical performance (Pasian et al., 2016; 2017c; 2018; 2020), and their injection leads to a reduced salt mobilisation in the substrate compared to water-based grouts (Pasian et al., 2017b).

It is important to note that the use of water- ethanol as the suspension medium may increase the chances of shrinkage; this needs therefore to be counterbalanced with other components in the grout formulation, for instance increasing the volume fraction (Pasian et al., 2018).

Testing

As mentioned, the testing process is an integral part of the grout design, and formulation of the grout and testing process proceed in parallel. If necessary, the formulation is modified and re-tested, following an iterative process. A meaningful testing programme needs to be established, testing first properties which are considered paramount for the grout to fulfill, always according to the performance criteria previously set, and then further properties requiring more complex testing methodologies (Pasian et al., 2020). Even small changes in the preparation of the grout may lead to a different behaviour (ex. addition of more suspension medium), therefore it is crucial to thoroughly test the mixtures and not to modify the formulation when implementing it on site.

Currently, no standards for testing of non-structural injection grouts are internationally agreed; a RILEM Technical Committee is working on reviewing laboratory standards (usually developed for cement-based materials) to adapt them to lime-based materials, including grouts (*TC 277-LHS: Specifications for testing and evaluation of lime-based repair materials for historic structures*).[1] Research on this has been carried out (BiçerŞimşir and Rainer, 2013; Rickerby et al., 2010; Pasian et al., 2016; Pasian et al., 2017c), and field testing procedures have been developed, and compared to laboratory procedures (BiçerŞimşir and Rainer, 2013).

- **Qualitative vs. quantitative**
  In general, tests can be qualitative or quantitative. A qualitative test gives a non- numerical datum and it is typically easier and quicker to perform (often it can be performed on site). Although less precise and reliable than a quantitative test, it still can provide useful information on the feasibility of a certain grout design path to follow, and it is useful for a comparison among different mixtures. Quantitative tests, on the other hand, give a precise, numerical datum, they are typically performed in the laboratory, so in controlled conditions (although some quantitative tests can also be performed on site), and they are usually associated with international laboratory standards (ex. EN, ASTM, UNI, etc.).
- **Field vs. laboratory testing**
  A comprehensive overview and testing methodologies description can be found in BiçerŞimşir and Rainer (2013). Field tests are designed so that no specialised instrumentation or full laboratory set-ups are required, while laboratory tests need controlled conditions and/or specialised instrumentation.

  When designing and testing a grout, field tests can be firstly adopted, to assess basic properties such as shrinkage (Fig. 3a and b), and to reduce the number of possible grout mixtures for properties requiring more complex testing methodologies, such as porosity and adhesion. Field tests can eventually be adapted to fit the specific problem encountered on site, preparing samples simulating the original materials (ex. shrinkage and adhesion field tests in Pasian et al., 2020).

  After the first round of field testing is performed and the number of the possible suitable mixtures is reduced, laboratory

1. https://www.rilem.net/groupe/277-lhs-specifications-for-testing-and-evaluation-of-lime-based-repair-materials-for-historic-structures-367, consulted on March 31, 2021.

Fig. 3a: Shrinkage test. Plaster cup simulating a plaster pocket (Pasian 2017©)

Fig. 3b: Shrinkage test. Plaster cup filled with grout: the grout has been excavated to assess shrinkage in depth; it shows shrinkage at the surface (probably related to fast evaporation), but not in depth (Pasian 2017©)

procedures can be adopted for the second stage of testing, if facilities are available (ex. porosity, water vapour permeability, mechanical strength tests).

Assessment and decision making

The assessment of the grout formulations and properties needs to be carried out throughout the design process, with an iterative method. It is important to remember that even if one performs a thorough testing, it is still possible that the grout behaves slightly differently when injected on site compared to when tested. This is because the porous original materials and stratigraphy form a complex system, which cannot be fully simulated with field or laboratory testing. The pre-wetting may have an influence on the grout performance, as well as the absorption of the original materials and the environmental conditions (ex. for shrinkage). These need to be all carefully considered during grout design and testing, but cannot be fully predicted.

Nonetheless, it is important to keep in mind the performance criteria set, and make sure that the grout fulfills them during the testing phase, trying to simulate as much as possible real conditions. It is typically unlikely to find the 'perfect' grout, fulfilling all the desired properties in an ideal way. Therefore, it is necessary to have clear what the priorities are, according to the problem on site, and compromise choosing the best and still overall satisfactory option.

5. Conclusions

As seen, grouting is a complex intervention: the problem is concealed, as well as the grouting intervention itself, which is therefore potentially inaccurate, difficult to assess, and not reversible. Furthermore, the grout design is complicated, since many variables may contribute to the overall behaviour of the mixture, both in the fluid and in the set state. Therefore it is necessary to tackle the problem with a rigorous methodological approach, starting from the knowledge of the original materials and technology, understanding and defining the problem and the performance criteria for the intervention, and developing the grout following an iterative design-testing approach.

It is paramount to keep in mind that every case is different, therefore there are not 'good recipes', which work with any wall painting – the grout needs to tailor the specific case under consideration and be specifically designed for the original materials present and to address the specific problem.

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On the Nature of and Managing Silver Tarnish

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Introduction

The tarnishing of silver is an intractable problem for conservation. The aesthetic preferences for surface finish have to be balanced with the resources required for cleaning and the potential for loss of surface material, detail or decoration. Slowing the rate of tarnish is therefore highly desirable and much research effort has been expended to achieve this (Ankersmit et al 2004, Argyropoulos et al 2004, Thickett and Hallett 2020). Understanding the tarnish process is critical to managing the rate of silver tarnish effectively. The corrosion and conservation literature (Costa 2001, Greydel 1996) identify hydrogen sulfide, and more recently, carbonyl sulfide as the main gases responsible, producing a predominantly silver sulfide tarnish layer.

The hydrogen sulfide and carbonyl sulfide concentration in a series of showcases were measured and compared to colour change of silver coupons. Air exchange rates of the showcases were also measured, and the colour change rates of silver coupons and silver tarnish rate, at different locations in showcases. The composition and tarnish layer thickness generated in a series of showcases, were investigated with a range of sensitive analytical techniques. The tarnish was found to be mixed, and frequently contain high levels of chlorides. The results were validated through examination of a large body of tarnished objects using scanning electron microscopy – energy dispersive x-ray analysis and potentiodynamic stripping.

The environmental sources of chlorides were quantified in a number of showcases at different locations in the UK.

Exposure Experiments

Three sets of exposure experiments were undertaken, shown in Table 1.

In the Roman Gallery, two trials were undertaken, one in July and a second in November, to allow for investigation of seasonal variation. A series of diffusion tubes and silver coupons were exposed in seven different locations. One location was external (G), in an interior road in the British Museum, the rest were within a Roman Gallery in the museum. The ambient gallery conditions were sampled on-top of a showcase (F). All showcases were metal framed glass with all materials having passed Oddy tests. Three other locations were within a showcase containing a large display of archaeological silver. One of these was beside a large silver dish to investigate any local depletion due to reactions at the silver surface (A). The second location was next to a display panel, at least 50cm away from any silver object (B). The final location was suspended from the light diffuser of the case to determine if thermal gain from the lights (the case is top lit) had any effect (C). Two further locations were in a showcase with a display of glass (D and E). This was considered to be the most inert material displayed in the gallery. Whilst glass can show some surface reactivity, all of the showcases have a significant surface of the sheet glass from which they are constructed.

The third set investigated twelve other showcases in four different galleries. The distribution of silver tarnish was also investigated in one case in each of the four galleries, by exposing coupons at several locations.

A further trial was undertaken using

Table 1: Exposure Trials

Location	Month-number of days	Number of Showcases	Number of Sensors in Showcases	Measurement
Roman Gallery	July – 28d	2	2 in 1 case, 3 in second case	H_2S, COS, Δb*
Roman Gallery	November – 28d	2	2 in 1 case, 3 in second case	H_2S, COS, Δb*, XPS, SIMS
Late Roman, Prehistoric, Numismatics and Medieval Galleries	May – 28d	12	6 in 4 cases	H_2S, Δb*
Apsley House	May – 5d	1	24 in 1 case	Tarnish rate

AirCorr 50nm silver sensors at 24 locations in a showcase with baton with dark dyed fabrics. The case was wooden framed, with a front opening, top hinged glass door. The three batons marked A, B and C were displayed on the inert cotton fabric covered backboard.

Diffusion tubes for hydrogen sulfide and carbonyl sulfide were exposed, each in quadruplicate, at some locations for 28 days. The temperature and relative humidity was measured at each location using either Smartreader or Humbug dataloggers. In order to have a perfect correlation with the hydrogen sulfide and carbonyl sulfide measurements, it was decided to expose silver coupons at the different locations during the same 28 day period. Silver tarnishes at a relatively slow rate in well designed showcases, and very sensitive techniques were required to determine the silver tarnish rate, and analyse that tarnish. The silver tarnish rate was determined using colorimetry. A square coupon was cut from Analar 99.9% silver sheet, abraded with a glass bristle brush and degreased with acetone. The colour of the surface was determined with a Minolta CR300 meter using the CIELab 1976 system (Billmeyer and Saltzmann 1981). Ranking pre-tarnished coupons had shown that an increase in the ‘b’ value, yellowing correlates well with the human perception of silver tarnish The colorimeter was able to determine a change in ‘b*’ approximately 100 times smaller than that perceived by the human eye (Thickett and Hallett ICOM in press). The air exchange rate was measured using carbon dioxide tracer gas decay (Calver et al 2005).

Further analyses were undertaken on the Roman Gallery coupons. X-ray photoelectron spectroscopy, XPS, was used to determine the elemental composition of circular silver coupon surfaces prepared in a similar manner. This technique is sensitive to all elements above helium and analyses up to 10 atomic layers of the surface. It also provides some information on the chemical environment present. XPS was undertaken with a Kratos XSAM Series 800 using aluminium K radiation at Johnson Matthey Technology Centre. Secondary ion mass spectrometry, SIMS, was also undertaken on small 2mm square silver coupons. In the static mode this technique is extremely sensitive and can detect less than 0.01% coverage of a monolayer, whilst in the dynamic mode it can be used for depth profiling. The SIMS coupons were analysed using a Millbrook Chemical Microscope at Imperial College, London (Eccles). Analyses were undertaken in large area (2.25mm square), static mode for both negative and positive ions. The instrument uses a raster scanned gallium liquid metal ion gun for the primary beam with low energy optics for secondary ion extraction into a 300Da quadrupole mass spectrometer. Several depth profiles were also measured using a 0.36mm square gated to 90% in a dynamic mode. In this mode the Gallium beam slowly ablates down from the surface.

The hydrogen sulphide and carbonyl sulphide concentrations determined in the first two sets of trials are shown in Figure 1. The measurement

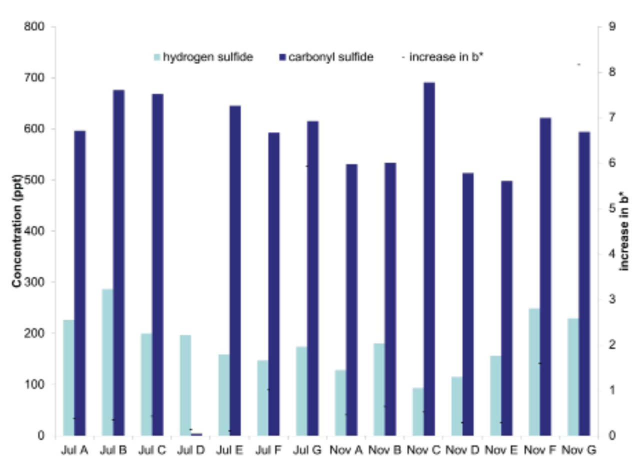

Fig. 1: *H_2S and COS in first two exposure experiments and yellowing, increase in b**

errors are such that almost no significant differences were detected between any of the locations measured. There is a just significant decrease in hydrogen sulfide close to the silver plate in the silver case compared to the other two measurements in that case. This is stronger in the second trial than the first.

Very significant differences exist between the surface colour measured externally and indoors. The external coupons were obviously darkened. The gallery ambient coupons could be seen to have a yellow cast on close inspection, whilst no change was visible to the naked eye on the coupons exposed inside showcases. Significant differences were detected in the b* values between the gallery ambient coupons and those exposed inside showcases and between the showcases.

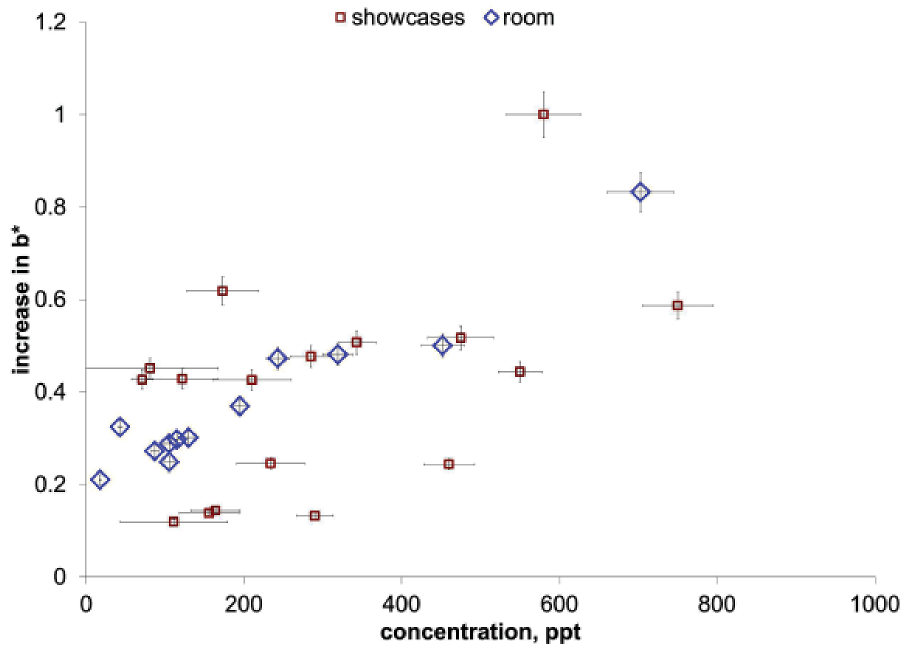

Fig. 3: Yellowing, increase in b versus COS*

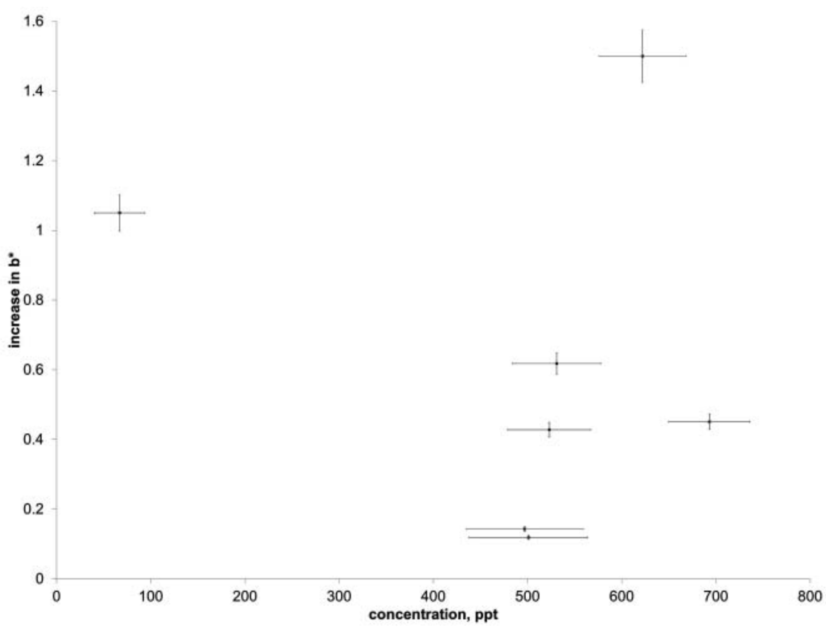

Fig. 2: Yellowing, increase in b versus H_2S,*

The measured increase in b* against hydrogen sulfide and carbonyl sulfide concentrations for the first and third trials are shown in Figures 2 and 3. Figure 3 also has data from a series of room experiments reported previously (Thickett et al 2012). The apparent tarnish rates were not found to relate to either the hydrogen sulfide or carbonyl sulfide concentration or to any obvious combination of these two concentrations. One explanation would be that the very high reactivity of the silver surfaces mean they react to the flux to the surface and

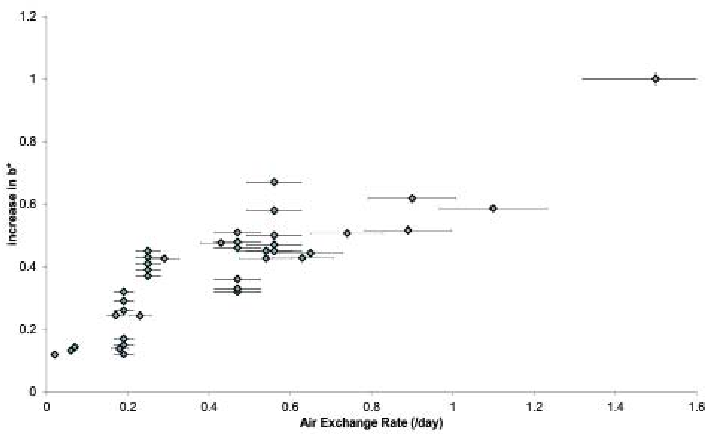

Fig. 4: Yellowing, increase in b versus air exchange rate*

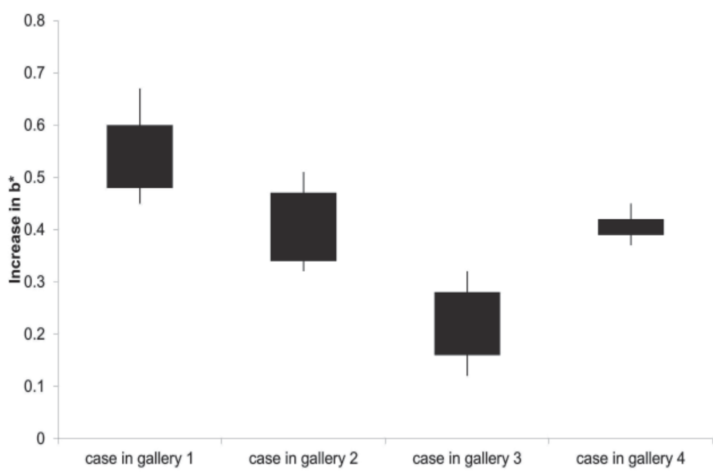

Fig. 5: Yellowing, increase in b in multiple location in showcases*

not the concentration. Hence, the very low air flows inside the showcases are important. In historic house rooms, the silver tarnish rate was observed to strongly correlate with hydrogen sulfide concentrations (Thickett et al 2012). This different behaviour may be due to much higher air flows in rooms, compared to showcases. Much better correlation for showcases was shown with air exchange rates as shown in Figure 4. Figure 5 shows the minimum, maximum and interquartile ranges of the six b* increases determined in four showcases, Figure 6 shows the silver tarnish rate in a single showcase. There are great differences between the values. Figure 6 indicates the batons with fabric covering are a significant source of tarnishing gases. This supports the concept that the air is not well mixed in the showcases.

The XPS results from the two trials are shown in Table 2.

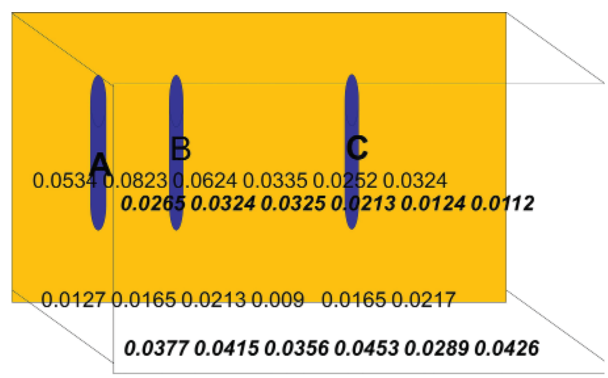

Fig. 6: Tarnish rate in 24 locations in a single showcase

Table 2: XPS results

	Atomic % species/atomic % silver				
	C1s	O1s	Cl2p	S2p	
				S2-	SO42-
Clean exposed	0.84	0.53	0.048	Bd	Bd
Gallery	2.4	0.99	0.25	0.16	0.059
Silver showcase	1.4	0.64	0.10	0.023	0.023
Glass showcase	1.4	0.53	0.092	0.057	0.028

Bd below detection limit

In all instances the tarnish was mixed and silver sulfide was only a small part of the surface tarnish layer. The relatively low concentration of silver sulfide in the tarnish is totally at odds with the accepted model for silver tarnishing. Significant concentrations of sulfate, chloride, oxide and a range of carbon containing organic species were also detected in the tarnish. Sulfide and sulfate are the only two sulfur containing species detected. Other sulfur species would generate peaks at different binding energies, which were not observed (Hercules 1980). The aliphatic carbon binding energies indicate three species; a saturated hydrocarbon, an oxygenated organic species and a carbonyl species. The carbonyl species could be interpreted as an inorganic carbonate, but several authors have concluded that silver carbonate does not form under ambient conditions and hence, an organic carbonyl is the most probable identification for this species. All of the coupons also have silica, sodium and zinc on their surfaces. The sodium and silica are common contaminants, possibly from dust deposition, whilst the zinc is a contaminant from a zinc oxide absorbent incorporated in the container used to transport and store the coupons from the showcase to the XPS instrument at Johnson Matthew Special Metals. Significantly higher concentrations of sulfide, sulfate, chloride, oxide and possibly the carbonyl species were observed on the externally exposed coupons compared to those exposed indoors. The silver concentration was also lower on the outdoor coupons and the silver Auger MNN peak was shifting to lower binding energy, indicating ionisation of the silver to Ag(I). The coupons exposed in the gallery ambient conditions showed slightly higher levels of sulfide, sulfate, chloride, oxide and slightly lower silver than those exposed inside showcases. No consistent differences could be identified between those sets of coupons exposed inside showcases.

The results from the SIMS analyses for the second exposure campaign are discussed below. Difficulties in sample preparation, handling, storage and analysis led to unreliable results from the first set of trials and these are not included. Handling the coupons with tweezers was found to be difficult especially mounting them onto aluminium stubs for the SIMS analysis. The slight curvature engendered in the coupons when cut with scissors, was found to lead to bad electrical contact and charging during analysis. This reduced the quality of the analysis. A much better methodology was adopted for the second set of analyses with the silver coupons mounted onto the SIMS stubs with self adhesive carbon pads for exposure. The surface SIMS results confirmed the XPS observations of a mixed tarnish layer, containing sulfide (S^- negative ions at m/z 32 and 33), sulfate (negative ions at m/z 85{SO_4^-} and 80{SO_3^-}), chloride (Cl^- at m/z 35 and 37), organic carbonyl species (M/Z 58{$C_3H_6O^-$}, 59{$C_2H_3O_2^-$} and 73{$C_3H_5O_2^-$}) and a range of positive organic mass fragments between C_2 and C_6 (m/z 15, 28, 29, 41, 43, 53, 55, 57, 63, 67, 71, 73, 77, 79, 81, 83 and 85).

SIMS depth profiling indicated that the mix of species was present through the whole depth of the tarnish layer. Figure 7 shows representative profiles for silver (Ag_{107}^+), and

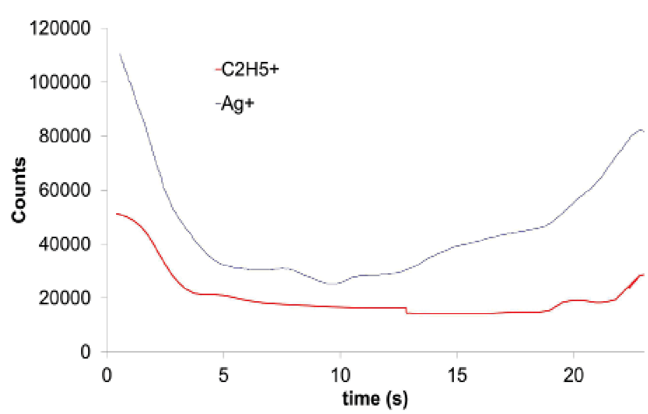

Fig. 7: SIMS depth profile

an organic species ($C_2H_3O^+$ at m/z 43). The equipment is limited to collecting three profiles at once, but the other important species were profiled separately, showing similar trends. The peak in the silver cation indicates the interface between the tarnish layer and the silver. Attempts to estimate the depth of the tarnish layer by measuring the ablation pits with a Zygo New View 200 scanning white-light interferometry microscope, were not successful because of the rough nature of the silver surface caused by the abrasive cleaning regime.

Object Examination

Neither the XPS nor the SIMS equipment used in this study are well suited for object analysis, as the sample chambers are very small. Scanning electron microscopy with energy dispersive analysis, (SEM-EDX) can provide some information about silver tarnish layers when they develop beyond a certain depth. The information is purely elemental, with no indication of the species present. Small silver objects showing tarnish accumulated over a number of years (between 2 and 25) were examined using a Joel 740 SEM with Cambridge Instruments EDX detector. The super atomic thin window on the Germaniun EDX detector allows excellent quantification of both carbon and oxygen. Analyses were taken from areas with as little dust as possible on the silver surfaces, as materials such as calcite, halite, gypsum and skin fragments would contribute carbon, oxygen, chlorine and sulfur to the analyses. Results are shown in Table 3.

The analyses followed the same trends observed from the previous XPS and SIMS results, indicating that tarnish formed over longer time periods still has a mixed composition. Of particular interest are the series of coins and medals analysed. These had 'cabinet' patinas, which are highly valued and had not been cleaned for over 50 years (conservation records) and are quite likely to have not been cleaned since acquisition, which was at least 100 years ago for all the examined objects. The analyses on these objects were undertaken on recessed

Table 3: SEM-EDX Analyses of Coins and Medals

Coin or medal	Sulfur	Chloride	Oxygen
A	0.40	3.74	9.72
B	0.38	4.48	6.40
C	0.47	6.01	6.01
D	0.34	4.00	4.00
E	0.30	6.11	3.06
F	2.84	3.92	3.43
G	0.04	1.44	1.44
H	0.20	1.32	0.66
I	0.58	1.47	1.23
J	0.26	2.33	6.06
K	0.78	2.57	1.29
L	0.80	3.64	5.72
M	0.36	5.03	5.03
N	0.62	2.96	7.70
O	0.48	3.86	1.93

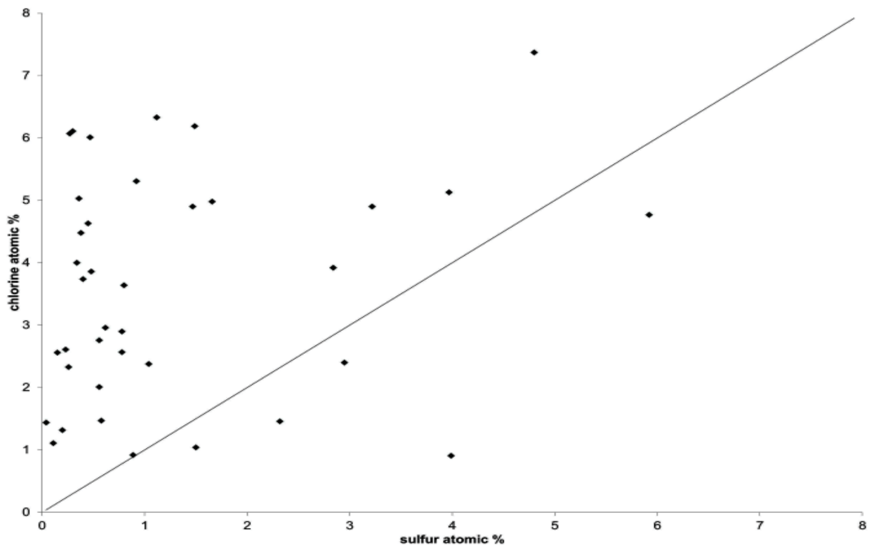

Fig. 8: Cl versus S for small silver objects

areas, where the patina was well preserved. Figure 8 shows a graph of the analysed chlorine concentration against the sulfur concentration. The line at 45° marks a one to one ratio of these two species and, as can be seen, the majority of analyses are above this line, as the patinas are predominantly chlorine based.

Species extending through the whole depth of the tarnish layer that had accumulated over 25 years on display.

The very long term tarnish formed on several objects was also analysed using potentiodynamic stripping (Palmsens 3 potentiostat, silver/silver chloride reference electrode, 0.1M sodium nitrate electrolyte) (Capelo et al 2013). Table 4 shows the estimated period (from conservation records) since last cleaning of the object, the calculated depth of silver sulfide, silver chloride, silver oxide and the full depth of the tarnish layer calculated from summing the three values.

Table 4: Potentiodynamic stripping analyses of tarnishes formed over long periods

Minimum period of exposure since last cleaning (years)	Equivalent layer depth (µm)		
	sulfide	chloride	Oxide
31	0.33	0.50	0.50
32	0.26	0.46	0.72
36	0.36	0.55	0.55
38	0.39	0.77	0.39
22	0.40	0.79	0.40
29	0.42	0.35	0.91
29	0.51	0.68	0.68
28	0.54	0.72	0.72
34	0.37	0.66	1.03
35	0.59	0.49	1.28
21	0.64	0.96	0.96
26	0.68	0.56	1.47
33	0.68	0.57	1.48
28	0.33	0.50	0.50

The tarnishes were all found to contain significant chloride and oxide, as-well as silver sulfide, Table 4. The technique is reported to have a very low sensitivity to sulfate (Sanders et al 2015). The tarnish layer thickness ranged from 1.4 to 2.7μm, despite the (up to) thirty five years of environmental exposure. This would place them in category IC2, – low according to the standard ISO11844-1 (ISO 2005).

A related project involved examination of a large number of silver objects from display showing unusual tarnish patterns. Examination with visual microscopy revealed particles with tarnish or discoloured halos around them. These were found to extend up to 1mm beyond the edge of the particles. In only one instance was the object sufficiently small to be examined in the SEM chamber and the halo was found to be rich in sulfur, chlorine, carbon and oxygen compared to the unaffected silver surface. Several of the particles were removed and analysed with SEM-EDX. This indicated that the particles responsible were of several different types, including clay particles (aluminium and silicon detected), fly ash, organic particles and one instance of sodium chloride. Such particles are thought to attract and hold humidity and pollutant gases onto the metal surface. Micro Raman spectroscopy of sodium chloride crystals has identified organic species absorbed onto the crystal surfaces. Particles have been shown to play a role in the atmospheric corrosion of several metals (Vernon 1935, Leygraf et al 2016). Recent research has shown deposited dust has a significant impact on silver tarnish rates in heritage buildings (Thickett and Costa ICOM CC 2014).

Environmental Sources of Chloride

The source of the chloride detected in the tarnish was further investigated.

Beyond handling and conservation treatments, the obvious airborne deposition routes are via particles and gases. Glass slides were exposed horizontally to collect particles, initially in the showcases tested, and then also in showcases at a series of sites across the UK. The slides were exposed for 28 days, after this time the surface was extracted with 10ml of 18.2MΩ cm-1 water and the extract filtered (50μm) and analysed with ion chromatography for anions.Long term deposition rates were also estimated from fabrics used to dress showcases. A 5cm by 5cm piece was cut from the fabric and analysed as for dust. The three fabrics analysed had been in situ for over 20 years.

Figure 9 shows significant chloride deposition in most locations. Those from maritime locations are higher, but there is a measurable rate at locations measured.

Chloride containing gas concentrations were analysed using Palmes diffusion tubes and the method developed for acetic acid (Gibson 1998) and the diffusion co-efficient quoted by (Dimmock and Marshall, 1987). The diffusion tubes are exposed vertically with the open end down and a 10μm dust filter fitted.

Some airborne species detected as chloride were analysed in all the showcases measured as shown in Figure 10. Without deposition velocities it is not possible to determine the likely deposition rates to the surface from the gas species. However, the dust deposition levels are high and likely to be the predominant source.

Discussion and Conclusions

The exposure experiments showed no clear correlation between tarnish rate and hydrogen sulfide or carbonyl sulfide concentration in showcase environments. This is a different behaviour than that exhibited in room environments. The tarnish rate is generally related to the air exchange rate of the showcases.

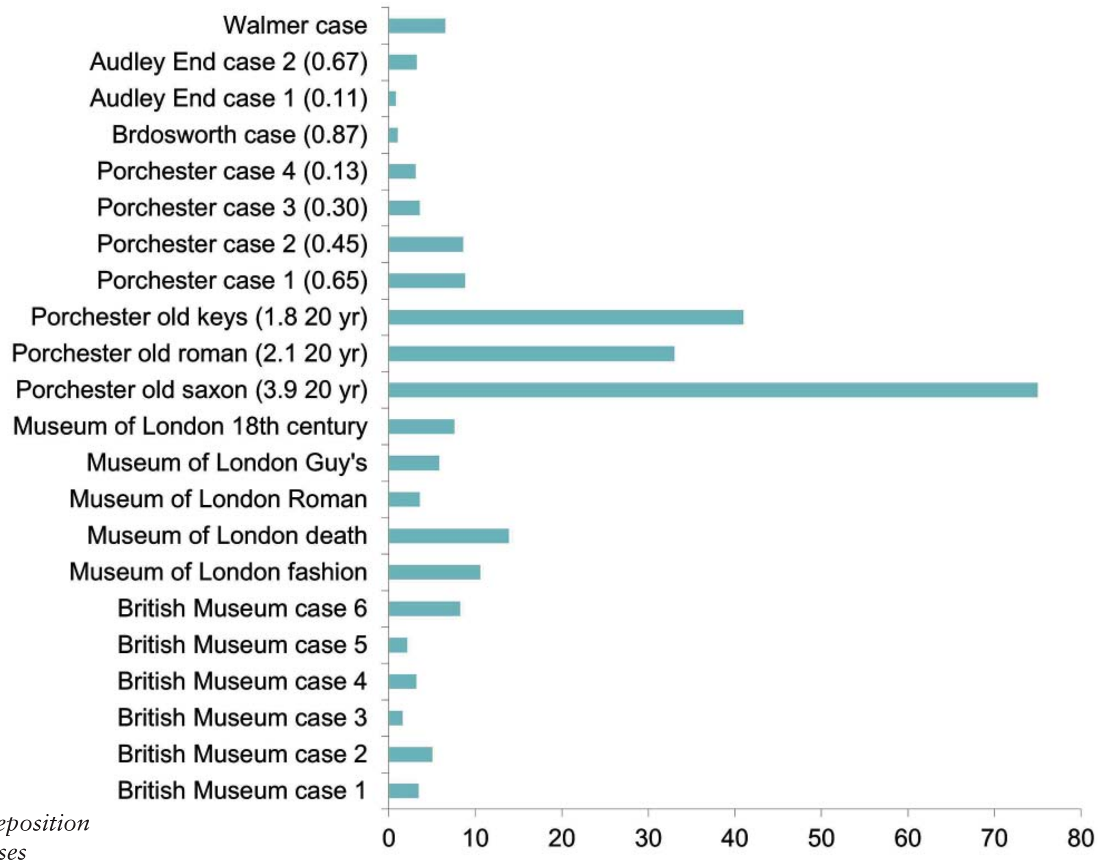

Fig. 9: Anion deposition rates in showcases

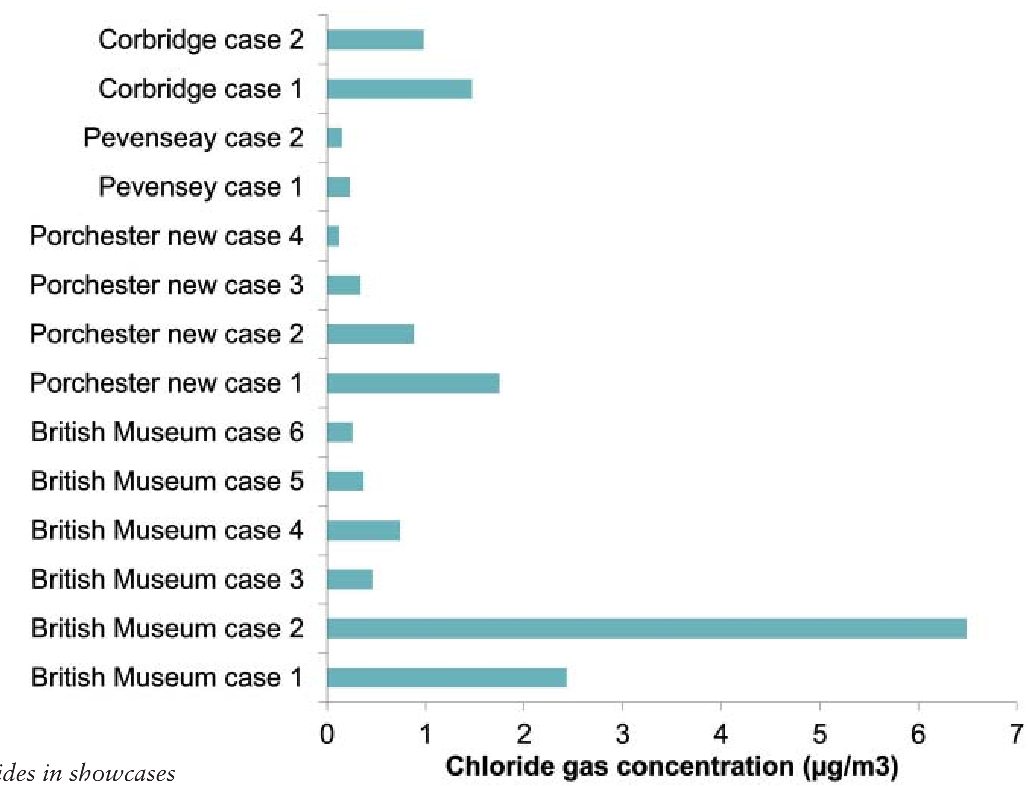

Fig. 10: Airborne chlorides in showcases

Some differences in tarnish rate were observed in some showcases. A possible explanation is the low air flow in showcases, combined with the very high reactivity of silver surfaces results in tarnish rates being controlled by fluxes as opposed to concentrations.

The tarnish formed was mixed and not predominantly silver sulfide, both in the short term exposures and in tarnishes examined that had formed over several decades. Chloride and oxide were almost always present along with a range of unidentified organic compounds. It is likely sulfate was also present in many instances, but only XPS and SIMS could distinguish it from sulfide. All compounds were found throughout the tarnish layer and not just at the surface. Industrial research has recently identified similar mixed tarnishes (Sanders et al 2015). Significant care had been taken to ensure showcase environments did not cause tarnish through emission from the construction and dressing materials used in the showcases. However, internal sources from mixed media objects were observed in one instance. Chloride deposition by both particles and from the gas phases was observed, the particles appear to be the main route.

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11 September 2020

The Butrint Foundation's Conservation Programme at Butrint, Albania: 1994-2020

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In 1976 he joined Sheffield University as a lecturer and launched excavations and cultural heritage projects in England and Italy at Roystone Grange (Derbyshire), Montarrenti (Tuscany) and San Vincenzo al Volturno (Molise). He joined the Butrint Foundation as its scientific director (1993-2012) to initiate new excavations and site management strategies at the Unesco World Heritage Site of Butrint (Albania). He is currently Principal Investigator of a major EU-funded project in Tuscany (2015-20).
He was Director of the British School at Rome (1988-95); Director of the Prince of Wales's Institute of Architecture (1996-98); Director of the Institute of World Archaeology at the University of East Anglia (1996-2007); Williams Director of the University of Pennsylvania Museum of Anthropology and Archaeology (2007-12). In 1999 he was principal adviser to the Albanian Minister of Culture, Edi Rama.
His books include *Dark Age Economics* (1982), *Mohammed, Charlemagne and the Origins of Europe* (1983), *Wall-to-Wall History* (1991), *Visions of Rome. A Life of Thomas Ashby* (2000), and *The Archaeology of Mediterranean Placemaking* (2016). He is general editor of Bloomsbury Debates in Archaeology and of the Butrint Foundation series of monographs. He is a columnist for *Current World Archaeology*. In 1995 he was awarded the OBE by Her Majesty the Queen.

Introduction

Graeco-Roman archaeological sites have been traditionally the subject of indifferent conservation. Athens and Rome, for example, places defined by their archaeological parks since the late 19th century, have a poor history of conservation and maintenance, notwithstanding their significance in global tourism (Hodges 2016). Many other ancient urban sites throughout the Mediterranean appear little more than jumbles of stones and unedifying footings of largely razed buildings (cf. de la Torre 1997; Teutonico and Palumbo 2002). Butrint, ancient *Buthrotum*, thanks to the intervention of the Italian Archaeological Mission of 1928-41, the Institute of Monuments of Albania after the 1960s, and more recently, the initiatives of the Butrint Foundation has had a more satisfactory history of conservation.

More to the point, it has passed with relative ease from the heavy interventionist approaches in conservation of the pre 1990s to the reversible approaches of the 1990s and modern era. This essay records recent conservation history and asks why this was possible in Butrint when it has proved more difficult in other Graeco-Roman urban settlements in the Mediterranean regions.

Conservation at Butrint before 1994

Butrint lies in south-western Albania, on the Vivari channel that leads from Lake Butrint to the Straits of Corfu (Fig. 1). A small sanctuary or port since Archaic Greek times, it became a Roman colony under the Emperor Augustus and was a prosperous later Roman port and bishopric, before being deserted in the 7th century. It was re-established as a town in the 11th century but was reduced to a fortified fishing centre by the 16th century (Hodges 2006) (Figs 2 & 3). The first detailed description in 1805 by Martin William Leake revealed it to be uninhabited and overgrown with only prominent medieval ruins being obvious. Luigi Maria Ugolini, leading the Italian Archaeological Mission to Albania, began the first systematic excavations at Butrint in January 1928. At that time there was no road to the site and it was normally reached by boat. The visible monuments were in a poor condition, but little that can be seen today was then on view. The absence of modern building made Ugolini's task comparatively straightforward. Just as helpful to him, in contrast to Butrint today, the vegetation was less developed with the promontory only partially covered by shrubs and low trees. The woodland matured after the Second World War and had become a distinctive feature when Nikita Khrushchev visited in May 1959.

Ugolini's goal was to make Butrint a place on the celebrated journey described by Virgil in *Aeneid* on the route from Troy to Rome. Making the archaeological remains accessible was essential to his mission (Ugolini 1937: 12; Gilkes 2003; Miraj 2003). From 1928 until 1936, when he died unexpectedly, Ugolini's mission transformed Butrint into Albania's first cultural heritage attraction. After Ugolini, successive directors of the Italian Archaeological Mission sustained the programme until the war brought the project to an end in 1941.

From August 1930 Ugolini excavated on a large scale, using small wagons mounted on a railway line to remove the overburden covering the monuments around the ancient theatre (Gilkes 2003: 56; Miraj 2003: 32). Elsewhere he excavated in sizeable trenches, exposing whole monuments. Central to his mission was the presentation of the excavated monuments.

Several members of his team were familiar with conservation and construction: these included his deputy, the artist, Igino Epicocco, the architect, Carlo Ceschi, and his junior archaeologist and engineer, who ultimately succeeded Ugolini, Dario Roversi Monaco. Giacomo Franz, assisted by Alfredo Nuccitelli, managed the large teams of local workmen, overseeing the excavations and conservation. This team transformed the remains on a remote hill into presentable ruins: the Hellenistic and Roman theatre and many other buildings were consolidated sensitively and in some cases partially, though discretely, rebuilt (Gilkes 2003: 10). Only the Byzantine and later medieval castle on the acropolis was dismantled and initially under Ceschi's direction then Epicocco's, completely rebuilt, making it more of a picture-book Italianate donjon. By contrast, the Great Basilica was left unroofed; only the columns of the Baptistery were erected in place (Fig. 4) (Bowden and Përzhita 2004: fig.10:4); the nymphaeum was conserved and

***Fig. 1:** Map showing the location of Butrint and principal monuments*

***Fig. 2:** View of Butrint looking towards the Straits of Corfu*

***Fig. 3:** Vertival view of the monuments on the acropolis and lower town at Butrint*

***Fig. 4:** Ugolini's team reconstructing the Baptistery, c.1930*

partially rebuilt, as were the fortifications of different periods. Ugolini's conservators, the Vetranno brothers from Rome, cleaned and consolidated the exceptionally well-preserved 6^{th}-century mosaic floor of the Baptistery as well as the late antique fresco above the earlier well of Junia Rufina. By comparison with the then contemporary practice in Italy (see, for example, Ostia), Ugolini's interventions were limited and essentially intended to make each building comprehensible to the visitor. Possibly, this strategy was imposed upon him by the availability of conservators, masons and materials in this singularly poor region. Nevertheless, the quality of Ugolini's work like his records was outstanding for the time, and as a result, the monuments were in a good state of repair, following almost twenty years of inattention, when the Instituti i Arkeologjisë (Institute of Archaeology) systematically tidied up Butrint for Nikita Khrushchev's visit in May 1959 (Hodges 2009).

After the Second World War and up until 1991 Butrint was situated in a frontier no man's land for which permission was required to make a visit. Not surprisingly, given Albania's post-war poverty, there were no excavations at Butrint between 1945-59, but with Khrushchev's visit new excavations were started by Dhimosten Budina, a Moscow-trained archaeologist.

Butrint was the southernmost stop on an itinerary for guided tours of communist Albania. Effectively now considered as a park, like the Graeco-Roman city of Apollonia near Fier (Ceka 2005), a concrete fence was erected around the western side of the site. Beyond this, after President Ramiz Alia visited in 1986, was a small café with concrete seats and tables dotted around in the woodland. Inside, a paved trail was made by Budina which was regularly upgraded thereafter. The excavations and accompanying surveys, now made exclusively by Albanian archaeologists and architectural conservators between the 1960s and 1991, were with one exception – Lako's investigation of the Hellenistic wall undertaken between 1975-76 – transacted on a small scale (Hodges 2012: fig. 1.4) (see Pani 1976 on the conservation strategy). For the most part, the documentation of these digs was minimal, and the record of conservation as a result was likewise negligible. The Instituti i Monumenteve të Kulturës (hereafter the Institute of Monuments, a section of the Ministry of Culture with an office at Saranda) was now responsible for the management of the archaeological site and followed an explicitly nationalist ideology in the management and conservation of Albanian monuments (cf. Kosta 1986).

The Institute's premier role was to promote the well-preserved, multi-period fortifications, illustrating the nation's long history of defiance against aggressors, as well as, once Albania began to encourage controlled tourism, its range of well-maintained monuments. At Apollonia, for example, the Institute pioneered the partial reconstruction of monuments. At Butrint the ethos was less ambitious and therefore less invasive, thanks to the sensitive management of a series of local overseers of works, the last of whom, from the late 1970s, was the surveyor, Telemark Llakana. All the monuments uncovered and restored by Ugolini were stabilized and restored, mostly using local lime mortar. Steel scaffolding with timber frames was now deployed to work on most monuments, the scaffolding and timber being imported to the site by trucks using the new road. The Institute of Monuments architect responsible for Butrint was Guri Pani. Amongst his most ambitious projects was the partial restoration of the *scena frons* of the Hellenistic and Roman theatre uncovered by Ugolini. Pani also drew up plans for reconstructing parts of the ancient civic centre including the temples (1988a; 2001) and stoa but none of these were pursued (Pani 1988b). For a time small pumps were deployed to drain the water filling the *cavea* of the theatre, but otherwise recourse to technical support was minimal as the supply of electricity to the ruins was intermittent. Pani's colleague, Aleksander Meksi, later Prime Minister from 1992-97, was responsible in the 1980s for the restoration of the Great Basilica, the Baptistery and the Triangular Fortress. The overall visual impact of the Institute's conservation policy at Butrint, in contrast to its work at Apollonia, was minimal. Part of this programme involved subjecting the woodland to systematic management, restricting the prodigious and invasive growth of the low vegetation especially threatening to the defensive walls.

Fifty years afterwards it is ordinarily difficult to distinguish the restoration work by the different missions from what was original. Unlike Ugolini, however, who transported the soil from his excavations either to the Vivari Channel or beyond the Western Defenses, the Albanian excavators mostly deposited the removed soil beside the open excavations. In this period all the mosaic pavements were also stabilized, following the practice of the Italian Mission. By contrast, with limited technical resources the Institute were unable to stabilize and protect the frescoes, mostly found by Ugolini: the late antique fresco in the arcosolium above the well of Junia Rufina; the later medieval frescoes in the church above the stoa; and the frescoes of the late medieval chapel by the north citadel wall, near Lake Gate (at the west end of the acropolis).

In 1991, with the breakdown of the communist state as Albania became a democracy, the Institute of Monuments was unable to sustain its workforce at Butrint. Only its local officer, Llakana, was retained with negligible operational resources. As a result from 1990-94 minimal conservation of any kind was undertaken at the site.

The Butrint Foundation Programme

The Butrint Foundation was created by Lords Rothschild and Sainsbury as a British charity in 1993. It actively operated in Butrint running research excavations, managing conservation programmes and generally assisting with the protection of the UNESCO World Heritage Site (inscribed in 1992). As of 2013, its active operations ceased, but the charity continues to provide grants for projects at Butrint while publishing its excavation reports.

Over the course of twenty years, the Butrint Foundation's conservation programmes can be summarized as follows (see also Hodges 2016):

Phase 1: 1993-97: an unlikely meeting of conservation minds

The first period of this project, between 1993-7, can best be described as a confrontation of scientific cultures (cf. Pettifer and Vickers 1997; Hall 1999). The Foundation set out to develop a strategy based upon a combination of research, low-cost reversible conservation (suitable for the local circumstances), presentation and marketing in order to increase tourism and therefore create income and employment at Butrint. The model for this strategy was Riccardo Francovich's innovative archaeological park at Rocca San Silvestro, a deserted medieval hilltop village in Tuscany that was fully opened to the public in 1996. The Foundation team included a buildings conservation architect, Richard Andrews (Carden and Godfrey Architects, London) and a practicing materials and finds conservator (Pippa Pearce, British Museum).

From the outset, therefore, the vision for conservation was to protect the unspoilt spirit of Butrint, created by Ugolini and sustained by the Albanian authorities between 1945-91.

Fortunately, while the Institute of Archaeology showed no willingness to engage in a planned programme for Butrint, including site conservation, the local official responsible for the Institute of Monuments, Telemark Llakana, with reference to his director in Tirana, Valter Shtylla, took a different position (Fig. 5). Llakana brokered the first conservation initiatives with the Foundation in 1995. These included support for woodland clearance to protect walls that were endangered by low, invasive vegetation, an outline survey of the monuments including the churches with frescoes, and a condition survey of the mosaic pavements at the Baptistery. With funds from the World Monuments Fund these early initiatives established priorities and at risk monuments, while re-invoking woodland management practices that had been standard annual exercises since the 1970s. By the end of 1996 the site was once again managed in conservation terms, and an outline condition survey now existed.

Fig. 5: Telemark Llakana with Lords Sainbury and Rothschild and Richard Hodges]

In 1995-96 one palpable conservation threat (which did not materialize) was a bid by the Institute of Archaeology for European Union funds to build a cover over the Baptistery. This scheme envisaged keeping the mosaic pavement exposed throughout the year. Perhaps the scheme failed to win support because the concept involved using solar-power energy, generated by panels on the roof, to operate a pumping system to drain the Baptistery of ground water (which in winter tends to cover the monument up to 30 cms deep).

Phase 2: Making the Butrint National Park 1998-2000

After the civil uprising (the so-called Pyramid Fund crisis) in February 1997, the World Bank and the Getty Grant Program encouraged the Foundation to be more aggressive in pursuing its objectives.

Phase 2 at Butrint began with a values-based workshop in neighbouring Saranda funded by the Getty Grant Program in April 1998 to determine its significance, from which it was proposed to develop a management strategy (cf. Demas 2002). This was not a 'meeting of experts ….. best …seen as a piece of political theatre in which archaeologists (and conservation professionals) played the role of the white-coated specialist on a television commercial for an over-the-counter cold remedy.' (Joyce, 2005: 267). On the contrary, the high level and diverse Albanian participants, perhaps artfully manipulated by the foreignors present, concluded that first and foremost the magical spirit of Butrint needed to be protected as its greatest asset. The gravitational pull of the monuments themselves was resisted and instead the context, the spirit of ruins in an unexpected woodland surrounded on three sides by water, was prioritized. The immediate outcome was a landscape plan for Butrint and its setting drawn up by Jamie Buchanan, the landscape architect who designed the Rocca San Silvestro park, Tuscany. This led to the enlargement of the UNESCO World Heritage Site in 1999 to include a buffer zone, encompassing an area of 29 km^2.

The workshop in 1998 had specific implications for the management and conservation of Butrint's monuments. Since the groundwater of Butrint did not damage the buildings, pumping the water out of the *cavea* of the Theatre, for example, contravened sustaining the spirit of Butrint. A better solution was to keep the water clean as opposed to suffer the perpetual noise from a pump. Cleaning the water also provided employment whereas a pump did not. At a second workshop in September 1998 dedicated to conserving the celebrated Baptistery pavement, the participants arrived at the same conclusion. Pumping the water from the monument, it was concluded, would destroy the spirit of the place; it was better to open the mosaic pavement each summer and train local conservators to maintain it. Again, the latter provided employment and the intervention involved was minimal.

In this unsettled period, though, the foundation was unable to carry out conservation on any scale or indeed to train any conservators. Nevertheless, Llakana skillfully maintained a small woodland management team and carried out limited conservation projects if these were urgent (with the foundation's support).

Phase 3: 2000-2007 – developing the park infrastructure

The creation of the Butrint National Park in 1999 (as an archaeological park belonging to the Ministry of Culture) facilitated major developments at Butrint over the following seven years. A (2000-5) management plan based upon a condition survey of the monuments paved the way for a strategy (cf. Sullivan 1997) that included regular conservation (Martin 2001). Objective 6 of the plan set out the following short-term (Phase I) and medium-term (Phase II) objectives:

Phase I

- Appoint a part-time conservation officer to direct and advise the skilled workforce on technical and conservation matters.
- Undertake a full condition survey of the monuments.
- Programme the reburial of old excavation trenches not needed for site interpretation and display.
- Develop a modern code of practice for conservation staff based on the old Institute of Monument's handbook and the knowledge of the existing experience workforce.
- Establish a placement and training programme for new staff.
- Create an accessible conservation archive.
- Facilitate a mosaic conservation and display programme.

Phase II

- Develop a dedicated conservation workshop with teaching and demonstration areas.
- Establish a formal apprenticeship system to assist local school leavers into skilled and semi-skilled conservation posts.
- Develop an annual maintenance and monitoring system.

Over the following decade the Phase I objectives were mostly met, and the will to meet the Phase II objectives certainly existed. In addition, during these years there were many other initiatives including the extensive refurbishment of the Museum (made in 1938 and enlarged in 1988), new hiking trails though the buffer zone, new information panels, a new website, new guidebooks, wide-ranging capacity building including a guide-training programme, an archaeological and conservation training school and a major research programme including archival studies. Significantly, in 2003 the Foundation also won support from RAMSAR for an even larger environmentally-protected zone encompassing Lake Butrint and its immediate surroundings.

The new Park administration included a conservator, Albana Hakani, who took over from Llakana after he retired in 2001. The conservator sustained the woodland management programme, and significantly, with the Foundation's support, created capacity building training schools. Wall conservation and mosaic conservation were taught as summer schools with experienced programme instructors in 2005-7. In October 2007 ICCROM supported Butrint's conservation officer to manage a South-East Europe Conservation course at the World Heritage Site. Before and after this, conservation interventions included: Ali Pasha's Castle (2008), the Baptistery mosaic pavement (2006), the well of Junia Rufina (2007), the nymphaeum (2005), the Triangular Fortress (2004-5), the Venetian Tower (2002-3), the Water Gate (2007), and the remains on the Vrina Plain (2006). In addition, the excavations of the Triconch Palace, covering nearly a third of a hectare, completed in 2004, were conserved and transformed into a presentable archaeological site in 2005 (Fig. 6). Part of the Triconch Palace conservation plan, designed by Andrews and implemented by Hakani, included the stabilizing and conservation of all the buried mosaic pavements (Bowden and Hodges 2011: 8). In 2005 Hakani also oversaw the backfilling and presentation of the maritime villa at Diaporit on Lake Butrint, excavated between 2000-2004 (Fig. 7).

In all these interventions, a strong effort was made to minimize the invasiveness of the conservation, to control the vegetation, to manage the seasonal ground water, and to back-fill archaeological excavations with the notable exception of the Triconch Palace (cf. Bowden and Hodges 2011: 7-8). Above all, over a dozen Albanian conservators were trained in contemporary techniques, alongside local workmen trained in the basics of stone and mortar restoration.

Phase 4: 2007-2012- towards a sustainable future?

By 2008 Albania was no longer a transition economy, and on the eve of the global financial crisis, the future of the Park seemed secure. During these years the Foundation updated and expanded the first condition survey of Butrint's monuments. Special attention was given by the Foundation's consultant, René Rice, to the condition of the kilometres of fortification walls. Many sections of the defences with their gates were cleaned, repaired and stabilized, this offering the opportunity to train a cohort of artisans in basic conservation tasks (Fig. 8). A number of monuments also received renewed interventions, but perhaps the greatest efforts

Fig. 6: *Conservation of the Triconch Palace (2005)*

Fig. 7: *Conservation of Diapoirit Roman villa (2005)*

Fig. 8: *Conservation of the lakeside (6th-century) fortifications (2008)*

were given to woodland management, path-making, landscaping, trench filling and spoil removal. One major project involved stabilizing Ali Pasha's Castle that suffered significance subsidence in 2008 and was stabilized after a systematic architectural study in 2010-11.

With greater collaboration and the availability of a cohort of workmen under well-trained management, this was the occasion to reflect upon the future of the Butrint Foundation. With the creation of a cultural section of the Albanian American Development Foundation (AADF) and an agreement by the Albanian Ministry of Culture to permit 90% of the ticket revenue from Butrint's 80,000 or more visitors (in 2012) to be employed at Butrint, the Foundation has, as of 2013, ceased active operations and now pursues only grant-giving. Since 2008 the Foundation, then, has supported conservation of individual monuments, primarily undertaken by Albanian conservators. As of 2013, the Butrint National Park's conservator, Eva Thomagjini, in collaboration with the Institute of Monuments is responsible for updating the conservation component of each quinquennial management plan, and for its implementation.

Towards 2030

Apart from grant-aiding conservation projects at Butrint, since 2018 the Butrint Foundation has collaborated with the Albanian American Development Foundation (AADF) on an ambitious project to create a new management structure for the World Heritage Site. Instead of being a park overseen by the Ministry of Culture, the new entity would be a small foundation – effectively an NGO – overseen jointly by the AADF and the Ministry of Culture with a capital grant from the AADFF to undertake many new initiatives at Butrint. The overall strategy, drawn up by the UK consultants Prince and Pearce (2020), would include a new traffic plan, a visitor centre, a long-term conservation schedule and a plan for protecting and presenting the park's hinterland. This plan was very advanced when the pandemic struck but looks set to be launched in 2021 with financial support in place until about 2030.

Discussion

Limited access to Butrint, because it was in a frontier zone accessible only with permission until 1991, almost certainly restricted the temptation to reconstruction of its excavated archaeological monuments. Unlike Apollonia, for example, there was instead an emphasis upon stabilizing the monuments and mosaic pavements. Reconstruction using concrete is almost absent. In addition, Butrint was fortunate in its local management from the 1970s through to the 21st century. Through this agency Butrint was protected from the excesses of non-reversible reconstruction that were favoured by communist governments after World War Two to generate tourist revenues in foreign hard currencies. The steady hand of Telemark Llakana managed the Institute of Monuments' operation at Butrint, providing an essential and intelligent continuity during the destabilizing early 1990s when inappropriate projects were being considered. He comprehended that 'the greatest challenge to pursuing a values-based approach to planning is acknowledging that values are mutable and there are few absolutes in terms of what is right or wrong' (Demas 2002: 49). One 'absolute', the greatest problem at Butrint also makes it an especially beautiful place, namely the vegetation that is prodigiously nurtured by the abundant winter and spring ground-water. Working with Llakana, then assisting the creation of a new generation of conservators trained in the importance of minimalist and reversible techniques, the conservation promoted by the Butrint Foundation has been a critical element in sustaining Ugolini's thoughtful legacy for modern visitors. Butrint feels unspoilt, and as Ugolini wished, the ruins remain a place for romantic meditation.

Acknowledgements

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1 October 2020

Understanding the Challenges of Historic Buildings in Ireland

DAVID is a Director of Architectural Conservation Professionals (ACP) which has offices in Ireland and Singapore. He established the practice in 2000 and since that time has worked on over 750 projects for private clients, charitable organisations, government departments and public authorities. He manages a team of over 15 specialist consultants covering all aspects of building conservation. He has over 30 years experience in both public service and private practice in Ireland, Canada, Australia and the UK. David spent 8 years working as a Senior Professional Officer with English Heritage and has extensive experience in managing large conservation projects. He has advised on projects in the Kingdom of Saudi Arabia, Newfoundland and Myanmar. David currently serves on the SCSI Conservation Group as Vice Chairperson and on the SCSI Project Management Group as Education Chairman.

NANCY has a B.Sc degree in interior architecture and is a registered building surveyor. Nancy has over 10 years of experience in the refurbishment and adaptation of historic buildings gained in both Ireland and Australia. She manages projects for ACP through all stages including inception, design, 3D modelling, planning, tendering and procurement of works on site. Her particular area of interest is in the conservation of historic timber and its use as a construction material in historic roofs. Nancy was the lead consultant and project coordinator on the restoration works at Quay Street in Galway that won Engineers Ireland excellence in conservation and heritage award.

Mr. David Humphreys is the founder and director of ACP group which is an multi award winning international multidisciplinary building conservation practice established in the year 2000. ACP has 15 specialist staff with over 30 years of experience in historic buildings and landscapes. They are accredited in building conservation by the RICS, SCSI, RIBA and IHBC. The headquarters are in Ireland with a North American office in St Johns Newfoundland, and a South East Asian office in Singapore. This article discusses the historic buildings in Ireland, the legislative context in the country, the challenges in undertaking conservation and specifically the case study of a complex project called the Aran Sweater Market in Galway to illustrate many of the challenges faced by ACP.

Legislative context in Ireland

In Ireland legislation is primarily made up of:

- The National Monuments Act dating back to the 1930s and subsequent additions. This relates to historical structures and monuments and archaeological sites that predate 1700 normally. According to the legislation, the archaeologists who deal with such designated national monuments need to be licensed under the National Monuments Act.
- Part IV of the 2000 Planning Act. In the year 2000, a new planning act was introduced that recognized a new category of buildings and structures namely Protected Structures (these are known as listed buildings in England). These important buildings have protection in Ireland for the first time.
- The Department of the Environment began a series of building and garden surveys under the National Inventory of Architectural Heritage (NIAH) survey program which is still underway. This project surveys and inspects historic buildings and gardens nationally and informs Government Departments and the Local Authorities regarding the historic buildings and gardens in the country.
- The Archaeological Survey of Ireland updates the records of the historic monuments and places in the country. This is an ongoing project also.

The various organizations involved in the built heritage in Ireland consist of a number of Government Departments, a number of prescribed bodies such as the Heritage Council, the various local authorities and County Councils, and a number of professional bodies such as the Society of Chartered Surveyors, the RIAI, Engineers Ireland and the Chartered Association of Building Engineers and so forth.

There are other bodies such as the Irish Georgian Society and Civic Trusts and other local community groups which take an active role in building conservation. The Construction Industry Federation has an accreditation scheme for builders. The Irish Blacksmiths Association have a heritage committee that represents heritage blacksmiths in Ireland and promotes traditional blacksmithing skills.

Many of these organizations work in partial isolation much the same as Skellig Michael is an isolated island off the Atlantic coast of Ireland. Skellig Michael is famous for its role in some recent Star Wars movies.

The historic monuments in Ireland are divided into two categories: national monuments and recorded monuments. National monuments are regarded as being nationally important and generally maintained by the Office of Public Works. Examples of these include the Rock of Cashel and Skellig Michael off the west coast.

Recorded monuments vary from church ruins dating back to the 13^{th}-14^{th} century to field monuments which can date from the iron or bronze ages.

Protected structures sometimes called ‘listed buildings’ are protected under the 2000 Planning Act. In some cases, a structure or building can be covered by the protected structures legislation and the national monuments acts. This is particularly important because in these cases the consultant has to then work with the National Monuments Service based in Dublin and the Local Authority.

Fig. 1: Saint Nicholas Church

Saint Nicholas Church (Figure 1) is an example of both a Protected Structure and a National Monument. ACP have over several years undertaken works such as reroofing the main Church and the Dunraven Mausoleum, undertaking works to help the historic building recover after a major flood.

(Figure 2) ACP have undertaken several projects at Mary Immaculate College in Limerick over the last 10 years including:

- the preparation of a conservation management plan for the campus,
- specifying and supervising repairs to the historic buildings,
- preparation of planning applications and the supervision of works.

Fig. 2: Mary Immaculate College, Limerick

In 2018 ACP was commissioned to prepare a conservation management plan for the Bunratty graveyard in County Clare (Figure 3). This project was funded by the Heritage Council.

Fig. 3: Bunratty graveyard, County Clare

Fig. 4: Archaeological fragments, Quay St Galway

The image (figure 4) shows a sandbox with a number of different stone mullion and transoms. These are archaeological fragments recovered from the site in Quay St Galway. During the project agreement was reached with the local authority Heritage Officer on the appropriate mullion and transom replacements using this particular method.

Challenges

Owners' perception

There are many challenges in preserving historic buildings in Ireland and the first of these is the perception of the public/owners. Generally, the public or the owners of historic buildings tend not to appreciate their value and sometimes their initial approach is that the building should be demolished completely and that a modern building should replace it. This would mean that all current building standards, building regulations are met and it has all the necessary modern conveniences.

Fig. 5: An example of a family home with a shop that is no longer economical so the house is left boarded up to decay

The reality is that historic buildings can be upgraded to meet modern living requirements such as heating, insulation and so forth. There is a considerable lack of understanding by members of public in this area. A significant education program is required to help change the public's understanding into one that is more friendly towards repurposing historic buildings as their ancestors have done for generations.

Rather than thinking that the first option is to demolish the building (whether it is a vernacular building in a town or village, an old farmhouse, etc.), the first option should be that it is feasible to upgrade and maintain these buildings and bring them back into use.

This is a very difficult challenge, not helped by uninformed officials who stick rigidly to the text books, and thus take a very restricted approach that is inappropriate and off putting to the owners of historic buildings. The challenge needs to be recognized first of all and then a real effort made to educate all the stakeholders involved in historic buildings.

Fig. 6: The building before restoration

Fig. 7: The building during restoration

This building is a project that ACP was involved some years ago where prior to their involvement the Planning Authority were being difficult and as the owners did not know anything about historic buildings, they were totally depending on their consultants who had no interest in taking the project forward after a grant of planning. This particular project is an example where the owners of the house didn't really appreciate the long history extending back over 700 years that the house had, and as the project progressed, they became to realize the significance of various aspects of their house including

Fig. 8: The building and the surroundings after restoration

Fig. 9: The interiors after restoration

the fact that the west wall of their guest room had originally been part of the entrance gateway through the Bawn wall of the tower house on the site.

The particular property has evidence of many medieval and later Elizabethan historic fabric within the outbuildings. The owners started out with no appreciation or understanding of the historic building complex they had purchased and as the project progressed, they became more drawn into it to a point that I believe the property is now safe in their ownership for a couple of generations.

Figure 10 shows an old thatched cottage (probably 18th Century) and figure 11 shows the same building in an advanced state of dereliction. The building had been the subject of a planning application to extend and restore in the early 21st century. ACP was not involved with the project and sadly the project was significantly delayed during the planning process which resulted in the owner abandoning the project to the detriment of the historic building. This is a sad case where the legislation and its implementation worked against the historic building.

Fig. 10: Old thatched cottage in need of repair

Fig. 11: The abandoned building with structural damage and loss of thatching.

The Quay St project in Galway which will be discussed later, is an example where the site had been derelict for many years and the Planning Authority were very anxious for the project to progress and facilitated the advancement of the project by working closely with the design team of which ACP were lead consultants. This is an example of a very successful collaboration between the stakeholders working for the good of the historic building.

Economic use

One of the biggest challenges facing historic buildings is the question of economic use. If a building has no obvious/potential economic use, then it is in real danger of dereliction and ultimate loss.

Fig. 12: *Old tower house with overgrown ivy*

The structure (figure 12) on the top, which is an old tower house overgrown with ivy and in a structurally unstable condition, is one of an example of hundreds of these structures in the Midwest of Ireland which have no apparent future. A small number of these have been refurbished as holiday residences at great expense to the owners. These are lovely projects but really are one offs.

Fig. 13: *Restored building converted to a hotel, County Longford*

The building at the top (figure 13) is a hotel in County Longford that has a history going back to medieval times. ACP have undertaken a significant fire engineering upgrade, introduced modern technology related to health and safety regulations to allow the building to continue to operate as a hotel.

The building on the bottom (figure 14) is a former seminary located in Thurles Co. Tipperary that is no longer used as a seminary. ACP advised on the upgrading of the dormitory buildings to accommodate residential facilities for postgraduate students as part of the University of Limerick, Mary Immaculate campus.

Fig. 14: *Seminary now a part of University of Limerick, Mary Immaculate campus*

Culture

In Ireland we are very proud of our culture, Irish traditional music and dance, Gaelic games such as hurling and football, and traditional skills such as blacksmithing.

Although one wonders if historic buildings are valued as part of culture? Over the years ACP has come across owners of historic buildings who have no value for them and when questioned the reply sometimes include 'they are nothing to do with Ireland they were built by the English' They forget that these buildings were built mainly by Irish craftsmen are part of our history and should be valued for this reason.

***Fig. 15:** Irish football*

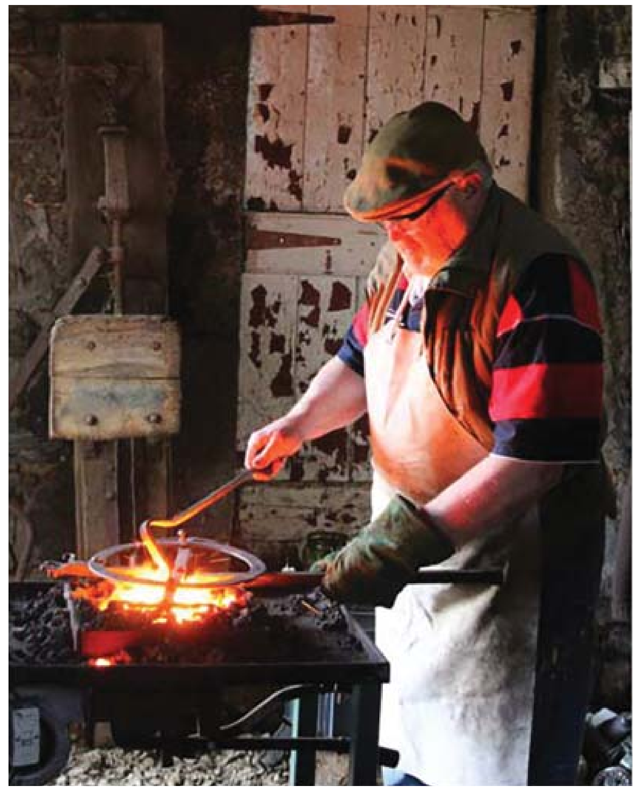

***Fig. 17:** Traditional blacksmith*

***Fig. 16:** Irish dance*

***Fig. 18:** Irish music*

Disappearing traditional craftsmanship

As one travels around Ireland there is evidence of traditional craftsmanship such as wrought iron gates and railings left to rust or decay in graveyards and farmyards and around cities. Many of the traditional heritage blacksmithing skills are no longer understood or practiced and all too often are being cast aside and replaced with modern fabricated steel that are mass produced probably in China.

Many of these traditional gates and railings date to the late 18th and 19th centuries and both the skills and techniques used to create these are in danger of being lost along with the examples that are rusting away and forgotten. It is probably one of the most undervalued and least understood part of our traditional heritage that is in danger of being lost.

Fig. 19: *Traditional jointing technique*

Fig. 20: *An old gate still in use*

Fig. 21: *Traditional method of wrought ironwork*

Fig. 22: *An old railing with traditional iron work*

Inappropriate repairs

Another area of concern is the acceptance by authorities and professionals of inappropriate repairs to historic fabric. Many examples of these include the typical situation where the original wrought iron gates were deemed to be beyond repair, and then completely replaced by modern fabricated mild/cast steel example with no historic relevance to the particular property. In most cases, the wrought iron gates/railings need some repairs particularly to the bottom rails which is very feasible with the right knowledge. They are often condemned to the scrapheap.

Another inappropriate use of materials is where OPC (Ordinary Portland Cement) pointing and/or render has been used and is now causing significant problems to the masonry such as cracking, delamination, water retention, etc. ultimately leading to structural failure and decay.

In other cases, repair works have been carried out to historic windows/staircases etc. which are totally inappropriate using the wrong materials and poorly skilled labor. In most situations this leads to further deterioration of the historic fabric and is really only a short term fix with very serious longer term problems.

Again these are examples where a lack of appreciation and understanding of traditional materials and crafts is leading to a serious loss of the original fabric and structural decay and failure.

The big challenge is that we need to educate owners, professionals, and other stakeholders on the use of appropriate materials and skills in undertaking repairs to historic buildings. Properly undertaken repairs will potentially last more than 200 years. Whereas a modern inappropriate approach may be just as expensive and only last 20 years or even worse, cause further damage to the historic fabric.

Fig. 23: *A new gate installed in place of an old gate that could have been restored*

Fig. 24: *A building with OPC plaster rendering*

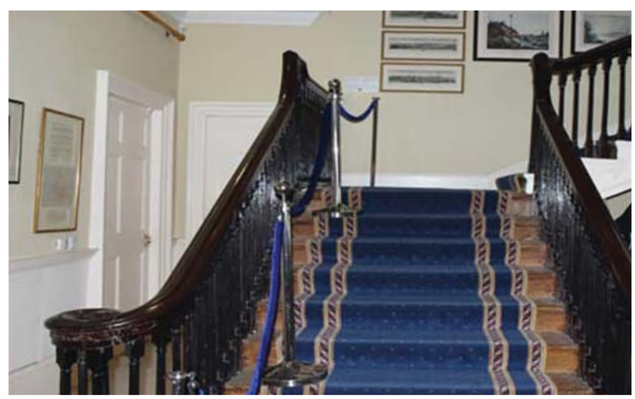

Fig. 25: *Inappropriate repairs in a staircase*

Fig. 26: *Cement pointing done leading to stone damage*

Technical challenges

The technical challenges faced are:

- the integration of traditional/ old technologies and new/ modern technologies which in many cases are incompatible
- the lack of building conservation expertise in the building professions, in the trades and in the authorities
- the need to upgrade historic buildings to take account of modern fire engineering requirements and
- the requirement to meet where possible modern building codes and securing DACs (Disability Access Certificates)

ACP has successfully upgraded many historic buildings to meet these requirements, but there are instances where some officials will not accept tried and tested solutions such as the introduction of high pressure mist systems in favour of fire escapes etc.

Fig. 27: *Historic building integrated with modern technology and still in use*

Fig. 28: *Electrical fittings and fire safety equipment installed in traditional building*

Fig. 29: *Historic building adhering to modern building codes*

Case Study Aran Sweater Markets, 25 Quay Street, Galway.

This project was undertaken in 2 phases:-

- Phase 1 – 2016-2018
- Phase 2 – 2018-2019

The phase 1 involving the work on the building will be discussed in detail as phase 2 was essentially refurbishing an existing retail premises and connecting it to the building where works were undertaken in phase 1.

The Aran Sweater Market is located at No. 25, No. 2-5 Quay Lane, Galway City.

Fig. 30: *Quay Street property before restoration*

The property was in a dilapidated state when ACP first visited it in 2016. It was originally a number of individual properties that were merged into one unit in 2009. However, the site was left vacant and in a ruinous state without windows, doors or a roof until 2016 when our client purchased the site.

The clients brief was to convert the building into a retail store while keeping all original features and characteristics of the building intact within their original settings. To achieve this extensive research and surveys were required to be carried out. The building also had to comply with the Building Regulations Technical Guidance Documents in particular Part B dealing with fire safety and Part M dealing with disability access.

The building is located in the historic core of medieval Galway City, and is protected by both the Planning Acts and the National Monuments Acts.

Fig. 31: *The interiors of the property with the missing roof, windows and other architectural elements*

ACP were appointed as the lead Consultants for the duration of the project – from inception to completion. We provided the following consultancy services:

- Conservation Building Surveyors
- Conservation Architects
- Conservation Engineers
- Project Managers
- Design Certifiers under the Building Control System

The site contained fabric from many different historic periods dating from the 13th century onwards. This was not fully discovered until construction works broke ground in January 2018 when opening up works and archaeological investigations started to reveal the detailed history of the property.

The design required a complex structural solution to protect the original historic fabric including the archaeology, medieval masonry walls, and to ensure a modern retail outlet with all the required services installed within the roofless ruin. This design was further complicated by the need to stabilise the original masonry walls, and protect the archaeology team undertaking excavations during the construction stage.

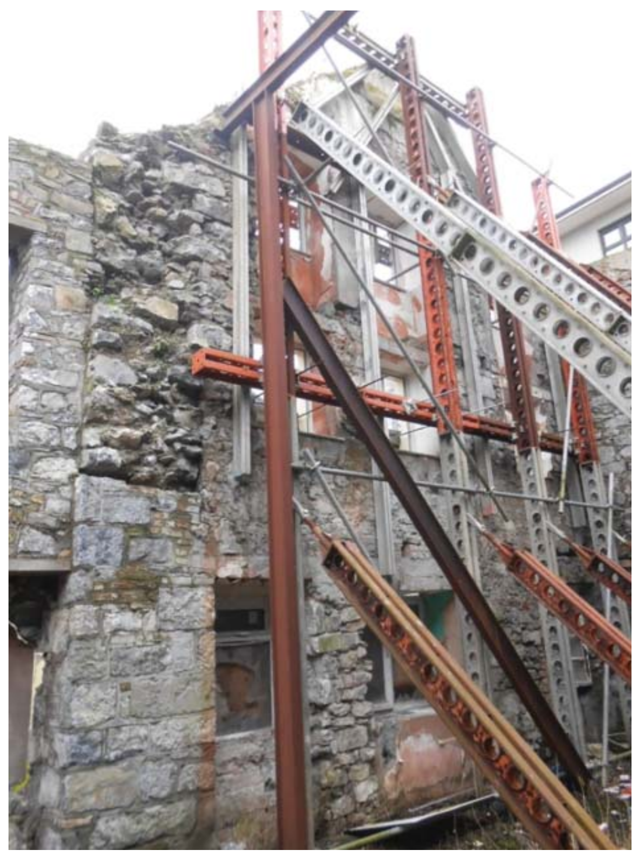

Fig. 32: *The structure prior to works*

Fig. 33: *All the internal walls had been demolished*

Fig. 34: *Detail of the concrete frame designed to support the building*

Fig. 35: *Concrete column to carry the main structure*

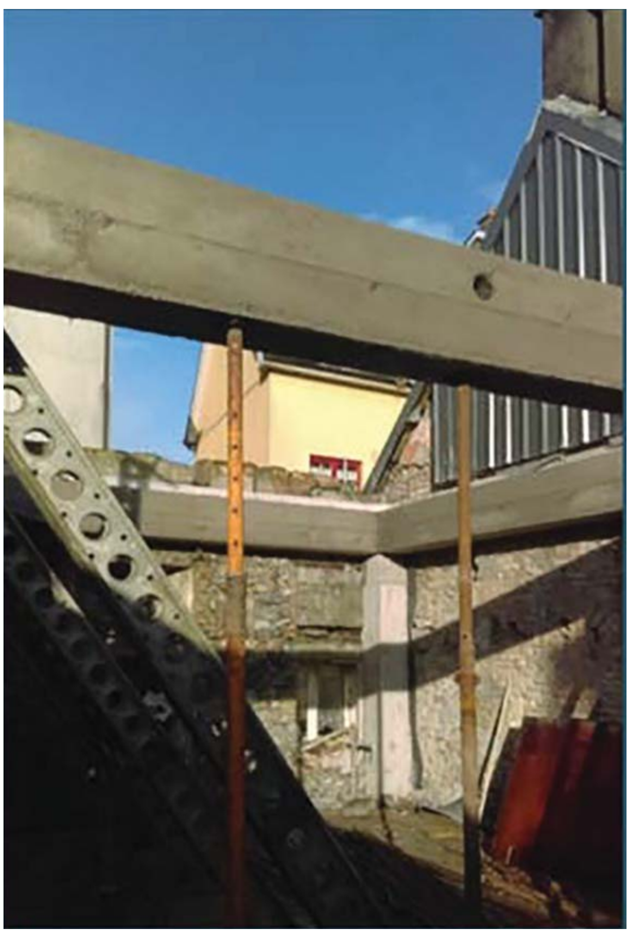

Fig. 36: *The work on the new concrete frame structure designed to carry the roof and floors in progress*

Fig. 37: *The new roof being built on the concrete frame*

The original walls were not capable of carrying a new roof and floors due to their age and condition. A new concrete frame structure was designed to carry the roof and floors independent of the walls. This allowed for greater flexibility in designing the internal spatial layout.

Repairing the stone/brick fabric – the walls were severely damaged and repaired using inappropriate materials such as concrete over the years. This presented a challenge to remove the modern materials and also stabilise the original

Fig. 38: *'King post' truss roof within the 19th century section of the building*

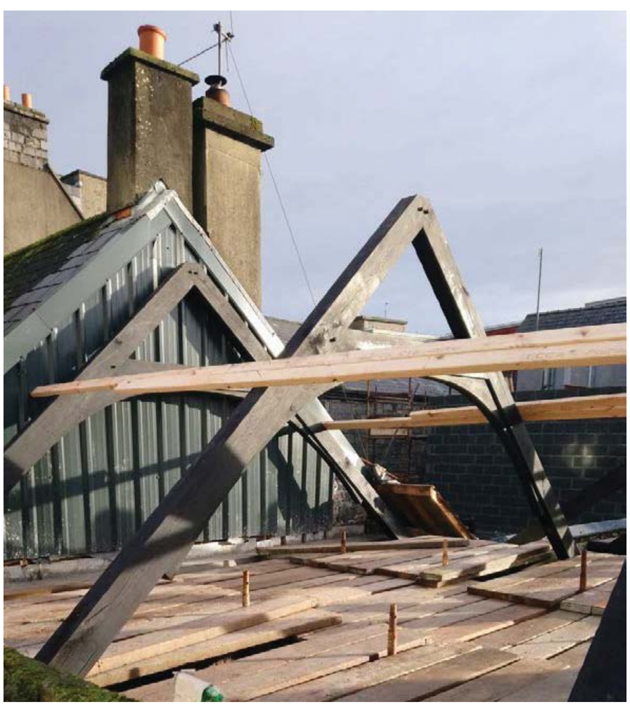

Fig. 39: *Medieval style roof trusses were designed and constructed within the 15th century building section*

fabric. The sections of stone medieval door surrounds and window mullions /transoms that were found during the works presented a unique challenge to understand their importance, and to agree with the authorities which style should be used in the restoration.

The overall concept for the works was to construct a frame within the building that would carry all the structural loadings including floors, internal walls and roof. The concrete structure was specifically designed to allow it to be concealed within the final shop fit-out. It was also designed to ensure that the

Fig. 40: *Interiors of the newly designed shop*

Fig. 41: *The interior roof design of the building*

structure could be removed at a later stage if it was needed i.e. reversible.

As the building had fabric from different centuries, we designed the internal features to match these periods in the appropriate sections e.g. medieval style roof trusses were designed and constructed within the 15th century building and a 'king post' truss roof within the 19th century section of the building.

The same approach was taken in the design of the windows and doors. Within the 15th century building, bronze casement windows were designed and set into cut stone windows with central mullions. Significant archaeological investigations were required to agree the final design of the medieval windows as a number of different fragments with different styles were found in the building. Within the 19th century part of the building, we designed timber sliding sash windows, representing that period of construction. Altogether these features allow one to identify which period of the building they are in while also expanding their knowledge of traditional building styles.

Modern underfloor heating and flood barrier systems were all installed during the works but again were all concealed and are undetected within the building. During the excavations the original shore line and the foundations of Caislean Na Gaillimhe castle were discovered within the building (under the site) and these were recorded, preserved in situ and a section is left exposed under a glass floor. The archaeology was undertaken during the construction stage and was planned and coordinated with the contractor to allow for a phased approach.

Fig. 42: *Archaeological excavations in progress to explore the foundations of Caislean Na Gaillimhe castle believed to be on the site*

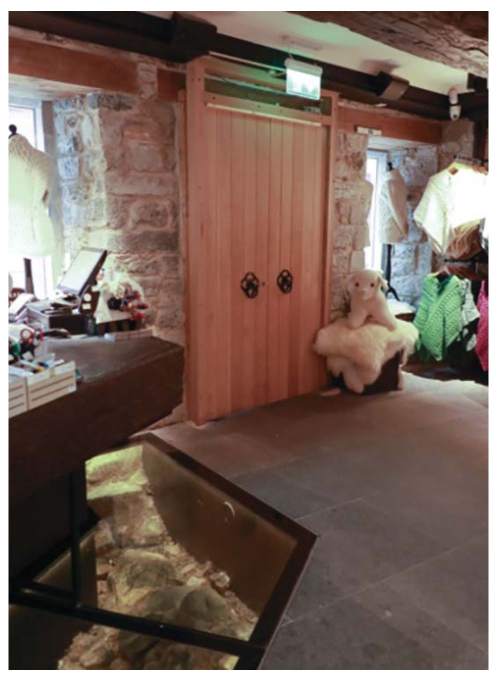

Fig. 43: *The section of the castle wall excavated preserved under the building and illuminated for visitors*

Planning approval was granted in July 2017 with works commencing onsite in August 2017. Phase 1 of the project was completed by June 2018 allowing our client to have the premises open for the tourist season.

Our overall approach was to ensure the building was as sustainable as possible and we specified materials that could be sourced and manufactured/constructed in Ireland. The works were carried out by local contractors.

The restoration of 25 Quay Street has been greeted with a warm welcome from all the locals in the area and some of the adjacent shop owners have thanked the project team for helping to rejuvenate an unused street. Visitors to the area are totally unaware of its previous ruinous state and the building blends into its environment and is aging gracefully within its setting.

ACP was awarded Engineers Irelands Excellence Award for Heritage and Conservation in 2018 and were awarded highly commended in the international Chartered Associations of Building Engineers awards 2019.

Finally, as part of the debate that we need to have around how we conserve our historic buildings, we need to be aware that in my opinion too often we are restricted by poorly implemented, well-meaning legislation that flows from very important international Charters and Treaties. Legislation can be a stick – but sometimes we end up beating ourselves with it, to the detriment of our historic buildings. In effect achieving the opposite of what was intended. More carrot and less stick is a better approach and to engender a love of our buildings as part of our culture. What we as conservation professionals do, is not rocket science in the main, but the practice of a set of traditional skills and techniques on traditional materials that has stood the test of time for millennia.

Fig. 44: *The restored building now housing the Aran Sweater Market*

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A Heritage of Ruins: Southeast Asia's Ancient Ruins and their Conservation[1]

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He has written on subjects ranging from the historic Volcano House Hotel in Hawai'i to the Wright Brothers National Memorial at Kitty Hawk, North Carolina. His latest publication is Ancient Sites of Southeast Asia: A Traveler's Guide through History, Ruins, and Landscapes (Bangkok and Honolulu: River Books and University of Hawai'i Press, 2018). A four-time Fulbright scholar (Italy, Cambodia, and twice in Thailand), he received the Frank Haines Award for Lifetime Contributions to Historic Preservation from the Historic Hawai'i Foundation in 2011. Since 2016, he has been a Fellow of the Explorers Club of New York. Chapman previously served as the Chair of the Department of American Studies and as the Director of the Graduate Certificate Program in Historic Preservation at UHM.

Imagining Ruins

Rudyard Kipling never visited Angkor Wat; nor did he see the temple-mountain of Borobudur or the vast expanse of ruins in the Plain of Pagan. But he clearly did so in his imagination. Led by the Monkey People to the proverbial "lost city in the jungle," Kipling's wild boy Mowgli, the hero of *The Jungle Book*, senses how "wonderful and splendid" was this "heap of ruins."[2]

1 This article, the subject of my talk on December 4, 2020 at the CI2020 Lecture series, is an edited and revised version of a portion of my book *A Heritage of Ruins: Ancient Sites of Southeast Asia and Their Conservation* (Honolulu: University of Hawai'i Press, 2013).

2 Rudyard Kipling, *The Jungle Book* (New York: Century, 1899), 70.

Fig. 1: *Phnom Bakong, Angkor Archaeological Park, Cambodia. Agnes Estioko-Griffin*

Kipling's vision was of a forgotten city, probably in central India. However, he did make a single trip to Georgetown, Penang on the Malay coast and took a hike into the interior. He saw waterfalls and tangled forests and, we can speculate, stumbled upon an ancient ruin. Whether this experience was the source of his inspiration or whether his image derived from the many ruins in the Indian state of Madhya Pradesh, which seem best to fit the outline of his story, remains a subject of debate.[3] Nonetheless, Kipling's encounter with ruins, described through the reactions of Mowgli, provides access to the mind of a nineteenth-century traveler in Asia. His treatment also points to an age-old fascination with the idea of ruins—a fascination that underlined so much of what the British, French and Dutch saw and did when they first ventured into this region east of India and south of China.

The ancient ruins of Southeast Asia have long sparked curiosity and romance in the world's imagination. They appear in the accounts of nineteenth-century French explorers, in G. A. Henty's Victorian tales of boyhood heroism, as props for Indiana Jones's adventures—themselves a nod to far earlier stories—and more recently as the scene of Lady Lara Croft's fantastical battle with the forces of evil. Southeast Asia's ruined temples and cities are the subjects of countless photographs, sketches, paintings, travel posters and postcards. A regular feature in the *National Geographic* magazine, they show up too on the *History* and *Discovery Channels* and serve as backdrops for popular television travel and reality shows; the fifth leg of the 2008 season of CBS's "Amazing Race" ended at the approach to the ancient Bayon Temple at Angkor.[4]

Many now recognized as World Heritage sites by the international cultural oversight organization UNESCO (The United Nations Educational, Scientific and Cultural Organization), Southeast Asia's ruins also represent unique "cultural assets," to use the language of modern heritage specialists. In Thailand, they form part of the nation's official pedigree, the supposed succession of sovereigns and kingdoms that laid the foundations for

3 Kipling visited the British colonial outpost of Georgetown and the hills near Penang in 1889. He never in fact visited the "Seonee" of *The Jungle Book* and appears to have based his ruin descriptions more on his research and discussions with others than any familiarity with these sites. Most scholars place Mowgli's jungle in central India at Seoni, which Kipling repeatedly spelled as Seonee. Candidates for the ruins include Mandu Fort and City, Ujjain, Khajuraho and Omkareshwar, all in Madhya Pradesh. See John Slate, "Seonee: The Site of Mowgli's Jungle?" Kipling Organization, Readers' Guide, 2007, http://www.kipling.org.uk. Accessed October 10, 2017.

4 Edgar Boulangier, *Un hiver au Cambodge: Chasses au tigre, à l'éléphant et au buffle sauvage; Souvenirs d'une mission officielle remplie en 1880–1881*(Tours: Mame, 1888); G. A. Henty, G. A. *On the Irrawaddy: The Story of the First Burmese War* (New York: Scribner's, 1902). The National Geographic Society offers at least four Angkor-based videos in its current list. A memorable *Discovery Channel* presentation was "Jewels in the Jungle," part of the "Mysteries of Asia" series, produced for TLC by Café Productions, Ltd. "The Amazing Race" is described in "Do It Like a Madman," Recap of Episode 13, Amazing Race Official Site, http://www.cbs.com. Accessed October 13, 2017.

modern Thailand. For Cambodians, the ruined city of Angkor stands for the memory of the past glory of the Khmer people and serves as an icon of the nation's independence. The present leaders of Myanmar (Burma) see the abandoned temples of Pagan (Bagan) as underscoring their country's rich pre-colonial past. Indonesia, through its role as a modern regional power, understands its monuments as a matter of national prestige—the necessity as a member of the family of nations to care for part of the world's patrimony, as well as an indication of early cultural achievement.

Nearly all Southeast Asian countries embrace their ancient sites as an integral part of their tourism-driven economies. Advertising campaigns for Thailand strongly emphasize the traditional culture of Thailand; and the ruins of Sukhothai and Ayutthaya often form a part of this image. For Cambodia, Angkor Wat and other nearby monuments are among the principal engines of economic growth for the poor northern province of Siem Reap and certainly a help to the entire nation's economy. The development of local businesses, access to foreign currency and even improvements to the education system all link to the number of international arrivals for many "monuments-rich" areas.

International travelers are now familiar with Southeast Asia's ancient ruins. Angkor Wat currently has over a million foreign visitors annually, and the tourism authority is hoping that the figure will double in the next few years. Borobudur's attendance figures hover around a 1.2 million a year (of which 10 percent are international visitors), from a height two decades ago of nearly two million. Many ancient sites have few outside visitors, and many more are undiscovered by the tourism market. However, if present trends continue, more and more sites will become opened to tourists in coming years, although most international visitors will no doubt want to spend time with the famous "stars," not the lesser examples.

Imprint of the West

The central question is: Why so many ruins? And, as a corollary, how have they come to be so valued? Southeast Asia's history lies at the heart of this. A critical site of human development during the early centuries of the Common Era—a time historians refer to as the Early Modern Period—the fledgling states of island and mainland Southeast Asia experienced an unsteady course of expansion, realignment and probably, as many experts now hypothesize, environmental change that resulted in the periodic abandonment of many settlements and the establishment of new ones. Ruined city walls, palaces and, especially, temples and memorials were the evidence of these many years of expansion and contraction and of the movements of peoples into and within the region.

By the time of Western interests in the Southeast Asia, there were architectural remains spread throughout many sections of both coastal and inland areas. Some were remote and abandoned; others were close to population centers and still functioned in a diminished way as sites of religious pilgrimage. Despite European explorers' proclamations of discovery, nearby residents were cognizant of the existence of ancient sites. Among elites, ruins occupied a place not unlike that in the West; these were "evocative" places, suggestive of romance and symbolic of decay, loss and death.[5]

5 In fact, there are a number of well-known Indonesian and Thai literary works — most famously the fourteenth-century Javanese epic *Nagarakertagama* — that employ the imagery of ruins. For details, see Theodore G. Th. Pigeaud, *Java in the 14th Century: A Study in Cultural History; The Nagara-Kertagama by Rakawi, Prapanca of Majapahit, 1365 A.D.* 3rd rev. ed. 5 vols (The Hague: Nijhoff, 1960–1963).

Whatever their continuing importance to the lives of Southeast Asian peoples, Western visitors and colonists assigned new kinds of meaning to these places, effectively wresting them from their former contexts. By the early twentieth century, the ancient sites of Southeast Asia would be enshrined in a complex apparatus of scholarship and institutional support, set upon the broader foundation of colonialism. The Kern Institute in Holland, the famous École française d'Extrême-Orient (EFEO) in Hanoi and later Paris, museums and colleges in Java, Singapore and Rangoon all promoted the study of Southeast Asia's past and the unique remnants of ancient kingdoms. The Archaeological Survey of India (ASI), an institution rooted in Great Britain's Indian Empire, also extended its aims and methods to British-held Burma. Ruins were a fundamental part of this program and would serve as a key focus of research and understanding of the region's complex history.

Fig. 2: *EFEO photographer and archaeologist Charles Carpeaux at Đông Dương, 1902. Jérôme Ghesquière,* Missions archéologiques françaises au Vietnam; les monuments du Champa, Photographies et itinéraries, 1902-1904 *(Paris: Les Indes Savantes, 2005). Courtesy of the Musée Guimet*

In 1944, historian George Coedès (1888-1969) summarized a century of Western scholarship with the publication of *Les états hindouisés d'Indochine et d'Indonésie*, issued in English in 1968. Employing an encyclopedic knowledge of ancient languages and a keen eye for points of interconnection, Coedès identified the origins and boundaries of the so-called Srivijaya Empire. He also worked out the chronology of Khmer inscriptions and developed a grand theory of Indian influence, in both mainland and island Southeast Asia.[6] Challenged by some scholars as early as the 1930s[7]—or even before Coedès published his full synthesis—his concept of "Indianized states" had a profound impact on the way the West viewed Southeast Asian societies and their history—and, ultimately, on the ways these peoples understood their own pasts.

In the context of French, Dutch and British colonial interests, an earlier "Indian" conquest seemed to both presage and lend a strange kind of legitimacy to the European presence in Southeast Asia. As Berkeley scholar Penny Edwards has shown, the French had a complex love affair with the ancient Khmer.[8] This extended to their involvements in Laos and especially

6 Among Coedès's seminal publications are: *Histoire ancienne des états hindouisés d'Extrême-Orient* (Hanoi: École française d'Extrême-Orient, 1944); and *Inscriptions du Cambodge*. 8 vols. (Paris: E. de Boccard, 1937–1966). On Coedès's contributions, see Ann Nugent, "Asia's French Connection: George Cœdès and the Cœdès Collection," *National Library of Australia News* 6, no. 4 (January 1966): 6–8; and Catherine Clémentin-Ojha, and Pierre-Yves Manguin, *A Century in Asia: The History of the École Française d'Extrême-Orient*, Translated by Helen Reid (Singapore: Editions Didier Millet; Paris: École française d'Extrême-Orient, 2007).

7 Notably in Gaspardone, Émile Gaspardone, "Fouilles d'Indochine," Revue de Paris 1 (December 1936): 615–637. On the controversy, see Haydon Cherry, "Digging Up the Past: Prehistory and the Weight of the Present in Vietnam," *Journal of Vietnamese Studies* 4, 1 (Winter 2009): 84–144.

8 Penny Edwards, Cambodge: T*he Cultivation of a Nation* (Honolulu: University of Hawai`i Press, 2007).

Cambodia and led to the appropriation of much historically under Thai control as well. Characterized by scholarly administrators with deep and often sympathetic interests in the history of their territories and by the patent manipulation of ancient symbols, French colonialism exhibited a strange marriage of the ancient and modern, the indigenous world and outside interests.

Columbia University Professor Edward Said long ago exposed the inherent conspiracy between colonialism and supposedly disinterested scholarship in his seminal book *Orientalism*.[9] Said based his thesis on European colonization in the Middle East and North Africa; the only figure in his book who is part of the story presented here was Lord Curzon, briefly Viceroy of India and a champion of Burmese antiquities. However, Said's arguments have striking relevance in the Southeast Asian context—so much so, it is surprising that he did not place French-controlled Indo-chine (Indochine) at the center of his story.

The Dutch in Java and Sumatra and the British in Burma, however, fit the template of Said's thesis less completely, reinforcing a suggestion by intellectual historian Lisa Lowe that the pattern of "orientalism" was not always the same.[10] The British seemed curiously uninterested in appropriating the pageantry of Southeast Asian regimes, largely ignoring historic remains in the Straits Colonies and sending Burma's last king to exile in India. Unlike in India, where British imperialists clearly celebrated traditional rulers and their symbols—arguably as part of a strategy to protect their own interests — the predominantly mercantile colonists of present-day Malaysia and Singapore showed little interest in history or antiquities. In Burma, British administrators barely supported historical research and provided few funds for the conservation of ancient monuments. Although the Dutch showed more interest in the ancient remains of Java and Sumatra especially, they did this without the enthusiasm or financial investment of their French counterparts.

While colonial rulers uncovered the foundations of ancient societies, modern states utilized this evidence in the construction of their own regimes, a point stressed long ago by historian Benedict Anderson.[11] In Thailand, revealingly the only country in the region not under direct colonial control, officials built upon museum collections and the physical evidence of the past to bolster the image of the state. They also instigated the beginnings of a national archaeology program that would lead to the creation of historical in the twentieth century. After World War II, other emergent countries followed this model, with newly created Indonesia extolling its ancient empires and Islamic sultanates, Burma (soon to be renamed Myanmar) celebrating the symbols of its ancient kingdoms and even monuments-poor Malaysia finding ways of commemorating culture and tradition as part of the country's new national perspective. In Malaysia, museums and university-based scholarship would also play central roles in the creation of a new national story.

Although long independent of colonial rule, the modern states of Southeast Asia remain indebted to the Western idea of their past. Much historical scholarship in the region still centers on the remnants of "Indianized states"

9 Edward W. Said, *Orientalism* (Harmondsworth, Middlesex, UK: Penguin, 1995).

10 Lisa Lowe, *Critical Terrains: French and British Orientalisms* (Ithaca: Cornell University Press, 1991).

11 Benedict Anderson, *Imagined Communities: Reflections on the Origin and Spread of Nationalism*. Rev. ed. (New York: Vintage, 1991). See also idem, *The Spectre of Comparisons: Nationalism, Southeast Asia and the World* (New York: Verso, 2002).

and with disentangling the evidence of early kingdoms and later empires. The pattern of historical change identified by Western scholars continues also to provide the foundation for the official narratives of national development. The average, increasingly urbanized resident of any given Southeast Asian country may have little direct attachment to ancient ruins, but these places form, nonetheless, an important part of what they are and how they conceive of themselves.

Ruined sites continue as well to play a significant role in the lives of peoples living near them. In much of Indonesia, where Buddhist and Hindu temples lie outside of Islamic practice, ancient temples still connect to longstanding folk traditions. In Thailand, ancient sites convey a sense of original value despite their ruinous condition; nearly all of them "deconsecrated," these mostly Buddhist sites resonate powerfully with Thai visitors. In Cambodia, ruins are for the most part "ruins." Nonetheless, both the local populations and visiting Cambodians continue to honor sacred images, often for their magical properties as well as their patriotic value. The same is true in Laos and Vietnam, where ancient sites invoke feelings of both veneration and cultural memory.

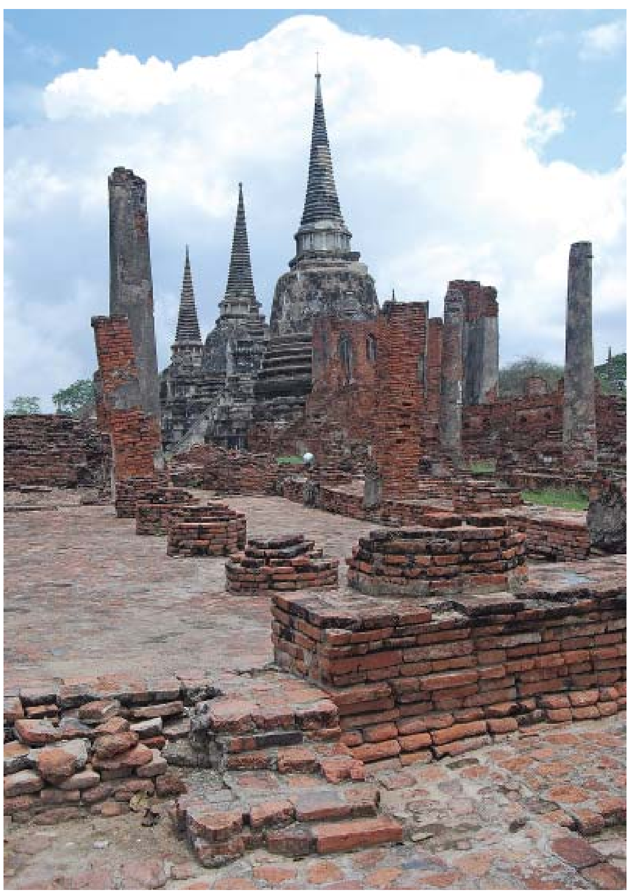

***Fig. 3:** Ayutthaya Historical Park, Thailand. Parinya Chukaew*

In Myanmar, these associations have a special value. Long considered ruins by Western visitors, the temples of Ava (Inwa), Pegu (Bago) and Prome (Pyay) attracted—and still attract—devotees despite their apparent neglect. The great site of Pagan had both active and abandoned temples at the time of British conquest. Some of these were *paya* (also spelled *hpaya*), or Buddhist temples; others were *zedi* containing relics of Gautama Buddha or otherwise honoring the memories of individual donors. When villagers or donors' families no longer contributed to their maintenance, these sites quickly fell into ruin. Other sites, especially the active *paya*, were subject to varying levels of renewal. To Myanmar's inhabitants all of this was normal, neither a cause for alarm nor a national concern, but simply life as it existed.

This tradition continues most visibly today at the national shrine of the Shwedagon in Rangoon (Yangon), where authorities and supplicants still maintain the shrine, recently adding a new layer of gilt to the enormous *stūpa*. Several of the more famous temples in the archaeological park at Pagan have been the object of similar treatment, as have been—and still are—many other sacred sites throughout the country—a process recently chronicled in telling detail by scholar Donald Stadtner.[12]

12 Donald M. Stadtner, *Ancient Pagan: Buddhist Plain of Merit* (Bangkok: River Books, 2005)

New coatings of plaster, fresh paintings and re-gilding are all part of the process of material and spiritual regeneration. At odds with many ideas of the international community, such practices are arguably in keeping with time honored Burmese traditions. For many people both inside and outside of Myanmar, however, these attempts to bring "completeness" back to ancient shrines goes in the face of more universal values—values bound up in the broader notion of "heritage."

Heritage and Its Critics

The concept of "heritage"—obviously from the title, a central theme of this article—is not a simple one. A century ago, matters seemed self-evident. There were important buildings and sites, and these needed saving for future generations. Scholars and other specialists selected which places were worthy of preservation and which were not. After World War II, the nascent heritage establishment, relying largely on European precedence and expertise, brought this way of thinking into new international organizations. UNESCO, founded as part of the United Nations in 1945, served as the center for ideas in the field, holding conferences and symposia and setting out the basic principles of conservation practice. Member countries looked to UNESCO for guidance and adhered to the international community's collective strictures.[13]

Training programs by UNESCO and other specialized organizations tended to focus on techniques of conservation—generally, physical interventions to ward off decay or repair past injuries—and on expanding the list of known monuments and sites. The Convention for the Protection of Cultural Property in the Event of Armed Conflict, passed in 1954, and the International Charter for the Conservation and Restoration of Monuments and Sites (known as the Venice Charter) of 1964 were hallmarks of international cooperation. The World Heritage Convention of 1972 was another important step. UNESCO also encouraged the further documentation of less known historic sites through a partnership with the international membership organization ICOMOS (the International Council on Monuments and Sites) and the standardization of training through its offshoot ICCROM (the International Center for the Study of the Preservation and Restoration of Cultural Property), founded in Rome in 1959.

UNESCO's efforts reaped notable results throughout the late 1950s and 1960s. Working on a modest budget and dependant on the largesse of donor countries, the agency saved the famous Abu Simbel Temple in Egypt, spearheaded efforts to protect the ancient site of Mohenjo-Daro in Pakistan and contributed substantially to efforts to protect the historic cities of Katmandu in Nepal and Fez in Morocco and the famous ruins on the Acropolis in Athens. From its headquarters in Paris, UNESCO sent

***Fig. 4:** UNESCO at work at Borobudur, Java, Indonesia, 1978. Courtesy of PT TWC Borobudur Prambanan Ratu Boko*

13 Fernando Valderrama, *A History of UNESCO* (Paris: UNESCO, 1995). For a sense of UNESCO's original optimism, see Hiroshi Daifuku, UNESCO, *Preserving and Restoring Monuments* (Paris: UNESCO, 1972).

out consulting experts on countless "missions" to other countries, following a pattern of top-down guidance that few questioned.

By the 1970s, however, UNESCO's hopeful model of social and cultural progress faced critics from both outside and within the organization. Committed to a wide range of programs, touching on many aspects of education, science and culture under its charge, UNESCO pushed ahead with projects that seemed to identify it with the communist block—at least in the eyes of the U.S, which withdrew its support in 1984. (The U.S. reinstituted funding for a period in 2003 following a number of reforms within the agency.) Answering increasingly to the appeals of less powerful, emergent countries, UNESCO became a bastion of "political correctness" long before the phrase became current. In the cultural arena, directives and "conventions" addressed issues of the theft of antiquities from poorer countries, ways to curtail the abuse of cultural artifacts by private owners and emphasized the need to ensure the participation of local residents in conservation-related projects.

Notwithstanding its own criticisms, UNESCO came to embody the very system of Western bias that it claimed to oppose. Largely European in leadership and reliant on European approaches to conservation practice, UNESCO embraced the seemingly contrary values of populism and elitism. However, by the 1990s, the organization could no longer claim supremacy over all aspects of cultural preservation. National programs, numerous non-governmental conservation organizations and the newborn academic field of heritage studies began to challenge UNESCO's authority in matters of conservation. Promotion of the idea of "cultural preservation," acceptance of regional differences and even a questioning of the very concepts of "conservation" and "heritage" became hallmarks of this transitional period.

Currently, there is no concurrence on what constitutes a "correct" approach to heritage conservation. Some experts favor the restoration of older sites. Others promote more conservative "preservation" and "stabilization." Sometimes the building or monument figuratively determines its own treatment. Twenty some years ago, conservation specialists restored the ceiling of the Sistine Chapel in Rome, opting to privilege Michelangelo's original work over later repairs and half a millennium of carbon deposits. At the nearby Roman Forum, the process mostly has been one of stabilizing, maintaining and cleaning the ancient structures—although, as art historian David Watkin has recently pointed out, many of these steps also entailed considerable manipulation of the so called "original" artifacts.[14] Experts, nonetheless, have never considered "restoration" of the forum in its entirety to be an option.

Some experts now eschew heritage listings, arguing that the very fact of recognition strips places of their more immediate cultural value.[15] Others, such as historian Robert Hewison, decry the inherent bias in selection, arguing

Fig. 5: Restored ruins, Pagan, Myanmar. Kreangkrai Kirdsiri

14 See David Watkin, *The Roman Forum* (London: Profile Books, 2011).

15 Laurajane Smith and Emma Waterton, *Heritage, Communities and Archaeology* (London: Duckworth, 2009).

that class preferences and commercial factors play an overly large role in the entire process of specifying heritage sites for recognition.[16] Over the last few years, there has been a virtual flood of critical articles, books, conferences and even journals dedicated to uncovering the prejudices and flaws embedded in heritage efforts. "Heritage," Larajane Smith suggests, is less "a thing [than] a set of values and meanings."[17] Setting themselves against the twin bugbears of "globalization" and the "commodification" of cultural sites, this new generation of critics is attempting to expose the inequities built into current practices and to some extent propose alternatives.

Heritage in Southeast Asia

Southeast Asia's heritage efforts certainly reflect this wider debate. In terms of specific "treatments," Cambodia adheres to long established European ideas of careful stabilization, marked by thorough research and almost surgical efforts to stabilize ancient ruins. Thailand favors a somewhat more "sanitized" program of interventions, again based on scholarship, but with the needs of tourists and local visitors more in mind. In Vietnam —with the exception of important project at Mỹ Sơn (also My Son or Mi Son), conducted in large part with international support—the work is often hurried and piecemeal. Myanmar has decided that a kind of semi-restoration of ancient monuments is a national cause, distancing itself from Western prescriptions.

Each country faces different conservation challenges as well. Indonesia must endure persistent earthquakes and tremors, which continually threaten historic sites. The same is true as well for Myanmar and to a lesser degree Thailand. In both Indonesia and Cambodia, technicians have to deal with the poorly conceived designs and engineering standards of ancient builders. Cambodian ruins in particular are often inherently unstable, performing badly from a structural point of view throughout their centuries of existence. Materials also affect performance. Stone has proved the most reliable and long-lived material. Bricks, the building material of most Thai, Burmese and Vietnamese structures, are susceptible to erosion and rapid decay when unprotected by roofs or stucco coverings. All of these cause national programs to differ in their emphasis and affect the outcomes of conservation efforts as well.

Several questions emerge when considering ancient sites in Southeast Asia. Do international conservation standards take precedence local practice? Are the ancient sites Southeast Asia of "transcendent value" or should national and local preferences take the upper hand? Many experts working in the region feel that current practice adequately addresses these issues. Others have begun to question the primacy of officially sanctioned heritage approaches and call for greater attention to local uses and values. A few, notably sociologist Tim Winter in the Southeast Asian context, argue that heritage efforts in fact rob local inhabitants of their own legacy and that officials often distort the past to advance special interests.[18]

For the uninformed observer none of these issues is immediately apparent. Most

16 Thomas F. King, *Our Unprotected Heritage: Whitewashing the Destruction of Our Cultural and Natural Environment* (Walnut Creek, CA: Left Coast Press, 2009); Robert Hewison, Robert, *The Heritage Industry: Britain in a Climate of Decline* (London: Methuen, 1987).

17 LauraJane Smith, The *Uses of Heritage* (New York: Routledge, 2006), 11.

18 Tim Winter, *Post-Conflict Heritage, Post-Colonial Heritage: Culture, Politics and Development at Angkor* (London: Routledge, 2011).

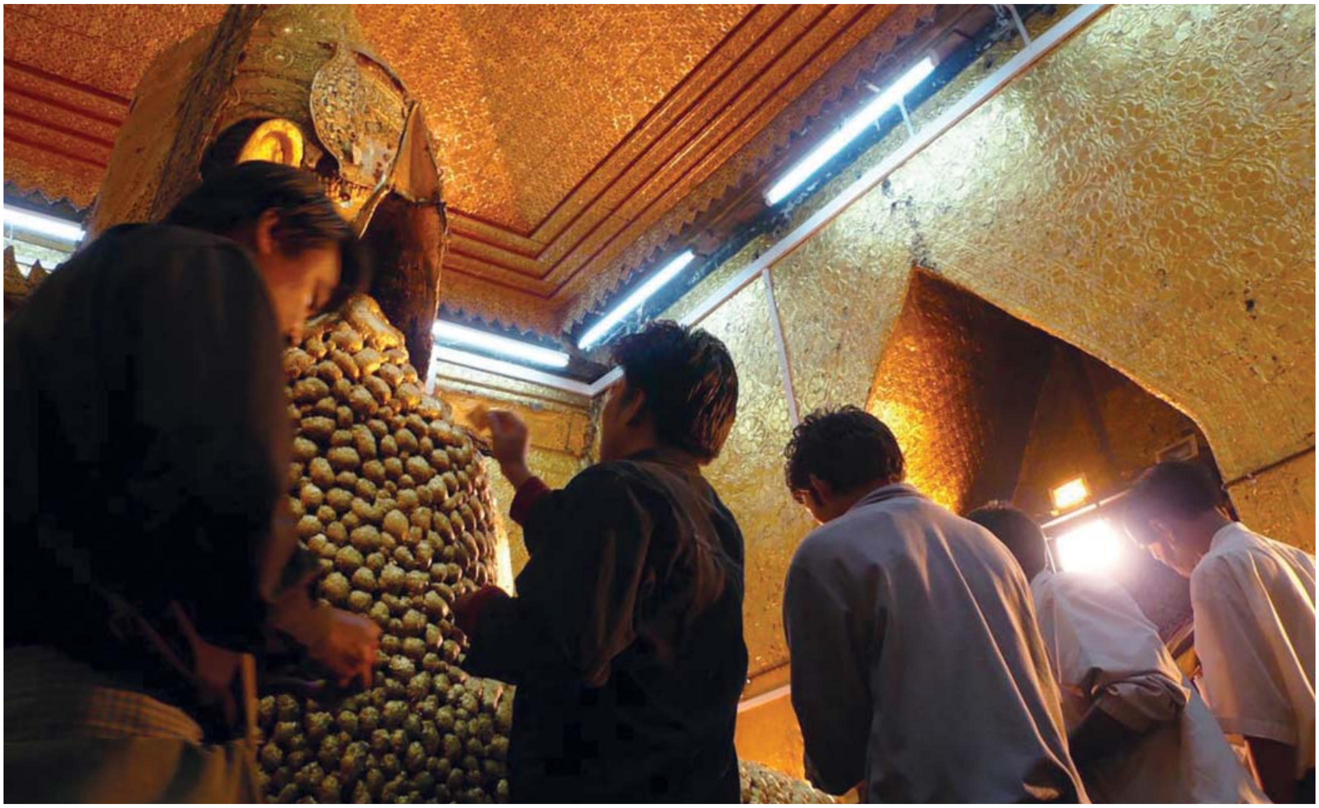

***Fig. 6:** An example of a living shrine, Maha Muni shrine, Mandalay, Myanmar. Yuthana Lertromayant*

international visitors to Angkor little question what is going on there. They encounter a seemingly natural forest environment strewn with ancient stone monuments. The far fewer, but still significant number, of tourists visiting Pagan observe a landscape of temples and *stūpa*. They see ruins, semi-ruins and reconstructed sites but have little idea of the disagreements that lie behind these choices. The adventurous traveler to Mỹ Sơn faces an incomplete site, with piles of bricks, few remaining carvings—most of the original art is in museums or has been long-ago grabbed up by private collectors—and obtrusive craters created by U.S. bombs during the Vietnam War. In Indonesia, the impression is of manicured gardens focused on the sites of Borobudur and Prambanan. A similar scene exists in Ayutthaya, where formal hedges line the well demarcated attractions.

Experts and site managers struggle daily with how to treat their sites. They must also deal with larger issues. Commercialization is a particular concern. Many visitors decry the proliferation of vendors and the evident creep of avarice into what were once sacred grounds. Theatrical performances at Borobudur, sound-and-light shows in the park at Ayutthaya and costumed *apsarās* (celestial dancers) awaiting camera-toting tourists at Angkor all constitute, for some critics, virtual "assaults" on heritage places. Entrepreneurs, working alone and with government endorsement, underwrite the costs of museums, such as that opened several years ago in the town of Siem Reap near Angkor, or collude with hotels to provide exclusive access to sites otherwise closed to visitors. Nearly all heritage experts lament the transformation of historic sites into tourism venues, seeing tourism as perhaps necessary to support the work at hand but ultimately threatening to the values of heritage efforts.

Experts also disagree on the degree to which local interests should prevail. The great park at Angkor depends directly upon the services of Cambodians living there. At the same time, the governing authorities are fearful that with greater affluence and larger numbers, the park's residents may begin to detract from the very qualities that made the Angkor ruins so special. In Thailand and Myanmar, government officials long ago moved residents away from the sites at Ayutthaya, Sukhothai and Pagan, placing priority on the physical character of these places and ignoring local concerns. Although there have been steps taken to ameliorate these circumstances, all three sites function still as rural parks, showing little of the lives of people who once existed there. Similar stories are true at the Indonesian sites of Prambanan and Borobudur, where only now are officials attempting to bring local populations back into the picture.

At some sites, such as Vat Phu in Laos, it is easier to accommodate local practices and still maintain the overall "heritage" quality of the site. At other sites, notably Myanmar's Pagan, the supposed reintroduction traditional practices has had the effect of obscuring the original qualities of both individual monuments and the site as a whole. Temples now have new finials, fresh coats of paint—sometimes obscuring ancient murals—and newly gilded *stūpa*. Burmese officials argue that this is part of an age-old process of renewal and "merit-making" for devote Buddhists. Outside experts decry the loss of original features. They also question the motives behind the process, wondering if Myanmar's aims are less to honor the past than to attract more tourists.

Fig. 7: *Living sacred heritage at Vat Phu, Laos. Parinya Chukaew*

Southeast Asia's ruins are no doubt a permanent part of the world's actual and imaginative landscape. Tourists visit Cambodia to see Angkor. They go to Myanmar for Pagan. And they often go to Java in search of Borobudur. While other sites might capture the attention of visitors and compete with or complement excursions to archaeological parks and monuments—certainly the Sultan's Palace in Yogyakarta, the historic capital of Luang Prabang in Laos and the living culture of Bali have their adherents—the region's ruins hold an unchallenged place as repositories of "official culture." How they are presented and how they are preserved will remain always an open question.

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Digitizing the Materiality of Books. The (Potential) Role of the Conservator[1]

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Books as Objects

Books have a twofold nature. Their content is the result of the intellectual work of humankind. However, as cultural heritage, books are, first and foremost, physical objects 'created for the convenience of eye and hand' that can be counted among the many artefacts created by civilization.[2] There is a set of characteristics that define a book as an object, a 'bookness', that Smith describes in its most general terms as 'the packaging of multiple planes held together

1 This paper is based on a presentation delivered online for the 2020 INTACH Conservation Insights Seminar cycle on 12th October 2020: Campagnolo, 'Digitizing the Materiality[-Ies] of Books. The [Potential] Role of the Conservator'.

2 Cummings, 'What Is a Book?', 20–21; Otlet, *Le livre sur le livre*, 9-facsimile.

in fixed or variable sequence by some kind of hinging mechanism, support, or container, associated with a visual/verbal content called a text'.[3] The text is not a sine qua non condition for such bookness, as exemplified by the series of the twelve textless proto-codices, *Prebooks*,[4] produced by the Italian designer Bruno Munari (1907-1998) to illustrate bookness to children, to teach them that 'books are objects made like this'. We refer to these objects as proto-codices, because the archetypal form of the book today—as empirically exemplified by an image search on the web for 'book'—is undoubtedly that of the codex format, i.e. 'groups of leaves of sheet materials […] gathered together and secured along one edge (the spine) with some form of structure that allows either surface of each leaf to be seen when the leaves are opened from the opposite edge'.[5] Munari had this format in mind in the design of his *prebooks*.

Books are generally collected for their content and decorative features, but, as cultural objects, they are complex entities that also preserve, in their manufacture, technological and material data from another time and place.[6] Books, as technological artefacts, are used unconsciously: to the readers, books are tools, information conveyors that bring them some content. The physical inner workings of this tool are, however, for the most part left unnoticed, because one does not need to know how to produce a book, in order to read it.[7] In this sense, books, for the typical user, are black boxes, i.e. technological artefacts that appear apparent, known, and predicted, but that are, at the same time, complex entities that result from a diverse system of techniques, materials, processes, and actions.[8] To understand the technical makeup of books, and investigate their influence on makers and users, one needs to open the black box and study its inner and outer networks. Inner networks being the complex system of component and materials that constitute the object book. Outer networks instead branch off—diachronically, diatopically, and diastratically—from the object to its context, to include agents, users, and other artefacts, allowing for investigations related to time, location, and social factors.

Books can be considered as content bearers, objects of use, and technological objects.[9] Books have traditionally been studied for their content as information and technological outputs. Similarly, books have been investigated as objects of use and object with which readers, within the limits of the object's physicality constraints, interact, leave marks on, travel.[10] Only seldom are books considered as technological objects, beyond their being a tool.[11]

The advent of new information delivery systems, such as the Internet and the Web, is now putting us in a position to distance ourselves from the book, re-evaluate it, decentre it, and to see it as a technology and a tool, and not just as something that's 'intrinsically e inevitably human'.[12]

Conventional Digitization of Books

After the experimentations of the 1980s, libraries begun digitizing their holdings, first concentrating on the most valuable and

3 Smith, 'The Whatness'.

4 Munari, *I Prelibri*.

5 Ligatus Research Centre, 'Codex-Form Books'.

6 Sharpe, 'The Catalogue of the Coptic Bindings', 420.

7 Frost, 'Mobility and Function', 92.

8 Callon, 'Techno-Economic Networks', 152.

9 Campagnolo, 'Bit by Bit', 92–100; Campagnolo, 'Understanding the Artifactual Value', 18.

10 Petrucci Nardelli, *Legatura e scrittura*; Bellingradt and Salman, 'Books and Book History'; Raymond, 'Matter, Sociability and Space'.

11 Szirmai, *The Archaeology*, ix.

12 Landow, *Hypertext 3.0*, 46.

treasured items, in the 1990s, and then, from the 2000s, as access to the Internet and its technologies progressed, digitization with online delivery has been utilized more systematically to provide accessibility and digital coverage of library collections.[13] Today, as, increasingly, libraries, and memory institutions in general, are putting their collections online through the International Image Interoperability Network (IIIF),[14] accessing and working with digitized library collections has become more agile and straightforward.

The threefold paradigm of books as content bearers, objects of use, and technological objects translates into the digital. Besides, in conventional digitization approaches, the same considerations by which the content has prominence over the technological (and archaeological) object still applies. On the one hand, the content of books is digitized through meticulous modelling and encoding of textual, paratextual, and decorative features through successful and best-practice initiatives such as the Unicode,[15] TEI,[16] and high-resolution images that can now be effortlessly delivered on our screens and annotated through IIIF compliant methodologies. This is what the great majority of digitization projects concentrate on. Since the 1980s, with the onset of GUIs (Graphic User Interfaces), efforts were made to build systems that mimicked the working of books in codex format in the digital environment. These concentrated on the concepts of *tangibility*, defined as 'the capacity of a book to convey information about itself through physical indicators', and *browsability*, defined as 'the book's ability to provide random access through tactile means such as flipping pages to move within the text'.[17] One well-known example of the transmediation of the book as an object of use into the digital is the Turning the Pages™ project, premiered by the British Library from 1996, that aimed at modelling representative three-dimensional books that reacted to the user's touch.[18]

The codex metaphor and the floating page

The codex book's metaphor that has made its way into the digital is a limited illusion, and a poor compromise at best, if one is looking for surrogates worthy of scholarly research, not simple outreach projects.[19] When we consider the book as a technological object, we notice how its commonplace black-boxing, inevitably, influences transmediation.

The fundamental working unit of books in codex format is the gathering,[20] defined as 'a group of folded or single leaves which can be used either singly or with other gatherings to create a textblock'.[21] A definition that, unsurprisingly, is echoed in one of the most straightforward descriptions of the codex: 'a collection of sheets of any material, *folded double* and fastened together at the back or spine, and usually protected by covers'.[22] Comparing this with the working idea of the three-dimensional digital book, 'the 3D codex

13 Lee, *Digital Imaging*, 160; Terras, 'The Rise of Digitization', 3–14.

14 IIIF, 'International Image Interoperability Framework'; IIIF, 'Introduction to IIIF'.

15 Unicode, 'Unicode'; Unicode, 'The Unicode® Standard: A Technical Introduction'.

16 TEI Technical Council, *Text Encoding Initiative P5*; TEI, 'A Very Gentle Introduction to the TEI'.

17 INKE, 'Features of Books and E-Books'.

18 Turning the Pages, 'Turning the PagesTM'; Campagnolo, 'Bit by Bit', 93-94.

19 McKitterick, *Old Books, New Technologies*, 222.

20 Andrist, Canart, and Maniaci, *La syntaxe du codex*, 50.

21 Ligatus Research Centre, 'Gatherings'. Because our interests here transcend manuscript production, we prefer the term 'gathering' to 'quire' (generally used for manuscripts), or 'section', 'signature' (used for printed books).

22 Roberts and Skeat, *The Birth of the Codex*, 1. Our emphasis.

book, bound on one side, with pages that turn',[23] it will not come as a surprise that most virtual representations of books do not concern themselves with the folded sheet as the basic unit, but rather with the singles pages, i.e. the sides of the sheet. The three-dimensional model of Turning the Pages™ couples the sides into one unit with its recto and verso, but, looking into the gutter of the computer-generated codex, one would notice how the virtual leaves are disjointed and unbound, floating in the three-dimensional void between the simulated boards. The floating-page issue is also replicated in scholarly facsimiles, whereby pages are presented as reels of image sequences, shown singularly, paired up to represent the opening spread of facing pages, or in galleries of thumbnail images. Even though some projects allow the user to browse the virtual codex on a gathering-by-gathering basis—e.g., the Codex Sinaiticus[24]—there is generally no manifest information about which pages come together in each gathering of the original object.

All in all, important information that would be necessary to record for the book conservator's work—and that of the codicologist or book historian—is not included or represented online through conventional digitization.

Conservation for Digitization

An online image search for 'book conservator' produces a series of photographs highlighting the intimate relationship enjoyed by conservators with books, one that can be much more physically involved than that of any scholar, librarian, or curator in the reading room. While, indeed, there are accounts of restoration practices that are unsympathetic to the object and do not consider, nor preserve, its history,[25] modern book conservation strives to make the book usable without altering it or losing evidence, through a philological approach that requires a deep understanding of the object before any treatment can be performed. Modern book conservation considers books not just as supports for text, but rather as complex objects, the study of which can contribute to research efforts in cultural history, and therefore advocates the necessity to preserve as much original evidence as possible: a noticeable departure from previous practices that only aimed at making the objects usable again.

This highlights the delicate balance between use and meaning that is only too familiar to book conservators.[26] The same contrast becomes evident when books are digitized, in which their 'use', under the digitization scanner and while being handled, can cause damage and loss of evidence and meaning. This is especially true when digitization is not carried out according to best-practice recommendations, with the appropriate equipment, and the utmost care towards the object and its structures throughout the digitization process, including the project's planning and budgeting phase. Notwithstanding the recognition of the conservator's knowledge of the artefacts (and of the limits of conservation practice), official digitization guidelines advocate for the conservator's input and involvement almost exclusively for the preparation treatment before, during and after digitization. The literature on digitization in the archive and library world is exceptionally prolific,[27] yet, rarely do guidelines prescribe a role to conservators that exceeds

23 Card et al., '3Book', 303.

24 The British Library et al., *Codex Sinaiticus*.

25 See, for example, Blades, *The Enemies of Books*, 95-97; Szirmai, 'Stop Destroying Ancient Bindings'; Szirmai, *The Archaeology*, 7.

26 Campagnolo, 'Understanding the Artifactual Value', 45-48.

27 Lindsay, 'Preservation Microfilming', 47.

that of preparation technicians, thus forgoing their knowledge.[28]

The Role of the Conservator in Digitization Projects

It would be appropriate for conservators to be involved in all phases of a digital conversion project, from the planning phase, to the activities before, during, and after scanning, including data and metadata generation and recording. List 1 illustrates the current and advisable involvement of conservators in digitization projects.[29]

List 1. Conservation Involvement in Digitization Projects

I Project planning and budgeting phase

Internal communication and management:

- Contributing to the management system setup (fields and metadata)
- Set up a standard language system (technical phrasebooks, guidelines, training)

Equipment:

- Contribute to the selection and adaptation of the digitization equipment

Environment:

- Contribute to the selection of the scanning setup and environment

Information management:

- Set up/adapt a database for record-keeping and documentation

II Before digitization:

Object assessment:

- Assessing conservation fitness of object: fragility and risks
  - *Assessing opening characteristics (and maximum safe opening angle)*
  - *Assess need for* digiprep
  - *Assess special handling requirements*

Object treatment:

- Prepare objects for digitization: securing pages and elements at risk

Object safety:

- Offer safe handling guidelines and training
- Check the adequacy of scanning equipment and availability of special equipment (book cradles)
- Check environmental conditions (temperature, humidity, light) in all locations

Object documentation:

- Documentation of the state of conservation
- Documentation of the treatments

III During digitization:

Object safety:

- Assure safe handling (in presence or with previous training sessions)
- Assure use of special equipment to minimize damage (such as humidifiers, book cradles)
- Monitor adequacy of environmental conditions (temperature, humidity, light)

Object treatment:

- Repair objects that are flagged up as in need of pre-scanning conservation treatment by the digitization team

IV After digitization:

Object assessment:

- Check the state of conservation of objects (against pre-scanning documentation)

Object treatment:

- Repair objects if damage has incurred during digitization, or if treatment was postponed assuring a better information capture at the digitization stage.

Object safety:

- Eventual rehousing: conservation envelopes, boxes.

28 Korthagen et al., ‘Checklist 2.0’, 27-28.

29 See Campagnolo, ‘Conservation and Digitization’, 60-69.

Object documentation:

- Documentation of eventual post-digitization conservation treatments

V **Outreach and research:**

Outreach avenues:

- Contribute contextual information (blogs, videos, websites)
- Contribute information to the Catalogue

Research avenues:

- Consider potential research value within the objects (during the survey, treatment phase)
- Seek collaborations to address research questions (heritage science, digital humanities)
- Publish contextual information (technical and academic)

The 'Outreach and Research' phase, listed as last here, can (and should) encompass the entire digitization project, but not only is this not routinely incorporated, conservators are also still rarely included in outreach activities. The importance of contextual information is, in fact, seldom understood and considered a part of the digitization project. Activities that can be counted in the outreach and research phase can be as simple as blog posts to illustrate particular conservation issues and procedures. However, alongside customary digitization data, the inclusion of datasets, databases, descriptions, and publications on specific conservation practices and particular binding structures or other materiality aspects would be even more appropriate.

Integrating conservators in all phases would have the additional benefit of curbing specific concerns that the community has raised about the possibility of a diminished need for conservation after scanning has taken place.[30] If it were to become common practice to value the informational input that conservators can provide, by integrating the data accumulated in their documentation records, digital surrogates would be more comprehensive, and conservators would likely feel less threatened by digitization projects.

Digitizing the Book as Object

What Do We Lose When We Lose a Library? is the title of a conference held at the Katholieke Universiteit Leuven, and co-organized by the Université Catholique de Louvain, in Belgium, in September 2015 to commemorate the centenary of the destruction of the University Library, there, in 1914.[31] More than thirty international scholars took the stage to consider all that is lost once a library is destroyed, from the books' content, to cultural heritage evidence, to a people's identity. The conference also explored how digital technologies and advanced imaging techniques can help preserve traditional documentary heritage.

Libraries and memory institutions are indeed often destroyed, still today, due to natural disasters, accidents, war, and terrorism. A Wikipedia page lists libraries lost: from the Xianyang Palace library, in China (206BC) and the notorious fire of the Library of Alexandria, to Mosul Public Library destroyed by the Islamic State in 2015.[32] The latest account of a library being lost is that of the National Museum of Brazil burnt in the tragic fire of the night of the 2nd of September 2018.[33] On that occasion, *Wired Magazine* commented that 'all those artefacts could have been systematically backed up over the years with photographs, scans'[34]

30 Ramsholt, 'Digitization'; Bülow et al., *Preparing Collections*, 19; Zanetti, 'La conservazione'; Zanetti, 'Le ragioni di una crisi'.

31 Watteeuw and Collier, *What Do We Lose*.

32 Wikipedia, 'List of Destroyed Libraries'.

33 Phillips, 'Brazil Museum Fire'.

34 Dreyfuss, 'Brazil's Museum Fire'.

assuming, erroneously, that digitization is the creation of sorts of virtual clones of the original items that can be backed up on the cloud, like the photographs taken on mobile phones. To digitize, however, is not to replicate an artefact in all its nature, and, as well-understood by most today, digitization does not, per se, equal preservation.

Undoubtedly, when cultural heritage is damaged or lost to some disaster, surrogates of any nature provide some support, as some information is unquestionably better than no information. Since the early 20th century, for example, the Vatican Library turned to image reproductions to preserve textual information. Then, to tackle the tragic circumstances of the war, microfilm surrogates were also sent to be preserved offsite in the Knights of Columbus Vatican Film Library, at the Pius XII Memorial Library, Saint Louis University (MO, USA),[36] so that at least the manuscripts’ content could be preserved in a different venue across the ocean.[35] Similarly, the work of the Hill Museum & Manuscript Library (HMML) at Saint John’s University (Collegeville, MN, USA), now holding an archive of more than 200,000 manuscript surrogates (microfilm and digital formats), has been exemplary in this.[37] Founded in 1965 as the “Monastic Microfilm Library” to photograph Benedictine monastic libraries in Austria and Germany, HMML brings to the modern era the Benedictine mandate of preserving knowledge through the manual labour of copying manuscripts. Its mission, over the years, expanded to preserve and share rare and endangered manuscripts across the globe, concentrating on those at higher risk of being destroyed and lost.[38]

Reformatting and Informational Preservation

Reformatting is not considered an actual preservation activity, but, undoubtedly, surrogates do capture some information. Muñoz Viñas, surveying the meaning of conservation within its current theoretical framework, found that, within the many conservation-related concepts that have surfaced since the 1980s, none identifies the category of preservation based on the production of records, which, in turn, users can employ to experience the object virtually (and remotely). He proposes a new concept, *informational preservation*, to indicate this partial preservation of the information contained in an object.[39] Reformatting allows the observer to access a restricted number of the original objects’ features and reduces direct use and exposure to potential damage. For this reason, Muñoz Viñas lists these activities as preservation, but with the caveat that the object is not actually being preserved, only some of its information is. Digital surrogates are then a form of informational preservation that saves some knowledge embedded in the object and becomes invaluable means to share them across the globe, despite their being limited and incomplete copies that do not replicate the original artefacts.[40]

If books as cultural objects are more than just their content and decoration, and if most of the information captured by conventional digitization relates solely to these features, can books as objects be digitized? To begin answering this question, we need first to consider the physicality and materiality of books, two concepts that are commonly considered

35 Campagnolo, ‘Conservation and Digitization’, 50-51; Núñez Gaitán, ‘Conservation towards Large-Scale Digitization’, 89.

36 HMML, ‘About’.

37 Stewart, ‘Yours, Mine, or Theirs?’; Stewart, ‘Giving Voice to Ancient Texts’.

38 See Stewart, ‘HMML and Syriac Manuscripts’, 59–59.

39 Muñoz Viñas, *Contemporary Theory of Conservation*, 24.

40 McKitterick, ‘Books and Meanings’, 146.

synonyms, but that, as noted by Hayles, are related, but distinct.[41] While physicality is a permanent quality, an infinite set of physical attributes that make up the object's reality, materiality is intended as an emergent property that depends on the attention of some observer who isolates as meaningful some particular attributes, setting them aside from the continuum of physicality—materiality results from human mediation and interpretation in an act aimed at the identification and discernment of information.

Digitization and Advanced Imaging

There is, therefore, an infinite set of materiality aspects that can be studied in a book, such as the gathering assembly mentioned above, or bookbinding structures, or the different materials and substances adopted and used to compose and construct the book, to mention but a few. The digitization of books is generally understood as capturing the page contents through photography and imaging, i.e., capturing, representing and reproducing form and features of an object through visual means. As noted, only a limited amount of information can be acquired through conventional digitization, but more features can be captured by way of advanced imaging processes, such as spectral imaging and x-ray photography.

Traditionally, spectral imaging has been applied to palimpsests or underdrawings to recover hidden texts and graphics. However, spectral imaging also provides a non-destructive tool for research into paper, parchment, and other objects within cultural heritage institutions. Spectral imaging works by capturing multiple images of an object at different wavelengths. Capturing is only one part of spectral imaging. Establishing close collaborations between preservation professionals, conservators, and curators spectral imaging can be used to track change over time, assess the efficacy of conservation treatments, characterize and identify inks and pigments, as well as for the recovery of hidden or faded texts. This is achieved by measuring the reflectance of materials and processing the data to reveal additional features, and to map and visualize spectral responses through false-colour images, or by plotting spectral curves, that, for example, differentiate between features that may look the same to the naked eye.[42] Spectral curves (see Figure 1) are particularly useful because easy to produce, and their shape can be used to compare and discern various materials present in a document or collection. Spectral curves allow the data to be analysed by scientists, scholars, and conservators alike, fostering communication and collaboration among different fields.[43] Spectral imaging is also an excellent technique to archive data on objects' materiality (at a specific date) and enhance conservation documentation.[44]

Spectral imaging allows the mapping of different materials on a page. This baseline map helps determining areas needing further study with other non-invasive analytical techniques. For example, one could use X-Ray Fluorescence spectroscopy (XRF), Fourier Transform Infrared spectroscopy (FTIR), Fibre Optic Reflectance Spectroscopy (FORS), 3D Fluorescence spectroscopy, Raman spectroscopy, or other techniques to capture

41 Hayles, *How We Think*, 326.

42 France, 'Spectral Imaging'; France, 'Spectral Imaging to Aid Preservation'; France, Emery, and Toth, 'The Convergence'; Toth, 'Multispectral Imaging'; Garside, Beltran de Guevara, and Duffy, 'The Repercussions'.

43 France, 'Spectral Imaging', 191-95; France, 'Visualizing Conservation Science', 17; Campagnolo, Connelly, and Wacha, 'Labeculæ Vivæ', 405-14; Wacha, 'Library of Stains'.

44 France, 'Spectral Imaging to Aid Preservation', 172-76.

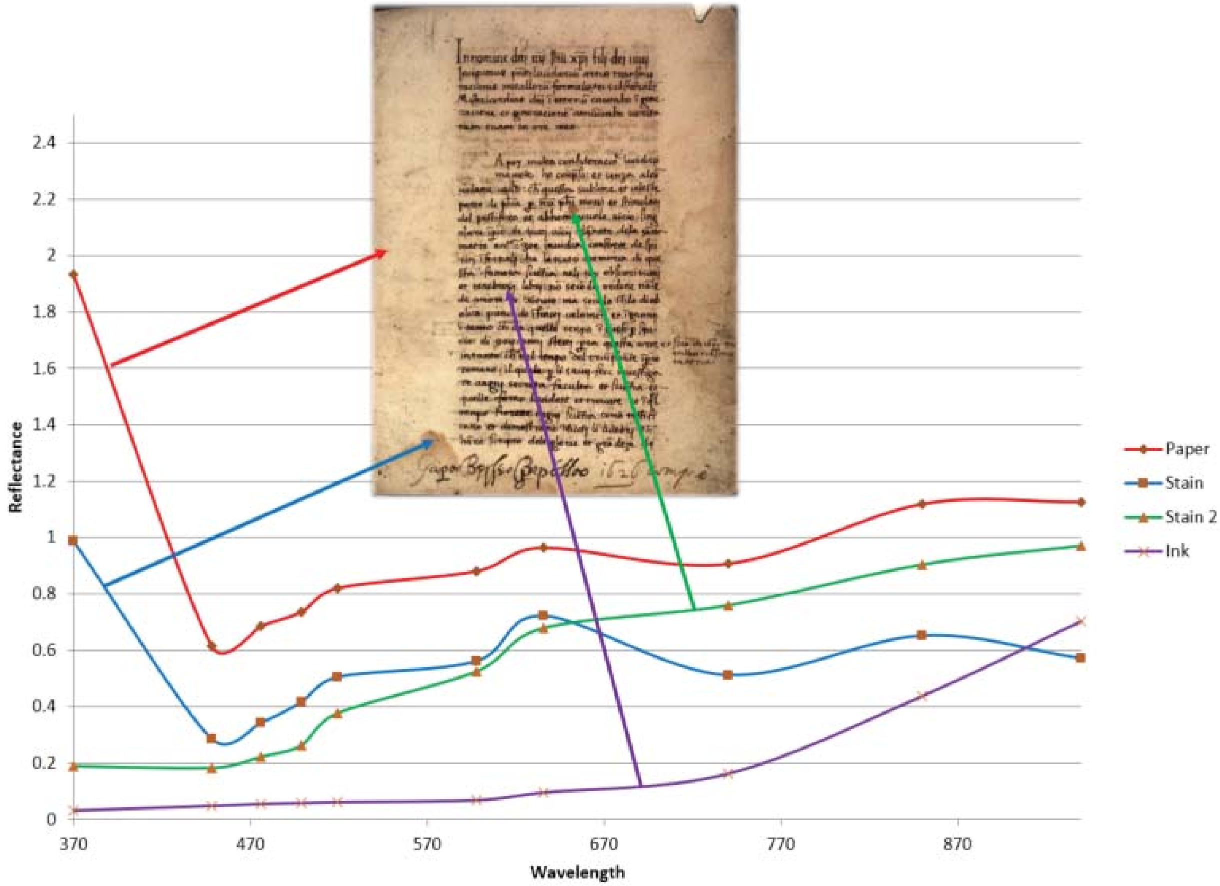

Fig. 1: Spectral curves for folio 1 recto of Science History Institute, Othmer 8,[45] *showing the different shapes of the spectral plots for two stains, the writing ink, and the paper, corresponding to different chemical compositions.*

additional useful information about materials.[46]

Reflectance transformation imaging (RTI) is another specialized photographic technique that can capture and reveal an object's shape and structural information that would otherwise be missed in traditional photography. RTI—also known as polynomial texture mapping (PTM)—is a computational photographic method that captures a subject's surface shape and colour from the information derived from multiple digital photographs, shot from a stationary camera position, and light projected from a series of different known directions.[47] RTI images can, for example, reveal the presence of flaking pigments on an illumination, or the occurrence of otherwise invisible scoring on the surface, making it an invaluable tool for the conservator.[48]

X-ray photography has been used for decades to examine book boards and their lacing patterns and micro-computed tomography (CT or CAT) scans have been used to analyse important items such as the cover of the St. Cuthbert Gospel and its unique

45 University of Pennsylvania Libraries, 'SHI Othmer 8'.

46 France, 'Spectral Imaging to Aid Preservation', 172.

47 Cultural Heritage Imaging, 'RTI'.

48 Schroer, 'Advanced Imaging Tools'.

decoration technique.[49] More recently, micro-CT scanning has been experimentally applied to codices to begin detecting, without opening, the structure of books, such as the gathering assembly or the sewing structure.[50]

Although not imaging techniques, modern scientific and technical methodologies generally applied to archaeological remains have also started to be employed to analyse books and documents as newer research and investigation avenues. For example, scientists have been analysing the odour of paper as a diagnostic tool,[51] or the molecular makeup of parchment and its DNA to identify species and reveal clues about the manufacturing process and, possibly, the deterioration of the medium.[52]

Beyond Direct-Acquisition Digitization

Of the infinite set of qualities that an object possesses, we have seen how traditional digitization methods could capture only a limited number, and that a few other features could be acquired through advanced imaging and other analytical methods of investigation. Digitization by direct acquisition of information fails to engage senses beyond that of sight, even though, indeed, digitization techniques can offer a much more potent visual perception than possible through human eyes.[53] There are characteristics of books that scholars interacting with the originals perceive with their other senses, often acting in concert with sight, such as hard-to-see features like the bumps of board lacings or the sound of parchment, board, and wood.[54]

Therefore, objects possess characteristics that while manifest, for economic or practical issues, cannot be easily transferred onto other formats through traditional techniques. These are typically bound to the objects' physicality.[55] We refer to these traits of the original artefact as *untransferable qualities*. As we will see, these are not untransferable in absolute terms, rather, for what concerns traditional reproduction technologies through customary digitization and direct acquisition.[56] As we will see, these features can be captured and brought into the digital, but to understand how this may happen, we need to reformulate and assign a broader meaning to the digitization of books. In these activities, alongside customary photography and imaging, we include any action directed at the computerization and transmediation of books and their features, materiality included, into digital media, and the use of such data.

Models and Metadata as Digitization

As noted, materiality—and its information—is extrapolated from physicality, and aspects of it can be represented and manipulated, also digitally. This digital representation and manipulation of an object's materiality is achieved through different means. Among these, besides advanced imaging and analytical tools, metadata designation is one of the most established processes.[57] Models, databases, and descriptive metadata are among the steps that are necessary to computerize important, yet

49 Pollard, 'Some Anglo-Saxon Bookbindings'; Duffy, 'A CT Scan'; Pickwoad, 'Binding'.

50 Old Books New Science Lab, 'Micro-CT'; Thaw Conservation Center, 'Inside Story'.

51 Strlič et al., 'Material Degradomics'; Fenech et al., 'Volatile Aldehydes'; Kirschenbaum and Werner, 'Digital Scholarship', 422.

52 Fiddyment et al., 'Animal Origin'; Beasts2Craft, 'Beasts2Craft'; Fiddyment et al., 'So You Want to Do Biocodicology?'

53 Wilcox, 'Introduction: The Philology of Smell', 3.

54 Campagnolo, 'Conservation and Digitization', 74.

55 Banks, 'Decline in the Standards'; Banks, 'Some Notes'.

56 Campagnolo, 'Understanding the Artifactual Value', 33.

57 Geismar, 'Defining the Digital'; Geismar, *Museum Object Lessons*, 61.

mostly *untransferable*, information about the structure and materiality of books.

In this manner, when we want to study a material object, we initiate an abstraction, categorization, and modelling process that allows us to select only a restricted set of its characteristics and work with these models of reality.[58] Similarly, when we want to communicate a description of such an object, we can use representations or models of reality that convey a restricted set of characteristics of the physicality of the object for which they stand. Modelling is a fundamental activity for the abstraction—and digital fruition—of reality. Modelling activities take different forms, among which are representation and diagrams.[59] Typically, representation models of material objects take the form of descriptive or database schemas, with precise metadata and controlled vocabularies.

Databases, coupled with well-developed models and description protocols, and controlled and normalized descriptive vocabularies that may convey the structures of the artefact in question, have the potency to support the creation, and peruse, of detailed and accurate descriptions that are the basis from which any other scholarly activity can stem.[60]

The Gathering Assembly

To give an example of how models and metadata function as digitization of untransferable features, let us have a look at the elusive gathering assembly of books in codex format. As we have seen, the gathering structure, while an essential piece of information, is not acquired or represented through conventional digitization. The typical number of leaves in each gathering varies diachronically and diatopically. The study of the gathering structure of books can help assessing the provenance and dating of an artefact or illustrating—highlighting irregularities and discontinuities—complex histories of addition, replacement, removal, and falling of leaves, as well as of different units and parts. The gathering structure of codex books represents the first key to begin studying the genesis and history of these objects and their content.[61] The description of a book's gathering structure is termed *collation*. Traditionally, besides discursive descriptions and diagrams, gathering structures are encoded in highly-formalized alphanumerical formulaic representations, referred to as *collation formulas*.[62] It is customary to include these formulas in paper-based and online catalogues, but, for what concerns manuscript studies, there are no actual standards, and different catalogues and scholars use their own set of rules and practices. In addition, the information density of collation formulas hinders the immediacy of their interpretation.

Gathering structures, however, can also be captured utilizing models and metadata, and taking advantage of the flexibility of the digital medium, can be represented and visualized to study this, and related features, allowing for a more immediate understanding and interpretation of the data. A project that takes advantage of this is VisColl.[63] Conceived

58 Cohen and Lefebvre, *Handbook of Categorization*.

59 McCarty, 'Modelling', 22.

60 Ouy, 'Quelques problèmes'; Gruijs, 'Codicology or the Archaeology of the Book?', 104; Szirmai, *The Archaeology*, xi–xii.

61 Andrist, Canart, and Maniaci, 'L'analyse structurelle du codex'.

62 Bischoff, 'Methoden'; Agati, *The Manuscript Book*, 160–69; Dorofeeva, 'Visualizing'; Andrist and Maniaci, 'Describing Quires'.

63 Porter and Campagnolo, 'VisColl'; Porter, Campagnolo, and Connelly, 'VisColl: A New Collation Tool'.

by Dot Porter (Schoenberg Institute for Manuscript Studies, University of Pennsylvania, Philadelphia, PA, USA) in the early 2010s, VisColl was proposed as a way to enable readers, scholars, and students to better visualize the structure of the object beyond the limitations of traditional formulas, diagrams, and collation statements.

The model behind VisColl permits users to collect structured data to describe the gathering assembly of an item and then to generate automatic diagrammatic representations and visualize digital facsimiles that re-join into virtual bifolia the photographs of the leaves of books, making overt the physical makeup of books. What is of particular interest to book conservators is the fact that users can opt to collect data that is richer than what is traditionally captured in collation formulas. For example, each leaf's attachment method, and to automatically generate detailed diagrammatic visualizations that can be used to record and describe complex structures (see Figure 2).

Describing Bookbinding Structures and their Conservation

The model behind VisColl permits the description of complex gathering structures and manipulation of the data for visualization, presentation, and research purposes. Similarly, book archaeologists have developed rigorous

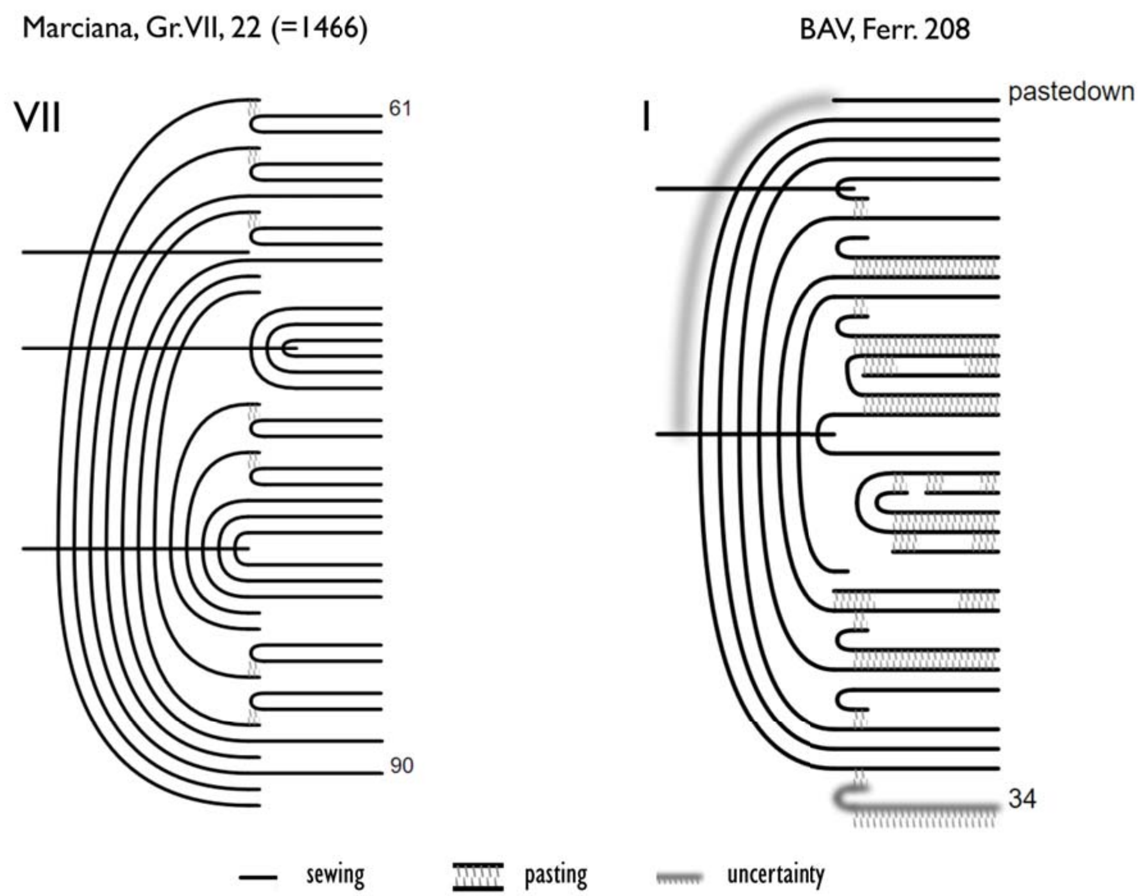

Fig. 2: *Examples of diagrammatic visualizations of elaborate gatherings automatically generated through VisColl scripts. Left, a diagram for gathering 7 of Marciana, Gr.VII, 22 (=1466). Right, a diagram for gathering 1 of BAV, Ferr. 208. Note the different graphic representations for the attachment methods, and to signal uncertainties.*

methodologies to record bookbindings and their structures within databases, thus facilitating consistent descriptions through a commonly understood hierarchy of information.

A successful example of the use of a hierarchical database for storing data on bookbinding structures and their state of conservation is the database of the St. Catherine’s Library Conservation Project (Sinai, Egypt), devised by the Ligatus Research Centre, University of the Arts London.[64] Through a methodology similar to VisColl, it has been possible to transform the information recorded in the database into a series of automated diagrammatic line drawings that grant better communication because of diagrams’ innate immediacy for spatial information.[65] The fact that these drawings could be automatically generated through algorithms testifies to the efficacy of the Ligatus description model.[66]

Lately, Ligatus has been working on a framework for integrating bookbinding and conservation databases built on semantic web technologies.[67] Conservation information is rarely made available during digitization projects, leaving behind important information.

Towards the Creation of Digital Cultural Objects

Conservators enjoy an intimate relationship with books and documents, giving them a unique perspective on their materiality and what can be read and understood from it. While documentation is a central activity of modern book conservation, conservators are only rarely consulted for their understanding of the objects and asked to contribute metadata and information when it comes to digitization projects. The conservator’s role is undoubtedly that of the object custodian, but recognizing the comprehensive knowledge they can provide could greatly enrich the scope of digitization projects.

A dialogue between conservators on the one hand, and digital content providers, digitizers, and researchers on the other, fosters better models capable of recording more untransferable information. These should be the premises of any digitization project. In turn, these models capture and convey more data, and lead to the creation of ‘digital cultural objects’[68] that are much more usable and feasible as digital surrogates of historical books. These digital surrogates, while certainly not a replacement for the original item, tackle issues and questions that cannot be addressed with the original item or traditional conservation. In this manner, digital cultural objects, even though unfinished and in constant development, due to the emergent quality of materiality, transcend the material items that they represent, facilitating particular uses and knowledge acquisition and allowing scholars to access information on the original documents and help construct a better history of the book.[69]

64 Velios and Pickwoad, ‘Current Use’; Velios, ‘Hierarchical Recording’; Velios and Pickwoad, ‘The Development’.

65 Campagnolo, ‘Transforming Structured Descriptions’.

66 Campagnolo, ‘Errata (per Oculos) Corrige’.

67 LCD Network, ‘Linked Conservation Data’.

68 France, ‘Spectral Imaging’, 190.

69 Campagnolo, ‘Coda’.

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Abydos Archive: Forgotten Cultural Heritage and Rescue Strategy

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Introduction

Archival turn is definition that characterized by a shift from 'archive-as-source to archive-as-subject', making the archive a focus of scholarly enquiry. This shift implies new understandings of what the archive is. Archives may reflect ideological concerns, but also practical day-to-day matters, and their meanings, functions, and uses may shift over time[1].

This archive guides us how the way the archive worked, and what kind was the archive. It also highlights the internal configuration of the archive: its shape and arrangement, which

1 Livingston, Daisy. "Managing paperwork in Mamluk Egypt (c. 1250-1517): a documentary approach to archival practices." PhD diss., SOAS University of London, 2018.

determined its use, and potentially also the details of its physical storage[2].

Archival records are extremely important to individuals and society in general. Neglect of archives and archival collections is an invaluable loss to society. Unlike libraries that hold volumes available in many copies and therefore in many places, archives have scarce and unique holdings[3].

Recently there is a growing interest in the study of the early history of Egyptology among a wide range of scholars, according to archives of early European explorers and diggers who worked at the beginning of the twentieth century in Egypt. Hence they copy a historical trajectory based on Western perceptions, with little or no mention of Egyptian history and perspectives[4].

The lack of local accounts in the many revision studies that attempted inclusion in narratives or reinterpreted archives in the context of European colonialism left wide gaps in the historical narrative[5]. As such, the Abydos Archive is unique in its ability to re-adjust the prevailing narrative of the history of Egyptology by including and overlooked local agents; assure their role in managing their heritage and in producing historical knowledge[6].

2 Brulon Soares, Bruno, and Kerstin Smeds. "Museology exploring the concept of MLA (Museums-Libraries-Archives) and probing its interdisciplinarity." Icofom Study Series 44 (2016): 29-33.

3 Livingston, "Managing." PhD, 2018.

4 Schneider, Thomas. "Foreign Egypt: Egyptology and the concept of cultural appropriation." Ägypten und Levante/ Egypt and the Levant 13 (2003): 155-161.

5 Kaeser, Marc-Antoine. "Biography as Microhistory. The Relevance of Private Archives for Writing the History of Archaeology.[In:] Archives, Ancestors, Practices. Archaeology in the Light of its History. Edited by Jarl Nordbladh and Nathan Schlanger." (2008): 9-20.

6 El Shakry, Omnia. ""History without documents": the vexed archives of decolonization in the Middle East." The American Historical Review 120, no. 3 (2015): 920-934.

The Abydos Temple Paper Archive Project (ATPA)

The Abydos Temple Paper Archive Project (ATPA) is a joint Egyptian-American mission under the auspices of the State Department of Antiquities and the University of California. When current curators reopened a room in the area known as the slaughterhouse in the Temple of Seti I in Abydos for photography by current investigators in 2013, thousands of archival documents of the Sohag inspectorate and the Egyptian Department of Antiquities were found scattered on the ground (Fig. 1).

Fig. 1: *The archive as initially found, Photo by Ayman Damarany*

This historical archive contains historical documents from the Heritage Administration of Egyptian Antiquities belong to the Abydos site and its surroundings, from about 1850 until the 1960s. The objectives of this project are to preserve and classify this historical archive to obtain important information in order to rewrite the modern history of the archaeological area and its sites from the new Egyptian point of view[7].

(SWOT) Analysis

The SWOT analysis - strengths, weaknesses, opportunities and threats - is used to illustrate the main features and elements that make up the internal and external project environment.

7 https://abydosarchive.org/ signed in at 2/3/2021

This analysis is of great importance for exploring the Abydos archive and setting realistic and achievable goals[8].

The Analysis of Strengths (S): – One of the most important strengths of this project is that there are many excavation reports and letters containing signatures of famous Egyptologists during this period mostly in Arabic, have been written by officials of the Antiquities Authority since the 1850s, such as *Maspero, Edgar, Gustave Lefebvre, Pierre Lacau, Omm Seti* and others[9]. These documents represent an important historical period and contain a many of important archaeological information. There were a lot of records, dating from the late 19th century, including correspondence, excavation reports and survey maps, made long before the landscapes around the site took their current form[10].

The Analysis of Weaknesses (W): – Most of these documents are in poor condition due to their being stored in unfavorable conditions. The most important types of damage include dirt, dust, breaks, holes, smudging, fungi, pest damage, brittleness, folding, creasing, ink fading, ink damage, and other conditions that can be considered as vulnerabilities. If documents are not handled properly, they can easily get lost[11].

8 Martín-Cáceres, Myriam José, and José María Cuenca-López. "Communicating heritage in museums: outlook, strategies and challenges through a SWOT analysis." Museum Management and Curatorship 31, no. 3 (2016): 299-316.

9 Nightingale, Florence. "13 Ancient Egypt in nineteenth-Century Art, Photography, and literature." Wonderful Things: A History of Egyptology: 1: From Antiquity to 1881 (2015): 239.

10 Shalaby, Nora, Ayman Damarany, and Jessica Kaiser. "Tewfik Boulos and the Administration of Egyptian Heritage at the Beginning of the Twentieth Century." The Journal of Egyptian Archaeology 106, no. 1-2 (2020): 75-88.

11 Bankole, Olubanke M. "A review of biological deterioration of library materials and possible control strategies in the tropics." Library Review (2010).

The Analysis of Opportunities (O): – Documenting, recording and preserving documents from archive Abydose and extract information of historical interest about the early history of Egyptology to make them available to future generations[12]. For the first time and more importantly, the early history of Egyptology can be examined from the point of view of Egyptians who worked in and administered the ancient sites over most of their modern history, rather than through the lens of foreign missions; by making the contents of this archive available to the public[13].

The Analysis of Threats (T): – However, there are a number of obstacles, the most prominent of which is the lack of sufficient funds to obtain the necessary preservation materials since most of the preservation materials related to preservation of documents and manuscripts are not available in Egypt. An additional threat is that the private storage area for documents once the archiving process is completed is not ideal due to the limited budget, which makes the documents vulnerable to deterioration again.

Stories from the archive

What became clear from the detailed study of the Abydos Archive is that it is a window to untold stories, a collection of documents discussing various and distinct topics, and official letters of correspondence between various departments, departments or ministries; Informal letters from guards or employees of the Ministry of Antiquities in the form of notifications or complaints; Circulars and notes

12 Letellier, Robin, and Rand Eppich, eds. Recording, documentation and information management for the conservation of heritage places. Routledge, 2015.

13 Sartori, Paolo. "Seeing Like a Khanate: On Archives, Cultures of Documentation, and Nineteenth-Century Khvārazm." Journal of persianate studies 9, no. 2 (2016): 228-257.

containing new and updated guidelines and instructions for employees, especially in times of war, hardship, or political change, the Office of Inspectors' early notebooks give us insight into the ways in which Egyptians administered and documented work. These are just some of the stories that have been uncovered so far in the Abydos archive, with more potential to be revealed (Fig. 2)[14].

***Fig. 2:** A signature of an employee in the antiquities service dated in 1939-1943*

Preservation procedures

1. Recording and processing system

The first step in the processing system was to assign a number to each document depending on which category it belongs to. The main consideration when assigning numbers was to enable searching for specific details (for example, subjects, people, places, or dates) in the archive, while preserving both the physical and objective context in which the documents were found[15]. This necessitated setting a hierarchy of numbers, whereby documents together in a file could be written on different dates and mention different locations, even though they are related to the same topic. Thus, all separate sheets were given an index number (C), while the ledgers, which consisted of a ledger of entries, were given a ledger number (L). The entries within the ledgers were then given separate catalog numbers. Illustrations, maps, drawings, era (Fig. 3) and other forms of drawings were all given drawing numbers (D).

***Fig. 3:** An example of a squeeze found in the archive*

The files, which consisted of separate documents grouped together by a pin or string, were given a file number (F) for the entire file and unique catalog numbers for all of the individual papers that made up the file. The packages, which can contain a variety of papers, ledgers, maps, and files, have been given the package number (B) and catalog numbers for the individual documents within them. All loose mixed documents and files scattered on the storage floor were assigned to Bundle (0)[16].

2. Photographic documentation

With a unique number assigned, each document was then digitized through photographic documentation with a Nikon D810 and a 60mm lens, scaled into each image. When the maps were digitized, the images were acquired with

14 https://abydosarchive.org/signed in at 2/3/2021

15 Whittaker, Steve, and Julia Hirschberg. "The character, value, and management of personal paper archives." ACM Transactions on Computer-Human Interaction (TOCHI) 8, no. 2 (2001): 150-170.

16 https://abydosarchive.org/ signed in at 2/3/2021

a 24mm tiltable lens to reduce distortion. Both the front and back of the document are copied and the numbers are entered into the scrapbook, written along with the unique catalog number (or package, file, ledger, or graphic). Since many of the documents were extremely fragile, this initial stage of documentation was carried out without any attempt to unfold the document if it was creased (Fig. 4).

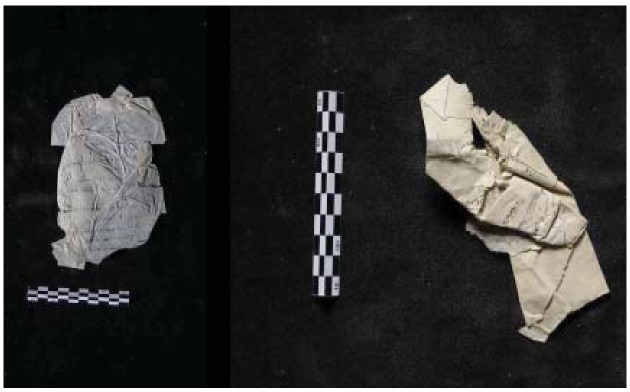

Fig. 4: *Crumpled paper in need of conservation*

3. Treatment and conservation procedures

These important historical Abydos archives were stored in very unfavorable conditions, that due to the extremely dry and sandy weather in Abydos. It was not preserved but placed directly on the ground that led water to reach them, making it vulnerable to damage by insects and micro-organisms[17].

A large amount of paper had already been eroded by insects also become very fragile due to fungi. These historical documents of papers suffered from a wide extant of deterioration aspects including folds, creasing; fractures; missing parts; stains; water damage; fading, and damaged ink; fungi; holes and rust stains[18].

17 Kite, Marion, and Roy Thomson, eds. Conservation of leather and related materials. Routledge, 2006, pp.200-224.

18 Abdel-Maksoud, Gomaa. "Analysis and conservation of an 18th/19th century vegetable-tanned parchment manuscript." Journal of the Society of Leather Technologists and Chemists 95, no. 2 (2011): 47-58.

Many different restoration techniques were used such as cleaning, consolidation etc. the main aim of these techniques is to repair all forms of deterioration found on the historical documents and to safe the condition[19].

3.1 Disinfection of the historical paper manuscript:

The disinfection process can be applied before any restoration treatments and/or after all conservation processes have been completed[20.] The most common disinfectant in microbiology: 70% ethanol. Ethanol can also have a good toxic effect on fungi if the contact time is at least 2-3 minutes[21] (Fig. 5).

Fig. 5. *The disinfection process applied by spray techniques*

19 Ibrahim, Alsayda Nafesa Ibrahim Elmoselhy. "Experimental study for the evaluation and modification of pastes used for gap-filling dented parchment manuscripts with application on an archaeological object." CU Theses (2012), pp.184-186.

20 Abdel-Maksoud, G. "Evaluation of wax or oil/fungicide formulations for preservation of vegetable-tanned leather artifacts." Journal of the Society of Leather Technologists and Chemists 90, no. 2 (2006): 58-67.

21 Nittérus, Mattias. "Ethanol as fungal sanitizer in paper conservation." Restaurator. International Journal for the Preservation of Library and Archival Material 21, no. 2 (2000): 101-115.

3.2 Cleaning process for the historical paper documents:

Dirt and grime was found on the surface of historical manuscripts, which led to physical damage to the manuscript by scraping the fiber structure and ink films. It destroyed the aesthetic value of the manuscript resulting in the distortion of other parts. Moisture may encourage mold growth because spores are often present in surface dust. A secondary consideration is that the appearance of the manuscript and the ink merge with the dirt[22].

Gentle brushing and removing stains from loose surface dirt appears to be the safest intervention[23]. After dry brushing and eraser, isopropyl alcohol absolute was used, to avoid absorbing much of the water if it was used alone. It should be noted that all cleaning operations applied to the document in question have been used in areas far from ink writing. After each cleaning step, the document was flattened and lightly pressed[24] (Fig. 6).

3.3 Fixing the inks of the historical paper:

The purpose of the fixing process is to secure the ink used in order to facilitate conservation treatment as a whole. The solubility test showed that if the ink used is sensitive to water. Inks should be fixed in some areas suffering from sensitivity to the chemicals used in the restoration. Before the conservation procedures the sensitivity of the inks with the

Fig. 6: *Cleaning steps*

22 Chahine, Claire, and Dominique Rouy. "The cleaning of parchment: how far can we go?." In International conference on conservation and restoration of archive and library materials, Erice (Italy), CCSEM, 22-29 April 1996: preprints, vol. I and II, pp. 363-369. 1996.

23 Munn, Jesse. "Treatment techniques for the vellum covered furniture of Carlo Bugatti." The Book and Paper Group Annual 8 (1989): 27-38.

24 Dobrusina, Svetlana A., and Vitaliya K. Visotskite. "Chemical treatment effects on parchment properties in the course of ageing." Restaurator: international journal for the preservation of library and archival material 15, no. 4 (1994): 208-219.

different treatments should be measured[25]. Many different materials have been used to fix water-sensitive inks. Many authors mentioned the use of Klucel G for this purpose. Klucel G (hydroxypropylcellulose) in ethanol at 0.5% was used. The area of ink is lightly painted with the consolidate using a very fine brush[26] (Fig. 7).

Fig. 7: *Fixing some sensitive inks*

25 Botti, Lorena, Giancarlo Impagliazzo, Orietta Mantovani, and Daniele Ruggiero. "Investigation of some polymers for the protection of paint films." In International conference on conservation and restoration of archive and library materials, Erice (Italy), CCSEM, 22-29 April 1996: preprints, vol. I and II, pp. 563-581. 1996.

26 Kolar, J., and M. Strlič. "The Iron Gall Ink Meeting." The University of Northumbria, Newcastle, (2001): 135-138.

3.4 Flattening of the historical paper documents:

The mixture of alcohol and water is isotropic, meaning that both components will evaporate simultaneously. The solution has less surface tension than water, which causes the fibers to suffer less shrinkage. Removing creases and flattening the paper through moistening are determined according to the condition[27]. 70% isopropyl alcohol can be applied directly

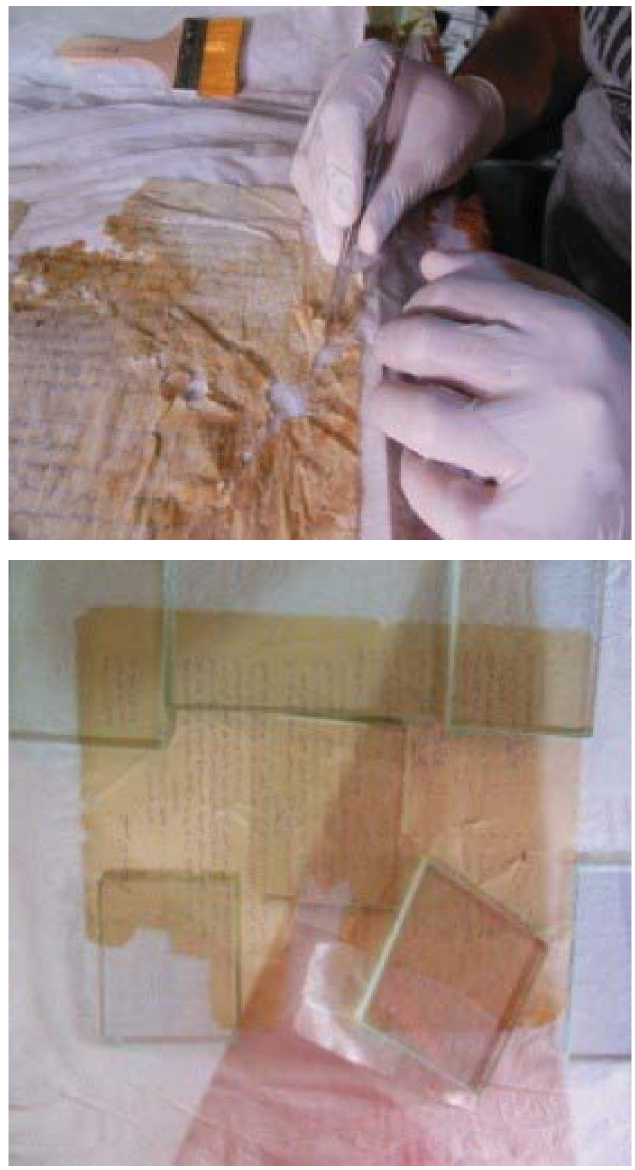

Fig. 8: *Flattening steps*

27 Clarkson, Christopher. "A conditioning chamber for parchment and other materials." The Paper Conservator 16, no. 1 (1992): 27-30.

to the wrinkles. Then small pieces of Plexiglas were placed as light weights on the outer circumference of the pane (Fig. 8). The piece was allowed to air dry then the process was repeated until most of the distortion had been removed from the paper document[28].

3.5 Repairing tears and the weaken parts of the historical paper:

Tears are repaired most often to improve the appearance of a torn sheet, to prevent a tear from lengthening, to keep fragments from separating, or to make a document safer to handle. The popular adhesive and consolidate is Klucel G (hydroxyl propyl cellulose (HPC)). It's also has a low-medium viscosity-grade[29]. Also it should be Reversibility: It should be possible to remove the repair materials with moderate effort and no damage to the object, even after many years[30]. Sheet of Japanese paper (9gm) was used Then small or narrow strips can be obtained that suitable for the required tears or weaken areas. The adhesive can be applied in a low concentration (1%) of Klucel G (hydroxyl propyl cellulose)[31]. Finally, apiece of Gore-Tex was put on the top of the repair area (to absorb excess moisture and adhesive), then pieces of light weight glass were placed over the repair place and left to dry[32] (Fig. 9).

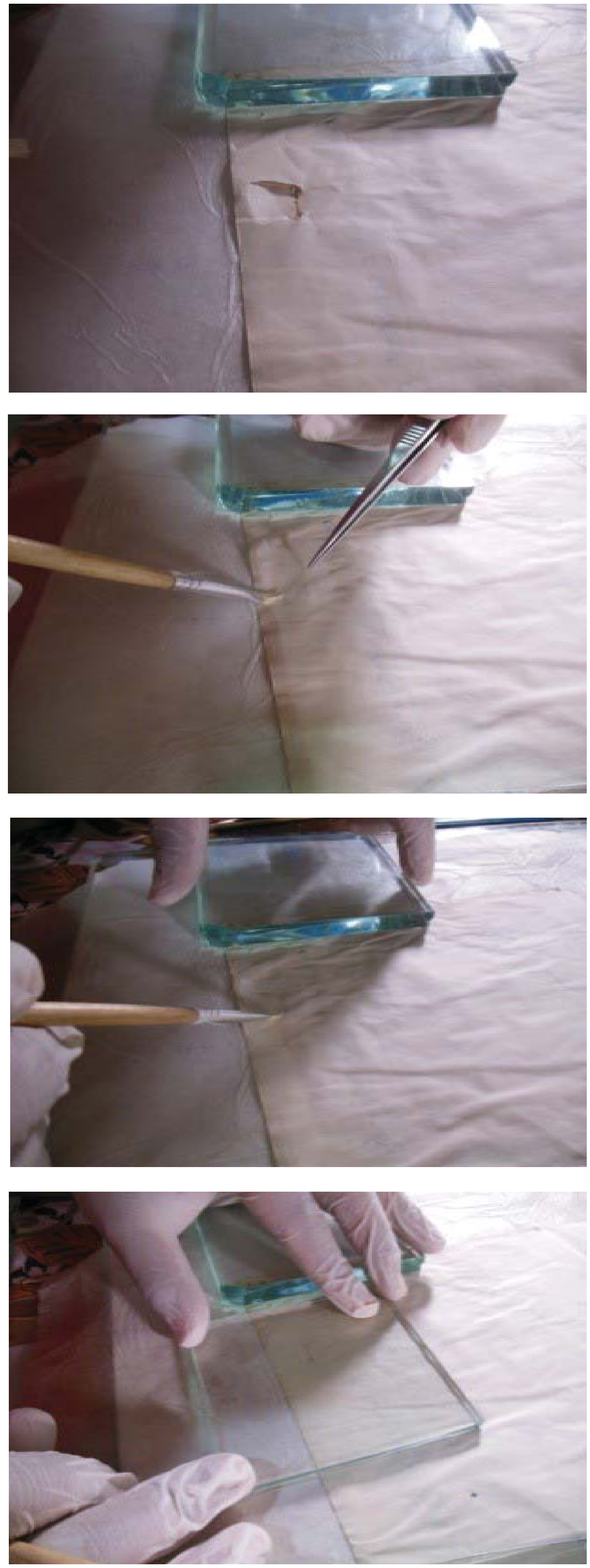

Fig. 9: Repairing tears

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28 Hansen, Eric F., Steve N. Lee, and Harry Sobel. "The effects of relative humidity on some physical properties of modern vellum: implications for the optimum relative humidity for the display and storage of parchment." Journal of the American Institute for Conservation 31, no. 3 (1992): 325-342.

29 Baker, Cathleen A. "Sodium Carboxymethylcellulose (SCMC) Re-evaluated for Paper, Book, Papyrus, and Parchment Conservation." Book Paper Group Ann 26 (2007): 177-185.

30 Ogden, Sherelyn. Preservation of library and archival materials: a manual. 1994.

31 Cains, Anthony. "Repair treatments for vellum manuscripts." The paper conservator 7, no. 1 (1982): 15-23.

32 Woods, Chris. "Conservation treatments for parchment documents." Journal of the Society of Archivists 16, no. 2 (1995): 221-238.

Fig. 10: Removing previous repairs

3.6 Previous repairs removal:

Removing inappropriate previous repairs is necessary not to cause further damage. It is important to know the nature of the repair whether it is original (as part of the history) or not. If the repair is actively causing damage, or obscuring significant parts of the document, it should be removed. Past repair techniques were most likely executed using patches of new paper adhered with based adhesive or paste. If the adhesive is dried out, and if the original paper is considered strong enough in that area, it may be possible to remove the repair patch and the adhesive residue by mechanical means. Locally humidify can be used in the repair by either direct application of an alcohol/water solution[33] (Fig. 10).

3.7 Lining the weaken parts of the historical paper:

The paper used for lining is called Tengoju the lightest weight paper, which is made from only kozo; Kozo papers have qualities often appropriate for lining because they have the longest fibers.it is also porous, absorbent, and has an even surface. Lining carried out on or against Mylar sheet, applying the kozo sheet with the same size of the hestorical paper sheet with 5 cm more from each side. Then applying the adhesive using Klucel G (2%) dissolved in Ethanol 95% Success in drying kozo is obtained by placing between Reemay (with the smooth sides facing the Kozo) sandwiching this between blotters and felts and placed under glass weight[34] (Fig. 11).

4. Storage and Display conditions:

Storage methods and preservation procedures play an important role in keeping historical objects in good condition. As a final step is conservation process, the reports were placed in acid-free folders and put in acid-free boxes to protect them from the dust[35] (Fig. 12).

To prepare for the exhibit, all the documents to be exhibited were conserved, photographed and their data entered into the project database. They were then put into specially made frames that would allow them to be placed in the vitrines, or fixed onto the walls without being subjected to damage or deterioration. After being transported to the museum the documents were placed in appropriate locations around the hall and labels that gave a brief description of

33 Singer, Hannah. "The conservation of parchment objects using gore-tex laminates." The Paper Conservator 16, no. 1 (1992): 40-45.

34 Othman, M. Abdel-Rahman, A. Tarek, A. Mostafa, E. Shaheen. "From Visual Documentation to Conservation Implementation: A Holistic Treatment Approach To Papyrus Cg 40005 = Boulaq 22." Analecta Papyrologica, XXVIII (2016): pp.319-347.

35 O'toole, James M., and Richard J. Cox. Understanding archives and manuscripts. Chicago, IL: Society of American archivists, 1990.

Fig. 11: *Lining process steps of the weaken parts of the historical paper*

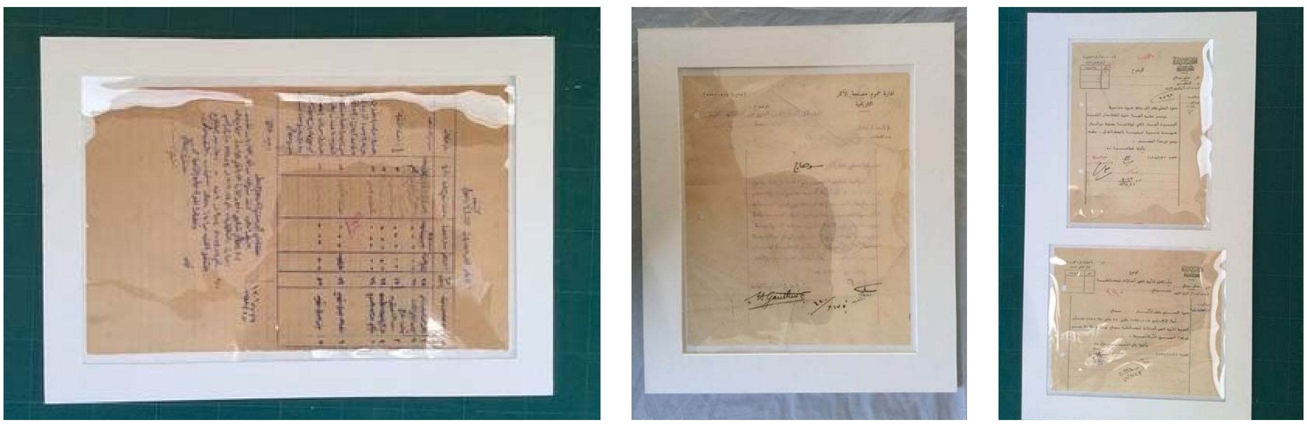

Fig. 12: *Storage methods of the reports which placed in acid-free folders in Sohag National Museum*

the contents of the document, fixed underneath each one. Accompanying the exhibit are three large posters that provide the visitor with information about the Abydos archive and its team members and highlight some of the different topics that feature in the archive[36].

Sixty documents from the archive were exhibited in a temporary exhibition hall in Sohag National Museum (Fig. 13). The name of the exhibit is ‘Hadret Sahib el-Ezza’ in reference to the way in which officials in the inspectorates were being addressed in early correspondence. The earliest document exhibited is a ledger dating to 1883.

The most important step in an archival processing system is Storage. To protect documents from any immediate or long-term damage and to allow preservation for future generations, documents kept in acid-free bins have been placed on specially designed aluminum shelves which are fixed to the workspace. Work is underway to create a central repository for archival materials in Abydos[37].

Fig. 13: *the Abydos archive team installing the temporary exhibit in the Sohag Museum*

36 Ahmad, Shamsidar, Mohamed Yusoff Abbas, Mohd Zafrullah Mohd Taib, and Mawar Masri. “Museum exhibition design: communication of meaning and the shaping of knowledge.” Procedia-Social and Behavioral Sciences 153 (2014): 254-265.

37 Foot, Mirjam M. “Housing Our Collections: Environment and Storage for Libraries and Archives.” IFLA journal 22, no. 2 (1996): 110-114.

5. Database design and data entry

Archives have made great use of modern digital technology. With the increase in interest in the archive and its collections, digitization and other methods of expanding access are also becoming more and more important[38].

Filemaker database is designed to meet the needs of the Abydos Archive. The database tables are linked to each other by the unique registration number assigned to each document. The ultimate goal of the database is to allow easy searches on specific topics, topics, areas and/ or people mentioned in the various documents, which can then be printed as topics reports covering many aspects of the archive.

Each document type has a specific layout within the database, and acts as a front end to the many related tables that make up the appropriate database. For example, the catalog layout includes information such as the date of the document, regions / regions, names, addresses, institutes mentioned as well as a general description. Also it was recorded, but not limited to type, color, number of handwriting (s), type of paper used, stamp impressions, and whether or not the document has been reused. Additional layouts for subtitles, transcriptions, and images, as well as archiving details, have been created. The buttons on each layout allow easy navigation through the database (Fig. 14).

***Fig. 14:** The opening layout of the ATPA database*

38 Lin, Rungtai, Ricer Cheng, and Ming-Xian Sun. “Digital archive database for cultural product design.” In International Conference on Usability and Internationalization, pp. 154-163. Springer, Berlin, Heidelberg, 2007.

Conclusion

An archive is an institution that aims to preserve records like paper, photos, etc., in a long and lasting term. The Abydos archive was discovered in 2013 containing thousands of documents in Arabic dating from 1880 to the mid-twentieth century, written by archaeologists who worked on Egyptian antiquities.

The significance of this discovery is because it includes many excavation reports and letters of famous Egyptologists such as Maspero, Edgar, Gustave Lefevre, Pierre Lacot, Uum City, and others. Most of these documents are in poor condition due to their being stored under unfavorable conditions. It represents an opportunity for future generations to learn a lot about the early history of Egyptology by making the contents of this archive available to the public.

Several steps have been taken to preserve this treasure, such as documentation, digitization, preservation, and the creation of an integrated database.

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19 October 2020

Reversibility and the Right Conservation Treatment

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She teaches and organizes international conservation courses at her studio as well as in other countries and with other institutions. She does lectures, research and short collaborations with paper conservators from other countries as well (Restauratoren Nederland, Institut National du Patrimoine, Paris; Cores from Belgium, Atelier pour le Papier in Switzerland, Universidad de Granada…). She enjoys sharing conservation issues in conferences, papers, and on social media, particularly with her blog (https://ritaudina.com) which has followers from all over the world.

Introduction

The idea to preserve the main features of historical objects unaltered has been present for all times. The term was first used among conservators in 1968[1] and increasingly gathered momentum since then. It has been thoroughly explored and although it is agreed that is an unattainable goal, reversibility still remains among the conservators community as a paradigm of good practice. It is assumed that any proficient treatment is necessarily reversible, and any irreversible one is at least the last option of many to be considered. Nevertheless reversibility in itself does not guarantee beneficial results, neither irreversibility involves a fatal loss of historical evidences.

1 *The Murray Pease Report: Code of Ethics for Art Conservators*. International Institute for Conservation of Historic and Artistic Works – American Group (New York: New York University, 1968), pp. 63.

Reversible… in which sense?

Which aspects of this concept actually define the essence of good practice and which do not (and should be avoided)?

1. Reversibility in conservation

In 1999 the British Museum published a book entitled “Reversibility: Does it exist?”[2]. Quite discouraging if the standards of the profession are to be built upon a solid ground. The chapters’ adjectives plunge any such hopes deeper: *Myth and mis-use*, *ideal*, *illusion*… or even a *ghost*!

Conservators from various disciplines suggest it’s a concept to which actual practice cannot really stick on in practical terms.

2. Reversibility and thermodynamics

Facing the fact from a purely scientific angle should help unravel all the hues derived from reversibility as an ideal. The definition according to thermodynamics is “a process that, after it has taken place, can be reversed and, when reversed, returns the system and its surroundings to their initial state”[3], and continues with the categorical affirmation that “perfectly reversible processes are impossible”.

Are then conservators intending to make interventions that go beyond the physical limitations of thermodynamics? Because however unrealistic that is, conservators claim our treatments to be mostly reversible. Vincent Daniels gives a fantastic example on the common use of starch paste[4], an adhesive accepted as reversible in book and paper conservation. Sticking to the chemical approach, its solubility in dried state is found to be less than 10%[5], being therefore not possible to remove completely. But in practical terms, it comes easily apart after being soaked in water. The visible residues can be scraped off, and the remnants embedded among the fibres are invisible and unobtrusive to further treatments.

Starch paste would certainly not be considered a suitable adhesive if reversibility ought to be judged from a purely chemical point of view. Thus reversibility is not really a priority being followed, or not as long as whatever is added on the artefact represents no harm to it, either chemically or visually.

On the other hand, an example of a typical not reversible repair which is valued not only as a historical repair, but also for its efficiency in the long term: the sewn repairs on parchment (figure 1). Piercing a vellum folio is definitely

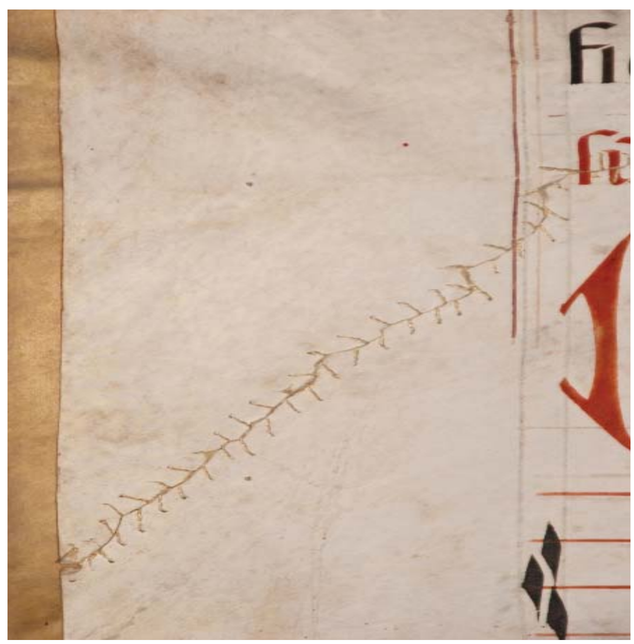

Fig. 1: *Parchment manuscript detail from a 17th century musical score bound in leather wooden boards. The old sewn repair has succeeded along time to the point that today does not lead to re-treatment upon most points of view. Private collection*

2 *Reversibility: Does it exist*? British Museum Occasional Papers #135, 1999.

3 McGovern, Judith *Reversible processes*. PHYS20352 Thermal and Statistical Physics. University of Manchester. Retrieved 2 November 2020. https://theory.physics.manchester.ac.uk/~judith/stat_therm/node23.html (accessed May 2021).

4 Vincent Daniels (1999). *Imperfect reversibility in paper conservation*. Reversibility: Does it exist? British Museum Occasional Papers #135, 1999. pp. 48.

5 Vincent Daniels. “The reversibility of starch paste”, Lining and backing (A. Phenix, ed.), UKIC, London, pp. 72-76.

not reversible, and nevertheless it is much more efficient and innocuous than adhering a patch or a tape: it does not cover the letters, does not modify any chemical feature, nor lessens the flexibility of the parchment along the tear. It can be re-repaired if ever the thread fails, it ensures that no further damage shall take place and enables a proper handling and reading at all levels. If this type of repair was any better to the current ones, or caused significant damage, they would have been replaced more often.

3. Reverting in time: theoretical aspects

Reversibility can't be beaten in physical terms, and yet the search for it endeavours conservators to reflect on their commitment towards heritage. On this regard there's an upmost holistic approach developed by Muñoz-Viñas with the *Contemporary Theory of Conservation*[6].

Facing the temporal dimension of the term *revert*, in its meaning of going to a previous stage, requires defining exactly which moment in the object's lifetime. Baldini sets three diverse stages[7]: First the creation of the object, second the lifetime and the conservation treatment as a third stage. It seems reasonable to expect that at least anything from the first stage ought to be kept as much unaltered as possible. But in practical terms these stages do not delimitate a real priority on what is to be preserved or not.

Taking pounce as an example, a finely grinded powder used during the writing process –first stage– to prevent inks from bleeding, and which is often found in manuscript books. Such powder is a soiling agent on a library and hinders further consolidation treatments, subsequently it is often removed. This historical evidence can be kept aside in a bag for further research. The impossibility of reverting cleaning processes with an unavoidable loss of historical evidence is somewhat compensated by preserving the extracted remnants.

But strictly grouping in terms of time, the same cannot be done with all evidence of the manufacturing process. Iron-gall inks for instance are also an indivisible component of the manuscript. As well as rosin added on paper sizing, which causes so much acidity, or oils in impregnated tracing papers. Should conservation treatments be restricted to the damages occurred after the creation of the object and avoid those arising from inherent degradation of original components? The truth is that preservation is inattentive to chemical integrity whenever it compromises supports' stability to a worrying extent. Deacidification is the most paradigmatic non-reversible treatment that is accepted as beneficial and necessary in many cases.

At the second stage (lifetime of the artefact) the eternal discussion about to which limit patina should be preserved is not yet deciphered. Because, where does patina end and where does dirt begin? There is no physical way to slice grime layers according to time, neither a logical dating parameter to define these hypothetical layers[8].

When it comes to historical events what does represent a meaningful episode of the object worth maintaining, or not (and thus removed?) is more ill-defined. It is not related to how old the episode is, neither to the scope of the physical alteration it provokes, but to subjective and immaterial reasons[9].

6 Salvador Muñoz-Viñas. Contemporary *Theory of Conservation*. Reviews in Conservation, number 3. 2002.

7 Umberto Baldini. *Teoría de la restauración y unidad de metodologia*. Vol. 1 Ed. Nerea/Nardini. Traducción de Marta Mozillo (Madrid, 1997).

8 Ashley-Smith, J. *Definitions of Damage*. Annual Meeting of the Association of Art Historians, London, 1995. https://cool.culturalheritage.org/byauth/ashley-smith/damage.html (accessed May 2021).

9 Salvador Muñoz-Viñas (2002). *Contemporary Theory of Conservation*. Reviews in Conservation, number 3. Pp. 25-34. DOI: 10.4324/9780080476834. pp. 26.

For instance, a book by Rudyard Kipling literally stopped a bullet from killing a legionnaire during World War. The grateful survivor sent it later on to the author as acknowledgement[10]. The Library of Congress might never conceive repairing the munition damage hollowing the folios, precisely because the loss is actually the main value of the book, and yet it occurred during the lifetime of that copy and injured the book, hindering proper reading for many folios.

As an opposite example, in 2012 a Russian artist made an inscription on a Rothko painting being exhibited in the Tate Modern (London). The artist claimed it was adding value to the Seagram mural, but Tate Modern deemed it was defacing it, rather than improving it, so the scribble was removed. A clear divergence of opinions evidence the subjective nature of what is a meaningful incident in the lifetime of an item, as opposite to one that provides an added value.

If no logical parameter defines what should be preserved from the past from what should not, it is illusory assuming that there can be defined standards to set which from the present conservation treatments need to be more reversible for the future (since 100% reversibility does not exist).

The third stage is unavoidably as subjective as the previous two. Under what criteria a certain amount of efforts is invested in preserving some materials, whereas others receive less attention? Quoting Fletcher Durant "*Conservation is not neutral, and neither are we*"[11] .

Attempts to keep all evidences, no matter what, are often not compatible with conservation requirements. Old repairs are frequently subject to such dilemmas.

Case #1: A manuscript plenty of repairs from diverse periods

This 17th century manuscript is a very good example. Most of the repairs are contemporary to the writing of the manuscript and have written text on it, while hiding the former writing underneath (figure 2). The patches had been glued in a clumsy way, causing tension, wrinkles and subsequent abrasion on a much deteriorated paper.

Fig. 2: *Before conservation. Green discontinuous line squares the oldest adhered repairs. They caused severe tension on the original manuscript, which already had older creases. Orange line squares later pasted patches (probably repairing the creases due to the former ones). The circle enlarges a detail showing how accurately the writing on the repairs matches the text underneath. Manuscript from Regional Archive of Vallès Occidental (Terrassa, Catalonia). Foto: Pep Soler.*

The conservation treatment consisted in keeping the glued repairs in place with a main structural modification: replacement of adhesion by a sewn attachment, which allowed to see both inscriptions at the same time (repair and original) and made it possible to flatten and consolidate the folio (figure 3).

However, by doing this the third stage (conservation) becomes quite another

10 Erin Allen (2016). *World War I: "Kim," the Life Saver*, The Library of Congress Blog https://blogs.loc.gov/loc/2016/10/world-war-1-kim-the-life-saver/ (accessed May 2021).

11 Fletcher Durant. ICON Book and Paper Webinar Series *Conservation: Together at Home, #35: Conservation is not neutral, and neither are we*, https://youtu.be/bFKS12TYTEg (accessed May 2021).

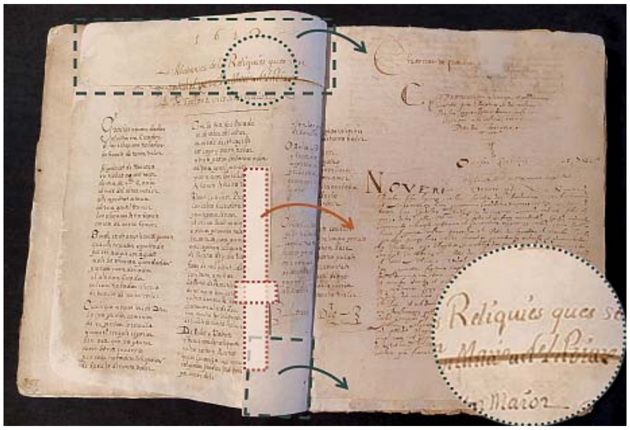

Fig. 3: After conservation. Oldest adhered repairs (squared in green) after detaching them from the manuscript and flattening the folio underneath. Repairs are now sewn but loose, and can be flipped as a folio, allowing to read both the patches' text and the former writing below. More recent repairs (squared in orange) were kept loose as well. The circle enlarges a detail showing that the text on the patch (top) and on the original (below) do not match anymore after flattening both papers. Manuscript from Regional Archive of Vallès Occidental (Terrassa, Catalonia). Photo: Paula Bueso

protagonist in the manuscript's lifetime. Now the loose patches are not repairing anymore, and the viewer needs an explanation of the former stage to picture what the loose patches mean in relation to the book, otherwise it might be misleading. Ironically, allowing to read simultaneously both texts (creation's and lifetime's), as opposite to being able to read only the second, might involve a lessening of readability of the object understood as a historical item. The message of the manuscript transcending that one of a mere text provider and speaking also about that old restoration (intention, skills…).

4. Reversibility and linguistics

The word "reversible"[12] fails in defining the boundaries of our profession, hence other terms have often been used instead with the hope to define a "good" conservation. *Removability* or *retreatability*, for instance.

But ethics and good practice in conservation are much too complex features to be pigeonholed by one single term defining its appropriateness. "Reversibility"[13], "retreatability" and "removability" do not gather all conservation treatments that are found eligible in general terms, neither they exclude those which are not.

These words cause conservators guilt headaches more often than not, and make them frustrated even when the outcome of their efforts is accepted as successful. Or else we lie to ourselves calling reversible treatments those that are actually not.

Searching for the right conservation treatment

Conservation processes keep some evidences and disregard the rest, modifying the message given by the object to some extent. It is expected to be so, since damage and ageing are usually the most purposely modified and appeased features.

Decision making cannot be applied systematically according to logical parameters, it's rather a subjective and mutable criteria: no matter which stage of the artefact's lifetime, how old the historical interferences are, how much harmful the damage is, and how reversible the treatments are.

The appropriateness yearned for is a mixture of concepts such as stability, functionality and readability. Stability being the less abstract and referred mostly to the preservation of the

12 Barbara Appelbaum (1987). *Criteria for Treatment: Reversibility*, Journal of the American Institute for Conservation, 26:2, pp. 65-73, DOI: 10.1179/019713687806027852.

13 Koenraad Van Balen, Ahmet Semih Ercan, Teresa Patricio (1999). *Compatibility and Retreatability versus Reversibility: a Case Study at the Late Hellenistic Nymphaeum of Sagalassos* (Turkey). Use of and Need for Preservation Standards in Architectural Conservation; Vol. 1355; pp. 105-118. DOI: 10.1520/STP14185S.

matter. Function is intimately connected to the collection it belongs, which determines what use that particular object is given (actual reading, exhibiting, etc.). Reversibility is often sacrificed for the sake of functionality: modifications that allow the object to be still in use are deemed necessary (for instance, lining of iron-gall ink manuscripts whose folios cannot be handled safely otherwise). And readability is connected to the abstract idea of meaning: whatever is done to the object, it is expected to deliver a particular (and selected!) information at the end: the textual, its historical context, the artistry…

Stability, functionality and readability should be sought for in the most reversible manner. The other way around: prioritizing reversibility to reach the aforementioned goals, is thermodynamically impossible and arbitrary regarding the temporal dimension. The outcome of a strict reversible conservation would not necessarily fit the actual goals in heritage conservation.

Reversibility: Practical Examples

An empirical example of feasible reversibility and appropriateness of conservation is shown by some books belonging to the Library of the Pharmacy Museum Alcon-Cusí[14] (Masnou, Catalonia). Thirty years after their restoration the owners considered a re-treatment of the books.

Case #1: Dioscorides by Andrea Matthioli, 1552

A printed book with limp vellum binding and striking losses (figure 4).

Fig. 4: *Limp vellum binding with massive intended loss on folios and cover (after 1980).*

Former treatment (1980):

A conservation report in the book explains: “Dated today all remnant of paper cancer (purple stain) has been eliminated. Bear in mind in case this paper disease arises again. October 27th, 1980. The conservator.”[15]

It is likely that the referred “cancer” was a fungal degradation, and it is implied that a surgical mutilation of any affected parts was executed as a conservation remedy. The eradication was indeed deadly effective, leaving no evidence of purple stains at all. The report does not provide further information, thereby the outreach and nature of the so-called disease cannot be weighted. In the mildest assumption that the treatment did save what’s left of the book from being completely lost, still it’s not for us to know what it was like before 1980.

Present treatment (2010):

The infilling of such a massive paper loss would be ineffective because of the sharp cuts,

14 The lecture shows more examples of the same collection not discussed in this paper to adjust to the desired extension. Yet the cases explained have the main features to be debated. Video and notes of the lecture accessible at: https://ritaudina.com/en/portfolio/reversibility-in-book-and-paper-conservation/ (accessed May 2021).

15 Translated by the author: “*En data d’avui ha estat eliminat tot vestigi de càncer de paper (taca vinosa). Tenir-ho present per si apareix novament aquesta malaltia del paper. Masnou, 27 d’octubre del 1980. El conservador* (signat).”

Fig. 5: *Before (left) and after the conservation treatment in 2010 (right). Bottom: Foam- board to fit*

which after all do not induce much further deterioration in case of handling, so only the binding was infilled, in order to recover the protective function of the book cover. A custom made foam board dovetails the shape of the textblock so that there's no distortion of the binding during storage (figure 5).

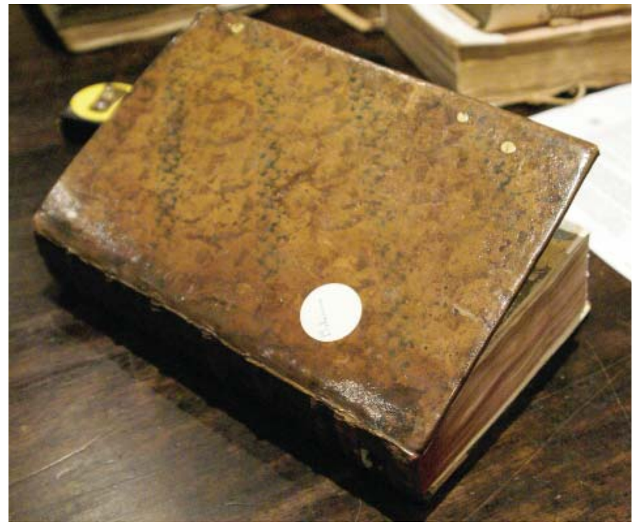

Fig. 6: *Glossy leather and ineffective closing of the covers due to the shrinkage of the leather caused by the varnish*

Fig. 7: *Discolouration of the painted edge (right, bottom), tide-lines on the edges (left) due to bleach. Pressure-sensitive tapes and later paper patches (centre)*

Case #2: Dioscorides Anazarbus, 1555

A printed book[16] with red painted edges, marbled endpapers and Spanish decorated leather binding (figure 6). There were some pressure sensitive tapes and later patches on top of them (figure 7). The treatment report of the former restoration was literally glued on the back marbled pastedown, stating that the book had been "*Washed and restored by E.P. Some folios are missing at the end of the book. April, 1980*"[17].

16 Rita Udina (2015). *Bibliopaths: The case of the lacquer binding*. Blog post https://wp.me/p4zghb-IE (accessed May 2021).

17 Translated by the author: *"Rentat i restaurat per E.P. Falten algunes fulles en el final del llibre. Abril, 1980"*.

Fig. 8: *Split image. Top: Treatment of 1980 (varnishing). Bottom: treatment of 2010 (varnish removal)*

Former treatment (1980):

Besides no allusion to any treatment on the binding was reported, the covers were awkwardly glossy and remained slightly opened. Apparently the book had been varnished at some point, and the synthetic resin had slightly shrank the leather, hindering the covers from closing normally. The varnish was also blurring the gilding on the spine (figure 8).

Interesting to realize that the red painted edges had been partially erased due to the “washing” (figure 7). This had consisted in fact in locally wet cleaning the leaves’ edges with bleach. Bleach not only erased the painted edges, but also weakened the paper fibres and left numerous tide-lines.

The report did not mention the reason for any of those treatments (unlike the previous example).

Present treatment (2010):

To the present point of view neither the leather nor the folios needed consolidation nor cleaning, therefore the treatment in 2010 consisted in reverting the negative effects of that restoration.

The varnish was removed with solvent enough satisfactorily (figure 8), both visually and mechanically: The gilding was glowing again, and the recovered hygroscopicity of the leather allowed the covers to remain properly closed, without tension.

It was deemed not necessary to recover the visual appearance of the washed out painted edge, that is to paint the whitened surface. But the formerly bleached areas were locally treated with water in order to remove the possible bleach remnants on the paper and also to reduce the tide-lines made at that time.

As for the paper patches and pressure-sensitive tapes, they were all removed to prevent further damage (figure 9). The paper strips were mechanically obtrusive to proper handling and the tapes a source of oxidation on the paper fibres. It is well known that the tape carrier and adhesive remnants can be removed, but the oxidation derived from the ageing of the synthetic resin is far from being fully reverted.

To conclude, the varnishing is a very much reversible treatment, and yet not really appropriate: it shifts the appearance of the leather and damages the binding. It is a reversible but pointless and detrimental treatment to nowadays standards, and it is found better to

Fig. 9: *After 2010: strips and tapes removed, tears consolidated again, tide-lines and bleach remnants reduced*

be avoided. The same for paper patches, that added malfunction and did not solve any issue at all.

As for the "washing" (i.e. bleaching) and the oxidation of the pressure sensitive tapes, their consequences are not as reversible: the painted edge is gone forever, and the chemical change and discolouration of the paper cannot be undone. Only part of the visual effects (the tide-lines), but not the weakening of the paper. Washing and applying chemical changes, are clearly not reversible treatments, and yet its appropriateness could more likely be shared or accepted as pertinent by other contemporary restorers of that time, finding in bleaching a good way to brighten old paper.

Table of reversibility in practical terms

The given examples substantiate that reversibility is not a guarantee for praiseworthiness of conservation treatments but

	Reversibility	**Some examples of interventions**
Altering physical integrity (seamless feature)	100% irreversible in any case. It's the most categorically irreversible type of treatment despite being usually accepted in relation to structural consolidation. For instance, assembling of wood boards or locks, in which the minimal loss of support and benefits of the pursued consolidation exceed the inflicted decrease.	• Slots, incisions, pierces, cuts, holes… • Fragmentation. • Commonly involved in the reinforcement reinforcement. That's because there's clasps, sewing folios, etc.
Removal	Irreversible. Notwithstanding, whenever an evidence of whatever removed parts are kept (patches, grime, varnishes…) the loss might be less important in ethical terms, since it permits access to unattached samples, providing valuable data of the previous stage.	• Cleaning (wet, dry and surface). • Stain removal. • Removal of corrupted materials (such as rust, mould damaged or burnt matter…). • Paring down supports, trimming edges. • Old repairs and former treatments removal. • ...
Addition	Less irreversible (in general). Degree of reversibility varies from 0% to almost 100% depending on how the treatment is applied. In ethical terms, it is important to gauge how distinguishable the addition is from the original support. Especially for retouch, but also sizing and other treatments, for an actual reversal of the process shall not be a realistic option.	• Inks fixation, varnishing. • Consolidation (mending, lining, sizing, adhering…). • Addition of materials (for instance, interleaving of buffered paper), which can alter the neighbouring original supports. • Inpainting / retouching (on original supports). • ...
Modification	Mostly irreversible (in practical terms). Alterations can be grouped in chemical and physical, being the first much less reversible in general. Structural changes though have implicit historical and ethical consequences of remarkable relevance, even if easier to be reverted and without textual or visual implications.	• Chemical modification: Any reaction involving a chemical shift on the matter. Most wet treatments are (washing, variation of conductivity, deacidification, chelating agents, phytate…). Red-Ox treatments (any kind of bleaching, pressure-sensitive tapes causing oxidation…), lead white treatment, etc. • Structural changes, for instance altering the order of folios on a book, or parts of it (concertinas), unsealing seals, but any change implying a variation on this regard, even if only relevant for structural means.

–in case of regret– at least it allows a return to the previous stage. However, the amount of reversible processes that conservators are likely to apply is quite small compared to those that are not in practical terms.

A table groups them strictly according to how reversible they are (not to what is considered to be beneficial). In general terms, they can all be classified in four: those which alter physical integrity (the seamless feature of an untouched support), removal, addition and modification:

Conclusion

In conclusion, reversibility is no guarantee for an eligible conservation treatment because many reversible treatments are deemed not pertinent to the present point of view. The actual practice applies in fact more non-reversible processes than reversible ones. Despite not being the priority it is advisable to commit to the highest degree within the existing alternatives, because reversibility gives the chance of re-treatment in case of regret.

Lack of reversibility has proven to be very disappointing for forthcoming (and current) generations, but only in case of major disapproval. There shall be no such reprobation if the conservation treatment fulfils the present standards. Even when the intervention appears old-fashioned to the future viewer, it shall be well admitted as part of the object’s lifetime in its historical context (see figure 1).

The appropriateness in the nowadays conservation treatments ought to have a right balance of stability, functionality and readability of the artefact. The complexity of this equilibrium lies in the fact that function and meaning of an object might vary according to the viewer’s background, the collection to which the item belongs and other idiosyncratic and mutable notions. However, searching for a long lasting validity of the present decisions is to be sought.

Be that as it may, facing such unreachable goals should not discourage conservators from assuming responsibility on the decision-making and conservation practice.[18] The profession is entitled by the skills, the knowledge and the experience. Our duty is to be most accountable for every step and to report conservation accurately, because future generations might not share what has been done, but they shall appreciate to know why, and more particularly how and with what specific products.

18 Jonathan Ashley-Smith (2016). *Losing the edge: the risk of a decline in practical conservation skills*. Journal of the Institute of Conservation, 39:2, pp. 119-132, DOI: 10.1080/19455224.2016.1210015.

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20 October 2020

White Lead Discoloration and Conversion

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Prior to joining the staff of CCAHA in 2015, Heather maintained a private practice outside of Philadelphia for five years. She also worked as a paper conservator at the Canadian Conservation Institute, the Yale Center for British Art, and Harvard University Libraries' Weissman Preservation Center. She completed conservation internships at the Canadian Centre for Architecture and the National Gallery of Canada. Heather received a MA in Art Conservation, specializing in Paper Conservation, from Queen's University in Canada. She received her BFA from the University of Lethbridge in Canada.

Introduction

Lead white is a manmade pigment that has been found in use as early as the 4th century B.C.E in Egypt, Greece, and Rome. It was the most commonly used white pigment in Europe since antiquity, and has appeared in oil paintings, frescoes, watercolors, and house paints. Outside of Europe, lead white has been documented in the Middle East, India, China and Japan. In the 20th century, the use of lead white has declined due to health concerns related to lead exposure and with the development of other modern pigment whites such as zinc white and titanium white.

Also known as flake white, lead white is produced by exposing metallic lead to acetic acid (vinegar) vapors, producing lead acetate, which then reacts with carbon dioxide in the air to create basic lead carbonate. The pigment is a warm, opaque white. However, it is known to be vulnerable to discoloration or blackening when exposed to hydrogen sulfide. Hydrogen sulfide may come into contact with artworks through atmospheric pollution, sulfur-containing pigments, or microbiological activity. Conservators can restore the white appearance through the careful application of dilute hydrogen peroxide.

Chemistry

Lead white pigment is mainly composed of a compound combining lead carbonate and lead hydroxide. When it is exposed to hydrogen sulfide, it will react to form lead sulfide and excess water and carbon dioxide. The resulting lead sulphide is a dark grey, slightly metallic color. Lead white discoloration is often described as blackening.

$2PbCO_3 \cdot Pb(OH)_2$	+	$3H_2S$	→	$3PbS$	+	$4H_2O$	+	$2CO_2$
basic lead carbonate (lead white)	+	hydrogen sulfide	→	lead sulfide	+	water	+	carbon dioxide

Because the color change depends on exposure to hydrogen sulphide, blackening is less likely to occur when pigments are protected by a continuous film of binder, such as oil paint, or protected by glazing. Lead white discoloration is most commonly seen in watercolors and frescoes, but can occur in any media.

Standard conservation of blackened lead white does not revert the discolored pigment back to basic lead carbonate. Instead, the lead sulphide is converted to white lead sulphate by the application of hydrogen peroxide. This restores the white appearance, but the original chemical composition is not restored. Because the original lead white pigment is not regained, this treatment should be referred to as "lead white conversion" rather than "lead white reversion".

PbS	+	$4H_2O_2$	→	$PbSO_4$	+	$4H_2O$
lead sulfide	+	hydrogen peroxide	→	lead sulfate	+	water

Recognizing discolored lead white

Pure lead sulfide is the mineral galena, which has a dark grey, slightly metallic appearance. The development of lead sulphide in white lead paint may result in a black or grey tone, and drier applications may even resemble graphite pencil. There is also often a transitional stage which occurs under acidic conditions: in these cases, the lead white appears peachy, pinkish, or salmon-colored before it turns black. (Hoevel, 1985) It is not uncommon to see areas of black, grey, pinkish-orange, and white within the same object as the discoloration proceeds. The combination of dull metallic grey and peach within a single stroke is strong evidence.

Recognizing discolored lead white becomes easier with experience. The first clue is to spot unexpected coloration, as areas that should be highlights become dark instead.

Fig. 1: *Discoloration has resulted in unnatural peach and black tones. Cooper Hewitt Smithsonian Design Museum*

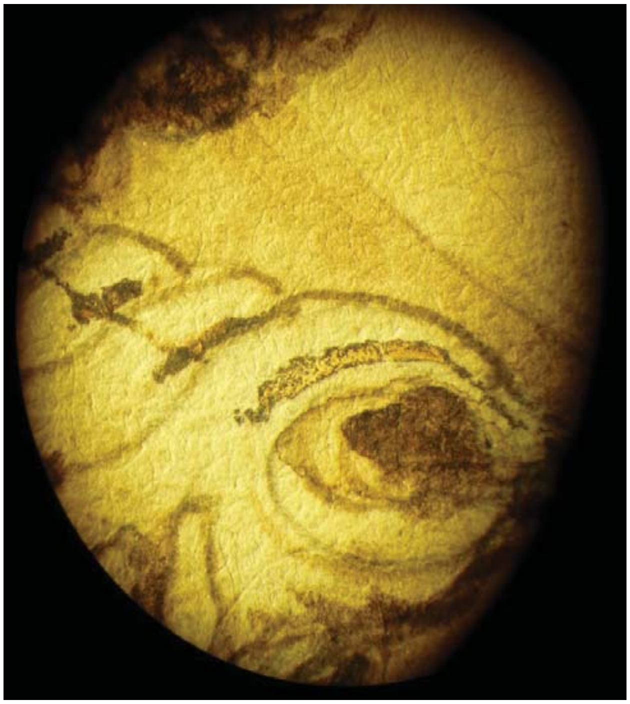

Fig. 2: micrograph showing lead discoloration is darker at the edges of the paint stroke (center). Arkansas Museum of Fine Art

Fig. 3: Discoloration of lead white coating on paper; the edges and abraded areas were more exposed to atmospheric hydrogen sulphide. Academy of Natural Sciences of Drexel University

The distribution of color in suspect areas is also an indication, as the edges may discolor before the center (Figure 2). Comparing many examples will help conservators learn to spot a certain dull appearance of colors.

Lead white may also be used as a coating on paper. In this usage, the pigment is finely divided and lightly bound, so it may be particularly susceptible to chemical reactions. Unusual discoloration on paper due lead discoloration may also resemble mold staining, foxing, or grime. In a collection of lead white coated papers examined and treated by the author, abrasions also resulted in increased local discoloration, possibly because of the disruption of a protective binding layer.

The final confirmation may be a spot test: a tiny drop of 3% to 10% peroxide will whiten discolored lead white almost instantly. Testing may be performed at a higher concentration than treatment because confirming the presence of discolored lead white is critical to determining future steps, while the subsequent conversion treatment should be performed using as little oxidizing agent as possible.

Peroxide considerations

Hydrogen peroxide is available in a wide variety of concentrations and purity grades. As with all materials, conservators should be aware of potential impurities that could adversely affect the artwork.

Hydrogen peroxide is known to be an unstable compound and will deteriorate over time. Many laboratory reagent quality formulations contain stabilizers such as tin salts, phosphoric acid, or other unknown chemicals. Stabilizers may not be listed as ingredients, although manufacturers or vendors may be willing to share information upon request. The effect of these stabilizers on works of art has not been studied, though some conservators have theorized that the presence of traces of tin ions may result in a pale purple rather than white result following lead white conversion.

Selecting unstabilized hydrogen peroxide is the simplest method to avoid unknown and unnecessary contaminants. Unstabilized hydrogen peroxide is sold as “food grade” through health food stores and internet retailers. Without stabilizers, the shelf-life of peroxide is reduced. Lower concentrations of peroxide are more stable, so selecting either 3% or 10% concentrations is recommended. Storing the bottles under refrigeration, factory sealed until use and tightly closed after, and away from light will also extend the lifetime of the solution. Following these guidelines, hydrogen peroxide will have an expected shelf life of 6 months to 3 years.

Application techniques

Although applying peroxide to discolored lead white is simple in principle, the ideal application method may vary depending on the media’s solubility and composition, the paper support, and the limitations of the conservator’s laboratory. There are five main application methods described in conservation literature: ethereal peroxide, direct brushing, cellulose ether suspension, rigid gel, and vapor phase.

Ethereal peroxide is a historic technique that has been described in the literature as the “standard method”. In this method, a relatively high concentration of aqueous peroxide solution (between 6% to 50% w/v) is shaken vigorously with an equal amount of diethyl ether. The container is then allowed to sit until the mixture separates into two phases, with water below and ether in a distinct upper layer. Due to its slight affinity, a few molecules of hydrogen peroxide will remain in the ether and can be applied in a non-aqueous manner. The conservator would carefully dip a brush into only the upper layer of ether and apply it to the discolored lead white. This technique allows non-aqueous application, so it may avoid swelling or solubilizing a water-based paint film. However, some practitioners have reported that this application method may still cause the paint film to solubilize (Couch, 1985) or rupture (Lussier, 2006). The ethereal method has largely been replaced by other methods, at least in American conservation labs, due to the toxicity of the diethyl ether and the effectiveness of other options. This treatment should only be performed in a fume hood or under equivalent ventilation.

Direct brush application of hydrogen peroxide is a simple and effective method in many cases. A concentration of 1%, 2%, or 3% w/v is used. The peroxide is applied carefully to the affected media with a very small brush. Some areas may require multiple applications. This method may be modified with ethanol to increase penetration throughout the paint film, either by mixing an ethanol and peroxide solution or by pre-wetting the area with ethanol prior to application. Of course, the increased penetration allowed by the ethanol can also result in the peroxide penetrating into the paper substrate. There is also a risk of swelling or solubilizing water-based paint films.

Cellulose ethers such as methylcellulose or hydroxypropylcellulose may be used as a modification of the brush application. A dilute solution of hydrogen peroxide is mixed with 1-3% cellulose ether to create a gel. The gel is applied to the affected media and rewetted with deionized water as needed. Following treatment, the gel is removed by repeated application of deionized water and careful blotting. An article on the cellulose ether technique (McFarland, 1997) found that it offers faster and more complete results than a similar concentration of peroxide without a gelling agent. This technique offers several benefits: it holds the peroxide in contact with the discolored pigments longer; it reduces the risk of peroxide wicking into the paper support; it may reduce the number and time of applications needed; and it appears to minimize disruption of the paint film.

McFarland acknowledges that some cellulose ether residues may not be removed, however, she argues that this can be a benefit because lead white paint films often suffer from flaking or friability, so the residual cellulose ether film can act as a consolidant. Other, non-cellulose based gels such as Carbopol have also been used to deliver hydrogen peroxide (Fiskovic, 2017), but Carbopol residues have been demonstrated to induce paper discoloration over time (Warda, 2007).

Peroxide can be prepared in a rigid gel such as agarose for extremely controlled local application. Rigid gels allow the conservator to limit the moisture exposure, keep the peroxide in contact for a longer period, and to apply the peroxide to very precise areas by cutting it into the desired shapes. Good contact between the gel and the paint layer is vital. The concentration of the gelling agent should be adjusted based on the absorbency of the paint film and the paper substrate. Agarose gel with peroxide is prepared by heating a slightly more concentrated than desired agarose solution to 80 degrees Celsius to fully hydrate the agarose, allowing the solution to cool to approximately 50-60 degrees Celsius, then stirring in concentrated hydrogen peroxide and quickly casting it into a sheet. Typical final concentrations of peroxide within the gel range from 3% to up to 7%.

Vapor application of peroxide can be extremely successful and requires relatively less conservator time when the discolored lead white is finely dispersed and present over a larger area of the object. The object to be treated in placed in a sealed chamber with a dilute solution of hydrogen peroxide (as little as 3%). Risk of unintentional contact can be reduced by containing the peroxide in a saturated non-woven fabric at the bottom of a flat plastic tray while the object is held safely above on a plastic grate. Color changes can be monitored through a clear acrylic sheet that closes the chamber when rested on the tray. Vapor exposure can also be limited by covering the artwork with a clear polyester sheet (Melinex or Mylar) with cutout openings exposing the discolored areas. Alternatively, a small local vapor chamber can be created over a specific area by inverting a glass container with a peroxide-soaked blotter fixed at the bottom (figure 5).

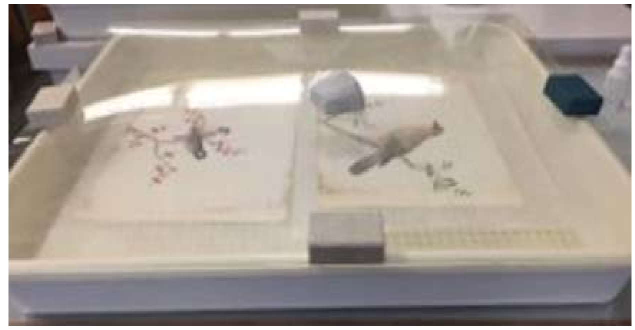

Fig. 4: *Undergoing treatment in an overall vapor chamber. Academy of Natural Sciences of Drexel University*

Fig. 5: *Small vapor chamber. Academy of Natural Sciences of Drexel University*

The exposure time in the vapor chamber can range from two to twelve hours, depending on the severity of the discoloration. The reaction is slow, but the conservator can monitor the progress while working on other projects, so this can be a relatively efficient approach to widespread discoloration. Although the object is exposed to elevated humidity, the paint is not fully wetted out so the vapor application technique can be used on water-sensitive media. This technique may not be appropriate for all objects because it will result in humidification of the artwork as well as peroxide exposure to a larger area of the paper support and other media.

Clearance

Hydrogen peroxide is an oxidizing agent and should not be applied to artworks without a plan for clearance. Peroxide residues can cause discoloration and weakening of cellulose. If the paper support has iron impurities, peroxide residues can result in the appearance of brown spots (Krann, 2006). Many types of media, including iron gall ink, can be sensitive to peroxide, resulting in discoloration or bleaching (Mowery, 1991).

When peroxide is used as a bleach on a paper support, conservators remove it through washing. Washing is not generally a practical removal technique after lead white conversion because it would endanger the media. Conservators instead rely on two properties of hydrogen peroxide: volatility and instability.

Hydrogen peroxide will evaporate at room temperature. The volatility will depend on many interconnected factors such as the ambient temperature and relative humidity, the rate of air exchange, the affinity of the peroxide molecules to their substrate, and the proximity of other absorbent materials. Evaporation is hindered when the treated object is enclosed in a folder, box, or closed book. Treating pages with peroxide then closing the book without sufficient clearance has caused the loss of manuscript ink inscriptions on other pages (Mowery, 1991). Recent research into sorption agents (Raab, 2020) suggests that activated charcoal cloth can help to absorb and sequester peroxide residues, even within a closed chamber, though the authors caution that the charcoal cloth is prone to shedding and transferring black fibers.

Hydrogen peroxide will also decompose to water and oxygen over time. Decomposition is accelerated by visible light, organic catalysts, metals or compounds containing metals. The half-life of hydrogen peroxide is again influenced by relative humidity, temperature, and substrate, but can range from 6 hours to a year or more, depending on storage conditions. Because the length of time of decomposition is so variable, it can be considered to contribute to clearance in combination with evaporation but will not reliably remove peroxide residues if evaporation is prevented.

The author chooses to air out drawings with peroxide treated lead white paint films on a drying rack for a full week. This length of time is believed to allow the peroxide residues to clear through evaporation and decomposition, however, this has not been confirmed analytically. Peroxide residues can be detected in solutions with color indicator Quantofix test strips or as volatiles with hydrogen peroxide sensors (Raab, 2020).

Potential Problems

Even when the application of hydrogen peroxide is carefully controlled and fully cleared, there is a possibility of negative effects on the paint film. The moisture exposure may soften, swell, or solubilize the paint. Scanning electron images reveal that application methods can cause changes invisible to the eye, including agglomeration of particles and enlargement of pores in the paint film (Lussier, 2003). Local swelling can cause paint films to become rougher or even to rupture.

In addition to the effects of moisture exposure, the conversion of lead sulphide to lead sulphate is creating a new mineral with a new crystalline structure. Possibly related to these changes in composition, converted lead white is often found to be more friable after treatment. Using a methylcellulose gel application can provide some consolidation, or additional consolidation may be required after treatment.

Incomplete conversion of discolored lead white has also been reported. The treated areas may remain greyish even after multiple applications of various techniques. A pale purple color has also been reported as a less than perfect result of conversion. Conservators may also choose to halt treatment before complete conversion as a compromise between protecting the paint film and paper support while achieving significant but not complete improvement in the blackened areas.

It appears that aged discoloration is more difficult to revert than fresh examples, a characteristic attributed to the increasing stability of the crystalline structure (McFarland, 1997). Another cause of incomplete conversion may be the presence or co-occurrence of brownish-black lead dioxide, also named plattnerite (PbO_2), or small particles of metallic lead. These other forms of lead cannot be distinguished from lead sulphide by eye. Instrumental analysis of the discoloration can be difficult because the discolored layer is extremely thin compared to the underlying lead carbonate. While these other lead products can in theory also be chemically converted to white lead compounds, application of hydrogen peroxide alone is not sufficient.

A final consideration is that the artist's intent may have included intentionally causing or planning for the discoloration of lead pigments. This has been documented in Japanese wood block prints (Walsh, Berrie, & Palmer, 1997) where the printed red lead pigments have been deliberately patinated with a silvery layer of lead sulphide. Artists may have been aware and welcoming of this potential change, so careful examination and connoisseurship to determine the true intent is necessary.

Conclusion

Lead white pigments have been used throughout the world for millennia, but are vulnerable to discoloration and blackening from exposure to hydrogen sulphide. Conversion of discolored white lead pigments can dramatically restore the appearance of disfigured artworks. While it can give remarkable results, hydrogen peroxide must be used with caution and skill. The selection, method of application, and clearance of the peroxide must be carefully determined to minimize unwanted effects in the paint film and paper support.

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Overlooked; Uncovering the Story of a Portrait with a Hidden History

DR. CLARE FINN ACR has been a conservator for 50 years, training in Newcastle, Zurich, Stuttgart and Rome. She has worked for a wide range of clients; private collectors, art dealers and auction houses and institutions, some well-known, others less so but all with collections they wish to preserve. She has worked as a conservator in Europe, Japan, the Philippians and India. Her doctorate is in Picasso's decorative metal work and she is an authority on his war-time bronze casting.

This is a story of an object that has hidden within it signs indicating some of the turbulent, religious, political and commercial history of the English Renaissance. In England the period is referred to as Tudor, after the dynasty of monarchs that reigned at that time.

Background context

The object in question is a painting, a portrait of a king, Edward VI, (Fig. 1). It is painted in oil on an oak panel and is not large, being 51cms x 40cms. It was not commissioned by a noble lord or a rich merchant so one might say it is not an important painting. Yet as will be shown such seemingly unimportant works can have hidden within them much more than their position in art history might indicate. Thus they deserve all

Fig. 1: *Portrait of Edward VI, (1537–1553), reigned 1547–1553, oil on oak panel, 51x40 cms*

Fig. 2: *Portrait of Henry VIII (1491-1547), studio of Hans Holbein the younger ©National Trust Images/ Derrick E.Witty*

the attention and ethical considerations given to grander works of art. But first some English history to place it in context.

Who was Edward VI?

Edward VI was Henry VIII's only son, (Fig. 2). Henry is famous for having six wives that he dispatched in various ways until finally the sixth one outlived him, (Fig. 3). The first of his wives was Catherine of Aragon. Wishing to marry Anne Boleyn he wanted to divorce her. But at that time everyone was Catholic and to get a divorce he had to ask the Pope in Rome. And the Pope said no, Henry could not have a divorce. So Henry was not happy and he told the Pope he didn't need him and from then on he, Henry, would be head of the Church in England. This is the case even today, 500 hundred years later, Elizabeth II is head of the Church of England.

So appointing himself Head of the Church of England enabled Henry to divorce Catherine and marry Anne. Henry was happy, for a while at least, but the matter effected every single person in England whether they were high born or low as Henry wanted everyone to swear

Fig. 3: *Henry VIII's six wives – (top row, L to R): Catherine of Aragon, divorced; Anne Boleyn, beheaded; Jane Seymour, died; (bottom row, L to R): Anne of Cleves, divorced; Catherine Howard, beheaded; Katherine Parr, survived*

allegiance to the Church of England and no longer be Catholic giving allegiance to the Pope in Rome. Not everyone was willing or happy with this change of affairs, and the matter of being Catholic or Protestant has kept appearing throughout English history and is still alive in Northern Ireland today.

I emphasis this is an extremely simplified version of this period of history and if you would like to dig a bit deeper into the complexities of the politics of the Tudor period Hilary Mantel’s Woof Hall trilogy is a good place to start.

Our little painting is part of the art collection owned by Guys and St Thomas’ Hospital, that is administered by Guys & St Thomas’ charity, (Fig. 4).

Fig. 4: *Guy’s & St Thomas’ Hospital today, with the statue of Thomas Guy*

The Hospital of St Thomas has its origins in a 12th century when it was run by mixed order of Augustinian monks and nuns. However, in around 1540 Henry VIII closed a great many monasteries in what is called the dissolution of the monasteries, and St Thomas’ Hospital was among those he closed. However, Henry died in 1547 and his only son Edward came to the throne. In the early 1550s, the City of London obtained a charter from Edward to re-open the Hospital. Depending on which account you read this occurred in either in 1551, 1552, or the rather precise date 26th June 1553. It re-opened in Southwark where it has occupied the same site for more than six centuries.

So St Thomas’ Hospital has a good reason to have an early portrait of Edward VI. But they seem to have acquired this portrait only in the 20th century. There are no records and they only began to catalogue their art collection in this century. The painting was recorded in their database in 2002 and was then promptly lost until 2012 when it was rediscovered in a strong room. So this is one good reason why conservators should document the treatments they carry out on objects and the decisions that are taken about works because when there is a gap in the records like this and you can’t find the painting it documents it existed!

So when it was found, Guys and St Thomas’ realised it was the missing painting from their catalogue, but they had no other information on it at all.

It was quite discoloured so it came to me to assess its condition and they also asked if I might be able to research its history. Most of the time I am only able to find fairly minimal information on paintings. But in the case of this painting we did gradually reveal its secrets.

The Painting

There are a fair number of portraits of Edward VI both full length and half length, and they vary in quality, (Fig. 5). Such portraits of monarchs were widely circulated not only during the various monarchs reigns but also for many years after their deaths. They also continued to be made for years after the sitters they depicted had died.

Guys and St Thomas’ small painting is a copy derived from a portrait of Edward VI by the artist William Scrotts, (Fig. 6). Scrotts was the highest paid artist in England after Hans

Fig. 5: *Portraits of Edward VI*

Fig. 6: *Portrait of Edward VI attributed to William Scrotts 1550s*

Holbein died and his portrait of Edward now hangs at Hampton Court. No one seems to know exactly when it was painted so it is dated to the 1550s.

So Guys and St Thomas' portrait is a copy and probably a posthumous portrait because if Edward indeed granted St Thomas' hospital a charter to re-open the hospital on 26th June 1553 a mere week and a half later, on 6 July 1553, he died.

Copying paintings has a long and socially interesting history. In an age when there was no photography, and you saw a painting you liked and wanted but that belonged to someone else asking an artist to make a copy of that painting was the only option. As you go further through the centuries of European painting by the 18th and 19th centuries copying was a well-established part of how artists were trained.

Sets of portraits of monarchs, (Fig. 7), can be placed within a chronology of English Decorative History. Made quickly and cheaply and like the Guys and St Thomas' Edward VI they were based on pre-existing patterns. They were produced into the 17th century and could be found hung round the gentry and aristocracy's baronial halls. They could also be found in civic buildings and educational establishments. They might give the impression one's ancestors were royal, or like framed photos one can see today on peoples' desks or mantlepieces showing them shaking hands with celebrities or politicians they added caché.

Once Guys and St Thomas' Hospital had found Edward again they wanted it conserved. Cleaning the painting was relatively straight forward. But during cleaning it began to be revealed in cracks and areas of damage that there was a layer of bright red under the image of Edward, (Fig. 8). If this bright red layer was a preparation layer it was an unexpected colour. More usual would be neutral tones, white, off white, perhaps ochre. The shade of this red

Fig. 7: *Incomplete Portrait set of English kings and queens, one of the most important surviving sets of its type. 1590-1610, NPG 4980 (1-16). Top Row – Norman Monarchs, L to R – William I, the Conqueror (1027-1087), William II (Rufus) (1087-1100), Henry II (1100-1135), Stephen (1135-1154); 2nd Row – Plantagenet Monarchs, L to R – Henry II (1154-1189), Richard the Lionheart (1189-1199), John (1199-1216), Henry III (1216-1272); 3rd Row – L to R – Henry IV (1399-1413), Edward IV (1461-1470), Edward V (1483-1483-78 days), Richard III (1377 – deposed 1399); Bottom Row – Tudor Monarchs – L to R – Henry VII (1485-1509), Henry VIII (1509-1547), Anne Boleyn (1501-1536), Anne Boleyn (1501-1536).*

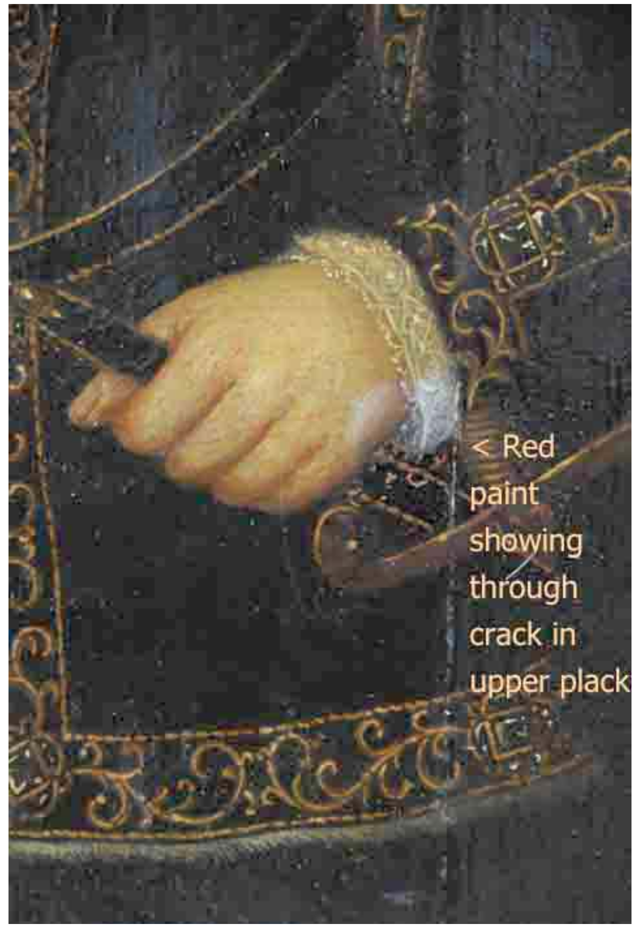

Fig. 8: *Bright red under the image of Edward seen below his cuff*

indicates it is probably vermillion, which would have been expensive. But why cover it up and paint over it?

The idea it might not be vermillion was considered. Could it be cadmium red that has a similar hue. However, Cadmium red was not produced until around 1910 and we did not think the Guys and St Thomas' Edward VI was painted in the 20th century. The painting was also unlikely to have been painted in the 19th century as examining the paint under under magnification the pigment particles were rough and angular. They have been hand, not machine ground. During the 19th century paint began to be ground by machines that produced pigment particles that were smaller, rounder and more even. Hence it was unlikely the red layer was Cadmium. Vermillion, or Cinnabar in its naturally occurring form, with its long history, known to the Greeks & Romans and was made artificially in the Middle ages, is the obvious candidate. Thus Edward was probably painted earlier than the 19th century.

To establish a better date for when the painting was painted pigment analysis was considered. But would it be able to identify which century the painting was created in? The portrait is painted in black, brown, yellow, white and, as has been said, red. Black pigments come from carbon, or soot, available to the cavemen and to every artist since right up to today. The browns and yellows under the microscope looked like earth pigments, again available to the cavemen and still today. Perhaps one might find lead-tin yellow in the brocade? Artists began depicting rich materials, precious metals and jewels using lead-tin yellow during the 16th century, in a move away from using actual gold and silver leaf. Cheaper than gold or silver the technique demonstrated an artist's skill in depicting gold without actually using gold. However, lead-tin yellow continued in use until the18th century so if it was identified it would still not narrow down which century the painting was created in. The pale flesh tones would be lead white, the alternative opaque white, titanium white, was not produced until the 20th century. Again lead white has a long history and is still in use today.

None of these pigments if scientifically identified would help tell us whether Edward was painted in the 16th or 17th or even 18th Centuries. There was no blue so no chance of finding a marker like Prussian blue that was first made by the paint maker, Diesbach, in Berlin in 1704. Hence pigment analysis was unlikely to help pin point a date.

The panel

As has been said the painting is on an oak panel and from the 14th to the mid-17th century there was an extensive trade in oak planks from the Eastern Baltic (Fig. 9). In the Baltic the trees grew slowly giving them a straight grained, unlike in England or Western Europe were trees were encouraged to grow more rapidly and were cut down more quickly. Edward is painted on two planks, a wider and a narrower one, (Fig. 10). The wider plank has not been trimmed significantly. Its width is approx. 25cms, a width typical of boards from the Eastern Baltic

Fig. 9: Europe at the beginning of the Reformation, 1519

Fig. 10: Back of the panel

used in the 16th & 17th centuries. The original saw marks are still evident.

The panel's grain is vertical and visible at its top and bottom edges are tree rings, (Fig. 11). In temperate climates as the season's change there are subtly different seasonal variations each year. These variations affect the growing rate of plants and trees that in turn affects the width and distance between

Fig. 11: End grain of the panel showing tree rings

each tree rings. These variations have been studied and collated to produce master graphs. By taking accurate measurements of the distance between each tree ring, at the top and bottom edges of the panel one is able to create a graph that can be compared against the master graphs. This is dendrochronology.

It was through dendrochronology that the following information was found: the panel's boards probably came from what is now N.E. Poland from a tree that was still growing in 1531, but likely to have been felled after 1539. Thus the panel was made from wood contemporary with Edward VI himself.

Further investigations

Further research found that the National Portrait Gallery, had on record a photograph of an X-ray of part of the painting that had been taken in the 1950s. It is not a clear image but it indicated there was probably another image below the portrait of Edward, which may explain the presence of the red layer.

A new X-ray was taken and the result is a particularly complex image to read, (Fig. 12). But if the x-ray is put on its side and the contrast is increased a scene of people round a table can be discerned, (Fig. 13). The image likely depicts a religious subject like 'Abrahams feast for the weaning of Isaac' or Salome dancing for Herod, (Fig. 14 & 15).

Fig. 12: X-Ray of the panel

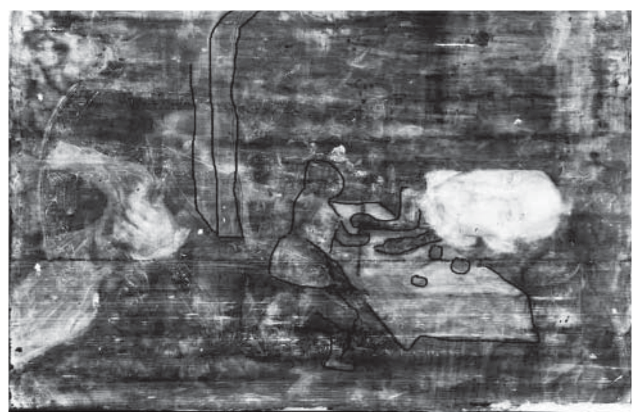

Fig. 13: X-ray with increased contrast and main features picked out

Going back to English religious history in the 16th century that began with Henry VIII leaving the Church of Rome and making England Protestant. When Henry died in 1547 he was succeeded by his son, Edward VI, who was also

Fig. 14: *"Abraham giving a banquet on the day Isaac is weaned" Engraving by Étienne Delaune, produced 1550-1572, From a set of thirty-six plates illustrating the Genesis, British Museum, Museum number: 1834,0804.77*

Fig. 15: *Benozzo Gozzoli, "The Dance of Salome" - 1461-62, Tempera on panel, National Gallery of Art, Washington D.C., Accession Number: 1952.2.3*

protestant and kept the country protestant. But when he died in 1553 he was succeeded by his half-sister, Mary Tudor. She was Catholic and took the country back to being Catholic again. When she died in 1558 and was succeeded by her half-sister, Elizabeth I, Elizabeth again made the country Protestant again. She died in 1603.

This all affected everyone in the country, and we find it affected artists commercial lives. Artists did not work only to commission. They would also make paintings of subjects they hoped would be popular and sell to passing trade. Before the political and religious upheavals described, often such speculative paintings were of religious subjects. By the late 1500s the complex politics of all these religious changes meant displaying religious images in certain situations was frowned upon. So artists with a stock of such religious images that they had painted for commercial gain now found their stock unsaleable. So they would paint over these religious images with more popular subjects. One such example is a portrait of Elizabeth I's Protestant spymaster and Secretary of State, Sir Francis Walsingham, that is in The National Portrait Gallery. It is painted over an earlier image the Virgin and Child.

As has already been said making sets of portraits of Tudor monarchs was popular. Such decorative paintings, made swiftly in artists' workshops where they could produce batches at a time. It is thought that the overall small size of the Guys and St Thomas' panel would make it a likely candidate to be from such a set of monarch paintings.

Thus our knowledge has advanced quite a bit although we don't have an exact date for the creation of Edward. Most likely it dates from between 1580 to 1620, later and one might wonder why the earlier religious scene beneath Edward was only covered over at such a later date.

Thus despite the painting's stature as an unimportant copy and likely to be overlooked because of this, the story that this painting encapsulates is resonant of the history of the period in which it was created and a good lesson to never overlook the overlooked, they also deserve all our care.

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Painting Hiding Behind Painting:
Rediscovery and Restoration of the Murals in the Big Temple of Tanjavur, Tamil Nadu, India

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Introduction

The Brhadisvara Temple is located in the town of Tanjavur, also called Tanjore, in Tamil Nadu in southern India. It was constructed around 1010 A.D. by Rajaraja I (985-1014 A.D.) of the Imperial Chola dynasty that ruled over large parts of South India and Sri Lanka from the mid-ninth to the mid-thirteenth centuries A.D. The temple has also been known as the Rajarajesvara Temple or Rajarajesvaram, after its founder. On account of its massive size (241m x 122m), the temple is locally called the Big Temple or *Periakovil* (Fig.1).

The Cholas built thousands of temples in South India and Sri Lanka. The majority of the temples are, not surprisingly, clustered in and around Tanjavur that served as the royal

Fig. 1: Main Shrine and adjacent structures

capital during most periods of their rule. Among all the Chola temples, the Brhadisvara Temple of Tanjavur is one of the biggest and most well-known. It was listed as a 'World Heritage Monument' by UNESCO in 1987. It is the only temple having a large number of wall paintings including those of the Chola period. None of the other temples have Chola paintings although many of these temples including those at Narthamalai and Gangaikondacholapuram (Tamil Nadu) exhibit a few murals of the late medieval times (fifteenth century and later.).

The history, art and architecture of the Chola temples, mainly the Brhadisvara Temple of Tanjavur, have been the focus of numerous studies and publications. Many of these publications provide interesting descriptive accounts of the Chola paintings within this temple. There have also been a series of publications exclusively dealing with these paintings in the wider context of the painting traditions of ancient and medieval India. There are passing references to these paintings in certain general technical papers on the conservation of wall paintings.

The present paper, for the first time, attempts a comprehensive collation and analysis of the various stages in the long process of conservation of the above Chola paintings—the pioneering but unknown efforts of the Nayak and Tanjavur Maratha dynasties between the sixteenth and the eighteenth centuries and subsequently, the more scientific and systematic efforts of the modern-day archaeologists. The present study is mainly based on field researches and archival sources, besides personal interviews with senior archaeologists involved in the conservation at different times. The Paper highlights the various problems pertaining to this complex ongoing conservation process and the practical remedial measures for the same, worked out by the conservators at the site.

The Paintings and their Rediscovery

In the Big Temple of Tanjavur, the main sanctum housing the *Shivalinga* is located almost at the centre of the large quadrangular complex (Fig. 1). The narrow vestibule or corridor on each of the four sides of the main sanctum is compartmentalized into five chambers corresponding to the five bays on the outer wall, thus resulting in two adjoining corridors meeting at right angles and sharing a common corner chamber (Fig. 2). In the eastern corridor alone, the middle chamber gives place to the doorway to provide access from the *ardhamandapa* (hall) to the east-

Fig. 2: Main Shrine – close-up view

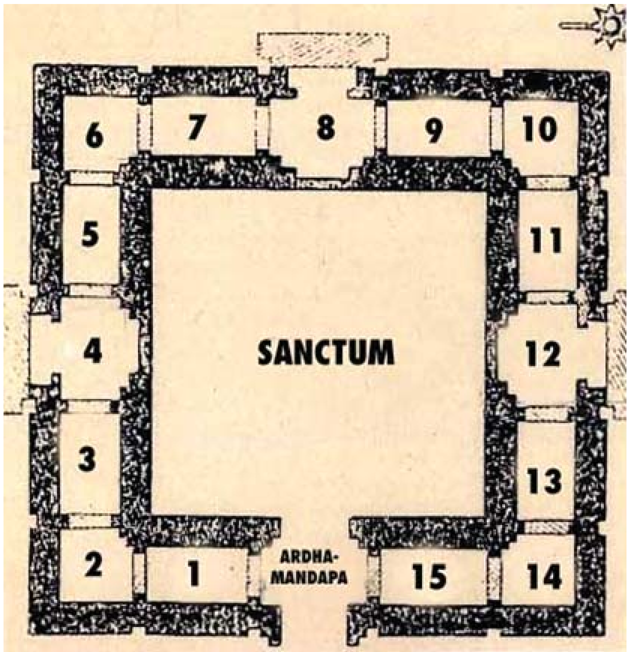

Fig. 3: *Circumambulatory passage divided into 15 chambers*

facing sanctum. Thus, we have altogether 15 chambers, serially numbered by present-day archaeologists (Fig. 3). Apparently, engineering requirements of structural stability led to the formation of these chambers. The corridors were intended to serve as a circumambulatory passage to enable the devotees to go round the main sanctum in a clockwise direction. Thus, the devotees would enter the passage from the *ardhamandapa* through chamber 1 and go out through chamber 15. Initially, these chambers received light and ventilation through openings in the middle of the outer walls on the south, west and north.

When the temple was built (eleventh century), the walls and ceilings of the above chambers were covered with paintings by the Cholas. The theme of these paintings is mostly religious. Many of the painted scenes feature stories relating to Shiva, the most popular deity in the Chola empire. For example, episodes from the life of Sundaramurti Nayanar, one of the most famous devotees of Shiva, are portrayed on the walls of chamber 7. Chamber 9 features Nataraja (dancing Shiva) and his

Fig. 4: *Rajaraja I Chola (right) and Karuvur Devar – Painting in chamber 10*

devotees. An interesting panel in chamber 10 features Rajaraja, the builder of the temple, with his preceptor, Karuvur Devar (Fig. 4).

Around 1600, the local Nayak dynasty rulers executed a second layer of painting over the Chola murals. This upper layer of painting, also featuring religious themes, appears to be part of a routine renovation of the entire temple and not, as believed by some historians, to be a symbolic assertion of the political supremacy of the Telugu and Kannada speaking Nayaks over the Tamil-speaking Cholas responsible for the inner layer of painting. The repainting of the chambers by the Nayaks was necessitated by the worn-out condition of the Chola murals which had, by then, been exposed to nearly five centuries of soot and smoke from the sanctum where the perpetual lighting of oil lamps and the frequent burning of camphor took place. Significantly, there are no Chola paintings below the Nayak murals on the walls of chambers 1, 2, 3 and 4 clearly indicating that the Chola murals on these walls had completely faded off even before the Nayaks began to repaint these walls. Ignorant of more effective ways to preserve the surviving flaking Chola paintings, the Nayaks simply chose to paint over them.

Towards the end of the Nayak rule (seventeenth century), all the openings or entrances to the circumambulatory passage were closed up by masonry walls. The small holes on some of these walls caused the entire dark interior to be infested with bats. The droppings of these bats were used as plant manure and thus, provided a source of revenue to the temple. But these droppings caused gaping pores on the paintings. The seepage of rainwater from the superstructure to the passage caused irreparable harm to the paintings on the upper portion of the walls while the lower panels suffered minimal impairment. Further damage was caused to the paintings when the passage was used as a military hideout during the Anglo-French rivalry in Tanjavur (eighteenth century). Significantly, the Nayak layer of paintings bore the brunt of these damages thereby protecting the underlying Chola murals.

The Tanjavur Maratha rulers, who succeeded the Nayaks, initiated steps to conserve the temple, specially after the damage caused to it by the Anglo-French rivalry. Serfoji II (1787-1832), the most well-known ruler of the Tanjavur Maratha dynasty, took a personal interest in the maintenance and upkeep of the temple. During his reign, some portions of the temple were replastered and rebuilt to conform to the original plan and design of the Chola times. Inscriptions on the walls of the temple and the royal records in the Saraswathi Mahal Library of Tanjavur provide detailed descriptions of these restoration works. The Marathas would not have known about the Chola paintings lying beneath the Nayak murals and they did not make any attempt to restore or retouch these paintings except periodically cleaning the passage and dusting the painted walls. Inspired by the theme of some of these Nayak paintings, they attempted paintings on the walls of some of the other shrines within this temple.

In the 1920s, one of the Nayak-period walls closing the passage developed serious cracks and partially collapsed. This, in turn, resulted in more people going round the passage which had, for many years, been closed to the public. In 1931, Prof. S. K. Govindaswamy of Annamalai University, Chidambaram (Tamil Nadu) discovered the existence of the Chola paintings below the Nayak murals that had cracked and fallen off at several places. As extant Chola paintings were, until then, unknown, this discovery was hailed as an event of the greatest importance in the history of Indian painting.

Pigments and Technique of Execution

Coming to the technique of the execution of the Chola paintings, the granite walls of the painted passage have a very rough surface which thus provide the ‘tooth’ enabling the first application of rough plaster stick to it. The plaster mainly consists of lime (Calcium Oxide) and silica or sand and is about 2.6mm thick, though it varies from place to place corresponding to the varying roughness of the wall surface. The Cholas appear to have used old and well-flaked lime for the preparation of the plaster or ‘ground’. The plaster itself consists of two layers—in the first stage, an average coating of 1.8mm thickness is applied over the uneven surface of the stone, followed by another coating, even when the earlier layer was wet, of about 0.7mm thickness to give the necessary smoothness to the base surface. The inner layer comprises nearly 50% of sand

and 28% of lime while the upper layer has a mere 7% of sand and 66% of lime. The other constituents of the plaster include iron and magnesium. Thus, the lower layer is coarser in texture than the upper one. In other words, the plaster has been carefully graded with sand as the inert material—a technique most well-known in medieval Europe, especially Rome. However, marble and gypsum, well recognized ingredients in the plaster of wall paintings in Europe, are totally absent in Tanjavur. On the plaster, the Chola artists executed the paintings in *fresco-buono* or true fresco technique i.e. painting in wet lime plaster. The water in the plaster eventually evaporates while, simultaneously, the lime absorbs carbon-dioxide from the atmosphere. This, in turn, leads to the formation, on the surface of the painting, a glassy layer of crystalline carbonate of lime which binds the pigment colours with the 'ground' in such a manner as to make them insoluble in water and also give them a fine sheen, characteristic of true fresco.

As the true fresco technique involves painting on the plaster before it dries up, the entire painting process has to be completed within a few hours. Hence, each day, the plaster for the surface to be painted is freshly laid. In such a process, plaster joint marks are seen between paintings done on the same wall at different days. To cite an example, such joint marks or lines exist on the frescoes within the Sistine Chapel in Rome. But such joint marks are absent on the Chola paintings. This may suggest that the Chola artists could have painted one wall per day in which case there would be no visible 'joints'. This would not have been an impossible task because each wall is divided into horizontal panels, ranging from 24 square feet to 60 square feet in size, by bands or patches of colour and each panel could have been executed by a single artist or a group. It is equally plausible that the various panels were painted on different days and the joint marks intelligently hidden underneath the bands or patches of colour separating the panels.

As regards the colours used in the Chola paintings, white colour was derived from lime, blue from ultramarine (the blue of lapis lazuli), yellow, brown and red from ochres, and light blue from ultramarine toned down with either lime or silica. Flesh tint was obtained by mixing red and white colours. Black was initially suspected to have been derived from wood charcoal or lamp black but later studies have conclusively indicated that the black is manganese-dioxide. Thus, all the colours were of mineral origin and were obtained locally.

Now, to the technique of the Nayak paintings superimposed on the Chola murals: On the smooth surface of the Chola painting, the Nayaks applied a plaster layer ranging in thickness from 1.5mm to 2.2mm. This was followed by an upper finishing layer with an average thickness of 0.6mm. Interestingly, the basic constituents of the Nayak plaster are the same as the Chola plaster, although the quantity of the constituents greatly differs between the two plasters. Thus the inner layer of the Nayak plaster comprises 63.4% of sand and 18.5% of lime while the upper layer has nearly 13.8% .of sand and 55.6% of lime. Although the quantity of sand in both the lower and the upper layers of the Nayak plaster is far greater than that of the Chola plaster, in both the plasters, the upper finishing layer has less sand and thus, is finer in texture. The Nayaks used almost the same colours used by the Cholas. But the flesh tint, seen on Chola paintings, is absent in the Nayak murals. The precise technique of execution of the Nayak murals has not been determined. These paintings have certainly not been done by the true fresco technique. Significantly, the adhesion of the Nayak paint layer to the 'ground' or plaster is much weaker than that of the Chola paint layer although the latter paintings are atleast five centuries older than the former.

Recent Conservation Efforts—Challenging Problems

The Archaeological Survey of India (ASI) took up the scientific conservation of the Chola paintings of Tanjavur in the mid-1940s. The first step was to remove the Nayak period walls covering the openings on the south, west and north walls of the painted passage. This was done to ensure ventilation for the passage and also to restore its original character as conceived by the Cholas. The area was cleared of bats and their droppings. With a view to restrict further infestation by bats and birds, bat proof doors were fitted in all the openings. Simultaneously, efforts were initiated to prevent the seepage of rainwater to the passage from the superstructure. In order to prevent soot and smoke from the sanctum reaching the painted walls, the two openings—entrance and exit—near the sanctum area were provided with tight-fitting doors, thereby also restricting public access to the painted passage. Presently, the passage is mostly accessed through the doorway in the middle of the southern wall. An iron ladder leads up to this doorway (Fig. 5).

Fig. 5: *Ladder leading to the circumambulatory passage*

The primary purpose of the entire conservation was to expose the rare Chola paintings lying beneath the Nayak paintings. In the initial years, the only practical method of achieving this was to carefully chip off the Nayak paintings including the plaster supporting them. In this method, the Nayak paintings were completely destroyed. This method was adopted to expose many important Chola paintings including those in chambers 7, 9 and 11. The archaeologists justified this destruction on the grounds that the Chola paintings were older and artistically superior to the Nayak ones. Also, Nayak paintings exist in many other temples whereas extant specimens of Chola paintings cannot be seen anywhere else.

In the early 1970s, there was a growing awareness, among archaeologists and art lovers, that the Nayak paintings too were valuable in their own way and should not be destroyed for the sake of exposing the Chola frescoes. The only alternative now was to find a method to separate the two layers of painting without causing any damage to either of them. There are two major non-destructive methods of transferring murals from walls to other types of supports such as fibreglass:

1) The *Strappo* method in which the paint layer alone is removed while the underlying plaster or 'ground' remains on the wall.

2) The *Distacco* method in which the paint layer is removed along with the underlying plaster.

Both these methods have been successfully practiced in Italy. In Tanjavur, the archaeologists first wanted to try the *Strappo* method to remove the surviving Nayak paintings. This would mean that the Nayak paint layer alone would be detached, leaving the Nayak plaster on the wall. This plaster could eventually be chipped off to expose the Chola frescoes. This method would have been a safer one from the perspective of the Chola paintings. But this method could not be adopted because the Nayak paint layer was found to be too weak and brittle to survive its removal without its underlying plaster. Hence, in 1975, the more difficult *Distacco* process was chosen to remove the Nayak murals.

The *Distacco* method was first tried on the west wall of chamber 10 and later extended to some of the other chambers. Before the commencement of the process, the Nayak painting on the wall was cleaned with organic solvents and then, photographed. Next, a strong facing of cloth was applied to the Nayak painting to be removed. This was done in two stages:

Fig. 6: Stage 1

1) First, overlapping strips of thin gauze, like the muslin cloth with slightly open weave, were applied with an adhesive such that the cloth firmly adheres to the painted surface without any air bubbles being trapped between the paint layer and the cloth (Fig. 6).

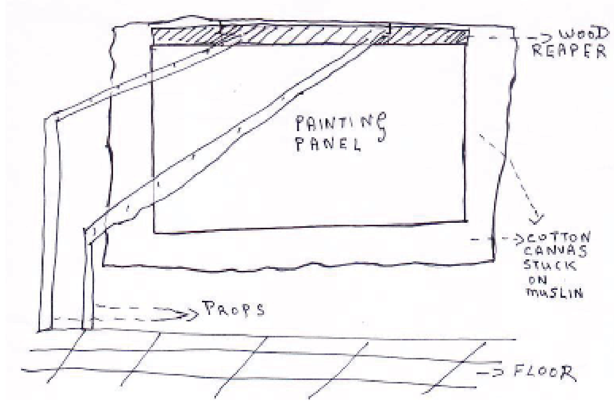

Fig. 7: Stage 2

2) After the muslin cloth had dried, another layer of thicker cloth, like the cotton canvas, was applied over it, with the same adhesive, leaving a free margin of cloth of around 10cm to 15cm on all the four sides (Fig. 7).

The actual removal of the Nayak painting was started after about three days to allow the cloth facing to completely dry. Now, the top portion of the painted panel was secured by applying a wooden reaper on the free margin of the cloth and supporting the reaper with suitable props (Fig. 7). This was done to avert any accidental fall of the panel, especially towards the final stages of this complex operation. The removal or cutting of the painted panel started from its bottom right hand corner. Slowly, incisions were made along the edges of the panel ensuring that only the Nayak layer was cut through and the underlying Chola layer remained undamaged. In the next stage, a rubber-tipped chisel was inserted along the incised edges and the Nayak layer carefully uprooted by tapping the chisel with a wooden mallet. At the same time, the conservators kept an eye on the Chola painting that was gradually getting exposed below. If any part of the Chola painting appeared to be brittle or revealed signs of peeling off from the wall, the entire operation was suspended until that portion of the Chola layer was properly consolidated. The back of the Nayak plaster was also continually monitored to ensure that no segment of Chola painting was adhering to it and was being removed along with it. After the Nayak layer was thus detached, it was placed face downwards in a safe place.

The next stage was the chemical treatment of the newly exposed Chola painting. All the loose edges of this painting were filleted with Plaster of Paris, appropriately tinted. The bulging portions of the panel were firmly fixed back.

The final stage was the remounting of the detached Nayak panel. The panel was put on a table, face downwards, and the back of the plaster surface was made even by rubbing the bulging spots with sandpaper and filling gaps and crevices with lime-casein. On this even surface, two layers of jute canvas were applied with an adhesive. After the canvas had dried, a layer of polyurethane foam was applied, again with the same adhesive. Finally, a layer of fibreglass mat was applied, using aluminum angles for additional reinforcement. After a day, the panel was turned face upwards. The two layers of cloth, covering or hiding the painting, were now removed.

The Nayak painting panels are now displayed in a small museum within the temple (Fig. 8, 9). The museum also exhibits large photographs of the Chola paintings (Fig. 10). The passage bearing the Chola paintings is presently not open to the public.

Fig. 8: *Nayak period painting panels on display in a row – right wall*

Fig. 9: *Nayak period painting on display – close-up view*

Fig. 10: *Photographs of Chola period paintings on display*

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6 November 2020

Reflectance Transformation Imaging (RTI)

MOHAMMED IBRAHIM is an archaeological conservator associated with The Egyptian Museum, Ministry of State for Antiquities Affairs, Cairo, Egypt since 2012. He works mainly on organic material (wood, papyrus, paper, etc.). He is responsible for photographic documentation and investigation using Multi Spectral Imaging and RTI. He finished his Licentiate in Archaeological Conservation from Cairo University in Archaeology, Restoration and Conservation Department in 2008. He has previously worked on many projects including the Egyptian Museum Coffin Conservation Project (EMCCP), Pop-up Museum 2019, Abydos Excavation project by American Research Center in Egypt and the Cambridge university excavation mission in Ttel Al amarna in Egypt. He also conducts training and workshops and has a number of publications to his credit.

Introduction

As conservator, our role is not limited to preserving cultural heritage through direct intervention with restoration work only, but also to study and collect information on artifacts through investigation, examination and analysis using non-destructive methods, which help in understanding the nature of the objects for better protection and applying better restoration.

Reflectance Transformation Imaging (RTI) is one of these non invasive methods widely used by experts in the field of archaeology, restoration and historical science. The technique is based on studying a set of images with varying known lighting.

Fig. 1: Painting being studied with RTI

What is RTI?

RTI is a computational photography technique used to study surface morphology through imaging an object under different directions of illumination to create a composite image.

RTI is an affordable and accessible resource which would be beneficial for both cultural institutions and individual conservators for the interpretation and evaluation of cultural heritage.

RTI was invented by Tom Malzbender and Dan Gelb in 2001, and at that time they were focusing on the surface texture and shape of paintings. By using the raking light photograph, made by casting light across the surface of a painting at a very low angle, surface texture or irregularities were highlighted and studies.

Fig. 2: Tom Malzbender and Dan Gelb performing RTI

RTI technology present several advantages:

1. Inexpensive and widely available hardware.
2. RTI can be carried out in the field or lab, with little equipment beyond that required for standard photography.
3. All the necessary software is freeware.
4. Can be applied on both large and small objects.

How does it work?

Reflectance Transformation Imaging is a method of capturing how the surface of an object interacts with light. This digitization process yields interactive visualizations that allow users to manipulate the direction of virtual light sources.

Light bounces off of surfaces such that the incident angle of the light and the reflected angle of the light are equal angles to the surface normal. Since the camera is in a fixed position, and we know where the light is coming from in each image, and because we sample from a variety of light positions, RTI software can calculate the surface normal per pixel in the image.

What is its use?

RTI in particular has proved itself as an invaluable interrogative tool for conservators and artifact specialists. RTI can pursue important tasks for investigation, documentation of state of conservation and the study of the techniques used in execution of art objects.

RTI has been employed for the virtual examination and study of the cultural heritage artifacts (high relief fossils, ancient stone tools, oil paintings, and many other materials). The textures can offer major perceptual and cognitive hints for the study of the artwork.

RTI has helped to discover textural features including identification of manufacturing techniques, that are imperceptible to the naked eye or through other inspection techniques, or that could not be properly recorded with raking light photography.

RTI has proved to be a remarkable tool because the combination of lighting, magnification, and rendering filters serve to discover size, location, extent character of apparent damage, and to document alterations that produced changes on textural patterns and glossiness. Further, damages on different surfaces can be better visualized. These include cracks on painted surfaces, flaking, losses, surface deposits, scratches, pitting, holes, incisions, metal corrosion, cupping, and deformation of supports, shrinkage and breakage.

How to use it?

There are two methods that can be used to implement the production of images.

The standard RTI

This can be achieved through the use of a dome, which consists of a light-proof structure with a large number of bulbs, each of which can be turned on individually to provide sufficient illumination to allow the fixed digital camera suspended over the artifact to take an image. By taking a sequence of images using all the lights, the data required for processing is acquired.

Fig. 3: *Standard RTI equipment*

The highlight RTI (H-RTI)

It is a more flexible approach that can be carried out in the laboratory, but is particularly effective in the field. It is more time-consuming that standard RTI method, but it is easy to use in the field.

The equipment required is extremely portable and flexible, involving few items beyond those already expected in a field photographic kit.

RTI equipment

Camera

A fixed camera to subject alignment is the primary requirement. Digital camera must be set on a tripod or camera stand for stability, and to eliminate vibration during image capture. Sandbags or other weights can help to further stabilize tripods and supports.

The recommended method is to connect the camera to the computer, and use the computer to control it for testing the setup, and when

Fig. 4: RTI photography

shooting the images. This way, one can trigger the camera and flash directly from the computer and download and name images at the time of capture.

Reflective spheres

At least 2 black reflective spheres are placed near the subject in the camera’s field of view.

Depending on the size and portability of the target object, one must compose the camera’s field of view in such a way that it can encompass both the object and the two reflecting spheres.

The string

The distance of the light source from the object must be the same for all shots. This can easily be achieved by attaching a string to the light source and measuring the distance.

The string is approximately 2 to 4 times the diagonal measurement of the object or object details to be studied.

Light Source

Portable lighting unit must be of a type and intensity appropriate to the location and environmental conditions Semi arch arm at 15°, 30°, 45° and 60° lighting angles are used to illuminate the surface of the object to produce the highlight point in the reflective target. The object illuminated from light positions by moving the arm every 20 degrees following a pattern with radial spokes creating a virtual dome. Light is reflected from the surfaces such that the incident angle of the light and the reflected angle of the light are equal angles to the surface normal. Since the camera is in a fixed position, light sources and distances of light positions are known, RTI software can calculate the surface normal per pixel in the image.

RTI technique is able to compliment not only visible light, but also UV and IR light. UV RTIs and IR RTI provide additional information on under painting, under-drawing, new and old repairs and their sequence, and some ‘textural’ information not otherwise available. The RTI IRR has a tremendous potential for fine art conservation and historical investigations.

If a computer is used to control the camera, it must be near enough to connect and be easily accessible, but it must be placed out of the way of the object, camera, and lighting area. In outdoor field situations, it is useful to mount it on another tripod stabilized by weights or sandbags.

RTI Software

RTI Builder

Creating a project

Invoke the RTI Builder, you create a named project and point to the location of specific image set.

Choose the processing sequence algorithm for the type of RTI file to be created; it can be produced with the Polynomial Texture Map (PTM) algorithm, or with the Hemispherical Harmonics (HSH) algorithm. Both types of RTI files can be viewed with the RTIViewer.

Finding light positions

First identify the spheres in one of the images, and then run the tool that detects the highlights and uses them to calculate the light positions and generate a light-position file.

In the case of dome RTI, data capture and processing is different because each dome has a pre-build lighting position file. There is no need to add spheres in the scene in data acquisition stage.

Cropping the images

The RTI should show only the target object; there is a tool to help you crop the image so that the reflective spheres are not included in the final RTI. The cropping tool automatically applies the same crop to the entire image set.

Generating the RTI

The final tool processes the complete image set to produce the final PTM or RTI file.

RTI Viewer

RTI Viewer allows one to load and examine images created with reflectance transformation techniques. These techniques calculate both color and shape information from a set of images illuminated from different directions, and store that information in files.

RTI Viewer offers interactive rendering of images, allowing one to change the view and alter the apparent direction of lighting. In addition, it offers a number of enhancement modes, which apply mathematical transformations to the color and shape information to enhance or emphasize particular features of the target object. These transformations do not alter the original data, but can be saved separately so that they can be reapplied.

Conclusion

RTI technology presents several advantages and it can help in revealing details that are imperceptible to the naked eye or through other inspection techniques. RTI is an effective tool not only for examination but also in the field of preventive conservation. Many new RTI tools, methods, and uses are emerging in the field proving the significance of this tool in documenting and accessing information on cultural heritage collections.

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9 November 2020

Introduction to the Conservation and Research Project on Pahari Drawings from the Museum Volkenkunde, Leiden, The Netherlands

AMÉLIE COUVRAT DESVERGNES is a freelance book and paper conservator in the Netherlands. During her career, she has developed an expertise in the study and conservation of Islamic and Indo-Islamic manuscripts and paintings and has carried out several projects on the knowledge and identification of materials and techniques relating to these objects. Currently she is working on the collection of drawings and paintings from north-western India from the Museum Volkenkunde in Leiden. Previously, Amélie worked at the Rijksmuseum in Amsterdam, at the Museum of Islamic Art in Qatar and in Paris for various museums such as for the department of Islamic Art of the Louvre.

The Museum Volkenkunde (museum of the world cultures) in Leiden comprises around 140 drawings and paintings from the Punjab and the Pahari lands (today Himachal Pradesh and Uttarakhand) popularly known as "Pahari miniature painting". The word "*Pahar*", meaning from the hills, relates as to the Western foothill of Himalaya. The collection covers a large diversity of themes and reflects the interactions between indigenous traditions, European and Mughal cultures. The works illustrate Hindu narratives (*Ramayana*, *Vikramaditya*, *Karita-Arjuna*, etc.) (figure 1), vernacular poetry (*Ragamalas*) (figure 2), portraits of rulers and historical figures (figure 3) and comprise also some interesting examples inspired by the Western culture or made for Europeans, the so-called

Fig. 1: *Rama gives his signet ring as an identification mark to Hanuman an episode from the Ramayana, Kangra, end of eighteenth century, RV-3025-7*

Fig. 2: *A lonely lady cuddling a dove, Verse 665 of the Bihari Satsai, Chamba style, beginning of nineteenth century, RV-3025-56*

Fig. 3: *Portraits of Sardar Jawahir Singh and two European ladies in medallions, black ink and watercolour on Indian handmade paper, circa 1840, RV-3025-84*

Fig. 4*: Depictions of an Indian crested cuckoo, a common quail and a lesser golden-backed woodpecker, before conservation Kangra, circa 1820, opaque watercolour on Indian handmade paper, RV-3025-121*

‘company painting’ (views of the Kangra valley sites, studies of local birds, view of Lahore fort) (figure 4). These constitute a considerable visual resource which illustrates the history and traditions of the region and emphasizes the techniques and the craftsmanship of the Indian artists.

The aim of the project which has begun in June 2020, is, alongside the conservation of these works, to study their materiality and particularly the various types of papers used as drawing supports. The collection epitomizes the shift which occurred, in Northwestern India, during the first half of the nineteenth century, in the artistic production and in the materials used. If most of the drawings from the collection was made on native papers, a small group, executed on European papers, shows the progressive invasion of British manufactured products on the Indian markets. For instance, the figure 5 shows some Himalayan birds painted on a sheet of imported machine-made paper which is transparent and therefore not suitable for artistic production. Traditionally, handmade papers were produced, since the fourteenth century, in paper mills located in Kashmir in Srinagar and Punjab in Sialkot.

***Fig. 5:** Depictions of an Impeyan pheasant and a grey francolin at recto and a flying white-necked stork at verso, opaque watercolour on European machine-made paper, RV-3025-123*

These might probably have supplied the *Pahari* workshops. At the beginning of the nineteenth century, the region saw the incursion of European travelers and scholars, British officers posted in the various stations of the Hills and French mercenaries who trained and commanded Ranjit Singh’s army. These foreigners commissioned paintings and graphic *souvenirs*, the so-called ‘company paintings’ which depict fauna, flora, trades, occupations and casts. Hence, western papers started being imported for that purpose and the Indian artists were requested to use these papers which fitted better to the taste of their new patrons.

After the death of Ranjit Singh in 1939 and both anglo-sikhs wars which opposed, in the 1840s, the British East India Trading Company along with the British Empire to the Sikh Empire, the British Raj eventually took over the administration of the Northwestern provinces of India, from 1849 onwards. The British not only took politic power but also controlled the whole economy of the Pahari and Punjab regions. The local manufactured products and traditional handicrafts could not compete with the importation of English goods and rapidly declined. As a result, Indian artists had no other choice to procure English papers of diverse qualities which were cheap and readily available but no always durable and sympathetic. Likewise, the painting techniques and the subject matters evolved to content Europeans patrons but also Indian who were attracted by western imagery and styles.

Therefore the study aims to understand further the visual material culture of the artworks during that peculiar time period. Hence, paper will be studied as a technical and ethnological commodity to explore deeper the social and material significance. Since the museum owns some series of drawings such as the *Ramayana*, the *Ballad of Amir Hath* and the *Vikramaditya*, among others, the analysis and the results of consistent groups of papers, combined with historical sources and previous field surveys, will certainly enable to draw typological features and establish a refreshed classification for these papers. In the past, some methodologies have been set up for the description of western papers but a proper method should be developed for the specificities of South-Asian papers. Therefore, a "custom-made" methodology will be established and will serve for further studies on Indian and South Asian papers in general. The reasons and circumstances of the decline of local handmade papers will also be explored from an artistic and social aspect in the light of the general Europeanization of practices in the region.

During the eighteenth and nineteenth centuries, papers from the regions are mentioned in travel accounts or brief notes from western artists and explorers. If some quotes are negative and raise the poor quality of the native paper and its brown colour, many authors report that papers from Kashmir is the best paper produced in India because of its whiteness and smoothness. Technical surveys from Europeans engineers and scientists provide economic data such rate numbers, benefits and employment figures or give important information on the types of materials used, the fibres and the production methods (Ironside, G. Watt).

Photographic documentations were also collected by engineers or simply by paper passionates (W. Raitt, Clapperton, D. Hunter). At last, paper samples were collected as part of nineteenth century collecting campaigns of local *naturalia* funded by Europeans states or simply by paper amateurs. Therefore Baden Powell collected many samples to be displayed at the 1854 exhibition in Crystal Palace in London. Some specimens won awards and prices. The Schlaginweit Brothers also travelled throughout North India and Nepal between 1855 and 1857 to survey zoological, botanical, geological specimens and ethnographic goods. They brought back some papers which were later mounted into albums in England. In the twentieth century, some works and researches have studied Indian handmade papers, the manufacturing process, the tools and the craftsmen (D. Hunter, A. Soteriou, N. Premchand, R. Pandey).

In the past, some methodologies have been set up for the description of western papers based on the examination of watermarks and on the laid and chain lines pattern[1]. A very useful and renewed approach adapted to western papers has recently been developed by Bas van Velzen at Universiteit van Amsterdam. Some attempts of classification applied to Islamic and Arab papers were made by C.M. Briquet, J. von Karabacek, G. Humbert, F. Richard and M. Bet Ariet but the fact that the Islamic paper does not have any watermark or paper mill marks made difficult comparison, study and typology. Claude Laroque and her partners already put together a useful online form to describe and study Asian papers, such as Chinese, Korean and Japanese. Agnieszka Helmann-Wazny, post-doctorate researcher at Hamburg university, specializing in Central Asian papers (Tiber, Nepal) has also developed significant methods to characterize non laid papers. However, a "custom-made" methodology should be developed for the specificities of South-Asian papers, and this is precisely what the present project aims to.

A excel spreadsheet form has been developed according to then various fields to be studied. Surface data (observation with the *Dinolite*®) (Figure 6) and structure data (mould imprints, thickness, look-through, etc) (Figure 7a, b, c, d) and composition of the pulp with sampling and fibre identification. Alongside the study of the MV drawings, the corpus is enlarged to

1. Summarized in Helen Loveday, 2001: 55-87.

Fig. 6: *Observation of the paper features with the dinolite® AM4113T-FVW*

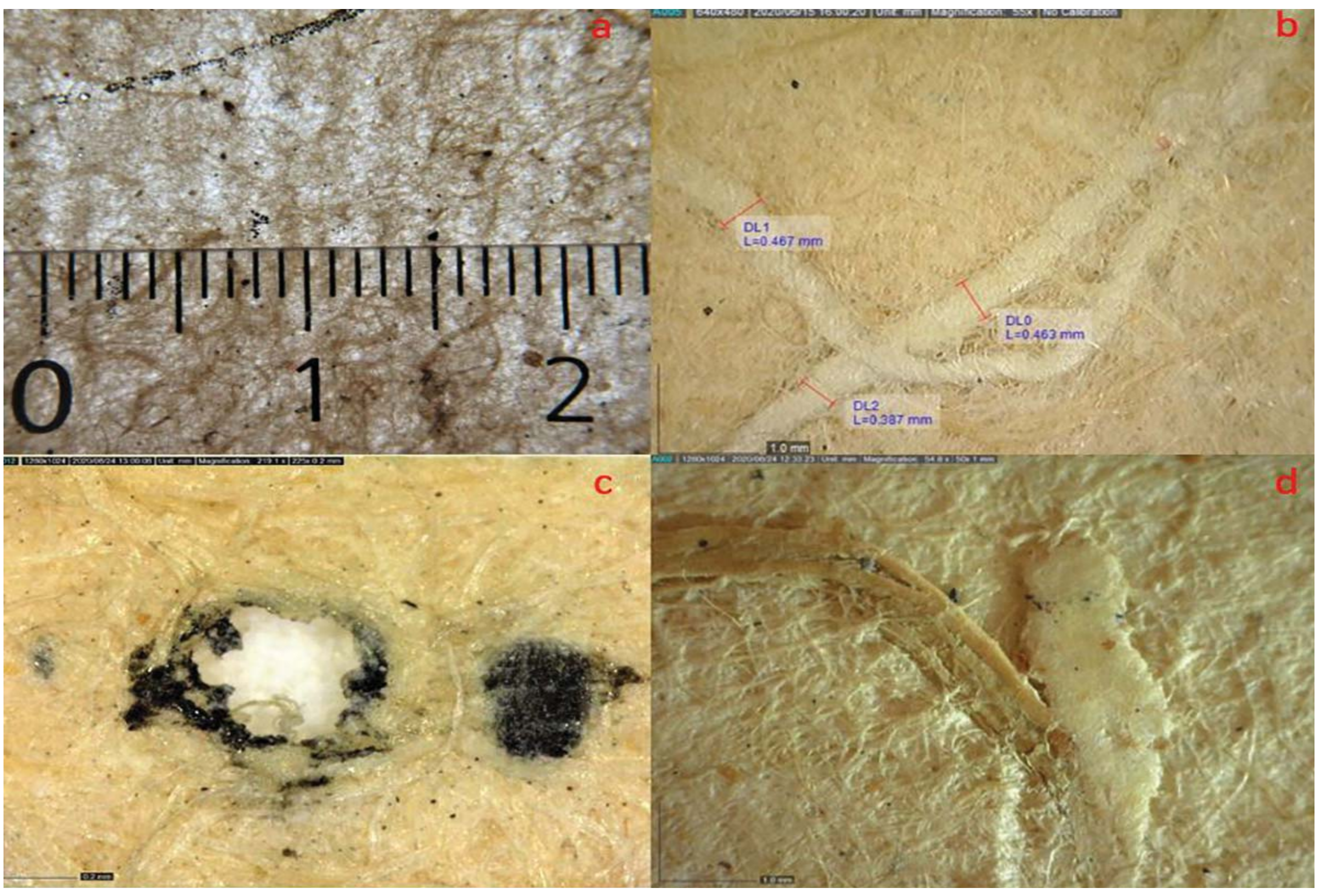

Fig. 7: *Counting of the laid lines per 1 and 2 centimeters on the light box (a), a white cotton yarn observed and measured with the dinolite®(b), a micro-hole and black carbonised particle (c), a hemp shaft and a bit of paper waste (d)*

Fig. 8: *Copy of the Ramayana, Indien 880 and a scroll illustrationg the Bahgavata Purana, Sanscrit 477, Bibliothèque Nationale de France, Paris*

other materials to get a broader understanding on the different types of paper produced during this time period: manuscripts, scrolls and historical records. Therefore, works from the Bibliothèque Nationale de France and Leiden University Library are examined for that purpose (Figure 8).

Preservation wise, the artworks of the collection are in various conditions: some are in a pristine state whereas others require conservation treatment. Most of the damages are mechanical such as tears, creases, bruised edge or losses and very chemical decay has been noticed. The supports do not show any signs of acidic and discolouration. After discussion with the senior conservator, Margrit Reuss and the curator of the collection, Dr. Priya Swamy, it has be decided to undergo minimal conservation treatments. Marks, stains due to previous water disasters or from unidentified liquids and other workshop traces will kept as evidences of the past life of the drawing. Most of the time these are not disturbing to the eyes and do not require treatment or even attenuation. The other underlying reason for such a treatment decision was also determined by technical limitations. The papers used are very porous, with very little sizing and burnishing. Hence, stain removal or wet cleaning treatments are often hazardous to perform on such type of paper and might imply irreversible changes on the surface appearance. For exemple, the large stains on the drawing representing Manini Nayika were not treated, since they are irreversible and do not alter the view of the scene (Figure 9). Therefore, the interventions will be limited to pigment consolidation if required, dry surface cleaning, support mending and infill of losses. Indeed some works such as the bird series which

Fig. 9: Representation of Manini Nayika on the recto. Black ink and watercolour on Indian handmade paper, circa 1810-30, Kangra, RV-3025-59

comprises 23 drawings of the avian fauna from the Himalayas, have been severely deteriorated by rodents and display today subsequent areas of paper losses on which traces of the rat teeth are still clearly visible. Conservators usually employ a large range of Japanese papers for the mending of the support losses. Japanese papers are made from Kozo, Gampi and Mitsumata fibres. Nevertheless, the perfect and smooth surface of these papers do not match with the rough and rugged aspect of the local papers used. A survey is currently ongoing to find handmade papers, available on the market, which could fit conservation requirements and match with the original paper supports. The various criteria taken into consideration are as follows:

- Conservation standard:
  pH: usually conservation paper are between pH 6 and 7
- No Harmful substances: bleached fibres, optical brighteners, etc (UV light inspection)
- Fibre identification: to make sure that the composition is really as advertised
- Texture and visual aspect: grain of the paper: long and apparent fibres, particles, bits of shaft, few impurities
- Structural aspect: equivalent thickness and look through
- Colour: similar or lighter hue to allow toning

Several papers have already been selected and are currently being tested:

- Papers supplied by Khadi paper UK (no information are provided by the company on the exact provenance, the manufacturing process and the pulp content): Laid handmade paper made recycled hemp by Muhammad Hussain in Sanganer, Ivory wove handmade paper made from hemp in India (Figure 10a).
- Ancient laid handmade paper from Rajasthani ledgers books, supposedly made with sunn hemp (*Crotolaria juncea)* known as brown hemp or Indian hemp, a multipuropose tropical and subtropical plant which is generally considered to have originated in India (Figure 10c, d).
- Izhar Neumann in Israel from handmade laid paper made from samar fibres (*Juncus arabicus* and *Juncus maritimus* collected along the local river) with an *Islamicate* type of mould. (Figure 10b).
- The project also includes the manufacturing of self-handmade papers at Moulin du Verger in France during summer 2021, and other papers produced by craftspeople and artists in India and Europe.

Some accelerated aging and light exposure tests are currently undergone at the National Archives in den Hague. Fibre identification

Fig. 10: *Muhammad Hussain making paper in Sanganer (a), samar papers from Izhar Neumann (b), a bundle of handwritten sheets from a ledger book (c), a bundle of blank sheets from an old Bahi Khatta (d)*

of each paper will also be conducted, in the second semester of 2021, in order to check the real composition of the pulp.

In October and November 2020, the series of the bird drawings was conserved. The support were surface-cleaned with cosmetic sponges and brushes, the residues of dirt and of the rodent metabolism were removed with a scalpel.

The paper supports were mended with remoistenable Japanese tissue paper ($9g/m^2$) precoated with a mixture of wheat starch paste and methylcellulose (50/50). Then, the losses were filled in either with ancient historical paper from Rajasthani ledgers books or samar paper from Izhar Neumann. Both papers were tested and the results were positive, therefore it has been decided to use them as their texture matched perfectly with the original supports. In some cases, the infills were toned with watercolour. The contour of the loss was pin-holed on the conservation paper and cut and the resulted infill was pasted with wheat starch paste onto a supportive layer of remoistenable tissue paper. The result was judged sympathetic and matched with the expectations (Figure 11).

Fig. 11: *Depictions of five Himalayan birds, before conservation (a) and after conservation (b), Kangra, circa 1820, opaque watercolour on Indian handmade paper, RV-3025-104*

Further Reading

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16 November 2020

Earthen Architecture in the World – Valorization and Underestimation

NORMA BARBACCI is a preservation architect with over 30 years of experience in developing and managing preservation projects in Latin America, Spain and Portugal. In 2020, Ms. Barbacci served as the Robert A.M. Stern Visiting Professor of Architecture at Yale University School of Architecture. In 2017 established Norma Barbacci Preservation Consultants, a private consulting firm, specialized in preservation of international cultural heritage. From 2001-2017, as Program Director at World Monuments Fund (WMF) she managed a portfolio of over 100 projects, which included envisioning and implementing comprehensive conservation and training programs at world-class monuments such as Easter Island in Chile, Teotihuacan and Monte Alban in Mexico, San Pedro de Andahuaylillas and Chankillo in Peru, and the Alhambra and the Segovia Aqueduct in Spain. Prior to joining WMF, Ms. Barbacci worked as a preservation architect at Beyer Blinder Belle Architects and Planners for 12 years, as senior project manager, associate, and studio director. Ms. Barbacci received her B.A. in architecture in 1983 from Carnegie Mellon University, Pittsburgh, PA, where she was awarded the AIA School Medal and Certificate from the Adams Fund for Excellence in the Study of Architecture. She received her M.S. in Historic Preservation in 1987 from Columbia University, New York, NY, where she was awarded the Historic Preservation Thesis award for her Master design thesis on the adaptive re-use of a medieval residential complex in Civita di Bagnoregio, Italy.

1. Earthen Architecture in the World

Earth as a building material, because of its abundance and accessibility, has been used successfully from Afghanistan to Argentina, and from Kerala to Chile, for thousands of years.

The fertile regions that made possible the development of the Neolithic Agricultural Revolution invited human beings to build their settlements from the alluvial soils, rich in sand, silt and clay, mixed with straw from agricultural crops, and gave birth to the first solid and durable building material: sun-dried mudbricks (Guillaud, Hubert, 2003).

According to United Nations statistics, approximately one third of humanity and possibly half of the population of developing countries live in earth buildings. From humble houses in Puno, Peru, to buildings with ten or more floors in Yemen, earthen architecture has been used to build homes, churches, mosques, palaces, fortresses, pyramids, barns, defensive walls and all types of structures, many of which have survived for centuries and even millennia in drier climates.

In Africa, Djenné-Djennó in Mali, one of the oldest villages in Sub-Saharan Africa, was built of adobe around 250 B.C.; in America, almost all Pre-Columbian cultures used earth in their constructions, especially in Peru, Mexico and the Southwest of the United States, but also in all those regions where hot and dry weather favored the use of this material; in Asia, one of the first expressions of architecture and the first surviving earth structures are found in Anatolia, Turkey, at the archaeological site of Çatalhuyuk; in Europe, some of the oldest settlements, located in Thessaly, Greece (Sesklo, Dmini,Volos) were built of mudbricks, wattle and daub, and stone, as early as the 7th millenium B.C.; while in the Middle East, the regions of the Mediterranean Levant (Lebanon, Syria, Palestine, Israel, Jordan and parts of Iran and Iraq), were the cradle of great ancient cultures which excelled in the art of earthen construction since the 8th millennium B.C. (Guillaud, Hubert, 2003).

The universal value of earthen architecture is evident and deserves the recognition, protection and conservation of the international community.

2. Earth, An Ignoble Material?

The following Strengths, Weaknesses, Opportunities and Threats (SWOT) analysis attempts to explore the reasons why earthen architecture, possessing such good qualities, longevity and wide geographical distribution, is underestimated in many parts of the world, with a particular focus in Latin America.

2.1 Strengths

Raw earth is an **ecological** material, since it is natural, does not have to be industrially transformed, consumes less energy and water than the manufacture of cement and other materials, does not require transportation since it is everywhere, is completely recyclable and does not generate waste during its construction or at the end of its useful life.

It is **economical** and its construction and maintenance techniques are relatively simple and do not require complex knowledge or equipment, therefore it is accessible to almost every nation in the world.

If it is well built and receives continuous maintenance, it can be **resistant** even against earthquakes and floods. In Peru, the destruction by an earthquake in 1609 of the masonry vaults of the old Cathedral of Lima generated a technical debate between builders and resulted in the use of new construction systems of greater lightness and flexibility such as vaults made of earth with cane frameworks; the reduction in the height of the walls and the increase of their thickness; the introduction of wooden reinforcements and especially; the requirement to maintain the structures after each earthquake. These recommendations proved to be effective as long as maintenance was carried out (Hurtado, Pedro, 2012). An evaluation conducted by the Catholic University of Peru of the adobe houses reinforced with cane and asphalt, built in 1973 by the government, in the community of Cayaltí, Chiclayo, indicated that after 25 years they had resisted the onslaught of El Niño phenomena without major damage, as long as they had received maintenance (Quiun, Daniel, 2012). Also, the report of the Earthquake Field Investigation Team of the Institute of Structural Engineers of the United

Kingdom, on the results of the earthquake of August 15, 2007 that devastated the central coast of Peru, mentions that the adobe houses that were reinforced by the Catholic University or the Japan International Cooperation Agency (JICA) before the disaster, in the cities of Guadalupe, Zúñiga and Huangáscar, performed satisfactorily during the earthquake, while all other adobe houses in the surrounding area suffered medium to severe damage or collapsed (Taucer, Fabio, 2008).

It is **healthy** since it does not contain toxic elements, does not pollute the environment in any of its stages and its manipulation is not dangerous.

Earth constructions are **comfortable** and contribute to the quality of life of their occupants since they have a great thermal inertia: adobe absorbs heat during the day and releases it slowly during the night. Earth walls have less thermal conductivity than concrete and brick. This feature is especially important in the Andes where temperatures can drop to -22º C. Earth construction also offers sound insulation and helps control humidity by acting as a sponge.

It is a **versatile** material with many construction techniques that range from mudbrick (adobe), rammed earth (tapial), wattle-and-daub (quincha), cob walls, etc. Each region has its own systems and they could be adapted to diverse needs. The basic earthen material can be improved with the use of local natural reinforcement products which are often waste materials, which can get recycled this way.

Furthermore, it is a **flexible** system since it can be built in stages and it can be expanded, reformed and improved during rebuilding.

Fig. 1: *Making adobe in Arica-Parinacota, Chile (Photos: Cristian Heinsen)*

2.2 Opportunities

Since a significant percentage of the world’s population lives in earthen structures and because of its **wide geographical distribution**, any improvement in the material or construction techniques can have a great worldwide impact.

Building with earth offers the opportunity to **express cultural identity** through its design, use of local materials and community maintenance activities. In Burkina Faso, the royal complex of Tiébelé, a group of mud constructions painted with geometric motifs, is maintained through a communal effort where the tradition of mud plaster and surface decoration is transmitted from generation to generation. In the Great Mosque of Djenné, the epicenter of the cultural and religious life of Mali and a UNESCO World Heritage site, wooden beams located throughout the exterior are both decorative and structural and also function as scaffolding for the re-plastering of the mosque during the annual festival called *Crepissage de la Grand Mosquée* or Plastering of the Great Mosque, in which the entire community participates, accompanied by music and singing.

The availability and low cost of earth as a construction material means that it has great potential to **contribute to poverty alleviation** and sustainable development. Hassan Fathy, the visionary Egyptian architect, was convinced of this and wrote the book: “Architecture for the Poor: An Experiment in Rural Egypt” in 1976, in which he describes his plan to build the adobe city of New Gourna, Egypt. New Gourna was built between 1945 and 1948 near Luxor, using mudbricks and traditional Egyptian architectural elements such as enclosed courtyards and vaulted ceilings. Fathy worked with the villagers to adapt their designs to their needs and taught them to work with adobe, supervised the construction of the buildings and encouraged the revival of old crafts such as lattice designs to decorate and ventilate the buildings. Francis Kéré, an architect based in Berlin, grew up in Gando, a rural settlement in Burkina Faso that had no school or medical services. After studying architecture in Europe, Kéré returned to his hometown to build a school together with the community. As a result, Gando revived the ancestral tradition of earth construction techniques and now has schools and homes of good quality and contemporary design, perfectly adapted to the climatic conditions of the region. In Neuquén, Argentina, the lack of housing and the difficulty of accessing mortgage loans forced many to look for construction alternatives that relied on their own labor. Since 2010, the Plottier Agricultural Professional Training Center No. 1 offers a workshop on earthen construction under the premise that by building their house with their own hands, the owners can reduce construction costs by up to 80% compared to a commercially built house (González, Georgina, 2018). In Puno, Peru, the *putucos* or *trulli* of adobe and straw are examples of sustainable architecture, accessible to people of limited resources. In 2014 the Ministry of Culture declared the ancestral knowledge in the construction of putucos as Cultural Heritage of the Nation.

In Mali and Burkina Faso, the Djenné and Kassena communities, by preserving their tradition of maintaining their earth structures, are developing an important **economic resource**, thanks to tourism.

Finally, given the imminent threat of **climate change** and global warming, earth construction offers a better alternative to concrete, which is responsible for 8% of the annual carbon dioxide emissions in the world. Furthermore, earth constructions have better thermal qualities and therefore require less energy to heat or cool.

So then, given all these wonderful properties, how can we explain that raw earth is not considered a “noble” material such as concrete and brick? Because, as with any material, there are some weaknesses…

2.3 Weaknesses

Earth constructions are **sensitive to moisture** and therefore require protection from rain, water penetration by capillarity and salt crystallization; they are **sensitive to wind erosion**; and structurally, **only work well in compression**, require a load distribution since they do not admit point loads, and in seismic areas, require reinforcement, especially at the angles and the connection between walls and foundations. Because of these vulnerabilities, earth is considered a "non-engineered" material (Quiun, Daniel, 2012). Earth construction **requires continuous maintenance**, and deteriorated mud dwellings can offer an ideal **habitat for insects and parasitic vegetation**.

Fig. 2: *Adobe cornice damaged by moisture (Photo: Marcelo Magadán)*

2.4 Threats

2.4.1 Earthquakes

In the city of San Juan in **Argentina**, where 98% of the buildings were built of unreinforced earth, the earthquake of January 1944 destroyed 80% of the city.

In **Chile**, the earthquake of February 2010 damaged a large part of the country's earthen architecture, including 30% of the buildings declared National Monuments (Sánchez, Mauricio, 2012).

In **Guatemala**, in response to the damage suffered by adobe homes due to earthquakes in 2012, 2014 and 2017, adobe ceased to be the main housing construction material in the country, to be replaced by concrete block. Adobe was listed as a construction risk material, associated with poverty (Pastor, Diana, 2018).

In **Peru**, earthquakes throughout the 20th century have caused the collapse of thousands of earthen buildings. However, it is worth mentioning that a UNESCO report of the devastating 2007 earthquake indicate that the earth structures that collapsed were those of poor construction quality, had walls that were too thin or too high, had a high percentage of openings, or had roofs that were too flexible or too heavy. Collapses occurred mainly due to the lack of adhesion between walls and roofs (Giuliani, F., 2008). In the case of the Church of the Company of Jesus in Pisco, the building had been rebuilt in 1704 after its predecessor was destroyed by an earthquake in 1687, based on the recommendations developed after the collapse of the Lima Cathedral, mentioned before. The church resisted the earthquakes of 1746, 1877 and 1942, without being destroyed, but the cumulative effects of these seismic movements required maintenance and restoration interventions which in 1960 introduced the use of cement to reinforce vaults and walls. In addition, the church's surrounding area was paved with cement and asphalt which, together with the plastic paint used as a finish on the walls, contributed to the trapping of moisture within the earthen structure, resulting in the crystallization of salts and the softening of the adobe. The added lack of maintenance and the attack of termites and fungi to the wooden elements, also contributed to the collapse of the church in the 2007 earthquake (Hurtado, Pedro, 2012).

2.4.2 Floods

In 2015, several rainy days and sandstorms, not experienced in 40 years, destroyed 700 adobe homes in a refugee camp in the Sahara, **Algeria**, where water dissolved the adobe blocks, apparently, for not containing straw. In March 2019, floods destroyed thousands of earthen houses in Herat province, **Afghanistan**. In **Peru**, floods are a recurring phenomenon during the rainy season in the mountains. El Niño Southern Oscillation contributes to flooding, which especially affects the country's earthen architecture.

2.4.3 Prejudice

Much of the world's earthen architecture is considered "popular" or "vernacular" because it is of local, native, indigenous, or traditional origin, which gives it a common, folkloric character, a "not being special" that diminishes its value and limits its appreciation. According to Graziano Gasparini, a Venezuelan architect and historian: "traditional popular architecture is fragile and breaks in the face of the emergence of more convenient new solutions. The traditional is valid until new options arise." (Gasparini, Graziano, 2009).

The destruction of earthen architecture through earthquakes and floods usually sparks the questioning of its capacity to resist natural disasters, and many times, authorities with a short-term vision, issue laws such as those promulgated in the wake of the earthquakes in Costa Rica (1910), Argentina (1944), or Peru (2007) by which the material became the scapegoat. In my opinion, because it is easier to blame the material, than to explain the failed public construction policies, uncontrolled development, lack of sanitation, lack of investment, poor building supervision, inadequate planning and disaster prevention, inexperienced builders, lack of maintenance, marketing of the cement industry, corruption, etc.

In a study conducted by the Ricardo Palma U. in communities of Puno, Peru, its residents indicated that as soon as their income increases, they replace the thatched roof in their homes with corrugated metal because it is considered a more durable material, easier to install and a symbol of modernity, although in practice this material only generates heat losses in the coldest hours of the night. Also, despite recognizing that the adobe-built enclosures are warmer than those of stone or metal, these residents indicated that if they had more money, they would replace the adobe with brick, since this is a material used in the city, and therefore associated with a higher economic stratum (Gayoso, Magaly, 2014).

In India, the outcome of a survey conducted by the World Bank between 2016-2018 to understand factors favoring or limiting earthen construction as an alternative to low income housing suggests that "'image' was the key barrier against a wide acceptance of traditional earthen houses which are linked to poverty." (Kulshreshtha, 2020).

Finally, prejudice against earthen construction extends to the banks that do not consider earthen houses as collateral or assets and therefore are reluctant to provide loans based on them (Kulshreshtha, 2020).

2.4.4 Loss of Ancestral Knowledge

In Ladakh, India, Buddhist communities built their earth cities according to established rituals and traditional beliefs based on a deep knowledge of water and underground evacuation channels in case of flash floods. This knowledge resulted from centuries of a unique relationship with their landscape which is manifested in all forms of culture, especially their architecture and the knowledge systems that dictate how, where and when a building should be built. Unfortunately, during the 20th century, this knowledge was lost or ignored, and the new settlements built without respecting the ancestral rituals based on a practical knowledge of local hydrology, or where declining knowledge and skills in building maintenance prevented the implementation of regular maintenance cycles, were terribly affected by the 2010 flash floods. (Sharma, Tara, 2012).

In the Argentine Northwest, the transfer of the knowledge of how to build with earth is part of the daily work of family life, passed along with other tasks particular and typical of the community, that over time generated the identity of the region, and the character of a recognized intangible heritage. This knowledge, unfortunately, is being lost because of the massive insertion of new materials, or the influence of "modernity" or the new cultural patterns brought by outsiders settled in the region.

In Latin America, for the most part, earthen architecture construction is not taught in technical schools or universities, there are not enough norms and regulations written, and it hardly appears in the books of structures or technology (Viñuales, Graciela, personal communication, 2019).

2.4.5 Lack of Maintenance

The lack of preventative conservation is a symptom of the loss of the culture of maintenance in general, but it specially affects earthen construction because of its susceptibility to water and earthquakes. In several examples mentioned before, we saw that many of the collapses caused by seismic movements occurred in structures that had not received proper maintenance. The cumulative effect of earthquakes requires constant maintenance,

Fig. 3: *Poorly maintained adobe (Photo: Kevin Gartner)*

otherwise, it eventually results in partial or total collapse. Earthen constructions can offer a habitat for insects and invasive vegetation but only when they are riddled with cracks and holes. A well-preserved adobe or rammed earth wall can be as much or more sanitary than a concrete or brick wall.

2.4.6 Inappropriate Interventions

Most of the damage in earthen structures is caused by interventions carried out with incompatible criteria and materials, applied with the goal of "reinforcing" or "improving" the material or its design. Many times when an earth structure deteriorates, some builders accustomed to iron, concrete, lime and cement, decide that the solution is to incorporate these types of materials to give it solidity. Thus abandoning the basic concepts of continuity, homogeneity, adhesion - in terms of construction - and of unity, texture and color, in the visual and morphological sense (Viñuales, Graciela, 2009).

A common intervention is the replacement of mud plaster with a cement one, especially in the lower parts of the walls where the wall is most exposed to use. This creates an impermeable layer that traps the moisture rising by capillarity, causes the accelerated

Fig. 4: Cement coating on adobe wall (Photo: Marcelo Magadán)

Fig. 5: Inappropriate opening (Photo: Norma Barbacci)

deterioration of the mud wall and eventually, when the cement coat falls due to lack of adhesion, it drags with it, parts of the original wall. The introduction of openings and additions of incompatible materials such as concrete blocks or reinforced concrete can cause detachment and separation, or “hammering” during earthquakes, and contribute to the loss of the structural unit of the construction.

Deterioration due to lack of maintenance or failures caused by inappropriate interventions contribute to a poor perception of the material. This creates a vicious cycle that results in the replacement of a viable, economical and locally accessible construction material with other materials that not only require a greater investment, but because of their industrial production and need for transportation leave a greater carbon footprint. In contrast, seismic reinforcement, installation of adequate drainage infrastructure, use of appropriate restoration designs and techniques and continuous maintenance, are key to the sustainability of earthen constructions, especially in seismic or flood-threatened areas.

3. Legislation

Legislation may be a threat or an opportunity for the preservation of earth building systems, depending on the intention and scope of the regulations. However, although there have been significant advances in recent decades, earthen architecture is neglected in many local and regional development plans.

In **Argentina**, although adobe is still used as a construction material, it is illegal in several regions, especially in seismic areas. However, environmentalists, architects and civil engineers started in recent years to research alternative construction techniques with low environmental impact, using earth, straw, cane and waste materials. This work resulted in the establishment of public ordinances that enable, regulate and promote these types of constructions in several cities. (Gioberchio, Graciela, 2016).

In **Chile**, in 2003, when the Altiplano Foundation started to restore historic churches in Arica and Parinacota, they were told by the Academy and the Government to conserve the shape of the buildings while replacing its original earth with another "noble" or modern material that complied with the strict norms of construction safety (Heinsen, Cristian, personal communication, July, 2019). Years later, and in response to the massive damage caused by the 2010 earthquake, the Chilean Government developed in collaboration with Peruvian experts, a new Technical Standard (Minvu NTM 002) to regulate the restoration and structural consolidation of earth constructions in Chile, but new construction with this material is not yet legalized.

In **Costa Rica**, following the earthquake of 1910 that devastated the city of Cartago, the government launched a Presidential Decree to prohibit the construction of adobe in the city, and by not including regulations on how to restore or reinforce this type of construction, many were demolished (Hernández, Ileana, 2014).

In **Peru**, a country that has pioneered the development of earthquake-resistant design standards, the Technical Standard E-080 issued in 1985 and revised in 2006 and 2017, regulates reinforced adobe constructions. The law's objectives are to regulate the design of buildings of social interest and low cost that can resist seismic actions. This Peruvian standard has served as the direct or indirect basis for other technical regulations in the world such as in India and Nepal (Blondet, Marcial, 2005).

4. Preservation of Earthen Architecture

Natural processes dictate that perishable construction materials such as earth, wood and paint, be consumed by the sun, rain, bacteria, insects or are violently decimated by earthquakes, hurricanes or torrential rains. In other words, conservation goes against the dynamics of nature itself (Rodríguez R., Fernando, 2003). To these natural threats we must add those anthropogenic such as wars, development pressure, architectural fashions and, unfortunately, corruption and ignorance.

Construction methods now considered traditional, such as earthen architecture, were the result of decades or centuries of trial and error processes through which the combinations of materials and constructive details that proved to be the best and most appropriate to local needs survived. Architecture converted into heritage remains architecture and therefore its construction logic remains an important factor in its preservation. The processes of architectural creation continue during the useful life of the structure, as well as changes in the needs and tastes of users, the availability of new materials or the disappearance of others, some historical challenges worsen, or new threats need to be addressed. Built heritage is a living and changing subject whose preservation is not governed by the same rules as movable or museum heritage.

A basic principle of conservation in any constructive typology is to use materials and technology compatible with those that it was built of, and this principle is even more important in the case of earthen architecture.

Incompatible interventions such as concrete or brick additions often produce negative results such as in the city of Bam, Iran, razed by the 2003 earthquake, or in the Pisco Cathedral, destroyed by the 2007 earthquake, or in the Gingerbread Houses of Haiti, affected by the 2010 earthquake. Furthermore, constant maintenance is key in long-term conservation, especially in earthen constructions.

The Great Mosque of Djenné in Mali and the Royal Court of Tiébelé in Burkina Faso are important examples of participatory maintenance. However, the spirit of this shared or communal work dedicated to the conservation of monuments that are of great importance to the community, should also be applied to the maintenance of houses, deposits or fences built of earth. It is this vernacular, self-constructed, common and utilitarian architecture, which is an integral part of many cultural landscapes, that is most threatened and in danger of disappearing. Its current “preservation by neglect” cannot be sustained for much longer.

Fig. 6: *Reinforcing adobe in Arica-Parinacota, Chile (Photo: Cristian Heinsen)*

5. Conclusions

What can be done to preserve and promote earthen construction in areas where this type of construction is most appropriate for geographical, climatic or economic reasons?

Should we promote structural and seismic reinforcement techniques such as compressed stabilized earth blocks (CSEBs), the use of geotextiles or nylon ropes, galvanized steel trusses or tensors, or stabilization with lime or polymer fibers?; or promote new and more efficient earth construction techniques such as prefabricated quincha?; or build houses of adobe reinforced with sea weed?; or build structures of earth contained in bags?

In any case, low cost, availability and durability of the proposed reinforcement materials should be prioritized in their selection, as well as the avoidance of “greenwashing” which some contemporary earthen architecture projects tend to do as in the Musée Régional de la Narbonne Antique in France which uses rammed earth with slightly less cement than concrete.

Many contemporary earthen architecture projects, consisting of either new construction or seismic reinforcement, are generally led by international development agencies, governments or academic researchers which in many cases fail to create sustainable local capacity. Undoubtedly, more research is needed but also more participatory processes, long-term national policies and effective knowledge transfer programs.

Since earthen constructions require constant renovation and maintenance, and its preservation is not just about conserving the physical object but mainly about the preservation of its construction and maintenance techniques, this local socio-cultural knowledge system becomes an intangible heritage asset that requires valorization, documentation and promotion.

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18 November 2020

Stained Glass – Materials and Conservation

STEVE CLARE MBE, FMGP, ACR is stained glass conservator by Royal Appointment to Her Majesty the Queen, and National Adviser on stained glass to the National Trust. He trained at The Glasshouse in Fulham, with Carl Edwards, later his mentor was Alfred Fisher at Chapel Studio.
In 1995 he founded Holy Well Glass in Wells. It is the largest studio in the UK, entrusted with works at many great churches, cathedrals and historic houses. The workshop moved to magnificent premises in a medieval watermill in 2018. Recently Holy Well Glass has carried out major projects at the cathedrals in Wells, Winchester, Exeter, Worcester, and St. Patrick's cathedral in Dublin.
As well as conservation work, Holy Well also makes original commissions and recently completed bespoke glass doors for the private chapel of Her Majesty the Queen at Windsor. Steve's young design team has won first prize twice in the last three years, and prizes for exceptional craftsmanship in the Stevens Competition hosted by the Worshipful Company of Glaziers.
Steve is also the author of *Stained Glass: Art, Craft and Conservation* published by Robert Hale 2014.

Introduction

The conservation of stained glass is a discipline that demands a wide range of skill sets. These encompass art historical knowledge to understand the periods, artists, and stylistic themes of various periods, as well as a knowledge of how windows fit into buildings: the stonework, mortars and essential iron support structures.

Also essential is the knowledge of when to look to other conservation disciplines for support, as well as calling on the knowledge of art historians and conservation scientists when problems and solutions fall outside the expertise of the glass conservator. It also involves working within standards and guidelines, both practical and ethical, such as those espoused in the UK by Icon, The Institute for Conservation.

In project documentation, the stained glass conservator must be able to formulate conservation policy for a window, or windows, and to convey that approach with clarity. This will involve examining all of the aspects of the structure of the window- for example the lead work, glass, glass painting, mortar, and support structures. This should be set out in the condition survey and conservation proposal document. At the end of the project, the conservation record must faithfully record interventions, in a manner which is accessible to layman and specialist alike.

Figure 1 shows a view of the modern conservation studio. They are broadly similar to any traditional workshop, with work benches, and libraries of glass. Any 19th century stained glass artist would recognise the set-up, tools and materials, and smells of the workshop. Where strides forward have been made is the availability of light boxes, on which to work, and to glass paint, the development of high speed kilns to fire painted detail on to the glass, and in the conservation studio, the provision of binocular microscopes to monitor work. Modern repair methods, as we shall see later, allow ever more subtle, and sympathetic repairs to be made.

The stained glass conservation workshop, like any other, must follow modern Health & Safety regulations and guidelines, including staff training regimes, and be able to demonstrate that to clients.

Breadth of Work

Over the years, Holy Well Glass has undertaken remarkable breadth of work to underline the stylistic differences from differing periods. Figure 2 shows a remarkable 16th century panel

Fig. 1: *Stained glass conservation studio*

from Sam Fogg gallery, demonstrating the touching in of resin repairs with artist’s acrylic paint on the light box. Every white line denotes a resin repair, where disfiguring repair leads have been removed, returning the panel to near the artistic intent of the original artist. Figure 3 shows a repair to a magnificent panel by one of the greatest medieval craftsmen Thomas of Oxford from Winchester College.

Moving on to the 18th century, when traditional stained glass technique had been lost, and transparent ‘paintings on glass’ came to the fore, the extraordinary layered technique of Francis Eginton of Birmingham is illustrated in figure 4. Eginton, who was an associate of Matthew Boulton at the celebrated Soho manufactory, developed the technique of sandwiching together, two, sometimes three pieces of paper thin crown glass with stippled transparent enamel on all faces of the glass, giving this extraordinary three – dimensional result.

Fig. 2: *Touching in of resin repairs with artist’s acrylic paint on the light box*

Fig. 3: *Repairs in a to panel by Thomas of Oxford from Winchester College*

Fig. 4: *Layered technique of Francis Eginton of Birmingham*

Not all glass is in windows, the fascinating clock in figure 5 belongs to Selfridges department store, which has two huge curved sections of glass containing literally millions of tiny glass beads forming orange 'flames'. When backlit, the effect is marvellous. Here, a scaffolder had unfortunately hit the front face and cracked the glass, and in-situ resin bonding is being undertaken to stabilise the structure.

Fig. 5: *Repair work being undertaken on a clock belonging to Selfridges department store*

Fig. 6: *Crown glass being spun by glass blower*

Common Glass types and cutting

The two main glass types used since at least the 14th century, crown glass, and cylinder or muff glass have been used in conjunction for centuries. Crown glass became hugely popular as the demand for large panes for painted windows and sash windows developed.

The crown glass method, illustrated in figure 6 commences with the glass blower producing a large flute of glass. This is then reheated, and rapidly spun by the glass blower. Centrifugal action results in a large disc or crown of glass, which is then annealed and cut into panes. The early 20th century crown in figure 6 is splendid enough, but it is remarkable that we know that in the heyday of crown glass production in England, discs six feet across were routinely blown, resulting in a brilliant material, often less than 1mm in thickness.

The cylinder process detailed in figure 7, commences with a large gather of glass being blown into a long cylinder – the elongation of which is aided by swinging the semi – molten glass over a pit. The end of the cylinder is then opened up by an assistant with an iron tool, and finally the end where the punty, or blowing iron is attached is scored, and broken off. The cylinder is then cooled. A diamond is used to make a single cut along the length of the cylinder, which is tapped to crack the glass. The prepared cylinders in figure 10 show the cracked edge, and the fact that tension in the cylinder has caused the crack to part slightly. The cylinders are then re-heated and rather dramatically teased open with an iron tool in the onto the floor of the furnace, and ironed flat with a block of fruit wood, kept in a water butt near to the furnace. The sheets are then slowly cooled in an annealing lehr, which moves on a conveyor belt system, which takes

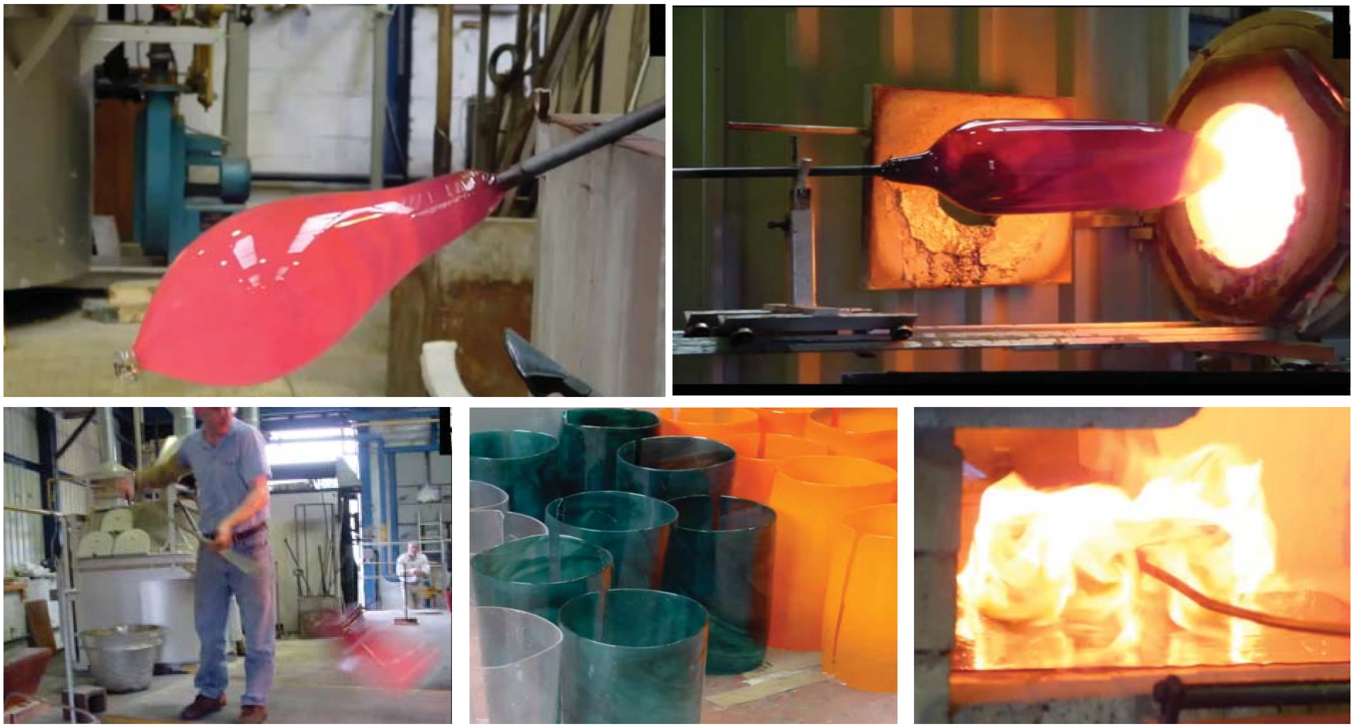

***Fig. 7:** Cylinder glass process*

stresses out of the glass, allowing it to be cut cleanly with a tungsten tipped wheel by the stained glass artist. The two disciplines of glass maker, and stained glass artist have always been distinct trades.

It should be noted that in the earliest form of cylinder glass, the sheets were cut open and flattened whilst still semi-molten. This smaller scale and more rustic glass is called ‘broad glass’.

During the Arts & Crafts period, a beautiful glass called ‘Norman Slab’ was developed, with the glass being blown into a rectangular mould. The resulting small panes had great intensity of colour, and were beloved of the principal artists of the period, Christopher and Veronica Whall, and Carl Parsons. The process, and examples are shown in figure 8.

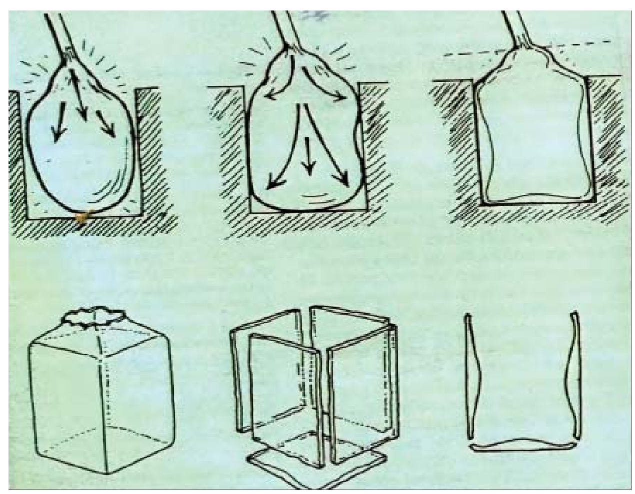

***Fig. 8:** Norman glass slabs*

Regarding the colour of glass, this is imparted in the crucible where the constituent parts of the glass are smelted. It is achieved by introducing metallic oxides such as manganese for pink, gold for pink and ruby, cobalt for blue etc. The colour is added ‘in the pot’ – hence the common term ‘pot metal glass’ (figure 9). Glass can also be gathered and blown in layers – termed ‘flash glass’. For example, many ruby and blue glasses are flashed with white glass, because the colour is so intense, it would be difficult to see through.

In the medieval period, glass was cut by

Fig. 9: Pot metal glass

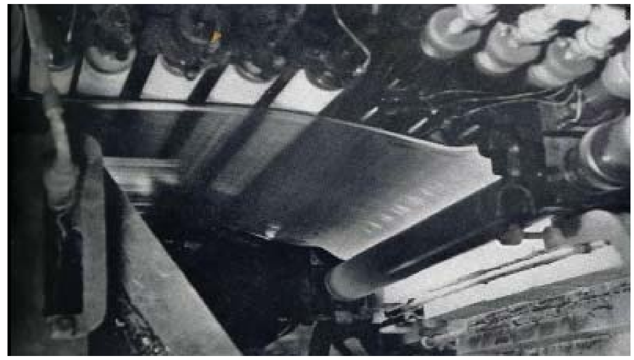

Fig. 11: Texture glass produced by rolling method

using a red hot iron to score the surface and water (The glaziers simply spat on the surface) used to use thermal shock to break the glass. The final forming was done with notched iron tools called 'grozing irons', which were used to nibble the glass to shape. A characteristic nibbled bevelled edge results, which can be used to identify ancient glass. Today, an oil fed tungsten tipped wheel is used to accurately cut the glass.

Of course eventually the processes were modernised and mechanised. Figure 10 shows the 'improved cylinder method' where huge sheets were formed by drawing out large cylinders of glass on a hoop, from the vat of molten glass, held in suspension by injecting compressed air at the top. A massive scaling up of the traditional cylinder method. The ubiquitous textured glasses produced from the late 19th century, and still in large scale production are made by a continuous rolling system, where glass is textured by water cooled rollers – shown in figure 11.

Fig. 10: The 'improved cylinder method', the large scale mechanization of the cylinder glass process

The Lead Work

Traditionally H-section lead has been used to form the structure of windows. The intersections of the lead are soldered with lead/tin solder to fix the sections together. Tallow is applied to prevent the area to be soldered from oxidising, and to allow the solder to flow. A soldering iron with a tinned copper tip is used to make the joint.

Originally the leads were cast into wooden, then iron moulds, then in the 16th century, milled were developed to extrude the leads to the sections required. Figure 12 shows an 18th century lead, with the maker's mark and date embossed from the wheels of the mill. Needless to say, historic lead, especially very rare cast medieval leads, should be carefully identified and conserved.

Figure 13 shows the leading process. Rubbings are taken from the original lead

Fig. 12: *Maker’s mark and date on the lead*

Fig. 13: *Leading process*

work, and used as a guide to allow dismantled panels to be re-constructed. Careful rubbings not only show the relative positions of the glass, but give important information about the flow and length of particular leads – very important in historic figurative glazing.

The leads are accurately cut with a very sharp flat knife – accurate joints are critical. When joints are slack, solder can run down and pool around the glass, holding it in a vice-like grip. Wind flex and expansion contraction mean that breakage of glass is far more likely over time.

Support systems and ties

Stained glass windows will not self-support. Iron bars have always been set into the stone work to support windows, and frequent strips of lead originally, then copper, the material favoured today for its greater

Fig. 14: *Support system*

strength, are soldered to the stained glass panels and twisted around the support bars. Lead ties are often tied in attractive rosettes. Simple tie bars are set into pockets in the stonework, more complex interwoven ‘ferramenta’ are common. In the remarkable original support system, dating from around 1307 shown in figure 14, the system is typified. Panels sit on the projecting lugs, and are secured by wrought iron wedges. This fixing system was ubiquitous in England (and across Europe – where it is still commonly used) until the 19th century, when English glaziers moved to stacking panels one atop another, with overlapping division leads – a retrospective step if ever there was one.

Applied Surface Decoration

The lovely image in figure 15 from the Vyne Chapel, National Trust has all of the traditional applied surface decoration techniques. The features are painted with glass paint or grisaille – a mixture of ground glass and iron or copper oxide, carried in a water or oil based medium, and fired onto the surface in a kiln at around 670 degrees. This technique has been in continual use since at least the 10th century. Silver stain was introduced in the early 14th century. Nitrate of silver, suspended in a clay carrier and thinned with water, is painted, usually on to the back of the glass, and fired in the

Fig. 15: *Stained glass from Vyne Chapel (National Trust) with traditional surface decorations*

kiln at about 550-600 degrees. The glass is stained yellow, although glass type and kiln manipulation can be skilfully used to achieve a range of colours from pale lemon yellow through to deep red.

Finally, transparent enamel was developed in the 16th century, it can be seen on the lips, and eyes of the figure. This is a paste of ground coloured glass and flux, which fires on to the surface at about 500 degrees. It produces a thin transparent layer, which is far less well fixed to the glass surface than the other two techniques, and can become detached, leaving a familiar disturbed 'crizzled'

Fig. 16: *Brushes and art material for staining*

Fig. 17: *16th century enamelled window by Joshua Price*

surface. Figure 17 shows an enamelled window by Joshua Price from the 16th century, where almost all of the coloured detail is applied with enamels on white crown glass.

Repair techniques

Epoxy resins with a very similar refractive Index to glass can be used to bond glass, avoiding the need for intrusive repair leads. The resins must be accurately measured by weight. Figures 18 and 19 show examples of repairs using this technique.

Figure 20 and 21 show the Tiffany, or copper foil technique, which can be used to good effect to produce very thin repair leads. An adhesive backed copper foil is applied to either side of the crack, and soldered with a small soldering iron. The technique is vet subtle, and very easily reversible.

Example projects

Figure 22 shows the superb Jesse Tree window circa 1380 from Wells cathedral. Note the superb glass painting and unusual palette with sparing use of blue and ruby. The window was conserved in an ultra-conservative manner, the only intervention being the part

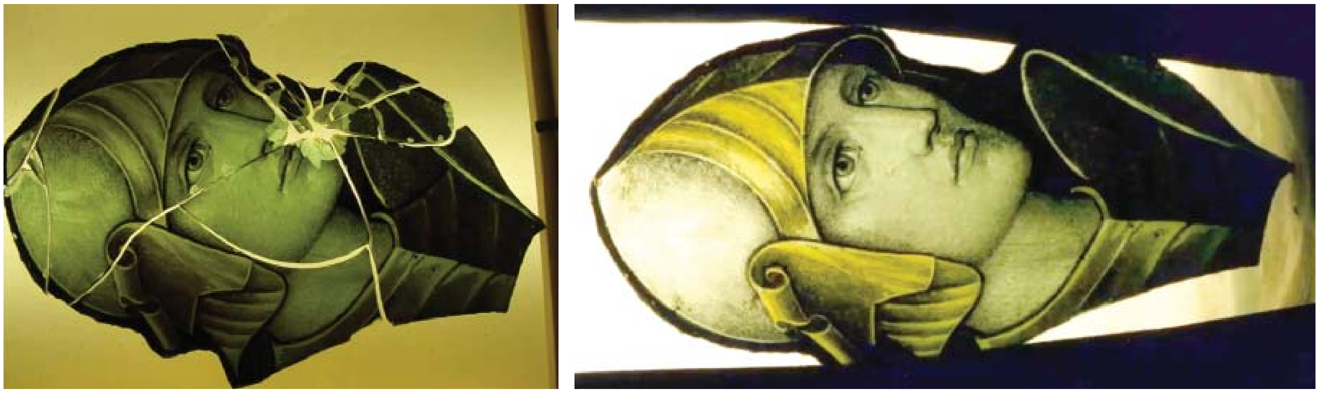

Fig. 18: *Before and after images of repair work done using epoxy resin*

Fig. 19: *Before and after images of repair work done using epoxy resin*

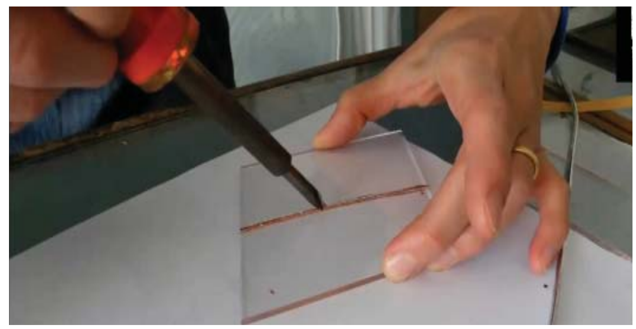

Fig. 20: *Copper foil technique*

Fig. 21: *Joining of pieces using the copper foil technique*

Fig. 22: *Jesse Tree window from Wells cathedral*

Fig. 23: *Repair work on the head of Christ*

replacement of the head of Christ from the great Crucifixion panel (figure 23).

Another interesting project was the conservation, including re-leading of the 19th century Great East Window at Worcester cathedral by Hardman (figure 24). Of particular interest is the usage of painted 1mm thick painted plates to support the images in critical areas where painted detail has been lost through under-firing (figure 25) and re-leading of these huge windows (figure 26).

Site Fixing

Stained glass panels fit into grooves in the stonework (figure 27). It is imperative that accurate templates are taken to ensure accurate fit. Lime mortar should always be employed. Figure 28 shows the mortar being roughly applied, compressed and attended by water spraying, and finally scraped back to raise the surface of the aggregate and ensure curing of the lime.

Environmental Protective Glazing

Environmental Protective glazing is a proven method of protecting ancient or vulnerable glass from damaging cycles of condensation by installing a new external glazed layer. The interspace is vented to the inside of the building.

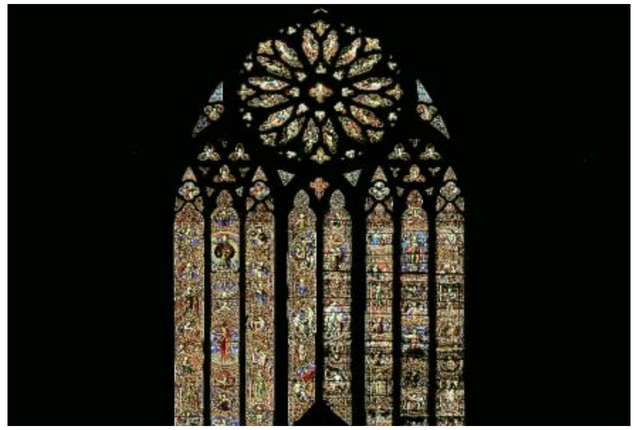

Fig. 24: *Great East Window at Worcester cathedral*

Fig. 25: *Painted details lost in a panel hence new painted plates were created and inserted so that the losses are now covered*

Fig. 26: *Re-leading of the Great East Window panel*

Fig. 27: *Stained glass panels being inserted into the groove in the stonework*

Fig. 28: *Application of lime mortar for fixing panels in stonework*

Figure 29 shows the EPG system applied at Wells cathedral, with hinged bronze opening frames corresponding to the panels of medieval glass. Note the additional shaped vertical bronze bars inserted as extra support as the decision was taken not to re-lead the stained glass.

3D scans were used to produce accurately cut bronze frames for the tracery sections. Figure 30 shows the same system refined for medieval glass at Exeter cathedral, meaning that the external glazing is completely invisible from ground level. Images Figure 31 show partial EPG system, used to avoid architecturally intrusive treatment of entire windows. Holy Well Glass is involved in the

Fig. 29: *EPG system*

Fig. 30: *EPG system where 3D scans were taken to cut bronze frames for external glazing*

Fig. 31: *Partial EPG system*

technical evaluation of partial EPG, and the application of EPG to tracery sections, in an important collaboration with Tobit Curteis Associates, a study sponsored by Heritage England at Exeter cathedral.

Collaboration

The major conservation scheme to the Clerestory windows at Winchester cathedral was a successful collaborative project . It was noted that window SII had suffered extensive paint loss when compared to other windows (figure 32). Research with the cathedral archaeologist confirmed that the window had been overpainted in the 19th century to subdue light falling on to a Benjamin West painting to the Great Screen below. Conservation scientists confirmed the applied layer was lime wash, but were not certain as to the cause of the paint loss.

It was here that cross- referencing with another project at Gloucester cathedral became critical. Shown in figure 33, local damage to tie bars were being discussed. An important document in the archive at Gloucester detailed

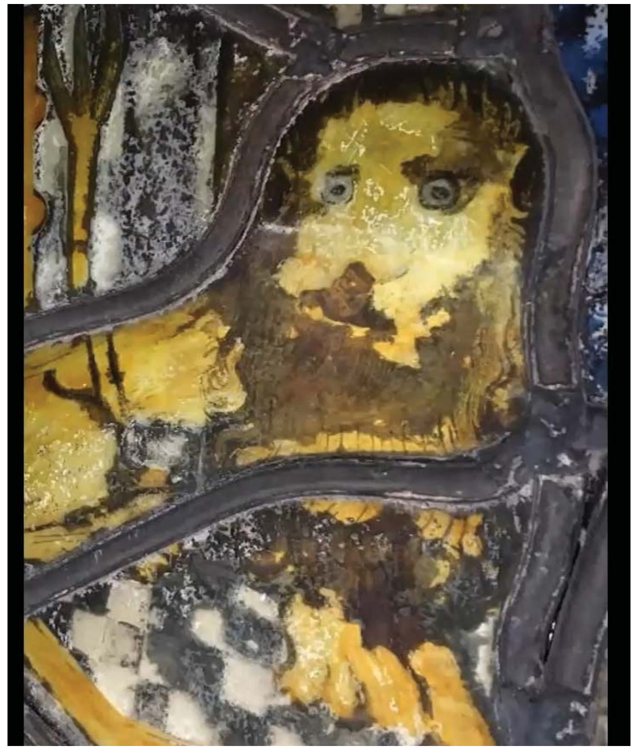

Fig. 32: *Extensive paint loss in the window*

Fig. 33: *Highly damaged tie bar*

a 19th century survey by the cathedral architect, which highlighted the installation of large coke burning Gurney stoves in many cathedrals and great houses in England. It was evident that these stoves had been installed at Winchester, and were in operation well into the 20th century. Research into the fuel, and the huge ammounts burned at Winchester, allowed conservation scientists to accurately model the alteration of the surface layer to window SII, and the cause of the paint loss.

Documentation

It is extremely important to document and ensure that any work done to the windows is accurately recorded. The conservation of important early 16th century glass of the presbytery at Winchester cathedral highlights the importance of accurate documentation. The system for recording the interventions digitally, using conservation diagrams applied to diagrams of the masonry for context is demonstrated in figures 34 and 35. Individual images can then be zoomed in on, and interrogated.

For major projects, the ideal paper records are also produced as for Winchester cathedral, using archival quality materials and bindings (figure 36).

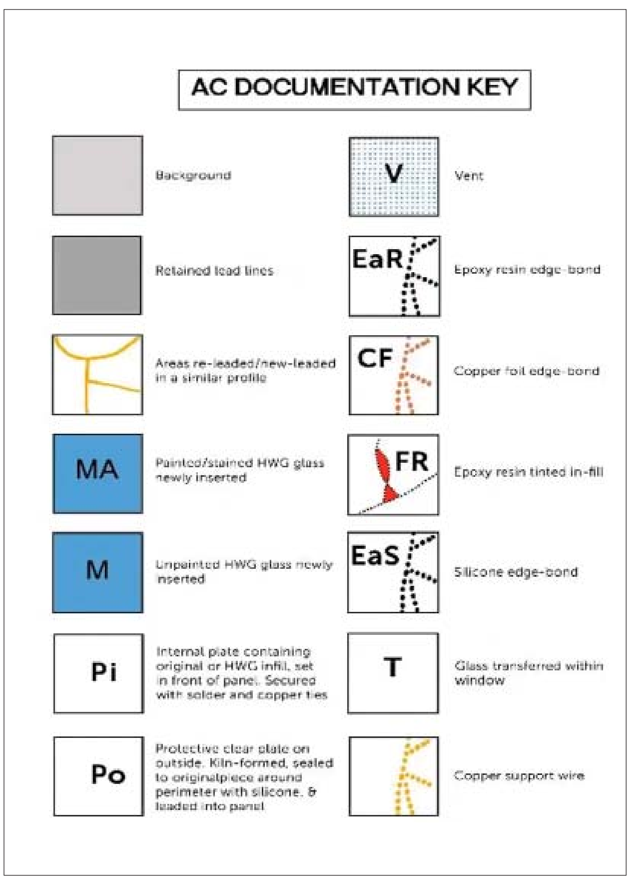

Fig 34: Abbreviations of different interventions

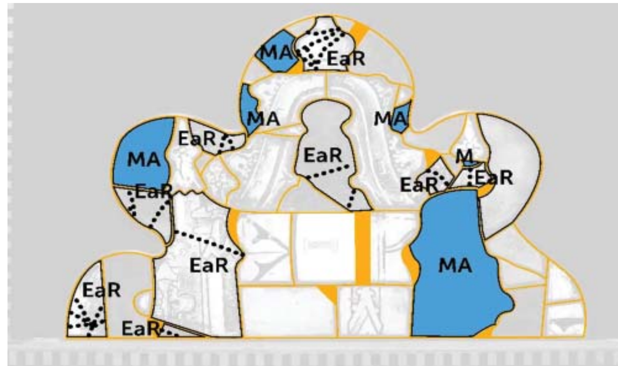

Fig. 35: Conservation diagram applied on the masonry diagram digitally

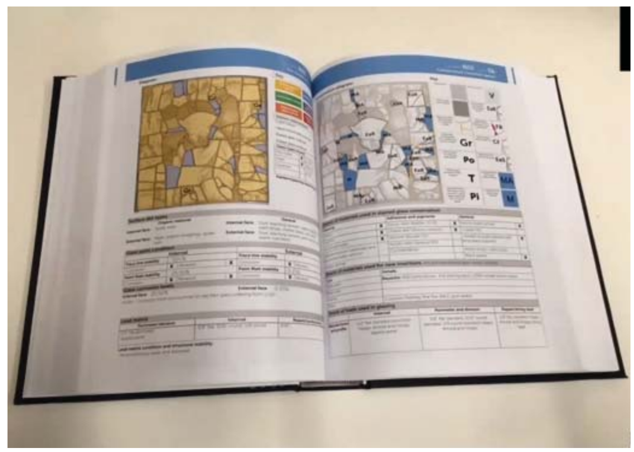

Fig. 36: Documentation records

Conclusion

This overview of the fascinating work involved in the conservation of historic glass, gives an insight into the working life of the stained glass conservator. The discipline demands an understanding of the glass as work of art, and at the same time, as an essential part of the building envelope – it is unique in this respect.

The stained glass conservator is fortunate indeed; the work is varied, each project posing new challenges, and each new building and its history providing new interest and fascination. Given this, it is essential that the craft skills underpinning the work are kept alive to safeguard our magnificent heritage in stained glass for future generations.

20 November 2020

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The Preservation of Photograph Albums: Making Cross-Disciplinary Decisions to Maximize Care

GEORGIA SOUTHWORTH is a rare book conservator who works both privately and on staff at The Metropolitan Museum of Art, as an Associate Conservator for books in the Photograph Conservation Department. She received her book and paper conservation training at Camberwell College of Arts, University of the Arts London, and has been working with The Met since 2005. Fascinated by the countless structures that allow books to function, her focus in the Photograph Conservation Department is on the preservation, research, and treatment of bound volumes, cased objects, and photograph albums. As a private conservator, she has worked on numerous grants, surveys, and projects with New York based cultural institutions, including The New York Botanical Garden, The New York Academy of Medicine, Columbia University, The Morgan Library & Museum, and the Yale Center for British Art.

Photographs are held throughout museum, library, and archive collections in numerous formats, from early cased objects, to loose photographic prints, to matted artworks, to those in bound volumes. The first photographs on paper were introduced to the world in 1839, and almost immediately were being mounted into books. Photograph albums have distinct preservation needs and their care must be approached cross-disciplinarily. Due to their hybrid nature photograph albums and photographically illustrated books must often be addressed by both a photograph conservator and a book conservator, always with the goal of minimal treatment intervention. Caring for bound photographic collections requires a holistic preservation approach that balances research, communication, and sometimes conservation treatment.

Fig. 1: Angel, Owen, [Follett Family Album of Children Costumed for a Fancy Dress Ball], ca. 1880. Cabinet card photograph album, 28.6 x 22.9 x 4.4 cm. The Metropolitan Museum of Art, Purchase, Joseph M. Cohen, William Talbott Hillman Foundation, Robert and Joyce Menschel Family Foundation, Robert D. and Virginia R. Joffe, Paula and Ira M. Resnick, and Maureen and Noel Testa Gifts, 2007 (2007.284)

Cultural institutions may employ a book conservator and/or a photograph conservator, though these professionals rarely work in the same conservation lab; a great many smaller institutions and libraries employ neither. Within museum collections, photographic holdings and their care regularly focus on spectacular highlights, and within rare book collections volumes of much greater age and value may dominate the preservation priorities. Yet, in recent decades there has been a rise in the curatorial and art historical interest in photograph albums, helping to flesh out our collective understanding of the private and more intimate settings in our shared cultural pasts. As more attention is paid to photograph albums, the preservation needs of these complicated objects are coming into further focus, as well.

The Metropolitan Museum of Art is privileged to host a book conservator within the Photograph Conservation Department (DPhC) which allows for these cross-disciplinary conversations and treatments. Georgia Southworth has been on staff part-time since 2007 conserving photograph albums, photographically illustrated books, and the bindings of cased objects. With the access and experience this position provides, the goal is to begin to share insights and resources that will build upon the dialogue between the book and photograph conservation communities. Here, a short discussion of the hybrid nature of albums and their more common structures and preservation concerns will be followed by conservation treatment considerations, preservation parameters specific to these artworks, and a brief review of handling, storage, and material resources to help conservators and non-conservation caretakers ensure that these delicate objects, which are held across all manner of institutions, receive the preservation care they need.

Although albums and photographically illustrated books combine the preservation concerns of both volumes and photographs, the characteristics of these two distinct artforms may encroach upon and even exacerbate one another. The challenges introduced by albums are not unfamiliar to book, paper, and photograph conservators, but as noted, the overlap of these practitioners does not always occur within a single conservation lab or even institution, which can leave the responsible preservation care of these hybrid objects either to a single practitioner, a non-conservator caretaker, or to a contract conservator hired to address them. Both disciplines require focused training, so although working with photograph-based collections at The Met has taught Southworth a great deal about their history and preservation, she was not trained formally as a photograph conservator, and works very much in collaboration with colleagues in the DPhC to determine an object's individual needs. Finding collaborative ways to approach these concerns is not new. In 1999 the American Institute for Conservation (AIC) held a joint Book and Paper Group and Photograph Materials Group session at the Annual AIC Conference to address the preservation of albums and scrapbooks. The postprints from that conference include a number of very valuable articles about album structures, survey approaches, and the ways their preservation concerns differ from traditionally bound volumes.

The bookbinding structures used for albums often differ significantly from those used in traditionally bound books. As in library or rare book collections, surveying and researching bindings and recreating photograph album styles helps build the knowledge necessary to inform proper care. All codex format volumes rely on numerous areas of movement to allow these objects to function. Understandably, at the time of manufacture the structure and the materials employed in a book's construction function as one and the volume opens well. The movement of inner and outer joints, the paper, and the sewing (or other spine structure) allow access to the contents. Critical, of course, is the continued mechanical endurance of these materials. Yet over time leather, adhesives, threads, and paper may inherently deteriorate on their own and suffer from external conditions – each component at a different rate. These structural breakdowns inhibit the function of the object, sometimes completely. Photographs, although historically created with very high-quality materials and developed on strong paper supports, may remain sensitive to light and to the chemistry of their immediate environments. As well, their surfaces are easily marked and must remain protected from any direct handling. In comparing the handling concerns of these two art disciplines, their needs can seem in direct contrast with each other: the volume only functions well while its movement is uncompromised, with the pages manipulated by hand; the photograph is healthiest when kept still and stable, untouched. Likewise, the book conservator must keep the bound object moving, while the photograph conservator must keep the photographic object still. The *photograph album*, of course, combines these two complicated artforms into one. Proper preservation care can be built on understanding the mechanics and the materials of this subset of bound volumes, including how the development of album structures followed the growth of the photographic industry, from the first photographs in 1839 up through the present.

Employed to house some combination of images, manuscript notations and printed text, albums serve as protective enclosures, as mechanisms to keep photographs flat, as carrying cases and display devices. Examined decades after their manufacture, some albums' bindings prove to have been a benefit to the photographs mounted in their pages, and also at times a detriment. Along with an understanding of the quality of the materials used at manufacture and that which is being asked of them in the function of the artwork, it is essential to be mindful of the method of attachment of the photographs. Each image is held in its location in a particular way; adhered overall, dabbed at the corners, hinged in with Japanese paper, slid into a pre-prepared recess in the leaf, edge-mounted, corners tucked through one or two slits in the support, held by paper or plastic photo corners, tipped in with a line of adhesive, guarded into place, even just intentionally loose, inserted into the textblock. Some newer album structures were sold with lines of adhesive and liftable plastic overlays, transparent plastic sleeves, or photo corners ready to receive snapshots. All of these methods of attachment may fail or inadvertently cause harm to the photographs or supports, and the handling or treatment of the object must be undertaken with the attachment method in mind.

The industrialization of production methods across all sectors during the 19th century changed the way businesses produced goods, and the shift toward mechanizing paper manufacture in particular revolutionized print and publication runs, from newspapers to novels to art. As demand for all printed matter increased, wood pulp was sourced as the main ingredient in paper slurries, replacing the less available linen, cotton and flax, and bleaching was introduced to brighten papers, offsetting the darker tone of wood pulp-based products. Photograph album structures across the 19th and 20th centuries were designed by innovative bookbinders to accommodate the various and changing processes that were being developed by photographers. Despite the creative solutions devised to pair the photograph with the book, industrially produced binding materials resulted in the reduced long-term quality of many products, including the adhesives, cloths, threads and leathers used in production bookbinding, as well as the papers used in the textblocks. Produced in great quantities as the photographic industry expanded, these albums often suffer the breakdown of the materials into which were mounted the high-quality photographs, leading to countless ethical considerations and structural decision-making on the part of the conservation team that is responsible for the artworks today.

Bookbinders accommodated the addition of the photographs into the pages of traditionally sewn books in various ways and altered the structures to account for the thickness of the new contents in manners similar to those employed to bind volumes with intaglio or woodblock prints. Initially, leaves were removed (fig. 2), folios were back-hooked and sections were sewn with compensation stubs, these stubs approximating the thickness of anticipated additional materials.

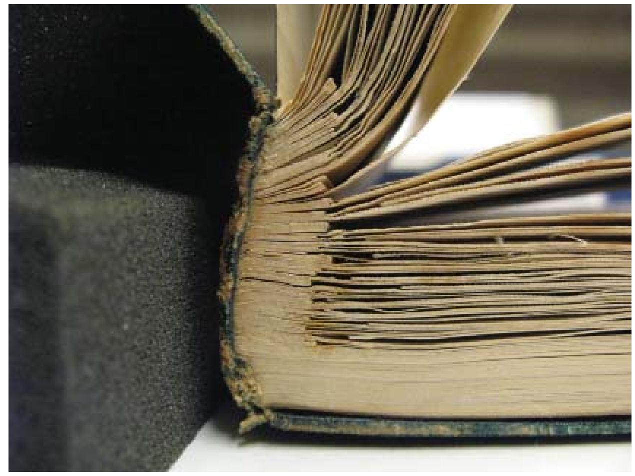

Fig. 2: *Traditionally sewn album with leaves removed to accommodate addition of photographs to textblock. Author's study collection object*

Photographers continually advanced their work and by the mid-to late-1850s the albumen silver print was the most widely used photographic process. Printed on very thin paper, these photographs tended to curl dramatically if left unrestrained, and in an effort to counter this effect they were mounted onto secondary supports, either into the leaves of an album or with growing popularity, onto individual rigid cardboard supports, as with the *carte de visite* (100mm x 64mm), and later the larger *cabinet card* (165mm x 108mm). Cartes de visite and cabinet cards were included in albums by being inserted into board-weight rigid leaves, rather than being pasted into the pages of a traditionally or side-sewn album. The following objects from The Met's collections example a few of the more common album structures and provide evidence of the manner in which their hybrid natures can exacerbate preservation challenges.

Emma Charlotte Dillwyn Llewelyn's Album (figs. 3 and 4) was produced between 1853 and 1856. The album is half-bound in red leather with marbled paper sides, and the textblock consists of sections of wove paper, sewn through the folds, with potentially light sensitive photographs mounted throughout on

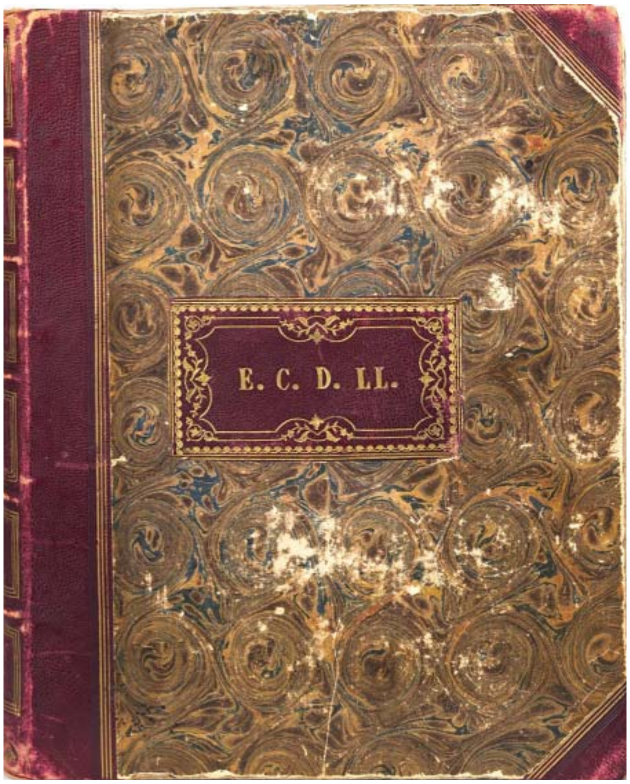

Fig. 3: Llewelyn, John Dillwyn, [Emma Charlotte Dillwyn Llewelyn's Album], 1853-1856. Album with salted paper and albumen silver prints. 28.8 × 22.3 x 3 cm. The Metropolitan Museum of Art, Gilman Collection, Gift of The Howard Gilman Foundation, 2005 (2005.100.382 (1-85)

Fig. 4: Llewelyn, John Dillwyn, [Emma Charlotte Dillwyn Llewelyn's Album], 1853-1856. Image of "Theresa", edge discoloration from attachment adhesive around the edges of the print

the rectos of the page openings. It contains 128 salted paper prints and albumen silver prints made from both paper and glass negatives, and the majority of the very thin photographs are attached to the album pages with adhesive along just their four edges, leaving the central portions of the photographs loose. A number of the photographs lack the tips of their corners which appear to have been snipped away prior to the images being added into the volume, but there is little information about the photographs' lives prior to being mounted in the album. As well, some of the images have faded where the adhesive applied to the verso has affected the image material, warranting further study. The opening action of this bound album, with its sections sewn through the folds and its flexible leaves, is typical for the style of binding, and its continued success relies upon the sewing, the linings of the spine, and the drape of the paper that makes up the textblock. As move the leaves, so follow the delicate photographs. In this case, the actions that allow the book to function smoothly may themselves pose a risk to the thin edge-mounted artworks, both causing their planar deformation and increased risk of tearing when the pages are turned, and placing strain on the adhesives that hold the photographs in place.

Unable to accommodate photographs mounted to rigid supports, sewn structures were joined by guarded leaf structures, which followed the invention of the carte de visite, noted above. Consisting of an albumen silver print adhered overall to a thick paper card, the carte de visite was introduced and patented in

Fig. 5: Primary hinge guarded leaf structure, from tail. Osborn's Gallery, Charleston, SC [The Evacuation of Fort Sumter], 1861. 12.6 × 9.4 × 2.5 cm. The Metropolitan Museum of Art, Gilman Collection, Museum Purchase, 2005 (2005.100.1174.1-.16)

Fig. 6: Secondary hinge guarded leaf structure, from tail. Harvey, Emily Clare, [The Harvey Album], 1868. 23.8 x 19.4 x 3.8 cm. The Metropolitan Museum of Art, Purchase, The Horace W. Goldsmith Foundation Gift, through Joyce and Robert Menschel, 1998 (1998.166)

Paris in 1854 by André Adolphe Eugène Disdéri. The introduction of these cartes, smaller in format and more affordable to produce and purchase, helped to democratize photography by allowing a broader demographic to have their images taken, to own their own cartes and albums, and to curate them for private enjoyment. Carte de visite albums, and beginning in the 1860s, the larger format cabinet card albums, are found in great numbers across institution and personal collections. Though there are numerous variations in their structural details, the primary hinge album and the secondary hinge album with board stubs are two very recognizable styles. Comprising the textblock, the leaves of guarded leaf albums each consist of a board from which has been excised a recess just larger than the object to be inserted. Paper facings are adhered to both sides of the board, each of which serves as a device to frame the image beneath and as an overmat to keep the carte de visite or cabinet card in position. In albums with primary hinges, the leaves are joined one to the next with cloth or paper guards, adhered underneath the facing papers of the conjugate pages at each opening (fig. 5). In albums with secondary hinges, the board or folded cloth stubs are sewn or adhered together at the spine edge, with the board leaf then guarded to the stub (fig. 6). In both the primary and secondary hinge guarded leaf albums, the opening action relies on the continued fold endurance of the guards that hold the textblock together, rather than on the thread, spine liners, paper drape, adhesives, or other traditional methods of opening support utilized by bookbinders over the centuries. Photographs on their rigid supports are slid into position in the leaves either from the tail, or through a slit in the page front, to sit back-to-back in the recess cut from the board, each object's recto then matted for the viewer underneath the paper facing. The design of these albums allows for relatively straight-forward insertion of a photograph, but they are not conducive to changing the order of prints by removing and reinserting them, which often results in damage to both the delicate images as they are slid in and out of the specifically designed recesses, and to the paper facings.

Fig. 7: Jackson, Ambrose; Stacy's Photographic Carte de Visite, Publisher, [Carte-de-visite Album of Central Park Views], 1860s. 15.4 × 13.4 × 3.9 cm. The Metropolitan Museum of Art, Bequest of Herbert Mitchell, 2008 (2015.400.199)

Fig. 8: Jackson, Ambrose; Stacy's Photographic Carte de Visite, Publisher, [Carte-de-visite Album of Central Park Views], 1860s. Paper facing lifting away from board

The *Carte-de-visite Album of Central Park Views* (figs. 7 and 8), with cartes produced in the 1860s by Stacy's Photographic Carte de Visite and gouache and varnish paintings by American artist Ambrose Jackson, is filled with images of New York City's newest treasure at the time, Central Park. The first and perhaps most famous park in the United States, Central Park was constructed between 1857-1863, years that coincided with an explosion in the popularity of the carte de visite. The *Carte-de-visite Album of Central Park Views* is bound in full maroon leather, with a blind raised pattern on front and back boards, and two brass clasps at the fore-edge that swing from the back to the front board. The guarded leaf structure of this album's textblock is constructed with folded compensation stubs made from cloth, the extension of which serves to attach the stiff leaves of the book block at the secondary hinges.

Numerous preservation challenges lurk in the pages of guarded leaf albums. The aforementioned concerns about 19th century papers, leathers, and adhesives must be considered, as the degradation patterns of these materials put handling and the function of the binding at risk. Cloth guards and facing papers lift away from the boards as adhesives fail. Efforts to remove and reinsert the cartes may dent their corners, and tear or cause creases in the aging papers. The textblocks, made of matboard, adhesives, paper, cloth guards and photographs, are heavy for their size and larger albums can succumb to gravity, essentially pulling their textblocks out of their squares, and then their bindings, when stored vertically as they often lack the rounding and backing of the spine to help support them on the bookshelf.

The single sheets of the small side-sewn volume *[Album from the Archive of the French Medium Henri Matthouillot]* from 1920-1938 (fig. 9), are bound with a cord laced through two holes that extend through the cover and the textblock. Gelatin silver prints are mounted overall, recto and verso throughout, adjacent to lengthy manuscript ink notations written on slips of paper. A very simple structure, its

Fig. 9: Unknown, [Album from the Archive of the French Medium Henri Matthouillot], 1920-1938. Side sewn album with gelatin silver prints and manuscript descriptions. 11 x 7.9 x 1.5 cm. The Metropolitan Museum of Art, Gilman Collection, Gift of The Howard Gilman Foundation, 2005 (2005.100.383.2)

continued function relies on the fiber strength of the textblock paper, and the continued fold endurance of the leaves and cloth spine covering, where all of the opening action occurs. The gelatin silver photographs in this album are quite stable, but they are mounted side by side with their descriptions and when the volume is closed, the adhesives and the inks rest in contact with the conjugate photographs’ surfaces. The loosely side-sewn structure offers limited planar stability for the album, and the user must be careful to avoid allowing the delicate and glossy surfaces of the photographs to rub against one another or the mounted annotations. With prints adhered almost to the fore-edges on each verso, the user risks touching the faces of the photographs in turning the leaves unless aware of the layout before handling. This is a good example of when to include handling instructions on the protective enclosure labeling.

An album titled *Girls I Have Known* from 1916-1917, is a personal memory book made by a teenage boy, discussing and documenting characteristics of his school-mates. Dan Rochford, the album’s maker, worked into a common blank stationer's notebook, which has rounded corners, lack of squares, and pre-numbered pages.

The thin paper of the textblock is folded in sections and machine sewn and the textblock is hung into the linen-covered boards with the endpapers. The whole was then trimmed as a unit, leaving the edges of the boards raw. The artist added photographs, along with personal notes, type-written surveys, magazine clippings, drawings, and various other ephemeral materials. The sheer quantity and diversity of inclusions makes handling and display difficult, and the challenge of accessing the complete contents of a single opening spread is increased with the condition of each addition. Although the volume opens well, access relies on the continued efficacy of the various adhesives and the endurance of the folded inclusions, both of which must be carefully considered in relation to the years the album was constructed.

The albums discussed here each present their own set of challenges, and the inclusion of the physically and chemically sensitive photographs adds a nuanced layer to their preservation. When adhered just around their edges, thin and potentially light sensitive salted paper and albumen prints are put at risk by the action of turning the pages, as well as by their proximity to 19th century papers and adhesives. The removal and re-insertion of cartes de visite into aging albums increases the risk of handling damage to both the photographs and the album pages. Side-sewn albums without spine support may not provide the planar stability necessary to prevent conjugately-mounted photographs from rubbing against one another. Personal scrap-books or albums can develop various handling concerns not found in volumes without additional inserted content. Photograph album structures from across the decades of the 20th century, such as post bindings, spiral bound albums, ring binders and plastic comb bindings, introduce unstable plastics and adhesives that can damage the mounted photographs as they degrade.

Conservation Treatment

Conserving photograph albums involves making decisions about how best to keep these dynamic objects functioning, while bearing in mind the particular preservation concerns discussed above. Maintaining the various moving parts of an album often requires stabilizing the existing material or replacing an original aspect of an album, and invariably, ethical questions arise in each treatment plan. Should a leather outer joint be replaced with new leather which will, based on its acidic nature, break down over time? Is it appropriate to introduce a different material to the structure, despite being a departure from the original design? If the sewing threads are broken in one part of a volume, should the entire book be resewn, though the treatment is more invasive? If photographs have detached from the pages, should the conservator use a different, but more reliable method of reattachment? How can manuscript captioning below a photograph be preserved if the paper on which it is written is inherently so weak that the photograph is separating from the page? How does the conservator wrestle with the pervasive issue of photographs made with stable materials that are kept in proximity to poorer quality papers and adhesives while striving to retain the integrity of the album as a singular object? These are among the various ethical considerations that enter into the treatment plans for albums.

In weighing possible treatment options, one should approach the process by considering the most vulnerable aspect of the album, whether it be the covering materials, the adhesives used for attachment, the photographic process, or the light sensitivity of the mounted images. With in-situ treatment of the photographs in a particularly delicate structure, the book and photograph conservators work together to set the volume up in a supported manner to allow for safe treatment. Determining whether to retain, remove or replace interleaving papers, and the decisions about treatment adhesives and housing materials are taken with the delicacy of the photographic material in mind. Cross-disciplinary communication encourages both book and photograph conservators to consider artwork sensitivities outside of their main disciplines, and usually more communication up front results in better longer term preservation of the objects.

Preservation

Providing protective enclosures for albums made from Heritage® or other similarly tested board (fig. 10), (rather than housing them in cloth-covered drop spine boxes), ensuring that storage and exhibition materials have passed the Oddy test and Photographic Activity Test, and maintaining a stable environment during storage, research, and display will result in

Fig. 10: *Heritage® board protective enclosures for volumes containing photographs*

the most effective long-term preservation of photograph-based artworks. Preservation efforts may be enhanced through well-placed education and advocacy, including providing handling sessions for new staff and fellows and reaching out periodically to registrars and curatorial teams to review these protocols. Welcoming visitors to the lab, whether students or potential donors, regularly results in new insights and excitement about the practices involved in the long-term care of art collections. In closing, provided below is a list of some housing and storage recommendations, handling guidelines, and the names of a small number of materials and vendors that supply them, with the hope that these will be useful in furthering the collaborative work undertaken by the book and photograph conservation communities.

Housing and Storage Recommendations

- Most photographs should be stored at cooler or colder temperatures
- Photographs and bookbinding materials are light sensitive
- Environmental conditions in galleries 50%RH / 70°F (21°C)
- Housing materials should pass Oddy test *each new batch tested
- Housing materials should pass Photographic Activity Test (P.A.T.)
- Enclosures of Heritage® board or other conservation quality material
- Micro-climate housings will slow down Temperature and RH fluctuations
- House and store heavy or unstable albums flat, on folio shelving
- Label housings with any handling instructions, warnings
- Include maximum safe opening angle instructions on housings
- Provide handling instructions for more complicated housing designs

Handling Guidelines

- Handle albums with gloves
- If volume is housed vertically on shelf, do not remove by headcap
- Be mindful of the condition of covering materials
- Lift an album up, do not slide it, and place it in new location
- Open album slowly to avoid draw and lifting of endpapers
- Use book supports or angled cradles to support open albums
- Adjust cradling support and opening angle to accommodate various openings
- Avoid flexing photographs with the movement of the album pages
- Handle only the outer margins of the textblock leaves
- Be aware of interleaving, and loose or detaching photographs
- Allow no photos or interleaving to slip into the gutter or become creased
- Examine album with photograph and book conservator
- Build cradle specific to the opening page spread and support the squares during exhibition
- Housing materials should pass Oddy test *each new batch tested
- Housing materials should pass Photographic Activity Test (P.A.T.)
- Strap leaves gently with polyethylene to keep open during exhibition
- Albums may appear robust even when in poor condition
- Consider exhibiting facsimiles if albums absolutely may not be exhibited
- Before permitting exhibition, understand an album's limitations

Housing Materials

- Heritage® Archival Corrugated Board
- Mylar® Polyester
- Polyethylene Strap
- Four flap enclosures
- Photo-Tex paper
- Tyvek®

Suppliers

- Talas
- Archival Products
- University Products
- Creation Baumann
- MasterPak
- Benchmark

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7 December 2020

Reflections on "Indian Ink"

TAMMY earned her B.A. in art history, studio art, and history from Syracuse University. As an art historian and a cultural heritage conservator in training, Tammy calls attention to the interdependence between tangible and intangible cultural heritage in her research and conservation work. She is currently the Andrew W. Mellon Artists' Materials Research Assistant in Conservation at the National Gallery of Art in Washington, D.C. In her position at the National Gallery of Art, Tammy explores the dialogues between conservation science, materials manufacturing, and art history through cataloging artists' materials and associating important items in the Art Materials Research and Study Center with their historical contexts. Her project on Chinese ink sticks in nineteenth-century Britain examines the connections between Chinese and European ink traditions through the lenses of artists' materials manufacturing, pigments, and globalization.

Introduction

As the Artists' Materials Research Assistant in the Conservation Division at the National Gallery of Art in Washington, D.C., my research investigates the web of transnational narratives that surround the mobility of artists' materials. In my position, I treat artists' materials as artifacts themselves and as primary sources rather than as tangible components that formulate the building blocks of an object. The application of this perspective in my research led me to the material culture, the narratives, and the people that occupied the intersections of Chinese and European ink traditions at the height of the British empire in the nineteenth-century.

Fig. 1: Charles Roberson & Co., Presentation Box for the Department of Science and Art, mid-late nineteenth-century, 19 cm x 7.5 cm x 3 cm, Art Materials Research and Study Center at the National Gallery of Art, Washington, D.C.

Fig. 2: Wang Jin Sheng (汪近圣), Chinese Ink Stick 青云路, Qing Dynasty, 1cm x 5cm x 0.5cm, from the Charles Roberson & Co. Presentation Box for the Department of Science and Art, Art Materials Research and Study Center at the National Gallery of Art, Washington, D.C.. Photomicrography by Tammy Hong

This story on nineteenth-century ink began with a presentation box by renowned British artists’ materials manufacturer Charles Roberson & Co. housed in the Art Materials Research and Study Center at the National Gallery of Art (Fig. 1). This presentation box that dates to the latter half of the nineteenth-century was made for the Department of Science and Art, a government sanctioned body that administered the British arts education system from 1853 to 1899. The box’s compartments held ten watercolor cakes embossed with the Roberson emblem, six brushes, a ceramic mixing palette, and most conspicuously, a Chinese ink stick (Fig. 2) from the Qing Dynasty ink studio, Wang Jin Sheng (汪近圣).[1] An initial examination of the Roberson box’s contents revealed that the artifact’s significance was rooted in the perspectives of a complex transnational network of cultural stakeholders. The combination of artists’ materials struck me as a fusion of Chinese and British art practices. The Chinese ink stick, an indispensable symbol of Chinese literary culture, from Wang Jin Sheng’s ink studio particularly resonated with my Chinese-American background. Due to this personal connection, the presentation box and its components automatically held a sentimental value to me despite the fact that I had only interacted with the artifact for the first time.

I came across a nineteenth-century Roberson catalogue with images of Chinese ink sticks

1 汪近聖撰, 汪氏鑑古齊墨藪 (China: 汪近聖撰. Reproduced online, Beijing: Peking University Library, 2010), 496-497. https://archive.org/details/02095375.cn/mode/2up

Fig. 3: *From Charles Roberson & Co., Catalogue of Materials for Drawing, Painting &c. In Philip Gilbert Hamerton, The Etcher's Handbook (London: Charles Roberson & Co., 1871). National Gallery of Art Library, Gift of Robert L. Feller and Ruth M. Johnston Feller, Washington, D.C.*
**The poetic phrase engraved on the ink stick in the second row and second to the viewer's left is reproduced upside down*

(Fig. 3) in the process of associating the Roberson box with its manufacturing literature. Instead of providing the Roberson box with more historical context, the Roberson catalogue only added to the mystery. In this catalogue, the Chinese ink sticks were labeled as "Indian Ink."[2] With the knowledge of Chinese ink traditions in mind, the term "Indian Ink" used to describe Chinese ink sticks in the catalogue was a misnomer. When I examined the catalogue further, I noticed the poetic phrase engraved on one of the ink sticks on the page was reproduced upside down. This observation indicated to me that the author of the catalogue likely did not recognize the significance of the phrase. Using poetic phrases as a part of an ink stick's ornamentation was a common design approach implemented by Chinese ink studios to distinguish their products from other ink studios located in different regions of China. The lack of recognition allocated to the ink stick's emblematic characteristic indicated that the manufacturer sought value in the Chinese ink sticks solely as a writing and drawing medium. Moreover, this implied that the interpretation of Chinese ink sticks as a Chinese cultural symbol had limited significance in nineteenth-century British art practices. This observation presented a conflict in interests between the value of Chinese ink sticks in Chinese literary and visual culture and the value of the medium's reinterpretation in nineteenth-century Britain.

The Chinese and European Understandings of Ink

What is "Indian Ink"? In nineteenth-century Britain, "Indian Ink" was neither from India nor the highly opaque carbon black liquid medium used for drawing and outlining recognized in the European and North American art historical context today. According to the visuals provided in nineteenth-century British colourmen[3] catalogues, "Indian Ink" was the term used to describe Chinese ink sticks imported to Europe through the China Trade. A product advertised as a liquid drawing medium made from prepared Chinese ink sticks was first introduced

2 Charles Roberson & Co., *Catalogue of Materials for Drawing, Painting & c.* (London: Charles Roberson & Co., 1871), 18. From Philip Gilbert Hamerton, *The Etcher's Handbook* (London: Charles Roberson & Co., 1871). According to Sally Woodcock, older Charles Roberson & Co. catalogues also mentioned "India Ink" as an item sold, but these catalogues were not illustrated.

3 A term used to describe artists' materials suppliers and manufacturers in nineteenth-century Britain.

Fig. 4: *Winsor & Newton, Limited, Winsor & Newton, Limited, Manufacturing Artists' Colourmen by Special Appointment to Her Majesty and to their Royal Highness the Prince and Princess of Wales (London: Winsor & Newton, Limited, 1895). National Gallery of Art Library, David K. E. Bruce Fund, Washington, D.C.*
**The description of the product mentions that “Liquid Indian Ink” is prepared ink from Chinese ink sticks.*

as “Liquid Indian Ink” by Winsor and Newton in the 1890s (Fig. 4).[4] The composition and physical state of this liquid drawing medium formulated the basis of the liquid ink familiar to European and North American audiences today. “Liquid Indian Ink” was popularized on the nineteenth-century British market due to its versatility and the conveniences the medium provided to its users.

“Liquid Indian Ink” was a product of the interactions between the conflicting understandings of Chinese and European ink traditions. The understandings of ink in China and in Europe are both associated with long histories. In China, “ink” (墨 *mò*) is understood as a solid stick. Chinese ink sticks are composed of carbon black particles, animal glue, and sometimes other additives. Though the sizes of ink sticks vary, the sticks were always small enough to be held by hand. The Chinese ink stick is one of the many beloved cultural objects of China. Chinese ink sticks—along with the ink stone, paper and the calligraphy brush—were the Four Treasures of the Study (文房四宝) in Chinese culture. The Chinese ink stick is indispensable in traditional Chinese painting and calligraphy, but it is also considered a form of art itself and a symbol of scholarship and knowledge. According to Chinese sources, Chinese ink-making began in the third-century and was refined over time due to the medium's close association to the art of calligraphy. By the Qing Dynasty (1644-1912), there were four main ink studios in China: Cao Xi Gong (曹素功), Hu Kai Wen (胡开文), Wang Jin Sheng (汪近圣) and Wang Jie An (汪节庵). In China, Chinese ink sticks were first described in a tenth-century treatise on writing materials titled *Collected Studies of the Four Articles for Writing in a Scholar's Studio* (文房四谱) from the Song Dynasty. Modern understanding of Chinese ink sticks in China is heavily dependent on monographs and treatises on ink and ink making from the Song Dynasty to the Qing Dynasty.

In contrast to the Chinese understanding of ink as a solid form, the European ink tradition recognizes ink as an aqueous solution. The use of liquid ink in Europe is observed in the use of iron-gall ink—the standard formulation for ink in Europe from the fifth century to the

4 “Liquid Indian Ink,” Winsor and Newton, Winsor and Newton. Accessed August 30, 2020. https://www.winsornewton.com/na/graphic-art/inks/drawing-inks/

nineteenth-century. Iron-gall ink is a dark ink made from iron salts and acids extracted from vegetable tannins. Despite the permanency iron-gall ink provided users, the medium’s chemical composition was less than ideal. Iron-gall ink was acidic and can eat through writing surfaces when applied. The medium also had a shorter shelf life and was more volatile when exposed to other environmental changes, like humidity, when compared to prepared Chinese ink sticks or “Liquid Indian Ink.” Due to these unfavorable characteristics of iron-gall ink, the medium gradually fell out of favor in the nineteenth-century. The Roberson box and its contents date to this time period when “Liquid Indian Ink” was popularized on the British market and replaced iron-gall ink as the most common drawing and writing vehicle.

Chinese ink sticks were introduced to Britain via the lucrative private trade system established by British merchants operating in China during the China Trade between the eighteen and nineteenth centuries. Upon its arrival in Britain, the Chinese ink stick received praise from both professional and amateur artists for its maneuverability and versatility as a medium for writing and drawing. Despite being recognized as “Indian Ink” by British consumers, the medium’s origin in China was widely recognized in volumes on color such as in the experiments of George Field, Winsor and Newton’s chemist in the nineteenth-century, as well as in instruction manuals produced for art students and art enthusiasts at the time. In China, liquid ink was traditionally prepared by submerging a Chinese ink stick in water while rubbing the stick on an ink stone. This ritual of ink preparation is still practiced in China today. A similar ink preparation method with a ceramic or stone plate was taught in British government schools in the nineteenth-century.[5] However, this ink preparation process was noted as

Fig. 5: *Winsor & Newton, Limited, Winsor & Newton, Limited, Manufacturing Artists’ Colourmen by Special Appointment to Her Majesty and to their Royal Highness the Prince and Princess of Wales (London: Winsor & Newton, Limited, 1895). National Gallery of Art Library, David K. E. Bruce Fund, Washington, D.C.*
**The description of the product mentions that “Liquid Indian Ink” is prepared ink from Chinese ink sticks*

tedious by some artists like Joseph Pennell.[6] Additionally, the British arts education curriculum taught drawing and watercolor practices that preferred liquid ink. By the latter half of the nineteenth-century, British colourmen began advertising “Liquid Indian Ink” as prepared ink that allowed product

5 Alston, J. William, *Hints to Young Practitioners: In the Study of Landscape Painting* (London: Longman, Hurst, Rees, & Orme, 1805), 19.

users to bypass the ink preparation process. Due to the rebranding of the Chinese ink stick by colourmen, the previous recognition of the medium's origin in China eventually disappeared from the descriptions of "Indian Ink" in British sources (Fig. 5). This disaffiliated the medium from its significance in Chinese culture. As a result, "Indian Ink" was reproduced as a British product associated with India at the height of the British empire.

A Multilingual and Interdisciplinary Research Approach

The mobility of the Chinese ink stick—from its origin in China, to its arrival in Britain and, to its affiliation with India—is inevitably interwoven with British empire building. The act of rebranding the Chinese ink stick as a British product advertised as "Indian Ink" was rooted in the intersections of language barriers, art history, economics, imperialism, and global trade that defined the nineteenth-century historical framework. A multilingual and interdisciplinary approach to research was necessary in order to gain a comprehensive understanding of nineteenth-century ink nestled within a web of transnational narratives and cultural values. The different notions of ink and carbon black materialities in Britain and in China posed research challenges for me when using terminology available in the English language to describe Chinese ink traditions. By incorporating the Mandarin terms that describe prepared ink into my research process, a breadth of common knowledge resources written in Mandarin were brought to the forefront. These sources would not have been revealed if the research of the intersections between Chinese and European ink traditions were conducted solely in English. Moreover, the different understandings of ink in China and in Europe became particularly apparent when I used sampling and microscopy to compare carbon black pigments familiar in the European context, like lampblack, to Chinese ink sticks from the Art Materials Research and Study Center. The solid state of ink in China and the liquid state of ink in Europe were two concepts that evolved from different ink traditions and do not directly translate. It was important to incorporate the terms that describe prepared ink in Mandarin, "墨汁 (*mò zhī*)" and "墨水 (*mò shu* ǐ)" in order to fully address the nineteenth-century narratives associated with these ink traditions and materialities.

Through this research approach, the categories of carbon black materialities became much more intricate. In both Chinese and European understandings of carbon black pigments, carbon black (碳黑), by definition, is any pigment that contains some form of elemental carbon as its main or sole ingredient. Carbon black pigments are overall very stable and versatile. Some examples of carbon black pigments include bone black, lampblack, vine black, and ivory black. How carbon black pigments are further classified revealed the different understandings of these materialities in Europe and in China. In the European context, carbon black particles obtained from the pyrolysis of gas or oil are known as flame carbons. According to this definition, Chinese ink sticks that are composed of 90-99% carbon produced by burning, oils, fats, resins, wood, or similar materials at a wick or in open pans bound by an animal glue binder would also

6 George Rowney & Co., *George Rowney & Co., Manufacturing Artists' Colourmen* (London: George Rowney & Co., 1907), 19. See Joseph Pennell, *Pen Drawing and Pen Draughtsmen, Their Work and Their Methods: A Study of the Art Today with Technical Suggestions*. London: T. Fisher Unwin Lrd., MCMXX, 1920. (First published in 1889) for Pennell's comment: "India ink is excellent…but it is very tedious to grind it down for yourself…" Pennell is an American-born artist who made his home in London.

be considered a flame carbon. By introducing Mandarin terms into my research, the European concept of a flame carbon can be further categorized according to the study of Chinese ink sticks. In Chinese ink studies, the source of the soot used in the medium must be identified. Soot ink (油烟墨 *yóu yān mò*) is produced from carbon black particles obtained by burning Tung oil (桐油), canola oil (菜籽油), sesame oil (胡麻油) and other vegetable oils (植物油) at a wick. Pine soot ink (松烟墨 *sōng yān mò*) is produced from carbon black particles obtained by burning pine wood. There are subtle differences in particle sizes and aggregations of the carbon black particles in Chinese ink sticks of different origins.

The smaller the particle size of carbon black pigments, the higher the tinting strength.[7] Chinese ink sticks have the smallest particles of any pigment other than organic colorants. Carbon black particles acquired from different sources required different carbon to animal glue ratios in the ink-making process to accommodate their hydrophobic characteristics. The carbon black particles in soot ink sticks are more fine than those of pine soot ink. There tends to be more animal glue in soot ink sticks so the grinds (the top and the bottom) of the ink stick would exhibit a sheen when examined. Additionally, the carbon particulates collected from burning oil contain lipids. A soot ink stick's interior would have an obvious reflective quality when compared to that of a pine soot ink stick from the Qing Dynasty. By contrast, the interior of a pine soot ink stick does not demonstrate a notable reflective quality due to aggregations of larger carbon particles and less animal glue

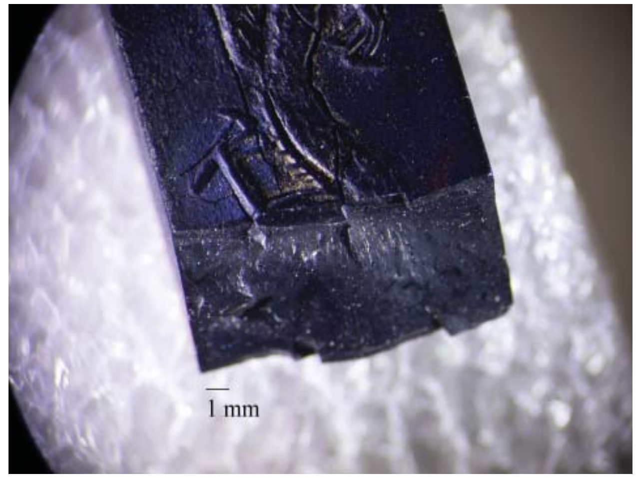

Fig. 6: *Chinese ink stick from G. Rowney and Co. Watercolor box (Catalogue entry 24457), mid-late nineteenth-century, Art Materials Research and Study Center at the National Gallery of Art, Washington, D.C. *The interior of this ink stick demonstrates a smooth texture and reflective quality indicative of soot ink sticks*

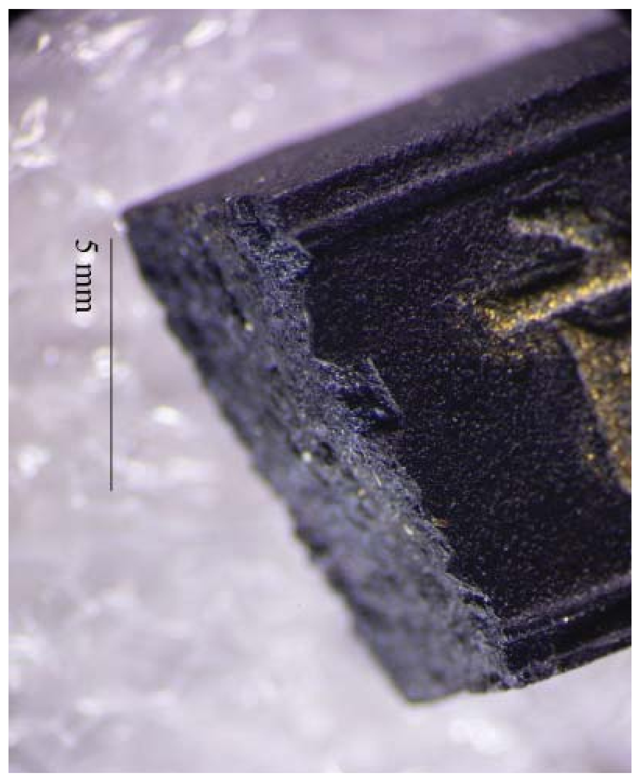

Fig. 7: *Chinese ink stick from (likely) G. Rowney and Co. Watercolor box (Catalogue entry 24391), mid-late nineteenth-century, Art Materials Research and Study Center at the National Gallery of Art, Washington, D.C. *This ink stick's interior demonstrates a gravel-like texture and lack of reflective quality that are indicative of pine soot ink sticks produced during the Qing Dynasty*

7 John Winter and Elisabeth West FitzHugh. "Pigments Based on Carbon." In *Artists' Pigments: A Handbook of Their Stories and Characteristics, Vol. 4*, edited by Barbara H. Berrie (London: Archetype Publications, 2012), 1.

being used in its make compared to those in soot ink sticks. Micrographs of two ink sticks (Fig. 6) (Fig. 7) from other color boxes in the Art Materials Research and Study Center demonstrate different levels of reflective qualities in their interiors. These characteristics were observed with the naked eye and are likely indicative of the differences between soot ink sticks and pine soot ink sticks. However, further scientific analysis and research are required to identify the sources of carbon black particles in Chinese ink sticks exported to Europe in the nineteenth-century.

The complexities of carbon black materialities in the Chinese ink tradition formulated the compositional basis of Chinese ink sticks, or "Indian Ink." The durability, versatility, and sophistication of "Indian Ink" surpassed those of other known carbon black drawing vehicles in Britain in the nineteenth-century. The understanding of carbon black pigment materialities and the ink-making process in China were oversimplified when translated into the English language for the British market. The lack of understanding and documenting of these cultural complexities by British merchants and materials suppliers were revealed in the ink stick imitations created by London colourmen that were a commercial failure. Despite being highly skilled technicians of color and pigments, London colourmen were unable to reproduce the delicacy and even particle dispersion that the Chinese ink stick offered in their imitations of the medium. The imitations of Chinese ink sticks made by London colourmen were easily distinguished by their "grittiness" during preparation,[8] their overpowering scent of musk, and the lack of delicacy and transparency during their application.[9] The ingredients used to make Chinese ink sticks were similar to other carbon black pigments known in London and could have been sourced locally. However, Chinese ink sticks were commercial items that depended solely on imports rather than domestic production in Britain.

Through meticulous record keeping practices, British imperial institutions contributed to the rebranding of Chinese ink sticks as "Indian Ink." These documents, preserved to this day, validated "Indian Ink" as a British product and justified the conflation of the Chinese ink stick, which is a symbol of Chinese culture, with India, Britain's most prized colonial possession in the nineteenth-century. By examining the Roberson box and its contents through a multilingual and inter-disciplinary research approach, the connections between the Chinese ink stick and "Indian Ink" were revealed. Moreover, these connections call our attention to the ruptured linkages between the transnational network of cultural stakeholders associated with the Roberson box. This project developed the groundwork for understanding the values the Roberson box held to its various nineteenth-century cultural stakeholders that will formulate the basis for any conservation treatment or collection care decision related to the artifact.

Cultural Stakeholdership and Reflections

As American objects conservator Barbara Appelbaum noted in her book on conservation ethics titled *Conservation Treatment Methodology*, the values an artifact holds to

8 George Hamilton, *The Elements of Drawing in its Various Branches: For the Use of Students: Illustrated by Fifty Engravings, Plain and Colored, Containing Several Hundred Examples from the Works of the Greatest Masters* (London: Printed for Sir Richard Phillips and Co. and to be had of all booksellers, with the full allowance to masters and schools, 1827), 11.

9 H.R. Robertson. *The Art of Pen-and-Ink Drawing Commonly Called Etching / by H.R. Robertson, fellow of the Society of Painter Etchers, Author of "The Art of Etching," "Life on the Upper Thames*," &c. (London: Winsor & Newton, 1886), 41.

its owner or user, such as its historical and sentimental values, are usually of greater relevance to conservation decision-making than quantifiable values like the monetary cost of the object. Moreover, the historical and sentimental values of an artifact underscore the whole practice of conservation. The narratives associated with the Roberson box observed a complex network of cultural stakeholders that formulated the basis of the artifact’s historical and sentimental values. The cultural stakeholders affiliated with the Roberson box —from the National Gallery of Art, to Charles Roberson & Co., to calligraphers in China, and to myself as the assigned caretaker of the object—derived different, and sometimes, even conflicting values from the artifact. Despite this, it is important to recognize that all of these perspectives are valid considerations in the decisions associated with the display, care, and conservation of the object.

This project on ink and the mobility of artists’ materials served as a reminder of my position as a stakeholder within a network of cultural heritage care. According to Ellen Carrlee, Objects Conservator at the Alaska State Museum, this network of care consists of not just people, but also tangible and intangible objects along with the environments in which these artifacts exist.[10] As an artifact’s first point of contact when it comes to the treatment of tangible and intangible cultural heritage, conservators possess the responsibility of identifying and distributing their agency throughout the appropriate network of care for every artifact they treat. It is important to acknowledge that every conservator offers a different gateway into the identification of an artifact’s cultural stakeholders and their values that drive conservation decision-making. The Roberson box held sentimental value to me during our first interaction due to our mutual link to Chinese ink traditions. This personal connection with the artifact combined with my ethos as the caretaker of the object propelled me to further investigate the stories behind the artists’ materials in the Roberson box. The box’s sentimental value was my entry way into the Roberson box’s network of stakeholders and the awareness of my inherent bias was crucial to my research process.

However, practicing the awareness of my inherent bias is not a flawless approach. As Dr. Padma Rohilla, Director of the INTACH Conservation Institute at New Delhi, pointed out during my presentation for INTACH Conservation Insights 2020, I have yet to elaborate on the ways in which Indian ink, ink originating from India which is also accompanied by a rich cultural history, intersected with those of Chinese and European ink traditions. Through my research lens, the major cultural stakeholders associated with the Roberson box identified thus far can be separated into two schools—the communities who recognize the reinterpretation of Chinese ink sticks as “Indian Ink,” and communities who resonate with the medium’s cultural value and origin in China. My research journey observed that the lack of interaction between the stakeholders associated with the Roberson box posed challenges to identifying the scope of the artifact’s network of care. Additionally, the conflicts between Chinese and European understandings of ink made it difficult to bring these transnational narratives in dialogue with one another.

This project made me think deeply about how the documentation of our conservation processes can affect the inclusivity of our

10 Ellen Carrlee and Nicole Peters, “Collaborative Conservation with Local Indigenous Communities,” Washington Conservation Guild Presents: The Sixth Meeting of 2020/2021 (monthly meeting, virtual platform, Washington, D.C., February 4, 2021).

approaches to cultural heritage care as I continue to research nineteenth-century ink traditions and develop my conservation practice. The rebranding of the Chinese ink stick as a British product through meticulous record keeping practices in nineteenth-century Britain reflected that the physicality of documentation is crucial. This physicality holds the potential to validate the existence of an idea, regardless of the idea’s historicity. It became clear to me that the vocabulary selected to document the cultural contexts of a tangible object can affect the ways in which the object’s history might be perceived for centuries to come. The physicality of paper and digital records can transform conservation documentation into a double-edged sword. When used appropriately, these records invite community partnerships and the consideration of all ethical courses of action into the decision-making process. However, when used inappropriately, it skews our perception of historical reality and our understanding of an artifact’s network of care. I believe the documentation process is where conservators have the most authority and agency to dispel the neutrality of the conservation profession. This also allows conservators to equalize the importance placed on all forms of cultural heritage within a broader, transnational context and take into account the perspectives of the various cultural stakeholders affiliated with an artifact.

As I continue to research the narratives associated with the Roberson box and the mobility of artists’ materials, I aim to gain a comprehensive understanding of the relationships between the values these artifacts hold for their owners, users, and cultural stakeholders. This approach will encourage me to assess my position as a cultural stakeholder myself within these artifacts’ networks of care. Treatment and the approach to care applied to an artifact can be defined as the selected set of values prioritized at a specific moment. Conducting a value assessment of the cultural stakeholders of an artifact upon my first interaction with the object will allow me to become aware of and appropriately record my biases that may contribute to the courses of action ultimately implemented in my research or in my collection care approach. According to Applebaum, “treatment is inherently an act of compromise, in which the stakeholders and the needs of the object are blended into an ideal course of action.”[11] In other words, the decision ultimately employed in the care of an artifact should strive to best accommodate all the values derived from an artifact’s cultural stakeholders. My exploration of nineteenth-century ink traditions through a multilingual and interdisciplinary lens reinforced the responsibility of conservators as stewards of tangible and intangible cultural heritage.

11 Sarah Norris, “43rd Annual Meeting - Opening Session, May 14, The False Dichotomy of ‘Ideal’ versus ‘Practical’ Conservation Treatments, by Barbara Appelbaum (presenter) & Paul Himmelstein,” May 18, 2015, https://resources.culturalheritage.org/conservators-converse/2015/05/18/43rd-annual-meeting-opening-session-may-14-the-false-dichotomy-of-ideal-versus-practical-conservation-treatments-by-barbara-appelbaum-presenter-paul-hi/

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Uncertainty in Conservation

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In 1995 he was awarded a Leverhulme fellowship to study risk methodology and eventually wrote the book *Risk Assessment for Object Conservation*. In 2019 he was awarded a visiting scholarship at the Getty Conservation Institute to study uncertainty and hopes eventually to write a book about uncertainty in the management of cultural heritage.

Introduction

Uncertainty may not be a subject that is constantly on your mind, you may never have thought about it much at all. That is until the year 2020, when the whole world was given a crash course. World health and global politics became headline news but were surrounded by such uncertainty that it was difficult to understand what was going on or what would happen next. There was a great deal of information available, but it wasn't easy to find anyone with the complete picture, it was difficult to know who to trust.

This paper is an exploration of the lack of certainty that haunts decisions that are made in the field of cultural heritage conservation.

Much of the discussion will be general and not specifically about conservation but it should be possible for you to use your own experience of conservation practice, science or management to make your own connections.

Uncertainty

In some fields the word uncertainty may appear to have a specific well-understood definition such as the variability of scientific measurements. In this paper I have deliberately chosen a broad definition. Uncertainty is typified by a lack of qualities such as certainty, clarity, accuracy, precision, purpose, reliability, reproducibility, and strength of will. Or if you don't like such a negative approach, it may mean an abundance of error, variation, ambiguity, ambivalence, ignorance and laziness. Jane Henderson has suggested that I have overlooked 'excitement' in the list of positive signs. It is certainly true that people undertake a range of hazardous activities such as motor-racing and rock-climbing for the sheer excitement associated with risk-taking.

Types of uncertainty fall into two broad categories: probabilistic and epistemological. The first of these describes a quantitative approach where the uncertainties can be associated with numbers that can be manipulated mathematically. This group is popular with gamblers, scientists, and with conservators that think conservation is primarily a science. Epistemology is the study of the nature, origin and scope of knowledge and the rationality of belief. It deals with potential sources of knowledge such as perception, reason, memory and testimony. It is related to the study of ethics. So, by contrast to the probabilistic approach it is predominantly qualitative. It appeals to conservators and managers with a philosophical bent, and often fails to appeal to scientists.

There are many books with the word uncertainty in the title; one I have found useful is *Understanding Uncertainty* by Dennis V. Lindley [1]. In the introduction he makes clear the subjective nature of the subject.

> "Uncertainty is a personal matter. It is not *the* uncertainty but *your* uncertainty."

This suggests that uncertainty is something created in your brain rather than existing in the greater physical world.

When I see a stunning photographic image of a galaxy, I may be tempted to use words like 'vast', 'beautiful' or 'complex'. But these words, and the feelings they describe, are only in my head. The galaxy just 'is' (Fig 1).

Fig.1: Pinwheel galaxy (ESA.Hubble)

If I think about the evolution of the universe, It is only in my own mind that there is lack of certainty about what will come next. The arrangement of atoms and subatomic particles just 'are' what they are. At another time they will be different. A human brain may worry that there are many possible future states, but the next state is actually just what happened to happen. Ignore for the moment the uncertainties of multiple universes!

You need a way to distinguish between the 'real' world and the personal world that is created from your own perceptions. The real world is a place of which large numbers of people all report similar descriptions. It exists outside the minds of these people and is not dependent on their existence. An analogy that I once thought might be helpful, was to imagine taking a train journey to somewhere new. You sit looking out of the carriage window and fleetingly see trees, fields, villages. You don't know what is coming next. You never get a clear view of the fragments of scenery through the window on the other side of the carriage. You have no idea what you missed when you went to the toilet. You believe that you will arrive at your destination, you hope that your watch is correct, you trust that the train will be on time. Nothing you see through the window gives enough information to help you. You believe that there was a starting point and will be a destination, but you can't see either of these through the window right now. Through the window you are presented with changing images which you choose to see as evidence of progress and movement toward a goal. You choose to believe in a fixed solid world outside your railway carriage because it gives meaning to the idea of a journey. We will return to this analogy when discussing science.

The origins of my prejudice, the limits of my knowledge

I spent all of my salaried years (1973-2004) working in just one institution. This was a large national museum situated in the national capital. A recent lesson in uncertainty has been the unpredicted effect of the coronavirus on levels of museum activity. It used to be thought that a museum career was secure, and not utterly precarious. I was fortunate to be employed at such a time.

Fig. 2: *Typical V&A objects on public display (Photo. Ashley-Smith)*

The museum I worked in contained millions of bits of stuff from all around the world.

The stuff in this museum was nearly all hand-made for rich people. It was so well made from high quality materials that each object was considered significant and valuable (Fig. 2).

Over the thirty years I was there I worked as conservator, scientist and manager and in these different roles I was obliged to make decisions, often without all of the information I needed to be sure that my decision would be right. Typical decisions about collections and individual objects would be:

To treat or leave alone
To put on display or stick in a store
To allow travel
To allow touching
To put in a case, put on a plinth or hang on the wall
To do something about the gallery environment
To do something about the rats

Every decision required some form of investigation, requiring questions to be asked, analyses to be made, measurements to be taken and further questions to be asked.

The complexity of communication: some guiding principles

In a museum, even simple activities require the cooperation of a number of people with different skill sets. It is important that communication between these different parties is clear and effective. Sadly the English language is not the best tool for this particular job.

Principle 1

There is no such thing as a synonym.

An individual word can mean different things to different people. Some words have a clearly specified meaning in a particular academic or professional field yet are also commonly used with a range of different meanings in every-day life. Examples are 'hazard' and 'risk' or 'probability' and 'likelihood'. If someone tells you that two words are interchangeable, they don't understand nuance, or have yet to be inducted into the secrets of your professional niche.

There is an instructive conversation between Alice and Humpty Dumpty in Lewis Carroll's *Alice in Wonderland*. Humpty says "When I use a word it means just what I choose it to mean". Alice queries this: "the question is whether you can make words mean so many different things". Humpty replies "The question is which is to be master – that's all."

You don't want to be dictatorial and impose just one meaning on a word. At the same time you want to be understood, so you must inform the listener which meaning you intend in this instance.

Principle 2

There is no such thing as a dichotomy.

Decisiveness is deemed to be the mark of a good manager. This often means hiding the uncertain middle ground between the options A and B. Surely something is either black or white. It can be, if you just forget about the more than 49 shades of grey that lie between. Conservation is full of false dichotomies: good or bad environments, safe and unsafe lighting levels, separated by strict boundaries such as 50% relative humidity or 50 lux.

Principle 3

Attempts to simplify, unify or generalize are often misguided.

Attempts to reduce problems to simple dichotomies by excluding the middle ground involve gross simplifications or generalisations. Simplification is deemed to make things easier to teach and to learn. Simplification has an admirable pedigree, whose beginnings are often attributed to William of Ockham, 14th century Franciscan friar. His advice, later known as Occam's razor, was "entities should not be multiplied without necessity". This is usually interpreted as "the simplest explanation is usually the right one".

When I was young, I was inclined to seek simple explanations. I used to criticise conservators who insisted that every case was different. I encouraged them to seek for generalisations. I now advocate the slogan It's never that simple. Some eminent people have also favoured this approach. Professor Sir Martin Rees, Astronomer Royal and President of the Royal Society, says "I am inclined to go easy with Ockham's razor". (It should be noted that the spelling of his name, and the dates of William's life, are subject to great uncertainty). Albert Einstein takes a cautious stance "Everything should be made as simple as possible, but no simpler"

Prediction

Principle 4

Prediction is an inevitable part of everyday life.

Taking the weather forecast as an example you can appreciate that prediction cannot guarantee certainty. Where there is uncertainty about future outcomes the only option is gambling.

There are several groups of activity to do with managing the cultural heritage. The first group concerns the regular activities of conservators such as: condition assessment, treatment proposals and preventive conservation. Condition assessments involve the use of words like 'stable' and 'unstable'. I take one look at an object and declare that I know what its future state will be. I might predict no change, or that the object will show further signs of deterioration. It is hardly scientific to extrapolate from a single observation, so it must be a gamble. Stable or unstable; toss a coin. A treatment proposal is a prediction that appropriate skill and knowledge will lead to a desired outcome. Preventive conservation requires faith in predicting long-term outcomes. The conservator may have retired long before it is known whether their actions (or deliberate lack of action) have had any effect on the appearance or stability of an object. The concept of sustainability suffers from the same lack of certain knowledge about future interactions between decisions, heritage and environment.

In the field of science a hypothesis is a prediction that your suppositions can be confirmed. An experiment involves the prediction that you have found a suitable test to prove or disprove your hypothesis. In heritage science there are mathematical predictions called damage functions and dose-response relationships that are based on the theory that if you know the chemical and physical properties of an object and the factors in its environment such as temperature, humidity and pollution levels you will know the state of that object at various points in the future. Because they are mathematical it is sometimes assumed that they are reliable.

Environmental standards and codes of ethics rely on predictions about the future behaviours of objects and people. They also rely the prediction that following one particular set of guidelines will continue to gain the approval of your professional peers.

Elements of management such as recruitment, training, planning and strategy, all require predictions and faith in personal judgment. As do actions and attitudes that are critical in your personal life: prayer, promising, trust, relationships and marriage. All involve incomplete information; all involve gambling and require some understanding of probability.

Probability 1.01

Any basic book on risk, uncertainty and probability will give examples from gambling: dice-rolling and coin-tossing. In theory, because these are simple activities with a known number of possible outcomes it should be easy to assign a probability to the outcome of a succession of events.

If you roll two dice, the probability of throwing a one and a two is the same as throwing a three and a four. However, if you add up the numbers on the top faces of the two dice you get a different picture. There is only one way to get a total of 2 but there are a number of ways to get a total of 7 (1 and 6, 2 and 5, 3

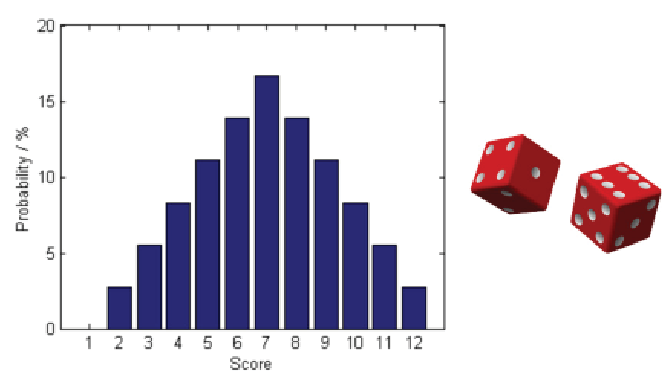


Fig. 3: *Distribution of the sum of spots on two rolled dice*

and 4). The probability distribution for the totals looks like this (Fig 3). At first sight this looks a bit like a bell curve. However, Just because it is tallest, and in the middle, doesn't mean that seven is the most correct, most accurate or even most desirable number. At the edges of this distribution – double six is highly desirable in the game of Monopoly, double one 'snake eyes' is a bad throw in the game of craps.

This shape of distribution appears only when you include values such as the numbers of spots on each face. If each face was marked with a single coloured spot the curve would be much flatter. For two dice the result would be the many, equally likely, combinations of two colours and the less frequent occurrence of two spots of the same colour. Note that assigning numerical values to a problem may actually cloud the issue.

If you throw multiple traditional dice multiple times you will end up with a distribution curve that is still fairly irregular. You can easily build an Excel spreadsheet to perform virtual dice throwing at the touch of a button. You end up with histograms that are never close to the idealised curve. This suggests that there is a difference between the complex real world of physical evidence as opposed to the simplified mathematical interpretation (Fig 4).

If you toss a coin several times it will not come up heads exactly 50% of the time, it would certainly be rare for it to come up monotonously heads then tails, heads then tails. Again it is easy to construct a spreadsheet that will do all the work for you. You can see from the graph of a marathon tossing event that there is about a one in five chance of getting twice as many heads as tails in a run of 32 (Fig 5).

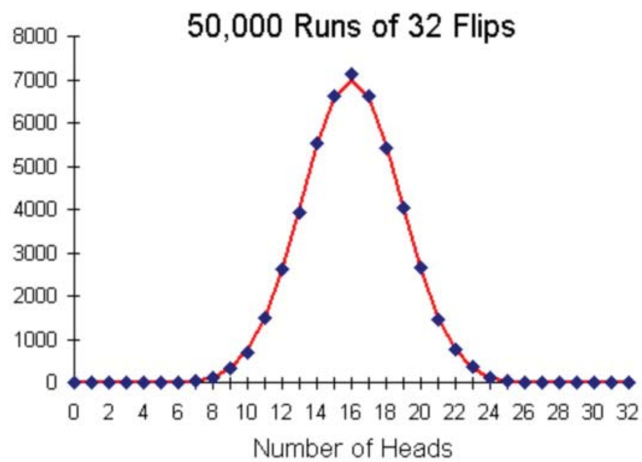


Fig. 5: *Even with a 50:50 chance there is a finite possibility of long sequences of heads*

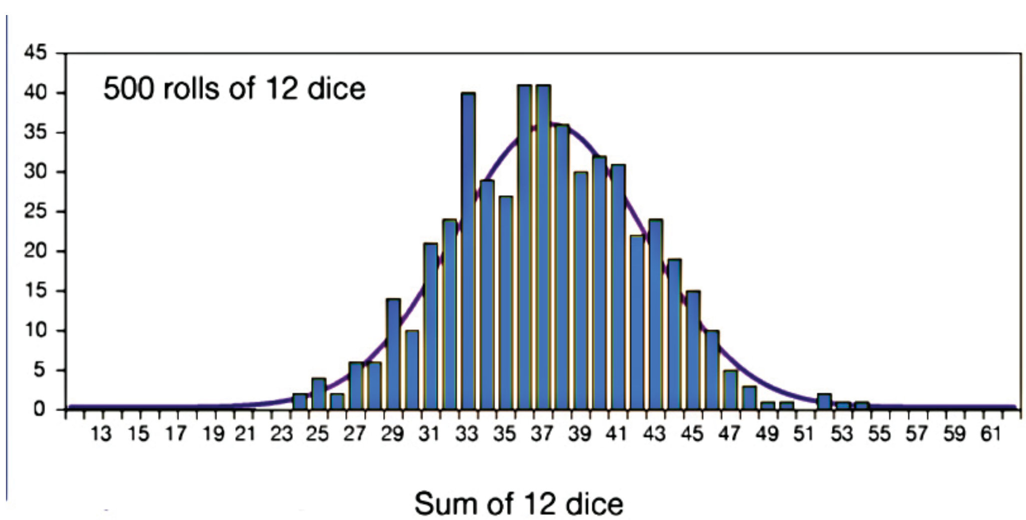


Fig. 4: *Even a large number of dice rolls does not give a smooth distribution*

A coin toss is deemed the fairest way to make a decision e.g. in deciding which team should bat first. However the result is not strictly probabilistic, it could be completely deterministic. The face that ends up on top depends on the speed of spinning and the velocity of leaving the player's hand, both can depend on skill and dexterity. If you were to practice for several hours a day for several weeks you might prove to be an expert tosser.

Science

If we return to the carriage-window analogy, the scientific outlook supports the belief that there is a whole world outside the train, that there is a fixed starting point and a fixed destination. With a map, a timetable and a watch we could make predictions about what we will observe through the window. Anyone else making the same journey would make the same predictions. The scientific outlook encourages belief in the predictable universality of everything that goes on outside the individual human mind. It allows the construction of laws that can predict with mathematical certainty how materials will behave as you alter their environment. What happens in reality is called 'non-ideal' behaviour.

Science – measurement

Conservators love to take measurements: temperature, humidity, illuminance, levels of particulates and pollution, numbers of insects, lengths of cracks. The desire for measurements to be more precise (small variation) and more accurate (closer to the 'real' value) often seems to override the need for information to help decision-making. The belief that there is a single real value would drive you to believe that the 'real' result of rolling two dice is seven.

Principle 5

The search for accuracy may not be necessary.
Mount Everest was recently found to be 86cm higher than previously thought. It is unlikely that this additional height will cause anyone to abandon their plans to reach the summit. There is an amusing story associated with the first measurement of the mountain's height. The figure of 29,000 feet looked as if it had been rounded up or down and was therefore not accurate. The published figure was a spurious 29.002 feet which looked believably accurate.

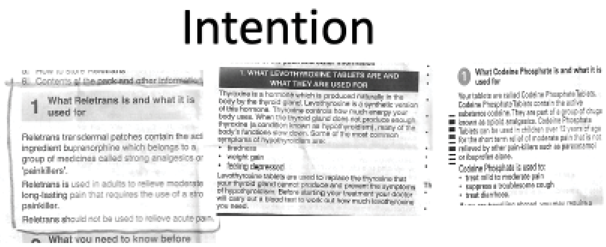
Science – experiment

Chemistry is often taught using equations. If you start with two chemicals A and B they will react to form a product C, or two products C and D. This is shown as:

$$A + B = C + D$$

The use of symbols lends an air of mathematical dependability. However it should be noted that not all chemical reactions are dependably repeatable. During my PhD research I carried out a reaction that only worked once. I tried many times to repeat it, but I couldn't. Many years later I published a letter in a chemistry journal asking if anyone had examples of non-repeatable experiments. I got two classes of reply. There were those who gave me their own experiences of experiments that worked irregularly or only once. And those critics who chided me for my bad faith in the universal truth of chemistry and remarked how poor my experimental technique must be.

The reaction of chemicals on living beings is known to be complex and not always predictable. My wife is currently on a course of treatment that requires her to take a variety of tablets every day. Each packet of tablets contains a piece of paper describing the



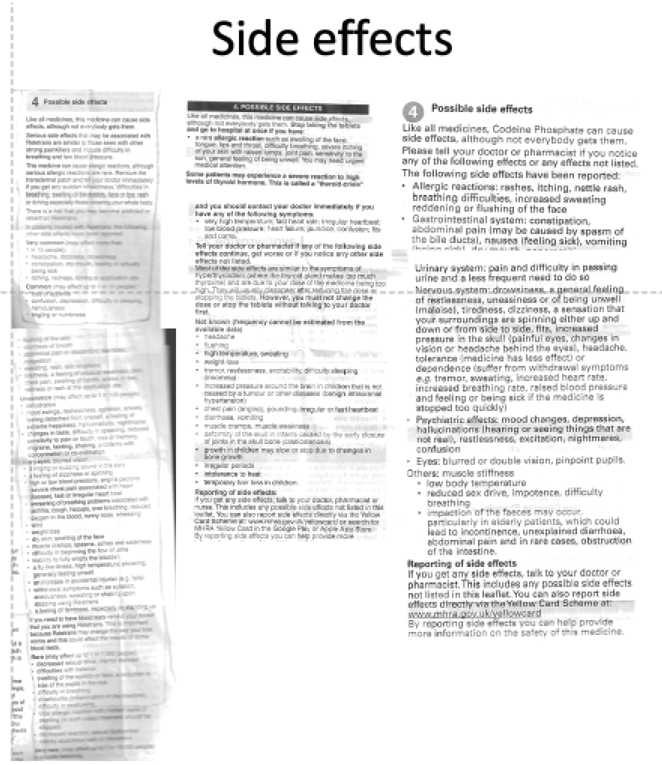


Fig. 6: *The possible adverse side-effects greatly outnumber the desired effect*

desirable effects and adding a long list of the possible adverse side effects (Fig 6).

You could argue that the occurrence of these unintended reactions was rare, but the important point is that there are numerous ways in which a simple A+B does not lead to the hoped-for C.

Ethics

The subject of ethics is full of uncertainties, yet people can be quite dogmatic on the topic. Many conservation decisions are influenced by concerns about ethical behaviour. Yet it is not certain how strong the foundations of conservation ethics are.

I have suggested that ethics are derived from the constraints imposed by the physical properties of the object. I have suggested that ethical guidance cannot be arrived at by thought alone or from heavenly messages. More recently I have concentrated on exploring the arbitrary nature of some ethical rules. I am currently examining the idea that conservators just like to make things difficult for themselves. In some ways this is related to the idea of the excitement of risk-taking, discussed earlier. Rock-climbers deliberately choose the challenge of the most difficult route to the top. I got the idea by watching my wife play card games (Fig 7).

Fig. 7: *Satisfying a desire to act ethically by choosing the most challenging way to play*

She routinely plays the two-pack game known as Miss Milligan. The game is a mixture of chance and strategy. You can improve your chances by careful thought, but If you follow the rules strictly you will only win two or three times out of ten. However there are some minor variations to the rules of play that improve your chances. My wife considers these to be cheating, that is unethical or immoral. However there are others who have never learned any other but the easy way.

Jigsaw puzzles offer another example of how some people like to increase the challenge of a harmless pastime. It seems obvious to me that you should use the information from the image on the lid of the jigsaw puzzle box. Hard-line puzzlers think that is cheating. Some people pick out all the edge pieces first. The masochists start at the top left corner and work row by row or column by column.

An example of deliberately making life difficult in a conservation context is the restoration of Sungnyemun a 14th century ceremonial gateway in Seoul, South Korea. This monument was severely damaged by fire. (Fig 8.) The subsequent restoration was carried out using traditional methods and materials, scrupulously avoiding any use of modern mechanical methods. Even the iron tools for stone-cutting were made on site using traditional skills.

Conservators make life difficult for themselves when deciding what aspects of the heritage they should respect. Respect is a word that has appeared from time to time in various codes of ethics, Conservators have devised self-imposed rules that say that they will respect the physical, historic, aesthetic and cultural integrity of an object, as well as the people or person who created it. That is hard enough but becomes even more difficult if

Fig. 8: Sungnyemun after the 2008 fire

you also want to respect the environment, the sustainability of forests and the rights of animals. Faced with an object that has ivory inlay that is broken and incomplete you have to tackle problems with the law and your conscience. You might also choose to consider that the current legislation on ivory use does not actually stop poaching, whereas regulated trade might do so. [2]

If you are going to rely on ethics to decide on or defend a course of action you should surely know where the ideas come from. I have proposed that you have to experience something before you can theorise about it; theory follows practice. I have been told by European colleagues that this is an Anglo-Saxon attitude (England is not a part of Europe!). One of these critics, Muriel Verbeeck writes: "The Continentals grew with the idealistic thought of Descartes, for whom truth illuminates reason and is later verified by experience."[3] She and I have agreed to disagree. One of my more useful maxims is "Evidence of fallibility is not evidence of stupidity". Just because, in your opinion, one person is wrong on one point it does not mean everything they say is wrong. My maxim is loosely based on the view that "Absence of evidence is not evidence of absence". This is an expression popularised by Carl Sagan to justify the search for alien civilisations and used by religious apologists in order to maintain their faith. This legitimises the idea that you can propose a theory with no evidence to support it. I rather incline to Christopher Hitchens Anglo-Saxon view that "what can be asserted without evidence can be dismissed without evidence".

Conclusion

In *The Comedy of Errors* William Shakespeare has one of his characters speak of "sure uncertainty". This is an indication that you must always expect uncertainty and must surely learn to live with it. I think you must learn to accept the complexity of decision-making within the cultural heritage field and should remember the maxim "It's never that simple".

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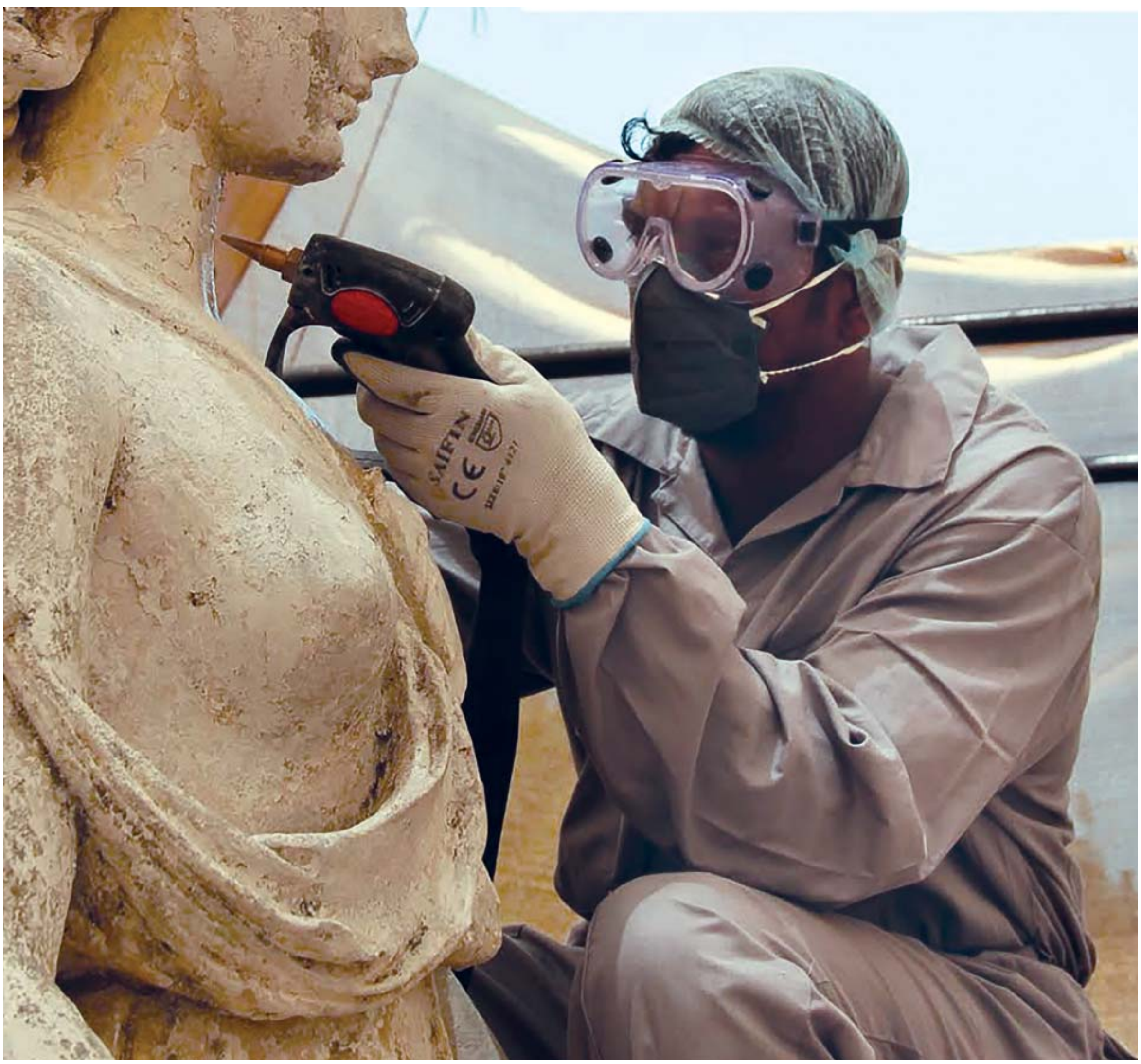
About INTACH Conservation Institutes (ICI)

INTACH Conservation Institutes or the **Art & Material Heritage** division with its main conservation centres located in Delhi, Lucknow, Bangalore and Bhubaneshwar undertakes continuous study and research to develop best methodologies in the field of art conservation in India. The division houses specialized departments for the treatment and care of paintings, works on paper, 3D objects, textiles and other works of art. The ICI laboratories are equipped with modern tools and facilities and a dedicated team of trained conservators to undertake art conservation. The Centres also undertake on-site conservation projects involving architectural features such as stones, stucco work, wall paintings, tiles, plaster work, decorative wooden elements, stained glass, gilding, etc.

The Centres offer a wide variety of professional conservation and preservation services to various governmental and non governmental organizations, private collectors and corporate clients all over India. These include examination of art work, assessments and surveys, documentation and inventory preparation of collections, conservation treatment, storage and display, museum design, preventive conservation, training and capacity-building activities, exhibitions and other outreach programmes.

INTACH is undertaking documentation of wall paintings sites in India under the self-funded ‘Wall Painting Directory’ project. It has also established ‘INTACH Lime Research & Testing Centre’ at Lucknow to offer laboratory testing services and to undertake scientific examination of lime, lime mortar, lime plasters used in building construction and architectural decorations. The scientific research unit of ICI is developing methodologies for analytical imaging and material analysis.



About INTACH

The **Indian National Trust for Art and Cultural Heritage** (INTACH) is India's largest non-profit membership-based organization dedicated to conservation and preservation of India's natural, cultural, living, tangible, and intangible heritage. Its mission is to:

- Sensitize the public about the pluralistic cultural legacy of India;
- Instill a sense of social responsibility towards preserving our common heritage;
- Protect and conserve our living, built, and natural heritage by undertaking necessary actions and measures;
- Document unprotected buildings of archaeological, architectural, historical and aesthetic significance; and cultural resources, as this is the first step towards formulating conservation plans;
- Develop heritage policy and regulations, and make legal interventions to protect our heritage when necessary;
- Provide expertise in the field of conservation, restoration and preservation of specific works of art; and encourage capacity building by developing skills through training programmes;
- Undertake emergency response measures during natural or man-made disasters, and support local administration whenever heritage is threatened;
- Foster collaborations, Memoranda of Understanding (MoUs) and partnerships with government and other national and international agencies; and
- Generate sponsorships for conservation and educational projects.

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