



# Conservation Journal

# V&A

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V&A Conservation Journal No.53

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Deputy Head, RCA/V&A Conservation  
Postgraduate Programme

Mike Wheeler  
Senior Paper Conservator

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All enquiries to:-  
Conservation Department  
Victoria and Albert Museum  
London SW7 2RL, UK  
Telephone +44 (0)20 7942 2133  
Fax: +44 (0)20 7942 2092  
e-mail conweb@vam.ac.uk

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**Head of Conservation**  
Sandra Smith

PA & Dept Secretary

## Conservation Department

Staff Chart Summer 2006

Science	Furniture, Textiles & Frames (FTF)	Paper, Books & Paintings (PBP)	Sculpture, Metals, Ceramics & Glass (SMCG)	Information Management & Administration
<b>Graham Martin</b>	<b>Marion Kite</b>	<b>Alan Derbyshire</b>	<b>Victoria Oakley</b>	<b>Fiona Campbell</b>
Boris Pretzel Brenda Keneghan Valerie Blyth Lucia Burgio	<i>Furniture</i> Shayne Rivers Tim Miller Nigel Bamforth  <i>Gilded Furniture and Frames</i> Christine Powell Zoë Allen  <i>Textiles</i> Lynda Hillyer Albertina Cogram Frances Hartog Susana Fajardo-Hunter Elizabeth-Anne Haldane Lara Flecker Miriam McLoed (c) Natalia Zagorska-Thomas(c)	<i>Paper</i> Merryl Huxtable Victoria Button Michael Wheeler Susan Catcher Lisa Nash (RIBA)  <i>Preservation Conservators</i> Clair Battisson Simon Fleury Chris Gingell Thordis Baldersdottir (c)  <i>Books</i> Jane Rutherford Anne Bancroft Anne Greig (c) Eoin Kelly (c)  <i>Paintings</i> Nicola Costaras	<i>Sculpture</i> Charlotte Hubbard Sofia Marques Victor Borges Brendan Catney (c) Johanna Puisto Lisa Wagner Jonathan Kemp (c) Sarah Healey-Dilke  <i>Metals</i> Diana Heath Joanna Whalley Sophy Wills Donna Stevens Katia Viegas Wesolowska Gates Turner (c)  <i>Ceramics &amp; Glass</i> Fi Jordan Juanita Navarro Hanneke Ramakers  <i>Stained Glass</i> Sherrie Eatman	Michelle Murray Angela Knight

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### Internships

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Priya Kapoor

#### Paper

Ilse Entlesberger

### RCA/V&A Conservation

#### Surface Studies

Marie Vest, PhD

#### Modern Jewellery

Cordelia Rogerson, PhD

#### Materials and Techniques of Tudor Portrait Miniatures

Timea Tallian, MPhil

#### Textiles

Alice Cole, MA  
Hazel Arnott, MA  
(with Historic Royal Palaces)

#### Conservation Science

Naomi Luxford, MA  
(with English Heritage)  
Tsing-Young Dora Tang, Msci  
(with Imperial College)

#### History, Ethics & Management

Helen Evans, MPhil

#### Conservation of Bronze

*Sculpture*  
Lucy McLean, p/t in-post MA

### Musical Instruments and Ethnographic Objects

Sandra Joly, MA  
(with the Horniman Museum)

### Metals and Surface Finishes of Social History Objects

Sia Marshall, MA  
(with the Museum of London)

### Characterisation of Photographs in The National Archives Collection

Simon Bloxham, MPhil  
(in association with The National Archives)

### The Drawing Media & Working Technique of David Smith (1940-1965) & its Significance to his Aesthetic Philosophy

Richard Mulholland, MPhil

### Natural History Conservation

Lirica Lynch, MA (with the Natural History Museum)

### Other Students

#### Enabling Museum Professionals with New Collections Management Tools

Emma Richardson, University of Southampton/V&A Collaborative PhD

#### Analytical Chemistry

Carolyn McSharry, Imperial College/V&A Collaborative PhD

#### Investigating the Problem of Consolidating East Asian Lacquer (provisional title)

Nanke Schellman  
V&A/Hochschule für Bildende Kuste collaborative PhD

#### Examination of the Effect of Western & Japanese Consolidation Treatments of Micro-cracks in the Surface of Aged Japanese Lacquer (provisional title)

Adel Elmahdy, 3 year PhD,  
Loughborough University

Key

Senior Management Team

(c) Contract Staff



# Editorial

Sandra Smith

Head of Conservation

This edition of the Conservation Journal is largely focussed on the preparation of the V&A's outstanding collections of Islamic art for a touring exhibition and for subsequent redisplay in the Jameel Gallery of Islamic Art which will open in July 2006.

Plans to redevelop the galleries began in earnest after £5.4 million was secured from an external benefactor (Thompson) in Spring 2003. Recognising the international importance of the collection, particularly in the current political climate, the Museum realised that it would not be appropriate to simply close the gallery and put the collections into storage. Instead, it was agreed that many of the star pieces in the collection would become part of an international touring exhibition. This involved conserving, condition checking and packing over 120 objects in just under six months.

The logistics of sending the touring exhibition (*Palace and Mosque*) on multi-venue tours is highlighted by articles from Ashbridge and Sofer, members of the Technical Services team. Working alongside conservators and curators, they developed durable and reusable systems to protect the fragile and environmentally sensitive pieces on the tour. The presence of ivory and other materials from endangered species added to the legal complexity of the loan. The need for architectural fragments to be reconstructed and fragile silk carpets and textiles (Hartog & Zagorska-Thomas) to be mounted required the presence of conservators at all installations and deinstallations.

Whilst this touring exhibition was in progress, work commenced on preparing some of the non-touring collections for the new display. The range and diversity of materials has involved the skills of all the conservation studios in its preparation: ceramic tiles from the walls of the tomb of Buyanquli Khan (Jordan & Wood); wooden furniture and architectural pieces such as the Minbar; the Ardabil carpet, which will for the first time be displayed flat on the floor of the gallery; an album page from Persia (Burgio); and exquisite metalwork and glass. The gallery is evocative and atmospheric, with beautiful imagery recreating the magnificence of the Islamic world. It is truly a delight to behold and will be an exciting and invigorating source of inspiration for the visitors.

Also in this edition the conservation of a period room is recorded (Melching). Not, as you may be imagining, some ornate seventeenth century music room with gilded mirrors, but something a little closer to home - a 1920s fitted kitchen complete with ironing board and dish rack! Intended as the star exhibit in the spring exhibition *Modernism: Designing A New World*, it challenged the traditional conservation approach normally taken to decorative finishes in a decorative arts museum. By discovering more about the design concepts behind the kitchen and the materials used in its construction, the article confirms that pest management and preservation has been an ever-present concern in even the most mundane aspects of our lives. Perhaps we should incorporate some of these ideas in museum storage in the future!

# Developing the Islamic Middle East gallery and touring exhibition

Claire Thompson

Islamic Project Co-ordinator

In 2003, the V&A received a substantial donation of £5.4 million from Hartwell plc, part of the Abdul Latif Jameel Group, to transform one of its historic galleries into a fitting home for the Museum's superb collection of Islamic art from the Middle East and finance a touring exhibition of the V&A's Islamic treasures. The Jameel Gallery of Islamic Art is dedicated to the memory of Mr Abdul Latif Jameel, the late founder of the Abdul Latif Jameel Group, and his wife Nafisa. Located in Gallery 42 on the ground floor, it is at the heart of the V&A, with a floor area of 550 square metres and a height of 13 metres at its centre. It houses treasures from the V&A's collection of more than 10,000 Islamic objects from the Middle East.

Following the donation, the V&A set up a dedicated team to develop the gallery and the touring exhibition intended as a showcase of star objects from the collection, to travel internationally during the gallery closure. A project team was formed of curators, a project co-ordinator and a gallery educator, who were responsible for intellectual content, and the structure and management of the refurbishment process. This team was supplemented as the project progressed by V&A staff working within the normal departmental structure (Collections Services, Public Affairs, Projects & Estate etc.).

The project team's first task was to forge the narrative concept and aims for the new gallery and touring exhibition, then work out how to deliver them. Following the example of the V&A's British Galleries, a framework document was developed, detailing intellectual content, the objects required and interpretation needed to make them accessible to the public. A programme was also developed, breaking the project down into manageable and integrated tasks so that activities, roles and responsibilities were clear. These tools enabled us to identify the objectives and the resources required to deliver the project by the agreed opening date of 18 July 2006.



Photography by Phil Sofer

Figure 1. The Ushak medallion carpet (T.71-1914) during de-installation, National Gallery of Art, Washington D.C.

Another tool developed out of the British Galleries was PROJEXS, a project-specific information database. The team inputted detailed information about every object, including photography and conservation requirements, object dimensions and display needs, while the database automatically drew down information from CIS (the V&A's central Collection Information System) and fed into the database to generate working lists for the conservation teams.

In August 2003, staff responsible for storage, collection records, object handling, packing, conservation and photography were brought together to plan the first practical step of de-installing the existing gallery. An off-site store was prepared for objects. Gallery 42 closed in November 2003 and, over a four-week period, 400 objects were audited, photographed, measured, condition checked, packed and taken to storage or for conservation work.

By the time of the gallery closure, the object list for the touring exhibition had been largely agreed. One hundred and twenty objects were selected and in just six months conservation work was completed, mounts made, travel crates built and packing undertaken. Because of time and resource limitations, a number of large ceramic objects were sent out of the Museum to be treated. A star object of the show, the Iznik fireplace (Museum no. 703-1891; Front cover image), needed six months' work alone to make it suitable for travelling to four international venues.

Once the touring exhibition arrangements were well underway, attention focused on the gallery in earnest. By August 2004 the framework document was agreed, enabling the team to set up the PROJEXS database. Object lists were then generated to enable assessments of conservation, photography and display requirements, and the resources needed to undertake this work. The considerable challenge of moving over 300 objects between the stores, mount-making workshops, photography and conservation studios was undertaken by the assistant curators. Short-term contract staff supplemented the V&A's existing conservators in order to deliver the objects in time for the installation in April 2006. A whole year before installation, in-depth mounting and framing decisions had to be made to inform the detailed design of display cases by lead architect Softroom, in liaison with the case manufacturer Goppion Srl.

The project team started working with Technical Services on the detailed planning of the object installation from late 2005 – we calculated that 400 objects of varying complexity would take the team eight weeks to install. Thirty out of the 47 display

cases in the gallery contained objects that were travelling in the exhibition, so we concentrated at first on the large carpets, heavy tilework, high level windows and textile displays. When the touring objects returned to the V&A, there were fifty crates to unpack before work could start on the rest of the gallery. We worked in teams tailored to the task in hand. The curators worked on small object displays, with a technician if needed to install object mounts. For large and complex objects, assessments were undertaken to plan the work stages, equipment and resources required.

Our biggest challenge was the project's timescale. The project team were all relatively new to the V&A and had to hit the ground running to deliver, from scratch, an international touring exhibition, two publications and a major new gallery in just over three years. In the early stages, the project team were under pressure to keep up with the design team who were solely focused on the gallery. Careful prioritisation and hard work were required to keep one step ahead, and in some cases, such as the Ardabil carpet light-fastness testing, the V&A was late in delivering vital information to the consultants.

The touring exhibition presented an interesting challenge. Initially it distracted from the delivery of our main goal – the permanent gallery. Yet it enabled narrative ideas to be thought through and helped us to see the objects in a new light. From a practical point of view, we sometimes found it frustrating to have 120 objects on the other side of the world. However, in moving the objects between four venues an intimate knowledge of them was gained – which came in particularly useful when detailing cases for, and installing, the new gallery. Nearly 300,000 people visited the exhibition at its four venues, which acted as a wonderful opportunity to showcase the forthcoming Jameel Gallery of Islamic Art at the V&A.

# Planning the packing for a touring exhibition

Richard Ashbridge

Packing and Transport Manager

The Packing Team, part of the V&A's Technical Services Section consists of myself and eight technicians. The team is responsible for packing all objects that go out on loan from a single item to a complete touring exhibition. This article focuses on the complex set of issues that need to be taken into consideration when planning the packing of a major multi-venue exhibition such as *Palace and Mosque*.

Claire Thompson's article explains how the content of an exhibition is developed. At an early stage (a year in advance) representatives from Technical Services are consulted on the feasibility of shipping larger, more complex objects such as the seven metre high mosque pulpit or Minbar (1050-1869), the packing of which is discussed in the accompanying article by Phil Sofer. Approximately six months prior to departure when the object lists are nearly (but never quite) finalised, the planning of the packing begins. As a manager the task ahead is to get the right resources in place for the scheduled packing time. To reserve the right number of people with the right skills, equipment and materials is never an easy task, even in a large museum, particularly as these technicians are also in demand for their mount-making and object installation skills and may also be acting as couriers.

Faced with the big list of objects (120 in *Palace and Mosque*) that comprise a travelling exhibition, one is confronted with the daunting task of satisfying a number of conflicting demands all at once. The most complex part of this preparation is often determining the number and size of the packing crates that will be required. At this initial planning stage it is important to keep an overview of the whole project. Most objects can be subdivided into a few basic categories for example, large 3-D, small 3-D, framed work, and perhaps some specialist categories such as rolled textiles, costumes on mannequins, or room set panels. By dividing up the initial list and developing a general strategy for each type, a rough time estimate can follow and resources can be quantified. This information is also required by colleagues who are, for example, planning the shipping, costing the tour and liaising with venues.

Exhibition organisers may present you with a further set of complications that arise from the legal side of exporting artworks. Objects may contain materials covered by CITES (Convention on International Trade in Endangered Species) such as ivory, tortoiseshell or coral and will require licences for travel. It is helpful if these objects are grouped together so that only one shipment is affected by this paperwork. There may be requests to keep the insurance values of split shipments roughly equal. This often works itself out without too much difficulty but a group of small, very high value objects, which may fit nicely into one crate, can skew these figures. If all this wasn't complex enough different venues may want to reconfigure the exhibition adding and subtracting objects, therefore those returning earlier need to be crated separately. All these concerns mean that drawing up the crate specification can be far from simple. The best approach is to accept that such a document will undergo several drafts, early versions of which will contain significant gaps where information is still to be confirmed. These early documents are worth circulating however, especially to the transport agent, as it helps them with their scheduling and ordering of materials.

For V&A tours, crates are usually constructed by the transport agent but may also be hired or made in-house. For a large exhibition the crate specification will generally be required six to eight weeks before the first crate is to be delivered. This document details the following:

1. General construction standards of crates: whether painted, require runners for pallet truck access etc.
2. The number of crates required with internal dimensions and the objects they are for.
3. Any internal linings, foam, Plastazote® battens etc, plus any internal boxes or trays to be supplied.

The first set of decisions that need to be resolved concern the physical space objects will require when travelling. Will objects travel upright or flat? Will objects be taken apart for travel? Will costumes stay on their mannequins? What will be the dimensions

of travelling rollers or picture frames? Questions like these are not always as straightforward as they sound. At this planning stage many objects are still being conserved and will not be in their final shape for exhibition. This is an ideal time to get involved in decision-making and discuss how objects are best configured for the purpose of travelling, handling, display etc. In return conservators will advise on where objects are physically vulnerable and how they are best handled. Transport agents can also provide useful information on how they dealt with similar projects and what worked well.

Given a free hand I would always prefer to pack like with like, for example crating frames of similar sizes together or key cutting contoured spaces in foam filled trays for small 3-D objects. This approach generally saves on packing time, volume and number of crates (and therefore cost). A touring exhibition of around 70 crates may need to be packed in two and a half weeks. For a show of mixed objects, I would estimate that a team of six technicians can pack one crate each from scratch per day. Obviously complex 3-D objects take longer to pack and handling heavy objects will require several technicians at once so this will need factoring into the estimate. Touring objects also require a certain amount of supporting material to go with them for example, hanging systems, book cradles, mannequins, acrylic mounts and even specialist toolkits. Many of these will only materialise in the last few weeks and need to have their dimensions estimated, therefore it is often more practical to have a dedicated fittings crate that also contains the condition reports and packing notes.

The final point to anyone trying to find their way through this maze is not to lose sight of the fact that your first priority is towards the physical wellbeing of the objects. In the end you may not have met every administrative demand but the key issue is that the packing offers the right degree of physical protection from the potential dangers of travel.

## The traveling technician – The role of a technician as courier

Phil Sofer

Packing and Transport Technician

In recent years there has been a continued increase in the number of loans from the Museum to exhibitions in the UK and around the world. The Museum exhibition program has also expanded and it is not unusual for there to be three or more V&A exhibitions travelling the globe. It is standard practice at the V&A for a representative of the Museum to act as courier during the movement of objects between locations. A courier is responsible for the safety of the object(s) during all stages of transport between venues and must supervise the unpacking (or packing), installation (or de-installation) and check the objects against condition reports provided by V&A conservators. As staff in the Museum continue to develop conservation and packing techniques, objects that would have previously not traveled, due to conservation issues, size or complexity of packing or installation, can now be included in exhibitions. This brings new challenges for the museum courier. In some situations there can be an advantage in sending either a conservator or a technician as that courier.

The recent touring exhibition *Palace and Mosque* illustrates the issues involved and the benefits of including a technician as courier, and how their role differs from that of other V&A staff. *Palace and Mosque*, which travelled to four museums on three continents, included some of the finest objects from the V&A's Islamic collection. The object list included a Minbar, a mosque pulpit with an overall height of 7 metres (Figure 1), a large ceramic fireplace, two large carpets and numerous fragile objects with specific handling and installation requirements. With these challenging objects and short installation/de-installation windows at some venues, a team of four couriers was put together comprising of the project coordinator, a curator, a conservator and a technician. The advantage of including a conservator and a technician is that they can be selected from staff who have worked on the conservation, installation/de-installation, and packing of the objects at the V&A, and so bring with them valuable knowledge of specific objects.



(Photography by Phil Sofer)

Figure 1. The Minbar (1050-1869) during installation

The 120 objects were packed in 50 crates and split into two shipments. The accompanying article 'Planning the packing for a touring exhibition' by Richard Ashbridge discusses the organisation involved in this. The crates were transported between venues by air and by road. Space is often tight on a cargo plane and it is often impossible to avoid stacking crates when palletising. All V&A couriers are trained to make decisions under these circumstances, however the *Palace and Mosque* crates were unusual in their size and weight and transporting them was complicated. As technician couriers are equipped



with the knowledge of crate construction and packing methods they can confidently make decisions as to which crates can safely be stacked. This knowledge is also helpful when loading and unloading trucks as it is important that the weight is sensibly distributed and the crates properly secured. The seven metre high Minbar (1050-1869) would be complicated to install, however the initial challenge was to get the crates to the venue! Due to the size of the object it had to be transported in smaller sections. The two largest crates contained the fragile sides of the Minbar, they were 3 metres tall, 4.5 metres wide and tipped the scales at 750 kg each. It helped to have a technician on hand with the knowledge to inspect slinging methods and instruct on the safest way to move crates of this size and weight. Figure 2 illustrates the loading of these crates onto a truck in Japan. The narrowness of the crate made it unstable, so all movements had to be carefully controlled.



Figure 2. Loading the Minbar crates

With all V&A loans, a courier is equipped with detailed conservation reports, packing notes and photographs and will usually be briefed by the V&A Packing and Transport team on how to unpack and repack an object. At each leg of the *Palace and Mosque* tour the V&A technician worked with local technicians to lead that team in the unpacking/

packing and installation/de-installation of the more challenging objects in the exhibition, as well as being on hand to help the other couriers with any packing or installation queries. It was vital to have a V&A technician to lead the installation of an object such as the Minbar. The components had to be installed in a very specific order that required a coordinated team of eight technicians and numerous pieces of equipment. In Figure 1, the Minbar is shown during installation in Japan before the addition of the elaborate door frame and doors at the foot of the steps. A technician is inspecting the finial, having just secured it against possible earthquakes.

Some objects in *Palace and Mosque* required specific climatic conditions that had to be tightly controlled both on display and during transit; an example of this is a brass mosque lamp holder (109-1888) that had to be kept below 30% rh to ensure areas of old corrosion would stay inactive. Following consultation with Conservation, a crate was designed to control the environment (Figure 3). The object was sealed in a micro climate, maintained through a combination of silica gel and molecular sieves to remove excess



Figure 3. Crate containing the brass mosque lamp holder (109-1888)

moisture from the air. The size and weight of the object dictated the use of a wooden crate so this was treated to prevent off-gassing. The object sits on an acrylic base within the packing which, is designed so that the lamp can be installed without directly handling its fragile surface. The technician's familiarity with both packing and installation methods ensured that the object could be transferred between the protective atmospheres of the crate and display case in the minimum period of time, reducing its exposure to higher humidity levels in the gallery. It was also vital that the object was repacked in exactly the same way each time, to ensure that the object's condition remained stable.

Acting as a courier also provides opportunities to share information with technical staff from other museums. A good example is the installation of the Iznik fireplace (703-1891) shown in Figure 4. Following conservation treatment the object was mounted into manageable sections for transport which ultimately fitted together onto an aluminium support structure for display. Although an installation method was

devised before the object left the V&A, the first time the fireplace was constructed in its new configuration was when it reached the National Gallery of Art in Washington D.C. This was an opportunity (since there was no tried and tested method of installation), to discuss, develop and improve methods with technical staff at each venue and to plan for the object's eventual installation on return to the V&A.

As we have seen there are many advantages in choosing a technician to act as a courier, particularly when dealing with complex objects that are difficult to install or that require specialist packing and transport. The technicians' primary concern will be the welfare of the objects, in addition by working at different venues in the UK and worldwide there is the opportunity to build relationships with other technical departments and exchange ideas which benefit the individual, Technical Services and the Museum as a whole.



Figure 4. Installation of the Iznik fireplace (703-1891)

# Harpies – Past and Present

Frances Hartog, Senior Textile Conservator  
Natalia Zagorska-Thomas, Textile Conservator



(Photography by V&A Photographic Studio)

Figure 1. The Harpies (T.399-1980) after treatment

Amongst the 47 textile objects chosen for the new Jameel Gallery of Islamic Art there were a proportion that had been treated in the past. There were those that had been displayed in the old gallery or elsewhere in the Museum and others that had been requested for loan. Each object was assessed with regard to the new design requirements and the estimated duration of display. Some of the past treatments proved robust and very little or no extra work, other than a new mount, was needed. In other cases failings came to light. There was also the odd treatment that altered our perceived prejudices.

An object known as the Harpies (T.399-1980) was a good illustration of all three. Its past treatment, though robust, had failings that could now be recognised as methods and materials have advanced. It also utilised a technique that has a slightly ambiguous reputation but which had served the object well.

The Harpies is a fragmented piece of exquisitely woven silk double cloth (approximately 1.8m x 0.5m) depicting large human headed birds or harpies (Figure 1). It was excavated in the 1920s from a burial site in Rayy, Iran and dates from around the eleventh century. The desiccated silk is now extremely friable and subject to powdering. There are remnants of what appear to be linen body wrappings adhering to the verso.

The piece was treated when it was acquired by the Museum in 1980. It had been lightly adhered to a silk covered, padded board using dots of carboxymethyl-cellulose (CMC) adhesive around the edges of the fragments. The object was then framed and glazed, utilising the weight of the glass to hold the bulk of fragments in position.

Although the fragments appeared well supported and their general condition had not obviously deteriorated, there were several points that needed to be considered before the piece could be re-displayed:

- the gallery designers' request for a metal frame – to better integrate the object into the new gallery
- the heavy weight of the thick glass bearing down on the object, its breakable nature and the inferred danger to the object
- the insufficient padding of the existing board
- the use of unsealed wood as a backboard and the current availability of more inert and potentially less harmful support materials
- the method of framing. As it was only the pressure of the glass holding much of the object in position, its removal would leave the object extremely vulnerable

All of the above could be addressed with a new pressure mount using updated techniques and materials.

The old frame was removed and the glass was found to be ill fitting and crudely cut. The fragments were painstakingly released from the padded board by softening each dot of CMC adhesive. During removal it was noted that there was a secondary, more sympathetic holding mechanism of 'sticky threads'. These were adhered to the reverse of the fragments, holding them very lightly together and to the cover fabric of the board. This allowed the object to be moved without small sections floating away on air currents. When the object had been released from the board, it was found that the sticky threads readily peeled away from the fragments leaving no apparent residue and causing no obvious loss, even though the condition of the silk was so poor that the slightest uneven pressure caused it to disintegrate. The removal of the threads allowed the pieces to be realigned.

What are 'sticky threads'? To create them, sections of fine thread are passed through a pool of thermoplastic adhesive mixed with water, forming rivulets of glue along its length. When dry the sticky threads can be applied across a textile's surface, using heat or solvent vapour for reactivation. This treatment is characterised mostly by its limitations. It does not impart any strength because of the minimal surface area of contact between the thread and textile. Therefore it can not be used to produce a self-supporting joint between separate fragments. The scant contact means that if any stress is exerted on the bond, it will quickly fail. When used on the obverse of an object, the threads sit on the surface, making them unsightly.

As a result the treatment has very restricted applications and enjoys a mixed reputation. However, when the options are few and the circumstances right, such as no strain being placed on the bond (i.e. in a pressure mount) sticky threads can be a very useful device. They also have one major advantage: the treatment is easily reversible, as was demonstrated in their removal from the 1980 treatment of the Harpies. It is also a method which does not interfere with the original structure of an object, a useful characteristic when dealing with very degraded textiles or non woven materials.

The object was carefully realigned whilst laying face down. A decision was made to replicate the sticky threads using fine polyester Skala thread and the thermoplastic adhesive Vinamul™ 3252 (vinyl acetate-ethylene copolymer). The threads were laid across the verso of the object at regular intervals and set in place using a heated spatula (Figure 2). They not only held the fragments in position but also prevented sections floating away on air currents in the Studio whilst the treatment was in progress (Figure 3). In addition, if the piece requires re-glazing in the future, the threads should counteract the effects of static electricity during removal of its Perspex® cover.



# Tiles from the tomb of Buyanquli Khan

Fi Jordan, Senior Ceramics Conservator

Barry Wood, Curator, Islamic Gallery Project (Asian Department)



(Photography by Natalia Zagorska-Thomas)

Figure 2. Sticky threads being heat-set to the verso of the object

The piece was mounted on a lightweight, rigid board, Hexlite® 620, padded with (a recently tested) needled polyester and cotton domet, and covered in dyed silk. A sheet of acrylic was screwed down over it, firmly but not tightly. It was then framed in the requested metal frame, with a secondary glazing of UV filtered acrylic. If the outer acrylic becomes damaged or a different frame is requested, the exterior package can be dismantled without disturbing the pressure mounted inner unit.

The Harpies is one of 47 differing textile objects in the new gallery. Assessing and preparing objects for a project of this scale is always an education. It gives us the invaluable opportunity to review and evaluate past and present methods whilst keeping an eye on the future.

## Materials

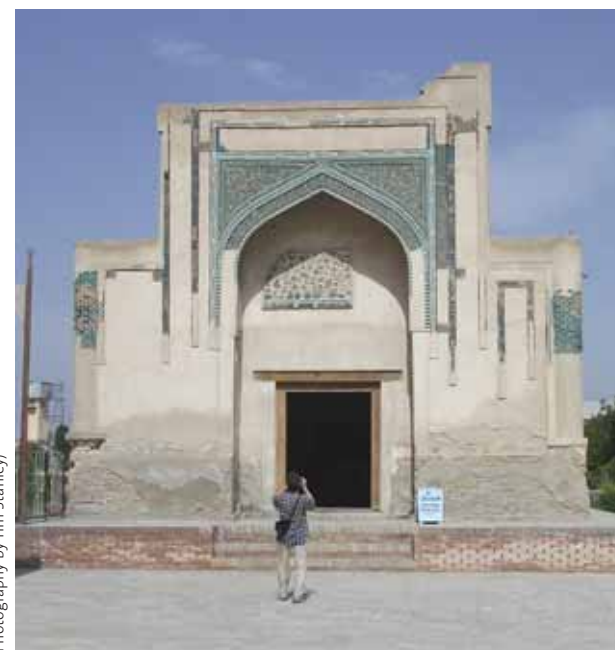
Hexlite® 620 (Hexcel Composites Ltd, Duxford, Cambridge, CB2 4QD)

Vinamul™ 3252 (Celanese Emulsions, De Asselen Kuil 20, 6161 RD Geleen, NL [www.celanese.com](http://www.celanese.com))



(Photography by Natalia Zagorska-Thomas)

Figure 3. Sticky threads holding textile fragments in place



(Photography by Tim Stanley)

Figure 1. Tomb of Buyanquli Khan, Bukhara

In the rough-and-tumble politics of fourteenth-century Central Asia, Buyanquli Khan was but a minor figure. Placed on the throne of Samarqand (in modern-day Uzbekistan) by the local power broker, he was a pious and devoted puppet until the assassination of his patron led to his own execution in 1358. His body was taken back to Bukhara and buried near the tomb of the revered Muslim saint Sayf al-Din Bakharzi at a complex called Fathabad in the western suburbs. In short order the political tables turned, and a faction of supporters and relatives avenged Buyanquli Khan's death. It must have been they who commissioned the splendid tomb which still stands, albeit in a highly restored state, outside Bukhara (Uzbekistan) today (Figure 1).

In architectural terms, the tomb of Buyanquli Khan is fairly straightforward; the exterior is just a flattened cube with a single dome and a high portal, while the interior consists mainly of two rooms, a large ziyaratkhana or "visiting room" and the tomb chamber proper. Yet this simple structure was sheathed inside and out with some of the finest

Islamic tiles ever made. All are made of deeply carved earthenware covered with a coloured glaze. The low-fired body is porous, pale yellow in colour with darker granular inclusions. The glaze colours are restricted to black, white, cobalt and aubergine details on a deep turquoise blue background, creating a powerful unifying effect. They are decorated with motifs ranging from simple stripes to geometric patterns and vegetal scrollwork of great complexity. The most impressive of the tiles are perhaps the inscriptions which once framed the façade; they include Qur'anic quotes and historical inscriptions in majestic *thulth* script 'floating' atop deeply carved arabesques.

The tomb's tiles were probably made by an independent local workshop. The style of the calligraphy, especially the elongation of the letters *alif* and *lam*, is typical of fourteenth-century monuments in Transoxiana, Central Asia. The austere restriction to one technique (deep carving under glazes of a severely restricted colour range), on the other hand, is striking; other tombs of the period, notably those at the Shah-i Zinda funerary complex in Samarqand, display a greater variety of techniques and more polychrome effects.

A great number of tiles from the tomb of Buyanquli Khan are now to be found in collections throughout the world. The V&A has an especially complete collection, much of which has long been on display in Gallery 133. The renovation of the Museum's display of Islamic art from the Middle East has provided an excellent opportunity to focus more attention on Buyanquli Khan, and an entire section of the new Jameel Gallery of Islamic Art is dedicated to a representative collection of tiles chosen to illustrate the quality and variety of the tomb's decoration.

The new display will include part of a decorative column and capital, individual tiles and framed panels of up to eight tiles. Tile dimensions vary greatly (the largest tile is over one square metre) but all are between 40-60mm thick. As the final surface layer attached to the fabric of the building, they had been exposed to the extremes of the Central Asian climate and other forms of deterioration associated with their architectural context, including damage caused by water (Figure 2).





Figure 2. White efflorescence on damp (previously tiled) walls indicating the potential for soluble salt migration

Structural damage ranged from minor chips and cracks to multiple breaks and losses – some likely to have been sustained during and after their removal from the mausoleum walls. The glaze surface was heavily soiled and encrusted in places. Soluble salt damage is visible on some tiles: salts have crystallised resulting in a network of glaze cracks and a weakened, powdery body below a distorted, lifting glaze.

Since their arrival at the V&A in the late nineteenth century, many tiles had been displayed high on gallery walls. Framing materials were cumbersome and, in some cases, they had not provided sufficient support to prevent the tiles from suffering further structural damage. In addition to historic dirt, a thick layer of black ‘museum dirt’ obscured both the brightly coloured decoration and damage beneath. It was apparent, on removal from the frames, that interventive treatments would be required to ensure stability and improve the appearance of the tiles prior to redisplay.



Figure 3. Deteriorated, unstable old repairs to tile inscribed 'Buyanquli Khan' (2043-1899)

Past restorations on the damaged tiles were often rather heavy-handed. Repairs to break-lines and missing sections of tile had also deteriorated making many objects unstable and unsightly. Layers of discoloured paint and crudely executed plaster fillings obscured large areas of original decoration including inscriptions (Figure 3). Removal of the over-paint and examination of the reverse of the tiles revealed further the extent to which the old repairs had failed.

Dowelling had been used extensively as a method of joining broken pieces. Channels had been cut out of the tile backs allowing iron bars to be set in a bed of plaster across the break-lines. The iron dowels had expanded due to corrosion. This resulted in the body being pushed apart causing new damage as well as weakening existing repairs and staining the surrounding area (Figure 4). The removal of the dowels, by mechanical means, was a lengthy, difficult process given the friable nature of the ceramic and extreme hardness of the rust-impregnated plaster. Dowels were only removed if actively weakening the joins.



Figure 4. Tile back: detail of iron dowels (2043-1899)

Reconstruction of the fragmented tiles began with the consolidation of friable areas. Paraloid® B-72 (ethyl methacrylate methyl acrylate copolymer) in acetone was used in different percentage solutions to consolidate and to bond detached pieces. As extra support on some of the heavier tiles, the cut channels were utilised to house carbon fibre rods (3-5mm diameter). The exposed earthenware was sealed with Paraloid B-72 in acetone prior to embedding the rods in Multipurpose Polyfilla® (calcium sulphate hemihydrate with cellulose ethers).

Conservators and curators agreed on options for the reconstruction of missing, or previously restored, tile sections. Incorrectly restored letters were changed. If tiles had large incomplete areas of script, small losses were restored to make the text legible, leaving the remaining missing design unfilled (Figure 5). Previously, large sections of loss had been replaced with blocks of wood or over-filled with plaster and, rather obtrusively, painted in white. These were removed to allow either for a partial reconstruction of the pattern (if known) or a reduction in the level of the plaster, which was then painted in the background colour.<sup>1</sup> This approach enabled the script to be easier to read and the losses more discreet. As part of a group display, consideration was given to the appearance of the tiles in relation to each other: this required a consistent level of finish to all restorations.



Figure 5. Tile after treatment: example of partial reconstruction (2043-1899)

Preparation for display included backing tiles on lightweight Hexlite® 620 boards, employing a method used in the Museum since the 1990s.<sup>2</sup> The larger tiles and panels are framed. The tiles are on open display and, as such, will be subjected to particulate pollutants in the air, which in turn attract moisture. In planning future care, the extent of the old and new restorations and evidence of soluble salts are important considerations. Preventive measures will need to include monitoring their condition, maintaining a stable relative humidity and keeping dust levels to a minimum.

The success of the Buyanquli Khan tile project relied on planning suitable treatments that would be achievable in time for the gallery installation. Inevitably, this did lead to compromises on some objects. In order to effect good results, conservators worked closely as a team and, in turn, gained valuable experience in the treatment of architectural ceramics.

#### References

1. Retouching medium: Golden® Polymer Varnish w/UVLS (acrylic/styrene copolymer) (Golden Artists Colors, Inc) and dry artist's pigments.
2. See: Jordan, F. 'The Remounting of a Victorian Tile Panel'. *V&A Conservation Journal*, (October 1999), no 33, pp.10-12. Method using Hexlite® 620 (Hexcel Composites Ltd, Duxford, Cambridge, CB2 4QD).

# Pigment analysis of a Persian album page

Lucia Burgio, Object Analysis Scientist, Science Section

Barry Wood, Curator, Asian Department

Robin Clark, Sir William Ramsay Professor of Chemistry, Chemistry Department, UCL

Mike Wheeler, Senior Paper Conservator



Figure 1. The Persian album page (L.6964-1980, dimensions 40.2 x 26.4 cm)

A Persian album page (L.6964-1980) is one of the most important works on paper displayed in the newly opened Jameel Gallery of Islamic Art (Figure 1). It was chosen for pigment analysis in the attempt to learn more about it and support the information currently available on its provenance and date. The album page, albeit clearly unfinished, is an early *collage* of several different contributions added in the sixteenth and seventeenth centuries.

The drawing of a mounted hunter in the centre of the page is signed by Riza-i Abbasi: the most important painter of Safavid Iran (active 1590-1640), whose style had a revolutionary impact on not just painting, but all art of the period. The hunter and his horse are only outlined and just a few minor details, such as part of the bridle and the hilt of the hunter's dagger, were actually painted. The painting of a standing man (top right) is attributed to Ustad Muhammad Qasim who, it has been suggested by Norah Titley of the British Library, worked under Shah 'Abbas II (reigned 1642-1666). This man is fully illuminated, and is considered to be of lesser quality than the mounted hunter.

Some of the calligraphic panels are attributed to Sultan-'Ali al-Katib al-Mashhadi, (died 1520) a key exponent of Persian calligraphy. He was described by the sixteenth-century author Qazi Ahmad as 'the cynosure of calligraphers'. The main selection of calligraphy on this album page, interestingly, is not in Persian but in Chaghatay (Eastern Turkish). According to Qazi Ahmad, Sultan-'Ali Mashhadi did copy the Turkish poetry of Mir 'Alisher Nava'i, a late fifteenth-century official and patron under the Timurid dynasty.

The painting is in good condition, except for the blue frame that has faded. Most pigments and inks on the page were identified by Raman microscopy, a spectroscopic technique that is particularly suitable for the non-destructive analysis of art objects (Figure 2). This identified lapis lazuli in all blue areas, except for the faded border (indigo); lead white in all white areas, red lead in all orange and red decorations and carbon black in the inks. Different grades of lapis lazuli were used to achieve different shades of blue. The best quality lapis lazuli, characterized by crystals of pure lazurite (intense blue in colour), was used to make the dark blue pigment, whilst lower grades (in which the blue mineral lazurite is mixed with variable amounts of

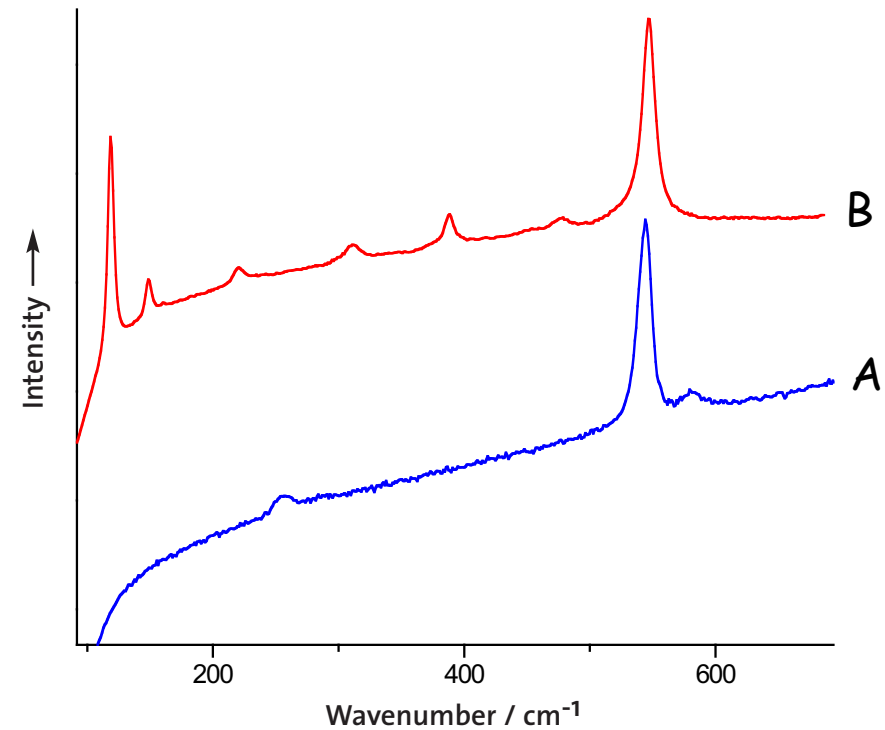


Figure 2. Raman spectrum of A) lazurite from the blue trousers and B) red lead from the face of the man, top right corner

lighter coloured materials, such as calcite) were used to decorate the lighter blue areas, such as the man's trousers, top right corner. The red lead was uncharacteristically deep in colour (dark red rather than orange-red). The crimson ink used in the drawing of the horse and the pink colour used for the small flowers did not give a Raman spectrum, and under the microscope had the appearance of a red lake rather than that of an inorganic pigment.

The analysis showed that all pigments and dyes identified were consistent with the provenance and the date of production of the object.



# Collaborative investigation of the Eltenberg reliquary

Sandra Smith  
Head of Conservation

The so called Eltenberg reliquary is one of the V&A's most celebrated and important pieces of twelfth-century ecclesiastical art. It was purchased by the museum in 1861 with a romantic and somewhat uncertain provenance and documentary history. Records suggest that it has had a variety of owners and has also passed through the hands of a number of dealers, who may have enhanced and improved its appearance through restoration.

The reliquary was examined in the Conservation Department, prior to being lent to an exhibition in Essen in spring 2005. Optical microscopy identified inconsistencies in paint application on the inner surfaces of the lid: under ultra-violet light, ivories fluoresced differently, signifying some later additions. 'Older' ivories exhibited localised, green, copper staining, but the associated metalwork was in good condition, suggesting that corroded metalwork had been replaced. From an art-historical perspective the designs on at least one of the enamels were not comparable with known examples of twelfth-century type; whether this indicates that they are authentic, but as yet un-attributed, is not clear.

The correct identification of provenance, date and original technology is necessary to support the Eltenberg reliquary's status as a 'star' object in the Medieval and Renaissance galleries, which are due to open in late 2009.

Only one other example of this type of reliquary is known. Owned by the Kunstgewerbemuseum in Berlin, the so-called Welfenschatz reliquary is very similar in shape, scale and decorative design; so much so, that the idea of them being produced by the same workshop has been suggested.

(Photography by Richard Davis, V&A Photographic Studio)



Figure 2. The Eltenberg reliquary

The Berlin reliquary was extensively investigated by a team of eminent art historians, curators, conservators and scientists in the 1990s, when the reliquary was undergoing conservation treatment. On completion of the work, a number of research questions remained unresolved, which could only be answered or verified by comparative investigation with the Eltenberg reliquary.

The Kunstgewerbemuseum team, lead by Dr Lothar Lambacher, raised the funds to enable the Eltenberg reliquary to be similarly researched. A joint venture agreement was signed in October 2005 between the V&A and the Kunstgewerbemuseum. The work began with meticulous and comprehensive technological drawings and has now proceeded to a detailed examination of individual components, such as the enamels and ivories. Scientific analysis is providing insights into provenance and date, whilst controlled and phased dismantling is revealing considerable evidence of original technology as well as illuminating phases of restoration. By working collaboratively, curators, conservators and scientists in Germany and England are sharing their experience and expertise.

In July 2006 a group of internationally eminent scholars and experts will be invited to discuss the findings of the investigation and examine the components of the reliquary, prior to reconstruction. Subsequently an exhibition, spotlighting the two reliquaries and associated twelfth-century enamels and ivories, will be held at the Kunstgewerbemuseum between September and November 2006. A small catalogue will accompany this exhibition and later an extensive publication will be produced for the academic community.

Figure 1. The V&A and Kunstgewerbemuseum Eltenberg reliquary team discussing interim results (© Satoria Linke, Berlin)

# Frankfurt Kitchen: Patina follows function

Karen Melching  
Furniture Conservator



(Photography by Karen Melching)

Figure 1: Frankfurt kitchen *in situ* before dismantling (©Stuttgarter Gesellschaft für Denkmalpflege)

In 2005 the Victoria and Albert Museum acquired a 'Frankfurt' kitchen (W.15-2005), which will be the centrepiece of the exhibition *Modernism: Designing A New World* (6 April – 23 July 2006). It was one of the first fitted kitchens, designed by the Austrian architect Margarete Schütte-Lihotzky in 1926 with the aim of minimizing the housework for a generation of women who had to balance their chores with a job outside the home. Ten thousand units were produced in the following four years and incorporated into housing projects in Frankfurt, Germany designed by the architect Ernst May (Figure 1).

The kitchen cabinets were made of functional and hygienic materials: softwood and plywood units, beech and linoleum work surfaces. The prototype of the kitchen was painted monochrome blue due to the fact that flies don't perceive it as solid and are therefore discouraged from landing on the surface. Later models were painted in a wider range of colours, including grey, green, white and blue, after they were installed.

Schütte-Lihotzky incorporated other methods to discourage pests in the kitchen. She recommended oak wood for the flour drawers to repel mealworms, and utilised raised concrete plinths to avoid dirt-catching and insect-attracting nooks and crannies. She designed a wall cupboard for the refuse bin which opened on the kitchen side for rubbish disposal and on the hall side for rubbish removal. Finally, Schütte-Lihotzky's design for the storage cupboards included holes in the doors, and grids instead of boards to facilitate ventilation and thereby prevent mould growth.

Magarete Schütte-Lihotzky's plan separated the kitchen from the rest of the flat in order to isolate cooking noises and smells. She followed the new trend away from the unhygienic 'eat-in' kitchen to a compact household 'laboratory'. These small rooms were intended to create space for cooking, washing, food storage and ironing, even in the tiniest of flats. Schütte-Lihotzky was influenced by the Taylor system, which had been successfully applied in the U.S. in planning for industrial operations. She studied household tasks and timed different movements with a stopwatch in order to find a way to reduce superfluous walking and handling while preparing meals. Her final design was based on the model of a railway dining car kitchen, where two people were able to rapidly prepare meals for up to eighty passengers.



Not surprisingly, for a kitchen in use for nearly eighty years, the painted surfaces were clogged with four layers of over paint. Preparation between coats had been poor and as a result brush strokes and runs disfigured the flat surfaces, whilst the edges, originally sharp and clean, were clogged with paint and rounded over. Microscopic analysis was used to identify the structure of the painted surface and showed the following layers, listed from the surface down: three different over paint layers, a pale green over paint layer, a high-gloss, pale green, linseed-oil-based layer, two undercoat layers, one grey primer and the wood substrate.

The first step in the conservation treatment was to see if it was possible to remove the over paint layers and reveal the original paintwork. A combination of solvent gels and mechanical removal appeared promising but proved too time consuming. With only a period of about six months between acquisition and display, the decision was taken to simulate the original but, wherever possible, to incorporate the evidence of wear so as to allow visitors to understand how the kitchen actually functioned. Worn paint, marks and small areas of damage reflect the long years of domestic use. For example, the paint has been worn down to the bare wood around the much-used grab handles of the cutlery drawer, whereas the doors and flaps of the high, inaccessible storage shelves are in almost pristine condition.

Paint removal tests showed that brush marks, drips and clogged edges were due to the poor application of the outermost white layers. If these were removed or reduced in thickness, the clean lines of the kitchen would be revealed. Several methods were employed to smooth the top layers. Some areas of wear, for example around handles and on the top corners of the doors (Figure 2), were covered by a single layer of white over paint, and this was removed with acetone. A similar treatment was used on surfaces, such as the ironing board, where the contrast between early- and latewood growth produced a distinctive and slightly three-dimensional effect. Large, flat areas were sanded.

Losses that were not representative of use were filled with Fine Surface Polyfilla®. A separating layer of 10% weight to volume ration Paraloid B 72® in toluene ensured that the new green over paint could be removed in the future without risk to the original paint below. During the process of testing over paint removal, all over paint had been removed from a small door. *Farrow & Ball* used spectral analysis of this surface to match the original colour and supplied new alkyd-based paint.



Figure 2: Patina areas around a drawer handle: Before conservation, after smoothing and filling, and the finished surface

(Photography by Karen Melching)

This new paint would need distressing in order to incorporate evidence of wear and represent the use of the kitchen. In order that this distressing should be as accurate as possible, areas of distinct wear were photographed before the kitchen was repainted. In addition, larger areas of wear were given an isolating layer of Regalrez 1094® coating and microcrystalline wax. This allowed rapid selective removal of the new green paint, revealing the original wear marks and providing the starting point for the final toning treatment (Figure 2).

Historical photographs of the kitchen show the glossy reflective character of the original paintwork. This type of finish was often described as enamel paint because of its similarity to the gloss and colour of enamelled kitchenware. To reproduce a similar effect, the new green paint was denibbed and lightly abraded before a finish of dammar was applied, which had to be toned afterwards to give the impression of wear and tear (Figure 3).



Figure 3: Kitchen surfaces repainted in the original green colour

(Photography by Karen Melching)

Rather than reproducing the kitchen 'as new' the aim was to combine the original paints scheme with evidence of how the kitchen was actually used. This gives the added dimension of allowing the viewer to assess the success of Schütte-Lihotzky's multifunctional design.

#### Acknowledgements

With thanks to Ms. Debus-Steinberg (Stuttgarter Gesellschaft für Denkmalpflege, Germany) for all her information about the Frankfurt kitchen; V&A Technical Service for the trial build and my colleagues Shayne Rivers and Katja Tovar for their brilliant collaboration and Dr Lucia Burgio for her assistance with the microscopy analysis.



## New Staff



### Jonathan Kemp

Sculpture Conservator

I have over fifteen years experience as a sculpture conservator working extensively on a range of movable and immovable cultural objects dating from between around 2000 BC to the twentieth century, made of stone, plaster, fresco, ceramic, artificial stone and metals. I have been working as a senior conservator and consultant to both public and private collections over the last twelve years liaising and collaborating with other conservation professionals, curators, heritage institutions, architects and allied professionals. I have worked internationally on projects in Spain and Ukraine, was project manager/senior conservator on large scale sculptural and architectural conservation programmes and I have also trained and taught students and recent graduates of various institutions and nationalities.

The Medieval and Renaissance Galleries are to be redeveloped as a part of V&A FuturePlan and a small team of sculpture conservators have been appointed to undertake all aspects of preventative and interventive conservation. I will be involved in the technical examination, assessment and documentation of the sculptures, and will be also devising and executing a range of conservation strategies from the deconstruction and reconstruction of large scale objects to the cleaning and consolidation of small artefacts.



### Angela Knight

Conservation Administrator

It is an amazing coincidence that my first permanent post was with the Government Art Collection. Since then I have worked for various types of organisations. These include, Camberwell Health Authority setting up one of the first Cervical Recall schemes in the South-East, and Action on Elder Abuse where I formed part of a team lobbying the Government to change legislation and took harrowing calls on the Elder Abuse response line. On a lighter note I spent a year working for John Lewis plc, behind the scenes, in the Home Decorating Buying Office; surprisingly not one of my happier positions.

I work in Conservation Admin, providing administrative support to the large team of conservators. My main responsibilities are maintaining adequate stocks of stationery and chemicals for use in the various studios/laboratories and ensuring equipment is serviceable. I also work closely with the Head of Information Management and Administration to ensure that departmental budgets are monitored throughout the year. My post offers a lot of variety; from the mundane filing of paperwork to the more complex reconciling of bank statements. I believe the work I do behind the scenes is very important and ensures that the conservators can focus on their specialities.

## New Staff



### Hanneke Ramakers

Ceramics & Glass Conservator

In 2001 I graduated from the Institute for Cultural Heritage in Amsterdam after studying glass and ceramics conservation for four years. During one year of the course, I spent time gaining further experience as an intern at the Rijksmuseum in Amsterdam and also in London at the British Museum and Plowden & Smith Ltd. After graduating I worked as a freelance ceramics conservator in a private workshop in Amsterdam for a year. In 2003 I moved to London to work at Plowden & Smith Ltd, becoming Senior Conservator of Ceramics, Glass & Related Materials and Head of the Ceramics & Glass Department in 2005. The range of objects worked on was vast: from archaeological to contemporary pieces; miniatures to large marble sculptures and extensive tile panels.

I joined the V&A Sculpture, Metals, Ceramics and Glass Conservation Section in May 2006. Based in the Ceramics & Glass Conservation Studio, I shall be involved in all aspects of the conservation of objects made from ceramic, glass or related materials in the collection for forthcoming gallery projects, exhibitions and loans.



### Lisa Wagner

Sculpture Conservator

In 2000 I graduated from the Academy of Fine Arts Dresden, Germany, with a specialisation in the conservation and restoration of retables (altar screens), panel paintings and polychrome works of art. After an internship with emphasis on the structural treatment of panel paintings at the Hamilton Kerr Institute, Cambridge, I began a PhD in conservation from the Academy of Fine Arts Dresden. My dissertation describes a collection of fine art materials dating from 1704 kept in an oak cabinet from Queens' College, Cambridge. Over the course of my studies I gained work experience in private studios, museums and governmental institutions responsible for the preservation of cultural heritage.

My work at the V&A will involve the preparation of sculpture and architectural details for the Medieval and Renaissance Galleries (due to open in November 2009) and the British Sculpture Gallery. The job entails preventive and interventive conservation, with treatments such as consolidation and cleaning of the artefacts, and will also include technical examination of the objects, along with their assessment and documentation. In addition to wooden sculpture, I will also be working with objects in ivory, plaster, terracotta and stone, as well as their polychromies.

## Interns



### Ilse Entlesberger

Paper Conservation Intern

After studying at the Higher Technical Collage for Graphical Design in Linz, from 1996–2001 I then worked as a Graphic Designer at an Advertising Agency in Linz until 2002. Since October 2002 I have been studying the conservation and restoration of paper, photographs, book and archival materials at the Academy of Fine Arts Vienna.

During my internship I hope to widen and deepen my technical as well as theoretical knowledge in the area of book and paper conservation. Additionally, I wish to improve my technical English relating to conservation and I look forward to gaining insight into the V&A's interesting collection.



### Priya Kapoor

Paintings Conservation Intern

Currently I am working as a conservator with Sanskriti Pratisthan Museums in New Delhi, a noted charitable trust, with which I have been associated for the last three years.

I joined Sanskriti in 2002 with the responsibility of setting up the Museum of Indian Textiles at its premises. The process saw me establishing a storage and fumigation chamber for the textile collection of Sanskriti, and doing preventive conservation for the same.

During my next project with the NGO (Non Government Organization) in 2004 I became involved with the two museums at Sanskriti – *Museum of Everyday Art* and *Museum of Indian Terracotta*. I not only took the initiative of establishing a conservation laboratory for the purpose of carrying out restoration work for these museums, but have also been looking after their documentation, storage and restoration.

My involvement with a prestigious project in collaboration with NMCL (National Museum Conservation Laboratory) and INTACH (Indian National Trust for Art and Cultural Heritage) – Delhi Chapter, gave me the opportunity to work on the restoration of “Qajar Paintings” at the President’s House, New Delhi.

I have also been involved in organizing a number of workshops on preventive and remedial conservation in association with Sanskriti Pratisthan and National Museum Institute, New Delhi.

I would like to thank Charles Wallace Trust for sponsoring my internship.

## New Student – Mazarin Chest Project



### Adel Elmahdy

3 year PhD, Loughborough University

I obtained my bachelor degree in physics (optics & laser) in 1993 after which I taught experimental physics in Helwan University, Egypt. Whilst working there, I obtained a masters degree for which my thesis was titled ‘Optical Behaviour of Annealed Polymeric Fibers as a Function of Draw Ratio’. My particular fields of interest were speckle interferometry and optical interferometry measurements.

The provisional title of my PhD is ‘Optical and Numerical Examination of the Effect of Western and Japanese Consolidation Treatments of Micro-cracks in the Surface of Aged Japanese Lacquer (Urushi)’. My PhD is a joint experiment and modelling project to consider the effects of traditional Japanese and western surface consolidation materials on lacquer artefacts. The deformation and damage characteristics of the material will be assessed using optical interferometry techniques.