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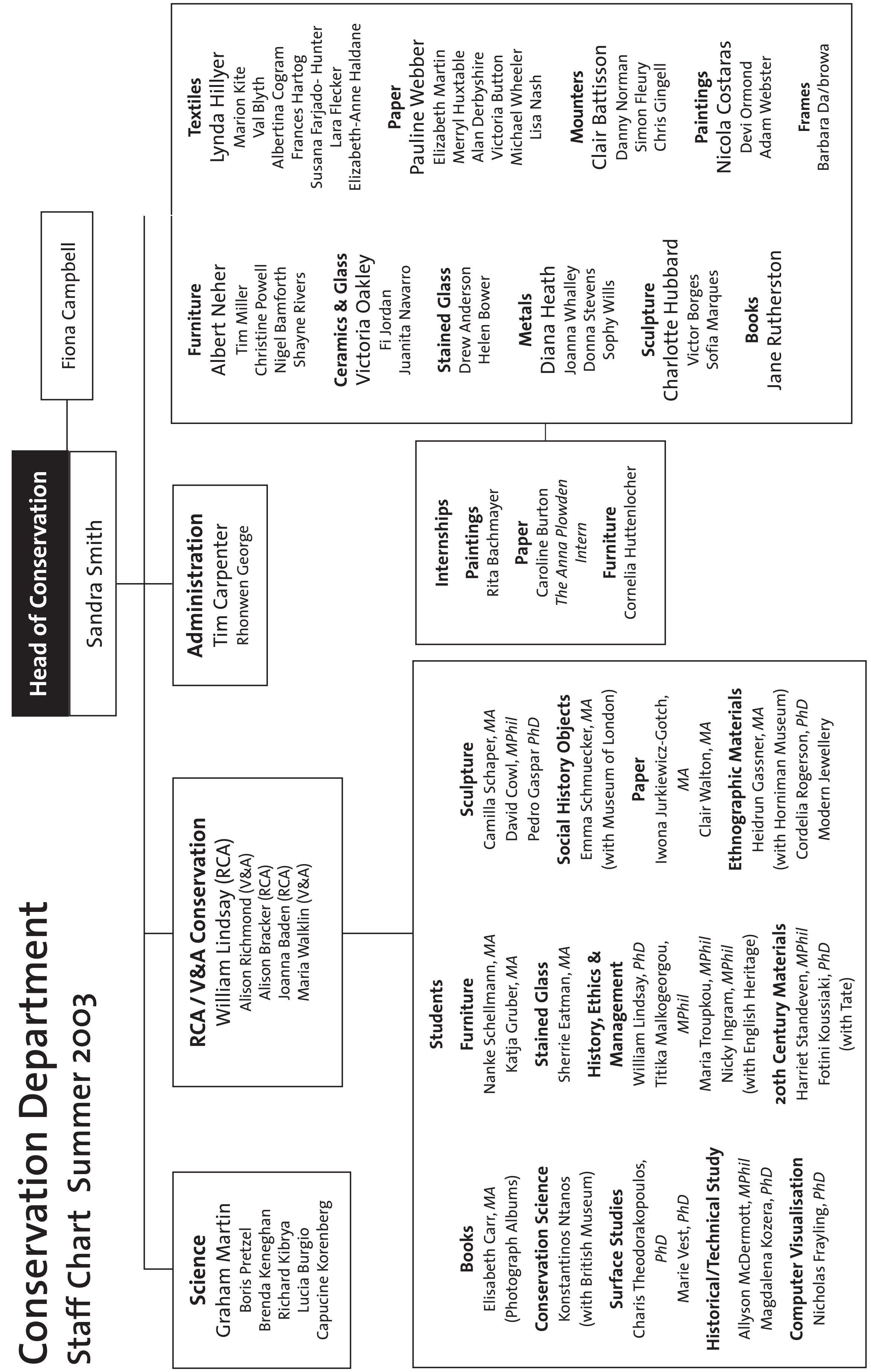

Editorial

Sandra Smith
Head of Conservation

I have now been in the post of Head of Conservation for seven months and I am just beginning to feel a sense of familiarity with the Conservation Department, its staff, and its belief systems.

Having worked in a national museum, I could relate to the wide, and often conflicting, demands on conservation time and understood the deep professional knowledge of conservation staff. But I quickly realised that the roles and relationships between conservation and the other Museum departments and the RCA/V&A course give the V&A Conservation Department a unique identity. I also realised that the V&A is undergoing radical and rapid change. An ambitious future plan for the South Kensington site, and comparable plans for the Theatre Museum and Bethnal Green Museum of Childhood will significantly increase physical and intellectual access to the collections over the next seven to ten years. The development of the online museum will increase virtual access to the collections.

The Department has an important role to play in this change. Conservation can inform museum policies and strategies by addressing the conflict between access and preservation. The articles by Boris Pretzel and Jonathan Ashley-Smith discuss some of the issues that will influence future directions. The 'Understanding Conservation' course, reviewed in this Journal, highlights public interest in preservation issues and we should be looking for opportunities to involve them with this debate. Developing stronger links with the Learning and Interpretation Division, Visitor Services, and increasing the conservation content of the web site are all opportunities to make this link.

Meeting the changes within the Museum also involves exploring activities within the Collections Services Division and within the Conservation Department. The Strand Palace is one example where combining the skills of conservation and technical services has enabled a complex project to be delivered. In the process new relationships were formed and plans to share communal working facilities are now been developed. The Collections Services Division, including the Conservation Department, is undergoing a strategic review to determine the needs of the Museum for our services over the next five years or so. During this we are hoping to streamline and simplify processes and create more effective ways of working and communicating.

With a background predominantly in archaeological and historical collections, I find the articles on synthetic materials, gloss paint and polyester stimulating and also a little daunting. Archaeological and historical objects are formed from natural products, albeit modified by man. Those which survive, are either inherently stable or have been preserved by uniquely benign environments and offer a wealth of information on natural ageing. Traditional, craft based techniques have evolved to preserve and restore them which in turn became the spring board from which 'conservation' developed.

Modern synthetic materials have no such history and folk knowledge behind them. In this throwaway society, where we are encouraged to have the newest and latest it will be the conservators who take the leading role in developing preservation systems. With such rapid developments in smart and techno fabrics alone it is sobering to contemplate how we can keep up!

Finally, to end on a personal note, I have really enjoyed these first few months at the V&A. I am continually delighted by the enthusiasm, commitment and professionalism of the staff. I have been made very welcome and look forward to working with them all in the future.

Sustainability and Precaution: Part 2 How precautionary should we be?

Jonathan Ashley-Smith, Senior Research Fellow, Research Department

The degree of caution exercised by conservators on behalf of museum objects has often been criticised. This caution, usually interpreted as negativity, is said to interfere with the plans of other museum professionals for the interpretation and display of the collections. Conservators also show a cautious attitude by adopting the ethic of minimum intervention. The principles of precaution and sustainability have developed in the area of public health and ecological conservation and although they seem to be based on coherent rational argument there is continuing disagreement about interpretation. Fashion and inertia may allow the transfer of these concepts into the realm of museum conservation where a similar vocabulary exists but where the problems may be entirely different.

The likelihood of this transfer of ideas is quite strong. The notion of conservation as the management of change has already been adopted by organisations, such as English Heritage and the National Trust, that have responsibility for both natural and man-made heritage. Nicholas Stanley-Price, the Director of ICCROM, recently suggested that his organisation should develop closer links with the field of nature conservation. Supporting this mental link to the conservation of the living world are convenient anthropomorphic medical metaphors for the conservation of objects that have never been alive.

In this discussion a distinction will be drawn between ordinary caution and the application of the Precautionary Principle. Caution means being aware that there are risks and then, considering the relative magnitude of risk, managing one's behaviour to minimise damage. As indicated in the first article in this series[1] the Precautionary Principle is incorporated in the Maastricht Treaty and is thus a basis for European law-making and regulation. In its most prescriptive forms the Precautionary Principle implies that regulation of behaviour is mandatory merely because someone can conceive of a potential hazard. Behaviour must be regulated even though there is no certainty that this hazard constitutes a real threat, even though there is no logical mechanism for realising the threat, even if the loss of benefit through regulation seems punitive. It is a requirement of the most rigorous interpretation of the Principle that the burden of proof does not lie with the regulator but with the person whose proposed behaviour might cause exposure to the hazard.

The conservator already has the tools to formulate relevant and acceptable interpretations of these principles. In collections conservation, preventive measures were traditionally demanded whenever there was a suspicion of harm. But there was always some sense of compromise. Even the most die-hard conservator would allow some light to fall on an object so that it could be seen occasionally. The ecological extremists argue against compromise. In object conservation some sense of proportion can be arrived at through risk assessment. Yet this approach seems to have failed in environmental conservation:

"We believe existing environmental regulations and other decisions, particularly those based on risk assessment, have failed to protect adequately human health and environment."[2]

In environmental conservation the rights of future generations have ferocious advocates:

"In risk analysis, the duty of care to prevent harms to the interests of future cohorts of human beings.... should outweigh any claims of benefits for current cohorts."[3]

Yet a large part of practical museum conservation is aimed at current access and interpretation, encouraged by a respect for current users. It seems curious that the philosophical move away from interventive conservation should coincide with the conservation profession's realisation that the business exists, to a large extent, for the present generation of users. By actively promoting the use of collections, conservators stand a far better chance of achieving what they claim as their major purpose, the objects' continuing preservation[4]. It is only by being less precautionary (which does not mean abandoning all caution), in both intervention and attempts at regulation, that conservators can be seen to be doing something of value and interest to contemporary stakeholders.

The Precautionary Principle cannot really ever be a statement of principle. It is in fact a 'vague and malleable policy guideline'[5], and as such has a recognisable similarity to the statements found in codes of ethics. To be useful such 'rules' are written in broad and simple terms, but to give absolute direction they have to be interpreted in the light of local and immediate circumstances. The interpretations will be governed by individual motivations and vested interests. Thus, there is a strong divergence of opinion about how absolutely the regulation of proposed new products and activities should be implemented, given uncertainty or the absence of evidence.

The most recent guidance for implementing the Principle within the regulatory framework of the European Union[6] recognises that there cannot be a blanket application of a single interpretation. There are numerous qualifications: the measures should be proportionate to the risk, must attempt to maximise net benefit and must take into account the costs and risks of alternatives (including doing nothing). Most importantly there is a need for continuing research to reduce uncertainties even after precautionary measures have been taken.

Over the past decade conservators and collections managers have been exposed to the idea that their actions and decisions could be guided by systems that include risk assessment and cost-benefit comparisons[7]. The risk assessment approach easily leads to a proportional response. Most importantly the conservation profession has continued research into hazard-harm relationships, and from time to time has attempted to relax precautionary guidelines that research has shown to be too restrictive. For instance, the attitudes of a large proportion of the conservation community to maximum light levels and tolerable bands of humidity have become more flexible.

However there is still cause for concern. The European Union, while advocating the benefits of continuing research, has more or less abandoned funding any research that would be useful in reducing uncertainties about the risks to cultural heritage. In recent years it has only supported short term projects aimed at producing commercial products rather than long term understanding. Another worry is the continuation in some areas of conservation of the ALARA principle. This is the line followed in some of the more extreme environmental regulations in both Europe and the US. What is 'As Low As Reasonably Achievable' must be of necessity, the best, regardless of need, cost or practicability.

The way in which other interpretations of sustainability and authenticity alter the need for precaution will be dealt with in the third and final article in this series.

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Strand Palace Hotel

Trevor Grainger, Technical Services

Designed by Oliver P. Bernard, in 1930, few Art Deco buildings were more glamorous than the luxury hotel. In England, Claridges, the Savoy and the brand new Dorchester all had sumptuous Art Deco interiors. But Oliver P. Bernard's designs for the Strand Palace made this one of the most celebrated hotel interiors in London.

Bernard had worked as a set-designer in theatre and opera, in Britain and the USA. This experience clearly influenced his work at the Strand Palace. The foyer combined traditional and new materials and made innovative use of glass and lighting. The walls were clad with pale pink marble and the floor with limestone. The balustrades, columns and door surrounds were made of translucent moulded glass, chromed steel and mirror glass. Bernard designed interiors for other London hotels and cafés, including the Lyons Corner Houses. The foyer was removed from the Strand Palace Hotel in 1969 and, for the first time, was partially reconstructed for the recent Art Deco exhibition.

When the Strand Palace Hotel entrance/foyer was dismantled it was rescued by the V&A and sent to Battersea Store, where it remained for many years largely forgotten and ignored.

The decision for an exhibition and celebration of Art Deco prompted the idea that the Strand Palace Hotel entrance would be one of the major features of the exhibit. At the store in Battersea Keith Marks and others laid out the dismantled pieces in situ, like a flat jigsaw puzzle but nobody had any idea what it consisted of, or if any parts were missing.

In a terrible state of disrepair and very badly damaged, it looked like it had been taken to the stores and just 'dumped'. There had been no provision made to store it correctly, as befits a beautiful and important work of art.

Lorries delivered the hundreds of pieces to the workshops at the V&A. The pieces ranged in size from the smallest at one metre high, right up to the spindle for the revolving door which was two metres high and weighed 108 kg. It took eight people to carry the spindle to the first floor workshop. It took about two weeks for all the pieces to be delivered and unloaded, storing them wherever room could be found. It was then down to me to start the process of putting the jigsaw together. The first job was to clean the pieces. I started to clean the items but as time went on Keith and John Dowling helped me, joined by Albert Neher and the woodwork conservation team.

The centrepiece of this exhibit are the revolving doors. The encasements for the revolving doors, which consist of two huge circular panels, had been badly stored. Instead of being circular they were completely flat. To restore them to their former glory we had to erect them in the workshop. A wooden circle the size of the revolving door was bolted to the floor. As the flat panels were erected around the wooden template, the metal pieces were clamped together, squeezed into the circular shape and bolted to the template. Although the majority of the pieces for the foyer were there, I had to make some items that were either broken or missing. The items that had been erected in the workshop were then dismantled and all the pieces had to be taken, either by hand or on a trolley, to the exhibition area.

Once everything was at the exhibition site, we had the job of putting all the pieces together. Albert Neher was in overall charge of the project. We had photos for reference and we had decided in the workshop, where and how various pieces went together. No-one however had seen it in its original setting in the Strand Palace Hotel. It was like compiling a huge three dimensional jigsaw which required a concerted, team effort. For some pieces, like the revolving door, it was obvious where they went, but there were a number of passionate debates as to the order of installing the various pieces. We found out that there was only one way to erect it, and if the pieces were not put in the correct order, it meant that at a later stage the glass and mirrors would not fit.

The delicate nature of the glass in the outer sections and the mirrors in the inner section proved to be very time consuming and nerve wracking to put in place. Above the revolving doors, the mirrors are like wedges of cheese. Keith slid the wedges into place, Albert then inserted a screw and I tightened the single nut to hold them in place.

It took about four weeks to erect. As the work was progressing it became a focal point for the whole museum. Staff from all departments paid a visit to see how it was progressing. A photographic record was kept of the work, and everyone working on it started to get very excited about the whole project.

From start to finish it was a team effort, everyone that worked on the project felt immensely proud when it was completed.

How fast do polyester fabrics age in the museum environment?

Capucine Korenberg, Research Assistant, Science Section

Introduction
Aromatic polyesters were discovered in 1941 by chemists of Calico Printers Association (UK) and have been commercially available since 1953. Today polyester fibres are the most widely used man-made fibres. Increasingly, fabrics are given special finishes to have specific properties (e.g. aesthetic appearance, skin-moisturising effect or spill-repellent property); these fabrics are called “techno” fabrics[1].

Not surprisingly, polyester fabrics and techno fabrics are entering museum collections at a fast pace. Polyester fabrics appear to be stable but since they have been around for only approximately 50 years, this is still an open question. In particular, the effects of techno pre-treatments, which represent a recent innovation, on the durability of polyester fabrics are unknown.

“Smart and Techno Fabrics”, a collaborative project between the Victoria & Albert Museum and the Textile Conservation Centre, University of Southampton, aims at investigating the deterioration of polyester fabrics in the museum environment. A plain polyester fabric and a techno polyester fabric were subjected to accelerated light- and heat-ageing and the changes in their mechanical strength were monitored using tensile tests.

Experimental
Fabric samples
The plain white polyester fabric sample was bought from the John Lewis department store, London. The techno polyester fabric, “spattering”, was a replicate of a museum object (T.118:24-1998) and was provided by Nuno Corporation, Japan. This fabric is made of polyester that has been calendered mirror-smooth and “sputter-plated” with three powdered metals (chromium, nickel and iron). This gives it a metallic shine (see Figure 1). Both fabrics were made in plain weave.

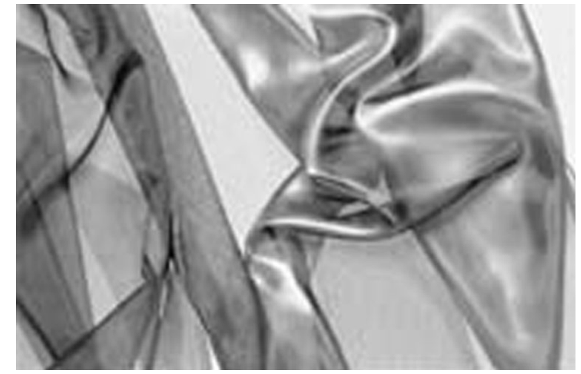

Figure 1

Mechanical tests
The tensile tests were conducted on an Instron machine. 19 mm wide strips of fabric were tested at a rate of displacement of 200 mm/minute with a gauge length (i.e. the length of fabric between the grips of the machine) of 75 mm. Three replicates cut along the warp and weft directions were tested every time. The load to failure and elongation to failure were measured. The results for the fabrics as received (i.e. not subjected to accelerated ageing) are given in Table 1.

	Warp	Weft
Plain	129±6 N; 33.8±1.5 %	96±2 N; 39.1±2.8 %
“Spattering”	125±3 N; 34.7±2.3 %	103±18 N; 26.7±4 %

Light-ageing tests
For the accelerated light ageing tests, strips of fabric were placed in a light box and six samples (three cut along the warp direction and three cut along the weft direction) were removed from the light box at regular intervals. The illuminance inside the light box was approximately 9 klux and the temperature 23°C. The ultraviolet radiation was filtered and cooling was fan-assisted.

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It should be noted that museums tend to use incandescent lamps to light their exhibits. However, fluorescent lamps are used in light-ageing tests for practical reasons: they are cheap, widely available and tend not to heat up the test samples much above 30°C, which is a problem with incandescent lamps. Fluorescent and incandescent lamps do not have the same power distribution spectra: fluorescent lamps have a continuous power distribution spectrum with discrete peaks, whereas incandescent lamps have a continuous spectrum. Thus, the deterioration of test samples illuminated by fluorescent lamps may not be the same as that of samples illuminated by incandescent lamps and the test results obtained should be interpreted with caution.

Heat-ageing tests
The polyester fabric samples were placed in an oven at 60°C in the dark.

Preliminary tests
Effect of pleating
Many polyester fabrics have permanent heat-set pleats. For example, Nuno Corporation manufactures a pleated scarf made of polyester, which folds back together when laid flat ("Origami" scarf, see Figure 2). It was decided to investigate whether pleating introduces a zone of weakness in the fabric. Pleats were made in the middle of the strips across the length of both the plain polyester and "spattering" samples using an iron heated to 130°C. To see whether the pleats were permanent, samples were soaked in tap water and it was checked that the pleats were still present once they were dried (these samples were not subsequently tested). Pleated samples did not tend to fail along the pleats and their strength was similar to that of the non-pleated fabrics. This suggests that permanent heat-set pleats do not have any detrimental effects on the strength of polyester fabrics.


Figure 2

Effect of soaking
Treatments performed by textile conservators often involve using deionised water to clean fabrics. Immersing a fabric in a liquid might swell the fibres and affect their mechanical properties. Samples of plain polyester and "spattering" were soaked for ten minutes in deionised water and left to dry on a tissue. Their strength was found to be unaffected by this treatment. This suggests that cleaning treatments using deionised water do not have a detrimental effect on the mechanical strength of polyester fabrics.

Ageing tests
Light-ageing tests
A textile on permanent display at the Museum is usually illuminated at 50 lux ten hours a day[2], meaning that it receives approximately 180 klux.h per year. Samples of plain polyester and "spattering" (with the metal-plated side facing upward) were placed in the light box for 69 days, which is equivalent to approximately 80 years in the museum. It was observed that the strength of both the plain polyester and "spattering" did not vary significantly during the ageing tests. These results suggested that (i) the tensile strength of polyester fabrics would not be affected after 80 years of illumination in the museum environment and (ii) the techno pre-treatment on "spattering" did not have any adverse effect on the durability of the polyester fabric.

Heat-ageing tests
Increasing the temperature of the environment is recognised to accelerate the rate of deterioration in an object[3]. After three months of heat-ageing at 60°C no change in the mechanical properties was recorded for either the plain polyester fabric or "spattering" and it was decided to increase the temperature to 80°C. However, after two months, the tensile strength for both fabrics was unchanged. It was concluded that the polyester fabrics under investigation were very stable.

Conclusions
Preliminary tests have shown that putting permanent heat-set pleats in polyester fabrics does not introduce a weakness zone in the fabric. Also, the strength of polyester fabrics that had been soaked in deionised water was unaffected.

Samples of plain polyester and "spattering" received a light exposure equivalent to approximately 80 years in the museum environment. Samples were also heat-aged in an oven at 60°C and then at 80°C. Following these ageing tests, the strength of both fabrics was found to be the same as for the unaged fabrics, which shows that polyester fabrics should be very stable in the museum environment. Finally, this study shows that the techno pre-treatment employed for the "spattering" fabric has no detrimental effect on the durability of the fabric.

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Materials and their interaction with museum objects

Boris Pretzel, Materials Scientist, Science Section

All objects are subject to deterioration from chemical interactions to some extent. The agents of chemical interactions might come from the materials from which an object is made, from materials used to treat the artefact, or from corrosive interactions with emissions from materials in close proximity. The results of some of the degradation processes are obvious while others are less visible bit, nonetheless, significant.

In order to protect objects within their care, museums seek to minimize potential deleterious interactions by choosing appropriate materials to use in the storage and display of objects. A summary of the types of interactions affecting different artefacts may suffer is given below. This is followed by a short list of indicative materials that present minimal potential hazards. Lists of materials that have been tested for their corrosiveness, either within the V&A or by other organisations, and have been found to be suitable for use in short-term display or storage containers for artefacts, can further help selecting materials appropriate for use with museums' collections.

Object sensitivities

Sensitivities of objects to chemical degradation vary widely depending on the materials from which they are made. General comments on common reaction for different artefact types precede a table indicating the effects of a range of common pollutants, below. The comments and table serve as an approximate guide only and consultation with a knowledgeable practitioner in this subject is highly recommended.

Metals. Metals and their alloys show a large range of corrosion reactions depending on the elemental composition of the alloys as well as the nature of the reactants. In general, metal corrosion is accelerated in the presence of moisture and acidic environments. Sensitivity to further corrosion is usually increased in the presence of existing corrosion patinas.

The large range in coloured corrosion products has been a rich source of inorganic pigments through the centuries and corrosion patinas on ancient artefacts are an important contribution to the aesthetic qualities and value associated with these objects. Nevertheless, it is generally accepted that further corrosion of metal artefacts in a museum should be avoided!

Organic artefacts. Materials such as cotton, cellulose, wool, silk, and leather are affected by highly acidic or alkaline conditions that can cause acid or alkaline hydrolysis, and by oxidation or biodegradation.

Minerals and rocks (calciferous materials). Objects such as bones, shells, sandstone, limestone, and the like will be dissolved in the presence of strong acids (and, to a lesser extent, in the prolonged presence of weak acids). Mineral hydrates are very sensitive to changes in water vapour concentration and the reaction rates of many minerals increase significantly with water vapour concentration.

Ceramics and vitreous materials. The stability of glass objects is very dependent on their composition. Vulnerable groups can be particularly unstable even over short period (especially at high humidities and in acidic conditions). Ceramics tend to be stable but again the stability will depend on a number of factors including the nature of the body and the temperature at which they are fired.

Rubbers. These materials include natural rubber (isoprene) and artificial rubbers (chloroprene and neoprene). Rubbers deteriorate by oxidative degradation and would need to be stored in an oxygen free environment or coated with protective films for long-term preservation. They are particularly affected by strong oxidants (ozone, oxygen, peroxides, nitrogen oxides). They are also affected by exposure to high levels of acetates (natural rubbers) and (for chloroprene and neoprene) by a high levels of exposure to a range other pollutants including carboxylic acids, aldehydes, peroxides, phosphoric acid, sulfur dioxide and toluene. Vulcanised rubbers are a common source of sulfurous gases, released on their breakdown.

Modern polymers. Many plastics leach plasticizers to become brittle and discoloured as they age. Several also undergo chain scission (saponification in the presence of moisture or oxidation / reduction in the presence of strong redox agents, heat and light) and chemical breakdown, releasing monomeric units from which they are composed. They are affected by exposure to a range of solvents (which can make them soft or tacky) and exposure to toluene diisocyanate. Many are degraded by acids and these reactions are often accelerated by the presence of metals (chiefly iron and zinc).

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Table 1 below, indicates specific hazards associated with a range of common potential pollutants.

Agent	Common sources	Metals	Organic artefacts	Minerals and rocks	Ceramics and vitreous materials	Rubbers	Modern polymers
Oxidative – reductive (redox)							
Oxygen O_2	All around us					Isoprene (natural rubber), chloroprene, and neoprene (artificial rubbers)	Polyurethanes (especially as foam)
Ozone O_3	Electrostatic discharge (printers, photocopiers, and some solid-state devices, high energy radiation interactions with air or oxygen		Cellulosics (including paper and cotton)			Isoprene, chloroprene, neoprene	Polyurethanes (especially as foam)
Nitrogen oxides NO_x	Combustion engines and industrial emissions, decomposition of urethane and cellulose nitrate films		Cellulosics, silk, wool, linen, and textiles in general	Stone building materials such as sandstone and limestone. NO_x will greatly accelerate reactions with SO_2		Isoprene, chloroprene, neoprene	Cellulose nitrate. At high exposure also for: cellulose acetate, and epoxies
Sulfur dioxide SO_2	Combustion engine and industrial emissions		High sensitivity: cellulosics. Medium sensitivity: vegetable tanned leathers and wools	Stone building materials such as sandstone and limestone		Chloroprene, neoprene	Nylons and (at high exposure) polypropylene
Peroxides ROOR'	Released during oxidative polymerisation of films	Copper, iron, lead	Cellulosics			Isoprene, chloroprene, neoprene	At high exposure for: epoxies, nylons, polypropylene, polystyrene and polyurethanes
Hydrogen sulfide H_2S, carbonyl sulfide OCS	Biodegradation of sulfur containing proteins, breakdown of vulcanised rubber an d wool, bio effluence (H_2S); biochemical and geochemical processes, breakdown of wool (OCS)	High sensitivity: silver, copper. Medium sensitivity: brasses, aluminium					At high exposure for: nylons and polyurethanes
Aldehydes chiefly methanal (formaldehyde) H_2CO, and ethanal (acetaldehyde) CH_3CHO	Wood products, such as block boards and MDF	High sensitivity: leads, brasses, bronzes. Medium sensitivity: aluminium, copper, silver	Newsprint paper		Glass at exposure to high concentration	Chloroprene, neoprene	At high exposure for: cellulose acetate, PVC, and polystyrene
Acid-base							
Carboxylic acids, R-COOH, chiefly ethanoic (acetic) acid CH_3COOH and mathanoic (formic) acid CHOOH	Wood products, such as block boards and MDF, some silicone sealants, and produced during the breakdown of polyvinyl acetate films	High sensitivity: lead and bronze. Medium sensitivity: copper, brass, cadmium, iron, aluminium, magnesium, and zinc	Cellulosics	Shells, coral, limestone, etc. Bones are also affected when the pollutant is present in high concentrations.	Ceramics containing soluble salts	Chloroprene, neoprene	Cellulose acetate and polyvinyl acetate (emitting ethanoic acid on breakdown, accelerating the reaction). Reactions are accelerated by some metals (chiefly Fe and Zn). Medium sensitivity: acrylics, epoxies, nitriles, nylons, polyethylene, polystyrene, and polyurethanes

Agent	Common sources	Metals	Organic artefacts	Minerals and rocks	Ceramics and vitreous materials	Rubbers	Modern polymers
Mineral acids: hydrochloric acid HCl, phosphoric acid H_3PO_4, sulfuric acid H_2SO_4, nitric acid HNO_3	Used as catalyst in some "formaldehyde free" wood products, potentially released during the breakdown of chlorinated additives and chlorinated films such as PVC, oxidation and hydration products of SO_2 and NO_x	Aluminium, brass, copper, iron, nickel	Adversely affect most organic and inorganic artefacts	Dissolve in strong acids		Chloroprene, neoprene	At high exposure for: cellulose acetate, cellulose nitrate, nylons, PVC, and PVDC. Reactions accelerated by some metals (Fe, Zn)
Nitrogen compounds, chiefly amines, RR'R''N, and ammonia, NH_3	NH_3 used in many cleaning systems and emitted by concretes during solidification	Aluminium, bronzes, copper, and iron			Ceramics (for NH_3)		PVC, poly (vinylidene chloride) PVDC, polystyrene, and polyurethanes
Solvents							
Toluene $C_6H_5CH_3$ and other organic solvents	Released from solvent bases systems (paints, coatings, etc).					Chloroprene, neoprene	At high exposure for: acrylics, epoxies (particularly sensitive to CS_2), PVC, polyethylene, polypropylene, and polystyrene
Acetates, CH_3COO-R	Released during the curing of some protective films	Mainly zinc but also copper					At high exposure for: acrylics, cellulose acetate, cellulose nitrate, epoxies (particularly to ethyl acetate), PVC, polyethylene, and polystyrene
Styrene (ethenylbenzene), C_8H_8	Often present as solvents in polyesters	Lead (when present in high concentrations)	Suspected of discolouring and staining fabrics on prolonged exposure				
Water, H_2O		Copper, iron, lead, bronze, brass, etc. Reactions greatly accelerated in the presence of acids	Paper, cotton, etc.	Mineral hydrates are very sensitive to changes in vapour concentrations. Reaction rates for many minerals increase with vapour concentration	Ceramics containing soluble salts, corroded glass		Cellulose nitrate, cellulose acetate (reactions greatly accelerated in acidic conditions)

Table 1: common pollutants and their effect on different classes of artefact.

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Mitigation
Ideally, museum storage and display environments should be free of all reactants that can interact with objects. This ideal is not (usually) a realistic expectation: many artefacts may be sources of corrosive agents that will interact with other objects. Anyway, increasing access to objects inevitably increases the rate of their degradation, if only by exposing them to radiation necessary for them to be seen and keeping them in climates that are appropriate for visitors.

Approaches to ensure that unacceptable rates of chemical interactions are not encountered in the storage and display of artefacts include:

- Use only inert materials in the construction of containers (avoid the problem)
- Use protective films to contain any sources of reactant species – by sealing materials that are known to be a source of corrosive agents or to provide a protective film around the artefacts themselves (keep the problem out)
- Use sacrificial materials preferentially to react with the corrosive species.

Limitations
Each of these approaches has its own drawbacks and limitations:

- The number of truly inert materials is limited and they do not, on the whole, offer enough flexibility fully to meet the design requirements. Restricting use to only such materials may also impose a severe burden on resources
- Protective films on artefacts may significantly reduce their aesthetic qualities (although the use of such films, for instance, for polyurethane or rubber artefacts, may be the only way of preserving the artefacts against rapid oxidative decay). The performance of barrier films used on materials known to be a source of hazardous corrosive emissions is dependent not only on the material from which they are made but also on the quality of their application. Many materials used as barrier films are themselves potential sources of corrosive reactants. The performance of any seal will deteriorate significantly if it is punctured (for instance, by pinning objects through it) and the effectiveness of any protective film may deteriorate with age and wear.
- The dynamics of interactions with sacrificial absorbers or adsorbers will affect the success with which these materials reduce the concentrations of reactive species near artefacts – especially if they need to be placed in discrete positions so as not to interfere with the display.

Possible solutions
Acceptable strategies will balance the risk to artefacts with access to them, in keeping with available resources. This will normally involve a combination of approaches, such as:

- Restricting materials as far as possible to ones that are inert
- Testing all materials not known to be inert to ensure that they do not pose unacceptable hazards to the artefacts in their vicinity
- Appropriately sealing materials that have been identified as potential sources of corrosive species to which artefacts in their vicinity are sensitive
- Giving appropriate consideration to sealing artefacts themselves (for instance, lacquering silver objects or varnishing artefacts) if they are made of materials particularly sensitive to decay
- Allowing sufficient time for any materials to dry and off-gas fully before installing artefacts (off-gassing times are dependent on the mechanism by which barrier films are produced and range from one day – for powder coating baked on to metals – to four weeks or more for films on wood product substrates produced by solvent evaporation, catalytic polymerisation, or coalescence)
- Segregating display contents to avoid interactions between artefacts
- Including general adsorbers (for instance, charcoal cloth or molecular sieves) in display cases contain artefacts that may be emitting corrosive chemicals
- Regularly inspecting the displayed artefacts so that problems are detected at their onset and appropriate action can be taken.

Other mitigation strategies will involve the control of climates (for instance, most metals will not corrode at relative humidity below 40%). Guidance on acceptable environments (climate and radiation) is outside of the scope of this paper but forms a crucial aspect in providing the best care for artefacts in a museum's keep.

Materials for display cases
The materials listed below can be considered as inert in terms of their chemical interaction with museum objects. They are safe for use in constructing tightly sealed environments providing good protection against externally generated pollutants and variations in external humidity.

- Glass and other vitreous systems
- Rigid plastic materials such as acrylics (Perspex™, Plexiglas™) and polycarbonates (Makrolon™). Unplasticized polyvinyl chloride (uPVC) structures are also likely to be stable for the periods in question although there is a small risk of the emission of HCl over longer time periods
- Unbleached, undyed cotton
- Acid free paper and card ("archival quality")
- Metals – but beware of the possible problems due to electrode potentials between different metals
- Powder coated metals (if appropriately baked)
- Alcoxy (non-corrosive, alcohol curing) silicones
- Silica gel
- Polyester films (Mylar™ D, Melinex™, etc)
- Polyethylene, polypropylene, and other "virgin grade" polymer films not containing plasticizers etc
- Carboxy methylcellulose adhesive.

Other materials should be tested for corrosiveness and pH before being used in the vicinity of delicate artefacts. However, it is unrealistic to expect each exhibition to undertake a full materials testing program before commencing the fabrication of displays, both because of the significant resources such testing programs require and also because of the delay this would necessarily introduce to the commissioning of an exhibition.

Many institutions now hold lists of materials that have been tested in the past and some, like the British Museum, will sell lists of materials found acceptable. Strictly speaking, the test results are only valid for the batch of material as tested as deterioration mechanisms involved in producing corrosive agents are often complicated and not elucidated in detail. Manufacturers may change composition and formulation processes without notification. Even very small modifications might introduce chemical components that will over time release corrosive agents, turning a material that had been tested as safe in to a potential hazard for artefacts.

An acceptable balance between the reliability of historical data from materials tests and the resources and time available for commissioning an exhibition might be to accept only results from test that have been performed in the last few years (minimizing the risk that the product formulation will have changed). If the evaluation of a materials is based on test results that are more than, say, five years old, exhibition teams will need to get reassurance from the manufactures / suppliers that the formulation and processing of the materials in question have remained unchanged since the testing was undertaken.

A final word of caution is warranted. Material degradation processes are sometimes not linear in that the evolution of pollutants may not be constant with time. Manufactures frequently use adsorbents and chemical modifiers that have a defined lifetime when in use. When these modifiers are exhausted there can often be a rapid increase in pollution emission.

V&A Conservation Journal No.44

Problems associated with the use of gloss house-hold paints by 20th century artists.

Harriet Standeven, final year PhD student, Royal College of Art / V&A Museum Conservation Programme.

Introduction.
Artists in the 20th century have chosen to use gloss house-hold paints in the place of artists' quality paints for a number of reasons: perhaps for the unique handling properties and surface characteristics they offer, for the social and cultural associations they evoke in the viewer, or simply because they are less expensive than traditional artists' oils. Although artists have made intermittent use of commercial house-paints since the 1920s, their use became widespread in the 1940s and 1950s. Partly responding to a desire to create textures and effects that simply cannot be achieved using traditional artists' oils, and partly due to a fascination with drawing everyday materials into the realm of fine art, artists began increasingly to incorporate non-traditional paints into their artworks. But the presence of gloss paints on works of art can cause problems for the object's care and longevity, not least because their glossy surface appearance is easily disrupted by many of the solvents and cleaning agents routinely used in conservation (figures 1 and 2).[1]

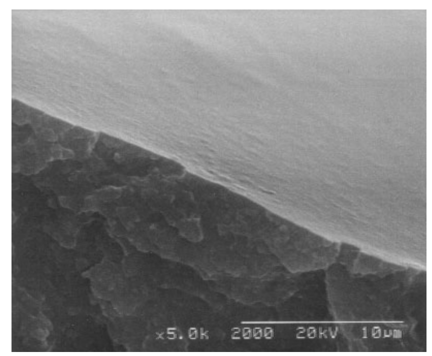

Figure 1 awaiting caption

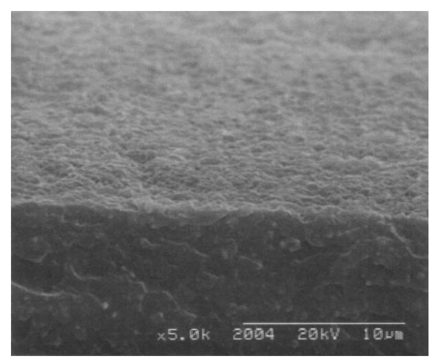

Figure 2 awaiting caption

In the field of painting conservation, little was known about the types of resin that have been used in gloss paint manufacture, when each was introduced or discontinued, or the extent of their use by artists – all of which is essential if one is to ensure that artworks are cared for appropriately and interpreted accurately. It was this gap in knowledge that the research sought to address.

Key developments in gloss paint industry history: the 1920s to the 1960s.
The period of study begins in the 1920s, when artists first began to experiment with commercial paints, and ends in the early 1960s, when all the major changes in formulation had been completed. The earliest decorative gloss paints were typically based on an oleo-resinous system such as linseed oil and copal and remained so until the introduction of the first synthetic resins for these purposes in the 1930s. It is apparent that these traditionally bound paints continued to be manufactured alongside their synthetic counterparts for a number of years, and they have been detected on works of art up until the 1960s. R. H. Kienle of America's General Electric Company was the first to patent a process for making oil-modified alkyd resins in 1927, which were introduced as binding media for American decorative paints shortly afterwards.

The first decorative paint to be made on an alkyd system in Britain was ICI's 'Dulux', introduced in 1932. It comprised phthalic anhydride, glycerol and linseed oil, and was formulated entirely from technology provided by the American company Du Pont.[2] It is evident that this first paint was of questionable quality, and problems associated with poor application properties were reported.[3] Production of this alkyd ceased during the Second World War, and it was not re-introduced until the late 1940s when improvements to its formulation were made. It was found that the substitution of glycerol for pentaerythritol enabled a resin with a greater oil length to be formulated, which improved its rheological properties significantly. A coincident development of the solvent method of manufacture meant that better quality, paler resins could be

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produced, and by the early 1950s many British companies were manufacturing oil-modified alkyds based on phthalic anhydride, pentaerythritol and linseed oil. Despite its excellent drying properties, linseed oil's tendency to yellow rendered it unsuitable for pale coloured paints, prompting companies to experiment with the paler semi-drying oils such as safflower, tobacco seed and soya bean. By the early 1960s, most British pale coloured decorative topcoats were based on phthalic anhydride, pentaerythritol and a semi-drying oil.

It is evident that materials such as dehydrated castor oil, maleic anhydride and rosin esters have also been used for gloss paint manufacture, especially during the War years when raw materials were in short supply. Although popular for applications such as ship's paint, there are conflicting accounts as to whether phenol-formaldehyde resins have ever been used as the binding media in decorative paints: some state categorically that they would never have been used due to their marked tendency to discolour,[4] whilst others assert that they have; to date, they have not been detected on works of art.

It is therefore apparent that there were a variety of household paints available in the mid-20th century, any of which could have been used by artists. But why should the presence of such paints cause problems on works of art, how do they differ from traditional artists' oils, and why does extra care need to be taken when treating them?

Artists' oil paints vs. gloss paints.
Firstly, gloss paints, and particularly oil-modified alkyd paints, differ substantially in terms of both appearance and chemical structure to artists' oils and are easily disrupted by the polar solvents and alkaline cleaning reagents that form part of many conservation treatments. The highest quality artists' oils are produced from cold pressed linseed oil, a manufacturing method that produces pale oils which are relatively stable in colour. Commercial paints however, often include lower grade oils, which may have undergone a refining procedure that will ultimately affect their colour stability. The resinous component of traditionally bound house-paints can also contribute to its discolouration on ageing. A desirable property of household paint is the speed at which it dries, achieved by the addition of metal soaps. But driers not only continue to have a siccative effect long after the film has thoroughly dried – ultimately contributing to its embrittlement and eventual breakdown – their solubility makes them susceptible to attack from solvents and cleaning agents.

Whilst artists' oils will tolerate the addition of mediums to alter the gloss and consistency with little ill-effect, gloss paints have been formulated for a particular application technique and use, and defects quickly become apparent if they have not been applied as the manufacturer intended. Adulteration with thinners or solvents, or even mixing with other paints can seriously compromise the properties of the binder, and unorthodox application techniques such as dripping and pouring frequently results in defects such as wrinkling.

Although the paint industry considers the durability of oil-modified alkyds to be far superior to that of traditional oleo-resinous binders,[5] in a conservation context, alkyds are far more susceptible to damage. When a paint formulator considers the durability of a coating, he or she is considering its resistance to UV light, its behaviour when exposed to extreme cycling of temperature and humidity, and the length of time for which it offers a coherent, protective coating. But (one hopes) these are amongst the last conditions to befall a work of art in a climatically controlled museum or gallery, and when conservators approach the concept of durability, they do so using a very different set of criteria. Durability of paint on a work of art relates more to resistance to the heat, moisture and solvents that form part of many conservation treatments, to factors such as physical damage caused by museum visitors – ranging from sticky fingerprints to cuts or blows to the surface – and perhaps most importantly for a painting that may be travelling to several overseas exhibitions each year, its reaction to the vibrations and knocks caused by travelling and handling.

When one considers alkyd gloss paints in these terms, their fragility quickly becomes apparent. Their susceptibility to basic attack makes the commonly used reagent ammonium hydroxide unsuitable for cleaning; their inferior water resistance means that care has to be taken if one is introducing consolidants or cleaning agents via an aqueous system, whilst their brittle nature means that they are more likely to crack and flake if applied to an inappropriately flexible support, or handled without due care.

The appeal of gloss paints.
Despite their potential problems, gloss paints possess a number of desirable properties that have appealed to artists. They are quick drying – traditional artists' oils take weeks to dry properly, whereas alkyds are touch dry in a matter of hours. Their fluidity allows unorthodox techniques such as dripping and pouring to be employed, enabling the creation of a range of unusual effects that simply cannot be achieved using traditional artists' oils (figure 3). They are considerably cheaper than artists' oils – an important factor to consider if artists are working on a large scale. Their glossy appearance appeals to artists wishing to exploit the effects of juxtaposed matt and glossy surfaces. Finally, the fact they are everyday, commercial materials has appealed to artists wishing to disassociate themselves from the traditions and techniques associated with 'fine art'.

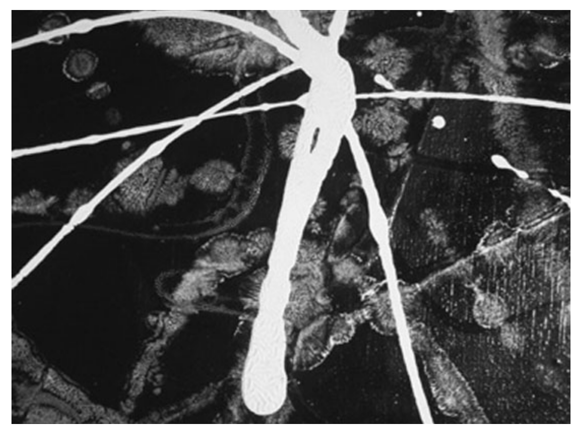

Figure 3 awaiting caption

But the surface appearance of such paints is easily altered, most commonly manifested as loss of gloss. This may occur naturally as the paint ages, or may be a direct consequence of an inappropriate conservation treatment, but when one considers that artists have often chosen to use such paints precisely because of the glossy surface they offer, the implications of this become clear: if the appearance of the painting has altered, it is no longer conveying the message that the artist intended.

Conclusion.
Knowledge about the precise nature of the materials present on a work of art therefore fulfils a number of important roles: it ensures that the artwork is cared for appropriately, it allows predictions to be made as to how it might age and deteriorate, and also offers valuable insights into artists' working practices and intentions. A defining feature of 20th and 21st century art has been the emphasis on materials. For many artists, the non-traditional materials they choose are integral to the meaning of the piece, and our appreciation of the artwork as a social and cultural object is greatly enriched by an understanding of when and why artists have chosen to use them.

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Shooting yourself in the foot: the do's and don'ts of working with weapons

Rachel Church, Assistant Curator, Department of Sculpture, Metalwork, Ceramics and Glass

From its inception, the V&A has collected arms and armour. They were collected as art; the Museum wanted to inspire visitors, viewing them as examples of the best in ornamented design and metalworking techniques from the various time periods and cultures represented. However, although these objects are regarded as works of art, it is important to remember that arms and armour were made for war, personal defence and hunting, and so are potentially dangerous or even lethal to handle.

Handling historic weapons is something which many museum workers find worrying, but an excellent talk and hands-on demonstration by Simon Metcalf, Neil Carleton and Donna Stevens allayed some fears. The aim was to familiarise staff including curators, photographers, conservators, museum technicians and members of Records and Collections with the main points to observe when working with weapons. Through a range of cautionary examples, participants were alerted to problems which they might encounter. These included objects with very loose parts, sharp points and blades, and unexpectedly heavy weapons. Simon stressed the fact that some firearms may still be loaded, and that it must be assumed that they are until proved otherwise. Neil put forward the example of poison-tipped arrows in the Indian and South East Asian Collections which have retained their potency for hundreds of years.

Damage to the objects themselves was also considered. Armour may appear robust but yet be extremely thin and vulnerable. A single fingerprint can ruin the surface of a polished sword blade. Handling the range of examples available from the Collections provided the opportunity to consolidate many of the points covered in the talk. By the end of the session, all those involved felt confident of their ability to handle arms and armour safely, and discovered a new respect for the craft and beauty of these objects.

Here is a checklist of do's and don'ts for handling arms and armour, compiled by Simon Metcalf.

Firearms
- Treat firearms as if they are loaded.
- Never point a gun at anyone.
- Never cock or fire a gun mechanism. Apart from the obvious risk that it could go off, the springs inside the gun lock are vulnerable to snapping. Firing the hammer or cock of a gun without the flint in position can cause the cock to break off.
- Keep the muzzle pointing upwards and away from colleagues/visitors when moving a firearm.

Swords and Bladed Weapons
- Most blades are sharp. There is always the risk of either being cut or stabbed.
- Avoid handling the cutting edge and the surface of the blade as much as possible.
- Be aware of the danger of a blade cutting through a scabbard. There is a real risk of a slicing or cutting injury when removing a blade from its scabbard. If it gets stuck, stop, and contact conservation.
- Be aware that blades can drop out of scabbards. Daggers especially are often ill-fitting.
- Carry blades vertically or in a basket.
- If using a basket take care with the pointed ends.
- Never use corks to contain a point. Corks cause corrosion.
- Scabbards can be rigid OR very floppy once the blade has been removed.

Armour
- Armour is very articulated and can become very floppy once removed from its mount.
- Care needs to be taken not to pinch your hands between the plates.
- Armour often has fragile leather or textiles – care must be taken not to squash these elements or make them bear weight.
- Mail, and particularly butted mail, can snag and catch on itself.
- Armour can often be very thin and fragile due to wear and corrosion.
- Armour can be much lighter or heavier than it appears.

Afterword
Although these procedures may seem to err on the side of caution, it should be noted that six probably loaded firearms have been discovered in the Museum's collections during a recent survey.

Understanding Conservation: An evening course at the V&A, 29 January – 26 February 2003

Ann Dooley, Courses Organiser, Learning and Interpretation
Victoria Oakley, Head of Ceramics and Glass Conservation
Alison Richmond, Senior Tutor RCA/V&A Conservation.

The work of the Conservation Department is generally a mystery to most people who visit the V&A. Almost all the work that conservators do, which is ultimately for the benefit of the visitor, goes unnoticed. The course, which was developed as a collaboration between the Conservation Department and Learning and Interpretation, was a rare chance for conservators to describe their work to a non-specialist audience. The aim was to provide independent adult learners with an opportunity to find out what happens to objects behind the scenes and consider the importance of conservation.

The course was spread over five Wednesday evenings. Each two hour session followed a theme, gradually building to give a broad picture of the range of different aspects covered by conservation. The question "What is conservation?" was asked on the first evening, with deterioration, specialist techniques and preventive care covered in further sessions. The call for speakers was answered with enthusiasm; 16 conservators delivered 17 presentations and others hosted studio visits. Course packs were provided for the 42 participants, containing an abstract and notes for each lecture, a list of unfamiliar words and a reading list. There were four or five presentations on each evening. Although the atmosphere was intended to be informal to encourage questions from the audience, there was a general tendency for speakers to become so absorbed in their subjects that they over-ran into the question time.

The subjects were wide-ranging: from a broad overview of the preparation of objects for an entire exhibition (Art Deco) to the treatment of portrait miniatures on ivory, from the conservation and installation of textiles for the British Galleries to 'Teddy bears under intensive care'. The deterioration of materials and preventive conservation were covered in a number of talks given by V&A scientists whilst two presentations on risk to collections and ethics introduced the audience to some of the broader issues of conservation.

For many of the participants the highlight of the course was the evening devoted to visits behind the scenes. A tour to the Stained Glass, Textiles, Books and Sculpture Conservation studios allowed participants to talk to conservators and see objects undergoing various stages of treatment.

The feedback from the audience was generally very favourable, with all agreeing that the course was pitched at the right level. Some commented that they would have preferred fewer talks and more opportunities for discussion, while one or two were critical of the style of delivery of some of the presentations. Overall, they said that they had enjoyed the course enormously and found it very engaging and highly informative. For the conservators, it was an opportunity to demonstrate their professional expertise and to share with members of the public some of the extraordinary things that happen to objects before they are displayed.

If you would like to know about the course in more detail please e-mail a.dooley@vam.co.uk

New Staff

Sofia Marques
Sculpture Conservator

I think my interest in conservation started with my taste as a child for very crowded interiors filled with all sorts of objects and pieces of sculpture. Years later, I went on to study for a degree in Art History in the hope of understanding some of the magic emanating from artistic forms. I don't think I have gained as much as I could from that degree, partly because of my immaturity at the time and partly because the structure of the course. The time spent at University was not wasted however and it was during my third year that I realised I could probably benefit more from my student status by taking a different approach to history.

I then started my search and looked for a workshop which would accept me as an apprentice with a view to gaining a more intimate relationship with objects and how they are made. This led to my acceptance by a restoration studio, where I spent most of my spare time until I concluded my degree. From then on my interest for conservation was confirmed. I had meanwhile been studying English in evening classes and I started investigating several conservation courses in England. My acceptance on the conservation course at the City & Guilds of London Art School represented an important turning point in my life which has given me great satisfaction.

My work experience began as a freelance conservator on various sites in England, Portugal and Turkey. I then spent seventeen months at the British Museum working on the King's Library Project and most recently have been enjoying working for the Sculpture Conservation section at the V&A! I don't think I can complain about anything.......

Victor Borges
Sculpture Conservator

I trained in one of the three official schools of conservation existing in Spain, The Escola Superior de Conservación e Restauración de Bens Culturais de Galicia, where an enthusiastic team of teachers infused me with all their knowledge to become a conservator specialising in sculpture.

After finishing my course I travelled to Madrid where I joined the conservation department at the Museo Nacional Centro de Arte Reina Sofía as a trainee working on their collection of contemporary sculpture. Since then a few years of freelance work took me travelling along the Iberian peninsula working on a variety of wooden and stone polychrome sculptures as well as wall paintings at locations like Salamanca Cathedral, Santiago de Compostela Cathedral...even Barcelona airport !!

After a long summer sabbatical in New England I ended up in London, where I joined the Decorative Arts Department of Plowden & Smith. Here, among other interesting projects, I lead the team for the conservation of the 'many' mosaics from the Hereford Screen, now on display in the Metalwork Galleries of the V&A. After this I started freelancing across England, working mainly on wall paintings.

During my employment at the V&A I will be working mainly on Italian terracotta and supporting the studio in other duties of conservation and care of the Sculpture Collection at this museum.

Beatrice Villemin
Intern in Painting Conservation

I am a 27 year old student at INP/IFROA Paris, Painting Department. I am completing the third year of my course by undertaking this internship at the V&A.

As part of the four-year programme we are required to spend a three month internship abroad at the end of the third year; the fourth year is devoted to historical and scientific research and the conservation of a wall-painting. The project I will be working on will be a 15th century wall painting from the Anjou region which is now stored in the Louvre.

I was 16 years old when I realised I could combine my interests in science and art history by training in conservation. After my Bac C in the sciences, I spent 4 years at Dijon University studying a degree in art history and then acquired some practical experience working in a private studio. I also worked on some beautiful 16th century frescos with a conservation team in Sucevita Monastery (world-wide cultural heritage), which is located in the region of Bucovina in Romania.

All of these experiences confirmed I was on the "right track" and I began my conservation training at INP/IFROA in September 2000. I am really happy to have the opportunity to work at the V&A and to be involved in, and able to contribute to the Paintings Galleries project. I am grateful to my supervisor Nicola Costaras for inviting me to work in this wonderful studio. I really appreciate my colleagues in the studio who trust me to carry out the practical work and are always ready to answer my questions.

Bigna Ludwig
Intern in Textile Conservation

After completing my Matura (A-Levels) in Luzern, Switzerland, I looked for a profession which would challenge my intellectual capacities and let me carry out manual skills as well. I was lucky to meet the textile conservator Karin von Lerber, who introduced me to this profession and allowed me to spend two months with her in her private studio. As a young enthusiastic girl from "little" Switzerland I didn't hesitate to take the opportunity, when offered, of an internship in "big" Munich at the Bavarian Castles' Administration. I spent a year of exciting work in various castles under the supervision of Beate Kneppel. I moved to Berlin for another year of conservation and exhibition preparation work at the Berlin State Museums, mainly at the Museum of Applied Art under the mentor-ship of Waltraud Berner-Laschinski, a textile conservator.

After two years in cities full of adventure I could not imagine returning to Switzerland to study. I was offered a place at the University of Applied Science, Cologne, studying textile conservation. As part of my studies I am required to spend my 4th term gaining practical experience. Acknowledging the V&A as a centre of excellence with one of with a renowned conservation department, I am delighted to have been given the opportunity of an internship in this studio.

I hope to graduate in 2005 and join the conservation profession. My internships will ensure that I do so as a well educated textile conservator.