The Training Programme in Conservation of Modern Art at the Limburg Conservation Institute

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Modern Materials Conservation

Modern Materials Conservation is the official newsletter of the ICOM-CC Working Group Modern Materials.

Number 4 August 2001 Committee of Conservation

Content:

Dear members and colleagues,

This is already the fourth newsletter. A little later than I had planned but it has been more work than I thought, updating the mailing list and splitting it up in two. One with Email addresses and one with post addresses.
Members with e-mail address will receive this edition by E-mail. Others by post.
I hope that members who have E-mail addresses and did not give it to me yet, will do so. Then the distribution of the next newsletter will be an easy job: pushing one button, in stead of printing, collecting, putting the newsletters into envelopes and then send it.
Please, make your co-ordinator happy and send your (new) email address. I will keep the mailing list updated!

Send me other news as well, because a newsletter written only by the co-ordinator will not survive because of lack of copy.

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2. The ICOM-CC 13th Triennial Meeting in Rio de Janeiro.

The ICOM-CC 13th Triennial Meeting will be held at the Hotel Gloria in Rio de Janeiro, Brazil and the date for the meeting is September 22nd –28th, 2002.

I received seven abstracts of our working group members, which, after reading, were ranked from one to seven by the co-ordinator and the assistant co-ordinator. Then they were sent to the Preprints Committee. The Preprints Committee has made their selection to five authors of our working group. They were invited to submit a full paper. They also have received the Instruction to authors. The final paper should reach the Working Group co-ordinator by October 31, 2001. The co-ordinators will collaborate with authors on the finalisation of the papers, rank them and forward them to the Preprints Committee. The final selection will be made by the Preprints Committee in February 2002. Authors will be notified immediately after.

Year	Month	Deadlines
2001	**Oct. 31**	**Deadline for submission of full papers**
2002	January 7	Deadline for co-ordinators. Co-ordinators to send papers to the managing editor/preprints committee
2002	Feb.	Deadline for Preprints Committee. Final decision for acceptance/rejectance of papers. Managing editor to inform each author.
2002	**April 30**	**Deadline for authors. Final (revised) paper to be submitted to the managing editor.** Table of contents to be published on the Website
2002	June 30	Papers to be placed on the Website
2002	Sept.	Preprints distribution at conference

3. Interim meeting in Cologne

The interim meeting that was held from 12 - 14 March 2001 in Cologne, Germany, was a big success. That was, however the meaning of the 120 people who attended the meeting. The meeting started at Monday with a speech of welcome by Elisabeth Jaegers, Dekanin of the Fachhochschule, Fachbereich Restaurierung und Konservierung von Kunst- und Kulturgut in Cologne and Thea van Oosten, co-ordinator of the Working Group Modern Materials of ICOM-CC.

Foto thea van oosten

Foto Fachhochschule

The program of the first day contained the scientific research into problems with plastics, the history of plastics in Germany and some case studies of the restoration of works of art. All speakers had very interesting talks and beautiful slides, especially those of the aliens and a shark of the movie Jaws.

Foto Fachhochschule

The successful first day was closed with a fantastic diner party. The students of the Fachhochschule did their utmost to transform one of the rooms of the Fachhochschule into a “plastic fantastic’’ world. Everywhere you could see, the decorations were amazing. I even saw plastic as a decoration between the abundance of food that was served. And let us not forget the Kölsch, the very tasty Beer of Cologne.

Foto Fachhochschule

The second day started with problems with the conservation of PUR foams, followed by case studies of the conservation of modern paintings and research into the identification of pigments and paints in modern paintings. The end of the day was reserved for a tour into the Conservation studios of the Fachhochschule. All participants joined this tour and were enthusiastic about the training program and facilities of the school.

The third day was devoted to the training of modern art conservators. Three different training programs of schools of conservation in Berlin, Maastricht and Bern were discussed. The last part of the morning was devoted to the problems of the conservation of contemporary art, followed by tours into two modern art museums, one in Bonn and one in Cologne. Again all participants attended the tours. The tours were very informative and were given by enthusiastic conservators.

Foto Fachhochschule

In this newsletter the abstracts of the talks are given. However, at the moment, Eva Brachert, Friederike Waentig and myself are looking for funding in order to publish a book of the talks . Such a wonderful state of the art of the conservation, the research into plastics and the training of conservators of modern art is worth publishing.

Thea B. van Oosten

4. Abstracts of talks of Interim Meeting

Perfection for an Instant – Conservation/restoration of a Polyurethane Sculpture by John Chamberlain

Iris Winkelmeyer

The paper deals with contemporary artworks made of Polyurethane soft foams. The first part introduces into the technology of the material: making, identification, ageing and conservation issues are discussed and illustrated by several examples of PUR artworks predominantly made in the sixties and seventies. The second part focuses on various aspects of the conservation and restoration of 'Funburn"(1967), investigating models for consolidation, cleaning and inlaying techniques as well as proposing the practical results of the final destination.

The Formation of Calcium Formate on a Rigid Phenolic Foam

Chris McGlinchey and Roger Griffith

Phenol formaldehyde substances were the first fully synthetic polymer material, commercialized as Bakelite in the early 1900's and continue to be a significant polymer because of its good electrical insulation, low flammability and economy of cost. The structures of phenolics were poorly understood when first developed because their complexity evaded characterization by analytical methods available at the time. Since the 1960's phenolics have been studied by more advanced methods to reveal a better understanding of how they polymerize and ultimately degrade. Although phenolics are known to readily oxidize, objects made from them can be found in good condition. There are several examples to be found in the collection at The Museum of Modern Art, in New York.

Recently, an architectural model that had been commissioned by the Architecture and Design Department showed signs of rapid deterioration shortly after it first entered the collection. This deterioration was in the form of a white crystalline efflorescence that appeared on passages constructed from rigid foam. The model builder informed the conservation staff that the foam substrate is Balsafoam®. This material is carvable phenolic foam with a cell structure comprised of a blend of open and closed cells. The builder skim-coated the joins, tool marks and cellular texture of this foam with DAP®, a joint compound readily available in North America. The first signs of this efflorescence were observed in the roof, which was also painted with black acrylic emulsion paint. Soon afterwards it was observed on all areas constructed with the foam. In less than three years after the model was constructed, the efflorescence had become so extensive that it is no longer considered suitable for exhibition.

FTIR spectroscopy indicates that Balsafoam® is a resole phenolic foam. Resoles are polymers based on a phenol-formaldehyde condensation reaction where formaldehyde is in slight excess. They are also referred to as 'one stage' resins because they cure to their final polymeric structure in one step. This is fitting for the production of certain types of foams, especially those produced by the continuous process used to make foams in long lengths of extruded profiles. The reaction can be carried out under acid conditions though it is more common to do so under alkaline conditions followed by neutralization with acid to stop the reaction at the desired degree of polymerization.

The scientific literature that discusses the chemical stability of phenolics mainly considers resins, not foams. The degradation studies that have been carried out on phenolic foam focus mainly on the correlation between the volatilization of blowing agent and loss of thermal insulation properties. The ingress of oxygen diminishes the insulation capabilities of the foam. Studies on resole resins indicate that oxidation is thermally induced and is a surface phenomenon. Consequently, it may be surmised that oxidation of foams, and in particular those with an open cellular structure, is most likely to occur around the outer core of the material where the blowing agent is most likely to be displaced by oxygen. Further, with the high ratio of surface area to volume, foams are the least stable class of phenolic materials.

FTIR spectroscopy and X-ray diffraction fitted with a Gandolfi camera we used to analyze the efflorescence on the foam; results from both methods indicate that the deterioration product is nearly pure calcium formate. This reaction product was most likely formed from the adverse reaction between the phenolic and the DAP®, which is a calcium carbonate containing compound bound in an acrylic emulsion. In general, joint compounds are formulated with a high pigment volume concentration (PVC) so that they are easily sanded. Unfortunately, the resultant minimal barrier properties of the binder in the joint compound were insufficient to isolate the calcium carbonate particles from the degradation products off-gassing from the foam. The source of the formate may be oxidation of residual formaldehyde, a volatile scission product of the degraded phenolic or (though unlikely) a formic acid blowing agent. Although formic acid is not appropriate as a blowing agent to produce phenolic foams, it is used in the production of some urethane foams and perhaps may have been used accidentally. Given the improbability of the latter, it is likely that oxygen plays a critical role in the production of formate. If the products are formed from residual formaldehyde the growth of calcium formate should cease once it has all reacted. On the other hand, if the products are linked to degradation products of the phenolic matrix it is likely that this phenomenon would persist until the foam has reached a totally degraded state. Mechanisms where both reactions occur can be devised, so proper storage is particularly important.

Manufacturers of phenolic foams have retreated from such niche markets as insulation for nuclear waste containers and roofing insulation because of its corrosive effect on metals, especially in the presence of high humidity. It appears that phenolic foams can be undesirable when long-term stability is a requisite property. Museum collections that have to confront the issue of long term care for such potentially unstable materials may want to consider storage in an oxygen free environment with relative humidity levels that are at the low end of conservation standards. While oxygen scavenging may not be practical for roofing and waste containment industries, it may be a viable option in the museum environment. Options like Ageless® may be one solution, however containment of residual off-gassing products may exacerbate other degradation reactions. Alternatively it might be possible to displace ambient air with an inert blowing agent substitute to prevent the ingress of oxygen into the foam.

Plastics in modern art

Lydia Beerkens

Since the earliest production of synthetic materials, artists began to explore the possibilities of their use as sculptural materials (Naum Gabo). The introduction of a wide range of plastic products to daily-life, after the Second World War, has resulted in the extensive application of consumer plastics in modern artworks.

The use of plastics in modern artworks can be divided into two groups. In the first group the plastic plays a significant and visible role. The second group possibly includes artworks in which the plastic is commonly used. Plastic is a cheap, widely available, lightweight material that is also easy to work with. The outside appearance of the work may not even reveal the large presence of plastic material.

In modern art museums, plastics are not separate collection items nor represent a specific art movement. Plastics are part of the work of art and have, or not have, a particular meaning depending on the artist and the significance of the work. The main conservation concern is the approach to take regarding the stabilisation of these objects: what to do with deterioration; how to translate some highly developed preventive conservation measures, as for safeguarding industrial design collections, to the preservation of modern art pieces; how to create an oxygen-free environment for large scale objects in storage; what to do with plastics that endanger other surrounding materials, and what to do when conflicting conditions are required for the conservation of different materials within the same object.

When studying the techniques for making modern artworks one can eventually recognise the specific use of similar materials by different artists. Despite the existence of thousands of industrially developed plastics, artists make use of the generally available range of products in suitable construction techniques. For instance, hard-foams such as expanded polystyrene (EPS) and polyurethane (PUR) are often utilised for constructing the central three-dimensional shape of a sculpture. These core materials are then mostly concealed by such substances as sand, plaster and paint, sometimes fibreglass reinforced with polyester resin or even metal paints when, for example, the intention is to imitate a metal object. Soft-foams (PUR) are applied as painted or unpainted elements, and thus remain visible. Sheeting materials, polyvinylchloride (PVC) and more recently polyethylene (PE) are used for wrapping and upholstering objects and as the primary support for paintings (replacing the traditional use of canvas).

The plastic materials can in many cases be recognised by their optical and physical properties (colour, shape, texture, solidity, density, hardness, flexibility and odour) and by macro-analytical identification tests. The general type of material can also be determined by knowing what products are available to the modern building industry and, likewise, at the ordinary DIY shop. The prognosis of life expectation for the work of art considers not only the component materials, but also their method of appliance, the (mal)treatment by the artist and the following life of the work within exhibitions: packing, transport and handling.

The correct conservation treatment can only be established after evaluating the role and priority of the plastic material in the whole object of art (structural, visible or concealed, with a certain meaning). The growing knowledge of plastics and their deterioration processes and the practical experience achieved when managing collections that hold synthetic objects, provides us with the tools to conserve plastics in modern artworks.

The general idea that plastics in modern art mean trouble can be narrowed down to the idea that some types of plastic may give some problems in particular situations. Modern art museums must not (and do not need to) avert works of art that contain plastics. When a newly purchased work of art is examined and the plastics identified there is forehand knowledge on what to expect; museums can manage synthetic materials in their collection as a calculated risk.

Preservation of contemporary electronic art at the Ludwig Museum

Christine Frohnert,

Museum professionals have always assumed that preservation of the evidence of the past is our primary responsibility, but that assumption is being put to a hard test by artworks that include electronic parts. There are three primary obstacles ahead: our reflective devotion to preserving all artworks at all costs, the little experience in preserving electronic arts and the vulnerability and obsolesce of electronic components.

This paper will focus on museological/conservational challenges of preserving contemporary cybernetic, kinetic and light-sculpture art in our collection.
The Ludwig Museum in Cologne is home to approximately 1,900 paintings, 800 sculptures, 40 electronic environments and installations, 15,000 works on paper as well as 120 video works and 12,000 photographs. Due to the fact that the building housed two museums, the Wallraf-Richartz-Museum and the Ludwig Museum, exhibition space for modern and contemporary art was limited. Now that the Wallraf-Richartz-Museum has moved to a new location, the building is entirely free for the Ludwig Museum's own collection. The new situation offers the possibility of showing artworks that haven't been on display for a very long time. As a result the need to examine and prepare the stored artworks for display has become urgent. The focus lies especially on the preservation of electronic artworks. We encountered several problems: for example missing, broken or worn down parts such as wires, drive belts, plugs, bulbs, control boxes etc. In the course of exhibiting, several substantial changes were made without sufficient documentary; e.g. modification of power circuits from US to European standards. To avoid similar difficulties in the future, the improvement and fixing of much more detailed ways of documentation are required.
Exemplary problems, which have occurred while working with the objects, will be outlined in general. The variety and complexity become clear by taking a close look at cybernetic, kinetic and light-sculpture works of Robert Rauschenberg, Dan Flavin, Keith Sonnier, Cai Guo-Qiang and Tatsuo Miyajima.

A work that encounters many different conservation problems mentioned above already is the kinetic environment *Buddha learning English, 1999,* by the Korean artist Ik-Joong Kang. This work forces the conservator to deal with problems of preserving transistor materials as well. For that reason this work will be looked at in more detail:
The work consists of 3024 paintings, with tip felt pen writings, glued on the walls of a circularly shaped room coloured red. In the centre of the room is brown polyester, chocolate covered and rotating Buddha placed on an old trunk. The environment also includes Korean buddistic music (magnetic tape). In addition to problems regarding the preservation of electronic components, the conservator is confronted with very sensitive and transitory materials: in the described environment these are the tip felt pen writings on the paintings and the chocolate layer. The conservator finds himself in conflict with having to define the sensitive borderline between the artist conceptual intent and conservation needs.

Crystals and Crazes: Specific phenomena in Plastics due to micro climates

Thea B. van Oosten

Crystals

Works of art from the sixties and seventies made of polyurethane foams were examined as a part of the research project of the Stichting Behoud Modern Kunst. Microscopic examination of the foams of two works of art revealed white crystals inside the pores of the several severely degraded soft poly(ester)urethane foams.
All these examples concerned PUR foam objects that has been enclosed. One of the works is called '59-18' made by a Dutch artist Henk Peeters, the other is called “Scheinbeinschützer für das linke Bein von Klaus Staeck made by C.P. Millig in 1974.

The degradation of soft PUR foams is known and degradation phenomena like discoloration, loss of flexibility and crumbling described. However, white efflorescence has been never mentioned. The white material was identified using FTIR and GC-MS analyses as adipic acid. Also butane diol was detected. Adipic acid and butane diol are used to synthesise a polyester from which a polyurethane is polymerised. Artificially ageing experiments with enclosed PUR esters foams showed the same phenomena.

Until specific conservation treatment for PUR foams are developed, the degradation caused by moisture, light and heat (a not controlled environment) can be inhibited by adequate storage conditions. Guidelines for storage conditions for PUR-ester foams should mention: low relative humidity, low temperature and low light levels.

Crazes

The National Scheepvaartmuseum in Amsterdam exposes works of art enclosed in Perspex® sheets, a common applied exhibition method. One of the Perspex sheets showed a white efflorescence. This Perspex sheet was enclosed with a acid free white board passe-partout, two bid format slides and a Perspex backboard in an aluminium frame. A lamp behind the frame illuminated the slides. After a six months' exhibition, the side of the Perspex closest to the side of the white cardboard was 'covered ’ with a white material.

Microscopic examination of the 'efflorescence' (40x magnification) showed not a white crystalline material, but fine crazing. Only the Perspex that had been in contact with the white cardboard showed this phenomenon. The front of the Perspex and the passe-partout side of the Perspex did not show the crazing.

During the day, the heath of the lamp behind the exposed slides had driven the water out the cardboard. The only way watermolecules could go, was the coolest place of the Perspex. Only in the space of the passe-partout the moisture can divide itself. Watermolecules are very polar components. Perspex (an acrylic component) is also a network of polar compounds, that is why water molecules can be transported easily through the Perspex.
The water transport is also a well known cause of damage of liquid preparations in natural history collections. When specimen are preserved in formalin in acrylic jars, the water slowly evaporates slowly through the Perspex the replacement of air. On the long term a under pressure exists, which can lead to the implosion of the jar.

When the transport of water molecules is taking place together with a present stress it can lead to the disconnection of the polymer bonds of the Perspex molecules. This is to be seen at the crazing.

When in the evening the lamps are shut off, the cardboard cools down and can take away the moisture. Cardboard is more hygroscopic than Perspex, so the moisture migrates back into the cardboard. By changing warming and cooling down of the cardboard en hence the caused transport of moisture, the surface of the Perspex is crazed within 6 month's.

This showed example is, however, an extreme situation (the heating behind the frame). But this transport of moisture as a result of changing temperatures, is not unusual in storage areas or under museum conditions and these are the cause of all sorts of degradation phenomena such as the discoloration of paper in passe-partouts.

This phenomenon can always be expected with a construction as showed above. Only the term at which it takes place is not known. This depends of the changes in temperature and the fastness of the changes. So it seems that a simple question of the content of the 'efflorescence' appeared to lead to the complex process of the creating of microclimates as the result of changes in temperature. Insight in the formation of microclimates are more and more gained by the research into the backboard protection of paintings, but the consequences of these microclimates for the conservation of objects of cultural heritage need more research before it will be exactly understood.

Deterioration of PVC components in Apollo spacesuits

Yvonne Shashoua, Lisa Young

Introduction

In March 2000, a two-year conservation project was initiated by the National Air and Space Museum in Washington DC, USA and involving industrial scientists and conservation professionals in many institutions worldwide. Its purpose was to establish the various types of deterioration exhibited by spacesuits from the Apollo Space program, and to use that information to develop a conservation policy to preserve them for future study (1). This was the first detailed examination of the spacesuits since their acquisition in the 1970s.

Visual examination of the 22 material types used to construct the Apollo spacesuits suggested that 3 of them were notably more degraded than the others. Soft polyvinyl chloride (PVC) tubing used to transport air and water, rubber components such as the joints allowing the wearer flexibility during movement and anodized aluminium connectors, had degraded to an unacceptable level. Since the suits were constructed and used as recently as the late 1960s, using the best quality materials available during that period, the extent of their deterioration gave cause for concern. The advanced level of degradation shown by the PVC life support tubing and cooling tubes will be discussed here.

Today, PVC is the second most heavily consumed plastic worldwide. However, unmodified PVC is a brittle, inflexible material with rather limited commercial possibilities; incorporation of additives dramatically increases its potential. Plasticisers are the major additive in PVC formulations, both in terms of percentage weight and their influence on the final plastics product. They increase the flexibility, softness, and workability of the final product by reducing the Glass Transition temperature. Plasticizer in commercial PVC tubing, such as that present in the Apollo space suits comprises approximately 30% by weight.

Use of PVC tubing in Apollo era spacesuits
PVC tubing was utilized for two main purposes in spacesuits. On the exterior of the suits, thick (15mm outside diameter) PVC tubing encased within nylon textile, was used for life support hoses which carried water and oxygen to the astronauts. Later Apollo era suits incorporated two sets of life support hoses into the suit so the astronaut could safely perform extra-vehicular activities, such as exploring the Lunar surface. PVC was also used to construct thin (3mm outside diameter) tubes which were an integral part of the liquid cooling garment. This garment was worn underneath the spacesuit in order to keep the astronauts cool while performing tasks. A series of thin, networked PVC tubes allowed circulation of cool water over the entire body of the astronaut, and thus allowed the astronauts to remain at a constant temperature while performing tasks in the very harsh environment of space.

Examination of deteriorated PVC tubing
Visual examination of the thick life support tubing and thin tubing from the liquid cooling garment showed three, apparently progressive stages of deterioration on internal and external surfaces.

1. Liquid stage. Droplets or thin films of liquid were visible on the surface of the tubing. PVC was tacky to touch. Pools of liquid were sometimes present, causing staining of adjacent suit materials. Shrinkage, embrittlement and severe discolouration of the PVC itself was associated with this stage.

2. Tacky stage. Dense, white crystalline material adhered to the discoloured, tacky PVC. Dust and packing materials had adhered to the surface.

3. Crystalline stage. Fine or coarse crystals adhered lightly to the brittle, dark yellow PVC. The crystals were readily removed by brushing.

All PVC tubing from the liquid cooling garment had attained the third, crystalline stage of deterioration, while tubing from the life support system exhibited either the liquid or tacky stages.

The plasticizer in the tubing was identified, using Fourier Transform infrared (FTIR) spectroscopy, as di-2-ethylhexyl phthalate, more commonly known as dioctyl phthalate (DOP) the most frequently used plasticizer since the 1930s. Attenuated Total Reflectance FTIR spectroscopy allowed identification of the liquid film and crystals present on the surfaces of the degraded tubing in a non-destructive way. The liquid film and droplets produced spectra characteristic of DOP while the white crystals were characteristic of phthalic acid.

Low-vacuum scanning electron microscopy (LV-SEM) was used to map the locations of DOP on the PVC tubing, by mapping for chloride (due to PVC and not present in DOP) and oxygen (due to DOP or phthalic acid) ions. LV-SEM was also used to examine cross sections of the tubing. Thin films, containing oxygen (indicative of plasticizer or its degradation products) were identified on all surfaces of the tubing, while plasticizer was also evenly distributed throughout the body of the PVC.

Conclusions
The appearance and chemical identification of plasticizer at internal and external surfaces of the life support tubing, suggested that DOP plasticizer had separated from the PVC polymer with time, forming thin liquid films. This is a recognised phenomenon, traditionally attributed to the fact that plasticizer is simply mechanically admixed rather than chemically reacted with PVC during manufacture. Physical bonds are approximately 10 times weaker than chemical covalent bonds and, therefore, may be broken more readily. However, the period over which separation occurs has not been established.

As esters, phthalate plasticizers are susceptible to hydrolysis when exposed to strongly acidic or alkaline conditions. Phthalic acid or anhydride and alcohol are the products of such reactions. Oxygen attack on alkyl groups in the plasticizer molecule also results in the formation of phthalic acid. Such oxidative reactions are expected to occur above 200ºC, such conditions were not experienced by Apollo spacesuits, but acidic conditions lower the necessary temperature (2). PVC components from spacesuits were likely to be exposed to highly acidic conditions by the dehydrochlorination reaction of degrading PVC polymer.

As the PVC component deteriorated, hydrogen chloride was produced and an unsaturated polymer containing a conjugated double bond structure resulted. It is the presence of such structures which is responsible for the severe yellowing of the tubing (3). The hydrolytic degradation of DOP resulted in the formation of phthalic acid, a highly crystalline material. Phthalic acid crystals were identified on internal and external surfaces of life support and cooling tubes. They were present together with undegraded liquid DOP at the surfaces of the life support tubes.

Examination of the life support and cooling tubes from Apollo spacesuits suggested that extensive deterioration of plasticized PVC is likely to take place within 30-35 years. As many of the spacesuits in the collections of NASM have reached this age, and the PVC components are heavily deteriorated, further research is on-going to determine how to inhibit such degradation in order to better preserve newly acquired suits, like those from the Space Shuttle era.

References

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Mass spectrometric identification of pigments and media in modern paint.

Jaap J. Boon, Tom Learner*, Nicolas Wyplosz and Ron Heeren.

The characterisation and identification of modern pigments and media present many analytical difficulties especially in mixtures such as paint. Modern media are prepolymerised high molecular weight (HMW) polymers of known structure but the characterisation of HMW polymers is not a trivial task. The colourants are synthetic organic pigments with,usually, well-known structures. Paints however are formulated according to proprietary methods, so the exact composition of commercially available artists paints are often unknown. With time, these paints undergo ageing processes leading to unknown compositions.

We are exploring the potential of direct temperature resolved mass spectrometry (DTMS)for the analysis of modern media and pigments. DTMS is capable of detecting organic pigments at extremely low concentrations as well as analysing fragments of synthetic polymers observed as pyrolysis products. In DTMS the polymer fractions, additives and colouring matter often appear in different temperature windows, because of their different physical chemical state in the sample. In this way it differs from FTIR which may fail to characterise a pigment in the presence of other materials which are interfering with characteristic absorptions for the pigment. In addition, appreciable quantities of an organic pigment are required so that its diagnostic peaks are not masked by other components in the paint.

DTMS data will be presented for acrylic polymers or resins and a selection of organic pigments (phtalocyanines, quinacridones, azo pigments).

We have also applied laser desorption ionisation mass spectrometry (UV laser at 337 nm) to modern pigments and pigments in paint media. This methodology is also applicable to paint cross sections. LDI-MS selectively desorbes and ionises many modern pigments. We will present data on phtalocyanines, quinacridones, azo pigments and perylene red. Phtalocyanines present an interesting example because mass spectrometry can easily recognise the different substitution pattern of chlorine and bromine, which determine the colour. Sample processing up is very simple.

A few examples will be presented of pigment data directly obtained from cross sections.

The *matter paintings* of Antoni Tàpies: a study of some mechanical properties of contemporary alkyd paint layers with high pigment volume concentration

Irene Civil.

This research is the result of a thesis carried out at the Canadian Conservation Institute, Ottawa, and Queen's University, Kingston, Canada, and with the support of the Antoni Tàpies Foundation, Barcelona, Spain. Antoni Tàpies is the most recognised Spanish artist of the second half of the 20th century. The term *matter paintings* stands for the innovative works that he created in the mid 1950s; these are definitive of the mature and distinctive style of the artist. These works are characterised by thick and highly textured paint layers made primarily of sand or crushed marble mixed with commercial oil-based alkyd varnish.

Cracks have formed within the heavy paint layers and conservators face challenging dilemmas when searching for the appropriate conservation approach. The research deals with the study of the materials and technique of the matter paintings, some of their physical properties and mechanical behaviour. Such studies give a better understanding of crack development. The discussion on the particularly close relationship between the technique, the materials, the artist's intent, the deterioration, and the artist's attitude towards deterioration and conservation, is gathered together for the first time.

In order to reproduce the mechanical behaviour, small samples of model paintings made in the manner of Tàpies were made with different high pigment volume concentration (PVC) and thickness. Physical tests, such as curing shrinkage and curl, tensile strength test, response to changes in relative humidity (RH), and flexibility, were carried on the model samples and helped to characterise some mechanical properties of these unusual composite layers.

The results showed the impact of small variations in PVC, in the range tested, as well as the importance of the thickness of the layers, on the creation of cracks. The *matter* layers proved to be only slightly responsive to changes in relative humidity.

Pratone'- a polyurethane-soft foam art-seat by 'Gruppo Strum'

Judith Buetzer

Synthetic material (plastics), which include foam rubber, have influenced contemporary artists and designers since the sixties. The particular properties of this new material inspired designers to experiment and create new forms of expression in furniture. Liberated from the constructional constraints and time consuming finishing processes required by natural wood, designers in the late fifties began to create sculptural, shell-shaped furniture out of plastic. In the mid-sixties young designers all over Europe reacted against the functional and increasingly production orientated design theory of the post-war years.

The series 'Fun-Foam' produced by the Italian company 'Gufram' played a prominent role in the development of design in the early seventies. These furniture-objects made out of polyurethane soft foam revolutionised our concept of form.

Elements borrowed from nature, art and architectural history were trivialised by radically increasing their size and reinventing their function as pieces of furniture. This translocation to the living space at once symbolised and ironised the longing for art and nature. Furthermore it questioned current valid rules for furniture not only with regard to the chosen material but also the form of expression and function.

The *“Sitzobjekt”* 'Pratone ' from the series 'Fun-Foam' was designed by the Italian group 'Gruppo Strum' in 1968 and has been in production by the company 'Gufram' since 1971. It is made of polyurethane soft foam based on polyesterpolyol and has a green and a transparent coating. It represents a magnified piece of lawn (x20) and is one of the most important design experiments of its time.

'Pratone' is a magnified representation of a small piece of 'cultural nature'; a lawn is a place to lie down, to dream, to encounter others and to relax. 'Pratone' invites you to rest while arousing interest in the new physical experience of sitting and lying between the oversized stylised blades of grass. 'Pratone' consists essentially of two elements: 42 blades of grass and a low pedestal-like base. It measures an area of 140x140 cm and is 95 cm in height.

Infra-red spectroscopy of the polymer material used (foam, green coating and transparent coating) showed all polymers to be polyurethane. The foam and green coating are both polyetherpolyol whereas the transparent coating is a polyesterpolyol.

A 'Pratone' from the first 'Fun-Foam' series was bought by the Kunstmuseum, Düsseldorf in 1997 for the contemporary design collection. All three polymer materials of this Düsseldorf 'Pratone' are very degraded. The coatings are cracked and appear brittle, while the exposed foam has yellowed, is furrowed in appearance and crumbles when touched.
Inspection of the degraded material showed that the deterioration of the foam was directly related to the cracks in, or wear of, the coating. Surface damage in the green coating leaves the exposed foam vulnerable to attack from external sources. Once the photo-oxidation and degradation process of the foam begins, the adhesion of the coating in the surrounding area is reduced making it particularly susceptible when subjected to mechanical stress. This interaction of original deterioration and further damage accelerates the progressive deterioration of the object. 'Pratone's' condition and the limited legiblity of the design idea placed it in the category of endangered cultural objects worthy of preservation so that an acute necessity for treatment existed.

The lecture concentrates on this aspect. It will give insight into the possibilities of restoring specimens from the 'Fun-Foam' series while taking into account the specific properties of polyurethane.

The aim of the restoration was to maintain the Düsseldorf 'Pratone' as an authentic 70s design object and to restore the legibility of the design and form. The knowledge that the continued deterioration of the object could be reduced by restoring the green coating was significant for the restoration concept.

Although restoration costs far surpass the current market price of a new 'Pratone' the significant importance for both art and design history is a sufficient argument to advocate treatment. 'Pratone's' unique character is underscored by the different/modified script and the varying arrangement of the blades of grass. This costly restoration is therefore appropriate both when we consider 'Pratone's' important position in the history of contemporary design and accept the fact that failure to treat foam objects necessarily results in continued degradation and eventual disintegration. On ethical grounds therefore the treatment can be justified and must necessarily be pursued.

The detailed documentation of the object and the condition of the Düsseldorf Pratone will be discussed. Furthermore the restoration concept and aims will be explained and solutions will be highlighted for the consolidation of tears and the filling of losses in both the green coating and the foam. The emphasis in the treatment is placed on the restoration of the protective green coating, since an intact coating can shield the foam beneath, protecting it from external degradation factors and thus slow down the ageing process.

After examination of the tears, tests with various adhesives were carried out on dummies. Where no, or negligible loss was evident, tears in the foam and green coating were consolidated. In areas where the foam had disintegrated the losses were first filled to create a smooth surface before the coating was restored. It was important that this fill material possessed similar flexibility and elastic properties to the original foam. A method using a fill material based on polyurethane soft foam was explored and successfully employed during restoration. After the losses in the foam were filled, a solution was found for the restoration of larger losses in the green coating. Finally the losses were optically reintegrated.

In addition to the conservation and restoration treatment, recommendations for the future display conditions of the Düsseldorf Pratone will be made as it is imperative to employ prophylactic measures which will ensure its long term preservation.

The restoration treatment shows that the intact appearance of the object can be achieved while also illustrating possibilities for both restoring and conserving polyurethane objects with protective coatings. However the methods and results of the restoration presented here may not necessarily have universal application, rather they are to be understood as a response to the demands of a particular case and as such should be valued as an experimental solution at the very beginning of research in foam restoration.

The use of Py-GC-MS for identification of the polymeric constituents in artworks, museum and collectible design objects.

Dominique Scalarone and Oscar Chiantore

An effect of the scientific and industrial progress achieved during the last century has been the development of many new materials, above all polymeric materials. Polymers, having low cost and great versatility, had an immediate success, firstly in the production of common objects and secondly in more specific industrial areas. Also artists were soon attracted by the innovative properties of the polymeric materials and by the possibility of using them to experience new forms of artistic expression.
Now, after only decades since they were first produced, many of these artworks and collectable objects show aesthetic problems due to degradation. In order to develop correct procedures for their cleaning, restoration, and storage, it is necessary to completely characterise their constituent materials.
We have analysed a considerable number of modern artworks, plastic objects and also items from classical movies belonging to the collection of the “Museo del Cinema” of Torino, Italy. In the analysis of such samples, together with other techniques, we have applied Py-GC-MS systematically and effectively.
Py-GC-MS is a powerful technique in the analysis of non volatile compounds, it is characterised by high sensibility, response specificity and by the capability of obtaining structural information from very small samples, in the range of micrograms. As pyrolysis is a process of thermal degradation, the identification of the pyrolysis products and the knowledge of the degradation mechanisms experienced by each class of polymers is fundamental for their recognition.
Three main categories of thermal degradation processes may be listed:

1. chain scission (PE, PI and natural rubber, PS, polysiloxanes)
2. unzipping (PMMA and other acrylates)
3. side-group scission (PVC, PVA).

An interesting modification of Py-GC-MS is the on-line derivatisation process known as thermally assisted hydrolysis and methylation (THM). The method is based on the high temperature reaction of tetraalkylammonium hydroxide with macromolecular substances containing functional groups susceptible of hydrolysis and methylation.This method is most useful in the analysis of condensation polymers (i.e. polyesters, polyamides, polyurethanes, phenolic resins, etc.) because in this way adequate elutions of polar compounds can be obtained with minimal sample manipulation.
Despite its utility, THM also shows some negative aspects. The major one is that measurements are less specific and sensitive, especially from a quantitative point of view, because of the formation of differently methylated isomers and the degradation of alkaline- sensitive compounds. Nevertheless, comparing all our data, we can conclude that, with few exceptions, Py-CG-MS is the analytical technique of choice for a wide range of polymers and organic compounds in general, including synthetic pigments, plasticizers, emulsifiers and other additives.

The training programme in conservation of modern art at the Limburg Conservation Institute.

Claartje van Haaften & Sanneke Stigter

The ‘Stichting Restauratie Atelier Limburg’ (SRAL) at Maastricht is a Netherlands provincial conservation studio. It has provided a post-graduate training programme ‘Conservation of Paintings and Painted objects' since 1990. The five-year course is divided into a three year period in Maastricht and two years of internships in Dutch museums. Training programmes exist in three conservation disciplines: old master paintings, decorated historic interiors and, since 1998, modern art. Students enter the course after finishing a full university training in Art History. The beginning of the programme in conservation of modern art was partially based on the recommendations presented by the Foundation of Conservation of Modern Art at the international symposium Modern Art Who Care's (Amsterdam 1997).

The conservator of Modern Art faces a wide scope of materials and techniques and often has to deal with unconventional ideas regarding conservation and restoration. In the 20th century many artists abandoned traditional techniques and tended to develop individual techniques. This often goes hand in hand with an experimental use of literally all materials available. Furthermore works of art can embody all kinds of specific meanings. From painting and sculpture the art-forms develope into installations, transitorial or process art, performances or site-specific art.

First three years of the educational programme:
From day one students work on modern art objects from Dutch museum collections. In performing research and making proposals for treatment, students apply the models developed by the Foundation of Conservation of Modern Art.
During the conservation research, the decision making and the final treatment the students face all aspects and controversies inherent in the use of modern materials: varying from un-orthodox treatments and the meaning of the artist to the intention of the owner. Interventive conservation treatments are performed, if possible, in dialogue with the artist. For a better understanding of the art-making process, reconstructions are made of the original object. Both conservation options and the aging process will be tested and investigated.

In twelve workshops, of one week each, the students are provided with a deeper understanding of crafts, techniques and specific materials. Since the modern artist is not always the actual producer or fabricator of the artwork, the workshops can be related both to industrial as well as artists applications. Theory and practice will be focused on the possibilities and limitations of conservation techniques to conserve these materials.
The workshops deal with: paper, metal, modern wood, synthetic materials, modern painting techniques, photography, electrical equipment, audio-visual systems and modern media, textile, ceramics and glass, casting techniques, conservation management / preventive conservation. If possible the subjects are taught in close connection with curricula of existing conservation disciplines. Guest-teachers are invited and excursions on these topics are organized.

Synthetic materials
In the set-up of the curriculum there are many parallels to and collaboration with the training programme of the conservation of old master paintings, for instance on subjects as chemical and physical properties of traditional materials and conservation techniques.
In the modern art objects they treat, students come across modern synthetic materials and their conservation problems. The workshop concerning synthetic materials provides them with general knowledge of plastics, analytical techniques, recognition of deterioration, and they learn how to set up preventive conservation. An actual conservation treatment often starts with tests on dummies and reconstructions in which maybe traditional techniques like tear mending, consolidation, gluing, filling and retouching are tested and adjusted. An adapted technique can finally be chosen to perform the treatment on the real art-work.

Year four and five of the programme
During the last two years of the programme the students leave Maastricht for their internships in three different Dutch modern art museums. One research project during those two years results in a final thesis. After exams the students receive a diploma.

Plastics: consumer goods or precious objects? The development of plastics and their use in German society.

Friederike Waentig

Considering the development of plastics from their invention in the mid 19th century until today, the high speed dissemination of the new materials in a, at that time, not yet global world is remarkable. World and industrial exhibitions played a very active part in the popularization of these materials at that time. Industrial nations, like England, the United States, France, Italy and Germany, were the leaders in the chemical and plastics industry. These nations were the main plastic producers, dealers and distributors in the world market.

The mid 19th century products were very versatile, alongside technical goods there were many everyday articles. Once production and processing techniques for, first the semisynthetics and later, at the beginning of the 20th century, also the synthetics, the variety of the output seems to be endless. During the turn of the century and the following period, the imitation of luxury goods like jewellery was very fashionable, but also household items, toys, everyday articles like combs, brushes, small jars or boxes and diverse items of office equipment, and many others were manufactured using plastics.

Each country developed their own plans, products and applications for their plastics products. One example is the Belgian company ‘Ebena’ which produced uniquely designed boxes and vessels in the 1920s. Regional designs were also found in household objects, office pieces, and jewellery. Overall, every country developed plastic objects and their regional design differences were clear.

During the 1920s Germany fell behind in design development and was not associated with a unique style until the end of the Second World War and the re-establishment of the Federal Republic of Germany. The First and Second World Wars, the Republic of Weimar and the scarce trade and industry are the reasons. Above all, the totalitarian regime of the National Socialists led to an isolation and suppression of free-thinking and, subsequently, creativity. Dark colours, especially the field mouse-grey of the uniforms and the brown-black Bakelite dominated that time.

Until the end of the 1930s there was an exchange of technology between Germany and the other industrial nations. After that period, cultural exchange was inhibited and the development of different styles no longer reached Germany. For example, American society was dominated by the ‘machine-style’ or the ‘streamlineform’. The development in the European countries was not too different than the situation in the United States. In England, the American influence was greater than it was in France and Italy. In general, the variations and interpretations of the American style create the differences in the individual styles of each country.

In Germany, the influence from the outside - even before design had really started to be developed - stopped by the assumption of power by Hitler in 1933. Although German scientists contributed decisively to the discovery and development of plastics, that is not reflected by the variety of produced objects that were available to the German public. The German chemical industry and therefore the German plastics industry were compelled to observe secrecy; although some companies for example the ‘IG Farben’ had a technological exchange with the United States until 1941. For this reason, these new materials were well known to the German plastic scientists, but not to the German public. At that time, the major application of plastics was in the armaments industry.

Consumer goods, household objects and pieces of jewellery were produced from Bakelite. Well- known and very popular was the radio set ‘Volksempfänger’, a design of Walter Maria Kersting in 1928 which was produced in brown Bakelite in 1930/31. Soon the set was in almost every household and the national socialists were now able to spread their propaganda. Many objects such as kitchen utensils and writing materials and also telephones were produced in phenoplasts that just allowed dark reddish, greenish or brownish and black colours. However, the history of plastics illustrates that in the 1920s and 1930s it was already possible to produce plastics in coloured and light tints. A look at England and the United States shows light, translucent, coloured and even marbled looking picnic dishes (Bandalasta, for example) and radio sets made from different aminoplasts. The majority of Germans did not know anything about aminoplaste. They were surrounded with field mouse-grey colours.

Analogous to industrial production was the creation of fine and decorative arts. In the 1910s and 20s, many artists had international exchange and were familiar with the new and modern materials like cellulose nitrate and cellulose acetate. For example, both Russian artists Naum Gabo and his brother Antoine Pevsner, stayed and worked temporarily in Germany. They were also the first artists experimenting with plastics. It was Moholy-Nogy who tried materials in pre-courses/classes at the ’Bauhaus’ and who included materials as Celluloid and Rhodoid beside the, still, very dominant and traditional materials.

With the assumption of power of Hitler, many German artists and foreign artists living in Germany had to emigrate. The stimulating exchange that had taken place for example in the vicinity of the 'Bauhaus' or at the 'Deutscher Werkbund' was no longer possible. This situation continued until after the war. Not before the re-establishment of the the German Republic did circumstances start to change. In the beginning, plastics remained simple substitutes for other materials because of their dark phenoplasts. This led to a plastic phobia.

Not until the early 1950s, was the re-founded Federal Republic of Germany authorized by the Allies to produce plastics again. Then the companies which arose from the former company 'IG Farben' rapidly became one of the foremost industries in plastics production.

In the German Democratic Republic the plastics industry grew into an exceedingly efficient organisation. Due to the shortage of raw materials and consumer goods, they supplied their own country and also other Russian countries with products made from plastics ('Plaste and Elaste') made from Soviet mineral oil. Because of the insistance of the government to use and to design plastics products, the dealings in the new materials flourished in East Germany.

In the 1950s the design of everyday goods was still not determined by the new materials in spite of the growing importance of plastics in the economics and the influence of the occupying powers, in particular the United States. This remained unchanged until 1951 when the re-founded 'Deutsche Werkbund' took the initiative to create the 'board for design' ('Rat für Formgebung'). This board arranged exhibitions like 'plastics-well designed' ('Kunststoffe-gut geformt') or exhibitions on products of designers like Wilhelm Wagefeld, Ernst Möckel and further artists from the vicinity of the University of Applied Sciences for Design in Ulm. Many producing companies joined in by realizing these ideas as plastic objects. Well known even today is the company 'Braun'. The increased presence of plastic objects in public, also supported by advertising, provided a stronger acceptance and distribution of plastics objects as consumer, housekeeping and everyday goods.

In the 1960s the plastics industry started an additional campaign to improve the image of plastics. The company BASF initiated a reward to motivate young artists to work with plastics. HOECHST invited artists to the plastic fair in 1967 to show their art made from plastics in an special exhibition. Many German artists and designers participated in such competitions and exhibitions.

However, the initiative of the German chemical industry and of the 'board for design' were not solely responsible for the plastic boom in the late 1960s and 1970s in Germany. The economic and even the cultural influence of the United States was certainly also important. At that time Germany renewed its affiliation to the world wide development of styles in the production of plastics. Examples are found in the style of living and in the production of furniture at that time, and also the importance of great architects and thinkers, for example Buckminster Fuller, or Stanley Kubrik who influenced the younger generation with his film '2001 Odyssey in the Universe'. The 'geo-dome' as a living house, the space capsule as living cave or installations in the universe style are representing the global hit.

Recent restoration works on items from the Cinema Museum of Torino:
Starwars, Robocop, Gremlins, Alien and other movies plastic devices

Antonio Rava

Restoration and other treatments of modern materials and especially Polyurethane (PUR) foams from "Museo del Cinema" in Torino and their collections were carried out in studio Rava during 1999-2000.
We identified the materials and studied the developing degradation, which in some cases was very serious, attempting to stop the processes using very simple methods. Information was given to the Museum staff in order to establish a good standard for preventive conservation. Within a few years of construction, the pieces showed disfiguring problems including soiling, loss of paint, discoloured repair materials, structural cracks and lacunas. The most disfiguring features were the marks of previous repair and the dramatical change of the brilliant original colours to subdued greys.

The removal of dirt proved to be difficult due to the extremely thin and fragmented paint layer. The composition of construction materials was investigated in order to select appropriate solvents, adhesives and repair procedures.

In the talk the complex problems faced in this work dealing with synthetic polymers will be discussed together with a description of the co-operation with Museum staff which was very significant in trying to develop storage and exhibition strategies for permanent display of the works.

As a result of analytical work performed by Prof. Chiantore and coworkers at the Department of Chemistry of the University, we could establish the most suitable methodologies for reaching fairly stable conditions for our objects now in permanent display in the "Museo del Cinema" in Torino. Further work will include documentation of the ongoing conservation problems of the entire collection, many of which contain synthetic polymers, are some of the most problematic work for conservators of our period of history.

A study of synthetic polymer gessoes and their behaviour in artificial ageing tests

Mari Kaukovalta

This study was a final thesis made in Espoo-Vantaa Polytechnic Department of Conservation Studies during Spring 1997. The study concerned synthetic polymer gessoes, their materials, characteristics and behaviour during artificial ageing tests. Four Finnish, one American, one British and one Chinese commercially- prepared gessoes were studied. Gessoes were: Suomalainen and Uusi Suomalainen Gesso by Colart, Gessorex by Kymin Palokärki, Taiteilija-Gesso by Raamarit, Fredrix Gesso, Galeria Acrylic Gesso by Winsor and Newton and Shanghai Siic Marie Painting Materials Company's gesso. All these were sold as acrylic gessoes.

The gessoes were applied on different grounds: canvas, wood, cardboard and glass as an inert material, and aged artificially with light or heat for ten weeks. The temperature of heat ageing was 75 ºC and the total lux hours during light ageing was 42 million (approx. 65–90 years in museum conditions).

The gessoes' binding media, pigments, fillers and some additives were investigated both by iodine and ammonia tests, scanning electron microscopy and Fourier transform infrared spectroscopy. Changes for example in colour, solubility, hardness, flexibility and adhesion to the ground were measured. Changes in colour were measured by spectrophotometer using the CIEL*a*b* system. Solubility tests were made using seven different solvents, two solvent mixtures and water. Hardness tests were made using pencils from 3B to 3H. Flexibility test was a simple manual test and adhesion to the ground was tested using a standardised manual test.

One of the major discoveries in the study was that all products sold as acrylic gessoes do not include acrylics.

Celluloid – a material is decaying. Testing environmental conditions for storage of Celluloid objects.

Kathrin Kessler

Celluloid is the American trade name of the first semi-synthetic plastic. First produced in 1872, the term 'Celluloid' prevailed compared to other its various other trade names. Today, Celluloid is not any longer just a trade name but it is the term for the type of plastic produced from cellulose nitrate and the softener or plasticiser camphor.

Celluloid did not only contribute as a support of movie films; many articles for daily use have been made from this first thermoplastic. The conservator has to deal with Celluloid in combs, toys, and in a variety of shaped boxes and vessels. Frequently, Celluloid was combined with different materials, for example as buttons on textiles, as decorative elements on ethnographic objects or as keys on instruments.

Celluloid objects are subject to a material specific degradation process. As a result, many objects in the museum collections show different damages more frequently. Differences in aging have been observed between objects made from opaque and translucent Celluloid. The Celluloid objects themselves, but also objects in their environment, can be damaged by the emerging degradation products. Although the outward appearance, shape and colour of an object are still intact, the interior of the Celluloid started already cracking. With that, the objects become more and more brittle and as a consequence, parts of the objects break.

The main component of Celluloid is cellulose nitrate polymer (70-75%). Cellulose nitrate is the main product of the nitration of cellulose molecules with nitric acid whereby water is released. On the surface of the Celluloid objects, the water forms nitric acid as an oily and greasy film. With this, the degradation of the Celluloid object has already started. Through cracks and scratches, water penetrates also into the Celluloid and forms nitric acid on the interior of the material.

In addition to this, nitrogen oxides is released as a result of oxidation of the cellulose nitrate molecules. In the presence of humidity, these gases form also nitric acid on the surface of the objects. The reaction is autocatalytic, that is, the reaction accelerates in the presence of increasing concentration of nitrogen oxides.

A second major component of Celluloid is the softener camphor. Camphor is not chemically bonded to the cellulose nitrate molecules but sublimates at room temperature. During sublimation, camphor leaves little holes and gaps in the Celluloid, allowing water to penetrate the Celluloid and form nitric acid inside the material.

The degradation of Celluloid depends on different factors. The severity of the degradation can be described by a graph where the intensity of the degradation is dependent on time. This graph can be subdivided into three phases. In the beginning, the Celluloid object shows almost no indications of degradation so that the grade of degradation is close to 0. At one unknown moment, the process of degradation is accelerated and the graph rises abruptly. At this time, a higher concentration of nitrogen dioxide or more nitrogen acid on the surface of the Celluloid object can be measured. This may be attributed to changes in the climatic conditions, possibly caused by the changes in the condition of the object itself. Under these new conditions, the intensity of degradation reaches a new maximum and stops. The graph describes a straight line again but on a higher grade of degradation. By changing the conditions again, the degradation of the Celluloid object accelerates again to a new, different, but under these new conditions stable point.

Each Celluloid object reacts in a different way to any changes of the environment conditions because of the differences in the compositions of each Celluloid formulation. It is, therefore, difficult to define a single process for the degradation of Celluloid . Objects showing these indications which are caused by the aging of the material - for example the formation of cracks in the material or the formation of nitric acid on the surface as described previously - requires special handling. With the knowledge about these specific indications to the aging and degradation of the material, interest has been directed towards the release of nitrogen oxides and on the formation of the nitrogen acid. How to avoid or to control the formation of these degradation products is important for the successful storage and handling of Celluloid objects.

Tests were carried out to find methods and materials to control the specific degradation process of each Celluloid object. Small boxes were manufactured to obtain comparable results from the tests. Combs of similar weight and manufactured from transparent Celluloid have been used as testing material. The combs had almost the same weight before the test. The pH value on the Celluloid surface was measured with indicator papers.

The amount of nitrogen dioxide was measured using DRAEGER tubes. An additional method to state the presence of the nitrogen dioxide was the use of glass sensors developed by the Fraunhofer Institute in Würzburg. A variety of indicators were tested to investigate sensitivity to the presence of nitrogen dioxide. Filters of activated carbon and molecular sieves or zeolites were applied to reduce the amount of nitrogen dioxide in the surrounding air. To reduce the formation of nitrogen dioxide, oxygen absorbents were tested. Different containers for storage such as closed dense boxes, plastic bags, cartons and an open shelf were tested and compared.
During these tests, the application of the molecular sieves and the storage of the combs in cartons were most effective at reducing the concentrations of nitrogen dioxide in the surrounding air.

Specialisation in Conservation of Technical Objects in the Degree Course Conservation/Field Archaeology at the FHTW Berlin, University for Applied Science.
Ruth Keller-Kompas

The training course for Conservation/Field Archaeology at the University of Applied Sciences in Berlin was established with four specialisations in 1993. One of the specialisations concerned the conservation of technical objects, a new subject in the field of conservation at that time.
Insight into the importance of heritage from the industrial era for our memory of the recent past, led to the development of this specialisation when the FHTW in the eastern part of Berlin was founded.

The launch of a new subject was an opportunity and a challenge for both lecturers and students.

We planned to do it step by step, from small devices to large machines, from manual- and water- driven devices and machines to motors deriving energy from wood, gas, petrol or electricity, from immobile to stationary to auto-mobile objects. We also wanted to consider the objects in relation to their aesthetic and historical messages being at rest or in motion.... we knew there would be innumerable problems in the identification and conservation of the many modern materials involved. How could we progress?

After many discussions about how important the visual consciousness of everyday life is for the conservation profession and how we are thought to realise the sense and importance of everyday objects by the art of the 20th century, we started the first scientific project in 1995. The Ministry of Sciences in Germany financed it. The purpose of the project was to define the basic problems of scientifically-based conservation as applied to fine mechanical, manually driven devices. It was possible to examine the technical collection of the filmhistorical museum in Berlin (Stiftung Deutsche Kinemathek) where the condition of 12 devices was examined and documented.

The result was that the main problems of these objects are not caused (as I would have expected) in the abrasion of the mechanical parts but by the, then new, materials of the beginning of the 20th century which are now degrading. The cleaning and conserving of surfaces of light metals, the flaking of corrosion products, the interaction between metals and leather (metallic soaps), the stabilisation of asbestos board, are some of the challenges offered by such devices.

The result of the project led to a series of seminar papers and thesis discussing some aspects of the problems.

“Exotic Europe. Journeys into early Cinema” was a second project financed by the Raphael program of the European Commission. In it the specialisations of conservation of technical objects and of photo/film/data carriers were combined. The aim was to disseminate in the public the importance of preserving the specific culture of the early 20th century. Unknown films from the participating archives and historical film technology from the first third of the 20th century were conserved. The work done was documented in a way to present it together with the digitised films and the conserved cameras and projectors in an exhibition which will be opened in July 2001 in Berlin and then continue to Great Britain. The content of the project, the ideas behind and methods of conservation of objects of 20th century mass culture have been published in a booklet and on a DVD with the same title as the project, edited by the FHTW Berlin. These publications will accompany the exhibition.

In a third project we made significant progress. In co-operation with and financed by Autounion GmbH in Ingolstadt (Germany) we conserved a motor car “Wanderer” from 1926 in the manner of scientifically -based museum conservation. The resulting theses by the graduates were:
The conservation and filling of the galvanised surfaces (nickel and chrome); the conservation of the imitation leathers (roof and boot); the conservation of the electrical system (generator, lighting installation, starter, ignition system, cables) the consolidation and esthetical adjustment of the layers of lacquer; the cleaning and conserving of the driving and of the braking system, the analysis of the old lubricants and the development of a lubricant for conservation purposes; cleaning and consolidation of the textiles in the interior (upholstery, ceiling and carpets).
Further problems to be solved included cleaning and conserving of different qualities of rubber, cleaning and conservation of the motor, cleaning and consolidation of lacquered and corroded metals.
After conservation, the car was exhibited in the newly opened museum of Audi Tradition in Ingolstadt. Its historic aspect is – in the world of brilliantly renovated old-new cars – an attraction for many enthusiasts. As it is an important aim of conserving technical objects to disseminate the ideas of a historically relevant conservation in the public we are satisfied with this result.

motion as material. the kinetic art of gerhard v. graevenitz(bewegung als material. die kinetische kunst von gerhard v. graevenitz)

Ulrich Lang

One approach of the arts has always been the examination of life, motion and its many manners of transformation. In the painted picture, very typical is a still life, transitoriness

may become an issue explored within the subject but the very material itself, in most cases, were seen to last forever. In comparison the Eat Art of the 1960's used food whose purpose was to decompose, degenerate and rot. Both may be concerned with transitory qualities of life as a main theme but their different approaches generate more complicated questions around preservation and restoration. Few would deny the restoration of a painting, but what of a piece of art whose purpose is to degenerate and decay? The divides which are apparent in these two approaches within conservation are blurred with art which employs stable physical forms in conjunction with moving elements.
For the purpose of this document and discussion I will focus on the questions concerning works of kinetic art which comprise of mechanical moving elements as part of its physical plastic form. No matter if the origin of the impetus comes from the artwork itself (engine, electricity, magnets, etc.), any environmental influence (sun, wind, water, etc.) or by activation through the visitor (pushing, pressing, stepping on, ...) etc.
Do artists who employ real motion through moving parts as an artistic expression realise that there is an inbuilt obsolescence that comes with it? Fundamentally such works of art offer the viewer an experience encapsulated in 'real time'. Integral then is the physical qualities within the duration of its motion and the associated time needed to experience such work. Looking at a sculpture or installation, I determine the time I need to grasp the whole. Whilst most aspects of the plastic arts have an unconditional time demand on its viewer, kinetic art demands a predetermined period to realize the full emphasis of the work.
The conservator when approaching such art has now not only to consider the physical qualities of the piece but also the dimension of time and the physical mechanics which contain and produce its time frame. The viewer has to take the time 'it needs', like that of Sound-, Video-, Computer-Art or the Performing Arts. The conservator confronted with the task of preservation and restoration of such kinetic artworks wishing to remain sympathetic to the intention of the work, is challenged by certain questions:
Can a kinetic artwork 'work', if it does not work? Therefore is it legitimate or even a necessity to keep a kinetic artwork going at all costs, or are there limits set by the properties of the materials used? May I or must I exchange parts of wear and tear? If I do so where does »retouching« end and »replacement« start? How far does the preservation of the mechanical working of the artwork take precedent over the pictorial form? Is there a difference between the pure impetus (invisible mechanical parts) and the works portrayal (visible parts)? What parts are fundamental to the works portrayal? How can wear and tear be kept as little as possible (active and passive conservation)? What consequences does that mean for care, maintenance, exhibition, storing, loans and transport?
Beside the relevant material problems in conservation I am trying to address questions like 'conserving and documenting the kinetic idea', the 'conservation of wear and tear' and a 'conception for storing and exhibiting' such works of art.
These questions are encapsulated in the Artworks of Gerhard v. Graevenitz. The work of this artist which employs motion set within a strict and conceptual form, is the focus for this paper.

Plastics in Archives: History, Degradation and Preservation

Brenda Keneghan

When we consider archives, more often than not we think about paper documents. Plastics do not automatically come to mind. Most archives, however, contain various kinds of materials other than paper and parchment and the proportion of archival media made from modern materials is likely to increase. Each of these materials has its own individual degradation pattern and requirements for proper storage. This paper sets out to describe where the different types of plastics may be found in archives and what preventive measures may be taken for their preservation.

Basically plastics occur in archives in the following guises:
As information carriers e.g. phonographic cylinders and discs, photographic negatives, audio & video tapes, compact discs;
As storage or organisational aids e.g. document wallets, boxes etc.

Many archives, in addition to containing a wealth of information may also contain examples of the development of recording technology such as phonographic cylinders. Degradation of information carriers is an extremely important area because when the objects degrade the loss is twofold. Both the information contained on the object and the object itself are lost.

There are four main types of information carrier:

1. Photographic material
2. Sound recordings
3. Magnetic carriers
4. Optical carriers

There are two main types of problems associated with plastics in archives. Firstly, the specific plastic which carries the information can degrade chemically, making it impossible to access the information. Secondly, the plastic object can deform or degrade mechanically thus making it difficult for any information stored on or within it to be retrieved.

The object of this project is to trace the development of information carriers over the past 150 years and identify the polymeric materials involved. The vulnerability towards degradation of each material is considered and storage parameters and remedial procedures are suggested. The types of plastics used as storage in archives are also studied and their susceptibility to degradation estimated.

Knowledge of two ways in the process of moulding plastic Materials. Compression moulding and Injection moulding
Eva Brachert

This report gives a short review about some theoretical backgrounds of two systems in the process of moulding plastic material. These two moulding types were new and the leading processes in moulding plastic in the thirties and forties of the twentieth century.
It is an attempt to explain the outward shape and ageing of household articles and works of art in plastic, which may also be a result of how they are moulded. But the practical proof is still missing.
At first the technique of these two processes of moulding plastic materials should be explained with the aid of drawings and figures.
These techniques were used either for thermosetting plastics or thermoplastics. The thermosetting plastics were compression moulded whereas injection moulding processed thermoplastics. The property and the outward shape of the product were characteristic for the kind of moulding.
But the pure plastic, which is obtained by synthesis in the laboratory, was only in some cases ready for the use in the process of plastic moulding. The quality of the most plastics has to be changed in a special way, which is determined by the use of the final product after the moulding process. So it was necessary to put some ingredients in the plastic mass to get a mass ready for moulding.
At the end of the statement these questions are left: does this processing fix the outward shape of the plastic product for household articles as well as the works or art in plastic?
Is it possible to say something of a different way of ageing when a thermosetting plastic or a thermoplastic material is moulded in compression old or in an injection old?

Thermally assisted hydrolysis and methylation- pyrolysis -
gas chromatography / mass spectrometry for the chemical
characterisation of synthetic binders in paints

Francesca Cappitelli and Tom Learner

The scientific study of paints used by artists covers a wide range of synthetic polymers. The situation for modern paints is complicated by the fact that numerous artists used industrial paints, such as housepaints.

Nowadays, there are three important classes of synthetic resins utilised in paint production. These are poly(vinylacetates) or PVA resins, acrylic resins and alkyd resins. Alkyd and PVA resins are principally used in housepaints, whereas acrylics are also widely used in the artist's paint market.

Thermally assisted hydrolysis and methylation-pyrolysis-gas chromatography/mass spectrometry (THM GCMS) has been successfully used for the analysis of traditional oils and natural binders. This technique has also been applied on freshly dried alkyds in the context of forensic science profession and showed much promise.

The poster describes some results regarding the application of THM GCMS for the characterisation of synthetic paints found on works of art. For PVA resins, peaks from acetic acid, benzene and plasticiser were detected.

With acrylic polymers, polymethacrylates produced spectra that were characterised by the relevant monomer, whereas the pyrograms of polyacrylates also contained peaks from the methylated monomer and very short chain oligomers.

The most-interesting findings were obtained from the study of alkyd resins. The alkyd resins/paints examined were readily identified by THM GCMS from their very dominant peak, the dimethyl ester of phthalic anhydride. Pyrograms produced by THM GCMS also contained two peaks corresponding to tri- and dimethyl ethers of glycerol.

For alkyds that contain pentaerythritol, two additional and characteristic peaks were observed, which correspond to 1,3-dimethoxy-2,2bis(methoxymethyl)-propane and 3-methoxy-2,2-bis(methoxymethyl)-1 propanol.

Fatty acids, as methyl esters, from the oil component were also identified, principally azelaic acid, from the degradation of polyunsaturated acids, and the saturated acids, palmitic and stearic. In several cases oleic acid and, very occasionally, linoleic acid were also detected. Palmitate/stearate ratios were calculated and found to correspond closely with those observed with standard GCMS analyses of pure drying oils.

Some of the more common modifications to synthetic resins, such as the incorporation of styrene or vinyl toluene, were easily identified as the pyrograms container very intense peaks from their monomers.

Paint sampled from Marcel Duchamp's Fountain (1917; replica 1964) (Tate Collection T07573) was also studied. On-going research will expand this study to cover all the most-commonly used natural paint binders.

Investigation on biodegradability of synthetic binders in paints by fungi

Francesca Cappitelli, Zanardini E., Principi P., Realini M. and Sorlini C.

It is well known that micro-organisms can damage chemically and physically artworks. The chemical degradation by micro-organisms depends on organic acid and pigment production whereas the physical action is due to their penetration into materials.
For a complete understanding of the alterative processes caused by micro-organisms on artistic manufacts, it is necessary both the identification of microbial species colonising the substrates and the observation of their direct action on materials (SEM observation).
The potential danger of micro-organisms on traditional paint binders has been fully investigated, however, the same has not been systematically studied for the various synthetic resins which were introduced throughout the 20th Century.
This work describes some results regarding the fungal attack on various acrylic, alkyd and poly(vinyl acetate) resins, which are the most utilised polymers as binding media in the industrial and artistic field.
The MIL-STD-8 1 OE 1989 method -the standard method for this analysis was used to evaluate the capability of fungi to grow on the synthetic binders. Five different fungal species (Aspergillus niger, Aspergillus flavus, Aspergillus versicolor, Penicillum funicolosum and Chaetonium globosum) were chosen for their ability to attack a wide group of compounds.
The research findings show clearly that fungi grew massively on alkyd resins and moderately on poly(vinyl acetate) resins whereas acrylic resins were not attacked.

5. New Conferences:

Deterioration of Artists' Paints: Effect and Analysis

A joint meeting of the ICOM-CC Working Group Paintings 1 & 2 and The Painting Section, UKIC

BP lecture Theatre British Museum
!0th and 11th September 2001

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Past Practice, Future prospects
12-14 September 2001

A conference organised by the **Department of Conservation of the British Museum**

Registration fee £ 140 (to include preprints of all papers, teas, coffees, lunches, and a reception of the first evening). Sterling cheques only, made payable to the British Museum.

Conference venue: The Clore Education Centre Great Court, The British Museum, Great Russell Street, London WC 1B 3 DG

Accommodation: Information about local hotels and hall of residence will be sent on receipt of the registration fee. Delegates should make their own bookings.
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6. News from our members

In February 2001 Carol Mancusi- Ungaro has left the Menil Collection. From April 1th, she will be Director of Conservation at the Whitney Museum in New York and Director of a Center for the Technical Study of Modern Art at Harvard University in Cambridge Massachusetts.

Deadline for Contributions to Next Issue of the Newsletter is December 3*1, 2001*

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