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A CHANCE FOR DAYDREAMING: CONSERVATION-RESTORATION AND TECHNICAL RESEARCH OF AN OUTDOOR UPR PLASTICS INSTALLATION FROM 1992

PÄIVI KYLLÖNEN-KUNNAS AND ULLA KNUUTINEN

INTRODUCTION

This article is based on the material technical research and conservation project, which together combined to form an elementary strategy, after the arm of the installation titled *The Mermaid* was broken off and thrown into the Oulu river delta, where a trespasser found the arm a week later in 2003. The initial impetus for the article was the writers' interest in technical workmanship and material examination of artworks made from UP composites. In the article we will examine the sculptor and performance artist Jan-Erik Andersson's (1954 -) artwork, an outdoor installation The Last Milk Platform (1992) as a case study project. The artwork is especially approachable, because by-passers are welcome to sit at the platform and are invited to write fragments of dreams on the inside of the blue walls of the installation. The project involved co-operation between a polymer chemist and paintings conservator specialized in contemporary artwork and creates a new theoretical and technical material approach for pioneering the technical research and the conservation-restoration of

Fig 1. Jan-Erik Andersson's the Last Milk Platform (1992) was reinstalled in the art square beside Oulu City Art Museum in 1995. During a celebration on 15.6.1995 Jan-Erik Andersson gave a speech and the student group Exema and the cow "Rousseau" gave an performance. Mrs. Jaana Laamanen gave a lecture on the significances of milk platforms. Photographer: Päivi Kyllönen-Kunnas

contemporary artworks made from non-traditional materials. The analytical research project has brought to light more detailed information on commercial unsaturated polyester products and UP composites. Through careful documentation which included interviews, examination and analysis, knowledge has been acquired for the well-qualified conservation-restoration of the art installation in question. Through the characterization of modern materials we are able to classify these single constructions in the continuity of the artist's oeuvre, for qualified exhibition, storage and conservation of the artwork.

MATERIAL TECHNICAL RESEARCH AND ANALYSIS TECHNIQUES

UPR MATERIALS IN ART

Unsaturated polyester resins, UPR, have been used as contemporary art materials over the last 20 -40 years because they represent inexpensive, easy to use materials and form rigid but light-weight structures. In artworks it has been popular to use unsaturated polyester resin to create strong three-dimensional shapes of fibreglass-reinforced polyester. Unsaturated polyester resins are formed from the reaction of polyhydric alcohols with dibasic acids or anhydrides, and then subsequently dissolved and cross-linked in an unsaturated monomer, usually styrene, to produce a rigid three-dimensional polymer network, that has important applications in glass fibre reinforced plastics (Bergens L., 1995; Whelan A., 1995). In practice, things are much more complicated in commercial products where several different alcohols and unsaturated acids may be used in the preparation of the polyesters and many different monomers are used as diluents. Further, the addition of a monomer unit, styrene, can be as high as 50% depending on the product and is always added in excess. Further two-pack systems of unsaturated polyesters are cured by a free radical mechanism started by adding initiators and accelerators based on peroxides. The physical properties and chemical stability are adjusted using plasticizers and inhibitors (Hare C.H., 1994; Penczek P., 2005).

When unsaturated polyesters are used as a part of composite material with gypsum and fiberglass, they are considered stable materials with good chemical resistance and weathering qualities. However, prolonged exposure to ultraviolet light, as well as changes in temperature and moisture, can cause chemical and physical degradation to unsaturated polyesters (Norman N.S. and Edge M., 1992). This is especially true of artefacts made of unsaturated polyester resin, reinforced with fiberglass, and exhibited in the open-air. The ageing of synthetic composite resin materials occurs faster compared to more traditional "craft" materials, such as stone and ceramics. Museum objects made of polymers like UPR can sometimes degrade very rapidly, and may have a useful lifetime of only a few decades. The chemical composition and manufacturing process of the polymers play a major role in shaping the degradation behaviour. For this reason analytical techniques that could identify PUR polymer materials and study the effects of degradation on their chemical and physical properties were needed.

UPR MATERIAL RESEARCH

In order to study causes of degradation and to propose conservation project, the authors organized a pilot project for UPR composite materials where three different commercial UPR products and samples of the *Mermaid* from the installation of the "Last Milk Platform" by Jan Erik Andersson were studied. The choice of commercial products was made on the basis of the information provided by the artist in the series of interviews. Similar UPR product formulations that were known to have been used by the artist for the construction of the art installation were studied as references. Preliminary results of the pilot project, which were published in the ePS (e-PRESERVATION Science) in 2006, showed that there are differences in the stability and ageing properties of different commercial UPR products. Damage, yellowing, degradation and photo-oxidation were verified through VIS (Visible light) stereomicroscope investigations, CIE L*a*b* colour measurements and FTIR (Fourier Transform Infrared Spectroscopy) analyses. VIS microscope studies showed that UPR and their fibreglass composites are very porous materials, which allow increased physical and chemical degradation. IR spectroscopy indicated some variations in the chemical composition of both unsaturated polyester resin products and samples from the artefact (Knuutinen U. and Kyllönen P., 2006).

NEW RESEARCH METHODS FOR UPR STUDIES

Research was continued after the pilot project in order to gain more detailed information about the chemical composition and its effect on curing, as well as cross linking density and the deterioration mechanism of commercial unsaturated polyester products and UPR composites. As a reference material one more commercial UPR product was added. Because the degradation of UPR materials is both a chemical and physical process, all four products: A, B, C and D[1] were first studied with physical breaking strain tests. After that, chemical analyses were performed with NMR (Nucleus Magnetic Resonance) Spectroscopy, and the original UPR samples from the *Mermaid* were analysed using NMR as well (Stamatakis G. et all., 2010). Although for 50 years NMR has been a very powerful tool in many fields, its application in the field of cultural heritage is rather recent. Usually in this field either liquid or gas chromatography – then – followed by mass spectrometry have been applied to separate molecular mixtures and their components. In fact, complex mixtures of organic compounds may be successfully analysed by NMR using acetone extraction in a very simple preparation. NMR spectroscopy is able to provide insight into both the chemical composition of UPR formulations and of the extent of the degradation processes that affect the physical properties during aging (Capitani D.et all., 2011; Stamatakis G. et all., 2010).

For the mechanical tests[2] samples of four different commercial reference UPR products were subjected to different weathering conditions including: moisture, melt/freeze cycles and UVB exposure. It was interesting to note that before aging all four UPR products had similar mechanical properties. This observation stressed the importance of aging studies to determine the suitability of plastics and polymers for use as cultural heritage materials. The mechanical tests showed that UVB radiation has a significant effect on the strength of UPR materials. In general the mechanical data suggested that one of the tested UPR resins (symbolized by C) was the one most susceptible to the deteriorating effects of aging. This conclusion was corroborated by the NMR analysis, which showed that UPR sample C extracts contained increased amounts of phthalates as a plasticizer, and 1.2 propylene glycol (PG) units after UVB aging, compared to the other resin samples, whose acetone extracts were slightly lower in phthalate and PG. UPR formulation C also contained the lowest amount of styrene in the original commercial formulation out of the UPR products. UPR resins of low styrene content have been shown to possess inferior mechanical properties compared to traditional UPRs. The reduction in styrene content requires a reduction in the molecular weight of the polyester pre-polymer to maintain the low viscosity of the formulation prior to crosslinking. This increases the number of free polar end groups (-COOH, -OH) available to interact with water, with the higher water absorption leading to more facile osmotic cracking of the UPR formulation (Stamatakis G. et. all., 2002; Spyros A., 2002).

Interesting NMR results were especially prevalent in commercial UPR product C, because the art installation sample had almost identical NMR features with the aged UPR C samples. This indicated that the UPR resin C or a compositionally very similar resin had been used in the construction of this work by the artist.

Furthermore, the NMR analyses showed that UPR resins contain several low molecular weight organic compounds including plasticizers and low molecular weight polymers, known as oligomers, rich in polar –OH groups that play a significant role in the degradation behaviour of the composite UPR materials.

With NMR it was possible to reveal more detailed secrets behind the chemical degradation process in The *Mermaid*. Polystyrene (PS) fragments which were produced during UPR degradation were found. The presence of PS fragments was expected for UPR materials that have suffered heavy weathering and that have been exposed to high humidity and extreme temperatures as a result of being exhibited outdoors for several years. Extended degradation can lead to large fractions of polymeric chains being chopped off the three-dimensional macromolecular network that includes polystyrene fragments created during crosslinking. The surface of The *Mermaid* was exposed to weathering and was therefore continuously subject to chemical alteration by environmental factors. At the same time the surface was the interface through which volatile chemical components, which formed during the ageing, escaped from the polymer matrix (Stamatikis G. et all. 2010).

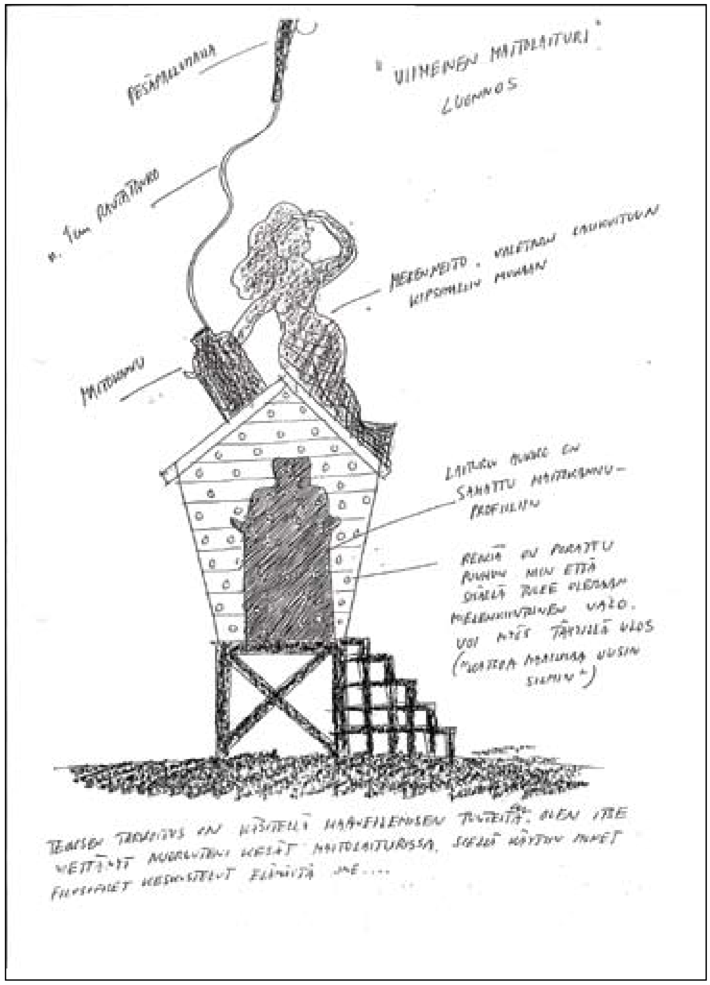

Fig 2. Artist's sketch for the Last Milk Platform. The artist writes in the drawing over the artwork that it is meant to highlight the feelings of daydreaming. He says that "I myself have spent time several occasions taking part in philosophical discussions at the milk platform."

THE ARTIST'S MATERIALS FOR THE INSTALLATION

The installation The Last Milk Platform (1992) consists of a white, blue and black wooden milk platform, with an aluminium milk churn and a red reinforced polyester mermaid on its roof. A metal stick is fastened to the milk churn pointing outwards with a black and white bat and a yellow ball.

The artist and a group of assistants built the installation for an exhibition in Sotkamo. It was later purchased for the Oulu City Art Collection in 1993. Andersson repaired some damage to the artwork before its reinstallation beside the main building of Oulu City Art Museum in 1995 with new pots of UPR paint and other materials.

Later in 2001, he was interviewed and asked to provide step-by-step, detailed structural and material information about the artefact. It was revealed that the form of *The Mermaid* was made from plaster-of-Paris bandages, which served the demands for sculpting the human figure. Polyurethane foam was extruded into the inside of the cast figure and some polystyrene, wood and metal particles were added. Then unsaturated polyester resin, as a composite with fiberglass, was used over a hand lay-up mould and covered with pigmented unsaturated polyester paint. (Kyllönen P., 2005).

UPR with fibreglass (chopped-strand matting) has been one of the preferred plastic materials used by Finnish artists for three dimensional work in art pieces. On The Mermaid, a reinforced UP resin matrix over a positive mould was made with a brush while working outside in the summer.[3]

The layup process using cross-linked polyester resins is often cold-cured, and for this purpose curing at room temperature is desirable (Nicholson J.W. 1997). Further in the process a two component paint was added to the polyester using a chemical initiator, which forms the rigid chemical bonds of the polymerised polyester. This results in a hard and shiny/smooth finish. In the case of The Mermaid, it is the Mermaid herself which is used as the open (positive) mould for structures made using a hand layup technique. During the layup the glass fibre is laid first, and then brushed over with resin until it is saturated forming the topcoat paint.(Saarela et al. 2003; Kessler K., 2003; Birley et al. 1994).[4]

THEORETICAL APPROACH ON CONSERVATION DECISIONS

ETHICS IN CONSERVATION AND RESTORATION OF OUTDOOR SCULPTURES

What makes an artwork original? For heritage preservation, the ethical and moral (critical) perception of decisions and recommendations made by conservators instil the decisions with a certain ethical and moral guarantee because of their professional qualifications (for example ICOM International Council of Museums membership). Conservation theory is unambiguous, where the importance is to maintain the physical, aesthetic and historical integrity of the objects (Muños Viñas S., 2005). In contemporary art conservation the respect for the artist's intent and the integrity of the artwork may impose the need for a certain shift in perception, from the importance of the material aspects of an art work, towards an emphasis on the artist's meaning with the longevity of the physical and conceptual nature of the sculpture (Davies L., and Heuman J., 2004). What therefore are the opportunities for managing and monitoring an artwork, with its inherent aesthetic controversies and originality, throughout its care? In cases where there is sufficient reference on the material culture of the artwork, as well as on the conservation history of the object, then the actions involving intervention and adjustment for aesthetic reasons are more comprehensible (Odegaard N., 1995; Stringari C., 1999). In this case, a detailed knowledge of synthetic materials such as plastics may be useful regarding age expectations and the ageing properties of the material.

THE PROLONGED LIFE OF AN ARTWORK?

The exhibition for which the artwork was originally constructed took place in Sotkamo in 1992. It was part of an exhibition titled Sculptures in Kainuu, funded by Association of Finnish Sculptors to last until 1993 in six municipalities in the region of Kainuu in Finland. After the exhibition, when the art work was sold to the City of Oulu, the intended life span of the artwork was changed unexpectedly from just one year for the exhibition to a longer period of time in another art collection outdoors. In many instances, as Andersson did with his piece for the exhibition, the artist sees the work not as an object, but as a process. The challenge in this case is to maintain the vital function and appearance of the work, while also conserving the material object as a historical document outdoors.

SYNTHETIC MATERIALS AND CONSERVATION-RESTORATION

A range of research and examination techniques are required to gain a full understanding of the work and all the ethical implications should be considered carefully before intervening (Rolfe, M. et all., 2000). While documenting the artefact and by cognitively focusing[5] on it, the essence of the artwork's background, as well as its technical uniqueness, is more likely to be noticed for remedial treatment. With synthetic materials, in contrast to inhibitive (preventive) treatments, we are also able to speak about interventive conservation, in other words conservation-restoration. This includes mending broken sections, and cleaning and strengthening surfaces. These interventive actions can be applied to individual objects to limit further deterioration and to preserve their significance.[6] With an outdoor sculpture it may be necessary for conservators to adjust their thinking to accept the heavier wear and maintenance as being a positive thing (Bellman M., 2002; Mack A. et all. 2002).

ADJUSTMENT FOR AESTHETIC INTEGRITY

In this case, for The Mermaid, leaving the artwork with a discoloured, weathered appearance was not an option for either artist, conservator or the collection management. For practical and technical reasons, the thermoplastics matrix surface of the UPR artwork needed to be supported from the inside and the surface fully covered to achieve the original kind of paint layer tacked to the base matrix properly – in order to resemble the original appearance of the art installation.

The co-work between the chemist and conservator, as well as the conservator's research into the contemporary artist's material techniques and intent in using plastics as part of her M.A. and B.A. studies, led to an in-depth and well-qualified approach to the conservation-restoration process. The final implementation also involved using special expertise from manufacturers, retailers and plastics engineers[7]. In this process, the life span expectations were considered and a detailed knowledge of the ageing of unsaturated polyester polymer systems was built up. In the final resolution, the research results had a clear effect on the choice of materials for the conservation-restoration.

The artist wished to restore the original appearance of the colour red, so the choice for the tone of the red colour was estimated with the artist using RAL colour cards. Paint was mixed by the conservator from three different colours: red, ochre and black UPR paint. For the chosen polyester product the original product was used .

We discovered during the technical research that the use of inexpensive UPR products result-

Fig. 3. Kyllönen-Kunnas working with the glass fibre and UP resin over the repaired parts at the armpit and arm. Photographer: Päivi Kyllönen-Kunnas.

ed in low quality properties in cured composite polyester resins for outside situations, where objects are exposed to weathering, UV-light and temperature changes throughout the year. To improve the situation and enhance UV-protection, a finishing coating was spread over the UPR paint.

When using industrial non-artist materials, as conservators, we may find it is not always possible to use the most perfect products best suited for the purpose. It may also be impossible to use seemingly straight-forward choices in materials for conservation treatment. This was the case with the polyurethane coating, which was not available in a half-matt formula. When using paints and coatings designed for industrial use, many of the products are not available for purchase in smaller quantities, or in some cases the products may only be safely used by plastics professionals.

THE PROCESSES OF CONSERVATION-RESTORATION 2005 AND 2009

The Mermaid's conservation concluded the study of the symptoms of the degradation. The fact that the Mermaid´s arm was broken off, the weathering and change in colour of the surfaces (i.e. the aesthetic reasons), not to mention the sight of the brownish reparations made in 1995, all encouraged the process. The conservation was carried out by the conservator in facilities which were stocked with the appropriate equipment for the work. The first part in 2005 took approximately 10 days over 2 weeks, and the second approximately 8 days over 2.5 months. The proper protective measures, such as using respiratory protection to filter out organic liquid gases and the use of protective clothing were taken care of. During the first phase in 2005 the mediums containing styrene were stored in a refrigerator between uses.

The first part of the conservation treatment in 2005 was a fairly traditional piece of conservation-restoration for an artwork. It consisted of conservation on the structural elements; working with just the lacunae, taking care of suitable support and in-between layers on the surfaces and fastening the arm into its original position. Using pieces of rigid polyurethane based foam, a polyester filler and clear UP resin with glass fibre captured the original materials well for the conservation-restoration. The second part of the treatment in 2009 was the process of working with the artist's idea or image of the artwork, taking care of the cohesion and adhesiveness between layers as well as the suitability of situating the artwork outside. It consisted first of treatment for the lacunae and the repaired clear

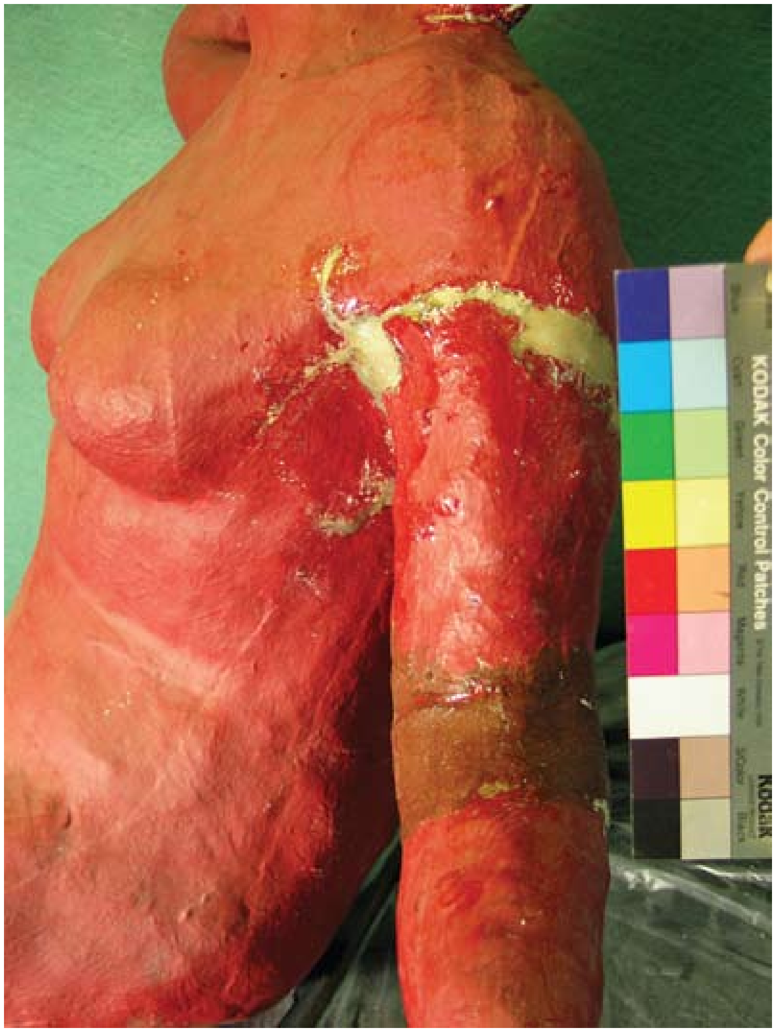

Fig. 4. End of the structural, remedial conservation-restoration work 2005.

Photographer: Päivi Kyllönen-Kunnas.

UP resin areas of the underpainting with PUR primer, and the second treatment was repainting with red UPR paint over the original matrix of the UP composite structure. After drying, the artwork was painted with a clear UV-light resistant coating.

The fastening of the arm into the correct position and structural conservation was done using a bar bent into the correct shape made from 99.9 % aluminium with solid pegs. It was placed inside the damaged armpit in order to hold up the arm. For the support material, Inota polyurethane foam was used with two-component body fibre glass polyester filler for the attaching medium. Support had to be built up in several parts because of the fast drying properties of the filler. Gelcoat paint was used under the final topcoat paint[8]. UP resin was added to the armpit and the arm on newly built areas in two thin layers over glass fibre, one with glass fibre and second over the dried surface.

The surface treatments in 2009 for The Mermaid included UP resin topcoat painting and a UV-protective coating. The second part of the UV-protection has not been added yet. The lacunae areas on the right hand, the armpit and elbow area, and the topcoat and brown-looking earlier repairs from 1995 were lightly sandpapered and painted with red primer, Temadur 50 polyuretane paint, and again after painting sandpapered. After that, the whole artwork was wiped with a cotton cloth soaked slightly in acetone. The next day after testing, it was decided to increase the ratio of the chemical initiator to maximum. To form the topcoat paint , a wax solution was added after mixing the colour. For this topcoat paint the pot life is only 15-25 minutes, so the red UP paint was spread by brush in two parts. Finally, a clear coating was spread after a break of 1.5 months. The choice of coating was recommended by the artist's retailer and Teknos laboratory engineers[9], and it was tested before use. During the drying process a cabin was used for controlled the warming.

CONCLUSIONS

The interest in the value and care of public artworks has increased both among professionals and the public. While situated beside Oulu City Art museum from 1995 to 2007 the artwork was frequently visited by the public and the media. The overall appearance of the original installation has been maintained over the years, and despite vandalism the maintenance has preserved the artwork for today. There have been requests to return the installation to its place in Oulu. The installation of the Andersson artwork beside the art museum building has however been delayed due to a hold-up in investment plans. For the safety of the artwork, it is essential to consider the placement of the artwork carefully.

Forward-looking technical conservation solutions for outdoor environments support the idea of minimising future interventions and it is generally known that future prospects for plastics are limited. Mechanical braking strain tests and NMR spectroscopy results presented in this article demonstrate the potential of these methods for the study of polymeric materials used in contemporary artworks. The NMR analysis of the organics present in UPR materials provided important information regarding the degradation state of the macromolecular UPR network. The results can be used to aid in the differentiation between various UPR formulations and facilitate the identification of original works of art based on their aging condition. Anyhow, further research is needed to be able to give recommendations on which definite commercial UPR products would be the best for conservation practices.

Contact and discussion with the artist on conservation has helped to develop conservation and restoration processes. It may lead to new avenues in testing, conservation and working together alongside chemists, technology engineers and other specialists in adapting established techniques from the plastics industry so as to make better choices in materials, if relevant to the artefact. The challenges faced in the project included understanding the different traditions in the use of UP composites: ranging from specialists in industry and trade, from artistic uses for making artworks all the way to technical research and the conservation-restoration of contemporary artworks. One important realisation to come out of the project was: that you can order other professionals to carry out treatments for you – but not without the overall picture of the process. From that point of view, for the conservator, it is an issue beyond compare to know the materials in the treatments as profoundly well as possible.

SUMMARY

New challenges have been taken on using synthetic materials for contemporary plastics art conservation in a case study. The article focuses on research into the technical materials and the artist's intent as well as the conservation-restoration of an outdoor artwork made by Jan-Erik Andersson, part of an installation The Last Milk Platform (1992) made from modern synthetic materials. Through analytical technical research and artificial ageing, results have been obtained which reframe the limitations for cured reinforced UPR in art installations. Results confirm the need for new insights into the use of paints and coatings in reinforced UPR plastics in contemporary art outdoors. The treatment of the artwork provides an example of contemporary 21st Century synthetic materials conservation for a unique artwork. Ethical and theoretical questions surrounding the case are raised.

KEYWORDS

Reinforced Unsaturated Polyester, NMR analysis, VIS, CIE L*a*b*, FTIR analysis, Conservation-restoration, Three-dimensional contemporary outdoor installations, Public art

YHTEENVETO

Nykytaideteoksen konservointia käsittelevässä artikkelissa esitellään modernista materiaaleista valmistetun taideteoksen konservointitapausta. Aiheena on Jan-Erik Anderssonin monimateriaalinen installaatio Viimeinen maitolaituri, 1992. Taideteokseen kuuluva lujitemuovinen merenneito hahmo on konservoitu. Lasikuituvahvisteisen tyydyttymättömän polyesterin materiaalitekninen tutkimus on osoittanut valmiin materiaalin vakaudessa teknisiä puutteita. Modernien materiaalien käyttö nykytaiteen taideteosten konservoinnissa kaipaa uusia näkemyksiä. Tapauksen yhteydessä käsitellään myös nykytaiteen konservoinnin eettisiä ja teoreettisia kysymyksiä.

AVAINSANAT

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THANKS

DI Juha Kokko, Kevra Oy.

MATERIALS

- Scan-Pool polyester filler, Kevra Oy .
- BPO-Paste, hardener for Scan-Pool filler. Kevra Oy.
- Polyurethane sheet Inota, 10 mm. Divinicel, Density of 40-50 kg/m3. Airex, Kevra Oy.

- Glass Fibre Chopped Stand Matt Aschland M 705 300 g/m2, Kevra Oy.
- Aropol M 105 TB general polyester resin, Ashland Oy., Kevra Oy.
- MEKP-50 hardener, Ashland, Kevra Oy.
- NORPOL NGA 2039 (RAL 3001) Signal red , Reihhold OY, Terpol Oy.
- NORPOL NGA 3179 (RAL 1024) Ocra, Reihhold OY, Terpol Oy.
- NORPOL NGA 8371 (RAL Black), Reihhold Oy, Terpol Oy.
- NORPOL Hardener Nr.1, Reichhold Oy
- NORPOL 9872 Wax solution, Reihhold Oy.
- Temadur 50, half-matt two-component polyurethane paint, red, Tikkurila Oy.
- Temadur 008 7590 hardener, Tikkurila Oy.
- Teknodur 0290 two-component polyurethane lacquer Comp. A polymer, Teknos Oy.
- Teknodur hardener 0200 Comp. B hardener, Teknos Oy.

ENDNOTES

1. The commercial UPR product references materials were: Synolite by Boang & Bonsomer (A) Norpol 540-800 (B), Norpol 450-500 (C) and Norpol 720-700 (D) by Terpol Oy:s.
2. The breaking strain measurements of the reference UPR samples before and after the three different aging protocols were performed according to ISO 527-2:1993.
3. Andersson uses topcoat polyester NORPOL (Reihhold) for his plastics artworks. Timo Terho, Terpol Oy 11.9.2001.
4. Topcoat contains wax solution to form a silky looking appearance.
5. While in the process of documenting, the conservator makes decisions based on the best possible knowledge, following the ethical and aesthetic formula for the decisions, with the collection management. (Decision Making Model 1997/1999).
6. In plastics, once initiated, the degradation cannot be prevented, reversed or stopped, but only inhibited or slowed. (Shashoua Y., 2009).
7. Kokko, J. (Kevra Oy) A interview at manufacturer fasilities 11.5.2005 and emails.; Silen, M. (Reihhold Oy) A interview at manufacturers facilities 5.2.2004; Terho, T. (Terpol Oy) 11.8.2001; Hurskainen K. (Terpol Oy) 5.5. 2009; Teknos paint laboratory 1.6.2009.
8. The average content of styrene for Norpol red UPR paint is according to the manufacturer: styrene content 25-50%, dibutyl maleat 2.5-10%. with inhibitor/hardener content of 1.5-2.3 %. (Reihhold Oy).
9. The half-matt silky looking clear acrylic lacquer is sprayed over PUR lacquer for finishing and for aesthetic reasons.

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