



UvA-DARE (Digital Academic Repository)

Retouching Monochrome Painted Metal Outdoor Sculptures: Tests for Claes Oldenburg's Trowel

van Basten, N.; Stigter, S.; Kensche, S.; Peschar, R.

Publication date

2014

Document Version

Final published version

Published in

Conserving Outdoor Painted Sculpture: Proceedings from the Interim Meeting of the Modern Materials and Contemporary Art Working Group of ICOM-CC, Kröller-Müller Museum, Otterlo, the Netherlands, June 4-5, 2013

[Link to publication](#)

Citation for published version (APA):

van Basten, N., Stigter, S., Kensche, S., & Peschar, R. (2014). Retouching Monochrome Painted Metal Outdoor Sculptures: Tests for Claes Oldenburg's Trowel. In L. Beerkens, & T. Learner (Eds.), *Conserving Outdoor Painted Sculpture: Proceedings from the Interim Meeting of the Modern Materials and Contemporary Art Working Group of ICOM-CC, Kröller-Müller Museum, Otterlo, the Netherlands, June 4-5, 2013* (pp. 73-80). The Getty Conservation Institute.

http://www.getty.edu/conservation/publications_resources/pdf_publications/conserv_outdoor_painted.html

General rights

It is not permitted to download or to forward/distribute the text or part of it without the consent of the author(s) and/or copyright holder(s), other than for strictly personal, individual use, unless the work is under an open content license (like Creative Commons).

Disclaimer/Complaints regulations

If you believe that digital publication of certain material infringes any of your rights or (privacy) interests, please let the Library know, stating your reasons. In case of a legitimate complaint, the Library will make the material inaccessible and/or remove it from the website. Please Ask the Library: <https://uba.uva.nl/en/contact>, or a letter to: Library of the University of Amsterdam, Secretariat, P.O. Box 19185, 1000 GD Amsterdam, The Netherlands. You will be contacted as soon as possible. University of Amsterdam (<https://dare.uva.nl>)

Proceedings from the interim meeting of the Modern Materials and Contemporary Art Working Group of ICOM-CC

Kröller-Müller Museum, Otterlo, The Netherlands, June 4–5, 2013

Conserving Outdoor Painted Sculpture



The Getty Conservation Institute works internationally to advance conservation practice in the visual arts, broadly interpreted to include objects, collections, architecture, and sites. It serves the conservation community through scientific research, education and training, model field projects, and the broad dissemination of the results of both its own work and the work of others in the field. In all its endeavors, it focuses on the creation and dissemination of knowledge that will benefit professionals and organizations responsible for the conservation of the world's cultural heritage.

The Getty Conservation Institute
1200 Getty Center Drive, Suite 700
Los Angeles, CA 90049-1684 United States
www.getty.edu/conservation

© 2014 J. Paul Getty Trust. All rights reserved.

Gary Mattison Production Coordinator
Dianne Woo, Copy Editor
Hespenheide Design, Designer

ISBN: 978-1-937433-21-5 (online resource)
ISBN: 978-1-937433-22-2 (print on demand)

Front cover: Robert Indiana, *Love*. © 2014 Morgan Art Foundation / Artists Rights Society (ARS), New York.
Photo: Tom Learner.

The International Council of Museums (ICOM), created in 1946, is the world organization representing museums and museum professionals, committed to the promotion and protection of natural and cultural heritage, present and future, tangible and intangible. With approximately 30,000 members in 137 countries, ICOM is a unique network of museum professionals acting in a wide range of museum-and heritage-related disciplines.

The Committee for Conservation of ICOM (ICOM-CC) aims to promote the conservation of culturally and historically significant works and to further the goals of the conservation profession. With over 2000 members, ICOM-CC is comprised of twenty-one specialist Working Groups, which actively communicate with members through newsletters, meetings, and at the Triennial Conference. The Coordinators of these Working Groups and the members of the Directory Board are conservation professionals who are elected to their posts by the general membership and who donate their time to ICOM-CC over a three-year cycle.

The Modern Materials and Contemporary Art Working Group of ICOM-CC aims to promote and facilitate the dissemination of research, discussion, and thinking on the full range of conservation issues and implications for modern and contemporary art. Specifically, the group aims to provide an effective platform for those professionals involved in this area of conservation to network and share information, and to ensure the rapid circulation of details on relevant conferences, seminars, events, and publications.

Retouching Monochrome Outdoor Painted Metal Sculptures: Tests for Claes Oldenburg's *Trowel*

Nikki van Basten, Sanneke Stigter, Susanne Kenske, and René Peschar

Abstract: *This study aims to investigate the possibilities of retouching as a solution to addressing local damages on monochrome outdoor painted metal sculptures. Trowel by Claes Oldenburg was selected as a case study. Four paints were tested on application and manipulation of gloss and color, then artificially aged with an Atlas Ci5000 Xenon Weather-Ometer. Good results were obtained with Sikkens Redox PUR Finish Gloss, an industrial paint, which was modified with Deuteron KM-F6 (micronized polymethyl urea matting agent), and Sikkens Redox PUR Finish Mix colorant paste, applied with an airbrush. Additional testing in an outdoor environment is suggested to confirm the outcome.*

Introduction

Degradation of paint layers on outdoor painted metal sculptures is a well-known problem (Considine et al. 2010; Pullen and Heuman 2007). Not only are the aesthetics of the artwork disturbed, but damages in the paint layer also facilitate and accelerate further degradation by allowing the metal structure underneath to corrode (Schweitzer 2006, 60). Although the overall repainting of outdoor metal sculptures is still common practice (Coddington 2007, 38; Considine et al. 2010, 134–43) and recent research has focused on high-quality industrial paint systems for this purpose (Mack 2002, 923–26), the importance of local treatment is generally recognized in the field as being a desirable approach in many cases. In 2012 a focus meeting on outdoor painted sculpture, organized by the Getty Conservation

Institute (GCI), emphasized the “lack of options available to the conservator, especially for local treatments” as a priority need for conservators (Getty Conservation Institute 2013).

Local treatment of damages or losses in the paint layer is attractive for various reasons. Minimal intervention complies with conservation-restoration ethics, and local treatment often can be carried out immediately, thereby preventing further damage to the sculpture in the short term. Furthermore, local treatment normally costs a fraction of a total repainting campaign, both in itself and by extending the period of time before a more invasive, complete renewal of paint layers becomes necessary. Of the steps typically involved in undertaking a local repair—namely corrosion elimination, priming, filling, and retouching—the last step is crucial. Retouching a monochrome paint layer on large outdoor sculptures is highly challenging and therefore rarely practiced or communicated (but see Esmay 2005 as an exception). Industrial paint systems with high outdoor stability are often difficult to manipulate and hard to apply locally without creating a visual discrepancy between the retouched areas and the existing paint layers.

The objective of this study was to investigate whether it is possible to carry out retouching as a local treatment to match a weathered paint surface and hence provide maximum visual improvement on the overall sculpture with a minimal amount of work. The outdoor painted metal sculpture *Trowel* (1971) by Claes Oldenburg (b. 1929), from the collection of the Kröller-Müller Museum (KMM), Otterlo, the Netherlands,





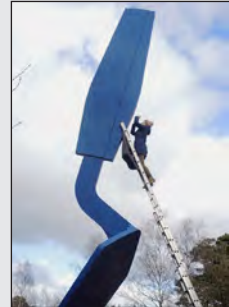
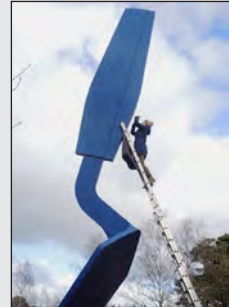
was used as a case study for testing.¹ Several industrial paint systems and some products commonly used in conservation treatments were tested on workability and long-term behavior. In addition, gloss and color were manipulated with matting agents and pigment pastes, and several application techniques were tried. A selection of prepared paint samples was artificially aged according to standards from the paint industry (Schulz 2008). The results showed that retouching of painted metal sculptures is technically possible if a suitable paint and the proper additives are used. Taking the current paint system present on *Trowel* as reference, good results were achieved with an industrial paint based on a two-component polyurethane polymer. The gloss of this paint was easily modified with appropriate matting agents, while manipulation of the color was achieved by adding pigment paste to match local differences in the existing paint layer.

Case Study: *Trowel*

Trowel is a nearly 12-meter-high outdoor painted metal sculpture (fig. 1). Claes Oldenburg is well known for his blown-up Pop art versions of objects from everyday life



Figure 1 Claes T. Oldenburg and Coosje van Bruggen, *Trowel I*, 1971–76. Steel painted with polyurethane enamel, 41 ft. 9 in. × 11 ft. 3 in. × 14 ft. 7 in. (12.7 × 3.4 × 4.4 m). Sited: 38 ft. 5 in. × 11 ft. 3 in. × 7 ft. 5 in. (11.7 × 3.4 × 2.3 m). Collection Rijksmuseum Kröller-Müller, Otterlo, the Netherlands. KM122.342. © 1971–76 Claes Oldenburg and Coosje van Bruggen. Photo by Nikki van Basten.

1971	1976	1987	1997	2002	2013
					
Inaugural exhibition <i>Sonsbeek 71</i> , Arnhem, afterwards moved to Kröller-Müller Museum. Aluminum colored.	Relocated, structural treatment and painted blue on artist's wish by Nebato BV, Bergeijk. Unknown paint system. No photo documentation.	Repainted with an epoxy primer and a two-component polyurethane paint by Schildersbedrijf Hop B.V., Schaarsbergen.	Relocated and repainted with an epoxy primer and a two-component polyurethane ester paint by Schildersbedrijf Hop B.V., Schaarsbergen.	Repainted with an epoxy primer and a two-component polyurethane ester paint by Schildersbedrijf Hop B.V., Schaarsbergen.	Research into local retouching with University of Amsterdam, Cultural Heritage Agency of the Netherlands and AkzoNobel.

Maintenance timeline for Claes Oldenburg's *Trowel*.

(Bruggen and Oldenburg 1995, 226). The work originally was aluminum colored when it was first exhibited, at the temporary outdoor exhibition *Sonsbeek 71* in Arnhem in 1971; at that time it was referred to as *Sculpture in the form of a trowel, stuck in the ground* (Beijeren and Kapteyn 1971, pt. 2:12).² In a program statement, Oldenburg called the object “a generalized version of the Trowel/Spade/Spatula called the Trowel” and specified, somewhat cryptically, the “color to be function of conditions of site” (Beijeren and Kapteyn 1971, pt. 1:54).

Later in 1971 *Trowel* was transferred to the Kröller-Müller Museum, which had financed the work (Kooten and Bloemheugel 2007, 304). Oldenburg was not happy with the aluminum color in the sculpture's new environment, and when structural conservation treatment became necessary he proposed painting it a different color. He suggested red at first, but Rudi Oxenaar, director of the KMM at the time, thought this “too aggressive,” and, in accordance with the artist, *Trowel* was painted blue in 1976 (Kooten and Bloemheugel 2007, 305).

Since 1976 *Trowel* has been repainted about every eight years, starting in 1987, by the same local paint company, Schildersbedrijf Hop B.V., Schaarsbergen. For the past three overall treatments, a two-component epoxy primer was sprayed on top of the previous paint layers, lacunae were filled with a two-component filling, and a two-component high-gloss polyurethane coating was applied on top, a paint system manufactured by AkzoNobel.³ Analyses indicated that the coating is a polyurethane ester.⁴ The last treatment was carried out in 2002, and the overall condition of the paint layer currently is still relatively good, in spite of the outer paint layer showing some damage and delamination locally (fig. 2) and some local shifts in color and gloss.⁵ The next treatment for the sculpture is approaching, which has prompted the KMM to look at alternatives to another overall treatment.

Selection of Paint Systems and Additives

After an initial literature survey and consultation with the paint industry, professional painters, and conservator-restorers, potential paints and additives to manipulate color and gloss were assessed, taking into account criteria such as compatibility, workability, reversibility, and outdoor stability. Initial tests led to a selection of four paint systems, details of which are given in table 1.

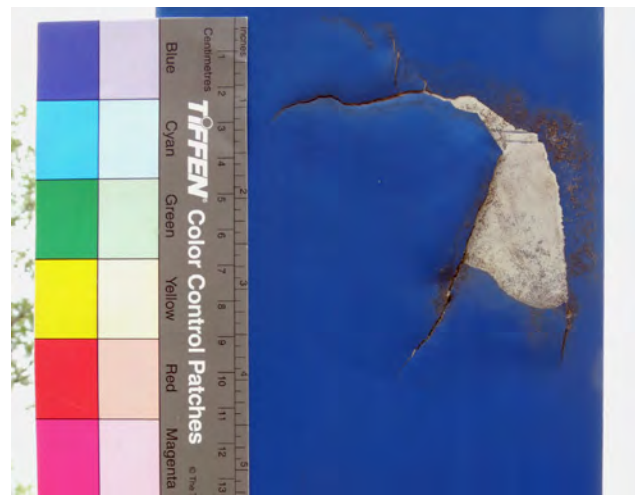


Figure 2 Detail of the back of *Trowel*, showing paint loss in the outer layer. Photo by Nikki van Basten.

Two industrial polyurethane-based paint systems for general outdoor use were selected, one acrylic paint and one type of Paraloid. The first paint was the same used on the current outer paint layer of *Trowel*: Sikkens Redox PUR Finish Gloss, a two-component polyurethane ester paint. This paint is known for its durability and can be painted over with the same paint system, making it compatible with the existing paint layer. However, the workability of a two-component paint is known to be difficult. The second system selected was Sikkens Rubbol BL Safira, a one-component polyurethane-based paint. For both paint systems, the paint manufacturer AkzoNobel suggested a matting agent, Deuteron MK-F6 (a micronized polymethyl urea), and two colorants, Sikkens Redox PUR Finish Mix (a colorant paste based on a polyurethane binding medium) and Acomix pigment paste. AkzoNobel proposed that these materials could be used to modify the overall surface finish of the paint system.

The third paint investigated was Golden Fluid Acrylics, an acrylic resin dispersion that is normally used only indoors by conservators and was therefore also tested with a protecting lacquer. Two lacquers were used: Zijdeglans Vernis PU (De IJssel Coatings B.V.), a polyurethane-based resin, and Paraloid B-48N (Rohm and Haas), a copolymer of methyl methacrylate and butyl acrylate dissolved in toluene (10 percent w/v). The fourth paint consisted of Paraloid B-48N resin dissolved in toluene (10 percent w/v) with copper phthalocyanine

Table 1. Four paint systems, modified with additives, were selected as potential retouching material for *Trowel*.

Paint		Additives		Artificial Aging (1184 hrs)		
Product	Product type	Colorant 2.5% w/w	Matting agent 1% w/w	Loss of gloss (Gloss Units)	Color change (ΔE)	
1	Sikkens Redox PUR Finish Gloss	Two-component polyurethane ester	Sikkens Redox PUR Finish Mix, colorant paste based on polyure- thane binding media	Deuteron MK-F6, micronized polymethyl urea	2.3	2.3
				Scotchlite™ S22, glass micro-balloons	NP*	NP*
2	Sikkens Rubbol BL Safira	One-component polyurethane	AcoMix, water-based pigment paste	Deuteron MK-F6, micronized polymethyl urea	+0.4**	2.4
				Scotchlite™ S22, glass micro-balloons	NP*	NP*
3a	Golden Fluid Acrylics	Acrylic resin dispersion	Golden Fluid Acrylics, acrylic resin dispersion	—	+1.5**	2.9
	+ De IJssel PU Zijdeglans Vernis	One-component polyurethane	—	Deuteron MK-F6, micronized polymethyl urea	4.9	3.9
3b	Golden Fluid Acrylics	Acrylic resin dispersion	Golden Fluid Acrylics, acrylic resin dispersion	—	+1.5**	2.9
	+ Rohm and Haas Paraloid B-48N in toluene 10% w/v	Copolymer of methyl methacrylate and butyl acrylate	—	Deuteron MK-F6, micronized polymethyl urea	+3.5**	3.9
4	Rohm and Haas Paraloid B-48N in toluene 10% w/v + pigments	Copolymer of methyl methacrylate and butyl acrylate	Pigments copper phthalocyanine blue and barium sulfate white	Deuteron MK-F6, micronized polymethyl urea	NP*	NP*

* Not pursued because of poor performance

** Increase of gloss compared to the start of aging, possibly heat has evened out the surface

blue and barium sulfate white, the same pigments as those used in the paint system of the last integral conservation treatment of *Trowel*.⁶

Application on Test Plates

For each of the four paint systems, a steel test plate was prepared. These plates were cleaned with white spirit and a layer buildup was created similar to that of the last integral repainting of *Trowel*. This meant a pretreatment with Sikkens Redox EP Multi primer applied with a spray gun. To simulate lacunae in the paint layer, blank areas were created by adhering patches of tape to the test plate before the final paint, Sikkens Redox PUR Satin, was applied. The composition of this pigmented two-component polyurethane polymer is similar to

that of Sikkens Redox PUR Finish Gloss, the paint used for the last integral repainting of *Trowel*, but the PUR Satin variant contains more matting agents. Optically the PUR Satin is a better match with the current paint layer of *Trowel*, as the PUR Finish Gloss has lost some of its gloss over time. To achieve a similar surface texture, the paint was sprayed on with a spray gun by the same professional painter who had performed the integral repainting of *Trowel* in the past.

The influence of additives such as matting agents and colorants on the retouching paint systems was assessed before applying them to the test plates in order to achieve a satisfactory match with the paint layer on the test plates (fig. 3). In the case of the two-component paint system, the colorant pastes were added before the

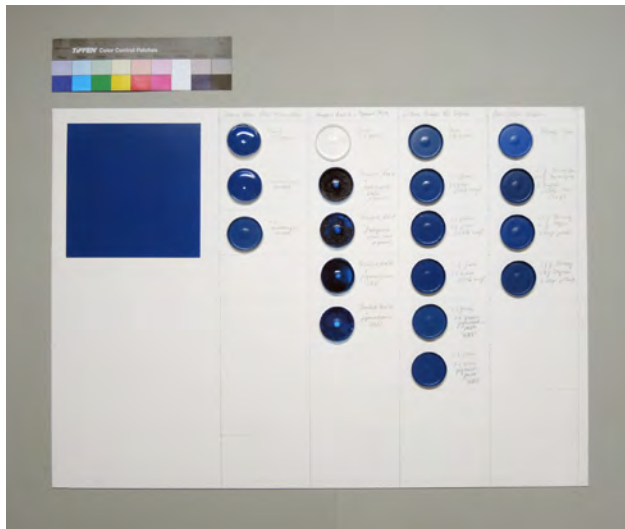


Figure 3 Additives such as matting agents and colorants were added to the paint systems to alter color and gloss. Photo by Nikki van Basten.

hardener. Various application techniques were tested, including those involving brushes, sponges, rollers, and airbrushes. The use of an airbrush required diluting the paints with a thinner (approximately 20 percent v/v). For each application technique, several trials were carried out with the addition of colorants and matting agents until the color and gloss matched the base paint layer. During preparation and application of each paint system, its workability, preparation time, manipulation, drying speed or curing time, and overall opacity were recorded.

Artificial Aging

Three paint systems that yielded promising results were exposed to accelerated artificial aging to assess their outdoor durability and, in particular, to observe whether the additives affect the behavior of the paint in any way (see table 1, systems 1–3). For the aging tests, four smaller test plates were prepared for each paint system: one test plate with pure paint, one with the addition of colorants (2.5 percent w/w), one with the addition of a matting agent (1 percent w/w), and one with both (2.5 percent w/w colorants and 1 percent w/w matting agent).

The aging tests were conducted at the laboratories of AkzoNobel in Sassenheim, the Netherlands, utilizing an Atlas Ci5000 Xenon Weather-Ometer and aging standards ISO 11341 (Cycle A) and ISO 4892-2 (Method 1), commonly used by AkzoNobel to test the outdoor



Figure 4 An automated robot was used to take color and gloss measurements during and after aging tests at AkzoNobel. Photo by Nikki van Basten.

durability of paint systems. The Xenon Weather-Ometer exposes the test plates to cyclic variations of light intensity, temperature, and humidity. The aging test ran for more than one thousand hours, similar to tests normally run by AkzoNobel. Gloss and color measurements were carried out regularly with an automated robot setup during and after the test. Color was measured with a BYK-mac spectrophotometer using the CIELAB 1976 color space model, and gloss units were measured with a BYK Micro-tri-gloss meter (fig. 4). The paints also were inspected visually by microscope to detect any loss of adhesion or cracking of the paint during aging.

Results

The two industrial polyurethane paints, Sikkens Redox PUR Finish Gloss and Sikkens Rubbol BL Safira, showed good workability. Color adjustment of these paints using Sikkens Redox PUR Finish Mix colorant paste and AcoMix pigment paste, respectively, was possible but not easily achieved, as the color of both polyurethane paints tended to darken when curing. Gloss modification with Deuteron MK-F6 (micronized polymethyl urea particles) was not particularly difficult for either paint. The use of glass microballoons (29–53 microns in diameter) for this purpose did not work well, as the particles remained visible in the paint and created an irregular texture.

Color matching with acrylic resin dispersion was easily achieved. However, to obtain a good overall opacity, multiple applications were necessary. By adding transparent protective lacquers, the gloss could be modified to the desired extent without difficulty. After the practical tests, Paraloid B-48N with pigments was not pursued further because of its inappropriate texture, with pigment particles left visible and very poor adhesion to the primer.

The practical tests revealed that a uniform texture is feasible with three of the paint systems employed, and application with an airbrush with a 0.5-millimeter nozzle achieved the best results. The additives tested (micronized polymethyl urea and the colorants) did not affect workability with the airbrush.⁷ Although a perfect match of color and gloss of a retouched area with the

neighboring paint turned out to be nearly impossible, a negligible visual difference could be achieved if it is taken into account that large outdoor sculptures such as *Trowel* are normally viewed at a distance of at least a few meters.

The artificial aging test involving Sikkens Redox PUR Finish Gloss, Sikkens Rubbol BL Safira, and Golden Fluid Acrylics, protected with transparent lacquers on top, revealed that the presence of additives minimally influenced the performance compared to the pure paints. The PUR Finish Gloss performed best, with a relatively small change of gloss (fig. 5) and an acceptable small shift in color ($\Delta E < 2.5$) in most cases (fig. 6). Judging from the similarity between the gloss unit curves and the ΔE curves, the presence of additives in this paint does not seem to have a significant effect on aging behavior.

Figure 5 Graph showing change in gloss units of two-component polyurethane (ester) paints during the artificial aging test.

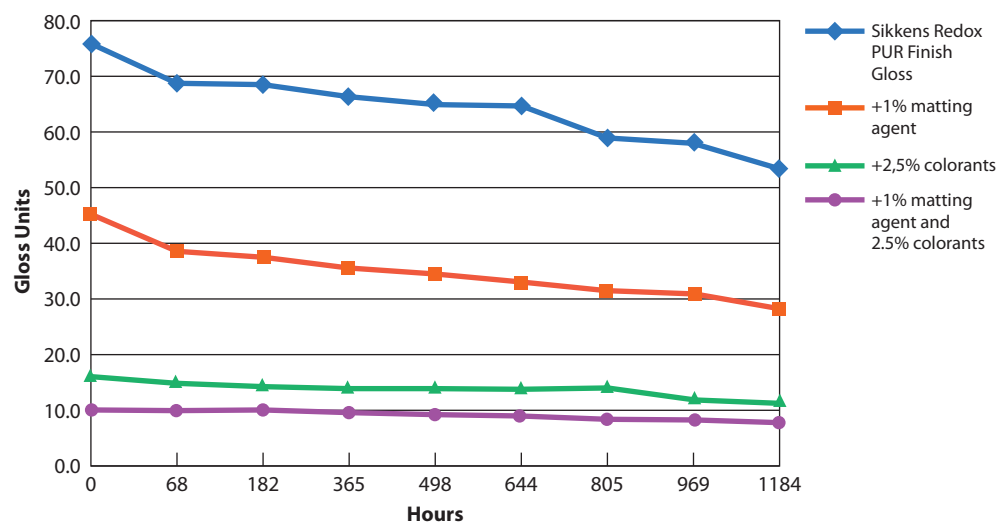
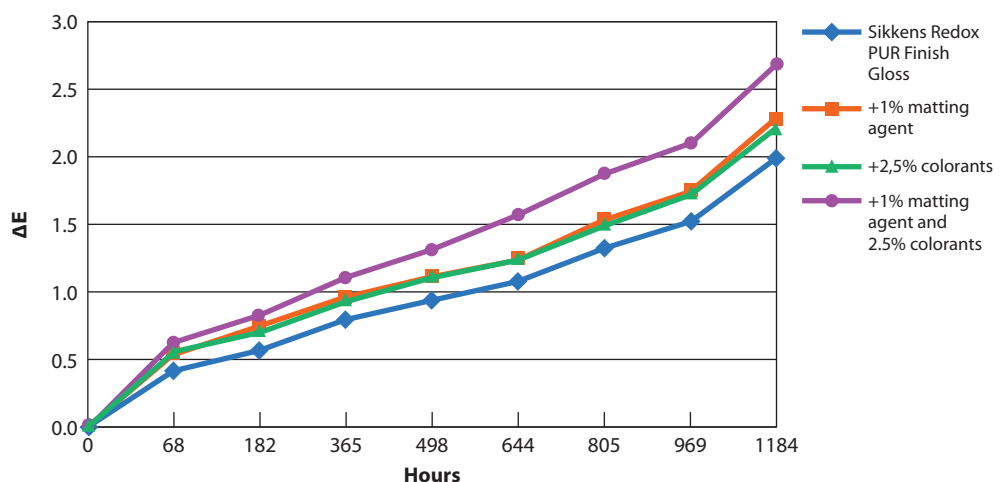


Figure 6 Graph showing change in color difference (ΔE) of two-component polyurethane (ester) paints during the artificial aging test.



The one-component polyurethane paint showed an equally acceptable minor gloss change and ΔE curves, but visual inspection revealed that some areas had lost adhesion as a result of artificial aging. The protective layer of De IJssel's Zijdeglans Vernis PU on top of Golden Fluid Acrylics showed cracks after aging. Interestingly, the Golden Fluid Acrylics resin dispersion paint turned out to be quite stable, even without either of the two protective layers on top, the shift in color being slightly higher ($\Delta E =$ in the range of 2 to 5) than for both polyurethane systems ($\Delta E < 2.5$) (see table 1).

Discussion

During artificial aging, the paint samples were exposed to cyclic changes in climatic conditions; however, this artificially simulated environment cannot model the wide variations in real outdoor conditions. This means that comparison of paints on the basis of their aging behavior is only indicative and cannot be extrapolated to their potential durability in time. The practical tests were carried out in the conservation studio of the Kröller-Müller Museum under stable climate conditions and not in an outdoor situation of more extreme circumstances. Preparation and application of a paint system outdoors may be more problematic in practice. Furthermore, the simulated damages in this study were quite simple, whereas real defects can be shaped quite irregularly (see fig. 2). A nonuniform gloss and color in the existing monochrome paint layer around the lacunae would present an additional challenge in obtaining a good visual match.

Signs of delamination, as observed in *Trowel*, require a more complex treatment because corrosion products underneath the paint layer around the lacunae need to be treated as well, and the lacunae need to be filled before retouching. Furthermore, local treatments cannot be carried out infinitely. However, we can state that local treatment is legitimate when a sculpture risks further damage due to local losses while the majority of the paint layer still is intact to postpone an integral treatment. In the paint industry, a standard of 10 percent of surface defects is the norm before proceeding to treat an entire surface (Bonestroo and Smale 2008, 20). Similar standards could be introduced in the conservation of outdoor painted sculptures such as *Trowel*. Although local treatments can postpone an integral and more invasive treatment for a number of years, it

is impossible to determine exactly how long, as this depends on the cause of the problem and variables in the outdoor environment.

Conclusion

Retouching monochrome painted metal sculptures locally is technically feasible if suitable paint, additives, and application techniques are used. Of the four paints tested as potential retouching material for Claes Oldenburg's *Trowel*, the best results were obtained with Sikkens Redox PUR Finish Gloss applied with an airbrush. This industrial paint, based on a two-component polyurethane polymer, is the same product that is currently used on the artwork, making it nonreversible from the existing paint layer. However, this paint is durable and compatible, and manipulation is feasible with Deuteron MK-F6 (micronized polymethyl urea particles) and Sikkens Redox PUR Finish Mix colorant paste. Their addition makes local manipulation of gloss and color possible.

Artificial aging revealed that the additives had little or no effect on the aging behavior of this paint. Moreover, the paint system can be repainted, validating the idea of re-treatability because integral treatment remains possible. Additional testing in a natural outdoor environment is needed to confirm the research results and to assess how long integral repainting can be postponed by local treatment in the case of Claes Oldenburg's *Trowel*.

Acknowledgments

The authors would like to thank Lydia Beerkens, who came up with the idea for this research; and the Kröller-Müller Museum, which provided access to Claes Oldenburg's *Trowel* and the opportunity for conducting research on their premises. We warmly thank professional painter Eric Hop, who assisted with setup and preparation of the test plates. The Cultural Heritage Agency of the Netherlands (RCE) is greatly acknowledged for assisting in instrumental analyses, as are Bill Wei for gloss and color measurements of the paint layer; Suzan de Groot, Henk van Keulen, and Luc Megens for analyzing the binding medium; and Matthijs de Keijzer for analyzing the pigments in the outer paint layer of *Trowel*. We are very grateful to Frank de Vries, Flip van

Heemst, Erik Zwarthoff, Jan Udem, Helen Veringmeier, John de Werff, and Ben Ouwehand of AkzoNobel for their hospitality, for providing test materials, and for offering their facilities and assistance during the technical investigation.

Notes

1. This article is based on research carried out as part of a master's thesis by Nikki van Basten. See Basten (2013) for full references and details on materials and suppliers.
2. Neither information from the Kröller-Müller Museum archive nor a paint sample cross section indicates that the aluminum color was a paint layer. Analysis was kindly carried out by Matthijs de Keijzer of the Cultural Heritage Agency of the Netherlands (RCE).
3. Information on the material history of *Trowel* (inventory number KM122.342) was gathered at the KMM archive. Additional details on application techniques were obtained by the authors' personal communication with Eric Hop, the professional painter who repainted *Trowel* in the past.
4. The binding medium of the outer paint layer was analyzed by Suzan de Groot, Henk van Keulen, and Luc Megens, RCE.
5. Current gloss and color condition of the paint layer was measured by Bill Wei, RCE, January 28, 2013. Adhesion of the paint layer was assessed by Erik Zwarthoff of AkzoNobel, February 13, 2013.
6. The pigments of the outer paint layer were analyzed by Matthijs de Keijzer, RCE. The pigments used for testing were kindly provided by AkzoNobel.
7. For additional details on application techniques and workability of the paints, preparation time, drying speed, and overall opacity, see Basten (2013).

References

Basten, Nikki van. 2013. "Het retoucheren van beschilderde metalen buitensculpturen als onderdeel van een lokale

behandeling. Een onderzoek naar de manipuleerbaarheid en duurzaamheid van verfsystemen." Master's thesis in Conservation and Restoration of Cultural Heritage in the specialization Contemporary Art, University of Amsterdam (in Dutch, unpublished).

Beijeren, Geert van, and Coosje Kapteyn. 1971. *Sonsbeek 71: Sonsbeek buiten de perken*. Exh. cat. Park Sonsbeek, June 19–August 15, 1971. Arnhem: Stichting Sonsbeek.

Bonestroo, Wim, and O. A. Smale. 2008. *Handleiding "Code of Practice" Metaalconservering*. Kennisplatform Duurzame Staalconstructies. Accessed February 18, 2014, at <http://www.staalplaza.nl/upload/documents/staalplaza2/SCON-2007-449-TCE%20handleiding%20code%20of%20practice.pdf>.

Bruggen, Coosje van, and Claes Oldenburg. 1995. *Large Scale Projects*. London: Thames and Hudson.

Coddington, James. 2007. "Modern Paints, Conservation of." In *Modern Paints Uncovered*, 30–39. Los Angeles: Getty Conservation Institute.

Considine, Brian, Julie Wolfe, Katrina Posner, and Michel Bouchard. 2010. *Conserving Outdoor Sculptures: The Stark Collection at the Getty Center*. Los Angeles: Getty Conservation Institute.

Esmay, Francesca. 2005. "Permanent Impermanence: Conserving Monument to the Last Horse." Paper presented at the Fifth Symposium on Conserving Synthetic Materials, Vitra Design Museum in conjunction with the AXA Art Conservation Project. Weil am Rhein, Germany, June 28.

Getty Conservation Institute. 2013. *The Conservation of Twentieth-Century Outdoor Painted Sculpture*. Los Angeles: Getty Conservation Institute. Accessed October 10, 2013, at http://www.getty.edu/conservation/our_projects/science/outdoor/outdoor_focus_mtg.pdf.

Kooten, Toos van, and Marente Bloemheugel, eds. 2007. *Sculpture Garden Kröller-Müller Museum*. Otterlo: Kröller-Müller Museum; Rotterdam: NAI Publishers.

Mack, Abigail. 2002. "Making Better Choices for Painted Outdoor Sculpture." In *13th Triennial Meeting, Rio de Janeiro, 22–27 September, Preprints, ICOM Committee for Conservation*, 920–26. London: Earthscan.

Pullen, Derek, and Jackie Heuman. 2007. "Modern and Contemporary Outdoor Sculpture Conservation: Challenges and Advances." *GCI Newsletter* 22(2): 4–9. Accessed October 10, 2013, at http://www.getty.edu/conservation/publications_resources/newsletters/pdf/v22n2.pdf.

Schulz, Ulrich. 2008. *Accelerated Testing: Nature and Artificial Weathering in the Coatings Industry*. Hannover: Vincentz.

Schweitzer, Philip A. 2006. *Paint and Coatings: Application and Corrosion Resistance*. New York: Taylor & Francis.