Bridging the Gap

Synergies between Art History and Conservation

Edited by Birgitte Sauge, Thierry Ford, Tine Frøysaker
and Klaas Jan van den Berg

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Front cover illustration: Asger Jorn in his studio at 143 Boulevard de la Gare, Paris. (Photo: Ib Hansen, courtesy Museum Jorn archive.)

Back cover illustrations: Left: Mark Manders, *Room, Constructed to Provide Persistent Absence* (2001–2002): detail. (Photo: Mathias Johansson.)

Right: Bernt Notke's altarpiece in Tallin: three faces of the Virgin Mary from the 15th, 17th and 19th century (before, during and after conservation treatment). (Photos: Martin Siplane.)

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Foreword

In November 2023, the Department of Conservation at the National Museum of Norway convened the international conference *Bridging the Gap: Synergies between Art History and Conservation*. This gathering emerged from the museum's commitment to a multidisciplinary approach, a cornerstone of the preparations for its newly opened collection exhibition. We have learned that while more time-consuming, multidisciplinarity offers a broader perspective and enhances the final outcome.

Years of collaboration between art historians and conservators across disciplinary boundaries piqued our curiosity to explore how other institutions around the world were employing this approach as a research methodology. The overwhelming response to our call for papers confirmed that we were not alone in embracing the value of multidisciplinarity. This international gathering showcased the widespread adoption of this approach across diverse fields and periods, creating a vibrant atmosphere of intellectual exchange. The conference's open-category format further enriched the experience, inviting contributions that transcended traditional disciplinary boundaries and embraced a versatility of materials and periods. This approach fostered a sense of collaboration and exploration, reflected in the diverse and thought-provoking presentations.

We are delighted to present this publication, which captures the essence of the conference and the enthusiasm of its participants. It serves as a testament to the transformative power of multidisciplinary approaches and their ability to illuminate new facets of art history, science and conservation. We hope this publication will inspire others to embrace the multidisciplinary spirit and embark on their own journeys of discovery and innovation. As we continue to bridge the gap between art history, science and conservation, we are confident that collaboration will lead to advancements in the understanding and preservation of our cultural heritage.

We extend our heartfelt gratitude to the members of the esteemed scientific committee for shaping the conference's intellectual direction. Their dedication to excellence ensured that the conference fostered meaningful exchanges among scholars. We are also deeply indebted to the dedicated initiators and organisers of the conference, Ida Antonia Tank Bronken and Marie Kleivane, and the Editorial group, Birgitte Sauge, Thierry Ford, Tine Frøysaker, Klaas Jan van den Berg, Ella Hendriks, Erma Hermans, Noëlle L.W. Streeton, Ida Antonia Tank Bronken and Marie Kleivane.

Finally, we express our sincere appreciation to the University of Amsterdam, the University of Oslo and the Cultural Heritage Agency of the Netherlands for their generous support of the conference and this publication. Their collaboration ensured that we reached our goal of sharing the many approaches to the multidisciplinary work.

Kari Skytt Andersen
Head of Conservation,
The National Museum of Norway

Introduction

The conference *Bridging the Gap: Synergies Between Art History and Conservation* aimed to bring forth new research in conservation and conservation science by highlighting the benefits of multidisciplinarity. The scientific committee invited conservators, art historians, educators and heritage scientists to present research from collaborative projects that aid our understanding, interpretation and dissemination of art, architecture and design. While our different fields of expertise independently set our research aims and questions, there is added value in questioning if and how the knowledge sought makes a difference in related fields. In many cases, professional collaborations representing multiple fields are necessary for achieving the desired knowledge and results. However, this is not always easy to achieve, as it demands reciprocal understanding and curiosity about each other's research methods, as well as mutual relevance within such a collaborative partnership. Therefore, our goal was to gather inspiring examples from the field of conservation with multiple viewpoints and trajectories. The conference had a far-reaching and massive response, resulting in three sessions from which selected papers have been chosen for this volume.

Part 1: Conservation narratives and practices

Understanding the conservation history of an artefact and museum collections is paramount, given that treatment histories often vary over time and between cultures. Questions regarding how past conservation practices have influenced and shaped the visual appearance and condition of artefacts need to be addressed in the context of their environments and collections. This first section includes papers that address topics concerning the evolution of conservation practices, conservation histories, the significance of art historical context and interpretation, exhibition history and dissemination. All five selected papers highlight the dilemmas faced in conservation decision-making within the multidisciplinary field of conservation in museums and collections.

Sujatha Meegama and Lori Wong discuss the importance of understanding the religious and cultural context of the bronze statue of Tara from Ceylon. In this study, both the physical object and its intangible values are considered in terms of preservation and curatorial strategies. Hilkka Hiiop *et al.* examine an art historically important altarpiece from Bernt Notke's (*c.*1440–1509) workshop, which had undergone multiple conservation treatments, none of which were deemed complete by the owner. Inheriting the decisions made by previous treatments, the authors discuss both the historic and physical layers of the object while making new choices to achieve a cohesive visual appearance – leaving aspects of the object's complex past for future researchers to address.

Nienke Woltman *et al.* delve into the extensive conservation history of Rembrandt's (1606–1669) *The Night Watch* (1642), focusing on research, decision-making and interdisciplinary dialogue. The paper discusses how the team enhanced the collaborative efforts by involving a large number of stakeholders within the museum before deciding on the path forward for the conservation treatment. Esther van Duijn *et al.* trace back the impact of changes in conservation strategies resulting from interactions between the Netherlands and the United Kingdom. Through archival research, they outline the narrative of how the Dutch wax-resin lining methods were disseminated and adapted.

Kira Alison Brown ends the first part with a paper that describes the complexity of technological obsolescence in artworks created with virtual reality in the early 1990s. After a period during which both the physical and technical aspects of these artworks rapidly deteriorated, they are now largely inaccessible. She discusses past interventions, as well as the future life, display and potential reinterpretation of these once technically groundbreaking pieces.

Part 2: Material practices, reconstructions and archival research

The material choices of the artist are important for art historical interpretation, mediation, conservation treatments and preservation strategies. Also, discussions on artistic actions in the historic context of time and place can bring new perspectives to the dissemination of art. This section features papers on subjects such as material practices – the results and details of artistic practices and choices; and the historic context of production companies and material brands – the underlying agency of industry and raw materials. The contributions use historical sources, archival and contextual research in dialogue with the original artworks.

Erma Hermens and Paul van Laar use a case study of a 17th-century green sea turtle carapace, painted with a portrait of the Dutch Prince Frederick Henry as a linchpin to a multitude of narratives. Exemplifying how much history can be embedded in a single material artefact. Fahed Ibrahim *et al.* offer a visual understanding of what may have been lost through age in the work of Frans Hals's (*c.*1582–1666) *Portrait of Aletta Hanemans* (1625). With a mixture of conservation knowledge, scientific data and practical skills, the team provides a compelling example of making research accessible to other museum professionals and audiences.

Muriel Geldof *et al.* studied the materials and techniques of Vincent van Gogh's (1853–1890) *Poplars near Nuenen* (1885) and compared this to investigations of other paintings from the same period. Connecting the various layers of the painting to a time and place not only gives us new depths to art historical understanding of Van Gogh's material practices, but also allows for more knowledgeable conservation decision-making for paintings from Nuenen in the future. Signe Endresen and Emma Turgut investigate the little-known hectograph technique which was used by Edvard Munch (1863–1944) over a 30-year period. The authors shed light on both the technical method and Munch's experimentation while using it.

Helen Kohn and Rebecca Chipkin unravel the discovery of *Atlantic City* (*c.*1915) by Helen Saunders (1885–1963), believed to have been lost but overpainted by Wyndham Lewis (1882–1957) with his now iconic painting *Praxitella* (1921). Through collaborative efforts and a digital colour mockup, the public can again glimpse how the Vorticist motif underneath might have looked. Corina Rogge and Kari Dodson investigate a series of artworks by the assemblage and installation artist Edward (Ed) Kienholz (1927–1994). Through a study of both the technique used for the late 20th-century works and archival material, the authors elaborate on the skill and motivation behind his apparent direct style. Sanneke Stigter and My Bundgaard discuss the many reflections needed and practical obstacles to overcome when using artist interviews actively to guide both conservation and curatorial practices in relation to the example of interviews of Mark Manders (1968).

Part 3: Material changes

When looking at an artwork, conservators, educators and art historians attempt to understand the 'gap' between the appearance of the artwork when first completed and how it looks now, in a changed state. It is important to reach an opinion as to how great the disparity between the past and the present is. As a research field it is necessary to investigate what the impact of age or deterioration on our understanding of the artwork might be, and when this is relevant for how we choose to disseminate it to the audience. The knowledge of these changes can also help inform decisions made for storage, exhibition and conservation treatment. This section features papers on challenges both for the dissemination of artworks and the examination of material changes often considered as 'decay'. Artistic intention and accepted appearance are difficult concepts, but important to include in a multidisciplinary discussion.

Kaja Kollandsrud and Linn Solheim discuss the dilemmas facing the future preservation of distemper church paintings that were previously consolidated with soluble nylon, focusing on the 13th-century barrel vault ceiling from the Ål stave church, now on display at the Historical Museum in Oslo, Norway. The authors also challenge previously published claims of inferior painterly qualities as a possible result of a lack of technical understanding. Charlotte Hoffman and Ester Ferreira search for more precise knowledge on the lightfastness of yellow lakes using a range of specific recipes as the basis for lake reconstructions. In particular, studying the influence of the lake substrates leads to a better understanding of the changing colours of tree canopies depicted in 17th-century paintings.

Alexandra Letvin and Nicole Passerotti describe a collaborative project aiming to present a fragile wax miniature in an exhibition in The Philadelphia Museum of Art, USA. The authors highlight the treatment dilemmas and choices made in order to enable the display of fragile wax objects that testify to the artistic agency of the women who made them in 19th-century England. Ida Antonia Tank Bronken *et al.* investigate the relationship between location, time, chemistry and condition in the paintings of Asger Jorn (1914–1973), focusing on his early works. Findings from analysis and contextual information allow for a reinterpretation of the role of wartime substitute materials on the condition of Jorn's paintings.

Irene Glanzer and Angela Matyssek discuss the accepted signs of age or 'patina' in contemporary art. Through the lessons learned from a larger book project exemplifying the ongoing discussion between art historians and conservators in many museums, the authors highlight the necessity of both a common language and understanding of each other's terminology related to issues of patina in contemporary art. Rea Grammatikopoulou and Tzu-Chuan Lin shed light on the ever-shifting challenges presented by time-based media conservation and its curatorial decision-making through a case study of the room installation by Reinhard Mucha (1950), **The Germany Device**, *Kunstsammlung Nordrhein-Westfalen, K21 Ständehaus, Düsseldorf* [**2021**], [**2002**], *XLIV Biennale di Venezia, German Pavilion, Venice* **1990**.

These 18 peer-reviewed papers are the result of various combinations of expertise uniting art historians, chemists, scientists, technical art historians and conservators. In addition, the studied artworks range from some of the most well-known iconic pieces in art history to objects of unknown origin, covering a diverse array of topics spanning over 1000 years, from the statue of Tara to contemporary artworks. In addition to these papers, poster contributions are included, allowing readers to engage with an even greater variety of work presented at the conference. We are proud to have assembled such a diverse and inspiring range of contributions.

Museums have the potential to become strong hubs for interdisciplinary research, both independently and in collaboration with research institutes and universities. We hope this volume will inspire others to take further steps in bridging the gap between our disciplines.

Ida Antonia Tank Bronken
and the Editorial group

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All the papers in this publication have been peer reviewed by external scholars.

Editorial group

- Dr. Birgitte Sauge (chief editor)
- Dr. Thierry Ford (papers part 1)
- Professor Dr. Tine Frøysaker (papers part 2)
- Professor Dr. Klaas Jan van den Berg (papers part 3)
- Professor Dr. Ella Hendriks, Professor Dr. Erma Hermens and Professor Dr. Noëlle L.W. Streeton (papers and posters)
- Dr. Ida Antonia Tank Bronken (photo editor)
- Marie Kleivane MA (editorial assistant)

Part 1: Conservation narratives and practices

An interdisciplinary, post-colonial response to the statue of Tara from Sri Lanka at the British Museum

Sujatha Arundathi Meegama and Lori Wong

ABSTRACT This collaborative paper between an art historian and a conservator re-examines an 8th–9th-century gilt bronze statue of Tara, a Mahayana Buddhist goddess, from Sri Lanka. Using the theoretical concept of object biographies as a shared method between the two disciplines, the study aims to question and expand the current understanding of this object, while highlighting recent scholarship from the Global South to advocate for decolonising practices. A comparative analysis of this standing statue of Tara with other sculptures of Tara from Sri Lanka together with information on materials, techniques of execution, and condition, enhances the appreciation of its local production and helps piece together its complex past, including its acquisition by the British Museum, London. Through interdisciplinary research, new observations help to reframe the Tara as a tangible museum object with intangible values to communities past, present and future. It links the statue to both Mahayana and Theravada Buddhist traditions, while also exploring the statue's identification as Pattini, a Buddhist and a Hindu deity in Sri Lanka. It also suggests that collaborative efforts between curators and conservators at the British Museum, alongside researchers in Sri Lanka, could yield deeper insights into the statue of Tara, offering fresh perspectives on its historical, cultural and spiritual significance.

KEYWORDS art history, Buddhism, conservation, decolonisation, Tara, Sri Lanka

Introduction

This collaborative paper formulates a preliminary response to the statue of Tara (Fig. 1)[1] an 8th–9th-century nearly life-size, solid-cast gilt bronze sculpture from Sri Lanka at the British Museum. By placing the two disciplines – art history and conservation – in dialogue with each other, this study expands the current interpretations of this statue by facilitating a fuller understanding of its object biography (Davis 1999: 7). The interdisciplinary nature of this research offers observations that reframe Tara as a tangible museum object with intangible values to communities. It links it to Mahayana and Theravada Buddhist beliefs and practices, while also exploring the statue's identification as the Buddhist deity Pattini, who is also worshipped as Kannaki by the Tamil Hindu community in Sri Lanka. Such a re-examination of Tara contributes to a more diverse reinterpretation of the statue, adding nuanced narratives about Sri Lanka's complex religious histories. A comparative analysis of this statue with other sculptures of Tara from Sri Lanka alongside information on its materials, techniques of execution and condition further helps to understand its local production,

Figure 1 Image of Tara, 8th or 9th century, gilt bronze, Sri Lanka, 1830, 0612.4. (Photo © The Trustees of the British Museum.)

its religious importance to worshippers in Sri Lanka, as well as the complex history of how it entered the collection of the British Museum.

This collaborative research relies on recent scholarship from the Global South and aims to advocate for decolonising practices and to foster connections with Sri Lankan scholars by highlighting contributions by archaeologists, Buddhologists, conservators, scientists and historians – giving a voice to local knowledge and interpretations. Furthermore, it provides an opportunity to explore how its current display at the British Museum can reflect the complexity of this object's history, the shifting identities of the goddess embodied in this gilt bronze sculpture, and her ongoing worship by communities in Sri Lanka.

The goddess Tara in Sri Lanka

In Mahayana Buddhism, Tara is known as the 'saviouress', a goddess who has multiple emanations and roles – primarily as a protector and liberator – but she also personifies compassion and wisdom. Her images first appear in India in the 6th century BCE and she is pictured alongside Avalokitesvara, the most popular bodhisattva in Asia. By the mid-7th century, she began to be combined with other divine groupings, and by the 8th century, she had her own attendants. Tara is also depicted as the goddess who can rescue one from the 'Eight Great Fears', a role initially associated with Avalokitesvara, and she 'responds to the needs of a broad spectrum of people – lay householders, travellers, monastics, and solitary meditators' (Shaw 2006: 319).

As a Mahayana Buddhist deity, Tara is revered in Nepal, Tibet, Mongolia and parts of Russia, but not in present-day Sri Lanka where an orthodox form of Buddhism – Theravada Buddhism – is currently practised. Yet the existence of this nearly life-size, solid-cast gilt bronze sculpture of Tara lends further evidence to a past comprised of more nuanced acceptance of differing religious thought on the island. According to the Theravada monastic chronicle, the *Mahavamsa*, Buddhism was transmitted to the city of Anuradhapura in north-central Sri Lanka in the 3rd century BCE by the Indian Emperor Ashoka's son, the Buddhist monk Mahinda. Written in Pali, the language of the Theravada *suttas* (teachings), this narrative enabled the Theravadins to connect to a distant past in India and to the oral tradition of the historical Buddha's earliest disciples (Holt 1991: 27). The arrival of Mahayana Buddhism in Sri Lanka in the 1st century BCE is seen through the disputes between the monasteries of the more conservative Mahavihara and the heterodox Abhayagiri Vihara at Anuradhapura (Holt 1991: 63–4). Monastic discipline, interpretations of the Buddha's teachings and different understandings of the path to nirvana were some of the points of contention. In fact, Mahayana followers offered a new corpus of teachings in Sanskrit (Holt 1991: 28–9). Although the Theravada chronicles and scholars generally frame Mahayana Buddhism as having little impact on the island, the large Mahayana monasteries of Abhayagiri and Jetavanarama at Anuradhapura with their monumental *stupas* clearly question this view (Jayawardene 2016: 21–2).

Seven 9th-century gold plates at the Jetavanarama *stupa* that contain the Sanskrit *prajnaparamita sutra* in Sinhala script demonstrate that Mahayana Buddhism was in practice among Sinhala-speaking Buddhists. The use of gold to faithfully replicate the format of a palm-leaf manuscript shows the wealth of the patrons and the value they placed in this particular *sutra* – an early Mahayana text. The numbers on the gold plates indicate that it once consisted of 35 plates that were likely worshipped rather than read (Prematilleke 1995: 71).[2] *Mantras* from the 9th and 10th centuries have also been discovered, and two copper plates from the Vijayarama monastery in Anuradhapura contain an invocation to Tara in the 9th-century Sinhala script, 'Om Tare tuttare ture svaha' (Mudiyanse 1967: 93), which translates as '*Om* Deliverer, Saviour, Swift One, *svaha*',[3] and provides further textual evidence that certainly by the 9th century, Tara was worshipped in Mahayana Buddhist communities in Sri Lanka.

Another intriguing textual source from Sri Lanka that mentions Tara is a treatise on Buddhist architecture and iconography, the *Manjusribhasita-Vastuvidyasastra*. Attributed to the Buddha, its title suggests that the text was transmitted by Manjusri, the bodhisattva of wisdom. Written in Sanskrit and in the Sinhala script, this 14th- or 15th-century palm leaf manuscript with 17 chapters was intended to be used by Sinhala-speaking temple builders. In chapter three, 'The Characteristic of the Caitya', in the description of the laying of bricks for a *stupa*, Tara is mentioned along with three other *saktis* (female principles of energy), who are all to be placed at the four corners after the installation of the five celestial Buddhas (Jayasuriya *et al.* 1995: 208). Such sources

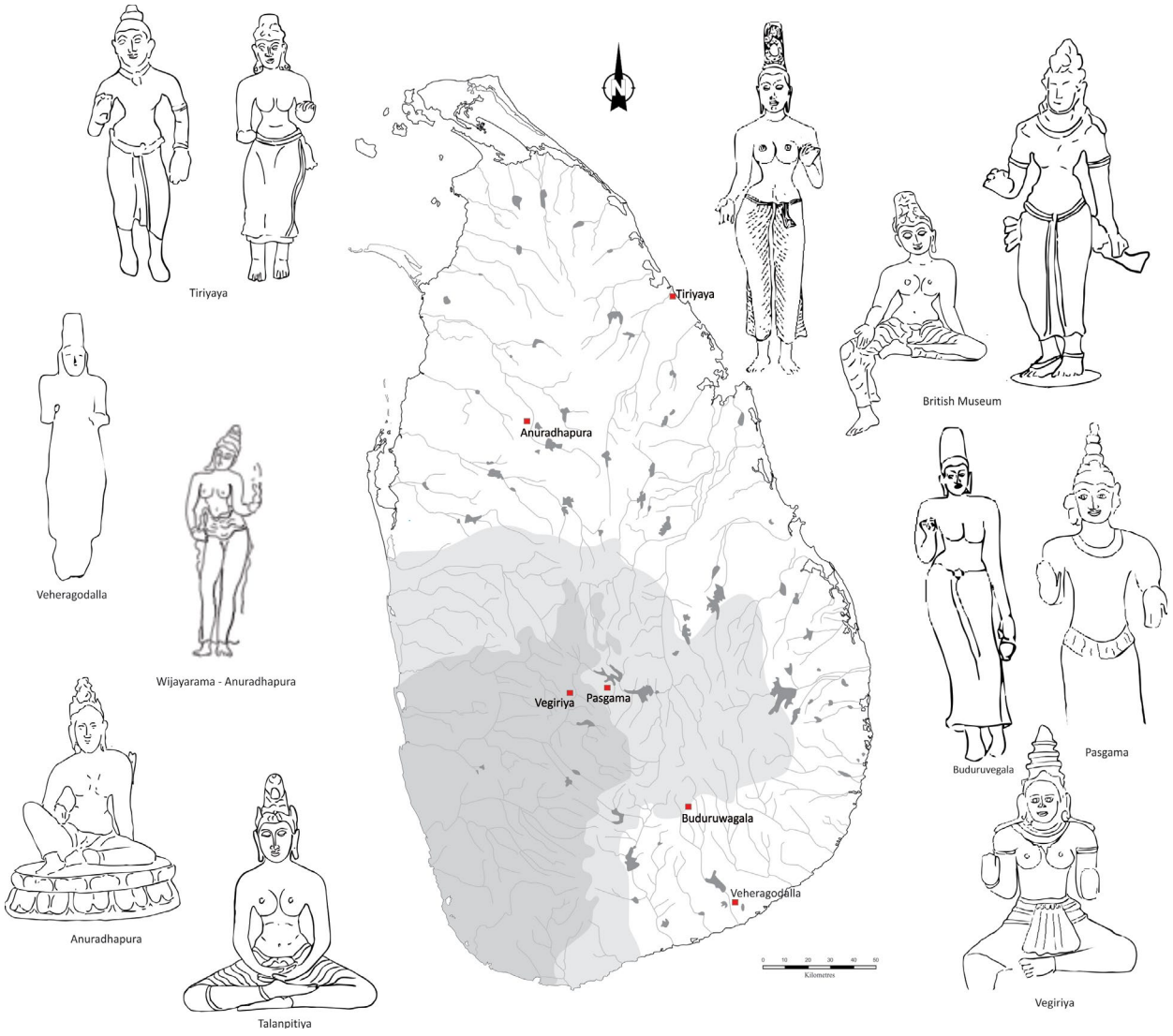

Figure 2 Map of locations where sculptures and carvings of the goddess Tara have been found or exist in Sri Lanka. The Tara statues in the British Museum are believed to have originated in the northeast of the country. (Drawing: Jayampath Senanayake.)

reveal that not only was Tara worshipped but she was also understood as an integral part of the Mahayana pantheon and its monuments in Sri Lanka.

Sculptures of Tara from Sri Lanka

Mahayana stone and bronze sculptures have been discovered in Sri Lanka that date to as early as the 8th century. These include images of Avalokitesvara, Vajrapani, Padmapani, Vajrasattva, Vajradharma, Manjusri, Arya-Janguli, Cunda and Jambhala as well as Tara (Mudiyanse 1967: 27–8). Avalokitesvara was the most popular Mahayana deity on the island and his sculptures have been discovered in various regions: while some are monumental stone images, others are small bronze statues suggesting an array of functions and devotees. Although surviving sculptures of Tara do not number those of Avalokitesvara, the diversity of materials, range of size and location highlight her importance in Sri Lanka.

A corpus of Tara sculptures has been discovered in Sri Lanka, produced from stone, metal and wood. A map (Fig. 2) indicating the locations of these statues reveals that she was worshipped at Buddhist centres such as Anuradhapura and also in Buddhist merchant communities closer to the island's eastern coast. Most depict her standing in the *abhanga* posture, similar to the statue of Tara at the British Museum, while others portray her seated in *lalitasana* and *virasana* postures. Some sculptures hold the *varada* hand gesture combined with *kataka mudra* or *abhaya mudra*, while another depicts the *dhyani mudra*. Some are quite small while others are monumental. Such differences point to a diversity of

patrons and functions, and indicates the significance of this Buddhist goddess to Mahayana Buddhist communities in Sri Lanka.

Although at the British Museum Tara stands alone, she may have been part of a group of images. At Buduruvegala, a 9th- or 10th-century rock-carved site in southeastern Sri Lanka, seven monumental Mahayana deities are depicted. The presiding Buddha in the centre is possibly Dipankara, while the two groups of three standing figures to his right and left consist of Avalokitesvara, Maitreya, Vajrapani and Sudhanakumara, Avalokitesvara, and Tara respectively (von Schroeder 1990: 292). This suggests that the goddess Tara may have been depicted and worshipped alongside other Buddhist figures in Sri Lanka.

The Tara statue at the British Museum and the rock-carved Tara at Buduruvegala share similarities in posture, dress and hair style. In both renditions, her right hip is bent, and her weight is supported by her right leg. Her upper body is unclothed, and she wears a tight-fitting cloth that is tied at the waist and clings to her shapely figure. The hair is piled in tall cylindrical chignons with central triangular shapes that may have included small images of a Buddha, indicating Tara's connection to Buddha Amitabha. Both the bronze and the rock carving are fairly large in size and hence illustrate not only the importance of Tara to Mahayana Buddhist communities of Sri Lanka, but also show that she was worshipped in public spaces.

But the differences suggest that religious communities did not have a static understanding of Tara and the functions of her images. Unlike the bronze Tara at the British Museum, who holds the gesture of giving with her right hand while her left hand is raised and may have once held a lotus flower, the rock-carved Tara at Buduruvegala holds a vase with her left hand and the *ahvana mudra* with her right hand. The ornamentation of the two differ as well: similar to the remnants of paint on the carvings of Avalokitesvara and Dipankara at Buduruvegala, the stone Tara may have also been covered with painted plaster. The bronze sculpture of Tara's hair is ornamented with a pair of *makara* finials that accentuate the central cavity that would have been surrounded by inlaid gems, all lost. While both sculptures of Tara glance down in compassion at devotees, the eyes of the bronze figure were most likely inlaid with crystals or precious stones, similar to other Sri Lankan bronzes from this time period. This comparison between the bronze statue of Tara at the British Museum and the stone carving of Tara *in situ* reveals that religious communities in Sri Lanka produced and sponsored diverse renditions of the same deity in different materials for specific socio-religious contexts.

Because of a heavy reliance on the conservative Theravada chronicles, Sri Lanka is framed as a predominantly Theravada Buddhist country. However, the epigraphical, literary and sculptural evidence demonstrates the widespread belief of Mahayana Buddhism in Sri Lanka. Mahayana deities were appropriated and worshipped on the island: patrons and devotees localised these deities and some are still worshipped to this day. Examining Sri Lanka's Buddhist histories through a new lens, recognising that Mahayana Buddhism also thrived in various regions and not only at the Abhayagiri and Jetavanarama monasteries in Anuradhapura, may allow for the development of more complex narratives about the island's Buddhist histories (Jayawardene 2016: 21–2). A re-examination of diverse materials from the monumental rock-cut sculptures of bodhisattvas to the gilded bronzes of Buddhist goddesses such as Tara, questions the religious 'orthodoxy and narrow sectarianism' that is still prevalent in Sri Lanka to this day (Deegalle 1999: 355).

The goddess Pattini in Sri Lanka

Tara continued to be worshipped as a Mahayana deity in Sri Lanka, but her identity was not stable. In a 14th-century *sandesa* or messenger poem, the poet of the *Tisara Sandesa* devotes five verses to a temple called Dorawaka Vihara (in the Kegalle district), which enshrined three statues including one of Tara:

> Depart thou hence, without tarrying, after worshipping the Queen Tara, who has adorned the magnificent mansion of Sri Lanka, with the multicoloured canopy of (her) fame; who has eschewed vice and is adorned with virtue as if with jewels; and who unfailingly bestows like the Divine Cow, whatever is desired of riches.
>
> *Tisara Sandesa*, verse 131[4]

The verse indicates that in the 14th century, Tara was worshipped alongside the historical Buddha and the bodhisattva Avalokitesvara as a goddess who would bestow boons to her devotees; most likely, in this

sculpture at Dorawaka, Tara may have held the hand gesture of giving. In this verse, she is called *biso* or queen: Tara was seen as a consort of the bodhisattva Avalokitesvara or Natha, as he is known locally, and was absorbed into the island's local Buddhist pantheon.

Her identity further evolved between the 15th and 19th centuries when she began to be associated with the Buddhist and Hindu goddess Pattini or Kannaki. Pattini was initially a South Indian goddess – she is the heroine, Kannaki, of the Tamil epic poem, *Cilappatikaram*, believed to have been written in the 2nd or 6th century CE in South India (Alwis 2018: 161). Although no longer worshipped in South India, Pattini is still revered in the central and southern regions of Sri Lanka by Sinhala Buddhists, while Kannaki is worshipped in the northern and eastern regions by Tamil Hindus. Pattini and Kannaki share the same iconography as they are depicted holding two anklets with their hands held up at shoulder level, and even certain narratives and rituals (Obeyesekere 1984: 5). As the iconography differs from that of Tara, further investigation is warranted to understand the reasons why Tara became known as Pattini in Sri Lanka.

Removal from Ceylon and arrival at the British Museum

The identification of the statue of Tara as Pattini is recorded in the 19th century when it entered the collection of the British Museum as a donation in 1830 by Sir Robert Brownrigg (1759–1833), the former governor of Ceylon. Brownrigg had captured the Kingdom of Kandy in 1815, an invasion that brought the island under the subjugation of the British as a crown colony until it regained its independence in 1948. A letter dated June 1830 from Sophia Brownrigg, wife of Robert Brownrigg, to Henry Ellis (1777–1869), secretary of the Society of Antiquaries, London and principal librarian at the British Museum, stated that the statue was 'representing one of the Hindoo Goddesses, which from the manner and place it was found was supposed to be of great antiquity, and to have represented the Goddess Patina' and 'was found in the North East part of Ceylon between Trincomalee and Baticalon [Batticaloa]'.[5] The attribution of the sculpture as the goddess Pattini by the Brownriggs refers to her both as 'Goddess Patina' and 'Patala Deva', in the two letters from Sophia Brownrigg in 1830.[6] This raises the possibility that the Tara may have been worshipped as Pattini by a local community somewhere between Trincomalee and Batticalo soon after its discovery in a similar manner to when the Sultanganj Buddha (Wingfield 2010: 59–60) and the Didarganj Yakshi (Davis 1999: 3–6) were discovered and worshipped in India.

The first scholar to have written about this sculpture at the British Museum was one of South Asia's earliest art historians, Ananda Kentish Coomaraswamy (1877–1947). In 1909, he published an article on Mahayana sculptures from Ceylon and Java and included the statue of Tara under a section on 'Hindu Feminine Divinities'. Due to a lack of data, he accepted the identification of this bronze as Pattini (Coomaraswamy 1909: 292–3). In *Bronzes from Ceylon Chiefly in the Colombo Museum*, Coomaraswamy again brought attention to the statue of Tara by publishing a full-page black and white photograph and identifying her as Pattini, 'a South Indian goddess of fertility and controller of diseases' (Coomaraswamy 1914: 12). Furthermore, he stated that, 'No figure of Tara has yet been found in Ceylon' (Coomaraswamy 1914: 7). Dating this sculpture to the 7th or 8th century, he grouped the statue of Tara with three other sculptures, which he also identified as Pattini, including the small bronze image of the seated Tara from the Hugh Nevill Collection at the British Museum.[7] Coomaraswamy included all four bronzes under the section 'Hindu Bronzes' and devoted one paragraph explaining Pattini's story, functions and rituals (Coomaraswamy 1914: 12). It was not until 1927 when Coomaraswamy re-identified the sculpture as 'Pattini Devi or Tara' (Coomaraswamy 1927: 250). From 1963 onwards, the name Tara became more or less fixed to the sculpture, although some writers continued to remind their readers of its former identity by stating in the description 'also known as Pattini' (von Schroeder 1990: 276). The ambiguity or the shifting identities of the goddess represented in this gilt bronze sculpture is not captured in the current object title, 'Image of Tara' or the label at the British Museum.

The statue was removed from Sri Lanka in 1820 when the Brownriggs returned to London, although the circumstances of how it came into their possession are not known. The Brownriggs did not appear to know much about the statue but had some understanding of its importance and value, describing it as a 'gilt female figure … found in

Ceylon and believed to be of great antiquity' such that it 'induced Sir Robert to bring it home and now to offer it to the British Museum.'[8] Interestingly, Sir Robert Brownrigg, 'always intended to offer it to the Antiquarian Society' and not the British Museum but Sir Thomas Lawrence (1769–1830), a portrait painter and president of the Royal Academy, passed away 'before he could perform his promise' and it was instead, 'on the advice of Henry Ellis, gifted to the British Museum.'[9]

Bronze sculptures in Sri Lanka

Buddhist and Hindu bronze sculptures of various sizes have been discovered in Sri Lanka from different regions of the island. Bronze Buddhist sculptures were not only enshrined within monuments as ritual deposits or offerings, but were also worshipped in public spaces, used for personal veneration and meditation, carried in processions and offered as votive images (Prematilleke 1995: 4).[10]

Most of the bronze Buddha images from Sri Lanka are seated sculptures in *virasana* (heroic posture) holding the *dhyana mudra* (meditation). Out of the approximately 200 bronze sculptures produced during the late Anuradhapura period, only seven standing Buddhas have been discovered so far on the island: the largest, at 66 cm, is from a discovery of nearly 50 sculptures from Veheragala Sirisangabo Vihara in the Anuradhapura district.[11] As nearly all hold the *abhaya mudra* or the 'do not fear' hand gesture, with their right hands, most likely 'they were objects of reassurance and protection for the worshippers' (von Schroeder 1992: 50). The largest standing bronze bodhisattva is an Avalokitesvara sculpture from Anuradhapura that is *c.*46 cm, significantly smaller than the bronze Tara, which stands at 143 cm tall (Prematilleke 1995: 40). Due to its size, standing posture and hand gesture, the standing Tara at the British Museum was likely an object of worship in a public space and may have been the central sculpture rather than an ancillary figure.

The production of the Tara

The Tara in the British Museum is striking due to its size and manufacture. At 143 cm she is the tallest bronze statue from Sri Lanka known to exist and hence was deeply valued by its religious community. Tara is a solid-cast bronze copper alloy which includes copper as the main component with small amounts of tin, iron, lead and other trace elements added or present as impurities (von Schroeder 1990: 551; Srinivasan 1999; Craddock and Hook 2007; Reedy and Harlacher 2007). Statues were made using the lost-wax technique and were either cast as hollow (*susira*) or as solid (*ghana*) bronze (Reeves 1962; Craddock 2015). Due to both technical reasons and religious injunctions, the solid-cast technique was favoured in Sri Lanka and South India from around the 9th century (Prematilleke 1995: 2; Srinivasan 1963: 26; Kasthuri 2016).

The *Sariputra*, a 12th-century treatise in Sanskrit with a Sinhala commentary, contains instructions on the proportions and production of sculptures. The section that addresses the making of images of the Buddha contains 139 verses providing instructions in all three postures (i.e. sitting, standing and reclining). After praising the Buddha and asking for his blessings, the text states that 'images of Buddha are made from gold, copper, clay, stone, wood, burnt clay, and lime'. It also prohibits the making of hollow images:

> No images of gold or other metal should be cast hollow within. The making of hollow images will ere long result in the loss of wife and wealth, and lead to quarrels and famine, and to delay in the performance of work, and dread of enemies to royalty… If this rule be deviated from it will result on the loss of wealth and life (Coomaraswamy 1909: 154).

Although these instructions are for the making of Buddha images rather than bodhisattvas and Buddhist goddesses, and are a later date than the Tara, they indicate a religious preference for solid-cast bronze sculptures. The choice of technique, namely between hollow and solid casting, 'depended on a number of quite disparate factors, ritual as well as practical' (Craddock 2015: 65). In South India, 'where the form of the image is strictly controlled, truly divine figures were and continue to be solid castings … to some degree a solid casting being regarded as a more de-luxe version of a hollow casting' (Craddock 2015: 65). Solid casting of a nearly life-sized figure also posed practical considerations such as the cost of materials and weight factors as several hundred kilos of metal could be required. As reference, a *Standing Buddha* (*IPN.2639*) statue at the Victoria and Albert Museum in London, dated

to the 11th–12th century from Nagapattinam, South India, described as 'gilt copper alloy' and only half as tall as Tara at 68.5 cm, weighs 49 kg.[12] The ability to pour molten metal into a mould and to avoid stress cracking and strain as the metal cooled and contracted is also indicative of the high degree of skills present (Craddock 2015: 66). There are only few defects visible from the casting process, demonstrating the extraordinary quality of craftsmanship, knowledge and skill in the Tara's manufacture and resources available for its production, but further investigation is still needed in this area.[13]

Analytical investigations

There have been numerous scientific studies conducted on South Indian and Sri Lankan bronzes using a range of different analytical and metallurgical methods to understand the source of ore and their production (Reeves 1962; Srinivasan 1999; Craddock and Hook 2007). A table of 'metallic composition analysed by atomic absorption' published by von Schroeder (1990: 551) includes samples from Tara that lists the trace element composition found in two samples.[14] It is not known whether an X-radiograph of the statue may have been undertaken that would help to indicate whether there are cast repairs or if parts of the figure may have been cast separately. It could also possibly provide information on the found condition of the object and whether any later restorations may have occurred (Slaczka *et al.* 2019: 18–23).

Most recently, analytical studies undertaken on Sri Lankan bronzes have identified ore sources using stable lead isotopic signature and trace element ratios (Thantilage 2008; Kasthuri 2016; Thantilage and Vithanage 2023). Work undertaken as part of the Ancient Copper Metallurgy Project by the Postgraduate Institute of Archaeology at the University of Kelaniya (2013–2016) also included archaeological fieldwork to support the analytical findings (Thantilage and Vithanage 2023). The outcome of this research has established local ore sources that have previously been overlooked, including the Seruwila region in the northeast of Sri Lanka as a place of copper mining and smelting activities. Thantilage measured the isotopic composition of lead as an impurity in over 50 objects from Sri Lanka to establish common ore locations.[15] Six lead isotope groups were found and the Tara matched closely with five other images (MLG2), three of which were also found on the eastern coast of Sri Lanka (Thantilage and Vithanage 2023). Thantilage uses a lead ingot sample from Tissamaharama in the southeastern region of the island to show that all objects from MLG2 have a similar lead content. None of the MLG2 group images were matched with the trace element trends of local Seruwila copper sources, which could suggest a possible second school of image production during the Anuradhapura period (Thantilage 2018). Thantilage also calls into question the accuracy of trace element data of the Tara image used for the study published in von Schroeder's *Buddhist Sculptures of Sri Lanka* (1990: 551) citing an 'unusual value of Cobalt/Nickel elemental ratio of 2.65 which is not even consistent with the South Indian image values' (Thantilage 2018). The scientific and archaeological studies conducted on Sri Lankan bronzes have helped us appreciate the local production of the bronze Tara, but conservation reports and further investigation by the British Museum would surely expand our understanding of this intriguing object.

The ornamentation of the Tara

Given that the Tara is a standing sculpture, which is nearly life-size and holds the hand gesture of giving, she was most likely also embellished for public worship. After the initial production phase, bronze sculptures were adorned in various ways: some like the Tara at the British Museum were fire gilded using a mercury-gold amalgam process, while others were ornamented with embossed sheets of gold foil and sandalwood paste (von Schroeder 1990: 379).

As demonstrated by the Tara and the seated bronze bodhisattva Avalokitesvara (Fig. 3) from Veheragala, precious gems were also inserted into their headdresses. The crowning flame ornament of some bronze Buddhas were also adorned with gems, as well as the *makara-torana* that would frame certain seated Buddhas. At times, traces of paint have been discovered on the seated and standing Buddhas from Veheragala (Prematilleke 1995: 24). While such ornamentation suggests wealthy donors and their devotion and desire for merit, the materials and efforts to ornament Buddhist bronzes also illustrate the highly developed technical skills of craftsmen. Considering such traditions of embellishment,

Figure 3 Seated Bodhisattva, gilt bronze, 9th century, Sirisangabo Monastery Veheragala, Sri Lanka, National Museum, Colombo.

further investigation of the Tara statue for traces of ornamentation is merited.

South Indian Hindu bronzes are often adorned with textiles, jewellery and flowers that devotees offered when they travelled outside the temple for festivals (Dehejia 2004). A rare 10th-century solid bronze sculpture from the Jetavana Vihara at Anuradhapura depicts a standing bodhisattva on a hollow pedestal with protrusions on either side that suggest it was carried in processions (von Schroeder 1990: 260). Similar to the pedestals found on South Indian Hindu bronzes and Buddhist bronzes from Nagapattinam, the presence of this bronze at Anuradhapura indicates that certain Buddhist bronzes in Sri Lanka may have been carried in processions and variously adorned by worshippers during festivals. Although the pedestal is now missing, the Tara too may have been further adorned during festivals and carried in procession.

The condition of the Tara

The condition of the Tara may also provide clues to her past history. She is recorded as being found between Trincomalee and Batticaloa, although the exact location and how she was found is not known. While the statue appears in good overall condition, there are large deep losses in the face such as on her right cheek and nose and around her left eye, and the gilding is abraded and worn in places – especially on her back side. The statue is also missing several toes, and her left hand has some deep losses and is missing much of its gilding. There is a circular hole in her right breast and a large loss on her upper arm, which might be due to corrosion and 'bronze disease'. While her front side is polished gold, the entire back side has a very different appearance. This could be a result of only fire gilding and polishing of her front side or potentially providing evidence of its past history.

Some scholars have suggested that statues were buried as a protective measure during times of political instability or when a monarch unified the monastic order (Dehejia 1993: 12–17). In South India, these would be ritual burials to protect icons that could later be purified and repaired for re-entry into temples. In a buried environment, bronze will corrode and can lead to corrosion products which manifest as mineral accretions and encrustations of chlorides and oxides on the surface. The accretions and materials from the corroded surface could provide information on the Tara's burial location and conditions (Gänsicke 2016).

The treatment that the Tara may have undergone is not fully known. If she was buried at one time, mechanical cleaning using scapels or chemical or electrochemical procedures may have occurred; bronze statues are also impregnated with wax coating to prevent further corrosion. In some cases, a clear acrylic resin coating is applied such as Incralac as suggested for use by the International Copper Research Association. The published conservation record accessible at the time of writing only mentions that the object was cleaned and polished in 2000 to 'improve appearance', 'grease and dirt removed with white spirit. Lightly polished with "Duraglit" wadding and soft paper tissues.'[16]

A comparison of the deterioration and loss in the three gilded bronzes from Veheragala and the statue of Tara at the British Museum might also reveal patterns that could suggest whether there is any possible relationship. The standing Buddha,

Figure 4 From James Stephanoff, *An Assemblage of Works of Art from the Earliest Period to the Time of Phydias, a watercolour*. (Photo © The Trustees of the British Museum.)

the seated Buddha and the seated bodhisattva Avalokitesvara from Veheragala appear to be in a slightly better condition with fewer noticeable losses than the Tara, indicating a different past history; however, further investigation is needed on all four sculptures to determine their material and physical relationships.

Life at the British Museum

Today, the statue of Tara is valued as one of the British Museum's prized possessions as demonstrated by the various ways the object has been highlighted in projects initiated by the museum. In 1830, the statue was included in James Stephanoff's (1788–1874) *An Assemblage of Works of Art, from the Earliest Period to the Time of Phydias, a watercolour* (Fig. 4) exhibited in 1845 at the Old Watercolour Society.[17] Tara was then hidden away due to its 'dangerously erotic voluptuous figure' (MacGregor 2012). It spent 30 years in the museum's 'Secretum', known as the 'Cabinet of Obscene Objects' and referred to by some as the 'porn room'. The Secretrum opened in 1865 after the Obscene Publications Act of 1857 to an audience of gentlemen only.[18]

In the 1970s, an oil painting was created by the artist Graham Arnold (1932–2019) that featured various objects from the British Museum's Asian art collection, including the statue of Tara. This became one of seven advertising posters used from 1977–78 with a tagline reading: 'A Painting by Graham Arnold based on the Collections of the Department of Oriental Antiquities. The Museum inspired the artist. Let its great and varied treasures inspire you.'[19] Tara is prominently featured with her golden body against a bluish background on the left side of

the poster, while her lower garment unravels into colourful ribbons and flutters conspicuously across the foreground of the poster.

The statue of Tara has been exhibited both in 1981, at the Commonwealth Institute in London's special exhibition, *The Art of Ancient Sri Lanka*, and in 1985 in the British Museum's special exhibition, *Buddhism: Art and Faith*.[20] A documentary aired on BBC 4 in August 2007 which explored the life of this object through a series of interviews with curators, an art historian, an artist, a Buddhologist, a conservator and a descendant of the donor.[21] The statue was included as object #54 in the BBC's and the British Museum's 2010 series, *The History of the World in 100 Objects*, narrated by then director, Neil MacGregor, which served as a 'history of humanity' told through 100 objects selected from the British Museum. Although this series toured as a global exhibition to nine cities including Abu Dhabi, Singapore, Shanghai, Tokyo and Perth, the statue never travelled: she was represented by her proxy, another bronze sculpture of Tara from Sri Lanka.[22] These diverse initiatives signal the importance of the standing bronze Tara from Sri Lanka to the British Museum's encyclopaedic collection. However, the attention bestowed upon the statue from scholars, curators and the popular media associated with the British Museum belies a more complicated history.

Tara in Contemporary Sri Lanka

Neil McGregor concluded his podcast by noting the following:

> Many centuries before, the island had abandoned the particular strand of Buddhism in which Tara had played such a prominent part, and her statue may well have been removed from that temple and buried for safe keeping during that religious upheaval. But, if no longer revered in Sri Lanka, Tara is in many places very much a living force (MacGregor 2012).

The documentary, *Masterpieces of the East, The Tara Statue* (2007) also suggests that she is no longer relevant to contemporary Buddhists in Sri Lanka. However, fieldwork at two small temples in the outskirts of Kandy suggest otherwise. At Pasgama Devale and Vegiriya Devale, temples dedicated to Natha or the bodhisattva Avalokitesvara, sculptures of Tara are placed next to Natha. Interviews conducted with the lay priests in July 2022 at both temples revealed that this goddess is now known as Pattini. Although photographed by the scholars Nandasena Mudiyanse and Ulrich von Schroder, and John Holt for their publications, these two images of Tara or Pattini, similar to other images of Buddhist guardian deities housed in the main sanctums of *devales* or temples to Buddhist deities, are never publicly revealed, even during annual processions, as they are considered too powerful to be seen by the laity. Sculptures of Buddhist deities are screened by painted curtains only to be seen by the ritual lay specialists of these temples. When Buddhist deities are taken in procession, it is only their insignia that is carried outside, generally on elephants. While the date when this tradition began is not known, the verse praising Tara from the *Tisara Sandesa* implies that in the 14th century it was still possible to see and approach her in a Buddhist temple.

The current-day practices of worshipping sculptures of Tara as Pattini indicates that sculptures of Tara in Sri Lanka may have been repurposed by Buddhist communities on the island to worship the new goddess, who had arrived from South India and was given her own temple in the capital cities of Kotte (1412–1597) and Kandy (1469–1815). It is intriguing to consider when, why and how Tara may have merged with Pattini. Similar to the sculptures of Tara at Pasgama Devale and Vegiriya Devale that are currently identified and worshipped as Pattini, the bronze statue of Tara may also have been identified and possibly worshipped at the time of its discovery in northeastern Sri Lanka as the goddess Pattini or Kannaki, who was and still is widely worshipped by Buddhist and Hindu religious communities in Sri Lanka.

At the Natha Devale in the centre of Kandy, near the former royal palace and the Temple of the Tooth Relic, there is a new sculpture of Tara (Fig. 5). On the right side, placed to the left of a recent painting of Natha, is a small sculpture completely covered in cloth. During an interview, the lay priest mentioned that this sculpture is a replica of the statue of Tara from the British Museum that was donated by a devotee as an offering to the former royal temple. The temple proposes building a small enclosure for it outside the main shrine. Even if the statue of Tara is thousands of miles away in the British Museum, a replica of her will soon be unveiled and worshipped at a former royal temple to Natha and close to the

Figure 5 Sculpture of the goddess Tara covered in cloth, Natha Devale, Kandy, Sri Lanka. (Photo: Sujatha Arundathi Meegama.)

former royal temple to the goddess Pattini in Kandy. These replicas at the Natha Devale, the National Museum in Colombo and at the Central Cultural Fund are a powerful reminder that the statue is not forgotten and still holds relevance to contemporary Sri Lanka.

In these diverse contexts, the manner in which the statue at the British Museum has been displayed must be considered. In the current presentation, we lose the history where she may have shared a space with Buddhas and bodhisattvas, was part of daily and annual ritual practices and was merged with another Buddhist goddess, as well as the complexity of her identification and worship throughout Sri Lanka with relevance to both Sinhala Buddhist and Tamil Hindu communities.

A decolonial approach to the statue of Tara

In December 2023, the Rijksmuseum, Amsterdam, returned six objects looted from Kandy, Sri Lanka during the Dutch–Kandyan war of 1762–1766. Currently displayed at the National Museum in Colombo, Sri Lanka, in a special exhibition to celebrate their journey home, these treasures are now appreciated by Sri Lankans as well as other visitors to the island. A visitor book at the exit to this exhibition records the various responses of viewers who have marvelled at the beauty of these objects and praised the Dutch government's actions. In seeing the technological prowess and rich materials even within this small cohort of objects, comments from local museum visitors reveal a sense of pride about

their heritage. This small but powerful exhibition has become a model for the display on entangled histories between Sri Lanka and the Netherlands.

The 2023 repatriation was undertaken under the auspices of the Pilotproject Provenance Research on Objects of the Colonial Era (PPROCE), funded by the Dutch Ministry of Science and Culture. The project traced the provenance of individual objects and provided a methodology. Dutch and Sri Lankan scholars collaborated and the core team was assisted by experts from the Rijksmuseum's Department of Science and Conservation, History Department, and its library and archives. Using object biography as a framework to approach these six Sri Lankan objects, the interdisciplinary team established the provenance of each object and provided a deeper understanding of these spoils of war and their meanings, both past and present (Schrikker and Van den Boogaart 2023: 12–14). Moreover, the direct participation of Sri Lankan scholars and curators provides a model for the teaching and research of sacred objects in colonial collections in the UK. What might be further discovered about the statue of Tara through collaboration with curators and conservators in the British Museum and researchers in Sri Lanka? Such a dialogue may reveal a similar narrative about museum artefacts and their complex roles in shaping understandings about empire, colonialism, violence, resistance, diplomacy and repatriation.

Many scholars have written about the removal of cultural property during the colonial era (e.g. Kamardeen 2017). In 2016, Shanthi Jayawardene's decolonial response noted, 'Her [Tara's] removal from Sri Lanka is inextricable from imperial power' (Jayawardene 2016: 2). Jayawardene also highlights the importance of restitution and the relationship between accessing objects and the value of producing new knowledge in Sri Lanka. She calls attention to Tara's exclusion in the Sri Lankan art historical canon – although Tara is included in the 1914 publication by the National Museum in Colombo, her absence from the 1995 National Museum's exhibition catalogue, *The Heritage of Sri Lankan Bronzes*, as well as the international travelling exhibition, reveals a certain ambivalence – and of course, the inaccessibility to the statue of Tara by Sri Lankan scholars. An official request to return the Tara, or the goddess Pattini as she was then known, was made in 1937 by the then colonial Government of Ceylon. The then museum director of the British Museum wrote 'a fine plaster cast of [the] image was generously donated to the Colombo Museum by the British Museum' (Jayawardene 2016: 22). Although the British Museum has not shown a willingness to repatriate this or other objects looted during the height of British colonialism (Lillehoj 2017: 148–9), this paper is a starting point, and perhaps a team of scholars from Sri Lanka and the UK can collaborate to reconstruct a fuller object biography that fills in some of the gaps in the research undertaken for this paper.

Conclusion

This paper offers some preliminary observations about the statue of Tara from Sri Lanka in the British Museum through an interdisciplinary lens in an age that also values a decolonised framework to studying objects within museum spaces. Inspired by actions in the museum world and academia in general to connect sacred objects with source communities, this research leverages the synergies of art history and conservation to reimagine the Tara not only as a tangible museum object but also to re-establish and reconnect its intangible values to existing communities, cultural practices and beliefs. Depicted in bronze, stone, clay and stucco, sculptures of Tara have been found in different regions of Sri Lanka revealing her importance to religious communities that once worshipped her. Sculptures of Tara are still venerated as Pattini in rural temples in Sri Lanka, today.

Notes

1. This study is undertaken through the Robert H. N. Ho Family Foundation Centre for Buddhist Art History and Conservation at The Courtauld Institute of Art, London.
2. Further discoveries of this *sutra* in the form of 91 copper plates dated to the 9th century at another *stupa* nearby in Sinhala and Sanskrit indicate that Mahayana Buddhism was flourishing in Anuradhapura: Holt 1991: 67.
3. Samye Translations (tr.). Tārā Who Protects from the Eight Dangers (**Tārāṣṭaghoratāraṇī*, Toh 731). 84000: Translating the Words of the Buddha, 2023: https://read.84000.co/translation/toh731.html.
4. Mudiyanse 1967: 52.
5. Letter 1, Original (a copy) in Department of Antiquities, November 1847, copy [June 1830]. Brownrigg Letter, from Sophia Brownrigg to Henry Ellis, Original Papers, Volume 8, June 1830 – June 1831.

6. 'Goddess Patina' is referred to in Letter 1, 'Patala Deva' is referred to in Letter 2, 7 June 1830, Hilston House, Monmouth.
7. British Museum object number 1994,1210.6: https://www.britishmuseum.org/collection/object/P_1994-1210-6 (accessed 12 April 2024).
8. From Letter 2.
9. From Letter 1, Brownrigg and Lawrence were acquainted as Lawrence painted Brownrigg's portrait *c*.1810 when he was a Lieutenant-General.
10. Although we have no exact date for the production of the first bronze image in Sri Lanka, in the 30th chapter of the 5th-century Pali chronicle, the *Mahavamsa*, a golden image of the Buddha is mentioned for the first time: King Dutthagamini (161–137 BCE) had installed it in the centre of the relic chamber of a *stupa*: Geiger 1950, XXX: 72–3.
11. In 1968 a hoard of gilded bronze sculptures was discovered at Veheragala which included the largest standing Buddha found in Sri Lanka, a seated Buddha, a seated bodhisattva, 39 small seated bronze Buddhas, as well as bronze ritual items. The importance of these objects – which are all large solid bronzes, gilded and ornamented with gems – indicate the signficance of the Veheragala Sirisangabo monastery east of Anuradhapura: Dehejia 1993.
12. https://collections.vam.ac.uk/item/O24788/standing-buddha-sculpture-unknown/ (accessed 12 April 2024).
13. The authors have noted possible metal defects or areas of modifications such as on the right arm of Tara, above her elbow, but this requires further investigation. At the time of writing, access to the conservation records at the British Museum has not been possible. This would no doubt cast light on its manufacture and provide more detailed information on the materials and techniques of execution of Tara. The findings in this paper are therefore preliminary and based only on *in-situ* visual observations by the authors and existing published material. It is our hope that this paper will spur interest and act as an invitation to the British Museum to collaborate on further research and investigation of the Tara.
14. Enquiries were made to the British Museum to find out whether additional samples may have been analysed but at the time of writing no further information was obtained.
15. Thermal ionisation mass spectrometry (TIMS) was used for the lead isotopic analysis of this study, carried out using the facilities at the lead isotopic laboratory, Natural History Museum, Stockholm. For more information, see Thantilage and Vithanage 2023.
16. https://www.britishmuseum.org/collection/term/54652:1 (accessed 3 April 2024).
17. British Museum object number 1898,0702.142: https://www.britishmuseum.org/collection/object/A_1898-0702-142 (accessed 12 April 2024).
18. https://www.britishmuseum.org/blog/29-things-you-probably-didnt-know-about-british-museum (accessed 6 April 2024).
19. https://www.britishmuseum.org/collection/object/PA_Painting-64 (accessed 29 January 2024).
20. https://www.britishmuseum.org/collection/object/A_1830-0612-4 (accessed 12 April 2024).
21. *Masterpieces of the East, The Tara Statue*, BBC 4 August 2007.
22. https://www.britishmuseum.org/collection/object/A_1898-0702-142 (accessed 29 January 2024).

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Whose story to tell? The many masters of Bernt Notke's altarpiece in Tallinn

Hilkka Hiiop, Anneli Randla, Hannes Vinnal and Kristina Aas

ABSTRACT This paper delves into the conservation and research aspects surrounding the carved retable with painted wings of Tallinn's Church of the Holy Spirit's main altar, crafted in 1483 at Bernt Notke's workshop. It is based on a large-scale project that launched in 2019, encompassing precise documentation of the altar's condition, historical and material studies as well as conservation efforts. The main intrigue revolves around the extensive overpaintings on the original 15th-century layer, which occurred on two separate occasions. The incomplete conservation works during the 1960s–80s have only contributed to the inconsistency, resulting in numerous questions and issues. Each historical layer encapsulates the values and information of its respective time. The question at hand is what to preserve and what to remove, and how to cope with earlier conservation decisions. This paper explores the tensions and synergies between modern conservation and documentation practices on the one hand and archival research on the other. It also examines how significant historical losses may occur when these aspects do not coexist effectively.

KEYWORDS Bernt Notke, medieval wooden sculpture, technical research of artworks, conservation of polychromy, conservation narratives, archival research, early modern craft guilds

Bridging the gap between historical archives and the conservation studio

This paper deals with the conservation and research issues concerning the carved and painted altarpiece of Tallinn's Church of the Holy Spirit, which was made at Bernt Notke's workshop in 1483. It is based on a project launched in 2019 to study the historical background of one of Estonia's best-known works of medieval art in preparation for carrying out its conservation. A major controversy arises from the fact that the altarpiece has been extensively overpainted on several occasions over the centuries, and conservation work has been repeatedly started but left unfinished. What are the values of these layers of history and how should we deal with earlier conservation decisions? The tensions and synergy of modern conservation and documentation practices are examined on the one hand and archival research on the other.

The paper first introduces the art historical context and conservation history of the altarpiece, as well as some results of technical investigations carried out thus far. Secondly, it unfolds the story of the 1625 overpainting of the altarpiece: at the same time as conservation work was proceeding at full speed, and millimetre by millimetre the overpainted layers were being removed, challenging new information about these so-called secondary intervening hands came to light. A third topic covers the 'three faces' of the Virgin Mary, in other words the set of problems associated with removing overpainting from the altar's central sculpture – the Virgin Mary. Consequently, the main focus of this paper concentrates on issues concerning historical overpainting. The original techniques used in Notke's workshop are discussed only briefly as part of the wider context.

Bernt Notke's altarpiece in Tallinn

A magnificent work of art stands at the high altar of the Church of the Holy Spirit in Tallinn: an altarpiece with carved and painted wings, completed in 1483 at Bernt Notke's workshop (Fig. 1).[1] It is one of the few works which undoubtedly originates from the workshop of the renowned master craftsman from Lübeck: two letters addressed to the town council of Tallinn have been preserved in which the master asks for an overdue fee for the completed and delivered work (*tafele*).[2] Written sources verify that the Calvary on the Lübeck Cathedral chancel arch and the high altar retable at Aarhus Cathedral are also

Figure 1 Bernt Notke's altarpiece (1483) in the Church of the Holy Spirit in Tallinn: open position before conservation in 2021. (Photo: Andres Uueni.)

works by the same master (Petermann 2000: 45–65, 70–93). The best-known works associated with Notke's name – the paintings of Danse Macabre at St Nicholas' church in Tallinn and St Mary's church in Lübeck (the latter work has not survived), and the St George group in Stockholm – have been attributed to him solely on stylistic grounds. Many other works are likewise attributed to Notke's workshop stylistically (Eimer 1985; Petermann 2000; Tångeberg 2009; Vogeler *et al.* 2010; Hoffmann 2014: 144–96).

The altarpiece consists of a carved corpus and two pairs of folding wings. The central scene of the corpus depicts the descent of the Holy Spirit, in other words the Miracle of the Pentecost. Twelve apostles surround the Virgin Mary sitting on a throne at the centre of the sculpture group. Several saints who were revered in Tallinn are placed on the carved wings. When the first pair of wings is closed, paintings come into view depicting four scenes from the Passion of Christ and four from the Legend of St Elizabeth. The images of Christ as the Man of Sorrows and St Elizabeth assisting the poor and the sick on the second pair of wings were intended to console the inhabitants of the medieval hospital of the Holy Spirit (Ehasalu and Vahur 2013; Mänd 2019: 180–97).

Notke's project in overview: previous research, new goals and first results

The altarpiece in the Church of the Holy Spirit is well preserved, although it has been repaired and

Figure 2 The twice overpainted and partially uncovered book in the hands of St Peter's sculpture. The dates of the two 'renovations' of the altarpiece are visible. The upper left part shows the 19th-century overpainting; in the upper right part the 17th-century overpainting is revealed. The original medieval polychromy is displayed in the lower parts. (Photo: Martin Siplane.)

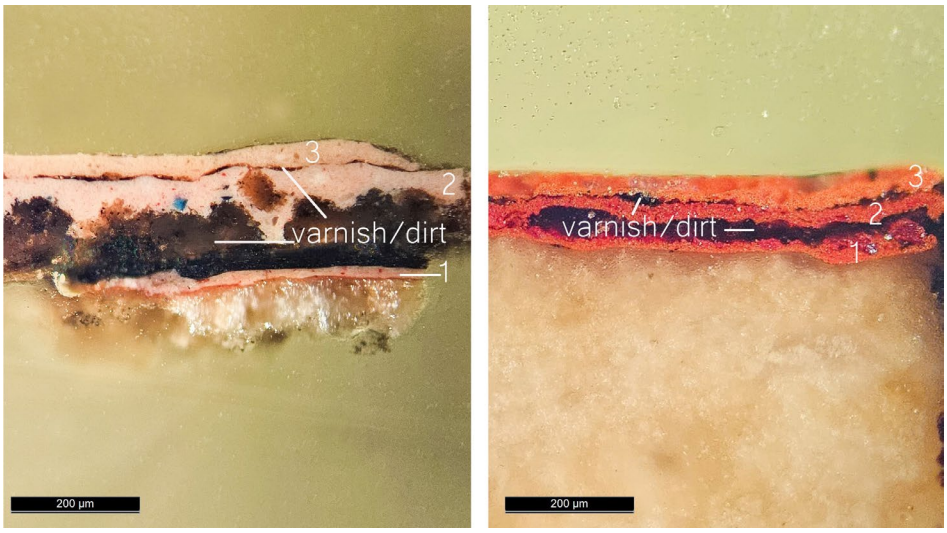

Figure 3 Three paint layers corresponding to the dates 1483, 1625 and 1815 as seen under the microscope (Leica DM2500 M): (*left*) the sample from the Virgin Mary's hand and (*right*) the sample from Philip the Apostle's red cloak. The dark layers between the paint layers show the areas of uncleaned dirt or varnish. (Cross-sections prepared and photographed by Kristina Aas.)

repainted repeatedly over the centuries. Only a few of the smaller original features are missing, most notably the dove of the Holy Spirit from the central scene. The first contemporary conservation was undertaken between 1964 and 1986 under the guidance of specialists from restoration centres in Moscow (Bregmann and Leleklova 1976). The main aim of the work was to reveal the original, exceptionally well-preserved 15th-century appearance of the altarpiece by removing later layers of overpaint. This work was not completed for political reasons (Estonia regained independence in 1991 and contacts with Russian conservation institutions were disrupted), resulting in the altarpiece's current overall grimy and uneven appearance. Minor conservation efforts were undertaken in 2001 and 2009 (Ehasalu 2010).

As this is one of the most important works of art in Estonia, not to mention internationally, researchers have been drawn to it over the course of the entire 20th century. Technical examinations on the

altarpiece have been conducted continuously since the time when conservators from Moscow worked on the retable. Data have also been published in various articles and books, but the information therein is fragmentary and primary source materials are often not available from the archives (Moltke 1970; Bregmann and Lelekova 1976; Birstein *et al.* 1978; Наумова *et al.* 1981; Ehasalu *et al.* 2009; Ehasalu 2010).

In 2019, preparations began on a large-scale project aiming to even out and complete the conservation work on the altarpiece, which had previously been launched at different times using differing methodologies but left unfinished. At the same time, comprehensive technical examination is under way to gain further insight into the materials and techniques used for creating this work, as well as the later alterations of the altarpiece.[3] In particular, it was decided to carry out an in-depth investigation into the details which could only be accessed during the course of the conservation work. Within the ongoing project the methods used include different imaging techniques,[4] pigment and binder analyses,[5] dendrochronology and geography.[6] Only results relevant to the context of this paper are discussed below.

Emergence of the so-called second master craftsman of the altarpiece

One objective of the project, besides studying the altarpiece's original state linked with Bernt Notke's workshop in Lübeck, was to shed more light on the relatively lesser-known later life of the altarpiece – the so-called post-Notke interventions. Here, the starting point of the investigation lies literally in the hands of St Peter whose sculpture holds a book inscribed with the dates 1625 and 1815 (Fig. 2). Stratigraphic examination of the paint from most of the sculptures and architectural elements revealed two layers of overpaint, which likely correspond to 1625 and 1815. Furthermore, three different blue pigments were detected by means of instrumental analyses. Azurite was found in the first layer (1483), smalt in the second (1625) and Prussian blue in the top layer (1815), which accords with the historical use of these pigments (Fig. 3). As such, the altarpiece offers an interesting insight into the changes in artists' techniques and materials over time.

In order to discover more information about those intervening masters of Notke's altarpiece in the 17th and 19th centuries, we consulted the historical accounts of relevant institutions. Although the accounts of the Church of the Holy Spirit are somewhat lacking in detail, we located a small booklet covering the years 1624 to 1626 which contains an entry in 1625 for a Pawell Blome, who was paid 284 marks for 'renovation' (the term used in the source) of the altar (Fig. 4).[7] On closer examination of the Tallinn City Archives, the name of a painter, Pawel Blome (or Paul Blum/Blom), is frequently mentioned. For example, he was paid for painting the tombstone of Dr Johannes Balliv and the weathervanes and gargoyles of the town hall but no, or very little, original polychromy is preserved from Blome's time (Ehasalu 2007: 322–3).

One of Pawel Blome's commissions was especially outstanding: in 1627 he was asked to paint full-length portraits of six Swedish kings on the facade of Tallinn's town hall, facing the main market.[8] Interestingly, the technique is even mentioned in the accounts: oil paint on a lead white ground was prescribed in the contract. There is a hint in the source that reveals the planned location of those paintings – they were to be placed between the wall anchors. Nowadays, there are five such anchors on the upper part of the wall, meaning that exactly six paintings would fit on the facade. There is no evidence of these monumental murals ever having been executed (and nothing has been preserved *in situ*), but it is known that 25 talers from a total of 150 (*c.*600 marks) were paid in advance and a certain amount of good quality linseed oil was also given to the painter.[9] This undoubtedly prestigious commission evidences that Pawel Blome was a master of some standing, but is the overpaint on Notke's altarpiece the only preserved work by him?

Interestingly, a painter with the same name was active at approximately the same time in northern Germany: a man also called Pawel Blome or Paul Blom, who worked in the region of Schleswig, is listed in the comprehensive lexicon of German artists (*Allgemeines Künstlerlexikon*) (Saur 1995: 565; Ehasalu 2007: 323). Moreover, in some local accounts he is mentioned together with the woodcarver and gilder Jürgen Blome, and a man with the same name cooperated with Pawel, also in Tallinn. Pawel Blome is last mentioned in northern Germany in 1624, the year when the same name first appears in Tallinn. Therefore, it seems plausible (although this needs further archival investigation) that it was the same Pawel Blome who moved from northern Germany to Tallinn around 1624 (Table 1).

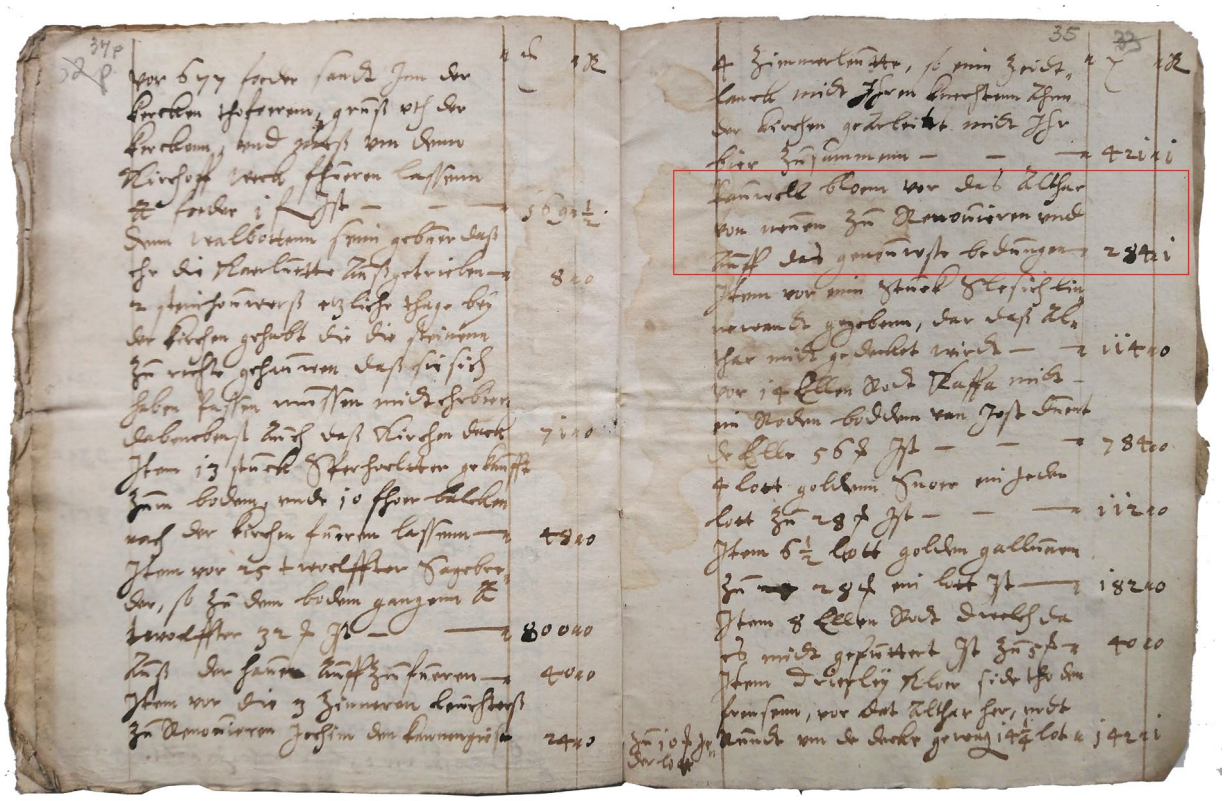

Figure 4 Account book of the Church of the Holy Spirit, which mentions the renovation of the altar in 1625 by master Pawell Blome, Tallinn City Archives. (Photo: Hannes Vinnal.)

Table 1 Two artists merging into one person: Pawel Blome/Paul Blum in German sources (*left*) and in Tallinn (*right*).

Pawel Blome / Paul Blom in Schleswig 1599–1624	**Pawel(l) Blome / Paul Blom in Tallinn 1624–1640**
1599 First mentioned in the town of Tönning **1606** In the workshop of the painter Johan Enum in Flensburg **1608** Painting of the organ panels of Garding church **1613** Paintings for the town hall in Tönning **1615** Choir and nave paintings in Oldenswort church **1615** Paintings on the organ panels of the Schwabstedt church, preserved **1618** Mentioned working in Gottorf **1621** Worked in the Tönning town hall together with the carver Jürgen Blome **1624** Paid for paintings in the choir of Garding church	**1624** Painted the door of St Nicholas' church and the tombstone of Dr Balliv **1625** 'Renovation' of the altar of the Holy Spirit **1625** Member of the Brotherhood of Blackheads, donated one watercolour painting to the brotherhood; became a citizen of Tallinn **1627** Painting of the gargoyles of St Nicholas' church **1627** Gilded and painted the weathervanes of the town hall **1628** Contracted to paint portraits of six Swedish kings on the main facade of the town hall **1633** Painting of the ball for the Viru gate's weathervane **1638** Decoration works in the gymnasium **1640** Died, buried in St Olaf's church

A somewhat odd reference from the city magistrate's archives may shed further light on Pawel Blome's origin. In 1638, Pawel Blome accused Lüdert Heistmann (Heissmann), a woodcarver in Tallinn, of insulting him by openly calling him a 'French dog' during a wedding party which got out of hand.[10] This may refer to his roots in French-speaking Netherlands or from the French Huguenots. It could place him in the context of the greater migration of artists and craftsmen to the north and Baltic Sea region, from west to east, particularly in the second half of the 16th and early 17th century due to the Eighty Years' War (North 2021; Ancane 2022). If the assumption holds true that the German Pawel Blome is the same person who overpainted Notke's altarpiece, we might even have four preserved paintings by him. In 1615 he was paid for painting the panels flanking the new organ in the parish church of Schwabstedt in Schleswig. These panels, depicting four Muses of Music (Saur 1995: 565), still exist in their original location in the village of Schwabstedt.

There might be another addition to Blome's oeuvre: the paintings on the pulpit of St Nicholas' church in Tallinn, previously attributed to an otherwise

unknown master Daniel Blome (Kangropool 1994: 126), were probably also works by Pawel Blome.[11] The mistake possibly derives from the misspelling of the visually very similar names in old German fonts – Daniel and Pawel. Pawel Blome worked in St Nicolas' church in 1624 together with Jürgen Blome, the contract for this work being listed in the latter's inventory in 1626 (*Contract wegen d Cantzell zu S. Nicolaus*), so it is possible that this commission brought Pawel Blome to Tallinn in the first place.[12] Unfortunately this richly carved and painted artwork was destroyed during the bombing of Tallinn in 1944.

From the viewpoint of local history, Pawel Blome initiated an important change in the organisation of craft guilds in Tallinn. Notably, he raised the claim against Tallinn's woodcarvers, accusing them – especially the well-known woodcarver Tobias Heinze (Heintze; *c.*1593–1653) – of painting their own carvings. In his complaint to the town council, Blome declares that they do it poorly and 'grab the bread out of the painter's mouth'.[13] We know that Heinze's woodcarving workshop did indeed have a 'bad habit' of painting his own works. For example, he completed the 'renovation' of another medieval altarpiece, the so-called 'Brussels altarpiece' and signed it similarly to Blome in the carved book in St Paul's hands (Tigane 2000: 129). As a result of this quarrel, the painters' guild separated from that of the woodcarvers in order to protect their profession more effectively. The long-lasting argument between Pawel Blome and Tobias Heinze is a textbook example of the so-called *Nahrungsschutzkonflikt* – a term from the older German historiographical discussion – typical for organisations of crafts in the early modern period (Cilleßen and Tacke 2020).

Now we know that for a newcomer in Tallinn, Pawel Blome achieved remarkable success in his career as a painter and leading guild member. From the inventory of the possessions of his widow, we learn that the family owned a big stone house in Tallinn (Lai Street 33). Lawyer Johann Friedrich Blome, an heir to her possessions, was probably Pawel's son,[14] allowing him to send at least one of his sons to university. Interestingly, both of his great commissions (the pulpit of St Nicholas' church and the paintings on the town hall walls) were bestowed by the renowned nobleman Bogislaus von Rosen (1572–1659), which probably suggests some kind of close relationship between the artist and his wealthy patron.

In conclusion, the newly uncovered secondary master of Notke's altarpiece – Pawel Blome – played an important role in Tallinn's history. His story represents the cultural exchange in the Baltic Sea region as well as tensions and cooperation in the institutional framework of the early modern craft guilds. However, the date of 1815 in the book of St Peter remains an enigma, at least for the time being, as no archival material could be found about this overpainting. This situation illustrates the importance of written sources for the understanding and evaluation of artworks as well as for conservation decisions. How do these findings influence ongoing conservation and documentation practices? Should we consider layers of these greater and lesser artists of different times as equally important from the conservation point of view? Can we do it without compromising the visual integrity of the artwork?

Dilemmas arise: conservation decisions and practice in between the two masters

The altarpiece and its sculptures were restored by Russian conservators during the Soviet period in 1964–1986. As previously mentioned, the conservation projects at that time came to a very sudden halt therefore three sculptures and some parts of the altarpiece remained unfinished. Unfortunately, no complete documentation of the works was made available to Estonia, and given the current poor bilateral relations, there is little hope of receiving any in the near future. Researchers have had to rely on the fragments of information in a few published articles (Bregmann and Lelekova 1976; Birstein *et al.* 1978; Наумова *et al.* 1981) on similar projects conducted around the same time, and memories of colleagues active at that time. Piecing together this puzzle presented only a vague notion of the materials and techniques that Russian conservators might have used.

Therefore, it is the visual observation and documentation of the altarpiece itself that provides a more complete picture of the works undertaken previously. An extensive on-site survey was carried out on the altarpiece and the sculptures in the autumn of 2021 (Aas 2021). Importantly, all parties – conservators, art historians, heritage authorities and the church community – were directly involved in the research. Not only was this highly advantageous to understanding the material and the problems involved, it also provided the opportunity to hold immediate discussions and devise solutions. The conservation

Figure 5 Three faces of the Virgin Mary (*left to right*) from the 15th, 17th and 19th century (after, during and before conservation treatment). (Photos: Martin Siplane.)

concept and methodology was developed in synergy during the on-site survey.

Visual observation was supported by various studies: the altarpiece and the entire chancel of the church were measured and georeferenced using laser scanning and a three-dimensional photogrammetric model of the altarpiece was produced. These are all of immense value in documenting the condition of the object as well as for the future presentation of the altarpiece and its sculptures to the public.[15] To study the sculptures' structure, the mechanisms for fixing them to the corpus and later repairs, X-ray examinations were conducted in cooperation with Estonian Tax and Customs Board specialists. In addition to the X-ray images taken on-site, we succeeded in transporting the figure of the Virgin Mary to the Estonian Forensic Science Institute where experiments to X-ray medieval wooden sculptures using computer tomography were conducted for the first time in Estonia. The result was an excellently captured three-dimensional X-ray image in which the metal elements within the sculpture, the distinctive features of the figure, and the use of pigments containing metals on the sculpture's surface became discernible. Examination of paint layers and determination of pigments, conducted in cooperation with the Estonian Centre for Environmental Studies and the Institute of Analytical Chemistry, University of Tartu, provided preliminary insights into the materials used in the original work and the later restoration layers.

In the spring of 2022, conservation work began on the first sculpture, the Virgin Mary. During previous, unfinished restoration efforts in the 1980s, which aimed at the full uncovering of the initial 15th-century polychromy, this sculpture was not cleaned and later paint layers were not removed. The sculpture of the Virgin was extremely grimy: cleaning samples and preventive facings in various areas disrupted its already uneven appearance. For example, there was an extensive overpaint removal sample on the right side of the Virgin's face which clearly showed three different paint layers: the original from the 15th century, the Pawel Blome layer from the 17th century, and the 19th-century layer.

Following thorough documentation of the sculpture's condition, a concept for the conservation work was formulated: to uncover the first (Notke's) layer. The near excellent condition of the original layer on the other sculptures gave hope and confidence that the Notke layer on the Virgin Mary would also be well preserved. Therefore, the first and very time-consuming stage of conservation involved removal of the secondary paint layers, which could only be done mechanically with a scalpel under a microscope with multiple magnifications.

One intention outlined in the conservation plan was to document the 1625 overpainting by Pawel Blome. At the time of this conservation, Pawel Blome's name was already known, but his significance in Estonian art history was not yet fully understood. Initially, it was planned to document Blome's overpainting using imaging techniques and paint analysis on a lesser scale. As the work progressed, however, it became apparent that the paint layers were separating relatively easily, leading to the decision to fully expose the 17th-century layer on Mary's face, enabling the layer's complete documentation (Fig. 5).

Figure 6. Photogrammetric 3D model of the figure of Philip the Apostle after conservation. (Photos and model: Andres Uueni.)

Despite the thorough analytical documentation and visual recording of the 17th-century paint layer, it was emotionally and mentally challenging for the conservator to start removing this historical layer. However, several arguments supported the removal of secondary paint layers. First, the initially formulated conservation concept – to reveal the 15th-century original layer – relied on the practice of the previous conservation works in the 1980s. More than 20 sculptures in the altarpiece had been treated in this way, therefore the conservation concept had essentially been decided decades ago. The Virgin Mary is central in the altarpiece's composition so within the context of a church with an active congregation, it would be challenging to find a justification for retaining the existing layers. In its present position, the sculpture is a sacred object in liturgical use, not a museum piece. The congregation values the visual integrity of the altarpiece and does not wish to see Mary's face cut by paint removal samples. Secondly, the bond between the 17th-century paint layer and the lower layer was extremely poor in some places. An uneven and in some areas very thick layer of varnish and dirt had been left between the two paint layers, disrupting the contact surface between them (Fig. 3). As a result, during removal of the 19th-century layer, several losses occurred in the 17th-century paint layer: the top layer stuck firmly taking the lower layer with it. Thirdly, the original 15th-century layer has been extraordinarily well preserved, with minimal losses and damage. The second stage of conservation involved cleaning the gilded areas of the sculpture: unlike the face and hands these had never been overpainted. The

conservation work was completed in the winter of 2022 and the Virgin Mary returned home just before Christmas.

In October 2023, conservation work began on the second sculpture, Philip the Apostle. By that time, the importance of Pawel Blome in Estonian art history had been recognised. This new knowledge has added even more emotional weight, increasing the difficulty of the conservator's task. Conservators, already overwhelmed with deadlines and the pressure of responsibility, face additional challenges with each new discovery, often dealing with complex ethical dilemmas such as deciding how much intervention is appropriate. In this particular case, the problem was how to remove the physical evidence of the only work definitively attributed to Pawel Blome in Estonia. Although decisions are made collaboratively – utilising the expertise of conservators, art historians and other stakeholders involved in the preservation of cultural heritage – the act of physical and irreversible intervention rests solely with the conservator. Consequently, even minor mistakes can engender significant impacts and decisions can lead to criticism. To deal with these emotional and mental challenges, conservators rely on strong support networks within their professional community. It is essential to have the opportunity to reflect and discuss the ethical and emotional dimensions of conservation work.[16]

For Philip the Apostle, taking into account all the points above, an alternative conservation approach was chosen and implemented. Philip is positioned sideways in the central shrine of the altarpiece, consequently only half of the sculpture's face is visible to the viewer. This enables us to keep the overpainted layers on the side not visible to the viewer with the secondary layers removed only from the visible side. This approach ensures the preservation of all the secondary layers, including the top oil paint layer dating back to the 19th century, and provides the opportunity to retain the physical evidence if and when the author or other information about the top paint layer is discovered (Fig. 6).

However, it is inevitable that the approaches taken in every conservation project will raise new questions. In most cases, there is no single correct answer: several values (visual, physical, historical, etc.) have to be balanced simultaneously on the scales of decision-making. Can cleaning only half of the sculpture's face be justified? For example, how does it affect the aging of the paint layers in the future? Or does it already face different environmental forces and impacts, given the fact that half of the face is hidden from direct light anyway? Although methodologies have been developed to tackle such problems,[17] the final decision remains unavoidably subjective to a certain degree and may produce unintended consequences in the future.[18]

Conclusion: conservation decisions in dialogue with archival research

The case of Bernt Notke's altarpiece in Tallinn raises many intriguing questions for both historians and conservators alike, such as how to deal with the situation when alongside the removal of secondary paint layers, archival research reveals historical significance and contextual information about 'undesirable' additions. The case of Notke's altarpiece exemplifies the importance of a written source – not only for (art) history but also for the practice of conservation. Bringing together historical archives and the conservation studio has proved to be illuminating and beneficial for both sides. In addition to Bernt Notke, an established name in art history, there is another signature attached to the altarpiece: that of the early 17th-century painter Pawel Blome. Whose story should be told through this magnificent historic artefact? Is it the story of a great medieval master and his workshop in Lübeck or that of artist migrations and the quarrel between painters' and woodcarvers' guilds in 17th-century Tallinn? Or can it be both?

In this case, the comprehensive documentation, technical analysis and visual recording of the 17th-century paint layer provided the assurance the conservator needed to remove it and thereby reveal the original. However, the archival findings and re-evaluation of this 17th-century painter did result in changes to the conservation concept. The initial plan was to document Pawel Blome's 17th-century overpainting using imaging techniques and paint analysis on a lesser scale, but this morphed into the decision to fully expose the 17th-century layer on the Virgin Mary's face and enable the layer's complete documentation. However, the conservator's ethical and emotional concerns over removal of historical material remained. Philip the Apostle's position made it possible to keep the overpainted layers on the side not visible to the viewer, the secondary layers being removed only from the visible side, an approach that ensures the preservation of all the secondary layers for further research.

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Notes

1. The dimensions of the altarpiece with wings open are 360 × 364 cm.
2. Tallinn City Archives, TLA.230.1.Bl, p. 1a; 44.
3. See the conservation and investigation reports: Aas 2021 and Estonian Academy of Arts 2022.
4. X-ray, near-infrared photography (NIR; 720–1060 nm), ultraviolet fluorescence (UV-A; 360–390 nm), documenting both in 2D and 3D.
5. Using polished cross-sections in incident and ultraviolet light, optical microscopy, portable X-ray fluorescence (pXRF), attenuated total reflection-Fourier transform infrared spectroscopy (ATR-FTIR), scanning electron microscopy-energy dispersive X-ray spectroscopy (SEM-EDS), pyrolysis-gas chromatography-mass spectrometry (py-GC-MS).
6. The initial results are published in Aas *et al.* 2023.
7. Tallinn City Archives, TLA.230.1.Bl 20, p. 35.
8. Tallinn City Archives, TLA.230.1.Ba 53, p. 60r.
9. *Ibid.*
10. Tallinn City Archives, TLA.230.4-I.6, folio 2, p. 109.
11. Sten Karling suggested in 1937 that Daniel and Paul (Pawel) Blome (Blume) were brothers and worked together on the pulpit (Karling 2006 [1937]: 130). However, he does not mention the source of his claim. See also Ehasalu 2007: 52.
12. Tallinn City Archives, TLA.230.1.Bt 9/III, p. 4.
13. Tallinn City Archives, TLA.230.1.Bf 33 III, p. 46.
14. Tallinn City Archives, TLA.230.1.Bt 11, p. 129.
15. See the project's webpage https://notke.eu/en/.
16. On the complexity of the ethical issues see Muñoz-Viñas 2020.
17. See for instance decision-making models based on value assessments in Appelbaum 2007 and Richmond and Bracker 2009.
18. Conservation works are presently in progress (March 2024).

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Use of a Treatment Option Diagram for ethical considerations and risk assessment related to the treatment of Rembrandt's *The Night Watch*

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ABSTRACT In July 2019, the Rijksmuseum launched Operation Night Watch, the largest and most wide-ranging research and conservation project in the history of Rembrandt's 1642 masterpiece. The overarching goal of the project is the long-term preservation of the painting. After two years of research, in the spring of 2021, a first Treatment Decision Document was compiled, which presented three treatment options. Based on this document, in the summer of 2021, the Steering Committee decided to first proceed with a structural treatment, which was considered urgent. This was conducted successfully at the beginning of 2022. This paper discusses the ethical considerations and risk assessment during a second decision-making process regarding the treatment of the pictorial layers of *The Night Watch,* which took place in the autumn of 2022. During team discussions a Treatment Option Diagram was developed to organise and structure the results from all the scientific research as well as the ideas and opinions of the large group of paintings conservators and other specialists involved. The diagram describes three different treatment options for the painting, listing pros and cons under each option. Using this diagram, the conservators were able to draft an informed and well-balanced advice on further treatment. This paper aims to give an insight into this process and document the ethical considerations, risks and associated advantages and disadvantages that were discussed regarding the complex treatment of a large painting in the public eye.

KEYWORDS *The Night Watch*, Rembrandt, Treatment Option Diagram, ethical considerations, risk assessment

Introduction

In 1642, Rembrandt painted *The Night Watch* (410 × 485 cm) for the great hall of the arquebusiers' civic guard headquarters (Kloveniersdoelen in Dutch) in Amsterdam (Fig. 1).[1] The hall contained five other large group portraits of militiamen and one group portrait of the governors of the Kloveniersdoelen. What makes Rembrandt's *The Night Watch* so unique as a militia piece is the implied action in the painting – the group seems on the verge of marching – as well as the innovative play of light and dark.

In July 2019, the Rijksmuseum launched Operation Night Watch, the largest and most wide-ranging research and conservation project in the history of Rembrandt's iconic masterpiece.[2] The overarching goal of Operation Night Watch is the long-term preservation of the painting. The three main research topics are: (1) characterising Rembrandt's painting technique and materials and their distribution within the painting; (2) documenting the condition of the painting by identifying past and ongoing degradation processes, with the goal of understanding their origin and preventing future recurrence; (3) developing a research-based, well-founded conservation treatment plan. Given the importance of *The Night Watch* to the Rijksmuseum's visitors, a glass enclosure was built around the painting in the Night Watch Gallery, allowing them to see the painting during the project (Fig. 1). Operation Night Watch brings together a large team of not only conservators, scientists, photographers, curators, engineers

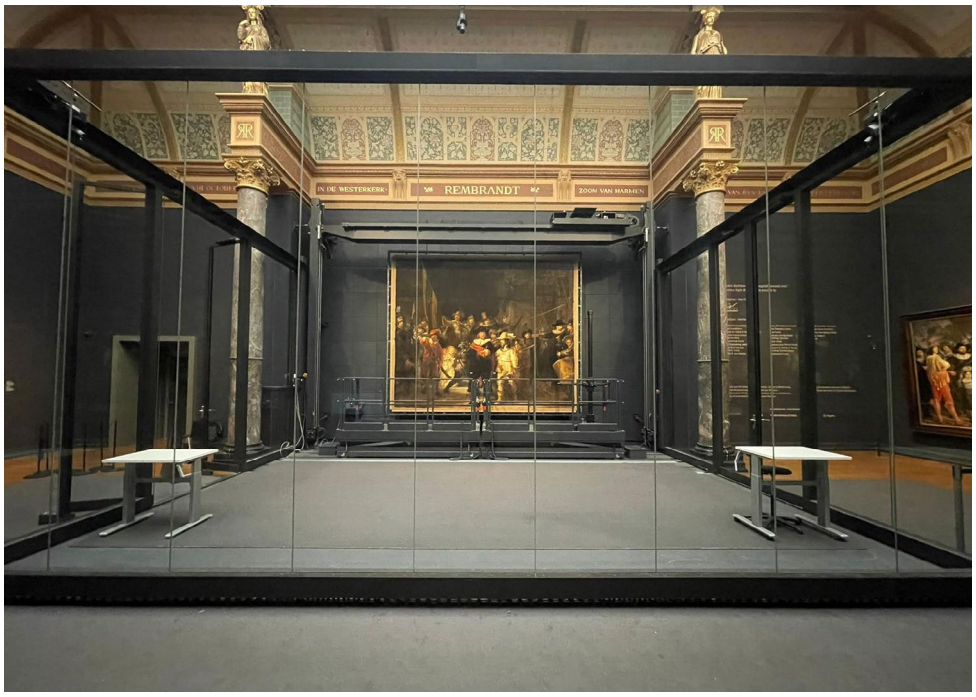


Figure 1 Image of *The Night Watch* in the former glass enclosure, March 2023. (Photo: Rijksmuseum.)

and several external research partners, but also other museum departments such as exhibitions, public and education, art handling, security, building management and maintenance, research services, development, and communication and marketing. The final responsibility and decision-making authority lies with the Steering Committee that supervises Operation Night Watch.[3] Additionally, the research and treatment of *The Night Watch* are guided by an Advisory Committee that comprises several (inter) national specialists from the conservation, science and curatorial fields.

After two years of research, in the spring of 2021, a first Treatment Decision Document was compiled, which presented three treatment options and included various tree diagrams and flowcharts to explore the numerous steps and decisions that would form part of each treatment option (Noble *et al.* 2023: 211–3). Based on this decision document, in the summer of 2021, the Steering Committee decided to first proceed with a structural treatment, which was considered urgent. This took place at the beginning of 2022. This paper discusses the ethical considerations and risk assessment during a second decision-making process for the treatment of the pictorial layers of *The Night Watch*, which was carried out in the autumn of 2022. During team discussions, a Treatment Option Diagram was developed in order to organise and structure the ideas and thoughts of the large group of paintings conservators and other specialists involved (see the Appendix).[4] Using this diagram, advice on further treatment of *The Night Watch* was formulated and incorporated into a larger Decision and Strategy Document, which also took into consideration a range of factors related to other museum departments. The Steering Committee used this document to reach a decision.

The aim of this paper is to give insight into, and to document the ethical considerations, risks and associated pros and cons that were discussed regarding the complex treatment of a large painting in the public eye. This would not have been possible without the participation of all project team members; the collaboration between conservators, scientists and curators was especially fruitful. This paper underlines the importance of collegial collaboration and frank, open discussions with everyone involved.

Conservation history of *The Night Watch*

The Night Watch has an exceptionally well-known conservation history of at least 31 documented treatments, which helps to explain its current condition (Van Duijn and Filedt Kok 2024: 268–303). With the only exception of the Second World War, the painting has remained in Amsterdam for most of its lifetime. However, its existence has been far from uneventful. In 1715, in preparation for its new location in the town hall, the painting was trimmed along all the sides – most prominently on the left – in order to fit it on

Figure 2 During varnishing of *The Night Watch,* 1976. (Photographer: Bert Verhoeff, collection Anefo. Photo: National Archive, The Hague.)

a wall between two doors. It was glue- or starch-lined at least once and wax-resin lined three times.[5] The painting was exposed to numerous varnish-related treatments, including six Pettenkofer regenerations, the removal of old varnish layers and the addition of new varnishes (Van Duijn 2021: 138–51). *The Night Watch* was also victim of a carpenter's accident at least twice: on one occasion in the second quarter of the 19th century and the other in 1901. Additionally, the painting was vandalised three times: in 1911, 1975 and 1990. The rich conservation history combined with the unusual oil preparation layer (Broers *et al.* 2023) and complex paint mixtures used by the artist has had a significant effect on the painting's current condition, resulting in various types of mineral-rich crusts and hazes, as well as severe abrasion and craquelure of the paint layers (Gonzalez *et al.* 2023).[6]

The last extensive treatment to the painting followed the knife attack in September 1975, when the painting was slashed 12 times. The treatment consisted of de-lining, tear mending, the third wax-resin lining, and subsequent removal of old varnishes and retouches. This was followed by the application of new varnish layers containing dammar resin mixed with a small amount of poppyseed oil, and new oil-based retouches (Fig. 2).[7] The two-month timeframe for the application of new retouches was exceptionally short, which meant that only the most obvious damages – those incurred from the knife cuts and the most visible areas of abrasion, for example, in the faces – were addressed.

Treatment Decision Document (2021)

Operation Night Watch is divided into two phases. During the first phase that took place between 2019 and 2021, scientific investigations were carried out using a wide variety of research techniques including analytical and imaging techniques at the macro- and microscale and computer science. The results of this phase addressed the three research questions and subsequently helped to define and guide the second phase, which involves the conservation treatment of the painting. After the research phase, in the spring of 2021, a first Treatment Decision Document was drafted and shared with the Steering Committee (Noble *et al.* 2023). This included decision tree diagrams for both structural treatment and varnish removal, incorporating the results of varnish removal tests that had been executed during the research phase. The Treatment Decision Document presented three options: (1) no treatment, preventive conservation; (2) structural treatment; (3) full treatment[8] that included both structural treatment and restoration to improve the visual appearance of the painting. Guided by this document, the Steering Committee decided to start with the structural treatment, the second option in the document, which was characterised as urgent. This choice allowed for the possibility of following with a treatment of the pictorial layers, which was marked as desirable.

Structural treatment

The structural treatment was deemed urgent because deformations had developed in the canvas support over the past decades. These were a result of the unevenly distributed tension of the canvas on the heavy wooden stretcher, which dated from the 1975–76 treatment. Additional research was carried out in the autumn of 2021 to address the risks involved in the proposed structural treatment. This showed that there was no need to replace the wax-resin lining from 1975 as the adhesion between the original canvas and the lining canvas was still good (Tao *et al.* 2023). However, the tensioning of the support was no longer sufficient. To create a uniform, even tension, and to reduce the deformations in the canvas as much as possible, the decision was taken to replace the stretcher and method of attachment of *The Night Watch.* A new aluminium strainer and a spring system was chosen, which enabled re-tensioning of the painting with a more evenly distributed, known tension.[9] Additionally, the spring system can be connected to sensors, allowing the tension to be monitored. After the structural treatment of *The Night Watch*, which was executed in the galleries between January and April 2022, the deformations were successfully minimised and the canvas was re-tensioned with significantly more evenly distributed tension.[10]

Salt-rich varnish remnants

After the structural treatment further varnish removal tests were considered necessary to evaluate the treatment of the pictorial layers of *The Night Watch.* In some of the earlier tests conducted during the research phase, varnish remnants predating the 1975–76 treatment were found (Raven and Smelt 2021) (Fig. 3). In the second half of 2022, it was decided to conduct more research into the nature and extent of these remnants. Additional paint samples were taken, extra varnish removal tests were carried out, and an international expert day was organised on the formation and treatment of metal salt crusts on paintings.[11] Research showed that the old varnish remnants found contain insoluble lead- and calcium-rich salts embedded in a matrix of degraded natural resin and oil. The cross-sections investigated show that the varnish

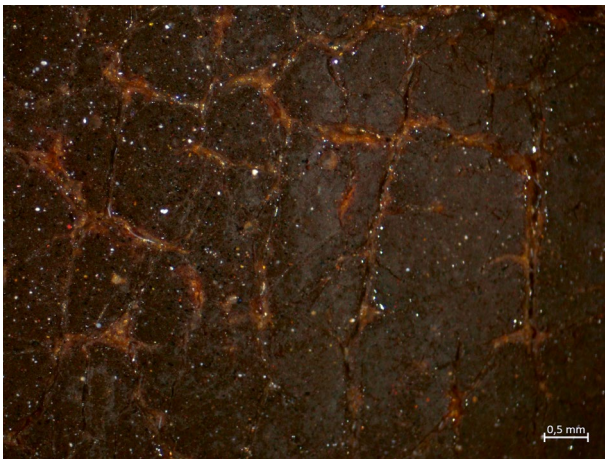


Figure 3 Microscope image of a varnish removal test area, centre left edge of the painting. On the right side of the photograph the obscuring salt-rich varnish remnants are still present; on the left they have been removed. (Photo: Rijksmuseum.)

remnants are not intimately bound to the paint: on the painting they appear as small islands, with a green fluorescence in UV. They are located directly on top of the paint, visually obscuring the layers underneath. Unfortunately, the location of these salt-rich varnish remnants can only be identified *after* removal of the varnish layers applied in and after 1975–76. This means that prior to varnish removal there is no way of knowing the extent of their presence on the painting. The initial varnish removal tests showed that – although very time-consuming – the salt-rich varnish remnants could be removed safely using a gel system. This does not necessarily mean that they can be safely removed in all locations of the painting.

The salt-rich varnish remnants should not be confused with paint crusts of calcium or lead salts, which are also found extensively, for example in the dog and the rosette of the shoe above the dog's head. Contrary to the salt-rich varnish remnants, these crusts are an integral part of the original paint layers and cannot – and should not – be removed (Gonzalez *et al.* 2023).

Treatment Option Diagram (2022)

Parallel to and informed by the research into the salt-rich varnish remnants, the conservators used the second half of 2022 to conduct broader ethical discussions regarding further treatment of *The Night Watch*. During semiweekly meetings, the ethical considerations and risks were discussed by the

entire team of conservators and scientists involved. To facilitate these complex discussions, a Treatment Option Diagram was created in which the ethical considerations, risks and associated pros and cons were recorded. In this diagram, three options were presented (see the Appendix):

- Option 1: no further treatment – finalising the structural treatment, monitoring and further research;
- Option 2: partial treatment – application of new retouches and varnish over old restoration layers;
- Option 3: full treatment – removal of old varnish (remnants), retouches, fillings and application of new fillings, retouches, and varnish.[12]

Arguments were listed in favour of (pro, in green) and against (con, in red) each option. They were then ranked democratically in order of importance and those that the team felt most compelling were indicated in bold. Risks to the painting were listed as cons. The risks described in all three options were categorised into three types: those commonly associated with the treatment of 17th-century Dutch paintings; those associated with the treatment of large paintings in general; and risks associated with *The Night Watch* in particular. This subdivision was made to further organise the risks involved to weigh their significance. It is important to be aware that the value ascribed to the given arguments remains subjective. Underneath the pros and cons of options 1 and 3, consequences were added that were not part of the substantive discussion, but related more indirectly to the work of conservators. In this paper we follow the exact order and phrasing of the arguments as they are presented in the Treatment Option Diagram.

The second option – partial treatment – quickly turned out to be the least viable for the conservators, the main reason being that the addition of new retouches and varnish over old restoration layers would distance the viewer further from the original appearance of *The Night Watch*. The result of matching saturation, gloss and colour of new retouches on top of old varnish layers and discoloured old retouches would never be optimal, while the time required would still be substantial. The result was also expected to be short-lived, since the old restoration layers would eventually cause new variations in saturation, gloss and colour due to differences in aging. In this paper, therefore, we focus on the first and third options.

Option 1: No further treatment

Although the first option is described as 'no further treatment', this would not mean that Operation Night Watch would end immediately: it was estimated that another two years would be needed to finalise and process all previous research and set up a monitoring protocol for the painting. The arguments listed under option 1 can be roughly divided into avoidance of risks related to conservation treatment on the pro side, and continuation of aesthetic problems or risks on the con side. It should be noted that all pro and con arguments of option 1 are also listed under option 3 but reversed and sometimes worded differently to clarify varying nuances.

The most important reason in favour of this option was that further treatment would not be necessary for the overall stability of the painting. The condition of *The Night Watch* after the structural treatment is stable. Another reason was that by not removing the post-1975 varnish layers and older remnants, not only would the cleaning cycle (i.e. the period between the use of solvents to clean a painting) be extended, but all risks associated with solvent exposure, mechanical action and the use of gels (such as leaching, swelling, solvent transportation, pigment loss, triggering of chemical degradation processes, and leaving behind gel residues on the paint surface) would be avoided.

Additionally, when choosing option 1, there would be no risk of triggering chemical degradation processes in the paint layers from exposure to relatively high amounts of lux and UV emitted by the conservation lighting necessary for the treatment.[13] This is especially relevant for *The Night Watch* as research has shown that Rembrandt used light-sensitive pigments, such as red and yellow lakes, Kassel earth, vermilion and pigments containing arsenic sulphides (De Keyser *et al.* 2024).[14] Finally, by not treating the painting, no historical conservation material would be lost.

The first two arguments *against* option 1, i.e. no further treatment, relate to the current appearance of the painting. The paint layers of *The Night Watch* are to a greater or lesser extent abraded or otherwise damaged. These areas have been retouched partially, very broadly, or not at all, and often the retouches have also discoloured. By choosing not to treat the painting now, these different areas would remain, discolour further and thus continue to impair the legibility and appearance of the painting.[15] This can be illustrated by the face of the left musketeer in

red, where bright red retouches covering original paint can be seen, as well as many abraded areas where the brown-coloured ground has become visible (Fig. 4). By choosing not to treat the painting, areas such as these would remain. A similar type of counterargument concerns the post-1975 varnish layers and the underlying salt-rich varnish remnants. The post-1975 varnish layers have a milky grey appearance, while the older varnish remnants are brownish and uneven in nature. When choosing option 1, these layers would continue to impair the legibility and appearance of the painting.

By not treating the painting, however, new risks could also emerge, as described in the last two counterarguments listed under option 1. Not removing the aging varnish layers and oil-based retouches entails risks associated with the treatment of 17th-century Dutch paintings in general. These layers will continue to discolour and become less soluble over time. This argument is even more pertinent and specific to the *The Night Watch* since the varnishes applied in and after 1975 contain, besides natural resins, 9% poppyseed oil, making the aging characteristics less predictable. The risks related to leaving the salt-rich varnish remnants on the paint surface are also specific to *The Night Watch*: increased insolubility and adherence of the remnants could make them more difficult to remove, which is especially problematic in combination with the vulnerable paint surface. There is also a possibility that over time they will become more visible under the post-1975 varnish layers. However, the time path and probability of these risks is unknown, making it hard to predict when full treatment will become urgent.

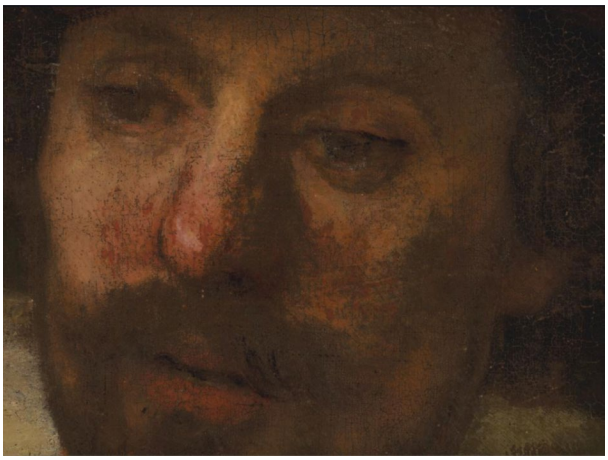


Figure 4 Face of the musketeer in red (Jan van der Heede) with discoloured red retouches covering original paint, as well as many abraded, unretouched areas where the brown coloured ground has become visible. (Photo: Rijksmuseum.)

Option 3: Full treatment

The arguments for and against the third option, full treatment, can be divided into the same categories as for option 1 but reversed. The arguments in favour of option 3 mostly concern improving the visual appearance of the painting, whereas those against mainly concern the risks associated with full treatment. The two most important reasons in favour of full treatment are related to bringing *The Night Watch* closer to Rembrandt's original intention (Muñoz Viñas 2020: 63–85).[16] First, meticulous new retouching of the numerous areas that are currently retouched partially, very broadly or not at all would significantly improve the legibility and appearance of the painting. Secondly, removal of the old varnish layers and the application of new varnish layers would substantially enhance its legibility and appearance. This, however, also depends on the extent and degree to which the salt-rich varnish remnants can be removed. As explained previously, the extent to which these remnants are present and/or can be removed is not fully known, complicating proper assessment of their risks. Another argument in favour of further treatment is that by using stable conservation materials, the future cleaning cycle of the painting will be extended. This could be seen as the counterpart of the second pro argument listed for option 1 (not removing varnish now extends the cleaning cycle). By choosing full treatment now, *The Night Watch* may not need treatment until well into the future, therefore lengthening the next cleaning cycle.

Additionally, several arguments listed in favour of full treatment relate to the *removal* of old retouches and varnish (remnants). First, removal of broadly applied old retouches, the thick border of overpaint along all edges and fillings will uncover original paint. Subsequently, removal of the salt-rich varnish remnants will reduce risks such as their increased insolubility and adherence to the paint surface, as well as future saturation problems. Removal of the remnants is desirable for optimal retouching and saturation of the paint layers with new varnish. The last argument related to the removal of old retouches and varnish (remnants) is the desirability to remove the post-1975 varnish layers and oil-based retouches as they will continue to discolour and become less soluble. The final argument in favour of continuing with full treatment concerns timing: the knowledge

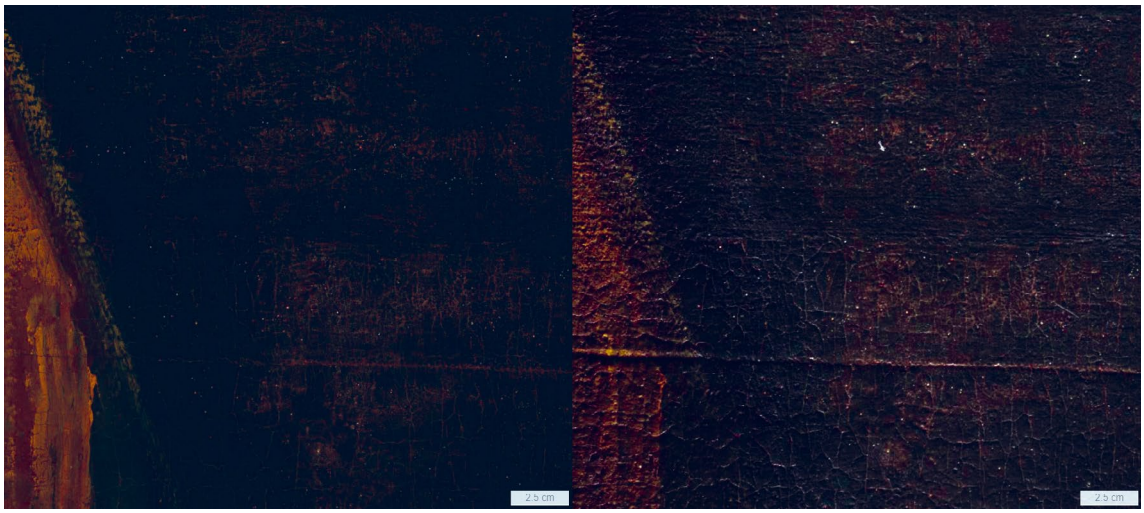


Figure 5 Abrasion (*left*, visible light) and cracked paint *(right*, raking light) in the background next to the flag. (Photo: Rijksmuseum.)

gained thus far during Operation Night Watch forms a solid foundation for further treatment.

All arguments listed as cons for option 3, full treatment, involve risks associated with varnish removal from solvent exposure and mechanical action (e.g. leaching, swelling, solvent transportation, pigment loss and triggering of chemical degradation processes), which conservators always face during this type of treatment. They are generally considered acceptable when weighed against the expected results, i.e. an improved visual appearance achieved by removing the discoloured varnish layers that have lost the ability to saturate the paint layers. In the case of *The Night Watch*, which has been treated so many times and consequently has a relatively damaged paint surface, it is especially important to take these risks into consideration (Fig. 5).

Most of the risks listed as cons for option 3 are specific to *The Night Watch* and relate to the salt-rich varnish remnants. As stated above, the extent and location of these remnants is largely unknown since they cannot be localised without removing the post-1975 varnish layers. Apart from being identified in one varnish removal test area, the remnants were also found in several paint samples taken from the highly abraded black costume of Captain Banninck Cocq and in the background around the main figures. It is desirable to remove the old varnish remnants to the extent possible as they obscure the paint surface and reduce contrast. This would also permit optimal retouching and saturation of the paint layers with a new varnish. However, their removal also subjects the painting to more solvent exposure and mechanical action, as this can only be done using a gel system which may need several rounds of rinsing using cotton swabs. This poses further risk of paint loss from the broken-up paint surface of *The Night Watch*. An additional risk associated with the use of gels is the unknown long-term effect of leaving gel residues (microscale) behind on the strongly abraded and cracked paint surface. In current international conservation practice, gels are used regularly despite this uncertainty.

Even though varnish removal tests, executed in one area, have shown that the salt-rich varnish remnants can be removed with a gel, we do not know if this will apply to all locations: some remnants may need to remain on the surface, which poses further risks. One of these risks is that by partially affecting the varnish remnants with solvents, their visibility could increase, and potential removability problems could occur in the future. Another issue if these remnants are left behind is that they will be hard to saturate with new varnish – even if they can be initially saturated, they may become more visible and/or whitish over time. Additionally, in these areas, lines could become visible on the paint surface from the use of abutting sheets of Evolon CR that will be used for the removal of the post-1975 varnish layers (Baij *et al*. 2021).[17] Once formed these lines can be hard to remove visually, especially in areas containing salt-rich varnish remnants.

Additional risks listed under option 3 are specific to *The Night Watch* and relate to its size, current location and the nature of a large and complex project such as Operation Night Watch. Collaborating with a large team of conservators challenges the uniformity of the results. A highly systematic approach to the treatment, well-organised supervision and communication during the process are essential to ensure

its success. The next argument against full treatment is that prolonged exposure to high levels of lux, UV and warmth from microscope lights, needed for the research and treatment, will accelerate chemical degradation processes in the paint layers.[18] Another risk relates to the high accumulation of dust in the glass enclosure as it was in 2022 due to the large number of visitors in the Rijksmuseum, but especially in the Night Watch Gallery.[19] This means that during treatment, the unvarnished, locally fragile paint surface will need dusting regularly with a subsequent small risk of paint loss.

The last risk mentioned as a counterargument for option 3 is that by not treating the painting, no historical conservation material will be lost. Because loss of this type of material is inevitable when pursuing full treatment, it is mentioned here as a con. However, it could be argued that when continuing with full treatment, it would be possible to identify, study and document the traces of historical conservation materials which could make this argument also worth mentioning as a con for option 1 or even as a pro for option 3. Although these arguments are not included in the Treatment Option Diagram, they are mentioned here to indicate the complexity of the discussions that took place.

Consequences as described in the Treatment Option Diagram

During team discussions, certain points recurred that were not part of the substantive argumentation. Although these were not actual arguments in favour of either option 1 or 3, they were deemed important enough to be included as 'consequences' at the bottom of the Treatment Option Diagram. Some of the consequences can be mitigated by proactive measures (see the 'Decision and Strategy Document' section below).

For option 1, no further treatment, both consequences listed under the pro arguments were related to time. Further treatment of *The Night Watch* will be a multi-year project involving almost the entire Rijksmuseum paintings conservation team. By not pursuing full treatment of this painting, the conservators would have more time to devote to the rest of the collection. This time could also be used for interpretation of the generated research data of Operation Night Watch. Regardless of which option is chosen, this will still be carried out. However, in the case of option 3, the focus will be on the actual treatment, which will impact on the time available for other activities.

When pursuing option 3, full treatment, several consequences were noted. The first consequence listed under the pro arguments is that the treatment will give (even) more insight into the painting technique, condition and conservation history of the painting, which would deepen and add to the research results achieved so far within Operation Night Watch. Secondly, it provides a unique experience for the public to learn about conservation and technical research. The treatment of *The Night Watch* could serve as a focal point for the presentation of information and educational material on topics such as general conservation practice, materials and painting technique, as well as its complex material and conservation history.

The first consequence mentioned under the counterarguments is that during cleaning, the image of *The Night Watch* will be difficult to read. When removing the current varnish layers and retouches, the unsaturated paint layers will appear grey and matte, and the old damages, including the 12 slashes of the 1975 attack, will become visible. The appearance of the painting may be challenging for the visiting public to understand.

Weighing ethical considerations

Ethical discussions are always complex, as Muñoz Viñas eloquently describes:

> Contemporary ethics ask them [decision-makers] to consider the different meanings that an object has for different groups of people, and to decide not just which meanings should prevail, but also how to combine them to satisfy as many views as possible. Even though this is a difficult task, the intent of contemporary conservation ethics is not to eliminate discussion, but to encourage it. It also intends for this discussion to take place *before* the actual conservation process begins (Muñoz Viñas 2005: 214).

Team discussions during the creation of the Treatment Option Diagram and subsequent advice revealed that there was no consensus between the conservators on whether or not to continue with

the treatment of the painting. However, it is important to note that none were strongly against either option (Muñoz Viñas 2020: 107, 108).[20] The main reason for conservators leaning towards option 1 was to extend the cleaning cycle, which took precedence over addressing the painting's appearance. The risks involved in cleaning a damaged paint surface weighed heavier than the expected visual gain, especially since the condition of *The Night Watch* is currently stable and further aesthetic treatment of the painting could wait another few decades, even though the old varnish and retouches would continue to age and discolour. As an iconic masterpiece, *The Night Watch* has received more than average attention by past restorers. Although their work was done with the best of intentions, the present understanding is that these former treatments have damaged the painting. Equally, our best intentions may be considered harmful to the painting by future generations.

The most compelling reason for conservators favouring option 3 was the replacement of the inaccurate and inconsequent old retouches and to address the numerous unretouched areas with meticulous new retouching. This would significantly improve the appearance of *The Night Watch*, uncover more original material, and bring the painting closer to Rembrandt's original intention. With this option all uneven and discoloured varnish (remnants) would also be removed, to the extent possible, improving the legibility and appearance of the painting. In the end, the expected visual gain of full treatment was considered sufficiently important to accept the risks involved, especially when minimised with additional research.

Decision and Strategy Document

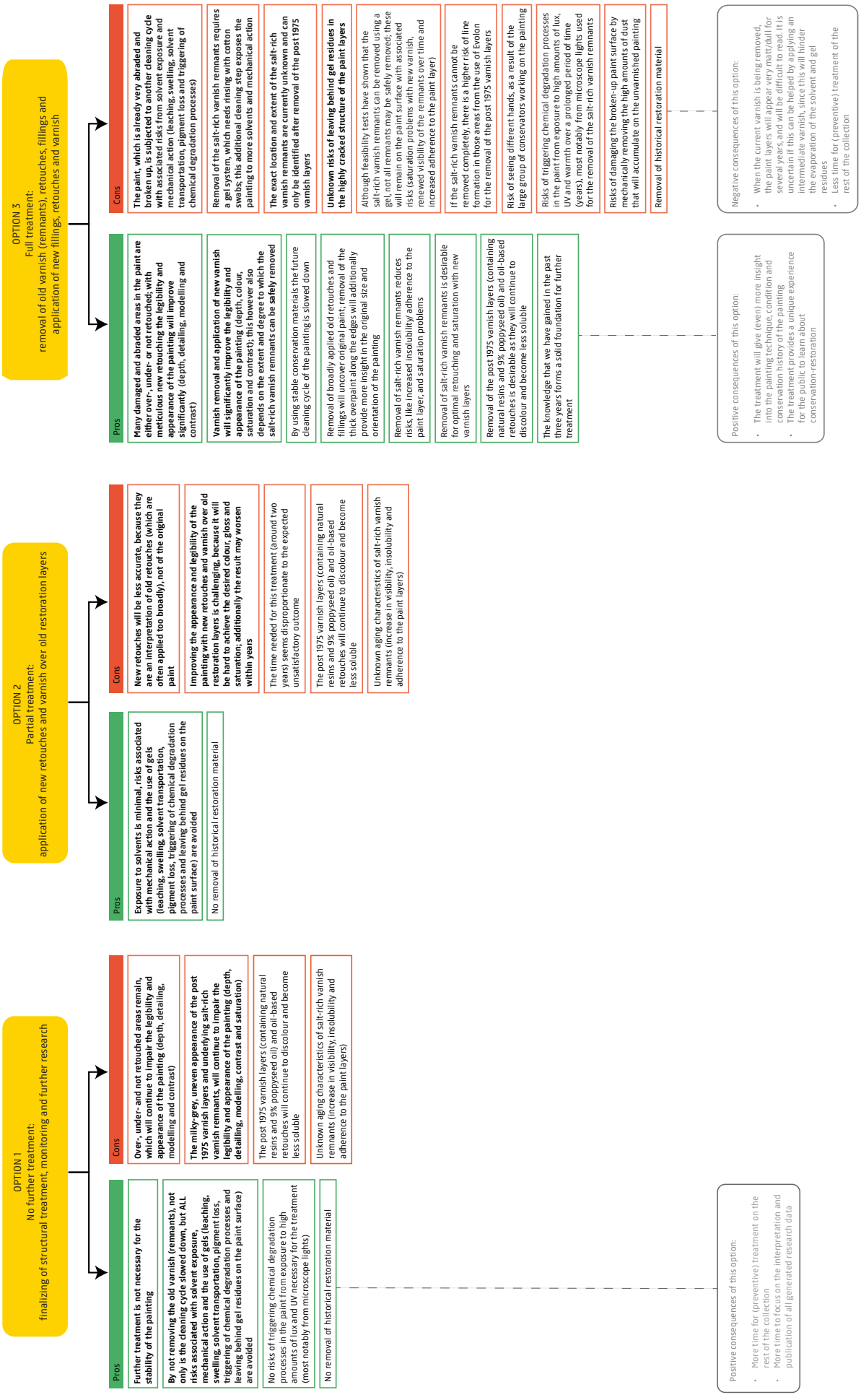
Using the Treatment Option Diagram, the conservators were able to draft an informed and well-balanced advice on further treatment of *The Night Watch*. This advice, including the Treatment Option Diagram, was embedded into an overarching Decision and Strategy Document that considered other important aspects, such as curatorial, financial, educational, marketing, exhibition, communication, documentation, safety and a general risk assessment.[21] After careful deliberation, taking all these aspects into account, the Steering Committee decided to continue with full treatment. The expected appearance of the painting after treatment outweighed the risks listed under option 3 in the Treatment Option Diagram. It was argued that more research could be employed to further minimise these risks. Additionally, the consequences described under the counterarguments of option 3 will be mitigated by proactive measures. These include temporary extension of the conservation team and project time management that will ensure conservation and research on the rest of the collection can be maintained. Secondly, a communication campaign will be implemented to not only inform, but also enthuse the public about the activities taking place during this unique process.

Concluding remarks

Weighing the ethical implications and risks is an inseparable part of any conservation treatment, and many publications have been written on the subject. In the case of *The Night Watch* it became even more pressing because the need for further treatment was ambiguous. Thinking processes and dialogues about the pros and cons of a treatment usually take place in the head of the conservator. To have been granted enough time to reflect with the large team of conservators involved in Operation Night Watch has been highly valuable. It has created a stronger awareness of the importance of assessing ethical implications and risks and will be used more explicitly in future conservation treatments of other paintings in our collection.

Taking a broader view, the large size of Operation Night Watch and the project team, as well as the scale and importance of the painting, have made clear that certain aspects must be addressed. We have learned the significance of exact role division, decision-making authority and the need for a clearly defined project structure. Careful planning and communication between various departments, under the guidance of a dedicated project leader, is essential. Solid integration of the project within the organisation is also vital to ensure a broad base of support. Finally for the conservators specifically, conditions of working in the public eye during a multi-year project need to be addressed. We hope that the insights contained in this paper may serve as an inspiration for professionals in the field of cultural heritage struggling with complex conservation projects.

Appendix: Treatment Option Diagram for *The Night Watch* (2022)



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Notes

1. Rembrandt van Rijn, *The Officers and Civic Guards of District II of Amsterdam under the Command of Captain Frans Banninck Cocq and Lieutenant Willem van Ruytenburch*, known as *The Night Watch*, 1642, oil on canvas, Rijksmuseum, Amsterdam, on loan from the City of Amsterdam, inv. no. SK-C-5. The strainer (which was added in 2022, see 'structural treatment') of the painting measures 410 × 485 cm.
2. https://www.rijksmuseum.nl/en/whats-on/exhibitions/operation-night-watch (accessed 18 December 2023).
3. The Steering Committee consists of: Taco Dibbits (General Director, Rijksmuseum), Eva Hermans (Head of Exhibitions, Rijksmuseum), Judikje Kiers (General Director, Amsterdam Museum, representing the city of Amsterdam), Robert van Langh (Head of Conservation and Science, Rijksmuseum), Pieter Roelofs (Head of Fine and Decorative Arts, Rijksmuseum).
4. The literature on decision-making referred to during both decision-making processes includes: Foundation for the Conservation of Modern Art 1999; Giebeler *et al.* 2021; Michalski 2018. In addition, the codes of ethics of several international institutions were consulted: Icon Professional Standards and Judgement & Ethics 2020; Icon Ethical Guidance 2020; ICOM Code of Ethics for Museums 2017; ECCO Professional Guidelines II Code of Ethics 2003; AIC Code of Ethics and Guidelines for Practice 1994.
5. The wax-resin linings were carried out during treatments in 1851, 1945–1947 and 1975–76. We know that before 1851 the painting had been glue lined because the 1851 restorer stated in his proposal that the old lining needed to be removed before he could apply his lining.
6. Several presentations on these topics were held at the *Operation Night Watch Symposium, Technical Innovations and Scientific Results*, 11–12 April 2022, Rijksmuseum Amsterdam, which will be accessible online on the Rijksmuseum website in the near future.
7. See six articles in the Rijksmuseum Bulletin of 1976, which was dedicated in its entirety to the knife attack of 1975 and the subsequent treatment and study of *The Night Watch*: *Bulletin van het Rijksmuseum* 24(1,2), 1976.
8. The term 'full treatment' was chosen here due to the lack of another more suitable and concise term. In this paper, the term is used to describe the treatment of the pictorial layers i.e. removal of old varnish, remnants, retouches, fillings and application of new fillings, retouches and varnish.
9. The re-tensioning of *The Night Watch* was carried out in collaboration with conservator Antonio Iaccarino Idelson (Equilibrarte). In 2012, a similar spring system had been used successfully working with Equilibrarte for the re-tensioning of two other large wax-resin lined canvas paintings in the Rijksmuseum*:* Jurriaan Andriessen, *Wall Hanging with Dutch Landscape with Open Bridge*, 1776, oil on canvas, 323.5 × 534 cm, Rijksmuseum, on loan from the Amsterdam Museum, inv. no. BK-2011-42; Jan Willem Pieneman, *The Battle of Waterloo,* 1824, oil on canvas, 567 × 823 cm, inv. no. SK-A-1115. See Sozzani *et al.* 2019: 115–40.
10. For the structural treatment of *The Night Watch* see: https://www.rijksmuseum.nl/en/stories/operation-night-watch/story/structural-treatment-of-the-night-watch (accessed 18 December 2023), publication forthcoming.
11. This expert day took place at the Rijksmuseum on 15 November 2022.
12. See note 8 above.
13. This applies especially to the stereomicroscope LED lights, as initial measurements have shown that these emit a relatively high amount of lux and W/m^2 (IR).
14. Various articles on lakes and arsenic sulphides present on *The Night Watch* are forthcoming within Operation Night Watch.
15. For appearance and legibility of the painting the authors considered aspects such as contrast, colour, detailing, depth, modelling, and saturation; see also the Treatment Option Diagram.
16. The authors are aware of the complexity and limitations of the phrase 'artist intention'. It is used here to indicate the aim to show as much original material of the painting as possible.
17. During the first decision-making process it was proposed that if the varnish layers would need to be removed, this could be done with Evolon CR using the controlled loading method. In this way mechanical action and solvent exposure will be minimised on the cracked and broken-up paint surface of *The Night Watch*. Additionally, due to the size of the painting, using the Evolon method could speed up the process

significantly and minimise the differences in cleaning by different hands. Baij *et al.* 2021 mention that the risk of 'line formation' was investigated specifically, and that this will be addressed in a future publication.

18. See note 13 above.
19. Almost 2.7 million in 2023. In the spring of 2024, the glass enclosure was adapted to the next phase of the treatment. This ensured noise reduction for the conservators and minimised dust accumulation.
20. The chapter 'Imperfect conservation' in Muñoz Viñas 2020 felt especially appropriate and recognisable within our discussions.
21. Operation Night Watch Decision and Strategic Document Full Treatment – 19 December 2022, internal document.

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Bridging the Channel: the dissemination of the Dutch wax-resin lining method to the UK in 1929 and 1930

Esther van Duijn, Michiel Franken and Mireille te Marvelde

ABSTRACT In April 1929, a delegation of three British museum specialists – a director, an assistant director and a curator – visited the restoration studio of the Rijksmuseum in Amsterdam and that of the De Wild family in The Hague, for demonstrations on wax-resin lining, also known as the 'Dutch method'. Wax-resin lining is a technique that had been invented in the Netherlands in the mid-19th century to both consolidate flaking paint and strengthen the canvas of a painting. It accommodated the humid Dutch climate better than more traditional aqueous lining techniques. The 1929 visit to the Netherlands was followed by a visit by the Rijksmuseum liner to London to demonstrate the technique to two British restorers. These combined visits seem to have been a catalyst for the dissemination of the technique into the UK, its intensive further investigation and following debate among specialists and consequently its appearance in the international literature. Studying this exchange answers not only questions on the dissemination of the technique, but also about the international contacts between museum directors, curators, scientists and restorers. The visit sheds light on important international developments in conservation history on the eve of the 1930 Rome conference, the subsequent foundation of several European museum laboratories and a general development in the field towards a more science-based conservation.

KEYWORDS wax-resin lining demonstrations, studio visits 1929/1930, dissemination lining technique the Netherlands/UK, De Wild family, Rijksmuseum

Introduction

At the close of the 1920s, a remarkable exchange of knowledge and skills between The Hague, Amsterdam, London and Edinburgh formed an interesting moment in the history of Dutch and British paintings conservation. In 1929, several British museum professionals visited the private restoration studio of Martin and Derix de Wild in The Hague and the paintings restoration studio of the Rijksmuseum in Amsterdam for demonstrations of the wax-resin lining technique, also known as the 'Dutch method'.[1] The Dutch method addressed both the consolidation of flaking paint and the strengthening of the original canvas, by adhering an extra canvas to the reverse of the original and impregnating the entire structure with a molten mixture of beeswax and resin. It was invented during the 19th century specifically to treat paintings that were suffering from neglect and the humid Dutch climate (Te Marvelde 2001; Van Duijn and Te Marvelde 2024).

In the first decades of its existence, the Dutch method was almost exclusively carried out by its inventors. The exact nature of its national dissemination is still largely unclear, but there is evidence that during the last two decades of the 19th century other Dutch restorers started carrying out wax-resin linings. Crossing the Dutch borders, dissemination of the method took place from the 1890s onwards, initially to Germany (Te Marvelde 2021). While we know that after the Second World War the method eventually spread worldwide (Te Marvelde 2021), its arrival in other countries is only recently starting to unfold in greater detail, for example to Denmark by the first decade of the 20th century (Wadum 2021: 21–2), and is part of further research.[2] This paper focuses on the exact nature of the transfer of the method to the UK, where paintings were traditionally glue lined. The 1929 visit of British professionals to the Netherlands turned out to be a key moment: it was followed by a visit to London in 1930 by the Rijksmuseum liner who gave demonstrations of the method to two British picture restorers. Undoubtedly dissemination of the wax-resin lining – like other restoration practices – generally took place through practical transfer of knowledge. But it is only when written or visual sources of these practices are available that we can start writing their history.

Figure 1 Twenty-five photos from the Rijksmuseum notebook by Louis Pomerantz who trained at the Rijksmuseum in 1950 and 1951, demonstrating the sequence of a wax-resin lining as it was carried out in 1950, which was very similar to how it was done in the previous decades dating back to the 19th century. (Photos © Louis Pomerantz papers, 1937–1988, Archives of American Art, Smithsonian Institution.)

Studying the exchange of both visits and the context in which they took place, answers the question of when and how the dissemination of the wax-resin lining technique to the UK occurred and paved the way for further spread to other parts of the world, as well as providing information on the international working relations between museum directors, curators, scientists and restorers at the time. The wax-resin demonstrations took place on the eve of the first international conference on conservation and scientific research in Rome in 1930, and the subsequent foundation of several European museum laboratories in the following decade. This fits into the larger developments of international exchange in the field of conservation and a trend towards conservation that is becoming more science driven (Vanpaemel 2019). This paper first presents a short overview of the early history of wax-resin lining, which originated in the Netherlands. It then explores the 1929 and 1930 demonstrations in-depth followed by an overview of some of the developments related to wax-resin lining in the UK after 1930, and a further dissemination of knowledge about the method through publications that can be closely linked to the protagonists involved in the demonstrations of 1929 and 1930.

The wax-resin lining method before 1929

The wax-resin lining technique had been invented in the Netherlands in the first half of the 19th century by the painter and restorer Nicolaas Hopman (1794–1870) (Te Marvelde 2001, 2021; Van Duijn and Te Marvelde 2024). He is known to have executed linings for the Rijksmuseum and the Mauritshuis from the 1840s onwards. His first documented wax-resin lining however, was in 1851, when he lined Rembrandt's *The Night Watch* (Van Duijn and Filedt Kok 2024: 272–3).[3] The Rijksmuseum and the city of Amsterdam would become important clients of Hopman: the archives show that he carried out numerous wax-resin linings for them, including many of the famous 17th-century militia and regent pieces in the museum. However, we know very little about the practical details of the method that Hopman used: only a few existing linings can be firmly attributed to him and there is no written documentation with such a description. After his death in 1870, he was succeeded by his son Willem Anthonij Hopman (1828–1910), who had been trained by his father and successfully continued their studio. He further refined the wax-resin lining method and became a specialist of national renown, his work being acknowledged internationally.

In 1879, Sir Frederic Burton (1816–1900), director of the National Gallery in London, visited Willem Anthonij Hopman's studio in Amsterdam for a demonstration of wax-resin lining. His handwritten notes on the visit, a four-page account of a wax-resin lining, provide a valuable source in the study of the method.[4] He described the execution of the method in detail. After careful removal of an older glue lining and stretching both the original and the lining canvases on working looms, in the initial step of the lining process, the molten wax-resin mixture was applied to the reverse of the original canvas and ironed in from the reverse, impregnating the entire paint structure. This step consolidated any loose or flaking paint. In a second step, the lining canvas was applied to the reverse of the original canvas. The process of wax-resin application and ironing was then repeated to firmly adhere both canvases together (Fig. 1). Despite the informative exchange between the London museum director and the Amsterdam restorer, the wax-resin lining method did not spread in the UK: the preferred structural treatment for paintings on canvas was, and remained, glue-based lining.[5]

The dissemination of the technique to Germany was more successful. In the summer of 1891, the Berlin restorer Aloïs Hauser Jr. (1857–1919) was invited to the Mauritshuis in The Hague by its director Abraham Bredius (1855–1946), to work on several paintings in his collection (Van Duijn and Te Marvelde 2024: 251). At the same time, Willem Anthonij Hopman was working there on the structural treatment of paintings, as he did annually. By then he was renowned for his wax-resin linings. Hopman respected Hauser and taught him (as one of the few) the wax-resin lining method, which Hauser adopted (Van Duijn and Te Marvelde 2024: 251). Although Hauser's execution of the lining technique (in two steps) followed Hopman's teachings closely, he did alter the ingredients (Mandt 1995: 222–4). Hauser, in turn, played an important role in passing on the technique to the Netherlands, to the young Dutch restorer Carel Frederik Louis de Wild (1870–1922). In the first quarter of 1896, Carel, after training in Vienna between November 1894 and December 1895, spent three months in Hauser's studio in Berlin. In Vienna, Carel de Wild had become familiar with the glue lining used there, but it was only in Berlin that he learned to execute the Dutch lining method from Hauser, which he would continue to use for the rest of his life (Van Duijn and Te Marvelde 2024: 251, 264). Carel's training as a paintings restorer in Vienna and Berlin had been made possible by the Mauritshuis director Bredius and his deputy director Cornelis Hofstede de Groot (1863–1930), who were looking for a successor to Willem Anthonij Hopman as he was nearing the end of his career. Carel himself described in an interview in 1904 how he had learned the Dutch method in Berlin, not in Amsterdam (Netscher 1904: 768–9).[6]

In the spring of 1896, Carel set up a studio in The Hague which quickly became successful. He had a growing clientele of museums, institutions, private collectors and art dealers – at first only Dutch but soon also international clients. The first lining for a British collector mentioned in his logbook dates from 1898.[7] Unfortunately we do not know exactly how Carel executed wax-resin linings and the extent to which it deviated from the method used by the Hopman family. Visually, Carel's linings are still very similar to those of Willem Anthonij, but the method developed differently in the studio of the De Wild family and changed considerably under Carel's nephew Angenitus Martinus (Martin) de Wild (1899–1969).[8]

Figure 2 Derix de Wild (*left*) in the London studio of the art dealer Knoedler at 15 Old Bond Street, London, with his son Marin de Wild (*centre*) and possibly his nephew Louis de Wild (*right*). (Photo: Netherlands Institute for Art History, The Hague.)

Figure 3 Martin de Wild at work in his studio making an X-radiograph (*left*) and taking a paint sample (*right*). (Photo: Bert Buurman/ Nationaal Archief/Collectie Spaarnsestad/Associated Correspondents.)

In 1911, Carel de Wild emigrated to the United States. His studio was continued by his brother Derix de Wild (1869–1932), who had presumably been trained by Carel himself (Van Duijn and Te Marvelde 2024: 253–4). The studio remained successful, both on a national and international level (Fig. 2). One of his most famous achievements was his treatment of the Haarlem regent and militia pieces by Frans Hals in the Frans Hals Museum between 1918 and 1927 (Van Duijn and Te Marvelde 2024: 252–5; Te Marvelde *et al.* 2024). Derix's son Martin, who trained as a restorer in his father's studio, was already involved in the treatment of the Frans Hals paintings in Haarlem, but simultaneously studied chemistry at the

Technical University in Delft. He defended his PhD thesis on the scientific examination of paintings in 1928 (De Wild 1928, 1929, 1931a). Although scientific research of painting materials, such as the properties and history of pigments, forms the main part of this study, he devotes one chapter to 'the restoration and preservation of paintings' (De Wild 1929: 83–91) (Fig. 3). For instance, he describes tests he had carried out in the laboratory of physical chemistry in Delft for the purpose of comparing canvas treated with glue with canvas treated with wax-resin under fluctuating degrees of humidity (De Wild 1929: 89). He concluded that the wax-resin-impregnated canvas, in contrast to the glue-impregnated one, had no reaction to fluctuating humidity.

Interestingly, Martin de Wild was the first to investigate paintings that had been wax-resin lined by Willem Anthonij Hopman. In an article published towards the end of his career, he concluded with admiration that these linings were still in excellent condition (De Wild 1964: 97). The (inter)national contacts of the De Wild studio appear to have been important for his research. In 1926, Martin had been invited to Edinburgh to examine the condition of the Dutch and Flemish paintings at the National Gallery of Scotland.[9] This led to a report and subsequent commissions for treatment, including wax-resin linings, in the following years. It may have been the British chemist Arthur Pillans Laurie (1861–1949) who encouraged the director of the National Galleries of Scotland, James Lewis Caw (1864–1950), to contact the De Wild family, since he was familiar with their work. He had published a very positive review about the treatment by the De Wilds of the Haarlem group portraits by Frans Hals in 1925 (Laurie 1925). Martin de Wild acknowledged the generous help and enthusiasm of both Caw and the curator of the National Portrait Gallery of Scotland, Stanley Cursiter (1887–1976) in his PhD thesis.[10] It was the beginning of an enduring and productive professional relationship between Martin de Wild and Stanley Cursiter, who became director of the National Galleries of Scotland in 1930.

The wax-resin lining demonstrations of 1929 and 1930

Caw and Cursiter were two of the three British delegates who visited the Netherlands in April 1929 for demonstrations on the wax-resin lining method. The third delegate was William George Constable (1887–1976), assistant director of the National Gallery in London. While the text above describes the relationship that existed between the De Wild family and the National Galleries of Scotland, the association between the Rijksmuseum and the National Gallery in London seems to have developed from a different connection. In 1928, one of the trustees of the National Gallery, Augustus Moore Daniel (1866–1950), visited the Rijksmuseum in Amsterdam and met with its director Frederik Schmidt-Degener (1881–1941). Schmidt-Degener was the first Rijksmuseum director to have been trained as a professional art historian.[11] He had a broad international network and advocated international loans for important exhibitions to a greater extent than his predecessors. Daniel, who would become director of the National Gallery in London in 1929, reported on his Amsterdam visit to the Museum Board.[12] In his notes, he commented specifically on the good condition of the paintings, as well as on his discussion with Schmidt-Degener on the benefits of wax-resin lining as an alternative to glue lining. Under the comments, Daniel wrote: 'The question of the hygroscopic glue and the springing of the body of the paint seem very important and might well be enquired into or even [wax-resin] relining tried on some unimportant pictures', a remark that clearly evidences his interest in the method.

The wax-resin lining tradition at the Rijksmuseum can be linked directly to father and son Hopman, both of whom were hired extensively by the museum during the 19th century. When Willem Anthonij Hopman retired in 1900, his long-time first assistant Hendrik Heijdenrijk (1848–1918) took over his studio and remained working for the museum as a contract liner (Van Duijn 2022: 164–5). Through a lengthy newspaper interview with Heijdenrijk in 1905, we have an in-depth description of the wax-resin lining as executed by Willem Anthonij Hopman, giving us an insight into some of the technical aspects of the execution of the method as well as the composition of the wax-resin mixture.[13] Willem Frederik Cornelis Greebe (1865–1946), who had been employed in the Rijksmuseum as a guard since 1889, was also gradually carrying out linings for the museum (Van Duijn 2022: 165–9). He was probably trained by either Willem Anthonij Hopman or Heijdenrijk, or possibly both. His method of wax-resin lining was very similar to that described by Hopman to Burton in 1879 and Heijdenrijk in 1905.[14] In 1908, Greebe officially became 'assistant to the paintings department'. By 1914 the museum had stopped hiring restorers

Figure 4 Portrait of Willem Greebe at work consolidating paint, 1920. (Photo: Rijksmuseum.)

and liners on a contract basis and Greebe became the first liner in permanent employment, probably for financial reasons (Van Duijn 2022: 165–6) (Fig. 4).

The process of wax-resin lining was demonstrated to the three British delegates by Greebe on 4 and 5 April 1929 in the paintings restoration studio of the Rijksmuseum. The painting used for this demonstration – *Landscape with Herdsmen and Animals in Front of the Baths of Diocletian, Rome*, now attributed to the Flemish artist Pieter van Bloemen (1657–1720), but then thought to be by the Dutch painter Jan Asselijn (1610–1652)[15] – belonged to the National Gallery in Scotland and was apparently brought along specifically for this purpose. Earlier that week, on 2 April, Cursiter and Constable (without director Caw) had been shown the process of wax-resin lining by Martin de Wild in the De Wild studio in The Hague. Which painting was used for this treatment is not known but detailed notes were taken by Cursiter and Constable during both demonstrations to report back to their respective museums.[16] They give a clear description of the similarities and differences in the approaches used by the two lining traditions – the British glue lining and the Dutch method – and are a remarkable source for the history of wax-resin lining. In his report for the Trustees of the National Gallery, Constable sums up the advantages of the wax-resin lining method over glue lining:

> There seems little doubt that the adoption of the method described above would be advantageous for the Gallery. The outstanding advantages are: –
> 1. The replacing of glue by wax as means of attaching the relining canvas. Wax is unaffected by damp and change of temperature and is not liable to chemical change; while glue is hygroscopic, and soon perishes.
> 2. The heat both of the relining mixture and the iron used, is considerably less than in the case of relining with glue.
> 3. The pressure necessary is far less than in the case of glue relining. The irons used are lightly handled, and pressure is applied only from the back. This largely arises from the fact that the

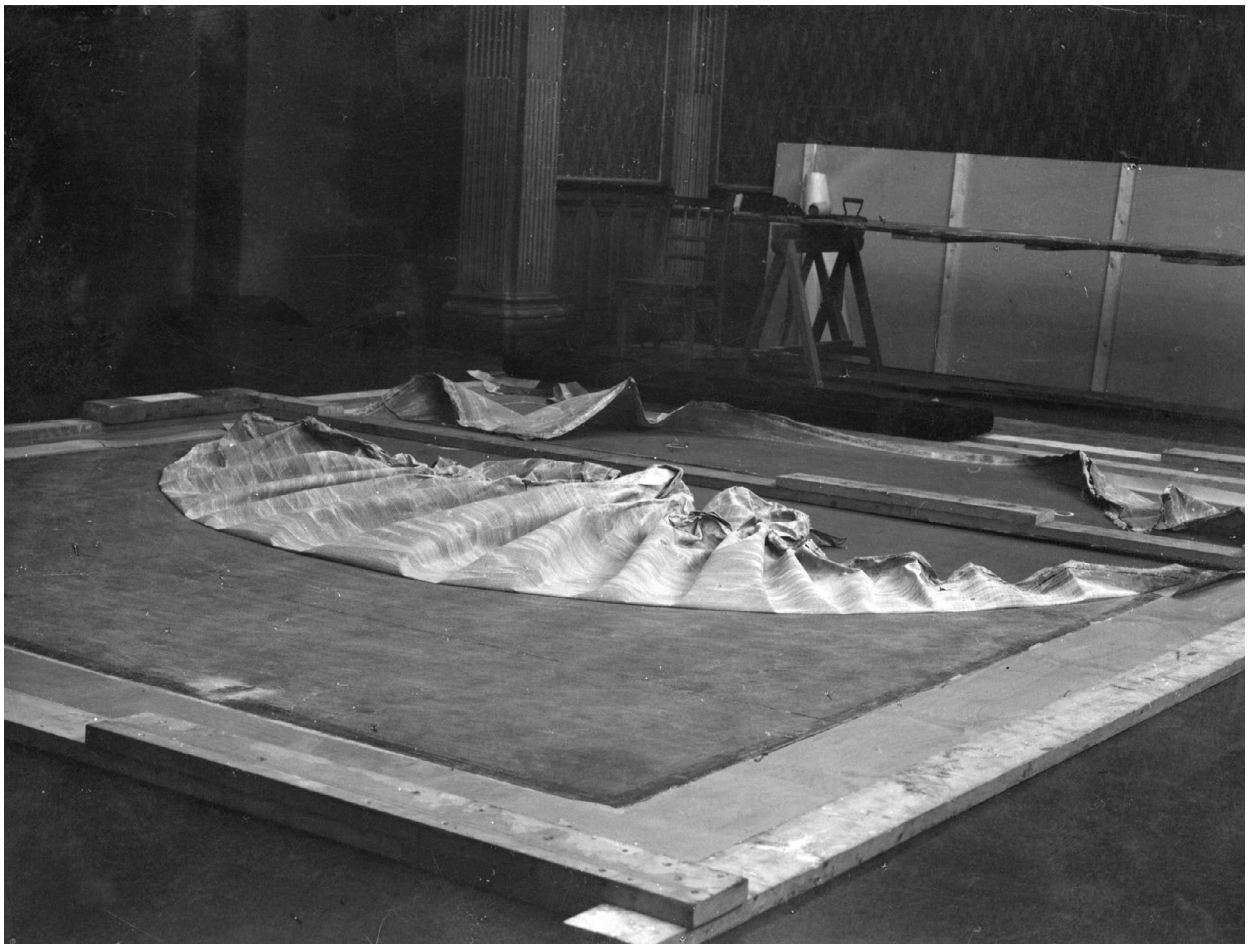

Figure 5 Christiaan Jenner removing the 19th-century wax-resin lining of Rembrandt's *The Night Watch* (1642) in preparation for a new wax-resin lining, 1945. (Photo: Rijksmuseum.)

> wax mixture acts less the part of an adhesive than that of a sheet of wax in which the layers of canvas are embedded. In lining with glue, failure to secure contact between the two canvases means a bubble; in the case of wax, only a slightly thicker layer of wax at that point. 4. If for any reason the relining canvas has to be removed, this is easily done by melting the wax mixture with a warm iron.[17]

The hydrophobic nature of wax has been stressed as one of the chief advantages of the method and as described above, had been studied by Martin de Wild for his PhD thesis (De Wild 1929: 89).

According to notes and later correspondence, the delegates were impressed by the Dutch demonstrations. However, none of the delegates were actual restorers: for this new lining method to be adopted across the Channel, British restorers needed to be taught directly. This seems to have occurred a year later, in 1930, when Greebe's successor as the museum's liner, Christiaan Hendrik Jenner (1896–1977), travelled to London for what the annual report of the Rijksmuseum describes as 'a series of demonstrations' (Schmidt-Degener 1931: 5). Jenner had started at the Rijksmuseum in 1923 as a carpenter and trained by Greebe as a liner (Van Duijn 2022: 169). By the time Greebe retired in 1930, Jenner was already familiar with the work and became his designated successor. Although we know little about Jenner's method of wax-resin lining in the 1930s, the fact that he was trained by Greebe as well as a report from his wax-resin lining of Rembrandt's *The Night Watch* in 1945, show that he continued the two-step application method that had been so characteristic of the Hopman method of wax-resin lining (Van Duijn and Filet Kok 2024: 270–72; Van Duijn 2021: 3) (Fig. 5). In London, Jenner demonstrated the wax-resin lining technique to two unnamed restorers but we do not know any of the specifics of this demonstration. From later correspondence, discussed in the next section, we can conclude that at least one British restorer was a member of the Morrill family of picture liners, who worked extensively for the National Gallery in London as well as other British museums.[18]

The wax-resin lining technique in the UK after 1930

The year 1930 is significant in the history of conservation. In October 1930, the *International Conference for the Study of Scientific Methods for the Examination and Preservation of Works of Art*, the so-called Rome conference, took place (Cardinali 2017, 2020; Vanpaemel 2019). It spurred developments into scientific research for art history and conservation. Only a handful of delegates from the Netherlands attended, no one from the Rijksmuseum. Martin de Wild was prominent among them, as was his dissertation supervisor, the chemist Frans Eppo Cornelis Scheffer (1883–1954) (Cardinali 2020: 118–21).[19] The names of the previously mentioned art historians Bredius and Constable were also included on the programme.[20] Several presentations at the Rome conference were published in the 1931 issue of *Mouseion*, including Martin de Wild's 'Méthodes de restauration et de conservation des peintures des Écoles Hollandaise et Flamande', which contains a generic description of the Dutch wax-resin lining method and the tests that he carried out for his dissertation (De Wild 1931). The same issue of *Mouseion* includes the article 'Nettoyage, rentoilage et vernissage des peintures', also an earlier Rome presentation, by the Canadian artist and restorer Percyval Tudor-Hart (1873–1954) (Tudor-Hart 1931). Tudor-Hart lived in London between 1917 and 1935. In the article, he speaks highly of the use of wax-resin adhesive for lining. Not much is currently known about his role as a restorer or from where he obtained his information on this method, but the article made clear that knowledge of the method was spreading.

This is confirmed by an article in *The Museums Journal*, which is basically a letter by Rijksmuseum director Schmidt-Degener to chemist Laurie, one of the contributors to the Technical Notes of the magazine. Schmidt-Degener (1932) gives a detailed account of the wax-resin lining method – the first step-by-step account of the method to be published in English.[21] He describes the two-step method as it was practised at the Rijksmuseum, including a recipe for the wax-resin mixture. At this point Laurie is clearly convinced of the advantages of wax-resin over glue as an adhesive for lining. He actively advocated these materials at a conference in London called *Ailing Pictures* on 20 October 1931 (Anon. 1931). In a resulting leaflet, some parts of which appeared in *The Museums Journal*, he wrote:

> The English practice of using mixtures containing glue and ironing with heavy irons is to be condemned for several reasons. … The best relining material is beeswax, which may be mixed with a little rosin and Venice turpentine to make it more sticky. … Its advantages are that it penetrates well. It forms a perfect protection for the back of the picture from moisture and injurious gases. It avoids injury to a loaded impasto which is flattened by the heavy irons. It cannot be attacked by mould … A certain number of restorers in this country now use this method, which has long been practised in the Rijksmuseum, Amsterdam (Laurie 1932: 523).

Interest in the method and the use of wax as a material in conservation was also taken up by Harold Plenderleith (1898–1997), chemist at the British Museum, possibly from questions regarding the material and technique posed by National Gallery director Daniel. The laboratory of the British Museum had been founded in 1920 by the renowned chemist Alexander Scott (1853–1947) and is among the earliest examples of museum laboratories. Correspondence from February 1932 shows that Daniel and Plenderleith were not only interested in the scientific study of wax as a conservation material, but also in the interaction of new varnish layers with wax from wax-resin lined paintings.[22] Daniel made an interesting remark in a letter to Plenderleith: 'Morrill is using the exact method shown to him in Amsterdam.'[23] It is unclear if this refers erroneously to the time in 1930 when Jenner visited London to demonstrate the method to two British restorers, or if this Morrill had visited Amsterdam on another occasion. Both Daniel and Plenderleith still show some caution regarding the method at this point.

It appears that attitudes towards wax-resin lining had changed by the following year. On 29 May 1933, Plenderleith wrote to Daniel:

> I have been regularly and systematically maltreating a wax-relined picture (obtained from Mr. Cursiter) for almost a year now, subjecting it to violent changes of humidity and temperature, growing mould upon it etc., and am beginning to have tremendous faith in wax. … wax relining is preferable, without question,

> provided the technique be adapted to the type of painting, height of impasto etc. and the work be in the hands of a good craftsman.[24]

To which Daniel replied:

> I am very interested to learn that you are becoming more inclined to wax relining. I am discussing it with Morill, our man, and he is steadily getting experience in relining with it; but from long habit and tradition he clearly still prefers glue. I have, however, told him that I think it is very probably that gradually those that cannot use wax with as much readiness and ease as in the past restorers used glue will be left behind.[25]

Clearly both Plenderleith and Daniel were becoming more familiar with, and excited about, the method (Plenderleith 1932).[26] As the National Gallery was one of their clients, the Morrill liners may have had little choice but to follow their 'advice', even though they may have had mixed feelings. Further research into the actual numbers of wax-resin lined versus glue-lined paintings from this period would be interesting in this regard and a topic for future study.

Similar research was conducted in America. In the second issue of the newly founded journal *Technical Studies in the Field of Fine Arts* in 1933, an article was published discussing an extensive investigation into the history and properties of various lining adhesives, conducted by conservator George Leslie Stout (1897–1978) and chemist Rutherford John Gettens (1900–1974) at Harvard's Fogg Museum (Stout and Gettens 1933). The Fogg Museum, under director Edward Waldo Forbes (1873–1969), with its research laboratory, at the time became internationally prominent in conservation and technical research (Bewer 2010). There must have been close contact between the British professionals and those at Harvard; Laurie was known to have been in contact with Forbes (Bewer 2010: 59). The article by Gettens and Stout discusses in depth the various properties that a lining mixture should possess. On wax-resin lining as discussed by De Wild, North and Schmidt-Degener, they state: 'It can probably be regarded as the prevalent material now used in the treatment at least of important paintings' (Stout and Gettens 1933: 86). From the various lining mixtures they compared (glue-paste emulsion, poly(vinyl acetate), poly(vinyl acetate)/wax, paraffin wax, paraffin wax/gum elemi, pure beeswax and wax/resin), the wax and wax-resin adhesives were cautiously considered the most 'safe and effective' (Stout and Gettens 1933: 103).

It is certainly no coincidence that in the years to come, more research on wax-resin lining was published in *Technical Studies in the Field of Fine Arts*, which attracted international contributions (Bewer 2010: 171). Most of the authors are now mostly familiar to us. The article 'The problems of lining adhesives for paintings: wax adhesives' by Cursiter and Plenderleith (1934) is basically a continuation of the previous article. Specifically, it discusses the various ingredients that could be used for a wax-resin lining in an attempt to find the best mixture by trying out various combinations of waxes and resins with different additives. The most important principle was to find a mixture that would, as much as possible, comply with the properties necessary for a good lining adhesive as formulated by Stout and Gettens. Most importantly, the adhesive properties and melting point of the mixture were emphasised. Reference to the latter property indicates that what was sought was a mixture that would require as little heat as possible. It was concluded that wax mixtures consisting of beeswax, resin and a suitable plasticiser could be considered a good lining mixture.

Interestingly, Stout and Gettens acknowledge at the end of their article that: 'The actual practice of lining is, of course, most important in this problem, but that technique will have to be discussed by those restorers who are engaged in using it regularly' (Stout and Gettens 1933: 104). They continue by thanking three restorers for help in the preparation of their research samples: 'Mr R. A. Lyon of the Fogg Museum, Mr S. Kennedy North of London, and Mr William Suhr of the Detroit Institute of Art'.[27] One year later, conservator Roger Arcadius Lyon (1885–1954) published his own article on wax-resin lining in *Technical Studies in the Field of the Fine Arts* (Lyon 1934). Although it is not known for certain where he learned the method, Lyon clearly had experience with wax-resin linings and had experimented with various mixtures. He presents the reader with the mixture that he clearly felt worked the best: he stresses the advantages of wax-resin over glue, significantly the better penetration of a wax-resin mixture.

Although the focus of the articles discussed above lie in the material aspects of wax-resin lining, a series of four articles by De Wild and Cursiter for *Technical Studies in the Field of Fine Arts* between 1937 and 1939 describe four different case studies of paintings that were wax-resin lined (Cursiter and

De Wild 1937, 1938a,b, 1939). While the method in the first article seems to consist of a fixed procedure, the others show different variants of the method, stressing the fact that every painting needs an individual approach according to its specific conservation needs. This was a modern approach; as we have already seen in the case of the Rijksmuseum, wax-resin linings seem to have been carried out in a rather formulaic way within studio traditions that had changed little over time. According to Cursiter and De Wild, the character of the lining canvas must depend on the size and type of the picture being treated. Additionally, different materials and adhesives were chosen for the application of a facing that protected the surface of the paint layers during lining. The point at which a facing was introduced could also vary; different facings could be used at different moments within a single treatment. A range of different materials varying in hardness could be chosen for the cushioning during the lining. With regard to the technique itself, there was a choice of whether or not to stretch the original painting in order to protect the paint layer against pressure; if the lining mixture should be applied to the original canvas or to the lining canvas or both; and whether to iron the front or reverse side of the painting. The treatment could be carried out in various stages. The articles in this series were the first to be illustrated with multiple and detailed photographs.

One of the decisions taken during the 1930 Rome conference was to compile a handbook on the conservation of paintings. In 1939, the *Manuel de la conservation et de la restauration des peintures* was published under the aegis of the International Museums Office, followed a year later by the English translation (ICOM 1940, 1997). The authors at that time remained anonymous to preserve the collective character of the book. The 1997 edition of the book lists the members of the scientific committee who were responsible for the text, among them De Wild, Constable, Plenderleith, Laurie and Stout (ICOM 1997: 5–6). The manual does not make a clear choice in favour of the various types of lining materials but does seem to lean towards a wax-based recipe when it numerates the advantages and disadvantages of all the materials. It does not give a detailed step-by-step description of a lining but lists all that is needed for a successful lining (ICOM 1940: 112–25). Although the original aim of the book was to better inform museum directors, curators and collectors on paintings conservation, the technical information was still detailed and thorough enough to provide an important source of information for restorers as well (ICOM 1997: 7–8). The start of the Second World War called a halt to the small flood of publications that had appeared on various aspects of wax-resin lining in the 1930s.

After the war, the international dissemination of the method spread to many corners of the world. However, ill-informed use of the method as well as further research into its disadvantages, especially when combined with the so-called vacuum hot table, halted and eventually reversed the spread (Percival-Prescott 2003). In 1974, the *Conference on Comparative Lining Techniques* took place at the National Maritime Museum, Greenwich. It was originally intended as an overview of the existing methods and materials of lining, including some of the more recent methods and synthetic materials which were presented as alternatives to the traditional glue or wax-resin adhesives. However, growing critique on 'this lining and relining habit' was vocalised during the meeting, which culminated in a moratorium of lining practice during the subsequent ICOM-CC Triennial Meeting, held in Venice in 1975 (Percival-Prescott 2003: viii). In the following decades, the drawbacks and eventual complete rejection of wax-resin lining slowly became more integrated into conservation practice. Nowadays, the method is mostly obsolete in favour of less invasive types of lining. However, the fact remains that many countries and institutions have large collections of wax-resin lined paintings meaning that a solid knowledge of the history of the method remains crucial, as well as more research on the response of wax-resin lined paintings to climate fluctuations and new treatments, and the possibilities of reversal (Krarup Andersen 2013; Froment 2019).[28]

Conclusion

The visit of three British museum professionals to the restoration studios of the De Wild family in The Hague and the Rijksmuseum in Amsterdam in April 1929 for live demonstrations of the wax-resin lining method formed a catalyst for the dissemination of the method into the UK. Although wax-resin lined paintings were known in the UK from the 19th century onward, the method itself was not part of the practice of British paintings restorers until the 1930s. The visits emerged from earlier contacts between Dutch and British museum professionals and private restorers, and

shows how history is often made through individual connections, chance meetings and a sudden enthusiasm for a subject. The demonstrations seemed to have firmly convinced the visiting museum director, assistant director and curator of the advantages of the method over glue linings, the then preferred method in the UK. However, while this was a crucial step, the British restorers also needed to be taught the method. This happened a year later when the Rijksmuseum liner travelled to London for more demonstrations. The value of these wax-resin lining demonstrations lies in the fact that they were practical, which was necessary to give insight into the different steps and technical aspects involved and to transfer this type of knowledge.

The decade following the demonstrations shows how quickly the method then disseminated supported by the interest, and ensuing publications, of both museum directors, scientists and restorers. These international contacts soon extended to the United States, where a platform was found in a new international journal. The intensive exchange of knowledge on the wax-resin lining method fitted into the larger context of the growing international exchange in the field of conservation and a tendency since the 1930s towards conservation that is more science driven, resulting in the first international conference in this field in Rome and the start of an increasing flow of publications on conservation. From then onwards, wax-resin lining was discussed in international literature, further investigated and extensively debated. This all happened in a close exchange of knowledge between restorers, scientists, museum directors and curators, perfectly fitting the theme of the current publication. By the end of the 1930s wax and wax-resin adhesives were concluded to be the best and safest for the lining of paintings. It was only much later that attention was drawn to the negative side effects of the method, which finally led to its rejection.

Acknowledgements

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Notes

1. Because of the historical nature of this paper, the terms 'restorer' and 'restoration' are used when discussing historical persons and practice, and 'conservation' to indicate the profession in general.
2. One of the initiatives to further this research is the Dutch Method Unfolded, which includes two masterclasses and a forthcoming publication. It is part of the Conserving Canvas Initiative, supported by the Getty Institute. The Dutch Method Unfolded is spearheaded by Emilie Froment, assistant professor at the University of Amsterdam. Esther van Duijn and Mireille te Marvelde are both involved in various roles. See also: https://dutchmethodunfolded.humanities.uva.nl/.
3. Rembrandt van Rijn, *The Officers and Civic Guards of District II of Amsterdam under the Command of Captain Frans Banninck Cocq and Lieutenant Willem van Ruytenburch*, known as *The Night Watch*, 1642, oil on canvas, Rijksmuseum, Amsterdam, on loan from the City of Amsterdam, inv. no. SK–C–5. The current strainer of the painting measures 410 × 485 cm.
4. National Gallery of Ireland, Centre for the Study of Irish Art, Bindon Burton Collection, 1987, Sir Frederic William Burton (1816–1900), IE NGI/IA/BUR1/2/6/1/8.
5. An interesting remark on the fame of English linings was made in 1851 by the poet and novelist Jacob van Lennep (1802–1868) in a laudatory article on the wax-resin lining of Rembrandt's *The Night Watch* by Nicolaas Hopman. He starts his article with the comment that many artists and art connoisseurs had felt that the painting needed to be sent to England, where such a feat – a lining – could be done properly, even though, Van Lennep added, it might mean that only a copy would be sent back! (Van Lennep 1851).
6. This is confirmed by his letters to Hofstede de Groot while in Vienna and Berlin. RKD- Netherlands Institute for Art History, The Hague (hereafter cited as RKD), Archive C.F.L. de Wild Sr., inv. no. NL–HaRKD.0227, Box 1, folders B and H. It is undocumented if Carel ever met Hopman.
7. RKD, The Hague, Archive C.F.L. de Wild Sr., inv. no. NL–HaRKD.0227.89, logbook p. 66.
8. As of yet unpublished research by Mireille te Marvelde.
9. See Jacob Simon on Derix de Wild and Martin de Wild in: https://www.npg.org.uk/collections/research/programmes/directory-of-british-picture-restorers/restorers-d (accessed 18 March 2024)
10. In the Dutch publication (De Wild 1928) the acknowledgements are on an unnumbered page before the index; in the English translation (De Wild 1929: viii) they are in the Foreword by Martin's supervisor, F.E.C. Scheffer.
11. He had started on 1 January 1922.
12. National Gallery Archive, Record NG25/2, Board Papers 1928.

13. *Haagsche Courant*, 18 May 1905; *De Sumatra Post*, 22 May 1905.
14. A detailed description of Greebe's method is given in notes kept by Caw and Cursiter, which are held in the Smithsonian Institute, Archives of American Art, W.G. Constable papers, 1905–1983, bulk 1920–1976, box 21, folder 15, lining. Research on the wax-resin lining technique in the Rijksmuseum is currently carried out by Esther van Duijn; there is a clear line of tradition in the execution of wax-resin linings at the museum that continued uninterrupted until at least 1950 (publication is forthcoming).
15. Pieter van Bloemen, *Landscape with Herdsmen and Animals in front of the Baths of Diocletian, Rome*, *c.*1700, oil on canvas, 48.5 × 63.5 cm, National Gallery of Scotland, inv. no. NG 1014.
16. Both sets of notes are kept in the Smithsonian Institute (see note 14 above).
17. National Gallery Archive, Record NG25/3, Board Papers 1929. A draft of this report is kept at the Smithsonian Institute, AAA (see note 14 above).
18. For information on the various members of this family see the British picture restorers, 1600–1950 database: https://www.npg.org.uk/collections/research/programmes/directory-of-british-picture-restorers/restorers-m (accessed 18 March 2024).
19. Cardinali 2020: 118–21 includes the full programme of the conference. Interestingly, Scheffer presents on pigment identification, the main subject of De Wild's dissertation (*L'examen chimique des tableaux*), while Martin de Wild discusses restoration (*Méthodes de restauration et de conservation des peintures des écoles hollandaise et flamande*).
20. Another Dutch attendant was H.E. van Gelder, director of the Municipal Museum in The Hague.
21. The Heijdenrijk interview (see note 13 above) is written in Dutch but had also been translated in German for an art journal (Raaf 1905); the De Wild thesis (English translation 1929) does not give a detailed account.
22. National Gallery Archive, Record NG16/48/2, Registry files: Conservation - 1932.
23. *Ibid*., letter from Daniel to Plenderleith, dated 22 February 1932.
24. National Gallery Archive, Record NG16/24/2, Registry files: British Museum 1931–1933, letter from Plenderleith to Daniel, dated 29 May 1933.
25. *Ibid*., letter from Daniel to Plenderleith, dated 31 May 1932.
26. Expressed one year later in Plenderleith 1932 in which he discusses – per subject not per article – several of the Rome conference articles that appeared in *Mouseion* in 1931. On lining he writes: 'The wax-resin mixtures are greatly to be preferred, however, for various important reasons, as Tudor Hart points out, but principally in our view because the canvas is not soaked with water during the relining.' Plenderleith also writes that a wax-resin is less stressful for a painting to reverse.
27. Stanley Kennedy North is an interesting figure in this story, but currently falls outside the scope of this paper. Although he practised a form of wax-resin lining, he was self-taught as a restorer and an isolated and somewhat controversial figure within the field.
28. See note 2 above. Keeping knowledge on traditional lining methods alive, as well as initiating further research, is part of the Getty Conserving Canvas Initiative.

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Fragments and variations: an archival afterimage of early virtual reality art

Kira Alison Brown

ABSTRACT In the early 1990s, driven by government-funded initiatives, artists in North America began experimenting with virtual reality (VR). In Canada, the Banff Centre for the Arts was one of the first institutions to facilitate the use of this emerging technology as an artistic medium through its 1991–1994 residency programs which produced several groundbreaking artworks. At the time, however, conservation standards did not support VR preservation, and as a result, many early VR artworks can no longer be seen or exhibited in their original forms. This paper investigates the history of early VR art and its preservation, highlighting two important artworks produced during the Banff programs: Catherine Richards' 1991 *Spectral Bodies*, the first artwork to incorporate VR technology in Canada, and Lawrence Paul Yuxweluptun's 1992 *Inherent Rights, Vision Rights*, the first VR artwork to be exhibited at the National Gallery of Canada. Moving emphasis away from their original state, this approach to art history relies on documentation and archival records to highlight how these artworks have transformed over time and developed into new forms, whether as fragments or variations. Within this discussion, reinterpretation, once considered a radical media art preservation method, is presented as a potential strategy to provide renewed access to this typology of art.

KEYWORDS virtual reality, media art, conservation, reinterpretation, digital art

Introduction

In the early 1990s, driven by government-funded initiatives, artists in North America began experimenting with virtual reality (VR). In Canada, the Banff Centre for the Arts was one of the first institutions to facilitate the use of this emerging technology as an artistic medium.[1] Through its residency programs, which took place between 1991 and 1994, several VR artworks were produced including Catherine Richards' 1991 *Spectral Bodies*, which is considered the first artwork to incorporate VR technology in Canada, and Lawrence Paul Yuxweluptun's 1992 *Inherent Rights, Vision Rights*, which was the first VR artwork to be exhibited at the National Gallery of Canada.

The artworks created during the Banff programs have been recognized by scholars for their innovative use of technology and aesthetics to challenge traditional viewer-object relationship norms (Moser and MacLeod 1996; Szawlowski 1997; Dyson 2009; King 2017). However, at the time, most museums did not have the desire or means to collect VR, and conservation standards did not support its preservation. This lack of knowledge and resources often resulted in these artworks being neglected, inadequately cared for, and displayed under less-than-ideal circumstances. For that reason, many of the VR works created during the 1990s can no longer be seen or exhibited in their original setups, and are often only experienced through two-dimensional formats such as photographs, video, or written descriptions.

Despite the importance of these artworks in the history of Canadian art, little scholarly attention has been paid to their fate. Moreover, while literature related to media art preservation is extensive, the preservation of early VR art is largely absent from such scholarship. Engaging with the theory and practice of media art preservation, this paper highlights two artworks realized under the Banff programs as a point of entry to explore how VR art from the early 1990s has been cared for and what it means to study works with incomplete, altered, or missing material legacy. Shifting emphasis away from their original state, this approach to art history relies on documentation and archival records to highlight how these artworks have transformed over time and developed into new forms, whether as fragments or variations. A consideration of the evolving practices

and standards which guide the maintenance of these artworks further allows for a richer history of early VR art by establishing a dialogue with the artwork, its materials, and the conditions under which it was created and disseminated. Within this discussion, reinterpretation, once considered a radical media art preservation method, is presented as a potential strategy to provide renewed access to this typology of art.

Early virtual reality art and its preservation

First promoted in the 1980s as a technology for the business sector, 'virtual reality' refers to display technologies that provide users with an audiovisual experience within a three-dimensional (3D) digital environment, allowing a sense of presence or immersion (Rheingold 1992; Gigante 1993: 3; Aukstakalnis 2016). Although there is no set definition, the term 'early VR art' is used throughout this paper to refer to artworks created between 1990 and 1994 as the enthusiasm surrounding VR spread from the fields of space exploration, cyberspace, and the military, into the arts through government-funded, museum-led programs. It may also be referred to as first generation or first wave VR art, although these terms also encompass artworks created in the mid-to-late 1990s, such as the VR installations *Osmose* (1995) and *Ephémère* (1998) by Canadian artist Char Davies.[2]

The defining feature of early VR art is that it was built on expensive, complex, experimental systems, using high-performance graphics workstations, computer-aided design software, head-mounted displays (HMDs), and/or wired gloves. Unlike the current second wave of VR artworks (e.g. Marina Abramović, *Rising*, 2018), which are created on more accessible, low-cost systems, the technical and financial resources necessary to carry out these early projects demanded a collaborative approach towards their development. In addition to government funding, these artworks were built in conjunction with academic and industrial specialists with technical foundations in hardware and software systems. Partnerships included the Department of Computer Science at the University of Alberta, the Autonomous Systems Laboratory at the National Research Council of Canada in Ottawa, and NASA's Ames Research Center in California. Additional support was provided by leading software and computing companies such as Alias Research, Silicon Graphics Canada, Apple Canada, the Intel Corp., and Autodesk Inc.[3]

In terms of subject matter, these artworks are not only built on VR systems, but also reference and reflect on the format itself, its relationship to gender and societal norms, the body, and systems of oppression. In particular, many of the artworks created during this early period were preoccupied with the concept of embodied virtuality and how to further develop a sense of presence within the virtual space (Moser and MacLoed 1996: xvii–xxv; Doyle 2021: 191–5).

The preservation of early VR art combines both the technological issues of preserving moving image and computer-based art with the more spatial characteristics of installation art. Early VR art can therefore be categorized as a form of complex media art, whose fundamental features include three-dimensionality, ephemerality, variability, and interactivity. The conservation risks to these artworks are generated not only from environmental factors such as the deteriorating plastics of a computer, but also, more critically, from issues of technological obsolescence – a phenomenon that generally occurs when an older technology is replaced by a newer one, effectively rendering the older technology dysfunctional. Compared to artworks created in more traditional artistic materials, such as oil paintings or bronze sculptures, early VR art has a much shorter lifespan, owing to its dependence on unstable materials, namely the hardware and software that define the VR experience.[4] And, as illustrated in the following two examples, rapid technological change and the use of expensive, experimental, and vulnerable materials can impact the nature of how an artwork is displayed, perceived, and perpetuated.

Spectral Bodies (1991)

Spectral Bodies (Fig. 1) was created by Canadian new media artist Catherine Richards in 1991 during the Bioapparatus residency, the Banff Centre for Art's first program dedicated to exploring VR. This 10-week residency, initiated and co-directed by Richards and Canadian electronic artist Nell Tenhaaf, was supported by a $50 000 start-up grant, and culminated in a two-day seminar, *Virtual Seminar on the Bioapparatus* (Century 2022: 165). The term 'bioapparatus' was coined by Richards and

Figure 1 Catherine Richards, *Spectral Bodies* (1991). Participant using HMD and wired gloves at the lab in Edmonton. (Photo: Catherine Richards.)

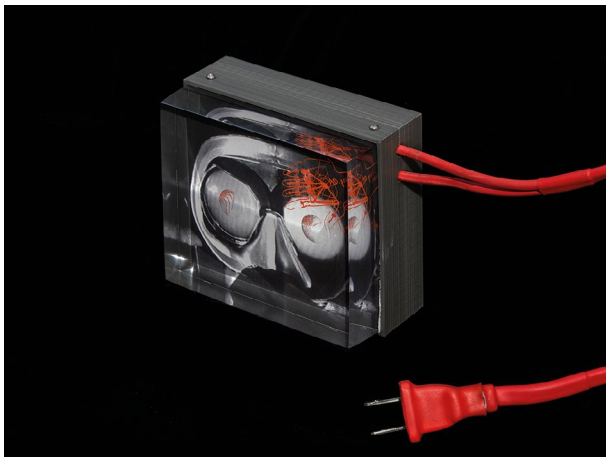

Figure 2 Catherine Richards, *Immersion 1991–2016* (2016). (Photo: Catherine Richards.)

Tenhaaf specifically for the residency and 'combines an understanding of particular philosophies of technology with theories about the technological apparatus, the technologized body, and the new biology' (Richards and Tenhaaf 1991). In line with this philosophical grounding, *Spectral Bodies* addresses issues of simulation and subjectivity within VR by exploring proprioception – the sense of position and movement of one's body parts – within the virtual space.[5] Richards collaborated with scientists at the Computer Science Department at the University of Alberta to produce *Spectral Bodies* using the first VR system in Canada at that time. A detailed technical description of the artwork is included alongside a proposal for Richards' follow-up project *Virtual Body*, an interactive VR artwork commissioned for the Antwerp '93 Festival in Belgium (Richards *et al.* 1994).

In this document, *Spectral Bodies* is described as an art installation comprising a head-mounted display (HMD) and DataGlove, a wired glove that detects and tracks the user's hand movements to project animated 'spectral-like' images inside the display system – low-resolution dots and skeletal lines representing the user's virtual body. For practical reasons, the project focused on a virtual hand and arm in the VR environment.[6] Additionally, a simple spectral dotted image was chosen to 'more closely resemble an illusionary transformation within the user'; a realistic image of the hand/arm, Richards argued, 'would carry with it constraints from the material world' (Richards *et al.* 1994: 387). Furthermore, a spectral image was faster to process than a realistic representation, leading to a shortened

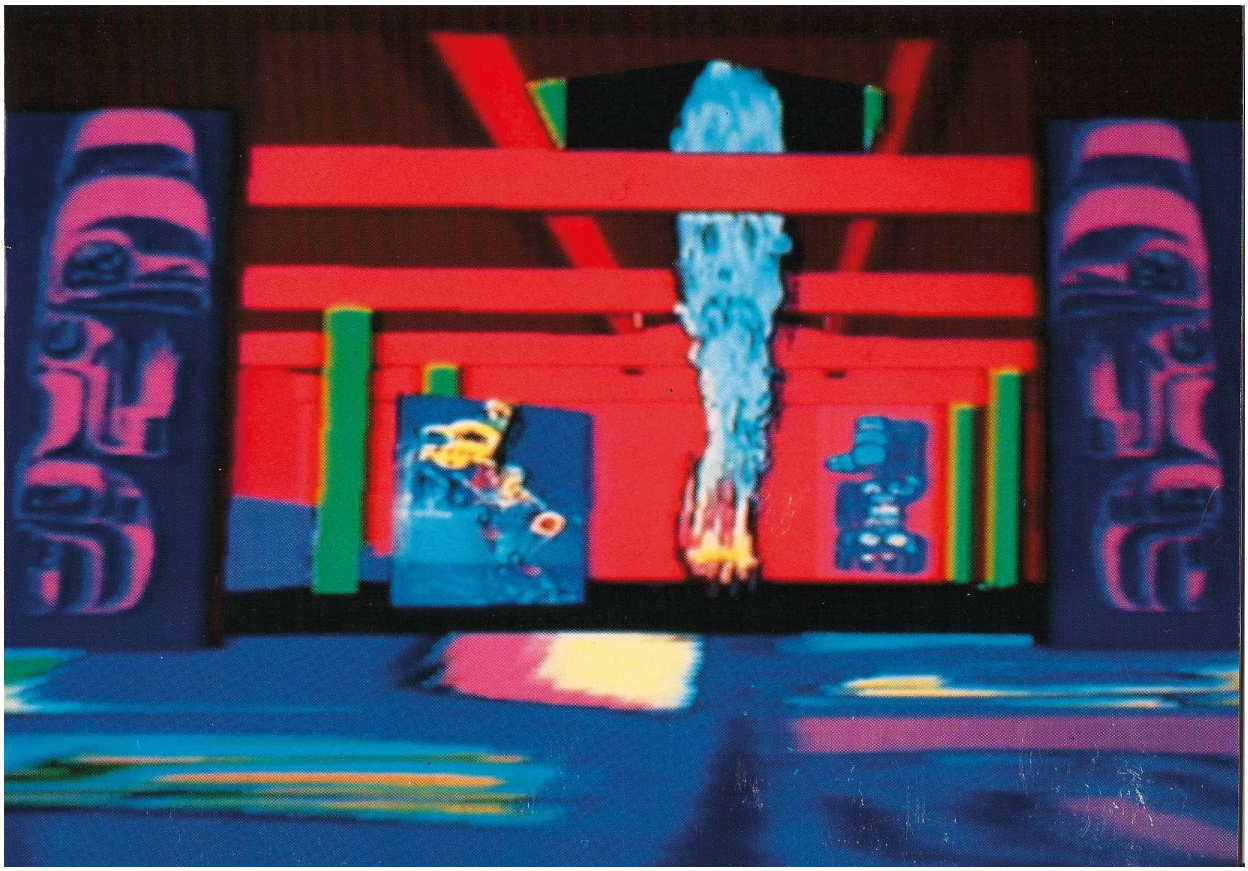

Figure 3 Lawrence Paul Yuxweluptun, *Inherent Rights, Vision Rights* (1992). Frame grab showing dancing figures inside the virtual longhouse. (Photo: Lawrence Paul Yuxweluptun.)

delay in response time. In the final immersive system, the 'experimenter' could manipulate the animation, for example to lengthen or shorten the user's virtual arm/hand, to destabilize the user's 'imaginary bodies' within the virtual space (Richards *et al.* 1994: 388).

Spectral Bodies has been celebrated for its pioneering use of VR and won the Canada Council for the Arts, Petro-Canada Media Biennial Arts award for outstanding and innovative use of new technologies in media arts in 1993.[7] However, the artwork currently does not exist as an immersive system, but rather as a 5½ minute-long videotape existing between speculative science fiction and documentation. Combining fictional and 'real' testimonies of bodily destabilization, the video draws upon several sources, including Oliver Sacks' story of the 'disembodied' woman, who lost sensation of her limbs due to neurological damage; accounts of 19th-century scientists going blind after staring at the sun while studying the optical phenomenon of the retinal afterimage; and documentation of the artist at the lab at the University of Alberta performing physiological experiments using the VR system. In one segment, video recordings of various blindfolded participants or 'subjects' are shown using the HMD and wired glove, narrating the bodily sensations they are experiencing as the spectral image is being manipulated (one woman, for example, describes her arms growing and stretching away from her body).

Several media scholars have written about *Spectral Bodies* within the context of developments in electronic art, embodied virtuality, and embodied feminist criticism. However, these discussions do not mention the transformation Richards' project underwent from its original conception as a three-dimensional, interactive art installation to a static, linear videotape. It was not until viewing a video documentation from a 2013 artist talk in which Richards presented her contribution to *Hybrid Bodies*, a collaborative exhibition, that it become clear that the original VR project was never exhibited. At this talk, the artist revealed that the technicians at the lab in Edmonton, where she had been working on *Spectral Bodies*, had unexpectedly dismantled their VR system before the project could be completed.[8] As a result, the artwork (as we know it today) was finalized in the Banff Media Arts facilities, taking an alternative direction: combining images, text, sounds, video recordings and narration to create a collage of stories recounting loss of bodily presence.

Spectral Bodies continues to have resonance with Richards, informing many of her future projects. In 2016, Richards would revisit *Spectral Bodies* in her mixed-media work *Immersion 1991 to 2016* (Fig. 2). In this artwork, a red sketch showing plans for the sensor pickups on the DataGlove is layered on a still image of a VR HMD from the *Spectral Bodies* videotape. The image is 'immersed' in thick Plexiglas and illuminated from within. As the artist writes, 'this red hand is shown next to the red electrical wire of this box – plugged in – just as the body is in VR'.[9] Once again, the notion of immersion is presented within a static (non-interactive) format.

Inherent Rights, Vision Rights (1992)

Initially conceived during the 1991 Bioapparatus seminar, *Inherent Rights, Vision Rights* (Fig. 3) was completed in 1992 by Lawrence Paul Yuxweluptun, a British Columbia artist of Coast Salish and Okanagan descent, under the Art and Virtual Environments program. Unlike Richards, who had a prior knowledge and interest in VR technology, up to this point Yuxweluptun had worked primarily in painting and mixed media to address environmental and political issues from an Indigenous perspective. The artist, therefore, worked with technical specialists from the Computer Applications and Research program of the Banff Centre for the Arts to carry out his artistic vision.[10]

Based on photographs of the artist at the lab in Banff, and written descriptions of the artwork, we can infer that the first incarnation of *Inherent Rights, Vision Rights* comprised a white HMD, hand-operated controller, and MAC-based computers, all of which were used to immerse the user/participant inside a virtual longhouse, an Indigenous space of worship, to witness a sacred Coast Salish ceremony. Yuxweluptun, the only Indigenous artist involved in Banff's VR programs, adopted the format to critique not just computer technology (which had been used in the past against Indigenous people), but also broader issues of colonial occupation and his culture's 'inherent right' to spiritual, cultural, and social freedom (Todd 1996; 2Bears 2013). In an essay accompanying the artwork, the artist describes the HMD as a 'white man's mask', which he employs to show other cultures his '*Indian* world'. Yuxweluptun likens the HMD to masks typically found in anthropological museums, arguing that the HMD used in *Inherent Rights, Vision Rights* 'will end up in museums just like other masks! Very primitive, with numbers on them, and the date they were made' (Yuxweluptun 1996).

Like *Spectral Bodies*, *Inherent Rights* underwent various physical changes. The first change to the artwork occurred for practical reasons, with the Banff team replacing the 'bulky' HMD with a static viewfinder and joystick prior to its unveiling at the National Gallery of Canada in 1992 as part of the exhibition *Land, Spirit, Power: First Nations at the National Gallery of Canada*, curated by Diana Nemiroff (Century 2022: 173). There is therefore, from this point on, no HMD to wear, but rather 'a kiosk with a viewer, like an old-fashioned stereoscope, [that] allows entry into the work' (Todd 1996: 191), a change which would define the artwork's aesthetic and function moving forward (Fig. 4). Once inside the virtual longhouse, the user is inundated with rhythmic sounds (played through a set of headphones), burning fires, and dancing (masked) figures based on imagery from the artist's paintings. A joystick affixed to a wooden control tower allows the user to walk forward or backward in the longhouse, giving the sensation of being present among the figures. But unlike VR experiences today that offer boundless movements within a virtual world, Yuxweluptun's artwork has been programmed to deny the user certain navigational decisions, never allowing the mostly non-Indigenous, settler museum visitors full sovereignty over the virtual space (Todd 1996: 192; King 2017).

After the *Land, Spirit, Power* exhibition, *Inherent Rights, Vision Rights* travelled to the Canadian Embassy in Paris in 1993 for the solo exhibition, *Inherent Rights, Vision Rights*: *Virtual Reality, Paintings and Drawings*. The work returned to the Banff Centre for Arts a decade later, in 2003, for the group exhibition on Indigenous new media art *Back/Flash*. Finally, in 2016, the work was revived as part of a retrospective of Yuxweluptun's work at the Museum of Anthropology, University of British Columbia (MOA) in Vancouver for the exhibition *Unceded Territories*. In comparing installation views of the artwork at the National Gallery in 1992 to photographs from the 2016 MOA exhibition, it appears that, at the very least, several changes had occurred to its hardware configuration. The 2014 outgoing condition reports from the Walter Phillips Gallery, and conversations with Karen Duffek, Curator Contemporary Visual Arts & Pacific Northwest at the MOA, made clear that the Banff

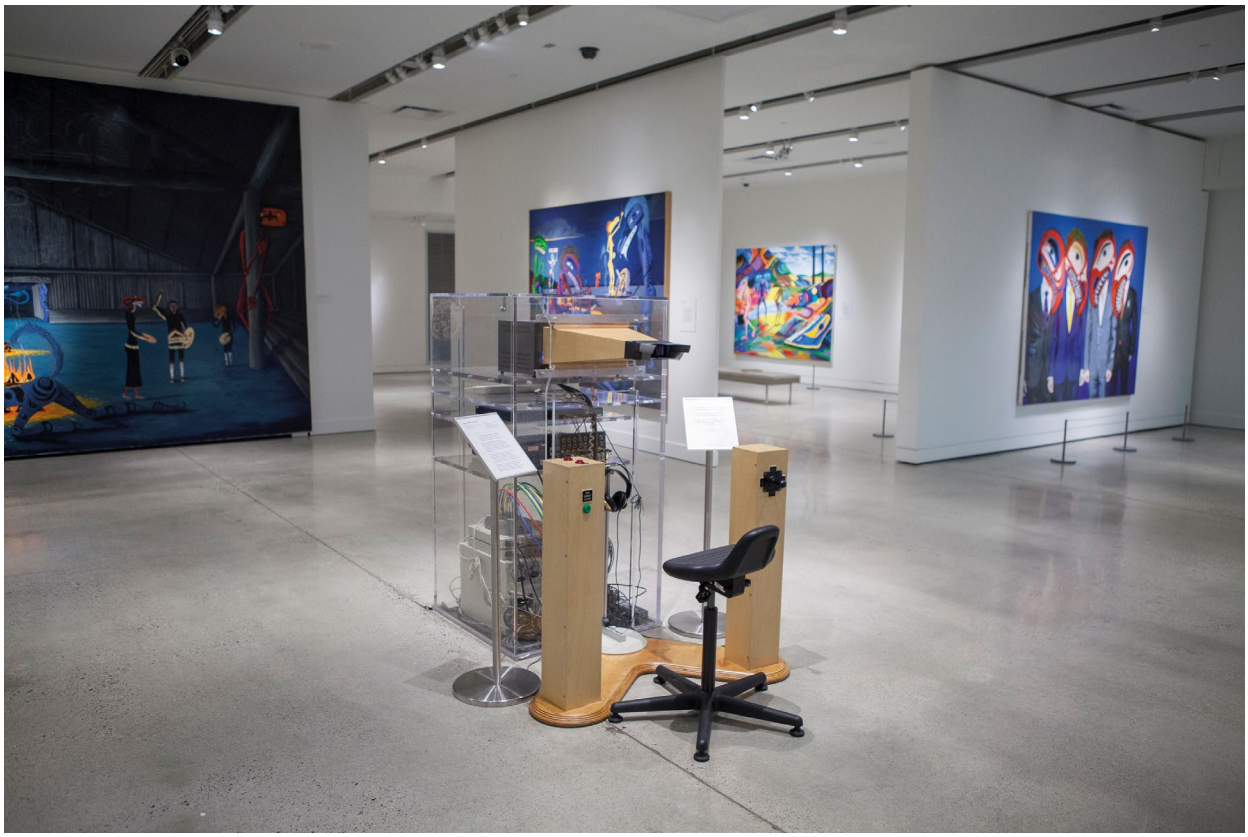

Figure 4 Lawrence Paul Yuxweluptun, *Inherent Rights, Vision Rights* (1992). Installation shot of the artwork installed at the Museum of Anthropology at UBC in 2016. (Photo: Karen Duffek.)

Centre had been storing the work for many years with little active conservation intervention, resulting in the need for hardware upgrades before it could be exhibited. Ahead of the 2016 MOA exhibition, the outdated hardware components were replaced with equally outdated, but still functioning ones. Unfortunately, this was unable to solve the software problem, and the artwork broke down several times during the *Unceded Territories* exhibition. At one point, the artwork stopped working entirely, and for the last two weeks of the exhibition, the work was replaced by a 25-minute video created by the museum's media technician with, of course, the interactive component missing. After the exhibition closed, the work was returned to the artist where it remains in his studio in Vancouver. Today, this important piece is inoperable and can only be accessed through its documentation.[11]

Unfortunately, *Spectral Bodies* and *Inherent Rights* are not unique examples: a survey of the other VR artworks created during the Banff programs reveals that these artworks were typically experienced by very few people, and that, in many cases, the original VR simulation was replaced by video documentation. Even widely discussed artworks like Davies' *Osmose* went nearly 15 years without being publicly displayed (and have only recently been restored).[12] Preliminary results of this research therefore raise many questions about what it means to experience, study, and write about early VR art. For example, if the display equipment becomes obsolete or impractical, might the translation into newer or different display formats alter the meaning of the artwork? Is a VR artwork that can no longer be experienced in its original format fully 'lost'? Or can an altered or two-dimensional version become its afterimage, testifying to it for the rest of time?

Renewal strategies

Given that the history of early VR art is inextricably linked to its preservation, the second half of this paper focuses on renewal strategies aimed at providing continued access to an artwork (physically and/or conceptually). Although little exists in terms of an early VR art preservation guide, there are, to date, various acknowledged strategies for the conservation of time-based media art and, more recently, software-based art. These strategies, in one way or another, draw on four main preservation approaches, ranging

from conservative to radical, and include: storage, migration, emulation, and re-interpretation.

While these approaches have been in practice for decades, they were initially described as a group of four in 2003 by media scholar Jon Ippolito in the *Variable Media Questionnaire* (Rinehart and Ippolito 2014: 236). Since then, numerous individuals and cultural heritage institutions have explored and created variations on this theoretical framework. In general, within the field of media art conservation, 'storage' refers to the traditional practice of keeping an artwork in a climate-controlled environment. For early VR art this means keeping original equipment, such as HMDs, hand controllers, monitors, and other computer hardware, functioning for as long possible in their original formats. 'Migration' involves updating an artwork by upgrading outdated, non-functioning elements (software and/or hardware) with newer, contemporary versions. For example, replacing an outdated monitor with a newer one, transferring an artwork stored on a U-matic tape to a digital video format, or creating new software code to allow an artwork to function on a contemporary computer. 'Emulation' involves reconstructing or imitating the original appearance of an artwork using newer or different means, referring to both the refabrication of an artwork's physical components, as well as running original software code for an outdated platform on contemporary hardware using a virtual machine (creating contemporary software and/or hardware capable of interpreting the original code and functionality of the artwork). Finally, 're-interpretation', considered the riskiest strategy, involves recreating, remaking, or reinventing an artwork, preserving the original artistic intention but reimagining the work through completely new means (De Vos 2018: 5–13; Rinehart and Ippolito 2014: 8–11).[13]

At the time of writing, exploratory research related to the preservation of VR focuses primarily on emulation and migration. Savannah Campbell's 2017 MA thesis *A Rift in Our Practices? Toward Preserving Virtual Reality*, and Candice Cranmer's 2017 report *Preserving the Emerging: Virtual Reality and 360-Degree Video*, an internship report, published by the Netherlands Institute of Sound and Vision, acknowledge the lack of standards in place for the preservation of VR in cultural heritage institutions. Their reports put forward emulation and migration strategies as possible methodologies, while also identifying issues of practicality with each approach, primarily that emulation and migration are costly, time-consuming, and labour-intensive processes (Campbell 2017; Cranmer 2017). In 2021, expanding on Campbell's and Cranmer's research, Tom Ensom and Jack McConchie, time-based media conservators, published the report *Preserving Virtual Artworks* as part of Tate's ongoing Preserving Immersive Media project. Likewise, this report analyses the suitability of storage, migration, and emulation strategies, specifically addressing the preservation of VR-based artworks (Ensom and McConchie 2021). To better understand the challenges of preserving VR, Ensom and McConchie consulted artists and makers currently engaged in the production of VR artworks. Their findings and recommendations, therefore, are largely based on their knowledge of contemporary VR systems and production methods employed in the creation of second wave VR art, although rapid technological obsolescence remains the key threat to their sustainability. The report proposes a combination of established conservation concepts, including stockpiling, hardware migration, emulation, and code migration, and outlines the usefulness and drawbacks of each approach. For example, while hardware stockpiling may provide a short-term solution by replacing failed hardware with a functioning equivalent, they acknowledge that all hardware is expected to eventually fail. Hardware migration, on the other hand, may be more useful in the long term, they argue, but is likely to alter the characteristics of the artwork.[14]

The main challenge of preserving VR art involves making decisions about what is important to store, migrate or emulate (and/or reinterpret). This involves deciding what components, or characteristics, are essential in identifying a particular (re)presentation as a faithful instance of that artwork, and what is an acceptable degree of change or loss (Laurenson 2006). The playback equipment used in VR art presents specific challenges as assigning value to components of VR art is independent of the art institution's ability to preserve what is deemed significant. Even under perfect storage conditions, the playback equipment (original or updated versions) will one day deteriorate and become obsolete. Therefore, any strong relationship between an artwork's material components and its identity or value will inevitably result in a level of change or loss.[15] Preservationists must decide if it makes sense to associate the identity of VR art with components that cannot be preserved (without loss). For early VR artworks, whose material components are often altered, fragmented or missing altogether, this decision is imperative as

the collecting institution may no longer have the capability to effectively address their preservation needs using established methods. These artworks, rather, demand alternative medium-independent strategies, such as reinterpretation, that consider and embrace the absence of the physical art object.

Reinterpretation redux

In recent years, the preservation community has reconsidered reinterpretation as an unconventional approach to preserving cultural heritage. As compared to object-oriented methods such as storage, migration, and emulation, reinterpretation establishes a more secondary relationship to the artwork as an object, 'sacrificing fidelity to the original material in favor of fidelity to the original spirit'.[16] Or, as Ippolito postulates 'to the aesthetic possibilities of a new artwork', a (re)definition of the term which signifies a clear shift in thinking.[17] While storage, migration and emulation strategies are frequently used for the preservation of media art, reinterpretation is seldomly practiced, often only considered if no other preservation strategies remain (Huber 2013: 143). Within the last decade, however, the preservation community, including Ippolito, Gabriella Giannachi, Richard Rinehart, and Gaby Wijers, among others, has re-evaluated the viability of reinterpretation to provide long-term access to artworks affected by rapid technological obsolescence. Research projects investigating this strategy, such as UNFOLD, led by Gaby Wijers from LIMA Media Art, Amsterdam, and theoretical publications such as *Over and Over and Over Again: Reenactment Strategies in Contemporary Arts and Theory*, edited by Cristina Baldacci, Clio Nicastro and Arianna Sforzini, challenge currently accepted conservation principles which place emphasis on authenticity and originality, focusing instead on access as essential to preservation.

Although the concept of reinterpretation is common with performance artworks such as theatre, dance, and music, until recently, it was viewed as a drastic approach for media art preservation, acceptable only under certain circumstances (ex. limitations of the physical space) (Rinehart and Ippolito 2014: 10). Characterizations of reinterpretation within the field of media art often follow or build on the definition included in the glossary of the 2003 book *Permanence Through Change: The Variable Media Approach*, published by the Guggenheim Museum in New York, co-authored and edited by Alain Depocas, Jon Ippolito and Caitlin Jones. Within the variable media concept outlined in the book, reinterpretation is defined as 'the most radical preservation strategy', as it involves 'reinterpret[ing] the work each time it is re-created'. Reinterpretation, the authors warn, 'is a dangerous technique when not warranted by the artist, but it may be the only way to recreate performed, installed or networked art designed to vary with context' (Depocas *et al.* 2003: 128). Similarly, in the description of the 2009–2011 Obsolete Equipment research project, led by Gaby Wijers and media preservationist Emmanuel Lorrain, reinterpretation is described as 'a dangerous technique if it is not used under the supervision of the artist him or herself', while also acknowledging that, 'in some cases [reinterpretation] is the only way, for example, to exhibit installations that differ according to the setting in which they are exhibited'.[18] This perspective is echoed in German artist and art historian Hans Dieter Huber's 2013 essay, 'From new media to old media,' published in the *Digital Art Conservation* anthology, describing reinterpretation as 'the most radical conservation strategy', and the last possibility for conserving an artwork if emulation does not represent a viable solution (Huber 2013: 143).

At the time these definitions were established, little research on reinterpretation of media art had been conducted, as indicated in the *Obsolete Equipment* report. Most preservation efforts focused rather on emulation strategies.[19] In the last 10 years, however, as issues of obsolescence accelerate (and important technology-based artworks have succumbed to its effects), there has been a shift in focus from authenticity to access. Preservationists who once considered reinterpretation as risky and radical have adapted their viewpoint, acknowledging its potential to move beyond the medium to preserve meaning and experience. Since 2016, for example, the UNFOLD team has re-examined reinterpretation as both a creative act and a conservation strategy for complex media art and digital art through a series of case studies, public talks, and publications. This ongoing project challenges conventional characterizations of reinterpretation by conceptualising and practicing preservation as an interpretive act in which the live, or performed, qualities of the original artwork can be preserved and represented through its reinterpretation (Wijers *et al.* 2017: 5–6). In the research group's 2016–2017 report, reinterpretation is positioned as

an ideal strategy for perpetuating and renewing cultural memory. Reinterpretation, they argue, has the capacity 'to rethink, rearticulate and recontextualize artistic thought' and 'would allow for the exploration of the past from the present that equally questions our contemporaneity and devises other possible futures' (Wijers *et al*. 2017: 22). Recent case studies carried out during the UNFOLD project include the reinterpretation of *Audience/Performer/Mirror* (1975), an iconic artwork by Dan Graham (1942–2022), and re-performances of installation artworks by media art pioneer Nan Hoover (1938–2008). In both cases, the original artworks featured performance combined with legacy video formats, elements that were translated and re-presented by contemporary artists and recontextualized using contemporary digital technologies and online social networks. The project organizers concluded that through reinterpretation, the artworks were given renewed relevance, establishing new meaning with a contemporary audience, while staying true to the essence of the original pieces (Roorda 2020: 6–7).

Reinterpreting early virtual reality art

As UNFOLD has demonstrated, a shift to a medium-independent approach could be fundamental to ensuring long-term access to early VR artworks, which are often fragmented, non-operational, or 'lost', and whose meaning, like performance art and other forms of time-based art, is derived when in operation, or when *performed*. Early VR artworks, like those created under the 1991–1994 Banff programs, demand unconventional forms of conservation not only because of their dependence on outdated technologies, but also their dependency on user participation/interaction (Wijers 2022: 193). Reinterpreting early VR art within a contemporary context might also allow the artworks (and users/participants) to engage with its history and memory within a renewed context, bringing new relevance to the work. While reinterpreting an artwork like *Inherent Rights, Vision Rights* may require altering its original appearance, it has the potential to preserve its performative qualities – the ability to at once allow users a glimpse into a sacred world yet react to their movements within the virtual space in challenging ways – something not afforded by a two-dimensional format. Mediated by contemporary VR technologies, reinterpretation could offer early VR art life beyond the playback equipment on which it was originally created and/or the context in which it was originally displayed/experienced. Since the experimental programs at Banff in the 1990s, contemporary audiences have a much different relationship with VR, video games and the internet. This new relationship with digital technologies might be worth engaging within the *spirit* of the original VR artworks. In this way, reinterpretation offers curators and artists the potential to change or reinterpret certain original aspects or components of the original setup and explore to what extent these changes mean in a renewed context. Rather than regarding early VR art as fixed or static art objects, a reinterpretation strategy has the potential to rearticulate an artwork beyond maintaining its physical availability, allowing its original artistic intention to remain accessible, intelligible, and relevant.

Furthermore, this preservation strategy seems quite appropriate for this typology of art; many of the artists involved in the Banff programs have already begun to revisit their early 1990s exploratory VR projects, creating new artworks with material and conceptual links to the originals. Like Catherine Richards' reuse of elements of *Spectral Bodies* in her 2016 work *Immersion 1991–2016*, Yuxweluptun has revisited his 1992 work *Inherent Rights, Vision Rights*. In 2020, Yuxweluptun and Canadian filmmaker and VR creator Paisley Smith created *Unceded Territories*, a VR experience that borrows from Yuxweluptun's art to address issues of colonialism, climate change and Indigenous rights within a contemporary context, using contemporary VR technology.[20] While not direct reinterpretations, these new artworks provide renewed access to their early 1990s counterparts, which are otherwise (in their original formats) inaccessible.

Reinterpretation and authenticity

While projects like UNFOLD show the viability of reinterpretation as a renewal strategy, a guide for its use in the field of media art preservation has yet to be established. Reinterpretation, furthermore, may have different theoretical and practical significance for art history than for art conservation. Although beyond the scope of this paper, the ethics of care associated with reinterpretation warrants further investigation. Research by Amy Brost, media conservator at the Museum of Modern Art, New

York, and Cristina Baldacci, associate professor in history of contemporary art at Ca' Foscari University, Venice, included in *Over and Over and Over Again*, offers a starting point for this discussion (Brost 2022; Baldacci 2022). Brost's article, 'Reconciling authenticity and reenactment', provides an art conservation perspective. Applying the score/performance model, the concepts of autographicity and allographicity, and the concept of iteration, Brost proposes a conceptual model based on the ritual aspects of continually presenting and representing artworks.[21] In this model, authenticity and repetition can be reconciled within a ritual context – guidelines that determine what makes a tradition, such as the Jewish ritual of the Passover Seder, authentic. If artworks are performed as a ritual, she argues, then they are authentic every time (Brost 2022: 190). In the article, 'Re-presenting art history: an unfinished process', Baldacci investigates reenactment, including the restaging of exhibitions, as an alternative method of re-presenting art history. Building on postmodernist concepts of repetition, Baldacci examines the boundaries between authenticity and auraticity, citing various examples of reconstructions by artists and museums which undermine the traditional concept of authenticity and original quality. Brost and Baldacci, respectively, demonstrate historical precedence for the use of reinterpretation and its cultural value in the field of media art and its preservation. Further areas of research include addressing questions pertaining to the physical and conceptual consequences of reinterpretation (for the artist, collecting institution, and viewer), the level of involvement of the artist/maker in the conservation decision-making process, and the limitations of its use.[22]

Conclusion

While research related to media art preservation is extensive, the history and preservation of early VR artworks is largely absent from such scholarship. Rapid technological change and the lack of established standards, however, necessitate art historians and collecting institutions to rethink and (re)develop strategies that can better serve these artworks. Unconventional and collaborative art historical methods and preservation strategies that acknowledge and accept decay, deterioration, and variation, as much as they do maintenance and restoration, may be essential to recovering at-risk artworks from being lost from the cultural record. By foregrounding how these objects have been and are currently cared for, and how these decisions have shaped their historical record, a richer history of early VR artworks can be established. Shifting emphasis away from the importance of the original version, this approach, rather, memorializes how early VR art has been altered or transformed over time, and the ways in which it has either developed, or has the potential to develop into new forms, whether as fragments, variations, or reinterpretations.

Acknowledgements

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Notes

1. For a history of VR technology in Canada and its inextricable links to Canadian government policy, see Century 2022: 159–82. In the chapter, 'Contesting a "New Art Form": Virtual Reality as Cultural Probe,' Century, who was involved in the funding of the Banff Centre of Art's 'Art and Virtual Environments' (1991–1994) project, provides insight into the organization of the programs and the creation of the artworks.
2. For an overview of first wave and second wave VR art which takes into consideration works created between 1990 and 1994 see, for example Dixon 2006 and Doyle 2021.
3. For technical and financial details related to the development of the artworks created under the Banff programs see, for example, Moser and MacLoed 1996: 159–82 and Century 2022: 159–92.
4. In the essay, 'From New Media to Old Media: Ambiguous Concepts, Complex Problems, and Open Questions,' published in the 2013 anthology *Digital Art Preservation*, Hans Dieter Huber, German artist, and art historian, calls technological obsolescence 'an acute threat to cultural memory'. See also Lorrain 2013: 232–42.
5. C. Richards, 'Spectral Bodies'. Available at: http://www.catherinerichards.ca/artwork2/Spectral_statement.html (accessed 23 June 2023).
6. This paper was originally presented at *IS&T/SPIE 1994 International Symposium on Electronic Imaging: Science and Technology Conference* and investigates methods for users 'to feel present in an unrealistic virtual body' via art installations.

7. C. Richards, 'Biography'. Available at: http://www.catherinerichards.ca/biography.html (accessed 23 June 2023).
8. C. Richards, 'Hybrid Bodies', PowerPoint presentation, PHI Centre Montreal. Available at: https://www.hybridbodiesproject.com/new-page-2 (accessed 23 February 2024).
9. C. Richards, 'Immersion Statement'. Available at: http://www.catherinerichards.ca/artwork2/Immersion_statement.html (accessed 23 June 2023).
10. For a technical background on the production of *Inherent Rights, Vision Rights* (1992) see, for example, Moser and MacLoed 1996: 320–27 and Century 2022: 171. According to Century, by spring 1992, a dedicated laboratory with high-performance graphic workstations and other state-of-the-art equipment was established at the Banff Centre for the Arts. Technical experts were recruited from the University of Alberta's Computer Science Department to carry out the second phase of the project between 1992 and 1994.
11. Karen Duffek, University of British Columbia, personal communication, 30 March 2018.
12. Century (2022: 173) notes that *Osmose* 'has not been shown publicly for the past 15 years'. However, the work was eventually restored and exhibited in 2022 along with *Ephémère* at the Fotografisk Center in Copenhagen, Denmark.
13. E. Lorrain, 'Obsolete Equipment,' *SCART: A Website on Audiovisual Heritage, PACKED: Centre of Expertise in Digital Heritage*. Available at: https://www.scart.be/?q=en/content/obsolete-equipment (accessed 13 February 2022).
14. Ensom and McConchie (2021) conclude the report with a set of recommendations for artists and collection institutions dealing with the immediate task of caring for VR artworks. The authors highlight the importance of gathering materials (a computer system and other hardware, executable software, and source materials necessary to operate the artwork), along with supporting documentation, at the point of acquisition. While this report is a useful guide for the collection and preservation of second wave VR art, it does not consider the challenges that complicate the acquisition and preservation process of early VR art, namely that many of the original hardware and software components, along with any supporting documentation, are often missing, altered or fragmented. Furthermore, early VR art is often built on expensive, experimental VR systems that required collaboration with technicians in their development. The workflows proposed in this report, therefore, may not be suitable.
15. See note 13 above.
16. J. Ippolito, 'Is reinterpretation the new emulation?' *Still Water blog*. Available at: https://blog.still-water.net/is-reinterpretation-the-new-emulation/ (accessed 23 February 2024).
17. *Ibid*.
18. See note 13 above.
19. *Ibid*.
20. L.P. Yuxweluptun and P. Smith, 'Artist Statements,' *Unceded Territories*. Available at: https://www.uncededterritories.ca/ (accessed 10 March 2024).
21. The score/performance model was put forth in 2006 by Pip Laurenson, pioneer in time-based media art conservation at Tate, London. The model addresses the variable nature of time-based media installations, defining an artwork in terms of its 'work-defining properties', which must be maintained to ensure its authenticity, while allowing other properties of the work to change without comprising integrity.
22. Baldacci (2022: 25), for example, argues that the greatest risk of reenactment as a curatorial and art historical method is the possibility that it will be used for economic rather than cultural means.

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Part 2: Material practices, reconstructions and archival research

Technical art history, itineraries, networks and interdisciplinary collaboration: the curious history of the green 'soup' turtle

Erma Hermens and Paul J.C. van Laar

ABSTRACT Technical art history employs an interdisciplinary research approach, combining methodologies from both humanities (including conservation) and science. Such interdisciplinary object-led research requires its participants to carefully develop a collective terminology and language, and construct a communal research area. This requires extensive thinking outside the box, away from disciplinary silos. By using object biographies and itineraries as a conceptual framework for technical art historical research, it becomes increasingly clear that to uncover the many intersecting narratives embedded in the matter and making of artefacts requires teamwork to bridge many knowledge gaps. To illustrate this, a case study of a 17th-century green sea turtle carapace, painted with a portrait of the Dutch Prince Frederick Henry is used. Its research led to a true interdisciplinary exercise with an important context of intersecting narratives on the use of turtle shields for artefacts, its historical connotations and use in medicine, Kunstkammer and much more. We are using a nodal net/meshwork approach that connects material and contextual narratives hidden in this curious object. Instead of framing the object's chronology in a linear fashion, with a moment of inception followed by consecutive events altering its materiality and meaning, the formulation of a net/meshwork with related nodes allows for a more holistic interpretation of its existence. This democratic approach – and the sometimes surprising narratives developing at the interfaces between nodes in a meshwork of intersecting narratives – has the potential to bridge many gaps and put together the object's open-ended and often astonishing material and contextual journey(s). Nodal networks and/or meshworks can also be used to plan research and develop and prioritise research strands.

KEYWORDS technical art history, material culture, meshworks, nodal networks, interdisciplinary research, object-led research

Introduction

Technical art history is often described as inherently interdisciplinary. However, setting the parameters and methodologies of such research remains a pertinent inquiry. This paper presents the use of nodal networks and meshworks as frameworks that support the development of interdisciplinary research trajectories, and facilitate storytelling interesting to scholars and the general public alike. These frameworks are discussed in light of a research project started by the authors during the pandemic: 'The curious history of the green "soup" turtle'. This project focuses on a green sea turtle (*Chelonia mydas*) carapace painted with a portrait of Prince Frederick Henry (1584–1647) on horseback in the collection of the Rijksmuseum, Amsterdam (Fig. 1).[1] While slightly unusual due to its untraditional artistic format, this case study provides ample material to demonstrate the functionality and usefulness of such networks. As 'the turtle project' is still ongoing, the aim of this paper is not to present its final results but rather to function as a proof of concept for the utilisation of various types of networks to support, guide and structure technical art historical research.

Technical art history

Background

The term 'technical art history' is relatively young. David Bomford was one of the first to formally refer to the term in his 1998 Introduction to *Looking through Paintings.* He describes technical art history as a 'wide ranging, inclusive, evocation of the making of art and the means by which we throw light on

Figure 1 *Equestrian Portrait of Prince Frederick Henry*, anonymous, in or after 1631, oil on turtle shell (green sea turtle, *Chelonia mydas*), 117 × 68 × 30 cm, NG-NM-2970, Rijksmuseum, Amsterdam, public domain.

that process. It is generally – but not exclusively – concerned with the physical materials of works of art and how they are prepared, used and manipulated.' He underscores that this approach should surpass a mere identification of materials and methods and should delve 'into questions of artists' methods and intentions and how concepts are translated into substance' (Bomford 1998: 9).

Since then, technical art history has undergone significant and fast-paced developments, in large part due to the expanding variety and accessibility of scientific analytical methods, imaging tools and computational techniques. While a few educational programmes and journals dedicated solely to technical art history have been established, its development has not been unequivocal or straightforward. Fundamental questions persist regarding its precise scope and focus, as well as its positioning compared to related fields such as heritage science and materials science. Is technical art history a distinct discipline or does it function rather as a sub-discipline within the broader realm of art history? Furthermore, what is the role of the technical art historian in achieving interdisciplinary research in both academic and museum contexts?

To address these topics, a comprehensive literature review or historiography is necessary – something that exceeds the scope of this paper. A recent research report by one of the authors of this paper, commissioned by the Samual H. Kress Foundation, serves as a valuable starting point, however, as it offers an evaluation of the state-of-the-art of the field using insights based on the author's experience, alongside interviews with a wide array of professionals (Hermens 2024). Based on that survey, the following updated definition of technical art history was formulated:

> Technical Art History addresses the 'when, why, who, what, where and how' questions of Art History, but does so by taking the object itself as the primary source of information, with a focus on understanding and contextualising its making and material composition, by using a holistic, multifaceted interdisciplinary research approach to construct object biographies and itineraries to answer these questions.

This references the definition presented by Bomford in 1998, as it focuses on contextualising knowledge related to an object's making and material composition – often substantiated by scientific analysis but starting with an art historical research question. Hence, while its toolkit may partially overlap with that of heritage science, technical art history differs significantly in the questions it asks and the aim it pursues (Streeton 2022).

A necessary step in the further development and formalisation of technical art history, and a requirement to address many of the disciplinary ambiguities, is the formulation of a robust methodology to support research trajectories for contextualisation and effective integration of scientific and arts and humanities research. This paper proposes such a methodological framework and uses a case study to illustrate how the technical art historical approach can enrich object-based research. This opens the way to expand the contextualisation of objects within a wider network of material culture, broadening our understanding of the artistic process and its historical significance.

Object biographies, itineraries and meshworks

An often-employed methodological framework that has its origin in anthropology and archaeology is to

reconstruct the object's life through the compilation of an 'object biography'. This approach was first put forward in 1986 by anthropologist Igor Kopytoff in the influential volume *The Social Life of Things* edited by Arjun Appadurai (Kopytoff 1986). Its main premise posits that objects can be examined through a trajectory akin to a human life cycle: they are 'born' when created, then experience a (social) life through interactions and relationships with other objects and humans, and ultimately reach a form of 'death' as those connections are severed through loss, oblivion or destruction.

In anthropological and archaeological discourse, the biography framework serves as a lens through which the intricate dynamics between people and objects are studied. It is used to question how the social interactions of an object change within specific spatial and temporal contexts, and thus is utilised to describe shifts in the meaning of objects (Fontijn 2013: 184). While technical art history pursues different lines of inquiry, drawing from such frameworks proves beneficial, as it showcases how to synthesise diverse narratives associated with a single object.

In the context of technical art history, the object biography requires a comprehensive examination of the environment in which the object was conceived by its maker(s), of the availability and affordances of materials and techniques used in its making, the changes that occurred to these materials over time, and the impact of its ever-evolving contexts such as new functions, ownership, fashions and status. Additionally, insights into the impact of external factors such as past conservation treatments, environmental conditions, changes in storage and location, as well as damages due to war or other unforeseen circumstances, also contribute to the comprehensive understanding of the object's history and its journey leading up to its current material state.

Since its introduction, however, the biographical approach has been subject to criticism, and recent discourse has moved beyond the object biography to allow for a more nuanced exploration of the entangled narratives that objects can embody (Bauer 2019: 336). For the purposes of technical art history, a notable deficiency is, as highlighted by Bauer, that the biographical approach is 'historical and cumulative rather than relational and multimodal' (Bauer 2019: 338). It therefore strongly implies finality or a definitive beginning and end with a linear trajectory in between. This perspective restricts the exploration of connections preceding an object's creation, such as the influence of material availabilities through trade networks and technological advancements, or those extending beyond its change and/or destruction, including fragmentation and reuse (Bauer 2019: 338). Such restrictions have been strongly challenged by, for example, anthropologist Tim Ingold, who argues that long before an object comes into being, its composite materials may already exist, and in turn, these materials may continue to exist in some way or another after the object loses its form (Ingold 2012: 87).

To overcome these limitations, a methodological approach has been proposed that complements the object biography: the concept of 'object itineraries' (Joyce 2012; Fontijn 2013; Hahn and Weiss 2013; Joyce and Gillespie 2015). Instead of viewing an object's existence as a linear process, moving from A (birth) to B (death), with a focus on its evolving social relationship with humans, the itinerary approach conceptualises the object following various routes as it moves through time and space, collecting many different stories. These stories may lack a straightforward beginning or end, nor do they only concern human interaction with or interpretation of the object. Furthermore, the itinerary approach emphasises that objects possess not one but multiple itineraries, that all may intersect and influence each other resulting in a complex entangled meshwork. This framework thus encourages a more holistic understanding of objects, acknowledging their dynamic and multifaceted existence within broader historical, cultural, and material contexts (Streeton 2017).

While at first sight this may come across as a mere ontological debate with limited practical implications, adopting the itinerary approach opens up many more interesting avenues for uncovering an object's entangled history that surpass the biographical framework. To illustrate, consider a typical 17th-century Dutch painting. Using the biographical framework, it is possible to attempt and trace the object's origins and a probable original appearance by studying its materials and assessing how various degradation processes have shaped its current appearance. The itinerary approach goes further than this, however, and instead acknowledges, for example, that each of these materials has its own route, or itinerary, prior to the painting's creation. Exploring these different routes not only provides essential knowledge for uncovering a probable original or 'authentic' state of these materials, but also

situates the material life of the painting within a wider network of pigment trade, technological advances in pigment production and extraction, as well as studio practice and artist experimentation. The itinerary approach reveals the painting as not just a standalone object but one linked to a complex web of interconnected historical and material narratives. While an object biography remains unique to that specific object, itineraries have collective aspects, in such a way that (parts of) a specific itinerary of an object might overlap with that of other objects, relevant events, societal changes and other factors (Ingold 2007: 82–5, 2011b: 62–94, 2015: 4; Joyce 2015: 29).

Tim Ingold has likened the entanglement and intersection of the various itineraries hidden within an object with a 'meshwork', a 'vast labyrinth of entangled lines' (Ingold 2007: 82–5, 2011a, 2011b: 62–94, 2015: 3). As Bauer puts it, such a meshwork better describes 'the objects' complex entanglements with human experience, places and time; a process which is in continuous motion' (Joyce and Gillespie 2015; Bauer 2019: 337). A compelling example of applying object itineraries alongside the meshwork metaphor to cultural heritage objects is Blair's 2015 study that focused on nearly 70,000 glass beads from Mission Santa Catalina de Guale, a 17th-century Spanish mission on St Catherine's Island, just off the coast of Georgia, USA (Blair 2015). By tracing the potential itineraries of this large collection of beads through material analysis and contextual research, Blair revealed the varied origin and paths of trade that brought the beads to the mission site. Analysis showed how the beads arrived in monochromatic bead strands from varying sources and were separated and recombined into distinctive patterns by the Native mission inhabitants. For instance, three graves contained necklaces alternating Venetian beads with those of a probable Spanish origin. The discovery of these rearrangements helped understand the active role beads must have played in the social context of the mission, something about which little was known due to a lack of archaeological context or documentary evidence.

Even for seemingly 'mundane' objects, as Blair puts it, the untangling of the meshwork of itineraries reveals meaningful connections enhancing understanding of both the object itself and the social contexts in which the objects were used. Tracing the objects' journeys through both material and scholarly realms unveils the richness and complexity that object itineraries bring to our comprehension of artworks and their making.

An often-recurring point in discussions of meshworks concerns the relationship and differences compared to regular nodal networks. Ingold makes a distinction between meshworks, characterised by an entangled maze of intersecting and overlapping lines, and nodal networks, consisting of lines connecting different nodes with one another. He is outspoken about the latter's static and sterile nature which is unable to capture the complexity that objects may contain over time (Ingold 2007: 79–81). On the other hand, the complexity and intertwined nature of the meshwork may inhibit a certain ease of documentation, as well as comparison to other meshworks. This criticism is aptly argued by Carl Knappett, who proposes that instead of thinking of meshworks and networks as two opposing concepts, we should think of them as two different approaches to material distribution through time and space, both with their own value (Knappett 2011: 45–6). As will become clear through the turtle case study, the nodal network is a useful way of visualising the interlinked narratives integral to the object, while the meshwork is more conceptual in its nature, steering the fundamental way in which we should approach object-based research open to accepting widespread connections and contextual associations.

Where does the discussion of these different concepts and their application leave us with regards to technical art history and the technical art historian? Borrowing these methodological frameworks from anthropological debates, it becomes clear that objects contain a multitude of different stories or itineraries that can be conceptualised as meshworks. It is up to the technical art historian, working at the interface between the arts and humanities, conservation and science, to build nodal networks based on the hybrid data collected, and disentangle the nodes where data collude and thus oversee the unravelling of an object's life history. By combining scientific data with (art) historical data through contextualisation, the various identified narratives will frame the object in a holistic way, connecting to other objects, people and places in ways that before might have gone unnoticed. Starting with interdisciplinary research as a foundation – and by building interconnected networks and meshworks using the hybrid data collected – the outcome, i.e. interpretation, will exceed the mere sum of its individual parts. The next section illustrates this using the case study of 'the curious history of the green "soup" turtle'.

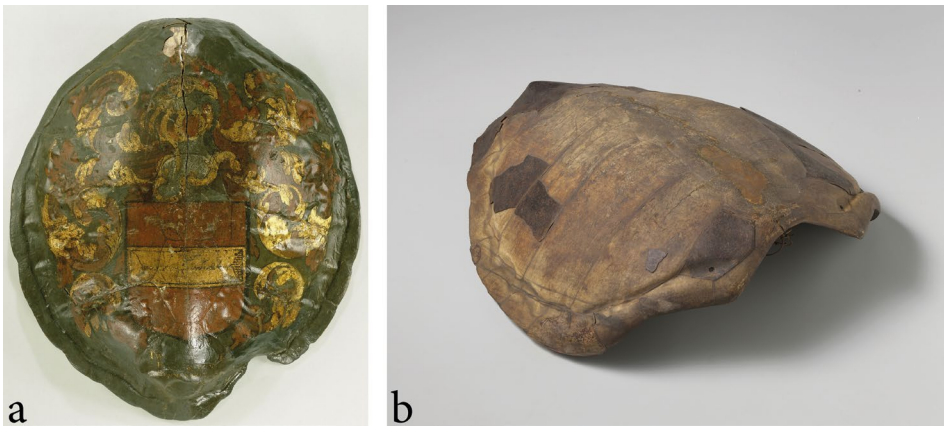


Figure 2 (a) *Turtle carapace with the crest of the lords of Bennebroek*, anonymous, 1500–1900, oil on turtle shell, 73 × 65 × 20 cm, NG-AHMA-15729, Rijksmuseum (on loan from the City of Amsterdam), Amsterdam, public domain; (b) *Turtle shield*, no date, NG-AHMA-15730, Rijksmuseum, Amsterdam, public domain.

Case study: Turtles

The turtle project

'The curious history of the green "soup" turtle' project started during the pandemic lockdown by a team of four students studying for their Masters in Technical Art History at the University of Amsterdam.[2] As the project is still ongoing, this paper will not present the full results but instead use preliminary data as a proof of concept of network methodology for technical art history. The main focus will be on the application of nodal networks and meshworks to guide research and inform object itineraries. The project started with the research of three large green and hawksbill sea turtle shells in the collection of the Rijksmuseum, Amsterdam. The largest carapace – 117 (l) × 68 (w) × 30 (h) cm – depicts a portrait of Prince Frederick Henry on horseback (NG-NM-2970) (Fig. 1) and was likely painted in or after 1631. The second smaller shell is decorated with the family crest of the Lords of Bennebroek (1500–1900), and the third is unpainted but seems to have had some surface treatment such as polishing and reveals marks that could be reminiscent of scratches (NG-AHMA-15729 and 15730, respectively) (Fig. 2).

The team published a popular blog series: 'The unexpected journey of the green sea turtle', read in more than 30 countries by more than 10,000 visitors.[3] The research project focused on the largest carapace and took the team, as the opening blog describes:

> Into many unknown territories, from marine biology – ever thought about the anatomy of giant sea turtles? – to the history of the famous or infamous turtle soup, to pirates and seafarers in the West Indies, traders and explorers, medicinal lotions and potions, the turtle as an artisanal material, Kunstkammer and cabinets of curiosities, military history from Livius (57 BC–AD 19) to Asterix and Obelix, fables and emblems, to name just some narratives that have emerged.[4]

The curator responsible for the object wrote in his invited blog on 'The Turtle and the General': 'This object is also rather complex, as it combines many different aspects: the Netherlands and (probably) the Caribbean, culture and nature, Dutchness and exoticism, if I may use these words, victory and death, etc.'[5]

Intersecting narratives

Based on X-radiography of the shell and a conversation with Rita Patrício, a specialist in the conservation of sea turtles at the Centre for Ecology & Conservation, Biosciences, Exeter University, the shell was identified as belonging to the *Chelonia mydas* genus, the green sea turtle, also popularly named the 'soup' turtle due to its culinary connotations.[6] The size of the carapace indicated that this was an adult at the time of its death.

This begs the question: from where would this carapace have come and, how did it reach the Netherlands? The green sea turtles were among others transported to the Netherlands from St Eustatius, St Martin and Saba, Caribbean islands at that time all under the direct command of the Dutch West India Company. Some 2000 km north, in the Atlantic Ocean, the English Virginia Company settled on Bermuda, the centre of English trade (Fig. 3).[7]

Figure 3 Willem Jansz. Blaeu and Joan Blaeu, *Map of the West Indies (Insulae Americanae in Oceano Septentrionali, cum Terris Adiacentibus)*, 1643–1650, copper engraving printed on paper, 38 × 53 cm. The red box delineates Bermuda, the blue one the Caribbean islands. Public domain. (Source: J. Blaeu, *Théâtre du Monde ou Nouvel Atlas,* Amsterdam, 1643–50).

The long voyages required extensive food supplies for the ships' crew and green sea turtles offered the perfect solution. Having been caught and kept alive easily on board, the turtles served as fresh nourishment for the crew in the event of low food supplies. In 1610, Sylvester Jourdain described the loss of the *Sea Venture*, one of the flagships of the Virginia Company, and the huge value of every part of the turtle as food:

> There are also great store of Tortoses, (which some call Turtles) and those so great, that I haue seene a bushell of egges in one of their bellies, which are sweeter then any Henne egge: and the Tortose it selfe is all very good meate, and yeeldeth great store of oyle, which is as sweete as any butter; and one of them will suffice fifty men a meale, at the least: and of these hath beene taken great store, with two boates, at the least forty in one day (Jourdain 1610: 12–13).

Many long expeditions and explorations were made possible in part by this exceptional food supply, which leads to interesting itineraries for our object, as the inedible turtle carapaces became to be appreciated as curiosities upon arrival to harbours across the globe. Later, a trade in living sea turtles developed whereby these reptiles were imported alive for special occasions, using their own carapaces to serve the famous turtle soup. Of course, these itineraries also connect to histories of colonialism and slave trade as well as to pirates. The latter were responsible for plundering, hunting and gathering logwood, but also, remarkably, for descriptions of nature and hosting explorers on their ships, who were able to travel to observe local flora and fauna.

Alexandre Exquemelin (1645–1707), for example, was a surgeon who joined the buccaneers, privateers who operated mainly in the Caribbean area and robbed the Spanish ships. Exquemelin wrote *De Americaensche Zee-Roovers* (*The History of the Buccaneers of America*), first published in Dutch in 1678, in which he described the buccaneers as famed for their food preparation, especially drying and salting meat, including that of turtles, which they sold to be used to feed slaves and workers at the plantations. Exquemelin

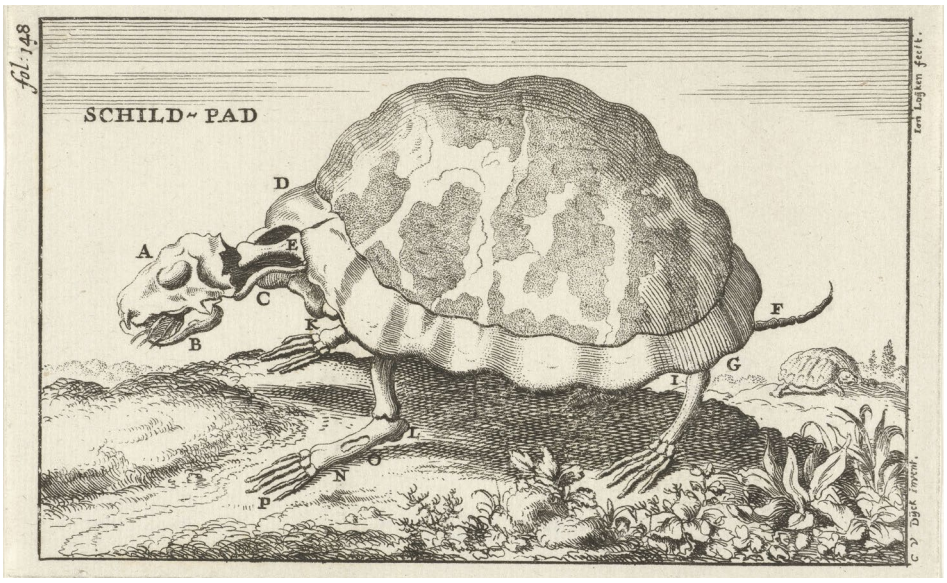


Figure 4 Jan Luyken (after Cornelis van Dyk), *Skeleton of a Turtle*, 1680, etching, 9 × 14 cm, RP-P-OB-44.113, Rijksmuseum, Amsterdam, public domain. With accompanying legend. (Source: Cornelis van Dyk, *Osteologia, of Nauwkeurige geraamt beschryving van verscheyde dieren, nevens hare historien*, vol. 1, Amsterdam, 1680, pp. 147–8.)

described four species of sea turtles of which only one is good to eat:

> In several parts of America are found four distinct pieces of sea turtle. The first are so great, that they weigh two of three thousand pounds. The scales are so soft, that they may be cut with a knife. But these are not good to eat. The second sort is of an indifferent bigness and of a green colour; their scales are harder than the first, and of a very pleasant taste. Their flesh is very sweet, the fat green and pleasant and so prominent that when one has not eaten turtle meat for three or four weeks, it will drench your clothes in sweat and make your body feel heavy (Exquemelin 1678: 37–8).

The turtles' carapaces were also used as a precious material for decorative arts objects. The carapace (the curved dorsal part of the shell) and the plastron (the ventral flatter part) are covered by so-called scutes. Each scute consists of multiple layers of thin plate-like keratin scales, that show the characteristic patchy hues of earthy browns, greens and yellows. Tortoise, as the material is mistakenly named, is found in many objects in museum collections, from utilitarian objects such as combs to beautiful pieces of costly marquetry. The scutes, however, are only a small part of the turtles' remarkable anatomy. Late 16th- and 17th-century illustrated books contain intriguing descriptions such as Cornelis van Dyk's *Osteologia, of Nauwkeurige geraamt beschryving van verscheyde dieren, nevens hare historien* (*Osteology, or Accurately seen description of various animals, and their histories*), published in Amsterdam in 1680, in which the bone structure of the turtle is explained as consisting of '58 bones' and the carapace is indeed interpreted as part of the turtle's skeleton (Fig. 4).

The actual strength of the material and structural composition made the large carapace of the green sea turtle suitable as a soldier's shield. This strength is alluded to by Conrad Gessner, who, in *Historiae Animalium* (1551–558), dedicates a chapter to the Tortoise and describes how:

> It is not without great cause that this shell is called *Scutum*, and the Beast *Scutellaria*, for there is no buckler and shield so hard and strong as this is. And *Palladias* was not deceived when he wrote thereof, that upon the same might safely passe over a Cart-wheel, the Cart being loaded (Topsell *et al.* 1658: 794).

This military connotation fits well with the depiction of Prince Frederick Henry, stadtholder of the Dutch Republic (1625–1647). He was a major military strategist in the Eighty Years' War and his most famous siege was of 's Hertogenbosch, which is depicted in the background of his portrait on the turtle shell. Several other interesting painted turtle shells with military depictions survive in

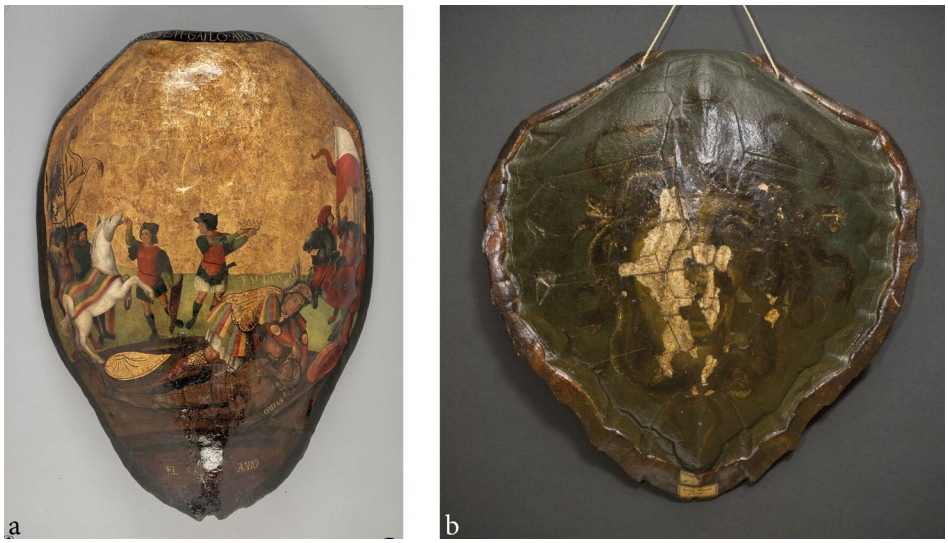
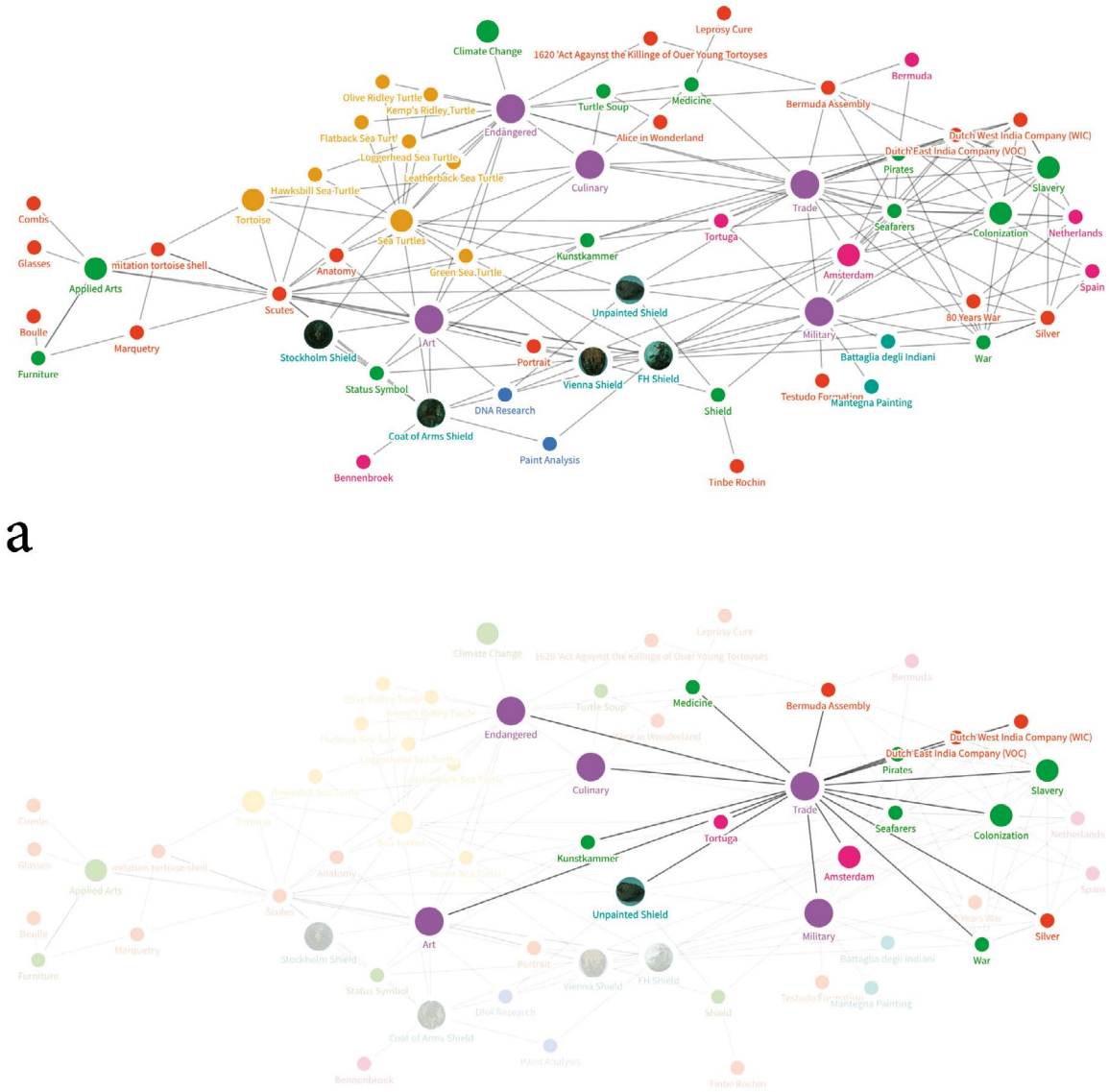


Figure 5 (a) *Painted Turtle Shell with the Battle between the Romans and the Gauls*, anonymous (Tuscan?), *c.*1510, oil on turtle shell, 70 × 59 × 17 cm, A164, Kunsthistorisches Museum, Vienna; (b) Giacinto Calindrucci, *Head of Medusa*, before 1707, oil on turtle shell, 49 × 48 cm, NM 7163, Nationalmuseum, Stockholm, public domain. (Photo: Erik Cornelius.)

museum collections. One such example is kept in Kunsthistorisches Museum in Vienna, depicting a scene from Livius' *History of Rome* (*c.*32 BC), *The Battle between the Romans and the Gaul*s (Italian, *c.*1510). Another carapace, painted by Giacinto Calandrucci before 1707, and nowadays kept in the Nationalmuseum in Stockholm, depicts the head of Medusa (Fig. 5). In Greek mythology, Medusa's head was placed on the shield of Athens, goddess of war, to give her protection as Medusa's power would petrify people even after her decapitation. Caravaggio depicted Medusa's head on canvas attached to a wooden shield, now in the Uffizi Gallery in Florence, symbolising the military power of the Medici. Such military connotations of power and strategy must surely have motivated the painter of Prince Frederick Henry's portrait or perhaps even steered its commission. This, in combination with large turtle shells showing up in Kunstkammer and cabinets of curiosities, makes the carapace not only an exotic and valuable, but also strongly symbolic painting support.

The examples described above provide only part of the many narratives related to the object's making and meaning in the 17th century. However, as the itinerary approach demonstrates, the object's journey continues and still takes on new meanings. In light of ecological concerns, the object can be related to the harsh present as the green sea turtle is now on the International Union for Conservation of Nature (IUCN) Red List of endangered species. Although on this planet for over 100 million years, there are only seven species of sea turtles surviving today. This specific narrative is not new, however, as concerns about decreasing numbers of sea turtles as a result of extensive hunting had already been raised in 1620, when the Bermuda Assembly expressed its concerns about 'the danger of an utter destrooyinge and losse of … so excellente a fishe' in *An Act Agaynst the Killinge of Ouer Young Tortoyses* (Murray 1991: 98–9).

The numerous narratives uncovered in this research, as highlighted briefly above, demonstrate the complex meshwork of intersecting histories embedded within this single turtle carapace. The object's itineraries are tied intimately to wider themes of craft, trade networks, colonial expansion, culinary traditions, military symbolism and much more. Each story provides another thread in the meshwork, connecting the turtle shell to people, places and themes around the globe over centuries. Whether exploring 17th-century scientific depictions of turtle anatomy, accounts of buccaneers utilising turtles for provisions, military connections or modern concerns over species endangerment, every inquiry reveals new layers of contextual information that link back to the object. In embracing this, the concept of the meshwork advances a holistic understanding of the life and legacy of this unusual artistic medium – from its military meaning and connection to (colonial) exploration that must have been clear to 17th-century viewers of the object or its commissioner to its future as a reflection on humanity's relationship with the natural world in a time of growing ecological concerns.



a

b

Figure 6 (a) The Turtle Nodal Network. Created with flourish.studio: https://public.flourish.studio/visualisation/15575446/; (b) Detail of the network, highlighting the connections around the node 'Trade', that reveals a distinct nodal centre at the intersection of connected object itineraries.

Visualised itineraries: the turtle network

As discussed previously, while the meshwork metaphor is a useful approach to conceptualise this complexity of hidden narratives, they are in their very nature wriggly and intertwined, and thus are rather complex to visualise or illustrate (Koppinen 2020: 62). To steer and frame the research, and set clear research aims for all the members of the interdisciplinary team, a nodal network was taken as a starting point, which effectively visualises connections resulting from intersecting narratives.

A nodal network example was made in the free online data visualisation tool 'Flourish' to which researchers in the project could add connections that resulted from tracing various lines of research looking into the turtle shield (Fig. 6a).[8] In the network, nodes lacking a connection are pushed away from one another, while connections between two nodes cause them to be attracted to one another. As a result, certain strong nodal centres or hubs start appearing as the network grows, due to increasing amounts of interconnectedness. These nodal hubs can be thought of as representing focal points in the research into the object's material itineraries. Any addition of new nodes into the network automatically leads to a reorganisation of the whole as new attractions and repulsions are added to the mix.

The (automatic) formation of such nodal centres as the network expands thus reveals new research

avenues to the interdisciplinary team and can guide the trajectory of research. For instance, Figure 6b illustrates the emergence of a distinct nodal hub centred around trade, colonial exploration, and seafarers on the right side of the network. As the previous section showed, pursuing the connotations embedded within such a nodal hub enriches the depth of understanding of how a turtle shield ended up in the Netherlands to be painted upon, and how the decision to paint on a turtle shield adds nuanced layers of meaning to the object, both at its time of creation and in shaping our contemporary perception of it.

Conclusion

The case study of the curious 17th-century portrait of Prince Frederick Henry on a large green sea turtle carapace demonstrates how meshworks and nodal networks can be applied in practice as methodological frameworks to structure and support collaborative interdisciplinary technical art historical research. Exploratory research revealed the many diverse itineraries present within this intriguing object. Through conversations with researchers and the students involved, it became evident that the resulting meshwork was a compelling one with many intersecting lines worth pursuing. By visualising these connections in a nodal network, the entangled narratives surrounding the turtle shell were quickly revealed. Nodal hubs centred around themes such as trade, colonialism and military symbolism emerged, pointing the interdisciplinary team towards new avenues of inquiry. Research into some of these themes uncovered fascinating stories that allowed for a deeper understanding of the added layers of meaning that the unconventional turtle carapace painting support contributes to the interpretation of the object itself, both at the time of its creation and in its continuing influence on our perception nowadays. Future work on the project will continue to unravel the meshwork through scientific analysis coupled with contextual research. The network will also be expanded to incorporate knowledge gleaned from related objects as they continue to be discovered in collections across the world.

The network approach is beneficial to accommodating true holistic interdisciplinary research, providing a clear structure for the collaboration between researchers with different backgrounds. Any team member can contribute nodes and connections to the network based on their own prior knowledge and expertise. As such, it levels the playing field and promotes direct interaction with each other's input as the research progresses. Moreover, it allows for more nuanced ways to acknowledge complex connections and comprehend stories embedded within objects when compared to the object biography approach, which has some limitations due to its linear approach to an object's 'life'.

The role of technical art historians is pivotal in disentangling the nodes where data converge. They oversee the revealing of an object's life history by facilitating the coming together of various experts and providing a research arena with the object at its centre. As the case study shows, this approach can be applied to any object and is not restricted to only the most famous and prestigious works of art around the world. The narratives that develop at the connections between nodes in a network or at the intersection of itineraries in a meshwork have the potential to bridge gaps and present an object's material and contextual journey(s) in a way that engages museum professionals and the general public alike.

Acknowledgements

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Notes

1. For more info, see the Rijksmuseum online catalogue: hdl.handle.net/10934/RM0001.COLLECT.12013 (accessed 26 February 2024). See also: Y. Bruijnen, 2007, 'anonymous, Turtle-Shell Painted with a Portrait of Frederik Hendrik (1584–1647), Prince of Orange, on Horseback, in or after 1631', in J. Bikker (ed.), *Dutch Paintings of the Seventeenth Century in the Rijksmuseum*, online coll. cat. Amsterdam: hdl.handle.net/10934/RM0001.COLLECT.12013.
2. Including Paul van Laar and the students' tutor, Erma Hermens, authors of this paper.

3. www.Lookingthroughartblog.wordpress.com. Statistics of visitor numbers and their nationalities are taken from the blog's WordPress website.
4. See: 'The unexpected journey of the green sea turtle…..'. Available at: https://lookingthroughartblog.wordpress.com/2020/05/19/the-unexpected-journey-of-the-green-sea-turtle/ (accessed 24 January 2024).
5. G. van der Ham, 'The Turtle and the General'. Available at: https://lookingthroughartblog.wordpress.com/2020/08/26/the-turtle-and-the-general/ (accessed 9 May 2024).
6. The X-radiography was performed at the Rijksmuseum. See also: 'Endangered sea turtle populations boosted', University of Exeter. Available at: https://www.exeter.ac.uk/about/cornwall/research/impact/seaturtles/ (accessed 24 January 2024).
7. Bermuda became a British Crown colony in 1684.
8. Flourish/ Data Visualization & Storytelling, Flourish Studio: https://flourish.studio/ (accessed 24 January 2024). See the interactive nodal network: https://public.flourish.studio/visualisation/15575446/.

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Purple with a purpose: investigating and reconstructing the discoloured skirt in the *Portrait of Aletta Hanemans* by Frans Hals

Fahed Ibrahim, Abbie Vandivere, Sabrina Meloni and Annelies van Loon

ABSTRACT Over time, Aletta Hanemans's skirt in the *Portrait of Aletta Hanemans* (1625) by Frans Hals (*c.*1580–1666) has lost its colour and tonal contrasts. The degradation of pigments – smalt, red lakes and lead white – has resulted in a loss of modelling. This study aimed to investigate the skirt's original appearance, utilising an interdisciplinary approach that integrates technical examination of the painting, pigment analysis and historical research. A combination of X-ray fluorescence imaging spectroscopy, analysis of microsamples and a review of historical art techniques led to an improved understanding of Hals's palette and the specific pigments he used in this painting. By undertaking a methodical reconstruction of the skirt section using historically appropriate materials and techniques, this research provides insights into the artist's working methods. The final result suggests a possible recreation of the artistic effects that might have been intended by Hals.

KEYWORDS painting reconstruction, Frans Hals, smalt, red lakes, pigments degradation, optical transformations

Introduction

Frans Hals's *Portrait of Aletta Hanemans* (1625) (Mauritshuis, The Hague) (Fig. 1a), exemplifies the significant optical transformations that a 17th-century painting can experience over time as certain pigments degrade. This study focuses on the skirt of Aletta Hanemans, which has undergone marked colour and tonal changes during the aging process. Its originally vibrant hue has transformed into the current brownish dull tint, caused by the degradation of smalt and red lake. These alterations challenge the understanding of Hals's intended visual effect and complicate appreciation of the skirt's modelling and three-dimensionality. Commissioned to commemorate the marriage of Jacob Pietersz Olycan and Aletta Hanemans, this life-size portrait – along with its pendant – was the first in a series of works Hals painted for the Olycan family (Biesboer 1989: 27–8). The intricate details in Aletta Hanemans's clothing, particularly her richly embroidered stomacher, denotes her social standing and is indicative of the period's expensive fashion.

This research involved studying microscopic samples – complemented by macroscopic X-ray fluorescence imaging spectroscopy (MA-XRF) and handheld XRF analysis and other non-invasive imaging technologies – to understand the composition and original colours of the skirt depicted in the portrait (see below). Informed by these scientific data, painted reconstructions were made using historically appropriate materials. These helped to reveal the artistic effect that Hals might have intended, and to understand the materials' aging behaviour and its impact on the painting. Ultimately, the analyses and reconstruction sought to answer the question: what was the original appearance of the skirt in Frans Hals's *Portrait of Aletta Hanemans*?

Existing research on pigment discoloration

This study builds on the foundational work of several scholars in the field of technical art history, focusing specifically on pigment discoloration. Margriet van Eikema Hommes's extensive interdisciplinary research has been pivotal in illustrating the

Figure 1 (a) Frans Hals, *Portrait of Aletta Hanemans*, 1625, oil on canvas, 123 × 98 cm, Mauritshuis, The Hague (MH460). (b) Detail of the skirt (the white rectangle indicates where the photomicrograph was taken). (c) Photomicrograph of the lower edge showing that the red lake paint is less faded having been protected from light by the frame's rebate; the ground layer is visible due to paint abrasion (original magnification 8×). (d) Photomicrograph of the same area at higher magnification (original magnification 20×). (Photomicrograph: Fahed Ibrahim.)

transformation of 17th-century paintings over time, particularly in terms of how artists anticipated and managed pigment changes (Eikema Hommes 2004). Her work delved into the specific challenges of discoloration related to the use of indigo in Frans Hals's oeuvre, particularly evident in the blue sashes of his civic guard portraits, rather than focusing on smalt and/or red lake. There were earlier attempts to study the visual impact of discoloured smalt (sometimes in combination with red lake and lead white) in old master paintings using paint reconstructions; however, these studies focused on artists other than Hals (Spring *et al.* 2001; van Loon *et al.* 2020; Carter *et al.* 2023).

Further contributions include the catalogue raisonné published by Seymour Slive in 1970–74, which contains a critical analysis of each painting by or associated with Frans Hals (Slive 1970–74), and the research by Karin Groen and Ella Hendriks into the technical aspects of the artist's paintings (Groen and Hendriks 1989; Hendriks 1991). Although these studies have enhanced the understanding of Hals's painting methods, they did not extensively cover the deterioration of specific pigments such as smalt and red lake. Additional studies focused on the analysis and conservation treatment of individual artworks by Hals (Bijl 1989; Abraham 2018; Tummers *et al.* 2019a,b). However, these projects did not specifically address questions concerning smalt degradation and the original appearance of these paintings.

The current research seeks to address this knowledge gap by focusing on the specific discoloration phenomena in Hals's *Portrait of Aletta Hanemans*. This is achieved by combining historical, scientific and technical art historical knowledge to provide a comprehensive understanding of the artist's materials, techniques and the original appearance of his paintings, paying particular attention to the degradation of smalt and red lake pigments. In the future, the knowledge gained about this specific painting could potentially be used to understand colour changes in other works by Hals, as well as those of other artists from the same time period and with similar studio practices.

Technical examination of the painting

Alongside a 2006–07 conservation treatment at the Mauritshuis, *Portrait of Aletta Hanemans* underwent extensive technical examination (Meloni *et al.* 2009: 111). A range of imaging methods was used, including ultraviolet-induced (UV) fluorescence, infrared reflectography, X-radiography and stereomicroscopy, together with material-chemical analyses performed on four paint samples that were taken from the skirt: two from highlights, one from a midtone area and one from a shadow area.[1]

Historically, this portrait had not always been attributed to Hals due to its poor condition (Broos and Suchtelen 2004: 110), but the abovementioned examination and treatment revealed the loose brushstrokes that are characteristic of the master. Varnish and overpaint removal improved the painting's appearance and colour balance; however, the treatment did not aim to 'restore' the original appearance of the skirt, given that many of the chemical and physical changes to the pigments are irreversible. Even after the treatment, Hals's precise visual intention with regards to the effects of the layer structure and colour combination was still unclear. The re-examination and re-analysis of old paint samples in 2020, coupled with imaging technologies such as MA-XRF, provided insight into the chemical composition and distribution of pigments in the skirt (Ibrahim 2020). The combination of these methods was crucial for understanding Hals's materials, techniques and layer stratigraphy.

Paint layers and painting stages

The painting's support is a single piece of fine, plain-weave canvas. The light grey-coloured ground layer – consisting of lead white, chalk, fine carbon-based black (probably lampblack) and some red lead in oil – was identified as consistent with Hals's early works (Groen and Hendriks 1989: 124–5). No underdrawings were detected using infrared reflectography (IRR).

At first glance, the skirt seems to have been painted directly as a single layer on top of the ground using a spontaneous wet-into-wet technique (*alla prima*). However, evidence from cross-sections taken from highlight and midtone areas suggests that an initially purple underlayer blocked out the skirt during the first application (layer 2 in Fig. 2a and b). Since the underlayer and the upper layer are similar in colour – containing the same pigments but in slightly different ratios – the underlayer might have functioned as an 'undermodelling' (Fig. 2a).[2]

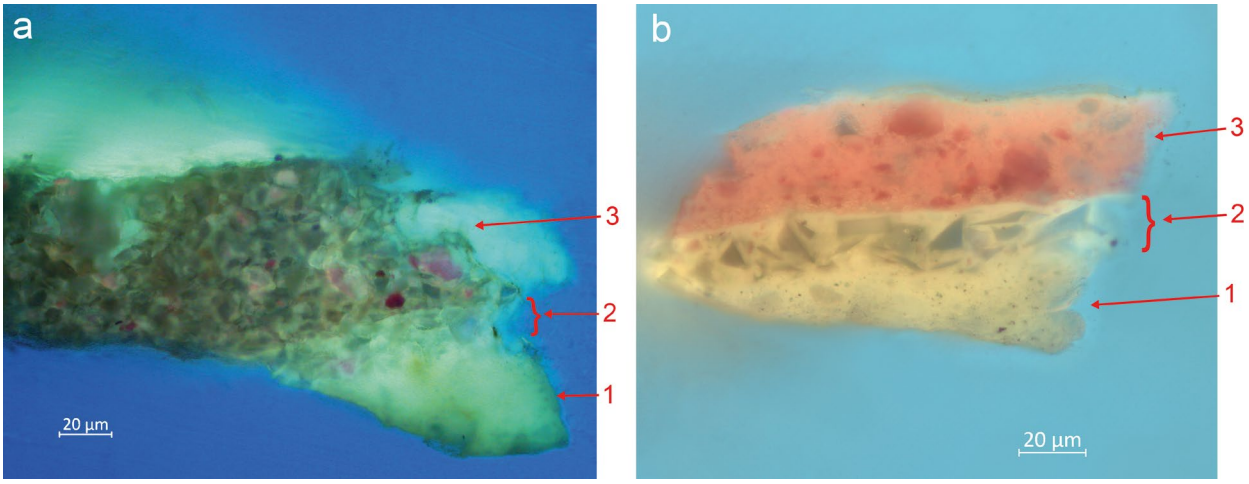

Figure 2 (a) Cross-section of sample x03 (h. 3 × w. 48 cm) from Aletta Hanemans's skirt, photographed at 400× magnification with UV illumination. (Photo: Fahed Ibrahim.) The layer structure (determined through visual examination) is as follows: **1** Ground layer: lead white, red lead, lampblack. **2** Lower thin (discoloured) purple layer: smalt, lead white and some red lake particles. **3** Upper thick (discoloured) purple layer: smalt, red lakes and lead white. (b) Cross-section of sample x12 (h. 32 × w. 41 cm) from Aletta's skirt, photographed at 400× magnification with UV illumination. The layer structure is as follows: **1** Ground layer: lead white, red lead, lampblack. The second paint layer (2) is similar in both samples; **2** Lower (discoloured) purple layer: smalt, lead white and some red lake particles; **3** Pink paint layer (highlights): red lakes, lead white and a small quantity of smalt.

The paint mixture contains particularly smalt, red lake and different ratios of lead white. Once the correct colouring of the skirt had been achieved, additional highlights and shadows were then applied, providing depth and three-dimensional modelling (see layer 3 in Fig. 2a). The highlights were applied with rapid, thick brushstrokes of dense, light pinkish paint, containing principally cochineal lake with a possible addition of some madder, lead white and a small quantity of smalt (layer 3 in Fig. 2b).[3]

Discoloration of the pigments in the skirt

The colour change has been caused by the degradation of smalt, as well as by the fading of the red lake in response to light (Meloni 2007; van Loon 2007). Remnants of the red lake can still be seen on the lower edge of the painting, where it was protected from light by the frame's rebate. However, the entire skirt (including the edge) suffers from smalt discoloration (Fig. 1c and d), as this is a chemical rather than light-induced degradation process (Boon *et al.* 2001: 959–60). The light pink impasto strokes, depicting the highlighted details of the folds, now dominate the visual appearance of the dull brownish skirt and are discrepant from the rest of the skirt. These light pink strokes might also have faded slightly (Saunders and Kirby 1994; van Loon *et al.* 2013: 237), but the midtones and dark areas have discoloured most severely, probably since they contain such a high proportion of smalt.

Smalt

Frans Hals appears to have used the blue pigment smalt mostly to paint skies or background colours, and sometimes foliage and draperies in fairly simple paint mixtures. In the skirt of Aletta Hanemans, the paint layers contain a high proportion of smalt; mixed with red lake and lead white, they must have originally been purple in colour. The choice of smalt as a blue pigment reflects the pigment's increased popularity in the early 17th century in response to the inadequate, excessively expensive or even an altogether interrupted supply of ultramarine and azurite pigments (Mühlethaler and Thissen 1993: 114).

Smalt is composed of ground potash glass that is coloured blue by the addition of cobalt. The cobalt ore was roasted to form a cobalt oxide, then melted with potash (tartar or wood ash) as a flux, and a source of silica such as quartz or sand, to form a blue glass. The blue melt, or vitrified mass, was shattered by cold water into small particles, which were then ground and washed (Mühlethaler and Thissen 1993: 113; Richter 2004: 178; Delamare 2013: 38). The pigment's colour intensity and quality vary with the cobalt content and particle size (Robinet *et al.* 2011: 5148; 2013: 4628).[4]

The degradation of smalt in oil paint, which results in a grey or brown translucent appearance, involves complex chemical reactions, due primarily to the leaching process of potassium from the smalt particles making the glass more acidic (Boon *et al.* 2001: 959–60; Spring *et al.* 2005, 2012; Robinet *et al.* 2011; van Loon *et al.* 2012; Noble 2019: 12).[5] The potassium content can help to assess the degree of the pigment degradation. In addition to the loss of colour of the smalt particles, associated browning of the paint matrix and surface blanching can be caused by the formation of potassium soaps and complex lead and potassium salts (Spring *et al.* 2005; van Loon *et al.* 2012: 209; Robinet *et al.* 2013: 4629; Spring 2016: 9).

Microscopic examination of the paint cross-sections from the skirt of Aletta Hanemans showed only a few particles that have retained a blue colour in their cores, particularly in the underlayers where smalt was mixed with lead white (layer 2 in Fig. 2a and b). Semi-quantitative scanning electron microscope-energy-dispersive X-ray (SEM-EDX) analysis of degraded smalt particles in sample x02 (from a shadow area) performed in 2006–07 showed the following elements in weight percentages: 78.50 wt% Si; 2.1 wt% K; 2–3.21 wt% Co; 4.50 wt% Fe; and 6.12 wt% As, with traces of Al, Ca and Ni (van Loon 2007).[6] These measurements were complicated by the fact that most of the smalt particles in the portrait are completely degraded, implying that some of the potassium migrated from the degraded smalt particles. Thus, the proportions between the elements are disturbed, and the original composition of the smalt in these particles cannot be precisely determined. Robinet *et al.* performed a series of quantitative SEM-EDX measurements of particles of both well-preserved and altered smalt in samples taken from 16th- and 18th-century paintings at the National Gallery, London, and the Musée de Louvre, Paris (Robinet *et al.* 2011: 5148). These indicated that the original composition of the smalt in well-preserved particles was as follows: 60–70 wt% SiO_2; 12–16 wt% K_2O; and 2–7 wt% CoO. Their findings suggest that the cobalt concentration and the grain size of the glass can provide an indication of the original colour of the smalt (Robinet *et al.* 2011: 5151; Kugler *et al.* 2013: 1428). Counting and estimating the size of the pigment particles present in the SEM backscatter images of paint samples taken from degraded parts of Aletta Hanemans's skirt, tentatively suggested that the pigment ratio in these paint layers is around 70 vol% smalt and 30 vol% red lake (van Loon 2007).

Red lake

Lakes, in particular red lakes, occupied a prominent place in European easel and mural painting, especially between the 14th and 16th centuries (Kirby *et al.* 2005: 71), although they were also used well into the 17th century. These pigments, commonly incorporated into paints for draperies, flesh tones and flowers, generally served two different purposes: applied in pure, translucent layers over more opaque paints to increase the latter's depth and brilliance or mixed with other pigments. With light pigments, such as lead white, they created opaque, pinkish-red shades for highlights or midtones. They were also found mixed with blue components to create purple paint admixtures in many of the paintings studied at the National Gallery, London and at the Metropolitan Museum of Art in New York (Ainsworth 2010: 81; Spring 2016: 5). The latter could potentially have been Hals's intention in the skirt of Aletta Hanemans, where he applied the red lake in mixtures with smalt and lead white. For the final decorated patterns, he painted dots and diagonal hatches with pure red lake glazing, and sometimes worked in lead white. In the shadow of the gold chain, the red lake strokes are much more intense in colour, suggesting a well-preserved glaze, due presumably to a high density of the pigment particles.

Ultra high-performance liquid chromatography analysis (UHPLC-HRMS) of a fragment from sample x12 (taken from a well-preserved red glaze in the skirt) confirms the presence of carminic acid – thus cochineal lake.[7] Unfortunately, it was not possible to identify the exact species of cochineal (American or European). Considering the date of the work, American cochineal is likely, since it was widely used in 17th- and 18th-century European paintings (Kirby and White 1996: 64; Noble and van Loon 2005: 90). XRF point analysis and SEM-EDX identified the use of aluminium as a substrate. Traditionally, the most frequently used mordants were hydrated alumina and calcium salt; however, the possibility of the presence of a calcium-containing substrate cannot be dismissed since Ca was also suggested by XRF analysis.

Lakes are considered among the most fugitive pigments due to their pronounced tendency to fade upon exposure to light (van Loon *et al.* 2013: 216). The chemical substances resulting from photochemical degradation can still provide colour but are generally not of the colour originally intended; at worst, a total colour loss occurs.

Factors such as the type of red lake, the nature of its substrate, its concentration, the thickness of the paint layer and its light exposure history can all determine the extent of deterioration (van Loon *et al.* 2013: 220, 237). In *Portrait of Aletta Hanemans*, the fading phenomenon of the red lake pigment in the skirt is widespread, but particularly evident in areas where the paint was thinly applied or mixed with other pigments. When mixed with lead white, UV radiation enters the paint layer more easily or is reflected back by the lead white particles, compounding the destructive effect of light (Saunders and Kirby 1994). In sections where red lake was applied more thickly and with greater pigment density, the fading process has been notably slower, maintaining traces of the original vibrant crimson (van Loon *et al.* 2013: 237).

The process of reconstruction

Reconstruction has emerged as a significant method in conservation and art historical research. This method goes beyond the traditional academic practice of copying, aiming instead to replicate specific aspects of artworks using materials and techniques as close as possible to those originally employed. In this context, reconstruction is informed by a 'learning by doing' approach, as articulated by Kempski (2012), and is integral to conservation training programmes at many universities and institutes (Jacob 2006). This approach is exemplified in practical guides such as *The Art of Copying Paintings* (Mohrmann 2006) and *In Artists' Footsteps* (Wrapson *et al.* 2012), which explore the connection between reconstruction and restoration.

The current research utilises reconstructions to explore the original appearance of Hals's *Portrait of Aletta Hanemans*. By reconstructing a 48 × 37 cm area of the painting depicting the skirt, within the total format of 123 × 89 cm, the current study aimed to gain insights into the artist's application techniques and the material composition of his work. This approach aligns with the principles outlined by Leslie Carlyle, who has discussed the concepts of 'historical accuracy' and 'historically appropriate materials' in the context of reconstructions (Carlyle and Stols-Witlox 2005; Carlyle 2012). Carlyle notes the challenges in sourcing 'historically accurate' materials, as modern-day equivalents often differ significantly in their chemical and physical composition from those used in the 17th century'.

Painted reconstructions made using historically appropriate materials have an advantage over digital ones in that they shed light on the practical challenges faced by the artists – for instance, how the pigments had to be prepared and applied to produce the desired effects. To better understand the original colour scheme that Hals intended in the skirt of Aletta Hanemans, both schematic and illusionistic reconstructions were made specifically for this study. The painting materials and their distribution were informed by the results of the technical examination and historical knowledge about pigments available in the 17th century.

Schematic reconstruction

For the schematic reconstruction, three types of smalt – prepared by different methods, differing in terms of cobalt content and particle size – were used. One (handmade) was obtained from the VRIJ-GLAS Foundation and two others from Kremer Pigmente.[8] The disintegrated glass from VRIJ-GLAS required pulverisation and grinding before processing it into a pigment, while the powdered smalt from Kremer has two ranges of particle size (Standard 0–120 μ and Fine < 80 μ). The smalt pigments were ground with stand linseed oil to create a smooth, buttery workable paint. Although the three powdered pigments showed different tones of blue, the paints did not reveal distinct differences in terms of colour and texture when they were applied directly onto the ground (column 1 in Fig. 3a). Smalt paints were then mixed with varying quantities (0, 25, 50 and 75 vol%) of cochineal (Kremer, extracted from *Coccus cacti* and precipitated onto an aluminium/calcium substrate), and with lead white (Rublev) (squares 2, 3 and 4 respectively in Fig. 3a).[9] After allowing this underlayer to dry, additional layers of paint were applied: smalt-cochineal in an 80:20 ratio (imitating a dark layer, column 1), pure cochineal (as a glaze, column 2), and red lake-lead white (as a highlight, column 3 in Fig. 3b).

The reconstruction showed that adding red lake also improved the handling properties and hiding power of the smalt paint. It was observed that even a small amount (25%) of cochineal changed the colour of the blue paint significantly, creating a distinctively red-purple colour. The 50:50 and 75:25 ratios of red lake smalt produced more reddish paint. Adding lead white to red lake-smalt-containing

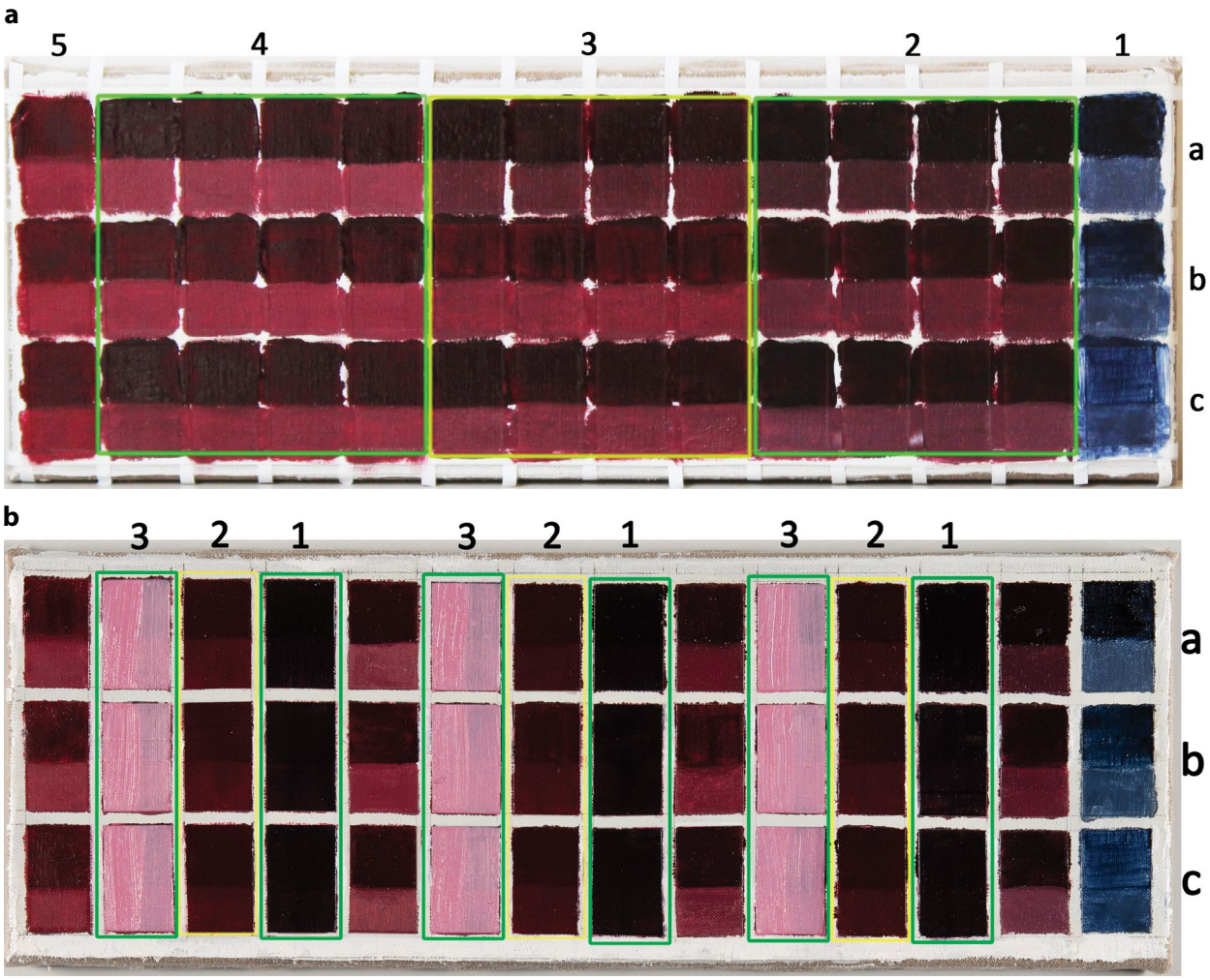

Figure 3 (a) The first stage of the schematic reconstruction. Row **a** contains smalt from VRIJ-GLAS, row **b** contains standard smalt from Kremer, row **c** contains fine grade smalt from Kremer. **1** column contains pure smalt + lead white, **2** smalt 75% cochineal 25%, **3** smalt 50% cochineal 50%, **4** smalt 25% cochineal 75%, **5** pure cochineal + lead white (cochineal on an aluminium/calcium substrate was produced by Fahed Ibrahim using raw materials from Kremer). (b) Second stage of the schematic reconstruction, with an additional layer of paint applied on top of those described in Figure 6-1: **1** smalt-cochineal paint, **2** red lake glaze, **3** red lake-lead white paint. (Photo: Fahed Ibrahim.)

paints affected their appearance, making the glazes more opaque.

The second layer of smalt/red lake paint considerably darkened the underlayer, imparting it with a blue-purple colour. Lake glazes deepened and reddened the colour beneath. Thickly applied highlights completely concealed the underlayers, yet when applied thinly, they partially revealed the layer(s) beneath. Experimenting with the abovementioned parameters helped to gain a better understanding of the handling and application properties. It also provided insight into the visible properties of the paints, as they seemed plausibly close to the colours that Hals originally used. Lastly, the schematic reconstruction helped as a reference guide to conduct an illusionistic reconstruction intended to, as closely as possible, resemble the original appearance of the painting.

Illusionistic reconstruction

For the illusionistic reconstruction, the commonly used 'lacing' procedure for stretching canvases by 17th-century Dutch artists was followed. The support was then brushed with a coating of size (rabbit skin glue). The composition and thickness of the ground layer was based on the analysis of paint samples. In *Portrait of Aletta Hanemans*, a light grey ground was found to contain a large amount of lead white, and a low proportion of chalk (calcium carbonate), fine carbon-based black (probably lampblack) and red lead, which were probably used to tint the preparation layer. These pigments were mixed with linseed oil to achieve the desired coloured paste then applied with a priming knife, in an attempt to approximate the thickness of the original ground (*c.*100 µm). Before starting with the 1:1 scale illusionistic reconstruction,

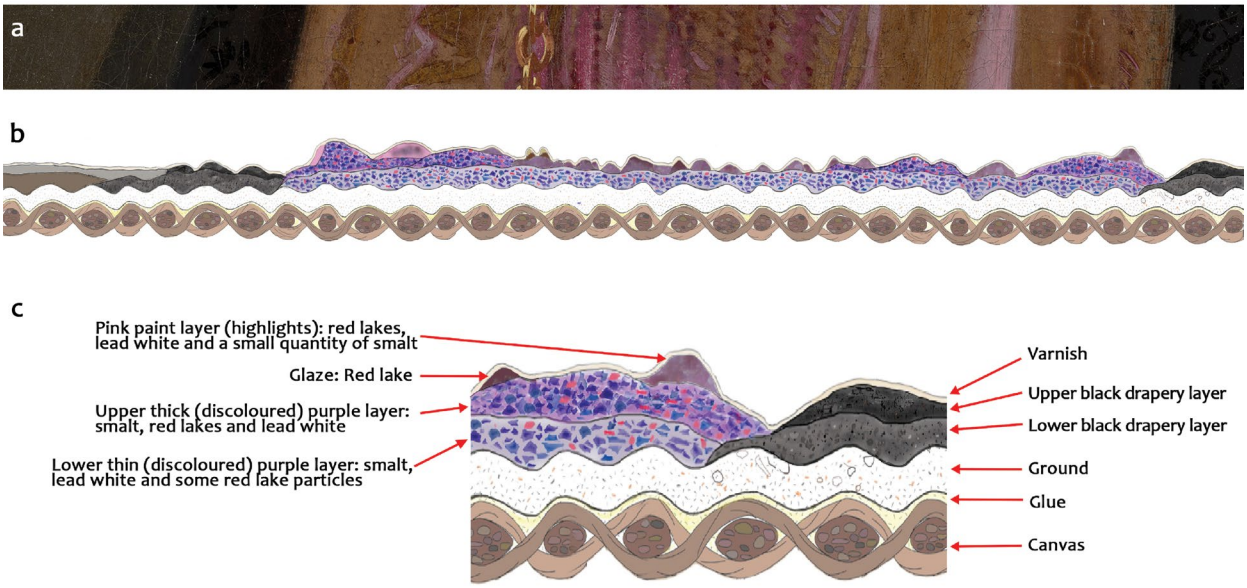

Figure 4 (a) Selected area of the skirt; (b) schematic diagram of the selected area (note: the X-axis is to scale with the painting, but the Y-axis is not); (c) detail of the extreme right of the schematic diagram. (Diagram: Fahed Ibrahim.)

a logical sequence for painting was designed. A schematic diagram of a selected cross-section of the skirt area was drawn to approximately illustrate the stratigraphy of the painting, showing the structure of paint layers (Fig. 4).

A 55 × 47 cm area of the primed canvas was selected to include the entire skirt section of the painting, which measures 48 × 37 cm in the original painting's total dimensions of 123 × 98 cm. In the initial step, the main folds were drawn and the form of skirt set down using a warm brown paint containing earth pigments. The following stage involved the laying in of a purple underpaint, which was made by mixing fine smalt with cochineal. This layer was applied thinly, imitating the thickness of the original underpaint in the skirt (*c.*20 µm). This initially purple underlayer was more subdued than the final colour. After underpainting the main tone of the skirt in a fluid purple paint, however, it was found that applying an opaque paint instead would improve the final design.

The underpainting layer was used as a guide for the initial modelling. The first modelling layer of the skirt was applied thinly. The ratios between smalt and cochineal were based on the cross-sections and the visible properties of the paints tested in the schematic reconstruction. A high proportion of smalt was mixed with 80:20 and 70:30 ratios of cochineal to paint shadows and midtones respectively, and the resulting purple paint was mixed with a little lead white to render the light parts of the composition. The subsequent relatively thick modelling layer was applied before the undermodelling was fully dry since Hals presumably worked wet-in-wet in this part of the painting. Light paints, with differing ratios of lead white, were applied more solidly, recreating the original's lightly textured surface. Dark areas were executed using a fluid paint, and because the layer consisted mostly of smalt, more linseed oil was required.

Despite all efforts towards objectivity, some subjective reinterpretations had to be made in response to the loss of the original colour and tonal contrasts. These issues made the accurate rendering of the skirt's folds more difficult. In order to find a suitable alternative to the original modelling, comparisons were made with other paintings by Hals and his contemporaries, as well as with artworks that depict historical costumes from the Baroque period. This style in painting, which spanned approximately from 1600 to 1680 in Holland, often emphasises rich detailing and dynamic compositions, characteristics that are especially apparent in the elaborate clothing of the era. In addition, two photographic documentation techniques – UV-induced fluorescence and false-colour infrared (FCIR) photography – were essential to understanding the details of folds or seams in the fabric, which are barely visible with the naked eye (Fig. 5a and b). In UV, the shape of the folds is more pronounced as the contrast between shadow areas is emphasised. This could be due to differences in fluorescence between thinly and thickly applied smalt paint, and also between some thinly applied red lake/lead white brushstrokes, which appear quite subdued in visible light conditions but are luminescent under UV. Moreover, FCIR

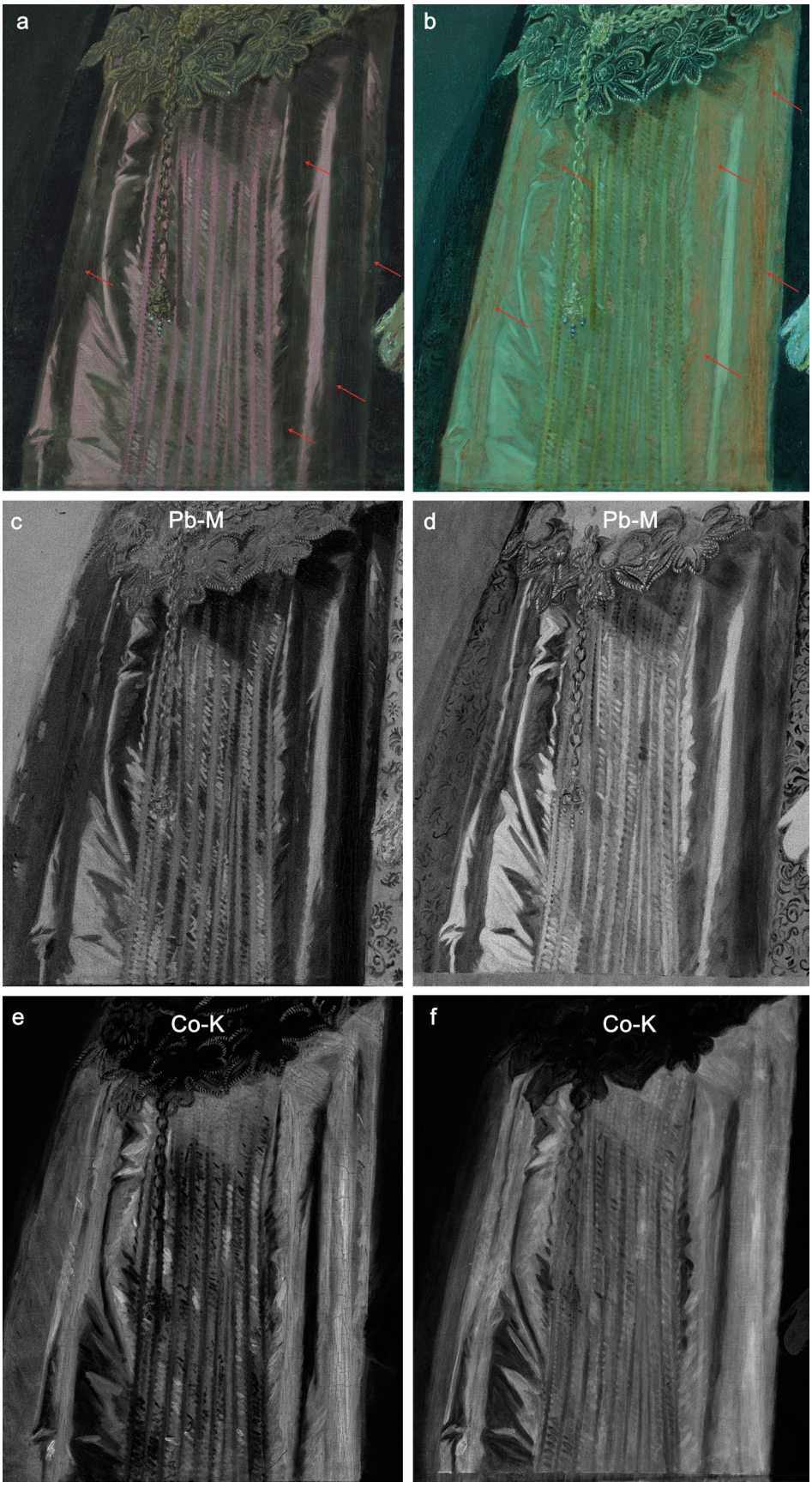

Figure 5 (a) UV fluorescence of Aletta Hanemans's skirt, red arrows indicate where the shape of the folds is more pronounced under UV illumination than in visible light; (b) False-colour infrared image (FCIR) of the skirt, red arrows indicate where thickly applied brushstrokes of smalt appear orangish-pink; corresponding MA-XRF maps of the original and the reconstruction: (c) lead map of the original; (d) lead map of the reconstruction; (e) cobalt map of the original; (f) cobalt map of the reconstruction. UV illumination and false-colour imaging by Fahed Ibrahim, MA-XRF by Annelies van Loon and Sabrina Meloni (© Mauritshuis).

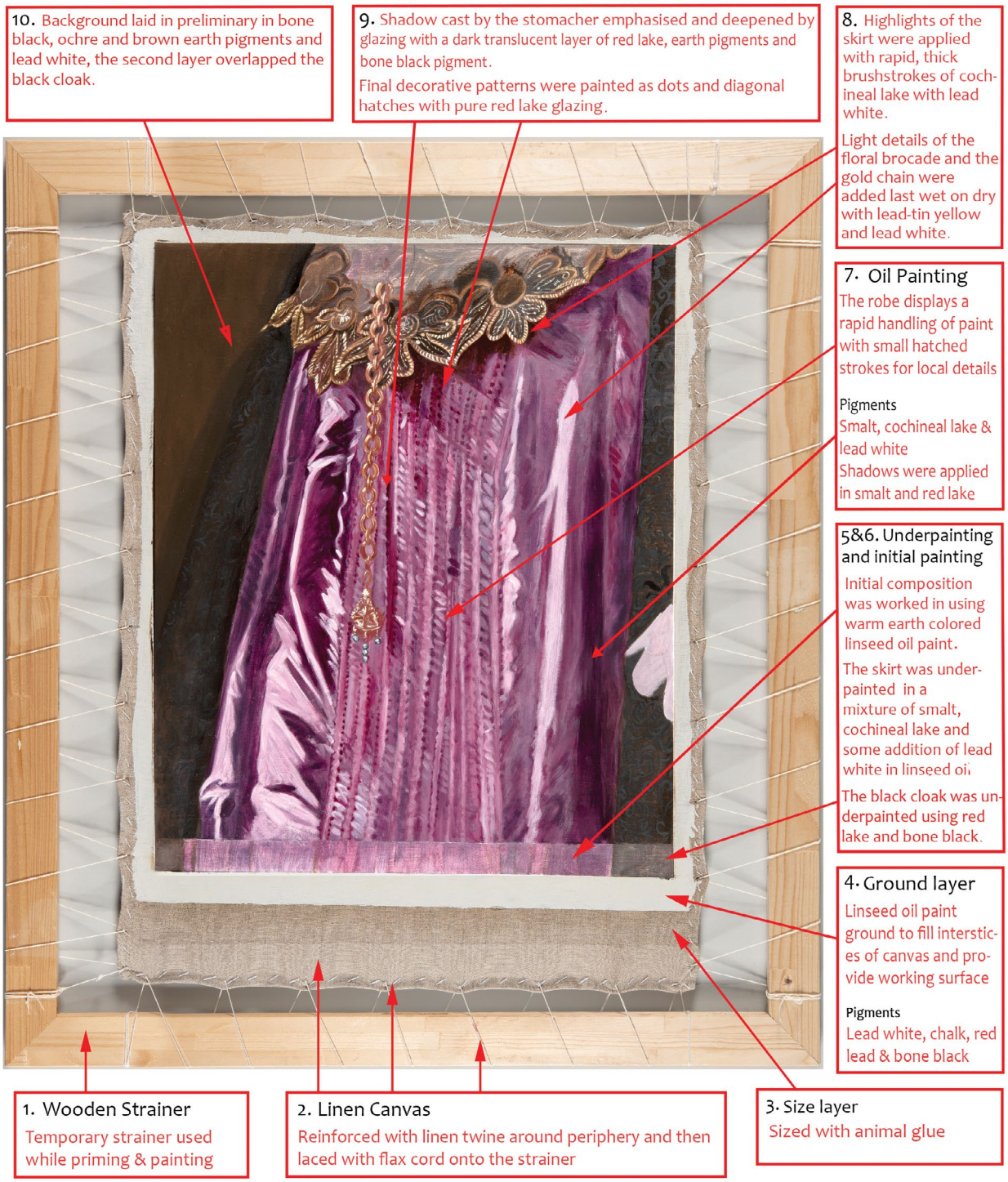

Figure 6 Diagram for the finished reconstruction of the skirt depicted in Frans Hals's *Portrait of Aletta Hanemans.* (Diagram: Fahed Ibrahim.)

photography distinguished thickly applied brushstrokes of smalt, as they appeared orangish-pink in FCIR while hardly visible in VIS.

Visual examination of the original painting showed that Hals painted the highlights and folds of the skirt freely with a confident hand, while the floral design of Aletta Hanemans's stomacher and accessories were rendered meticulously with intricate details to achieve the final effect. It was initially assumed that the detailed brushstrokes would be the most difficult to recreate, yet the opposite proved true: the skilful free hand of a great artist is of course impossible to imitate entirely. Impasto strokes depicting the highlighted details of the skirt were applied by mixing red lake with lead white – based on the ratios tested in the schematic reconstruction – using a bristle brush. The decorated patterns in the middle of the skirt were painted as dots and diagonal hatches with pure

red lake glazes using fine-scaled, fluent brushwork. The floral brocade motifs and the gold chain were painted in ochre/brown earth pigments mixed with red lake, then highlighted – after drying the paint underneath – with lead-tin yellow and lead white, applied with a very fine brush.

Discussion

The reconstruction process offered valuable insights into Hals's working methods and the layering effects in his paintings. While achieving an exact replication of each brushstroke's size, position and direction was challenging, the reconstruction provided a credible approximation of the original artistic intent, particularly in the skirt's colour and texture. Hals's original paints were likely stiffer due to different preparation methods of pigments and binding medium, but were approximated to the best of our ability considering modern material constraints.

A comparative analysis between the original painting and the illusionistic reconstruction was particularly revealing. The MA-XRF maps for cobalt (Co-K) and nickel (Ni-K) indicate a significant presence of smalt in the skirt, as evidenced by the high Co signals (Fig. 5e, Ni map not shown). The Co maps (Fig. 5e and f) further reveal a similar distribution of smalt in both the original and the reconstruction, suggesting that the reconstruction in fact approached the original appearance of the skirt in the portrait. The lead M-line map (Fig. 5c) reveals Hals's working manner in the light areas of the skirt. The Pb map of the reconstruction (Fig. 5d) showcases the attempt to replicate Hals's broad brushstrokes of thickly applied lead white paint, mixed with red lake, to depict highlights of folds in the skirt. Despite these similarities, it is important to note that direct comparisons of pigment ratios and layer morphology were limited. The reconstruction is recently painted, so the paint layers have not had sufficient time to dry to be sampled with a scalpel. This precluded a more detailed comparison of the morphology and pigment ratios within comparable layers in the original painting.

A visual and technical comparison of the current appearance of the painting with the finished illusionistic reconstruction of Aletta Hanemans's skirt (Fig. 6) was insightful. In its current condition, the skirt of Hals's painting has lost its three-dimensionality, and the degraded colours (brown/light pink) compromise the work's visual harmony. The illusionistic reconstruction suggests that the seemingly 'flat' brown passages were originally a dark purple, which served as shadow tones. The dark purple would have contrasted strongly with the opaque pink highlights applied with forceful diagonal brushstrokes, creating a shimmering effect. The illusionistic painted reconstruction shows the light and shades of the skirt in rich colours, which not only affects the colour balance of the skirt but also the visual impact of the whole painting.

Conclusion

The illusionistic reconstruction of the skirt depicted in Frans Hals's *Portrait of Aletta Hanemans* – based on analytical evidence, knowledge about the historical materials and techniques used, together with a comparative visual interpretation of the original and other well-preserved paintings – provides a plausible impression of the artistic effects that Hals may have originally intended. The reconstruction has allowed for a better understanding of the original colour scheme used by Hals, and is a powerful visual tool to educate conservators, art historians and the museum public about the effects of colour change.[10]

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Notes

1. The imaging methods were conducted by Sabrina Meloni, and the material-chemical analyses on paint samples were performed by Annelies van Loon.

2. This method is reasonably consistent with painting techniques advised by Van Mander and De Lairesse in the 17th-century (see Mander 1604: f. 47r; Lairesse 1712: 1–36).
3. These cross-sections mostly show no more than two or three layers, indicating that Hals was economical in his paint application; he was also able to achieve the final result with only a few layers.
4. Smalt intended as a pigment typically contains 1–7 wt% cobalt; the higher the cobalt oxide content in the glass, the stronger the blue colour (Delamare 2013: 86).
5. According to Boon *et al.* (2001), the degradation process would have taken between 25 and 50 years to become visible.
6. This result is consistent with the findings of the National Gallery, London (Spring *et al.* 2005: 70). Impurities such as arsenic, iron, aluminium, calcium and nickel are also commonly found because they are present in incompletely purified cobalt oxide (Mühlethaler and Thissen 1993: 115).
7. The analysis was carried out in 2019 by Art Proaño Gaibor (Cultural Heritage Agency of the Netherlands).
8. Quantitative analysis of the smalt from Kremer Pigmente, conducted at the National Gallery, London, gave the following results: 77–74 wt% SiO_2; 16 wt% K_2O; 6.5–9 wt% CoO; 0.2–0.3 wt% Al_2O_3 (Spring *et al.* 2005: 67; Robinet *et al.* 2011: 5147). The smalt from VRIJ-GLAS contains: 55 wt% SiO_2; 22 wt% K_2O; 12 wt% CoO; 0.5 wt% Al_2O_3. Although the Kremer smalt is lower in cobalt content than VRIJ-GLAS, its rather high silicon levels can make it more durable than typical smalt.
9. The materials chosen as most 'historically appropriate' included stack-process powder lead white from Stichting-Arti et Gaudia for the preparation layers and lead white tube paint from Rublev for the paint layers. The reason for this choice is that paint layers require more sessions than a ground layer, so repeatedly preparing a new paint batch from the powder pigment for every session would not have been feasible given the need for extremely delicate handling due to its health risks. Freshly pressed linseed oil, processed in a reconstructed windmill in Zaanse Schans, and smalt pigment produced following an 18th-century recipe were also sourced; however, the reconstruction also incorporated modern-day equivalents to 17th-century pigments, obtained from modern art suppliers such as Verfmolen de Kat and Kremer – these included cochineal lake, smalt, red lead and lead-tin yellow pigments.
10. The reconstruction was used in the very successful educative exhibition *Facelift & Makeovers* at the Mauritshuis in 2021 (Meloni and Buvelot 2023), which is also available on the Mauritshuis website: https://www.mauritshuis.nl/en/our-collection/stories/facelifts-and-makeovers-exhibition-online/ https://www.mauritshuis.nl/en/our-collection/artworks/460-portrait-of-aletta-hanemans-1606-1653/.

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Layered interpretations: Van Gogh's practice of reworking his Nuenen paintings

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ABSTRACT This paper reports the in-depth, interdisciplinary investigation of Vincent van Gogh's *Poplars near Nuenen* (Museum Boijmans Van Beuningen, Rotterdam; inv. no. 1239 (MK); F45), Nuenen, autumn 1885. The main aim of the research was to unravel the complex layer build-up of the painting that was made on top of another Nuenen picture and reworked by the artist, presumably later in Paris. The stratigraphy and material composition of the two Nuenen pictures largely complies with Van Gogh's known working practice. A protein-containing layer, most likely an egg white varnish, was identified in between both compositions. The later paint additions were applied directly onto the paint surface of the second Nuenen composition. They seem more extensive than was previously assumed and contain pigment mixtures that can be linked to his Paris paintings of the summer of 1886. Further research into Van Gogh's paints and varnishing practice, in particular his use of egg white, targeted a group of six paintings from the Van Gogh Museum's collection, including works that were overpainted and/or reworked. It appeared that the artist reworked his Nuenen paintings in different ways, probably at various moments in Paris. Furthermore, two additions and one possible correction to Van Gogh's known Nuenen paint palette could be made, and it was shown that the artist used egg white mostly on paintings that remained in the Netherlands rather than those that were sent or taken to Paris. As such, the study contributes to the proper art historical interpretation, conservation and restoration of Van Gogh's paintings.

KEYWORDS Van Gogh, Nuenen, painting, reworking, egg white

Introduction

The case of Poplars near Nuenen

Poplars near Nuenen (Museum Boijmans Van Beuningen, Rotterdam; inv. no. 1239 (MK); F45)[1] painted by Vincent van Gogh (1853–1890) in Nuenen in the autumn of 1885, was recently subject to extensive investigation in preparation for restoration treatment (Fig. 1). It was anticipated that such treatment might be challenging because of the painting's fragile condition and complex build-up of paint and varnish layers. Previous research on the painting has shown that the current composition was painted on top of another image (Werf 1991). Furthermore, it is known that Van Gogh brought the painting from Nuenen to Antwerp and subsequently Paris, where he probably reworked it, as testified by a letter from Andries Bonger, the brother of Van Gogh's sister-in-law Jo.[2] In his letter, Andries does not mention which areas of the painting were reworked. Shortly before Van Gogh left Nuenen for Antwerp, he described and sketched the painting, thus providing information on how the painting looked before he presumably reworked it in Paris (Letter 542).[3] This description is however not very specific.[4] Several scholars from different disciplines have tried to establish the extent to which the painting was reworked in discussions that focused mainly on the blue and white strokes in the sky, the red roofs and some of the bright touches in the foliage of the trees (Vanbeselaere 1937; Tellegen 1967; Werf 1991).[5]

Since the last investigations that took place in 1990, considerably more research has been conducted on the materials and techniques of Van Gogh's Nuenen, Antwerp and Paris paintings, comprising around 40 Nuenen paintings and 100 paintings from the Antwerp and Paris periods (Tilborgh and Vellekoop 1999; Hendriks and Tilborgh 2011; Snickt 2012; Vellekoop *et al.* 2013), while more advanced analytical techniques have become available. Together these developments prompted this new research into the

Figure 1 Van Gogh, *Poplars near Nuenen*, 1885, oil on canvas, 78 × 98 cm, Museum Boijmans Van Beuningen, Rotterdam (1239 (MK); F45). (Photo © Studio Tromp.)

different painting stages of *Poplars near Nuenen*, in particular aimed at distinguishing and verifying the presumed Paris reworking of the painting. The investigations employed methodologies from the fields of conservation science, conservation and art history, such as chemical analysis of the paint and varnish layers, technical and stylistic examination of the painting and the study of historical sources. Furthermore, to contextualise the results, a group of six paintings from the Van Gogh Museum's collection was selected for further research, thereby concentrating on Van Gogh's varnishing practice and his Nuenen palette, aspects that have received relatively little attention up to now. This brought to light new information about Van Gogh's working practice which improved the understanding of the different painting stages of *Poplars near Nuenen* and supported decisions regarding conservation treatment. In addition, the findings also proved to have wider implications for the art historical interpretation, conservation and restoration of Van Gogh's Nuenen paintings.

Context: reuse and reworking

Vincent van Gogh had lived in Drenthe for three months from September to December 1883 before moving to Nuenen, where he stayed for almost two years. In November 1885, he decided to move to Antwerp and subsequently to Paris, where he lived with his brother Theo from February 1886 until February 1888. Theo, an art dealer, supported Van Gogh financially throughout his career. From his early years in the Netherlands, the artist regularly sent a selection of his paintings to his brother in Paris in return for this support. Other paintings were brought to Paris by Theo following a visit to the Netherlands (Letter 489) or by Van Gogh who took some pictures when leaving Nuenen for Antwerp. All these paintings finally ended up in the family collection, which for the main part has been kept in the Van Gogh Museum, Amsterdam, since its opening in 1973.[6] Another substantial portion of works was left in the parental home in Nuenen and later stored in Breda, from where they found their way into several

Table 1 Analytical techniques used for the investigation of the paintings by Van Gogh.

Title	F no.	Collection	Date	In-situ analysis	No. of cross-sections	Analytical techniques
Peasant Burning Weeds	F20	Van Gogh Museum, Amsterdam/ Drents Museum, Assen	October 1883	XRF	2	OM/SEM-EDX, FTIR-ATR, proteomics
*Congregation Leaving the Reformed Church in Nuenen**	F25	Van Gogh Museum, Amsterdam	January–February 1884/autumn 1885	XRF	1	OM/SEM-EDX, FTIR-ATR, proteomics
The Old Tower at Nuenen#	F34	Kröller-Müller Museum, Otterlo	February–March 1884	_	1	OM/SEM-EDX, FTIR-ATR
Head of a Man	F179r	Van Gogh Museum, Amsterdam	March–May 1885	_	2	OM/SEM-EDX, FTIR-ATR
The Cottage	F83	Van Gogh Museum, Amsterdam	May 1885	XRF	1	OM/SEM-EDX, FTIR-ATR
Basket of Apples	F99	Van Gogh Museum, Amsterdam	September 1885	XRF	1	OM/SEM-EDX
Birds' Nests	F109r	Van Gogh Museum, Amsterdam	September–October 1885	_	12	OM/SEM-EDX, FTIR-ATR
Birds' Nests	F111	Van Gogh Museum, Amsterdam	September–October 1885	XRF, Raman	1	OM/SEM-EDX
Poplars near Nuenen	F45	Museum Boijmans Van Beuningen, Rotterdam	Autumn 1885	XRF scanning, Raman	13	OM/SEM-EDX, FTIR-ATR

*XRF, OM/SEM-EDX and FTIR-ATR were previously performed (Iwanicka *et al.* 2022); the current study involved (new) OM/SEM-EDX analysis and proteomics.

#Technical examination was not performed.

collections (Tilborgh and Vellekoop 1999: 17).

When he lived and worked in Nuenen and Paris, in particular, Van Gogh frequently reused his picture supports, either painting over the original picture or starting a new one on its reverse (Hendriks *et al.* 2013). This practice was prompted by a lack of canvas supports due to his poor financial situation. Besides starting a completely new picture, Van Gogh also reworked existing paintings with the aim of improving them, as can be deduced from his letters and examination of his works (Hummelen and Peres 1993; Tilborgh and Vellekoop 1999; Struick van der Loeff *et al.* 2012; Iwanicka *et al.* 2022). This reworking included later modifications or additions to the composition that can be considered part of a single creative process (Hummelen and Peres 1993) as well as the retouching of paintings in a later stage (Iwanicka *et al.* 2022).

It often seems difficult to distinguish between the different painting stages and establish their dating. For the paintings that were not kept in the family collection, the interpretation of later paint additions by Van Gogh is further complicated by the fact that the pictures may have been retouched during early restoration treatments.

Materials and approach

An overview of the paintings by Van Gogh that were investigated and the analytical techniques used are given in Table 1. A description of the analytical techniques and methods can be found in the Appendix.

Corpus of paintings

Besides *Poplars near Nuenen*, this study includes the paintings *Peasant Burning Weeds* (F20), *Head of a Man* (F179r), *The Cottage* (F83), *Basket of Apples* (F99), *Birds' Nests* (F109r) and *Birds' Nests* (F111),

all in the collection of the Van Gogh Museum, Amsterdam (Vincent van Gogh Foundation). In addition, the previously examined *Congregation Leaving the Reformed Church in Nuenen* (F25), from the same collection, was subject to further investigation (Iwanicka *et al.* 2022). With the exception of *Peasant Burning Weeds*, which was painted in Drenthe, all the examined works date from the Nuenen period (Table 1). Four were painted on top of another image (F83, F99, F109r, F45), while two have a self-portrait on the reverse of the canvas that was added in Paris (F109r/v and F179r/v) (Hendriks *et al.* 2013). Three paintings were suspected to have been reworked, either in Nuenen (F25) or in Paris (F111, F45) (Tilborgh and Vellekoop 1999; Iwanicka *et al.* 2022).

Historical sources

Several historical sources were consulted including Van Gogh's letters to his brother[7] and the correspondence between P. Haverkorn van Rijsewijk, Jo Bonger and her brother Andries from around the date when *Poplars near Nuenen* was acquired by Museum Boijmans Van Beuningen.[8] In addition, available research and conservation documentation was studied in the archives of the Netherlands Institute for Art History (RKD) and the Van Gogh Museum.

Technical research

Technical imaging of all paintings was conducted including visible and raking light, UV fluorescence and X-radiography, and for *Poplars near Nuenen*, infrared photography (IR), false colour infrared (FCIR) and infrared reflectography (IRR) as well. Surface examinations were performed using a stereomicroscope with magnifications up to 50×.

Samples

Cross-sections taken from four of the paintings (F25, F83, F109r, F45) and *The Old Tower at Nuenen* (F34) of the Kröller-Müller Museum, Otterlo, were available for re-examination. These samples had previously been prepared and studied by other researchers and some of the present authors (Werf 1991; Groen 1995; Geldof and Megens 2013; Iwanicka *et al.* 2022). Recently, additional samples for cross-section analysis were taken from six paintings (F20, F179r, F83, F99, F111, F45). In total 34 cross-sections were studied (Table 1).

Results

Layer structure

First composition

The X-radiograph of *Poplars near Nuenen* has shown that the first composition – also referred to as the 'underlying composition' in this paper – depicts the old church tower in Nuenen located on the east side of the village which Van Gogh drew and painted many times (Berge *et al.* 2003: 51). Since its spire was demolished in May 1885, the first composition must originate from before this date (Brouwer 2000). X-ray fluorescence (XRF) scanning revealed that next to the old church tower, a figure and a second, smaller church are depicted, as shown in the Hg-Lα map indicating the presence of vermilion (Fig. 2). Van Gogh also rendered this smaller church, identified as the Roman Catholic church of St Clement, in the current scene of *Poplars near Nuenen* (Verkooijen 1998).[9] In order to determine whether or not the old church tower and the first rendering of the St Clement church belonged to the first composition, samples were taken to establish the stratigraphy. The cross-sections indicated that the paint layers of both churches were indeed applied during the same painting phase, and confirmed the presence of a relatively large amount of vermilion in the paint used for the St Clement church (Fig. 3). As the latter was located around 500 m west of the old church tower, it can be deduced that Van Gogh painted the view standing northeast of this tower.

Examination of the paint cross-sections revealed that the first composition was covered with a transparent, organic layer (Fig. 3). This layer has a thickness ranging from 2 to 12 µm and exhibits a bluish fluorescence in UV-induced fluorescence microscopy. Quantitative scanning electron microscopy with energy-dispersive X-ray (SEM-EDX) analysis confirmed that it contains nitrogen in around 15 wt%. Furthermore, protein was identified by Fourier transform infrared-attenuated total reflectance (FTIR-ATR) analysis of two of the cross-sections, indicating the probable presence of an egg white varnish.

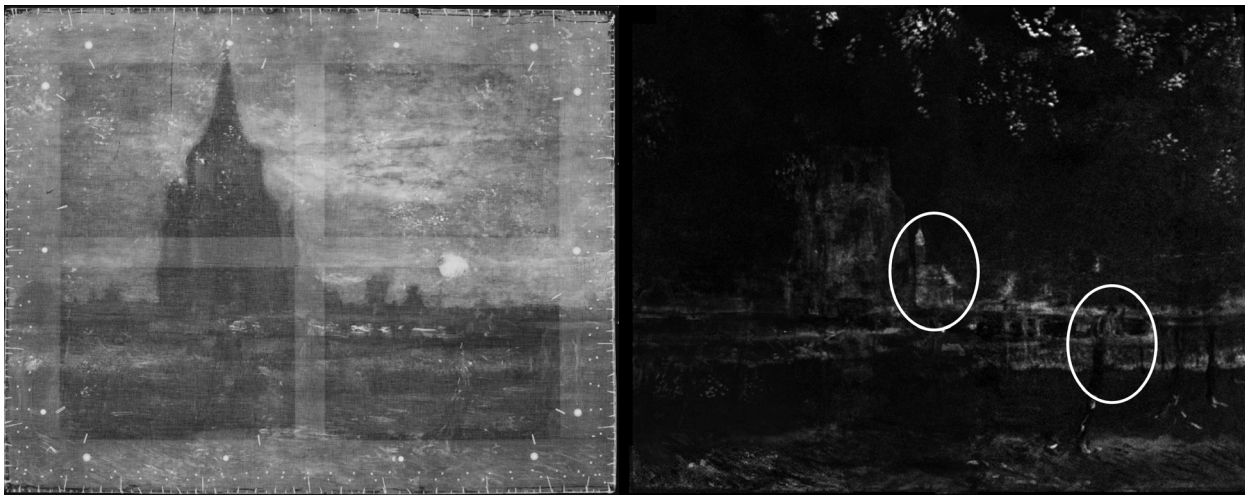

Figure 2 (*Left*) X-radiograph of *Poplars near Nuenen* and (*right*) the 2D XRF scanning Hg-Lα map, revealing the distribution of vermilion. The ovals indicate the church and figure that are not apparent in the X-radiograph. (X-radiograph © René Gerritsen Art & Research Photography.)

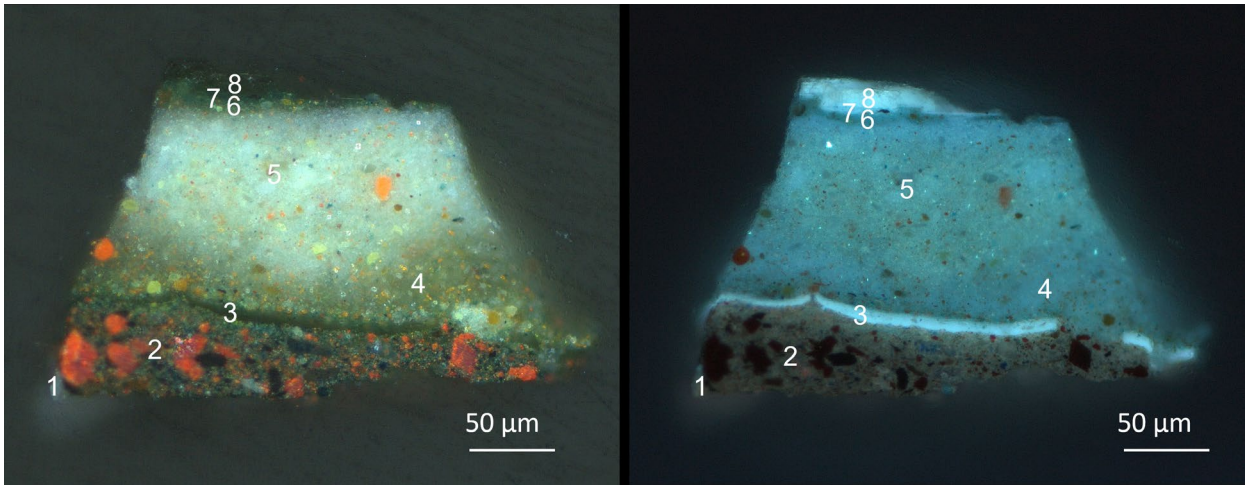

Figure 3 Photomicrographs of a cross-section taken from the location of the first, underlying rendering of the St Clement church in *Poplars near Nuenen*, shown in bright field (*left*) and UV illumination (*right*). **1** Fragment of the ground layer. **2** Paint layer of the underlying church. **3** Presumed egg white varnish. **4–6** Paint layers of the current Nuenen composition. **7–8** Organic top layers.

Second composition

With two exceptions, the cross-sections taken from *Poplars near Nuenen* revealed that the second composition, that is the landscape currently visible, was painted directly on top of the existing picture without first being covered with a layer of paint, a practice that agrees with earlier findings (Hendriks *et al.* 2013). The exceptions concern paint cross-sections taken from two spots just above the horizon of the current landscape: they show an additional lead white-containing paint layer in between the first and second compositions. The presence of this white intermediate layer might be explained by the fact that it was necessary to locally cover the dark paint of the first composition, the horizon of which lies slightly higher than it does now, before proceeding with the application of further light paint in this region.

Contrary to his working method for the first Nuenen composition, Van Gogh did not varnish the second. It is possible that the paint was not sufficiently dry when he left Nuenen for Antwerp in November 1885; apparently, he did not varnish the painting later on either. However, in two of eight cross-sections, a very thin (*c.*1 µm) organic layer was observed in between the second composition and the presumed Paris paint additions.[10] The function and composition of this intermediate layer is unclear. It may concern a local retouching varnish that would have enabled the artist to resume painting after a pause in the work process, in which case it is more likely to have been applied in Paris, before the painting was reworked, than in Nuenen.

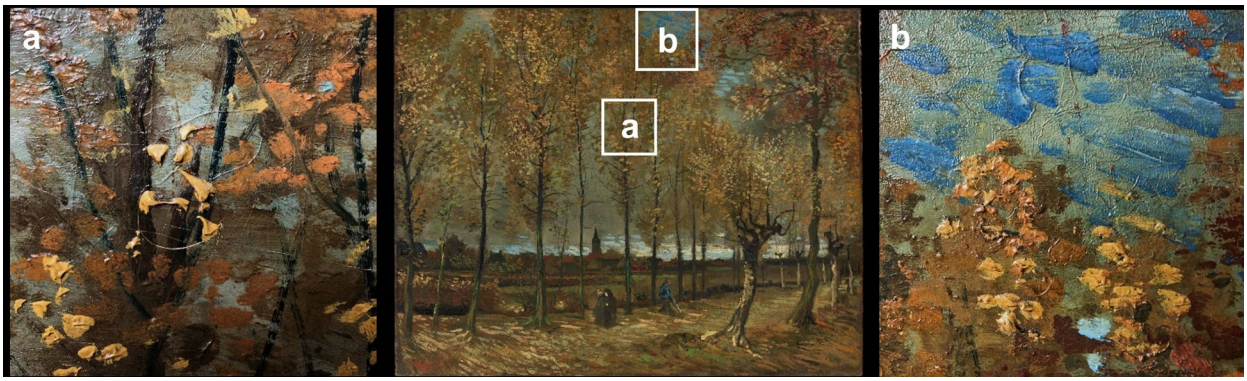

Figure 4 Detail photographs of the areas indicated by the white squares in the centre image, showing the later additions to the foliage (a) and sky (b).

Reworking

The character of the later reworking clearly differs from the technique of the second Nuenen painting. The added bright colours were applied either in thick and loose touches (notably in the foliage), or broad individual strokes (especially in the foreground and sky) (Fig. 4). These features of paint application resemble those seen in Van Gogh's Paris pictures, rather than in his Nuenen works (Hendriks and Tilborgh 2011).

The paint surface of the second Nuenen composition had dried thoroughly before the reworking took place, as can be deduced from examining the picture surface as well as paint cross-sections. It is not known whether or not Van Gogh varnished the painting after he reworked it. Nowadays the paint surface is covered with a varnish layer, probably a mixture of colophony and damar with oil, as identified by gas chromatography-mass spectrometry (GC-MS) analysis,[11] but this is thought to originate from the 1938 restoration treatment by Hendrik G. Luitwieler, restorer at Museum Boymans at that time.[12]

Context: varnishing practice

The different varnish applications found for the various stages of painting *Poplars in Nuenen*, including the identification of a possible egg white varnish, prompted further research into Van Gogh's practices of varnishing in Nuenen. The use of egg white varnish was probably a widespread and well-known practice at the time. Contrary to a resin varnish, it could be applied on a fresh oil painting. However, it had unfavourable drying properties, so was generally used as a temporary varnish that was intended to be washed off before the application of a final (resin) varnish (Peres 1991).

In two letters to his brother Theo, Van Gogh refers to the use of egg white (Letters 389 and 497).[13] These letters make clear that the application of egg white served two functions: it was applied either as a top layer to saturate the colours or as a retouching varnish. Van Gogh's letters indicate that most of the paintings he sent to his brother in Paris were left unvarnished and that they were meant to be varnished later (Letters 389, 507 and 534). Aside from *Poplars near Nuenen*, egg white varnish has recently been identified in his *Congregation Leaving the Reformed Church in Nuenen* that was painted in January–February 1884 and reworked by the artist in autumn 1885 (Iwanicka *et al.* 2022). The layer was found between the initial composition and the reworking, but in the current study a second, very thin egg white layer was recognised, probably applied during the first painting stage. In addition, four more paintings were identified as containing egg white: *Peasant Burning Weeds*, *The Old Tower at Nuenen*, *Head of a Man* and *Birds' Nest* (F109r).[14] In *Birds' Nest* the egg white layer is present in between the underlying and current composition, as in *Poplars near Nuenen*. In the other three works, egg white was identified on the painting's surface (Table 2).[15]

The egg white varnishes share a similar appearance with characteristic features observed both on the paintings and in paint cross-sections. Due to shrinkage of the egg white layer during the drying process, wide cracks have formed resulting in distinct 'islands' of varnish on the picture surface. Similarly, in cross-section this varnish layer often appears disrupted by cracks and cupping. From the cross-sections taken from *Birds' Nest* (F109r) and *Poplars near Nuenen*, it can be concluded that cracking took place before the works were overpainted as the paint of the second (top) image ran into the cracks as it was applied. Contrary to the yellowish or greenish fluorescence of resinous varnishes, egg white exhibits a distinctive

Table 2 Van Gogh paintings with (presumed) egg white varnish.

Title	F no.	Collection	Date	Underlying composition	Date of underlying work	Location in layer structure	Thickness *c.* (µm)	Nitrogen content (wt%; SEM-EDX)	FTIR-ATR/ proteomics (F/p)	Early provenance
Peasant Burning Weeds	F20	Van Gogh Museum, Amsterdam/ Drents Museum, Assen	October 1883	n/a	n/a	On paint surface	3–12	14.2	F - protein; p - chicken egg white	Left in Nuenen
Congregation Leaving the Reformed Church in Nuenen	F25	Van Gogh Museum, Amsterdam	January-February 1884/autumn 1885	n/a	n/a	Part of first painting stage?	1	13.7	F - not possible due to limited thickness	Left in Nuenen; gift of the artist to his mother
idem	*idem*	*idem*	*idem*	*idem*	*idem*	Between first composition and reworking	40	15.8	F - protein; p - chicken egg white	*idem*
The Old Tower at Nuenen	F34	Kröller-Müller Museum, Otterlo	February–March 1884	n/a	n/a	On paint surface*	80	8.1	F - protein	Left in Nuenen; gift of the artist to Margot Begemann
Head of a Man	F179r	Van Gogh Museum, Amsterdam	March–May 1885	n/a	n/a	On paint surface, locally	30	18.7	F - protein	Sent to Paris either 5/6 May or June 1885
Birds' Nests	F109r	Van Gogh Museum, Amsterdam	September–October 1885	*Interior with a Loom*	First half of 1884	Between first and second composition	1–12	13.8	F - protein	Possibly sent to Paris October or November 1885
Poplars near Nuenen	F45	Museum Boijmans Van Beuningen, Rotterdam	Autumn 1885	*The Old Church at Nuenen*	Autumn 1884?	Between first and second composition	2–12	14.9	F - protein	Taken by the artist to Antwerp and Paris

*Based on the paint cross-section

Table 3 Pigments identified in the different painting stages of *Poplars near Nuenen*.

Painting stage	First composition	Second composition	Reworking
Place	Nuenen	Nuenen	Paris?
lead white	x		x
zinc white		x	x
calcium carbonate		x	
calcium sulphate			x
barium sulphate	x	x	x
strontium yellow			x
Naples yellow	x	x	x
cadmium yellow	x		x
yellow ochre	x	x	
chrome yellow	x	x	x
chrome orange		x	x
orange/ red ochre	x	x	
red lead	x	x	x
vermilion	x	x	x
eosin			x
cochineal (Al/Ca)			x
cerulean blue			x
ultramarine	x	x	
cobalt blue			x
Prussian blue	x	x	x
emerald green			x
chromium oxide green			x
brown ochre	x	x	
umber		x	
organic brown	x	x	
bone black	x		
carbon black	x		

light blue fluorescence.[16] Apart from differences in appearance and fluorescence behaviour, their solubility also differs. Unlike resinous varnishes, aged egg white is not soluble in organic solvents, nor does it dissolve in water.[17]

The identification of the egg white layers involved a combination of analytical methods (Table 2; see also the Appendix). As a first indication, nitrogen was detected in cross-section using quantitative SEM-EDX. With the exception of *The Old Tower at Nuenen* that contained a relatively low amount of nitrogen (8 wt%), around 15 wt% of the element was found to be present in the egg white layers of other paintings, which agrees with the expected concentration for proteins (Gürtler Subal 1993). Secondly, the presence of protein in the layers was confirmed by FTIR-ATR in a cross-section from each painting. Finally, proteomics of samples taken from the varnishes of *Peasant Burning Weeds* and *Congregation Leaving the Reformed Church in Nuenen* confirmed the presence of chicken egg white.

Apart from the Drenthe painting *Peasant Burning Weeds*, all the paintings with an egg white layer date from the period between early 1884 and spring 1885. Furthermore, it appeared that nearly all the paintings with an egg white layer had not been transported to Paris or only after they had been overpainted. The one exception is *Head of a Man*, which was sent or taken to Paris somewhere between March and November 1885 (Tilborgh and Vellekoop 1999: 238; Berge *et al.* 2003: 51).[18] Indeed, Van Gogh's correspondence indicates that no consignments of paintings were sent to Paris between March 1884 and May 1885 due to a quarrel between the brothers. However, Theo did take a couple of paintings with him at the end of March 1885, after attending the funeral of their father (Letter 489) (Tilborgh and Vellekoop 1999). Because the paintings remained in Van Gogh's studio for a long time, he probably varnished them himself using egg white.

Palette

First composition

The palette used in the first, underlying composition of *Poplars near Nuenen* consists of rather traditional pigments such as ochres, Naples yellow and blacks, which accords with earlier findings on Van Gogh's Nuenen painting materials (Table 3) (Snickt 2012; Geldof and Megens 2013). The only exception was the identification of a small amount of cadmium yellow in a paint layer belonging to the sky area of the first composition. To our knowledge, to date this pigment has not been detected in other Van Gogh paintings from the Nuenen period.[19] It was, however, found in a few paintings executed in The Hague, where Van Gogh lived before his move to Drenthe and afterwards Nuenen, as well as in many of his works from the following Antwerp and Paris periods (Hummelen and Peres 1993; Hendriks and Tilborgh 2011; Snickt 2012; Geldof and Megens 2013; Defeyt *et al.* 2020).

Second composition

The palette used for the second, current Nuenen composition resembles that of the first composition, although cadmium yellow was not detected, and zinc white was found to be the main white paint used rather than lead white (Table 3). This agrees with previous research indicating that Van Gogh used zinc white more frequently in his later Nuenen paintings (Geldof and Megens 2013). In *Congregation Leaving the Reformed Church in Nuenen*, which he executed in 1884 and partially reworked in 1885, a similar shift in choice of white paint also helped to differentiate between the two painting stages (Iwanicka *et al.* 2022).

Reworking

A clear distinction could be made between the composition of the paint layers applied in Nuenen and those paints that were thought to have been added in Paris (Table 3). The study indicated that Van Gogh probably applied these around the summer of 1886. The added paints contain pigments that he used in both periods, but more importantly, also some pigments that he did not use or hardly used in Nuenen including strontium yellow, cadmium yellow, viridian, emerald green, cerulean blue, cobalt blue and two organic red pigments, eosin and a cochineal, on an aluminium- and calcium-containing substrate. Eosin was only detected in the signature used in a mixture with red lead.[20]

Although emerald green has been identified in small quantities in a few paintings made in Nuenen (Snickt 2012), and cobalt blue and (a trace of) chromium oxide green (possibly viridian) were each identified once in a sample taken from a painting of this period, it was only in Antwerp that Van Gogh started to use them regularly; he continued working with paints containing these pigments in Paris (Hendriks and Tilborgh 2011; Geldof and Megens 2013). In Antwerp and Paris, he frequently employed

cadmium yellow which, as well as in the later paint additions, was also identified in trace amounts in the first composition of *Poplars near Nuenen* (see above). Previous research has shown that Van Gogh used different types of cobalt blue while residing in Paris. This distinction was based on the nickel to cobalt ratio in the pigment and the presence or absence of phosphorous. The cobalt blue found in *Poplars near Nuenen* has a relatively high nickel content and no phosphorous, characteristics that correspond to the cobalt blue that was used by Van Gogh around the summer of 1886 and subsequently from the summer of 1887 onwards (Geldof and Steyn 2013).

Strontium yellow, cerulean blue, eosin[21] and cochineal on an aluminium- and calcium-containing substrate have not been identified in Van Gogh's Nuenen or Antwerp paintings thus far. Cerulean blue was detected in 11 paintings created in Paris between the spring of 1886 and late 1887[22] (Hendriks and Tilborgh 2011; Struick van der Loeff *et al.* 2012), while cochineal was found in three of Van Gogh's Paris paintings: two made in early summer/autumn 1886 and one dating from the summer of 1887 (Bommel *et al.* 2005).[23] Strontium yellow and eosin were each found only once in a Paris painting; both concern floral still-lifes from the spring or summer of 1886. Strontium yellow was detected in *Still Life with Meadow Flowers and Roses* (Kröller-Müller Museum, Otterlo, F278) dated to the early summer of 1886 (Struick van der Loeff *et al.* 2012) to which a number of touches were added later, probably in early 1887. Eosin, indicated by the presence of bromine, was found in the flowers of *Vase with Poppies* (Wadsworth Atheneum Museum of Art, Hartford, USA, F279), dating to spring 1886 (Geldof 2018).[24]

As well as the individual pigments found in the later paint additions, the paint mixtures composed of one or two colours supplemented with white also correlate with Van Gogh's working practice in Paris rather than the Nuenen period. In Nuenen, he typically mixed several paints in primary colours to obtain different shades of brown, blue and green instead (Geldof and Megens 2013).

In several paints used for the presumed Paris reworking, filler materials were found. Two paints contain large crystalline particles of calcium sulphate.[25] In the green used for the leaves, a mixture of chrome yellow, Prussian blue and the filler barium sulphate was identified. XRF scanning confirmed that the ratio between chromium and barium is constant, therefore it is probably a tube paint mixture of chrome yellow and barium sulphate to which Prussian blue paint was added by Van Gogh. Indeed, microscopic examination of the painting's surface revealed that the green paint is rather inhomogeneous, indicating that a palette mixture of yellow and blue was used. Furthermore, instead of the red paint vermilion that was found in signatures of his South of France paintings (Pilz 2013: 101, n. 53; Martins *et al.* 2024), in *Poplars near Nuenen* Van Gogh used a mixture of red lead and eosin which was sold as a cheap substitute for the more expensive vermilion paint (Geldof *et al.* 2013). Van Gogh thus seems to have employed a couple of paints of inferior quality.

Previous research has shown that he used a particular cheap variant of red lake pigment (redwood) in floral still-life studies in the summer of 1886. The use of this paint was probably prompted by a lack of money: Van Gogh turned to painting floral still-lifes because he could not afford to pay for models (Letter 569) (Bommel *et al.* 2005). In that period, the artist started to paint in a more colourful and loose style, and the floral still-life studies were the first examples of this new approach (Hendriks and Tilborgh 2011). They were described as being 'very gay and colourful' by Andries Bonger in a letter to Theo from *c.*18 August 1886 (Letter 568). Because Theo was visiting the Netherlands at the time, Andries stayed in the apartment where the brothers lived to keep Van Gogh company and possibly saw him reworking *Poplars near Nuenen*.

Distribution of the later paint additions

A tentative overview was made of the presumed Paris paint additions, suggesting that these were probably more substantial than was previously assumed (Fig. 5).[26] For this overview, two criteria were used to label paint strokes as belonging to the reworking phase: they must have been applied onto the dried paint surface of the second Nuenen composition and contain pigments that correspond to those detected in Van Gogh's Paris paintings. This approach, however, proved to be rather ambiguous. Many areas of the painting that were considered to be part of the Paris reworking were found to contain cobalt blue, viridian and cadmium yellow: cobalt blue in the sky, cadmium yellow in the leaves, cobalt blue and cadmium yellow in the foreground, and viridian in the tree trunks and branches. These three pigments have been identified in many Antwerp and Paris

Figure 5 Tentative overview of the presumed Paris additions (indicated in white).

paintings, but they were each found once in Nuenen paintings as well (see above). Moreover, strontium yellow and eosin, used respectively in the leaves and foreground and in the signature, have so far only been identified once in Paris and not in Nuenen. Therefore, while these areas of the painting were also thought to be part of the Paris reworking, they could not be decisively dated to one or other period. Further investigation was needed to corroborate Van Gogh's Nuenen palette, especially to establish whether or not these pigment 'exceptions' signal later additions.

Context: Van Gogh's palette and reworking practice

The Cottage

Cobalt blue was previously detected in a cross-section from a sample taken from the Nuenen painting *The Cottage*, dated May 1885, which has an underlying composition depicting a *Shepherd with his Flock* (Hendriks *et al.* 2013; Geldof and Megens 2013). The sample was taken in the late 1990s from the far edge of the painting, but renewed microscopic examination of the painting's surface could not fully clarify the layer build-up at the sample location. Subsequent XRF analysis showed the presence of cobalt in two distinctive areas of the painting: in the lighter paint touches of the figure and the smooth grey-brown paint passage of the sky. It is uncertain at which point during painting the light touches were applied, but the grey-brown paint was added to reduce the width of the orange band in the sky in the last painting stage (Tilborgh and Vellekoop 1999). Apart from cobalt, tin, cadmium, chromium and strontium were also found in this paint.

The cross-section taken from this grey-brown paint in the sky includes the paint layers of the first and second composition, an organic intermediate layer, the later added grey-brown paint and an organic top layer (Fig. 6). Analysis showed the presence of cobalt blue in the grey-brown layer as well as two other cobalt-containing pigments, cerulean blue and cobalt violet (cobalt phosphate variant); in addition,

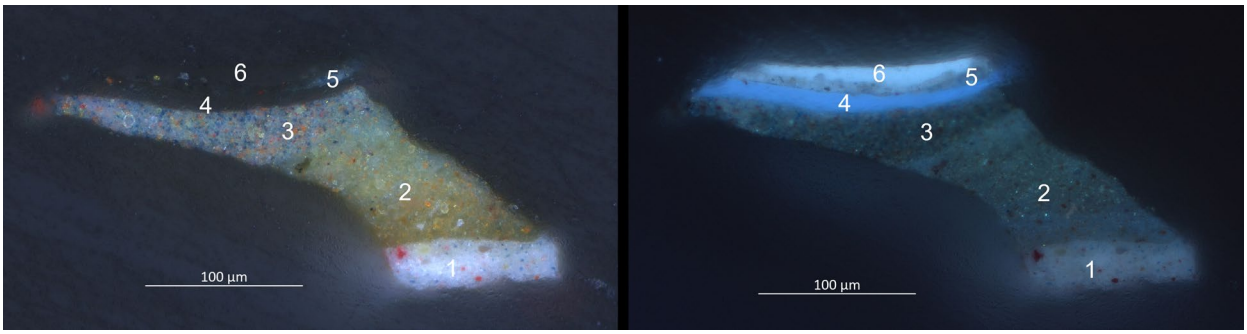

Figure 6 Photomicrographs of a cross-section taken from the smooth dark paint in the sky of *The Cottage* shown in bright field (*left*) and UV illumination *(right*). **1–3** Paint layers of the first and second composition. **4** Natural resin varnish layer. **5** Layer of grey-brown overpaint. **6** (Restoration) varnish layer.

cadmium yellow and presumably strontium yellow are present. Cerulean blue and cobalt violet have not yet been found in paintings from the Nuenen and Antwerp period but are known to have been employed by Van Gogh in Paris. He used cobalt violet for just a short period: from the 88 Paris paintings investigated, it was only detected in six paintings dating from January to April 1887 (Hendriks and Tilborgh 2011: 559; Pozzi *et al*. 2021).

Further analysis showed the organic intermediate layer to be a natural resin varnish. When *The Cottage* was sent to Paris in June 1885 together with *The Old Tower at Nuenen* (F84), Van Gogh wrote: 'I'd like you to give both the paintings a varnish before you show them to Portier or Serret'[27] (Letter 507). Therefore, it seems likely that the intermediate varnish corresponds to the original varnish that was applied by Theo, or at his request, confirming that the cobalt-containing paint is a Paris addition.

Birds' Nests

Like *Poplars near Nuenen*, *Birds' Nest* (F111) was probably reworked by Van Gogh in Paris, as colourful and bright additions were made to the painting in a later stage (Tilborgh and Vellekoop 1999). These additions include the light yellow background, and red and green strokes in the foreground. XRF analysis indicated cadmium yellow in the background, and vermilion, emerald green and presumably chromium oxide green in the foreground. Analysis of a cross-section taken from the background confirmed the presence of cadmium yellow in the light paint. In addition, lead white and possibly zinc white, vermilion, ultramarine and small amounts of cobalt blue and chromium oxide green were identified in the light yellow layer of the background. Except for ultramarine, these pigments were also found in the later paint additions of *Poplars near Nuenen*. Moreover, in the later added green touches in one of the birds' nests, a mixture of chrome yellow, barium sulphate and Prussian blue was identified. Examination of the green touches under the microscope showed an inhomogeneous mixture of yellow and blue paint. As previously noted, a similar mixture was identified in the green leaves of the trees in *Poplars near Nuenen*.

Birds' Nests was probably part of a consignment that was sent to Theo around 10 October 1885 (Tilborgh and Vellekoop 1999). In a letter of this date, Van Gogh announced that he was going to send a couple of still-lifes and then added: 'They'll sink in after a while, but in a year, say, they'll be better than now once they're dry right through and are given a thorough varnishing' (Letter 534). In contrast to *The Cottage* however, the cross-section taken from the background of *Birds' Nests* (F111) showed that no varnish layer was applied between the Nuenen painting and the presumed Paris paint additions. Therefore, it cannot be fully excluded that Van Gogh reworked the painting in Nuenen instead of Paris. Nevertheless, it seems more likely that *Birds' Nests* (F111) had not (yet) been varnished when Van Gogh resumed working on the painting in Paris.

Basket of Apples

The painting *Basket of Apples* (F99), dated September 1885, was suspected to contain eosin because bromine was previously detected by XRF scanning, in particular in the dark shadows of the apples.[28] In the current study, the presence of eosin was further investigated. The occurrence of bromine was confirmed by XRF and a cross-section was prepared from a sample taken from a dark brown-blue apple shown to contain bromine. It revealed the complete layer build-up, including the ground layers, the paint layers of the first, underlying composition,[29] and the dark paint of the apple, which is composed of several pigments such as earth pigments, Prussian blue,

vermilion and red lead. The upper part of this paint layer fluoresces somewhat cooler, more greyish in UV than the bottom part, which has a warmer, rather reddish-brown fluorescence. This may indicate the presence of two layers of paint, each with its own fluorescence, but it might also be the result of discoloration of the paint as eosin exhibits an orange fluorescence that decreases as the pigment fades. SEM-EDX analysis of an area (*c.*250 × 60 µm) that included most parts of the paint layer confirmed the presence of a small amount of bromine, while point analysis of a single, very fine orange-fluorescing particle (*c.*2 µm in diameter) showed a higher concentration of bromine, indicating that eosin is finely divided across the paint layer.

Similarly, bromine was also identified in a small red pigment particle (*c.*3 µm in diameter) in a cross-section taken from the greenish paint of the background of *Head of a Man*, dated to spring 1885, suggesting that Van Gogh's use of eosin in Nuenen was not limited to a single painting.

Discussion

Varnishing practice

Egg white is most likely present in the varnish layer between the first and second composition of *Poplars near Nuenen*. The study of a number of Van Gogh's Drenthe and Nuenen paintings indicated that this was no exception; he appears to have regularly varnished his paintings using egg white. In particular, this seems to relate to paintings that were not sent or taken to Paris, but which stayed in the Netherlands. Because egg white becomes insoluble in organic solvents and water after aging, later removal of this material is difficult and, as a consequence, it was often left on the surface of his paintings. Furthermore, in Nuenen, Van Gogh reused several of his canvases, some of which were already varnished with egg white, thereby preserving the material in between the initial picture and the overpaint. We can expect to find such intermediate egg white layers in more paintings that were laid aside for a while before Van Gogh returned to work on them.

On the other hand, most of the paintings transported to Theo in Paris were probably sent unvarnished, as can be deduced from his letters, and were later varnished in Paris or otherwise left unvarnished. In choosing one or other of these options, it seems that Theo followed Van Gogh's instructions closely, as examination of *Birds' Nests* (F111) and *The Cottage* has shown.[30] *Birds' Nests*, which the artist probably sent to Theo in October 1885 with the advice to varnish the work after a year, was unvarnished when Van Gogh started to rework the still-life study, presumably in the summer of 1886 (see below). On the contrary, *The Cottage*, shipped to Paris four months earlier, in June 1885, was indeed varnished in Paris. Van Gogh intended this large painting for sale and it was most likely varnished for this reason shortly after its arrival in Paris.

Generally, it is difficult to determine which varnish material was applied in Paris to the Dutch period paintings as in most cases the original varnish was probably removed during past restoration treatments. However, it could be hypothesised that in *The Cottage*, the layer of natural resin varnish preserved between the second Nuenen composition and the paint used for the Paris reworking in fact concerns the original Paris varnish.

Most paintings from the Dutch period in the Van Gogh Museum's collection were transported to Paris, while the paintings that remained in Nuenen largely found their way to other collections. As a consequence, the results of our research imply that most of the paintings with egg white varnish are expected to be found outside of the Van Gogh Museum's collection. The artist's use of egg white has implications for the current condition of these paintings and choices for their conservation treatment as the (degraded) appearance of the material may be perceived as disturbing. Therefore it is very important that collection keepers are made aware of the possible presence of such original varnish layers.[31]

Palette and reworking practice

The dating of the later paint additions made to *Poplars near Nuenen* was complicated by the fact that some identified pigments could be considered anomalies to Van Gogh's known palette. The investigation of these exceptions in relation to his reworking practice resulted in the extension of his known Nuenen palette with cadmium yellow and eosin, while cobalt blue should possibly be omitted. These findings have further consequences for both art history and conservation. The idea that cadmium yellow was among the new colours that Van Gogh purchased in Antwerp must be reconsidered, as well

as our previous suggestion that he only started to use eosin after his move to Arles (Hendriks and Tilborgh 2011; Geldof *et al.* 2013). This knowledge about his choice of paints is essential for a proper dating and attribution of his paintings. Furthermore, as eosin is known to be extremely light sensitive (Burnstock *et al.* 2005), this result also has implications for the exhibition and storage conditions of Van Gogh's early works.

Poplars near Nuenen was reworked in a later stage using bright and thick paint applications. Investigation of these later paint additions indicated that they were applied in Paris around the summer of 1886 when Van Gogh cautiously started to work with stronger colours. A similar technique and palette was used for the later paint additions made to *Birds' Nests* (F111), which may therefore have been reworked by Van Gogh in the same period. In contrast, *The Cottage* was reworked in a different way, using a very smooth and dark paint. The presence of cobalt violet suggests that this paint addition was applied by the artist at a later date, as so far this pigment has only been identified in his paintings dating from January to April 1887. However, the painting technique seems to differ from Van Gogh's working method of early 1887: although he was experimenting with a thin, watercolour-like technique in that period, he had already adopted a rather modern painting style with much more colour (Hendriks and Tilborgh 2011). When Van Gogh returned to work on *The Cottage* in Paris, he apparently adjusted his actual working method to match his initial painting.

Conclusion

The investigation of Van Gogh's *Poplars near Nuenen* in context helped to distinguish and date the different phases in the execution of the painting that was overpainted in Nuenen and reworked later, most likely in Paris in the summer of 1886. The concurrent examination of a selection of Dutch Van Gogh paintings showed that at various times during his stay in Paris, he probably reworked his Nuenen paintings in different ways. Furthermore, analyses of the paints and varnishes resulted in two additions and a possible correction to the pigments known to belong to Van Gogh's Nuenen palette, and in extending our knowledge on his varnishing practice, in particular his use of egg white varnish. These findings proved to be essential for accurate art historical interpretation of his paintings and also have considerable implications for the preservation and restoration of these valuable works.

This research, however, also showed the complexity of studying Van Gogh's practices of reworking his Nuenen paintings. Despite all knowledge of Van Gogh's materials and techniques in the different periods of his career, it remains difficult to interpret later paint additions with certainty. The results of this study can be regarded as the first steps towards unravelling these issues, but further research into Van Gogh's practices of reworking will be needed as based on our experience, there is every reason to believe that so far we have only seen the tip of the iceberg.

Appendix: Analytical materials and methods

Portable X-ray fluorescence spectrometry (XRF)

The chemical elements were identified at different spots on four paintings (F20, F83, F99, F111) (Table 1) using a portable Bruker Tracer 5i X-ray fluorescence spectrometer equipped with a low power Rhodium X-ray tube and a silicon-drift energy-dispersive X-ray detector. The measurements were carried out in the spectrometer mode under atmospheric conditions, using a 3 mm collimator, a tube voltage of 40 kV and 8 μA current, without primary beam filter. The acquisition time was 60 s.

Portable Raman spectrometry (Raman)

In-situ Raman analyses were performed on two paintings (F111, F45) (Table 1) using a Bravo spectrometer (Bruker), conducting measurements at a distance of about 0.5 mm with a spot size of 1 mm. The device works with two excitation wavelengths, recording spectra in two separate spectral ranges of 300–2200 cm^{-1} and 1200–3200 cm^{-1} with a DUO laser system (785 nm and 853 nm).

Optical microscopy (OM) and (quantitative) scanning electron microscopy-energy-dispersive X-ray spectrometry (SEM-EDX)

The additional samples for cross-section analysis were embedded in Polypol PS 230 polyester resin and

ground with SiC-paper (Struers and Micro-Mesh). All cross-sections were examined using a Zeiss AxioImager A2m optical microscope with incident polarised light from a VIS-LED lamp for bright field illumination and incident UV light from the Solid-State Light Source Colibri 7, type RGB-UV, LED 'UV' (385 nm) for UV-induced fluorescence. The filter set used for UV-induced fluorescence consists of the following filters: excitation G 365, beam splitter FT 395 and emission LP 420 (filter set 02).

The elements present in the cross-sections were analysed using a Jeol JSM-IT700HR SEM with energy-dispersive X-ray spectrometry. The primary electron beam energy used was 20 kV. The cross-sections were examined in the low vacuum mode (30 Pa). Quantitative SEM-EDX measurements were performed using the standardless Phi-Rho-Z correction method. The weight percentage of nitrogen in the organic layers was determined with respect to the percentages of carbon and oxygen. Several spots/areas were analysed and the outcomes averaged.

Fourier transform infrared spectrometry by attenuated total reflectance (FTIR-ATR)

FTIR-ATR imaging was performed on paint cross-sections from six paintings (F20, F34, F179r, F83, F102r, F45) (Table 1). The measurements were carried out using a Perkin Elmer Spectrum 100 FTIR–Spectrum Spotlight 400 FTIR microscope with a Perkin Elmer ATR imaging accessory.

2D micro X-ray fluorescence scanning (XRF scanning)

XRF scanning (also called MA-XRF imaging) of *Poplars near Nuenen* was performed with the Bruker Crono micro-XRF scanner. The painting was scanned in two sessions, yielding 7 partial scans with a spatial resolution of 1.00 × 1.00 mm. The scans were acquired with a 1 mm collimator, a thin rhodium anode tube with a tube voltage of 50 kV, a tube current of 70 μA and no primary beam filter; the area with the signature at a spatial resolution of 0.50 × 0.50 mm, 0.5 mm collimator, 50 kV, 200 μA, no filter. Element distribution maps and spectra were extracted from the resulting data cubes using homemade software. The element distribution maps were stitched manually in Adobe Photoshop to obtain overall maps of almost the entire painting.

Proteomics

Varnish samples of two paintings (F20 and F25) (Table 1) were treated with PNGaseF followed by urea (Vinciguerra Anal Chem 2015). The extracted proteins were reduced and alkylated. Enzymatic hydrolysis was carried out with trypsin and the sample was desalted with a ZipTip C18 pipette tip (Dallongeville Analyst 2013). The peptide mixtures were analysed using nano-liquid chromatography (Ultimate 3000, Thermo Scientific) coupled with a Q Exactive Focus Hybrid Quadrupole-Orbitrap (Thermo Scientific) via an EASY-Spray source. The MS/MS spectra were searched against Chordata in the SwissProt database using Mascot software version 2.6.2. Protein identifications were accepted with two or more peptides.

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Notes

1. This paper uses the De la Faille oeuvre catalogue number to identify the paintings throughout the text (Faille 1970).
2. When Museum Boijmans Van Beuningen acquired *Poplars near Nuenen* in 1903, Andries Bonger wrote to Mr Haverkorn van Rijsewijk, director of the museum: 'you may not be aware that he [Van Gogh] worked on it later in Paris' (translation from Dutch by the authors).

Letter, Andries Bonger to P. Haverkorn van Rijsewijk, 5 May 1903, Rijksprentenkabinet, Amsterdam. With thanks to Teio Meedendorp, Van Gogh Museum, for sharing this letter.

3. The letter dates from *c.*17 November 1885. All letter references are taken from Jansen *et al.* 2009.
4. For example, in his letter Van Gogh wrote: 'The sky higher up, grey, against it the black trunks and yellow leaves.' As there are multiple tints of yellow leaves apparent, probably applied in different painting stages, the interpretation is not straightforward.
5. In 1937, art historian Walther Vanbeselaere wrote that 'half of the canvas [was] reworked in a pointillist technique' (translation from Dutch by the authors) stating that the blue and white strokes in the sky as well as the red lake roofs and the red and yellow touches in the trees were applied later. In 1967, art historian Annet Tellegen agreed with Vanbeselaere about the blue strokes in the sky, adding that the isolated strokes in the foreground were also probably applied in Paris. According to Tellegen, however, the centre part of the painting as well as the light yellow dots in the trees belong to the Nuenen picture. Finally, in 1990 the painting was investigated by conservation scientist J.R.J. van Asperen de Boer and his art history student Pien van der Werf, including technical photography and sample analysis. Van der Werf pointed out that more knowledge about Van Gogh's palette would be needed to be able to distinguish between the Nuenen painting and the presumed Paris paint additions. With this reservation, she cautiously concluded that the latter may include the signature, some touches in the trees and possibly the red roofs.
6. As far as is known seven works were sold: see Tilborgh and Vellekoop 1999: 15–16.
7. See Jansen *et al.* 2009.
8. Accessible at the Rijksprentenkabinet, Amsterdam.
9. The church was identified by Teio Meedendorp, Van Gogh Museum, Amsterdam.
10. It concerns samples taken from the red/yellow leaves and the green tree trunk respectively. This very thin intermediate layer may possibly be present in two more samples as well (although unclear): one taken from the blue in the sky, the other from a yellow leaf.
11. GC-MS analysis was performed by Saskia Smulders of the Cultural Heritage Agency of the Netherlands: see Geldof *et al.* 2022a.
12. Two treatment invoices, dated October 1938 and January 1939 respectively, are kept at the Netherlands Institute for Art History (RKD), The Hague, archive of H.G. Luitwieler and N. Pappenheim Luitwieler, access no. 0883, inv. nos. 6 and 38.
13. In the first letter, written in Drenthe on 24 September 1883, Van Gogh mentions three studies that he had just sent to Paris and then adds: 'The smallest one, in particular, has sunk in a lot, go over it with the white of an egg in about a week, or some varnish in a month's time, to lift them' (Letter 389). In the second letter, dated 30 April 1885, he wrote to Theo describing the progress he had made on *The Potato Eaters* (F82) stating that 'In 3 days or so, I'll go over there and lift it with a little white of egg and finish off a few details' (Letter 497).
14. In the *The Old Tower at Nuenen* the presence of egg white was detected as early as 1995 and its presence was also confirmed in our current study: see Groen 1995.
15. For *Old Tower at Nuenen* the location of egg white in the stratigraphy was based on the cross-section, as no technical examination of this painting was performed in the current study.
16. The egg white restoration varnish in Rembrandt's *Marten and Oopjen* showed a similar blue fluorescence: see Noble *et al.* 2018: 320.
17. This is caused by changes in the (secondary and tertiary) structure of the egg white proteins after application and the subsequent degradation of the material: see Gürtler Subal 1993 and Imbrogno *et al.* 2014.
18. *Head of a Woman* (F269r), like *Head of a Man* dated between March and May 1885, appears to contain an original varnish that was presumably applied before the painting was transported to Paris: see Tilborgh and Vellekoop 1999: 25. It would be interesting to investigate whether or not this also concerns an egg white varnish.
19. Cadmium yellow was also identified recently in existing cross-sections from Van Gogh's Nuenen painting *The Old Tower at Nuenen* (F34) and *Basket of Apples* (F101). However, as no technical examination of these paintings has been conducted so far, it is not completely certain to which painting stage they belong.
20. Cochineal was identified by Sanne Berbers of the Cultural Heritage Agency of the Netherlands using high performance liquid chromatography coupled to high resolution mass spectrometry (HPLC-HRMS): see Geldof *et al.* 2022. The identification of eosin was based on the detection of bromine in the signature by XRF scanning and SEM-EDX in a cross-section taken from this area.
21. For the current findings of eosin in Nuenen paintings see the section above headed 'Van Gogh's palette and reworking practice', subheading 'Basket of Apples'.
22. Cerulean blue was detected in the light blue paint strokes above the horizon. The pigment contained some magnesium, next to cobalt and tin, presumably present as magnesium oxide or magnesium hydroxide. Magnesium was also identified in the cerulean blue used in Van Gogh's Paris paintings as well as in cerulean blue pigments from other origins: see Hendriks and Tilborgh 2011: 129.
23. Traces of vermilion were also detected in the cochineal-containing paint used in Paris, while this addition was not found in *Poplars near Nuenen*.

24. Both *Vase with Poppies* and *Still Life with Meadow Flowers and Roses* were recently attributed conclusively to Van Gogh. See https://www.vangoghmuseum.nl/en/about/news-and-press/news/two-paintings-attributed-to-vincent-van-gogh (accessed 24 January 2024) and Struik van der Loeff *et al*. 2012.
25. Combining OM/SEM-EDX analysis of cross-sections with the XRF element maps indicated that the calcium sulphate filler was presumably part of the strontium yellow and cochineal tube paints.
26. Without these additions, the painting is reminiscent of other 1885 autumn landscapes by Van Gogh, such as *Autumn Landscape* (F44) from the Kröller-Müller Museum, painted in November 1885.
27. Alphonse Portier was an art dealer and Charles-Emmanuel Serret a painter in Paris. In a letter dated 28 June 1885, Vincent urges his brother once more to varnish the paintings (Letter 510).
28. *Basket of Apples* was scanned in the early 2010s by Geert van der Snickt, researcher at the University of Antwerp, in collaboration with Ella Hendriks, former senior paintings conservator at the Van Gogh Museum, Amsterdam.
29. *Basket of Apples* was painted on top of a composition of a *Vase with Honesty*, which was probably painted between late March and early April 1885: see Hendriks *et al*. 2013.
30. With thanks to Teio Meedendorp (Van Gogh Museum) for pointing this out.
31. Apart from the fact that it is essential to preserve such an original egg white varnish, the layer is not only insoluble in organic solvents, but has also usually formed a tight bond with the underlying paint layers. Removing it, e.g. mechanically, would result in original paint particles chipping off as well.

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Discovering Edvard Munch's hectographs: materials, characteristics and conservation

Signe Endresen and Emma Turgut

ABSTRACT Munchmuseet holds a substantial group of Edvard Munch's hectographs in its collection, consisting of 506 prints and 32 original drawings. The focus of this study is to investigate how one artist, Edvard Munch (1863–1944), worked in this medium. His material choices and the characteristics of his prints are considered. Furthermore, the implications this has had for the art historical interpretation of his hectographic prints, and the conservation and preservation strategies for them, are examined. To accomplish this, an interdisciplinary approach has been adopted. The perspectives of the authors, as an art historian and a paper conservator, make it possible to investigate historical and contextual material about the works in tandem with technical and material analysis. The study consists of a collection review, workshops recreating the characteristics of Munch's hectographs, along with analytical tests. This research project provides new insights into understanding this now obscure, but complex printing technique, Munch's visual experimentation and innovations with the process, and the effects of light and environmental factors on hectographs.

KEYWORDS hectography, gelatine duplicator, Edvard Munch, synthetic dye, innovation

Introduction

In its collection, Munchmuseet[1] holds a substantial group of Edvard Munch's hectographs consisting of 506 prints and 32 original drawings. Hectography is an early form of direct duplication technique that was invented in 1878 (Ridout 1879; Batterham 2008: 44; Rhodes and Streeter 1999: 137).[2] It was a cheap method to reproduce texts and documents, and was widely used in schools, households and workplaces at the beginning of the 20th century. A handful of artists used hectography for making images in the decades after 1900, but only a few prints exist today from these artists.[3] The aniline dyes used in hectography are susceptible to light damage and museums are often reluctant to display the prints in exhibitions due to their fragility. This restricts the public display of hectographs, leading to their presentation mostly in digital formats or, if available, in study rooms.

Edvard Munch (1863–1944) worked with hectographs for almost 30 years – from 1905 to 1934 – and created over 500 prints using this technique. His hectographic prints have rarely been exhibited and they are barely mentioned in the research literature,[4] so very little is known about these prints, either in art historical research literature or in conservation. In this paper, Munch's material choices and experimentations with the hectographs are investigated. Furthermore, the implications this has had for the art historical interpretation of his hectographic prints and the conservation and preservation strategies for them are examined. To accomplish this, an interdisciplinary approach has been adopted. The perspectives of the authors, as an art historian and a paper conservator, make it possible to investigate historical and contextual material about the works in tandem with technical and material analysis.

This paper is structured in three parts. The first section covers background information on hectography, research questions and methodological considerations. This is followed by specifics on Edvard Munch's hectographic prints in the collection at Munchmuseet. Thirdly, based on our observations of various peculiar characteristics (see Table 1), the hectographs are subjected to technical analysis in order to provide the fullest possible, yet still provisional, knowledge of Munch's hectographs.

Previous research

Hectography was widely used for making copies of documents, not a method developed to make visual

art. However, the technique is mentioned in standard works on printing techniques, such as Antony Griffiths' *Prints and Printmaking: An Introduction to the History and Techniques* (Griffiths 1980/1996: 142). A limited number of research studies in conservation has been done on hectography and aniline dye, such as Robyn Tait (1997), Liz Dube (1998), Agnes Blüher *et al.* (1999), Wlodek Witek (2010) and Agata Kłos (2014). This previous research focused primarily on the inks and material used in hectographs and employed a variety of analytical techniques to identify the inks, and evaluate their challenges and requirements for care and conservation.

When it comes to artists using hectography, a few prints exist made by Emil Nolde, Max Pechstein and Russian avant-garde artists Olga Rozanova and Nikolai Kul'bin.[5] Their hectographs have not been the subject of much art historical research with the exception of Margit Rowell's book *The Russian Avant-Garde Book 1910–1934* (2002) which presents hectographs in artists' books by Olga Rozanova and Nikolai Kul'bin. In one article, 'Kruchenykh contra Gutenberg', Gerald Janecek discusses the radical nature of these works. He argues that the use of hectography introduced variety and chance as important factors in avant-garde artist books (Janacek 2002). With regard to Edvard Munch's hectographs, they are mentioned in Gustav Schiefler (1927/1974), Gerd Woll (2001/2012), and Magne Bruteig and Ute Kuhlemann Falck (2013).

Research questions

Although a few of the hectographs in Munchmuseet's collection have been exhibited a handful of times,[6] they have never been subject to analytical testing. For the most part the hectographs have been kept in storage, and research emerging from the museum contains little knowledge on the technique. As part of this project, the condition of the collection was reviewed in order to update the handling and storage recommendations. The hectographs are briefly mentioned as a one line item in the review of Edvard Munch's estate from the spring of 1944.[7] They have been catalogued and dated by Gerd Woll.[8] The motifs, and when Munch worked with them, are therefore known. However, little is known about how Munch made them and why the technique interested him for such a prolonged period. He would sometimes include hectographs in letters to friends but does not discuss how he worked with them in correspondence.[9] No equipment or hectographic materials are preserved in the museum's collection. The following research questions are examined in this study:

- From looking at the prints, is it possible to understand how Edvard Munch worked with hectographs?
- What is characteristic for his hectographs?
- How light sensitive are the inks?
- How many hours can the hectographs be exhibited?

What is hectography?

Hectography is a gelatine duplicator (Rhodes and Streeter 1999: 128–37; Batterham 2008: 173).[10] A hectographic print is made by drawing on paper using hectographic ink of synthetic dyestuff (commonly containing aniline dyes).[11] Usually, a pen with a nib, a brush or a copying pencil is used. The drawing is placed face down on a compound consisting primarily of water, gelatine, glycerine and alcohol.[12] After about a minute, the paper with the original drawing is removed leaving the hectographic drawing transferred onto the gelatine. Following this, blank pieces of paper are placed onto the inked gelatine surface (Fig. 1) to make new impressions of the drawing. Seemingly, the name 'hectograph' (derived from the Greek *hekatón*, meaning 'a hundred') indicates the number of possible impressions. Sources suggest that it is possible to achieve around 50 to 70 impressions before the ink fades (Witek 2010: 24; Batterham 2008: 45). Munchmuseet's collection contains at the most 17 prints of an individual motif.[13]

Hectography was invented as a direct result of the discovery of aniline inks (Batterham 2008: 44; Rhodes and Streeter 1999: 141), a synthetic dye (Blüher *et al.* 1999: 181). In the late 1800s and early 1900s, writing inks diversified in their production, composition, colour and purpose. A standard ink typically includes a colorant and a water-dissolved binder. A pivotal moment in their modernisation occurred in 1856 when W.H. Perkin introduced the first aniline dye, mauveine. By 1861, production began of the first fully synthetic ink based on methyl violet. These new and modern inks were praised for their affordability, convenience and the wide range of colours that could be made at home (Witek 2010: 25; Kłos 2014: 3). Aniline dyes are a broad class of synthetic

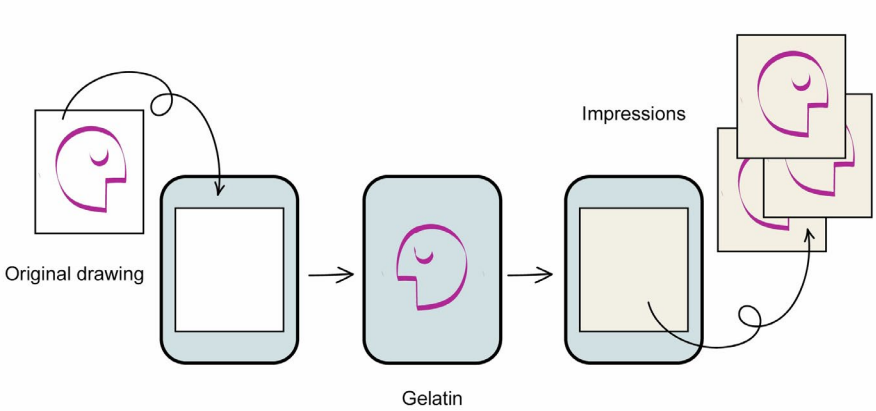

Figure 1 Schematic illustration of the hectographic printing process. (Graphics: Signe Endresen/ Munchmuseet)

dyes derived from benzene via various chemical reactions. The invention of these dyes marked a significant shift from traditional natural dyes derived from plants and insects (Brill 1980: 159).

The widespread adoption of aniline dyes revolutionised textile manufacturing and printing as well as the production of a variety of coloured materials. The most popular aniline dye used in the late 1800s and early 1900s included nigrosine, eosin, fuchsine, methyl violet, crystal violet, indigo carmine, malachite green, methylene blue, phenol blue and induline (Kłos 2014: 3). Copying pencils emerged to address the widespread desire for a writing tool combining the best of pens and pencils for the former's permanence and the latter's ease of use. These were first patented in England in 1874 (Batterham 2008: 40). Adding glycerine slowed down the drying of the ink. Copy pencils comprise a core with a concentrated dyestuff solution, graphite and clay (primarily kaolin). Writing on dampened paper with copying pencils closely mimicked penmanship, blurring the distinction between the two (Rhodes and Streeter 1999: 137–42).

Research method

The study started with a review of the hectographic print collection at Munchmuseet: 506 prints and 32 original drawings. An important aim of this review was to identify Edvard Munch's material choices and experimentations, some of which have not previously been described in research literature on the hectographic process. A number of technical peculiarities was observed in the prints in the collection (Table 1) and attempts to replicate these were done in workshops in the spring of 2023. Additionally, six inks and three gelatines made from historic recipes were tested.[14] The workshops revealed that the performance of the ink is closely linked to the recipe. In certain cases, the type of paper used also affected the outcome of the print. Notably, the methyl violet ink performed best on dry, smooth, calendared thin paper, highlighting the subtle interaction between ink and substrate. The tests showed that the quality of the hectographic prints is closely linked to the dye, the ink's recipe, and the type of paper used, with printing time playing a less significant role. The transfer time takes no more than a few seconds and copying with dampened paper is not necessary, as described by Witek (2010: 25). Overall, methyl violet ink gave the best results, especially on smooth, calendared paper.

Some of the observed characteristics in Edvard Munch's hectographs could not be fully understood by the workshop tests. Technical analysis was therefore utilised on a smaller subset of prints. In the next section the aspects that were relatively easy to replicate in the workshops are highlighted followed by an in-depth overview of the more challenging aspects of Munch's hectographs.

Table 1 Overview of research.

	Observed in collection	Testing in workshops	Analytical testing
Paper and inks	◉	◉	◉
Hand colouring	◉		
Multi-coloured prints	◉	◉	
Bubbles	◉	◉	
Blocked-out areas	◉	◉	
Reverse printing	◉		
Side-by-side printing	◉	◉	
Second state	◉	◉	
Fading	◉		◉
Colour change	◉		◉
White layer	◉	◉	◉

Figure 2 Edvard Munch, *Burlesque Couple*, 1906–07, Woll G H 31 / MM.G.00739-02. (Photo: Munchmuseet.)

Munch's hectographs

The motifs in Edvard Munch's hectographs are varied: they display a range of subjects from intimate portraits of dogs, caricatures, self-portraits and landscapes to complex group scenes.[15] They vary in size from quite small vignettes intended as decorations in letters to larger works that he signed, and thus possibly artworks intended for display.[16] Some of the motifs are familiar from Munch's larger artistic output,[17] while others are unique and can only be found in the hectographic material.[18]

Munch used an original hectographic drawing to create each of the 100 hectographic motifs; Munchmuseet has in its collection 32 of these originals. Munch appears to have used a brush and a pen with a nib for his drawings in ink. Depending on the ink used, two different characteristics are distinguishable from the prints. When he used violet (methyl violet) for the original drawing, it displays a metallic-looking sheen. Munch's original drawings with green (malachite green) and blue (possibly methylene blue) ink often display a discharge of glycerine around the inked lines; they also frequently include underdrawings in pencil.

Munch printed hectographs in a range of colours, violet and blue being the most common: these colours occur in 465 prints (from a total of 506). The remaining colours utilised are pink, green, turquoise and grey. There are no prints with red ink in the collection. Munch used a copying pencil for only six motifs, probably blue and red – the red copying pencil prints as pink.[19] Munch also made prints with more than one colour.[20] In most of his hectographic prints the ink is quite faint, with one or two impressions of each motif darker in colour than the others.[21] The coverage of the ink is often translucent, resembling watercolours. Commonly, the fine lines are somewhat fuzzy or they display a sort of 'feathering' of the line.

There are several instances of Munch having made more than one print of an image on the same sheet of paper. In most of these cases, he printed the motif at different angles, suggesting that he reused the paper for several impressions.[22] However, in one image, *Man with Hat* (1905–07, Woll G H 3),[23] two identical impressions are positioned on the paper at the same distance from each other. Munch transferred the original drawing to the gelatine twice and then printed them side-by-side.[24]

In the motif *Self-portrait with a Little Puppy* (1933, Woll G H 81) Munch reversed one of the impressions in comparison to the rest of the existing prints of this motif. The original drawing has not been preserved,

but this reverse print lacks some of the fine detailing seen in the other prints of this motif, such as the tiny 'bubbles' in the lines on the nose, paw and ear of the puppy.

'Bubbles'

Lines of ink with what appear to be 'bubbles' are very common in Munch's hectographic prints. This feature is particularly visible in thick ink lines, for example in *Portrait of a Little Girl* (1906, Woll G H 8) and *Self-portrait* (*c.*1908, Woll G H 38). The original drawing to Munch's self-portrait (inv. no. MM.G.00767-01, Munchmuseet) has been preserved. Comparing the drawing to the finished prints, it becomes clear that the white areas in the inked lines are only seen in the prints and never in an original drawing. In the workshops, the effect of bubbles in the inked lines was very easy to achieve: it is a by-product of having too much wet ink on the original drawing when it is transferred to the gelatine. Not all of this excess ink can be absorbed into the gelatine during transfer of the original drawing. In such cases, the hectographic ink will bulge and blister as it is sandwiched between the paper and the gelatine.

The number of bubbles that appear is hard to control, but there is a correlation between the amount of surplus wet ink on the surface of the original drawing and the bubbling when it is transferred to the gelatine. If the drawing is fresh and wet when placed onto the gelatine, bubbles are more likely to occur. A large blob (bottom right) in *Portrait of a Little Girl* (1906, Woll G H 8) appears to have been accidental. The artist restrains the number of bubbles in subsequent motifs, and he seems to have learned to control this effect for his artistic benefit. The bubbles are a characteristic feature of Munch's hectographic prints, and often contribute to giving the impressions a textural, tactile appearance. In *Burlesque Couple* (1906–07, Woll G H 31), the large bubbles and the texture they create in the inked lines give an almost dry grittiness to the image that works well with the content of the image (Fig. 2).[25]

Blocked-out areas

While Edvard Munch must have partially left the amounts of bubbles up to (calculated) chance, white (or light) areas in other motifs seem to be more planned. The impression of *Peer Gynt: Peer and Ingrid* (1930, Woll G H 69) contains parallel vertical white (or pale) lines with softly rounded edges.[26] These lines are not completely without ink, but only have a faint ink colour.[27] Another type of blocked-out areas can be found in the image *Peer Gynt: The German, the Swede, the Frenchman and the Englishman* (1930, Woll G H 71), and a portrait of *Karl Wefring* (1934, Woll G H 90): the impressions contain horizontal lines where ink is missing. In the former motif, this area is located on the legs of two of the figures and in the latter on the cheek of the man's face. In both instances the individual lines in the drawings continue on each side of the white areas, indicating that the ink has been prevented from being transferred from the gelatine. In the 11 impressions of *Peer Gynt: The German, the Swede, the Frenchman and the Englishman* in Munchmuseet's collection, the blocked-out effect is not constant; these lines are not always completely clear of ink.

Cutting away areas of the inked gelatine after transferring a drawing was tested in the workshops. This was difficult to control and left a jagged outline in the prints. The outcome was much easier to control with correction pencils used directly on the original drawing (on top of the hectographic ink).[28] Tests were performed with strips of paper on top of the inked surface of the gelatine. These promising results gave outcomes comparable to those achieved by Munch.[29]

Second state

When working with graphic printing techniques, Edvard Munch often reworked the printing plates multiple times thereby creating different states of a motif. Motifs such as *Madonna* (1895/1902, Woll G 39), *Vampire II* (1895/1902, Woll G 41) and *The Sick Child I* (1896, Woll G 72) have 7, 11[30] and 10 known states, respectively. The hectographic technique is unlike other major printing techniques such as etching, lithography and woodcut: the motif is not carved or drawn onto a printing plate that can be reworked.

In Munchmuseet's collection there are several hectographic prints that have been reworked, or strengthened, with ink. In addition, the collection contains hectographic prints that the artist reworked with hectographic ink. *Self-portrait with a Little Puppy* (1933, Woll G H 81) contains prints in different states.[31] In subsequent impressions Munch added several details, such as on the palm of the hand of the figure and on the rim of the glasses around the

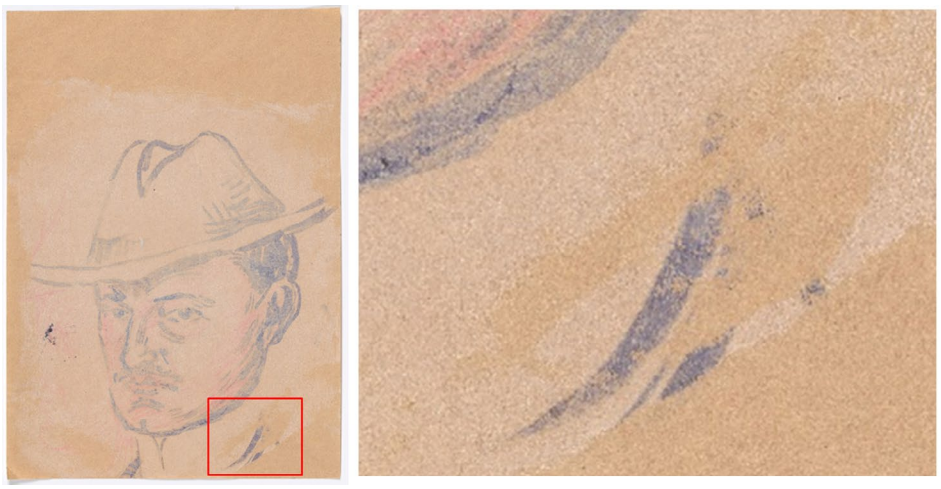

Figure 3 Full image *(left)* and magnified detail (*right*) of *Self-portrait with a Light Hat, c.*1905, Woll G H 1 / MM.G.00797A-03. (Photo: Munchmuseet.)

figure's right eye. In this case, the print with added hectographic drawing has not been preserved (if it existed). Although works in the collection support the assumption that Munch attempted to make second states of some of his hectographic motifs, it is unclear how he achieved such results. In the workshops it was documented that it is indeed possible to make hectographic second states from prints with added hectographic ink. However, in these second state prints there is a clear difference in the intensity of the ink: lines from the original first state are fainter than those added as part of the second state reworking.

The white layer

One of the more mysterious observations in the collection of Edvard Munch's hectographs was a white substance on the prints. This white layer is visible on at least 24% of the hectographic collection.[32] In some of these prints, Munch applied the white substance generously, in others the substance appears smudged, and in some prints this white layer is barely detectible to the naked eye. This substance is present more often with blue ink than with other colours: the white substance is visible in at least 58% of blue ink prints. In comparison, it is visible in only 6% of hectographs made with violet ink. What is the purpose of the white substance?

Initially it was considered that the white substance served as a form of ground on the gelatine or as a fixative on top of the finished image. When transferring the ink from the original drawing to the gelatine, there is a limited amount of time before the ink descends into the gelatine (Batterham 2008: 45). A ground could help prevent the ink from penetrating the gelatine too fast, thus prolonging the time available to make impressions. Another reason for including a ground on the gelatine is that the blue hectographic inks seem to deplete faster than violet ones; a ground could possibly prevent this from occurring.

One of the impressions of *Self-portrait with Light Hat* (1905, Woll G H 1) visualises a contact problem with the gelatine when the print was made (inv. no. MM.G.00797-03). At the bottom right, next to the neck collar of the figure, both the ink and white substance are missing (Fig. 3). In another copy of this image (inv. no. MM.G.00797-04), the impression picked up the ink outlining the collar and the white substance in the process of making the print. This is a clear indication that the white substance and the ink must have been transferred at the same time. The assumption is supported by other motifs where brushstrokes can be seen in the substance. These strokes appear to be identical on every copy of a motif. [33] It seems likely that Munch printed the white substance at the same time as the ink.

There are also impressions in which the white layer includes a clear 'rim' or edge. The substance seems to have gathered in a thicker layer in these areas.[34] This could be the edge of the dish used by Munch to hold the gelatine, indicating that the paper picked up the substance when it was in contact with the gelatine (and the ink). Workshop attempts to recreate the white layer were unsuccessful (this is addressed in detail in the 'Analytical testing' section below).

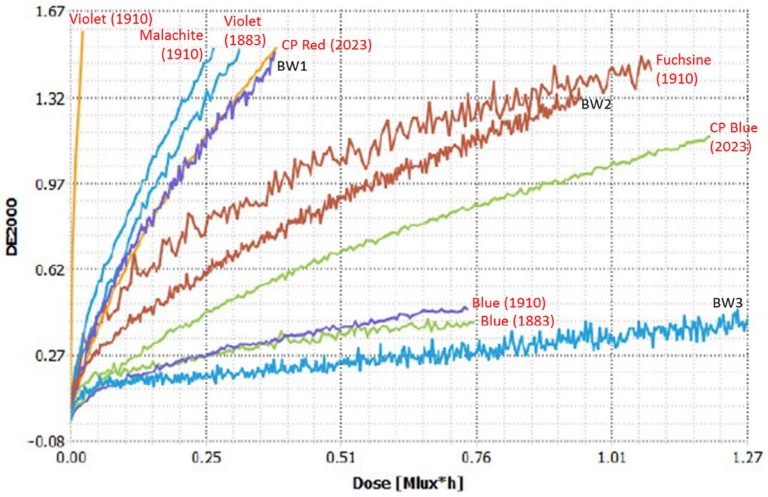

Figure 4 Total colour change values (in ΔE2000) of the tested ink in comparison with the reference material.

Analytical testing

Fading and colour changes

The study of the collection at Munchmuseet reveals that Edvard Munch experimented with the hectographic technique itself and its range of visual possibilities. A central challenge with hectographs is to understand the inks and how light exposure affects them. In the collection there are examples of prints that show signs of light exposure. Partial fading of the image is common, especially along the edge of the motif, but a few prints are so faded that the image is barely visible.[35] It is sometimes difficult to distinguish between fading due to natural aging and that caused by excessive printing, leading to exhaustion of the aniline dye. While the vulnerability of hectographs to light exposure is known, there is little research quantifying how exposure affects prints. How much light exposure can Munch's hectographic prints handle? Do the different inks behave in the same way or are there differences in their resilience when exposed to light?

To assess the overall light sensitivity of aniline dyes, a representative selection from the collection was subjected to accelerated light aging using microfading testing (MFT).[36] The method utilises an automated instrument equipped with a spectrometer to collect real-time colour changes.[37] It measures the spectra of the light reflected from the measurement point. This technique is essentially micro-destructive because the testing spot provides a light source of a high-power white LED (UV and IR excluded) at no greater area than 0.5 mm. To assess colour changes during MFT tests, reflectance values were continuously collected every two seconds. CIELAB colour space for the colorimetric measurements was employed to quantify the difference in colour, chroma and hue between initial and final colour states using ΔE units. Larger numerical values, both positive and negative, indicate a substantial alteration which influences the final colour.

The results are presented by categorising them in the scale of the ISO Blue Wool (BW) standard, a European standard (ISO 105–B08) used to measure and calibrate the permanence of coloured material (Michalski 2018). This scale anticipates light damage to colorants and is applicable when evaluating the results from the MFT tests. A yearly exhibition duration for each category is determined by estimating the amount of lux hours needed to cause a just noticeable fade (JNF) or noticeable colour change in a material (Chan *et al.* 2022: 1627). The three most sensitive swatches – BW1 (3,000 lux hours annually to JNF), BW2 (10,000 lux hours annually for JNF), and BW3 (30,000 lux hours annually for JNF) – represent the fugitivity range of light-sensitive colorants and the MFT data are commonly calibrated to their colour difference curves. Colour change is assigned a blue wool category, which can then be used to assign the entire artwork to the nearest equivalent blue wool category (BWE).

Lightfastness of modern inks

Accelerated aging testing with MFT was carried out on the six inks created for the workshops: two methyl violets, two methylene blues, one green (malachite) and one red (fuchsine). In addition,

Table 2 MFT result over tested hectographs with blue wool equivalence (BWE), allocated light dosage and annual allowance in exhibition.

	CIE76	CIE2000			Color changes					Total light dose allocated	Annual allowance of exhibition days*
Title and measure spot	ΔE76	BW Range	BWE	ΔE2000	ΔL*	Δa*	Δb*	Δh	ΔC	Lux hours annually	
Self-portrait with a Dog (1925–1930)											
MM G 738-03, Woll G H 53											
Ink	2.56	BW1–BW2	BW1	1.51	1.43	–2.01	0.68	–2.08	–0.52	3.000	6
Paper	2.17	BW2		1.45	0.26	0.10	–2.15	–1.46	–2.13		
Self-portrait on the Sofa (1925)											
MM G 770-06, Woll G H 49											
Ink with white layer	1.98	BW2	BW1	1.23	1.30	–0.70	1.33	0.04	–1.50	3.000	6
Ink	1.95	BW1–BW2		1.52	1.53	–0.78	0.93	0.62	–1.20		
Cardboard 1	2.43	BW2		1.51	0.02	–0.09	–2.43	–1.52	–2.40		
Cardboard 2	2.17	BW2		1.27	0.15	–0.10	–2.16	—1.32	–2.13		
Portrait of a Little Girl (1906)											
MM G 771-02, Woll G H 8											
Ink	1.75	BW1	BW1	1.51	1.59	0.49	0.56	7.24	–0.27	3.000	6
Paper	2.46	BW2		1.17	0.05	–0.34	–2.43	–0.65	–2.44		
Paper with white layer	1.91	BW2		1.14	0.57	–0.69	–1.69	0.50	–1.82		
Four Men in a Small Town Street (1930)											
MM G 787-04, Woll G H 62											
Ink	2.21	BW1	BW1	1.51	0.55	2.07	–0.55	4.00	–1.37	3.000	6
Paper with white layer	1.72	BW2		1.11	–0.02	–0.18	–1.71	–1.47	–1.68		
Paper	2.14	BW2		1.04	0.11	–0.77	–2.00	0.18	–2.14		
Standing Nude and Three Small Children (1907–1908)											
MM G 786-04, Woll G H 35											
Ink	0.73	BW3	BW2	0.60	0.55	0.04	–0.48	0.65	–0.48	10.000	20
Paper	1.19	BW2–BW3		0.74	0.15	–0.03	–1.18	–0.58	–1.17		
Paper	0.12	BW2–BW3		0.76	0.10	0.08	–1.12	–0.73	–1.11		
Self-portrait with a Light Hat (c.1905)											
MM G 797-04, Woll G H 1											
Ink	1.58	BW2	BW2	1.51	1.26	0.40	0.82	2.39	–0.81	10.000	20
Copying Pen (red)	1.62	BW2	BW2	1.40	0.49	–1.48	–0.45	2.96	–1.39		
Paper with white layer	0.91	BW2–BW3	BW2	0.72	0.20	–0.41	–0.78	0.28	–0.88		
Paper	1.20	BW2–BW3	BW2	0.83	0.55	–0.52	–0.93	0.68	–1.05		

(*with current opening hours and light level to 50 lux)

two modern copying pencils in blue and red were included. While direct comparison of newly prepared inks and aged hectographic prints from the collection is not entirely possible, the comparison provides valuable insights into the general nature of hectographic ink.

As seen in Figure 4, the lightfastness of the inks overall is noticeably poor, with the majority falling between BW1 and BW2. Methylene blue demonstrated more stability, particularly when compared to the copying pencil, which experienced significant fading. Conversely, violet and green inks exhibited extremely poor lightfastness with substantial colour loss. Fuchsine, the red ink, fell somewhere in between these two extremes, exhibiting moderate to poor lightfastness.

Lightfastness on works from the collection

In order to provide a more accurate representation of the collection's lightfastness profile, testing was carried out on a selection of impressions from the collection. A group of six hectographs was selected on the criteria of their ink colour, condition (in this case, heavily faded ink), and, to some extent, whether they exhibited any qualities unique to Munch's hectographs. The six prints in Table 2 exhibit a relevant interplay of colour, white layer and characteristics described in the previous section. While the preliminary analysis suggested categorisation as BW3, the artwork is ultimately classified as BW2 based on the findings presented in the accompanying study. The singular instance in which the ink was tested to be BW3 was *Standing Nude and Three Small Children* (1907–08, Woll G H 35). The ink was already severely faded, making it less receptive to more measurable changes, which probably influenced the findings.

Art museums can use the measured light sensitivity of any object in their collection to determine the maximum display time allowed under their light policy. A common preservation policy of restricting the display of works of art on paper as highly light sensitive is applied at Munchmuseet. Based on the results, like the findings from the test with newly prepared modern inks, the overall lightfastness of hectographic prints from the collection is also notably poor, falling within the BW1 to BW2 range. Additionally, these impressions will inevitably lose their colour vibrancy over time. The hectographs may only be displayed in low museum lighting (max. 50 lux with no UV), and for no more than 6–20 days a year (Table 2). To solve the challenge with such a limited amount of exhibition time, the museum needs to adopt an exhibition plan that not only showcases these hectographs safely but also educates visitors on the fragile nature of these materials.

Colour change and pH effects on dye stability

The pH sensitivity of hectographic ink can also be a factor in why hectographic impressions are not as durable as other types of prints. Modern inks are not only susceptible to fading but may also alter their colour due to oxidation and photochemical changes, which can further degrade the colour and quality of the prints (Witek 2010: 28). Colour change can be seen in Edvard Munch's hectographic prints in blue ink, such as impressions of *Self-portrait in Self-portrait* (1933, Woll G H 84). While most of the impressions are dark blue, in one the ink is now black (inv. no. MM.G.00782-02). It is known that the blue colour from inks such as iron-gall ink transforms into brown and black hues with age. Scholars attribute this change to the oxidation of the ink components into quinonoid structures, and the degradation of cellulose and/or gum arabic (Carme Sistach *et al.* 1999: 156, 159).

On two hectographs, pH measurements on three spots respectively were carried out: on the blue ink, the white layer and the paper. The surface pH was measured with agarose gel plugs. The pH tests indicated the presence of moderately acidic blue ink with pH levels ranging from 4.4 to 6.3. While the specific ink type on these hectographs remains unidentified, if the blue ink is indeed methylene blue, preserving its vibrant colour over time requires maintaining an acidic (pH 2–3) pH to prevent fading, which is due to carbinol formation in an alkaline environment causing the loss of colour (hue) (Blüher *et al.* 1999: 181). This underscores the crucial role of housing hectographs in pH neutral, unbuffered paper folders to mitigate the risk of colour change.

Non-destructive detection of faded ink

Multispectral imaging (MSI) has become a vital tool for investigating cultural heritage objects as the technology can aid the readability of damaged objects with faded inks (e.g. manuscripts in iron-gall ink).

The Phase One Multi Spectral Imaging system was used to analyse original hectographs, capturing a selection of images across the UV (200–400 nm) and IR (760–1700 nm) spectrum (Dyer *et al.* 2013: 2).

In her MA thesis, Kłos (2014) found that synthetic inks can be identified with MSI by their low fluorescence emission intensity, minimal IR radiation adsorption and connection to glycerine. However, despite the sophisticated techniques, extracting details with multispectral imaging requires training: the efficacy of these methods ultimately depends on the user's specific needs and objectives. These findings highlight the nuanced capabilities of non-invasive techniques, enabling researchers to gain valuable insights into the composition and characteristics of hectographic inks and aniline dyes.

In one impression of *Standing Nude and Three Small Children* (inv. no. MM.G.786-04), Edvard Munch used a blue ink (possibly resorcin blue in resemblance of iris blue). It is in a good physical condition. Parts of the motif have been partially covered but exposed areas are heavily discoloured and have lost almost all traces of ink due to extensive fading. Unfortunately, none of the images taken for this study were able to achieve satisfactory results. While MSI technology theoretically holds tremendous potential for visualising faded hectographic images, this study revealed limitations in extracting comprehensive information from the heavily faded print. By simply enhancing the contrast and modifying the image in visual lighting, the method can be rendered more informative and efficient.

The white layer, again

As mentioned earlier, trying to replicate a white layer observed in a large number of Edvard Munch's hectographs proved difficult. Two methods were employed to test ground-based copying: (1) direct application to the gelatine after transferring the original and (2) direct application to the printing paper. The ground used consisted of sturgeon glue, water and China clay.[38] The inks Violet (1883) and Blue (1910) were used in these tests. Direct application of the white ground to the gelatine resulted in poor results, as the moisture from the ground caused the ink to bleed uncontrollably, damaging the transfer and producing 'spotty' impressions. This was particularly evident with the ink Blue (1910), which resulted in almost completely inkless prints after the first impression. Direct application of the ground to the printing paper also proved problematic because the moisture tended to cause the test papers to curl and/or unevenly apply the ground, leading to poor quality prints. Pre-coating the gelatine with the ground followed by a brief drying time resulted in the uneven release of the ground and a compromised impression. Based on these findings, direct application of the ground to the gelatine is not recommended due to the risk of damaging the image and producing poor prints. Direct application to printing paper may be feasible, but close attention must be paid to the moisture content and application technique to achieve satisfactory results.

MSI imaging of the *Portrait of a Little Girl* (1906, Woll G H 8) revealed that the white layer reflects exceptional UV reflectance, appearing as a light grey nuance. This observation supports the presumption that the white layer is positioned above the ink layer and serves a purpose similar to a protective coating. High-resolution images with an Olympus optical microscope SZX16 were taken to acquire a more detailed understanding of the layer's exact positioning. The white layer clearly overlays the blue ink blot and the paper, indicating that it is indeed positioned on top of the ink. Munch has transferred the white layer at the same time as the image for a specific effect or aesthetic intention.

Experimental investigation of the white layer

To identify the elements of the white substance, a handheld or portable X-ray fluorescence (pXRF) analyser was utilised. Initially, the aim was to point toward a preparation of a ground with binder and inert pigment. The analysis identified major elements of titanium and silicate, along with minor traces of calcium and sulphur. These elements suggest findings closer to the paper rather than the white substance. While titanium oxide was introduced in 1906 for pigment-coated paper (Van der Reyden *et al.* 1993: 493), its use was incorporated with calcined clay or synthetic silicas and silicates, replacing up to 25–50% of the titanium dioxide to increase paper volume. However, no direct correlation has been established between hectographs and pigment-coated paper in the available literature. This raises the possibility that the presence of titanium and silicate elements in the white substance might be a coincidental finding and require further investigation and analysis for verification.

Areas for future research

To comprehensively understand the susceptibility of hectographic ink to colour changes, a more in-depth exploration of how environmental factors impact synthetic dyes is necessary. Studying Edvard Munch's hectographs provides a valuable starting point for further investigation and offers the potential to enhance understanding of both this technique and Munch's artistic output. Additionally, the museum intends to pursue further research, incorporating studies on the white layer including its application method without compromising or altering the image or transfer process, as well as its potential impact on dye changes caused by pH fluctuations. While the definitive presence of a white layer or protective layer in Munch's hectograph prints remains inconclusive, the research suggests that Munch employed this feature purposefully. Efforts to replicate the white substance used in Munch's impressions have so far been unsuccessful, and the complete composition of this substance remains elusive. The ultimate goal is to uncover the complete process by which Edvard Munch created his hectographic prints.

Conclusion

With a touch of poetic flair, R.H. Ridout describes the hectographic process as a moment of attraction: 'When the copy is placed on the jelly, the glycerine comes out to meet the ink, for which it has an intense liking' (Ridout 1879: 155; see also Rhodes and Streeter 1999: 139). Considering the current condition of the works and the insights gained from the workshop experiences lead to some conclusions. The comprehensive review of the entire hectographic collection at Munchmuseet revealed that these prints – even to this day – maintain a remarkable freshness and are prone to smudging with ease. This underscores the necessity for careful handling.

A prudent selection of materials (inks, gelatine and papers) seems to be important for the final outcome of the hectographic prints. The findings in this project underscore that achieving good imprints requires a significant level of skill on the part of the user. Hectographic inks are inherently light sensitive, thus exhibition standards commonly advise against displaying them. This has been confirmed by the findings in this project: restricted exhibition time is important for the hectographs. It is hoped to find the innovative means to possibly show them in the future.

Edvard Munch's hectographic prints are a little known aspect of his oeuvre. His inquisitive and technical abilities have tested the possibilities of this printing technology. While hectographic printing might seem straightforward at first glance, the collection at Munchmuseet shows that Edvard Munch found room for visual experimentation and innovations with the process.

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Notes

1. Munchmuseet is a single artist museum located in Oslo, Norway. The basis for its collection is the estate left by Edvard Munch to the City of Oslo in his testament. The museum's registrered, official name is Oslo Kommune Munchmuseet. The name of the museum used throughout this paper is therefore Munchmuseet. See https://w2.brreg.no/enhet/sok/detalj.jsp?orgnr=995138670 (accessed 22 March 2024).
2. See also American patents from 1880: 227,629 'Method of producing multiple copies of writing', and 228,362 'Dry copying process' (Rhodes and Streeter 1999, 326 and 374). These patents cite preceding patents in Europe from 1878 and 1879.
3. Emill Nolde in Schiefler 1926/1995/1996, vol. 2, p. 152. Emil Nolde's hectographs are in the collection of Nolde Museum Seebüll and Sprengel Museum Hannover; Max Pechstein's hectographs are in the Kunstsammlungen Zwickau Max-Pechstein-Museum collection https://sachsen.museum-digital.de/objects?&sv=hektografie (accessed 22 March 2024); Olga Rozanova and Nikolai Kul'bin's hectographs are in the MoMA collection: https://www.moma.org/collection/?utf8=✓&q=hectograph&classifications=any&date_begin=Pre-1850&date_end=2024 (accessed 22 March 2024).
4. Exhibitions: 1972: 3 hectographs, Munchmuseet; 1975: 3 hectographs, Vestlandske Kunstindustrimuseum; 1981: 16 hectographs, Munchmuseet; 2006: 1 hectograph, Musée Charlier; 2013: 5 hectographs, Munchmuseet. Woll 2001/2012: Appendix IX and X,

486–95. Literature: Schiefler 1927/1974: Appendix II, 460–73; Helliesen 2013: 47–8.

5. See note 3 above.
6. 1972: 3 hectographs, Munchmuseet; 1975: 3 hectographs, Vestlandske Kunstindustrimuseum; 1981: 16 hectographs, Munchmuseet; 2006: 1 hectograph, Musée Charlier; 2013: 5 hectographs, Munchmuseet.
7. *Edvard Munchs Bo*, 1944, A.000001, 64 (Munchmuseet).
8. Woll 2001/2012, Appendix II. Six of the hectographs are also included in Schiefler 1927/1974.
9. Munch seldom discusses his artistic working process in his letters. The absence of any mention of working with hectographs is therefore not out of character. There is one letter from Gustav Schiefler / Louise Schiefler to Edvard Munch thanking him for a hectograph received in a card. Dated February 21, 1934. MM.K.03304 (Munchmuseet).
10. Hectography is not the same as the stencil copying process. The two different techniques were in use in the same time period. Stencil copying, in common use from the 1870s on, uses a stencil cut with a pen-like object. Ink is pressed through the stencil to the paper underneath.
11. Recipes (ink): Anon. 1883; Hopkins 1915: 913; Witek 2010: 25.
12. Recipes (gelatine): Hopkins 1915: 907; Larsson 1954: 93–4.
13. Woll G H 16 – this is not conclusive proof that Munch did not produce more than 17 prints of a given motif. Observations of Munch's hectographs supports the assumption indicated in other sources.
14. A comprehensive test was devised to compare variables in gelatines, inks and papers. Gelatine bases, three inks and six paper types were used. The tests consisted of drawing with the hectographic ink directly onto cut-out paper sheets before subsequently transferring it onto the gelatine bases. To ensure credible variables were used, specific variables were established, including a 60-second transfer time and a printing time range spanning 1–2 minutes (short and long printing time). Three copies were made for each combination of gelatine/ink/paper. In addition, the original drawing was retained, thus there are four examples of each motif. Recipes of hectographic inks and gelatines were provided from historical sources: Anon. 1883; Hopkins 1915; Larsson 1954; Witek 2010.
15. All the motifs are mentionned individually in Woll 2001/2012, Appendix II, 460–73. See also: https://www.munchmuseet.no/en/the-collection?query=hectograph&page=1&sortOrder=default&years=1863|1944&munchSamlingen=true (accessed 22 March 2024).
16. The smallest in size is Woll G H 18 *Vignette: Head of Satyr* (1906) measuring 32 × 32 mm; the largest is Woll G H 93 *Karl Wefring* (1934) measuring 475 × 335 mm. The dimensions of Munch's hectographic prints are available in Woll 2001/2012, Appendix II, 460–73.
17. Such as Woll G H 35 *Standing Nude and Three Small Children* – painted Woll M 771 *Woman with Children*; Woll G H 59 *The Bohemian's Wedding* – painted Woll M 1524 / Woll M 1526 *The Wedding of the Bohemian*, lithograph Woll G 702 *The Bohemian's Wedding*; Woll G H 74 *The Pretenders: The Death of Nikolas* – woodcut Woll G 620 *The Pretenders: The Death of Bishop Nikolas*; Woll G H 77 *Alma Mater* – lithograph Woll G 487 *Alma Mater*, painting Woll M 969 *The Researchers*; Woll G H 93 *Karl Wefring* – painted Woll M 1724 *Karl Wefring*.
18. Such as *Woman's Head* (1906, Woll G H 12); *The Gallows* (1923, Woll G H 44 and 45); *Self-portrait in Self-portrait* (1933, Woll G H 84).
19. Munch's prints made with copying pencil are pink and/or blue. In the workshops the prints were made using modern copying pencils in red and blue (Koh-i-Noor). The red copying pencil printed pink.
20. See *Burlesque Couple* (1906–07, Woll G H 31).
21. In workshops it was found that the ink is generally more intense in colour and coverage in the first prints made. Subsequent prints tend to be paler than the first.
22. For example *Munch in Front of Ekely* (1933, Woll G H 83); *Self-portrait with Beard and Glasses* (1933, Woll G H 85).
23. When referring to Munch's prints the numbering in the catalogue raisonné is used: Woll 2001/2012, Appendix II, 460–73. The dimensions of Munch's hectographic prints are also available in this source. Woll numbers have the following format for graphic prints: Woll G XXX, and for hectographic prints: Woll G H XXX. When referring to a specific impression in Munchmuseet's collection the museum's inventory number is used. It has the following format: MM.G.XXXXX-XX.
24. The ink is slightly paler in the print to the right. It is also possible to see a faint line to the left of the hat in the impression on the right. The faint line is probably due to Munch starting to place the drawing on the gelatine, lifting it and then repositioning it. This faint line is only visible in the print on the right side of the sheet of papers.
25. For example MM.G.00739-02 (Munchmuseet).
26. Particularly to the right of the female figure, on the male figure, and in the rocks to the right.
27. For example MM.G.00806-01 (Munchmuseet).
28. Heyer white correction pencils. Batterham (2008: 48) mentions the existence of correction fluids that were used with hectographic masters in office copying. This was not used in the workshops for this study.
29. Other options to try could be wax or gouache to mask areas on the original drawing. This was not attempted in the workshops for this study.
30. A new state of *Vampie II* was recently discovered (private owner). This was not previously known to

Munchmuseet, and is therefore not mentioned in Woll 2001/2012. The state is prior to the first state described in Woll G 41, and can thus be considered to be a state 0.

31. MM.G.00813-01/02; MM.G.00813-03/04 (Munchmuseet).
32. This white substance is not always visible to the naked eye. It was not the focus of this study to identify all the impressions with a white layer present in the collection at Munchmuseet.
33. For example, *Man with Hat* (1905-07, Woll G H 3).
34. For example, MM.G.00739-01 (Munchmuseet).
35. For example, MM.G.00786-04; MM.G.00794-01 (Munchmuseet).
36. Not all 506 hectographs in the collection at Munchmuseet were tested, only a selection of 6.
37. From the Instutyt Fotonowy. Light source: ~5 Mlux. Colour change measurements were taken until a ΔE value of approximately 1 unit was reached, or for a maximum of 300 seconds (5 minutes) if a ΔE value was not obtained.
38. The recipe for the ground was sourced from paintings conservator Terje Syversen at Munchmuseet. Munch is known to have used a ground consisting of sturgeon glue, water and China clay for his paintings.

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From research to display: Wyndham Lewis's *Praxitella* and Helen Saunders's lost *Atlantic City*

Rebecca Chipkin and Helen Kohn

ABSTRACT This paper explores the rediscovery of *Atlantic City* (*c.*1915), an abstract Vorticist masterpiece by British artist Helen Saunders (1885–1963). The painting was thought to be lost until it was discovered beneath Wyndham Lewis's (1882–1957) iconic painting *Praxitella* (*c.*1921) (Leeds Art Gallery). Using archival research and technical analysis, the authors – an art historian and conservator – successfully identified and partially reconstructed Saunders's abstract work in colour. *Atlantic City* is the only known Vorticist oil painting by Saunders to survive, although it has been painted over. The rediscovery therefore challenges previous assumptions about Saunders's Vorticist oeuvre and sheds light on her role as a pioneering artist in the avant-garde movement that for a long time has been overshadowed by her male colleagues. This paper presents the project's results, which culminated in the exhibition *A Modern Masterpiece Uncovered: Wyndham Lewis, Helen Saunders and Praxitella* at the Courtauld Gallery in London in October 2022. Overall, this case study highlights the importance of collaboration between art historians and conservators as it was the interdisciplinary nature of this project that made possible the remarkable rediscovery of *Atlantic City*, further research into Saunders's work and the staging of an exhibition.

KEYWORDS Helen Saunders, Vorticism, Wyndham Lewis, reconstruction, technical analysis, collaboration

A fruitful collaboration

This paper presents the compelling research results of an interdisciplinary research project by the authors (an art historian and conservator), and highlights the importance of collaboration between the two disciplines. The research started as a one-year student project as part of The Courtauld's Painting Pairs project in 2019 and ended with an exhibition of the project's findings. Soon after the research began, the focus shifted from the painting *Praxitella* (*c.*1921) (Leeds Art Gallery) by the British artist Wyndham Lewis (1882–1957) to the composition lying beneath Lewis's work. This work could be identified as the thought-to-be-lost painting *Atlantic City* by Helen Saunders (1885–1963), a crucial discovery as all of Saunders's abstract works on canvas were previously believed to be lost (Peppin 1996: 55). This paper gives an insight into the project's various stages: the initial research on Lewis's *Praxitella*, the discovery of Saunders's *Atlantic City* underneath it, the creation of a colour mockup of the rediscovered painting, and the exhibition at the Courtauld Gallery in 2022.[1]

The Vorticist painting underneath *Praxitella*

The painting *Praxitella* (*c.*1921, 142 × 101 cm) (Leeds Art Gallery) by Wyndham Lewis is captivating at first glance. At the centre of this large canvas sits an intimidating female figure in a metallic, sharp-edged blue dress with yellow-red stripes at the hem. It is a portrait of Lewis's partner at the time, Iris Barry (1895–1969), a poet and later pioneering film critic. Upon close examination of Lewis's *Praxitella*, intriguing aspects hinted at the presence of an underlying composition beneath. Notably, cracks on the paint surface in the background and middle of the composition revealed a distinct red colour that differs from the upper dark blue paint layers belonging to *Praxitella*. Furthermore, when observing the surface in raking light, raised lines became apparent, which deviate from the forms in the upper paint layers. Because of this, and the fact that Lewis had the habit of reusing his canvases, scholars had already speculated about the possibility of a hidden abstract composition beneath *Praxitella* (Edwards 2016: 26–7). Before Lewis painted in a figurative style, as seen in the painting of *Praxitella*, he was

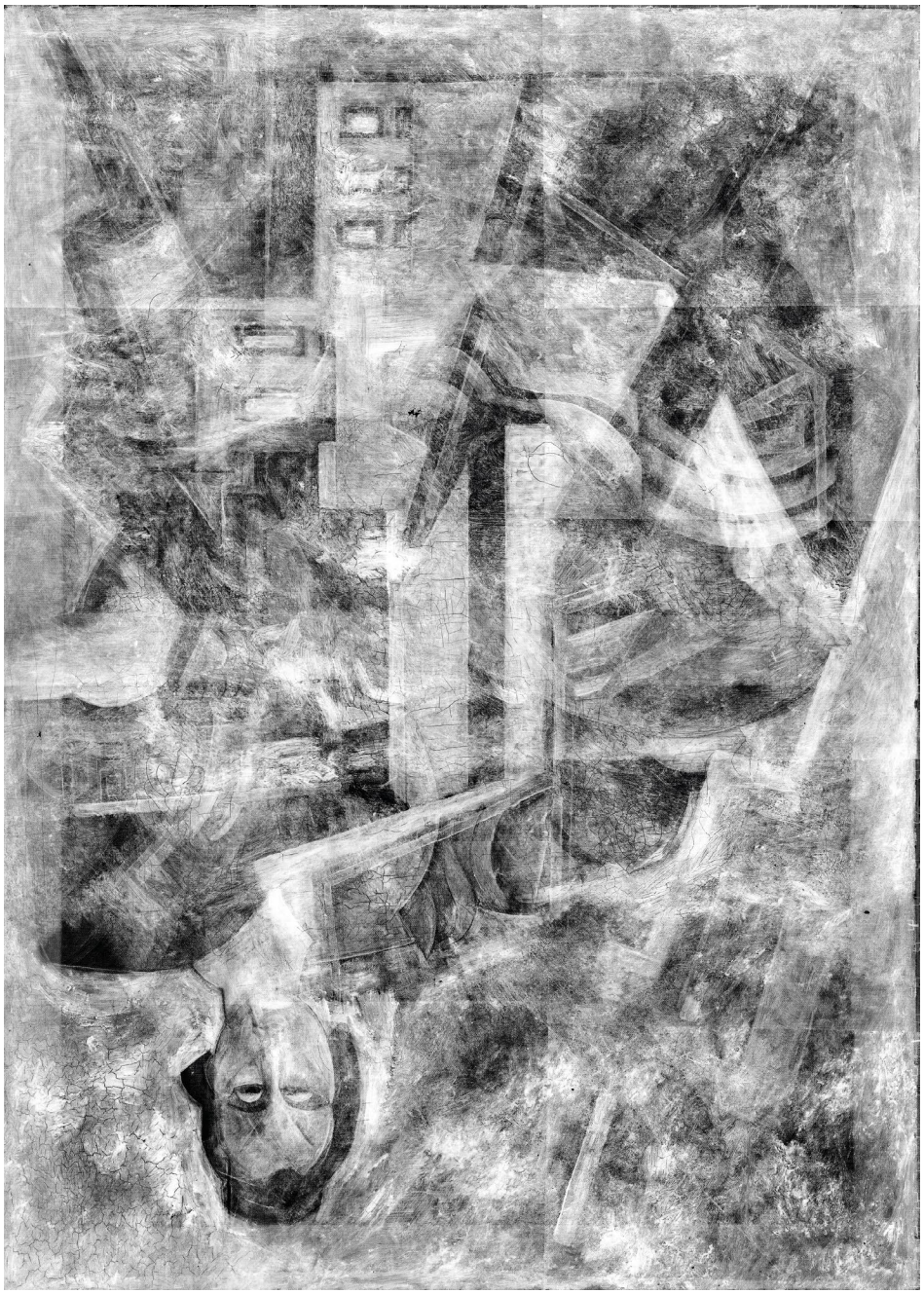

Figure 1 X-radiograph of *Praxitella*, 142 × 101 cm. (Image: Rebecca Chipkin, The Courtauld Institute of Art.)

part of a short-lived British abstract art movement called Vorticism, which began just before the First World War in 1914 and was disrupted and terminated by it around 1917.

With the force of a vortex, the name from which Vorticism is derived, Lewis and his colleagues aimed to discard old artistic concepts and form a modern abstract artistic language, which frequently featured angular, dismantled objects and geometric forms more akin to machines than human forms and the natural world. Despite its short duration, Vorticism was renowned at the time and had an enduring influence on British art. Lewis was the proclaimed leader of this movement and until this day, his name appears most frequently in connection with the movement. However, his role should not be overvalued, as the other members saw their art as much less dependent on his. As this later statement by Helen Saunders shows, when asked about the Vorticist group, she responded that it was 'a collection of very disparate artists each working out his own ideas under the aegis of the group and its very able leader and publicist Wyndham Lewis' (Heathcock 1999: 41). Because the raised lines seen in *Praxitella* appear to be from an abstract work, scholars have thought that it might be a work from Lewis's previous Vorticist phase

Figure 2 Helen Saunders, *Atlantic City*, *c.*1915, reproduced in *Blast*, p. 57. (Photo © Estate of Helen Saunders.)

(Edwards 2016: 26–7). In addition, as there were suspicions of a work beneath *Praxitella*, X-ray analysis was carried out. The X-ray images confirmed the hypothesis that there is a fully painted abstract composition beneath *Praxitella* (Fig. 1), showing the entire underlying composition for the first time.

The identification of the underlying composition

Many Vorticist paintings by Lewis and his colleagues have been lost, making it difficult to stylistically compare the composition seen in the X-ray with other similar paintings. However, the group produced a magazine called *Blast* of which two issues were published (Lewis 1914, 1915). In the magazine, reproductions of Vorticist artworks and designs by artists from the avant-garde group and associated artists were published, along with texts by the Vorticists and other writers such as the British poet Ford Madox Ford (1873–1939) and the British writer Rebecca West (1892–1983). This made *Blast* a pivotal source for the project.

In the second issue of *Blast*, the composition *Atlantic City* (Fig. 2) by Helen Saunders appears. At first glance, the skyscraper-like structure and sharp diagonal lines are strongly reminiscent of the composition under *Praxitella* seen in the X-ray (Fig. 1). When the X-ray is digitally overlaid with the image of *Atlantic City* from *Blast*, it becomes apparent that these are not merely stylistic similarities but that the compositions match almost exactly.[2] The underlying Vorticist composition beneath Lewis's *Praxitella* can therefore be identified – without a doubt – as the work *Atlantic City* by Saunders. This work was exhibited with three other paintings by Saunders at the first Vorticist exhibition at the Doré Galleries, London in June 1915, one month before the second issue of *Blast* containing the image of Helen Saunders's *Atlantic City* was published (Doré Galleries 1915).

Helen Saunders, *Atlantic City* and Wyndham Lewis

While many publications on Wyndham Lewis were available at the time of the rediscovery of *Atlantic City* in 2020, there was only *one* publication entirely devoted to Helen Saunders (Peppin 1996). This made researching her work, in comparison to Lewis's, much harder.[3] Yet, her story is worth exploring because it shows how a female artist was excluded from the traditional art historical canon.[4]

Helen Saunders studied art in London before becoming part of the radical Vorticist movement and one of the first female British artists to explore abstraction. As an active member of the group and one of only two women, she signed their manifesto in 1914, published in the first issue of *Blast* (Lewis 1914: 43). She exhibited together with the Vorticists at both of their exhibitions: the aforementioned Doré Galleries exhibition in London in 1915 and the second at the Penguin Club in New York in 1917 (Doré Galleries 1915; Penguin Club 1917). In the second issue of *Blast*, she contributed *Atlantic City* and *Island of Laputa* and the poem *A Vision of Mud* – a disturbing description of drowning in the mud in a dystopian world (Lewis 1915: 73–4). Much less depressing are her colourful Vorticist watercolours: they are characterised through complex, mainly angular forms which are often interlaced and differentiated by contrasting colours or black outlines such as *Vorticist Composition, Black and Khaki* (*c.*1915) (The Courtauld, London).

As well as being an artistic member of the Vorticist group, she supported both them and Lewis with her organisational skills. Her involvement became particularly important after the outbreak of the First World War, when some of the male members, including Lewis, were called up to serve in the army. Alongside her full-time job, Saunders helped with the distribution of the second issue of *Blast* in 1915, organised art transports to New York for Lewis in 1916, and assisted him with other tasks during the war (Peppin 1996: 15; Pound and Lewis 1985: 27). Saunders and Lewis became so close that even her sister, Ethel Saunders, helped him when he fell ill and secured him a place in hospital in early 1919 (O'Keeffe 2000: 211). However, the relationship between Saunders and Lewis ended soon after the war in the spring of 1919, when he broke it off for unknown reasons.[5]

Not only did their relationship end in 1919, but Lewis's attempts to reactivate the Vorticist group also failed, marking the end of this radical but short-lived abstract art movement in Britain. This was most likely the time when *Atlantic City* was painted out with lead white. A period in which the two were *not* in contact, and the Vorticist language was no longer resonating in a postwar society. This, among other reasons, makes it most likely that Lewis and not Saunders painted it out.[6] Presumably Lewis had obtained her painting after it was exhibited at the Vorticist's exhibition at the Doré Galleries in 1915, but it is not known where it was stored after the exhibition and why it was in his possession afterwards.[7]

While Lewis was still active as an artist after the war and staged his major solo show *Tyros and Portraits* in 1921, in which *Praxitella* was exhibited for the first time, Saunders decided to withdraw from a public career as an artist. She painted privately for the rest of her life but exhibited her works only sporadically (Peppin 2022: 18). This self-imposed withdrawal from the public art scene is one reason why her work fell into obscurity after being part of the Vorticist movement. Another major issue is the misogynistic behaviour and downplaying of her achievements, mainly by her male colleagues, which has had an impact on art historians.[8] Furthermore, it is important to consider that until the recent rediscovery of *Atlantic City*, all her Vorticist oil paintings were thought to be lost. Before this rediscovery, Saunders's Vorticist oeuvre could only be studied from her works on paper. Although striking, they were often bypassed or downplayed.[9] As a result, it has been easy to overlook Saunders's contribution to the Vorticist movement. However, *Atlantic City*, with its intricate skyscraper-like and zigzag forms, is a complex composition and one of the largest known Vorticist paintings, proving that she was perfectly capable of painting powerful, radical and large-scale abstract works. This is what makes its rediscovery so crucial to understanding Vorticism and Saunders's role in the movement.

The colour palette of *Atlantic City*

The X-ray (Fig. 1) and image from *Blast* (Fig. 2) provide an idea of how *Atlantic City* might have looked, however these images only show the composition in black and white. From Saunders's Vorticist watercolours it is known that she would have used a colourful palette which is why comprehensive technical analysis was undertaken, including samples set in cross-section, X-ray fluorescence (XRF) using a Bruker Tracer III-SD, and scanning electron microscopy with energy-dispersive X-ray spectroscopy (SEM-EDX). The cross-sections show that Saunders did employ a colourful palette of primary colours as well as more tempered browns and ochres. The combined elemental results from XRF and SEM-EDX analyses suggest the use of vermilion (indicated by the presence of mercury and sulphur) and red lake (indicated by the presence of aluminium, likely used as the substrate) to create bright reds as well as deep burgundies. Copper, arsenic and iron were detected, which suggests a mixture of emerald green and Prussian blue or a synthetic organic blue.[10] Lead white, as well as chromium and iron-based pigments are present in varying amounts to create bright yellows and ochre tones. The brown passages comprise a mixture of iron oxide-based pigments and umber (indicated by the presence of manganese) (Chipkin and Kohn 2024b). These results suggest that *Atlantic City* is a vibrant painting and highlights the importance of undertaking more research to gain a deeper understanding of the composition in colour.

Analysis and reconstruction of *Atlantic City*

In order to investigate the colours of *Atlantic City* further, the painting was analysed using a Bruker M6 Jetstream scanning macro X-ray fluorescence (MA-XRF) machine. During the scanning, however,

a problem arose – the lead white layer between the two compositions was preventing the machine from detecting the elements belonging to *Atlantic City*. As a result, the painting was scanned from the reverse, effectively resolving the problem and revealing the compositional elements belonging to *Atlantic City* (Chipkin and Kohn 2024b).[11] In order to improve detection of the elements, the sensor needed to be close to the canvas, which meant limiting the scans to the two areas within the stretcher and cross-bar members (Chipkin and Kohn 2024b). This made it possible to use the maps generated from the MA-XRF analysis to confirm the pigments that were detected with XRF and SEM-EDX. Moreover, the maps provided elemental information about areas in the painting that were not previously sampled (Chipkin and Kohn 2024b). These maps played a crucial role in the understanding of *Atlantic City*, prompting an exploration of ways to visualise its original colours by painting a partial reconstruction and creating a digital mockup.

Figure 3 Installation shot of the partial colour reconstruction, 40 × 40 cm, displayed over a wall print of *Atlantic City* from *Blast*, 142 × 101 cm, at the exhibition *A Modern Masterpiece Uncovered: Wyndham Lewis, Helen Saunders and Praxitella* at the Courtauld Gallery in 2022. (Image: Rebecca Chipkin.)

Painting a partial reconstruction

As mentioned previously, in October 2022 the results of this research project were presented at an exhibition at the Courtauld Gallery. For the exhibition, a small section measuring 40 × 40 cm of *Atlantic City* was chosen to be painted with oil on canvas (Fig. 3). The selected section was painted meticulously, drawing upon insights gathered through the comparison of various techniques including X-ray scans, elemental analysis, raking light imaging and examination of Saunders's methods. The plan was for the reconstruction to be displayed on top of a printed image from *Blast*, which would be printed at 1:1 scale to the size of *Praxitella* and presented on the exhibition's wall (see below for further discussion about the display and the decision-making behind it).

The objective of the reconstruction was not to use the exact materials as Saunders but to create a convincing final result that approximated how *Atlantic City* would have partially looked. Many of the paints that Saunders used are now considered hazardous and not readily available in art supply stores. The file from the exhibition's graphic designer served as the template for the reconstruction, which was crucial for consistency, as painting the reconstruction was to take place in the Netherlands before being sent to the exhibition in London. The approach for the paint combined the suggested pigments from the elemental analysis with the colours observed in the paint cross-sections. For example, similar appearing colours were used, such as cadmium red instead of vermilion. For some colours, an exact pigment and colour match was used for chrome yellow and yellow ochre. While the reds and yellows were confirmed using both elemental analysis and corroborated visually with the samples, other colours required some educated guesswork. The green colour was informed by the elemental analysis which indicated copper and arsenic, thereby suggesting emerald green. As there was no sample available for this area, a similar colour to emerald green, Winsor & Newton's Winsor Emerald (a non-toxic version closely matching the emerald green pigment) was chosen.

This painting process served as an invaluable tool in understanding Saunders's application techniques and colour choices. Executing the reconstruction enabled a deeper exploration of her methods by replicating similar visual effects. Techniques such

Figure 4 *Atlantic City* colour mockup. (Image: Rebecca Chipkin.)

as scumbling were employed to achieve nuanced gradations (Fig. 3). This can be observed in the MA-XRF imaging, where in the bottom left corner of the composition there is more dense information gradually blending into less dense information related to the use of an iron oxide pigment. When examining *Praxitella* in raking light, one of the initial observations made was the presence of raised lines corresponding to *Atlantic City*. These raised areas of paint are indicative of Saunders's application technique, where she used thick layers of paint. This is seen particularly at the perimeter of the shapes, characteristic of the use of a loaded brush with pressure applied. This is confirmed in the MA-XRF images where there is more dense elemental information at the edges of the shapes. This technique would probably create clean hard edges, something that was replicated in the reconstruction.

The digital colour mockup

The partial colour reconstruction (Fig. 3) helped to inform the next step in the research which involved reconstructing more colours in a digital mockup of *Atlantic City* (Fig. 4). Overlaying the false colour MA-XRF image with the X-ray filled in more of the composition of *Atlantic City*, providing more elemental information about areas that were not previously sampled or analysed using point XRF (Chipkin and Kohn 2024b).[12]

There are still gaps in our understanding of the composition: areas where information is lacking are indicated by a grey colour on the bottom right and far left. However, the colour mockup provides a new perspective on the composition, leading to new interpretations. The introduction of colour alters the dynamics between the forms and the overall arrangement of the composition in *Atlantic City*. Whereas the black-and-white image unified forms with the same monochromatic hue, now the colours either connect or separate them from each other. The background, for example, is not one monochromatic colour – it is vibrant with texture and different colours such as brown and green. The zigzag forms in the centre and right side of the composition are now linked by their yellow colour, echoing each other and enhancing tension and movement within the composition (Chipkin and Kohn 2024b).

The colour mockup reveals previously unseen shapes. For example, the blue shape at the top right is an addition: it sits next to the triangular brown shape, helping to define the beginning and end of the shape. These colours begin to show an image of *Atlantic City* that is built not only of shapes and colours but also changes the relationship between them such that they gain three-dimensionality, with certain elements coming forward and others being pushed back, as seen in the upper left and the centre in the orange forms. Comparison with her watercolours highlights Saunders's use of triangular forms and outlines in either white or a darker colour. She also incorporates stripes in her watercolours, a motif that is likewise seen in the image from *Blast*. This may have been interpreted literally as stripes in the final composition (Chipkin and Kohn 2024b).

The image from *Blast* gives an idea of how the composition of the oil painting may have looked. The colour mockup, however, confirms that Saunders's painting is far more complex. Her work stands out among her Vorticist colleagues for her use of more vibrant juxtaposing colours. The shapes she creates are not static – they are placed in such a way that lends tension and movement to the composition with certain elements running into one another, being cut off, or seemingly jutting out of the picture plane.

Figure 5 Installation shot from the exhibition *A Modern Masterpiece Uncovered: Wyndham Lewis, Helen Saunders and Praxitella* at the Courtauld Gallery in 2022. (Photo: courtesy of The Courtauld, London; photographer Fergus Carmichael.)

Atlantic City: a new interpretation

Seeing the composition in the colour mockup also changes the interpretation. Before the rediscovery of *Atlantic City*, the black-and-white image from *Blast* was understood to illustrate Saunders's awareness of the horrors of war and its destructive power, and in this sense, the painting showed a fragmented modern city.[13] The colour mockup, however, shows a vibrant and pulsating painting which is perhaps less concerned with war and its destructive power than with Vorticist interests in the metropolis and the liveliness of a modern city. This may have influenced the choice of title *Atlantic City*, then a modern American city with imposing hotels such as the Marlborough-Blenheim and the Traymore, which Saunders could have known from photographs.[14] Furthermore, the destructiveness of the dismantled shapes might be explained not so much in terms of war and its destructive power, but rather as an expressive depiction of what her art movement was named after – a vortex. A painting full of energy, designed to disrupt and explode old artistic ideas.

New bridges to cross: explaining interdisciplinary research in an exhibition

The Courtauld Gallery owns, thanks to Brigid Peppin's generous gift of 20 works on paper, the largest collection of works by Saunders in any public collection (Vegelin van Claerbergen 2022). This prompted the gallery to stage the exhibition *Helen Saunders: Modernist Rebel* (14 October 2022–29 January 2023) at their Drawings Gallery, and to publish a significant catalogue with entries of all gifted works by Saunders (Sloan 2022). This was the second monographic exhibition of her works and the first in over two decades (Peppin 1996). The Courtauld's exhibition was the perfect opportunity to present the fascinating story about Saunders's *Atlantic City* beneath Lewis's *Praxitella* and the further research into Saunders's hidden work for the first time to the public. The exhibition's success was made possible due to collaboration across the museum's various departments and the loan of *Praxitella* from Leeds Art Gallery.

The exhibition *A Modern Masterpiece Uncovered: Wyndham Lewis, Helen Saunders and Praxitella* opened parallel to the show of Saunders's drawings and watercolours in the Courtauld's Project Space: a large room, separated in the middle into two smaller rooms. This setting allowed for the exhibition to be divided into two chronological sections. In the first room (Fig. 5) it was crucial to present the 'evidence' that the painting underneath *Praxitella* is indeed *Atlantic City*, which meant that *Praxitella*, the X-ray and *Blast* magazine were displayed – the three clues that led to the unravelling of *Praxitella's* secret. When Lewis painted *Praxitella* on top of *Atlantic City*, he turned the canvas 180 degrees so that it was

oriented upside down. Accordingly, the X-ray shows only *one* painting, *Praxitella* or *Atlantic City*, in its correct position. It was therefore decided to display the X-ray on the opposite wall in the correct position of *Atlantic City* and not Lewis's work. This made it easier for the visitor to see the correspondence and compare the X-ray with the image of *Atlantic City* in *Blast*, displayed in a glass box underneath the wall text. The accompanying wall text explained the rediscovery and also included an image with the overlying composition of the X-ray and composition of *Atlantic City* in *Blast*.

Armed with this information, visitors were well equipped to enter the second room. The adjoining wall showcased a black-and-white reproduction of *Atlantic City* from *Blast*, scaled to the dimensions of *Praxitella*. In addition to gaining an understanding of the original scale, visitors also had the opportunity to see the colours of *Atlantic City*. This was achieved by displaying the partial colour reconstruction on top of the black-and-white composition such that there was a seamless integration of the compositional elements between the two (Fig. 3). The effect was a stark contrast between the black-and-white image and the coloured portion of *Atlantic City*.

It was a deliberate curatorial decision to show 'only' a partial colour reconstruction and not a full version of *Atlantic City*. Even though the technical analyses, especially the MA-XRF images, helped in the understanding of *Atlantic City*'s colours, there still remain many areas that are unclear.[15] By showing only a portion, rather than a fully reconstructed version of Saunders's painting, it was also possible to convey another important key message: even if in the future we might know exactly how *Atlantic City* looked, the original will never resurface.[16]

Why collaboration matters

The research project on Lewis's *Praxitella* that led to the rediscovery of *Atlantic City* underneath demonstrates the importance of bridging the gap between art history and conservation, as this can lead to original research that neither discipline would have been able to achieve independently. Without the X-ray of *Praxitella*, it would have been impossible to match it with the composition of Saunders's *Atlantic City* from *Blast*, and without further research into the composition's colours, no new interpretations could have been made about *Atlantic City*. From the start, the project's success hinged on the close collaboration between the two scholars, even though physical boundaries often separated them. They were able to share their knowledge and findings despite obstacles such as the pandemic and residing in different countries. This collaborative process became standard practice, so when it came to working on the Courtauld Gallery exhibition, they were familiar with the challenges. It required extensive coordination with the curator, exhibition graphic designer and museum personnel, spanning the UK, the Netherlands and Germany. The success of this research, which began as a student project, underscores the importance of initiatives that aim to build bridges between these two disciplines, which are still separated too often. The exhibition as a medium to communicate research findings to the museum visitors added another aspect to the success of the research project.

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This project would not have been achieved without the kind support of Silvia Amato, Pippa Balch, Aviva Burnstock, Jo Cottrell, Paul Edwards, Ketty Gottardo, Pia Gottschaller, Brigid Peppin, Clare Richardson, Karen Serres, Rachel Sloan, Nigel Walsh, Barnaby Wright and the team at The Courtauld Institute and Gallery.

Notes

1. The Painting Pairs project at the Courtauld pairs each year a small group of art history and conservation students as a team of two to undertake interdisciplinary research, with the support of the Conservation Department and the Courtauld Gallery team. Part of this research is published in Chipkin and Kohn 2024a and 2024b.
2. The digital overlaid X-ray and image of *Atlantic City* from *Blast* is published in Chipkin and Kohn 2024a.
3. A major contribution since 2020 has been the monographic exhibition of Helen Saunders's work on paper at the Courtauld Gallery, in conjunction with the publication of the exhibition catalogue by Rachel Sloan (2022).
4. Since the 1990s, female art historians have been attempting to rewrite the art historical canon that has focused mainly on the achievements of male Vorticists. Important contributions to this topic include Tickner 1992, Beckett and Cherry 1998, Heathcock 1999, Peppin 2011, Hickman 2013, Deepwell 2015, Foster 2019 and Sloan 2022.

5. It is not known whether Lewis and Saunders were only friends or if they also had a romantic relationship. For a discussion on this topic see Peppin 2022: 16–18.
6. For a detailed discussion as to why the authors believe that it was Lewis and not Saunders who painted out *Atlantic City*, and further information regarding the white interlayer, see Chipkin and Kohn 2024a.
7. Brigid Peppin suggested that *Atlantic City* might have been stored together with Lewis's paintings at his mother's house in Ealing, which the authors of this paper find reassuring. Due to the limited scope of this paper, further possibilities are not investigated.
8. For example, Saunders's Vorticist colleague Frederich Etchells (1886–1973) spoke in a pejorative way about Saunders's achievements when he said, 'If Lewis had painted Kate Greenaway pictures Saunders would have done them too', indicating that she was copying him (Cork 1976: 419). This might have influenced art historian Richard Cork, who published Etchells's comment in his first comprehensive study of this avant-garde movement where he also made undifferentiated statements about the female Vorticists such as 'Could it be that a feminine temperament was congenitally incapable of sustaining the amount of aggression needed to create a convincing Vorticist work of art? This male chauvinist hypothesis might seem tenable when Dismorr's Abstract Composition is examined, a picture which may have been one of her four contributions to the Vorticist exhibition' (Cork 1976: 416).
9. For example, Cork belittles Saunders's complex *Abstract Composition in Blue and Yellow* (*c*.1915) (Tate Gallery, London) of which he writes 'its hastiness precludes complete success' (Cork 1976: 420).
10. A synthetic organic blue pigment was not detected using analytical techniques. Copper, arsenic and iron were identified in a layer in the cross-section that appears bright blue. Pigment options that may appear in the paint mixture which account for this colour include Prussian blue or a synthetic organic blue pigment.
11. Scanning the painting from the back was a suggestion from Professor Aviva Burnstock and Dr Silvia Amato. The authors extend their gratitude to both for their invaluable support, which includes the operation of the MA-XRF machine and interpretation of the results.
12. The X-ray was used as the foundation for the digital colour mockup instead of the image from *Blast*. This decision was made due to slight disparities in alignment between the *Blast* image and the X-ray, suggesting that the former is not a reproduction of the oil painting but another work sharing the same composition, possibly a sketch for, or after, the oil painting of *Atlantic City*. The location of this work remains unknown. A more detailed discussion of the differences between the two compositions can be found in Chipkin and Kohn 2024b.
13. The painting as it was known from its black-and-white reproduction in *Blast* has been interpreted by art historians who have commented on its destructive power, references to a modern city or even urban devastation in the wake of the First World War. See, for example, Cork 1976: 427; Peppin 1996: 13–14; Heathcock 1999: 97; Beckett and Cherry 1998; Hickman 2013: 121.
14. The authors would like to thank Brigid Peppin for her observation that images of *Atlantic City* might also have inspired Saunders's painting.
15. As this is an ongoing research project, the authors hope that with further analysis it may be possible to reconstruct and repaint the entire composition of *Atlantic City*.
16. To celebrate the rediscovery of Saunders's *Atlantic City*, Leeds Art Gallery staged the show *Things Left Unsaid: Percy Wyndham Lewis, Iris Barry, Helen Saunders and the story of Praxitella* (22 June–5 October 2023), which in part reprised the Courtauld's exhibition.

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Edward Kienholz: digging a deeper truth

Corina E. Rogge and Kari Dodson

ABSTRACT Edward Kienholz (1927–1994) was an American artist who created biting social critiques through the repurposing and manipulation of commonplace objects. Many contemporary critics dismissed Kienholz's works, contributing to the lack of scholarly interest paid to his methods and materials, particularly in the period of the late 1950s to early 1960s as he moved from painted wooden reliefs to freestanding, three-dimensional constructs. To understand the materials and construction methods during this critical transitional period from several perspectives, a multidisciplinary team of a conservator and a conservation scientist studied four works from the Menil Collection and one from the Museum of Fine Arts Houston: *George Warshington in Drag* (1957), *Conversation Piece* (1959), *John Doe* (1959), *Walter Hopps Hopps Hopps* (1959) and *The Mort Soul Searcher* (1960). Visual examination complemented by X-radiography helped determine construction technique, and analysis of paints and other applied materials provided insights into Kienholz's paint choices, which were more varied than artist interviews suggested. Technical analysis revealed that the artworks' outward slapdash appearance belies a complex and deliberate construction for which Kienholz drew upon his earlier carpentry and mechanics training. This interdisciplinary approach and contextualization of the findings with the artist's own words provides deeper understanding of the complexities of Kienholz's works.

KEYWORDS Edward Kienholz, assemblage, pigment analysis, binding media analysis

Introduction

Edward (Ed) Kienholz (1927–1994), an American assemblage and installation artist, began his career working in two dimensions. By the time of his first solo show in 1955, he was painting abstractly and beginning to incorporate relief elements into his works (Hopps 1995). Kienholz said that at this time he favored hard supports such as wood or metal because they could be cut to shape, primed, and quickly made ready for use; in contrast he found canvas 'cumbersome' stating that it was 'stupid' to have to stretch it (Kienholz 1977: 81). For paints, he used 'House paint, enamels. … Not Winsor-Newtons particularly, although sometimes I would get a hold of some actual paint' (Kienholz 1977: 81–2).

Kienholz began creating assemblages saying that 'I decided it was perhaps more honest for me to take a head and paint it than to paint a head on canvas like on a two-dimensional plane' (Kronick 1961). However, unlike paint, objects have cultural associations, and repurposing the discarded remnants of society in a way that allows their original form to be recognized will invoke those associations in viewers. Kienholz, more so than some of his contemporaries, sought to use this synergy to deepen the emotional impact of his work. The comic books, football helmet, beer cans, car, and condoms of *Boy, Son of John Doe* (1961, private collection), for example, automatically invoke different stages of American childhood and adolescence in the mid-20th century. Kienholz reused recognizable objects and their associative cultural meanings to create pointed social critiques about contemporary society. Death, war, racism, misogyny, and economic inequity were among his common themes.

One of the problems artists face when creating artworks from disparate, used materials, is how to integrate them into a cohesive whole. Kienholz's approach was to apply dripping materials to unify the constructed artwork. He claimed that in this way, the disparate objects in an assemblage 'lose their individual identities, and they all become a single art identity, and it goes forward from that point in time' (Kienholz 1977: 227–8). In a 1995 interview after Kienholz's death, his wife and collaborator Nancy Reddin Kienholz stated that the dripped material on his early works was orange shellac, and that he also used, and later transitioned to the exclusive use of, polyester resin (which he referred to as 'fiberglass' as it was typically used with glass fibers).

Figure 1 **A** Edward Kienholz, *George Warshington in Drag*, 1957, oil on wood and plywood, 97 × 106 cm. The Menil Collection, Houston, Gift of Caroline Huber and the estate of Walter Hopps. © Estate of Nancy Reddin Kienholz, Courtesy of LA Louver, Venice, CA. (Photo: Adam Neese.) **B** Edward Kienholz, *Conversation Piece*, 1959, wood, plywood, metal, mannequin parts, plaster, oil paint, resin, velvet, and imitation leather, 111 × 76 × 94 cm. The Menil Collection, Houston, Gift of Walter Hopps. © Estate of Nancy Reddin Kienholz, Courtesy of LA Louver, Venice, CA. (Photo: Paul Hester.) **C** Edward Kienholz, *John Doe*, 1959, oil paint, metallic paint, resin, plaster, and graphite on mannequin parts with wood, metal, plastic, paper, rubber, and stroller, 100 × 48 × 79 cm. The Menil Collection, Houston. © Estate of Nancy Reddin Kienholz, Courtesy of LA Louver, Venice, CA. (Photo: George Hixson.) **D** Edward Kienholz, *Walter Hopps Hopps Hopps*, 1959, alkyd and acrylic paint on hardboard and wood with oil, metal, plastic, animal vertebrae, candy, plaster, leather, pills, glass, printed paper, graphite, colored pencil and ink on paper, mat board, and adhesive tape, 221 × 106 × 53 cm: recto and verso. The Menil Collection, Houston, Gift of Lannan Foundation. © Estate of Nancy Reddin Kienholz, Courtesy of LA Louver, Venice, CA. (Photo: Caroline Philippone.) **E** Edward Kienholz, *The Mort Soul Searcher*, 1960, mixed media assemblage with power drill and electric lights, 70 × 133 × 45 cm. The Museum of Fine Arts, Houston, Gift of Ruth and Ted Baum. © Estate of Edward Kienholz. (Photo © The Museum of Fine Arts, Houston; Thomas R. DuBrock.)

Goal of the investigation: to dig a deeper truth

While there have been a small number of conservation treatments published on Kienholz's work (Daniel *et al.* 1994; Pattison 2015), there are none that discuss in-depth the technical aspects of his oeuvre. As he transitioned from low relief to bricolage sculptures, his substrates changed, but did his paints? Is the haphazard appearance of his work reflected in their construction methods? Did he use shellac and polyester resin? Are his paints retail trade paints or did he, as he said, sometimes use artists' paints as well? To tell a more nuanced story about Kienholz, his material choices, and the construction methods he used during this transitional period, a multidisciplinary team consisting of a conservator and a conservation scientist analyzed five works from the Menil Collection and the Museum of Fine Arts Houston (MFAH). The works included *George Warshington in Drag* (1957), *Conversation Piece* (1959), *John Doe* (1959), *Walter Hopps Hopps Hopps* (1959) and *The Mort Soul Searcher* (1960) (Fig. 1). By combining several perspectives, we sought to gain a well-rounded and data-backed understanding of Kienholz's body of work. A conservator's examination guided questions to be answered by conservation science, all of which was filtered through the artist's own descriptions of his materials and methods. Conservators of Kienholz works and Kienholz scholars now have access to information that will aid in treatment, exhibition, and interpretation.

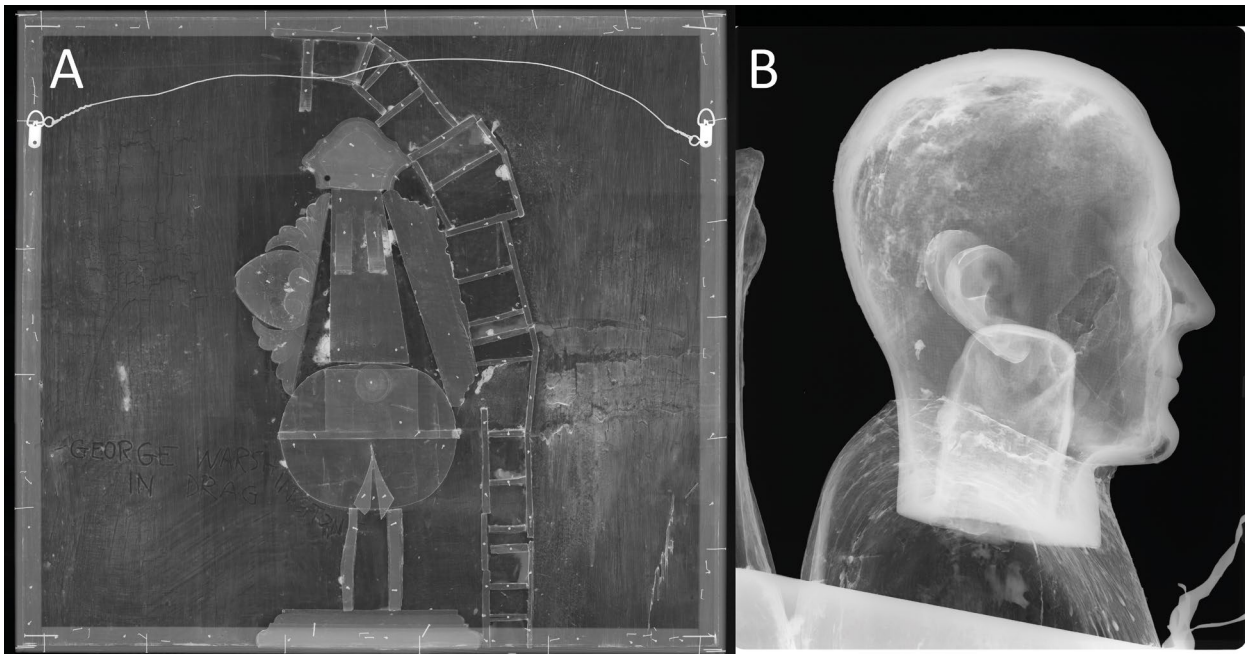

Figure 2 A Composite X-radiograph of *George Warshington in Drag*. (Image: Adam Neese.) **B** X-radiograph of a portion of *John Doe*. (Image: J. Craven.)

Table 1 Pigments, fillers, and binding media of materials identified on *George Warshington in Drag*.

Colour	Pigments and fillers by XRF or SEM-EDX	Pigments and fillers by FTIR and Raman	Binding media by TSP-GC/MS	Binding media by FTIR
White	Titanium white	Rutile co-precipitate with anhydrite	NA	Alkyd
Black	NA	Carbonaceous black	Alkyd (P/S = 1.16, Az/P = 0.19, Su/Az = 0.24, 19% PBA), fish and safflower oil), pentaerythritol, *Pinaceae*, shellac	Oil
Red	NA	PR3	NA	Alkyd
Orange	Lead chromate	Lead chromate	Alkyd (P/S = 0.6, Az/P = 2.7, Su/Az = 0.59, 12% PBA), *Pinaceae*, shellac	Oil
Yellow	Lead chromate	Lead chromate	Alkyd (P/S = 1.25, Az/P =0.5, Su/Az = 0.45, 19% PBA, fish and safflower oil), *Pinaceae*, shellac	Oil
Blue	NA	Prussian blue	NA	Oil

Note: NA indicates a particular material was not analyzed by a given technique.

George Warshington in Drag (1957)

The earliest artwork analyzed, *George Warshington in Drag* (1957), consists of small bits of scrap wood arranged into the form of a standing figure (Fig. 2A). Kienholz used three pieces of decorative molding: one for the figure's head, a second suggestive of a doffed hat where the figure's proper right arm would go, and a third for the dais upon which the figure stands. He attached additional pieces of wood meant to indicate breasts and labia to provide the feminizing features. Kienholz's use of nails is economical and neat: each of the smaller wooden pieces is attached using a single, centered nail, while larger pieces were secured with two or more.

After attaching the wooden relief pieces, Kienholz applied paint directly to the wood; no ground layer is visible. The pigments present include PR3, lead chromate, Prussian blue, rutile co-precipitated with anhydrite, and a carbon-based black (Table 1). The use of a co-precipitated titanium dioxide pigment may be indicative of a retail trade paint (Rogge and Arslanoglu 2019). TSP-GC/MS analysis of samples of orange, black, and yellow paints indicates that they are alkyds, the black paint contains pentaerythritol, but the rest likely use glycerol as the polyol. The samples of yellow and black paints have high levels of myristic acid (myristic to palmitic acid ratios of 0.18 to 0.6) suggestive of the use of fish oils and longer chain fatty acids (arachidic, behenic, and

Table 2 Pigments, fillers, and binding media of materials identified on *Conversation Piece*.

Colour	Pigments and fillers by XRF or SEM-EDX	Pigments and fillers by FTIR and Raman	Binding media by TSP-GC/MS	Binding media by FTIR
White	NA	Rutile co-precipitated barium sulfate	NA	Oil
Black	Magnetite, barium sulfate	Prussian blue, barium sulfate	NA	Oil
Red	Molybdenum based heteropolyacid pigment	PR3, talc	Alkyd (P/S = 0.84, Az/P =0.87, Su/Az = 0.49, 24% PBA, safflower oil), pentaerythritol, PR3, *Pinaceae*	Alkyd
Orange	Titanium white, lead chromate, calcium species, barium sulfate	Rutile, lead chromate, kaolinite, calcium carbonate, barium sulfate	Alkyd (P/S = 1.23, Az/P =1.07, Su/Az = 0.43, 24% PBA, fish and safflower oil), *Pinaceae*	Nitrocellulose modified alkyd
Drab green	Chromium oxide, zinc white, iron and calcium species	Calcium carbonate, viridian	NA	Poly(butyl methacrylate)
Dripped brown material that fluoresces green	NA	Prussian blue, kaolinite, calcium carbonate	NA	Oil
Dripped brown material that fluoresces tan	NA	Prussian blue, barium sulfate, calcium carbonate, calcium oxalate	NA	Oil or oleoresin
Dripped brown material that fluoresces dull orange	NA	Prussian blue, kaolinite, gypsum, calcium oxalate	NA	Natural resin or oleoresin

Note: NA indicates a particular material was not analyzed by a given technique.

lignoceric acids) indicative of safflower oil (Lísa and Holčapek 2008; La Nasa *et al.* 2021). Oils from fish such as menhaden were often added to more expensive vegetable oils in retail trade oil and alkyd paints. All samples also contain significant amounts of *Pinaceae* resin and shellac as indicated by the presence of published marker compounds (Pastorova *et al.* 1997; Wang *et al.* 1999; Van den Berg *et al.* 2000; Columbini *et al.* 2003; Osete-Cortina and Doménech-Carbó 2005). The presence of high levels of resin suggest that these paints were meant to be smooth, glossy 'enamel' paints, and the alkyd binder indicates that they were retail trade paints, as artists' alkyds were not marketed until the 1980s (Standeven 2011; Learner 2000). FTIR analysis on samples of the white, blue, and red paint suggests they too may be alkyds.

Walter Hopps related that at the end of the creation process Kienholz scratched 'George Warshington' into the yellow paint of the background and said 'How do you like the mother of our country?' (Whitney Museum of American Art 1996: 30). Kienholz reportedly did not mean this work to be a condemnation of women, LGBTQ+ individuals, or, despite the deliberate misspelling in the inscription, to George Washington, but rather to ask viewers to imagine what the nation might have been like if the 'founding father' of the United States had been a mother (Whitney Museum of American Art 1996: 67). This combination of social critique leavened with humor would become a Kienholz signature.

Conversation Piece (1959)

While *The Little Eagle Rock Incident* (1958, private collection) was the first piece in which Kienholz included an entire object (a mounted deer head), *Conversation Piece* (1959), is one of the first in which Kienholz incorporated a human mannequin. In this artwork, the lower portion of a hollow, child-sized, plaster-coated fabric mannequin projects at a 90-degree angle from the upper part of a shield, reminiscent of the mounting of the deer's head in *The Little Eagle Rock Incident*. As with the figure of *George Warshington in Drag*, the shield was made by attaching dozens of wooden pieces to the surface of a board. X-radiographs reveal

that the hollow torso of the figure is fitted over a wooden block and the join is reinforced and obscured by small triangular scraps of wood glued and nailed around the mannequin's waist. Kienholz also attached a metal hangar strap to provide additional support for the cantilevered weight of the legs when the artwork is hung. The mannequin is wearing red velveteen spats with imitation leather fringe but is otherwise unclothed, and Kienholz has added an unidentified fibrous material to depict pubic hair. This work is one of Kienholz's first explicit commentaries on racism, made in response to the rape of an Indigenous woman. By deliberately placing the mannequin's legs and groin where a deer head would go, he forces the viewer to realize that rapists consider women trophy prey and the act of rape worth memorializing. Protruding from the shield below the legs are the woman's bent arms, visible from just above the elbow; many traditional head mounts have the deer's hooves positioned in a similar location to serve as a gun rack. At the bottom edge of the board, inscribed in graphite are the words, CONVERSATION PIECE, CONTEMPLATION PIECE, CONSERVATION PIECE, KIENHOLZ '59'.

Although from a distance the work appears to be painted a greenish-brown, close inspection reveals areas of orange, white, red, green, and black paints. Analysis confirms Kienholz used a wide variety of binding media (Table 2). TSP-GC/MS indicates that the red paint is a *Pinaceae* and pentaerythritol-containing alkyd that may contain fish and safflower oils, materials indicative of a retail trade paint. This technique suggested that the orange paint is also an alkyd, but FTIR indicated the presence of nitrocellulose, so this paint may be a nitrocellulose-modified alkyd. FTIR analysis suggests the white and black paints are oils, while the drab green paint could be Magna as the spectrum of the binder indicates it to be an acrylic paint and it most closely resembles poly(n-butyl methacrylate), the binder of Magna – the first artists' acrylic paint introduced on the market and widely available by 1953 (Rogge and Epley 2017). UV-induced visible fluorescence suggests that Kienholz applied drips of three different types of material to the figure, all of which according to FTIR appear to be oils or oleoresins. One of these exhibits a dull orange fluorescence and could include shellac although GC-MS analysis would be necessary to confirm this. Pigments identified included rutile, viridian, Prussian blue, lead chromate, and PR3.

John Doe (1959)

John Doe and *Moses* (1959, private collection) were among the first freestanding sculptures Kienholz made (Kienholz 1977: 226–7), creations perhaps influenced by the artist having moved into an A-frame studio with limited vertical walls for hanging art (Kienholz 1977: 215–16). To create *John Doe,* Kienholz used parts from three mannequins, attaching a head to a headless torso and using the footless legs from a third. The distinctively different opacities of the head and torso in the X-radiograph indicate Kienholz utilized the head from one mannequin and the torso from another (Fig. 2B). He secured the torso and legs back-to-back onto an arrow-shaped wooden board set into the frame of a baby stroller using small wood pieces, reminiscent of the attachment of the torso of *Conversation Piece.* Kienholz created a sloping, cylindrical cavity lined with metal tubing through the center of the chest of the mannequin and extending into the groin region of the section behind it, and placed a cross at the opening on the torso. The end of the metal tubing was cut and splayed open into a starburst where it exits the chest, and one ray of the starburst supports a vintage dexterity puzzle. To provide *John Doe* with a penis, Kienholz took a jointed piece of galvanized metal stovepipe and covered one end with a rubber Halloween mask; the other end fits into the tube in the groin of the mannequin. As the penis was designed to be removable, Kienholz built a drawer below the legs where it could be stowed when not in use or in matters of discretion; in the 1961 film *The Story of an Artist – Edward Kienholz*, it appears that he chose not to attach it. Another possible implication of the drawer is that the dissociation of the penis from the mannequin can denote impotence, hidden secrets, or shame.

After assembling the sculpture, Kienholz painted the torso of the mannequin yellow; the paint is an alkyd pigmented with chrome yellow, barium sulfate, and calcium carbonate, though some zinc white may also be present (Table 3). To indicate that *John Doe* was supposed to be wearing a sweater he painted ribbing of a v-neck in a brownish-red paint. The mannequin head is painted a beige color. A cross-section sample (Fig. 3) reveals that four paint layers are present: (1) a white calcium sulfate ground that may be bound with an alkyd; (2) a dark pink nitrocellulose layer with titanium white, lithopone, talc, silicates, and iron species; (3) a very thin yellow lead chromate and calcium carbonate-containing layer

Table 3 Pigments, fillers, and binding media of materials identified on *John Doe*.

Colour	Pigments and fillers by XRF or SEM-EDX	Pigments and fillers by FTIR and Raman	Binding media by TSP-GC/MS	Binding media by FTIR
White on stroller	Zinc white and barium sulfate or lithopone, lead white, titanium white	NA	NA	NA
Red on torso	Organic	PR3, talc	NA	Alkyd
Yellow on torso	Lead chromate, zinc white, barium sulfate, calcium species	Lead chromate, barium sulfate, calcium carbonate	Alkyd (P/S = 1.00, Az/P =0.05, Su/Az = 0.14, 24% PBA)	Alkyd
Green of eyes	Zinc white, PY3,	PY3, phthalocyanine blue, kaolinite	NA	Oil or alkyd
Brown drips on torso	None detected	None detected	NA	Alkyd
Black drips on torso	Iron earth species	Silicates, Prussian blue, calcium carbonate	Alkyd (P/S = 0.88, Az/P =0.43, Su/Az = 0.61, 22% PBA), pentaerythritol, *Pinaceae,* mineral wax	Alkyd
Silver on legs	Aluminum	Silicates, lead white, lead chromate	NA	Alkyd
White drips on legs	Titanium white, calcium species	Rutile, calcium carbonate, talc, gypsum	Alkyd (P/S = 0.87, Az/P =0.10, Su/Az = 0.33, 16% PBA)	Alkyd
Blue drips on legs	Prussian blue, zinc white	Prussian blue, calcium carbonate, talc, gypsum	Alkyd (P/S = 0.88, Az/P =0.12, Su/Az = 0.36, 19% PBA)	Alkyd
Brown drips on legs	NA	None detected	Alkyd (P/S = 0.96, Az/P =0.28, Su/Az = 0.35, 39% PBA), *Pinaceae*	Alkyd

Note: NA indicates a particular material was not analyzed by a given technique.

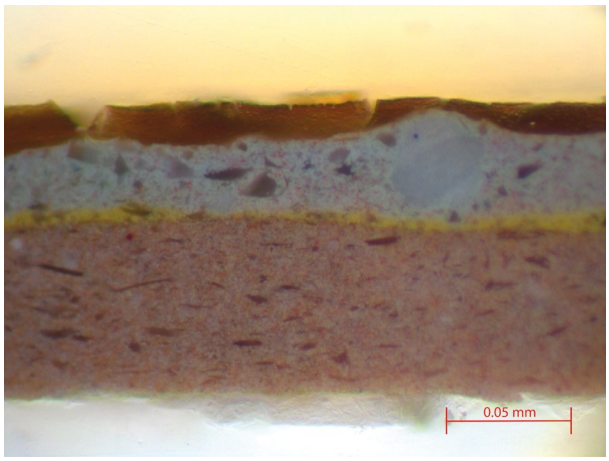

Figure 3 Cross-section sample taken from the face of *John Doe* (1959). There are five layers of material present, from the bottom: (1) a thin and fragmentary white layer; (2) a thick pink nitrocellulose layer; (3) a thin yellow layer;(4) a light pink layer; (5) a transparent brown alkyd layer.

(the binder may be an alkyd but the thinness of the layer precludes precise identification); (4) a surface light pink alkyd layer with calcium carbonate, titanium white, possible lithopone, and iron species over which was dripped layer 5, an alkyd layer. The evenness of the lower three layers suggests that they may have been applied by the mannequin manufacturer, with only the surface paint being artist-applied. Kienholz painted the mannequin's eyes white and green and used a graphite tool to scribe lines into the whites of the eyes. The green paint contains PY3 and phthalocyanine blue and is likely a color Kienholz mixed. He used a free-flowing red alkyd paint pigmented with PR3 to paint the interior of the chest cavity and depict blood flowing from it. He applied black and brown 'sweat' to the head and allowed it to drip over the figure. Both of these dripped materials are alkyds, the brown is unpigmented (it appears as layer 5 in Fig. 3) while the black contains Prussian blue, calcium carbonate, barium sulfate, and iron earth species. The legs are painted silver with an alkyd paint that has aluminum flakes, lead white and lead chromate. In contrast to the torso, Kienholz applied cream, brown and blue colored drips on the legs. The white alkyd paint contains rutile, calcium carbonate, talc, and gypsum. The blue alkyd paint likely contains calcium carbonate, Prussian blue, talc, gypsum, and zinc white. The brown material may be an unpigmented alkyd, perhaps the same material used on the torso.

The name of the piece evokes an anonymous 'average' American male, and on the foot support

Table 4 Pigments, fillers, and binding media of materials identified on *Walter Hopps Hopps Hopps*.

Colour	Pigments and fillers by XRF or SEM-EDX	Pigments and fillers by FTIR and Raman	Binding media by TSP-GC/MS	Binding media by FTIR
White of jacket	Titanium white	Rutile	NA	Alkyd
Red of tie	Cadmium sulfoselenide	None detected	NA	p(EA:MMA)
Blue of tie	Phthalocyanine blue	Phthalocyanine blue	Alkyd (P/S = 0.78, Az/P =0.71, Su/Az = 0.45, 41% PBA), pentaerythritol, *Pinaceae*	Oil (?)
Brown of pants	Iron earths, calcium species, zinc white	NA	NA	NA
Gray of jacket	Zinc white, barium sulfate, magnetite, calcium species	NA	NA	NA
White on verso	NA	Rutile co-precipitated with calcium sulfate, phyllosilicate	Oil (P/S = 1.23, Az/P = 0.16, Su/Az = 0.30), possible fish oil, *Pinaceae*	Oil
Yellow on verso	Titanium white, lead chromate, zinc white	Anatase, lead chromate, barium sulfate, calcium carbonate, gypsum	Alkyd or alkyd mixed with oil (P/S = 0.9, Az/P = 0.14, Su/Az = 0.39, 7% PBA), *Pinaceae*	Oil (?)
Green on verso	NA	Prussian blue, lead chromate, lead sulfate, calcium carbonate	Alkyd (P/S = 0.92, Az/P =0.56, Su/Az = 0.57, 41% PBA), *Pinaceae*	Oil (?)
Purple on verso	Cadmium sulfoselenide, titanium white, phthalocyanine blue, calcium species	Rutile co-precipitated with calcium sulfate phthalocyanine blue, PR2	Alkyd (P/S = 0.98, Az/P =0.39, Su/Az = 0.31, 12% PBA), *Pinaceae*, mineral wax	Oil (?)
Brown on verso	Iron earth species	Goethite	Alkyd (P/S = 1.29, Az/P =0.62, Su/Az = 0.61, 32 % PBA), safflower, pentaerythritol, *Pinaceae*, PR3	Alkyd
Transparent brown drips type 1	NA	None detected	Alkyd (P/S = 1.4, Az/P =1.20, Su/Az = 0.72, 11% PBA, safflower, tung) *Pinaceae*	Tung oil
Transparent brown drips type 2	NA	None detected	Alkyd (P/S = 0.89, Az/P = 0.59, Su/Az = 0.63, 18% PBA)	Oil

Note: NA indicates a particular material was not analyzed by a given technique.

of the stroller, Kienholz inscribed 'A riddle: Why is John Doe like a Piano? Answer: Because he is square, upright and grand. Old sooth saying.' This everyman is dependent upon others for mobility, cut in two with intellect separated from sexuality, and while his heart bleeds for religion his impassive stare suggests an emotional remove even while 'sweat' pours from him.

Walter Hopps Hopps Hopps (1959)

To create this simultaneous homage to and satire of his erstwhile Ferus Gallery partner, Walter Hopps, Kienholz repurposed a standing, larger-than-life plywood advertising sign depicting the Bardahl Man. In the 1950s and 1960s, Bardahl advertised their gasoline additives using a cartoon detective wearing a trench coat and hat, shown pulling his coat open to reveal a can of Bardahl oil, rather than a police badge. Kienholz modified the figure by cutting off the hat, attaching a series of latched wooden compartments to the back, then repainting it and collaging on mammalian vertebrae, paper, telephone parts, and adding items like candy and dental impressions to the compartments. The majority of the paints analyzed are alkyds, but FTIR suggests that the cadmium sulfoselenide red paint used on the tie utilizes a poly(ethyl acrylate:methyl methacrylate) (p(EA:MMA)) binder (Table 4). This suggests it may be a Liquitex artists' acrylic, as this company introduced this binder in 1954, while the Bocour Company did not begin utilizing it until 1963–1964 (Lodge 1988; Marontate 1996). TSP-GC/MS analysis revealed that Kienholz used at least two different materials to depict sweat

Table 5 Pigments, fillers, and binding media of materials identified on *The Mort Soul Searcher*.

Colour	Pigments and fillers by XRF or SEM-EDX	Pigments and fillers by FTIR and Raman	Binding media by TSP-GC/MS	Binding media by FTIR
White underlayer on the wooden body (type 1)	Zinc white, lead white	Rutile co-precipitated with anhydrite	Oil (P/S = 1.6, Az/P = 0.32, Su/Az = 0.5), *Pinaceae*	Oil
White on legs, canvas, and the surface layer on the wooden body (type 2)	Titanium white, zinc white, calcium sulfate	Rutile co-precipitated with anhydrite	Oil (P/S = 1.40-1.74, Az/P = 0.49-0.71, Su/Az =0.33- 0.38), *Pinaceae*	Oil
Black drips and white type 2	Titanium white, zinc white, calcium sulfate, cobalt driers (?)	Rutile co-precipitated with anhydrite, zinc soaps	Oil (P/S = 1.35, Az/P = 0.98, Su/Az = 0.53, heat bodied), *Pinaceae*	Oil
Red	Cadmium sulfoselende, barium sulfate	PR112, barium sulfate	Oil (P/S = 1.6, Az/P = 1.5, Su/Az = 0.25), *Pinaceae*, PR112	Oil
Pink drips and white type 2	Titanium white, zinc white, calcium sulfate	Rutile co-precipitated with anhydrite, talc	Oil (P/S = 1.5, Az/P = 0.4, Su/Az = 0.43, heat bodied), *Pinaceae*	Oil
Dark pink on head	Lead white, barium sulfate	Lead white, barium sulfate, PR112	NA	Oil
Greenish drips and white type 2	Titanium white, zinc white, calcium sulfate, cobalt driers (?)	Rutile co-precipitated with anhydrite	Alkyd (P/S = 1.6, Az/P = 1.62, Su/Az = 0.52, 33% PBA), pentaerythritol, *Pinaceae*	Alkyd
Blue[a]	Ultramarine, cobalt violet, Prussian blue,	Ultramarine, Prussian blue, calcium carbonate; talc, rutile co-precipitated with anhydrite, zinc white	Oil (P/S = 2, Az/P = 0.07, Su/Az = 0.31, safflower), trace of *Pinaceae*	Oil
Transparent brown drips on white type 2	Titanium white, zinc white, calcium sulfate	Rutile co-precipitated with anhydrite	Oil (P/S = 1.34, Az/P = 1.30, Su/Az = 0.49)	Oil

Notes: NA indicates a particular material was not analyzed by a given technique.

[a] A description of the multiple layers of blue paint is provided in the results and discussion section

on this sculpture, one of which is an alkyd with high levels of 9-(o-propylphenyl)nonanoic acid and other cyclized fatty acids indicative of tung oil, but the presence of longer chain fatty acids suggest that safflower oil may also be present, as is a small amount of *Pinaceae*. The second material is an alkyd that may be linseed oil-based and displays no markers for the presence of tung or safflower oil.

The piece is a moderately gentle (for Kienholz) critique of Walter Hopps (he was somewhat bitter about having been bought out of the Ferus Gallery and replaced by Irving Blum in 1958). The name of the artwork refers both to Walter Hopps' full name, Walter Hopps III, and to the fact that he was forever bouncing between endeavors. Instead of a can of Bardahl as on the original sign, Hopps is depicted opening his jacket to reveal reproductions of paintings by Willem de Kooning, Jackson Pollock, and Franz Kline. In one of the compartments on the figure's back is a list, written by Hopps at Kienholz's request, of artists Hopps would like to represent – but with the names playfully twisted: 'Franz Climb' and 'Willem de Conning' are among them. The figure's watch dial reads 'LATE' because Hopps was notoriously never on time, his eyes are bloodshot from chronic lack of sleep, and he is dripping 'stress sweat' due to an addiction to speed (Hopps 1998). The candy and dental impressions, the latter of which are labeled 'BLUM,' relate to Irving Blum, whom Kienholz did not like, and reportedly referred to as a 'candy-ass'. The telephone and list of phone numbers refer to a private spat between Hopps and Kienholz, which started when Hopps called Kienholz itinerant. In retaliation Kienholz listed every phone number he had to use before he was able to contact Hopps – locations where Hopps had either lived or 'shacked up' with someone (Hopps *et al.* 2017: 137–8).

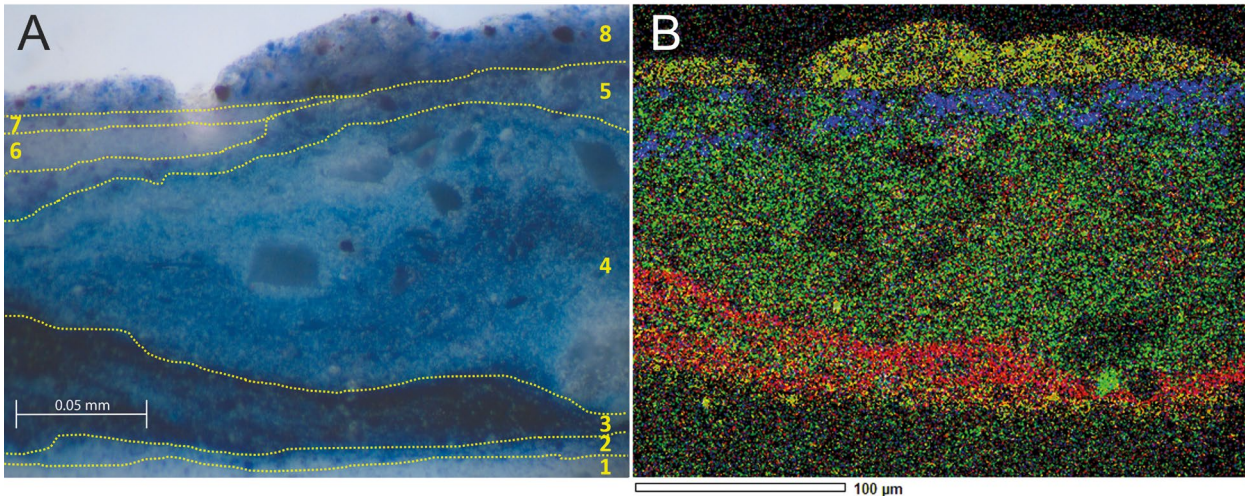

Figure 4 Sample of blue paint taken from *The Mort Soul Searcher*. **A** Visible light, the different paint layers are labeled and delineated: (1) white ground containing titanium dioxide anhydrite co-precipitate; (2) ultramarine blue, $CaCO_3$, $BaSO_4$; (3) Prussian blue, zinc white, $CaCO_3$, $CaSO_4$, $BaSO_4$, silicates; (4) Prussian blue, zinc white, $CaCO_3$, $CaSO_4$, $BaSO_4$, silicates; (5) Prussian blue, cobalt violet, zinc white, $CaCO_3$, $CaSO_4$, $BaSO_4$, silicates; (6) zinc white; (7) zinc white, cobalt violet; (8) ultramarine blue, $CaCO_3$, $BaSO_4$. **B** SEM-EDX elemental map: cobalt (blue), aluminum (yellow), iron (red) and zinc (green).

The Mort Soul Searcher (1960)

This sculpture, evocative of a three-legged animal, is created from a variety of repurposed materials including chair legs, wooden boards, a stand mixer, and cans. The body is made from two wooden boards that were joined with nails and given an initial coat of a white oil paint ('white paint type 2 in Table 5) containing *Pinaceae* and pigmented with zinc white and lead. There are paint drips that run horizontally from head to rear indicating the paint was applied when the boards were perpendicular to their current orientation. The face is made from a piece of wood cut into the shape of the Union Shield, a symbol officially adopted by the United States of America in 1782 to signify the union of the 13 original states; it is painted red and blue, with green light bulbs for eyes.

The red oil paint on the face contains cadmium sulfoselenide, barium sulfate, and PR112. The presence of cadmium suggests that this is an artists' paint, and the organic pigment may be present as a 'toner' or extender for the more expensive cadmium pigment (Rogge and Epley 2017). A cross-section sample taken from the blue of the face (Fig. 4), reveals the presence of multiple paint layers. Visual inspection and SEM-EDX analysis suggests that over the white ground Kienholz laid down a thin blue layer containing ultramarine blue, calcium carbonate and barium sulfate (layer 2). Over this he applied a dark Prussian blue-containing layer that has a small amount of zinc white unevenly mixed in; calcium carbonate, calcium sulfate, barium sulfate, and silicates are also present (layer 3). The tonality of this layer was evidently too dark because he covered it with a very thick layer of unevenly mixed paint that is also pigmented with Prussian blue and zinc white (layer 5). He then adjusted the tonality by adding cobalt violet into his Prussian blue and zinc white paint (layer 5). There is then a partial layer of zinc white paint (layer 6) and a partial layer of cobalt violet and zinc white paint (layer 7). Dissatisfied, he then appears to have gone back and applied a surface layer of ultramarine blue, the color he had initially used (8). While an individual layer may be inhomogeneous, there seems to be little wet-on-wet mixing of the different paint layers, suggesting that Kienholz had periods of time for reflection and that these differences in tonality were quite deliberate explorations on his part. TSP-GC/MS analysis of the co-sampled blue layers reveals the binding media to be oil with *Pinaceae*. While Prussian blue and ultramarine blue are inexpensive pigments, cobalt violet is not, suggesting that Kienholz used at least one artists' paint in this area.

The wooden face is attached to the handle of a stand mixer that serves as the front of the body (Fig. 5). Comparison of the shape of the stand mixer's base plate, control knob, and handle suggests that it may be an early model Sunbeam Mixmaster. Kienholz modified the mixer by attaching a secondary system to the beater shaft that enables the mixer to drive a drill bit. The hind legs are chair legs, which were originally varnished with cellulose nitrate, and the front leg consists of two painted tin cans into which the drill bit fits. Kienholz strung red, blue, and clear

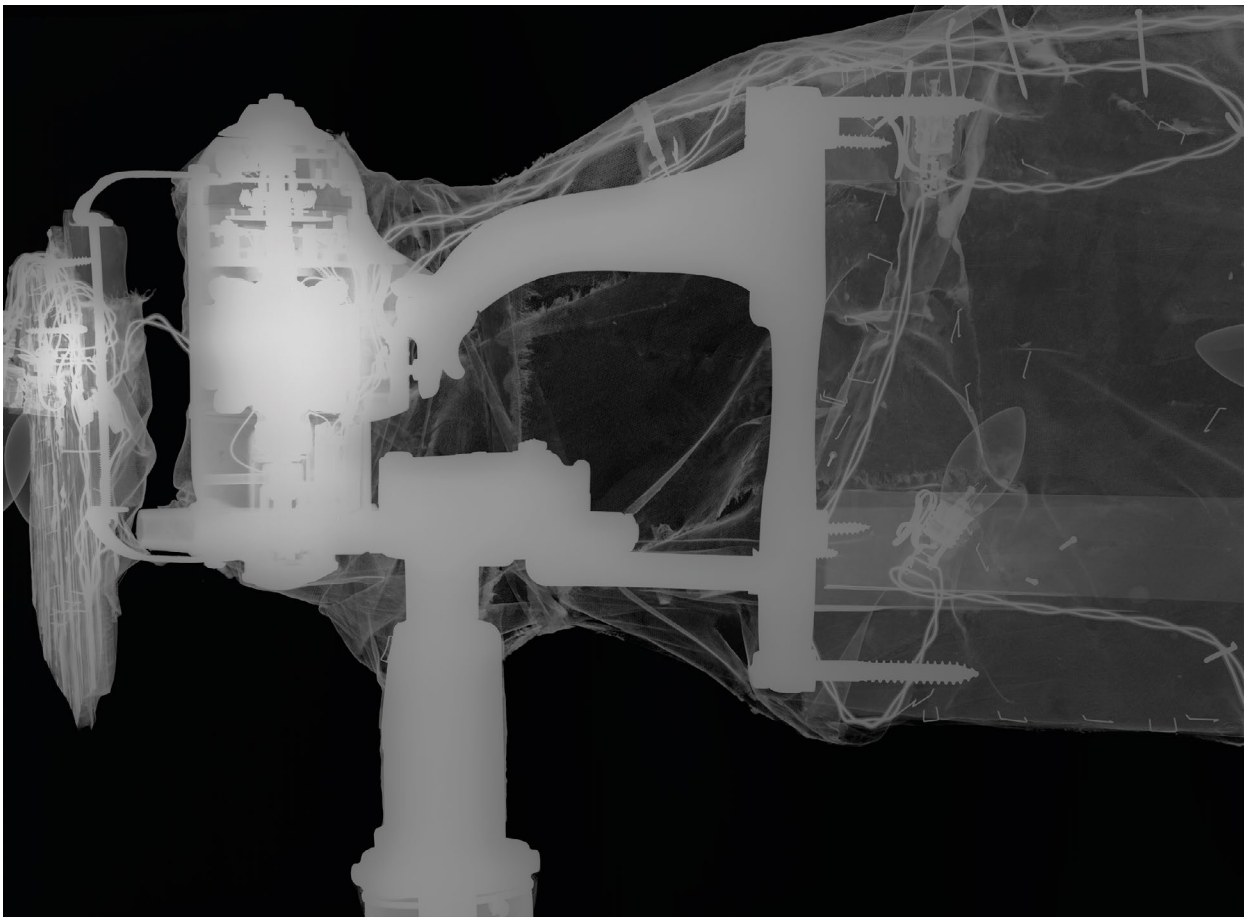

Figure 5 X-radiograph of front portion of *The Mort Soul Searcher* showing the canvas-wrapped stand mixer used to create the front of the body. (Image: S. Hanley.)

blinking lights around the body, pinning the cords in place with metal hooks, and then covered much of the body with cotton canvas with holes cut to allow the lights to poke through. The assemblage was then painted with a white oil paint containing *Pinaceae* and pigmented with titanium white co-precipitated with anhydrite and zinc white. He carefully indicated what color of lightbulb belonged in a given socket by swiping the corresponding color of paint on the socket or nearby canvas. After assembly and painting, Kienholz applied free-flowing black, pink, brown, and greenish materials that were allowed to drip down the body. The greenish material is an alkyd, but the pink, tan, and blackish drips are all oil-based.

The name of the artwork is a pun referring to the comedian and social satirist Mort Sahl. At the top of the object's 'head' is written 'little truth' and 'deeper truth', with the implication being that the extent of truth uncovered depends upon how deeply the sculpture is set to drill down. This is one of the first of Kienholz's works to use light, something that would become more common in later objects and installations.

Discussion of results and contextualization of findings

Kienholz's aesthetic of drips, repurposed objects, and seemingly slapdash construction techniques create an aesthetic that impels many viewers to underestimate the craft, skill, and complexity of his art. However, he used his background in carpentry and mechanics to try and create stable, well-constructed works; for instance, he carefully sought to offset the impacts of gravity on the cantilevered mannequin legs in *Conversation Piece*. The common presence of binding media such as alkyds and oils made with fish or safflower oil confirms the use of house or other retail trade paints, just as he stated in his 1977 interview (Kienholz 1977: 81–2). However, expensive cadmium and cobalt pigments and artists' acrylics are also present, indicating that when available or necessary for his vision he would use the pure, bright colors of artists' paints (the presence of Winsor & Newton materials could not be specifically confirmed). He was ecumenical about his white pigments but appears to have favored inexpensive Prussian blue, organic reds, and lead chromate, but

it is unclear if this was due to specific color preferences or economy. His repeated revisions of the blue color on the face of *The Mort Soul Searcher* reveal his works were not made easily or without care to their appearance; the exact tone of blue mattered, and he struggled to find a color that matched his vision of what the work should be. There appears to be no significant shift in painting materials during Kienholz's transition from two- to three-dimensional works, suggesting that he continued to use what he knew, understood the handling properties of, and liked using.

Dripped material, often depicting body fluids such as sweat and blood, are a common thread running through Kienholz's oeuvre, one of the first occurrences being on *Conversation Piece*. All the works in this study except for *George Warshington* have such drips, and the practice extends to the later tableau works made in collaboration with his wife, Nancy Reddin Kienholz. The application of the unifying dripped material remains one of the strongest links to his early painting practice. On the works analyzed here, the materials Kienholz used vary and include alkyd and oils. Despite the information gleaned from interviews, neither shellac nor polyester resin was positively identified in the drips present on this group of transitional objects, underscoring that although artist interviews are tremendous resources, they should be verified analytically.

Kienholz's artworks are complex entities, constructed from disparate objects and layered with both materials and meaning. We hope that through this collaborative, multidisciplinary study we can help others better understand and appreciate this deeply nuanced art, and the artist who created it.

Appendix: Analytical materials and methods

Optical microscopy

Images of cross-section samples under both visible oblique and UV illumination using B-2A or V-2B filter cubes were obtained using a Zeiss AxioCam MRc5 camera controlled by Zeiss Axiovision AC software release 4.5 and mounted onto a Nikon Labophot-Pol optical microscope equipped with 10×, 20×, and 40× objectives. Scale bars were created in Adobe Photoshop using images of a micrometer scale taken using the same objective.

Dispersive Raman microspectroscopy

Dispersive Raman spectra were collected on a Renishaw InVia Raman microscope running WiRE software version 5.5 using a 785 nm excitation laser operating at a power of 74.4 μW to 782 μW at the sample. A 50× objective was used to focus the excitation beam on the sample supported on a glass microscope slide (Rogge and Gardner 2023). Sample identification was achieved by comparison to spectra of reference materials, the KIK/IRPA and IRUG reference libraries and to those published in the literature (Fremout and Saverwyns 2012; Price *et al.* 2014).

Attenuated total reflectance (ATR) Fourier transform infrared spectroscopy

Attenuated total reflectance (ATR) spectra were collected using a Bruker Lumos μ-FTIR microscope running Opus software version 8.2.

Micro-Fourier transform infrared spectroscopy (μ-FTIR)

Transmission μ-FTIR spectra were collected using a Bruker Lumos μ-FTIR microscope running Opus software version 8.2 (Rogge and Gardner 2023). Sample identification was aided by searching the Infrared and Raman Users Group Spectral Database, a spectral library of common conservation and artists' materials using Omnic software version 9.11.706 (Thermo Scientific).

Scanning electron microscopy with energy-dispersive X-ray spectrometry (SEM-EDX)

Backscatter electron images of the uncoated cross-section samples were taken with a JEOL JSM-IT100 SEM operating at 20 kV, running under low vacuum mode with a pressure of 50–55 Pa and a probe current of 40–50 (unitless). EDX analysis using the integrated detector was performed under the same voltage and pressure conditions, but with higher probe currents (65–75) to increase the counts.

X-ray fluorescence spectroscopy

Spectra were collected using a either a Bruker Tracer III-SD handheld energy-dispersive X-ray

spectrometer equipped with a Peltier-cooled XFlash silicon drift detector (SDD) and a Rhodium (Rh) target X-ray tube, operated at 40 kV and 10 μA current, or a Bruker Artax 400 energy-dispersive X-ray spectrometer system equipped with a Rh target X-ray tube with a 0.2 mm thick beryllium (Be) window, and operated at 40 kV and 400 μA current. Full experimental details are published in Rogge and Epley (2017) and Rogge and Gardner (2023).

Thermal separation probe-GC/MS (TSP-GC/MS)

Samples were run using a TSP (Agilent Technologies, Inc, Palo Alto, CA), installed in a multimode inlet on an Agilent 8890 gas chromatograph, interfaced to an Agilent 5977B single quadrupole mass selective detector. The full details of sample preparation, instrumental settings and data analysis methodology are published in Rogge *et al.* (2022).

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Video calling Mark Manders: from artist interview to co-constructed audiovisual art technological source

Sanneke Stigter and My Bundgaard

ABSTRACT This paper demonstrates how careful use of interviews for conservation research and technical art history can help bridge the gap between conservation concerns and curatorial practices by the example of interviewing Dutch artist Mark Manders, with special reference to his object-based installation *Room, Constructed to Provide Persistent Absence* (2001–2002) from the collection of Moderna Museet, Sweden. This study not only addresses the interview content but also analyses the influence of technological aids, methodology and the social setting, including the museum context and the educational purpose of the interview, conducted with students from Malmö Art Academy/ Lund University. The project resulted in a strengthening of institutional collaboration through a follow-up interview with Swedish curator Andreas Nilsson, and a redressing of the power relations between interviewer and interviewee when Mark Manders started filming around his studio with his mobile phone to better explain his work. The use of video calling allowed the interviewee to steer the narrative and transform the interview into a 'virtual walking interview', resulting in a co-constructed, audiovisual art technological source on Mark Manders' studio practice. New developments in transcribing spoken narratives and FAIR archiving of standards are highlighted to support inter-institutional collaboration, including as part of the Dutch research project Oral History – Stories at the Museum around Artworks (OH-SMArt). Moreover, the project illustrates how collaboration between museums and universities can support good practice in conducting interviews, not only by sharing time and expertise together but also by eliciting engagement through student involvement.

KEYWORDS artist interview, artmaking process, contemporary art, Mark Manders, oral history

Introduction

This paper demonstrates how careful use of interviews for conservation research and technical art history can help to bridge the gap between conservation concerns and curatorial practices by the example of an interview with Dutch artist Mark Manders (b. 1968), on 12 January 2023, with special reference to his object-based installation *Room, Constructed to Provide Persistent Absence* (2001–2002) from the collection of Moderna Museet, Sweden. This study not only discusses the interview content but also analyses the influence of the social setting and the used technical methodology that has resulted in a co-constructed, audiovisual art technological source.

The use of interviews in conservation research and technical art history has increasingly become standard practice for museum professionals, as evidenced by the various guidelines and programmes that have been developed to support the conservation of modern and contemporary art (e.g. INCCA 2002; Beerkens *et al.* 2012; Ryan and O'Banion 2016; Rivenc *et al.* 2017; Debik and Giering 2021; Schaik 2023).[1] Conducting interviews is an invaluable means of documenting aspects of complex artworks that are not easily grasped in images and writing. Moreover, oral communication with the artist can be helpful to gauge preferred appearance or possible development of an artwork, and to understand the relation between the content and material technological specificities of the work, which is vital to inform appropriate forms of care. Meanwhile, academic studies in conservation have shown how interviewing is not merely retrieving information but a critical practice that can add to the artwork's identity and steer its development (e.g. Saaze 2009; Stigter 2012; Wharton 2016; Gordon 2021; Wielocha 2021). Indeed, as part of constructing artwork documentation, interviewing can be of direct influence on the artwork's future, depending on how the information is interpreted and used in decision-making for conservation and presentation. Many museums, on the other hand, are still grappling with finding the time and resources to critically reflect on their own roles as part of this research practice and are lacking the tools to do

so. Archiving interview material requires time and attention to compile a transcript, acquire metadata and obtain consent following ethical research procedures and the General Data Protection Regulations (GDPR).

Apart from gaining insight into how to interpret spoken narratives critically, many museum professionals cannot always conduct interviews at pivotal moments in an artwork's life, such as acquisition and new installation moments because of time constraints. Nor do they have sufficient time and tools to archive the resulting material in a sustainable way, hindered by the lack of access to a long-term archiving system to facilitate the laborious workflow of transcribing and disclosing the material according to oral history standards.

Recording and archiving interviews for future consultation is in fact what largely defines oral history, following historian Donald A. Ritchie:

> An oral history interview generally consists of a well-prepared interviewer questioning an interviewee and recording their exchange in audio or video format. Recordings of the interview are transcribed, summarized, or indexed and then placed in a library or archives (Ritchie 2015: 1).

Keeping such research material safe and accessible is highly recommended by UNESCO in support of Open Science (Bronner *et al.* 2022). Sharing information is especially desirable if public money is involved, as is the case with most universities and many museums. The aim to make all generated research material Findable, Accessible, Interoperable and Reusable (FAIR) has become an important principle in academic research (Wilkinson *et al.* 2016).

This contribution suggests that collaboration between museums and universities can support good practice in oral history research – not only by sharing time and expertise together, but also by eliciting engagement through student involvement, and strengthening of institutional collaboration where this is not always a given, considering the division of tasks and lack of time. In addition, it highlights developments that importantly have improved transcribing and archiving oral history data to help make these unique interviews fit for (digital) research in the future.

Oral history workflow tools

To overcome the hurdles associated with archiving spoken narratives and improve the laborious workflow for oral history as well as advance critical use of this source material, the University of Amsterdam has initiated various research projects, including Oral History – Stories at the Museum around Artworks (OH-SMArt) (2021–2025) in collaboration with the Netherlands Institute for Sound and Vision (NISV), DANS and the University of Twente.[2] Some of the deliverables of this project have been used to process the recordings and disclose the discussed interview with Mark Manders.

An important development since the beginning of OH-SMArt is the significant improvement of automatic speech recognition through a fundamental change in technology, now based on artificial intelligence. The open source programme Whisper, from Open AI (Radford *et al.* 2022),[3] has been adopted by the Dutch digital research infrastructure, including for OH-SMArt, and was used to process the recordings of this interview. To correct small mistakes in results of the automatic speech recognition, Whisper Corrector has been used, a free open source and downloadable program that makes processing possible completely independent from commercial web-based applications.[4]

These new developments allow for a relatively easy transcription process, making it attractive to do by researchers themselves, as was done for this interview. Moreover, revisiting the interview through careful listening of the recording provides good insight into the dynamics of the interview process, including one's own role as interviewer. A more nuanced understanding of how the dialogue has unfolded allows for a critical view of how issues are addressed and discussed, and especially why, which provides a better basis for interpretation.

Another new tool is the OH-SMArt Deposit Application (DANS 2024) with a user-friendly interface to archive the recordings, alongside metadata, a summary, related links and keywords connected to the Getty Art & Architecture Thesaurus (AAT) and Union List of Artist Names (ULAN). This application channels the data to an open-source research repository at DANS and is available for all researchers and museum professionals in the Netherlands or concerned with Dutch art and cultural heritage.

Figure 1 Mark Manders, *Room, Constructed to Provide Persistent Absence* (2001–2002), collection Moderna Museet, donated by Gerard and Eva De Geer. Courtesy Mark Manders, Zeno X Gallery, Antwerp & Tanya Bonakdar Gallery New York/ Los Angeles. (Photo: Prallan Allsten/Moderna Museet.)

Setting

The immediate reason for the interview with the Dutch artist Mark Manders (1968) was a three-day Artist Interview Workshop as part of a Research Ethics Seminar for the two-year MA Fine Arts in Artistic Research (MFAAR) at Malmö Art Academy/ Lund University, a postgraduate programme that prepares artists for a doctorate in the visual arts.[5] The Moderna Museet agreed to become involved and proposed interviewing Mark Manders about his work *Room, Constructed to Provide Persistent Absence* (2001–2002), which was on display in Moderna Museet Malmö as part of the exhibition *Conditioned Movement: Works from the Moderna Museet Collection* (26 February 2022–29 January 2023).[6] There were no installation guidelines when this object-based installation was donated to Moderna Museet by collectors Gerard and Eva De Geer in 2013. As there had not been any contact with the artist at that time, it was a longstanding wish of the conservators to conduct an artist interview because of the vulnerable items in the installation and the configuration of the elements in the exhibition space.

Figure 2 Mark Manders, detail of *Room, Constructed to Provide Persistent Absence* (2001–2002) showing his clothes, shoes, toothbrush, toothpaste and contact lenses. (Photo: Mathias Johansson.)

Figure 3 Interview setup with My Bundgaard filming Mark Manders' *Room, Constructed to Provide Persistent Absence* during the exhibition *Conditioned Movement*, Moderna Museet Malmö, 12 January 2023. (Photo: Sanneke Stigter.)

Room, Constructed to Provide Persistent Absence is an object-based installation that consists of three separate furniture elements – a bed, a daybed and a chair – made out of square steel tubes and sheet steel, the beds covered with a muddy grey substance as bedding made out of polyester. An abstract figure without arms is lying on the daybed and has the same muddy grey appearance as the bedding, giving the setting a rather alienating atmosphere (Fig. 1). This feeling is enhanced by some strange elements: a ballpoint pen suspended from an iron rod above the figure on the daybed, pointing downward to a hole where the figure's mouth would be, creating unresolved tension; five unused tea bags standing upright in a carefully arranged composition on the floor; and a bundle of neatly arranged clothes to be worn by a single person wedged between the bed end and the chair, secured by the pressure of a pair of shoes. On top of the clothes are placed a packed toothbrush, a tube of toothpaste and a pair of contact lenses (Fig. 2).

Over the years, a number of questions have arisen. There are concerns about the exposure of small elements with the risk of displacement, and the installation history of the work suggests some liberty in the way the objects are placed. However, what is allowed or desired and what not? The word 'room' in the title suggests that a confined space is required: is that indeed the case? What is an ideal architectural setting? Also, the row of teabags, absent in the first iterations of the installation, has been presented by itself with a distinct title, suggesting it is an independent work – not an unimportant one given its prominent place in *Mark Manders: Reference Book* (Manders 2012: 8). Can it still function independently?

The interview (12 January 2023) was planned to take place in the vicinity of the installation on display. It was set up as a videocall using Zoom to connect Sweden with Belgium. The interview was recorded on a MacBook Pro using earbuds with microphones for optimal speech recording and to prevent acoustic feedback using multiple audio devices (Fig. 3). The questions prepared by the four MFAAR students[7] for a semi-structured interview were placed in a logical order based on the SBMK Interview Scenario (SBMK 1999). This structures the interview from general to specific questions to establish a firm base about the creative process and the sociocultural context, to serve as a backbone for the details that follow. This should create a rich source that has broader

relevance and applicability than if solely discussing a single case study. Furthermore, establishing general values at the beginning of the interview creates a reference for validation of what is being discussed later in the interview.

Interview Part I: Self-portrait as a building

When Mark Manders is asked to describe the work *Room, Constructed to Provide Persistent Absence* on display, he replies by explaining how he developed his art practice to provide context to the work. He stipulates the importance of understanding the work as part of a larger whole.

> In my work, I started as a writer. And when I was 18 years old, I kind of stopped writing and I started writing with objects. My plan was to write about an imaginary building as a kind of self-portrait. I decided to write about the building for the rest of my life; a fictional building with objects. So, I started making floor plans and later rooms (Stigter and Bundgaard 2024a).[8]

Room, Constructed to Provide Persistent Absence is one of these rooms. During the interview, Manders provides numerous details about the artmaking process and the materials he used. He kept notes that he had consulted for the interview. Most spectacular is his story about how he had left his clothes by way of concluding the artmaking process of this work. This information was also published when the work was first shown (Manders 2002: 29). This suggests that it is an important contribution to the idea of the work.

> After I was finished with this room, I took off all my clothes and my lenses, and I put them in between the chairs [furniture]. So, it feels like somebody who lived in this room just disappeared. It's really about not being there. It's about absence.

By making the act of undressing and leaving the room a part of the artmaking process, it becomes clear that it is not just 'somebody' who disappeared, but the artist. Manders left the clothes that he was wearing almost by way of signing the piece. After further questioning, Manders confides, 'To be honest, I think I washed them.' This suggests that inclusion of the bundle of clothes was well prepared or at least consciously presented as a performative aspect as part of the work, deliberately communicated by the artist. By doing so, he indeed provides the 'persistent absence' from the title, as part of the room that he had just created.

Prior to the interview, the conservators at Moderna Museet understood the undressing before leaving the room to conclude the artmaking process as a performative aspect that is integral to the work. From this impression follows that his personal items hold significance as tangible remnants that capture the essence and memory of this specific event, so that it would be problematic to replace these exact same items for exhibition copies out of precaution or if required in the future. However, with the following information from the interview, a more conceptual understanding of the installation can be weighed against the narrated performative aspect when attributing value to the personal items in the work.

The importance of 1986

Manders continues to explain that time, or rather timelessness, is important in his work. His rooms should look timeless, or at least of no later than 1986, regardless of when the installations are actually made. They are all part of the self-portrait that he conceived as an ongoing project stretching over time:

> I want to put all my work in one moment. All the rooms that I make are just left behind. And I started in 1986, so they should be made in 1986. They're related to that same time area. So, I cannot use a tea label from 2000 or 2008. So, I kind of remade a tea label.

Manders refers to the inclusion of the teabags in *Room, Constructed to Provide Persistent Absence*. He remade the design of the tea label matching older ones to replace the labels of modern-day teabags: 'I printed the labels because the labels that you could buy around the 2000s … I was not allowed to use them.' This strictness in directing his artmaking returns several times during the interview, as does the work's precise visual appearance, in this case suggesting a different time period, in other cases a different material as will become clear in Part II of the interview.

The row of five teabags already existed as a separate artwork with a rather abstract title consisting of five en dashes in a mathematical notation, *— (— / — / — / — / —)* (1998). Manders added this work to *Room, Constructed to Provide Persistent Absence* when it was exhibited at Jarla Partilager in Stockholm, the exhibition space managed by collectors De Geer (13 September 2010–18 February 2011). He explains that he has continued using teabags in other works:

> I made more groups of teabags. … They form kind of sentences. These pieces are called *Finished Sentence*. Just to let you know that these five teabags later evolved into other pieces.

Only with this installation, now in the Moderna Museet collection, can the row of five teabags still function as a separate work with its own title. As it turns out, Moderna Museet has not one work by Mark Manders in their collection, but two: a welcome result of the interview for a curatorial follow-up.

Time capsule

Manders' wish to generate a sort of timelessness for his work linked to the moment when he conceived his self-portrait, forms the basis for his thoughts about aging and damage. The use of exhibition copies would be an important precautionary measure to prevent complete loss of the small and vulnerable items, given the value that can be attributed to the original objects because of their story. The loose items on top of the clothes are especially susceptible to decay and loss, in particular the contact lenses lying unprotected during an exhibition period. The installation came with only this single pair of hard contact lenses, still intact and kept in the contact lens holder in which they had been stored. Based on Manders' information, he had been wearing these contact lenses during the art-making process, until he took them out and made them part of the artwork.

In order to make well-informed decisions about possible replacement of parts, it is crucial to know the significance of these items to the artwork as a whole, so that it will not harm the work's meaning. Using exhibition copies would perhaps save some of the authentic features for the purpose of research and later reference. When addressing the possibility of replacing vulnerable items during exhibition, Manders agrees and makes clear that he is in favour of keeping the objects reminiscent of the time when they were made.

> If something is wrong, and you know that something is wrong, and you know how it should be and if it's possible to replace it, I have no problems to … Yeah, I think it's fantastic if you can replace it then.

He knows that conservators are not keen to replace original parts in artworks, as one of his assistants is a trained art conservator. That may be why he formulates the idea of replacement cautiously at first, and then almost with enthusiasm, calling it 'fantastic'.

Manders is clearly in favour of replacing or remaking elements if their condition no longer conveys the desired timeless appearance. This principle applies equally to Manders' shoes, considering the condition of the rubber soles. They are under constant tension when pressed together between the pieces of furniture to hold the bundle of clothes in position. The rubber has already started to decay judging from the loss of flexibility. Ultimately, they will become unable to fulfil their task of holding up the clothes. When asked for his view on the matter, Manders made clear that he has no problem with either replacing or remaking them providing they look similar.

> I understand that's a really difficult topic for you all [conservators]. Because some artists really think that the decay is part of the work, or it shouldn't be remade because when it's lost, it's lost. I really prefer that it gets replaced.

If replacing original parts is allowed, the question arises of how to value the specificity of the unique personal items to the artwork. A better understanding of the fact that the various items in the work should be representing the artist in 1986, rather than that they carry importance because they were his and worn by him, opens up the possibility of using exhibition copies when the work is on display. Manders indicates that this is possible for the clothes as well. The fact that he admits that he had actually washed the clothes before making them part of the work makes clear that this feature is more about suggesting the idea of having left the room than that this performative act is part of the work.

Carpet flooring

Manders' overall idea of his work as his self-portrait as a building is best expressed in his solo exhibitions that include carpet flooring to connect the rooms, like chapters in a book, considering the artist started out as a writer. However, in a collection presentation, such a connecting element is lacking. In Malmö, this was partly solved by positioning the work at the far end of the last gallery space. The fact that *Conditioned Movement* was a group exhibition formed a good starting point to discuss the work's installation parameters.

In answer to the question of whether his work can be shown in the vicinity of different work by other artists, Manders does not directly reject it. Instead, he tactfully explains how the work was first conceived, and how he installed it previously.

> When I made it, I really made it as one room. I showed it one time in a museum in Toronto, and the room was too big. And then, I made a kind of line, so that you couldn't enter from the other part. And there was a carpet. The room felt almost scary – but also very precise.

When enquiring about his first impression of how it is installed in Malmö, Manders indicates that it lacks the sense of a room, and misses some kind of subdued sense of suspense.

> Here, how it's shown, it is more like three objects of which you can see that they belong to each other. But for me, it's not really a room. I would do it totally different. … I would really create more tension in it. That's something that I also really enjoy when I make exhibitions; to create these very silent rooms; that if you step into it, that it feels like that you're in a place that you don't belong. There's a strange kind of tension.

At the same time, Manders is respectful of the choices made, well aware of the forces that come into play after a work has left the studio.

> I make these works and I have certain ideas how I want to present them. But at the same time, they're also part of the world now. And I can say things about them, but they're also part of the world. And the world, in this case a museum, can also show them in the way that they think is best at this moment.

When preparing exhibitions himself, he prefers to install his 'rooms' with a specifically chosen wall-to-wall carpet in a muted colour of which he keeps reference samples in his archive. He makes an effort to match the colour as closely as possible, but the final result depends on what is locally available.

Curator interview

As carpeted gallery rooms contribute to the overall atmosphere of Mark Manders' work, it was felt necessary to engage the museum curator of the exhibition, Andreas Nilsson, in the discussion. He emphasises the intended uncanny feeling in the exhibition text, 'There is a melancholy and slightly creepy aura about Mark Manders' installation *Room, Constructed to Provide Persistent Absence*' (Nilsson 2022: 24). In a curator interview organised to complement the artist interview on 17 October 2023, Nilsson explains that he had included Manders' work in *Conditioned Movement* because of the suggested stillness: 'We were looking for this piece that somehow addressed movement in a very subtle way. I think he says it himself in your interview; it is as if time is frozen in his work' (Bundgaard 2023).

This arrested development is indeed important and also becomes clear in the artist interview, when Manders replies to the question as to what he thinks of the single-channel video work that is exhibited in the same room as his object-based installation: 'Normally, in my work, there's no movement. Like, everything is frozen. So, for me it's a bit strange that there is movement in the room.' Such details about the way *Room, Constructed to Provide Persistent Absence* is presented are of critical importance when discussing the desired appearance in relation to conservation. This is why both conservation issues and installation matters are addressed during the artist interview; they are closely interwoven. After all, a correct presentation of the installation is part of the work's conservation.

When the curator hears the results of the artist interview, he specifies in reaction, 'I really like the idea of a carpet.' Moreover, sensing the overlap of conservation and presentation, Nilsson suggests collaborating in defining the guidelines for the work. 'I think that maybe we can help each other in making an installation manual.' This demonstrates how the practice of interviewing various stakeholders involved in an artwork not only sheds light on conservation concerns and curatorial practices, but can also strengthen

collaboration in a mutual understanding of the required care for artworks in the collection.

On an even larger scale, to maintain Manders' concept of his self-portrait as a building, it is important to realise that this interview has cross-institutional significance. Manders' work is collected all over the world and represented by galleries on three different continents: Europe, the United States and Asia. Ideally, worldwide collaboration is required between collectors and institutions to guarantee an overall approach in the preservation and presentation of his work so that it can remain a potential whole as a self-portrait.[9] Therefore, it is important for museums to engage with the national digital research infrastructure to ensure interoperability of their research material. Interoperability is the most critical aspect from the FAIR principles (Jacobsen et al. 2020). This can only be achieved by careful collaboration to secure the possibility of connecting archival data, both on a national and international level, in support of knowledge exchange between museums to manage an artist's oeuvre with shared responsibility.

Critical interpretation

How could the results of this case study interview be used? It seems that the importance of the year 1986 can be used as a possible touchstone for decision-making in conservation, frozen in time, over valuing Manders' personal items because he has worn them. Whereas this is a suggestion based on interpretation of the information gathered at this point, it deviates from what is generally believed to be a prerequisite in museums to permanently include the original materials that the artist has touched, used or worn and then selected to include in a work of art.

Such a line of reasoning based on the interview could be made explicit and archived as professional user interpretation to enrich the interview data to better understand the possible consequences for the work of art when using the source. The aim of OH-SMArt is to add such user input to the source to help advance critical use of interview materials in order to elicit a reflexive stance with the next professional involved. This would not only enrich the interview but also contextualise it with several viewpoints that, moreover, serve to enhance critical reflection with the researcher, which is vital when interpreting the interview content for the purpose of conservation of an artwork.

The idea of adding user feedback is based on the DIAL for Complex Artworks (Stigter 2017, 2019; Tartaglia 2024). A comparable tool to raise awareness with the researcher is being developed as part of a digital research environment where the interview material can be consulted alongside other audiovisual material.[10] This should make the act of interpretation explicit, one's own role as part of it. New research testimonies will be archived as related documents that can be consulted with the source. Such a reflexivity tool serves two ends: it enriches the source with a layered information system and elicits a reflexive approach with the researcher, both by a question prompted, e.g., what is the purpose of the query, and by being confronted with viewpoints of other users, making one aware of one's bias when interpreting the material. A dynamic archiving system that gives voice to researchers accessing the material activates critical thinking and allows for a more diverse understanding of the source material, ultimately resulting in better qualitative research.

Interview Part II: Studio practice

Mark Manders is keen to convey his way of working in relation to maintaining his work, judging from his extraordinary hospitality to offer a filmed tour around his studio, situated in Ronse, Belgium, stipulating how this adds to the understanding of his art. Indeed, this second part of the interview underlines the precise character of Manders' work, his careful choice of materials and exact way of presentation. His willingness to get this across is telling: 'I care that it survives.'

This virtual studio tour is also recorded and reveals that Manders' visual language is based on a set of rules about the use of words, numbers and colours. His artmaking practice seems to be situated between structure and layout, shaping up in floor plans and furniture design, and his fascination for single elements functioning in groups. Language is such a system, using groups of words. His self-imposed rule that every word cannot be used more than once per artwork forms the basis for a stock of newspapers that Manders has printed using all the words that exist in the world, but only used once. The sentences appear normal but cannot be read or related to time and place. They form the perfect material for making papermâché, as it is timeless and universal, something he anticipated.

Figure 4 Part of Mark Manders' studio with *Composition with Four Yellow Verticals* (2017–2019). Painted bronze, wood, iron (edition of 3 + 1 AP), 266 × 391 × 419 cm. Courtesy Mark Manders, Zeno X Gallery, Antwerp & Tanya Bonakdar Gallery New York/ Los Angeles. (Photo: Piet-Albert Goethals.)

> I couldn't use [normal] newspapers because they are related to time. And to a place also. So, I started making my own newspapers, and I used every word in English only once. And so these newspapers are made. These are all the words that we have, all the English words. So, if I make an exhibition, I take for example the words, 'table'; 'chair'; 'yellow'; 'newspaper'. So like a writer, I choose words from these newspapers (Stigter and Bundgaard 2024b).

Manders continues to explain nearly every artwork in his studio with particular detail to his use of materials. He zooms in on *Composition with Four Yellow Verticals*, a more than lifesize sculpture of four giant busts with human faces, eyes closed. They have a monochrome light grey tone, with one contrasting yellow vertical bar pushed into each of the faces just below the left eyebrow, as if a book is placed into the head instead of on a shelf. While these yellow segments are as smooth as the spine of a book, the rest of the sculpture's surface texture shows an overall pattern of drying cracks suggesting dried clay (Fig. 4).

However, Manders reveals the true nature of the material of *Composition with Four Yellow Verticals* by knocking on the sculpture to produce a clear and hollow sound. 'This is … painted bronze … painted with acrylic. First it has a protection layer, and then it's painted with acrylic. But it feels exactly like dry clay.' This imaginative play with materiality is telling for Manders' sensitivity to the visual appearance of his work. The impression of clay, including the lumps at the back of the neck near the edges of the bust, suggest the act of sculpting, or rather, an arrested act of sculpting, leaving the material to dry and form cracks as a result. Still standing on what seem to be adjustable pallets, the sculpture suggests a situation where the artist has left the work, recalling the atmosphere of *Room, Constructed to Provide Persistent Absence*.

Another work that Manders describes is one based on his fascination for 'things that want to be together, in a group', pointing to *Still-life with Broken Moment* (1998–2004). He explains that he is fascinated by seeing 'a group of sugar' expressed in a sugar cube or in a heap of sugar. It is a revealing example of how Manders speaks about his work. One part of the 'group of sugar' is sitting on the vinyl record, the other part directly next to it; it is broken. Whereas neither group can produce a sound, Manders considers the group that has landed on the vinyl more poetic than the group spilled next to it, detailing how the particles are similar in size and appearance as the diamond head of the needle in the arm of a record player. Although the arm is absent, it is the suggestion of sound that supports this thought. Installing this piece includes an act of pouring sugar over the edge of the record every time it is being put on display; a gesture of 'writing' that activates the poetry of the work.

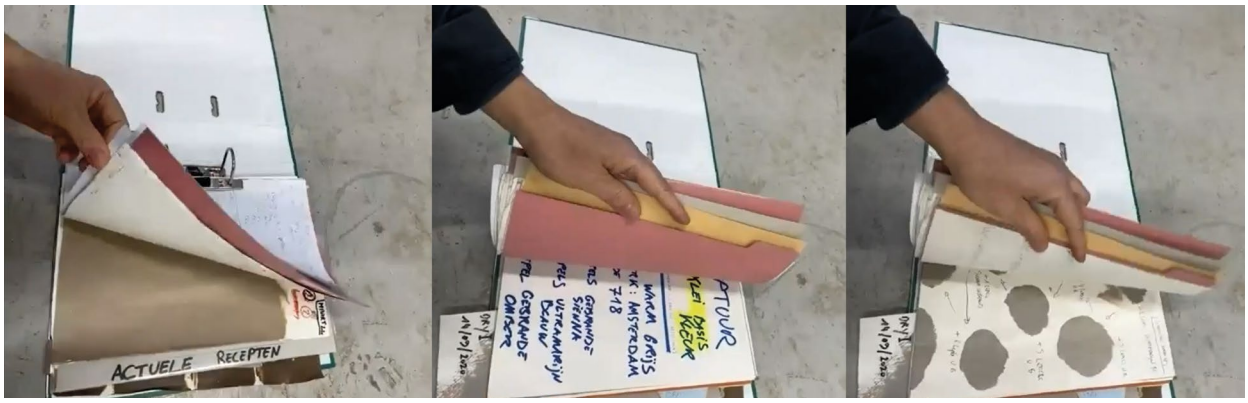

Figure 5 Mark Manders shows one of his studio recipe books, here with recipes for the clay colour for his painted sculptures. (Interview stills: My Bundgaard.)

Reversal of power

To conservators this studio tour was an unbelievable treat, seeing and hearing all the 'ins and outs' of Manders' work right in the heart of where it is made. However, sensing that the students' attention seemed to have waned at this point, and that we had already taken up so much of Manders' time, there was an attempt to bring the interview to a conclusion: 'Well, I think we have a really fantastic impression of how you work. Thank you so much for sharing.' Manders, however, responds hastily: 'Yeah, but now I come to the department … Wait. I will show you a little bit more and then you will also understand the technique.' He hurries through the factory-like hall, pointing to several works in passing. Finally, he arrives at a large painting studio. 'So this is the place where I paint my things', filming a wall-covered cabinet filled with pots of paint, brushes and varnish. He demonstrates his painting technique for the clay-like textures of his sculptures, achieved with several sprayed layers of acrylic emulsion paint, of which the last two are dry brushed when still wet to finalise the matte texture that is mimicking dry clay. To substantiate the care that goes into this artmaking process, he shows us a large notebook with studio recipes and paint samples that he is willing to share (Fig. 5).

This demonstrates how Manders – the interviewee – starts guiding the interview and is directing the filming with his mobile phone. Although the interviewers have clearly designed the interview from a conservation point of view, the interviewee is now in charge of pointing out projects that he deems of interest in this respect. It fills in what we may never have thought of asking. This shows the benefit of an online interview and using mobile devices. Being able to walk around resembles the method of a 'walking interview', a form that is often used in social anthropology and urban studies, exactly because of what the sense of place has to offer; to provide 'richer insights into embodied and sensory experiences' and 'reversal of power between interviewer and interviewee' (Bilsand and Siebert 2023: 1). Being at ease in his own space and habitat allows the interviewee to think more freely. Control over the recording tools is another asset that can redress the power relations between interviewer and interviewee, i.e. the museum and the artist. The result of this 'virtual walking interview' is a co-constructed, audiovisual source with genuine enthusiasm from both sides, demonstrating that Manders clearly cares about the conservation of his work and to get this across with conservators and students representing the next generation of professionals.

Skiapodes

To conclude the interview, Mark Manders shows his latest work, a set of creations based on one word, namely 'Skiapode'. It refers to a mythical figure with one giant foot, typically holding it upright to protect its face from the sun when laying down. Manders has created an entire artistic canon around this little known mythical figure, including depictions of Skiapodes by other artists, which he is distributing using several media: installed as a slideshow, and on what appears to be a Wikipedia page, headed *WipipekiA* in the exact same font,[11] as well as in two books, one notably in Italian, *La Scomparsa degli Sciapodi*, meaning *The Disappearance of the Skiapodes* (Manders 2022).[12] Similar to knocking on his clay-like sculptures to reveal that they are bronze, Manders demonstrates the book's hidden trick. He taps the cover with one hand and shows

how the images on the pages have turned into black and white; tapping the cover again, but now crosswise with two hands, the images have disappeared altogether. Pointing at the back of the book, 'But with this QR-code, you can get it back.'

The technique used for this book will possibly become common knowledge in a few years' time but at this moment the work succeeds marvellously in bewildering the audience. This becomes all the more apparent during an artist talk led by curator and Orange County Museum of Art director Heidi Zuckerman in celebration of the exhibition *Writing Skiapod* at Tanya Bonakdar Gallery (11 February–8 April 2023). Although Manders clearly indicates that part of his project is fake, the paintings represented in the slideshow, supposedly by, among others, Philip Guston, Maria Lassnig and Kazimir Malevich – with instantly recognisable painting styles – prompted Zuckerman to say, 'I've seen a bunch of these paintings before, but I never knew what they were representations of, was a Skiapod' (Zuckerman and Manders 2023). Manders' overall concept, visual language and choice of media is apparently so sophisticated that it takes time to sink in.

While Manders' installation, *Room, Constructed to Provide Persistent Absence*, has been living its life for over 20 years by the time of this interview, Manders' myth of the Skiapod is only just entering the world. What he says about it now may be crucial for future care, indicating the importance of interviews contemporary to the time when artworks are created, exhibited and acquired, making them highly resourceful for later moments in time.

Conclusion

The interview with artist Mark Manders about the art installation *Room, Constructed to Provide Persistent Absence* has made clear that his working process adheres to a set of conceptual rules based on the idea of writing with objects, and that all of his works are part of a self-portrait as a building, conceived of in 1986. On a practical level, rather than adhering the highest value to the objects in the installation that have been the artist's personal items, it is the representation of the year 1986 – frozen in time – that could guide decisions for conservation treatment and presentation of the work. Importantly, the work's presentation in a carpeted gallery contributes to convey the intended alienating atmosphere and thus helps to preserve the idea of the work, bridging conservation and curatorial practices. The result of the artist interview nourished renewed collaboration between museum departments through a follow-up interview with curator Andreas Nilsson, indicating that interviewing is not only a good research tool but also a means to connect museum departments and collaborate in the care of artworks.

On a methodological level, the technical methodology turned out to allow for a redressing of the power relations between interviewer and interviewee during the interview, which became apparent when Mark Manders started filming around his studio with his mobile phone to better explain his work. This way the interviewee could steer the narrative. The simple technical setup of video calling and using mobile devices provided a perfect platform to share authority over the interview content and allow for a 'virtual walking interview'. Both the interviewee and interviewer could remain situated in their own habitats, at the location of their choice, while co-creating the narrative. With a mobile phone, the artist could direct the filming, choose the subject and emphasise the themes and details that he considered most important with respect to the care of his work, turning the interview into a valuable co-constructed art technological source.

Finally, the project has illustrated how collaboration between museums and universities can support good practice in conducting interviews – not only by sharing time and expertise together, resulting in a strengthening of institutional collaboration, but also by eliciting engagement through student involvement. The educational setting might have contributed to the artist's willingness to share his ideas so thoughtfully with a younger generation, using the interview to bridge the gap between Manders' art today and the future, serving art history through the lens of conservation. This unique source is made accessible and interoperable for worldwide reuse to guarantee that the information can serve Mark Manders' lifelong 'Building as a Self-Portrait', distributed in collections all around the world, could still remain a potential whole.

Acknowledgements

We would like to sincerely thank our interviewees, artist Mark Manders and Moderna Museet curator Andreas Nilsson; the co-interviewers Line Kallmayer, Ida Brottmann

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Notes

1. See also 'VoCA: Voices in Contemporary Art': https://voca.network (accessed 28 May 2024).
2. OH-SMArt has been granted funding from the national Platform for Digital Infrastructure - Social Sciences and Humanities (DPI-SSH).
3. For OSX, MacWhisper is available free from https://goodsnooze.gumroad.com/l/macwhisper, or via payment from the App Store; for Windows either through Subtitle Edit, https://github.com/SubtitleEdit/subtitleedit/releases, or Python, both options explained in the UvA's *Interviews in Conservation Initiative* (I.C.I. Guidelines under Resources, www.uva.nl/ici (all accessed 28 May 2024).
4. Whisper Corrector generates a text file (txt), subtitles (srt) and an especially prepared 'word-txt' file (txt) that includes layout settings to produce a readable transcript; if copy-pasted in Word the left margin can be dragged 3.5 cm to the right for speaker separation. The tool is free and supported by CLARIN, the European research infrastructure for language as social and cultural data, http://speechandtech.eu (accessed 28 May 2024).
5. The workshop was organised by Sanneke Stigter and took place between 11 and 13 January 2023.
6. The exhibition was curated by Andreas Nilsson in cooperation with the artist duo Gideonsson/Londré.
7. In consultation with the authors of this paper.
8. Mark Manders is quoted from both interviews conducted on 12 January 2023 in chronological order; the case study first, the studio tour second, referred to as 'a' and 'b' in the references (Stigter and Bundgaard 2024a,b).
9. The idea of a potential whole refers to the concept of 'potential oneness' in Brandi 2005: 50.
10. A prototype of OH-SMArt's Reflexivity Tool will be integrated in the CLARIAH Media Suite, a research environment for audiovisual data of the Dutch digital research infrastructure for the humanities and social sciences (CLARIAH): https://mediasuite.clariah.nl/ (accessed 28 May 2024).
11. See https://www.markmanders.com/wikipedia-skiapode (accessed 28 May 2024).
12. Manders has appropriated and expanded the Skiapode myth in collaboration with artist Simon Bultynck, one of his co-workers.

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Part 3: Material changes

A new look at the 13th-century painted vault from Ål stave church: its nature, conservation history and future care[1]

Kaja Kollandsrud and Linn Solheim

ABSTRACT The painted high medieval barrel vault ceiling from the choir of the lost stave church from Ål in Hallingdal, Norway, has been on display in the Historical Museum in Oslo since 1904. In the mid-1960s the distemper painting was consolidated with soluble nylon, a new synthetic polymer with promising properties. Time has shown otherwise, with crosslinking causing it to become distinctly non-soluble. This paper describes the history behind the decision to use this consolidant, a discussion that involved both Norwegian and renowned international conservation experts in the field at the time. It also presents a new project aimed at re-examining the ceiling painting in an integrated and fully multidisciplinary way. A research group was founded in 2023 with the goal to re-examine the ceiling painting. The work will involve new analysis of the vault's construction, materials and painting technique. This is expected to lead to new interpretations of how the painter's use of materials and colours in the ceiling contribute to communicate the Christian stories seen through the optics of its own time. Importantly, the effect of the soluble nylon treatment and its degree of re-treatability will be investigated, enabling new decisions on how to best care for the painting for the future.

KEYWORDS high medieval, barrel vault, distemper, soluble nylon, conservation history

Introduction

For more than a century, the monumental painted 13th-century barrel vault ceiling from the choir in Ål stave church has been on display in the Historical Museum in Oslo, Norway (Figs 1 and 2).[2] The vault (h. 2.70 × w. 5.80 × l. 6.40 m) once towered over the choir in the stave church located in the mountain municipality in the valley of Hallingdal, Norway. Archaeological excavations undertaken on the church site in 1959 set the date for the oldest part of the church to the late 12th century, with an extension of the choir in the second half of the 13th century.[3] This places the painting among the oldest medieval distemper painted church interiors preserved in Norway. Other examples from the same period include the canopy from Torpo (Brænne 1982), once part of a lectern still preserved *in situ* in the church that neighbours Ål; the smaller canopy from Årdal that supposedly crowned the main altar, now in the collections of Bergen University Museum;[4] and the large vault in the choir of a church in Vestre Slidre, with paintings that mimic a stone vault combined with decorative borders.

The ceiling is divided into 23 painted scenes with motifs from both the Old and the New Testament that centre mainly around the Creation and the Life of Christ. The painting was originally part of a fully decorated room. Boards from a wall decoration, painted in the same manner, were discovered under the floorboards of the new church in Ål in 1957 (Løken 1965: 7); a Doomsday motif has been identified on 14 of these (Fuglesang 1996: 92–3).

The stave church was torn down in the summer of 1880, despite repeated protests from both the congregation and the minister (Fuglesang 1996: 9). The painted choir vault and the intricately carved western portal were donated to the Collection of Norwegian Antiquities (Oldsaksamlingen) and transported to Oslo.[5] As the building of the Historical Museum at that time was only in its planning phase, these objects were stored together with the newly excavated Viking ship from Tune in a wooden building in the university garden (Fig. 3).[6] The museum's annual protocol states that the museum acquired a

> large and strange medieval ceiling painting from Aal church in Hallingdal that successfully last summer was mounted somewhat satisfactory gathered and exhibited under the roof in the house made to store the Tune boat, so that it is now both secured against harm and can be viewed in its full extent (University of Oslo 1882).[7]

Figure 1 The Ål barrel vault ceiling, northern side. (Photo: Eirik Irgens Johnsen © CC BY-SA 4.0 Museum of Cultural History, UiO.)

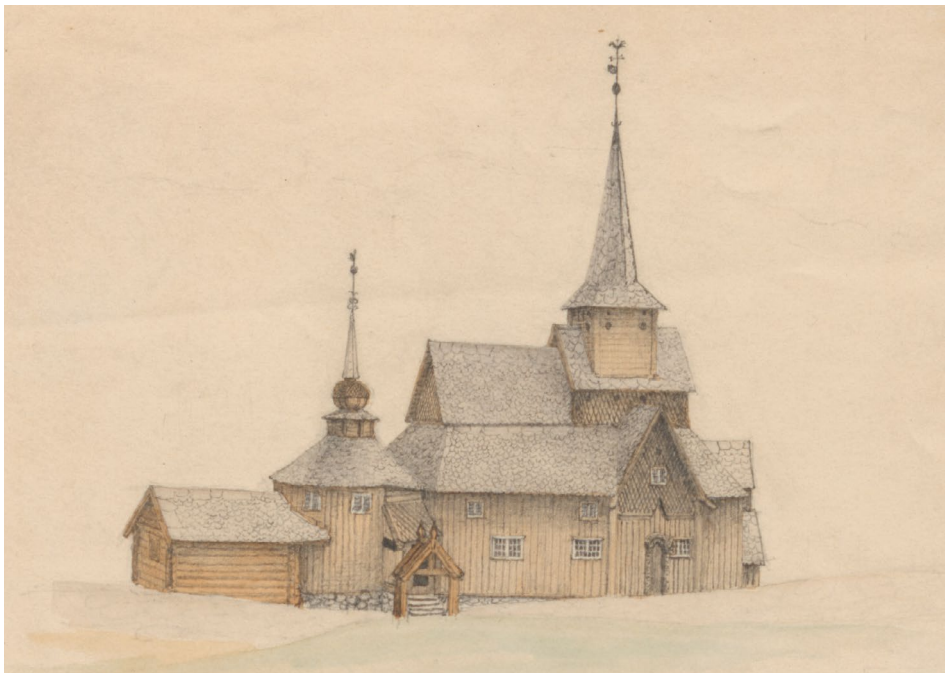

Figure 2 Ål stave church seen from the north. (Drawing by Georg Andreas Bull 1885, Fortidsminneforeningen no. 445; www.kulturminnebilder.ra.no, public domain.)

The Historical Museum in Oslo, designed by architect Henrik Bull (1864–1956), first opened its doors to the public in 1904 (Mikkelsen 2004: 52). The barrel vault has since been on permanent display.[8,9] A recent report into the stability of the museum's structure has concluded that ground subsidence is causing stress and damage to the building.[10] Experts have recommended that the building must undergo extensive renovation in the following 5–10 years to prevent irreparable damage. Such work would most likely require the building to be emptied of its exhibitions and the Ål vault dismantled for the first time in over 100 years. This has prompted the need for both new documentation and investigations of its mounting and current condition.[11]

Figure 3 The Tune boat shed: Professor Theodor Kjerulf with students in front of the boat shed containing both the Tune Viking ship and the Ål barrel vault painting. (Photo: Ole Tobias Olsen. License. Oslo museum OB.OT377. www.digitaltmuseum.no, public domain.)

The barrel vault's construction and technique

The vault consists of 28 pine boards held together with a partly new construction of tailormade curved cross-bars at the back and closed off with end walls made from 10 boards (Løken 1965). Vertical rows of nail holes suggest that originally it was secured to a wooden framework. Larger openings in the corners indicate where large support columns passed through the vaulted structure. The boards are roughly hewn diagonally at the back and planed following the length of the boards on the visible painted side.

A common feature of the monumental painted medieval church interiors is that they are typically made *in situ* in a distemper medium.[12] Analyses carried out on the binding medium of distemper interiors have so far mostly been performed on 17th-century interiors in Norway, but according to Jærnes and Ørnhøi (2021: 163), unspecific animal collagen has been detected in a medieval distemper structure with ovalbumin, indicating egg as an additive. A binder based on animal glue has been suggested for the Ål painting.[13] The earlier conservation interventions on this painting make new analysis challenging. However, paint samples from the vault collected before the conservation treatment in 1964 have been preserved.

The nature of the painting

Although highly praised by some, the characterisation of the Ål painting has not always been a positive (Fig. 4). Art historian Harry Fett in *Norges Malerkunst i Middelalderen* from 1917 described the painting as 'the most typical peasant painting in all of our medieval art', and the painter as a 'fresh and freely talent, who tumbles with the style in his own naïve way, revealing a lack of education' (Fett 1917: 56, 60).[14] In a later booklet from 1996, art historian Signe Horn Fuglesang described the painting as simplistic, rough and provincial in style (Fuglesang 1996: 12).[15] Furthermore, stating that its thin ground, the materials used and what she assumes is easily obtainable cheap pigments suggest the same when compared to the altar frontals from the same period. That the style is provincial is repeated by historian and prose writer Tore Skeie as late as the 2019 catalogue text that presents the ceiling to the museum visitor today (Skeie 2019: 55).

As part of the new examination, the painting will be approached from the point of view of its own time. The painter's use of materials, range of pigments available on the palette, and the way they were employed will be further investigated. There are signs of a painter well versed in the contemporary visual vocabulary in the way the painting visualises

Figure 4 Eucharist scene from the western end wall of the Ål barrel vault. (Photo: Eirik Irgens Johnsen © CC BY-SA 4.0 Museum of Cultural History, UiO.)

the presence of the Divine in the stories presented to the medieval congregation (Kollandsrud 2017). We believe that insights gained through new analyses, combined with a view through the cultural optics of the Middle Ages, will contribute new understanding of what conditions the appearance of this painting.

The choice of binder and the way the painting was executed was based on both practical and technical reasoning. The main design of the painting was incised into the wooden surface of the pine boards and a thin overall chalk ground bound in animal glue was applied as preparation for the painting (Løken 1965). Because the painting is intended to be viewed at a distance, there was no need for the time-consuming smoothing of a thick ground that can be seen in the panels and polychrome sculptures meant for close observation: on the contrary, such a thick hygroscopic layer would introduce a weak point and future problems for the stability of the work. There is typically no gilding applied to these large decorations. Although a water gilding could have been applied on the chalk ground, the roughness of its surface finish would not have allowed for it to be burnished to a high gloss. The aqueous binder allows for matte, brilliant and saturated colours that cover fully in a single quick-drying layer. This lets the painter work fast as opposed to the time-consuming, layered oil-based painting on the movable panels and polychrome sculpture. These are believed to be produced more efficiently within the controlled workshop environment connected with the major bishoprics in Norway (Plahter 2004: 200–201).

The binding medium affects the way the pigments behave in the binder. The tailoring of the paint guides the way it would have flowed from the brush, indirectly contributing to the painterly result. There would not have been enough time to work the colours wet-in-wet, which is one of the main properties typical of the slow-drying oil paints. In addition, because the paint dries quickly, it could not be easily corrected. The technique therefore lends itself to a graphic line. Unlike an oil medium, a painting bound in a water-based medium does not allow for the play of translucent glazes.

Scientific analyses carried out on the movable medieval painted church art preserved in Norway concluded that the origin of the materials and techniques used in these works are not typically 'Norwegian', but part of Northern European traditions (Plahter 2004: 200–201; Kollandsrud and Plahter 2019). Compared to later periods, a limited range of materials and techniques are used in the paintings from medieval Europe. Conservation scientist Unn Plahter identified approximately 16 pigments, including fillers and extenders, on the medieval painter's palette in Norway (Plahter 2004: 138–59). In the Ål painting, she describes the use of azurite, copper green, a yellow glaze, red lead, vermilion, red iron oxide (probably hematite), lead white, chalk and charcoal black.[16] From these nine

pigments, which include chalk acting as a colour where the white chalk ground is left uncovered, the painter produced a wide range of hues and pigment combinations. In her investigations of the altar frontals dating from the period between 1250 and 1350 in Norway, Plahter concluded that a painter's use of a restricted palette did not necessarily mean a lesser painterly quality (Plahter 2004: 200). Her study revealed no clear connections between the technical complexity of a painting and its artistic qualities: she stressed that how the painter handles the palette is what makes the difference.

The following investigations of the Ål ceiling may reveal to what extent the painting of the various scenes follows an orderly and traditional pattern. Initial investigations indicated that the painter(s) deliberately used colour to visualise the light of the Divine in line with the colour vocabulary used to express meaning such as identified in research by Kollandsrud (2017).[17] We can already conclude that the character of the water-based binder had a significant impact on the painterly qualities. The thin ground and the limited range of pigments on the Ål painter's palette is not necessarily a criterion of an unprofessional painter, but rather a deliberate choice for such a monumental painting performed *in situ*. We must be careful to compare the qualities of a distemper work to paintings executed with the characteristics of an oil painting.

Climate history, conservation history and current condition

The way the ceiling appears today is also affected by its preservation history. The climate history has had a profound impact. Climate history, or historical climate, are concepts that are now replacing the idea of strict, climatic guidelines for museum collections. In the European Standard EN15757 (2010: 6), historical climate is defined as: 'Climatic conditions in a microenvironment where a cultural heritage object has always been kept or has been kept for a long period of time (at least one year) and to which it has been acclimatized.'

In 'Climate in Nordic historical research', Huhtamaa and Ljungqvist (2021: 683) explain the different approaches to the concept of climate history in the humanities and the natural sciences. While the physical sciences understand 'climate history' as past climatic events, periods and variations, the humanities see it in relation to how the climate has consequences for human societies and how humans adapt to climatic change. The former definition is more in line with how the term is used by conservators, who examine how the climatic events experienced by historic objects during their lifetime are evident in the damages and natural deterioration that have already occurred.[18] Structural damage occurs when an object's environmental climate exceeds the limits of a material before it cracks, warps, crumbles, corrodes, bleaches, yellows or undergoes any other display of natural deterioration triggered either by fluctuation in temperature, relative humidity (RH) or light. Instead of the strict 50% RH +/- 5 goal, conservators now aim for climatic boundaries based on the climate history of an individual object or collection. This is a response to how conservators and the museum world can aim towards a greener, more sustainable approach with realistic climate goals for their institutions, based on scientific evidence, to prolong the life of objects.

The stave church represented the centre of the village of Ål in Hallingdal, situated 437 m above sea level and surrounded by mountains. The climate is typical for inland Norway, with dry cold winters and short humid summers. The church was unheated and followed the outdoor weather variations through the seasons. The uninsulated wooden church protected the painted interior from rain, snow and wind, but was unable to buffer against periods of cold or warm weather. When Jon Brænne, paintings conservator from the Norwegian Institute for Cultural Heritage Research (NIKU), worked in the neighbouring Torpo stave church in 1977, he recorded a maximum summer temperature in the valley of around +30 °C. The indoor temperature underneath the Torpo canopy reached as high as +40 °C, and the outdoor winter temperature as low as −30 °C (Brænne 1982: 195). As part of the Ål project, climate loggers will be placed on site and in the stave church in Torpo to record the current climate. A study of historic weather data will also be conducted.

The climatic conditions for the Ål vault changed when it was brought to the capital Kristiania (now Oslo), a coastal city in the southeastern part of Norway. In 1881, the barrel vault was then mounted in a boat shed together with the Tune ship, also a wooden building without insulated walls or any form of heating.[19] The Historical Museum (Fig. 5) was purpose-built to house the Collections of Norwegian Antiquities, the Coin Cabinet and the Ethnographic Museum. The beautiful Jugend-style building with stained glass

Figure 5 Historical Museum, Oslo. (Photo: Nina Wallin Hansen © Museum of Cultural History, UiO.)

Figure 6 Detail of tenting paint before treatment in 1965. (Photo: Conservation Archives © Museum of Cultural History, UiO.)

windows, gilded walls and decor inspired by historic objects and ornaments was considered highly modern due to its central heating system and custom-made electric lamps (Myklebust 2004).[20] When the Ål vault finally found a permanent place in the exhibition on the ground floor of the museum, the climatic conditions changed once again, but this time with more dramatic consequences.

Moving the Ål ceiling from an unheated environment in a wooden church to a more airtight brick building with central heating resulted in a drop in RH for this object, far below that ever experienced by the painting previously. Heating the cold air in winter can reduce the RH to as low as 15–20%. In a climate that dry, the wood shrinks, and when the paint layers cannot follow the movement, this leads to flaking and loss of paint (Fig. 6).

It had already been noted in the 1950s that the condition of the painted ceiling was changing for the worse, with visible losses and flaking paint. The congregation of Ål had commissioned a copy of the vault for the new church that replaced the old stave church, and paintings conservator Ola Sæter from the Directorate of Cultural Heritage in Norway was chosen for the job. In 1958, he spent time observing the original ceiling in order to paint the new copy.[21] In an unsigned letter dated 17 October 1958 to the head of the Collection of Norwegian Antiquities, archaeologist and architect Gerhard Fischer, the latter is alerted that 'The Ål ceiling is in such a bad state, that it is obvious that something radical needs to be done.'[22] A conservation studio for paintings and polychrome sculpture had not yet been established at the museum and there were no official educational programmes for the conservation of heritage objects in Norway. Therefore, Fischer's colleague, conservation scientist and head of conservation Anne M. Rosenqvist, sought advice from paintings conservators outside the museum. On 23 January 1959, Fischer and Rosenqvist organised a meeting to which they invited Leif Einar Plahter, head of paintings conservation at the National Gallery, Oslo.[23] A few days later paintings conservator Jan Thurmann-Moe[24] and paintings conservator, architect and painter Finn Krafft from the Norwegian Directorate for Cultural Heritage (Riksantikvaren) were also consulted regarding the condition of the ceiling.

After the meeting, Krafft immediately sent a letter to Fischer in which he strongly recommended

that paintings conservator Bjørn Kaland from the University Museum of Bergen should perform the conservation.[25] He based this on Kaland's expert knowledge on medieval art and recent experience with the conservation of the medieval canopy painted in distemper from Torpo stave church in 1957. Kaland and Thurmann-Moe subsequently delivered their individual conservation proposals with quotes for suggested methods as to how to consolidate the painting.[26] Plahter gave his view of the different proposals and recommended using traditional glue (gelatine) as the consolidant, in line with Kaland's proposal.[27] Thurmann-Moe advised against the use of traditional glue, as this would not stabilise the wood and would therefore not be a lasting solution for the paint.[28] He recommended that the wood should be impregnated with a mixture he called 'wax-harts', described by Plahter as a 'wax/kunsthartz-mixture',[29] and suggested that the materials in the painting and the wood substrate should be analysed. Kaland recognised the painting as 'performed in distemper on a chalk ground.'[30] He advised against the proposition made by rival Jan Thurmann-Moe on the grounds that the application of wax or wax mixtures would forever change the saturation and visual appearance of the matte painting. Furthermore, it would make it difficult to re-treat the paint layers with anything other than wax in the future. Kaland therefore recommended gelatine as it would be possible to re-treat the painting and would not darken or change the saturation of its matte surface. However, they all agreed on two important aspects, namely that the paint layers were in a critical condition and in need of immediate conservation, and that the climate conditions for the Ål ceiling were the main cause of damage and paint loss. Kaland accurately stated that any conservation work would only have a short-lived effect if the current climatic situation was not improved.[31]

The conservation archive at the Museum of Cultural History (MCH), University of Oslo (UiO) contains several recommendations and quotes for the installation of local humidifiers and dehumidifiers, dating from 1959.[32] A letter of acceptance from the state architect of Norway, dated July the same year, was followed by a second acceptance letter for the plumbing work necessary to install local humidifiers in November.[33] As a result of the recommendations from Plahter, Kaland, Thurman-Moe and the climate engineers from Teknisk Import, the room exhibiting the Ål ceiling was the first in the museum to be climatised.[34] The climate records for this room have been kept continuously since 1962.[35] Since the early 1960s, the local humidifiers have managed to keep the RH to between 40 and 50% in the winter. Regrettably, the advisory committee did not follow the recommendations regarding the installation of local dehumidifiers, resulting in RH levels as high as 70–80% in the summer.[36]

New times, new adhesives: soluble nylon

The hunt for a consolidation medium and an application method to stabilise and preserve matte, fragile paint layers – without changing the surface colour, saturation or causing any other visual change – is still a core research subject in paintings conservation today, both in Norway and internationally. Distemper paint is water-soluble and its matte surface is challenging to conserve, as traditional consolidants tend to darken and change the visual appearance of the painting. It can create tidelines or stains when attempts are made to stabilise and secure loose paint flakes or powdery paint.[37]

In the 1950s, Norwegian conservators had little experience of treating large scale distemper paintings.[38] Leif E. Plahter therefore consulted conservator of archaeological material Stephen G. Rees-Jones at the Courtauld Institute, London, who recommended traditional glue/gelatine as the consolidant.[39] In 1960, medieval art historian Martin Blindheim replaced Fischer as the curator for the medieval collections. Together with Rosenqvist, he assumed responsibility for the conservation project. A letter in the conservation archives at MCH shows that Rosenqvist received a visit from mural conservator Ian S. Hodkinson from the National Trust of Scotland, who was also seeking a conservation solution for 'a glue-tempera painting on wood.'[40] Curiously, Hodkinson mentions a new product named 'soluble nylon', although knowledge about it was only empirical at this stage.[41]

Chemist Paul Coremans (director and head of the chemical laboratories at the Institut Royal du Patrimoine Artistique (IRPA) in Brussels) entered the debate in 1961 (Plahter 1961).[42] He was invited to the University Museum of Bergen to raise awareness about the alarming state of medieval church art in Norway (Skaug 2006). Coremans was quoted in several newspapers, including *Bergens Tidende* and *Aftenposten*, deploring the catastrophic preservation state of these priceless and unique pieces of art.[43] Among his recommendations was the establishment

of two regional conservation centres with chemical laboratories, one in Bergen and one in Oslo (Anker *et al.* 1961; Magar Meurs 2019: 58).[44] His visit to Bergen led to an invitation to Oslo on a similar call, and finally to his role as the main advisor for the consolidation of the Ål painting.

Coremans reportedly rejected the traditional treatment proposals from the Norwegian conservators and instead suggested a new synthetic adhesive, recommended and promoted by the British Museum, London.[45] Soluble nylon was a substituted polyamide made between 1939 and 1945 by Du Pont de Nemours and Imperial Chemical Industries (ICI). It has a regular molecular structure, many hydrogen bonds and a high degree of crystallinity may be present (De Witte 1975: 30), making it hard, non-elastic with a high melting point and almost insoluble. However, if nylon reacts with formaldehyde and alcohol in the presence of an acid, the melting point will lower and the solubility will increase, producing the product sold as Maranyl C, 109 P.D.V. 55, and later known as Calaton CB or soluble nylon (De Witte 1975: 30; L.E. Plahter 1997: 118).

In 1958, chemist Alfred Emil A. Werner, head of the laboratories at the British Museum, presented a new synthetic nylon-based polymer in his paper 'Technical notes on a new material for conservation' (Werner 1958). News of this new material quickly spread throughout the conservation world (Hodkinson 1960: 1). It was also recommended in the 1971 edition of *The Conservation of Antiquities and Works of Art* written by art conservator and archaeologist Harold Plenderleith and co-authored with Werner. Plenderleith was Keeper at the British Museum from 1924 until 1959, director of the International Centre for the Study of the Preservation and Restoration of Cultural Property (ICCROM) in Rome, and founder of the International Institute of Conservation (IIC). He was arguably one of the most influential figures in conservation on the world stage in the middle of the 20th century (Oddy 2011).

The soluble nylon products were initially recommended because of its believed properties such as good adhesion, flexibility, matte appearance after drying, and with no undue contractile forces (Werner 1970: 73–4; Sease 1981: 102). Importantly, it was also described as permeable to water vapour, therefore it was recommended as a consolidant and applied to porous surfaces in a magnitude of fields from the conservation of textiles, bones, stone, ceramics, wood and porous paint.

Soluble nylon was attractive to produce as a coating in the chemical industries because it could be transformed from hard insoluble nylon to soluble nylon, resulting in a solution that could be applied to any given surface as a coating (Sease 1981: 105). However, the material is unstable and will return to the insoluble parent nylon if subjected to acids, hydrolysis or condensation (De Witte 1975: 31). These properties seem to have escaped the attention of the conservation scientists that warmly recommended the new product.

Truls Løken was appointed paintings conservator for the new studio for paintings and polychrome sculpture at MCH. He took on the treatment of the Ål ceiling painting together with paintings conservation student Svein A. Wiik.[46] In 1965, after initial tests had been performed at IRPA on a painted board from the distemper wall decoration in the choir of the same church, the paint layers on the Ål ceiling were consolidated with a 6% solution of soluble nylon dissolved in 80% warm alcohol (Løken 1965: 8–10; L.E. Plahter 1997: 118). After an initial application by brush, flaking paint was secured by putting pressure on the surface until the glue dried, followed by applying the solution over the whole painting twice. Excess nylon was removed with a mixture of methanol and trichloroethylene (Løken 1965: 11–13).[47]

The treatment seemed successful (L.E. Plahter 1997: 118), however, from the 1980s and onwards, conservators started reporting severe decline and changes both in the condition and visual appearance of objects formerly treated with soluble nylon (Sease 1981: 107–8). The groundbreaking articles by conservation scientist Eddy De Witte and conservator Catherine Sease addressed the unsuitability of soluble nylon for cultural heritage objects. They showed that Werner neither tested nor aged the new material as recommended by scientific procedures and international ethical standards for conservation (De Witte 1975; Sease 1981; L.E. Plahter 1997: 120). Soluble nylon became insoluble, increasing the risk of irreparable damage to treated objects (Sease 1981). It was also reported that these objects turned grey, and that residues of the soluble nylon continued to be sticky and attract dust and dirt, leaving fragile objects unstable and difficult to re-treat (Sease 1981: 106).

The aftermath

Wiik and his colleagues at MCH kept the Ål ceiling under surveillance during the years following the conservation treatment (U. Plahter 1997: 118).

In January 1997, a small part of the ceiling was re-examined, and the nylon-treated painting sampled for analysis by Unn Plahter. The new material was compared with the old, taken before treatment, using optical and electron microscope SEM-EDX coupled with a visual evaluation of the state of the painting. It was concluded that the soluble nylon had not discoloured and was still flexible (U. Plahter 1997: 125). The nylon was observed 'as a sticky syrup' surrounding the particles. An open surface texture remained, as pigment particles were encapsulated and not embedded in the nylon, leaving the paint with a matte appearance. Like De Witte, Plahter stressed the nylon's sensitivity towards water and warned against the application of water-based consolidants when re-treating these nylon surfaces (U. Plahter 1997: 126). Overall, it was concluded that no new damage or darkening of the surfaces was observed (U. Plahter 1997; L.E. Plahter 1997; Wiik 1997). Although a new initial condition check of the surfaces in 2023 identified some tenting, the extent of new damage does not seem alarming. The painting has still retained a matte surface as the consolidant has not formed an even continuous layer on the surface. The fact that the painting sits underneath the vault protects it from dust pickup.

Little has been published in recent years on the consequences of the use of soluble nylon in conservation, and there are only a few case studies of the results from treatments of specific objects. What we do know is that a considerable number of museum objects from different categories were treated, such as ostraca from the British Museum (Werner 1970: 73–4),[48] early medieval wall paintings from St Botolph's church in Hardham Sussex, Canterbury and Winchester cathedrals (Kyi and Drew 2013: 101), and Peruvian ceramics from the ethnographic collection at MCH.[49] The conservation report for the large altarpiece from Onsøy in the MCH collections mentions the use of Maranyl for the smaller sculptures.[50] NIKU reports its use on church art in several churches in Norway, the altarpiece in Hessdalen church being one example (Wedvik 2009).

The painted 13th-century canopy ceiling painting still preserved *in situ* in Torpo stave church was re-conserved with soluble nylon in 1977 (Brænne 1982; Stein and Matheson 2007; Solberg 2008). The Ål and Torpo ceilings, both distemper paintings from neighbouring churches in the same valley, are two of very few remaining large-scale medieval paintings on wood from the latter part of the 13th century. However, their conservation and climate history differ: Torpo's complicated conservation history includes treatments with what seems to be a keratin glue made from animal horn in the 1920–30s, a treatment with gelatine performed by Kaland in 1956, and local consolidation with synthetic plastic glues and casein solutions before the soluble nylon treatment was performed in 1977 (Brænne 1982: 198). Furthermore, the vault from Torpo has been partially re-treated in later years by conservators from NIKU (Brænne 1982; Stein and Matheson 2007; Solberg 2008). The Ål ceiling painting has been kept in a climatised museum space since 1960, i.e. before the soluble nylon was applied, while the Torpo ceiling still resides *in situ* in the unheated stave church.

In 2000, the Wall Paintings Department at the Courtauld Institute of Art, London, and conservator Caroline Kyi published a potential method to remove and break down soluble nylon in order to re-treat medieval wall paintings (Kyi and Drew 2000: 101). Since soluble nylon is a synthetic protein, they tested whether bio-remedial methods might break the nylon down, but concluded that 'At present, passive environmental control is the only viable option.'

Conclusion

The choice of soluble nylon was based on professional discussions at a pivotal point in history for the conservation of medieval church art in Norway, drawing on the best national and international expertise. The treatment was performed with the best of intentions, but unfortunately knowledge not available to the team of experts in the 1960s has shown that soluble nylon does not possess any of the promised properties expected for a consolidant suited to preserve our cultural heritage. What are the consequences for the painted church art treated with soluble nylon in Norway? In what condition are they now, and which options do we have for their safe re-treatment?

A research group has been set up to investigate the preservation state, materiality and visual communication of the ceiling painting in the barrel vault from Ål, involving once again both Norwegian and international colleagues.[51] This time the task is even more complex, as the distemper painting has in effect turned into a nylon picture. New results gained from our research on this ceiling have the potential to improve the preservation of the broad range of museum objects consolidated with soluble nylon in the past.

Acknowledgements

With thanks to Bjørn Vidar Johansen for locating the entry for the Ål ceiling in the University of Oslo's annual records from 1881 and 1882; Espen Uleberg for providing information on the Tune boat shed; Unn Plahter for sharing her knowledge and contributing eyewitness information; and Anne Apalnes Ørnhøi for useful discussions and literature searches. And finally, to Sophie Rowe-Kancleris for correcting our English.

Notes

1. The word 'nature' in the title of this paper is used in accordance with the definition in the *Oxford English Dictionary*: 'The inherent or essential quality or constitution of a thing; the inherent and inseparable combination of properties giving any object, event, quality, emotion, etc., its fundamental character.'
2. The Historical Museum is part of the Museum of Cultural History (MCH), University of Oslo (UiO). The Historical Museum is the name of the building that houses the exhibitions in the centre of Oslo, part of MCH that also embraces the Viking ship museum.
3. G. Fischer (?), unsigned report 1959. 'Ål stavkirketuft, Ål s.p. og k.Buskerud Undersøkelse 1959'. Medieval Archives, MCH, Oslo.
4. Årdal measures 115 × 150 cm.
5. Oldsakssamlingen was incorporated into the new structure of MCH in 1998.
6. Det Kongelige Norske Frederiks Universitets Aarsberetning (today University of Oslo) 1881 and 1882.
7. *Ibid*. 'Et i 1881 indkommet stort og mærkeligt middelaldersk Tagmaleri fra Aal kirke i Hallingdal lykkedes det siste Sommer at faa paa nogenlunde tilfredsstillende Maade sammensat og opstillet under Taget i det for Tunebaaden opførte Hus, saa at det nu baade er sikret mot Beskadigelse og kan besees i sin Helhed' (English translation: the authors).
8. The vault from Ål and the stave church portal from Sauland are the only objects that have been on permanent display since the opening.
9. T.M. Løken, 'The painted ceiling from the Ål stave church', unpublished report, 1966. Conservation Archive, MCH, Oslo.
10. Multiconsult, 'Historisk museum – setningsskader.' Report for UiO: document code 10210744-RIB-RAP-001.
11. 3D documentation and mapping of the vault's preservation state is planned for spring 2024.
12. The term 'distemper' is used here to refer to any various water-based paints.
13. U. Plahter, 1969, unpublished report on analysis performed on cross-sections from the Ål vault, MCH, Oslo.
14. 'endu mere stilistisk urent end arbeidet i Torpo er nabomalerierne i nabokirken Aal. Her staar vi foran den mest typiske bondemaleren i hele vor middelalderske kunst, et friskt og freidig talent, som tumler med stilen paa en egen naiv maate' (English translation: the authors).
15. 'teknikken er enkel og grov og stilen provinsiell. Pigmentene som er brukt, tyder på det samme ... de er billige og lett tilgjengelige' (English translation: the authors).
16. See note 13 above.
17. See Kollandsrud 2024.
18. ASHRAE Standards and Guidelines 2019: 24.2.
19. See notes 7 and 9 above.
20. H. Bull, 'The Museum Building', undated handwritten lecture notes, p. 14. Archive, Collection of Norwegian Antiquities 1829–1991, MCH, Oslo.
21. Letter from Thorleif Sjøvold (acting director of the Collection of Norwegian Antiquities, Oslo) to Fredrik Konow Lund, architect responsible for the restoration of the new Ål church, 25 January 1958. Medieval Archive, MCH, Oslo.
22. 'Imidlertid har det vist seg at Aal-taket er i en så dårlig forfatning at noe radikalt åpenbart må gjøres' (English translation: the authors).
23. Letter from Leif E. Plahter (National Gallery, Oslo – now part of the National Museum) to the Collection of Norwegian Antiquities, Oslo, 26 January 1959.
24. Thurmann-Moe worked on the conservation of Edvard Munch's paintings at the Ekely estate in Oslo.
25. Letter from Finn Krafft to Gerhard Fischer (Collection of Norwegian Antiquities, Oslo), 27 January 1959. Conservation Archive, MCH, Oslo.
26. Letter from Bjørn Kaland to Gerhard Fischer (Collection of Norwegian Antiquities, Oslo), 20 February 1959. Conservation Archive, MCH, Oslo. Letters from Jan Thurmann-Moe to Gerhard Fischer (?) (Collection of Norwegian Antiquities, Oslo), two different letters are dated 29 January 1959, one page is undated and a second letter with a quote for the treatment is dated 6 March 1959.
27. Letter from Leif Einar Plahter (cited in note 23 above).
28. Letters from Jan Thurmann-Moe to Gerhard Fischer (?) (cited in note 26 above).
29. Letter from Leif E. Plahter 1959 (cited in note 23 above).
30. 'Takmaleriet er utført med limfarve på krittgrunn' (letter from Kaland cited in note 26 above) (English translation: the authors).
31. Letter from B. Kaland, 20 February 1959 (cited in note 25 above).
32. Unpublished letter from Teknisk Import, Ravnsborg og co., to engineer Blystad, Riksarkitektens varme og Sanitæravdeling, 9 June 1959. Conservation Archive, MCH, Oslo.
33. Two letters from Egil Orvei, Riksarkitektens varme og Sanitæravdeling. Oslo to the Collection of Norwegian Antiquities dated 17 July 1959 and 9 November 1959 respectively. Conservation Archive, MCH, Oslo.

34. The medieval exhibition hall and the room containing the Ål ceiling were deliberately left out when a new HVAC system was installed in the cellar of the Historical Museum in the 1970s. These areas are therefore only ventilated through doorways and cracks around windows.
35. Museum of Cultural History 1962–1970, 'Relativ fuktighet og temperatur. Åltaket', unpublished reports. Conservation Archive, MCH, Oslo.
36. Local dehumidifiers were recommended by the consulting ventilation engineers, but not installed: unpublished letter from Teknisk Import, Ravnsborg og co., to engineer Blystad, Riksarkitektens varme og Sanitæravdeling, 9 June 1959. Conservation Archive, MCH, Oslo.
37. Truls M. Løken in a 1999 film by Svein A. Wiik, 'Interviews regarding the conservation of the Ål ceiling', Conservation Archive, MCH, Oslo.
38. Leif E. Plahter in a 1999 film by Svein A. Wiik, 'Interviews regarding the conservation of the Ål ceiling', Conservation Archive, MCH, Oslo.
39. *Ibid*.
40. Ian Hodkinson became one of the most important figures in the history of art conservation in Canada. His accomplishments include the co-founding of the Canadian Association of Professional Conservators (1971), the creation of the Queen's University Art Conservation training programme (1974), the training of multiple generations of paintings conservators (1974–98), and the conservation of important works of art for communities across Canada. See https://capc-acrp.ca/en/about/award-of-distinction/ian-hodkinson (accessed 8 March 2024).
41. Letter from Ian S. Hodkinson (National Trust, Scotland) to Anne M. Rosenqvist (Collection of Norwegian Antiquities, Oslo), 26 August 1960. Conservation Archive, MCH, Oslo.
42. On the legacy of Coremans see Deneffe and Vanwijnsberghe 2018.
43. *Bergens Tidende* 18 January 1961, 'Bergen har verdenskunst som verden ikke kjenner', unpaginated, main page and last page of no. 15 ed. 94; *Aftenposten, A-magasinet* 17 December 1966, 'Vi øder våre kunstskatter!', pp. 6–7 and 24.
44. *Bergens Tidende* 24 January 1961, 'Forslag om sentralt atelier for konservering av kunst', unpaginated, main page and last page of no. 20 ed. 94.
45. Martin Blindheim in a 1999 film by Svein A. Wiik 'Interviews regarding the conservation of the Ål ceiling'. Conservation Archive, MCH, Oslo.
46. Both Truls M. Løken and Svein A. Wiik studied under Leif E. Plahter at the National Gallery, Oslo. Wiik later became head of the studio for paintings and polychrome sculpture at the Museum of Cultural History, University of Oslo.
47. See note 9 above.
48. Ostraca are Egyptian ceramic tablets or fragments of pottery or limestone used for writing or drawing on (Werner 1958: 273).
49. Eivind Bratlie, personal communication, 14 March 2023.
50. Inv. no. C9896, MCH, Oslo: https://www.unimus.no/portal/#/things/f96418a1-61fa-4331-8276-7a116cb6793f.
51. https://www.khm.uio.no/english/research/research-groups/aal-ceiling/.

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Colour changes in depicted foliage: investigation into the role of gypsum in the light aging of yellow lake pigments

Charlotte Hoffmann and Ester S.B. Ferreira

ABSTRACT Yellow lake pigments have been identified as colorants in mixed green paints in many Dutch landscape paintings dating from the 17th century. Their use is often associated with alteration and fading resulting in hue changes from green to blue. Historic written sources mention yellow lakes as components of green paints and comment on their instability but few contain detailed recipes for their preparation. It is known that the manufacturing process has an influence on their stability. Yellow lake pigments produced by adsorbing a flavonoid-containing dyestuff on an inorganic substrate such as chalk or lead white, so-called schiet yellow, are known to fade whereas lake pigments prepared by precipitating the dyestuff-metal complex on an inorganic substrate are more stable to light. In the written sources, lead white, calcium carbonate of various types as well as gypsum are mentioned as substrates for yellow lake pigments. In contemporary research, the influence of the use of gypsum as a substrate for yellow lake production on the aging behaviour of the pigment has not been investigated. This paper compares the light-aging behaviour of six yellow lakes based on three historic recipes using chalk and gypsum as pure pigments, paint swatches in linseed oil and as paint swatches mixed with azurite in linseed oil. Light aging is performed with a microfading tester and in an artificial daylight-aging chamber. Results show that the use of gypsum influences the light-aging behaviour of the colorants. In oil paint, yellow lakes prepared with gypsum exhibit a hue change towards green and fade less than yellow lakes prepared with chalk.

KEYWORDS yellow lake pigments, discoloration, light aging, green mixtures

Introduction

Material and documentary source research on the painting technique of Dutch landscape painters of the 17th century shows that the tone and composition of green paint differed depending on where the foliage was situated in the landscape such as in the foreground, middle ground or background. The use of flavonoid-containing yellow lake pigments in green pigment mixtures is documented in contemporary historical written sources (Kirby 2003; Kirby and Saunders 1998; Stoll 1981). The presence of yellow lake pigments can be inferred from the detection of calcium carbonate or calcium sulphate (Kirby and Saunders 1998). Saunders and Kirby (1994: 88) observed that yellow lake pigments containing gypsum (formed as a reaction product during lake pigment precipitation with alum) are more stable than yellow lake pigments simply adsorbed on calcium carbonate, and proposed that gypsum might stabilise the lake pigment.

With the aim of testing that hypothesis, this paper investigates the influence of gypsum as a substrate on the aging of yellow lake pigments in mixed green paints. The aging properties of yellow lakes with different substrates have been investigated in various research projects. This study complements previous research by using gypsum directly as a substrate for yellow lakes, based on written sources dating from the 17th century, and by comparing these colorants, in terms of their colour effect and aging properties under the influence of light, with yellow lakes on chalk substrate produced using the same recipe. Studies such as these can provide a more in-depth insight into the aging of paintings, thereby enabling a better understanding of their appearance at the time of their creation and the production process.

Research background

Yellow lake pigments are prepared using flavonoid-containing plant extracts. The dyestuff is either directly adsorbed onto, or precipitated as an aluminium complex on, an inorganic substrate such as chalk or lead white, thus forming a pigment. Since these colorants are unstable and fugitive, their

presence is inferred from the detection of significant amounts of calcium or aluminium-containing components in paint layers and observed chromatic alterations. For example, foliage in *Company in the Backyard of a House* by Pieter de Hooch (1629–1984) has been associated with the presence of faded organic yellow dye due to its blue colour (Hermens and Wallert 1998: 289), which contrasts with the realistic depiction of the green leaves. The presence of yellow lake pigments is supported by macro-X-ray fluorescence (MA-XRF) imaging and the analysis of paint cross-sections, revealing a high calcium content in the paint layer corresponding to the leaves attributed to a calcium-containing substrate (Gabrieli 2020). Previous research has shown that dark green paints containing yellow lakes, used in the foreground layers, can change towards brown upon light aging (Hoffmann *et al.* 2021). In summary, two types of chromatic alterations have been described in green paint mixtures with yellow lake pigments: darkening towards a brown hue and fading to a blue tone.

Fourier transform infrared (FTIR) spectroscopic measurements on microsamples taken from 17th-century landscape paintings in the collection of the Wallraf-Richartz-Museum & Fondation Corboud (Cologne) and LVR-LandesMuseum Bonn in areas of depicted foliage, which today appear brown, green or blue, show that both calcium sulphate and calcium carbonate are present in different ratios. The manufacturing method of the yellow lake pigments influences the lightfastness properties of the colorant (Saunders and Kirby 1994). In flavonoid-based lake pigments prepared by adding an alkali and alum to the dyestuff solution, the deprotonated flavonoid molecule forms a coordination complex with aluminium, which then precipitates onto the substrate.[1] The lake pigments thus formed are generally more stable to light than lake pigments prepared by adding calcium carbonate, where the dyestuff is only adsorbed onto the substrate, so-called schiet yellows (Hermens and Wallert 1998; Saunders and Kirby 1994).

Gypsum can be used either as a substrate for schiet yellows (Stoll 1981) or formed as a by-product in the precipitation of lake pigments with alum ($AlK(SO_4)_2$) (Saunders and Kirby 1994). Dutch documentary sources mainly mention chalk in combination with alum. For example, in the recipes from the Pekstok papers dating from the second half of the 17th century, 'krijt' and 'krijtwitt' are mentioned as substrates (Hermens and Wallert 1998). In earlier German recipes, chalk and alum are cited in combination with an alkali (Kirby *et al.* 2014). Other calcium carbonate-based substrates are also mentioned, such as eggshells in the text by Norgate (Kirby 2003). Lead carbonate, or lead white, also features as a substrate in the de Mayerne manuscript dating from the early to mid-17th century (Stoll 1981). In Italian sources, gypsum is listed as a substrate for paints containing yellow lake pigments, for example in the Padua manuscript from the second half of the 17th century: 'gesso purgato' (Merrifield 1967: 708).

The sensitivity of yellow lake pigments towards light is already documented in historical sources. Yellow lake pigments are described as sensitive by de Mayerne, and painters are warned against using them in oil paint (Berger 1975: 271; see Stoll 1981: 92).[2] This is also reflected in later sources. In a text dating from the 18th century in the Van Leen manuscript, the author states: '[Light schiet yellow] is an unstable colour that should be used sparingly on oil paintings. … [Brown schiet yellow] is a perfect glowing colour, that may turn black in time. It can be used with care, but only for glazing' (Hermens and Wallert 1998: 287).[3] This is particularly interesting since two shades of yellow are mentioned with different associated aging behaviours. 'Light', 'brown' and sometimes a 'green' colour of yellow lake pigments are also found in written sources dating from the 17th century, for example in Willem Goeree's *Verligterie-Kunde of regt gebruik der Waterverwen* (Goeree 1697: 2).[4] Although these different colour nuances are not directly linked to any recipe, it can be presumed that the colour of yellow lake pigments is influenced both by the dyestuff source and production method.

Experimental

This study combines various methods from the field of art technological source research. Historically informed reconstructions are subjected to light-aging tests to investigate the role of the composition of the substrate, focusing on gypsum and chalk, in the light aging of yellow lake pigments. Six yellow lake pigments were selected for this study, all based on the dyestuff extracted from dried buckthorn berries (Kremer Pigmente #373901) and prepared based on historic or standardised recipes (Fig. 1). Two schiet yellows based on a water extraction of the plant dyestuff were examined.

BAC and BAG (Pekstok papers)

The first schiet yellow was based on a recipe from the Pekstok papers dating from the second half of the 17th century (Hermens and Wallert 1998), prepared with chalk and gypsum.[5] For this recipe, 8 grams of dried buckthorn berries were soaked in 240 ml distilled water overnight and subsequently boiled for 30 minutes. The extract was filtered, divided into two 250 ml beakers and heated to 80 °C. Calcium carbonate (6 g, Kremer Pigmente #58000) in the form of natural chalk was added to one beaker (BAC) and calcium sulphate in the form of natural gypsum (6 g, Kremer Pigmente #58300) to the other (BAG). The pH value of the solution with chalk was 9 while that of the solution with gypsum was 7. Potash alum (4 g, Kremer Pigmente #64100) was added to each dyestuff solution. The pH value of the solution with chalk dropped to 7 and effervescence was observed. The pH value of the solution with gypsum dropped to 4, no effervescence occurred, and the substrate sank to the bottom of the beaker. The solutions were left to stand overnight before being filtered and washed using a Büchner funnel.

BACd and BAGd (Padua manuscript)

The second schiet yellow was prepared by pouring the dyestuff solution mixed with alum over chalk or gypsum based on a recipe in the Padua manuscript, also dating from the second half of the 17th century. For this recipe, 8 grams of dried buckthorn berries were soaked in 80 ml distilled water overnight and subsequently boiled for 30 minutes. The extract was filtered, divided into two 100 ml beakers and heated to 80 °C. Chalk (0.25 g, Kremer Pigmente #58000) and alum (3 g, Kremer Pigmente #64100) were mixed and added to the dyestuff solution in one beaker while stirring. The pH value of the solution was 7 and no strong effervescence was visible on the surface but a reaction in the solution could be observed. Gypsum (0.25 g, Kremer Pigmente #58300) and alum (3 g, Kremer Pigmente #64100) were mixed and added to the other dyestuff solution. The pH value was 4, no effervescence was visible, and the substrate sank to the ground of the beaker. The solution was kept on a heating plate (moderate heat) until the water evaporated.

BlwCA and BlwGA (standard recipe with alkaline dyestuff solution)

A lake pigment prepared with an alkali dyestuff solution and alum and chalk or gypsum, based on a standardised recipe (Kirby *et al*. 2014: 90) was examined. For the preparation of these lake pigments, 8 grams of unripe buckthorn berries were placed in a one litre beaker with 240 ml limewater (prepared according to the recipe in Kirby *et al*. 2014: 81) and soaked overnight. The solution was then boiled for 30 minutes and filtered. Subsequently, the dyestuff solution was divided in two equal parts and transferred into two 250 ml beakers. Potash alum (8 g, Kremer Pigmente #64100) was dissolved in 40 ml distilled water. The dyestuff solution was heated to 80 °C then chalk (1.2 g, Kremer Pigmente #58000) was added to one part of the dyestuff solution, while gypsum (1.2 g, Kremer Pigmente #58300) was added to the other half; both dyestuff solutions had a pH value of 12. Immediately after this, the alum solution was added drop by drop (about 3–4 g alum) to each dyestuff solution until no further effervescence was observed. Effervescence was only observed in the solution with chalk – the pH value in this solution dropped to 7 after mixing all components. The pH value of the solution with gypsum remained 12 and the colorant was deposited at the bottom of the beaker without visible effervescence. After being left to stand overnight, the lake pigments were filtered and washed using a Büchner funnel.

FTIR spectroscopy was carried out on the prepared reference materials and selected painting samples to determine the presence of calcium carbonate and calcium sulphate, and their ratio in mixtures. A Thermo Scientific Nicolet system coupled with a Continuum microscope was used (spectral range 4000–570 cm^{-1}, 128 scans, 4 cm^{-1} spectral resolution). The paint films were applied on a polyethylene terephthalate sheet (Hostaphan, Deffner & Johann #2748140) with a paint film applicator with a wet film thickness of 90 µm. Cold-pressed linseed oil (#73054) and azurite (#10200) were acquired from Kremer Pigmente GmbH & Co. KG. Mixtures of yellow lake pigments in linseed oil were prepared by mixing yellow lake pigment: linseed oil 1:1.5 (volume). Mixtures of yellow lake pigments with azurite and linseed oil were prepared by mixing yellow lake:azurite:linseed oil 1:1:1 (volume).

The lightfastness of the different lake pigments was evaluated with a microfading tester from Instytut Fotonowy (Kraków). A spot with a diameter

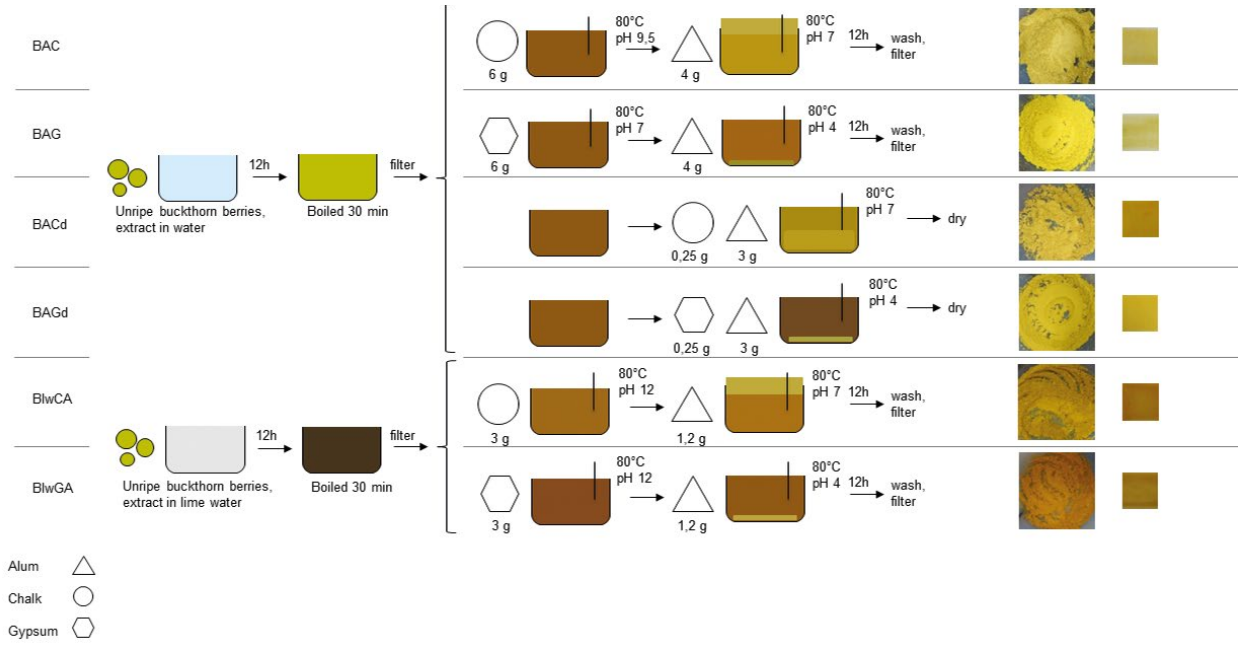

Figure 1 Overview of the production process of the examined yellow lake pigments. The images on the right show the ground colorants produced and the paint swatches prepared by mixing them with linseed oil. (Image: Charlotte Hoffmann.)

of 0.5 mm is illuminated for five minutes with a 4 mW LED (illuminance 0.004W/0.0000002m^2) in the range 400–750 nm and the spectral data are continuously recorded. Measurements were performed on powder samples and dry paint swatches in linseed oil. To compare the results, a second set of samples was artificially aged in an Atlas Suntest CPS+ light aging-chamber, aging the samples in artificial daylight with 1500 W xenon light (illuminance 1500/0,031m^2) in the range 300–800 nm and constant temperature and humidity for 72 hours. Colour measurements were carried out at regular intervals with a Datacolor CHECK3 handheld spectrophotometer.[6] To investigate the influence of gypsum on the aging stability of the lake pigments, the CIE L*a*b* data and respectively the spectra of the microfading tester were compared with each other and with the ISO Blue Wool standards.

Results

FTIR spectroscopy

The presence of calcium carbonate and calcium sulphate and their ratio in mixtures in the prepared lake pigments were determined by FTIR spectroscopy. In the lake pigment BlwCA (Fig. 1), it was observed that gypsum (identified through the presence of the bands 1617, 1143, 1110, 658 and 594 cm^{-1}) had formed as a product of the reaction between alum and chalk. This confirms what has been previously described by Saunders and Kirby (1994): the presence of both calcite and gypsum allows the interpretation related to the preparation method, i.e. that the aluminium complexed dyestuff is precipitated on the calcite substrate. In the schiet yellow samples BAC and BACd prepared only with chalk, both calcite and aluminium hydroxide are present. In sample BAG only gypsum was detected while in samples BAGd and BlwGA gypsum and hydrated alumina are present.

Colour and colour changes

The lake pigments prepared according to the recipes described above differ in colour and texture after grinding. Samples BAC, BAG, BACd and BAGd are optically similar to each other. The same applies to samples BlwCA and BlwGA, which are darker and more saturated than the extended schiet yellows. However, in the paint swatches with linseed oil, all the yellow lake pigments prepared with gypsum appear greener. Both BlwCA and BlwGA lake pigments are harder and finer grained than the other colorants.

The yellow lakes in powder form were pressed into an aluminium stencil. This allowed the study of their light-aging behaviour in the absence of a binding medium as well as optimisation of the

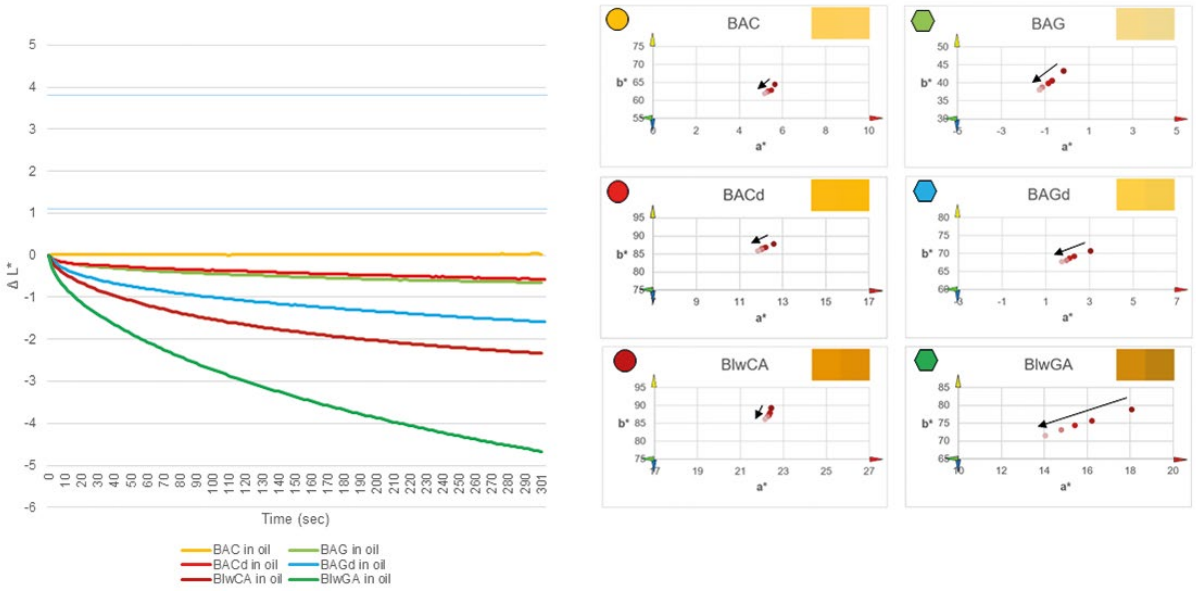

Figure 2 Results of the light aging and colour measurements by the microfading tester. The light blue lines indicate the Blue Wool standards 1 and 2. The small colour samples illustrate the total colour change, comparing the unaltered stage on the left and the colour after light aging on the right. (Image: Charlotte Hoffmann.)

experimental parameters for the microfading tester. Measurements for 5 and 20 minutes resulted in the same colour difference between the unaged and light-aged material; a measurement duration of 5 minutes was therefore chosen. Measurements on powder samples did not evoke fading of the yellow lake pigments. Instead, lake pigments prepared with chalk turned brown and those prepared with gypsum became dark green. It was assumed that this colour change occurs due to the high concentration of dye in the yellow lake powders and that the aging is not applicable to yellow lakes in an oil binder. To obtain a better insight into the aging of the colorants in oil paintings, paint swatches in linseed oil were examined. A first set of paint swatches prepared with yellow lake pigments in linseed oil was examined using a microfading tester. Evaluation of the change in lightness over the time of the aging experiment (Fig. 2, ΔL* values) showed that all samples turn darker, except for the first lake prepared by adding alum to a chalk and dyestuff mixture (BAC). It was possible to observe a different trend in discoloration when comparing yellow lake pigments prepared using chalk and gypsum: the yellow lake pigments prepared with gypsum showed a tendency to turn green and exhibited a higher overall colour difference between the initial and aged state, i.e. they became darker than the colorants prepared following the same recipe but using chalk (Fig. 2, changes in a* and b* values, the arrows indicate the colour change, according to the exposure time). Furthermore, the colour changes differed depending on the preparation method. The paint swatches with BlwCA and BlwGA showed significantly greater differences in brightness between the initial state and the aged state than the other samples. This could be explained by the fact that the precipitated yellow lakes were distributed much more finely and therefore more colorant was present in the paint swatches compared to the other samples.

A second set of paint swatches was artificially aged for 72 hours exposed to alternative dark (8 hours) and light (8 hours) periods. The difference in lightness (ΔL*) is shown in Figure 3. For each paint swatch three measurements were performed and averaged. The difference in lightness in comparison between the unaged, dried paint swatch and the paint swatch after light aging are displayed. The colour fields at the bottom show the RGB values of each paint swatch before and after aging. In general, the paint swatches with yellow lake pigments prepared with chalk (BAC, BACd and BlwCA) faded to a greater extent (higher ΔL*) compared to the paint swatches with yellow lake pigments prepared with gypsum (BAG, BAGd and BlwGA). All the paint swatches faded (ΔL* >0) during this experiment except for the pigment prepared with an alkaline dyestuff solution and precipitation of the dyestuff on alum and gypsum (BlwGA). This paint swatch turned darker and greener. All paint swatches containing yellow lakes prepared with gypsum became

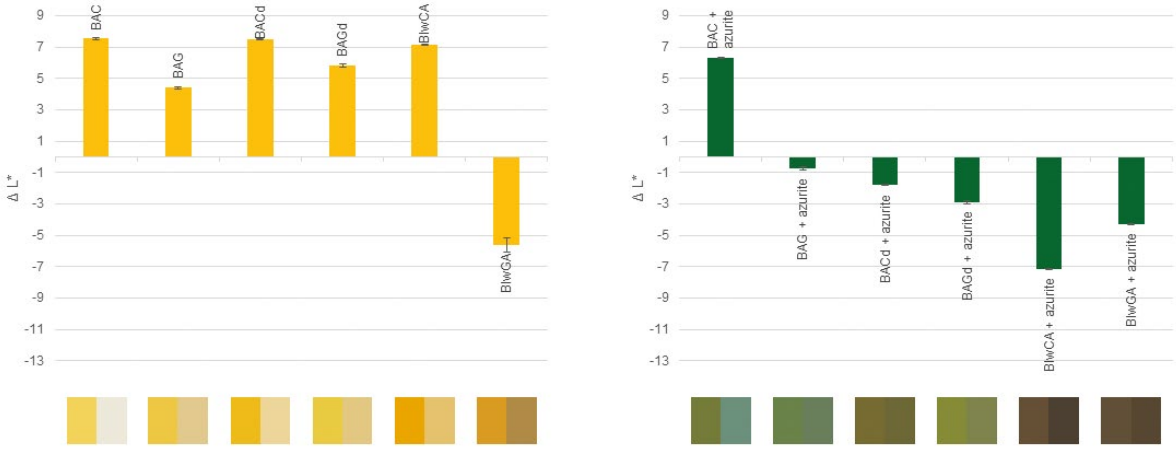

Figure 3 Difference in brightness of the paint swatches in linseed oil before and after artificial aging in the light-aging chamber. The small colour samples illustrate the total colour change, comparing the unaltered stage on the left and the colour after light aging on the right.

greener ($\Delta a^* < 0$) during light aging. This effect is observed in samples aged using both the microfading tester and the daylight-aging chamber. While the microfading tester only provides information on a very small examination area that is exposed to intensive illuminance over a short period of time, aging in the daylight-aging chamber enables the aging of a larger area and thus, in addition to the L*a*b* measurements, also a direct visual assessment of the colour change. In particular, after observing the unexpected darkening of the yellow lake pigments and paint-outs during microfading testing, comparison with another aging method seemed relevant. The daylight-aging experiment showed that the yellow lakes prepared with chalk faded (increase in L* value) more than the analogous paint swatches containing colorants prepared with gypsum.

To discover more about the aging behaviour in mixed greens, mixtures of the lake pigments with azurite in linseed oil were examined. The results of the colour measurements after light aging are shown in Figure 3. All the paint swatches turned darker, except for sample BAC, the schiet yellow prepared with chalk. The sample BAC mixed with azurite turned blue (b* value from 34.38 to 7.06). The aging of the green paints was probably less intense due to the fact that the concentration of yellow lake was lower compared to the pure lake pigments in linseed oil. Furthermore, it is possible that the azurite pigment particles partially shielded the yellow lakes from photochemical degradation. In this experiment, the paint swatches with azurite and the lake pigments BlwCA and BlwGA turned darker during light aging (negative ΔL^* values).

Discussion

This study provides new insights into the tonal variation of green mixtures with yellow lakes not only at the time the painting was created but also tonal changes due to exposure to light. It shows that yellow lakes based on gypsum in oil paints turn greener and fade more slowly than lakes based on the same recipe with chalk. It is particularly interesting to note that the two yellow lakes, which were produced based on an alkaline extract of the plant dyes (BlwCA and BlwGA), showed a tendency to become darker as pure pigments. This tendency was also clearly visible in the yellow lake prepared with gypsum (BlwGA) in an oil binder. To our knowledge, this is the first documented observation of browning and greening of a yellow lake in an oil binder. In landscape paintings from the 17th century, a darkening and browning of foliage areas is frequently observed. This observation is usually associated with the aging of copper-containing pigments, but this study shows that the aging of yellow lakes may also play a role, at least in the short term. In general, it is notable that artists probably had to work with a wide range of yellow lakes with different aging properties, and that the aging in green mixtures could hardly be predicted.

The observation that yellow lake pigments prepared with gypsum have different colour and aging properties is of relevance in the art technological and art historical study of paintings. In terms of art technology, it is beneficial to know more about the possible composition of the substrate of yellow lakes in order to better interpret and contextualise material analyses. The evaluation of paint samples to determine whether

a lake pigment was produced on the basis of chalk or gypsum can also be relevant for art historical interpretation. With this information, the current appearance of paintings can be better assessed and possible colour changes better understood. Subsequently, the knowledge of the impact of the yellow lake composition and manufacturing process on the specific colour changes enables a more accurate interpretation of the intended coloristic effect by the artist. This can be particularly interesting for the study of paintings created in Italy, as it is expected that yellow lakes would have been prepared with the locally available gypsum instead of chalk. As some Dutch landscape painters worked in Italy during the 17th century, a closer examination of the substrates of yellow lakes could help to contextualise the paintings and possibly provide indications as to colour changes and the intended chromatic effect. In this context, it would be interesting, for example, to examine works attributed to Cornelis van Poelenburgh (1595–1667) or Jan Both (1618–1652), both of whom worked in Utrecht and Italy. In works attributed to these two artists, colour changes are sometimes suspected. It would be worth investigating whether there are differences in the composition of the yellow lake substrates, and if these are associated with differences in the current colour effect and possible colour changes.

Conclusion

This paper adds relevant observations on the influence of gypsum on the light stability of yellow lake pigments to previous findings and already published studies on the aging of these colorants. The investigation of gypsum as a substrate for yellow lake pigments is of relevance since lake pigments in the 17th century were probably produced with locally available materials, i.e. dyestuff source and substrate material. It is therefore suspected that yellow lake pigments prepared in the Netherlands used chalk as a substrate whereas in Italy, for example, gypsum would have been more common.

The results presented in this paper suggest that the use of gypsum instead of chalk as a substrate would influence the aging properties of the paint – at least in the earlier stages of aging. However, longer exposure times are required to clarify if this clear disparity in behaviour between gypsum- and chalk-based yellow lake pigments is also observed in the long term. The browning and darkening of yellow lakes discussed in contemporary written sources should be investigated further in the context of the results obtained.

The results also suggest that, when bound in oil, yellow lake pigments prepared with gypsum turn green during light aging. Darkening also occurs, at least in the short term, with yellow lakes produced by precipitating the aluminium complexed dyestuff onto gypsum. The causes and mechanism of the different aging properties of yellow lakes prepared with gypsum in comparison to those prepared with chalk are still unclear and require further research. By-products formed in the preparation process of lake pigments might also influence the aging behaviour of the paint. Kirby *et al.* (2014: 86) recommend the thorough washing of pigments to wash out sulphate ions as by-products such as these might influence the colour and light-aging behaviour of the paints. Raman spectroscopy study into Al (III) complexes in aqueous solution shows that sulphate ions are able to penetrate the inner coordination sphere aluminium hexaaqua complexes and replace water molecules as ligands (Rudolph *et al.* 2000). It is conceivable that sulphate ions in solution, originating from the dissolution of alum, can participate in the flavonoid-aluminium coordination sphere and influence the aging behaviour. Further research is required to confirm the nature of the coordination sphere of these lake pigments and its influence in aging behaviour.

This study is part of a larger context of research that aims to improve the art historical reading of these paintings based on the investigation of aging mechanisms. For this purpose, it is relevant to investigate which materials were used, which ageing phenomena are feasible, what knowledge artists might have had in this regard and what significance this might have had in the artistic creative process. The study contributes to an improved reading of landscape paintings by taking a closer look at one of the many factors influencing their appearance today. It is thus a contribution to recognising gaps in our understanding of the paintings and bridging them in further interdisciplinary research.

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Notes

1. The relative acidity constant (pK_a) of quercetin is 8.2; see Georgievskii 1980: 137. Accordingly, the molecules are deprotonated at an increased pH value and complexation is possible.
2. In his specifications on the lightfastness of various pigments, entitled 'ces couleurs meurent', De Mayerne lists schiet yellow in first place; see Berger 1975: 271.
3. Willem van Leen, Over Teken- en Schilderkunst & Raad aan Kunstverzamelaars (unpublished Ms.), Rijksprentenkabinet, Amsterdam, Ms. 1976-7 314k.
4. In his list of pigments, Goeree mentions 'Ligte Schijtgeel' and 'Bruyne Schijtgeel van verscheyde soorten'; see Goeree 1697: 2. He points out that the brown lake pigment is rarely used in water-based colours but is suitable for oil paint: see Goeree 1697: 19; Hermens and Wallert 1998: 284.
5. The so-called Pekstok papers are a compilation of recipes dating from the second half of the 17th century, associated with Willem Pekstok, a manufacturer and dealer of artists' materials based in Amsterdam. The recipe used for this study is dated to 1692 (Hermens and Wallert 1998: 282).
6. The aging parameters are based on studies already carried out on the light aging of yellow lake pigments (Saunders and Kirby 1994).

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A collaborative conservation and curatorial approach to wax sculpture

Alexandra Letvin and Nicole Passerotti

ABSTRACT The Philadelphia Museum of Art (PMA) has one of the largest collections of wax miniature sculpture in the United States. A malleable and readily available medium, beeswax has been used by artists for centuries. That wax could be acquired and manipulated without highly specialized tools also meant that many women sculpted in wax. However, wax is also a vulnerable medium. This paper examines the intersection of wax's accessibility and susceptibility to material change through a case study of an interdisciplinary research project on the PMA's wax sculpture collection undertaken by a conservation and curatorial fellow that resulted in the treatment and display of a wax flower basket, likely made by an unrecorded English woman working in the 19th century.

KEYWORDS wax, sculpture, women artists, Victorian, X-radiography

Introduction

A malleable and readily available medium, beeswax has been used by artists for centuries; wax sculptures even survive from the ancient Mediterranean. In European art, wax was employed frequently for seals, medals, sketches, and as part of the lost-wax casting process. Wax's ability to replicate the appearance of human flesh in its translucency and texture also made it a popular medium for a range of lifelike figural representations (Panzanelli 2008; Syson 2018: 26–31). Wax ex-votos replicating body parts became common beginning in the medieval period, as did life-sized wax funeral effigies (Harvey and Mortimer 2003; Maniura 2009; Wood 2011). In the 18th century, wax was often used for anatomical models (Harvey 2003; Maerker 2011; Ebenstein 2016).

That wax could be acquired and manipulated without highly specialized tools also meant that many women sculpted in wax (Hunter 2008). In the 17th and 18th centuries, known women artists, including Caterina de Julianis (1670–1743) and Anna Morandi Manzolini (1714–1774), created wax devotional objects, anatomical models, and mixed media tableaux (Dacome 2007; Messbarger 2010). In the 19th century, a new craze for wax flowers in England led to the rise of both women entrepreneurs who published guides to modelling wax flowers as well as countless women who purchased wax flower kits to create their own sculptures at home, one of which is the subject of this paper.

The qualities that made wax a popular and accessible choice for sculpture also make it a vulnerable medium. This paper examines the intersection of wax's accessibility and susceptibility to material change through a case study of a 19th-century wax flower basket (43-95-116) likely made by an unrecorded Englishwoman and now in the collection of the Philadelphia Museum of Art (PMA). Its treatment and display highlight the potential of interdisciplinary work and collaborative decision-making between curatorial and conservation departments, and contribute to the ongoing re-evaluation and presentation of works by unknown women makers in museum collections.

Project overview

Between 2017 and 2018, as fellows in the Departments of Decorative Arts and Sculpture Conservation and European Painting and Sculpture at the PMA, the authors undertook a comprehensive condition survey of the museum's collection of approximately 190 wax sculptures, which were both in storage and on view in a dedicated gallery. An interactive survey form was created to document condition issues and rank the sculptures according to conservation and curatorial priorities. Cooperation between the two departments ensured an efficient, consistent, and comprehensive approach that led to a shared working vocabulary and understanding of condition issues.

Figure 1 Photograph thumbnail from the accession card for the wax flower basket, Philadelphia Museum of Art, *c.*1943.

The PMA has one of the largest collections of wax sculpture in the United States, primarily featuring works made in Europe and the Americas between 1650 and 1900. The majority of the collection was given to the museum in 1943 and 1944 by the collector Louise Franchot Munson, who began collecting wax sculptures while on a cycling trip through Switzerland. She describes seeing a portrait miniature in a shop that 'beckoned to me with a magnetism equalled only by my own haste to possess [it]' (Munson 1927: 258). Over time, she amassed a collection wide-ranging in genre and chronological scope. The objects she gave to the PMA include three-dimensional sculptures, seals, votives, and tableaux, as well as a large selection of small-scale, framed relief portraits, ranging from 3.8 cm to 30.5 cm high. In most cases, these relief portraits are attached to a glass, slate, or wood support that is painted, waxed, or covered with textile or paper. The object is then framed with metal or painted wood. Few of the sculptures in this collection are attributed to known artists; of those, most are men.

The survey of the collection found that the most common condition issues included dust, embedded dirt, scratches, cracks (ranging from hairline to gaping), overpaint, old repairs, and loss of surface details. After the initial survey, eleven waxes were selected for analysis, with the goal of assembling a group of objects that spanned multiple centuries and geographies and included both known and unknown makers. This group also represented a range of materials and modes of manufacture, including waxes made from prefabricated kits, from moulds, and those that were hand-built over an armature. In order to establish protocols for future treatment of the collection, a group of seven of the eleven waxes that illustrated a range of common condition issues were treated.

Among the objects selected for treatment was a basket of flowers by an unknown maker working in England in the 19th century. As documented on its accession card, when the basket arrived at the museum in 1943, it was missing its cover glass but overall was in relatively good condition (Fig. 1). The detailed lines impressed into the leaves and the repetition in the size and shape of different types of flowers suggest the basket's individual elements were made with prefabricated moulds that were likely part of a wax flower-making kit, similar to the one produced by Mintorn & Son and now in the Victoria and Albert Museum, London (Fig. 2). These kits became popular in Victorian England, particularly among middle class women who would model wax flowers, arrange them by hand, and display their arrangements under glass in their homes (Shteir 2007; Whitenight 2013; Riley 2017). Several handbooks on the artform were published in the mid-19th century, with lessons on modelling a variety of wax flowers (Mintorn 1844; Francis 1849; Peachey 1851; Skill 1852; A Lady 1855). The popularity of wax flowers was sparked in part by Queen Victoria's love for them; thousands of wax roses were distributed as bridal favours on the occasion of her marriage to Prince Albert in 1840. It further developed in the wake of the 1851 Great Exhibition held in the Crystal Palace, London, which included displays of wax flowers under the category of 'Miscellaneous Manufactures and Small Wares' (Anon. 1851: 795).

While previous scholarship might have dismissed a work like the PMA's flower basket as made by an 'amateur' rather than a professional artist, scholars and curators are increasingly reassessing the gendered biases that lie behind this term and concomitant notions of quality and exceptionalism (Badie Banta *et al.* 2023). Dispelling benchmarks of professional success created by men – and questioning art history's traditional privileging of artistic biography inherited from Giorgio Vasari (1511–1574) – opens new pathways for exploring women's artistic production, as demonstrated eloquently in the recent exhibition *Making Her Mark: A History of Women Artists in Europe, 1400–1800* held at the Baltimore Museum of Art, USA, and the Art Gallery of Ontario, Canada.

At an unknown time between 1943 and 2017, the PMA's flower basket sustained extensive damage while in storage, likely due to insufficient housing and its missing cover glass. Because of this

Figure 2 Mintorn & Son (London), Wax Flower Making Kit, 1850–1860. Box of japanned metal, with wax, paper and wood flower-making materials. Victoria and Albert Museum, London. Given by Miss Mary Scott, W.185 to AAA-1923.

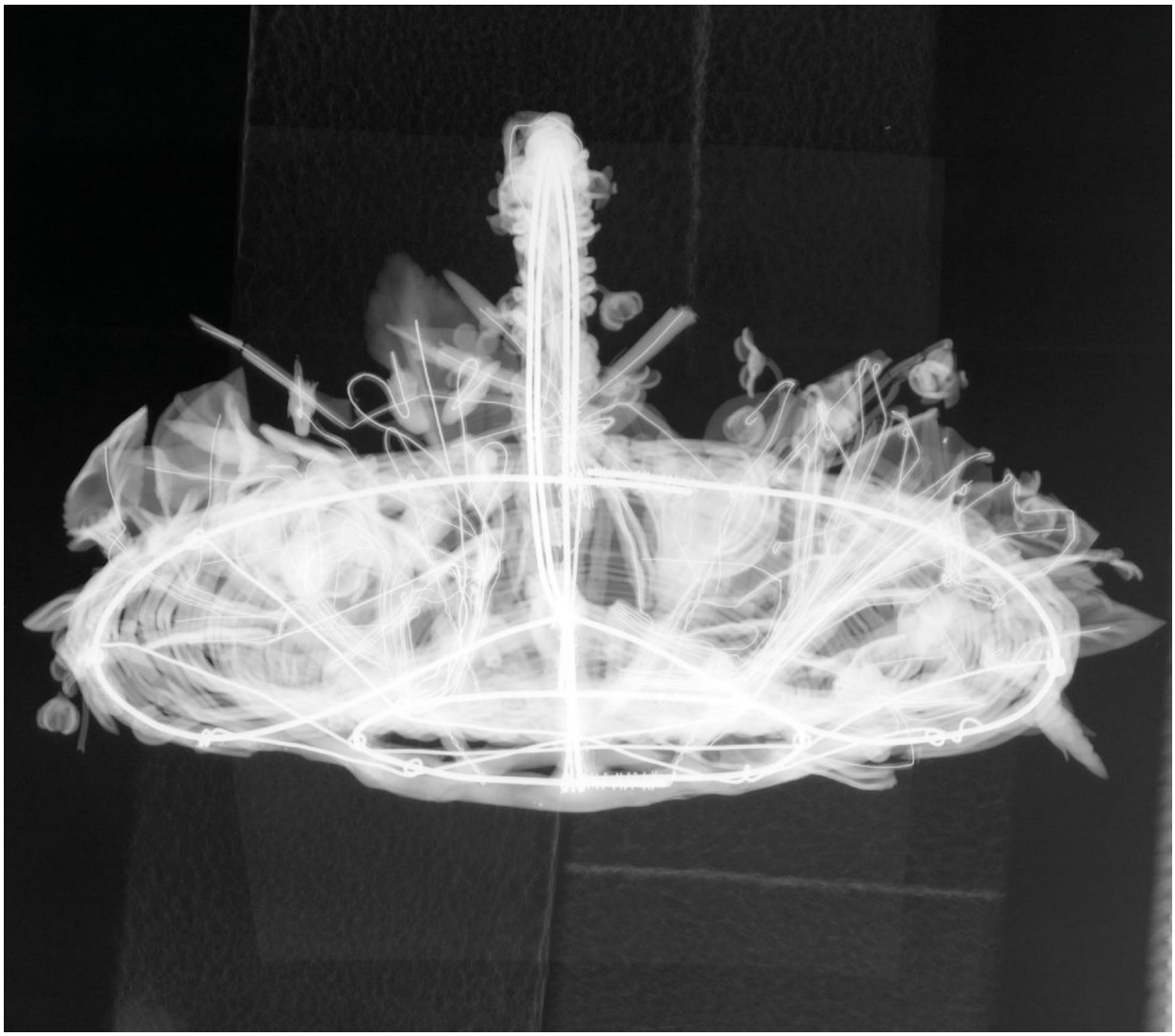

Figure 3 X-radiograph of the basket of flowers, Philadelphia Museum of Art, Conservation Photography Department, 2017.

disfiguring damage, deaccessioning was being considered. However, X-radiographs revealed an elaborate internal structure of metal wires that had been wrapped in string and coated in wax (Fig. 3). This structural system suggested the basket might be safely manipulated and restored. The fine detail of the delicate flowers and leaves were visually compelling, as was the opportunity to conserve and display a sculpture probably by a woman.

Conservation treatment and rationale

Beyond its structural concerns, the flower basket also exhibited similar condition issues to other waxes across the survey. Surface grime and embedded dirt were noted for all the waxes surveyed. Creating cleaning protocols for the group was therefore a high priority. This included variable suction vacuuming using a soft brush, but many of the waxes required additional intervention because the dirt was embedded deep into the surface and vacuuming alone would not remove it.

Preliminary material analysis of the eleven waxes using Fourier transform infrared (FTIR) spectrometry indicates that original material including the basket appear to be a plant- or insect-based medium, likely beeswax.[1] Additionally, the initial data suggest chrome yellow and Prussian blue as the colorants of the green leaves from the flower basket.[2] Beeswax is soluble in organic solvents. Anecdotal evidence, past treatment reports, and a literature review for known cleaning materials for wax miniature sculpture (Murrell 1971: 100–101) include examples of mild cleaning methods with distilled water and soap to organic solvent cleaning with chloroform, toluene, xylene, naphtha, isopropyl alcohol and dilute ammonia. One noted traditional cleaning method includes rubbing a wax surface with butter followed by washing with methanol. Based on archival documents and observational evidence, historically, cleaning wax sculpture frequently involved solubilizing the surface with a solvent and attempting to wipe away the dirt while simultaneously wiping away the top layer of the wax. A vast majority of the waxes surveyed had been cleaned with organic solvents at some point in their history, which was documented in condition reports from the 1970s. This has resulted in a soft or melty looking surface with loss of definition that was also observed in analogous collections including the Victoria and Albert Museum, the Wallace Collection, and the Royal Collection Trust, all situated in London. With limited published information about the cleaning of these types of waxes, informal correspondence and interviews confirmed that similar methods, with less toxic solvents, were still being used in 2018.

Beeswax is insoluble in water and therefore water-based solutions were considered, leading to the use of the Modular Cleaning Program (Stavroudis *et al*. 2005). A series of combinations of pH-adjusted water, surfactants, and chelators, were systematically tested to remove the embedded soiling. A water solution (see 'Materials and cleaning specifications' section below), adjusted to a pH of 8.5 plus citric acid as a chelator, was used to clean and rinse the waxes. The desire to clean the surface of the wax without disturbing it as previous cleaning materials did, also required a light touch. The cleaning solution was applied using a small brush tip onto tiny squares of 1-ply cellulose fibre Kimwipe papers. This process helped control the flow of the solution to small drops applied through the paper, which then acted as a poultice to pull the grime into the paper as it dried (Fig. 4).

Typically, when approaching a reconstruction or major repair, there are many considerations: the type of collection, expectations for display, artist intent, historical or cultural context, and material compatibility and limitations. The goal is generally similar: stability for access, display, travel, storage, and longevity. In the best-case scenario for a restoration, one has clear examples or references of what will be reconstructed. In the case of the basket, the only reference available was a small (24 × 36 mm) 1943 thumbnail from a negative contact sheet on an accession card. When the basket was found crushed in storage, there were many detached pieces scattered randomly around and piled inside the basket. It was not obvious where the displaced pieces were originally positioned. The deformations of the basket were carefully reshaped by hand, referencing the thumbnail image. The integrity of the internal support and pliability of the wax made it possible to do so without any additional damage or major breaks: the inherent vulnerability of the malleable wax also made it repairable. Prior to reconstruction, small globs of a brittle and yellowed adhesive, likely hide glue found inside the bottom of the flower basket, were mechanically removed using scalpels, small hand tools, and water poultices to soften. It is unclear when this adhesive was added but could indicate a restoration prior to the basket arriving at the museum. Small sections of the basket were

Figure 4 (L–R): Basket found in storage in 2017, during, before and after treatment.

repaired using isinglass to adhere fragments. In areas that required more structural support, lightweight Japanese tissue paper was dipped in melted beeswax to create small fills and support.

Until relatively recently, conservators have considered their work as objective and only in the last decade has the field started to openly discuss the inevitable subjectivity of treatment decisions. The illusion of neutrality (Henderson 2020: 199) and dedicating full chapters on the topics of objectivity claiming that (in conservation) 'Objectivity is overrated. Highly overrated' (Muñoz Viñas 2020: 31) is noted in several recent publications. Without full-size images elucidating the details of the wax basket of flowers before it was damaged, it was impossible to reconstruct it back to its original state when it arrived at the museum. Repairing the displaced pieces required an acceptance of unknown change to the placement of flowers and leaves. Knowing that the basket was created using a prefabricated kit, by an unknown artist, made acceptance of these subjective changes acceptable.

Figure 5 Basket of flowers on display with its X-radiography as part of an exhibition focused on modes of making wax sculpture at the Philadelphia Museum of Art.

Conclusion

As stewards of collections of art and cultural heritage, curators and conservators frequently return to the idea of best practices, and we are accustomed to thinking of museums as safe places for storage. However, accidents and disrepair are bound to happen. Whether by well-intentioned but outdated conservation treatments, like using chloroform to clean beeswax, or inadvertent neglect in storage, as in the case of this basket, mishaps will happen. The need and desire to clean, repair, and fix condition issues such as these will continue.

In the case of the PMA's wax flower basket, the attention it received is the result of interdisciplinary work and an updated approach to the collection. Although the sculpture had been donated to the museum in 1943, it had never been put on view. Without some enthusiasm from museum fellows and intervention from conservation, the sculpture might have remained in storage or may even have been deaccessioned. Following treatment of the basket and the six other wax sculptures, a co-curated installation highlighted this collaborative project by focusing on close-looking and different methods of manufacture (Fig. 5). It was particularly gratifying to put the flower basket – now a star object – on view.

In the years since this project was completed in 2018, wax sculptures have become increasingly sought after by museums seeking to expand the representation of women makers in their collections. The fate of the flower basket thus speaks to the shifting priorities in the field of art history and the reflection of these changes in museum collections and installations. For decades, it was left in storage – perhaps because it was considered to be a work by an 'amateur' artist – where it was inadvertently damaged. Its pre-treatment state was thus a reflection both of the inherent vices of wax as an artistic medium, but also human error and benign neglect. Adopting a collaborative approach created the possibility to address both human and material change in this vulnerable medium while simultaneously highlighting the artistic agency of women makers in 19th-century England.

Materials and cleaning specifications

- Beeswax
- Isinglass
- Sturgeon bladder adhesive
- Japanese mulberry fiber tissue paper
- Kimwipes low linter 1 ply papers, lab wipes
- Cleaning specifications: Modular Cleaning Program (Stavroudis *et al.* 2005). Cleaning solution: pH 8.5 (pH 8.5 bicine/sodium hydroxide (10%) pH buffer concentrate), pH 8.5 citric acid/sodium hydroxide (10%) concentrate, 1000uS pH 8.5 adjusted water

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Notes

1. Analysis of materials completed at the Scientific Research Department at the Philadelphia Museum of Art, by Dr. Beth A. Price, Senior Scientist, in 2018.
2. MFTIR and EDS: green leaf colorant data suggest chrome yellow (lead chromate) and Prussian blue $(Fe[Fe(CN)_6]_3$ and $PbCrO_4$. The medium data suggest insect- or plant-based wax, likely beeswax.

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Asger Jorn's oil paint: visual, physical and chemical aspects of solid and soft paint

Ida Antonia Tank Bronken, Wim Genuit, Ineke Joosten and Klaas Jan van den Berg

ABSTRACT This paper investigates the condition of paints in selected paintings by Asger Jorn (1914–1973), contrasting the early works with only solid paint made before 1955 with later examples of soft and dripping paints. The major event of Jorn's move to Paris serves as a linchpin for this study of the visual and physical properties, as well as chemical composition of the paints applied by Jorn, using a broad range of methods for characterisation. Microsamples from a group of 13 of Jorn's paintings were analysed using thermally assisted hydrolysis and methylation (THM) pyrolysis-gas chromatography-mass spectrometry (Py-GC-MS) and scanning electron microscopy with energy-dispersive X-ray (SEM-EDX) spectroscopy. The results were compared with analytical results from a set of samples of soft and dripping oil paints from works by other artists working in Paris within the same timeframe as Jorn. This comparison has brought new insights and an increased appreciation of the complexity of modern oil paint. Contrary to common assumption, a correlation is proposed between the use of so-called cheap materials, substitute oils, decoration paints and the solid and good condition of Jorn's early career paintings.

KEYWORDS Asger Jorn, Py-GC-MS, fish oil, A/S Sadolin & Holmblad, Lefebvre-Foinet

Introduction

The Danish artist Asger Jorn (1914–1973) was a very hands-on artist, and the painting materials that he used were of importance to him. As he stated in 1944: 'It is only nowadays that people become conscious of the fantastic significance of the paint.'[1] Until recently, however, the material aspects of his oeuvre have been understudied. The material practices of Asger Jorn were described for the first time by Bronken (2022a; 2023). Jorn worked fast, sometimes rushing – shipping his paintings to exhibitions while they were still wet, with corks in between to avoid them sticking to each other. Jorn had very strict political principles, consequently breaking contact with fellow artists or refusing awards. But he was also generous with both his time and money and embraced collaboration, often playing the role of a catalyst. His art historical impact is therefore far from limited to his actual artworks, as the intellectual instigations or motivation for many initiatives – such as Cobra, Mouvement Internationale pour un Bauhaus Imaginiste and Situationist International – owe so much to him (Atkins 1968, 1977). We believe that we can come closer to the artist Jorn by knowing more about his working habits, the context in which he worked and the artistic choices behind his paintings. Furthermore, the influence of developments around the availability and production of artists' materials during his lifetime, played an important role. What impact did these factors have on the paint surfaces we see today?

The motivation for this study of Asger Jorn's paintings in public and private Norwegian collections was an investigation of the occurrence of soft and dripping oil paint in paintings made by six different artists – Jean-Paul Riopelle (1923–2002), Pierre Alechinsky (b.1927), Asger Jorn, Karel Appel (1921–2006), Stephen Gilbert (1910–2007) and Pierre Soulages (1919–2022) – all of whom moved to Paris during the 1940s and 50s to establish a career there (Bronken 2022a). Examples of the phenomena of soft and dripping oil paints were found in paintings made in Paris after 1950, at a time of financial stability for the individual artists involved (Bronken 2022a; 2023). The joint examination results of the selected paintings and information gathered on the material practices of the artists led to a hypothesis that French artists' oil paint might be a common factor linking this cluster of soft and dripping paints.

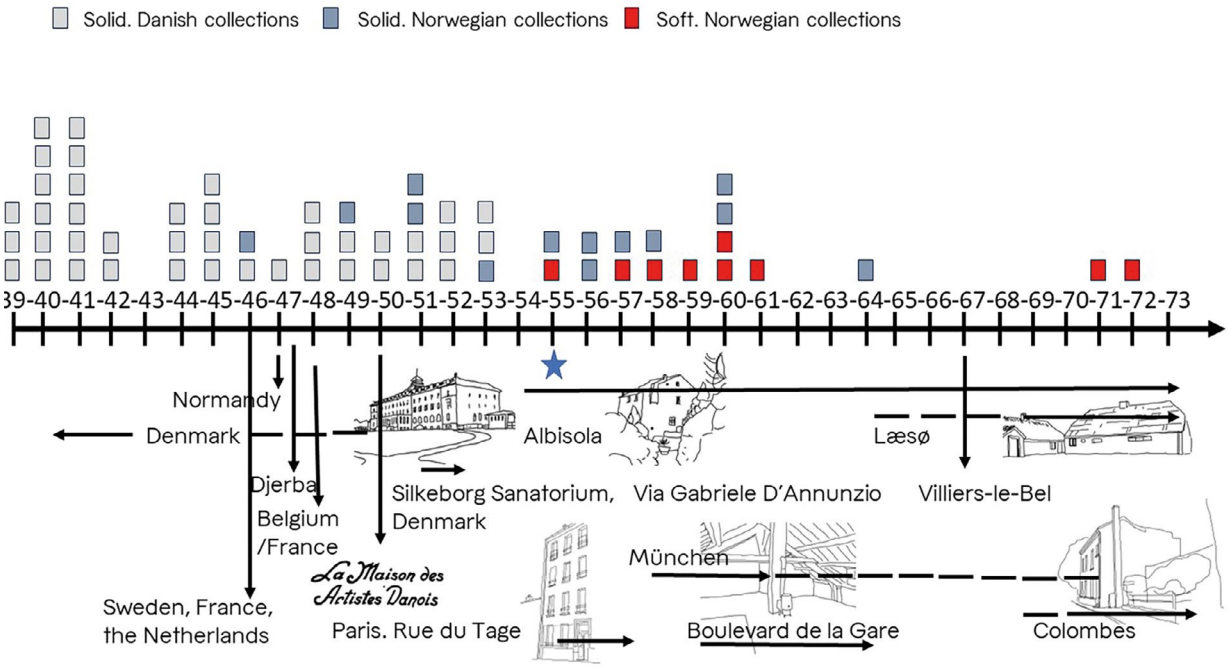

Figure 1 Timeline showing the main working locations for Asger Jorn between the years 1939 and 1972 with the examined paintings placed by year of production (see the Appendix). Soft Norwegian collections: partly soft paints (Bronken 2022a: appendix).

In the same Norwegian art collections, no examples of soft paint in Asger Jorn's artworks were identified in paintings from before 1955 – the year that Jorn moved to Paris more permanently. Should investigation of other collections support the current hypothesis that the use of French artists' oil paint is key in the formation of soft and dripping paints, then the question becomes which contextual factors might be important to explain the observed differences in the examined paints. This paper investigates whether the differences in the condition of Jorn's early versus his later works may relate to potential local variations in the preparation process or formulation of the oil medium. This entails the visual and physical examination of a large group of Jorn's paintings, study of archival sources and historic patents, and chemical characterisation of oil paint media in microsamples from a select group of Jorn's paintings.

Relevance of this study: hypotheses

Condition problems caused by either soft or dripping oil paint have relevance for many international collections of modern and contemporary paintings. For the purpose of this research, paint is classified as 'soft' when it responds to moderate pressure applied in standard museum climatic conditions (e.g. 40–60% RH) by leaving a minute dent (Bronken 2022a). Alternatively, the surface may be covered with a soft exudate, in effect rendering local areas soft. Some examples of solid paints have been documented as having a surplus of mobile fractions, such that they even produce drips.

Several hypotheses have been put forward as to the cause of these soft paint phenomena in relation to insufficient curing of the paint medium into a stable polymeric network. Sulphuric pollution, which has been suggested as a possible cause of water-soluble oil paint, may also be a factor in the development of soft paint (Silvester *et al.* 2014; Bronken 2022a; 2023). So far, the only example of an observed correspondence is that of a soft and dripping paint with sulphur and magnesium-containing crystals at the film surface on a Jean-Paul Riopelle painting, with a statistical correlation between when the artwork was produced and a known period of elevated levels of sulphuric pollution (Bronken 2022a; 2023). Another possible cause of defects such as the formation of soft or water-soluble oil paint could relate to aspects of oil production, including the quality of the original material, heat pressing or preheating routines before paint production, and the use of semi- or non-drying oils. Paint production in Europe underwent significant changes in the 20th century with the development of numerous new products and industrial process innovations (Kokkori *et al.* 2014a,b; Boon and Hoogland 2014).

Contrasting case study: Jorn's early career

As previously mentioned, earlier examination of Asger Jorn's paintings in five Norwegian collections (Bronken 2022a; 2023) gave a strong indication of a correlation between Jorn's move to Paris in 1955 and the soft and dripping paints found in his artworks created in that city. This study was combined with investigation of 50 paintings produced before 1955 in two additional art collections: the National Gallery of Denmark and Museum Jorn, Silkeborg, Denmark. In these works, individual paint colours and areas of wet-in-wet were subject to physical and visual examination (under normal and UV light) to localise the presence of soft and dripping paint (Fig. 1) (see the Appendix).[2] Indeed, no soft or dripping paint was observed, corroborating the assumption that Jorn's soft paintings only originate from his French period. It should be noted that the method of examination did not cover the potential existence of other paint defects, such as water sensitivity and soap formation.

With one possible exception, all the investigated paintings pre-1955 were found to be solid. The exception was *Pot-belly – on fire* (1953), visual examination of which suggested that it might have similar issues to paintings with soft paint, as the black paint fluoresced under UV light and exhibited severe delaminations like those observed in connection with soft paints (Bronken 2022a). Examination of soft and dripping paint has shown that the majority of the investigated paints with soft areas similarly fluoresced under UV light where exudate had gathered on the surface (Fig. 7b).

Examples of solid paint in Jorn's early works: *Composition* 1946 and *Masks* 1949

Composition (1946, cat. no. 440) and *Masks* (1949, cat. no. S.62) were investigated in more detail. Both paintings are believed to have been made in Denmark and contain only solid paints (see the Appendix). Asger Jorn's material practices after 1955 have been described at length by Bronken (2022a). This section presents additional information obtained on his use of materials.

Before 1936, between late 1939 and 1945 and from May 1951 to October 1953 are probably the only three periods for which we can be certain that Jorn used materials purchased in Denmark (Fig. 1). Before the trip to Djerba in Tunis in 1947, he acquired a large art supply most likely from Denmark (Ågerup 1984; Bronken 2022a). Again, before his trip to Switzerland in 1953, he stocked up on materials from the Copenhagen office of A/S Sadolin & Holmblad in Denmark who shipped it to Jorn in Silkeborg (Bronken 2022a; 2023). Since Jorn moved around for most of his career, the situation is not straightforward. However, for the majority of the period between late 1939 and 1953, Jorn worked in Denmark or with paint from Danish retailers. During the war, for example, the artist reportedly bought some supplies from Henning Larsen's paint shop where Egil Jacobsen worked (Jespersen 1967). *Composition* (cat. no. 440) is listed in the catalogue raisonné as made in Dragør (Atkins 1968), which is known to have had a A/S Sadolin & Holmblad paint shop (Bronken 2022a; 2023). Members of the Sadolin family recalled that Asger Jorn stayed with them on several occasions when he was younger. The family extended invitations to artists to stay with Esther Margrethe Schultz and Gunnar Asgeir Sadolin (1874–1955) at Vestgrønningen 18–20 in Dragør.[3] This creates a further plausible link between *Composition* and the paint brand A/S Sadolin & Holmblad. The painting was made with colour fields and little use of wet-in-wet, following a sketch of the composition in pencil on a thin white ground which may have been applied by Jorn himself (Bronken 2022a).

Shortly after the war Asger Jorn was central to the founding of the artist movement Cobra (after the cities Copenhagen, Brussels and Amsterdam), whose main members included Christian Dotremont (1922–1979) and Pierre Alechinsky from Belgium, and Constant Nieuwenhuys (1920–2005) and Karel Appel (1921–2006) from the Netherlands. The fast-changing group existed for a short period from 1948 until 1951, resulting in several joint exhibitions, magazines and group projects. The painting *Masks* (cat. no. S.62) (Fig. 2a)[4] was made in 1949, the year in which the two collaborative Cobra painting workshops were held in Denmark (Atkins 1968). Jorn is known to have acquired paint from Stelling's paint shop in 1949 for the Cobra workshop in Bregnerød (Thoresen 1987). In general, *Masks* is in a solid and stable condition. The paint layer is built up with four dominant paint colours, each with different surface gloss. The black paint has a solid and highly glossy surface similar to oil enamel paint which does not fluoresce/luminesce under UV light (Fig. 2b), while the grey-blue paint mixture is distinctly matte. The white and brown paints have an intermediate gloss.

These observed differences between paint areas with high gloss resembling decorative house paint

Figure 2 Asger Jorn, *Masks* (1949) 49 × 100 cm: (*left*) under normal light and (right) UV light. (Photos: Børre Høstland, The National Museum. © Donation Jorn / BONO, Oslo.)

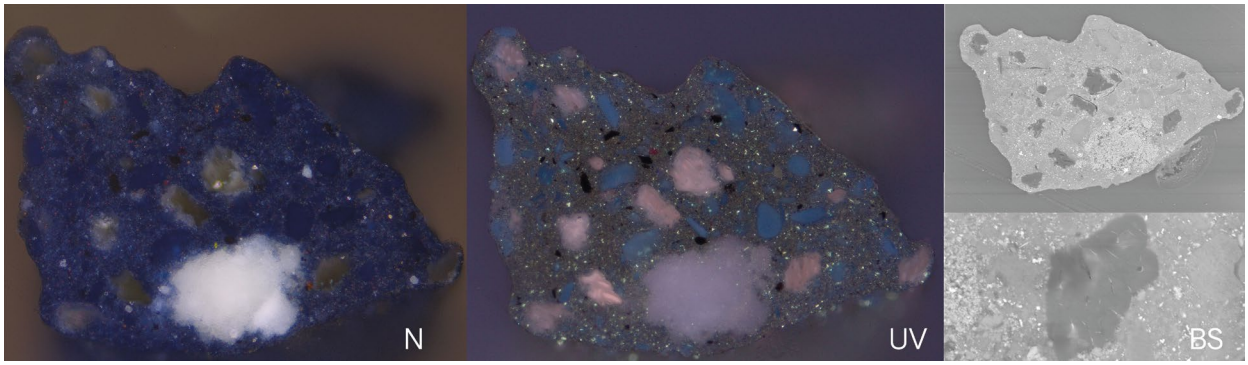

Figure 3 Asger Jorn, *Masks* (1949): cross-section of blue matte paint (*left)* under normal light (N); (*middle*) under UV light (UV) and (*right*) details in SEM-EDX backscatter (BS).

and other colours that are matte make it likely that *Masks* was not painted with ordinary artists' tube paint due to its excellent condition. Examination of a cross-section from the grey-blue matte paint shows clusters of what appear to be starch grains (pink under UV light) (Fig. 3). This points to either a possible addition to the paint by Jorn or an example of the many commercially adapted formulas used during the (post-)war shortages in the paint market. The matte blue colour is primarily cobalt blue with traces of ultramarine and Prussian blue.

Danish paint production: the impact and development from the Second World War

Since Asger Jorn spent most of his time in Denmark during the war and before his confirmed move to Paris and Italy, the context of Danish paint production is relevant for many works produced in this period. One of the most prominent paint manufacturers in Denmark was A/S Sadolin & Holmblad (Fig. 4), whose products were used by Jorn both in Denmark and France (Bronken 2022a; 2023). A/S Sadolin & Holmblad was a leading producer for both industrial and artists' paints. The Second World War impacted every paint company as evidenced by newspapers and other publications that describe a radical change in oil paint formulations. For example, the Danish legislation of 14 March 1941 demanded that all use of linseed oil or replacement materials for sale, and not intended for personal use, should be approved by the Ministry of Trade, Industry and Shipping (Rasmussen 1942). This regulation must therefore also have included artists' paint production although in all probability it was mainly intended for the bigger market of industrial paints. The first two years of the war had such an impact on paint production that *The Painter's Craft* by Einar Robert Rasmussen (b. 1909), the eldest son of the owner of the Robert Rasmussen paint firm, paid particular attention to replacement materials such as 'Swedish cod liver paint' with cod liver oil mixed with rye flour among other ingredients (Rasmussen 1942), or to completely new products as alternatives.

In 1942, a Danish newspaper reported that:

> The paint and lacquer industry counts on a decline in necessary raw material supply for the coming year, even if in many respects they are replacement materials. Linseed oil is in demand, but the industry has some herring and cod liver oil at its disposal, … Linseed oil is

Figure 4 Manufacture of colour and paints, A/S Sadolin & Holmblad, *c.*1930. (Photo: Royal Danish Library.)

> extended by mixing in Cell wool waste, Casein, artificial resin, water and more, in such a way that creates an emulsion that can be used for indoor use and outdoor woodwork … the distribution issues are in such a way ensuring that the necessary activity of the industry is kept.[5]

A Danish painter's book edited by laboratory superintendent J.S. Aabye at the Technology School in Denmark states two years later:

> Animal oils are used for the colour and lacquer industry, particularly during the war. The most important are cod liver oil and fish oil. Cod liver oil has quite good drying properties, but herring oil can also be used, particularly if it is made from fresh fish. Unfortunately, many of the herring oils, used in the market, are made from waste products or even depraved fish, when the oil becomes much darker and does not have the same drying properties.[6]

The book mentions many other oils as well. As it was printed during the war it confirms that these were known replacement materials at the time. Early in the war, A/S Sadolin & Holmblad had already been looking at replacement materials and were quick to state that they were in charge of the situation:

> Great difficulty has affected the paint industry, which in peacetime gathers its raw materials from all five continents, and that today are cut off from the majority of its suppliers. In the laboratories one has been busy solving the many problems, and to a great extent succeeded in doing so. In most new colours there is fish oil, which as known does not smell good; but Dr. techn. A.N. Neergaard, Sadolin and Holmblad, claims that they have succeeded in removing the unpleasant smell; and also found a method to increase the drying index, making it an ordinary paint.[7]

These statements, made in 1942, probably relate to a patent A/S Sadolin & Holmblad registered on the treatment of drying oils.[8] The patent states that it applies from September 1943, although the official date of the patent is 6 March 1950. In support of the notion that this is the technique reported in the newspapers, the patent text refers directly to fish oil:

Figure 5 Asger Jorn and other artists experimenting with modern materials during the conference in Alba, Italy in 1956. (Photo courtesy Museum Jorn archive.)

> According to the invention, crude triglycerides, such as crude linseed oil, crude fish oil and crude castor oil, can be used as starting material. Triglycerides can also be used that have already been refined to a greater or lesser extent or otherwise pre-treated, e.g. lacin oil, filtered fish oil and refined mustard seed oil. … The oils according to the invention can be used in the usual way, e.g. for paint colours, varnishes of all kinds, with resins as well as natural and artificial opals, and printing inks.[9]

In the first few years after the war, the situation for the paint industry deteriorated further as demand for paint increased while the available supply of oil remained low or further diminished. In 1947–48, archival sources point to the production of local crops of flax to provide local linseed oil both in Denmark and England (Bronken 2022a; Bornemann Mogensen 2022). Around 1949, linseed oil became available again and restrictions were lifted.

Jorn's intentional use of industrial paint

Although the situation described above relates mainly to the production of industrial paints, the restrictions had a practical impact for artists' paints as well. A/S Sadolin & Holmblad also made artist- and student-grade tube paints and might have used their new formulas for these paints (Bronken 2022a; 2023). Jorn used industrial paints regularly – not necessarily because of limited financial resources, but as an intentional part of his artistic project. He discussed with fellow artists such as Guiseppe Pinot Gallizio (1912–1964) how to allow industrial progress and new products to become a vehicle for art (Bronken 2022b).

One well-known example is the congress in Alba in 1956 in which modern materials were central to collaborative artistic experimentation (Fig. 5) (Bronken 2022a).[10] More than technique, the materials and process became part of the artwork as a statement on Jorn's theoretical discussions and ideas. One example is the series of *Luxury* paintings that exhibited the distinct use of enamel paints such as Ripolin and Sadolux (Fig. 6) (Bronken 2022a,b).

In images of Jorn at work in his studio he can be seen seated on the floor making the *Luxury* paintings surrounded by a few pieces of furniture filled with various tins and tubes. In one shot, Jorn is working on the floor with threads dipped in thinned paint in a bowl, with a tin of grey Ripolin paint placed next to the canvas on the floor (Fig. 6). The shiny and wrinkled paint observed in a handful of paintings is typical of

Figure 6 Asger Jorn in his studio at 143 Boulevard de la Gare, Paris, painting one of his *Luxury* paintings with string. A Ripolin tin can be seen on the floor next to the canvas. (Photo: Ib Hansen, courtesy Museum Jorn archive.)

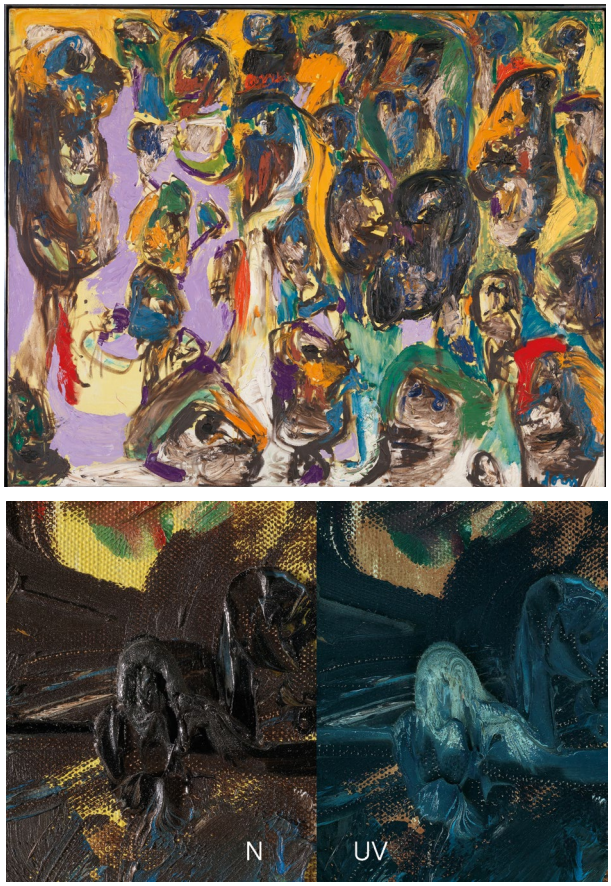

Figure 7 (*Top*) Asger Jorn, *Le ciel jaune* (1961) 130 × 160 cm. (*Bottom*) Details from Asger Jorn, *Le ciel jaune* (1961): *(left)* under normal light and (*right*) UV light. (Photos: Børre Høstland, The National Museum of Norway. © Donation Jorn / BONO, Oslo.)

enamel paints such as Ripolin (Kokkori *et al.* 2014a). The *Luxury* paintings examined in connection with this study are all in excellent condition: they were made after the Alba conference experiments at a time of relative financial stability. They are examples of the use of cheaper or non-artist paint materials.

Example of soft paint: *Le Ciel Jaune* 1961

Jorn continued to use paint from both tins and tubes after a gradual improvement in his financial circumstances from 1955 onwards. By 1961 he was living for six months of the year in Paris and the remaining six months in Albisola in Italy. His studio in Paris at Boulevard de la Gare 143 was located close to the train station on the Rive Gauche (Left Bank) (Fig. 6) where several paint shops could be found, such as Lefebvre-Foinet at Rue Vavin. Among the paintings examined to document the various paint properties and physical characteristics of soft paint in Asger Jorn's paintings is *Le ciel jaune* from 1961. While no dripping is observed in this painting, the black pastose paint areas have a layer of exudate and the paint is distinctly soft; the softest details fluoresce under UV light (cat. no. 1334) (Fig. 7b). The canvas features a stamp from Lefebvre-Foinet as well as some custom stamps from Paris, indicating that the painting was made in Paris.

Paint analysis

Paint samples taken from 11 paintings were analysed by thermally assisted hydrolysis and methylation (THM), pyrolysis-gas chromatography-mass spectrometry (Py-GC-MS) and scanning electron microscopy with energy-dispersive X-ray spectroscopy (SEM-EDX) (see the 'Experimental' section below for details of the applied analytical techniques). Results of the analyses are summarised in Table 1. All the paint samples were found to contain a drying oil as the primary binding medium. In addition to information on (inorganic) pigments and extenders, results of Py-GC-MS analysis are presented in the form of ratios of different fatty acids of the (drying) oil present. Fatty acids are mostly present as triglycerides, but all are hydrolysed to fatty acids in the Py-GC-MS preparation process. Large datasets such as these can be used potentially to provide clues relating to composition and degree of aging and/or oxidation (Mills and White; Van den Berg 2002; Van der Werf and Van den Berg 2022).

Table 1 Summary of SEM-EDX and Py-GC-MS results. The ratios determined by Py-GC-MS: C6-C10 fatty acids/palmitic acid (C6-10F/P); azelaic/palmitic acid (A/P); lauric/myristic acid (L/M); myristic/palmitic acid (M/P); palmitic/stearic acid (P/S); oleic/stearic acid (O/S); monohydroxy-C18:1/stearic acid(oxy1/S); epoxy-&dihydroxy-C18/stearic acid (oxy2/S). In each column, the colours indicate a relative scale ranging from green (low) through yellow to red (high).

Painting	Year	Sample code	Colour	Paint condition	SEM-EDX	Ratios determined from Py-GC-MS								GC-MS, other findings
						C6-10F/P	A/P	L/M	M/P	P/S	O/S	oxy1/S	oxy2/S	
Shutter No III	1941	C.nr. 231 S2	Orange 1	Solid	Cadmium pigment upper layer, zinc white	0,2	0,8	0,6	0,1	2,4	0,1	0,1	0,1	Bone black (trimethylphosphate, C9-C17 alkenes, alkylbenzens), Pinaceae resins
Shutter No III	1941	C.nr. 231 S3-1	Green 1	Solid	Chrome green/viridian + cadmium yellow	0,1	2,9	0,3	0,1	1,4	0,0	0,0	0,1	Pinaceae resins, hydrocarbons, cyclohexanone
The troll and the birds	1944	C.nr. 348 S1-1	Green 1, yellow 1, ground	Solid		0,3	1,1	0,5	0,1	1,7	0,0	0,0	0,4	Starch/gum, Pinaceae resins, bone black
Komposition	1946	C.nr. 440 S2	Black 1	Solid	Bone black, silica/kaolin, and mars black/ochre	0,3	0,3	0,3	0,1	1,8	1,8	0,5	0,1	Aged resin, indigo, starch?
Masker	1949	C.nr. S.62 S2	Black 1 (glossy)	Solid	Kaolin	0,3	0,8	0,6	0,1	1,5	0,8	0,2	0,4	Pinaceae resins, bone black
Masker	1949	C.nr. S.62 S4	Blue 1 (matt)	Solid	Cobalt blue, with inclusion of Prussian blue?	0,2	1,2	0,4	0,1	1,3	0,2	0,1	0,6	Starch/gum, Pinaceae resins, bone black, wax, cyclohexanone
Untitled	1950	C.nr. 631 S1-1	Red 1, ground	Solid		0,2	1,0	0,8	0,1	2,7	0,2	0,3	0,1	Starch/gum, bone black
Havets Guder	1951	C.nr. 691 S1	Black 1	Solid	Mars black, ochre, calcium filler, barium sulfate, kaolin, bone black, cadmium red, dolomite	0,3	1,0	1,0	0,0	1,6	0,6	0,4	0,4	
Pot-belly – on fire	1953	C.nr. 804 S2-1	Black 1	Solid	Bone black	0,2	1,4	0,5	0,1	1,2	0,1	0,8	0,7	Pinaceae resins, bone black
Communauté de joie	1960	C.nr. 1232 S7b	Blue 1	Solid, So-W	Ultramarine, cerulean, gypsum	0,1	1,1	0,6	0,0	1,8	0,0	0,0	0,1	Bone black
Le rossignol monstreux/amoureux	1960	C.nr. 3121 S2b	Green 2	Solid, matte and cracking (drips)	Viridian (chrome green?)	0,4	8,8	0,2	0,1	3,0	0,3	0,0	2,0	(skin grease contamination)
Le ciel jaune	1961	C.nr. 1334 S1	Black 1	Soft, slightly soft	Bone black, talc, kaolin	0,2	3,1	0,3	0,0	1,3	0,2	0,7	0,9	Bone black
Hvisken	1971	C.nr. 1933 S4	Blue 1	Solid, So-W	Barium sulfate, ultramarine, gypsum	0,6	4,2	0,1	0,1	1,6	0,1	0,0	0,2	Starch
Paint sample from tin for reference	1972	Paint tin: Jorn's Colombes studio	Red	Solid		0,1	1,5	0,2	0,0	1,6	0,0	0,2	0,3	PR3 pigment

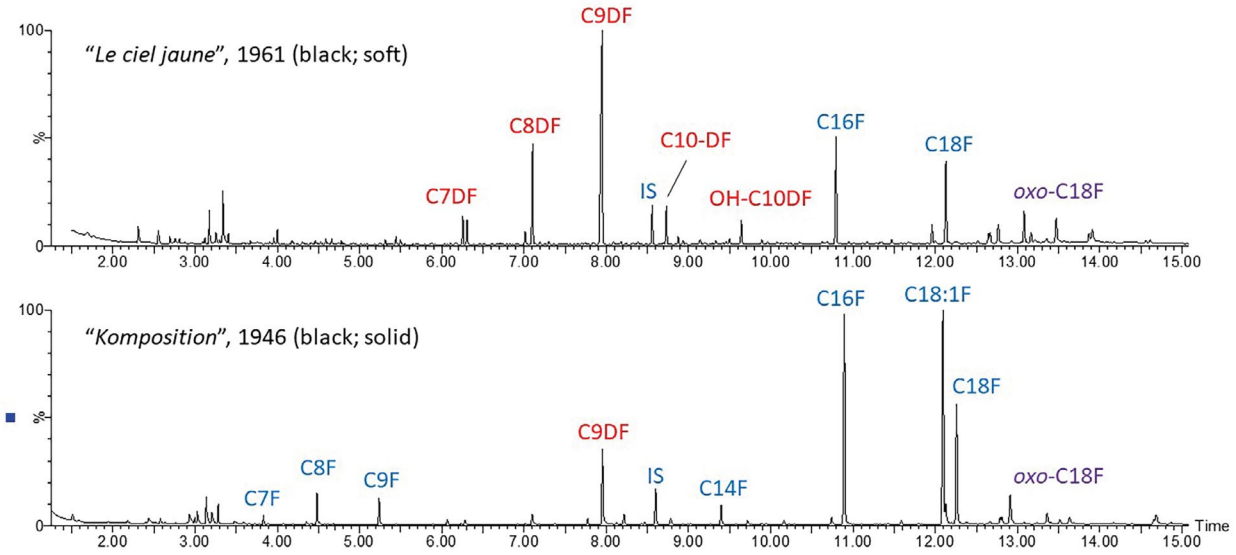

Figure 8 Analysis results from microsamples taken from paintings with catalogue numbers 440 and 1334.

Two revealing examples of Py-GC-MS chromatograms of samples of bone black-containing soft (top) and solid paint (bottom) paint are shown in Figure 8. Clear differences can be observed in the relative amounts of short-chain fatty monoacids (C7F, C8F, C9F) and diacids (C7DF, C8DF, C9DF and C10DF), which are formed from longer unsaturated fatty acids by oxidative degradation.[11] Since these compounds are formed in competition with the oxidative polymerisation process, they may be considered indicators of sub-optimal curing of the paint, and thus predict problematic paints (Van den Berg *et al.* 2021; Bonaduce *et al.* 2019). Indeed, high concentrations of the short chain fatty mono- and diacids have been found in different types of soft, water-sensitive and other problematic paints (Lee *et al.* 2018; Bronken 2022a). Rather unexpectedly perhaps, the mono-unsaturated oleic acid was detected in high abundance in the sample from *Composition* (cat. no. 440) (Fig. 8). Why the solid black paint contains so many unreacted bonds remains unexplained at this point. Nevertheless, it is known that in some cases the double bonds may be stabilised in the paint by plate-like structures consisting of alternating layers of close-packed fatty acid chains and zinc oxide, as has been shown for zinc white paints (Rogala *et al.* 2010: 103).

The aforementioned unevenly fluorescing bone black paint in *Pot-belly – on fire* (cat. no. 804) is not soft (according to the definition in Bronken 2022a), while the paint surface is similar to that in *Le ciel jaune* (cat. no. 1334) (Fig. 8). Py-GC-MS analysis shows elevated quantities of fatty diacids (A/P 1.41), which is common for softer paints. However, compared to the later soft paint, the relative amount of short monoacids is comparatively low with an C6-10F/P of 0.17. This confirms that the fluorescent paint skins in both paintings are reflected in relatively high A/P ratios (Bonaduce *et al.* 2019). Whether the low abundance of small monoacids is significant for the softness of the paint is not clear; the variation of the C6-10F/P ratio is too high in the analyses. Furthermore, the variation could also relate to the pyrolysis and derivatisation yields in the presence of different pigments (Lee *et al.* 2018). The other striking difference is the relatively high abundance of C14F, which is a potential marker for the use of fish oil (see below). The results in Table 1 show relatively high amounts, noted as M/P ratios, across the board for the pre-1951 paints compared to the later paintings. This could indeed indicate the presence of fish oil in the paintings created around the Second World War. However, there are two notable later exceptions: cat. nos. 1321 and 1933 (see the Appendix).

The long chain fatty acids C14F (myristic acid), C16F (palmitic acid), C18F (stearic acid) and C18:1F (oleic acid)[12] are originally present in the paint as stable compounds. The C14 fatty acid is always present in low concentrations in drying oils; however, in fish oils they have been reported to be present in slightly higher concentrations (La Nasa *et al.* 2021). La Nasa *et al.* report values of M/P > 0.1 while L/M < 1. C18:1F is slightly reactive and may slowly react to form oxidised short (C9DF) and long chain oxidised fatty acids (epoxy- and dihydroxy FA18; present in Table 1 as *oxy2/S*). Other potentially significant fatty acids detected with Py-GC-MS include unsaturated

hydroxy fatty acids, intermediate oxidation products in the curing process (Van den Berg 2002); these are presented as *oxy1/S*. At this stage, however, the significance of these 'post-oxo' fatty acids is not known and is the subject of further study.[13]

A better indication of strong heating of linseed oil is given when characteristic cyclic markers – alkylphenylcarboxylic acids, predominantly 9-(2-propylphenyl) nonanoate and 8-(2-butylphenyl)octanoate) – are detected as methyl esters in the GC chromatograms (Van den Berg 2002). However, these markers have not been detected in any of the paint analyses. As already stated, consistently quantifying datasets such as those in Table 1 may be useful. Indeed, trends derived from short chain/long chain fatty acids ratios related to healthy vs problematic paints are supported as well as some trends of values of lauric/myristic acid (L/M), potentially indicating the presence of fish oil; other ratios are too varied to be significant in this context. The analytical results have to be used with caution as there is a plethora of known and unknown factors that may influence the ratios to some unknown extent: the pigments, undetectable compounds such as driers, environmental circumstances under which the paintings were kept, etc. Variations in analytical conditions, contaminations from treatment of the sample etc. may also be of influence. Nevertheless, by presenting and discussing this information, the authors hope to show the potential of large Py-GC-MS datasets in this way.

The perception of the quality of paints

One important reason to look more closely at the artworks by Asger Jorn that date before 1955 was the solidified opinions about condition problems and a relation to economic or biographical issues. First, the statements made, particularly by Danish conservator Bernt Hacke, strengthened the reason to investigate a larger group of early Jorn paintings. Hacke's claims have affected our view of Cobra paintings to this day. In 1982, he wrote:

> This category includes a series of problems concerning damage to the paint layer caused by using the wrong techniques such as, for example, binders (oils) that never dry, excessively strong binders that tear and darken the whole paint layer, other material additives that have a negative effect on the paint layer, and so on. On this subject, it should be mentioned that this is a particular problem for our collections of COBRA painters. … When the paintings were made in the 30s and 40s it was almost impossible for artists to acquire materials of some quality. Furthermore, the artists' economic situations would not allow them to invest in materials of better quality. The paintings are therefore to a large extent made with easily available materials, such as wall paint (oil and glue), decoration paints, and homemade colours, for example, dry pigments in herring oil (during the war) and other oils unsuitable for the purpose.[14]

Hacke is probably not implying that the artists were using the wrong techniques, but that they had to use what was available. It is important to distinguish between personal technique and commercial production processes and paint formulations. Jacobsen mixed paint tubes for Larsen from fish oil and pigments, which supports the assumption that the lack of raw materials broadly affected paint manufacturing, including artists' tube paints. Since companies such as A/S Sadolin & Holmblad in Denmark claimed success with their replacement formulas, there might be a higher chance of mixtures with fish oil contained not only in their tins but also in their tube paints. Several reports on Jorn's many collaborative workshops with other artists point to accounts of using personal mixtures and material experimentation.

There are good reasons to consider the possible use of fish and whale oil in the paint production during the Second World War and in the subsequent years (Wedvik 2019, 2021; La Nasa *et al.* 2021; Bornemann Mogensen 2023; Bronken 2023). Analyses of the oil paints with Py-GC-MS showed no indication of mediums other than oil: indeed, the analytical findings support a potential correlation of fish oil in paintings made in Denmark with the solid paints in the early works. Exceptions are to be found in two later paintings with local soft paint (cat. nos. 1321 and 1933) (see the Appendix): one made in Denmark and one believed to have been made or stored in Paris (Bronken 2022a).

While there is no full overview of the actual effect of the wartime legislation and lack of materials on the industry, archival material does show that there was a need to use whale and herring oil in Denmark during and after the war until 1948 (Bronken 2023). As artists partly used paint intended for house or decoration purposes, we might expect that both A/S Sadolin &

Holmblad and Stelling might have used fish oil for their artists' paints; replacement oils could be present in many paintings from the Second World War onwards.

Consequences for our view on Asger Jorn's artistic practice

Asger Jorn was among several artists who sacrificed both their health and security to achieve their artistic goals. The collapse of Cobra came about when both Jorn and co-founder Christian Dotremont lay hospitalised together with tuberculosis in Silkeborg, Denmark (Atkins 1968; Bronken 2023). The idea that a certain group of his artworks might be in a fragile state because of economic problems or highly experimental practices has been cemented as true. Because of this, it is even more important to challenge this idea. The fragmented information we do have about Jorn's solutions to financially challenging situations points to him asking for donations or trading artworks for paint from reputable suppliers such as Stelling and A/S Sadolin & Holmblad. When experimenting with industrial paints and novel materials, there are several reasons to connect this to artistic influences such as Picasso and the discussions around the circle of artists, including Pinot-Gallizio: first in the Mouvement International pour un Bauhaus Imaginiste (MIBI) and later in the Situationist International (SI). These suggest irregular use of new products or industrial brands not just out of need, but as a conscious choice.

Since the idea of a so-called 'wrong technique' or bad practice often leads to blame for condition issues, it is particularly important to distinguish between systemic changes, international trade issues and what might be personal choice and hence an intended physical outcome that is observable in an artwork. Furthermore, this extended condition survey shows that in paintings made at the height of both personal and economic problems in Jorn's life, the paints are solid and generally stable. On the other hand, when Jorn became more successful, more artworks exhibit occasional examples of soft paint and other issues associated with this problematic condition (Bronken 2022a).

Conclusion

From examination of a select group of 72 works by Asger Jorn, we have established a strong link between replacement materials, used during and shortly after the Second World War, and canvas paintings in Denmark. Clearly, the wartime shortages and (partial) replacements of traditional linseed oil paint binders have not led to problematic, soft paintings in Jorn's oeuvre, nor did the painter's critical financial situation early in his career. However, his later work in which soft paints do occur can now be linked more strongly to the artists' paints he purchased and used while in Paris. We propose that a systematic examination of patents for oil products for the paint industry is an under-researched source that demands further study. Another relatively unstudied area is the extent to which the challenges in material supplies impacted other European (e.g. Norwegian) artists and fine art paint manufacturers.[15]

Experimental

Microsamples of individual paints were analysed. Thermally assisted hydrolysis and methylation (THM), pyrolysis-gas chromatography-mass spectrometry (Py-GC-MS) analyses were performed using either a Thermo Scientific Trace GC-MS or a Thermo Scientific Focus GC-MS instrument, both equipped with a Frontier Laboratories 3030D pyrolyser. Paint samples were put in a stainless steel Eco-cup to which was added 5 µl of a tetramethyl ammonium hydroxide (TMAH) solution (Sigma Aldrich 334901, 25% TMAH in methanol, diluted to 5% with methanol) including a C13F internal standard. After evaporation of the methanol solvent, the cup was placed in the pyrolyser and the analysis started. The results were analysed using the AMDIS (Automated Mass Spectral Deconvolution and Identification System) software package developed by the National Institute of Standards and Technology (NIST) and the ESCAPE (Expert System for Characterisation with AMDIS Plus Excel) report template developed at the Cultural Heritage Agency of the Netherlands (RCE) in collaboration with the Getty Conservation Institute (USA). Details of this analytical procedure have been published by Van Keulen and Schilling (2019). When sufficient material was available, scanning electron microscopy with energy-dispersive X-ray (SEM-EDX) analysis was conducted on the paint samples using a JEOL IT700HR FEG (field emission gun) SEM with a JEOL SDD detector and JEOL software. Analysis was carried out under 20 kV in a low vacuum (30 Pa).

Appendix: List of works by Asger Jorn examined for physical softness

Title	Date	Cat. No[1]	Solid/soft[2]	Country of execution[3]
Hills at Sminge	*c.*1933	20	Solid	Denmark
Remise	1934	25	Solid	Denmark
Landskab	1934	26	Solid	Denmark
Vej i by	1934	31	Solid	Denmark
Uden tittel	1935	37	Solid	Denmark
Portrait of Jens August Schade	1937–44	63	Solid	Paris
Uten tittel	1937	S.10	Solid	Paris?
On the way	1938	85	Solid	Paris
The tortoise, I	1938	93	Solid	Denmark
Le printemps	1939	96	Solid	Denmark
Untitled	1939	107	Solid	Denmark
The green beard	1939	119	Solid	Paris
Untitled	1940	139	Solid	Denmark
Uden titel	1940	146	Solid	Denmark
Ulysses	1940	150	Solid	Denmark
Grædeøjne	1940	153	Solid	Denmark
Udsigt over Kralundborg fjord	1940	S.21	Solid	Denmark
Untitled	1940	192	Solid	Denmark
Shutter No I	1941	229	Solid	Denmark, Copenhagen
Shutter No II	1941	230	Solid	Denmark, Copenhagen
Shutter No III	1941	231	Solid	Denmark, Copenhagen
Shutter No IV	1941	232	Solid	Denmark, Copenhagen
Shutter No V	1941	233	Solid	Denmark, Copenhagen
Shutter No VI	1941	234	Solid	Denmark, Copenhagen
Four and three	1942	258	Solid	Denmark, Nørre Lyngby
Untitled	1942–44	S.33	Solid	Denmark
Røde syner	1944	346	Solid	Denmark
The troll and the birds	1944	348	Solid	Denmark
Sommerfantasi	1944–45	S.38	Solid	Denmark
Untitled	1945	409	Solid	Denmark
Untitled	1945	418	Solid	Denmark
Night feast	1945	419	Solid	Denmark
Untitled	1945	S.42	Solid	Denmark
Composition	1946	440 (AJ-I)	Solid	Denmark, Dragør
Untitled	1946	480	Solid	Paris, Nice, Amsterdam
Abstraksjon	1947	545	Solid	Paris, Nice, Amsterdam
Untitled	1948	554	Solid	Tunis
Det store tog	1948–50	582	Solid	Denmark, Hjarnø
A face may contradict the mirror	1948	586	Solid	Belgium and France
Untitled	1949	595	Solid	Denmark
Untitled	1949	624	Solid	Denmark, Bregnerød
Masks	1949	S.62	Solid	Denmark
Untitled	1950	631	Solid	Humlebæk, Islev, Bergen?
The golden swine	1950	645	Solid	Humlebæk, Islev, Bergen?
Family	1951	684	Solid	Suresnes
The eagle's share II	1951	690	Solid	Suresnes
Sea gods I	1951	691 (AJ-II)	Solid	Suresnes/(Silkeborg)
The Feast of St. John, I	1951–53	729	Solid	Suresnes/Silkeborg
Undselig hyrdescene	1952	742	Solid	Silkeborg
Despair	1952	759	Solid	Silkeborg
Livshjulet	1952–53	797	Solid	Silkeborg
Pot-belly – on fire	1953	804	Solid	Silkeborg
Swiss picture	1953	825	Solid	Switzerland (and Italy)
Swiss guard	1953–54	S.84	Solid	Switzerland and Italy
What now	1953–54	840	Solid	Switzerland and Italy
Sagra dei Pesci	1955	S.115 (AJ-III)	Soft/solid	Italy, Abisola
Composition	1955	925	Solid	Undetermined
Animal	1956	967	Solid	Undetermined
Poetisk Gratifikassion	1956	1008	Solid	Undetermined
C'est grace à nous	1957	1020 (AJ-IV)	Soft/solid	Paris, Albisola
Attention danger !	1957	1028	Solid	Undetermined
Schwächeanflug	1958	1036	Solid	Undetermined
Il faut les garder	1958	1095 (AJ-V)	Soft/solid	Munich, Paris, Albisola
Varulv	1959	1174 (AJ-VI)	Soft/solid	Munich, Paris, Albisola, Denmark
Communauté de joie	1960	1232 (A-VII)	Soft/solid	Paris
Perspective troublante	1960	1243	Solid	Undetermined
Le cri	1960	1253 (AJ-VIII)	Solid	Paris
Le rossignol monstreux/amoureux	1960	1321 (AJ-IX)	Soft/solid	Paris
Le ciel jaune	1961	1334 (AJ-X)	Soft/solid	Paris
Betrængte komplekser	1964	1581 (AJ-XI)	Solid	Denmark?
Hvisken	1971	1933 (AJ-XII)	Soft/solid	Denmark, Læsø
Cabaret Voltaire	1971–72	1959 (AJ-XIII)	Soft/solid	Colombes

Notes

1. Atkins 1968, 1977, 1980; Atkins and Andersen 2006. AJ-roman numbers refer to Bronken 2022a.

2. Paints that are soft follow the definition described in this paper. Soft/solid means that there are paints both within and not within this definition.

3. Atkins 1968, 1977, 1980; Atkins and Andersen 2006; Bronken 2022a, Appendix 1.

Notes

1. Stokvis 2017: 38. Quote from Asger Jorn in 1944.
2. Details on the examination, visual symptoms and methodology can be found in Bronken 2022a, chapters 2 and 4.
3. Nick MacGregor Sadolin, personal communication, 19 December 2023. Gunnar Asgeir Sadolin was one of the original founders of A/S Sadolin & Holmblad.
4. S62 in Atkins 1986.
5. *Thisteds Amts Tidende,* 31 January 1942: 6. Translated from Danish to English by Ida Antonia Tank Bronken.
6. Aabye 1944: 122.
7. *Viborg Stifts-tidende*, 5 May 1942: 8. Translated from Danish to English by Ida Antonia Tank Bronken.
8. Patent Nr 70749. Ans. Nr. 2329/43. *Fremgangsmåde til fremstilling av tørrende olier. Aktieselskabet* Sadolin *& Holmblad. København. Direktoratet for patent- og varemærkevæsenet. Patent utstedt den 6. marts 1950.*
9. *Ibid*.
10. The First World Congress of Free Artists, Alba, Italy, 2–8 September 1956.
11. Some of these short fatty acids are already present in the drying oil. They have been found in particularly high concentrations in zinc- or lead white-containing paints, their formation perhaps catalysed by these pigments or better contained due to the formation of soaps (Lee *et al*. 2018). The patents and other literature mention several ways of removing free fatty acids and other components from the drying oils in preparation steps. Nevertheless, it is likely that most fatty acids are only formed after paint formulation in the curing process of the paint.
12. Other original and stable fatty acids that are present in very low concentrations in drying oils are Lauric acid (L; C12F) and arachidonic acid (C20F).
13. Post-oxo fatty acids are oxidised long chain C18 fatty acids, most notably produced from oleic and linolenic acid.
14. Hacke 1982: 40–41. Translated from Danish to English by Ida Antonia Tank Bronken.
15. For information on industrial paints and the impact from the wars in Norway, see Wedvik 2019 and 2021.

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On interdisciplinary research. Patina: traces of the past in contemporary art

Irene Glanzer and Angela Matyssek

ABSTRACT Patina is a key concept illustrating the relationship between art and time. The overarching use of patina – as both a term of material description and a concept of value – lies at the intersection of aesthetics and historicity, and makes it correspondingly complex. This complexity offers rewarding research that bridges the gap between conservation and art history. As the field of conservation/restoration has always been concerned with the aging of art, patina touches the core of its discipline. Until now, the issue of patina has been almost exclusively related to older art. Contemporary art and its temporality brings its own, new challenges. Patina refers to accepted or positively connoted signs of age, and patina phenomena can be seen as evidence of authenticity. Whether traces of age are perceived as positive or disturbing elements seems to be much more difficult to answer due to individual artistic strategies and new materials. This paper pursues a dual goal: (1) to share the research results and new findings and (2) to present the challenges and synergies of interdisciplinary collaboration.

KEYWORDS patina, contemporary art, concept, materiality, interdisciplinarity

Introduction

As a conservator and an art historian, the authors' ongoing engagement over many years with contemporary art inevitably led to questions about the intersections of aesthetics and historicity, and thus to the concept of patina – a key idea in the relationship between art and time. Patina's dual nature as both a description of material condition and a concept of value makes it inherently complex. It is this very complexity that presents a compelling area of research for both art history and conservation science. Patina is traditionally seen as a long-term phenomenon, and is associated with works of art that have enduring forms and materials – but what about contemporary art? How, through the lens of patina, can challenges of aging, transience and temporality be made productive in art history, conservation and artistic production?

This paper is based on the research for and the results of the 2019 interdisciplinary conference in Dresden and the 2023 publication *Patina. Spuren der Zeit in der Kunst der Gegenwart* (*Patina. Traces of the Past in Contemporary Art*) (Glanzer and Matyssek 2023).[1] Since the original publication is in German, this English paper shares the research, results and synergies of the project with an international community: the individual articles are presented with their diverse viewpoints and overlap, and the form of cooperation is outlined.

Conservation/restoration has always dealt with the change and aging of art, so patina touches the core of its discipline; temporality, on the other hand, is a central theme in art history. Nevertheless, there is hardly any detailed literature specifically on patina or on the relationships between material aging and temporality.[2] During the investigation of aging phenomena and the review of the sparse literature on patina, just how broad the topic is became clear – after all, it is about material behaviour, aesthetics, dividing lines between aging and damage, evaluation of art in different contexts, historical processes and historicity. The following questions show the range of diverse topics within the investigation:

- How are different traces of aging on 'new' artworks judged?
- Where is the caesura between positively and negatively evaluated changes, such as in installations whose components consist of materials that age differently?
- How is patina assessed in art forms made of rapidly changing or iconographically charged materials?
- How do notation-based artworks age, such as conceptual or performance art?

› Some artists use patination, aging and transience as artistic strategies. But if the actual aging of an artwork is not meant conceptually, are new productions to be understood as a negation of patina?

The focus for the conference and the book was to bring together a wide collection of views and opinions from restorers, art historians and artists, as well as a curator and a collector. After all, professionals from different disciplines experience the heterogeneous aesthetics of aging contemporary art in different contexts, and they certainly form their own conclusions. Their key theses are woven into this paper.

Patina as a material manifestation and as a concept of value

Materially, patina manifests itself in a variety of forms. Roughly speaking, these are traces caused by the natural aging processes of materials, also paraphrased as 'the friendly traces of time' (Mörsch 2006). A few examples include the following: colour- and three-dimensional transformations of metal surfaces (such as the formation of verdigris on copper); the darkening of binding agents (such as drying oils); the yellowing of varnishes and the formation of craquelure on paintings. However, the material definition of patina is not agreed upon, even among restorers.

Generally, the term 'patina' is used indiscriminately to describe surface changes. But how is 'the surface' defined? For example, where on a varnished painting or in a latex object by Eva Hesse does 'the surface' end? Similar to the use of patina as 'surface phenomena' are interpretations of patina as a layer, referring to materials such as dust, dirt, varnish or metal. The classification of patina as a layer facilitates restoration decisions, as – theoretically – a demarcation line is specified. However, both definitions exclude, for example, craquelure or discoloration; and overall, they remain vague, as it is difficult to determine precisely the boundaries of layers or surfaces.

The concept of patina is also used as an abbreviated communication code for connoisseurship: patina refers to the 'look' of diverse – yet often unspecified – material signs of age on an object, which in their entirety and at a glance indicate its origin date and preservation history. The phenomena of aging point to the materials used and their ability to date the artwork. Implicit knowledge about materials and their typical aging processes can lead to the attribution of authenticity (Van de Wetering 1982). Here, the material-term subsuming patina-phenomena is interwoven with trans-material significance, or, in other words, tips over into a concept of value.

On a positive–negative scale of age-related changes, patina traditionally represents at least approval and more often, welcome. Poetically stated, 'Patina reconciles time and perfection' (Starn 2002: 89). Attributions of patina and value to an art object are symbiotically linked. In the case of decorative arts, antiques and ethnographic objects, patina often reflects use and testifies to the intrinsic performative aspect of everyday objects or sacred artefacts. Traces of use can therefore be classified as patina and are consequently regarded as indicators of authenticity. Still, patina embodies the potential for aesthetically undesirable changes – the assessment of whether signs of aging are perceived as beautiful, neutral or disfiguring depends on different premises. Patina is therefore an aesthetic concept of value that is subject to diverse attributions and interpretations.

Ursula Haller (2023) examines the historical and current uses of the term patina in conservation. She discusses its relevance for restoration theory and, in doing so, expands the spectrum of synonyms for aging or use, positively applied terms or the relationship to nostalgia. Among the many sources she cites, José Delgado Rodrigues takes a very original approach to the indeterminacy of (material) patina in the field of stone conservation by proposing to use the 'ignorance gap' around patina in the following way: as a term, it should only describe indeterminate phenomena of material transformations (Rodrigues 2006). Haller relates the general lack of clarity regarding the concept to the fear of restoration as the destruction of patina in the sense of historically accumulated original substance.

A contrasting approach to viewing patina is offered by Eva Kernbauer (2023). She shows how the concept of a linear passage of time – the basic prerequisite for the growth of patina – is thwarted by scientific, philosophical and social upheavals in modernism, and consequently, by artistic positions. Using 'The work of art in the age of mechanical reproduction' (Benjamin 1936) as a starting point, she explains how changes in media have dramatically increased the dissemination of art and thus also the possibilities – and obligations – of the artistic self-positioning in time. Temporal ambiguities or incongruities between an artwork's form and the time period associated with it are explained using examples from Eva Hesse

(1936–1970), Tacita Dean (b.1965) and Joachim Koester (b.1962). Kernbauer positions the handling of their own artistic concepts, materials and techniques along art-historiographical concepts such as 'Eigenzeit' (inherent time) (Nowotny 1989: 67–85)[3] and 'after-history' (Karlholm 2018). The 'elaboration of aspects of duration, transience, obsolescence (and) the staging of anachronisms and heterochronisms that do justice to the plural temporalities of the present' in these works, however, also include the 'dilemma of the anachronistic position of art historians and restorers, who have to deal with the undead remains of artistic works' (Kernbauer 2023: 45). By turning away from the conventional model of time, Kernbauer sheds light on artistic positions that allow us to think beyond the 'material patina' to a 'conceptual patina.'

Thoughts on patina in conservation, art history and art: some spotlights

The few written sources on patina, of which only the essentials for our project are set out here, show a different assessment of and approach to patina. The term patina ('patena') is found for the first time in written form in *Vocabolario toscano dell'arte del disegno* by the painter and art theorist Filippo Baldinucci, when signs of aging became evident on oil paintings and their varnishes.[4] Without tools to analyse material behaviour, it is likely that the term 'patina' indiscriminately subsumed all slow, visible transformations on artworks. These early, mostly irreversible, transformations were categorised in a positive light. In stark contrast, almost 100 years later, in *Time Smoking a Picture* (1761), the artist William Hogarth (1697–1764) portrayed time as a deteriorating force on paintings. The Greek inscription on the frame reads: 'Time is not a great artist; on the contrary, it weakens everything it touches.' This is a prime example of how judgements about patina are subject to taste, fashion and views on aesthetics (Fig. 1).

In his keystone preservation publication *The Modern Cult of Monuments: Its Character and Origin*, the art historian Alois Riegl systematically classified monuments under 'commemorative' and 'contemporary' values (Riegl 1982[1903]). In order to acknowledge the intersections of time and aesthetics, he introduced the concept of 'age value' – an emotional value that combines identification with a monument with fear of loss in the face of its decay – but, out of respect, he prohibits arbitrary intervention in its natural form. Patina, in his view, indicates the 'age value' of a monument. With the 'double memory value', Riegl, in turn, differentiates between the reference to historical points in time on the one hand and the passage of time on the other.[5] According to Riegl, stylistic elements and material properties point to the moment when a work of art was created; and historical, material traces, which he calls 'patina', to the course through history. Patina thus represents a slowly and steadily growing quality whose material form can be experienced in the 'now' and yet represents constant change. Paradoxically, signs of age on monuments refer both to permanence and to hope for timelessness. This nostalgic, melancholic notion of patina, located in old and even decaying monuments, is a distinctly Western concept (Lowenthal 1985).[6]

In 1963, the art historian and monument conservator Cesare Brandi places the coexisting 'commemorative' and 'present-day values' in a practical, ethical restoration context. He positions 'historical' and 'aesthetic' authorities as opposites that underlie every restoration decision, and the difficulty of weighing them up is an ongoing tension (Brandi 2006 [1963]). For him, too, patina is a valuable addition to a work of art.

The conservator Thomas Brachert makes a similar assessment in *Patina. Vom Nutzen und Nachteil der Restaurierung* (*Patina. The Benefits and Disadvantages of Restoration*) (Brachert 1986). Against the background of the expanded scientific possibilities and findings within the research on artists' materials and their transformation, he, for the first time ever, differentiates the phenomena of patina categorised by materials. Beyond that, Brachert criticises traditional restoration as the destruction of historically accumulated substance. Patina, according to him, is original substance and, in its atmospheric appearance, a mitigating counterweight to the inevitable decay of everything earthly: patina grows 'out of the original in a way that only time can produce. Yet, inimitably for … forgery, it compensates for the process of progressive decay with the poetry of picturesque transience' (Brachert 1986: 9). Furthermore, patina is a 'synonym for all ageing processes on works of art and also includes conservation work' (Brachert 1986: 7). In other words, one could say that the traces of restoration bear witness to the status of artworks as cultural assets to be preserved.

Figure 1 William Hogarth, *Time Smoking a Picture*, 1761, etching and aquatint, 23.5 × 18.4 cm, The Metropolitan Museum of Art, New York.

Patina was brought into play as a figure of thought for art history which, until then, had not dealt with the aging phenomena of artworks. In a metaphorical turn on the history of the interpretation of artworks, in 1925 the art historian Gustav Münzel called the accumulation of decades of art historical interpretations 'on the work' an 'intellectual patina', which, 'lies over the work and increases its content' (Münzel 1925). Such layers of meaning speak to the significance of a work, since they can ultimately – similar to material patina – guide or distort observation and interpretation.

In his overview of patina in art history, particularly for the early modern period, the art historian

Figure 2 Maria Lassnig, *Spannungsfiguration*, 1961, oil on canvas, 200 × 189 cm, Bayerische Staatsgemäldesammlungen, Munich: before conservation in raking light. (Photo: Nicole Wilhelms, BStGS © Maria Lassnig Foundation/ VG-Bildkunst, Bonn 2021.)

Hubertus Günther reflects on the expansion of the topic, in design, architecture and even language. He sees a 'shimmer' in factual texts and in academic language, similar to the patina on paintings. Both 'cover' the subject, for example, in titles and terms that appear old; in words or grammar that seem cumbersome; or in the design of annotations that go beyond their task as evidence and become 'genealogical charts of research' (Günther 1996: 23). This raises the question of how concepts become historical.

As a concept of value, patina addresses cultural, including connoisseurly, social and economic values and their transformation. For Walter Benjamin, it serves as proof of the authenticity of an artwork:

> The presence of the original is the prerequisite to the concept of authenticity. Chemical analyses of the patina of a bronze can help to establish this ... The authenticity of a thing is the essence of all that is transmissible from its beginning, ranging from its substantive duration to its testimony to the history (Benjamin 1969[1936]: 3–4).

'Aura' has its origins in cult and ritual, and for Benjamin, it is always associated with the past, tradition and inaccessibility. Patina, by proving the authenticity of a work of art, is thus a component of the 'aura' of an object.

Aging, originality and authenticity in contemporary painting and photography

The concepts of 'originality' and 'authenticity' have become much more complex since Benjamin addressed them in 1936. What kind of history can a contemporary artwork show and when does 'the original' get lost? Is there any appreciated aging in works that promise immaculateness? In other words,

Figure 3 (*Top*) Jeff Wall, *Eviction Struggle*, 1988, *c.*229 × 414 cm. (*Bottom*) Jeff Wall, *An Eviction*, 2004, *c.*229 × 414 cm. The now definitive *An Eviction*. *Eviction Struggle* was replaced in 2004 by the artist with a slightly different staging and title. (Photo: Sibylle Forster © Estate Jeff Wall © BStGS – Pinakothek der Moderne, Munich.)

can the concept of patina be used productively for the preservation of contemporary art?

Interpretations of the artist's authority with regard to traces of aging in paintings are the focal point of Irene Glanzer's reflections on contemporary painting surfaces (Glanzer 2023). The handling traces and fingerprints on the painting *Spannungsfiguration* (1961) by Maria Lassnig (1919–2014) were caused by the artist herself (Fig. 2). In controversial discussions among conservators and art historians, these traces were referred to as 'damages', 'grown conditions' or 'patina'. Research sheds light on the eventful biography of this painting before it was acquired by the Bavarian State Painting Collections.[7] In the context of Maria Lassnig's life as a penniless artist who went unrecognised for decades – and thus had no chance to take optimum care of her prolific oeuvre (Lettner 2017) – the traces can be interpreted even more as a 'narrative patina'. The enormous value placed on the artist's hand in the West speaks in favour of this interpretation. However, when evaluating an artist's oeuvre, this interpretation also means that no distinction is made between the creator of the works of art and the practitioner in everyday matters. Should one change the condition of this painting or – under the argument of destroying patina – not?

Patina persists in recurring, sharp debates on removing time-induced marks and on cleaning artworks. Notable is the 'National Gallery Cleaning Controversy', mainly carried out publicistically in *The Burlington Magazine* between 1946 and 1963, where interpretations of patina – oscillating between a scientifically defined material and an aesthetic concept – ignited fierce debates among art historians, conservators and scientists. In the aftermath of this and similar controversies, important texts about practical conservation techniques and ethical conservation considerations emerged (Brandi 2006[1963]; Phillipot

1966; Hedley 1990). In cleaning controversies, the dispute centres on the sovereignty of interpretation over the 'original state' intended by artists. In this discourse, it is essential to precisely substantiate and document one's own (interpretative) distinction between aging phenomena and damage. For debates on the conservation of contemporary art, Brandi's distinction between 'historical' and 'aesthetic' authority is extended to include further concepts of authenticity, namely material, artistic, functional and contextual (Van Saaze 2013: 48). Using the 'disturbances' deformations, cracks and surface dirt, Glanzer explores the questions if, how and why the first signs on the sensitive surfaces of paintings are assessed and inscribed as valued traces.

Angela Matyssek investigates both the tendency not to accept colour shifts in photographs as valued traces and the resulting practice of reproducing prints (Matyssek 2023). She conducted interviews with curators, conservators, and photography-artists of the Becher School, and collected attitudes and perspectives, among others by Andreas Gursky (b.1955), Thomas Ruff (b.1958), Axel Hütte (b.1951) and Laurenz Berges (b.1966). Photography's dilemma of serving as a container for 'truth' and, at the same time, not being durable, is exacerbated when photography – beyond the documentary – is situated in the realm of art. In this case, the original has much more significance. While a black-and-white photograph is already an abstraction of this truth, a colour photograph is assumed to show a strict coherence between the subject and the photograph itself. When discoloured, the visual information and aesthetics appear significantly distorted – and this happens at a rapid pace. Summarising her research, Matyssek notes that 'almost all my interlocutors make a bona fide effort to at least accept *patina* – who likes to go against the passage of time?' (Matyssek 2023: 155). In her conclusion, new productions are the way to hand over one's own œuvre, and to reassure owners and the art market. In the past, however, these reproductions were executed – and evaluated – very differently.

It is not difficult to imagine that technical changes, as well as content changes, result in a strong unease: the common temporal anchoring of motif and materialisation – the joint material, conceptual and thematical evidence – no longer exists. New productions that replace the original images – even when as close as possible – always insert a secondary authenticity. This supposed authenticity is tied neither to material nor concept, but solely to the authority of the artist (Fig. 3).[8]

In relation to *Spannungsfiguration*, Irene Glanzer interprets the use of the term 'patina' as an appeasement term for damages that are hardly restorable and to which a special historical and even artistic relevance has been attributed. Angela Matyssek, in contrast, argues that 'in the face of new productions that do not correspond to visual experiences and expectations, patina is simply the lesser evil that is grudgingly accepted'. In this context, she interprets patina 'as a figure of thought for the discursive coping with contingency' (Matyssek 2023: 158).

Patina-Negation

Patina is thus still used in one art form (paintings) as an argument for preserving traces of contemporary history, while in art forms based on materials that age rapidly or disruptively, it is barely tolerated or simply negated. Artistic positions that do not accept any traces of aging in their work also point in this direction, above all representatives of conceptual approaches such as Richard Tuttle (b.1941) and Sol LeWitt (1928–2007). Their works were intended to always look pristine. In LeWitt's approach, repeated renewal of wall drawings was intended to free them from material aging. Nevertheless, we believe that even conceptual artworks cannot escape temporality: concepts also age, not least because they are conceived in the materials of their time as the only possible horizon of realisation.

Carol Mancusi-Ungaro compares the attitudes of the conceptual artist Sol LeWitt with those of the materially powerful Robert Serra (b.1938) (Mancusi-Ungaro 2023). Both embrace a duty to preserve their artwork as they intended it, either by repetitive execution or by reworking it later. Astonishingly, for Serra, regardless of how dramatic his later alterations are, the date of creation should also be fixed at the time of the execution of the idea. Mancusi-Ungaro describes how the simultaneously material and immaterial character of artworks induced new productions demanded by contemporary artists, causing a paradigm shift for conservation. She acknowledges 'the great privilege and challenge of a conservator's professional pursuit' in preserving and nowadays often replicating artworks, that 'reside in the conservators' domain, given their professional propensity to look at art both materially and ideologically' (Mancusi-Ungaro 2023:145).

While the need for new productions here is of a conceptual nature, reproducing or copying artworks

can also stem from material questions. The aging of plastics is judged by Friederike Waentig, without exception, as damage (Waentig 2023). She offers an outline of the image of plastics throughout history and demonstrates the extent to which attributions of value – not only to objects, but also to materials – influence labelling signs of age; after all, plastics had their entry into the world of materials as 'cheap imitations' (Meikle 1993: 1). Ways of slowing down decay in plastics are examined as well as replacement of plastics as a last resort. She concludes that since any signs of aging, such as cracks or colour shifts, are the first signs of ongoing decay in plastics, they cannot form patina. On the one hand, it is the speed with which modern materials age that negates patina formation while on the other, Waentig describes underlying chemical changes that, once started, cannot be stopped even under the best conditions.

Andreas Weisser also observes unique ways of aging in media art. He examines the different layers of aging in (reeled) film versus videotapes; and he maps them against disturbances in digital film recordings (Weisser 2023). The material aging of image and sound carriers, as well as the playback media and their obsolescence, are described. Visual phenomena in the temporally unfolded, replayed form that could indicate aging are examined. It becomes clear that in the digital realm, a constant, acceptable deterioration of 'the work's condition' hardly ever occurs, but instead it is dropouts or other intermittent image disturbances which prohibit a classification of this aging as patina. According to Weisser, when viewers are confronted with 'colour streaks, blurring and multi-grained, shimmering image interference' (Unnützer 2000: 19) in transferred media, they do not see patina, but nostalgia, because:

> the slow emergence of digital technology has turned analogue imperfections into a historical phenomenon with a nostalgic touch … After the slow extinction of analogue technologies, the layers of aging remain only in the form of copied errors and imperfections. They are therefore either restored or historicized (Weisser 2023: 186).

Traces of the past in the art of the present: temporality, ephemerality, artistic production

Artists have repeatedly explored temporality and transience as subjects. In contemporary art, however, patina and other aging phenomena – including material decomposition itself – are being used as means of artistic expression. Traces of aging with a positive connotation or decaying material became a theme for artists as diverse as Dieter Roth (1930–1998), Karin Sander (b.1957) and Walead Beshty (b.1976). Roth, for instance, worked with perishable materials such as food; his decaying artworks were only realised in their decomposition. Objects made of sugar or chocolate, for example, are not only exposed to the climate and insects: in installations such as *Selbstturm/Löwenturm* (1969), they are stacked on top of each other under the pressure of the weight of the glass shelves that are not anchored to the frame – a melancholic image of the artist working like Sisyphus against forced decay through constant new production.

Against the background of material-iconographic considerations, Christian Scheidemann examines the highly charged materials of dust and dirt as materials for artistic production (Scheidemann 2023). In subtitles such as 'dirt and narration', 'dust as metaphor', 'dust – Picasso and Bacon', or – in relation to a video installation by Anthony McCall (b.1946) – 'dust as an image support', he reports from his practical experience as a conservator how these materials were collected, produced, used and valued by different artists, as well as how to preserve them. In chapters such as 'dust and taboo' and 'cleanliness', Scheidemann sharpens the view for the sociopolitical dimension of this – originally patina-connoted – 'non-material' with contrasting references to Robert Gober (b.1954) and Jeff Koons (b.1955) (Scheidemann 2023: 104).

Dust is also a theme in Carolin Bohlmann's evaluation of Joseph Beuys' (1921–86) installation *Richtkräfte für eine neue Gesellschaft* (1974)[9] (Bohlmann 2023). Here, artificial dust was used to restore a layer that is part of the history of the artwork's creation, which emerged from a performance. Based on three case studies on space filling installations by Joseph Beuys, Bohlmann examines in which way imagined, projected, supposedly intended and real patina overlay the legibility and reception of his works. The installations have very different origins, and the materials used by Beuys – such as grease, wax, copper, chalk and blood – are subject to relatively rapid changes inherent in the material. Statements that Beuys explicitly related to the examined works can hardly be used as guidelines or instructions for preservation, due to their contradictory nature. Next to his oeuvre, it is the abundance

Figure 4 (*Top*) Photographic template. (*Bottom*) Martin Honert, *Foto*, 1993, painted epoxy resin and wood, 100 × 100 × 123 cm, Museum MMK für Moderne Kunst, Frankfurt. Acquired with the generous support of the donation of Margarethe and Gustav Kober, Frankfurt am Main, previously on permanent loan to the MMK. (Photo: Axel Schneider © Martin Honert © VG-Bildkunst, Bonn 2021, © Museum MMK für Moderne Kunst.)

of statements he conveyed to the public, which rendered the artist monumental. Bohlmann links his status with museum practice, which did not question the condition of the large installations for more than 40 years. Any intervention on these works was seen as a threat to any patina, and thus, a sacrilege. Through interdisciplinary research, Bohlmann assigns 'Eigenzeit' to histories of origin, to materials and finally to actual aging. This leads her to conclusive restoration concepts and decisions. The individual iconographic meanings of materials in contemporary art as well as connotation shifts by aging have kept conservators and art historians busy for well over 25 years. The status of transformations, aging, patina or decay can only be determined with detailed knowledge of the genesis of the work, material iconography, the typical aging process of the materials and the artist's opinions on the subject.[10]

Pia Gottschaller's collaboration with many artists, including interviews, flows into her findings, when looking at another aspect of individual artistic production, namely the relationship between an artist's self-positioning in time, their artwork's production time and its material transformations (Gottschaller 2023). She examines how visual artists – in relation to their own production – are affected by transience and temporality. The topic is clearly located in Western phenomenological and ontological philosophy, but Gottschaller chooses to focus her essay primarily on the material discourse, in which 'temporality and transience are also ... not strict, but only partial synonyms' (Gottschaller 2023: 47). Against a backdrop of knowledge on their creative processes, Gottschaller examines age topoi in the artistic production of Frank Auerbach (b.1931) and Lucian Freud (1922–2011). Liz Deschenes' (b.1966) working methods and her approach to the survival of her works – the categorisation and (non-) acceptance of various material changes and other traces of time – are mapped. Cy Twombly's (1928–2011) work is considered in terms of his respect for antiquity and his 'standing in time'. The artists react differently to the challenges of transience, but what they all have in common, according to Gottschaller, is 'a fearless and fruitful confrontation with the basic conditions of our temporality, as it is the 'enabling condition of our existence'.[11]

Within the project, manifold links between material and time, time and art, the experience of time and the artist's life were observed – within the concept of *patina*, but also within the broader framework of the subtitle: *Traces of the Past in the Art of the Present*. The artists interviewed also deal with these traces out of different reasons and in various ways: Karin Sander works in distinctive ways with the passing of time and transformations. Her *Kitchen Pieces* (2012) hang on the wall like a pictorial object: apples, leeks, potatoes, etc. dry out, grow shoots and can either be preserved like this for years or replaced by their owner. They are therefore not only the most direct form of still life, but of vanitas paintings par excellence. Quite differently, in her *Patina Paintings* (2002–20), white canvases remain in a specific place for a period of time determined by the owner. After

this 'creation process by time and location', they bear the temporal and spatial coordinates as titles. We conducted a long, verbal interview with Karin Sander which, for publication in the book, the artist decided to transform into a printed, thus duplicated, graphic work of art.

By translating memories into sculptures, Martin Honert (b.1953) quite differently deals with the past in his works. He uses photographs or drawings from his childhood to create a three-dimensional world. The template for the complex work *Foto* (1993) is a family photograph in which only the young Martin Honert looked directly into the camera (Fig. 4). The artist isolates this decisive moment of reference of photography itself – the relationship between the lens and the person photographed, with maximum impact through direct 'eye' contact. The essence of photography is not only translated metaphorically, but also literally, as the artist stays materially faithful to the template in its temporal location: the painted surface materialises the shadows of the original situation, but also the colour shifts of the aged photograph. Since the content of the work is 'photography' in the literal sense, Honert summarises:

> Converting a photo into a three-dimensional work is an absurdity. I have no other choice but to find a stylization of photography. … My aim with this work was not to commemorate an event in the past, but to find a stylized form in the present that is a photograph without actually being a photograph.[12]

Honert's search for the prototype image may seem paradoxical in view of his recourse to historical images and outdated formal models. However, coherent references from childhood help to abstract an essence; in this way, many of his artworks are linked to the past in an obvious, yet enigmatic way.

Beyond considerations of material, narrative or conceptual patina, Mareike Herbstreit brings an art form into play that is difficult to imagine connecting with the term, as it unfolds selectively over time: performance art (Herbstreit 2023). Central to her argumentation are action relics. Paul McCarthy's (b.1945) *PROPO* assembles a collection of artworks that have evolved from a series of performances, as he explains:

> Between 1972–1983, I did a series of performances which involved masks, bottles, pans, uniforms, dolls, stuffed animals, etc. After the performances these objects were either left behind or they were collected and stored in trunks to be used in future performances. In 1983, these trunks were stacked on a table and exhibited as sculpture.[13]

In 1991, he reopened the trunks, photographed every performance object, and created smooth, flawless colour prints in documentation style. In her essay, Herbstreit locates these photographs and the relics as the patina of the performances. With this thesis, she challenges long-established notions of performance art's ephemerality.

Synergy effects within the collaboration

In conclusion, the collaboration described contributed significantly to this project's versatile, productive results: the project began with an extensive research phase lasting almost two years. The willingness to immerse oneself in a different academic tradition, to adopt the perspective of another discipline and to shed light on one's own, held this interdisciplinary project together. Research was carried out, literature was discussed, collections were visited, colleagues were involved. A profound overview of the topic with a common language was developed.

A detailed, jointly written synopsis helped to attract the desired colleagues as speakers and authors, as well as to apply for funding. Thanks to the Fritz Thyssen Foundation's generous support, the speakers/authors were invited to the conference, and participation fees were waived. In this way, a large and heterogeneous audience could be addressed. Each participant chose their own topic within their respective academic tradition. Individual contributors' research and their central assumptions were formulated in different, stimulating ways and answered in different literary forms: some more theoretical and conceptual, others more empirical, source- or interview-based.

Deciding on the language of the conference and the book was difficult. Although English as a scientific language would have reached more colleagues, German was chosen as the native language. It was essential to approach the already vague concept of patina with precise vocabulary. Overall, it became clear that the various disciplines do not speak different languages when it comes to patina. But they pose and examine the concept differently. They use

different approaches and methods, and they tell their stories differently, which proved to be very rich. And if the disciplines continue to listen carefully to each other, not every gap needs to be bridged.

Notes

Unless otherwise stated, all translations from German into English are by the authors. Rebecca Benarroch kindly revised the full text.

1. The conference (Dresden University of Fine Arts, 5–7 December 2019) and book were sponsored by the Fritz Thyssen Foundation and the Dresden University of Fine Arts.
2. On the subject of patina and contemporary art, for example, see Hiiop 2000; Stigter 2005a,b.
3. Within the concept of 'Eigenzeit', the author maps the connection between individual perception of time and the corresponding experience in its various levels of intersection with the social structuring of time.
4. Baldinucci 1681: 119; compare Günther 1996: 7.
5. 'Commemorative value – Erinnerungswert', 'present-day value – Neuigkeitswert', 'age value – Alterswert', 'double memory value – doppelter Erinnerungswert'.
6. Lowenthal's seminal work on heritage studies devotes two chapters to patina, which he links to nostalgia and aesthetics.
7. Bayerische Staatsgemäldesammlungen, BStGS.
8. On 21 January 2004, conservator Florian Schwemer states within the archive of the BStGS: 'Reprint-Ankauf, September 2003, Dia-Positiv mußte wegen Vergilbung ausgetauscht warden' (Reprint purchase, September 2003, slide had to be replaced due to yellowing). The different versions, prints and documents of authorisation are documented in detail, and the artist's performing assistants are listed. Today, Jeff Wall does not remember the yellowing but the change in content and the replacement of the slide (personal correspondence with the author in February 2024).
9. Approx. 12 × 5.5 m, Hamburger Bahnhof – Museum für Gegenwart Berlin.
10. Conservators such as Erich Ganzert-Castrillo and Carol Mancusi-Ungaro started collecting artist interviews and statements as early as the 1970s and 80s; they demonstrated the need for systematic questioning of contemporary artists in order to present their intent; see Hummelen and Sillé 1999.
11. Gottschaller 2023: 61, quoting Boehm 1982: 104.
12. M. Honert talking with I. Glanzer and A. Matyssek, 'Referenz und Erinnerung, Stilisierung und Simulation', in Glanzer and Matyssek 2023: 81–92, 88.
13. Paul McCarthy - PROPO - Hauser & Wirth (hauserwirth.com). Available at: https://www.hauserwirth.com/hauser-wirth-exhibitions/4279-paul-mccarthy-propo/ (accessed 18 January 2024).

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Material changes in time-based media art: obsolescence and artistic intervention

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ABSTRACT The dynamic relationship between time-based media art and technological evolution makes material change inevitable throughout the lifecycle of artworks. Within the ever-evolving landscape of time-based media conservation, the traditional conservation approach of minimal intervention sometimes gives way to a more open approach, allowing contemporary artists to reconfigure their artworks and adapt them to changing technologies. This paper navigates the delicate balance between preserving the material versus conceptual integrity in media installations, using the case of *Das Deutschlandgerät (The Germany Device)*, [2021], [2002] 1990, a large-scale room installation by Reinhard Mucha installed at the Kunstsammlung Nordrhein-Westfalen, Düsseldorf, Germany. The artwork, featuring media elements that have been on permanent exhibit since 2002, has a rich history of changes: some initiated by the artist and some not. Adopting a biographical approach, the authors unravel the complex evolution of *Das Deutschlandgerät* to examine the material changes it has undergone along with its history, production and present state.

KEYWORDS time-based media conservation, obsolescence, intervention, artwork's biography, Reinhard Mucha

Introduction

In the field of time-based media conservation, change of materials is approached as a certainty that will happen within a timeframe that can vary from two to ten years. Artists, conservators and curators collaborate to navigate these changes, ensuring that the artworks remain true to the artist's original vision and accessible to audiences over the course of time. One of the unique challenges that the caretakers of these artworks are called upon to tackle is to preserve the delicate balance between the artist's intent and the need for technical upgrades. In order to retain this fragile balance, conservators incorporate preventive conservation practices that include thorough documentation, research, and artist and curator interviews aiming to scrutinise the identity of the artworks and explore questions regarding material changes, obsolescence and future presentation options. This paper focuses on exploring the impact that a series of material changes have had on *Das Deutschlandgerät* (*The Germany Device*), [2021], [2002] 1990, a room-spanning installation that is part of the collection of the Kunstsammlung Nordrhein-Westfalen[1] in Düsseldorf, Germany, created by Reinhard Mucha (b.1950, Düsseldorf). This case study perfectly illustrates how, in museum practices, a gap between the artist's intent for his work and obsolescence-related challenges can be bridged by collaborative action with the artist and specialised conservation staff.

Material change is inherent in every object's existence, but while in contained works of art, such as paintings or sculptures, conservators aim to prevent it, in the case of time-based media the objective is to effectively manage the changes (Wharton 2016: 33). The traditional approach of minimal intervention is shifted towards a more open approach, where artists are included in and often attempt to dictate the decision-making process, as perfectly exemplified by the case of *Das Deutschlandgerät.* The full title of the artwork is: **Das Deutschlandgerät**, *Kunstsammlung Nordrhein-Westfalen, K21 Ständehaus, Düsseldorf* [**2021**], [**2002**], *XLIV Biennale di Venezia, Deutscher Pavillon, Venedig* **1990**.[2] The choice of words, dates, font and punctuation are significant in Mucha's artwork titles for reasons that will be investigated later in this paper; however, in favour of legibility it will be referred to as *Das Deutschlandgerät* from now on. *Das Deutschlandgerät* is a large-scale work permanently installed at K21, the Kunstsammlung's venue for contemporary art, since 2002, and incorporates

Figure 1 Installation view of *Das Deutschlandgerät*. (Photo: Documentation archive of the Conservation Department, Kunstsammlung Nordrhein-Westfalen, 2024.)

Mucha's signature post-minimalistic sculptural elements accompanied by audiovisual components (Fig. 1). When entering *Das Deutschlandgerät* viewers encounter natural, beige travertine tile[3] floors and walls, grey felt display showcases, footstools and the vibrating sounds that cause the glass of the showcases to tremble. Fifteen cathode ray tube (CRT) monitors showing 'video-animated photographs' (Heynen 2022: 89) are positioned in the installation, as well as speakers, subwoofers, DVD and CD players. It takes some time to become acquainted with this vast room installation and its essence that lies within the history it conveys, the constellation of the materials, the surfaces, the sound and the visuals of the screens.

Although most materials in *Das Deutschlandgerät*, like the travertine floor or the felt on the display showcases, have endured minor changes caused by the passage of time and the long exhibition hours, this paper sheds a light only on the media components. Before describing and then evaluating these changes, it is essential to first fully grasp this multilayered artwork. In order to dive into the vast universe of its evolution, spanning from the moment of production to the present day, the authors applied the biographical approach that was introduced by Renée van de Vall *et al*. (2011). After unfolding all the layers of history hidden in *Das Deutschlandgerät*, the identity of the artwork, the material changes and the present state are investigated through the lens of time-based media conservation.

Milestones in the history of *Das Deutschlandgerät*

As implied in the full title, the history of *Das Deutschlandgerät* can be divided into three milestones: 1990 at the Venice Biennale, Italy, 2002 and 2021, both at the Kunstsammlung Nordrhein-Westfalen, Germany. The first milestone was when Mucha created *Das Deutschlandgerät* for the German pavilion at the 44th Venice Biennale in 1990. The artist along with the Düsseldorf-based photographer couple Bernd and Hilla Becher were

Figure 2 One of the 38 constellations in the vertical, felt display showcases in *Das Deutschlandgerät*: a wooden footstool and its iron casting, resting on a tape measure case. (Photo: Documentation archive of the Conservation Department, Kunstsammlung Nordrhein-Westfalen, 2024.)

the last contributors representing West Germany in the exhibition.[4] In his typical approach to artistic creation, Mucha combined personal and historical themes with physical objects to construct a network of references.[5] The resulting multi-part installation was conceived around the three following main conceptual ideas.

The period of the exhibition coincided with the reunification of Germany, which led Mucha to come up with the initial concept of referring to the history of the exhibition building. He discovered that, during the reconstruction in 1938, the original Ionic columns of the façade from 1909 were replaced by rectangular pillars in order to represent the aesthetic characteristics of National Socialism (Hoff 2010; Egenhofer 2022: 173). Hence, he imitated the form of the rectangular pillars of the entrance of the German pavilion by creating long, vertical display cases covered in grey felt and suspended them symmetrically around the exhibition space (Egenhofer 2022: 173). In each of the pillar-like display showcases, a sculpture of repeated elements was placed: a wooden footstool raised into the air by its own raw untrimmed iron cast, which rests on a steel measure tape casing (Fig. 2).

For his room installation, Mucha built an additional room in the centre of the exhibition space of the German pavilion, constructed with the same travertine floor as the one used for the 1938 reconstructed pavilion. On the inside walls of this room-within-a-room construction, he installed wall-mounted display cases containing the wooden floors he removed from his studio, along with glass panes painted with the outline of his studio windows using alkyd enamel. By showcasing the studio floor in glass cases, Mucha transformed the area where he created art into an exhibited object. Thus, he created an exhibition within an exhibition, questioning the mechanisms of exhibiting and institutionalising art.

Digging a little further into Mucha's reference networks, it is noteworthy that the wooden floorboards of his studio not only carry the history of his artistic work and life but also the history of the building his studio was located in (Schüller 2005: 157). Before Mucha occupied it, the building served as the headquarters of the Düsseldorfer Waggonfabrik,[6] the company that produced all city railroad vehicles and streetcars between 1908 and the 1970s (Ostendorf 1979; Mucha 1990: 8). Mucha's fascination with the progress of industrialisation, such as heavy machinery and railways, is a theme prevalent in his overall body of work, and he often channels that into the materials he uses, as well as into the titles for his artworks. The title *Das Deutschlandgerät* is derived from a hydraulic lifting mechanism known as 'Deutschlandgerät' (Fig. 3), made to lift derailed locomotives back onto the tracks. The device was manufactured by an important and long-lived engineering company founded in 1872 called Maschinenfabrik Deutschland AG (Ostendorf 1979; Egenhofer 2022: 177).

Even at this stage of scrutinising the identity of *Das Deutschlandgerät*, the grammar of weight bearing (Egenhofer 2022: 177) becomes an apparent conceptual pattern that is recognisable in the architectural references to the German pavilion pillars, mirrored in the similarly shaped display showcases. It also extends to the hydraulic mechanism, the Germany Device, designed for support and lifting, as well as the studies of the footstools and their iron casts resting on the measure tape cases (Mucha 1990: 7).

By combining the aforementioned conceptual, personal and historical references, along with the financial and moral support of ex-sculptor and collector Heinz Ackermans and his wife Simone Ackermans, Mucha successfully realised this monumental installation in Venice. The Ackermans not

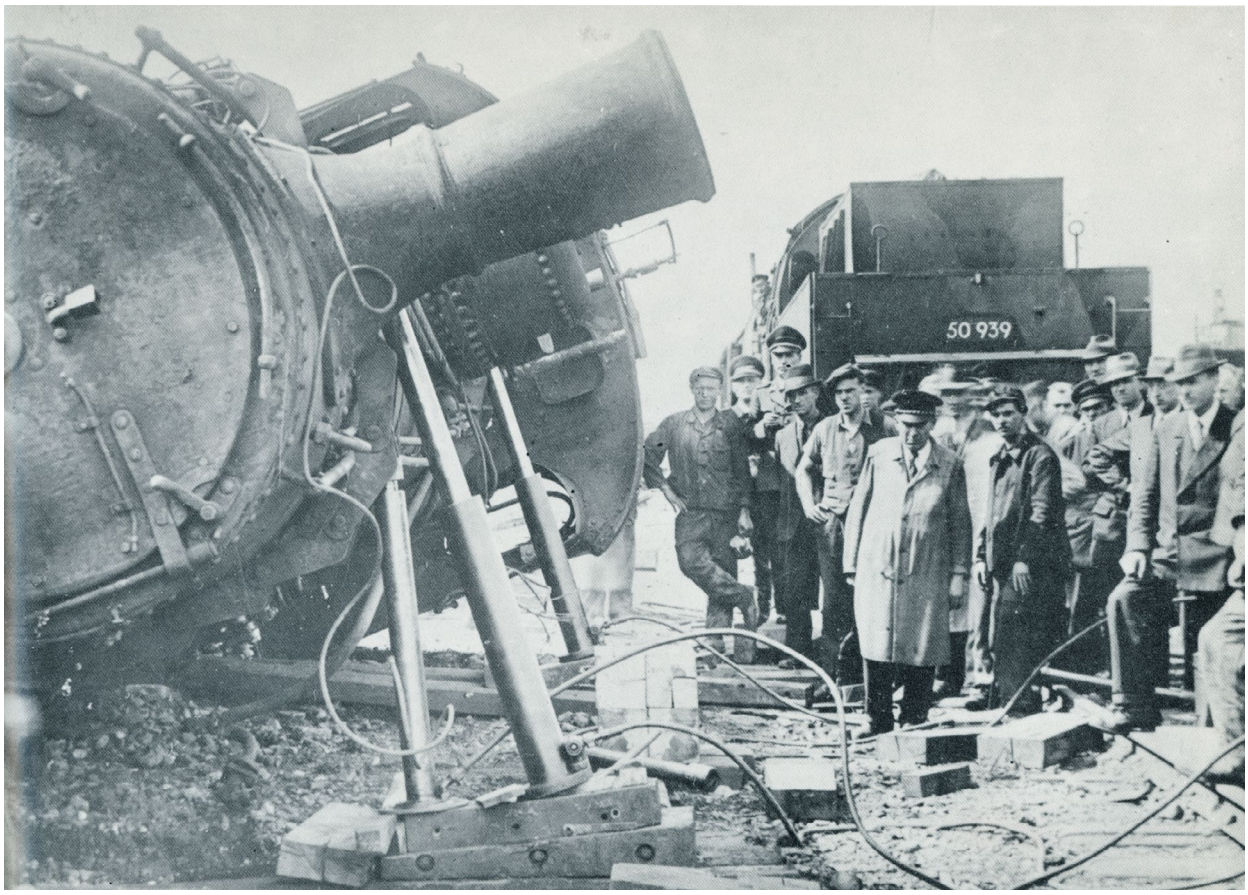

Figure 3 The 'Deutschlandgerät' while in use, lifting a derailed locomotive (from Ostendorf 1979: 259).

only played a role as producers, they also boldly chose to acquire this work even though its future after the presentation at the Venice Biennale was uncertain at the time (Heynen 2002: 22). Due to the lack of suitable space and opportunities for further exhibitions, the work had been stored for 12 years when an opportunity finally emerged, marking the entry of *Das Deutschlandgerät* into its second milestone.

The renovation of the so-called Ständehaus in Düsseldorf presented an opportunity to repurpose a historic building with cultural and political significance. The building used to host the North Rhine-Westphalian parliament until its relocation in 1988. Subsequently, the state government planned to repurpose the building as a venue for displaying contemporary art in collaboration with the Kunstsammlung Nordrhein-Westfalen (Tönnesmann 2002: 90–91). This endeavour involved extensive refurbishment efforts, which continued until 2002, aiming to adapt the space to its new cultural function. However, the Kunstsammlung's collection of contemporary art could not fill this expansive space at the time. The then director Armin Zweite therefore partnered strategically with private collectors Simone and Heinz Ackermans due to the unique position of their extensive collection in contemporary art. Their plentiful collection included works by many Düsseldorf-based artists such as Katharina Fritsch, Reinhard Mucha and Thomas Ruff, as well as internationally renowned artists including Tony Cragg, Jeff Wall, Andy Warhol and others (Zweite 2002: 7). Among the selected works loaned for the inaugural exhibition at the Ständehaus from the Ackermans' collection, *Das Deutschlandgerät* took centre stage as the highlight. It was favoured by Zweite at the Venice Biennale (Grasskamp 2016: 145), which explains his decision to allocate the central cube of the Ständehaus – the former plenary hall – to this particular work.

The substantial financial backing provided by the Ackermans facilitated the reconstruction of *Das Deutschlandgerät* (Zweite 2002: 7; Grasskamp 2016: 144). Mucha himself and his team carried out this massive iteration, but unfortunately the conservation department of the Kunstsammlung was not involved as a collaborating partner.[7] As a result, the iteration was not documented on the museum's part and no handover regarding conservation- and presentation-related issues took place. Mucha seized the reconstruction opportunity to expand his

installation, establishing deeper connections within his network of historical contexts in the artwork. To do so, he incorporated 15 CRT monitors to showcase video-animated photographs. One monitor was placed on the top of the wall of the middle room. The other monitors were assembled in sets of two to form a small tower, echoing the shape of the vertical display cases that were showcasing the footstools. The videos on the CRT monitors were photocollages of the three main conceptual ideas: the German pavilion, Mucha's studio and the Germany Device (the hydraulic device). Mucha collaged the image of several hydraulic devices while in use on mining sites, overlaid with the footstools that he placed in the display showcases. He also incorporated a historic photograph of the Germany Device (Fig. 3), which first appeared only in the supplement to the 1990 Venice Biennale, into the photocollage. In addition, he took close-ups of the German pavilion from different angles, such as the pillars of the façade and the travertine floors. He then mixed these photographs from his archive with the photographs of his studio floors, the footstools and the exhibition views to create other collages.

This peculiar combination of photographs played on the screens of the CRT monitors served not only as an interesting documentation material but also provided explicit evidence of the interconnection between the exhibited objects and Mucha's conceptual framework. In addition to the video-animated photographs, Mucha also added a booming soundscape of the traffic crossing the Flehebrücke, a bridge in Düsseldorf built in 1979 and serves as the highway over the Rhine River, connecting the main city with the industrial area (Egenhofer 2022: 173).

These were the main changes undertaken by Mucha for the new presentation of *Das Deutschlandgerät* in 2002, responding to the history of the work itself and its connection to the local area of Düsseldorf. The vast size of the room installation, along with the demanding resources and the enhanced interpretation of the work, contributed to *Das Deutschlandgerät* rightfully claiming one of the largest, most prominent spaces of the Ständehaus (Zweite 2002: 7). Although the artist envisioned this reconstruction of *Das Deutschlandgerät* as a permanent installation, the work transitioned from loan to part of the Kunstsammlung's collection in 2004. However, not until after an art world controversy in 2009, which was triggered by Zweite's successor Marion Ackermann's desire to use this gallery space for other artworks, was it understood that in the eyes of the artist and his supporters, *Das Deutschlandgerät* was a permanent room installation and dismantling it would constitute its destruction.

The thorough retrospection into the history of *Das Deutschlandgerät* is now followed by the third milestone of the artwork's history, which investigates its most recent years up to the present.

The material changes in *Das Deutschlandgerät* and Mucha's intervention

The fact that the iteration and later the acquisition of *Das Deutschlandgerät* took place without the involvement of the conservation department led to a vast gap between the artist's wishes for the care of his work and museum practices. As mentioned earlier, documentation neither of the aesthetic meaning nor of the positioning of the media elements, footstools and cables had taken place. During the long, ongoing exhibition timespan of nearly 23 years, the display equipment of the room installation has had to be repaired or replaced several times. While the original[8] DVD players were replaced by another model by Mucha shortly after the first install of the work in 2002, other changes were implemented by museum staff without consulting the artist. When DVD players failed later on, the museum's technical support team repaired or replaced the devices and returned them to the installation in slightly off positions. Visitors from time to time misinterpreted the immersive nature of the work and interacted by rearranging the footstools and the cables on the floor to their liking. Consequently, the replacement and the rearrangement of these sculptural elements was resented by the artist. As the following will show, bridging the gap between the Mucha's vision and the proper care for *Das Deutschlandgerät* only started to happen after the conservation and curatorial teams were called to face a bigger technical challenge.

In 2018, the DVD players started to fail and media players with a composite output were implemented from museum staff as an impromptu solution in order to keep the videos running. The artist was not pleased to discover this initiative taken without his permission, rightfully arguing that the addition of the media players twisted the sculptural perception of his artwork. Towards the end of the same year, however, a bigger technical issue occurred that would act as an impetus for a greater multidisciplinary conversation between the museum stakeholders, the artist as well as

external specialists: the screens of the CRT monitors began to have shifted colour temperatures, making the images appear distinctly green, magenta or purple tinted (Fig. 4). The former head of conservation, Otto Hubacek, sought advice from Jochen Saueracker, Nam June Paik's longtime assistant, an acquaintance known from a previous exhibition project for Paik's *TV Garden* (1974–1977/2002). Saureacker advised contacting Christian Draheim, a CRT specialist, who was based in Leverkusen at the time.

After exmining the possibility of repairing the broken CRT monitors of *Das Deutschlandgerät*, Draheim took the monitors one by one to his workshop and provided temporary replacement devices of the same brand and model, in order to keep the installation running. It is important to note at this point that repair shops for analog technical equipment and especially CRT monitors are very scarce nowadays. During their repair in Draheim's workshop, the cathode ray tubes in the monitors were replaced by another model more suited to continuous operation.[9] Replacing the cathode ray tubes is a very delicate process, not only because it is difficult to acquire spare tubes but also because it requires thorough technical precision while implementing a compatible replacement. The repair of the CRT monitors took place over a course of two years and by 2020 most of the CRT monitors had undergone treatment and had been reincorporated in the installation. Due to the lack of time-based media conservators working in the museum at the time, the CRT monitor repair project was not properly supervised. Due to poor documentation, there are no troubleshooting records and the exact number of the repair sessions required by each monitor is to this day unclear. The shifted colour issue was not resolved even after the multiple repairs: according to Draheim, this was due to the lack of a proper technical handover. Reinhard Mucha finally pleaded, somewhat frustratedly, with Falk Wolf, the curator in charge of *Das Deutschlandgerät*, to completely migrate the display equipment from analog to digital by implementing flatscreens that would be attached on the sides of the CRT monitors. The CRT monitors and DVD players were to retire as functional equipment but remain in their positions.

With the occasion of Mucha's upcoming retrospective[10] that would open at the Kunstsammlung in the autumn of 2022, it was in both the museum's and the artist's interest to have the issue resolved before the opening. Mucha's discontent, along with the upcoming retrospective, led to a roundtable meeting

Figure 4 Shifted colour temperature on one of the CRT monitors in *Das Deutschlandgerät*. (Photo: Documentation archive of the Conservation Department, Kunstsammlung Nordrhein-Westfalen, 2019.)

in the summer of 2020 to discuss the viable options. The attendees included Mucha and his representative gallerists, Jochen Saureacker, Christian Draheim and from the Kunstsammlung: the director Susanne Gaensheimer, then head of collection Annette Kruszynski, curator Falk Wolf, head of conservation Nina Quabeck as well as the museum's media technicians. In the roundtable discussions, Mucha explained his dissatisfaction with the condition of the monitors, indicating that the shifted colours on the video-animated photographs in his installation were an irreparable technical issue, hence considering the migration of the media components. Other options were examined with regard to their viability and costs, while Christian Draheim and Jochen Saureacker explained the technical challenges posed by this kind of analog equipment exposed to long exhibition hours. The costly option of continuously repairing the CRTs while hoarding spare ones in the museum depots for future replacements had

Figure 5 Photo of the custom-made holding system for the flatscreens that Mucha conceived together with his technicians taken during the intervention on *Das Deutschlandgerät*. (Photo: Documentation archive of the Conservation Department, Kunstsammlung Nordrhein-Westfalen, 2021.)

started to seem like unreliable investments from the museum's side. The meeting did not conclude in a clear decision. Until the autumn of 2020, Mucha had taken the initiative and built a prototype of customised holding brackets that would help to mount the flatscreens on the CRT monitors. Having been shown the prototype, Susanne Geansheimer and Falk Wolf became convinced that this strategy would actually work well for the presentation of *Das Deutschlandgerät*. The artist proceeded to acquire all the necessary equipment in order to implement the technical intervention on his artwork. One year later the gallery space of the *Das Deutschlandgerät* was closed to museum visitors and became a work in progress site.

In November 2021, the artist and his studio technicians arrived with tools and boxes filled with the new technical equipment that would soon become part of the room installation. Apart from Mucha and his team, this time the project was closely supervised and documented by head of conservation Nina Quabeck and then assistant time-based media conservator Rea Grammatikopoulou, who had been employed the previous year. It was striking to see Mucha's way of working and it became apparent to the accompanying conservators that each step of the implemented transformations on the artwork was carefully prepared and thought through.

Each CRT monitor was brought to the working table and treated separately in order to attach the custom-made holding system for the flatscreens on the monitors in a symmetrical and weight-proof way. The holding system that Mucha had conceived together with his technicians was made from threaded rods, carefully measured and cut to fit on the perimeter of the CRT monitors, steel brackets, screws, painted black wood and protective rubber pads. Metal, wood and rubber, all materials that Mucha often uses in his works, have been used recurringly in *Das Deutschlandgerät*. This demonstrates that the choice of materials for the transformation in the room installation was made consciously with respect to the identity of the artwork. One of the reasons Nina Quabeck supported Mucha's idea for this intervention was that the holding brackets had been built in such a way as to be non-invasive towards the materiality of CRT monitors. Figure 5 shows how the metal construction for mounting the flatscreens has been attached to the CRT monitors, almost 'hugging' them. It is screwed tightly around them somewhat precariously, reminding one of the reversibility-oriented approach implemented in traditional conservation practices.

Once ready, each CRT monitor was returned to its original position, the whole 'tower' was turned to 90 degrees, and then the flatscreens were mounted.

The rotation of the towers took place so that the flatscreens would face towards the same direction as the original screens of the CRT monitors. For a coherent visual experience, Mucha implemented 4:3 flatscreens with the same screen size as the one of the old monitors. The media players were positioned on the travertine floor with a protective thin layer of polyethylene foam underneath them in order to avoid misplacements and scratches on their surface.

After about one month of work in the gallery space, the project was completed, allowing the new era of the artwork to begin. At this point, Mucha handed over a signed document to the conservation staff, instructing that it should be kept in the conservation archives. It was a waiver, pointing out that all media elements that the artist has integrated in the work are exactly as relevant in formal and aesthetic terms as every other component in the installation, and that any alteration without the expressed permission from the artist would represent an infringement of the author's rights.

The intervention, as well as Mucha's waiver, were incorporated in the identity report of *Das Deutschlandgerät,* which Nina Quabeck had started compiling during the decision-making process regarding the broken CRT monitors. The third milestone of the artwork may therefore be defined not only by the artist's intervention, but also by a new era of showcasing and safeguarding *Das Deutschlandgerät* in alignment with the artist's intent again.

Table 1 The material description as reconfigured by Reinhard Mucha in 2021.

Multi-part sculptural room installation
Raised travertine floor, circumferential cornice with 27 fluorescent lamps each with 2 restraint brackets
Gallery 2.1 non-demountable exhibition space (reconstruction), 2002
4 solid walls travertine, felt, blockboard, *27 display cases* aluminium profiles, alkyd enamel painted on reverse of float glass, felt, blockboard, floorboards (*the artist's studio floor*), folding table (found object), 2 cable reels with an electrical connection toward the ceiling of the room
'Menzione d'Onore', 2021
Float glass, mirror glass, engraved brass plate, casket, footstool (found object), conference table (found object) with tight-fitting travertine pedestal, display case resting on top, felt-covered console with glass case, *38 wall mounted vitrines* aluminium profiles, etching on front of float glass (*augmented in 2002*), felt, 38 bronze casts, 38 wooden footstools (found objects), 38 steel tape measures, blockboard, 17 wooden footstools, brass brackets, 3 felt-covered base elements, 19 base plates, *15 videofiles and 2 audiofiles*, 15 DVD players, 15 CRT monitors, 3 CD players, 2 subwoofers, 7 audio monitors, electrical cord with female and male plugs, power strips, zip ties, cable reel, 16 brass floor outlets (*augmented in 2002*), *transition to digital video and audio systems* 15 LED flat screens, 15 media players, 2 media players (audio) (*augmented in 2021*)
Zollverein I|II, 2002
Felt, alkyd enamel on reverse of float glass, acrylic resin dispersion on MDF board
Overall dimensions (reconstructed plenary chamber of the Rheinischer Provinziallandtag from 1880) 2700 × 1700 × 1000 cm
Kunstsammlung Nordrhein-Westfalen, Düsseldorf
Acquired 2004, formerly Sammlung Ackermans

Reconceiving *Das Deutschlandgerät*

Mucha's bold and transparent way of working is mirrored in so many aspects of his artworks, one of them being their titles and descriptions. Having developed a distinctive method for documenting the changes in his artworks, he often revisits not only the materials but also the titles and descriptions of his artworks by making small additions. When researching his body of work, one quickly discovers that many of his artworks have multiple dates that are sometimes in square brackets and seem to be an actual part of the title. This is because whenever he carries out readjustments to his artworks, he adds the date of this readjustment in a square bracket (Wolf 2022: 31). The dates in his titles are arranged in chronological order with only the last date, the year of the initial creation, at the end of the order without a square bracket. This unique pattern is recognisable in the title of *Das Deutschlandgerät*, in which Mucha deliberately also added the names and cities of the exhibition places in order to underscore the importance of the artwork's historical context. In this case, the artist also revisited the material description and edited the wall text of *Das Deutschlandgerät*. The new material description, as reconfigured by Mucha, is shown in Table 1.

As seen in the table, Mucha thoroughly catalogued each material within the installation, highlighting the growth of the media elements both in 2002 and 2021, by adding the phrase 'augmented in' followed by the respective year. Notably, he seized the opportunity to address the controversy surrounding the dismounting of *Das Deutschlandgerät* back in 2009 by introducing the phrase 'non-demountable exhibition space' at the beginning of the description.

Figure 6 Installation views of *Das Deutschlandgerät* before and after the migration of the videos on flatscreens. (Photos: Achim Kukulies (left: 2002) and Documentation archive of the Conservation Department (right: 2021), Kunstsammlung Nordrhein-Westfalen.)

Indeed, so far in this paper it has become clear that Mucha is an artist who is actively engaged in the presentation of his works and often 'revisits' them. As Falk Wolf, the curator of Mucha's retrospective, pointed out in his research on Mucha's extensive oeuvre: 'he creates works that are absolutely complete and finished, and simultaneously can be expanded, changed, and updated at any time when a review of a new context makes this necessary' (Wolf 2022: 31). The artist's precise and thorough way of working, his commitment to the materials he uses, and his archival dedication to incorporating the changes into the title of *Das Deutschlandgerät* are all distinctive traces that resonate with the approach of conservators when documenting and exploring the biography of an artwork. Working closely with Mucha not only during his intervention on *Das Deutschlandgerät* but also for his retrospective that followed, allowed the conservation team to capture the artist's wishes for the proper presentation of his artwork and win the artist's trust in the museum as the main caretaker of his work (Fig. 6).

Exploring the identity of *Das Deutschlandgerät*

It could be argued that the addition of flatscreens in *Das Deutschlandgerät* is a rupture, as the reproduction of the video-animated photographs on the CRTs represent a certain era in which the installation was created and harbours the zeitgeist of the 1990s. Flatscreens, on the other hand, are clearly from a more recent time and offer a different viewing experience. Although the authors of this paper were not part of the Kunstsammlung team during the decision-making process leading to the intervention, the documentation files and talks with the team members involved have given an insight into this part of history. It seems that one of the things that made Mucha's idea for this intervention particularly attractive to the conservation and curatorial team was the fact that although it was a vast migration from analog to digital, the replaced media elements were not to be removed from the installation, but to stay in place, gracefully claiming their sculptural and historical significance in the installation.

Collaborating with artists after their works have entered an institution is not uncommon, as artists frequently want – or rather have – to revisit their works. In this ever-changing landscape, artists as well as time-based media conservators often find themselves at the intersection of artistic creation and technological progress, constantly navigating the challenges posed by the obsolescence of the media elements used. The approach taken by artists when migrating their work to new technologies can vary significantly from one case to another, such as Dara Birnbaum's *Transmission Tower:Sentinel*, for example, originally made in 1992 as a commission for Documenta 9, Kassel, Germany. The media installation once combined eight CRT monitors hanging on a section of a former transmission tower. For a reinstallation in 2019, the hanging CRT monitors were replaced with hanging flatscreens. Due to very limited information being available about this interesting case study, it is unclear in what context this migration happened or whether or not the artist was involved in the decision-making process. Given that

Birnbaum is still an active artist and that the modification in *Transmission Tower:Sentinel* occurred in her primary representative gallery, Marian Goodman Gallery in New York, it can be assumed that she was involved in the process.[11] It is intriguing to note that despite facing a similar challenge, Mucha and Birnbaum adopted different approaches. In the case of *Transmission Tower:Sentinel*, the media components were replaced without the addition of a new date to the artwork's title or modification of its material description. Unlike with Mucha's work, in Birnbaum's case, the monitors seem to serve as an interchangeable component for the artist, devoid of an inherent sculptural significance.

Another similar case of CRT reconfiguration is Bruce Nauman's two-channel video sculpture *Think*, part of the Museum of Modern Art's (MoMA) collection in New York. Originally made in 1993, *Think* consists of two CRT monitors sitting on a shelf table, with the laserdisc recorders and the empty laserdisc containers located on top of the recorders. For the 53rd Venice Biennale in 2009, the artist decided to show the work on two flatscreens mounted on a wall, flanked by two speakers. Nauman – whose stance is that it is not the equipment that is important, but the image[12] – revised the wall label description for this iteration. The label included the new media elements, along with the clarification that the artwork was 'originally configured as two video monitors, laserdisc players, laserdiscs and metal table' (Wharton 2016).

The comparison between Mucha, who identifies as a sculptor, and the two aforementioned pioneering time-based media artists may be somewhat unfairly drawn. Nonetheless, it is interesting to explore the distinct perception of the materials they use. For Mucha, the media elements in his work serve as sculptural components, as relevant in formal and aesthetic terms as every other component in the installation.[13] This view definitely influenced his choice for the way he implemented the migration in *Das Deutschlandgerät*, where the media components were replaced but not removed; instead, they are now highlighted as components with sculptural significance in the installation. In contrast to the case of Birnbaum, whose artwork title and description remained untouched after the monitor replacement, Mucha made sure to emphasise the modification in *Das Deutschlandgerät* as an integral part of the artwork's biography.

The changes in *Das Deutschlandgerät* unfold two distinct layers. The initial layer involves the continuous and unintended shifts in hardware and cabling, the malfunctioning DVD players, the introduction of media players by museum staff, and the colour distortions on the monitors. As noted by Muñoz Viñas, the physical integrity of an artwork refers to the material components that cannot be altered without violating it and the aesthetic integrity describes the sensational effect an artwork has on the observer (Muñoz Viñas 2005). The initial changes were indeed violating the physical as well as the aesthetic integrity of the artwork. The second layer of change was the artist-intended intervention. While the first layer of change in *Das Deutschlandgerät* posed a threat to the artwork's integrity, the second layer of change that was initiated by the artist sought to revive both the physical and aesthetic integrity of the artwork. It was Mucha's response to the technical glitches in his installation as well as to the failure of the museum, as its custodian, to find a viable solution.

Staying true to the integrity of a complex, multilayered installation that is permanently on display is with no doubt a challenging task that curators as well as conservators serve in an interdisciplinary effort. One of the main conservation strategies when caring for this type of artwork is keeping a detailed documentation through troubleshooting, compiling inventories, conducting curator and/or artist interviews as well as through compiling identity reports. Identity reports are expandable documents that consist of all the information that orbit around an artwork, such as its production history and conceptual meaning, the changes undergone, the artwork's defining properties as well as a risk assessment accompanied by a suggested conservation strategy. The ontological approach of these documents emphasises the understanding of the fundamental nature of artworks and what inherent qualities or features contribute to their identity (Van de Vall 2023: 14–17). It plays a pivotal role in not only detailing an artwork's journey but also in describing the conceptual framework that envelops it, bridging the intentions of the artist with the materials employed in their creation.

The longevity of exhibited artworks, as seen in the case of *Das Deutschlandgerät* spanning over 23 years, presents challenges in troubleshooting but also enriches the identity report with a wealth of information accumulated during an artwork's presentation. The identity report of *Das Deutschlandgerät* is regularly updated whenever new information emerges or vast changes, such as

the 2021 intervention occur. In the realm of complex media installations, identity reports could be described as comprehensive documents that encapsulate the artwork's essence – perpetually incomplete 'open documentation cases' requiring re-evaluation to stay up to date. It could be argued that the constant extension of the identity report mirrors the conceptual and physical expansion of *Das Deutschlandgerät*, in a symbiotic relationship. Just as the artwork evolves, the identity report serves as a dynamic record that grows with it.

It took years of engagement with *Das Deutschlandgerät* for the current authors to become familiar with its identity. Collaborating with the artist for the intervention in 2021 and the subsequent significant retrospective the following year, proved instrumental in becoming acquainted with Mucha's universe. This collaboration was crucial for comprehending the multilayered, immersive artwork and understanding the impact that material changes have had on *Das Deutschlandgerät*. The intervention went beyond a simple replacement of obsolete media components with new ones; it was an intentional expansion, deemed necessary by the artist in order to keep his artwork alive. It was a thoroughly calculated act, both in the selection of materials as well as in the conceptual underpinnings. Despite the noticeable discrepancy in the form and shape of *Das Deutschlandgerät* from its installation in 2002 to its present state, the recent intervention functions more as an expansion of Mucha's conceptual patterns, enriching the artwork's identity and history.

In perfect alignment with his tendency to incorporate exposed power cables and position DVD players with their backs facing the front, Mucha extends this boldness to signify the recent addition of the flatscreens to his artwork. This is evident not only in the deliberate manner in which he mounted the flatscreens alongside their predecessors but also in the updated title of *Das Deutschlandgerät* that acknowledges the latest enhancements. Now turned off, the CRTs remain as witnesses to the intervention; the old monitors embrace their obsolescence and adopt new roles as sculptures that are supporting the flatscreens. This adaptation mirrors the weight-bearing functionality of various elements within *Das Deutschlandgerät*, such as the pillars of the German pavilion in Venice, the footstools in the display cases and the Germany Device itself. Contrary to signifying loss of historical integrity (Muñoz Viñas 2005), the change of materials in *Das Deutschlandgerät* takes on a different significance. Rather than erasing historical imprint, Mucha's intervention becomes a reflection of industrial development, the changes that accompany it, as well as the ongoing thematic recurrence of older elements supporting their successors – all prevalent concepts in *Das Deutschlandgerät* and in Mucha's broader body of work.

Further thoughts

The authors of this paper refrain from stating that artistic intervention should be a universally embraced conservation strategy in response to obsolescence-related issues. Instead, they aim to highlight the case of *Das Deutschlandgerät* as a unique instance of a time-based media artwork reconfiguration. In this context, the change did not compromise the physical or conceptual integrity of the artwork but rather unfolded as an organic evolution in its lifecycle. As discussions about the future of *Das Deutschlandgerät* continue, certain unresolved questions linger. The debate includes obsolescence-related considerations, particularly concerning the implemented flatscreens, which now carry a sculptural significance, like all media elements in the installation. Despite the conservation department having stored spares for the flatscreens, their availability on the market is temporary and they will soon become obsolete, potentially encountering technical failures within the next decade. *Das Deutschlandgerät*, being permanently on display, will continue to pose challenges for its caretakers, who must also be able to navigate them in the absence of the artist.

Addressing obsolescence-related issues of CRT monitors without the artist's involvement or statement is intricate, and merely migrating to flatscreens is not a viable strategy for time-based media conservators. The balance between preserving the artist's vision and the practical need for updates often raises ethical considerations and leads to a breach. Time-based media conservators aim to bridge the gap between an artwork's identity, the artist's intent and its technical operability. Even though it can be difficult to clearly draw the line when working with artists after their artwork has entered a collection, it seems vital to acknowledge that artworks are often continuous with artists' lives (Quabeck 2021) and, as in the case of *Das Deutschlandgerät*, expandable. Embracing material change as an inherent

property of these 'unruly' objects is equally crucial as anticipating it directly upon an artwork's entry into a collection (Dominguez Rubio 2014). Since time-based media conservation has been established at the Kunstsammlung, obsolescence-related issues are discussed during the acquisition process – not only with curators but also with the artists. Time-based media works of art are so susceptible to material change that they simply defy being perceived as fixed entities in the realm of time, and conservators play a critical role in safeguarding the cultural and artistic heritage embedded in them.

Troubleshooting throughout the exhibited lifetime of artworks, researching their production history and collaborating closely with artists and curators are useful, multidisciplinary practices that can serve as tools to comprehend the identity of an artwork and treat it when this becomes necessary.

Acknowledgements

We are grateful to our colleagues from the Kunstsammlung Nordrhein-Westfalen, head of conservation Nina Quabeck and curator Falk Wolf, who generously offered their knowledge and insights on this case study.

Notes

1. From here on also referred to as Kunstsammlung.
2. The English title is: **The Germany Device**, *Kunstsammlung Nordrhein-Westfalen, K21 Ständehaus, Düsseldorf* [**2021**], [**2002**], *XLIV Biennale di Venezia, German Pavilion, Venice* **1990**.
3. According to the research report by former head of conservation, Werner Müller, the source of this travertine stems from quarries in Chiampo, Italy.
4. The original source comes from the archive of the website of the Institut für Auslandsbeziehungen (ifa), the author and date of editing are unknown. Source: Institut für Auslandsbeziehungen, 'The German Contributions 1971–2022', *German Pavilion at the Biennale di Venezia* (Stuttgart: Institut für Auslandsbeziehungen). Available at: https://www.ifa.de/en/art/german-pavilion-venice-biennale (accessed 16 January 2024).
5. *Ibid*.
6. The wagon factory, formerly named Carl Weyer & Cie., was founded in 1861 and later changed its name to Düsseldorf Eisenbahnbedarf before becoming Düsseldorf Waggonfabrik; see Mucha 1990.
7. According to internal correspondence from the former head of conservation Werner Müller, the iteration of *Das Deutschlandgerät* was carried out exclusively by the artist's technical team. The involvement or support of the conservation department was not desired.
8. The term 'original' is used here to imply the first one in this artwork, in a series of replacements that followed, and not the original in terms of authenticity.
9. According to the documentation from a meeting with Draheim, the original Sony cathode ray tubes were replaced by the more resilient Hitachi tubes.
10. The exhibition *Der Mucha. An Initial Suspicion* took place at the Kunstsammlung Nordrhein-Westfalen, 3 September 2022–22 January 2023. It was the first retrospective of Reinhard Mucha.
11. Attempts to contact the gallery to confirm or deny this assumption have been unsuccessful.
12. 'I think that one of the things that need to be considered when we are dealing with technology is to not let it take over. It's the image that's important, not the equipment'; see Nauman and Hochdörfer 2005.
13. According to the waiver that he handed over in 2021.

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Posters

Conservation or creation? Murals restored by Gerhard Gotaas

Susanne Kaun and Elisabeth Andersen

In 2021, an interdisciplinary study disclosed an unusual and surprising story about a mysterious wall painting and an unbelievable fraud. It was revealed that the enigmatic mural called *demonveggen* (the Demon Wall) in Sauherad church, Telemark, Norway, commonly believed to be from the 17th century, was created in its entirety by conservator Gerhard Gotaas in 1940–1941 (Fig. 1). The conservator himself had claimed the motif was authentic and that he merely restored it (Andersen and Kaun 2021). In the wake of this revelation the question arises: were other murals restored by Gotaas also partly or entirely created by him?

Gerhard Gotaas (1879–1963) was a respected conservator in Norway who dedicated his whole career to the conservation and restoration of church interiors and inventory. He uncovered and restored murals in several medieval stone churches in Norway. Gotaas's mural restorations are characterised by extensive retouching and reconstructions. Although the reconstruction of missing ornamental parts was a common practice at the time, Gotaas often went a step further in 'freshening up' or supplementing motifs. This applies particularly to figurative scenes where he added lost details, often without marking his additions, as found in Nes church, Telemark, Norway (Berntsen and Kaun 2022).

In Botne church, Holmestrand, Norway, the north wall of the nave is covered with unusual scenes from the Doomsday and the Nativity. Art historians have

Figure 1 Detail from the Demon Wall in Sauherad church. (Photo: Susanne Kaun.)

not found any iconographic or stylistic parallels, and the character of the painting and the artistic expression differ significantly from older murals (Ørum 2018). Surface examinations showed that virtually all the paint strokes of the Nativity scenes were secondary – only a few traces of older paint suggest that there may have been some form of wall painting, but these could not provide any basis for determining the motifs. Archive photos from the restoration by Gotaas in 1942 show highly degraded and illegible mural remains in the Doomsday scene, which can hardly be interpreted as today's motif. Ultraviolet (UV) fluorescence examination revealed comprehensive additions, therefore most of what we see today of the wall paintings in Botne church is largely the creation of Gotaas.

The conservator Gerhard Gotaas has had a significant influence on the appearance of many church interiors with murals in Norway. His restoration practice on murals is marked by comprehensive additions and reconstructions, and the subjects have often been altered significantly from what must have been their original appearance. He went beyond what is considered to be restoration as he created motifs without sufficient foundation – or indeed any foundation. The most striking example of this is the Demon Wall in Sauherad church, where he created an entirely new mural.

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Varnished, overpainted and ennobled: the plaster cast collection of the National Museum of Norway

Katharina Kruck

When the Sculpture Museum was established in Kristiania in 1881 (now part of the National Museum of Norway), the plaster casts were an important part of the early collection, just as in other European museums during the late 19th century (Fredriksen and Marchand 2010; Schreiter 2020). Examination of the sculptures shows that their surfaces are not simply white as might be expected from historic plaster casts, which were typically left untreated when acquired by the museum in the 19th century. The surfaces of the plaster casts show great variety today, either painted or varnished with various materials including shellac, wax and paint (Fig. 1).

This project investigates the when and why of the surface treatments through the study of archives at the National Museum. To identify the treatment materials, ultraviolet (UV) light and handheld X-ray fluorescence (XRF) analyses were employed.[1] Plaster is inherently highly porous and hydrophilic, therefore to make the plaster surface more resistant to maintenance treatments and general care, research had already been carried out at the end of the 19th century (Rathgen 1915: 114–23; Winkler-Horaček 2019: 86). Possibly inspired by a procedure implemented by the Königliche Museen in Berlin (Bohnhagen 2003: 192), Christopher Borch (1817–1896), a Norwegian sculptor, proposed a treatment of plaster sculptures to the management of the Sculpture Museum using a mixture based on sodium silicate and barium hydroxide.[2] According to a protocol entry,[3] Borch was commissioned in 1883 to treat several plaster sculptures with his method. When examining individual sculptures under UV light for this current project, a light blue fluorescence was visible, which could indicate the presence of barium carbonate as a result of Borch's treatment.[4] Traces of barium were also confirmed by XRF, but due to the low indication, its presence should be corroborated by other investigative methods.

When art historian Jens Thiis (1870–1942) was appointed director in 1909, he introduced extensive changes in the collection displays. As the cast collection had become less popular, he decided not only to decorate the rooms in the style of the period from which the sculptures belonged but also to paint the plaster casts to imitate the material of the original sculptures in the hope of increasing public interest (Messel 2012). Thiis opened up two new areas: one for casts of medieval stone sculptures, painted to imitate stone and another for casts of Renaissance artworks, painted to imitate bronze. The quality of their finishes varies widely[5] but analyses of the materials and applied techniques for these finishes are still pending.

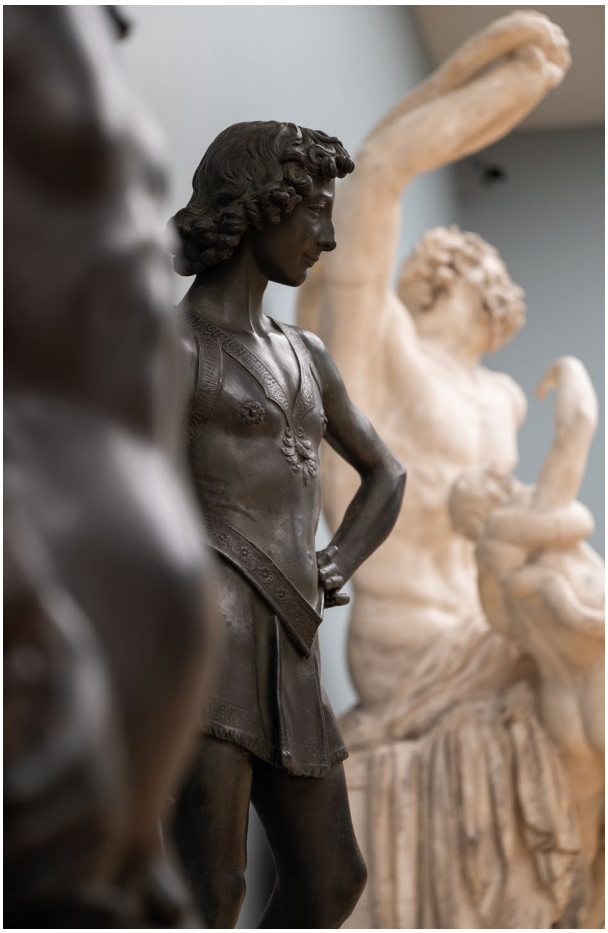

Figure 1 Plaster casts on display in the National Museum. (Photo: National Museum/Ina Wesenberg.)

Due to the combination of material properties of plaster and fluctuating popularity over the decades, few other museum objects have been subject to such severe interventions as the cast collections. Many of the plaster casts at the National Museum underwent surface treatments for different reasons: to either strengthen the material for maintenance reasons or to ennoble the surfaces to modernise the exhibition concept and attract visitors. The variety of finishes found on these sculptures can be read as a reflection of the collection's eventful history over the course of time.

Notes

1. The analyses were carried out using a handheld XRF Thermo NITON XL3t GOLDD+.
2. Christopher Borch's offer is mentioned in the protocols on 9 May 1882. His letter has the reference J.N. 33/82.
3. NMFK/Christiania Skulpturmuseum/ C-0003, protocols of the sculpture museum. Protocol 31 May 1883.
4. https://www.kremer-pigmente.com/elements/resources/products/files/64090.pdf. Product information for barium carbonate, Kremer Pigmente.
5. Several plaster casts in the collection can be seen on pictures taken of the interior of the Sculpture Museum in 1885 with a white surface, including casts of David by both Donatello and Verrocchio. Photos from 1913 show the same sculptures with a bronzed surface as we see them today in the exhibition rooms of the National Museum. Plaster casts acquired from 1913 and later were often already given a high-quality surface finish in the reproduction workshop as, for example, the cast of Donatello's Equestrian Statue of Gattamelata.

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Before de-restoring a painting: use of a combination of OCT with analytical methods to unveil a former restoration and enhance the history of conservation of 19th-century Paris

Diane Le Corre, Elsa Perruchini, Chloé Ranchoux and Gaël Latour

Restoration workshops often work on artworks that have previously undergone several phases of restoration treatments in the past. When the best conservation option is to remove prior restoration work, a question arises: how can it be documented in such a way that prevents losing the history of the conservation which is also part of the history of the painting? This study focuses on a Spanish oil painting on canvas dating from the mid-17th century and depicting the sculpture of the *Virgen del Sagrario* in Toledo, Spain. Nowadays it is kept at the Musée national de la Renaissance, Écouen, France. The task of retracing the complete history of the painting and restoring it was entrusted to the Institut national du patrimoine, Aubervilliers, France. A historical study and the use of analytical techniques were chosen in order to both document and understand the intention of this earlier restoration.

The historical study was based on material and textual sources which focused on the intervention on the back of the painting. We found traces of a stencil on the lining canvas and identified the maker, Deforge & Carpentier, a supplier of artists' materials in Paris in the second half of the 19th century who also carried out restorations (Sofio 2017). Using the research tool Guide Labreuche, comparison with other stencils of the same brand enabled us to date the previous lining to around 1865 (Labreuche 2014).

Different analytical techniques were also used to obtain more information on changes made on the front. A non-contact and non-destructive approach was chosen to preserve the integrity of the work: optical coherence tomography (OCT). This optical technique allows a stratigraphic imaging of the semitransparent layers with a resolution around 1 µm (Latour *et al.* 2009; Latour and Robinet 2019).

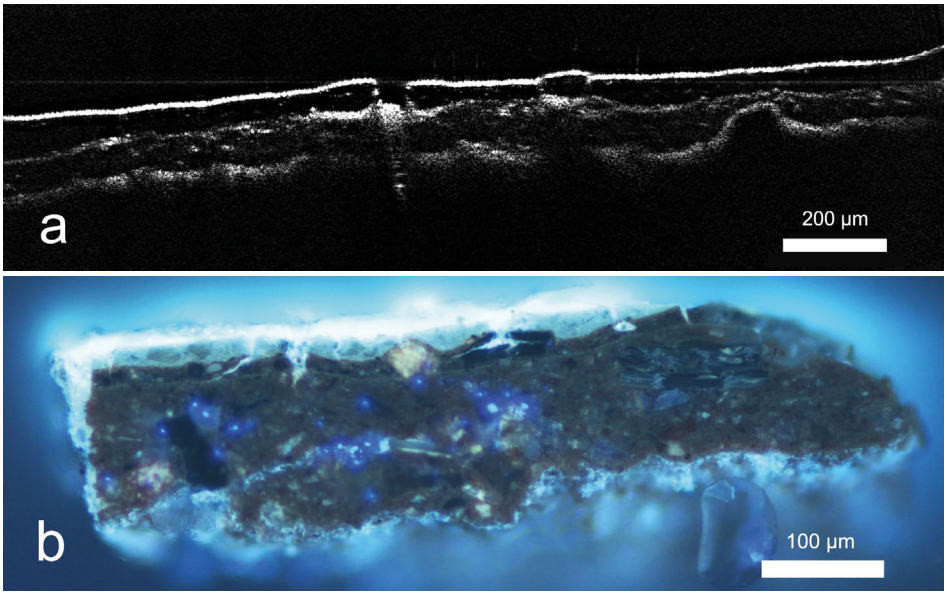

Figure 1 (a) OCT cross-section imaging showing two varnish layers (scale bar: 200 µm). (Photo © LOB/Gaël Latour.) (b) Painting sample cross-section under UV light, showing two varnish layers with morphological details such as particles in the oldest (scale bar: 100 µm). (Photo © INP/Diane Le Corre.)

We carried out this analysis on different parts of the painting to reveal the presence of two overlaid varnishes in some areas and to enable the mapping of their distribution (Fig. 1), as well as to identify and locate the overpaintings in this stratigraphy.

A selective sampling of each stratified varnish assisted by OCT enabled us to analyse the chemical compounds by gas chromatography-mass spectrometry (GC-MS). Both varnishes were composed of *Pinaceae* resin mixed with oil, but the older varnish differed from the restoration varnish as it contained particles of aluminium and calcium (Stols-Witlox 2001; Zumbühl *et al.* 2020). This information was obtained on a single sample, observed under optical microscopy and analysed by scanning electron microscopy with energy-dispersive X-ray spectroscopy (SEM-EDX). This study documents the previous restoration and more precisely the treatments carried out on the front:

- A selective cleaning of the older varnish only at the composition level in order to lighten it.
- A darkening of the brown background with overpaintings.
- Variable treatment of the lacunae, with covering retouching on the brown background and unretouched areas in the middle of the composition.
- An oily slightly brown restoration varnish to create a 'patina'.

It seems to show that the former restorer left the artwork with visible alterations and preserved most of the old varnish. By retaining the appearance of an old object, the painting corresponded to the 'antique taste' of many collectors of the time (Charpy 2012).

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The reuse of a medieval cope from Stavanger Cathedral, Norway

Hana Lukesova

In 1867, the architect Conrad Fredrik von der Lippe (1833–1901), responsible for the reconstruction of Stavanger Cathedral, Norway, wrote a letter about the discovery of an antependium on green velvet with an embroidered shield in the cathedral's attic and donated it to the Bergen Museum.[1] In 1919, it was sent back as a loan to Stavanger where, based on a proposal by art historian Thor Kielland, it was taken apart and reconstructed as a cope used in the episcopal consecration of the Bishop of Stavanger in 1925.

The shield is decorated with the Obeisance of the Three Kings, and a long band on the cope's upper edge depicts saints and secular figures. The main motif beneath the shield was interpreted as St Swithun surrounded by seraphs (Kielland 1921); the depictions of two persons accompanying him are later additions. The Stavanger cope shares its technique and some of the motifs with other high-quality medieval English embroideries. The combined depiction suggests that this object was originally a cope dating from around 1500. The piece is in a poor state, presenting a complex combination of old and modern materials – original and recent embroidery. The embroidery had been modified before the reconstruction in 1925, probably even before it became an antependium. The object calls for technical research to distinguish between original areas and later alterations or additions.

In the Middle Ages, precious textiles were reused frequently. How can we evaluate the gap between the artwork when first completed and how it looks now, in the changed state? Is it possible to present the Stavanger cope as a medieval garment knowing

Figure 1 The Stavanger Cope, resewn and re-embroidered from an antependium in 1925. (Photo © BitMap, Stavanger Museum.)

it was constructed in 1925? In-depth material analysis and close collaboration of specialists in various fields are necessary for a thorough understanding of the artwork's authenticity. A reliable dating of such a reused object can only be achieved with a detailed knowledge of its construction and the materials used. Radiocarbon dating (^{14}C) is a standard procedure for proof of authenticity and fibre analysis using microscopy is a useful complementary tool for interpreting heritage textiles. Fibre analysis can also aid with targeted sampling for ^{14}C and interpretion of the results. Knowledge about textiles and the choices in the materials used enable interpretation of reuse and indirect dating: for example, the use of cotton as an embroidery thread in medieval English artwork is highly improbable, and synthetic fibres exclude originality entirely. Furthermore, material characterisation, such as fibre degradation level, can distinguish between older and newer threads.

The antependium, discovered before 1867, was resewn into a cope in 1925 (Fig. 1). It is incorrect to describe the cope as a medieval garment since it was constructed only in the 20th century. Today, the object represents a complex mixture of original embroidery and other reused materials with implementations of modern embroidery.

Acknowledgements

I would like to thank Sonja Marie Innselset for tracing the historical correspondence in the University Museum of Bergen's archive. Trude Eriksen and Kate Newland from the Stavanger Museum are acknowledged for their valuable collaboration, and Dr Clare Browne, Prof. Evelin Wetter and Dr Michael Peter are thanked for their consultations.

Note

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The conservation and restoration of the relief *Lamentation over the Dead Christ in painted stucco*

Joana Martins and Conceição Ribeiro

In 2022, the National Museum of Ancient Art of Lisbon (Museu Nacional de Arte Antiga, MNAA), designed an interdisciplinary team for conservation to research and intervene in a large 16th-century, painted *stucco* relief, *Lamentation over the Dead Christ*.[1] The relief was removed from the Chapter House of the suppressed Convent of Esperança in Lisbon in 1891 (Lima 1972: 325–6). The complex and delicate process of removing it from the walls used a pioneering technique of *stacco a massello*,[2] following which it was transferred onto a timber structure to be moved to MNAA[3] (Vieira da Silva 1950). Despite the successful removal, this large polychrome panel has received an extensive overpainting with the application of an artificial patina in a restoration process to repair the losses and cracks, with new support additions and adjustments of the shape forms. The nature of the *stucco* support material had, until recently, been mistaken for terracotta of Juan de Juni authorship (Martin Gonzalez 1974: 374–5).

The current intervention faced several challenges since some of the restoration processes would have

Figure 1 *Lamentation over the Dead Christ*, MNAA 671 Esc., after intervention. (Photo © MNAA/MMP.)

changed the appearance of this work of art[4] and influenced its interpretation. The first issue was the removal of the support fillings of old restorations, which raised the hypothesis that the overall original shape of the relief differed from the square frame currently imposed. A second dilemma arose in relation to the reconstitution of the poorly made replacement parts, in terms of whether to carry out a minimal intervention, a new reconstruction or to just tolerate missing parts. It was decided to accept the previous reinterpretation of the lost and unknown forms as part of the history of the object, and those previous reconstructions of these forms, which were in poor condition, were removed and reconstructed with compatible and stable materials.

The third dilemma occurred when the overpainting was removed, mostly mechanically using scalpels under magnification, to reveal an unknown original and intensely coloured painted surface. The final decision to carry out a profound and scientifically based 'de-restoration' allowed a return to the true chromatic values of the 16th-century sculpture (Fig. 1). The support was identified as *stucco* composed of mortar of lime, sand and stone dust, which has played a crucial role in the prominence of an important late Renaissance sculpture from the Iberian Peninsula.[5,6],

These issues sparked ethical discussions involving various cultural heritage actors such as conservators, art historians and conservation scientists. Through archival research, diagnosis, analysis of materials and technical studies, these discussions provided essential contributions to resolving these conservation challenges (Martins *et al.* 2023).

Acknowledgements

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Notes

1. The José de Figueiredo Laboratory in Lisbon provided a conservation consultancy service to the project and materials analysis was carried out by the HERCULES Laboratory in Évora, Portugal.
2. For a description of the *stacco a masselo* process see Mora *et al.* 1984: 251–5.
3. The removal of the relief and its transportation to the walls of MNAA's Janelas Verdes' entrance was coordinated by architect José Luis Monteiro from the Lisbon Municipality. See Vieira da Silva 1950.
4. For a definition of restoration see*:* ICOM-CC – Terminology for Conservation (2008), https://www.icom-cc.org/en/terminology-for-conservation.
5. Support characterisation was carried out by HERCULES Laboratory (University of Évora) using Fourier transform infrared spectroscopy (FTIR) and scanning electron microscopy coupled with energy-dispersive spectrometry (SEM-EDS).
6. Those of the Corral Villalpando brothers in Spain. See Pérez Martin 2017.

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Dilemmas and decision-making during conservation and restoration of wall painting fragments from the church of St Nicholas in Palež, Serbia

Bojana Savić and Radomir Samardžić

Conservation and restoration of wall painting fragments from the medieval church of St Nicholas in the village of Palež took place at the Faculty of Applied Arts in Belgrade, Serbia (Fig. 1). This exceptionally complex task required collaboration between art historians, biologists, physicians and conservator-restorers, respectively. In cooperation with the Institute for the Protection of Cultural Monuments of Serbia and the Institute of Botany (both in Belgrade), final year students at the Department of Conservation and Restoration, Faculty of Applied Arts in Belgrade, carried out conservation and restoration of the fresco fragments, and successfully reconstructed the collapsed wall painting.[1]

A full-length depiction of St Kyriaki and a portrait of an unknown ruler, partly damaged, were represented on the frescoes, originally situated on the western facade of the church. Having been exposed to the weather and other atmospheric conditions for centuries, pieces of the frescoes fell off the wall in 2006 and disintegrated into several hundred fragments of various sizes. They included remnants of the aforementioned unknown ruler's attire, a cross-shaped ornament adorned with pearls and gemstones – a detail discovered over a decade before the start of the conservation and restoration process. That important scientific evidence enabled the wall paintings of the church, previously dated to the beginning of 15th century, to be more accurately dated to the middle of 14th century, i.e. during the reign of the last rulers of the Serbian Royal House of Nemanjić (Vojvodic 1998: 134). The fragments, 214 pieces in total, were collected and delivered in cardboard boxes for further treatment. For sensitive and vulnerable objects of immovable cultural heritage, particularly medieval artefacts, a multidisciplinary overview, including the expertise of art historians, is a legal obligation. Reconstruction was conducted successfully with the expert assistance of art historian D. Vojvodić as well as the examination of older photographs kept at the National Museum of Serbia.

Scientific analysis – Raman spectroscopy, infrared spectroscopy and scanning electron microscopy (SEM) – revealed the presence of calcite in the

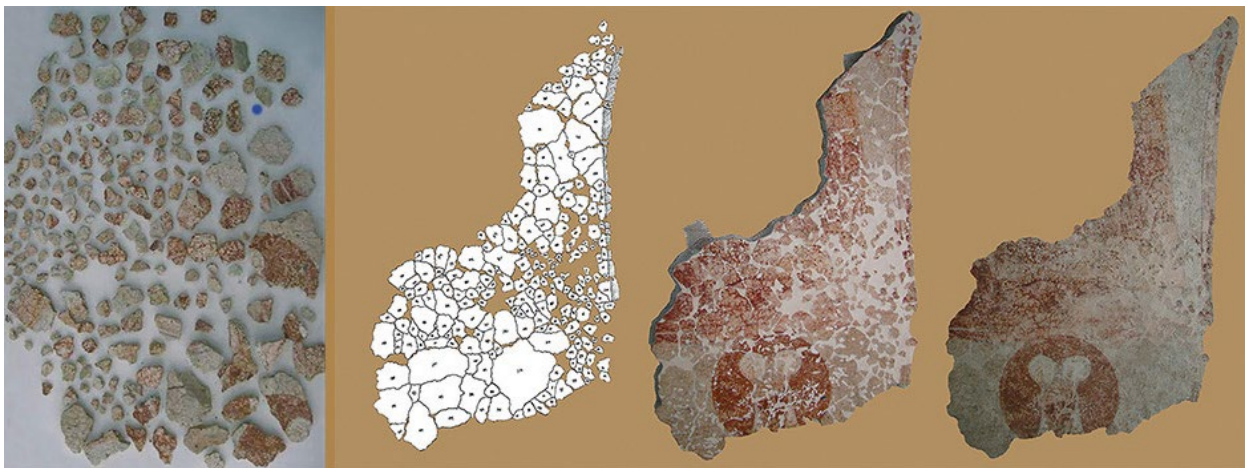

Figure 1 State of the fresco painting before reconstruction, drawings of fresco painting fragments and the fresco painting after reconstruction, conservation and restoration.

mortar as well as hematite or red ochre as a pigment in the paint layer. Damaged fragments were covered with microorganisms which had caused the mortar and colour layer to turn green, so a biologist was needed to establish an efficient procedure which would prevent further degradation of the wall painting fragments. As the microorganism *Aspergillus flavus*, a producer of aflatoxin B_1 was detected, the fragments had to be handled with precaution requiring the use of protective equipment including masks and gloves. Extensive textual, technical and photographic documentation was made about each phase showing the condition of the wall painting prior to work being undertaken, the progression during the conservation and restoration process, as well as the appearance and condition of the wall painting after its reconstruction, conservation and restoration.

The process of restoration required many issues to be resolved including the best methods for reconstruction of the fragments, use of materials and colour reintegration. It would not have been carried out successfully without the joint efforts of experts from different fields.

Note

1. Under the mentorship of Full Professor Radomir Samardžić.

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Different contexts, common challenges: conservation of a distemper wall painting from 1690 by Henning S. Munch in Vågå church, Norway

Lena Porsmo Stoveland, Anne Apalnes Ørnhøi, Karen Mengshoel, Calin Constantin Steindal and Tine Frøysaker

During two weeks in 2023, a Norwegian 17th-century distemper wall painting on wooden panels by parish priest and artist Henning S. Munch (1646–1696) was investigated and conserved. This remarkable painting from 1690 covers 28 m^2 of the choir of Vågå church built 1625–27 in Ottadalen, Norway. It depicts landscapes and biblical scenes from the Old Testament in stylised grisaille (Fig. 1). Distemper paint, a technique that dates to the medieval period, was commonly used to decorate Norwegian churches (Olstad and Ørnhøi 2017). Following visits to Vågå between 1895 and 1939, renowned artist Edvard Munch (1863–1944) commented on the Vågå painting and assumed that Henning S. Munch was a distant relative (Bjerke

Figure 1 (*Lower images*) Details of the condition of the Vågå wall painting before treatment. (*Upper image*) Detail of the painting after treatment. (Photos: Birger Lindstad and NIKU.)

et al. 2022). This present study highlights the conservation challenges of distemper paint like the Vågå painting, analogous to those of modern matte paintings by artists such as Edvard Munch.

Archival research and analysis of the Vågå painting using common visual and analytical techniques – including microscopy, ultraviolet (UV), portable X-ray fluorescence (pXRF), scanning electron microscopy with energy-dispersive X-ray spectroscopy (SEM-EDX) and Fourier transform infrared spectroscopy (FTIR) – were carried out to investigate its history, materials and condition. The examinations showed that the painting had paint loss and flaking paint, the surfaces were heavily soiled by air- and waterborne dirt, and the paint and ground were extremely sensitive to water. Several consolidation tests using methyl cellulose (cp 4000, 400, 15, 1–3% w/v with and without ethanol) and sturgeon glue (2% w/v) applied though Japanese tissue were carried out to secure loose paint and ground and absorb soiling and stains.

SEM-EDX of a few minute samples revealed the use of natural clay (silicon, aluminium, iron and magnesium) as a ground for historic distemper paint, probably identified for the first time in a Norwegian context. The white and black paint appear to be composed mainly of white chalk and black carbon pigments. FTIR showed absorption bands for amide I and II, suggesting a glue binder in the paint. The light blue-grey colour in the sky of the upper half of the motif was found to be a non-original, now severely faded and soiled, blue distemper paint of alumina containing Prussian blue. All consolidation tests applied through Japanese tissue resulted in tidelines, pigment removal or an uneven cleaning result. The only acceptable consolidation option found within the timeframe of the project was local application of methyl cellulose (2% w/v 1:1 water:ethanol) or diluted Lascaux Medium for Consolidation. Dry polyurethane sponges were used to remove a visible amount of loose surface dirt but were less effective on the imbedded soiling and water stains.

Despite the differences in materials and age, the Vågå wall painting shares similarities such as stylised motifs, matte appearance, and consolidation and cleaning challenges with works by Edvard Munch such as the Aula paintings, University of Oslo, Norway (1909–16) (Frøysaker 2010[2008]). Notwithstanding different funding and contextual frameworks, both cases underscore the need for further exploration of gentle and effective treatment options for consolidating and soiling removal from large-scale, unvarnished and water-sensitive painted surfaces.

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Connecting the dots in the Coastal Memory Fort at UNESCO Geoparque Oeste Portugal: collaborative efforts in art history and conservation

Vanessa Antunes, Carla Tomás, Gunnar Liestøl, João Serra, Victor Ferreira, Luis Mateus and Marluci Menezes

The Forte das Memórias (Coastal Memory Fort) project aims to revitalise tangible and intangible heritage through the safeguarding of the 17th century fort of Nossa Senhora dos Anjos de Paimogo, Lourinhã (Portugal). Located on the cliffs of Paimogo Beach – a place marked by the historical landing of the Duke of Wellington's forces during the Napoleonic Wars – the fort stands as a prime example that brings together the best of Portuguese military architecture of former eras. The project endeavours to make this building become a living part of community identity once more.

The current state of the art in the Lourinhã region showcases a dynamic blend of cultural heritage preservation, technological innovation, and environmental conservation, reinforced by its recent integration as part of the UNESCO Geopark West since 2024. This recognition highlights the region's profound geological and cultural significance. By adopting an interdisciplinary approach and leveraging innovative technologies, the group has overcome existing challenges and paved the way for more effective and efficient heritage preservation efforts:

- *Preservation of cultural heritage*: Through interdisciplinary collaboration, we have successfully preserved the cultural heritage embodied by the fort. By integrating art history with conservation practices, we have developed comprehensive strategies to safeguard the fort's architectural integrity and historical significance for future generations.
- *Innovative imaging techniques*: Our collaboration has enabled the adoption of innovative imaging techniques, such as augmented reality (AR) and photogrammetry, which have revolutionised the way we document and interpret the fort's cultural heritage. These technologies have enhanced our ability to capture detailed information about the fort's condition, important information to perform preventive conservation (photogrammetry) (Fig. 1) and engage visitors in immersive experiences.

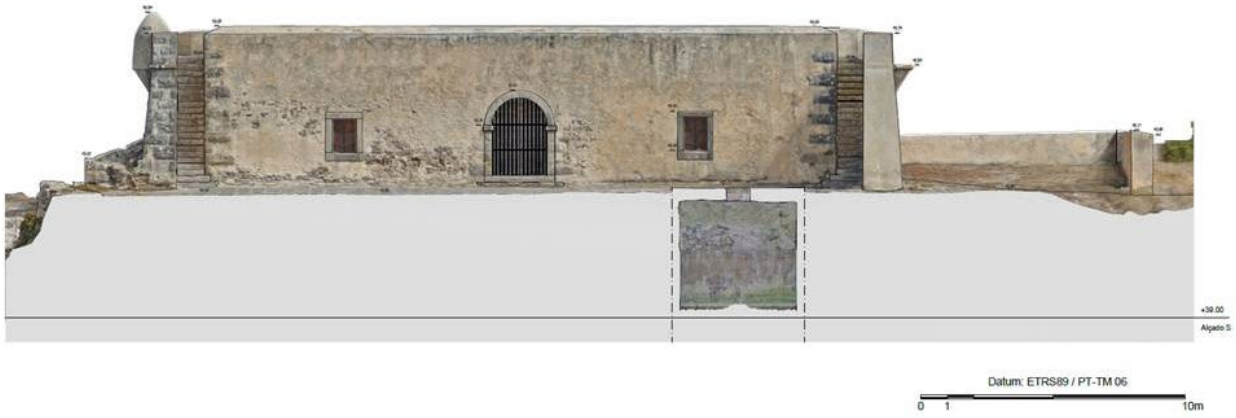

Figure 1 Paimogo Fort (17th century, Lourinhã, Portugal): photogrammetry overcomes challenging retrofitting measures, potentially resulting in the inefficient allocation of financial and material resources.

- *Community engagement and empowerment*: Interdisciplinary collaboration has facilitated meaningful engagement with the local community, empowering residents to take an active role in the preservation of their cultural heritage. By involving stakeholders from diverse backgrounds, we have fostered a sense of ownership and pride in the fort, ensuring its continued relevance and significance.
- *Educational outreach*: Our collaborative efforts have extended to educational initiatives aimed at raising awareness about the fort's art historical importance and conservation practices. By integrating conservation principles into school curricula and public outreach programmes, we have inspired future generations to become advocates for cultural heritage preservation.
- *Legacy of interdisciplinary collaboration*: As the project concludes (2024), the legacy of interdisciplinary collaboration will endure, serving as a model for future conservation efforts. We have set a precedent for sustainable and holistic approaches to preserving cultural heritage by demonstrating the value of integrating art history with conservation practices.

In conclusion, interdisciplinary collaboration has been instrumental in bridging the gap in the Forte das Memórias project objectives, ensuring the long-term preservation of the fort's cultural heritage. This collaborative approach not only safeguards its historical significance but also actively engages current and future generations of the local community, fostering a deeper connection to their shared heritage.

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The Vilhelm Hammershøi Digital Archive: an interdisciplinary research project on the materials and working methods of the Danish painter Vilhelm Hammershøi

Anne Haack Christensen, Pauline Lehmann Banke, Loa Ludvigsen, Troels Filtenborg, Gianluca Pastorelli, Annette S. Ortiz Miranda, Annette Rosenvold Hvidt and Jørgen Wadum

The Vilhelm Hammershøi Digital Archive (ViHDA) is a 5-year research project at the National Gallery of Denmark (SMK), investigating the painting technique and development of the working methods of the Danish painter Vilhelm Hammershøi (1864–1916). More than 120 paintings by Hammershøi have been examined by a cross-disciplinary team of conservation scientists, painting conservators, imaging experts, art historians and digital experts, resulting in an open access digital archive. This abstract presents results from the analyses of the painting *Woman Seen from the Back* (Fig. 1), which has led to a revised understanding of the compositional context of this painting.

Technical images such as macro X-ray fluorescence spectroscopy (MA-XRF), X-ray radiography (X-ray) and infrared reflectography (IRR) illustrate how Hammershøi first painted a thinner female figure with a slightly more side-turned position, after which he decided to change the composition into a wider figure with her back turned more against the viewer. Infrared reflectography reveals how the ribbon from the apron was shifted to a lower position in the final composition, and that the concentration of carbon-containing black is higher in the garment belonging to the first version of the figure compared to the final version. Furthermore, it is evident that the artist attempted to reduce part of the composition in the area of the figure's waist by scratching the paint. The MA-XRF elemental maps reveal Hammershøi's use of lead white and zinc white. Aside from being applied to paint various elements in the final composition, zinc white was used in the production of the first version, as evidenced by dense layers to the right of the figure.

The research suggests that Hammershøi first painted his sister Anna, but later decided to change the composition by overpainting Anna with a new figure, possibly depicting the then maid of the family (Rosenvold Hvidt and Oelsner 2018). Furthermore, changes in the furniture suggest that the table might have been more rounded in the first version and that the location of the chair has shifted slightly. These changes put forward the hypothesis that the painting was originally related to a group of works depicting the interior of Hammershøi's living room when residing at Frederiksberg Allé such as *Interior with the Artist's Mother and Sister* (1884, private collection,

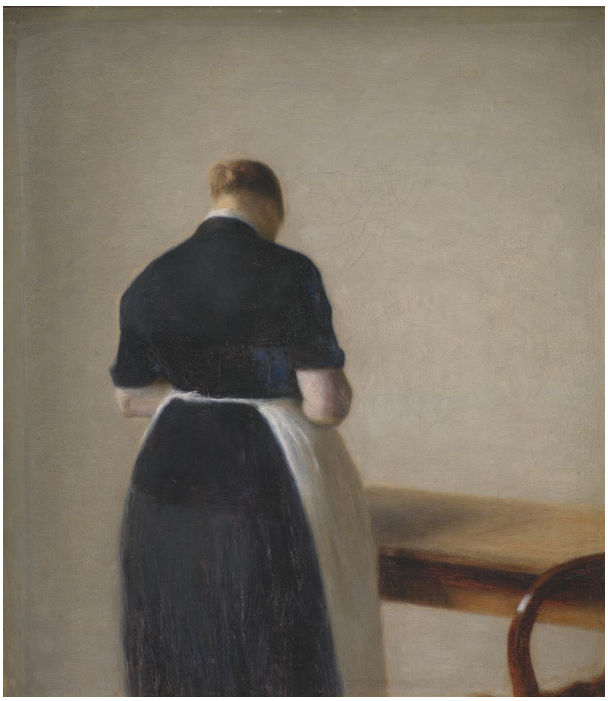

Figure 1 *Woman Seen from the Back*, 1888(?), oil on canvas, 63 × 55 cm, National Gallery of Denmark: photographed in visual light. (Photo: SMK.)

deposit at Ordrupgaard) and *Young Girl Pouring from a Teapot* (1884, private collection). While the composition of the painting has previously been seen as related to the later work, *A Bakery Shop* (1888, Vejen Kunstmuseum) (Michaelis and Bramsen 1918: 85), the recent technical investigations have led to a revised interpretation of the position of this painting among other works by the artist, thereby suggesting an earlier dating of the first composition to around 1884. The interdisciplinary research supports the observation that Hammershøi's general working methods were experimental and that he continually 'built upon' his own painted figures.

The digital archive will be based on a relational database designed to systematically document the research activities and results of the project. Initially serving as a repository for the data generated by the project, this database is evolving into the platform supporting the digital archive. The archive will be characterised by a design inspired by similar tools currently available in the conservation science community and will offer valuable resources to the public. For example, a sophisticated viewer will allow the overlay and selective swiping of various images, including high-resolution pictures of the paintings, multi-band images and elemental maps. This feature will enable a detailed examination of the artworks, revealing insights into the function and composition of their various layers.

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Learning the golden ways: communicating gilt leather manufacture to a new audience

Vilde Dalåsen, Marie Kleivane and Brynhild Slaatto

In June 2022, the new National Museum of Norway opened its doors to the public following a decade of preparations for the move including a large-scale conservation project of a 17th-century gilt leather wall hanging (Kleivane *et al.* 2024) due to be shown in the new collection display. This led to the idea of disseminating this old craft to the audience. Areas in the exhibition in which information on arts and crafts are communicated to the audience are the responsibility of the curators of education. These activities are presented through a tactile approach based on physical touch-and-feel objects close to the artworks that allow as many people as possible to participate actively regardless of functional ability.[1]

For the gilt leather wall hanging, a collaboration between conservators, curators of education and gilt leather makers made it possible to create an educational toolset that invites visitors to see, feel and read about the craft of gilding leather.

To create an activity conveying how gilt leather is manufactured and built up – while at the same time reflecting the wall hanging on display – a wooden mould and a leather replica were made based on the pattern of the wall hanging. The wooden mould was carved by furniture conservator Ingvild Aunan, and three leather replicas, showing the different stages of making gilt leather (Fig. 1), were produced by gilders Turid Hop and Kjersti Leikvold. Results of previous

Figure 1 One of the replicas visualising the layers that comprise the gilt leather. (Photo © Nasjonalmuseet/Børre Høstland 2021.)

analyses of the original wall hanging (Kleivane *et al*. 2024) were utilised in deciding what the kinds of material that should be used when making the replica to reveal the original vivid colours of the wall hanging. One replica is shown on top of the wooden mould on a specially designed table placed in front of one panel of the wall hanging. The viewer can touch and lift it to reveal the mirror image of the pattern in the wooden mould. A short text accompanies the replica – written by the conservators and the curator of education – explaining the different stages of gilt leather manufacture.

A year after the opening, the setup seems to be a successful way of communicating the craft of gilt leather making. The first replica displayed is beginning to show signs of wear, evidence that the audience is interacting with the activity. This collaboration has benefited cross-disciplinary relations between the conservators and curators of education, just as much as the audience; the gilded wall hangings have taught us a golden way.

Note

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The painter Hans Heyerdahl's experiments with materials and techniques in their historical context

Hans-Martin Frydenberg Flaatten and Trond Erik Aslaksby

The Norwegian painter Hans Heyerdahl (1857–1913) was an artist who, throughout his career, experimented tirelessly with a wide range of painterly techniques and materials. When it comes to investigating and establishing a connection between an artist's choice of materials and painting technique, and the resulting artwork's aesthetic expression and physical condition, Heyerdahl's early paintings are of particular interest. They are often executed in a mixed technique the artist called tempera – not to be confused with the common egg tempera with its matte and opaque appearance – using oil and resin

Figure 1 Hans Heyerdahl, *Portrait of the Actress Laura Gundersen*, 1879, oil on board, 53 × 45 cm, The National Museum of Norway, inv. no. NG.M.00491. (Photo © The National Museum/ Børre Høstland.)

as binding media and the paint applied in translucent layers, which may explain the peculiar aging characteristics of some of the paintings. Since 2017, the present authors have collaborated on a research project combining conservation studies and art history, where one area of focus has been the study of Heyerdahl's experiments in their historical context.

Between 1874 and 1877, Heyerdahl was a student at the Academy of Fine Arts in Munich and his painting technique during these years has been studied by Aslaksby (2002). In the late 19th century, Munich also became an important centre for the tempera revival. This previously neglected development has recently been the object of renewed attention (Neugebauer 2016; Beltinger and Nadolny 2016; Dietemann *et al.* 2019). This new research supplies a wider historical context for understanding Heyerdahl's experiments with materials. While residing in Florence between 1882 and 1884, Heyerdahl also knew and regularly met Arnold Böcklin (1827–1901), who was a leading representative of the tempera revival, allowing him the opportunity to learn technical methods from the famous Swiss artist. A recipe for mixing paint, handed down from Böcklin to Heyerdahl, has also been preserved (Aslaksby 2002: 406).

During the research project, one of the present authors (H.-M.F) concentrated on looking at the exhibition history of several of the paintings and also studied the critical response. This material includes remarks on Heyerdahl's painting method such as comments – by a newspaper reporter who had visited the artist's studio in Paris in 1880 – about a portrait executed in 'tempera' (Fig. 1), a peculiar technique which was then 'generally unknown' (Janzon 1880). Other sources also include the literary notes of the Norwegian artist Edvard Munch (1863–1944), where a figure based on Heyerdahl comments on his painting technique and use of materials (Flaatten 2020: 27–34; Flaatten 2022: 120–125). These written records present a rich source material that can be combined with investigations into the artwork's aesthetic expression and physical condition.

Several of Heyerdahl's most important paintings are owned by the National Museum of Norway. During the project, we looked closely at a group in the collection. Apart from visual observation, one of the present authors (T.E.) documented and studied the paintings using photographic techniques such as X-ray, ultraviolet (UV) fluorescence and infrared (IR), plus microscopic analysis of pigments and cross-sections of paint layers. Further investigation will rely on scientific and financial support.

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Drawing with 'scales from a butterfly's wings': Belgian *fin-de-siècle* artists' use of friable drawing techniques

Marie-Noëlle Grison

Pastel became a popular artistic medium in the 18th century but its attractive powdery texture is also the source of its fragility. Indeed, as Diderot noted, 'the precious powder falls off as easily as scales from a butterfly's wings' (Diderot 1995: 77). Belgian painters around 1900, the so-called *fin-de-siècle* artists, also favoured pastel and other friable media such as charcoal and chalk. Their drawings evidence how masterfully they harnessed the expressive properties of these brittle materials to fulfil their aesthetic goals. Because these materials only partially adhere to the support, friable media are particularly prone to damage (Sauvage *et al.* 2018), therefore acquiring a deeper knowledge of these materials and how they were used is necessary to inform collection care strategies. Hosted by the Royal Museums of Fine Arts of Belgium, the FRIABLE project (2022–2026) was therefore launched to investigate these issues.

Within this broader framework, the present research aims at answering the following questions:

- What causes the weak adherence of pastel particles to the support?
- How does this vary according to the choice of materials and their handling?
- Can we infer fragility levels based on visual examination?

In order to tackle these issues, a methodology informed by the 'materials science and engineering' paradigm was implemented, which posits that 'processing' dictate 'structure' and 'structure' dictates 'properties' (Askeland *et al.* 2010). This led

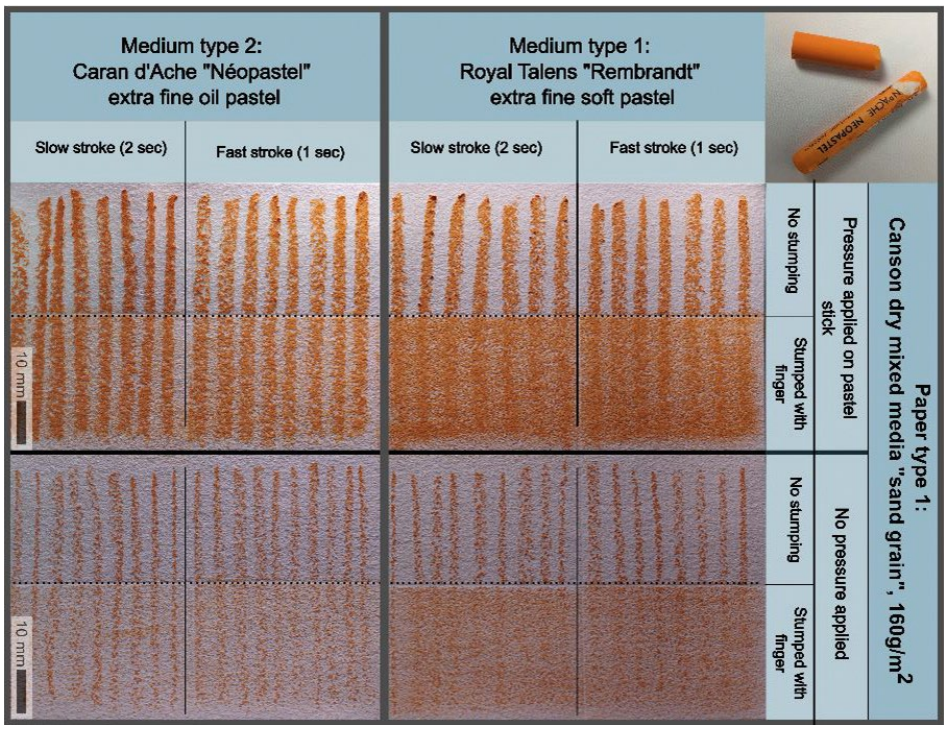

Figure 1 Raking light photography of pastel draw-outs performed with a Canon EOS 5DSR camera with a 90 mm TSE-E lens, f/6.3, 1/10 sec., ISO-125. (Photo: Marie-Noëlle Grison.)

to designing a matrix-like experimental workflow investigating specifically how variations in processing (supports, materials, gestures) would affect the properties of a pastel draw-out (visual appearance, friability, adherence) (Fig. 1). To this aim, I used three qualities of supports ('sand grain', laid and 'velvet' pastel papers), all of which had their equivalent in the late 19th to early 20th century. On all three papers, I drew strokes of the same length with two kinds of materials (soft and oil pastel sticks), varying my drawing gestures based on the following parameters: pressure/no pressure applied; drawing speed (1 or 2 seconds); and stumping with a finger/no stumping.

As preliminary conclusions, I observed that soft pastel particles fall off more easily when applied onto the toothy surface of 'sand grain' and laid papers, but this also produces a more expressive stroke. Pressure seems to be a bigger contributor to the amount of particles deposited and their cohesiveness than drawing speed. The greater amount of binder present in oil pastel significantly lowers its ability to be stumped, regardless of other parameters. Finally, the fluffy texture of the 'velvet' paper evens out the amount of particles deposited throughout a stroke and retains them inside its fibres in all tested conditions. Comparisons between raking light images of the obtained samples confirmed how much the visual and mechanical properties depend on the processing applied. Using drawing practice as a research tool further showed that the simultaneous combination of haptic feedback and visual monitoring while drawing is a powerful way to train the eye in linking the appearance of a stroke and the processing applied. This can lead to more systematised inference of the structure and processing of a sample pastel stroke based on the visual examination of its properties. Our goal is to expand this into a materials identification and characterisation protocol for friable media.

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Artists' acrylic varnishes applied over acrylic and PVA paint films 1966–1982

Laura Homer

Acrylic paint manufacturers recommend applying a protective coating to acrylic emulsion paintings and, although not standard practice, several artists have followed these recommendations. As with natural resin varnishes, these synthetic varnishes, often acrylic-based, degrade over time: they can discolour becoming yellow or grey, the gloss and discoloration can be patchy, they can become dull or milky in appearance and may even fuse with the underlying paint layers. Critically, the level of degradation can severely damage the intended aesthetic of the artwork, especially modern works with flat fields of colour.

However, removing an acrylic coating from an acrylic paint film poses serious risks due to the similarity in chemical composition of the two layers (Lomax and Fisher 1990). In recent years there has been extensive research into both surface cleaning of unvarnished acrylic paints (Learner *et al.* 2007; Ormsby *et al.* 2008) and the development of gels, gel composites and microemulsions as alternative cleaning methods to traditional swab cleaning (Angelova *et al.* 2018; Baij *et al.* 2021). However, there has been very little research into the removal of synthetic varnishes from synthetic paint films. There is an urgent need for this research to enable conservators to act and remove the varnish layer when required. This research aims to generate an ethical, low-risk, sustainable treatment for practising conservators. The main goal is to evaluate the effectiveness and suitability of a range of novel and sustainable cleaning methods to remove degraded synthetic varnishes from sensitive modern paint films including acrylic emulsion and polyvinyl acetate (PVAc).

The research includes a review of the range of synthetic varnishes produced by several leading commercial paint manufacturers (Fig. 1) through both archival research and oral communication with manufacturers and living artists. Testing of possible varnish removal methods – such as microemulsions, rigid nanogels and spreadable PVA-borax gels – will be carried out on artificially aged paint and varnish samples and also on existing historic swatches. Varnish degradation processes and the resulting visual effects will be assessed before and after artificial aging on the samples. Evaluation of the cleaning tests will assess the degree and evenness of varnish removal, gloss/texture changes, residue, control, ease of use, sustainability and health and safety. Ten paintings from the collection of the National Museum of Norway, will be used as reference points and case studies throughout the research. The materials and construction of the mockups used for testing of the varnish removal methods will be based on the collection paintings. Therefore, it is vital that examination and assessment of the varnishes present in the collection should take place prior to carrying out research into and testing of potential cleaning

Figure 1 A selection of commercial acrylic varnishes. (Photo: Laura Homer.)

methods. Analyses of these paintings have been carried out by five teams from MOLAB (MObile LABoratory, part of the EU-funded IPERION HS Programme) using multiple non-invasive, portable techniques.

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Material practice in Morocco: Hilda Rix Nicholas' paintings and drawings in Tangier

Catherine Nunn

Australian painter Hilda Rix Nicholas (1884–1961) resided in France from 1907 until 1914. During this period, she travelled to Tangier, Morocco, for two painting trips: once in 1912 accompanied by American artist Henry Ossawa Tanner (1859–1937) and later in 1914, with her sister Elsie (1877–1914). In a letter dated 1912, written before she departed for Morocco, Rix Nicholas describes the art materials she purchased in Paris for her trip: 'got most things – oh a jolly pencil bag – really a hunters bag & the place for holding the cartridges is just fine for holding my pencils – it straps across my shoulders … – my! don't the paints weigh heavily!'.[1] Her comment about the weight of the paint tubes hints at her painting method, which was to work in the *soko* (marketplace in Tangier), painting directly before her subjects.

A letter from the artist in Morocco reveals that she was able to source some materials there: 'Mother dear, No I don't want alizarin crimson paint – guess I'm set up for paints – & we find we can get a great many things here'.[2] However, in 1914, she asked her mother to send her 'Conte a Paris' pencils, written as an afterthought in the margin of a letter.[3] A note in the margin of another later letter (from both sisters) reveals that Hilda did find Conte pencils in Tangier:

> [Hilda] And the pencils – but oh if only I had asked you to send 2 or 3 more dozen "Conte"

Figure 1 Hilda Rix Nicholas, *The Souk of Morocco*, 1912–1914, oil on canvas on board, 26 × 33 cm, Art Gallery of New South Wales, Sydney. Edward Hamilton Stinson Fund 2023. Image showing white halos at the corners indicative of the use of drawing pins, and compressed paint in the white highlights. (Photo: © Estate of Hilda Rix Nicholas. Bronwyn Wright and Art Gallery of New South Wales, Sydney. Edward Hamilton Stinson Fund 2023.)

> pencils (No 2) – for I've nearly run out of them & twill take 10 or 15 days before more will come if I send to Castelucho's[4] which I'll have to do tonight. For I mustn't run out of those. Ph! Don't know how I miscalculated them
> [Hilda in margin]: Have been hunting for Conte pencils in the town – no success
> [Elsie in black ink underneath] Yes she found them![5]

From a conservation perspective, these letters highlight the paucity of technical information in artists' archives, emphasising the importance of close reading to uncover information not routinely documented in traditional art history. Combining archival research and the material characteristics of Rix Nicholas' artworks in Tangier reveals the place-specific materiality of this period of her oeuvre. Her drawings of people in the marketplace are made from locally purchased pencils and embody the visual, mercantile and material environment.

Material changes in Rix Nicholas' Tangier paintings also reflect the site of production and the artwork's mobility. In the *soko*, she painted on small pieces of canvas, around 20 × 30 cm, pinned to a drawing board. Evidence of drawing pins is revealed by white 'halos' of unpainted ground in the corners (Fig. 1). Moreover, when she returned to her hotel with a stack of finished paintings, some areas of paint became compressed. The artist's lived experience of her time in Morocco is therefore embodied in the materiality of these paintings, affirming the benefits of the synergy of technical, art historical and archival research.

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Notes

1. Letter from Hilda Rix to Elizabeth and Elsie Rix, 9 Rue de la Grand Chaumière, Paris, 25.1.12, Papers of Hilda Rix Nicholas, National Library of Australia, Box1, MS9817/1/1.
2. Postcard from H. Rix, from Tangier, Morocco, to Elizabeth and Elsie Rix, no date, probably 12 February 1912, Papers of Hilda Rix Nicholas, National Library of Australia, Box 31, MS9817/17/2.
3. Letter from Hilda Rix to Elizabeth Rix (in London) from Hotel Villa de France Tangier Maroc, 9th March 1914, Papers of Hilda Rix Nicholas, National Library of Australia, Box 32, MS9817/17/3.
4. Castelucho refers either to Claudio Castelucho (1870–1927) or the colourman Maison Castelucho Diana. Claudio Castelucho was a master at the Académie Colorassi and the Académie de la Grand Chaumière, which Hilda attended in 1908 (Travers 2021: 37). Several other Australian artists also studied under Castelucho, including Kathleen O'Connor (1876–1968), Bessie Gibson (1886–1961) and George Bell (1878–1966) (Curtin 2018: 26; Underhill 1978: 10). Maison Castelucho Diana was established in 1906 on the rue de la Grand-Chaumière in Montparnasse, Paris (Vigouroux 2017: 126).
5. Letter from Hilda and Elsie to Elizabeth Rix, 1914, from Hotel Villa de France Tangier Maroc 11.3.14, Papers of Hilda Rix Nicholas, National Library of Australia, Box 32, MS9817/17/3.

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Thomas Fearnley (1802–1842): material aspects in an art historical context

Tina Grette Poulsson

The National Museum of Norway collection contains 834 drawings by the Norwegian artist Thomas Fearnley, including rectos, versos and pages in sketchbooks. Many of the drawings are made with graphite pencil and covered by a fixative applied by the artist himself. Fearnley used drawing papers both from well-established papermills and local mills in the areas in which he was residing or travelling through. The soft pencil used in many of the drawings could easily smudge, therefore the artist applied

Figure 1 NG.K&H.B.05229 (pen, 41 × 30 cm) is a sketch with an architectural motif of unknown date and location. The watermark shows that the paper was made by the papermaker Johann Ernst Trexler Jr. at the papermill of Raitenhaslach monastery close to Burghausen in present Germany. The search for location was narrowed down to areas nearby, and the motif was found in the Berchtesgaden Royal Castle, where Fearnley spent time in 1830. (Photo: The National Museum/Andreas Harvik.)

a fixative, which is known in two instances to be milk (Reissland *et al.* 2017).

Fearnley's drawing papers and fixatives are currently being further investigated in a PhD project, the goal being to gain insight into the artist's material practice and the aging and preservation of fixed drawings. An initial survey of 440 included individual sheets; not sheets in sketchbooks, prepared papers or papers fully adhered to board. The drawings were examined in normal, raking and transmitted light as well as ultraviolet radiation, and their characteristics noted down in a spreadsheet. They were then classified according to type of mould, watermark, possible bar shadow and chain line interval.

The initial survey showed that Fearnley used paper from at least 35 different papermills. There seems to be a strong correlation between most types of paper and their geographical use; this correlation can be used to confirm probable or approximate dates, indicate dates for undated drawings and locations for production (Fig. 1). A fixative is visible in about one third of the surveyed drawings. However, so far there is no obvious pattern in the use of fixatives on pencil drawings; out of 351 drawings made with pencil only on paper, 122 have a visible fixative applied (229 do not have visible fixatives).

The initial survey established groups of fixed drawings made on paper from known producers and from different areas and periods in Fearnley's production. The next step in the research is the identification of fixatives used. A representative selection of fixed drawings will be analysed with the use of non-invasive and micro-invasive methods. The analysis will be used to identify substances used as fixatives and to investigate issues of preservation.

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Reconstructing multimedia installations from uncertain sources: the case study of *Blikk* (1970/2022)

Jøran Rudi, Randi Godø and Jina Chang

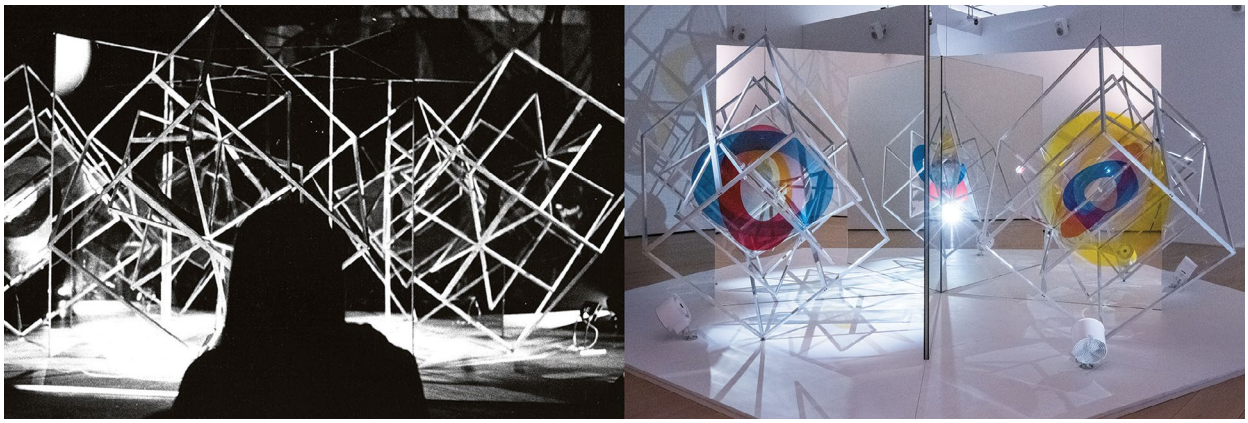
Op art and kinetic art constitute one of the groundbreaking experimental and avant-garde art dialects that emerged in post-war Europe. Influences were also felt in Norwegian art, a prime example being the kinetic installation *Blikk* (Glance): a collaboration between the artist Irma Salo Jæger, composer Sigurd Berge and poet Jan Erik Vold commissioned by and exhibited at Henie Onstad Art Centre in Bærum in 1970 (Fig. 1).

The reconstruction of *Blikk* was initiated by the National Museum of Norway, and the effort faced the problems of scarcity of surviving materials and technical components along with limited original production documentation (Rudi 2023). Extensive research and consultations were essential among various experts including the artist, exhibition technicians, conservators and curators (Chang 2023). The main goal was to fill knowledge gaps about the artwork's illusive workings and authenticity. The museum staff reverse-engineered *Blikk*'s visual framework – including the kinetic sculpture, lighting placement and laser drawings – using visual and written documentation and discussions with the original engineers.

External audio experts led the audio restoration, light and audio sequencing, and program timeline creation. Initially, audio restoration seemed straightforward, but complications soon arose. Digitising an unclear audio tape allowed for a timeline that matched the program booklet, even though the sound quality was suboptimal. A better-quality tape emerged later, enabling a clear sound sequence which was adjusted for original acoustic clarity.

Constructing the timeline posed challenges due to differences between the program booklet and performance tapes in total duration. Resolving the conflict favoured the tape, preserving the dramaturgy. The light sequence was another significant challenge as the lighting score in the printed program booklet had clearly never been used and was not accepted by the artist. The original control information was not received until quite late in the project, however the analog control signals matched with the duration of the reconstructed audio material. With these elements finalised, a digital control file was created, and a custom-made display now controls cube rotation, light sequence and sound playback and projection.

The conservator contributed to the project primarily by concentrating on documenting and providing detailed explanations of the decision-making processes of the participants. This involved tasks such as interpreting, selecting and utilising information



Left: *Blikk* performance at Henie Onstad Art Centre, 1970. (Photo: Henie Onstad Art Centre Archive.) *Right*: *Blikk* installation at the National Museum of Norway, 2023. (Photo: National Museum/Annar Bjørgli.)

extracted from records, as well as observing interactions among the participants. The conservator also identified and documented the methodologies for utilising and interpreting the available documentation, the roles and responsibilities of the participants, and the key priorities in communication and decision-making.

During our endeavour, we encountered the challenge of harmonising different facets of authenticity including:

- Ensuring the accuracy of materials and technologies used.
- Maintaining historical precision.
- Preserving the overall conceptual coherence.

We realised that the act of reconstruction is indeed a creative undertaking that demands meticulous execution to align with the overarching artistic vision, physical/functional objectives, and the intended audience experience. Despite working with limited resources, our reproduction project proved successful in capturing the essence of the original artwork. Additionally, documenting our decision-making process offered valuable insights into how we interpreted, selected and employed information from historical records, as well as the dynamics among the participants involved.

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Inflatable structures and 'new' plastic materials in the democratic design of De Pas D'Urbino Lomazzi studio: archival research for the conservation of the design objects and their history

Ilaria Saccani, Grazia Cavanna, Davide Riggiardi, Maria Fratelli, Elisabetta Pernich, Mariella Brenna and Maria Teresa Feraboli

De Pas D'Urbino Lomazzi (DDL) design studio achieved the highest creative and functional outcomes as a result of its long-term relationship with industry and the new materials available in Italy during the post-Second World War economic boom. The CASVA archive (Centro di Alti Studi sulle Arti Visive of the Municipality of Milan), which plays a fundamental role in the history of Italian design and architecture, holds the entire materials of the DDL studio including plans, models, prototypes and photographs. Through a careful comparison using these resources, an oral interview with Paolo Lomazzi as well as valuable original footage shot by the architects, it has been possible to gain an insight into the studio's processes, allowing us to reflect on their conservation techniques.

DDL projects combined the possible with the 'thinkable' (Manzini 1985) in a game with precise rules (Pasca 2012). A good example of this material research and the influence of their projects is the well-known 'Blow' chair (1967), designed together with Carla Scolari and produced by Zanotta. In CASVA storage are conserved some 'air Blows' in their original cardboard packaging: the first prototypes and produced elements of the 'Blow' chair. This innovative object was a transparent cloud, a low-cost piece of furniture designed for the lounges of the first 'homes for all', promoting a free and joyful idea of living. The DDL 'Blow' chair is a close realisation of the Hungarian-German architect Marcel Breuer's utopian vision of a future where 'sitting on a column of air' would be possible (Breuer 1928). Similarly, the opportunities offered by plastic films (in this case, electro-welded plasticised-polyvinly chloride, P-PVC) and research on the technologies used by the industry led to the construction of sustainable temporary domes for art and design exhibitions, such as the 'air domes' made for the Eurodomus exhibition in collaboration with Plasteco (Fig. 1). The studio's research on materials technology included the use of complex plastic moulds, which opened up great possibilities in the design of ABS furniture components with a political function involving aesthetics 'within everyone's reach', such as in Dado & Vite's modular panel system (1970) and the 'Junior' children's chair (1972). Personally selected by Emilio Ambasz, some are part of the Italian Style presented by the architect at MoMA in New York (1972), making Italy and

Figure 1 Part of the P-PVC model of the EURODOUMS 4 pressostatic and self-standing dome (Turin, 1972) realised in collaboration with Plasteco (Milan). Original photograph by DDL studio, now part of the CASVA archive. (Photo: Comune di Milano/CASVA.)

its polycentrism of production a model that is still unsurpassed (Ambasz 1972).

'The three men on a boat' (Koenig 1989) innovative and democratic design with its socio-economic and ethical relevance deserves to be understood and preserved, not least to prevent other new utopias being transformed in dystopias. The research on the DDL object stemmed from the collaboration between CASVA, the Departments of Architecture and Urban Studies (DAStU) and Design of the Politecnico of Milan, and CESMAR7 - Centro per lo Studio dei Materiali per il Restauro, as part of the project Storie di Plastica (PANN20_00738, Italian Ministry of Education MUR), resulting in the first exhibition *Life in plastic [could] be fantastic*[1] at CASVA/ Satellite alla Fabbrica del Vapore, Milan. The study was implemented through a careful study of archival materials, as well as an analysis of the artefacts and their state of preservation, in order to put in place specific preventive conservation measures for P-PVC objects (Shashoua 2002).

Note

1. *Life in plastic [could] be fantastic* in CASVA/ Satellite alla Fabbrica del Vapore was the first exhibition of De Pas D'Urbino Lomazzi studio archival materials (with curator Mariella Brenna, DAStU).

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Giorgio Vasari's *Book of Drawings* and an analysis of works attributed to Davide Ghirlandaio

Helen Evans, Carina Fryklund, Cecilia Heisser, Tom Sandström and Karin Wretstrand

In 2019 Nationalmuseum, Sweden, began a collaboration with the Musée du Louvre, which culminated in the exhibition *Giorgio Vasari, The Book of Drawings: The Fate of a Mythical Collection* (Paris 2022 and Stockholm 2022–23). Both institutions hold Italian drawings from the 14th to the 16th century, purportedly collected by historian and critic Giorgio Vasari (1511–1574). In preparation for the exhibition, Nationalmuseum embarked on a research project with the Swedish National Heritage Board to investigate the techniques and materials used to produce the drawings.

Two double-sided drawings (NMH 63-66/1863) examined here are part of a stylistically diverse group of figure studies attributed by Bernard Berenson (1938) to Davide Ghirlandaio. Following a tentative suggestion by art historians Carlo L. Ragghianti and Gigetta Dalli Regoli (1975), the curator and art historian Furio Rinaldi (2023) reintroduced these sheets with an attribution to Sandro Botticelli's workshop. The drawings are executed in metalpoint on a yellow ochre-coloured prepared paper with heightening in lead white. Investigation using raking light revealed the paper chain lines (34–35 mm apart) and a watermark, but also the incised lines caused by a hard metalpoint such as silver. Infrared reflectography (IRR) performed with an Osiris camera (Opus instrument, InGaAs line array 900–1700 nm) showed differences in absorbance between drawn lines, indicating that more than one metalpoint was used. Different metals give a certain characteristic line depending on the hardness of the metal, with softer metals or alloys giving broader lines. The IRR images also revealed an underdrawing – the face of a man looking right – under the head of one of the figures.

X-ray fluorescence (XRF) analysis of the drawing was carried out with an ARTAX 800 μXRF (Bruker) equipped with a Mo X-ray source and polycapillary lens, with a spot size of <100 μm. As metalpoint generally consists of a thin, uneven deposition that can be difficult to detect with XRF, mockups were tested to assess the level of detection. Micro scale mapping was able to show the use of tin for the underlying face, corresponding to the IR results. It also indicated the use of silver for the overlying face. Further analysis of the body and drapery suggested a similar use of silver, with the line work being reinforced with

Figure 1 NMH 65/1863: detail in visible light (left) and IRR (middle) (Photo: Cecilia Heisser, Nationalmuseum.) Comparison with BM 1895, 0915.448: detail of Sandro Botticelli, *Faith* (right). (Photo: British Museum.)

lead metalpoint. Analysis of the other three drawings showed that the use of tin is similarly only found in selective areas, such as in the rendering of just the head or a specific section of drapery.

The suggested attribution to Botticelli's workshop is supported by IRR scans and technical analyses. Different styluses used for some figures suggest they were made by different artists. While the expressive line work defining a fluidly underdrawn head seems to reveal the hand of the master (Fig. 1), the final studies, although closely informed by Botticelli's material and stylistic choices, are not executed as confidently. Here occasional quick strokes of corrective parallel hatching were added to define volume. A shears watermark (near Briquet 3766) supports a dating in the 1470s. The use of IRR in combination with XRF for the analysis of metalpoint was shown to be successful in revealing different hands, supporting a new attribution for these particular drawings.

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'The best preparation of smalt'? A lasting honey coating on smalt particles[1]

Paul J.C. van Laar, Dominique M.E. Thies-Weesie, Thijs Hagendijk, Maartje Stols-Witlox and Gert Jan Vroege

Smalt is a finely ground blue-coloured, potassium-fluxed, cobalt glass that became popular as a pigment for oil painting throughout the 16th century. Unfortunately, nowadays smalt in oil mixtures has often degraded into a muddy brown or greyish colour, accompanied by a gritty surface texture due to potassium soap formation and migration (Spring *et al.* 2005). Artists and writers of artistic treatises in the 16th and 17th centuries seemed to be aware of the pigment's handling and discoloration issues. In the context of this awareness, art technological source research reveals a substantial subset of recipes and rules experimenting with different ways of treating smalt to limit its discoloration and overcome its gritty texture. Recommendations vary from changing the binding medium to strewing powdered smalt on top of wet paint layers without embedding it in an oil film itself.[2]

This research investigated a peculiar painterly instruction, written by Dutch painter and polymath Simon Eikelenberg (1663–1738), that describes the preparation of smalt by grinding it with honey prior to mixing with oil.[3] What sets Eikelenberg's unpublished notes apart from other historic sources on painting technique and materials are the accounts of experiments he carried out in the studio. These detailed descriptions, or '*ervarenissen*' as he called them, offer unique insight into historic workshop practice (Hagendijk 2019). In one such *ervarenis*, Eikelenberg described how he ground the smalt with white honey for 'upwards of an hour'. After grinding the smalt, he then washed the pigment multiple times with water to remove the residual honey. Even though Eikelenberg did not shy away from describing failures in these *ervarenissen*, he nevertheless observed that 'this is the best preparation of smalt that [he has] known until now'. The seeming contradiction between the long grinding time and the high quality of the smalt sparked interest in the possible effects of the addition of honey.

Based on reconstructions of Eikelenberg's 1704 *ervarenis*, we investigated the effect of using honey as a grinding medium (Fig. 1). Microscopic analysis, examination of the particle size distribution in various stages of the process, complemented by transmission electron microscopy (TEM), and the characterisation of the isoelectric point (IEP) through zeta potential titrations reveals that honey aids in the separation of smaller from larger pigment particles during washing, and provides evidence indicating

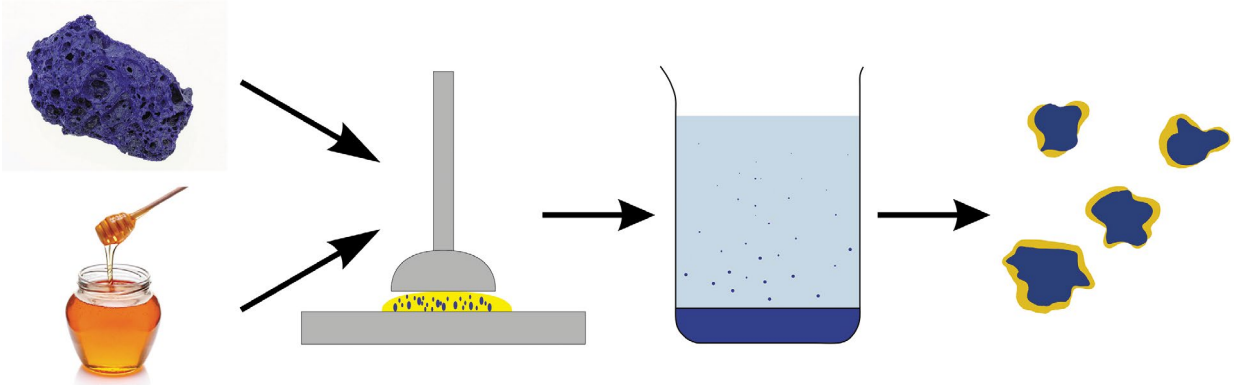

Figure 1 Graphical abstract of the reconstruction process showing grinding in honey, washing in tap water and a final honey-coated pigment.

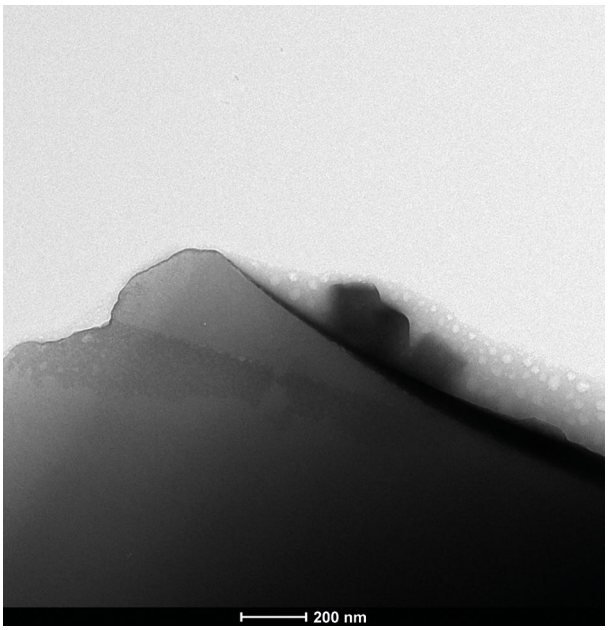

Figure 2 TEM micrograph of a smalt pigment particle ground with honey after being washed three times. Note the greyish coating on the surface of the particle (scale bar: 200 nm).

that honey forms a persistent coating on the pigment particles (Fig. 2), which might well influence the final properties of the paint.

Notes

1. To see the full poster in an interactive environment, see: https://www.paulvanlaar.nl/honeyandsmalt.
2. As of yet, there is no comprehensive publication on the various ways of using smalt, and the wide-ranging recommendations for altering its properties. However, the current author (PvL) is working on such a publication linked with an online database to facilitate smalt research.
3. Simon Eikelenberg 1679–1708. 'Aantekeningen over Schilderkunst', MS390-394. Collectie Aanwinsten. Regionaal Archief Alkmaar.

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Performing objects, objects to be performed: Fluxus legacy and the notion of activation

Aga Wielocha

The research project Activating Fluxus examines strategies for exhibiting, conserving and documenting works created within the framework of the artistic phenomenon called Fluxus. Capitalising on interdisciplinarity, this project draws from artistic, curatorial and conservation practice as well as art history, performance studies and museology. Its aim is to expand the concept of conservation for Fluxus works by exploring new and existing techniques under the overarching concept of 'activation'. The verb 'to activate' implies the action of rendering something active or operational. For instance, in performance art conservation, activation is understood as an action related to making historical works accessible. Presentation of a performance often requires its enactment, and the subsequent enactments are referred to as activations. Activating a performance piece entails transitioning it from dormancy to an active state in which it can communicate with the public (Lawson *et al.* 2019). This process involves supporting the work to function aesthetically as art (Cometti 2000), which may involve actualisation, adaptation or migration to different formats and mediums.

Fluxus emerged in the early 1960s as an international network of artists, engaging in a wide range of actions, events and gestures including object creation. Rejecting the boundary between art and life, Fluxus capitalised on key aspects influencing contemporary art: viewer participation, collective artistic production and the shift towards the performative. Fluxus works often operate on instruction-based logic, appearing as textual, graphic or objectual scores meant for execution across media and formats. Rarely discrete, they manifest as relational forms – objects resulting from score interpretation, notational objects seen as scores themselves or objects intended to be performed (Harren 2020). They can take the form of publications, multiples, editions or unique pieces.

Institutionalised art care is rooted in the single-artist, single-artwork paradigm, emphasising unique, autonomous art objects categorised into established genres and media. Often resulting from collective or participatory actions, Fluxus objects confound

Figure 1 George Brecht, *Games & Puzzles: Bead Puzzle* (1983). (Photo: Giorgia Palmisano, courtesy of Archivio Conz, Berlin.)

this model through intermedial approaches, erasing the lines that separate art categories. For instance, Fluxboxes, conceived as games and events, were meant to be performed – handled and reconfigured, fostering ongoing reinterpretation (Fig. 1). Today, often displayed under protective glazing, they are reduced to historical documents. Conservation similarly approaches them as self-contained, finished artworks rather than vessels for ideas and engagement. For conservation decision-making, determining an object's status is crucial. Is this item an artwork or historical evidence? Unique or reproducible? Who is the creator and who determines its display and perpetuation? For Fluxus works, the multitude of potential answers to these questions can overwhelm available conservation strategies, complicating preservation efforts.

Activating Fluxus scrutinises activation as a potent notion capable of integrating intangible aspects of artworks into conservation decision-making, moving beyond the emphasis on the original artefact. This transcends traditional museological paradigms, encouraging broader community involvement and fostering a more multifaceted approach to engaging with art. The strategies under the umbrella term 'activation' – including replication, (re-)enactment and (re-)interpretation – can benefit all art custodians interested in disseminating and perpetuating art in various forms and mediums.

Acknowledgements

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A multi-analytical study on 20 synthetic ultramarine blue and cobalt blue oil paint samples from tubes belonging to Edvard Munch's studio

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The blue paints used by the Norwegian artist Edvard Munch (1863–1944) are frequently subject to certain degradation phenomena such as flaking, water sensitivity, chalking, cracking and colour changes, highlighting the importance of technical studies on artists' materials as evidenced by previous studies (e.g. La Nasa *et al.* 2015; Sandu *et al.* 2022; Garappa *et al.* 2022; Caruso *et al.* 2019). This study presents the multi-analytical approach and the results obtained from samples taken from 20 paint tubes of blue colour (cobalt blue and ultramarine blue) from the brands owned by Edvard Munch: Winsor & Newton, Lefranc Bourgeois, Ambor, Mussini oil paint from Schmincke & Co., Lusk & Holtz, Vilhem Pacht, Schoenfeld and Rembrandt Talens. The formulation in these paint tubes varies greatly from completely dried out and crumble to still liquid spreadable paint.

The main aim of the study is to understand the formulation (binding media, additives and pigments) and to characterise the chemical changes that occurred during aging of the paints under analysis. The findings are useful to better understand the dynamics behind some deterioration patterns observed in blue-painted areas in Munch's artworks. The multi-analytical approach makes use of techniques such as portable X-ray fluorescence (pXRF), attenuated total reflectance–Fourier transform infrared spectroscopy (ATR-FTIR), micro-Raman spectroscopy (μ-Raman), X-ray diffraction (XRD), FTIR and gas chromatography–mass spectrometry (GC-MS) available at MUNCH, Ca' Foscari University in Venice and in collaboration with FIXLAB (Ipanema + University of Ljubljana), as well as the infrared beamline at the BESSY II synchrotron facility, HZB in Berlin.

Figure 1 (*Left*) A selection of the paint tubes analysed and (*right*) detail of a darkened blue area and samples from *The Drowned Boy.* (Photos: MUNCH.)

This investigation provides more information on the paint formulations from early industrial oil paints and sheds light on their compositional complexity. Based on the characterisation of organic and inorganic phases, some unexpected compounds have been identified including: non-siccative oils, animal fats, resins in the binding admixtures and driers plus adulteration of pigments with Prussian blue, magnesium carbonate and other fillers. The presence of patterns similar to those observed on paintings such as the formation of darker aggregates and separation of the binding media was observed (Fig. 1). The compositional complexity of these paints poses a challenge for the preservation of Edvard Munch's paintings in accordance with previous studies reported in the literature (Banti *et al.* 2018; Izzo *et al.* 2014 a,b; Beerse *et al.* 2020).

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From ghost image to lost image: how an overlooked phenomenon led to a key discovery

Maude Daudin-Schotte, Elyse Canosa, Tom Sandström and Kathrin Hinrichs-Degerblad

An 18th-century portrait miniature by Swedish miniaturist Peter Adolf Hall (1739–1793) (Olausson 2023) recently revealed an exciting discovery in an unconventional format. The painting, made in unvarnished gum arabic on ivory, is protected by a removable glass cover, the latter of which has revealed a 'ghost image' of the portrait, including a clear signature and date, which are not visible on the painting itself unless under UV light (Fig. 1). This project aims to understand the interactions between paint layers and glass to form ghost images on glass covers and promote the ghost image as a source of important historical information.

Peter Adolf Hall's technique and materials have not yet been researched and his personal archives do not inform on his choices of materials.[1] Today many of his works are considered unsigned. Is this signature original and was it initially more visible? Is there a relation between the degradation process of the signature and changes observed on the glass cover? Visual analysis and archival research are consistent with an original signature and date of execution. The lack of elements related to inorganic pigments in X-ray fluorescence (XRF) spectra infer the use of an organic paint for the signature, such as madder lake, which could provide novel information on Hall's technique.

Interpretation of results from ion chromatography of the glass surface did not establish the presence of glass disease (Verhaar *et al.* 2016; Biron *et al.* 2019). This research highlights the need for a new conservation narrative and approach towards ghost images and options for their preservation. Further analysis should clarify the potential relation between the formation of ghost images, composition of paint layers and potential glass disease. Scanning electron microscopy (SEM) of the ghost image on the glass will be conducted. Fibre optics reflectance spectroscopy (FORS) and Fourier transform infrared spectroscopy (FTIR) options are currently under discussion to identify a potential organic pigment, binder and additives.

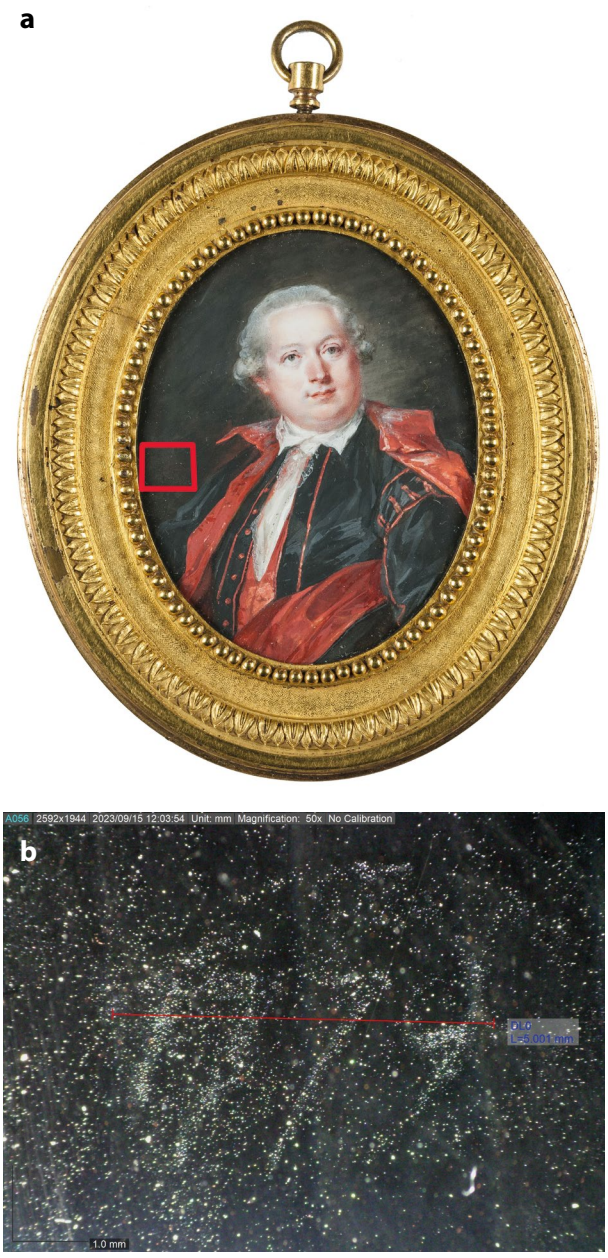

Figure 1 General view of the portrait miniature. (a) Johan Tobias Sergel by P.A. Hall, 6 × 8 cm (unframed). The red square indicates the signature. (Photo © Anna Danielsson/Nationalmuseum CC BY-SA.) (b) Ghost image of the date (1779) on the inner side of the glass cover, taken in transmitted light by a digital light microscope (original magnification 50×). (Photo © Maude Daudin/Nationalmuseum CC BY-SA.)

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Note

1. Personal Archives of Peter Adolf Hall, Volume 3, Letters from 1782 to 1791, Cash Book and Miscellaneous Documents (PH 1:3), Archives from Nationalmuseum, Sweden.

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Connecting to colour slide film

Lénia Oliveira Fernandes, Élia Roldão and Sanneke Stigter

Boosted by vibrant marketing campaigns, and especially popular in the 1960s and 1970s, slide film ended up in many personal and institutional collections worldwide. For decades, manufacturers of photographic materials have produced an immense variety of these chromogenic films through major advances in chemical, material and industrial engineering. Nevertheless, those same technological improvements were insufficient to guarantee their long-term stability, yielding images with noticeable

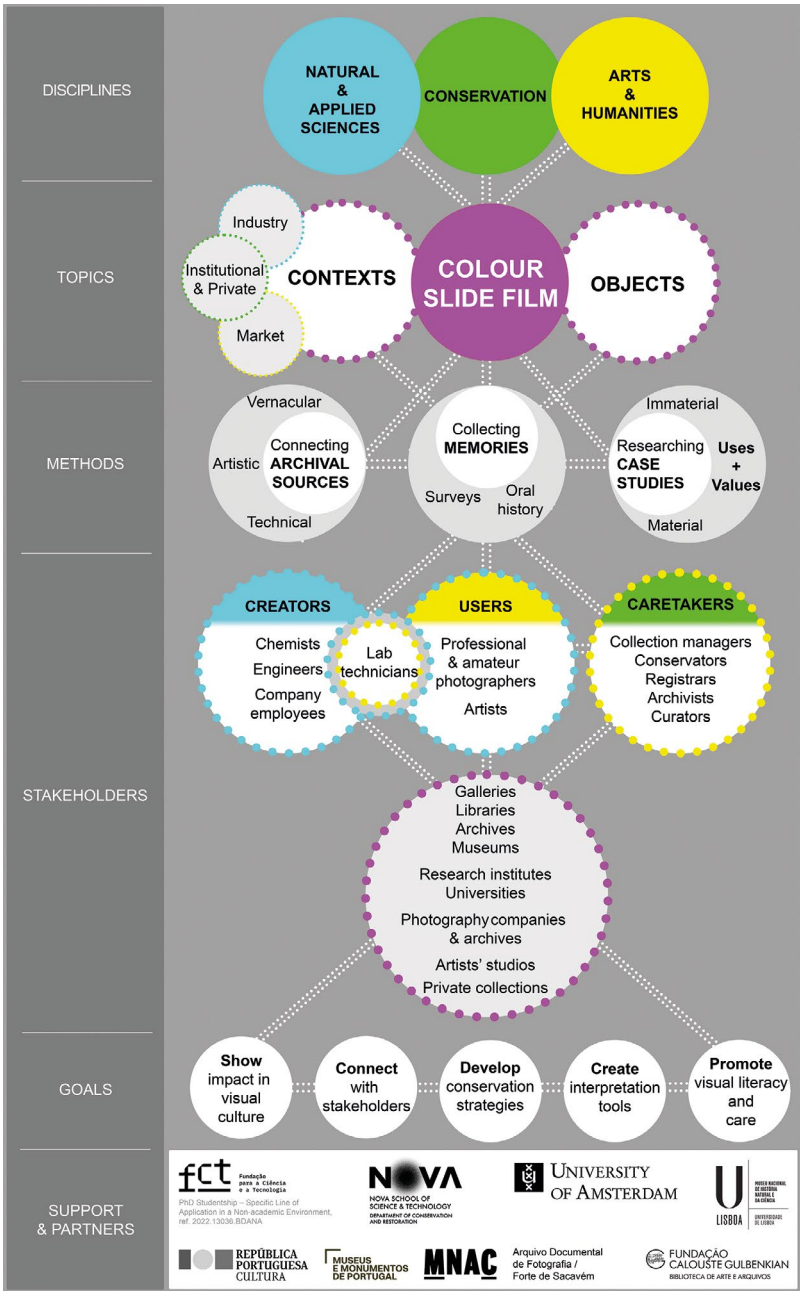

Figure 1 Overview diagram of the approach taken to study colour slide film. (Diagram: Lénia Oliveira Fernandes.)

colour shifts. In earlier films, this issue became visible shortly after their use and chemical development, leading to a misperception of the image and a risk of total loss (Pénichon 2013: 161, 219). As it continues to be manufactured by a few companies, in-depth knowledge about slide film seems easily attainable (Shanebrook 2016). However, patents and corporate secrets obstruct access to further details. Understanding these objects' complex photochemical decay mechanisms is essential to grasp the changes they have gone through and find possible solutions to their preservation. As time goes by, various other types of deterioration continue to challenge heritage professionals working with colour slides, including mould growth, vinegar syndrome and exuding plasticisers (Oliveira Fernandes 2021).

The photographic industry shifted towards digital technology in the early 2000s, as have its consumers. It is undeniable that the heyday of slide film is over. How can we understand the intricacies of dying technologies if they are vanishing before our eyes? Who will be able to explain this photographic process and surrounding industrial and artistic context 50 years from now? If no action is taken, we are at risk of losing an unrecoverable amount of highly specialised information, making an obsolete technology progressively ambiguous. In light of this scenario, it is imperative to create interpretation resources to overcome this expanding knowledge gap.

This project aims to explore the materiality and sociohistorical context as well as the cultural significance of colour slide film using examples that made their way into Portuguese cultural heritage institutions. As an example of a nation without strong connections to the photographic industry, Portugal personifies an end-user of an array of chromogenic films. To provide a better overview of the international cultural significance of these objects, selected case studies display the use of these photographs in artistic, commercial, cultural, documental, educational and scientific practices (Fig. 1). The context of each case study will be examined, through oral histories and survey responses of the stakeholders responsible for their creation, use and care, to analyse both professional and vernacular use of colour slide film. Artistic, technical and vernacular sources will provide further insights into the material and immaterial values held by slide film in each scenario.

This study represents an interdisciplinary approach and the goals of a project that maps the technical, social and artistic impact of colour slides through their different uses. Ultimately, this project strives to challenge the way slide film is perceived and valued and intends to promote its visual literacy and connoisseurship, aiming at improving conservation strategies applied to colour slide collections. This interdisciplinary approach can potentially be used as a sample model for cultural heritage research which focuses on technologies that are prone to disappear.

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Bio*Vanitas* a matter of Time

Haizea Salazar-Basañez

What are artworks treated for? According to Juan Carlos Barbero there are multiple reasons and, even knowing that it is impossible to achieve it completely, one reason could be to bring them as close as possible to the appearance of their original state. However, what happens if there is no state to return to (Barbero 2008: 25)? Or if decay and transformation are part of their creative process? Shall we be facing a strange specimen of Bio*Vanitas*?

Bio*Vanitas* are ephemeral and sensory installations, with reflective intentionality, made with organic matter in which Time works as a material (Salazar-Basañez 2022). In other words, fleeting artworks in constant evolution, whose creative process derives from their organic nature. Even if it is not usual, it is possible to locate some Bio*Vanitas* in collections such as *Preserve "beauty"* (1993–2004) by Anya Gallaccio (1963–) at Tate Modern, London, or *Boter en Bijenwas, Grondstofmateriaal 4/bis* (1975–1986) by Joseph Beuys (1921–986) at Stedelijk Museum voor Actuele Kunst (SMAK) in Ghent. The acquisition of these artworks is very brave. Firstly, because of the purchase of an ephemeral artwork which could physically disappear, and secondly, because they suggest several dilemmas regarding common practices such as documentation, exhibition, treatment or storage.

The main feature of the Bio*Vanitas* is the use of Time as a material. This, added to their transience, makes them free artworks. However, documentation may annul this freedom provided by Time as a performer, as it links them to a precise moment. So, maybe we should consider whether or not documentation respects their ephemeral intention. The transformation of the Bio*Vanitas* comes from the mixture of Time and organic matter materialising, usually in decay. The natural evolution of these artworks, which has to be experienced by the public, could be very dangerous – not only for other artworks but also for humans – and that is why it is so important to create safe exhibition spaces.

On the one hand, the idea of the experienceable metamorphosis does not seem to suit traditional storage, as the transformation will remain active without anyone to experience it. This makes us look for other solutions such as modified atmosphere packaging (MAP) suggested by Julie Gilman. This system may keep the artwork stable and changeless, creating a specific atmosphere based on its materials (Gilman 2015). On the other hand, Bio*Vanitas*' permanent change makes them live artworks, where it is nearly impossible to know if they are finished or if they will ever be. This may question their need of treatment as, if they are unfinished, anything could disrupt their natural evolution. Besides, if decay and material disappearance are part of their evolution, perhaps no treatment is what respects them the most, as there is nothing to treat but there is much to rethink from a new perspective.

However, although we are still far from accepting what Bio*Vanitas* in collections entails, it is a big step that brings us closer to a vision of collections beyond matter and ruin. But, do not worry, *it* is only a matter of time.

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Collaborative research across diverse fields of expertise and institutional boundaries can lead to new insights and hence dust off long-held beliefs. Although challenging, pursuing this goal can yield surprising results when accomplished. This volume of peer-reviewed papers and poster texts is the result of the international conference *Bridging the Gap: Synergies between Art History and Conservation*, held at the National Museum of Norway. The papers, which explore artworks created over a span of more than 1,000 years, discuss topics ranging from abstract concepts to molecular details.

The research presented in this volume originates from both small-scale collaborations within museums and larger projects involving specialists from museums, universities and research institutions. In both fields of conservation and art history, the use of primary historical sources and archival material enhances our understanding of artistic processes and individual works of art. Chemical and technical investigations have increasingly become an integral part of our methodology. This volume highlights the different perspectives and methodologies which are crucial to bridging the gap between disciplines and generating new knowledge.

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