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Reconstructing Rogier : Practical Insights into the Original Appearance of the *Lamentation* Attributed to Rogier van der Weyden, Based on Student Reconstructions

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Students in the Technical Art History master's programme at the University of Amsterdam made reconstructions of The Lamentation of Christ *(ca. 1460–64), a painting attributed to Rogier van der Weyden that was recently treated at the Mauritshuis, The Hague. Technical examination revealed that some passages and pigments in this artwork have changed over the centuries. By focusing their reconstructions on specific research questions, the students' reconstructions provided new insights into some of these changes. Their research focused on preparatory phases (underdrawing and intermediate layer), changes that have occurred in coloured fabrics, and small reflective details like gems and blood.*

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Introduction

Educational programmes that train paintings conservators or technical art historians often involve students in making reconstructions of artworks.[1] At the University of Amsterdam, students from the Technical Art History master's programme learn about the process of making and the stratigraphy of historical paintings, as well as the interpretation of technical data, by attempting to make a faithful copy of a painting using historically appropriate materials and techniques. In 2020, students based their reconstructions on the *Lamentation of Christ* (ca. 1460–64) attributed to Rogier van der Weyden, which is the oldest painting in the collection of the Mauritshuis, The Hague, in the Netherlands (**Fig. 1**).[2] In 2018–19, this artwork underwent a thorough technical examination using advanced scientific technologies, as well as conservation and restoration treatment, in front of the public.[3] The

results from this research were an excellent basis for the student reconstructions and led to discoveries about the materials and techniques that were used to make the painting.

The panel (80.6 X 130.1 cm) was made from six vertical planks of oak, prepared with a chalk-glue ground, probably applied with a brush. The underdrawing was executed in at least three phases (and possibly by different hands), employing both dry and fluid materials.[4] An intermediate layer, applied thinly on top of the underdrawing, is a slightly warm pinkish colour. The composition of the paint layers is in keeping with the palette usually employed by Rogier van der Weyden and his workshop.[5] The colours used to differentiate the clothing of eleven different figures are bright and saturated, generally created by using opaque underlayers superimposed with translucent glazes. The visual effect of some of these glazes – to impart modelling and colour intensity – has been affected by fading in response to light.[6] Although in some cases it was difficult to determine the extent of fading, comparing exposed areas of paint to those that had been covered by old retouchings and fills gave an indication of colour change.

Fig. 1 Attributed to Rogier van der Weyden (and studio?), *The Lamentation of Christ*, ca. 1460–64? Oil on panel, 80.6 x 130.1 cm. Mauritshuis, The Hague, Mh264. https://www.mauritshuis.nl/en/our-collection/artworks/264-the-lamentation-of-christ/ After-treatment photograph (and after-treatment details used below) are by Margaretha Svensson. Reconstructed areas are marked as squares, with numbers corresponding to the figures below.

Despite the wealth of technical information provided by scientific analysis and imaging, some questions remained, specifically: the functions of layers beneath the surface, the original appearance of certain coloured fabrics and how they might have changed over the centuries, and the working process of the artist to create shiny, reflective details. Previous studies have demonstrated how reconstructions made with historically appropriate materials can be used to investigate the original appearance of artworks.[7] Such reconstructions also allow a practical perspective on the making process that may support the interpretation of analytical data and help to substantiate suggested relations to art-technological sources.[8] A 2012 article by Marie Postec describes how painted reconstructions made by students helped to answer questions specific to Rogier van der Weyden's *Seven Sacraments Altarpiece* (ca. 1445–50, Koninklijk Museum voor Schone Kunsten, Antwerp).[9] The recent research into the *Lamentation* involved a similar approach but focused on different questions.

By making reconstructions of specific areas of the *Lamentation*, the students could experience every step in the production process of a painting: from the making of raw materials to the joining of planks and the application of ground layers, to the preparation and application of paints containing a variety of pigments and processed linseed oils. They were able to appreciate the bright colours of un-aged paints, which provided them with a reference to assess the degree of ageing and discolouration in historical paintings. They also developed their skills in interpreting the scientific data that they used as a basis for their reconstructions, and learned to design their experiments in a way that would answer specific research questions. Thus, they learned to appreciate the values and limitations of reconstructions as a research method in technical art history. Whilst most educational programmes would not necessarily expect student reconstructions to solve any particular questions about the original artwork, in this case the exercise was seen as a chance to complement the technical study of Van der Weyden's *Lamentation.* In their reconstructions, the students were encouraged to evaluate rationales behind the choice of materials and techniques, and to investigate some hypotheses that were brought forth by the conservators who carried out the treatment of the original painting.

That said, there are some obvious limitations to this approach. While a fifteenth-century Netherlandish artist would have been trained over several years as an apprentice in a master's workshop, these modern-day students had little prior experience with making reconstructions as part of a course in interpreting art historical sources. This meant that they quickly gained a lot of tacit knowledge, including the affordances and properties of various materials and the way they can be used to create certain effects *while working.* Such a learning-by-doing approach means that the students inevitably made some – often quite insightful – mistakes, and may have experienced difficulties that professional artists would not have. Moreover, in some cases concessions had to be made regarding the historical appropriateness of materials and tools due to safety

regulations and practical limitations. Despite our efforts, it is never possible to truly replicate a historical process in all its peculiarities, and it has not always been possible to prove that an effect observed in one of the reconstructions necessarily accounts for a similar effect in Van der Weyden's *Lamentation*. However, performing technical analysis on the reconstructions and comparing the results with those from the original artwork provides both students and readers with an opportunity to gain deeper insight – not only into the quality of the reconstructions – but also into the interpretation of the historical painting. Therefore, we would like to propose that technical research into reconstructions become a more common part of reconstruction-based research, as well as education.

Reconstructions

As part of the course "Historical Reconstructions," selected areas of the *Lamentation* were reconstructed by second-year students of the Technical Art History master's programme in the Conservation and Restoration Department of the University of Amsterdam.[10] Two paintings conservators who had participated in the treatment of Van der Weyden's *Lamentation* at the Mauritshuis (authors Pottasch and Vandivere) made reconstructions alongside the students. The course was supervised and coordinated by the third author (Kneepkens).

Before the reconstruction process began, the conservators gave a presentation about the history and technical features of the *Lamentation*. Each student selected an area of the *Lamentation* (approximately 12 X 12 cm), conceived of appropriate research questions, and thought about how to organise their reconstruction to address their questions. Students were provided with digital and printed technical images of the painting, including: X-radiographs, macro-X-ray fluorescence scans (MA-XRF), infrared reflectograms, and photographs taken at different stages of the conservation treatment.

Each student joined two oak planks, sized the panel, and applied and sanded a chalk-glue ground.[11] The next phase was the application of the underdrawing, using the infrared reflectogram as a guide (see Question 1 below). On top of this underdrawing, they applied a thin pinkish-grey intermediate layer (see Question 2). The students continued painting their selected area based on the technical information provided. "Historically appropriate" pigments and materials were selected when possible, but for reasons of safety and time limitations some substitutions had to be made (see Table 1).[12] Naturally, the materials and stratigraphies of the reconstructions varied somewhat based on the research questions and the choices made by each student. Within their 12 X 12–cm squares, some parts were "finished," and others were left intentionally incomplete or incorporated materials or techniques that differed slightly from those used in the original painting. Each student kept a logbook documenting their steps and observations and photographed their reconstructions at different stages. Through the process of exploration and reconstruction, new questions and observations arose that generated discussions amongst the group. Five questions were selected for this article, based on different parts of the painting's layer structure.

Research Questions

1. What does the appearance of the underdrawing in the reconstructions tell us about the preparatory phases of Van der Weyden's *Lamentation*?

The underdrawing of Van der Weyden's *Lamentation* has been detected using various infrared cameras.[13] Differences in the width and intensity of the lines suggest that the underdrawing was applied in at least three phases, possibly using different materials and tools, and/or drawn by different hands.[14] For example, at an early phase some contours and guidelines were applied with a dry material (black chalk). In the Virgin Mary's blue cloak (Fig. 2a), the folds were indicated by broad dark lines applied with a black liquid medium and a brush or quill, whereas the shadows were indicated with fine hatching, also likely applied with a liquid medium (Fig. 2b).[15] Some compositional changes between drawing and painting phases (pentimenti) were detected: for instance, a shift in the position of Christ's hand.

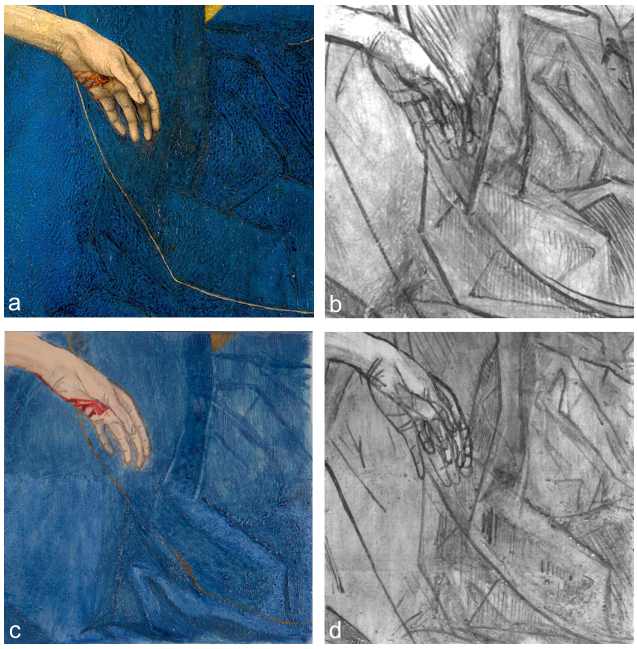

Fig. 2 (a) Detail of the Virgin Mary's clothing. (b) Infrared reflectogram of the Virgin Mary's clothing, Osiris IRR camera (Opus Instruments, wavelengths up to 1700nm). (c) Finished reconstruction by Mané van Veldhuizen. (d) Infrared reflectogram of the reconstruction, Osiris IRR camera. Unless mentioned otherwise, the photographs of reconstructions illustrated in this article were taken approximately two months after the reconstructions were completed.

In their reconstructions, the students tried different methods to apply their underdrawings. After tracing the infrared reflectogram using a dry material, they chose a fine brush, a feather quill, or both to apply an aqueous black ink, and tried to emulate the thick and fine lines that were detected in Van der Weyden's painting.[16] The brush was good at achieving dark pointed lines that resembled the broader underdrawing of the *Lamentation*. Several participants mentioned that a homemade quill was easier to use, perhaps because it felt more like a modern pen. They observed that it was possible to draw in all directions by slightly adjusting the angle of the quill, and the thickness of line was easier to control than with a brush. Therefore, the quill was found to be particularly suitable for the finer lines. Also, it held ink better than a pen and did not require repeated dipping into the inkpot.

To assess which tool created lines that were most similar to those applied by Van der Weyden, the reconstructions were examined using an Osiris camera: one of the same infrared reflectography cameras that had been used to examine his *Lamentation*. In most reconstructions, the visual effect of the combination of fine and thick lines appears very similar to the original. The student who reconstructed the area around the Virgin Mary's blue cloak primarily used a quill to apply the underdrawing: both the dark broad contours (for the folds) and the thin hatched lines to indicate the shadows (Fig. 2d).[17] One difference is that in the original painting the broad lines appear more pronounced and sometimes have a "puddle" at the end; they might actually have been applied with a brush. Already after the application of the first layer of paint (containing azurite and lead white), the underdrawing became difficult to follow because the paint was rather opaque (Fig. 2c). In contrast, several other students remarked that it was sometimes difficult to cover the darkest lines at the painting stage. This was especially true where the paint was relatively translucent, or where pentimenti were present.

In Van der Weyden's *Lamentation*, the underdrawing was adjusted during different phases, and also the artist changed some of the outlines during painting; however, it is remarkable that pentimenti are rarely visible with the naked eye, apart from a few places in the flesh tones and where the paint is thinnest.[18] Although this remains hard to prove, we may be able to conclude that Van der Weyden was aware of the degree to which the underdrawing would eventually be visible through the paint layers. From a practical perspective, it seems plausible that he might have varied the intensity of his lines, perhaps anticipating the specific mixtures that would be used on top, including eventual intermediate layers.

2. In the flesh tones and light-coloured areas, what is the role of the intermediate layer?

In most cross-sections from Van der Weyden's *Lamentation*, a thin layer (less than 10µm thick) lies between the underdrawing and the paint layers (see Fig. 7b). It contains lead white, red earth, and a very fine black pigment. In historical sources and literature, such a layer is referred to as an isolation layer, tinted priming, or *primuersel*.[19] Similar layers have been identified in other works from Van der Weyden's oeuvre, including the *Seven Sacraments Altar*.[20] Its presence may have fulfilled several functions, including: preventing the underdrawing from smudging when paint layers were brushed on top, muting the dark colour of underdrawing, preventing the binding medium of the paint layers from being unevenly absorbed into the ground, and acting as a base tone.[21]

All students applied the same paint as an intermediate layer to (parts of) their reconstructions, made with pigments mixed with linseed oil that had been sun thickened in a lead container.[22] Once it was dry, the layer had a rather rubbery surface that gave some resistance when it was wiped with a finger. During painting, the layer had different characteristics across the various reconstructions, depending on the thickness of application and the smoothness of the ground layers beneath. On the

smoothest panel, the layer seemed the most rubbery; as a result, during application of the subsequent paint layers, the coarse pigments did not always stay in place as they were being brushed on top. In other panels where the ground layer was rougher or uneven, this smoothness was an asset during painting.

One participant reconstructed the area around Christ's body and applied the intermediate layer over the underdrawing (charcoal bound in gum arabic, applied with a brush) on the left part of the panel only (Fig. 3b). She then observed whether there were differences when flesh-coloured paints and the white paint of the loincloth were applied on top of the surfaces (Fig. 3c). The four aforementioned functions of the intermediate layer were assessed. It prevented the underdrawing from smudging when paint layers were applied, but even without such a layer, the smudging of underdrawing was not a major problem. Both the light and dark lines of underdrawing remained visible and easy to follow at the paint stage; however, the intermediate layer muted the darkest lines of the underdrawing, which was important in minimizing the visibility of pentimenti. Comparison of cross-sections taken from the primed and unprimed parts of the composition showed that the intermediate layer did indeed prevent oil from the paint layers from being absorbed into the ground.[23] Although when it was first applied, the layer was perceived as having a somewhat dull and pale colour, the intermediate layer was an effective base tone. Its greyish-pink colour helped to give Christ's dead flesh a convincing tone, especially where the paint was thinly applied; however, in the completed reconstruction, there is barely any colour difference between the flesh applied on top of the primed and unprimed areas (Fig. 3d).

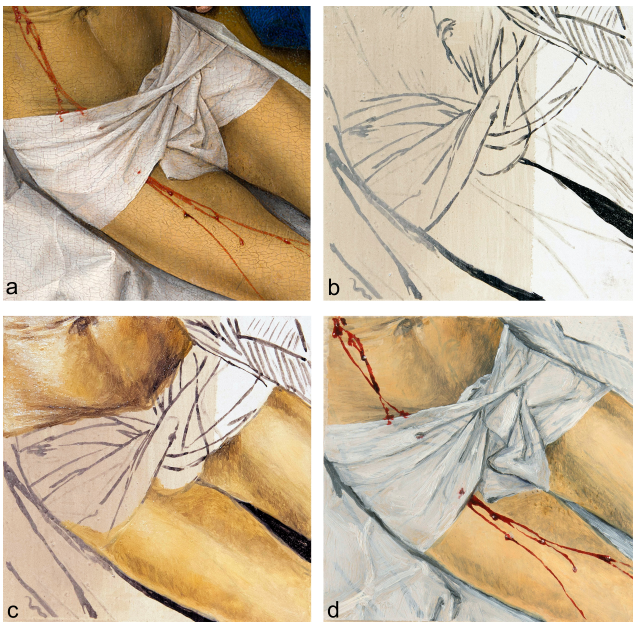

Fig. 3 (a) Detail of Christ's body. (b) Reconstruction after application of the underdrawing (dark and light lines) and the intermediate layers (thickest on the left, thinner in the middle, not present on the right). (c) Reconstruction after application of the flesh paint. (d) Finished reconstruction by Abbie Vandivere.

The function of this layer as a base tone is likely one of the reasons why some early Netherlandish painters seemed to have adopted flesh-coloured intermediate layers, especially for portraits or compositions with many figures.[24] It made the painting process more efficient because fewer or thinner paint layers needed to be subsequently applied to give a convincing impression of skin. Visually, its colour encompasses both the cool and warm tones of real flesh. Most parts of Van der Weyden's *Lamentation* are rather thickly painted with bright colours.[25] Although the colour of the intermediate layer might have helped to make the process more efficient in the skin tones of the eleven figures, the rest of the painting barely benefits from its visual effect. Perhaps its main functions were to prevent the medium from soaking into the ground layer, to tone down or even out visual differences in the underdrawing, to efficiently build up certain colours, and/or to provide a smooth surface on which to apply and blend the paint.

3. What was the original appearance of coloured draperies in the *Lamentation*?

The following sections investigate the buildup and original appearance of various draperies from Van der Weyden's *Lamentation*, some of which seem to have been affected by chemical and physical changes over time. The pigments identified using MA-XRF and examination of cross-sections were similar to the pigments found in previous studies on paintings by Van der Weyden, including the Boston *Saint*

Luke Drawing the Virgin (ca. 1435–40), the Uffizi *Entombment* (ca. 1460–63), and paintings from the National Gallery, London.[26]

3a. Blue draperies

Van der Weyden's *Lamentation* features several blue draperies that originally had slightly different tones. Each of them seems to have changed over the course of time, but in different ways. The dress worn by the standing woman on the left (Mary Magdalene) is very dark – almost black – and appears to have little modelling (Fig. 4a). There is almost no definition between highlights, mid-tones, and shadows, and her upper arm seems to have merged into her bodice. Cross-sections reveal that the dress consists of a layer of very coarse azurite (a relatively opaque and inexpensive blue pigment), followed by a glaze of fine ultramarine (a more translucent and precious blue pigment) (Figs. 4c, 4d).

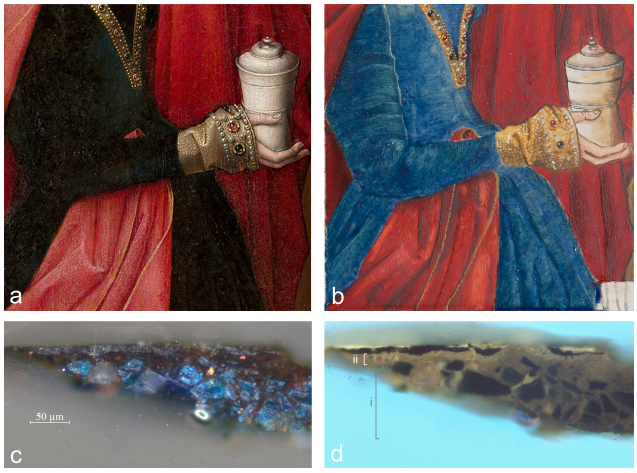

Fig. 4 (a) Detail of Mary Magdalene's clothing. (b) Reconstruction by Paul van Laar showing modeling of the blue dress in three ways, and the profound contrast between the dress and the red drapery (vermilion, heightened with lead white and glazed with red lake). Photograph taken within two months of completing the reconstruction. (c) Cross-section taken before treatment from the bottom of Mary Magdalene's dress, 200x magnification, dark field (DF). (d) Cross-section taken before treatment from the bottom of Mary Magdalene's dress, 200x magnification, ultraviolet illumination (UV). Note the difference in size between the large azurite particles (layer i, also containing red particles) and the small ultramarine particles (layer ii). The layers above are overpaint and varnish.

Based on this information, one student investigated the original modelling of Mary Magdalene's dress by testing three different approaches (Fig. 4b).[27] In the bodice, he first applied a thin, unmodelled layer of pure azurite, then achieved the modelling in the upper ultramarine layer. In the sleeve, he attempted to differentiate the folds by adjusting the thickness of the azurite underlayer, then applied a relatively even layer of ultramarine on top. In the lower part of the dress, he also applied modelling in the azurite underlayer, both by varying its thickness and by producing highlights by mixing the azurite with lead white. When he compared his reconstruction with details from Van der Weyden's *Lamentation*, the student was most convinced by the approach chosen for the sleeve.[28] It should, however, be noted that cross-sections from the original and reconstruction had different layer thicknesses; the ultramarine layer that Van der Weyden applied was thinner than the one in the reconstruction (Figs. 4c, 4d). Whilst the student had a clear preference, this may have been influenced by his lack of experience. The extreme darkening of this section in the original artwork makes it hard to draw a sound conclusion; however, the reconstruction does give an idea of the original contrast, now lost, between the blue and red draperies.

A similar experiment was conducted by another student, who tried three approaches to paint the dress of the Virgin Mary (Fig. 2c). In Van der Weyden's *Lamentation*, this garment may also have lost some of its modelling, although its overall colour is still rather blue, and some folds have remained visible. The student concluded that mixing the azurite with lead white was the most successful way to achieve convincing midtones and highlights in the Virgin's dress. Modelling the garment by only varying the thickness of the azurite paint was especially difficult because the large pigment particles slid around on the intermediate layer. Trying to achieve differences in tone with only ultramarine was difficult because it was too translucent to provide a convincing suggestion of depth and shadow.

Cross-sections from Van der Weyden's *Lamentation* show that the Virgin Mary's dress was also painted with azurite, followed by a glaze containing exceptionally large particles of ultramarine. The MA-XRF scans indicate that one or both paint layers also contain lead white. This may have helped provide the heightened impression of highlights and midtones, and could explain why this garment retained its modelling better over time as compared to Mary Magdalene's dress (described above), where much less lead white was incorporated into the paint. Unfortunately, the glazes in the Virgin Mary's dress – especially in the darkest shadows – have been affected by "ultramarine sickness." The particles scatter the light, causing surface blanching and thereby diminishing the contrast between the lighter and darker areas.[29]

The third "blue" drapery studied was the light-coloured dress of the Seated Mary at the lower left (Fig. 5a). A significant part of the skirt had become severely damaged by the heat from candles. The original paint had burnt or flaked off, and the damaged area was overpainted in the

sixteenth or seventeenth century.[30] During the recent conservation treatment, it was found that the old overpaint covered parts of the original paint and had locally protected it from exposure to light. The protected areas were more purple or pinkish in tone than the rest of the skirt. The presence of white, blue, and red pigments – as well as the areas that were protected by the overpaints – suggest that the dress worn by the Seated Mary originally had a somewhat more purplish appearance.

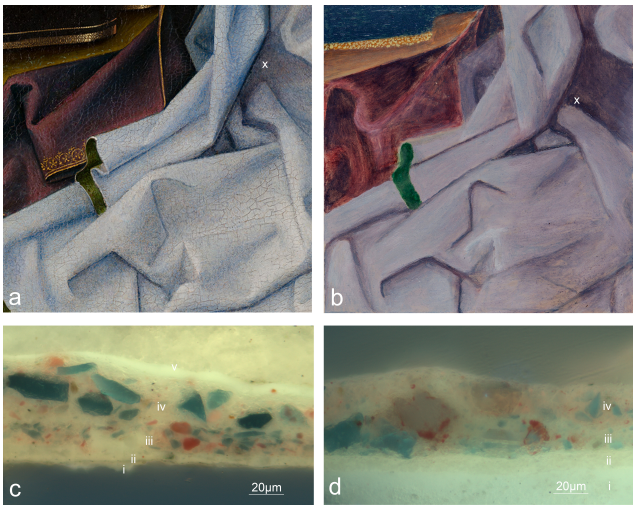

Fig. 5 (a) Detail of the skirt of the Seated Mary. (b) Reconstruction by Anne-Sofie Hamers, photographed approximately seven months after making. (c) Cross-section taken during treatment from the shadow in the Seated Mary's dress, 400x magnification, UV. Sample location is marked with an X on fig. 5a: (i) ground and underdrawing; (ii) intermediate layer, (iii) paint layer containing lead white, azurite, and red lake; (iv) paint layer similar to iii, but with larger particles; (v) varnish and overpaint (not original). (d) Cross-section taken from the reconstruction, 400x magnification, UV. Sample location is marked with an X on fig. 5b: (i) ground; (ii) intermediate layer; (iii) paint layer containing lead white, azurite, and red lake; (iv) paint layer similar to iii, but with more lead white.

One student wondered how the presence of red lake originally affected the colour of the paint mixture. She incorporated several types of lakes into her reconstruction, including madder lakes she made based on historical recipes, and commercially available pigments (Fig. 5b).[31] During the reconstruction it became clear that the specific colour of the red lake had a profound impact on the mixture; while a slightly brownish madder lake rendered a greyish-brown paint, a more bluish madder resulted in a pale violet that was closer to the present appearance of the dress. Although it was impossible to determine the precise colour of the original paint, and therefore the extent of fading, it did become clear that even a little amount of the correct red lake turns the paint from light blue to purple.

A comparison of cross-sections from shadow areas in the original skirt and reconstruction showed similarities in the type and size of pigment particles; in the original, however, finer pigments are in the lower layers, whereas in the reconstruction they are in the upper layers (Figs. 5c, 5d). A comparison of the uppermost paint layers suggests that the reconstruction could have been more comparable if additional blue and red pigments had been incorporated, which would have resulted in an even darker drapery. Despite this difference, the few particles of red lake that were observed in the paint sample and under the microscope indeed suggest that the dress of the Seated Mary was originally more violet or purple in colour.

3b. What was the original appearance of the clothing worn by the Standing Mary?

We also had questions about the original appearance of the clothes worn by the Standing Mary (second figure from the left) (Fig. 6a). Her brown gown is lined with fur, and the fabric itself appears heavy due to its crisp folds. Underneath she wears an orange kirtle, which seems to be made of a lighter fabric with looping folds. Such a colour combination might seem unusual for clothing worn by a Biblical figure or by a wealthy person in the fifteenth century (that is, contemporary to Rogier van der Weyden). So far, no clothing with this specific colour combination has been found in other works from his oeuvre or by other fifteenth-century artists.

MA-XRF scans of the brown gown in Van der Weyden's *Lamentation* reveal that it contains mercury (Hg), lead (Pb), and potassium (K), respectively corresponding to the pigments vermilion, lead white, and probably the substrate for a lake pigment. Examination with a 3-D digital microscope shows that the paint mixture in an underlayer contained a black pigment in addition to red and white particles. The surface layer with a finer crack pattern is likely a faded layer of red lake glaze. A reconstruction tested whether this combination of pigments would result in a brown colour, or perhaps more purple (Fig. 6c).[32] A paint layer containing vermilion, lead white, and carbon black was applied, followed by a thin, even layer of madder lake precipitated on a potash-alum substrate. The resulting colour was a dark reddish-brown. Presumably, choosing a different type or shade of the red lake (see Question 3a) would have resulted in slightly different tones for the garment.[33]

Fig. 6 (a) Detail of Standing Mary. (b) 3-D digital microphotograph of the brown gown, 100x, showing the mixture of red (vermilion), black, and white (lead white) pigments. On the surface is a faded glaze with a finer crack pattern. (c) Reconstruction by Carol Pottasch. The areas of the brown gown outlined with yellow show the brown paint without the red glaze. The part of the sleeve outlined in green shows where only the light underlayer was applied (no glaze). To the left of this, red lake was applied on top; to the right, a mixture of red lake, vermilion, lead white, and black was applied on top. (d) Cross-section from the orange kirtle (sample taken in the skirt), 400x, UV: (i) underlayer containing lead white, lead-tin yellow, red lake, azurite, and a fine black pigment; (ii) layer containing lead white and (unidentified) blue; (iii) upper layer containing red lake, vermilion, and a little lead white and black; (iv) varnish (not original). (e) Cross-section from the orange sleeve of the reconstruction, 400x, UV. Sample location is marked with an X on fig. 6c: (i) ground; (ii) intermediate layer; (iii) and (iv) two indistinct paint layers, containing red lake with vermilion, lead white, and black.

The kirtle that the Standing Mary wears underneath the gown is an opaque orange colour. Microscopic examination suggests that the top layer contains red lake, which has since faded. A cross-section from her skirt confirms that the paint is built up in three layers, the topmost of which includes both pink and colourless particles at the surface, indicating a faded red glaze (Fig. 6d). This suggests the orange kirtle would have had a redder hue when it was first painted. The highlights in the sleeves – where the glaze is thin or absent – would likely have contrasted with the intensely coloured mid-tones and shadows, creating a more convincing modelling.

A cross-section was taken from a shadow in the sleeve of the reconstruction of the Standing Mary (Fig. 6d). Although the samples were taken from different parts of the garment, the sample from the orange skirt in Van der Weyden's painting and the thickness of the upper paint layer in the reconstruction (Fig. 6e) are similar. In ultraviolet (UV) illumination, both cross-sections show strongly fluorescing red lake particles; however, in the reconstruction the drying time between painting sessions was not long enough, so the red lake paint has blended with the layers beneath. The type(s) of red lake used in the original and reconstruction might not have been identical,[34] but the effect of a red lake glaze shows that it imparts extra colour intensity and saturation.

3c. What was the original appearance of the red fabrics?

Different shades of red draperies are found throughout the *Lamentation*, and some appear to have changed more than others. The red lake used to depict the velvet of the bishop's cloak (at lower right in Fig. 1) seems to have retained the intensity of its deep crimson colour. In comparison, in the clothing of Mary Magdalene (standing at far left), Saint John (center), and Saint Peter (far right), the red lake glazes applied as a final layer to impart midtones and shadows have faded. The more noticeable effect of fading due to light exposure may have been the result of the thinner application of glazes and/or abrasion during restoration treatments. The underlayers in the clothing of Mary Magdalene and Saint John also contain lead white, which could have additionally contributed to internal light scattering and fading.[35]

In Saint Peter's red cloak, the mid-tones and shadows have become faded and/or abraded, which affects its three-dimensional effect (Fig. 7a).[36] A cross-section from a shadow in the cloak shows that Van der Weyden laid in the underpaint with vermilion mixed with red lake (Fig. 7b). He then achieved the modelling by applying several layers of glazes, each containing progressively more red lake. The student who reconstructed this area noted that vermilion is very opaque and consequently tended to cover the underdrawing before proper modelling was achieved (Fig. 7d). She found that incorporating red lake in the underpaint was an effective way to create shadows. Finally, she applied the darkest shadow with a pure red lake glaze, in this case, an insect-based lake made from the secretions of *Coccus Lacta*.[37] This stratigraphy can be seen in a cross-section from the reconstruction (Fig. 7c). Although initially the bright orange-red underlayer and translucent red glaze seemed quite close to the colours that we presumed to have been used by Van der Weyden, a surprising effect was noted once the reconstructions had been displayed for several months in the conservation studio. After approximately three to four months, the red lake glaze began to darken and turn more purplish (Fig. 7e). The reason for this colour shift is unclear, but it was observed in all of the reconstructions that incorporated this pigment. As

most red lakes eventually fade in response to light, one expects that over a longer term this and other red paints will change colour again.

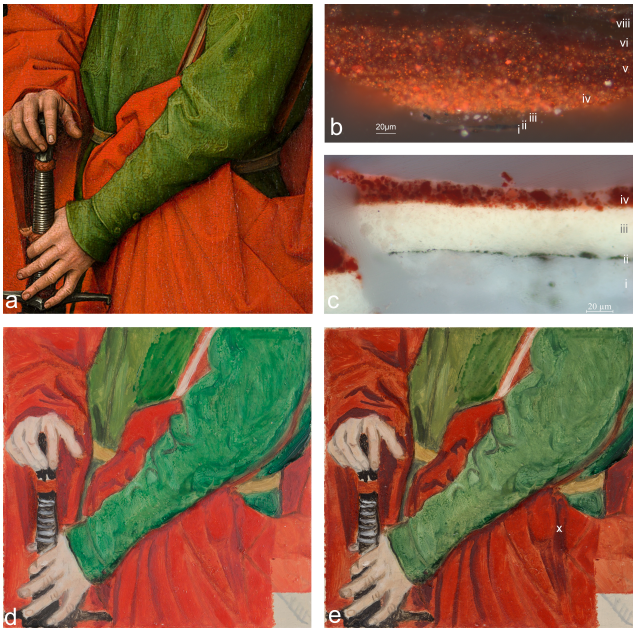

Fig. 7 (a) Detail of Saint Paul. (b) Cross-section from the shadow on the right edge of Saint Paul's cloak, 200x, DF: (i) ground; (ii) underdrawing; (iii) intermediate layer; (iv) red layer containing red lake and vermilion; (v) red lake containing red lake, vermilion, and a blue pigment; (vi) glaze containing red lake and a little vermilion; (vii) varnish and overpaint. (c) Cross-section from a shadow in the reconstruction, 400x, UV: (i) ground; (ii) underdrawing; (iii) intermediate layer; (iv) red paint layer containing vermilion and red lake. Sample location is marked with an X on fig. 7d. (d) Reconstruction by Ingrid Kramer, photographed approximately two months after making. (e) Reconstruction by Ingrid Kramer, photographed approximately seven months after making.

Previous studies of paintings from the Van der Weyden group have suggested that several types of red lakes were used – including madder and insect-based lakes (probably kermes) – but have also acknowledged that identifying these materials is difficult.[38] Currently, it is unclear which specific types of red lakes were used in Van der Weyden's *Lamentation*. The upper layers of a cross-section from the orange kirtle (Fig. 6d) appear to contain two types of red lake particles, each with a different fluorescence in UV illumination. The orange-pink fluorescence of some particles suggests madder, but the dyestuff of the red lake(s) has not been confirmed. A combination of MA-XRF scanning of the painting and scanning electron microscopy–electron dispersive X-radiography (SEM-EDX) analysis of cross-sections confirmed that red lakes used in different areas of the *Lamentation* were precipitated on substrates containing calcium (Ca), aluminium (Al), and/or potassium (K).

During the reconstruction exercise, the students had access to several madder lakes.[39] Unfortunately, kermes was not available, so a different insect-based dyestuff (lac dye made from the secretions of *Coccus Lacta*) was used. The students chose the lake that seemed to "work best" for them, meaning that it had the desired working or colour properties. For this reason, it is difficult to draw firm conclusions about the lakes that Van der Weyden might have used. The exercise, however, demonstrated that red lakes made from different raw materials or recipes each have a distinct colour, and that even a very small admixture of red lake can have quite a dramatic effect on the colour of a paint. For Van der Weyden, it would have given a "blue" drapery a lilac or purple colour (see Question 3a), and provided modelling in a sleeve (Question 3b). Red lake applied as a thin glaze would have intensified and deepened colours, including the brown dress (Question 3b). We also observed that such colour effects are subject to change in both the short and longer term, and that changes can deeply affect the colour balance in a painting, eventually leading to seemingly unusual shades or combinations (Questions 3a and 3b).

4. How might the artist have achieved small reflective details, like gems and drops of blood?

Once the landscape, figures, and clothing had been laid in, Van der Weyden applied small details to enliven the painted surface: gems, tears, blood, and reflections on metal. By reconstructing these details, the students came to understand how he was able to convincingly depict small objects that are meant to appear reflective, translucent, or shiny.[40]

Mary Magdalene's clothing is lavishly decorated with pearls, gems, and gold threads (Figs. 2a, 8a). Although he used real gold to embellish the edges of the garments, Van der Weyden created the other details with paint only. The student who reconstructed this detail tried to follow the same steps (Fig. 8b). He presumed that painting the gems would be complicated, but when he examined microphotographs, he noticed that they are similar to each other and rather schematic. The challenge lay in the timing; he had only a few days to complete them. Mary Magdalene's neckline is embellished with pearls and red and blue gems, painted on top of a brown paint layer (Fig. 8a). This brown colour established the base tone for the metal setting around each gem; on top, he applied a darker brown shadow as a half-circle underneath and a bright reflection in the upper left. To reconstruct each gem, the student applied either ultramarine or red lake on top of a brown paint layer. The next day, when he attempted to apply the highlights, the glazes were still wet; the result was

less successful because the roundness and reflectivity of the gems relied on crisp highlights in specific places. After waiting for the base tone to dry further, the student proceeded with the application of highlights: first a diffuse reflection on the bottom of each gem, and then a stronger highlight in the upper left.[41]

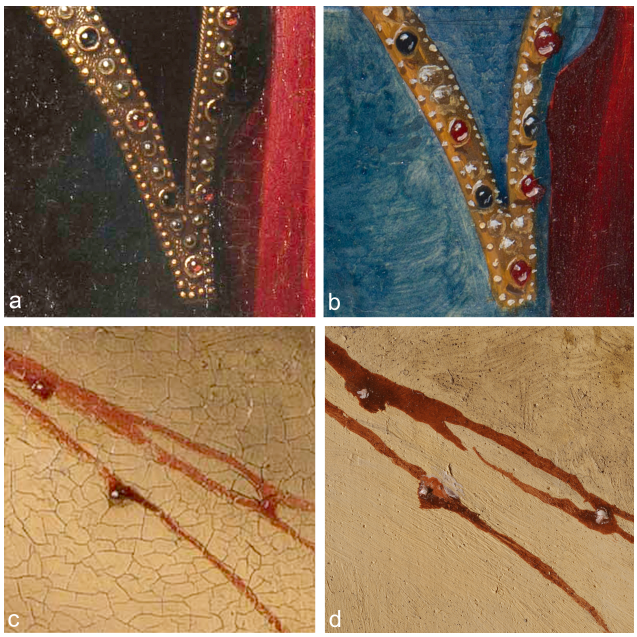

Fig. 8 (a) Detail of the neckline of Mary Magdalene's dress. (b) Detail of the reconstruction by Paul van Laar, photographed seven months after making. (c) Detail of Christ's blood. (d) 3-D digital microphotograph of the reconstruction by Abbie Vandivere, 30x magnification.

A simpler technique was used to paint the drops of blood dripping from Christ's wounds (Fig. 8d). The base tone contains vermilion, with small touches of a darker red lake glaze, applied when the vermilion was still wet. The combination of a glossy glaze and tiny dots of lead white created convincing reflections that imitate the viscous liquid.

These reconstructions suggested that the successful imitation of gems and blood droplets depends less on the meticulous rendering of tiny details, and more on adhering to a consistent formula. In his logbook, a student remarked that Van der Weyden would have needed to plan ahead and follow a series of specific steps, with ample time for drying between each.

Conclusion

Reflecting on the experience of reconstructing various sections of Rogier van der Weyden's *Lamentation*, all students reported major and minor discoveries that they would never have made if it were not for their physical involvement in every step of the production process. Most of these results have a primarily didactic value. As is often the case in reconstruction-based art-technological research, there is a certain degree of subjectivity that must be taken into account. It is also important to consider that the reported observations are those of novice painters. Nonetheless, the exercise provided some insights into the use of certain materials and techniques, and its effects on the discolouration of the *Lamentation*.

Challenges in the painting process were educational when it came to understanding what the process of painting was like in the past, with the materials available at the time. It also illuminated practical aspects of the working process that are rarely described in historical sources, or even in modern literature.[42] One student realised the importance of working from top to bottom, after repeatedly covering her hands in paint and smearing her work.

Occasionally there were surprising results that even the more experienced participants could not have foreseen, such as the initial darkening of a specific type of red lake, contrary to the fading that is so commonly described. Results like this evoke questions about the relative stability of various types of red lakes and their relation to the appearance of paintings over the course of time. Other questions were less easy to answer, like determining precisely which underdrawing tools were used in the original artwork. Even though the images produced by infrared camera suggest that the underdrawing of the reconstructions came quite close to the appearance of the original drawing, it remains a question to what extent fifteenth-century painters adapted the thickness of their lines anticipating the subsequent paint layers. It did, however, become clear that the absence of split ends in the underdrawn lines does not automatically exclude the use of a quill, and that it is possible to apply both broad and fine lines with a quill. Insight was also extended to the role of tinted intermediate layers in the work of Van der Weyden. The experience showed how such a layer would have toned down an underdrawing to a significant extent, and how its colour may have affected the number of layers required to achieve a convincing skin tone. Moreover, it became evident how the choice of a certain processed oil as a binding medium for such a layer may have influenced paint handling in subsequent layers.

A crucial element of this study was examining the reconstructions with some of the same scientific methods that were also applied to the real painting. Comparing the results from infrared examination and/or analysis of

samples showed the ways in which the reconstructions are similar to – or different from – the original. Although it is impossible to say anything conclusive about the original appearance of the draperies in the *Lamentation* based on reconstructions alone, comparing the reconstructions and original artwork has yielded valuable insights about the visual impact of change, and the effects of specific materials and application techniques on their ageing processes. In other words, we do not necessarily know exactly how the colours originally looked, but we have increased our understanding of the factors that were of influence. We witnessed the dramatic effect of fading red lakes, both on the colour of individual areas and the balance between them. Although the fading of lakes is nothing new, and the exact amount of fading is impossible to assess, the fresh colours of the reconstructions do provide a reference that helps us imagine the original splendour of the artwork. We also saw how different approaches to the modelling of blue draperies may well explain why in some places all three-dimensionality has been lost, while in others it is comparably well preserved. Some students were surprised by the tinting effect of even the smallest addition of red lake, as well as its particular colour. Two different lakes based on the same raw material could make the difference between a warm orange-red and a cool one tending towards purple. This underpins the need for more thorough analysis of remnants of various lakes on early Netherlandish paintings.

Making these historically informed reconstructions was a humbling experience. Regardless of the body of data we now have on the *Lamentation*, there was always some crucial information missing. Although some of the reconstructions came close to mimicking Van der Weyden's finest details, all the students were happy to acknowledge that they would need more practice to become a master.

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Table 1. Materials Used in Reconstructions

Reconstruction stage	Materials	Manufacturer	A in
Panel	Quarter-sawn European oak planks		Pr H O
Ground	Rabbit-skin glue	Kremer Pigmente: www.kremer-pigmente.com	Ra gl (6
	Chalk	Kremer Pigmente: www.kremer-pigmente.com	Cl Cl Fr na ca ca (5
Underdrawing	Carbon black	Verfmolen de Kat:www.verfmolendekat.com	Ca
	Binding medium	Kremer Pigmente: www.kremer-pigmente.com	G (6
Intermediate layer	Tube paint	Natural Pigments: www.naturalpigments.eu	Ru pr w bo w sa re pa fa pr le th
	Dry pigments	Verfmolen de Kat: www.verfmolendekat.com	Ca
		Ôkhra: www.okhra.com	Re
		Kremer Pigmente: www.kremer-pigmente.com	Cl ch
		Natural Pigments: www.naturalpigments.eu	Ru fla (D m pi

Reconstruction stage	Materials	Manufacturer	Additional information
	Leaded linseed oil	Linseed oil, pressed at Windmill *'t Pink* (Koog aan de Zaan), left to thicken in the sun in a lead container	The proportion of lead white to chalk was approximately 1:1, with very small quantities of carbon black and red earth added. This resulted in a slightly warm greyish colour, similar to the colour visible on the exposed ground on the edge of the panel.
Paint layers	Tube paints	Natural Pigments: www.naturalpigments.eu	Rublev stack-process lead white #1, bound in linseed oil
	Dry pigments	Verfmolen de Kat: www.verfmolendekat.com	Carbon black, yellow ochre, red ochre
	Dry pigments	Kremer Pigmente: www.kremer-pigmente.com	Red: vermilion (42000), madder lake (37200), dye (30020). Blue: azurite (10200), ultramarine (10510). Yellow: lead-tin yellow dark (10110). Black: charcoal black from beech (47800)

Reconstruction stage	Materials	Manufacturer	Ad in
	Dry pigments	Ôkhra: www.okhra.com	Ea pi ye (2 H Va br (2 (3 (3
	Dry pigments	Pigments made by Technical Art History students	Ve M
	Binding media for dry pigments	Linseed oil pressed at Windmill *'t Pink* (Koog aan de Zaan), processed in different ways[a]	Se of oi av th in su (le w ±2 he le "I la

[a] Indra Kneepkens, "Masterful Mixtures: Practical Aspects of Fifteenth- and Early Sixteenth-Century Oil Paint Formulation" (PhD diss., University of Amsterdam, 2021).

[b] Made according to "ML-Std" and "ML-pot-Al" recipes in Kirby, van Bommel, and Verheken, *Natural Colorants for Dyeing and Lake Pigments*, 91–92.

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Notes

1. Mary Kempski, "Making Reconstructions at the Hamilton Kerr Institute," in *In Artists' Footsteps: The Reconstruction of Pigments and Paintings*, ed. Lucy Wrapson et al. (London: Archetype, 2012), 1–16.

2. The question of whether Rogier van der Weyden was the (only) artist who painted the *Lamentation* has not been entirely resolved. See J. R. J. van Asperen de Boer et al., "Underdrawing in Paintings of the Rogier van der Weyden and Master of Flémalle Groups," *Nederlands Kunsthistorisch Jaarboek* 41 (Zwolle: Waanders, 1992), 171–80; Helene Mund, catalogue entry, in *Rogier van der Weyden, 1400–1464: De Passie van de Meester*, ed. Lorne Campbell and Jan van der Stock (Leuven: Davidsfond,

2009), 520–22. The Mauritshuis attributes the painting to Rogier van der Weyden and his studio, and here we refer to it as "Van der Weyden's *Lamentation*."

3. *Rogier van der Weyden Unveiled*, Mauritshuis, June–September 2018. The phase of treatment presented to the public was varnish removal. The next phases (overpaint removal, varnishing, filling, retouching) were carried out in the conservation studio of the Mauritshuis.

   The scientific technologies used to examine Van der Weyden's *Lamentation* included: infrared reflectography, reflectance imaging spectroscopy (RIS), X-radiography, macro-X-ray fluorescence spectroscopy (MA-XRF), and examination of samples embedded as cross-sections using scanning electron microscopy–electron dispersive X-radiography (SEM-EDX). Articles focusing on the materials and techniques of the *Lamentation* are planned for publication in the *Journal of Historians of Netherlandish Art* (www.jhna.org), including: Carol Pottasch, "Rogier van der Weyden's *Lamentation*: Discoveries and a Changed Appearance"; and Carol Pottasch et al., "Rogier van der Weyden's *Lamentation*, ca. 1460–64, Mauritshuis: Combining MA-XRF and Reflectance Imaging Spectroscopy and Cross–Sections."

4. Van Asperen de Boer et al. (*Underdrawing in Paintings of the Rogier van der Weyden and Master of Flémalle Groups*, 171–80) describe the underdrawing as being consistent with the core group of works by Rogier van der Weyden; see the forthcoming article by Carol Pottasch and Kirsten Derks, "The Underdrawing of Rogier's *Lamentation* in the Mauritshuis revisited."

5. Rachel Billinge et al., "The Materials and Technique of Five Paintings by Rogier van der Weyden and His Workshop," *National Gallery Technical Bulletin* 18 (1997): 68–86.

6. David Saunders and Jo Kirby, "Light-Induced Colour Changes in Red and Yellow Lake Pigments," *National Gallery Technical Bulletin* 15 (1994): 79–97.

7. Wrapson et al., *In Artists' Footsteps*.

8. Pamela H. Smith, "In the Workshop of History: Making, Writing, and Meaning," *West 86th: A Journal of Decorative Arts, Design History, and Material Culture* 19, no. 1 (2012): 12.

9. Marie Postec, "Technical Reconstitutions Based on 'The Seven Sacraments' by Rogier van der Weyden: An Experimental Approach," in *Rogier van der Weyden in Context: Papers Presented at the Seventeenth Symposium for the Study of Underdrawing and Technology in Painting*, Leuven, 22–24 October 2009, ed. Lorne Campbell et al. (Leuven: Peeters, 2012), 147–57.

10. Technical Art History at the University of Amsterdam: https://gsh.uva.nl/content/masters/conservation-and-restoration-of-cultural-heritage/study-programme/technical-art-history/technical-art-history.html?cb

11. After planing and joining the quarter-sawn oak planks with animal glue, the students applied one layer of 5% and two layers of 10% rabbit-skin size on both the front and the back of their panels. The remainder of the 10% size was used as a basis for a chalk-and-glue ground. The warm ground was applied with a brush in six layers, in alternating directions. Once dry, these grounds were polished with sandpapers and eventually with metal scrapers, until smooth and glossy. Some carbon black pigment was sprinkled on the surface before final scraping to reveal any missed dents.

12. Leslie Carlyle, "Reconstructions of Oil Painting Materials and Techniques: The HART Model for Approaching Historical Accuracy," in *Reconstruction, Replication and Re-enactment in the Humanities and Social Sciences*, ed. Sven Dupré et al. (Amsterdam: Amsterdam University Press, 2020), 63–76.

13. Van Asperen et al., *Underdrawing in Paintings of the Rogier van der Weyden and Master of Flémalle Groups*, 171–80; forthcoming article by Pottasch and Derks (note 4 above).

14. Carol Pottasch and Lieve d'Hont, "Rogier van der Weyden's Underdrawing," *Mauritshuis in Focus*, no. 2 (2018): 20–24. A similar multiphase approach to drawing has also been observed in underdrawings and drawings attributed to Van der Weyden. See Micheline Comblen-Sonkes, "Rogier van der Weyden dessinateur: Comparaison de ses dessins autonomes et du dessin sous-jacent de ses tableaux," *Bulletin de l'Institut royal du patrimoine artistique* 16 (1976–77): 130–42; Cyriel Stroo and Pascale Syfer-d'Olne, *The Flemish Primitives* (Brussels), no. 6 (1996): 101.

15. Although it remains unclear whether a quill or brush was used to paint the folds, it is notable that the characteristics of a quill – "lines that had darker lines running along the edges, and the end of the mark separated into the shape of a swallow's tail, thus indicating the splayed nib of the quill" – as described by Rose Miller and Christine Patrick were not observed in the infrared reflectogram of the *Lamentation*. See Miller and Patrick, "Four Weeks of Work for Four Seconds of Fame: Reconstructions for Television," in Wrapson et al., *In Artists' Footsteps*, 169.

16. The underdrawing was transferred to the panel by tracing a detail of a 1:1 print of the infrared reflectogram that was covered with charcoal black on the back. The lines were then fixed with an ink based on carbon black and gum arabic in water (10%), using either a fine pencil or a quill.

17. Unless mentioned otherwise, the photographs of reconstructions illustrated in this article were taken approximately two months after the reconstructions were completed.

18. In the Antwerp *Seven Sacraments* painting, the initial drawing was not always followed. See Postec, "Technical Reconstitutions Based on 'The Seven Sacraments,'" 149–50.

19. The Dutch term *primuersel* was used by Karel van Mander in the didactic poem that introduces the *Schilder-boeck* (1604, fol. 47v,

48r). Abbie Vandivere, "In Search of Van Mander's Primuersel: Coloured Intermediate Layers in Early 16th-Century Netherlandish Paintings," summary of a poster presented at the fourth symposium of the Art Technological Source Research Working Group, ICOM Committee for Conservation (ICOM-CC), Vienna, September 2010, in *The Artist's Process: Technology and Interpretation*, ed. Sigrid Eyb-Green et al. (London: Archetype, 2012), 198–99.

20. Reconstructions of the Antwerp *Seven Sacraments* suggested that the type and thickness of an intermediate layer would could be translucent enough to allow the underdrawing to show through at an initial phase of painting, but that the drawing could be minimised as more paint layers were applied. Postec, "Technical Reconstitutions Based on 'The Seven Sacraments,'" 150. See also Billinge et al., "The Materials and Technique of Five Paintings," 95; Ester B. Ferreira et al., "Chemical Characterisation of Thin Intermediate Layers: Case Study of a Sample from the Fifteenth Century Painting, *The Descent from the Cross* by Rogier van der Weyden," *Reporting Highlights of the De Mayerne Programme* (The Hague: Netherlands Organisation for Scientific Research, 2006), 53–62; Catherine A. Metzger and Michael Palmer, "The Washington *Portrait of a Lady* by Rogier van der Weyden Reconsidered in Light of Recent Investigations," *Studies in Conservation* 43, supp. 1 (1998): 94–97; Jana Sanyova, "Report 822 2L/43 of the Laboratory Study of the Holy Trinity Attributed to the Workshop of Rogier van der Weyden (?)," *Laboratorium Schilderkunst en gepolychromeerde sculptuur* (2009): 1; Catherine A. Metzger and Griet Steyaert, "Painting, a Distinct Profession," in Campbell and van der Stock, *Rogier van der Weyden*, 162–79; Griet Steyart, "Some Technical Aspects Observed during the Restoration," in Campbell et al., *Rogier van der Weyden in Context*, 119–35.

21. Abbie Vandivere, "Reconstructing Intermediate Layers in Early Netherlandish Paintings," in Wrapson et al., *In Artists' Footsteps*, 63–76.

22. It could not be determined with certainty whether the binding medium of the intermediate layer in Rogier's *Lamentation* is leaded oil. Analysis of a similar layer in the *Descent from the Cross* suggested that a leaded oil had been used (Ferreira et al., *Chemical Characterisation of Thin Intermediate Layer*s).

23. In other reconstructions, the extent to which the ground had been polished or scraped seemed to have a greater effect on the absorption of oil from the paint. Reconstructions of the *Seven Sacraments* suggested that the ground in Van der Weyden's painting was applied using a flexible spatula, based on characteristic parallel lines that were observed in the ground layer. See Postec, "Technical Reconstitutions Based on 'The Seven Sacraments,'" 149. No such parallel lines were found in the ground of the *Lamentation*.

24. Vandivere, "Reconstructing Intermediate layers in Early Netherlandish Paintings," 63–76.

25. For a discussion of thick paint layers, see Stroo and Syfer-d'Olne, *The Flemish Primitives*, 137.

26. Richard Newman, "The Painting Materials Used by Rogier van der Weyden in St. Luke Drawing the Virgin," in *Rogier van der Weyden: St. Luke Drawing the Virgin; Selected Essays in Context*, ed. Carol Purtle (Turnhout: Brepols, 1997), 135–47; Anna Mazzinghi et al., "2MA-XRF for the Characterisation of the Painting Materials and Technique of the *Entombment of Christ* by Rogier van der Weyden," *Applied Sciences* 11 (2021): 6151; Billinge et al., "The Materials and Technique of Five Paintings."

27. The *Sforza Triptych* by Rogier van der Weyden also contains blue draperies, each modelled with different approaches. Stroo and Syfer-d'Olne, *The Flemish Primitives*, 137–39.

28. He found the modelling in the lower part of the dress appeared too "harsh," whilst in the bodice the ultramarine that was bound in sun-thickened linseed oil was difficult to keep in place, as it tended to drip and level.

29. Joyce Plesters, "Ultramarine Blue, Natural and Artificial," in *Artists Pigments: A Handbook of Their Characteristics*, ed. Ashok Roy (Oxford: Oxford University Press, 1993), 2:37–65; E. René de la Rie et al., "Photo-catalytic Degradation of Binding Media of Ultramarine Blue Containing Paint Layers: A New Perspective on the Phenomenon of 'Ultramarine Disease' in Paintings," *Polymer Degradation and Stability* 144 (2017): 43–52; Kokkie Schnetz et al., "Evidence for the Catalytic Properties of Ultramarine Pigment," *Journal of Cultural Heritage *45 (2020): 25–32.

30. The presence of soot and wax indicated that the damage had been caused by heat from candle flames. The presence of smalt in the retouching led the conservators to believe that the overpaint could have been applied as early as the sixteenth or seventeenth century.

31. The recipes to make the red lakes were from Jo Kirby, Maarten van Bommel, and André Verhecken, *Natural Colorants for Dyeing and Lake Pigments: Practical Recipes and Historical Sources* (London: Archetype, 2014), 91–92, specifically recipes "ML-Std" and "ML-pot-Al." The commercially available red lake used in the reconstruction of the Seated Mary was lac dye, Kremer Pigmente 37202 (see Table 1).

32. E. Melanie Gifford et al., "The Making of a Luxury Image," in *Elegance and Refinement: The Still-Life Painting of Willem van Aelst* (Houston: Museum of Fine Arts; Washington, DC: National Gallery of Art and Skira/Rizzoli, 2012), 88n40. A lake recipe with an excess of potash would have shifted the pH, creating a more purple-red colour. Jo Kirby, Marika Spring, and Catherine Higgitt, "The Technology of Red Lake Pigment Manufacture: Study of the Dyestuff Substrate," *National Gallery Technical Bulletin* 26 (2005): 71–87.

33. For example, Van der Weyden depicts dark purple dresses in the *Crucifixion* triptych, ca. 1443/45, Kunsthistorischesmuseum, Vienna; and in the *Abegg Triptych*, ca. 1445, Abegg-Stiftung, Bern, Switzerland.

34. The different types of lake pigments that were used in the different reconstructions are described in section 3c.

35. Saunders and Kirby, "Light-Induced Colour Changes in Red and Yellow Lake Pigments," 79–97.

36. During the conservation treatment, the choice was made to slightly reinforce some of these glazes to regain the modelling.

37. Kremer Pigmente 36020: Lac Dye, Indian lake, red, made from the secretion of *Coccus Lacta*, also known as *Laccifer Llacca*, precipitated with aluminium hydroxide.

38. Marika Spring, "The Materials of Rogier van der Weyden and His Contemporaries in Context," in Campbell et al., *Rogier van der Weyden in Context*, 93–105.

39. See "Paint layers," Table 1. The lakes used in the reconstructions included lac dye (Kremer Pigmente 36020) and madder lake (Kremer Pigmente 37202). Other madder lakes were prepared by students by following recipes in Kirby, van Bommel, and Verheken, *Natural Colorants for Dyeing and Lake Pigments*, 91–92.

40. Marjolijn Bol, "Gems and Tears: Rogier van der Weyden and the Discovery of the Specular Reflection," unpublished presentation at the symposium *Rogier van der Weyden & the Mauritshuis Lamentation*, Netherlands Institute for Art History (RKD), 21–22 November, 2019.

41. The student applied a mixture of vermilion and lead white to the bottom of each red gem, and a very thin scumble of lead white to the blue gems. The crisp highlights at the upper left were achieved with pure lead white.

42. Miller and Patrick ("Four Weeks of Work for Four Seconds of Fame," 175) seemed to explain this omission when they wrote about how difficult such experiences are to describe.