Young Woman in a Broad-Brimmed Hat

Painting Technique and Restoration

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Caesar van Everdingen's *Young Woman in a Broad-Brimmed Hat* has been undergoing restoration in the Ateliergebouw (Conservation Studios) for the past year, providing the perfect opportunity to examine the artist's technique and the materials he used in the painting.*

Van Everdingen's approach was very different from the sort of emphatic use of materials we see in the work of Rembrandt and others. Van Everdingen painted the *Young Woman in a Broad-Brimmed Hat* at almost exactly the same time Rembrandt made the *Self-Portrait*, now in the Frick Collection in New York – a portrait in which Rembrandt's paint-handling '...went off to lead a life of its own; an amazing vagabond life of daubing, dragging, twisting, dabbing, drizzling, coating, sloshing wet-into-wet, kneading, scraping, building into monumental constructions of pigment that had the mass and worked density of sculpture...'[1] A world away from the elegantly modelled, brilliantly lit figure in crystal-clear colours by Van Everdingen, who did everything in his power to eliminate any trace of the production process. No vigorous daubs in thick browns here, but the ultimate in smooth, fluid brushstrokes. Bright colours, in fresh contrasts, applied in gossamer thin layers.[2]

Detail of fig. 6

Van Everdingen's conception of style differed hugely from that of many of his colleagues. His *Young Woman in a Broad-Brimmed Hat*, like many of his other paintings, seems almost to be the classicistic response to De Lairesse's exhortation to painters not to work '... in the manner of Rembrandt or Lievens, who drag the paint like muck across the canvas; but on the contrary evenly and fluidly, so that your objects appear round and prominent by art alone and not by daubing'.[3] This admonition implies not just another style, but an entirely different way of handling materials from that of these famous contemporaries. In classical painting, form and content were largely governed by the dictates of art theory, but this also went hand in hand with other materials and other methods of creating a work.[4]

Most of the artists who painted in this style, Van Everdingen among them, worked in a series of steps. Van Everdingen drew the outlines of the composition on the second ground layer on the canvas.[5] These outlines were most likely very precise so that essentially they just had to be coloured in. The underdrawing was probably done in a light medium like white chalk on the bluish-grey tinted ground.[6] Scratches were made in the wet paint in two places – around the neck of the young woman's gown and on her

right hand. These scratches served as a general indication of location in the composition. Scratches were also found in the *Allegory of Winter*, another painting by Van Everdingen in the Rijksmuseum collection, but their primary purpose there was to create detail in the hair.

Once the white underdrawing had been sketched in, Van Everdingen embarked on the actual painting. To start with, the figure in her light drapery was put in with a relatively even base colour. This is known as 'laying in'. Next, shadows in a darker colour were added to the drapery that had been laid in – 'deepening'. Finally, her figure was given more volume by painting the lighter areas of the folds in her gown with a mixture of lead white and a little of the laying-in paint or another light paint, or simply just white – 'heightening'. The even areas of colour with which the outlines of the underdrawing were painted are known as dead colouring. This established both the outlines and the base colour for the flesh tones and the folds of the drapery. Gerard de Lairesse stipulated that each individual element of the whole composition had to be given a layer of dead colouring in the initial stage of the work. Each element had to be evenly painted in on the basis of a precise underdrawing. The dead colouring had to approximate at least to some extent the eventual colour: '... the paints, ground thick with drying oil, will be thinned with turpentine, and said canvas or panel will be covered with a soft brush in this wise: the sky blue, and the ground grey or green, more or less dark as your composition and finishing require...'[7] There were, in other words, three important stages in the production of the painting: blocking it in as a sketch over the grey ground – the invention – dead colouring and finishing.

As his dead colouring for the sky, Van Everdingen used the cool grey mixture of lead white and carbon black with a tiny amount of red ochre and umber that he had used for the ground. This grey underlayer formed the basis for a second layer, the actual clear blue of the sky, which was painted with a mixture of lead white, smalt and a little bit of blue verditer.[8] Smalt was a widely-used pigment in the seventeenth century. It is actually nothing more than glass coloured blue with cobalt salts.[9] Its manufacture was relatively simple. The purified cobalt ore was mixed with quartz sand and potash (K_2CO_3). This mixture was then heated until it fused together into molten glass. The red-hot liquid glass was then plunged into cold water so that it shattered into splinters. These blue glass splinters were subsequently ground into a homogeneous pigment powder.

When we examine the surface of the paint with a powerful microscope, we can clearly see that this layer is full of what are actually quite coarse, sharp splinters of glass (fig. 1).[10] They are only just small enough to flow from the brush when they are mixed with oil as a pigment.

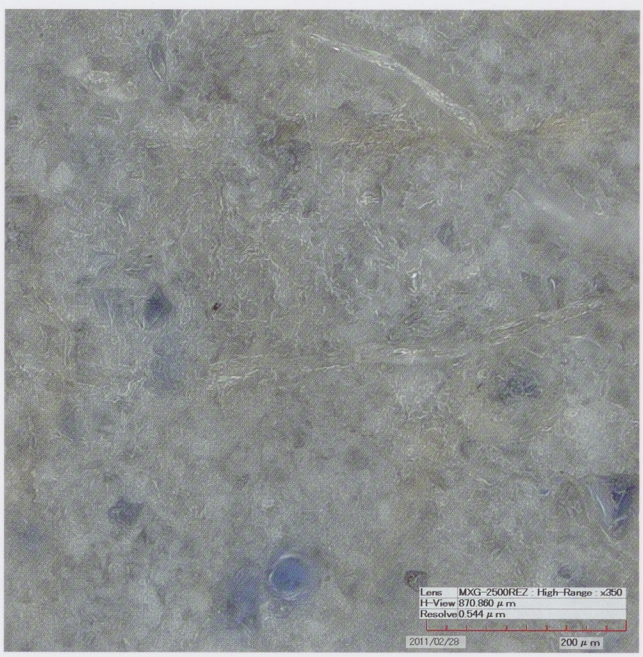

Fig. 1
The surface layer of paint in the sky contains smalt: the jagged, glassy particles are partly still a beautiful blue, partly discoloured (Hirox microscope image, 250x magnification). The round white particles are lead white.

There are also other very fine round blue particles in the paint. These particles are so small that we could not detect them on the surface. We did find them, however, in paint cross-sections under the light microscope. The chemical composition and the optical properties indicated that this was what is known as blue verditer. This is a relatively rare synthetic pigment that is made by reacting copper dissolved in acid with alkaline liquids: soda, potash.[11] The result is a very fine deposit of – depending on the conditions – blue or green copper carbonate. In this case it is a beautiful light blue azurite for the sky.[12]

Although the verditers are mentioned in the historical literature, they are nonetheless relatively unknown. This is probably because the particles are very fine indeed and easily overlooked. The coarse grains of smalt, with the associated problems, are always very much in evidence. The verditers are almost exclusively found in mixtures with other pigments, are quite small and as a rule cause few problems. They have recently become the focus of interest again: verditer has been found in many of the paintings that Van Everdingen and other painters made for the Oranjezaal (the central gallery in the Royal Palace Huis ten Bosch).[13] Applied in a very thin layer, the mixture of smalt and verditers with lead white produced the beautiful bright, slightly translucent blue of a summer sky.

When he came to paint the sky, Van Everdingen did not follow the plan of the dead colouring precisely. He changed his composition as he painted: the trees to the left of the figure were initially placed much higher in the preliminary sketch and the dead colouring. He must have decided that these background elements were much too prominent.[14] Over the years, as a result of saponification of the binding medium, the overpainting has become more transparent, and the initial laying-in has consequently become rather more visible than was originally the intention. This unintended prominence has now been carefully reduced with modest and reversible retouches. A few other changes to the original design, *pentimenti*, were also found (fig. 2). For instance, Van Everdingen placed the outline of the hat half a centimetre lower than he had originally planned. The positions of the light orange sash around the young woman's waist, the neckline on the right, the shoulder on the left, both arms and the right hand also appear to have been shifted slightly.

Fig. 2
The infrared reflectogram reveals the changes (*pentimenti*) Van Everdingen made while he was painting: the trees on the left were originally higher, and the contour of the right arm is narrower than originally planned (image taken with an Osiris camera).

Reflections

The most striking aspect of Van Everdingen's technique is the way he exploits reflections. This can best be explained on the basis of an illustration in the textbook *Cours de Peinture* by the French academician Roger de Piles (1635-1709), a widely-read author in classicist circles (fig. 3).[15] His precise, theoretical approach is in line with the carefully conceived methods of the classicist artists. This illustration in his book shows how a round form can be suggested on a flat surface. It begins with the simple depiction of a single small ball. The painter just has to draw a circle and then paint it a lighter colour on the side where the light falls. A darker shadow tone is then put on the side that is not in the light. The object is already beginning to look somewhat round. On the shadow side the ball is very slightly lighter again exactly where it touches the ground. This is because some of the light that falls on the ground is reflected on to the underside of the ball. This light is thus bounced back on to the shadowed underside of the ball. When it is painted, therefore, the shadow is not filled in all the way to the extreme edge of the drawn circle, but gradually tapers off precisely at the edge. Artists were very well aware of the effect of this reflection in the seventeenth century: '*Weerglans* (reflection) is in fact the rebounding of the light from all lit things, but in art we only use the terms *reflexie* or *weerglans* to refer to the secondary lighting that falls in the shadow.'[16] The three-dimensional impression this reflection creates becomes even more convincing when the shadow that the ball casts on the ground beneath it is also depicted. The shadow cast on the ground is usually darker in tone than the shadow on the ball itself. The effect is reinforced by the contrast that occurs because the reflection makes the ball's own shadow rather lighter at the edges. This interplay of shadow and reflection clearly tells the viewer that there is a spatial connection between the object and its surroundings. This effect works for the depiction of all three-dimensional forms.

Van Everdingen played this game with great skill in the folds of the dress worn by the *Young Woman in a Broad-Brimmed Hat*. Sometimes he made the indirect light of the reflections on the undersides of the folds so powerful that they are almost as bright as the directly lit upper surfaces. Sometimes the folds even light up in places where, according to the rules, there should only be shadow. They look so bright that at times it seems as if the light is emanating from the inside of the fabric and a lamp is shining on the inside of the folds.

He achieved this effect by rendering these cast shadows, intrinsic shadows and reflections not just in light and dark contrast, but in very subtle differences in colour. These differences were barely measurable in our analyses.

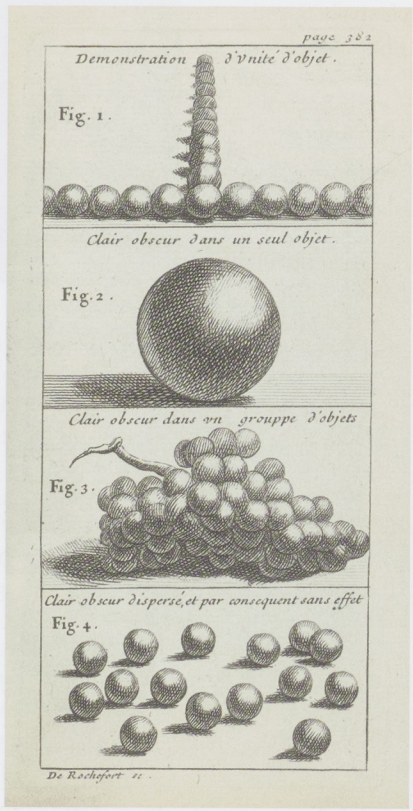

Fig. 3
The use of shadows to render three-dimensional forms. Instruction on p. 382 of Roger de Piles's *Cours de Peinture par Principe*, Paris 1708.

Fig. 4
Detail of shadows and reflections in the right sleeve. The tone of the underpainting for the drapery glimmers through the second layer of paint.

In one highlight there was just the tiniest trace more iron from the ochre that was mixed in than the fraction of tin from the lead-tin yellow that was mixed into the corresponding shadow. The way Van Everdingen set off the warm pink of the reflections against the cool grey of the shadows in which they fall is very evident in the woman's right sleeve. The technique known as scumbling was extremely useful here. Scumbling involves sweeping a brush with slightly dry paint very swiftly over the surface of the canvas. The paint is not applied so that it covers and fills the canvas; instead it touches the surface of the canvas very lightly. As a result, the paint clings like dust to minuscule irregularities in that surface. The underlying dead colouring is not completely covered by this 'veil', so it glimmers through the scumbled paint. We can see in various places in her gown the cool grey tone of the underpainting showing through a reflection painted over it in a much warmer mixture of lead white, a little bit of yellow ochre and a trace of red lake (fig. 4). Given the complexity of all these different shadows and reflections, building them up in one or two layers of paint is remarkably simple. Here and there under the clothes and the flesh tones, the monochrome underpainting can be seen in small voids in the top layer. The paint is usually applied wet-into-wet, with subtle transitions in colour and chiaroscuro. An intermediate tone in brown has been left open here and there in shadows in the flesh tones. The deepest shadows in the dress and the shadow cast by the brim of the young woman's hat on her forehead were put in last.

Fig. 5
The condition of the painting before restoration: a badly yellowed and irregular layer of varnish, a hole in the canvas, a tear in the sky and deformation in the corners of the canvas.

It appears that Van Everdingen concentrated first and foremost on the figure of the woman and initially paid less heed to her surroundings. In painting, artists almost always work from the general to the specific: painters usually worked from the background to the foreground, and the paint of the figures in the foreground very slightly overlapped the paint used in the background. The aim was to prevent the ground showing through at the outlines of the figures. As a rule, therefore, the sky and the landscape would be painted first, and only then would the human figure be placed in it.

In this instance, Van Everdingen tackled things differently. In this painting, the figure was put in first. The young woman's white dress is painted right up to the bottom edge. When it was being finished, however, this edge was left unpainted elsewhere in the painting. There the paint was taken just far enough to fit inside a frame.[17] The sky was clearly painted around the figure, after which – in the final stage – the outlines of the figure were adjusted so that they overlap the sky. In the young lady's neck, an earlier version of the hair that escapes from under the hat has been covered with the blue paint of the sky – which was painted later. The under-

Fig. 6
Young Woman in a Broad-Brimmed Hat during the removal of the varnish.

lying cool grey dead colouring is visible where the layers of paint of the skin and those of the sky do not quite meet. Van Everdingen took this method to extremes. Even the ribbons on her hat were painted first, and only after that were the light blue verditer and smalt mixture of the sky and the soft pink shades of the skin painted around them.

The Restoration

When the painting was purchased it was in reasonably good condition, but this was obscured by a number of unsightly elements. The severely yellowed and irregular layer of varnish, the hole in the canvas at the left breast, the restored tear in the sky on the left and the deformations in the corners of the canvas were the most noticeable (fig. 5). Complete restoration was essential to conserve the painting for future generations and so that the composition could be seen in all its splendour.

To begin with, the thick layer of surface dirt was removed from both the front and the back, where an unprecedented amount of dust, pieces of straw and other undesirable detritus was found between the canvas and the stretcher. The next step was the removal of the old, yellowed varnish with organic solvents.[18] The effect was immediate: the brightness of the

Fig. 7
Young Woman in a Broad-Brimmed Hat after the removal of the varnish: the brightness of the colours is revealed, but so too are the areas of damage and abrasion.

colours and the three-dimensionality of the composition reemerged because subtle colour nuances and transitions from dark to light (particularly in the white dress and the face) could be seen more clearly (figs. 6 and 7).

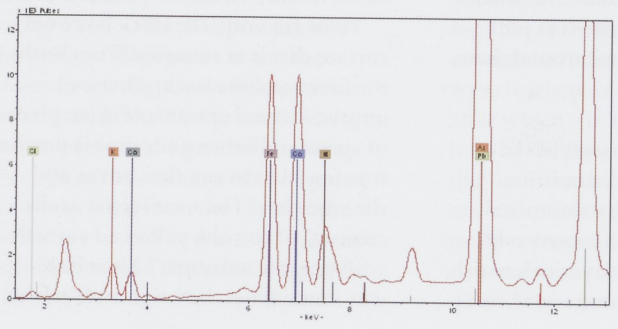

Fig. 8
X-ray fluorescence spectrum (XRF) shows the presence of large quantities of the element potassium (the high K peak in the spectrum), the main component of smalt.

The removal of the varnish also, however, revealed the extent of the damage, for instance in the blue paint of the sky, which contains smalt. On analysis, it was found that the smalt Van Everdingen had used contained large quantities of potash (fig. 8).[19] Because potash can undergo a reaction with the oil used as the binding medium, it often causes conservation problems later. The paint in this case has become increasingly sparser and 'leaner', and the particles of glass now stick out like reflective sparkles from the meagre, leached out surface of the paint (fig. 9). This effect is very evident in raking light. In this light the sound

paint of the young woman and her hat stands out in sharp contrast to the matt paint of the light blue around her (fig. 10). And it is not only that the paint becomes ever leaner over time, different forms of discolouration also occur.[20] The indissoluble yellowish discolouration in the blue of the sky in the *Young Woman in a Broad-Brimmed Hat* was probably also caused by a chemical reaction between the smalt and the binding medium.[21] It also seems to occur in other paintings by Van Everdingen. The topmost original layer of blue paint in his *Grape Harvest* in the Frans Hals Museum in Haarlem seems to have discoloured in a similar fashion.[22] His *Lycurgus Demonstrates the Benefits of Education* in the Stedelijk Museum Alkmaar has a blue sky that appears to be damaged in the same way.

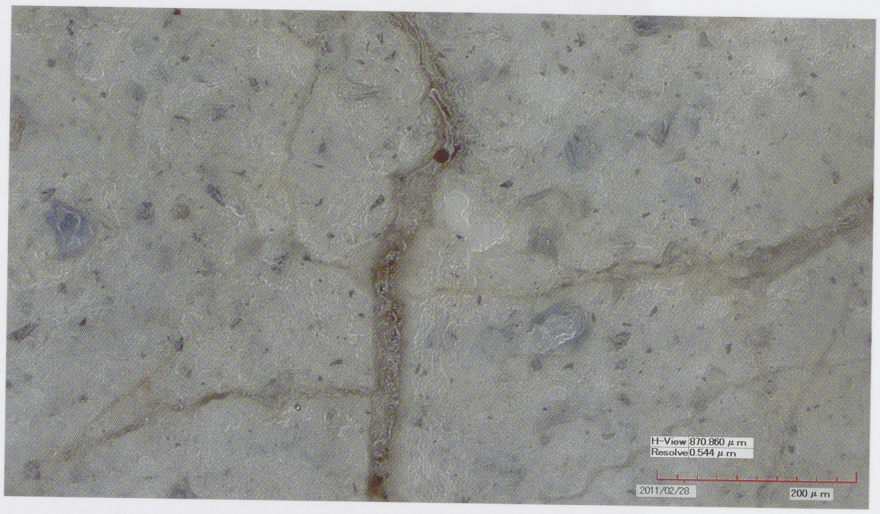

Fig. 9
Smalt splinters are lying almost loose on the lean paint (Hirox microscope image, 250x magnification).

Fig. 10
A striking matt effect in the paint in the sky was very evident in raking light. Here the painting is without varnish, during restoration.

Not only were parts of the sky marred by yellowish spotting, there was also abrasion in the greater part of the sky. This could be seen in the sky as dark flecks: the grey ground had become visible as the paint was abraded from the peaks of the canvas. As we have already seen, the paint and ground were applied extremely thinly. Over the years, the volume of a completely dry oil paint decreases. The paint 'sinks in'. This makes the texture of the linen weave rather more evident than it was originally. Another factor that contributes to the formation of this 'weave-imprint' is the wax and resin lining applied to this painting in the past; because too much heat and pressure were used, the texture of the canvas has been 'impressed' into the paint layer.[23] The unevennesses in the canvas with its many knots, lumps and bumps appeared on the surface, and these superficial irregularities are, of course, the most susceptible to abrasion (fig. 11). The paint in the face and neck – particularly the thin shadow passages – was also abraded. The white paint of the dress was in relatively good condition because it was lead white, a pigment that is not readily scuffed by overcleaning. Small voids, down to the canvas, were found in the forehead, in the sky around the edges of the pale purplish-red ribbon, in the left sleeve and at the bottom of the white garment.

Fig. 11
Abrasion on the surface of the paint in the sky (visible as dark specks because the dark ground has become visible here) on the peaks of the weave of the canvas.

After the old varnish and part of the overpainting had been removed, the conservation of the support was carried out: the deformed corners were planed and the hole in the canvas was closed. This was achieved by inserting a small piece of synthetic canvas, slightly larger than the hole itself and impregnated with a synthetic, flexible glue, between the lining canvas and the original canvas, where the adhesion was already poor around the hole. This immediately restored the adhesion between the lining canvas and the original canvas around the hole.
To bring the void back 'in register', a filling (likewise made of a synthetic, reversible material) was applied on both the front and the back (to make good the loss of a piece of the wax lining at this spot). Silicones were used to make a mould of the original surface of the paint, and this was used to 'imprint' the original texture into the filling on the front.

Once the support had been treated, an intermediate varnish made from a synthetic resin was applied in order to obtain good saturation for retouching and to act as a buffer between the original paint layer and the restorer's additions.[24] After this the small voids in the face and neck, along the purplish-red ribbon in the sky and here and there in the white dress were filled and retouched. After the abrasion in the sky had been 'touched in', the yellowish spots, particularly at the top of the sky, were more conspicuous. Efforts were made to 'suppress' this effect with retouches, continuing until the eye was no longer distracted from the figure in the foreground. We have to accept that it will never be possible to see the sky in its original state, but after retouching it does serve much better as a background for the beautiful young lady, who looks almost as though she is about to step out of the painting.

Fig. 12
The painting after restoration.

The less obvious abrasion – at least from a distance – in the dark shadows in the face, neck and dress was retouched as, of course, were the larger and smaller voids that had been filled and the repaired tear on the left above the cloud. The *pentimento* of the tree on the left was also touched in because it had become clearly visible through the paint of the horizon above it. Once the retouching process was complete, a final varnish was applied to seal the retouches, integrate them better optically with the original and create an attractive satin finish. Finally, the painting was put into a frame recently adapted from a seventeenth-century model (c. 1640).[25]

Result

After restoration (fig. 12), Van Everdingen's subtle painting manner in the *Young Woman in a Broad-Brimmed Hat* can now be experienced again in all its glory: now that the delicate nuances in colour and the effects of light and shade have been revealed, the superb expression of surface texture in the dress and hat appears to full effect. The three-dimensionality, so beautifully achieved in the flesh tones, has been restored. And, lastly, the brightness and clarity of the colours so typical of this painting can be seen again, so that it can resume its place as a true highlight of seventeenth-century Dutch art.

NOTES

* With thanks to the Irma Theodora Fonds (held by the Rijksmuseum Fonds) for making the restoration possible. We owe our colleagues in the studio an immense debt of gratitude. Gwen Tauber was particularly generous in providing much of her information for the catalogue raisonné on other paintings by Van Everdingen. Laurent Sozzani contributed a great deal of information derived from his restoration in 1991-92 of *Allegory of Winter*. Mireille te Marvelde provided access to the research material on the *Grape Harvest* in the Frans Hals Museum.

1 S. Schama, *Rembrandt's Eyes*, New York/London 1999, p. 620.

2 The fine weave of the canvas made this possible. The warp of the canvas (14.5 threads/cm) runs horizontally, the weft (14.1) is vertical. The pattern of the weave, the absorption of the ground layer, and the radio-absorbent layers of paint were particularly visible in the x-radiographs (Balteau, 40kV, 4.8mA, 18 sec. 100cm, Agfa Structurix D7 films). The statistics of the different weaves are described in an internal report by R. and D. Johnson. There is cusping (visible stretching marks) roughly every 10 cm, corresponding with the original stretching with cords in the stretcher. Although the weave is fine, the canvas is quite irregular with numerous knots and lumps. The support differs from that used in the *Allegory of Winter* (80.5 x 97 cm), which is painted on a much coarser canvas (13.1 horizontal, 10.1 vertical). There too we see pronounced cusping every 9 to 11 centimetres, with remnants of the original cords used for stretching.

3 '... op zyn Rembrands of Lievensz., dat het sap gelyk drek langs het stuk neer loope; maar (contrary) gelyk en mals, dat uwe voorwerpen alleen door de konst rond en verheeven schijnen en niet door kladdery'. Gerard de Lairesse, *Groot Schilderboeck, waar in de schilderkonst in al haar deelen grondig werd onderweezen, ook door redeneeringen en prentverbeeldingen verklaard, met voorbeelden uit de beste konststukken der oude en nieuwe puikschilderen bevestigd: en derzelver wel- en misstand aangeweezen*, 2 vols., Amsterdam 1707, vol. 1.

4 The changes that took place with the rise of classicism in painting have thus far only been interpreted in stylistic terms. The technical aspects of these important art historical developments have very rarely been the subject of research. An honourable exception to this is the study by Margriet van Eikema Hommes and Lidwien Speleers, 'Nine Muses in the Oranjezaal: the painting methods of Caesar van Van Everdingen and Jan Lievens confronted', *Studying Old Master Paintings; Technology and Practice*, The National Gallery Technical Bulletin 30th Anniversary Conference Postprints, M. Spring (ed.), London 2011, pp. 157-64.

5 There are two ground layers. The first – red ochre, black, lead white and other earth pigments – was just enough to fill the unevennesses in the weave of the canvas. The second layer, a bluish grey, is thicker and contains lead white, quite a few black particles, and some red and yellow ochres. It is not clear how these layers were applied since there are no visible signs of a knife or brushstroke. The structure of the layers of paint and ground was studied in microscopic paint cross-sections with a Leica DMLM microscope (magnifications 50x, 100x, 200x, 500x and 1000x). Microscopic examination in direct light (bright field) and in ultraviolet fluorescence (filter cube BL/V10 C105) was done with the aid of a digital Leica DFC 420 camera.

6 Making an underdrawing with white chalk over a tinted ground or imprimatura (priming layer) was not uncommon in the seventeenth century. The refractive indices of the chalk and the binding medium are very similar. As a result, any traces of chalk remaining in the paint are actually transparent. It proved impossible to make any clear underdrawing in carbon black visible with infrared reflectography (IRR). Only a few vague outlines on the left along the neckline and the left arm could be made out in the reflectogram. IRR was done with an Osiris scanning InGaAs camera, with a 16 x 16 tile system obtained with a 512 x 512 focal plane array, with a sensitivity to just beyond 1700nm. Visible light was filtered out with an 875nm infrared filter.

7 '...de verwen, met droogenden olie dik gewreven, zal men met terpentynolie dun mengen, en met een zacht kwastje het gemelde doek of paneel op deze wyze overstryken; de lucht blaauw, en de grond graauw of groen, min of meer donker, na maate dat uwe Ordinantie en Aftekening zulks vereischt...' De Lairesse, op. cit. (note 3), vol. 1, p. 331.

8 Element analyses were carried out in a non-

destructive manner directly on the surface of the painting using a Bruker Artax μ-XRF spectrometer (40kV, 500μA, 120 sec., Mo-anode, 0.090μm capillary lens, over 50keV). Smalt is generally easily identified by the presence of Si, K, Co, Ni and As.

9 In this glass matrix the covalently bound Co is responsible for the blue colour. A tiny quantity of the Co in this complex is bonded to four oxygen ions, which in turn are bonded to Si.

10 These observations were made with the Hirox Digital Microscope KH-7700, using the high resolution MXG-2500 lens.

11 P. Mactaggart and A. Mactaggart, 'Refiners' verditers', *Studies in Conservation*, 25 (1980), pp. 37-45.

12 The peak for Cu in the XRF spectra of the blue sky was an early indication that azurite could be present. This was confirmed with the aid of polarized light microscopy (PLM): pigment dispersions on microscope slides in Melt-mount (N_D = 1.662) were studied in ordinary and polarized transmitted light with a Zeiss Standart 07 microscope.

13 A. van Loon and L. Speleers, 'The use of blue and green verditer in green colours in the mid-seventeenth-century paintings of the Oranjezaal, the Hague', *Studying Old Master Paintings; Technology and Practice*, op. cit. (note 4), pp. 260-68.

14 A combination of smalt and verditer was also used for the exceptionally well preserved green of the trees in the background. In this case it is green verditer. This combination is not uncommon. A. Wallert and J. Dik, 'The scientific examination of a seventeenth-century masterpiece', *Zeitschrift für Kunsttechnologie und Konservierung*, 21 (2007), pp. 38-51.

15 R. de Piles, *Cours de Peinture par Principe, composé par Mr. De Piles*, Paris 1708, p. 382.

16 'Weerglans is wel eygentlijk een weder-omkaetsing van het licht van alle verlichte dingen, maar in de konst noemen wy maer alleen reflexie of weerglans, de tweede verlichting, die in de schaduwe valt.' S. van Hoogstraten, *Inlydinge tot de Hooge Schoole der Schilderkonst: Anders de Zichtbare Werelt*, Rotterdam 1678, p. 262.

17 This unpainted edge was painted over much later during a restoration, probably to get the painting to fit into a larger frame or surround.

18 Manja Zeldenrust, head of the paintings restoration studio, carried out the preliminary investigation and removed the varnish. Erika Smeenk-Metz then continued the treatment.

19 Potash was an essential component in the historical manufacturing process for smalt. It was added to lower the melting point of the glass. This meant that the temperatures needed to melt the other ingredients – quartz sand, calcite and cobalt ore – to form blue glass did not have to be so high and the pigment could be produced more cheaply.

20 Recent research has demonstrated that the potash not only produces soluble soaps, it also reacts with anions from the environment to form nasty insoluble crusts on the surface of the paint. These crusts are composed of potassium salts and oxalates, which appear as yellowish discolouration on top of the paint. See M. Spring, C. Higgitt and D. Saunders, 'Investigation of Pigment-Medium Interaction Processes in Oil Paint containing Degraded Smalt', *National Gallery Technical Bulletin*, 26 (2005), pp. 56-70. Also L. Robinet, M. Spring, S. Pagès-Camagna, D. Vantelon and N. Trcera, 'Investigation of the Discoloration of Smalt Pigment in Historic Paintings by Micro-X-ray Absoption Spectroscopy at the Co K-edge', *Analytical Chemistry*, (May 2011).

21 This is the subject of ongoing research. The precise nature of the yellowish layer on the blue is not yet known. Analysis of a very small paint sample with Fourier transform infrared spectroscopy (FTIR) showed absorptions that could be interpreted as amide I and amide II wavelengths. This would indicate proteinaceous substances.

22 It is possible that an earlier restorer took the yellowish layer on that painting to be a layer of varnish that had turned brown and tried to remove it. Mireille te Marvelde and Lidwien Speleers, 'De Wijnoogst van Caesar van Van Everdingen', *CR* 1 (2006), pp. 20-25, 22.

23 The painting has been restored several times in the past, as we can tell from the lining (a process that involves reinforcing the back of the original canvas with a support canvas, in this case using a mixture of wax and resin to secure it), the repaired tear in the sky on the left and the presence of very thin, barely soluble overpaintings in various places in the composition (clouds, horizon) and on the edges. These treatments were not documented, so we have no idea when they were done.

24 As far as possible reversible materials are used in a restoration so that they can easily be removed in the future if needs be.

25 This frame was already in the Rijksmuseum's collection and was reduced in size and adapted for the *Young Woman in a Broad-Brimmed Hat* by frame conservator Hubert Baija and furniture restorer Iskander Breebaart. The model is after a flat frame with a large ogee (ebony) dating from 1639. See P. J. J. van Thiel and C. J. de Bruyn Kops, *Prijst de Lijst*, The Hague 1984, fig. E4, pp. 56 and 128.