Paintings in the laboratory: scientific examination for art history and conservation

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Very little technical information concerning paintings attributed to Judith Leyster has been published prior to this catalogue, which has involved systematic technical examination of 16 oil paintings, some of which are no longer accepted as by Leyster. Among these are six signed works (four of them dated) which serve as key points of reference in comparing examination results. Although surviving documents offer little definite information concerning Leyster's training and the practices of her studio, we hope that this first technical examination of some of her paintings may provide fresh insight into these issues.

The first of our goals is to determine whether among the heterogeneous styles of the paintings examined — which has been explained as eclectic — any common characteristics may be considered hallmarks of Leyster's painting technique. Second, we hope to discover whether any similarities in her painting technique would support the proposition that she apprenticed to Frans Hals around 1629. Up until now, the close affinity in style and subject matter of some of her paintings has supported this suggestion. Results of an earlier technical study of paintings attributed to Frans Hals provide important comparative material. Technical studies of other painters thought to have taught or influenced Leyster have not taken place on this scale and are beyond the scope of this project, although some information is available. Finally, we hope to augment current knowledge concerning the studio practices of painters in Haarlem in general and to provide a foundation for continued research.

The Painting Support
Leyster's accepted oeuvre consists of about twenty oil paintings, all of which appear to date between 1629 and about 1636, when she was still single. This catalogue includes fifteen of those paintings, seven of which are on wood panel and eight on canvas. This is roughly double the proportion of paintings on wood panel found in the known production of Frans Hals from the same period (13 out of 47 paintings). Leyster's frequent choice of wood panel as a painting support, as indicated by her known paintings, counters a general tendency for canvas to supersedede wood as the dominant support in seventeenth-century Netherlandish painting. The largest of Leyster's panels, Carousing Couple (cat.4) measures 68 x 55 cm. For works larger than this, Leyster turned to canvas as a support. The moderate size of her largest known canvas, Jolly Toper (cat.2), which has been trimmed around the edges and now measures 88.0 x 83.7 cm, confirms Leyster's predilection for painting on a modest scale.

There are several likely reasons for Leyster's frequent choice of wood panel for her painting supports. First, canvas gained popularity only gradually throughout the seventeenth century, and as the traditional painting support, wood panel would have been readily available. The small panels used by Leyster could be simply made, mostly from a single plank (see below). Second, the potential advantage of canvas as a lightweight material that could be easily rolled up for transport would not have been important for the small-scale paintings, mainly genre pieces, in which Leyster specialized. It appears that she never executed commissions for large-scale portraits or group portraits on canvas to compare with those of other Haarlem artists, such as her purported teachers, Frans Hals or the De Grebbers. The production of her husband, Jan Miense Molenaer, provides a closer comparison with Leyster's specialization in small-scale works. In general the 1668 postmortem inventory of Molenaer's effects specifies far more panels than canvases used as painting supports, although two entries do record 'large' and 'extraordinarily large' canvases.
Wood Panel

This study involves technical examination of six rectangular paintings on wood panel, whose present dimensions are listed below.9

<table>
<thead>
<tr>
<th>CAT.NO.</th>
<th>HEIGHT (CM)</th>
<th>WIDTH (CM)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Serenade</td>
<td>45.2</td>
<td>32.5</td>
</tr>
<tr>
<td>8 Man Offering Money to a Young Woman</td>
<td>39.7</td>
<td>24.1</td>
</tr>
<tr>
<td>9 A Game of Tric-Trac</td>
<td>40.6</td>
<td>31.0</td>
</tr>
<tr>
<td>13 Children with a Cat and an Eel</td>
<td>58.5-59.5</td>
<td>48.0-48.7</td>
</tr>
<tr>
<td>14 Portrait of a Woman</td>
<td>53.2</td>
<td>41.4</td>
</tr>
<tr>
<td>40 The Rommel-Pot Player</td>
<td>39.0</td>
<td>30.8</td>
</tr>
</tbody>
</table>

Five of the panels examined each comprise a single plank. The smallest plank width occurs in the virtually intact Man Offering Money to a Young Woman (cat.8) and measures 24.1 cm. The widest plank used occurs in Portrait of a Woman (cat.14), which could originally have measured as much as 49 cm, unusually wide. Leyster's larger painting on panel, Children with a Cat and an Eel (cat.13, fig.42, 44), now measures up to 48.7 cm wide and shows a more complex construction. In this case, two vertical planks have been butt-joined (straight edge against straight edge) and glued. As was usual practice, weaker sapwood portions of the planks (which have been prone to woodworm attack) have been joined along the inside.10

Seventeenth-century sources suggest that painters could obtain wood panels made by specialist cabinet makers and joiners, probably with standard height and width dimensions that corresponded to standard-size frames.11 An entry in the postmortem inventory of Molenaer's effects records twenty-six single piece panels, all of the same size.12 Although the concept of uniformity in the seventeenth century was less exact than it is today, taken literally this would suggest a reserve of standard format panels. Since existing paintings on wood panel by some other seventeenth-century painters can be characterized by a system of standard sizes, we wondered whether this would apply to Leyster's production. The present dimensions of six vertical rectangular panel paintings attributed to Leyster are given in fig.39. The small sample of paintings considered, as well as the fact that examinations show that some have undergone slight later changes in format (see note 10), limit the conclusions that can be made. However, one can observe a range in the proportion of height to width in the panels, from 1.32:1 to 1.39:1.13 Possibly manufacture of the smallest panels, which comprise a single plank, was dictated by the size of the planks delivered by the sawmill rather than by predetermined sizes. The width of a plank was governed by the diameter of the tree trunk, which was cut for minimum wastage.14

Seventeenth-century traders' inventories grouped paintings under categories of size, named according to Dutch coins (e.g. guldens or stuivers), monetary values (e.g., stooters, one stooter being equivalent to two and a half stuivers), or subject matter that had a particular format (e.g., salvators). Attempts have been made to rediscover the approximate formats intended by this seventeenth-century nomenclature.15 All the rectangular paintings on wood panel attributed to Leyster can presumably be associated with the smallest categories of paintings named in seventeenth-century inventories, from the salvator down to the stooter. It has been suggested that Children with a Cat and an Eel (cat.13) could be associated with a salvator format measuring about 62 x 49 cm, though a possible reduction in size of the panel should be taken into account.16 On the other hand, the smaller Rommel-Pot Player (cat.40), which is now no longer thought to be by Leyster, can presumably be compared to two other small Rommel-Pot Players recorded in seventeenth-century inventories, one

FIG.39 Wood panels

Upright rectangular format

Catalogue no.
The painting support is a tangentially sawn plank. An undulating pattern of the wood grain is made visible by the x-ray absorbent properties of the lead-white based ground. Only three of the six panels examined (A Game of Tric-Trac, Portrait of a Woman, The Rommel-Pot Player, cats. 9, 14, 40) retain their original thickness. In raking light (light from the side which skims the surface), marks from the tools used to work the timber can be observed on the reverse of the planks. The other three panel supports examined, Serenade, Man Offering Money to a Young Woman and Children with a Cat and an Eel (cats. 1, 8, 13) have been shaved down to a few millimeters thickness, as part of later restoration treatments intended to reduce warping.

As with most Netherlandish paintings of the period, oak appears to have been used for the wood supports of the paintings examined. Although indigenous to Holland, oak was imported from the Hansa towns on the Baltic. A robust wood, oak of about one centimeter thick provided sufficient strength. Usually planks were cut radially from the tree, perpendicular to the annual growth rings, in order to reduce the tendency to warp with changes in humidity. This is the case for A Game of Tric-Trac and The Rommel-Pot Player (cats. 9, 40); in the latter it results in a natural wedge shape tapering slightly toward the left side (corresponding to the inside of the tree) where less beveling is required. The plank used in Portrait of a Woman (cat. 14), in contrast, has been cut tangentially, parallel to the annual growth rings, close to the heart of the tree. A characteristic undulating pattern of the wood grain results, clearly visible in an x-ray (fig. 40).

### Canvas

This study involves technical examination of eight paintings on canvas, which have all been lined (adhered to a backing canvas) at a later date. The present maximum edge-to-edge dimensions of the original canvases are listed below.

<table>
<thead>
<tr>
<th>CAT. NO.</th>
<th>HEIGHT (CM)</th>
<th>WIDTH (CM)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>88</td>
<td>83.7</td>
</tr>
<tr>
<td>5</td>
<td>74.4</td>
<td>62.9</td>
</tr>
<tr>
<td>6</td>
<td>88.7</td>
<td>73.2</td>
</tr>
<tr>
<td>7</td>
<td>74.4</td>
<td>65.3</td>
</tr>
<tr>
<td>38</td>
<td>75.8</td>
<td>69.0</td>
</tr>
<tr>
<td>39</td>
<td>67.9</td>
<td>58.1</td>
</tr>
<tr>
<td>41</td>
<td>61.2</td>
<td>49.0</td>
</tr>
<tr>
<td>42</td>
<td>76.2</td>
<td>66.4</td>
</tr>
</tbody>
</table>

For their painting supports, seventeenth-century Netherlandish painters made use of fabrics woven for other purposes, especially linen, which was commonly used for clothing and sails. Haarlem was an important center for specialized processing of linen, such as bleaching threads and damask weaving. Coarser types of linen were probably imported. Ghent was an important export center for coarse linen in the early seventeenth century and Spain supplied a certain coarse grade of linen used for sails. Linen canvas was available in standard widths, associated with particular grades, which were sold in the appropriate category of market. The standard widths of canvas strips available were related to standard units of measurement, like the Brabant el, which measured about 69.5 cm. Standard widths...
could be based on a fourth, an eighth, or even a sixteenth of an el.\textsuperscript{20} With the exception of The Last Drop (cat.6), the works examined are painted on a single strip of canvas. One can generally assume that in order to avoid wastage, the smallest dimension of the painting support, here the width, corresponds to the entire width of the canvas strip used. In this case, this could not be confirmed since the complete absence of selvages suggests that none of the canvases examined are completely intact. Nonetheless, allowing for slight changes in format, one might therefore suggest that three paintings (\textit{Merry Company}, \textit{Self-Portrait}, and Violinist, cats.5, 7, 42) have been painted on strips of canvas which are one Brabant el (about 69.5 cm) wide. Only Jolly Toper (cat.2) shows a strip width greater than one el; it measures almost 85 cm, or one and one quarter el. This is the equivalent of a standard width of canvas called a zeildoek (sailcloth), used in the measurement of sails.\textsuperscript{21}

An exception is the canvas support of The Last Drop (cat.6), which is made up of several pieces. The X-ray shows that the main canvas, which measures up to 81.4 cm high and 67.9 cm wide, has been enlarged by three small strips of a different grade (thread density) of canvas attached along the top, left, and bottom sides. The main canvas appears virtually intact, showing pronounced cusping on all four sides and evidence of the original rolled stretching edges along the three sides with additions, suggesting that a one el wide strip was used. (See below concerning stretching canvas). Examination of paint layers suggests that the strips added to enlarge the composition were attached after the main painting had been executed and that they are very early, if not original additions by Leyster. In its original format, the design would have appeared incomplete, with part of the head and back of the left figure cut off at the edge and the toe and pipe of the standing figure so close to the edge that they would probably have been hidden by the inner edge of the frame. An early copy of the painting shows the composition in its extended form.\textsuperscript{22}

Although sources suggest a relation between the width and the grade of canvas strips sold on the market, the present examination did not reveal a consistent relationship in the painting supports examined. Listed below are average thread densities of the canvas supports measured from available x-rays or directly on the paintings (cats.38, 39, 42).\textsuperscript{23}

<table>
<thead>
<tr>
<th>CAT.NO.</th>
<th>VERTICAL THREADS PER CM</th>
<th>HORIZONTAL THREADS PER CM</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>Jolly Toper</td>
<td>13</td>
</tr>
<tr>
<td>6</td>
<td>The Last Drop</td>
<td>14</td>
</tr>
<tr>
<td>7</td>
<td>Self-Portrait</td>
<td>14</td>
</tr>
<tr>
<td>38</td>
<td>Laughing Youth with a Wine Glass</td>
<td>10</td>
</tr>
<tr>
<td>39</td>
<td>The Jester</td>
<td>11.5</td>
</tr>
<tr>
<td>42</td>
<td>Violinist</td>
<td>12</td>
</tr>
</tbody>
</table>

The diversity of linen types available to artists at the time is reflected even in this select group of works. For example, three canvases, which were all presumably one Brabant el wide, all show different thread densities (the main canvas of The Last Drop, Self-Portrait, and Violinist; cats.6, 7, 42).\textsuperscript{24} The rather fine thread density measured in Laughing Youth with a Wine Glass (cat.38) cannot be used as a criterion to link this painting with the Utrecht School, as similar grades of canvas have been encountered in paintings made in both Utrecht and Haarlem during this period.\textsuperscript{25}

Only three of the canvases examined are securely attributed to Leyster in this volume; the monogrammed canvases of Jolly Toper and The Last Drop and her Self-Portrait (cats.2, 6, and 7). The thread densities measured in these paintings all fall within the middle range, but a wider survey is required to draw valid conclusions. One need not expect to find that the painter preferred to use a particular type of canvas. Studies of canvas supports used by the workshops of Frans Hals and Rembrandt have shown a broad range of thread densities, even in closely dated paintings. These cases suggest that it was studio practice to draw on the wide choice of available canvas grades, rather than to stock only a few bolts. Contemporary recipes for priming suggest that its function was to provide a smooth surface on which to paint, regardless of the grade of canvas used.\textsuperscript{26}

Presumably, Leyster’s canvases were laced onto a wooden frame or strainer for preparation as a painting support, as was usual practice (see fig.27 and cat.33). The canvas edge would have been reinforced by sewing it around a cord, in order to prevent a stretching cord laced through at intervals from pulling through. Only the main canvas of The Last Drop (cat.6) shows evidence of the original stretching edges, which in other paintings examined were cut off during later lining treatment. The canvas was drawn into peaks at the points of stretching and the resulting scalloped deformation,
known as cusping, was fixed by the application of size (animal glue) and ground layers. Measurements of the cusping span (the distance between scallop peaks) in the paintings examined suggest that the stretching cord was laced through the canvas edge at regular intervals ranging from 7 to 8 cm.27

The Ground Layer(s)

Panel

This study of ground layers applied to wood panel involves six paintings, of which three are monogrammed and dated (Serenade, Man Offering Money to a Young Woman, and Portrait of a Woman; cats.1, 8, 14) and one signed (Children with a Cat and an Eel; cat.13). Tiny paint samples could be removed from the paintings for analysis (see fig.41).

Only two works show the traditional method of priming a panel that one would expect in the seventeenth century, A Game of Tric-Trac (cat.9 and fig.42A) and the signed Children with a Cat and an Eel (cat.13 and fig.42B). In his notes on painting technique compiled from 1620 onward, T. T. de Mayerne describes this traditional method of priming panel using chalk bound in glue with an imprimatura (a thin and slightly colored oil paint layer) applied on top to seal the absorbent chalk ground.28 The chalk ground visible in the paint samples from these two paintings is very thin, barely covering the grain of the wood.

On the other hand, the three monogrammed and dated works have been prepared with a lead-white based paint, tinted by the addition of a little ochre or umber and also some black pigment in Serenade and Man Offering Money to a Young Woman (cats.1, 8

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**Ground Layers**

<table>
<thead>
<tr>
<th>CAT. NO.</th>
<th>TITLE</th>
<th>DATE</th>
<th>CANVAS</th>
<th>COMPOSITION</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Serenade</td>
<td>1629</td>
<td>P</td>
<td>lead white, umber, very little fine black</td>
</tr>
<tr>
<td>2</td>
<td>Jolly Toper</td>
<td>1629</td>
<td>C</td>
<td>100 μm thick; lead white, very little fine brown ochre or umber</td>
</tr>
<tr>
<td>6</td>
<td>The Last Drop</td>
<td></td>
<td>C</td>
<td>&gt;60 μm thick; lead white, brown ochre or umber, fine black</td>
</tr>
<tr>
<td>8</td>
<td>Man Offering Money to a Young Woman</td>
<td>1631</td>
<td>P</td>
<td>Two layers, &gt;40 μm thick; lead white, ochre and carbon black. Bottom layer whitish, top one grayish</td>
</tr>
<tr>
<td>9</td>
<td>A Game of Tric-Trac</td>
<td></td>
<td>P</td>
<td>two layers: i) chalk</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>ii) pinkish imprimatura; lead white, umber, a little red ochre</td>
</tr>
<tr>
<td>13</td>
<td>Children with a Cat and an Eel</td>
<td></td>
<td>P</td>
<td>two layers: i) chalk</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>ii) pinkish imprimatura; lead white, chalk, red ochre</td>
</tr>
<tr>
<td>14</td>
<td>Portrait of a Woman</td>
<td>1635</td>
<td>P</td>
<td>lead white, a little ochre or umber</td>
</tr>
<tr>
<td>37</td>
<td>Laughing Youth with a Wine Glass</td>
<td>1635</td>
<td>C</td>
<td>double ground</td>
</tr>
<tr>
<td>38</td>
<td>The Jester</td>
<td></td>
<td>C</td>
<td>i) 130-240 μm thick; fine red ochre</td>
</tr>
<tr>
<td>39</td>
<td>The Rommel-Pot Player</td>
<td></td>
<td>P</td>
<td>ii) 0-45 μm thick; lead white, fine (probably charcoal) black</td>
</tr>
<tr>
<td>40</td>
<td>Standing Cavalier</td>
<td></td>
<td>C</td>
<td>80 μm thick; lead white; a little ochre or umber</td>
</tr>
<tr>
<td>41</td>
<td>Violinist</td>
<td></td>
<td>C</td>
<td>lead white, fine brown ochre or umber</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>two layers</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>i) chalk, a little lead white, umber</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>ii) lead white, a little ochre, very little black</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>&gt;40 μm thick; lead white, very little umber</td>
</tr>
</tbody>
</table>
The Rommel-Pot Player (cat. 40 and fig. 42c) shows a similar ground. These presumably oil-based grounds are more than twice the thickness of the oil imprimaturas applied over the chalk grounds in A Game of Tric-Trac and Children with a Cat and an Eel (cats. 9, 13). This makes it unlikely that chalk grounds are present in these four paintings but they are simply too thin to be detected in the paint cross sections. Presumably the panels have been sized with glue, without the addition of chalk, in order to ensure good adhesion of the ground and paint layers to the panel. De Mayerne provides a recipe for the direct application of an oil ground to fill the pores of a panel sized with glue only, a procedure that he personally preferred to the traditional method of priming.  

Our previous study suggests that Frans Hals, like Leyster, seems to have followed the advice of De Mayerne in applying an oil priming to wood panel.  

Hals’s and Leyster’s practice differs from that of Rembrandt’s workshop, where a thin light ochreous imprimatura applied over a chalk ground appears to have been the rule. Recent examination of Molenaer’s series of The Five Senses (cat. 36) has also revealed that the panels are primed using a thin ochreous imprimatura on a chalk ground. One might wonder whether the introduction of oil ground applied to panel in paintings both by Leyster and by Hals was inspired by the increasing popularity of canvas prepared with an oil ground among Dutch artists throughout the seventeenth century. This is not supported by a chronological relation, however, and, indeed, the opposite seems true. Whereas the early panels have oil grounds, chalk grounds with an imprimatura occur from about 1630 onward. The appearance of both types of priming as a painting surface must have been similar so that this would not have been a consideration in choosing one over the other. Possibly the size of the panel was a deciding factor, as the largest paintings on wood panel possess a chalk ground.

Canvas  

This study of ground layers applied to canvas painting supports involves seven paintings, of which one, The Last Drop (cat. 6), is monogrammed, and another, Jolly Toper (cat. 2), is monogrammed and dated. Tiny paint samples were removed from these paintings for analysis.  

In nearly all the paintings on canvas examined, the ground appears light, white to light ochre or pink in color. The main constituent is lead white, mixed withumber or ochre and sometimes very little bright red ochre or black pigment. The very early, if not original, additions in The Last Drop (cat. 6) have been primed separately from the main canvas. The ground on the additions is a darker mixture of the same typical pigments (lead white, red and brown ochre or umber) in use in the seventeenth century (see fig. 42c, f). Although the color of the oil primings on canvas resembles that of the oil primings on wood panel, those on canvas are more thickly applied. The ground measures up to 80 μm in The Jester (cat. 39 and fig. 42c), 100 μm in Jolly Toper (cat. 2 and fig. 42k), and 60 μm in The Last Drop (cat. 6 and fig. 42e). In virtually every case and not only on the canvases that date from around 1629 – when it is commonly suggested that Leyster could have apprenticed or assisted in the studio of Frans Hals – the color and composition of the grounds analyzed agrees with that found in paintings on canvas attributed to Hals. Thus the ground layer cannot be used as a criterion for attributing a painting to one artist or the other (see, for example, Standing Cavalier, cat. 41). Given that sources suggest that seventeenth-century painters did not necessarily prepare their own painting supports but could readily obtain them from a professional primer, one cannot rule out the possibility that Leyster and Hals obtained their primed supports from the same source in Haarlem. A document of 1676, preserved in the Leiden town clerk’s office archives, implies that there was only one authorized supplier of primed canvases and panels for the city of Leiden (see n. 37). In any event, the present survey supports the conclusion made earlier, that Haarlem painters seem to have continued the early Netherlandish tradition of the use of a flesh-colored priming on panel even when canvas supports came into vogue. This differs from the color and composition of the grounds found in other circles, Rembrandt’s, for example.

One painting on canvas examined, Laughing Youth with a Wine Glass (cat. 38), shows a very different ground (see fig. 42l). A gray layer (up to approximately 45 μm thick) which contains lead white and finely ground, possibly charcoal, black overlies a thicker layer (approximately 130–240 μm) of fine, bright red ochre which seems bound in an aqueous medium. This observation could support the attribution of this painting to the Utrecht Caravaggistti (see the essay by Biesboer in the present catalogue and cat. 38), whose paintings on canvas often show this type of double ground, gray over red. Yet the attribution of this painting cannot be shifted away from Leyster solely on the evidence.
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Paint cross section from the top edge of a game of tric-trac (cat. 3). Paint cross section from the gray sleeve in the right foreground in The Woman Carrying Water (cat. 2). Magnification 200x. Layers: 1) ground containing lead white, fine black pigment, and yellow ochre; 2) brown paint layer containing lead white and fine brown ochre; 3) red and black pigment; 4) varnish. Detail of woman's face in A Game of Tric-Trac (cat. 3). Magnification 200x. Layers: 1) ground containing lead white, fine black pigment, and yellow ochre; 2) brown paint layer containing lead white and fine brown ochre; 3) red and black pigment; 4) varnish.

Paint cross section from the addition to the left side of The Last Drop (cat. 3). Magnification 200x. Layers: 1) ground containing lead white with brownish orange, carbon, and a little lead white; 2) varnish; 3) ground containing lead white and fine black; 4) varnish; 5) synthetic varnish.

Detail of the hand inolly Toper (cat. 2). Magnification 200x. Layers: 1) ground containing lead white, fine black pigment, and yellow ochre; 2) fine black, yellow, and a little brown ochre; 3) modern synthetic varnish.

Detail of the costume of the right player in A Game of Tric-Trac (cat. 3). Detail of the costume of the left player in A Game of Tric-Trac (cat. 3). The costume is modeled using ultramarine blue and lead white; the background is visible at the bottom right corner of the painting. The scratches on the player's shoulder are visible at the bottom right corner of the painting. The costume is modeled using ultramarine blue and lead white; the background is visible at the bottom right corner of the painting.

Paint cross section from the left edge of The Man Offering Money to a Young Woman (cat. 2). Magnification 200x. Layers: 1) ground containing lead white and fine brown ochre; 2) brown paint layer containing lead white and fine black; 3) brown and red ochre with a little fine brown ochre or umber; 4) carbon black, lead white; 5) grayish layer of lead white, fine black pigment, and very little ochre; 6) yellowish brown containing brown, yellow, and a little red ochre, lead white, and black; 7) dark brown containing brown ochre and black; 8) varnish.

Paint cross section from the gray sleeve in the right foreground in The Woman Carrying Water (cat. 2). Magnification 200x. Layers: 1) ground containing lead white and fine brown ochre; 2) brownish gray underpaint containing lead white, carbon black, lead white, and fine black; 3) thin layer of varnish; 4) remnant of this grey overpaint.

Paint cross section from the left edge before the painting was cleaned. Magnification 100x. Layers: 1) ground containing lead white and fine black; 2) brown ocher, bone black, and a little lead white; 3) varnish; 4) ground containing lead white, fine black pigment, and very little ochre; 5) yellownish brown containing brown, yellow, and a little red ochre, lead white, and black; 6) varnish.

Paint cross section from the addition to the left side of The Last Drop (cat. 3). Magnification 200x. Layers: 1) ground containing lead white with brownish orange, carbon, and a little lead white; 2) varnish; 3) ground containing lead white and fine black; 4) varnish; 5) synthetic varnish.

Paint cross section from the addition to the left side of The Last Drop (cat. 3). Magnification 200x. Layers: 1) ground containing lead white with brownish orange, carbon, and a little lead white; 2) varnish; 3) ground containing lead white and fine black; 4) varnish; 5) synthetic varnish.

Paint cross section from the gray sleeve in the right foreground in The Woman Carrying Water (cat. 2). Magnification 200x. Layers: 1) ground containing lead white and fine brown ochre; 2) brown paint layer containing lead white and fine black; 3) brown and red ochre with a little fine brown ochre or umber; 4) carbon black, lead white; 5) grayish layer of lead white, fine black pigment, and very little ochre; 6) yellowish brown containing brown, yellow, and a little red ochre, lead white, and black; 7) dark brown containing brown ochre and black; 8) varnish.

Paint cross section from the left edge before the painting was cleaned. Magnification 100x. Layers: 1) ground containing lead white and fine black; 2) brown ocher, bone black, and a little lead white; 3) varnish; 4) ground containing lead white, fine black pigment, and very little ochre; 5) yellownish brown containing brown, yellow, and a little red ochre, lead white, and black; 6) varnish.

Paint cross section from the left edge before the painting was cleaned. Magnification 100x. Layers: 1) ground containing lead white and fine black; 2) brown ocher, bone black, and a little lead white; 3) varnish; 4) ground containing lead white, fine black pigment, and very little ochre; 5) yellownish brown containing brown, yellow, and a little red ochre, lead white, and black; 6) varnish.

Paint cross section from the left edge. Magnification 200x. Layers: 1) ground containing lead white and fine brown ochre; 2) brown paint layer containing lead white and fine black; 3) brown and red ochre with a little fine brown ochre or umber; 4) carbon black, lead white; 5) grayish layer of lead white, fine black pigment, and very little ochre; 6) yellowish brown containing brown, yellow, and a little red ochre, lead white, and black; 7) dark brown containing brown ochre and black; 8) varnish.

Paint cross section from the right edge of Laughing Woman with a Wipe Glass (cat. 9). Magnification 200x. Layers: 1) ground containing lead white and fine brown ochre; 2) brownish gray underpaint containing lead white, carbon black, lead white, and fine black; 3) thin layer of varnish; 4) remnant of this grey overpaint.

Paint cross section from the right edge. Magnification 100x. Layers: 1) ground containing lead white and fine black; 2) brown ocher, bone black, and a little lead white; 3) varnish; 4) ground containing lead white, fine black pigment, and very little ochre; 5) yellowish brown containing brown, yellow, and a little red ochre, lead white, and black; 6) varnish.

Paint cross section from the right edge. Magnification 100x. Layers: 1) ground containing lead white and fine black; 2) brown ocher, bone black, and a little lead white; 3) varnish; 4) ground containing lead white, fine black pigment, and very little ochre; 5) yellowish brown containing brown, yellow, and a little red ochre, lead white, and black; 6) varnish.
of this unusual ground structure. One cannot rule out the possibility that painters occasionally acquired canvases primed in other cities. A case in point is the large group portrait on canvas, Meagre Company, documented as a commission in Amsterdam that was begun by Frans Hals and completed by Pieter Codde. This painting also shows a double, gray-over-reddish layer structure which is unlike Hals's typical flesh-colored primings. Hals may have obtained his primed canvas in Amsterdam, rather than Haarlem, for the sake of convenience; Rembrandt is known to have used this type of primed canvas for his early works in Amsterdam.32

**Underdrawing**

Most of the paintings by Leyster that were examined reveal glimpses of an underlying initial sketch of the composition on the primed painting support. Forms are schematically indicated with painted lines, such as the ellipses of the woman's face and her glass in *A Game of Tric-Trac* (cat. 9 and fig. 42), or those of the tankard in *Jolly Toper* (cat. 2). Both dark and light painted lines of underdrawing occur. Dark lines are often colored gray to brown, but microscopic examination of *A Game of Tric-Trac* suggests that the dark lines apparent under translucent areas of light flesh contain red lake (a natural organic dye stuff). On the other hand, abrasion of colored garments often reveals relieved white strokes of underdrawing, which sketch the folds. This occurs in the grayish-green breeches of the player at left in *A Game of Tric-Trac* and in the black dress in *Portrait of a Woman* (cat. 14). The initial contours and folds of the white parts of the costumes are similarly indicated using raised strokes of whitish paint, which may be so extensive as to constitute a layer of underpaint. These underlying paint strokes are revealed where they cut across final layers of paint, such as in the collars and cuffs in *Serenade* (see fig. 43), *A Game of Tric-Trac*, and *Portrait of a Woman* (cats. 9, 14) or in the seamstress's cape in *Man Offering Money to a Young Woman* (cat. 8).

The character of the painted sketch in the examined paintings by Leyster agrees with that observed in paintings attributed to Frans Hals. *The Rommel-Pot Player* (cat. 40), now attributed to the studio of Frans Hals, shows a similar underlying sketch made using dark and light painted lines. For example, gray lines sketch the zig-zag outline of the triangular lace lobes around the girl's cap, whereas relieved white strokes sketch the folds of the boy's jacket at lower left. Further technical research is required to confirm whether this procedure is typical only of Frans Hals, who may have influenced Leyster, or whether it is common to other Haarlem artists in a period when painters appear to have dispensed with a detailed stage of underdrawing. Two of Leyster's genre paintings on wood panel show a particularly extensive painted sketch: *A Game of Tric-Trac* and *Children with a Cat and an Eel* (cat. 6, 13). The boldly painted lines of underdrawing are revealed where they do not coincide with the overlying design in the finished painting (see Revisions and Pentimenti, below). This suggests a spontaneous procedure, whereby the composition is sketched with paint directly on the primed support and revised throughout subsequent stages. Again, this agrees with the characteristic practice of Frans Hals.33 Examination of *Cardplayers by Lamplight* (cat. 28), which has only recently been attributed to Molenaer and is closely related in composition to Leyster's *Game of Tric-Trac* (cat. 9), did not reveal this same bold stage of painted underdrawing.34

*Man Offering Money to a Young Woman* (cat. 8) shows another technique of underdrawing. Lines were scratched into the ground layer while it was still wet. Converging lines in the background radiate from the right side to the top of the woman's head and parallel to her left thigh, and a shorter line marks the far edge of the floor. Though subsequently painted over by Leyster, the lines are still apparent in raking light and in the x-ray. These lines of underdrawing were used in constructing the perspective of the asymmetrical composition, which focuses on the figures in the left foreground. This dramatic effect heightens the psychological tension of the scene.35

**Build-up of Paint Layers**

The 1668 postmortem inventory of Jan Miense Molenaer lists a number of paintings according to stage of completion: "begommen" (begun), "aengelijdt" (laid in), "gedooverfd" (dead-colored), and "opgenaeteck" (worked up).36 Although the exact meanings of these terms now elude us, it is further evidence of the separate stages in the build-up of the paintings examined. Surface examination even suggests distinct stages in execution of the alleged swift portrait sketch *Standing Cavalier* (cat. 41). We shall describe the various stages in an attempt to reconstruct the painting procedure, although this cannot be rigidly defined.37

**Backgrounds**

Examinations suggest that Leyster's compositions were laid in using areas of underpaint,
thinly applied on the light ground. Light and dark areas of the backgrounds were first established in underpaint, working around the areas reserved for the figures. Evidence of this procedure appears in *Merry Company* (cat.5) where patches of underpaint, visible through the background, outline the main figures. As in this painting, sometimes the initial reserves for the figures in other works were not strictly adhered to in the finished painting.43

Underpaint of the backgrounds is often apparent in paint samples as the bottom layer of two thin paint layers. For example, greenish gray background paint in *A Game of Tria- Trac* (cat.9 and fig.42k) has been applied in two thin (approximately 12 μm) layers which contain fine bone black, lead white, and ochre. The underpaint layer is slightly lighter in color. Similarly, the light greenish-gray background in *Children with a Cat and an Eel* (cat.13 and fig.42e) is applied in two thin layers: a 10 μm thick layer of underpaint containing lead white and umber with a 7 μm thick layer containing fine black and yellow ochre on top. Background paint sampled on an added strip in *The Last Drop* (cat.6) contains pigments similar to those in the main background, though in a darker grayish green mixture, and applied as a single layer. The main background shows a characteristic buildup of two paint layers, here applied wet-in-wet.44 The two-layer buildup of the backgrounds, generally observed in the Leyster paintings that were examined, differs from the simpler buildup of backgrounds found in paintings by Frans Hals. Examinations have shown that in almost every case, Hals applied his commonly greenish gray backgrounds to his portraits in one layer, directly on the ground. Their hue was adjusted by varying the mixtures of lead white, black, and ochre pigments.45 Leyster seems to have used a slightly more elaborate buildup in order to achieve a greater variety of background effects, which influence the moods of her paintings.

Sometimes underpaint is exploited to provide atmospheric modeling of the backgrounds, as in *Merry Company* (cat.5). Pale yellow underpaint of light areas and dark gray underpaint of shadow areas in the background has been left visible through the light gray paint which has been brushed streakily on top. This provides the jovial, daytime scene with an airy setting. Leyster favors dramatic, artificial lighting effects in many of her backgrounds. In the scene of *Man Offering Money to a Young Woman* (cat.8 and fig.42l), lit by an oil lamp, a large area of black underpaint shows through the greenish background on the right side to provide a faint shadow cast on the wall. Paint samples show this (approximately 40 μm) thick layer of underpaint to contain very finely ground bone black. Finely ground yellow ochre has been applied over the black underpaint in order to achieve the final green effect of the background.46 In contrast, the background of *Jolly Toper* (cat.2 and fig.42m) appears as a rather flat and opaque backdrop behind the figure. In this case, a thin layer (approximately 7 μm) of dark gray underpaint present in the right background is not visible at the paint surface. It is covered by a lighter layer of gray paint of about the same thickness and containing the same lead white, fine black, and a little red and yellow ochre pigments. The background is slightly modeled by varying the proportions of these mixed pigments rather than exploiting the visibility of underpaint. The slight contrast between the gray colors of the background and the toper’s costume (see fig.42m), together with his flat pose, accentuate the shallower relief of this painting.47

Sometimes a small margin of light underpaint for the background is revealed around figures, where the top paint layer of the background does not quite extend to the figure. This technical device is used to highlight the figure contours. Examples include the light contours of the figures lit by an oil lamp in *Man Offering Money to a Young Woman* (cat.8), the woman’s left sleeve in *Portrait of a Woman* (cat.14), and the strongly lit black feathered beret in *Serenade* (cat.1 and fig.42n, o). In the last example, a paint sample confirms that the light contour is clarified by a local touch of paint, in the same whitish color as the exposed underpaint of the background but applied on top. Such painterly tricks are frequently observed in the contours of Frans Hals’s figures. Exceptionally wide margins are left uncovered by background paint around the left- and right-hand figures in *Merry Company* (cat.5), so that they appear peculiarly detached from the background.

One of the final elements added to the background is the signature and date (see fig.42m, o). The monogram and date in *Jolly Toper* (cat.2) is painted using gray paint on the lighter gray background. The other monograms and dates, as well as the signature ("judith") in *Children with a Cat and an Eel* (cat.13), are thinly painted using brown or black paint. These are heightened with fine white lines to provide trompe l’oeil modeling in *Serenade* (cat.1).

**Flesh**

In Leyster’s paintings, flesh areas are usually applied as an opaque layer, although sometimes it is possible to catch a glimpse of underpaint in diverse
colors. Thick, light gray underpaint often appears in 'cool' areas of flesh, such as in the faces lit by an oil lamp in *Man Offering Money to a Young Woman* (cat.8 and fig.428) and *A Game of Tric-Trac* (cat.9). Curls drawn by scratching through wet paint in the forehead of the reveler on the left in *Merry Company* (cat.5 and fig.428), similarly reveal cool gray underpaint. Sometimes small patches of this underpaint, or alternatively the gray ground, are left deliberately exposed to create half tones in the flesh (see the woman's face in *Man Offering Money to a Young Woman* and *Portrait of a Woman* (cats.8, 14).

Microscopic examination suggests that a different procedure has been used to achieve the cool gray flesh tones in two paintings of problematic attribution. Unusually, in *The Jester* (cat.39) and even more extensively in *Violinist* (cat.42 and fig.427, 43w), blue pigment has been mixed (sometimes with black) into the top layer of flesh paint.

In contrast, the ruddy flesh of *Jolly Toper* (cat.2) has been laid in using a rather thin and even layer of light orange underpaint. The orange underpaint of the man's left hand is allowed to run under the lid of the tankard where it shows through thin gray paint to provide a warm reflection on the metal, heightened by touches of orange paint applied on top (see fig.429). Color nuances in the flesh were detailed at a late stage. Abrasion reveals that the red accents of the drinker's nose, flushed cheeks, and lips are thinly painted on top of the main layer of light flesh paint (see fig.437). This differs from Leyster's slightly later *Self-Portrait* (cat.7), where quite detailed modeling of the face seems to have already been established in the underpaint stage. In *Self-Portrait* numerous tiny paint losses reveal underpaint in a wide variety of colors, ranging from whitish gray to dark yellow and pink.48

**Costumes**

Leyster's genre subject matter allows for more brightly colored costumes than appear in the commissioned portraits of Frans Hals, who was largely confined to painting somber black Regent garments from the 1630s onward. In her costumes Leyster repeats certain colors, achieved by using a typical range of pigments and underlayers of a particular hue.

Blue costumes are most often painted using dark blue indigo, mixed with various proportions of lead white in order to model folds.49 Rather than using pure indigo in the shadows as one might expect, Leyster often mixed it with lead white and applied it over brown underpaint in order to obtain a very dark blue (see, for example, *A Game of Tric-Trac* (cat.9 and fig.427) and *Children with a Cat and an Eel* (cat.13 and fig.424). This procedure was preferable, as pure indigo is a strong color and would have looked black instead of blue. In places where indigo (a vegetable coloring matter) was thinly applied and not mixed with lead white, it has tended to fade from exposure to light. This partly accounts for the transparent appearance of the violinist's blue costume in *Merry Company* (cat.5 and figs.428, 43w), revealing the light ground beneath. In this case, there is no underpaint and the reflectance of the ground (the property of the pale ground to reflect light) is exploited to intensify the color of indigo glazes applied directly on top. Indigo also appears in the blue costumes in *The Rommel-Pot Player* (cat.40 and fig.427) and *Violinist* (cat.42).

The use of indigo was not recommended in the seventeenth century; nonetheless, Leyster and her contemporaries in Haarlem, including Frans Hals and Molenar, appear to have used it despite its tendency to fade.50

Azurite, a more greenish-blue pigment than indigo, has been used in the green costumes in *The Rommel-Pot Player* (cat.40 and figs.429, 43b). This copper pigment was mixed with lead tin yellow and lead white to obtain green — usual practice in the seventeenth century as no ideal green pigment existed. In the girl's skirt, the green paint mixture has been applied on top of light gray underpaint in the light folds and thin brown underpaint in the shadows. The adjacent greenish-gray jacket of the boy shows a similar buildup. Unlike the natural form of azurite identified in the mixed greens of the tablecloth in *Jolly Toper*, the chair in *Portrait of a Woman*, and the landscape in *Standing Cavalier* (cats.2, 14, 41 and fig.433), an artificial form of azurite with small and regularly rounded crystals can be observed in *The Rommel-Pot Player* (see fig.438).

Use of artificial copper green has been noted in paintings by Frans Hals, but artificial copper blue and green pigments are known to have been in use even before the seventeenth century.51

In the paintings examined, blue is often set off against bright red costumes or details. Different shades of red have been obtained using various combinations of opaque vermilion and transparent red lake pigments, sometimes mixed with black. For example, the red feather in the cap of *Jolly Toper* (cat.2 and figs.43a, d) was laid in using a dark mixture of red lake and black and then detailed using strokes of vermilion and thick touches (approximately 60 μm) of red lake paint applied.
on top. Similarly, the red costume in The Last Drop (cat.6 and fig.42e) shows a dark red underpaint containing vermilion and organic red, with light folds painted on top using vermilion mixed with lead white. The dark purplish shadow area of the costume of The Jester (cat.39 and fig.43g) shows a brownish-black underlayer containing bone black lead white. The dark purple shadow area of the costume of The Jester (cat.39 and fig.43g) shows a brownish-black underlayer containing bone black and a little vermilion, with bright strokes of vermilion painted on top.52

As mentioned above, collars and cuffs usually show white underpaint. A calculated procedure was followed in painting the ruff in Portrait of a Woman (cat.14 and fig.43h). Whereas the light part shows the usual undersketch in white paint applied directly on the ground, the dark part has been thinly painted over the finished background in order to provide shadow. Unusually, light pink underpaint (microscopic examination suggests a mixture of lead white and red lake) appears under the whitish cap and collar. Possibly this was intended to imitate the effect of the pinkish ground or imprimatura showing through translucent white paint, which can often be observed in the collars and cuffs of portraits by Frans Hals. In this painting, the ground layer appears whitish. The pink underpaint provides a warm tint in the collar, contrasted by cool gray shadows which contain a fine blue pigment.

Sequence of Painting Parts
As one might expect, areas of the composition that involved a different palette were not necessarily worked up together. Study of the overlap of paint layers reveals the sequence in which different areas of the paintings were completed. A general procedure appears to be a progression from background to foreground features. Thus figures were usually completed after the background, which they overlap around the edges. This is sometimes difficult to establish, since the figure contours have been reworked with local touches of paint. However, the two principal figures in Merry Company (cat.5 and fig.43h) show a straightforward procedure; the figures have been filled into an excessive reserve in the finished background, which they overlap in places. On the other hand, the figure in Jolly Toper (cat.2 and fig.43l) was largely finished when the top paint layer of the background was applied around it, generally overlapping the figure and cutting abruptly across his right ear. The tankard, his fingers holding it, and the final details of the costume were the remaining features to be completed over the background. The precise physiognomy of the character portrayed has led to the suggestion that it represents an actual portrait (see cat.2). In this case, one might suggest that dependence upon the presence of the sitter may have determined the unorthodox procedure followed. Where the background overlaps the figures, rather than the反之 versa, this may also indicate that the background has been reworked in order to disguise a pentimento, or change in the original design, as in The Last Drop (cat.6).53

Conforming to a general sequence of completing background elements before foreground elements, Leyster usually finished undergarments before those on top. Thus collars and cuffs and other costume embellishments are usually detailed last, although exceptions occur. In the case of two figures in The Last Drop and Concert (cats.6, 10), where it is suggested their costumes are worn over normal clothing, the undergarments were completed last, overlapping the collars.54 Sometimes a pentimento can explain a reversed procedure as in A Game of Tric-Trac (cat.9 and fig.43i). Two red ribbons on the seamstress's cape have been largely obliterated by white paint applied during the modification of her right sleeve.

Slight adjustments were sometimes necessary to draw together adjacent areas which had been painted successively. For example, the lute player's right cuff in Serenade (cat.1 and fig.43k) has been extended to meet his hand. Such observations provide evidence that, especially when Leyster was dependent upon the presence of a portrait model, the face may have been painted separately from the rest of the figure. This practice is not surprising. Constantijn Huygens recounts how the painter Jan Lievens first painted Huygens's clothing and bare hands and postponed the painting of his face until spring, since the days were so short.55 In Leyster's Portrait of a Woman (cat.14 and fig.43i), strokes of paint added across the neck draw together the separately executed head and body, and the collar has been slightly extended where the two meet. Slight adjustments to the width of the collar and shoulders were made at a late stage, presumably in relation to the head. Even more clearly in Concert, (cat.10), the heads and necks have been added later, overlapping the finished collars and background. The impasto of the white collars appear to have been dry when the faces were added on top, suggesting a significant time interval between the painting of the
two components. Once again, the right figure shows minor pentimenti, which suggest that it was necessary to realign the collar and shoulders with respect to the added head. These observations lend support to the suggestion that the faces portrayed in Concert are actual portraits rather than idealized characters (see cat.10).

Revisions and Pentimenti
Examination often reveals that the initial painted sketch has been revised during subsequent stages in the painting procedure. Such adjustments are often made to costume details, such as the size or form of collars and cuffs (cats.3, 9, 10, 13, 14), substitution of the girl’s kerchief for a ruff in Children with a Cat and an Eel (cat.13), or shortening of the blue jacket in A Game of Tric-Trac (cat.9). Another detail frequently modified is the placement of hands or fingers (cats.2, 9, 13, 14) where the gesture of playing a musical instrument may be refined (cats.3, 5, 10 and fig.43M, N).

Examinations also reveal changes made to the placement or pose of figures, notably in Merry Company and in Children with a Cat and an Eel (cats.5, 13; fig.44). These two paintings show a spontaneous procedure whereby the composition was worked out during the act of painting rather than through a preliminary study. Two alternative indications for a higher position for the cat in Children with a Cat and an Eel suggest that Leyster changed her mind more than once; the right shoulder and eye of the boy holding the cat have also been lowered. The legs and feet of the revelers in Merry Company have been slightly repositioned and the pose of the central figure seems to have been resolved at a late stage with parts added over the background.56

Microscopic examination of Leyster’s Self-Portrait (cat.7 and fig.43O) confirms the presence of a face underlying the present painting of a fiddler to the right of the main figure and provides further evidence for the sequence of underlying paint layers.

Finally, this examination uncovered two unsuspected pentimenti in The Rommel-Pot Player (see the essay by Levy-van Halm in the present catalogue and cat.40). First, microscopic examination suggests that the laughing boy in a fur hat initially wore a floppy red hat, modeled with brownish shadows. A paint sample confirmed that this first hat was painted using vermilion mixed with a little black and was still wet when the fur hat was painted on top (see fig.43P, Q). Second, infrared reflectography (figs.45 and 43R) reveals that two faces in the right doorway originally turned in the opposite direction, to their left around the doorpost. Before these two changes were made, the composition would have been closer to that found in contemporary and later versions of this theme, one of which has been attributed as a prototype version by Frans Hals (see fig.40A). The boy in a fur hat recalls other figures painted by Frans Hals between c.1625–30.58

Paint Application
One remarkable feature of the paintings examined is the diversity of their paint application (regardless of the material of the painting support), which does not permit a single encompassing description of Leyster’s characteristic method. Leyster’s Self-Portrait (cat.7) displays an array of rounded, tapering, and splayed brushes suitable for manipulating paint in various ways. In the background and costume of Jolly Toper (canvas, cat.2), stiff and opaque paint mixtures have been spread using bold zig-zag and straight strokes, applied wet-in-wet (see fig.438). Also dated 1629, Serenade (panel, cat.1) similarly shows opaque and viscous paint applied to the flesh areas using succinct touches (see fig.43T). These two paintings contrast with the generally thinner application of paint in Merry Company (canvas, cat.5), and the signed Children with a Cat and an Eel (panel, cat.13). In this last case, the thin application of paint over a sketchily brushed brown underlayer is exploited to provide the so-called turbid medium effect, whereby a light color laid over a dark one appears cooler because of the scattering of the blue light and the absorption of red and yellow light. Increased transparency of thinly applied light paint areas has caused the brown underlayer to become more apparent in the animals and costumes. Laughing Youth with a Wine Glass (cat.38) shows an exceptional paint application in the exaggerated relief of stiff brushstrokes applied in light paint areas (see fig.43V). Microscopic examination reveals a pitted structure of the paint, which might suggest use of an emulsion paint mixture to achieve this effect.59 Paint has also been thickly applied in the gray and yellow costume of Standing Cavalier (cat.41), in contrast to the thinly brushed background. The different gray shades of the costume have been achieved using various opaque mixtures of gray paint. This technique differs from the juxtaposition of alternating translucent and opaque touches of paint, exploiting the turbid medium effect to
provide a rich variety of cool to warm grays, which one usually observes in the costumes of Frans Hals.\(^{60}\)

In the paintings examined, Leyster shows a rather refined treatment of contours. Contours are formed where adjacent paint areas either just meet or do not quite meet, with a subtle accent occasionally added along the boundary (see fig. 43v). She appears not to have been influenced by the bold and jagged contour lines that already appear in Hals’s genre portraits of the late 1620s, which would become especially typical of his later portraits. Infrared reflectography and other methods of examination reveal that these contours were built up using a series of touches applied in successive paint layers.\(^{61}\) This difference in technique need not refute the suggestion that Leyster trained in the studio of Hals around 1629.

Surviving pupils’ contracts specify only the most general obligations regarding what the master would be expected to teach the pupil of his method. How closely the pupil assimilated the master’s technique must have varied in each case according to the status, inclination, and ability of the pupil (see the essay by Levy-van Halm in the present catalogue).\(^{62}\)

Examination of Violinist (cat. 42), attributed to the circle of Frans Hals, reveals a detailed treatment of the contours. The bold blackish contour around the underside of the violinist’s left hand, as well as the finer contours between the fingers, show a delicate hatched structure (see fig. 43y). Some of the contour lines appear to have been swept across with a brush while they were still wet, in order to achieve this effect. More obvious hatched brushwork can be found in paintings by Hals dating from the late 1620s.\(^{63}\) Other features of paint application recall the technique of Frans Hals, such as the juxtaposition of red lake accents, sometimes over dark contours, and the highlights in the flesh which are drawn by the impasto edges of fluid brush strokes.

**Summary**

In this first attempt to describe the painting technique of Judith Leyster based on detailed technical analysis, six signed works provide important points of reference, and several paintings of more problematic attribution were also examined. Despite the varied styles of the paintings examined, it was possible to observe common technical features, some associated with general seventeenth-century Dutch painting practice, others with a specific Haarlem tradition, and others particular to Leyster.

First, Leyster shows a frequent use of wood panel, the traditional material, for her smallest painting supports. Presumably the wood panels relate to the smallest types listed in seventeenth-century inventories, but a select survey suggested that they could not be characterized by a system of standard proportions, as one might expect. Possibly the sizes of the smallest panels, each of which is made from a single plank, were governed by the size of planks supplied by the saw mill rather than by the standard of a predetermined size. Leyster followed common practice in using lightweight canvas for her larger paintings, although these, too, were modest in scale.

With one exception (Laughing Youth with a Wine Glass, cat. 38), the color and composition of the priming layers examined match those generally found in paintings attributed to Frans Hals. Use of flesh colored grounds applied to canvas and the introduction of oil grounds on wood panel differ from the methods of priming encountered in Amsterdam during this period and appear to be a specifically Haarlem practice. Possibly Leyster and Hals obtained their primed painting supports from the same source in Haarlem. Yet several larger paintings on panel by both artists show the traditional method of priming, with an oil imprimatura over a chalk ground. Together with other differences, such as the texture of paint application, the unusual ground structure observed in Laughing Youth with a Wine Glass could provide evidence to associate this painting with the Utrecht School.

Like Frans Hals, Leyster seems to have set to work without detailed preliminary studies, sketching the composition directly on the primed support with the brush and revising it throughout subsequent stages of painting. Two paintings in particular show this spontaneous approach: A Game of Tric-Trac (cat. 9) and Children with a Cat and an Eel (cat. 13). More major pentimenti were confirmed in Self-Portrait (cat. 7), and discovered in The Rommel-Pot Player (cat. 40), no longer thought to be by Leyster but by another artist working in the circle of Frans Hals. Pentimenti sometimes explain a deviation from what appears to have been Leyster’s typical practice of finishing background elements before foreground elements. The separate execution of heads and bodies observed in a number of alleged portraits may indicate a painting procedure dependent upon the availability of a portrait sitter.

The moods of Leyster’s genre scenes and portraits are partly set by varied character of the backgrounds, typically applied in two paint layers. Underpaint plays a particularly important role in
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[Image 0x0 to 595x842]

**Paint cross section from the green landscape in Dancing Cavalier (cat. 4).**

The bright red contour of the underlaying figure is visible around the lower left side of the presence for her costume (fig. 820a) and see also fig. 492b).

**Detail of a pentimento in the faces in the doorway in The Rembrandt Pet Player (cat. 40).** The two faces in the right doorway were originally turned towards left (compare figs. 495a and 498).

**Detail of the mouth in Merry Company (cat. 3).** The woman’s cap shows a more fluid and thinner application of paint. Blue (azurite) pigment is mixed into the red around the mouth (see also fig. 413).

**Detail of the mouth in Laughing Youths with a Wine Glass (cat. 2).** Light areas of Bush paint show a slightly broader effect. The lips are thinly painted on top.

**Detail of the mouth in Violinist (cat. 2) showing a more fluid and thinner application of paint. Blue (azurite) pigment is mixed into the red around the mouth (see also fig. 423).

**Detail of the mouth in Jolly Fifer (cat. 2).** A fine, light contour is formed where the gray paint of the background does not quite extend to the lip.
achieving the dramatic lighting effects of her nocturnal scenes. In *Man Offering Money to a Young Woman* (cat.8), drama is also provided by the strongly asymmetrical composition, which our examination suggests was constructed with the aid of perspective lines scratched into the ground layer.

Leyster’s paintings show a more consistent stage of underpainting than those of Frans Hals, not only in the backgrounds, but also in the costumes and flesh areas. The degree of modeling in the appearance of flesh suggested in the underpaint stage appears to vary in different paintings.

Leyster’s choice of pigments is in keeping with those usually found in seventeenth-century Dutch paintings. Some brightly colored costumes are repeated, with certain pigments always being used for the same color. Typically, indigo appears in the blue costumes, in spite of the fact that its use was not recommended due to its tendency to fade. Two paintings of problematic attribution show unusual mixture of blue pigment to provide ‘cool’ flesh tones, rather than by the exploitation of a gray underlayer observed in paintings by Leyster.

On the basis of our current study, it is not possible to draw any firm conclusions as to whether or not Leyster apprenticed with Frans Hals. Our research, which has revealed both similarities and differences between their painting technique, is an important step in understanding the influence of Hals on his contemporaries. This first technical examination of Leyster’s paintings does not give all the answers to the many questions regarding Leyster’s studio practices; yet it does bring us one step further in our appreciation of not only her work but Haarlem genre painting in general.

Notes

1. A few technical photos of individual works have been published. Hofrichter 1989, plates 54-58, and Maclaren and Brown 1991, plate 48. We are grateful to the following institutions and collectors who have kindly allowed us to examine their paintings and who have assisted us in our research: Rijksmuseum, Amsterdam; Art Institute of Chicago, Maurithuis, The Hague; Statliche Kunsthalle, Karlsruhe; The National Gallery, London; and Collection of Her Majesty Queen Elizabeth II, Buckingham Palace, London; Noortman sv, Maastricht; Metropolitan Museum of Art, New York; Philadelphia Museum of Art; Virginia Museum of Fine Art, Richmond; National Gallery of Art and the Wallace and Wilhelmina Holladay Collection; and the Worcester Art Museum. Most of the paintings were examined in situ. These circumstances limited examination of *Concert* (cat.10) to scrutiny with the naked eye. Other paintings were also examined with a stereomicroscope using magnifications up to 40x. Select photographs were made to record observations. Existing x-rays and infrared and other technical photos and information were kindly made available to us. X-rays of *Jolly Tapper* (cat.2) and *Portrait of a Woman* (cat.34) were made by the Röntgen Technische Dienst, Rotterdam. We were able to scan three paintings (*The Rømmel-Pot Player*, cat.40; *Violinist*, cat.42; *A Game of Tric-Trac*, cat.9) using an infrared vidicon camera. In almost every case the owners of the paintings granted permission to remove one or more tiny paint samples (about 0.25 mm²) from the edges of the painting or existing damages, so that we might gain further insight into the composition and buildup of paint layers. Cross sections were made by embedding each paint sample in a block of polyester resin. The block was ground down and polished to expose the sample at one surface. The cross sections were then examined under a Leitz microscope in normal and long wavelength ultraviolet incident light. Remains of the sample material were used for microscopic examination in polarized light and for microchemical tests. Elements present in very small selected areas of the samples were further identified using the scanning electron microscope with energy dispersive x-ray analysis (SEM-EDX), carried out by NSF Research.

2. A false Frans Hals monogram, executed with a warm brown glaze, is visible both with the naked eye and with the microscope in *Violinist* (cat.42). It is located in the background, directly below the scroll of the violin and above the figure’s sleeve. We are grateful to Carol Sawyer, conservator of paintings at the Virginia Museum of Fine Arts, for carrying out technical examinations of the monogram and confirming that it has clearly been added later, over abraded paint layers. The presence of age cracks suggests that the monogram is definitely old.


6. The surviving works of contemporary painters active over a longer period, including Frans Hals and Rembrandt, show an increasing use of canvas in place of wood panel. See Groen and Hendriks 1989-90, p.322, n.9, and Van de Wetering 1986, p.35, n.3. In the Netherlands, the use of canvas did not supersed that of wood panel to the same extent as in Italy. See Miedema and Meijer 1979, p.82.

7. The dimensions of *Carousing Couple* are those listed in Hofrichter 1989, p.46. Miedema 1981, p.53, notes an approximate transitional format of 70 x 55 cm in the substitution of canvas for panel for paintings attributed to Rembrandt. Groen and Hendriks 1989, p.159, note an approximate transitional format of 60 x 50 cm for paintings attributed to Frans Hals.

8. Vasari mentions that an advantage of canvas is that it is ‘of little weight and, when rolled up, easy to transport’ (see Vasari *on Technique*, ed. G. B. Brown 1907, Dover Publications, New York 1910, p.230). Mention of Leyster in the context of the De Gribbers
Infrared detail of pentimento in The Remondi Pot Player (cat. 29). Dark painted lines of underdrawing reveal that two faces in the right doorway originally turned in the opposite direction around the doorpost.
The dimensions of Carousing Couple (cat.4) plotted in Hofrichter 1989, since these were not determined.

Miedema, 1981, notes a general height to width proportional relationship of 1.25:1 in north Netherlands upright rectangular paintings of the sixteenth and seventeenth centuries. In a broad statistical survey of paintings on wood panel attributed to Rembrandt, a broad range of standard panel sizes emerged. In Groen and Hendriks 1989, p. 149, a survey of forty upright rectangular paintings on wood panel attributed to Frans Hals did not reveal any groupings of standard sizes, but did agree with a general height-width proportional relationship 1.30:1 observed by Miedema.

Bath and Eckstein 1981, especially pp. 253 and 254. A dendrochronological survey of paintings on wood panel by Rembrandt shows that the smallest planks were cut from inner heartwood, in order to use valuable timber efficiently.

Bruyn 1979.

Bruyn 1979, pp. 200-207. See also above, regarding a possible reduction in size of Children with a Cat and an Edel (cat.11).

Bruyn 1979, p. 41.


Hofrichter 1989, p. 41, lists larger dimensions for Merry Company (cat.5) of 88.5 x 53.5 cm. This was the size of the painting with later additions, which were removed during its restoration in 1987. Before restoration the painting matched the present format of The Last Drop (cat.4). The original canvas support of Merry Company (cat.5) has been cut on all sides, removing capping, especially along the right and bottom sides. There are margins of damage along the sides of the reduced painting. A close copy of the painting shows the uncropped composition; cat. 5A, in Hofrichter 1989, The National Trust, Goodwood House, Chichester.


We are grateful to Mark Tucker, who carried out our recent restoration of The Last Drop (cat.6), for confirming and supplementing observations made during our technical examination of the painting before the cleaning. The treatment was at an early stage at the time of writing this article, when no clear evidence had yet come to light to refute the possibility that the very early additions could be by Leyster despite the fact that no other examples of original format alterations in her work are known.

One curious feature of the added strips of canvas is the manner of attachment. Contrary to what one might expect, the x-ray does not show that they have not been sewn on, but their frayed edges simply show the edges of the original panels of the canvas.

The copy of the composition in its extended form mentioned is cat.no. 40B in Hofrichter 1989, canvas 91.5 x 69 cm, Kunsthandel P. de Boer, Amsterdam.

Most of the thread densities were measured from available x-rays, in which the canvas weave is made visible by the x-ray absorbing properties of the lead in the ground and canvas layers. The results listed here are the average of several measurements made in both directions. Where no x-rays were available, measurements were made directly on three paintings: Laughing Youth with a Wine Glass, The Jester, and Violinist (cats. 35, 39, 43). In these cases the measurements are less reliable, due to the fact that they were limited to small areas of damage where the canvas was exposed. This enabled fewer measurements, over shorter distances, to be made in each painting. The thread density listed for The Last Drop (cat.6) is that of the main canvas.

Other surveys have been unable to conclude a consistent relationship between the width and thread densities of canvas supports examined. See Houtzager et al. 1967, p. 62. For paintings on canvas attributed to Frans Hals, see Groen and Hendriks 1989, p. 112 and Hendriks and Levy-van Halm 1990, p. 8. Hendriks and Levy-van Halm made the general observation that the widest canvases used by Frans Hals show a relatively fine, though not necessarily regular weave. Six small canvases, which measure one brick or less are more coarsely woven, with twelve threads or fewer per cm.

Houtzager et al. 1965, pp. 226, 228, 242, and 244 lists thread densities of canvases used by the Utrecht painters Hendrick ter Brugghen and Gerard van Honthorst.

For studies of canvas thread densities used by the workshops of Rembrandt and Frans Hals, see respectively Van de Wetering 1986, pp. 31-37 and a smaller survey in Groen and Hendriks 1986, p. 113.

De Mayerne gives several recipes which suggest smoothing the priming layer using a curved priming knife or pumice stone; see Van de Graaf 1985, pp. 138-43, nos. 10-11.

An x-ray of The Last Drop (cat.6) shows thickening of the ground layer along the top, left and right sides of the main canvas, which would have accumulated along the rolled stretching edges when the ground layer was applied. The original stretching edges have been unrolled and trimmed off close to the painted area, slightly further in along the right side where no ridge of ground is apparent. Concerning preparation of canvas support see Van de Wetering 1986, pp. 31-32; Groen and Hendriks 1989, p. 133.


Frans Hals's large pendant portraits Cornelis Claesz Vugt
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45 Groen and Hendriks 1989, p. 119. Another type of blue pigment called smalt (glass colored by cobalt oxide) was found together with lead white in the sky of Standing Cavalier. A very fine (approximately 10 μm particles) and therefore pale variety has been used.

46 A study of the overlap of paint layers suggests that the red costumed figure in front was already finished when parts of the central figure were added. A bright red layer under the shoulders of the central figure, which runs under the background up to the figure in red costume, similarly suggests a pentimento. Finally, white and red contour lines covered by the floor drew his leg in another position. The yellow paint of the floor also conceals changes in position of the two feet in the middle of the composition.

47 Paint samples show that the gray paint mixtures of the background and clothing both chiefly contain lead white and black (lamp black), mixed withumber in the costume and very little fine red pigment in the background.

48 Painted paint losses are most extensive in the upper background, excluding two margins along the top of the right and left sides. The fact that paint areas containing lead white are most damaged suggests the action of an acid substance perhaps applied during earlier restoration treatment. If such an action was the cause, one would expect dark paint areas to show most damage. In any event, the numerous tiny paint losses allow an unusually complete picture of the stage of underpainting in flesh areas. An x-ray of the painting suggests that a more bulbous face was indicated in the underpaint stage.

49 Microscopic examination suggested use of indigo in the blue costumes in Serenade (cat. 1), Merry Company (cat. 5), The Last Drop (cat. 40), and Self-Portrait (cat. 7). Indigo has been identified in analysis in paint samples in Jolly Toper (cat. 2), Man Offering Money to a Young Woman (cat. 6), A Game of Tric-Trac (cat. 30), Children with a Cat and an Elf (cat. 40), The Hammel-Pot Player (cat. 40), and Violinist (cat. 42).

50 Indigo has been identified in: Haarlem Civic Guard group portraits by Frans Hals (see Van Grevenstein et al. 1990, pp. 92-93 and Groen and Hendriks 1989, p. 117), Officers of the St. Adrian Civic Guard at Haarlem, 1641 (cat. 72), and Portrait of a Man (M. M. Bang 1991, restoration report in Fran Halsmuseum) and Jan Miense Molenaer’s Touch (cat. 36; see Christie and Wadum 1992). Indigo also appears to have been used by Johannes Cornelis Verspronck in the tablecloth of his Regents of St. Elisabeth’s Hospital at Haarlem, 1642, Frans Halsmuseum. For De Mayerne’s advice against the use of indigo, see Van De Graaf 1958, p. 44.

51 Artificial copper green has been identified in several paintings by Frans Hals, including a Haarlem Civic Guard group portrait and the late Regent and Regentess group portraits. See Groen and Hendriks 1989, p. 119. Another type of blue pigment called smalt (glass colored by cobalt oxide) was found together with lead white in the sky of Standing Cavalier. A very fine (approximately 10 μm particles) and therefore pale variety has been used.

52 Microscopic examination suggests that the bright vermilion and yellow stripes in the jester’s costume are thinly painted on top of whitish and pink strokes of underpaint.

53 Our microscopic examination of The Last Drop before restoration revealed that the figure contours were overlapped by green background paint. During cleaning, Mark Tucker noted that this green paint, associated with retouching the additions around the edges, extended in a thin layer well into the picture, worked around in the figures’ flaking losses revealed a cooler gray underlayer.

54 The blue underpainting of the figure with a wine tankard in The Last Drop (cat. 6) was finished after his red jacket and white collar, which is overlaps. The gray color of the late player’s underpaint in Concert (cat. 40) was applied last, covering a bright blue underlayer (apparently indigo) and two ribbons hanging from his lace-trimmed collar.

55 Microscopic examination of The Last Drop before restoration revealed that the figure contours were overlapped by green background paint. During cleaning, Mark Tucker noted that this green paint, associated with retouching the additions around the edges, extended in a thin layer well into the picture, worked around in the figures’ flaking losses revealed a cooler gray underlayer.

56 Microscopic examination of The Last Drop before restoration revealed that the figure contours were overlapped by green background paint. During cleaning, Mark Tucker noted that this green paint, associated with retouching the additions around the edges, extended in a thin layer well into the picture, worked around in the figures’ flaking losses revealed a cooler gray underlayer.

57 The features of the face underneath the painted figure of the fiddler composition. The yellow paint of the floor also conceals changes in position of the two feet in the middle of the composition.

58 The features of the face underneath the painted figure of the fiddler composition. The yellow paint of the floor also conceals changes in position of the two feet in the middle of the composition.
which is painted using a red lake glaze applied over a light yellowish underlayer. Flaking losses reveal two paint layers on the ground, under the present painting of a fiddler. First, a light blue paint layer, which apparently contains indigo, extends between the legs of the fiddler's indigo costume. On top is a red layer, which continues under the artist's palette and terminates along a white impasto line under the fiddler's right thigh. This marks a transition to a gray underlayer, also present under the top part of the painted canvas.


59 Groen 1988, especially pp.59-61. Research suggests that the formation of pits or holes throughout the body of certain emulsion paint mixtures can be caused by bubbles of trapped solvent. An oil paint, in which hydrophilic substances used for grinding pigments got trapped, could show this same phenomenon.

63 See notably: Young Man with a Skull c. 1626-28, fig.50.