Jobarde, a Rediscovered Painting
by Édouard Manet
Jobarde, a Rediscovered Painting
by Édouard Manet

Milko den Leeuw

Atelier for Restoration & Research of Paintings
## Contents

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Foreword</td>
<td>6</td>
</tr>
<tr>
<td>Introduction</td>
<td>8</td>
</tr>
<tr>
<td>The Object of Research</td>
<td>10</td>
</tr>
<tr>
<td>The Method</td>
<td>16</td>
</tr>
<tr>
<td>Art Historical Research</td>
<td></td>
</tr>
<tr>
<td>1.   Written Sources</td>
<td>16</td>
</tr>
<tr>
<td>1.1 Bibliography of Édouard Manet</td>
<td>17</td>
</tr>
<tr>
<td>1.2 The Will of 30 September 1882</td>
<td>21</td>
</tr>
<tr>
<td>1.3 Inventaire Après Décès Édouard Manet</td>
<td>22</td>
</tr>
<tr>
<td>1.4 Retrospective Exhibition of 5-28 January 1884</td>
<td>23</td>
</tr>
<tr>
<td>1.5 The 1884 Hôtel Drouot Auction Catalogue</td>
<td>23</td>
</tr>
<tr>
<td>1.6 The Durand-Ruel Archive</td>
<td>23</td>
</tr>
<tr>
<td>2.   Provenance</td>
<td>24</td>
</tr>
<tr>
<td>2.1 The Provenance of Jobarde</td>
<td>24</td>
</tr>
<tr>
<td>3.   Image Research</td>
<td>30</td>
</tr>
<tr>
<td>3.1 Lochard's Photographs</td>
<td>30</td>
</tr>
<tr>
<td>3.2 Preliminary Sketches</td>
<td>31</td>
</tr>
<tr>
<td>3.3 Sketchbooks</td>
<td>33</td>
</tr>
<tr>
<td>3.4 The Names, the Monogram, and the Colour Signature of Jobarde</td>
<td>34</td>
</tr>
<tr>
<td>3.4.1 The Names</td>
<td>34</td>
</tr>
<tr>
<td>3.4.2 The Monogram</td>
<td>38</td>
</tr>
<tr>
<td>3.4.3 The Colour Signature</td>
<td>44</td>
</tr>
<tr>
<td>4.   Œuvre Research</td>
<td>46</td>
</tr>
<tr>
<td>4.1 Introduction</td>
<td>46</td>
</tr>
<tr>
<td>4.2 The Classification of Manet’s Work</td>
<td>48</td>
</tr>
<tr>
<td>4.3 Two Styles</td>
<td>50</td>
</tr>
<tr>
<td>4.4 Renoir</td>
<td>51</td>
</tr>
<tr>
<td>4.5 The Summer of 1873</td>
<td>52</td>
</tr>
<tr>
<td>4.6 Survey of the Year 1873</td>
<td>54</td>
</tr>
<tr>
<td>5.   Context</td>
<td>56</td>
</tr>
<tr>
<td>5.1 Hispanism</td>
<td>56</td>
</tr>
<tr>
<td>5.2 The Prado</td>
<td>59</td>
</tr>
<tr>
<td>5.3 The Manet-Manette ‘Style’</td>
<td>62</td>
</tr>
<tr>
<td>5.3.1 Internal Symmetry</td>
<td>62</td>
</tr>
<tr>
<td>5.3.2 Bilateral or External Symmetry</td>
<td>64</td>
</tr>
<tr>
<td>5.4 Image Comparison</td>
<td>65</td>
</tr>
<tr>
<td>5.5 The Superlative: Life!</td>
<td>70</td>
</tr>
<tr>
<td>5.6 The Title Jobarde</td>
<td>72</td>
</tr>
<tr>
<td>6.   Evaluation Art Historical Research</td>
<td>74</td>
</tr>
</tbody>
</table>
Painting Technique Analysis

1. Pictorial Analysis
   1.1 “The Daumier of his Time”
   1.2 The Studio of Thomas Couture

2. Étude, Ébauche and Fini in Manet

3. Manet’s Brushes

4. The Development of Manet’s Painting Hand

5. Analysis of the Painting Technique in Jobarde
   5.1 Composition and Perspective
   5.2 Light and Colour
   5.3 Paint Layer and Brushstroke

6. Pictorial Comparison of Jobarde with Manet’s Oeuvre

7. Visualization Analysis of the Painting Technique in Jobarde
   7.1 UV-Fluorescence
   7.2 False Colour Infrared
   7.3 Infrared Reflectography
   7.4 X-Ray
   7.5 K-Edge

8. Pictorial Comparison of the Summer of 1873

9. Evaluation Painting Technique Analysis
Technical Material Analysis

1. Painting Materials
   1.1 Maison Blanchet
   1.2 Stretcher and Canvas
   1.3 Manet's Palette
     1.3.1 Paint Cross-Sections
     1.3.2 The Palette of Étude, Ébauche and Fini

2. Lead Isotopes
   2.1 The Context of Lead Isotope Research
   2.2 From Ore to Paint
   2.3 From Lead Powder to Paint Tube
   2.4 The Comparison of Isotopes in Jobarde and Le Bateau Goudronné
     2.4.1 Protocol Isotope Research

3. Evaluation Technical Material Analysis

Conclusion

Annexes

Appendix A
Report of the analysis of the monogram

Appendix B
Multispectral imaging at 480 dpi with 13 filters including additional infrared data

Appendix C
Applied Physics 2006
Zeitschrift für Kunsttechnologie und Konservierung 2005

Appendix D
The element research of Jobarde
Report on scientific examination
Binder Analysis

Bibliography

Articles & Technical Studies

Index

Photograph Credits
In 2002, a painting was presented to the Atelier voor Restauratie & Research van Schilderijen (ARRS) with the request to investigate the authenticity of the work. The owner asked for this research because documentation on the painting was limited to a summary provenance of the object: just a few letters by painting experts.

We decided to draw up a rigorous research plan. The first thing to do was to determine if we were dealing with a painting ‘from the period’. Once this had been confirmed, we decided how to proceed with our investigation into the maker of the painting. This book is the record of that ‘road to authentication.’

The goal of this publication, however, is not only to determine the authenticity of the painting as such, but also to document the many aspects that play a role in such an authentication. It is about interdisciplinary research. The small number of works on authentication that have been published are dominated either by the art historical or the technical approach. This publication aims at breaking new ground by recording every aspect of the art historical, technical paint and material research.

Several people have generously participated in the extensive research and this calls for a note of thanks for their willingness to share their knowledge and experience.

Firstly we would like to thank the owners of the painting for their patience and support. Without their enthusiasm this project could not have been completed.

We are indebted to Willem Russell for his particularly stimulating contribution to the methodology of the process of authentication. The Technische Universiteit Delft played an important role by contributing brain- and manpower to parts of the technical analyses. The technical research conducted by Kris Krug was of particularly great significance for the conclusions of the authentication research. In this respect we also owe a debt of gratitude to the team lead by Alberto Bravin at the ESRF in Grenoble that gave us permission to use the medical beamline.

We would also like to thank the Department of Earth Sciences-FALW, Vrije Universiteit Amsterdam, for the preparation of polished oriented sections of paint chips. We owe a special debt of gratitude to Wynanda Koot. The Geotechnical Laboratory for Optical Microscopy, Electron Microscopy and Qualitative X-ray Analysis (EDS) was also very helpful. We would like to thank Alex den Ouden, Saskia Kars and Wim Lustenhouwer in particular.

We would also like to thank Gareth R. Davies of the Thermal Ionization Mass Spectrometry (TIMS) Laboratory for his contribution to our investigation.

Our special thanks go out to Nicholas Eastaugh and Jilleen Nadolny.

Our gratitude goes out to Pascal Cotte and Jean Penicaut of Lumière Technology for their contribution to the imaging of the painting.

The archive research in Paris was very efficiently and thoroughly prepared by Eloise d’Argent. We would like to thank her and Monsieur Hermès and Madame Du Chantelle of the equestrian Museum Hermès in Paris.

The museums that gave us permission to examine paintings by Édouard Manet were instrumental in helping along our investigation. The American museums in particular were a paragon of hospitality and openness.

We thank Judith F. Dolkart and Marilyn Kushner at The Brooklyn Museum of Art in New York, Barbara Buckley at The Barnes Foundation in Merion, John Zarobell at the Philadelphia Museum of Art and Inge Dupont at The Morgan Library in New York, Iris Schaefer, Caroline von Saint-George and KatYes Lewerenz at the Wallraf-Richartz-Museum in Cologne.
and Clotilde Roth-Meyer in Paris, as well as Bernard and Maria Hahnloser from the Hahnloser Collection in Bern and Rudolf Jäggi at the Kunsthalle in Bern. Thanks to Bonham’s auction house in London. Thanks to Musée d’Orsay, Paris.

Our special thanks go out to the handwriting expert H. Hardy for examination of the handwriting at Manet’s letters.

We would also like to thank the curators and owners of several private collections.

Our special thanks go out to Paul Durand-Ruel who received us with great hospitality and granted us access to his family’s private archives. His encouragements to pursue our investigation were heartwarming.

Our special thanks go out to Rudi Ekkart, Nanne Dekking and Betsy Wieseman for the critical reading and positive advise.

We would like to thank Solange de Boer and Hanny Opheij for their editorial work on this publication and Walter van der Star for the translation. The iconography was handled expertly by Maarten Helle.

Design, layout and printing were done by DeltaHage.

Finally we would like to thank the transport firm Art Handling Service that succeeded in shipping the painting all over the world on time and in perfect condition.

“We are fully aware that we trespassed into fields that belong to other specialists but we trust that they will forgive us.”

Milko den Leeuw
Introduction

Modern authentication research can be divided into three research schools: art historical research, technical paint analysis and technical material analysis. The art historian focuses on historical and visual analysis. The painterly aspects are investigated by the painting conservator. Material analysis is based on scientific research which is carried out in various laboratories under the supervision of a conservation scientist. The fact that these three schools have been brought in an authentication project is actually no more than a ‘natural’ consequence of the genesis of a painting. Initially, the concept, the manual work and the materials exist as separate entities and they are subsequently combined to produce the work of art.

Yet collaboration between the three disciplines has not always been a matter of course. In the 19th century, it was common practice within the discipline of art history to settle questions of authentication on the basis of individual authority. For generations a minority of ‘art experts’ determined the authenticity of works of art. It wasn’t until the 1930s that there was a call for collaboration which would involve not only art historians, but also experts from different technical disciplines. Some scientists put the theory into practice and formed a more diversified team.

By now history has learned that authentication isn’t ‘research based on authority’ and that the stacks of certificates this usually produced were in fact an open invitation to forgery.

In the 21st century the technical possibilities for authentication research have substantially grown, but this hasn’t made the task of the art historian any easier. A modern art historian is by no means properly prepared to collaborate on such a complex task. Many years of research into the oeuvre of one artist is no guarantee for a reliable assessment of a painting. He or she must also be able to assess technical reports and participate in setting out the course of a technical investigation.

A second obstacle is that there is a lack of consensus about the course that such research projects should follow. Every editor of a catalogue raisonné, member of an authentication committee, staff member of a museum or an art institute or individual expert has developed his or her own particular method of assessment. Although in the United States these issues are now openly being discussed, there is still room for a greater transparency of methods.

Finally, the demands of the market, which always requires a quick answer, partly because of the enormous financial interests that are involved, are responsible for the increasingly strained relations in art authentication research.

All of this has led us to decide that this publication should give a comprehensive description of the methodology and procedures of authentication research. Perhaps this case study can serve as a model for future research. The wide-ranging method of analysis has been applied on a painting that in our opinion should be attributed to Édouard Manet. Why the painting should be attributed to him, and why it has escaped attention so far, is unravelled step by step in this study. But those essential questions that could not be answered adequately are also presented here.

We have conducted wide-ranging art historical research. New technical and material research methods were only used on this painting after extensive testing, unless they had already been applied in other fields of research. The outcome of the different investigations were assessed in consultation with the team in order to determine what the results meant and which conclusions should be drawn from them.

We hope that this unique study of Jobarde will give renewed incentive to authentication research and open new avenues will raise the standard of this type of investigation.
The Object of Research

Description of the painting as seen with the naked eye.

The representation on the canvas is an Amazon, a woman rider on horseback in a slightly rolling dune landscape by the sea or by a lake. There are mountains in the background. The Amazon is dressed in a woman’s riding costume with a masculine aura. It consists of a close-fitting tailored coat and a voluminous woolen skirt that is longer on one side to accommodate the side-saddle position. Around the neck and the wrists the collar and cuffs of the white blouse are visible, which adds to the feminine aspect of the costume. The same can be said of the red flower on her left breast. The Amazon is wearing gloves and she is holding a whip in her right hand and the horse’s reins in her left. The costume is completed by the ultimate symbol of masculinity: the silk top hat. The Amazon’s dress appears to be in keeping with the clothing style that was fashionable during the 1870s under the Second Empire.

The horse, a so-called ‘park or ladies hack’, is an English thoroughbred crossed with an Anglo-Arabian, and is probably between 1.45 m and 1.60 m high. The horse has a dark brown coat and its manes are trimmed and loosely combed. The nineteenth-century haute bourgeoisie used this popular type of thoroughbred horse to ride to fashionable meeting-places. The horse is equipped with a side-saddle, a park saddle with a broad cord girth with a single strap that is fastened around the saddle. The bridle is a double full or Weymouth bridle with a Pelham bit and is fastened to a fixed martingale that hangs loosely over the horse’s chest.

At the bottom left we see a monogram ‘M’. In the middle we can see the almost illegible word ‘Jobarde’ and at the bottom right there is a name that has been scraped off or erased and that reads Beau(?)(?)Z(?). The painting is oil on canvas and measures 85.6 x 50.5 cm. The stretcher edges have been cut off and the painting has been relined.

The painting is mounted on a twentieth-century stretcher onto which the remains of a nineteenth-century stretcher have been screwed. These stretcher remains bear the inscription: ‘Blanchet 17, Rue de Grenelle 17’. To the right there is an inscription in modern pen ink: Haras: Jobarde/Cheval: ‘Beauté’.
The backside of the painting
The Method

The method that has been applied in our investigation resulted from the current discussion about painting authentication. This research method broadens traditional authentication research to three main groups. Each main group has a number of subgroups. During our investigation, each subgroup was given its own status on the scale of the assumed authorship of the painting. When one element establishes a positive connection, this of course argues in favour of an assumption. Each status can lead to three possible evaluations: negative, positive, or neutral. The process of attributing a status is explicitly described in this publication and summarized at the end of each chapter.

Furthermore, each status has a level of complexity is indicative of the extent to which the authenticity or authorship can be (deliberately) manipulated. A low status can easily be manipulated, a high status is virtually immune to manipulation (during the demonstration process). The introduction date indicates in which period a certain research method became generally accepted, for example through the introduction of new technical methods or the wider application of existing scientific tools.

When this system is applied to the painting Jobarde, this leads to the following model. The qualifications and results will be explained under each section in the course of this publication.

<table>
<thead>
<tr>
<th>Research Art Historical Research</th>
<th>Location</th>
<th>Complexity</th>
<th>Introduction date</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Written sources</td>
<td>Archives/Collections</td>
<td>low to high</td>
<td>nineteenth century</td>
</tr>
<tr>
<td>2. Provenances</td>
<td>&quot;</td>
<td>average-high</td>
<td>nineteenth century</td>
</tr>
<tr>
<td>3. Image research</td>
<td>&quot;</td>
<td>high-highest</td>
<td>nineteenth century</td>
</tr>
<tr>
<td>4. Oeuvre research</td>
<td>&quot;</td>
<td>average-high</td>
<td>twentieth century</td>
</tr>
<tr>
<td>5. Context</td>
<td>&quot;</td>
<td>average-high</td>
<td>nineteenth/twentieth century</td>
</tr>
</tbody>
</table>

| Painting Technique              | Studio                    | high-highest   | twentieth century       |
| 6. Pictorial analysis           | "                         | average-highest| nineteenth/twentieth century |
| 7. Technical paint analysis     | "                         |                |                         |

| Material Research               | Studio/Laboratory         | high-highest   | nineteenth/twentieth century |
| 8. Material analysis            | "                         |                |                          |
Jobarde, a Rediscovered Painting
by Édouard Manet

Art Historical Research

“The historian should not collect the facts randomly, without any system.”
Lucian of Samosata (ca. 150 A.D.)
Art Historical Research

One of the most important aspects of art historical research in determining authenticity is the analysis of visual material, documents, and written or published sources. For this investigation, they have been subdivided into five main groups: written sources, provenances, image research, oeuvre research and context. What follows is an account of the assessment of the painting Jobarde on the basis of this classification.

1. Written Sources

Édouard Manet did not leave a Liber Veritatis reproducing all the artworks that he made. In this investigation, we were dependent on secondary sources. The existing documents proved to be of uneven quality and in some cases even contradicted each other. This is partly why we have compiled a biography that focuses on topics that are relevant to the development of Manet’s oeuvre in relation to the object of research, Jobarde.

This biography was used as a guideline for further art historical investigation and led us to the “Inventaire Après Décès Édouard Manet”, the will of 30 September 1882, the retrospective exhibition of 5-28 January 1884, the Hôtel Drouot auction catalogue and the Durand-Ruel archive.
1.1 Bibliography of Édouard Manet

1832, 23 January. Édouard Manet is born in Paris.
Source: Birth certificate in the Paris municipal archives.

1845. Manet takes his first drawing lessons at the Collège Rollin. Here he meets Antonin Proust, with whom he strikes up a lifelong friendship. Proust later declared that Manet paid regular visits to the Spanish Museum to see the paintings in the collection.

1848. Manet enrolls as an apprentice pilot on the merchant ship Guadeloupe in Le Havre. He spends the winter of 1848-1849 in Rio de Janeiro. His caricatures are especially appreciated by the ship’s captain and members of the crew.

1849. After failing the entrance exam to naval college, Manet is given permission by his father to dedicate himself to painting.

1850, January. The painter Thomas Couture accepts Manet as a pupil in his studio. Couture had won a gold medal at the Salon of 1846 for his painting Romans of the Decadence. Manet works in his studio for six years.

1850. Manet takes piano lessons from his future wife Suzanne Leenhoff, a Dutch girl from Zaltbommel.

1852. On 29 January Suzanne Leenhoff gives birth to a son, Léon-Édouard Koëlla Leenhoff. It is commonly assumed that Édouard Manet is the father. However, Manet never officially acknowledged the child as his own.

1852. Manet studies the work of the Spanish masters in the Paris museums.

1852, July: Manet travels to the Netherlands for the first time and studies the work of the Dutch masters.
Source: Edmond Bazire, Manet, Paris 1884.
1853. Manet travels to Kassel, Dresden, Prague, Vienna and Munich to study the work of the old masters. He copies a painting by Rembrandt.

1853, September. With his brother Eugène, Manet goes on the Grand Tour and travels through Italy. Their itinerary includes stays in Venice, Florence and Rome.

1856. After another quarrel Manet leaves the studio of Thomas Couture. He opens his own studio on the rue Lavoisier.

1858. Manet paints *Le Buveur d’Absinthe*, as proof of his originality. The painting is rejected for that year’s Salon. His teacher Thomas Couture was probably among those who opposed Manet’s painting.

1861. Manet’s *Espagnol Jouant de la Guitare* is admitted to the Salon, together with *Portrait de M. et de Mme M....* The former painting receives an honorable mention. It is Manet’s debut at the Salon.

1862, 15 September. Auguste Manet, Édouard Manet’s father, dies.
Source: Death certificate in the Paris municipal archives.

1863. 28 October. Manet marries Suzanne Leenhoff in Zaltbommel.

1865, September/October. Manet travels to Madrid. The city leaves a lasting impression on his work.

1867. Manet’s work is rejected by the jury of the *Exposition Universelle* in Paris. Émile Zola writes an article in defense of Manet in the review *Le moment artistique*.

1867, 24 May. Manet opens his *Exposition Particulière* on the Pont de l’Alma in Paris, right next to the *Exposition Universelle*.
Source: Exhibition catalogue *Exposition Universelle*, May 1867.
1867. Manet works on the painting series L’Exécution de Maximilien.

1868, Summer. Manet works on views of the port in Boulogne-sur-Mer.

1870, September. Outbreak of the Franco-German war.

1871, 18 May. Manet returns to Paris, where the civil war is still raging in the streets.

1872, January. The art dealer Paul Durand-Ruel buys a total of twenty-five paintings from Manet in two transactions. This temporarily alleviates Manet’s financial problems.

1872. Manet rents a new studio on the rue de Saint-Pétersbourg.

1872. Manet paints Les Courses au Bois de Boulogne, commissioned by M. Barret.

1872-1875. Manet works on paintings of horses with riders or Amazons. Many of these remain unfinished.

1873. Manet submits Le Repos and Le Bon Bock to the Salon. The works meet with mixed reactions. The first work is vilified, the second receives high praise.

1873, summer. The Manet family spends the summer in Étaples near Berck-sur-Mer. Manet draws and paints views of the beach.

1874, 15 April. On the Boulevard des Capucines number 35, in the building of the friendly photographer Félix Nadar, the first exhibition is held of the “Société Anonyme coopérative à capital variable des artistes, peintres, sculpteurs, graveurs et lithographes”. From that moment on, the group is known as ‘the impressionists’. The idea for the exhibition came from Frédéric Bazille, who had died during the war, and followed the constant rejection of modernist works by the Salon. Manet does not participate in the exhibition. He is absolutely convinced that the
battle against the establishment should be fought from the ‘inside’.

1874. Manet submits three paintings to the Salon: *Les Hirondelles*, *Le Bal de l’Opéra*, and *Au Chemin de Fer*. Only the last painting is shown.

1876. 15 April - 1 May. The Salon submissions *L’Artiste* and *Le Linge* are rejected. Simultaneously with the second impressionist exhibition, Manet organizes an exhibition of the works that were rejected in his studio.

1876. In that year, Manet probably experiences the first symptoms of his fatal illness. He has trouble walking.

1878. Manet chooses not to submit any work to the *Exposition Universelle* and the Salon. As a consequence he cannot be rejected. He prefers to show his work in his own studio.

1880. Manet once again starts to work on portraits of Amazons.

1882. 3 May. Manet exhibits his last masterpiece, *Un Bar aux Folies Bergère*, at the Salon.

1882. 30 September. Manet writes two copies of his will in the presence of his notary.
Source: Archives Nationales, Paris.

1883. Manet dies on 30 April, at the age of 51, and is buried on 3 May in Passy.

1884. 5 January. On the recommendation of Antonin Proust, an exhibition of Manet’s work is organized at the École des Beaux-Arts in Paris. Émile Zola writes the foreword of the catalogue.

1884. 2-5 February. The auction catalogue contains 169 paintings that have been inventorized in Manet’s studio.
Source: *Catalogue de Tableaux*, Hôtel Drouot 1884, salles nr. 8 and 9.
1.2 The Will of 30 September 1882

Seven months before his death Manet drafted his will.¹ He appointed his brother Eugène Manet, his wife Suzanne Leenhoff, and his cousin Jules Dejouy as his executors. His friend Théodore Duret was instructed to supervise the sale or destruction of the works in his studio. Manet wrote: “The pictures, sketches and drawings remaining in my studio after my death are to be sold at auction. I should like my friend Théodore Duret to take charge of this sale, trusting entirely in his taste, and in the friendship he has always shown me, to decide what should be put up for auction and what should be destroyed. I should like him to choose from my work a picture to remember me by.”²

This last wish supports the assumption that the oeuvre as a hermetic legacy was incomplete on two points. Manet speaks of “the pictures, sketches and drawings remaining in my studio” and of “what should be destroyed.” Both remarks suggest that Manet had already sifted through the works at an earlier stage, warranting the conclusion that the oeuvre was no longer complete even before he died.

¹ The will is kept in the Archives Nationales in Paris and was examined by us in 2004.
1.3 Inventaire Après Décès Édouard Manet

On Monday 18 June 1883 at 13.00, according to the “Inventaire Après Décès Édouard Manet no. 40,” an inventory of the paintings of Manet was made at “[u]n appartement dependant d’une maison sise à Paris rue de Villejust no 40” and “l’atelier de M. Manet, sise à Paris rue d’Amsterdam no 77.” This inventory was intended as a survey of the works by Manet that were present in his studio and his living quarters at that moment. Most probably the document was drawn up under pressure, because problems surrounding the rights of inheritance of Suzanne Manet-Leenhoff and her son Léon Leenhoff had to be adequately resolved and existing financial debts needed to be settled. Since Manet’s paintings did not always have definitive titles at the time, it is necessary subject this inventory to renewed scrutiny.

It soon becomes clear that many of the titles were not attributed by Manet himself, for example because a work was unfinished. There also seems to be some confusion about which title belongs to which work. For example, on page 9 under number 30 we find the mention: “Amazone à cheval prisé cent francs 100”. This painting can be linked to a photo by Lochard with number 48. However, it’s unfinished companion piece, of a horse rider who was only later identified as Émile Guillaudin, is not recognized as such. It was photographed by Lochard under number 88. Number 35 carries the mention “Amazone fond bleu prisé cent cinquante.” This painting is linked to photo 161 by Lochard, but later became known as Amazone de face. Under the heading “Estimation des études paintes” on page 11 we find the following descriptions: Le cavalier (probably Lochard number 88), Amazone de profil (Lochard number 124), and Amazone déchirée (no corresponding photo by Lochard). This unfinished work, which later became known as Amazone from 1882, is now in the Hahnloser Collection in Winterthur.

This brings us to the conclusion that the titles of the artworks are exchangeable and that Lochard’s photographic record does not include all the works that were present when the inventory was drawn up or were added to the ‘Inventaire Après Décès Édouard Manet’.

---

3 For Fernand Lochard, see § 3.1, see page 30, Lochard’s Photographs.
5 Ibidem, p. 249-250.
6 Ibidem, p. 249.
1.4 Retrospective Exhibition of 5-28 January 1884

More than 13,000 people visited the retrospective of Manet’s work. The retrospective was held at the École Nationale des Beaux-Arts and was a posthumous tribute to the life and work of Manet. However, it did not give a complete overview of Manet’s work. One hundred sixty-nine works were shown. On the occasion of this exhibition a catalogue was published, the *Catalogue Exposition posthume Manet*, with a foreword by Émile Zola. The catalogue makes no mention of the painting *Jobarde*.

1.5 The 1884 Hôtel Drouot Auction Catalogue

Both the will of 30 September 1882 and the inventory of his studio of 18 June 1883 were used as official documents accompanying the auction of Manet’s works on 4 and 5 February 1884 at the Hôtel Drouot. The auction catalogue makes no mention of the painting *Jobarde*, so we might assume that it was no longer part of the collection of Manet’s heirs at the time.

1.6 The Durand-Ruel Archive

In 1872, Durand-Ruel was the first serious buyer of Manet’s work. The firm of Durand-Ruel continued to deal in works by Manet, even after his death. As mentioned earlier, Paul Durand-Ruel was also one of the compilers of the ‘Inventaire Après Décès Édouard Manet’, so there was every reason to consult the firm’s archives. Our request to do so led to an interview with the grandson of Paul Durand-Ruel, Mr. P. Durand-Ruel, about our object of research. He then personally looked into the firm’s archives, but this did not produce any information about *Jobarde*.

---

8 Catalogue des Tableaux, *Hôtel Drouot 1884, salles nr. 8 and 9*. 

---

WITTEN SOURCES
Provenance

The double meaning of the term provenance has evolved historically. On the one hand, provenance refers to the succession of owners of an object; it refers to the moment that the object reveals its existence to specialists working in the field of historical research. On the other hand, it is the source that reveals where and in which period an object is made. Provenance therefore is either causal or personal and thus leads to a timeline.

2.1 The Provenance of Jobarde

In the history of the provenance of Jobarde there are four moments when a personal connection emerges:

<table>
<thead>
<tr>
<th>1. Pierre M. Blanc</th>
<th>1930</th>
<th>Paris</th>
</tr>
</thead>
<tbody>
<tr>
<td>2. Maurice Marignane</td>
<td>1955</td>
<td>Paris</td>
</tr>
<tr>
<td>3. Erich Fehlmann</td>
<td>1961</td>
<td>Basle</td>
</tr>
<tr>
<td>4. J. Meier</td>
<td>1971</td>
<td>Basle</td>
</tr>
</tbody>
</table>

1. The first description of Jobarde dates from approximately 1930. The written note of a Paris painting expert, Pierre M. Blanc, was made during that period. We succeeded in tracing this expert in French archives. He was an art dealer and a “professeur en art.” He probably only wrote appraisals at the request of his clientele. Nothing can be surmised about his qualifications, because it is unclear on what his appraisals were based. Blanc's description of Jobarde includes the measurements of the painting, which in fact exceed its current dimensions. In his description he also attributes the painting to Manet. He situates the painting in Trouville and dates it around 1880.

* In de Bottins du Commerce from the period 1930-1933 Pierre Blanc is listed as an art dealer. He had probably already been active for some time.
Le trésor de la ville est très important et l'étude qui en a été faite a été réalisée par M. Blanc. Elle est très élaborée, avec un costume noir avec un petit col blanc, coiffé d'un haut de forme et garni de crème. Le style du vêtement donne l'époque de l'exécution de la peinture vers 1880.

Le peintre dont il s'agit ici est un homme du monde très apprécié par les gens des plus hautes classes et de la meilleure société. Il est dû à la plupart probable que cette peinture fut faite à Trouville ou sur la Côte d'Albâtre lors des vacances de l'artiste. Il aurait gagné des plages mondaines, d'ailleurs, du monte-carlo, et admis au club des cavaliers, ainsi avec ses amis, dirant des blagues et des," selon l'inscription qui suit.

Le manuscrit a été signé et daté de 1880.

[Signature]

Toile : Hauteur 0,86
Longueur : 0,51,52
2. Twenty-five years later, in January 1955, Maurice Marignane, “Expert près le Tribunal de la Seine et la Cour d’Appel de Paris,” writes that the painting Jobarde stems from a Hungarian collection.\textsuperscript{10} There is no further mention of the collection itself. It is notable that he also situates the painting in Trouville and dates it to around 1880. The measurements of the painting are also the same. He presumably read Pierre M. Blanc’s appraisal and copied large parts of it, see page 27.

3. The inside of the twentieth-century stretcher bears the stamp of “Erich Fehlmann Gemälde-restaurator Basel” and the date “15 dez. 1961.” We have tried to trace the restorer, but were only partially successful. According to former staff members of the Kunstmuseum Basel, this restorer was active about twenty-five years ago. We were unable to find any further information.

\textsuperscript{10} Several sources reveal that Maurice Matignane acted as an “Expert près le Tribunal de la Seine et la Cour d’Appel de Paris.”
Je reconnais pour une œuvre originale d'Édouard Manet. La peinture représentée au verso montrait une jeune et élégante amoureuse sur un cheval au bord de la mer.

La toile peut de dater aux environs de 1879-1880, époque où le maître passait le vacances à Bordeaux ou à Trouville.

La toile mesure 0.86 x 0.51 de large. Provenant d'une collection d'appréciation qui dit à son sujet à l'étranger dédié à une collection de Manet:

L'œuvre est monogrammée au bas à gauche, à droite est le nom du cheval par une autre main.

Paris Janvier 1955

Marignane
4. Dr. J. Meier was probably a chemist or painting restorer who wrote art appraisals in Basle. In his documentation, no address or additional information was found. Further attempts to trace this person did not yield any additional details.

On the basis of this provenance we have established that the painting surfaced on a couple of occasions throughout its history. Upon closer scrutiny, however, it still remains a mystery on which criteria the attributions were based. When we look at the complexity of provenance research in the graph under ‘The method’, average to high, then the quality of this provenance has to be rated as average. The information seems to be reliable insofar as contemporary experts were involved, but the written reports themselves are not sufficient proof of authenticity. Their status therefore should be evaluated as neutral.
3. Image Research

In image research the painting as it appears to the naked eye is compared with other pictorial sources such as studies, sketches, drawings, paintings, etchings or photographs. It allows us to date the whole or parts of the object of research and establish its place ‘in time’ and thus to back up or reject any visual proof of the artist’s authorship. The sources that have been examined in relation to the object of research are: Lochard’s photos, Manet’s drawings and sketchbooks, and every feature that might be connected with the written and painted marks that were found on the painting.

3.1 Lochard’s Photographs

Ferdinand Lochard had already taken photographs of some of Manet’s paintings during his life. After Manet’s death, Lochard proceeded to photograph the remaining works in the studio in a more systematic manner without being exhaustive. The photos were probably intended as illustrations for Léon Leenhoff’s study on Manet’s work and as a supplement to the ‘Inventaire Après Décès Édouard Manet’. However, this last document makes no mention of Lochard’s photos. Lochard’s photo albums are kept at the Département des Estampes of the Bibliothèque Nationale de France in Paris and at the Tabarant archive in the Pierpoint Morgan Library in New York. We searched both archives for a possible record of Jobarde, but found no photo of a matching painting.11

---

11 The investigations in Paris and New York were conducted in 2005.
3.2 Preliminary Sketches

To back up our investigation of Jobarde we have studied all the known drawings and water colours by Manet as far as this proved possible.\footnote{Denis Rouart and Daniel Wildenstein, Manet Peintures: catalogue raisonné, vol. 2, Lausanne: Bibliothèque des Arts, 1975.} ‘People and horses’ is a recurrent theme in Manet’s œuvre, but there are only two periods in which he worked on female horse riders or Amazons. The first period extends from 1872 to 1875, the second covers the year 1882. From 1872 to 1875 Manet focused on Amazons and male horse riders, in 1882 he studied Amazons as separate models. In connection with the investigation of Jobarde it is the first period that is of special interest.

\begin{figure}[h]
\centering
\includegraphics[width=0.5\textwidth]{image}
\caption{Édouard Manet, water colour L’Amazone, 1873-1874}
\end{figure}
One of the most striking and powerful water colours from that period is *L’Amazone*, a work that is kept at the Brooklyn Museum in New York.\(^{13}\) It was donated to the museum in 1923. It came from the collection of Suzanne Leenhoff-Manet and was sold to the art dealer Ambroise Vollard in 1894. The museum archives hold a note and a letter from Anne Coffin Hanson in which she writes that the water colour probably dates from around 1873-1874.\(^{14}\) Coffin Hanson does not go into any detail, but in earlier publications she has already established these dates on the basis of Manet’s choice of subject and colour palette.\(^{15}\)

The background of the water colour *L’Amazone* is formed by a colourful impression of a landscape with no recognizable features. This is characteristic of Manet’s style and colour palette in the years 1873-1874. The colour palette has apparently been applied to investigate the contrasts and dynamics of the light surrounding the Amazon and the horse. This is also suggested by the use of powerful brush strokes. Furthermore, the light source in the painting cannot be identified. The double shadows suggest that the light is coming from several different directions at once. Like in other works by Manet, the light has been made to accord with the way it is ‘experienced’. In his publication on Manet, Antonin Proust mentions his preoccupation with figures in daylight from the 1850s onward and quotes him as saying: “What is still not sufficiently understood is that one does not paint a landscape, a seascape, a figure; one paints the impression of an hour of the day in a landscape, a seascape, a figure.”\(^{16}\)

The 1993 catalogue, in which *L’Amazone* is reproduced in full colour for the first time, dates it to circa 1875-1876.\(^{17}\) Although it isn’t clear on what grounds this date has been chosen, the water colour can certainly be situated in the period 1873-1876. *L’Amazone* served as a preliminary study for an unfinished painting. But parts of the composition and the light and shadow effects show clear similarities with *Jobarde*. These observations are supported by analysis with the latest X-ray techniques. It has revealed notable similarities with respect to the light source and shadow effects. A detailed account of those results is included in § 7.5, pages 144-147: K-Edge.

---

\(^{13}\) The water colour is a preliminary sketch for another (unfinished) painting.

\(^{14}\) Brooklyn Museum, New York, Manet archive, number 23.45.


3.3 Sketchbooks

Lot 21 in Bonham’s 1991 auction catalogue of *Modern British and Continental Pictures*, was a drawing from a sketchbook by Manet. Unfortunately we have been unable to locate the present whereabouts of this drawing.\(^{18}\) However, we still have the photographic material and the description in the catalogue, confirming that the drawing also represents Amazons and horses. The ‘sketchbook page’ measures 7 x 11.5 cm and has the same dimensions as the loose pages from Manet’s sketchbooks kept at the Louvre (Département des Arts graphiques) and the Bibliothèque Nationale (Département des Estampes et de la Photographie) as well as in several private collections. The horses on the drawing are represented in the so-called ‘collected’ walk of dressage which doesn’t correspond with the halted stance of the horse on the *Jobarde* painting. However, the hats and costumes of the riders in the drawing and in *Jobarde* are somewhat similar. Here, it appears that Manet has mainly concentrated on making studies of different sidesaddle sitting positions and postures of a horse. The drawing is not dated, so in that respect no link with the object of research could be established.

\(^{18}\) *Email from James Knight of Bonham’s in London, 25 May 2007.*
3.4 The Names, the Monogram, and the Colour Signature of *Jobarde*

3.4.1 The Names

Texts or names on paintings aren’t unusual in the work of Manet; they had a functional and sometimes even humorous role. In the 1868 portrait of Émile Zola, for example, a book title is clearly visible, and on the portrait of Théodore Duret from the same year, a signature appears next to the tip of Duret’s walking stick. *Au Café* (1878) shows the mirrored lettering on the café window, while the names of dogs written on the paintings *Tama*, *Donki* and *Follette* are of a more private nature. Manet’s passion for graphic work also revealed itself in his etchings for book covers and book illustrations. In his younger years he already manifested himself as a caricaturist. Caricatures and texts, image and word have been closely related for centuries, but a painting with deliberately selected texts is another matter altogether. In this area Manet has also pushed back the boundaries of what was accepted. Texts were magnified or mirrored in the painting, or placed in such a way that they would immediately catch the eye. In fact, he used texts in his paintings in much the same way as was done in etchings or caricatures.

At the bottom of the painting *Jobarde* there are three groups of letters: a monogram ‘M’ at the bottom left, the word ‘Jobarde’, rendered almost illegible as a result of an earlier restoration, in the middle, and an erased name which reads as Beau(?)(?)Z(?)(?) at the bottom right. The name ‘Jobarde’ reappears on the back of the stretcher. Although it is written in modern ink, it is important as a confirmation of the name written on the actual canvas.

*At the bottom left there is a monogram ‘M’. At the bottom centre ‘Jobarde’ is already almost illegible. At the bottom right there is an erased name which reads as Beau(?)(?)Z(?)(?)*
At the bottom right of the photo, which probably dates from the 1960s, we can read the name ‘Beauté’. At the bottom centre ‘Jobarde’ is already almost illegible.
In a letter from 1955 Maurice Marignane writes: “The work is signed at the bottom left and the name of the horse at the bottom right is written in another hand.”

The sequence of the old photos, the earlier authentications and the visibility of the name at the bottom right of the painting itself have never been adequately documented. Therefore the chronology of the names cannot be determined. We can only assume that at one time the name must have been legible and that it has been overpainted at a later date and thus made invisible to the naked eye.

On this photo from the 1990s we can see the name ‘Beauté’ at the bottom right has been painted over.

In 2003, we removed the overpainting so that the name became partially legible.

‘Beau(?)t(?)éZ(?)’ could refer to ‘beauté’ (beauty), but it could also be read as ‘Beause’, which means ‘belly’ in Parisian argot.²¹ The female ‘Beauce’ was corrupted to ‘barbillon’, “a partner or lover kept by a demi-mondaine.”²² Because the writing was erased, it remains uncertain what the exact text was, but Beauté, Beause or Beauce all refer to the content of Jobarde. The earliest appraisal only hints at the name of the horse without actually mentioning it.²³ The name Beauté is the most plausible, because it was mentioned in the earliest appraisal, at a time when the name was probably still clearly legible.

²¹ Césaire Villatte, Parisismen, Gouda: Van Goor, 1895, p. 21.
²² Ibidem, p. 18.
3.4.2 The Monogram

Besides *Jobarde* there are twelve known paintings by Manet signed with the monogram ‘M’. Some of them are in a similar hand as the one on *Jobarde*, although there are still some slight differences. The one which most resembles the monogram on *Jobarde* is found on the small painting *L'Asperge* (1880, collection Musée d'Orsay, Paris). Adolphe Tabarant’s 1947 publication on Manet mentions an anecdote about this painting which is also relevant for *Jobarde*. We quote Anne Coffin Hanson’s version: “One of the most delightful still life paintings of his last years is the *Bunch of Asparagus*, bought by his friend Charles Ephrussi. Ephrussi was apparently very pleased with his purchase and sent Manet two hundred francs more than the agreed price. With characteristic gentle humor, Manet made a very private painting for Ephrussi, a single stalk of asparagus, which he sent to his friend with the message, ‘There was one missing from your bunch’.”

```
24 Anne Coffin Hanson argues that it must have been a very personal gift. Presumably the intended recipient of the painting ‘knew’ that it could only have come from Manet. All the sender had to do was place his monogram. ‘Manet’s art was all Manet; one cannot think of Manet’s paintings without thinking of the man himself,’ his friend George Moore wrote. But the fact that both paintings have a humoristic undertone also makes it quite likely that the recipient and the sender were closely acquainted. After 1880, the painting *L'Asperge* disappeared from the public domain for almost fifty years.
```

```
26 It took another twenty-five years before a graphic reproduction of the painting was brought into circulation. Altogether it had disappeared from view for over half a century. The fact that *L'Asperge* is the only other painting that has a comparable M as a monogram, raises the presumption that *Jobarde* suffered a similar fate: a gift from Manet that was cherished by the recipient and in due course by his family as well. In the light of this hypothesis we could also ask ourselves if the recipient of the painting was the model riding the horse, since the horse and the model are addressed ‘personally’ by their names. However, we must not forget that the impressionist painting style makes it hard to identify the model for *Jobarde*. For the person represented on the painting, who presumably belonged to Manet’s inner circle, ‘recognizability’ was probably not an issue.
```
Monogram ‘M’ on Jobarde
What follows is a list of all the paintings with a monogram that only consists of the letter M. More than half of these paintings were given away by Manet. Four of the twelve paintings represent animals. Three of these were named after the animal that was portrayed.

1. *Tête de Vieille Femme*, 1856
J.B. Faure was the first owner of this painting; it was first exhibited in 1906.

2. *Scène d’Atelier Espagnol*, 1860
This painting was bought by J.E. Blance at the 1884 auction.

3. *Cavaliers Espagnols*, 1860
This painting, bearing a monogram that is different from that on the painting under number 2, was first exhibited in 1905.

4. *Toreros en Action*, 1863
Salon de 1864, nr. 1282.

5. *Deux Poires*, 1864
Exhibited in 1867 at the Avenue de l’Alma, nr. 37.

6. *Tiges de Pivoines et Sécateur*, 1864
Given to Thoré-Bürger in 1869 and first exhibited at the *Exposition posthume Manet* in 1884.

7. *Les Amandes*, 1869
Given to his friend Henri Fantin-Latour. The painting was first exhibited at the *Exposition posthume Manet* in 1884.

---

28 Manet’s conceived his very first monogram in Couture’s studio. However, its style bears no resemblance with that of later monograms. See catalogue Rouart and Wildenstein, op. cit. (note 7), p. 36.
8. *Portrait de Berthe Morisot à l’Éventail*, 1874
Given to his friend Berthe Morisot in 1874. The painting was first exhibited at the *Exposition posthume Manet* in 1884.

9. *Huitres*, 1876
Given to his friend Claude Monet. The painting was first shown at the *Manet* exhibition at the Thannhauser in Berlin in 1927.

Given to his friend J.B. Faure. The painting was first shown at the *Édouard Manet* exhibition in Berlin in 1928.
The monogram M is a later addition.

11. *Le Chien – Donki*, 1876
The painting was first shown at the *Art Moderne* exhibition in Paris in 1912.

12. *L’Asperge*, 1880
Given to his friend Charles Ephrussi. The painting was first shown at the *Édouard Manet* exhibition in Berlin in 1928.
In the year 2002 we were given the opportunity to examine the monogram on the painting *L’Asperge* with a magnifying glass. Of all the monograms on Manet’s paintings, the one on *L’Asperge* bears the greatest resemblance in rhythm and style with that on *Jobarle*. Also notable is the fact that this specific painting had not been on public display for almost half a century.

Consequently, the idea was born to make a comparative analysis of the authenticity of the monograms on the basis of Manet’s letters and the monograms on *L’Asperge* and *Jobarle*. The handwriting expert H. Hardy who had already had ample experience in the comparative analysis of the signatures of Rembrandt van Rijn while working for the Rembrandt Research Project, was prepared to collaborate with us. The outcome of Hardy’s research for the Rembrandt Research Project was published in *Oud-Holland*.29

In our study this was the first time that a painter’s monogram was analyzed by comparing it to the handwriting in his letters. The results of H. Hardy’s analysis of the Manet monogram are reproduced in their entirety in Appendix A, see page 182-194, and will therefore not be discussed at this point. His conclusion is that the monogram on *Jobarle* is unmistakably in Manet’s handwriting.

---

The monogram on Jobarde

The monogram on L’Asperge
3.4.3 The Colour Signature

Manet did not only sign his paintings with the letters of his name. There is also the so-called colour signature. According to Beth Archer Brombert, it first appears on his paintings in 1865.\(^{30}\) She argues: "This was also the first of Manet’s paintings to use acid yellow as an accent, a signature touch that would reappear in the presence of a whole or partly peeled lemon, a handkerchief, a patch of light, or the binding of a book."\(^{31}\) Because Archer Brombert doesn’t name a source for this observation in her book, we have put the question to her. She told us that she most probably found the information in Anne Coffin Hanson and that Anne was the first to make this observation. We checked this, but were unable to locate the source.

On each of the more than one hundred and twenty paintings that were examined by us a colour signature was detected. From this we can deduce that, although no mention of this practice was found in contemporary sources, Manet’s paintings should have such a colour signature.

The colour signature consists of a small tuft of yellow applied with a single brushstroke – sometimes bright lemon, sometimes ocher. In some instances the signature is clearly visible, like on the protruding little handkerchief on *Mlle. V. in the Costume of an Espade*, in others it is very subtle, even in paintings in which apparently no yellow has been used. A good example is the painting *Dead Toreador* (National Gallery of Art, Washington): on which the small tuft of paint is visible on the stocking of the instep of the toreador’s right foot. It is minute and incompatible with the painting’s overall colour scheme. During my visit in November 2004 I had the

\(^{30}\) Brombert argues that the colour signature first appears in the series of paintings of beggars from around 1865. Our own findings suggest that it must have been around 1860.

\(^{31}\) Archer Brombert, op. cit. (note 16), p. 72.
opportunity to examine the Dead Toreador with a magnifying glass in the museum hall and was able to determine that the colour signature was part of the original paint layer. It is an elegant, deliberately placed tiny string of lemon yellow paint in the white highlight. 

Jobarde also has a yellow colour signature. It can be seen on the ground, directly under the horse’s hindquarters: a string of ochre paint on a boldly applied finish that was painted in one go, see page 44.

Another remarkable colour phenomenon that occurs in the works of Manet is his use of the single colour red to paint a motif or an object. In the paintings of the year 1873, this seems to only apply for individual details – for example the flowers on the hat in Le Chemin de Fer, the fire in the pipe in Le Bon Bock, the motif on the shoe in Sur La Plage, the fire under the kettle and the fire near the boat in Le Bateau Goudronné, the fish catch in the basket and the hat of the fisherman in Les Travailleurs de La Mer, the flag in the cradle of the windmill in Les Hirondelles, the sports paraphernalia in La Partie de Croquet à Paris, the costume of the unmasked woman in Le Bal de l’Opéra, or the crimson lips of Nina de Callias in La Dame aux Éventails. In the case of our object of research, Jobarde, it is the flower on her lapel.

A single brushstroke consisting of a small tuft of yellow paint on Le Bateau Goudronné
4. Oeuvre Research

Oeuvre research in authentication is the reconstruction of the chronology of the entire body of an artist’s known works. Works with a debatable provenance or date can then be situated within the framework of that chronology. The periodization of Manet’s work, its stylistic features, and general bibliographic research served as guidelines within this purely historical frame of reference. Our investigations were focused specifically on dating the painting Jobarde within the context of Manet’s oeuvre.

4.1 Introduction

On 30 April 1883 the artist Édouard Manet died. His legacy consisted of an oeuvre that leaves no viewer unaffected. The work is so dynamic and multifaceted that several generations were needed to form an overall picture and to interpret it. Antonin Proust wrote that Manet himself repeatedly expressed the wish that his oeuvre should be judged in its entirety. Manet said: “You know, I need to be looked at as a whole. And, I beg you, if I die, don’t let me enter public collections piece by piece. I would be poorly judged.”

However, because of his controversial actions, which also applies to other aspects of his life, Manet has made this virtually impossible. On several occasions Manet cut up or destroyed his own work. Other paintings disappeared from view after they had been sold or began on an obscure journey outside the public domain. Manet wanted his work to be seen as a whole, so that its evolution could be discounted in the way it was judged. “It has always been my ambition not to remain on the same level as myself, not to redo the next day what I had done the day before, constantly to be inspired by a new aspect, to seek to make a new note heard. Ah! the ones who don’t move, who have a formula, who hold themselves to it, who make a living from it, how can that interest art? I ask you that. On the contrary, to decide on one step forward, and a suggestive step, that is the function of a man with a brain! They will be happy, my dear friend, the people who live a century from now; the organs of their vision will be more developed than ours. They will see better.”

According to Manet, each new batch of works for the Salons demanded a different approach, and so they became visual benchmarks that make it easier for us to trace the evolution of his oeuvre. He used the Salons as a platform for his ideas and as a showcase for his painting style. This is corroborated by his numerous submissions to the Salons. Anne Coffin Hanson argues: “During his adult life from the time of his first submission in 1859 until his death in 1883 twenty-one Salons were held. Manet twice sent no works, was completely rejected from four...”

---

35 For Une botte d’asperges, bought by Charles Ephrussi and now in the Wallraf-Richartz-Museum in Cologne, see: Adolphe Tabarant, Manet, histoire catalogographique, Paris: Montaigne, 1931, p. 381. For L’Asperge, given to Charles Ephrussi and currently in the Musée d’Orsay in Paris, see: ibidem. The painting Bateau de Pêche Arrivant Vent Arrière, shown at Manet’s 1867 exhibition, is one of the many paintings that are still missing. See Coffin Hanson, op. cit. (note 15), p. 85.
exhibitions, but succeeded in showing works in all the others. To these exhibitions he submitted thirty-seven paintings of which twenty-six were accepted." And in a note she adds: “There is no record of the smaller works such as prints and sketches which were often shown hors catalogue.” Apart from the Salons, Manet’s own exhibitions provide an excellent yardstick for the development of his work. The paintings that were shown on those occasions were all made with an equal amount of dedication, vision and passion.

Manet’s work has been documented in numerous catalogues raisonnés. We have examined all of them in an attempt to locate or situate Jobarde and to map the chronology of the oeuvre. The works that were consulted are Manet by Edmond Bazire (1884), Histoire d’Édouard Manet et de son oeuvre by Theodore Duret (1902/1919), Manet et ses œuvres by Adolphe Tabarant (1947), and the catalogues raisonnés compiled by respectively Paul Jamot and George Wildenstein (1932) and Daniel Wildenstein and Denis Rouart (1975). These particular catalogues were consulted because some of them offer early descriptions of paintings, while the others display a clear systematic method which is indicative of an analytic approach. The most relevant details concerning the chronology that emerged from these publications will be discussed in the following chapters.

4.2 The Classification of Manet’s Work

In the account of our investigations into Manet’s drawings, see Image Research: § 3.2 Preliminary Sketches, see pages 31-32, we already mentioned that people and horses are a recurrent theme in Manet’s oeuvre, but that he focused specifically on the subject of women on horseback in the period from 1872 to 1875. The comparison with the drawing *L’Amazone* was also an indication that *Jobarde* probably dates from that same period.

In order to come to a more accurate definition of the period in which *Jobarde* was made, we took a closer look at Anne Coffin Hanson’s classification of Manet’s work according to subject and colour palette. She based herself on the Salon submissions, which in turn served as a guideline for the undated work. Coffin Hanson distinguishes three phases. In the course of these subsequent phases, the colour palette shifts from a fairly dark (the copies of old masters) to a lighter, more modern colour scheme. This light colour scheme coincides with the rise of impressionism: “A third phase begins in the early 1870s (from 1872 till 1883) when Manet was in close contact with his Impressionist colleagues and his work underwent a lightening of palette, a loosening of brush stroke, and a further simplification of form. On the surface, he seems to have turned more to direct observation of every day life (...) The year 1873 forms a great turning point, a transmission between his past, historical subjects and style in general and the very next year 1874.”

The outline of the three phases is as follows:

<table>
<thead>
<tr>
<th>dating</th>
<th>subject</th>
<th>colour scheme</th>
</tr>
</thead>
<tbody>
<tr>
<td>First phase: 1859 to 1865</td>
<td>copies and pastiches</td>
<td>dark palette</td>
</tr>
<tr>
<td>Second phase: 1865 to 1873</td>
<td>study in depth of traditional sources</td>
<td>dark palette</td>
</tr>
<tr>
<td>Third phase: 1874 to 1883</td>
<td>impressionism and independent work</td>
<td>light palette</td>
</tr>
</tbody>
</table>

---

37 In 1862 Manet painted a female model with a horse’s head in the background. The choice for this scene, entitled *Indienne Fumant une Cigarette*, can probably be traced back to the opera *Carmen*. In the following years, from 1864 till 1872, he regularly made paintings of race horses at Longchamp.

38 Coffin Hanson, op. cit. (note 15), p. 55-56.
However useful this classification may be, it became clear during the course of our inquiries that another classification could also be applied to Manet’s oeuvre. This classification, which is based on the subject matter of the work and was then used as a working hypothesis, is as follows:

<table>
<thead>
<tr>
<th>dates</th>
<th>subject</th>
<th>content</th>
</tr>
</thead>
<tbody>
<tr>
<td>First phase: 1859 to 1865</td>
<td>copies and pastiches</td>
<td>old masters, first</td>
</tr>
<tr>
<td></td>
<td></td>
<td>contemporary themes</td>
</tr>
<tr>
<td>Second phase: 1865 to 1873</td>
<td>traditional sources at a deeper level</td>
<td>topical work</td>
</tr>
<tr>
<td>Third phase: 1874 to 1883</td>
<td>still lives, friends, everyday life</td>
<td>independent work</td>
</tr>
</tbody>
</table>

And as a guideline:

First/third phase: 1859 to 1883 influence of old masters thematic work

This classification mainly focuses on the subject in relation to the content and is less clear-cut because there are overlaps between the different phases. The first period is characterized by paintings whose composition is based on partial studies of old masters. The period that follows is marked by a shift from the old masters to a modern vision. The final phase of Manet’s career is dedicated to independent work.

When we look at Jobarde in the light of Coffin Hanson’s blueprint we see that its subject fits in both the second and the third phase. Furthermore, Jobarde has a rather dark palette which, according to Coffin Hanson’s outline, corresponds with the work from the first two phases.

The second outline represents the treatment of content. Within that framework Jobarde can be classified under the second phase because, as we will see below, it also contains a clear reference to social relations.

Resuming, we can say that the painting should be situated in the second phase. In order to give this hypothesis a more solid basis and come up with a more accurate date, we have taken a closer look at Manet’s painting style and the periodization of his oeuvre.
4.3 Two Styles

One of the most striking features of *Jobarde* is the presence of two painting styles; the Amazon is depicted in an ‘impressionist,’ the horse in a ‘realistic’ style. The same contrasting styles can be found in the painting *Le Bon Bock* from 1873. At this point we should note that Manet never considered himself as part of the impressionist group. The term, however, had already been used in connection with painting technique since the eighteenth century.

In Manet’s time this had already been observed by Marie-Amélie Chartroule de Montifaud. On 1 June 1873 she wrote in *L’Artiste*: “Manet’s *Bon Bock*, if one consents to stand at a distance to look at it – which is really necessary – achieves a sort of lively brutality in the execution, if I may express myself. Don’t demand of the picture preordained rules of composition; the author doesn’t understand them or doesn’t want to understand them, but only the free and dominant note which each object has in nature. Manet doesn’t look for the expression of a face but rather for its general appearance. One perceives at first glance in his *Drinker* color areas laid on one next to the other with a somewhat crude simplicity and without any shading. But stand off a bit. Relations between masses of color begin to be established; each part falls into place, each detail becomes exact. I know that the strongest objection that can be brought against it is that a painting is made to be seen close to as well as from a distance. But one must, I believe, cease to judge Manet except by those standards by which his work becomes comprehensible and distinct. Then, since it acquires from a certain point of view serious qualities, it would be unfair not to use them in judging him.”

Here we also see that it is possible to distinguish two different styles or views for that matter in one painting.

Anne Coffin Hanson writes about that same year in connection with *Le Bon Bock*: “However, the year 1873 is seen as the key point in his career. All paintings from that year ‘look’ in palette, painting set up, brush stroke or composition more or less traditional. Controversies, the naturally aspect of his work, formed in this year well controlled and in balance.” And Manet’s biographer Beth Archer Brombert remarks: “Coming after *Le Bon Bock* (which was accepted at the Salon of 1873), such innovations (about the ‘full-blown’ impressionist technique in 1874) raised the hackles of the critics; he had fooled them into praising him for that painting (*Le Bon Bock*), and here he was back to his old tricks (about the painting *Boating*).” 1873 was therefore not only a turning point in Manet’s choice of subject matter and colour, but also in his choice of painting technique. For Manet it was the year of transition from a ‘realistic’ to a more ‘impressionist’ style, and some of his paintings show a combination of both styles. And it is precisely because of the simultaneous occurrence of both styles in *Jobarde* that it should be dated to the year 1873.

In the eyes of the viewers in 1873 such a combination of two painting styles was an outright provocation. Realism was considered to be the ultimate goal as well as the standard. Mixing two styles was of course a deliberate slap in the face of the viewer; the realistic style proved that the painter had ‘mastered his craft,’ while the impressionist style demonstrated that the realistic approach wasn’t the only true style.

---

40 Coffin Hanson, op. cit. (note 15).
4.4 Renoir

In order to find further evidence that Jobarde should be dated to the year 1873, we will take a short detour to Manet’s circle of friends, more specifically, to a work by Auguste Renoir that was rejected for the 1873 Salon: Allée cavalière au bois de Boulogne.

Manet must have spoken with Renoir about this rejection, especially because in that same year two works by Manet were accepted. The rejection of Allée Cavalière au Bois de Boulogne was also an important impulse for the founding of the Société Anonyme des Artistes on 15 April 1874. As we know, this gave way to the birth of the impressionist movement.

What is most important for our research is that the clothing depicted in Allée Cavalière au Bois de Boulogne and that in Jobarde are almost identical. The costumes of the Amazons are similar in design and fabric, the white collars and sleeves of both blouses and the flowers and hats are alike. However, Jobarde is not wearing a voile, contrary to Renoir’s Amazon, who looks chaste in every respect. Renoir’s Amazon is accompanied by a page, while Jobarde seems to have gone out riding alone, something which in those days was deemed socially unacceptable for a lady.

Auguste Renoir, Allée Cavalière au Bois de Boulogne, 1873
4.5 The Summer of 1873

Manet often drew inspiration from (aspects of) the work of earlier masters. In some cases he even fell back on certain aspects of his own work – sometimes the subject, sometimes just painterly details. One example of the latter is the way in which the surf is depicted in Jobarde. It closely resembles the surf in the painting *Sur la Plage* from 1873. This justifies a further investigation into the circumstances in which that last painting was made.

We have examined *Sur la Plage* in situ for technical details. It turned out that the paint surface contained a large amount of sand, so it seems probable that it was painted on the beach. This is not surprizing, because Manet would often work *en plein air* during the summer and return to his studio in the fall. From the bibliography we already know that Manet spent the summer of 1873 on the coast, in the town of Étaples.

---

42 During the exhibition Manet and the Sea which took place at the Van Gogh Museum in Amsterdam in August 2004.

Then we turned our attention to another painting from the summer of 1873: *Le Bateau Goudronné*. This work does not only display the same contrasting painting technique as *Jobarde*, but also a similarity in motifs: a controlled, evenly painted sky and a ground layer which moves in several directions: impressionist human figures and a realistic main motif (the boat, the horse). We have also examined *Le Bateau Goudronné* in situ for traces of sand, but none were found.** It was probably painted in the studio following the summer holiday of 1873 in Étaples. *Jobarde* is therefore comparable to *Le Bateau Goudronné* in two respects: it is situated outdoors, but the treatment of the paint surface suggests that it was made in the studio. As it now appears that we can date *Jobarde* to the late summer of 1873.

** During a visit to the Barnes Foundation in Philadelphia in March 2007.
4.6 Survey of the Year 1873

Although most of Manet’s paintings from the year 1873 are undated, we can reconstruct the production of that year as follows. The Salon exhibitions always opened during the first week of May. This, the main cultural event in France, usually caused a great deal of stress, so that month Manet probably spent little time behind his easel. The Manet family left for Étaples on 7 July and was back in Paris at the end of August. Le Bon Bock was submitted to the Salon of May 1873 and is generally considered to be a turning point in Édouard Manet’s oeuvre. However we chose it as a starting point for the year 1873 and subsequently focused on those paintings which, although their theme might suggest that they were made en plein air, were actually painted in the studio. On the basis of the catalogues raisonnés mentioned under § 4.1, see page 46-47, we have found five paintings from the period May to September that fit in this category, the numbers 3 to 8 in the list below. As we have indicated in the previous chapter, Le Bateau Goudronné was presumably painted during the late summer of 1873, and Jobarde was probably made in the same period.

1. Le Chemin de Fer dated 1873
   Oil on canvas
   93 x 114 cm.
   National Gallery of Art, Washington D.C.

2. Le Bon Bock dated 1873
   Oil on canvas
   94.6 x 83 cm.
   Philadelphia Museum of Art, Philadelphia

3. Sur la Plage undated
   Oil on canvas
   59.6 x 73.2 cm.
   Musée d’Orsay, Paris

4. Le Bateau Goudronné undated
   Oil on canvas
   59 x 60 cm.
   The Barnes Foundation, Merion, Pennsylvania

5. Marine undated
   Oil on panel
   20 x 33 cm.
   Wallraf-Richartz-Museum, Cologne

---

6. **Plage de Berck-sur-Mer à Maré Basse** undated
Oil on canvas
56 x 73 cm.
Wadsworth Atheneum Museum of Art, Hartford

7. **Les Travailleurs de la Mer** dated 1873
Oil on canvas
63 x 79.3 cm.
The Houston Museum of Fine Arts, Houston

8. **Marine** undated
Oil on canvas
50 x 61.5 cm.
Private Collection, New York

9. **Les Hirondelles** undated
Oil on canvas
81 x 65.5 cm.
Private collection

10. **La Partie de Croquet à Paris** undated
106 x 72.5 cm.
Kunstinstitut in Frankfurt

11. **Portrait de Marguerite de Conflans** undated
Oil on canvas
56 x 46 cm.
Oskar Reinhart collection, Winterthur

12. **Le Bal de L'Opéra** undated
Oil on canvas
60 x 73 cm.
National Gallery of Art, Washington D.C.

13. **La Dame aux Éventails** undated
Oil on canvas
113 x 166.5 cm.
Musée d'Orsay, Paris

---

5. Context

In authentication research the context divides into two parts. On the one hand there is the relation of the contemporary environment of the artist to his work in general. On the other hand each individual work has its own contextual network. In the case of Jobarde it is the Spanish influence on Manet’s work that leads to new insights.

5.1 Hispanism

There are numerous contemporary sources of Manet’s life and work: primary sources such as letters, wills and deeds of sale, and secondary sources such as eye witness accounts, news-papers, reviews, cartoons, and publications by contemporaries or friends, among whom Émile Zola, Charles Baudelaire, George Moore, Théodore Duret, Zacharie Astruc, Auguste Renoir and Antonin Proust. All of this creates a broad picture of the time in which Manet worked and lived. One of the characteristics of Manet’s time is the great interest in Spain – a direct consequence of the fact that the empress of France, Eugénie de Montijo, was Spanish. This so-called Hispanism ranged from fashion, music and dance to bullfighting and a taste for Spanish art. Manet had already been enchanted by Spain after visiting the collection of the Spanish Museum in Paris with his friend Antonin Proust, where he first saw the works of El Greco, Goya, Ribera, Murillo, Zurbarán and Velázquez.48 Later in his life, when he had already used Spanish themes in his work many times, Manet visited Madrid; in September 1865 he traveled to the Prado in order to study his favorites. In a letter to his friend Henri Fantin-Latour from 3 September 1865, he writes:

“How I miss you here and how happy it would have made you to see Velázquez who all by himself makes the journey worthwhile; the artist of all the other schools around him in the museum at Madrid, who are extremely well represented, all look like shams. He is the supreme artist; he didn’t surprize me, he enchanted me. The full-length portrait we have in the Louvre is not from his hand. Only the Infanta is indisputable. There is a huge painting here, full of little figures like those in the Louvre picture called the Cavaliers, but with figures of women as well as men, perhaps of higher quality and above all completely unrestored. The landscape in the background is by a pupil of Velázquez.

The most extraordinary piece in this splendid oeuvre and possibly the most extraordinary piece of painting that has ever been done is the picture described in the catalogue as a portrait of a famous actor at the time of Philip IV; the background disappears, there’s nothing but air surrounding the fellow, who is all in black and appears alive; and the Spinners, the fine portrait of Alonso Cano; Las Meninas, another extraordinary picture; the philosophers, both amazing pieces; all the dwarfs, one in particular seen sitting full face with his hands on his hips, a choice picture for a true connoisseur; his magnificent portraits – one would have to go through them all, they are all masterpieces.”49

---

48 When King Louis-Philippe acquired more than four hundred works from the collection, a large number of those paintings were transferred to the Louvre. See Archer Brombert, op. cit. (note 16), p. 9-11.
49 Wilson-Bureau, op. cit. (note 2), p. 34.
The letter reveals what Manet experienced during his visit to the museum, particularly when he saw the works of Velázquez ‘in real life,’ but it is also important because it helps us understand which influences may have surrounded the making of Jobarde. But let us begin with the analysis of the letter and the visit to the museum.

a. “How I miss you here and how happy it would have made you to see Velázquez who all by himself makes the journey worthwhile; the artist of all the other schools around him in the museum at Madrid, who are extremely well represented, all look like shams. He is the supreme artist; he didn’t surpize me, he enchanted me.”

Manet felt enchanted and amazed when he came face to face with the work of Velázquez. He found the paintings of Velázquez to be far superior to the works of all his contemporaries and followers. Velázquez was in fact both thematically and technically an important source of inspiration for Manet.

b. “The full-length portrait we have in the Louvre is not from his hand. Only the Infanta is indisputable.”

Manet doubts if the portrait in the collection of the Louvre was actually painted by Velázquez.

c. “There is a huge painting here, full of little figures like those in the Louvre picture called the Cavaliers, but with figures of women as well as men […]”.

Although it may be too early to bring up the Manet-Manette contrast, to which we will return later, Manet’s way of seeing always indicates a certain susceptibility to male/female features.\[50\]

d. “[…] perhaps of higher quality and above all completely unrestored. The landscape in the background is by a pupil of Velázquez.”

Manet clearly sees the difference between the hand of Velázquez and that of the pupils in his studio as well as later additions such as restorations.

e. “The most extraordinary piece in this splendid oeuvre and possibly the most extraordinary piece of painting that has ever been done is the picture described in the catalogue as a portrait of a famous actor at the time of Philip IV; the background disappears, there’s nothing but air surrounding the fellow, who is all in black and appears alive”.

---

\[50\] See: The Manet-Manette ‘Style’, § 5.3.1, see pages 62-64: Internal Symmetry.
Here Manet describes a portrait by Velázquez that we know under the title *The Jester Pablo de Valladolid*. This painting inspired Manet’s masterpiece *L’Acteur Tragique*, which he painted in 1865-1866. However, ten years later, in 1876-1877, he would return to the same source of inspiration for *Portrait de Faure dans le rôle de Hamlet*. In this last work, Manet reverses Velázquez’ composition scheme. We will return to this later.51

Manet actually thought that he was dealing with a portrait of an actor from the time of Philip IV, which turned out not to be true.52

f. “[…] and the *Spinners*, the fine portrait of Alonso Cano; *Las Meninas*, another extraordinary picture; the philosophers, both amazing pieces; all the dwarfs, one in particular seen sitting full face with his hands on his hips, a choice picture for a true connoisseur; his magnificent portraits – one would have to go through them all, they are all masterpieces.”

Before we continue our analysis of this letter and its significance for our investigation, we must first look at a photo of the reconstruction of the arrangement of the paintings in the halls of the Prado at the time of Manet’s visit.

---

51 See: *The Manet-Manette ‘style’*, § 5.3.2, page 64: Bilateral or External Symmetry.

52 Velázquez painted several portraits of Philip IV that were in the Prado as well as in the Louvre. Manet made an etching of Philip IV in 1862, before he visited Madrid. The model for this etching was the painting in the Prado, but Manet probably copied it from an etching by Goya from 1778. It is one of a series of Goya etchings after works by Velázquez.
5.2 The Prado

The arrangement of the paintings in this photographic reconstruction dates from 1879-1885. According to the exhibition catalogue Manet/Velázquez. The French Taste for Spanish Paintings, the arrangement remained unchanged during many decades after the museum first opened in 1819. The wall of the main hall must have had the same appearance at the time of Manet’s visit in 1865, see page 61. It is remarkable to note how many of the paintings that are seen hanging side by side had a direct or indirect influence on Manet. Manet’s 1862 series of etchings in eight states, Philippe IV, Roi d’Espagne, was inspired by the painting Philip IV, which hangs five paintings removed from Velázquez’ Las Meninas. To its immediate left we see El príncipe Baltasar Carlos a caballo. Diagonally above this painting hangs the portrait of Marianna of Austria, which served as a model for the etching L’Infante Marguerite. And diagonally below it there is El Primo, which inspired Manet’s portrait of Émile Zola.

In our opinion, it is likely that Velázquez’ El príncipe Baltasar Carlos a caballo greatly influenced the composition and theme of Jobarde. Although Manet doesn’t mention the painting in his letter, he cannot have failed to notice it during his visit to the Prado. He may even have already known El príncipe Baltasar Carlos a caballo from an etching by Goya, which was part of a popular series of publications on Spanish painters.

---


55 Ibídem, p.70.

Francisco Goya,
El príncipe Baltasar Carlos a caballo, etching 1778

Overall view of the Large Hall of the Prado in Madrid, 1879-1885
Diego Velázquez,
El príncipe Baltasar Carlos a caballo, 1634-1635

Philip IV [1], Las Meninas [2], El príncipe Baltasar Carlos a caballo [3], Marianna of Austria [4], El Primo [5]
5.3 The Manet-Manette ‘Style’

In order to place the Spanish influences on and pictorial characteristics of Manet’s style in the right context, it is necessary to gain a clear understanding of an essential aspect of his personal vision on content and form.

5.3.1 Internal Symmetry

In Manet’s circle of literary friends in the 1860s, traditional themes were being replaced by a modern and self-conscious form of realism. Manet represents the pictorial variant of this movement. This was an aspect of his work that did not always go down well with the general public and the critics, and it lead among others to the feminization of Manet’s name. In 1865, the caricaturist Bertall renamed the painting *Olympia* and named it *Manette*.\(^{57}\) In her publication *Manet Manette* Carol Armstrong demonstrates how complex the relations were between Manet’s modern opinions about the role of the painter on the one hand and the traditional place of the model or source of inspiration on the other and comes up with the hypothesis that “what Manette constitutes is a figure of the supplement and the principle of internal alterity: disrupting the boundaries between the native and the alien, the self and the other, the maker and the made, she stands in place of a Nature-made body and face, and instead of proper, heterosexual relations between male painter and female model.”\(^{58}\) Armstrong expands on more than 125 years of historical writing about the strong emotions caused by Manet’s work. They could result from the appearance of the work as well as from the state of mind of the viewer. As we know, these emotions have lead to a deep rift between supporters and opponents of his work. Our study elaborates on Armstrong’s interpretation and even takes her model to another level. Armstrong’s trichotomy brings the following relations or contradictions to light:

<table>
<thead>
<tr>
<th>Painting</th>
<th>Painter</th>
<th>Viewer</th>
</tr>
</thead>
<tbody>
<tr>
<td>Object/Subject</td>
<td>Manet/Manette</td>
<td>Individuality/Universality</td>
</tr>
<tr>
<td>Man/Woman</td>
<td>Impressionism/Naturalism</td>
<td>Self/The Other</td>
</tr>
<tr>
<td>Concept/Nature</td>
<td>Agitator/Creator</td>
<td>Insider/Outsider</td>
</tr>
<tr>
<td>Actor/Model</td>
<td>Inspire/Inventor</td>
<td>Humorism/Moralism</td>
</tr>
</tbody>
</table>


\(^{58}\) Ibidem, p. 63.
In other words, Manet and his Manette are the two poles that constitute the mental model deployed by the painter to confront the viewer with his inner contradictions or with ‘the other’. Thus the painter – or the model – can make the viewer experience different ‘feelings’ – the concepts in the outline above have no fixed order and are interchangeable. For Manet, content and form are two opposed ‘realities’, which for example is reflected in the opposition between impressionism and naturalism. Manet’s dictum: “Concision in art is a necessity and a matter of elegance. The concise man makes you think; the verbose man is a bore. Always aim for concision,” clearly indicates what kind of provocation Manet had in mind. But for the sake of the argument and to clarify Manet’s own ideas, it might better to simply call it ‘impressionism’. In the end a confrontation takes place between image, painting, words and thoughts. Every aspect of the model above opens the way for individual thoughts, morals or feelings. The distance that separates the model from the viewer who judges and deals with him or her on an emotional level become theoretically interchangeable. Although Manet often derived his themes from the old masters, every statement or thought about the painting is the product of an individually coloured and equivalent contemporary or modern point of view.

About this Juliet Wilson-Bareau remarks: “Between 1862 and 1865, Manet continued to transform old art into new. The figure in Espagnol jouant de la guitare was clearly a model dressed and posed to ‘look Spanish’. But starting in 1862, Manet presents his models – Victorine Meurent and Gustave Manet, Lola Melea and Mariano Camprubi – as distinct individuals. Yet they are all performers in one way or another. The Spanish dancers are performers in real life. Victorine is a professional artist’s model. In the Déjeuner sur l’herbe, she is portrayed as a model posing for Manet, while Manet’s brother and brother-in-law, who modeled in turn for the males, are more or less recognizable themselves in spite of the references both to contemporary students mores and to classical earlier art. Manet’s Olympia is not a picture of a prostitute posed like a Titian Venus but a picture of Victorine portraying the prostitute and being quite amused by the whole thing.”^59 In fact, it is a comment on the relation between Actor and Model, Inspirer and Inventor or Humorism and Naturalism, as outlined in the model above.

By following this thought, we gain insight into the complex, humoristic content of Manet’s work. It is the playing field in which Manet shapes his ideas and images. This model is also important for Jobarde, as we will see later. But first we need to define its direct sphere of influence.

5.3.2 Bilateral or External Symmetry

Antonin Proust recorded the following remark of Manet about an exceptional phenomenon in his work: “Renaud de Vilbac called in yesterday. All he could see was that my Guitarrero was playing a guitar strung for the right hand with his left hand. What do you think of that? Just imagine, I painted the head in a single sitting. After two hours at it, I looked in my little black mirror, and it worked. I didn’t add a single brushstroke.” This refers to the phenomenon of mirrored symmetry which occurs throughout Manet’s entire oeuvre, in the early copies of old masters as well as in his later works and in numerous etchings, in which the nature of the technique itself invites to create mirror images, as well as in a series of paintings. Sometimes only details are mirrored, as in Le Christ aux Anges from 1864, which depicts the spear wound is on Christ’s left side while it should be situated on the right. But there are also entire paintings that are mirror images, for example Manet à la Palette from 1878-1879, painted ‘in’ the mirror, in which the right-handed Manet is represented in reverse as a lefty.

A possible ground for Manet’s preoccupation with mirror image compositions is the fact that as a pupil of Thomas Couture he must have made studies of the human body. The bilateral symmetry of the body is a natural fact. But there are no direct indications that this was the basis for Manet’s inclination towards mirror image compositions. Antonin Proust writes that Manet literally looks in the mirror to check his work, which is in fact a continuation of an age-old tradition, as controlling a painting with a mirror was already an accepted practice in the painting workshops of classical antiquity. But in the case of Jobarde it will become clear that Manet does more than simply use this as a technique.

60 Ibidem, p. 29.
61 The first author to note this phenomenon is Germain Bazin in Manet, Manet und die alten Meister, Stuttgart: Wissen Verlag, 1972, p. 84-93.
62 Archer Brombert, op. cit. (note 16), p. 89.
63 Manet was not the only one to continue this tradition in his time. See Michael Fried, Manet’s Modernism, Chicago: The University of Chicago Press, 1998, p. 371-372.
5.4 Image Comparison

Since Roman times, horses have been one of the elements that gave the emperor the desired aura of majestic power. Such an aura of power was also what the young Baltasar Carlos was supposed to radiate on Velázquez’ painting from 1635, in which he is seated on a rearing stallion that he holds in check. The effect is enhanced by the commander’s baton held high in his right hand, the tassels that fly in the wind behind his back and the breast martingale with rosette which is part of the gilt leather royal show harness. The grace, control and daring depicted in this fluently painted masterpiece are meant to win over the viewer for the future monarch. The painting was to be fitted above the door in the main hall of the royal palace in Buen Retiro. This explains the perspective of the landscape in relation to the rearing horse and the so-called hay belly of the horse. When Manet saw this painting during his visit to the Prado in 1865, it was hung so high, making the horse’s bloated belly look distorted to the viewer standing at floor level.

Earlier we stated that El príncipe Baltasar Carlos a caballo had greatly influenced Manet’s Jobarde and now it will become clear why. Keeping in mind Manet’s regular recourse to the old masters and the mirror symmetry he often applied in his paintings, we proceeded to rotate El príncipe Baltasar Carlos a caballo around its vertical axis and compared it with Jobarde. Both paintings are after all equestrian portraits.

---

66 Baskett, op. cit. (note 64), p. 81. Baskett writes, without naming his source, that the horse was stuffed after it died and then painted by Velázquez. That would explain the swollen belly of the horse. In our view, this is rather farfetched, because it would mean that the horse, or even only its belly, hadn’t been stuffed properly. Baskett overlooks the function of the painting which was meant to hang above a door. The horse’s belly represents a distorted perspective; seen from below, it appears as if the horse is rearing over us.
See for comparison text pages 68-69.

*Mirror image of El príncipe Baltasar Carlos a caballo*
Jobarde
Then we examined the symmetry model, which resulted in the following outline of the relation between painting, painter and viewer:

<table>
<thead>
<tr>
<th>Painting</th>
<th>Painter</th>
<th>Viewer</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Amazon</em></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>Impressionism</td>
<td>Self</td>
</tr>
<tr>
<td>Concept</td>
<td>Agitator</td>
<td>Insider</td>
</tr>
<tr>
<td>Actor</td>
<td>Inspirer</td>
<td>Humorism</td>
</tr>
<tr>
<td><em>Horse Amazon</em></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mare</td>
<td>Naturalism</td>
<td>The Other</td>
</tr>
<tr>
<td>Nature</td>
<td>Creator</td>
<td>Outsider</td>
</tr>
<tr>
<td>Model</td>
<td>Inventor</td>
<td>Moralism</td>
</tr>
</tbody>
</table>

For *El príncipe Baltasar Carlos a caballo* the model produces the following motifs:

<table>
<thead>
<tr>
<th>Baltasar Carlos</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Prince</td>
<td>Naturalism</td>
<td></td>
</tr>
<tr>
<td>God</td>
<td>Creator</td>
<td></td>
</tr>
<tr>
<td>Actor</td>
<td>Inventor</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Horse Baltasar Carlos</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Stallion</td>
<td>Impressionism</td>
<td></td>
</tr>
<tr>
<td>Nature</td>
<td>Agitator</td>
<td></td>
</tr>
<tr>
<td>Model</td>
<td>Inspirer</td>
<td></td>
</tr>
</tbody>
</table>
Additionally, we can juxtapose the following (contrasting) elements:
- Prince: worldly conqueror. Amazon: woman of the world.
- Prince unknown to outsiders as a person. Jobarde known to those directly involved.
- The rearing stallion. The steadfast mare.
- The position of the left arm is the same, but the prince is pointing the commander’s baton upwards while the Amazon’s whip is pointing downwards.
- The ears of the stallion are pointed forwards. The ears of the mare are pointed backwards as they listen to the Amazon, but also as a sign of stubbornness.
- The tail of the rearing stallion is flowing proudly and unrestrained in the wind, while the mare’s tail is invisible, maybe tied up or shaved.
- The background against which prince Baltasar Carlos is mounted on his rearing horse are snow-capped mountains (possibly the Grand Paradiso) bordered with woods, while the Amazon is set against a background of rolling hills or dunes and an open body of water.

Another striking similarity is that of the direction and height of the mountains in both landscapes: in Jobarde they run parallel to the mirror axis of El príncipe Baltasar Carlos a caballo. An X-ray image of Jobarde clearly shows that this landscape slopes from the top left to a lower point on the right, exactly like in the Velázquez painting. The composition of the mountain landscape in three or four layers is also similar. The landscape in Jobarde was overpainted at a later stage by the artist himself.
When we first see and experience the painting Jobarde, we immediately experience contradictory feelings. We are attracted by the beauty and realism of the horse, but at the same time pushed back by the mysterious smile and impressionist painting style of the Amazon.

The Amazon holds the reins in her driving hand which is resting in her lap. She is in control of what happens and checks the power of the horse like a true Amazon.\(^67\) One more step and the tension or pose would be abolished. It is as if she can change the intention of the painting. Is she standing still as an Amazon, as the woman confronting the painter, or is she simply holding still together with the horse, as a model for an equestrian portrait? This brings the statement of Duret to mind: “Manet had often been blamed for painting his figures in unintelligible attitudes because no definite action was suggested.”\(^68\)

By painting the Amazon in the impressionist style, Manet was perhaps trying to compensate this indecisiveness or ambivalence. It seems as if the painter wanted to achieve an acceptable balance for himself by compensating the command of the Amazon over the horse with his own command over the painting. But this command is fragile; the true command lies more in the subtle representation and perception. By gesturing with her right hand in which she holds the whip, the Amazon invites us to fix our gaze on the horse, a so-called ladies hack.\(^69\) It is wearing a full harness with a side saddle and radiates beauty and grace. It stands at rest on a slightly forward sloping dune. The front legs are straining to brace the weight. The left hind leg is relaxed and slightly bent. The combination of sloping terrain, relaxed left hind leg and the weight of the Amazon pushes the horse’s belly outwards. The belly catches enough light for a subtle accent, but the highlight on the ribs makes it look as if the horse’s belly is separated from its hind quarters. However, physiologically speaking, the ribs in that area are not that long. Furthermore, the ribs of a horse are not angular, except for the last floating rib, the \textit{costa fluctuans}, which is pushed outwards when the horse is in the last stages of pregnancy.\(^70\)

The largest or longest ribs of a horse are situated directly under the rider, more to the front, and they become shorter towards the back. The sharp, angular forms in the belly clash with the naturalistic depiction of the horse. Or could it be that this refers to a different or a new reality?

We decided to seek advice from a horse specialist. The director of the Hermès equestrian museum in Paris, Madame Du Chantelle, showed a photo of the painting to the horse specialist and art lover Monsieur Hermès. His diagnosis was unequivocal: “This horse is in the last stages of pregnancy.” To which Madame Du Chantelle replied: “But sir, you don’t ride a pregnant horse.” Monsieur Hermès said: “That’s absolutely true! But a painter may paint it.” And that is exactly how someone who saw the painting in 1873 Paris might have reacted, although it would have been conceived as an outright provocation, certainly if we consider the double connotation of the word Amazon at the time. “The word Amazon became one of the many euphemisms used to refer to women of easy virtue.”\(^71\) An Amazon was synonymous with a woman with loose morals. The combination of a pregnant horse, almost certainly named \textit{Beauté}, and an Amazon, probably named Jobarde, who makes an enticing gesture with her whip, justifies the following conclusion.

\(^67\) Helen Diner, Mothers and Amazons, New York: The Julian Press, 1965, p. 120-140.
\(^68\) Archer Brombert, op. cit. (note 16), p. 412.
\(^69\) Tamsen Pickeral, Horses & Ponys, Bath: Parragon, 2003, p. 177. The ladies hack was a cross between an English thoroughbred and an Anglo Arab. It is no longer bred. This type of horse was popular in the nineteenth century and was bred especially for lady riders because of its character and reduced height, namely between 1.45 and 1.60 meters.
\(^71\) Coffin Hanson, op. cit. (note 15), p. 86.
5.6 The Title *Jobarde*

In the works of Manet, the relation between title, subject and style is always complex. This also applies to the painting *Jobarde*. Beth Archer Brombert discusses this extensively in connection with Manet’s painting *Olympia*:

(...)an extended parenthesis as the background of this painting is opened. A sexual revolution had taken place in nineteenth-century Paris, concurrent with the rise of the bourgeoisie. Although female virtue had always been treated as a volatile commodity, certain expectations remained unchanged. Young girls of respectable, meaning dowried, background were expected to arrive at the marriage bed intact; wives were expected to remain faithful primarily to protect the bloodline of progeny and their rightful inheritance of property. A king could choose mistresses among the wives of his courtiers without dishonoring them, and aristocratic women were expected to take lovers, without which society would wither. But for lesser mortals, adultery was a serious infraction of social as well as religious laws – except when committed with a prostitute. In Alexander Dumas’ “Filles, lorettes et courtisanes,” published in 1874, all the nicknames and the related “positions” of ladies of light virtue in society were given place.

The lowest rank, that of fille, consisted of three categories: fille de maison, fille de boulevard, and fille de cité, in descending order. The fille de cité was the dreg of society, she went by slangy nicknames; “La Calorgne,” “La Bourdonneuse,” “La Trimarde” (a trimadeur is a bum). The upper class of the profession bore high-flown names taken from epic poems or the ancient world: Arnaud, Arthemise, Olympe etc. (...) The lorette was a nineteenth-century invention, named in 1841 by Nestor Roqueplan, director of the Paris Opera, after the quarter of Nortre-Dame-de-Lorette, northeast of the Opera. Settled in the 1830s and 1840s by celebrities in the arts such as the actress Mlle Mars, George Sand, Frederic Chopin, and Alexander Dumas père, this was an affluent quarter that bordered on the upper fringes of the demi-monde. Unlike her lower-class sisters, a lorette went by a bourgeois name and a bourgeois background, often invented, letting it be known that she was the orphaned, abandoned, or illegitimate daughter of an army officer, a bankrupt industrialist, or a nobleman. (...) The lorette, if she were lucky enough to attract the attention of one or more very rich men, could rise to the aristocracy of grande courtisane. (...) By the time Manet painted his reclining nude, the grande courtisane, also known as the grande horizontale, had long since entered the public’s imagination.  

---

72 Archer Brombert, op. cit. (note 16), p. 138-143.
The position of the Amazon should also be considered against this background. She was the product of the greater freedom from restrictions that had been achieved in Paris in the second half of the nineteenth century. “Bois de Boulogne became a forum of gallantry that lasted into the twentieth century. Ladies of society and their husbands’ mistresses paraded in their carriages, gathering gossip, while gentleman surveying the scene from their horses sought out new challenges. A relatively new phenomenon was the amazone, the woman rider mounted sidesaddle; horseback riding became very fashionable among courtesans during the Second Empire. In his novel ‘Nana’, which chronicles the period, Zola explains that ‘ever since Lucy [patterned after Cora Pearl, one of the great courtesans of the time] went out on horseback in the Bois, which launched her, all of them were seized by a madness to ride.”

In the case of Jobarde, as we made clear earlier, we are not only dealing with a lady of loose morals, but also with a horse that appears to be pregnant. The question is: is Manet referring to the socially unacceptable pictorial representation of a woman on a pregnant horse, to intercourse during pregnancy or to unplanned pregnancy, or is he warning the libertine woman to curb (her) animal instincts? Maybe it is a combination of those things. Add to that the meaning of the name Jobarde, which is ‘foolish’, and the viewer of the painting will know what happens to a lady who is not particular about her morals.

In fact, what we see in this work is a further elaboration on the theme of the antihero. “Manet allowed the object viewed to view the viewer, thereby throwing into stunning disarray patterns long established. He discovered the reverse image of the hero, of the heroic gesture, the heroic act. What nineteenth-century writers would contribute to literature, Manet would contribute to painting: the disturbing figure of the antihero.”

The combination of a realistic and an impressionist painting style reinforces the provocative content of the painting. The mysterious smile of the Amazon, which is executed in an impressionist manner – and which corresponds with the smile of Victorine Meurent in Le Déjeuner sur l’herbe –, establishes a relation between the concept (the painting), the agitator (the artist) and the insider (the informed viewer). Viewers who do not understand the ‘message’ are made to feel like outsiders. The defiant nature of such provocation and exclusion produces strong reactions.

In conclusion we can ask ourselves ‘who’ the portrayed Amazon is. During our research different names were suggested: Marguerite de Conflans or Nina de Callias. Both women acted as models for Manet in 1873, and true, their hair could be dyed red but the identification of the face is most likely not to be intended as a portrait.

\(^{73}\) Ibidem, p. 378.

\(^{74}\) Ibidem, p. 95.
6. Evaluation Art Historical Research

In the evaluation the results in the first part of the investigation are named in the order in which appear. The results are discussed in the context of the status. Subsequently, the value that can be used to establish a connection between the object of research, Jobarde, and Manet’s oeuvre is derived from each status.

**The negative status.** This is the status which argues against the authorship of Édouard Manet.

* No mention of Jobarde in any contemporary or later source
* No mention of the work by collection owners

The fact that Jobarde is not explicitly mentioned anywhere is no exception. In comparison with the first retrospective exhibition in 1884, the latest catalogue raisonné from 1975 lists no less than 314 ‘new’ works. Especially the paintings that were sold or given away in Manet’s lifetime were only catalogued at a later stage.

**The positive status.** This is the status which argues in favour of the authorship of Édouard Manet.

* Similarity between the monogram on L'Asperge and that on Jobarde
* Yellow colour signature

The painting L'Asperge had disappeared from public view (and that of possible copiers) for almost fifty years. The similarity of the two monograms on L'Asperge and Jobarde is a strong argument in favour of Manet’s authorship. We must add that more than half of the paintings with a monogram were given by Manet to acquaintances.

The yellow colour signature was only discovered long after the catalogues raisonnés had been compiled. As we have established, Jobarde has such a colour signature.

**The neutral status.** This is the status that argues neither in favour of or against the authorship of Édouard Manet.

* Édouard Manet didn’t leave a Liber Veritatis
* The first provenance dating from the 1920s and the 1930s
* The provenance of 1955 and the investigation in 1971
* The restoration in 1961
* Period from 1872 to 1875: Amazons and horse riders
* A sketchbook page by Manet that was sold at auction in 1991
* The similar dress fashion in works by Renoir and by Manet
* The turning point in 1873: change of colour palette and painting style
* The red colour used for a single object
* The traditional style of 1873: deeper level and dark palette
* ‘En plein air’, but painted in the studio
* The sharp contrast between ‘impressionist’ Amazon and ‘realistic’ horse
* The pictorial source: *El príncipe Baltasar Carlos a caballo* by Diego Velázquez
* The bilateral or mirror image relationship between *Jobarde* and *El príncipe Baltasar Carlos a caballo*
* Relation model-painter-viewer
* The names or texts that appear on a number of works
* The double-layered content of *Jobarde*
* The list of Manet’s Salon submissions since 1831
* No identification of the Amazon *Jobarde*

As far as the neutral status is concerned, with the exception of the identification of the model, we have found no argument against *Jobarde*. On the contrary, there are numerous clues which argue in favour of giving the painting a place in Manet’s oeuvre. We would like to point out that copiers of Manet would not have been able to create such a playful painting so quickly and most likely never sign the painting with a monogram (instead of a full signature). However, we must remain conscious of the fact that no positive link can be established on the basis of the many clues because all the knowledge that is involved has become fairly accessible in the 125 years following Manet’s death.
Jobarde, a Rediscovered Painting
by Édouard Manet

Painting Technique Analysis

“Each new art form is, in effect, a new technique.”
Max Liebermann
Painting Technique Analysis

The painting technique of an artist is initially determined by his training and its further development is by later personal choices.\(^1\) The first factor is largely culturally determined, while the second is of an individual nature. Besides training and personal choices, the tools and the characteristics of the applied materials are important elements of an artist’s painting technique. To investigate a painting technique the surface of the painting and the inner layers are being placed in the context of a so-called pictorial ‘code’. Modern laboratory techniques are used to reveal the deeper, ‘hidden’ layers in the painting.\(^2\)

1. Pictorial Analysis

Pictorial analysis is the study of those aspects of painting technique that are inherent to the work practice of the artist: the sequence of the build-up of a painting, its composition and perspective, light and colour, the texture of the paint and of the surface layer. It deals with aspects that are characteristic of the artist’s vision as it manifests itself in every aspect of the painting. Pictorial analysis lays the grounds for a connection with the painter’s personal handwriting that materializes during the execution, the physical act of painting.

Pictorial analysis relies heavily on the state of the artwork. Knowledge of the painting’s restoration history is a precondition for pictorial analysis and for gaining a clear insight into the painter’s handwriting.

---

\(^1\) The range of this study is limited to the nineteenth century.

\(^2\) Thanks to modern detection techniques it has become easier to prove that a work is not authentic, because forgers almost always trust that their products will be accepted on the basis of their outward appearance and tend to pay little attention to the underlying build-up.
1.1 “The Daumier of his Time”

Édouard Manet had a natural talent for drawing; painting was something he had to learn. It is important, for this study, to define his drawing talent and its relation to his painting technique. Manet’s drawing talent was stimulated at an early age at home by his uncle Edmond, who took pleasure in drawing caricatures for his little nephew. At school, at the Collège Rollin, there was little appreciation for his drawings, and his unreadable handwriting was often criticized. The young Manet was probably trying to ‘draw’ as he wrote. It was a way of communicating that re-appears later in his letters, in which the text is almost always accompanied by drawings: a feast for the eye of those who read them now. These letters are written in a powerful, highly personal but very versatile hand.

By the age of sixteen Manet’s writing had matured, and this is reflected in a series of letters to the home front in which he gives an account of his sea passage to Rio de Janeiro. From these letters we can infer that the ship’s crew greatly appreciated his caricatures. In a letter of 5 February 1849 to his father, Manet writes: “We haven’t been able to find a drawing teacher in Rio, and the Captain has asked me to give my shipmates lessons, so now they’ve set me up as a drawing teacher; I may say that I acquired quite a reputation during the voyage, all the officers and tutors asked me to do caricatures of them and even the Captain wanted one as a New Years gift; I was lucky enough to carry it all off to everyone’s satisfaction.” One of the few surviving caricatures from that voyage is that of his friend on board, Adolphe Pontillon.

In Manet’s family milieu, drawing caricatures was considered frivolous, an innocent pastime. This doesn’t alter the fact that caricature is one of the most difficult forms of drawing. Caricatures not only ‘should’ be accurate, they ‘must’ be accurate, otherwise they simply would miss the mark. Recognizability, invention and humour dance hand in hand on the paper stage. Not only those who are amused, also the fans of the medium have to be catered to. Caricatures are characterized by smooth lines, transparency and a straightforward lay-out, clear coloured areas, powerful contrasts between light and dark, manipulation of space and light, originality, recognizable people and/or situations, humour and provocation. Replace the word ‘caricature’ with ‘painting’, and Manet’s paintings immediately come to mind.

---

6 See part 1, § 3.4.2, pages 38-43: The Monogram.
7 Ibidem, p. 23.
8 Archer Brombert, op. cit. (note 3), p. 32.
In his standard work *Art and Illusion*, Ernst Gombrich says about the art of caricature: “It relies not on pre-existent forms, on the schemata of academic art checked and clarified in front of the model, but on configurations arising under the artist’s hand as if by accident.” He cites Daumier as one of the fathers of caricature and also sees instances of this form of drawing in the work of ‘serious’ artists such as Leonardo da Vinci and Rembrandt. Manet’s teacher in the art of painting, Thomas Couture, was the first to see the connection between Manet and Daumier, but not in a positive sense. Manet, who according to Antonin Proust had made a habit of drawing people on the street in the neighborhood of Place Pigalle, asked the models to keep their clothes on during a drawing lesson in the studio. Couture intervened and snapped at him, saying that he would never amount to anything more than the Daumier of his time. Manet replied that he would rather be the Daumier than the Coyncel of his time. Coypel belonged to a family of academic painters who were held in high esteem by people like Couture. Manet chose to follow a new avenue. He solved problems with his technique by falling back on the technique and themes of his caricatures. This is clearly demonstrated by the provocative and humorous nature of his paintings, but on closer consideration he appears to have also drawn on his ‘visual memory’ in a more indirect manner. His experience with caricature clearly helped him stretch the boundaries of painting and solve certain ‘pictorial issues.’ This is reflected in two ways in Manet’s early drawings, preliminary sketches, etchings and use of photographs, at a time when he was attempting to bring the subject in harmony with painterly expression: on the one hand by his accuracy which was based on the technique of caricature, and on the other hand by his wish to push the boundaries of that same technique by using a more free play of lines in his search for the right form.

The fact that caricature literally remained at the centre of Manet’s life is exemplified by the following anecdote. Around 1850, Manet painted a caricatural self-portrait on which he wrote the text “Un ami!” In this self-portrait the always immaculately groomed but prematurely balding Manet depicted himself with an incredible wild mane of hair. The portrait never left his studio. After his death Suzanne Manet sold the painting to the art dealer Ambroise Vollard. It was last described by Tabarant in 1931 and has since vanished without a trace.

---

12 Alan Krell, *Manet*, London: Thames and Hudson, 1996, p. 14-15. In his book Krell has reproduced an illustration of the painting that was believed to have been lost, but without naming his source.
1.2 The Studio of Thomas Couture

In January 1850, Édouard Manet was accepted in the studio of Thomas Couture which was located on the rue Victor Massé in Paris. Here Manet begins his years of schooling as a painter. Couture was highly regarded because he had won first prize with his submission to the Salon of 1837 and because he had been trained by Baron Gros, a former student of the French painter Jacques-Louis David. His teaching method focused on traditional draughtsmanship, but he had rather distinctive ideas. Couture saw himself as a self-taught man and his vision was contrary to that of the academic realism of his time. His book on the art of painting, Méthode et entretiens d’atelier from 1867, has an undertone of revolt against academic teaching methods. However, just like Manet, he is also tributary to the technical tradition in drawing. Tabarant stresses this in Manet et ses oeuvres by stating that “Couture was among those who wanted to maintain indefinitely the formulas of the past.” It is important for our research to have a clear understanding of these “formulas of the past” before we pass on to Manet’s specific technique.

This vision of painting was essentially dedicated to the continuation of traditional forms (nature and the human body) and styles (naturalism) which were of course combined with modern influences. When discussing those influences in his book on the ateliers of that period, Albert Boime writes: “The study of old masters ran like a continuous thread through woof and warp of the teaching fabric, and the master had to stress the ‘quick’ copy in the form of a pencil sketch for the beginner. More independent artist, such as Delacroix and Couture, affected a kind of compromise and advised their pupils to make rapidly executed painted sketches after works in the Louvre.” Thus the technique taught by Couture was based on the study of the old masters, but the sketches had to be executed rapidly. These skills were vital for the underpainting or first blocking in of a painting. And leaving the final result aside, we can conclude that the underdrawing received great attention in Couture’s studio.

Couture taught étude, ébauche and fini as three separate, successive phases. The following outlines provide an overview of the ‘classical training’ as it was practiced in his studio.

---

13 Although there are indications that Manet was enrolled at Couture’s studio until 26 November 1858, it is generally assumed that he had already left the studio in 1856. See Theodore Reff, Art Bulletin, vol. 46 (1964), p. 559.
When the technical stages of the learning process are schematically arranged, this leads to the following classifications, ordered by increasing level of complexity:

**The Drawing Lesson**

<table>
<thead>
<tr>
<th>Method</th>
<th>Subject</th>
<th>Execution</th>
<th>Goal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Modèles de dessin</td>
<td>copies of etchings</td>
<td>line drawing</td>
<td>volume</td>
</tr>
<tr>
<td>Dessin au trait</td>
<td>after etchings</td>
<td>outlines</td>
<td>dexterity</td>
</tr>
<tr>
<td>Dessin ombré</td>
<td>after drawings</td>
<td>shading</td>
<td>hachures and estompe</td>
</tr>
<tr>
<td>Mise en trait</td>
<td>combination</td>
<td>light underdrawing</td>
<td>first free composition</td>
</tr>
<tr>
<td>À la bosse</td>
<td>after plaster casts</td>
<td>light/shading/mass</td>
<td>effet</td>
</tr>
<tr>
<td>À la nature</td>
<td>after live models</td>
<td>modelling/proportions</td>
<td>demi-teinte</td>
</tr>
<tr>
<td><em>Hachure</em></td>
<td></td>
<td></td>
<td>cross-hatching, cross-hatched drawing</td>
</tr>
<tr>
<td><em>Estompe</em></td>
<td></td>
<td></td>
<td>erasing or softening of lines</td>
</tr>
<tr>
<td><em>Effet</em></td>
<td></td>
<td></td>
<td>unifying of proportion with light or dark tones</td>
</tr>
<tr>
<td><em>Demi-teinte</em></td>
<td></td>
<td></td>
<td>natural transition from the brightest light to the darkest shadow</td>
</tr>
</tbody>
</table>

There were also skills that were defined on the basis of the materials used in each successive phase:

| Croquis            |                       | pencil sketch of a few lines |
| Mise en place      |                       | two phases during the composition of the drawing |
| Fini               |                       | the final result           |
| Fusain             |                       | charcoal drawing           |

Twice a week, at the end of the day, Couture would come by and comment on the drawings of his students. These visits were called *séances de correction* and a pupil in the studio was called a *rapin*. Before a pupil was allowed to pass on to the next phase in the learning process, he had to take a drawing exam. Once he had passed, the pupil was allowed to study oil paint sketching. The transition was concluded by making of a copy after an old master. This allowed the teacher to determine if the pupil had any talent in the use of oil paints.
The Preliminary Study

The preliminary study was a specific part of the learning process and consisted of making a so-called *esquisse*: a small sketch after life that was executed either with a pencil or a brush.

The Painting Lesson

The final goal was of course the realization of an oil painting in which the following three successive phases of the work process can be distinguished: *étude*, *ébauche* and *fini*. Each phase is associated with certain characteristics that are set out below.

<table>
<thead>
<tr>
<th>Method</th>
<th>Stage</th>
<th>Execution</th>
<th>Goal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Étude</td>
<td>underpainting</td>
<td>drawing</td>
<td>line pattern composition</td>
</tr>
<tr>
<td>Ébauche</td>
<td>intermediary layer</td>
<td>light/shadow</td>
<td>modeling/proportions</td>
</tr>
<tr>
<td>Fini</td>
<td>finishing layer</td>
<td>glazing</td>
<td>creation of depth</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Method</th>
<th>tools</th>
<th>layering</th>
<th>characteristic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Étude</td>
<td>pencil/brush</td>
<td>one layer</td>
<td>croquis</td>
</tr>
<tr>
<td>Ébauche</td>
<td>brush/palette knife</td>
<td>wet on wet</td>
<td>demi-teintes</td>
</tr>
<tr>
<td>Fini</td>
<td>brush/fingers</td>
<td>wet on dry</td>
<td>frottis, pleine pâte or glacis</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Method</th>
<th>opacity</th>
<th>palette*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Étude</td>
<td>opaque</td>
<td>red ochre and umber</td>
</tr>
<tr>
<td>Ébauche</td>
<td>(semi-)opaque</td>
<td>lead white, Napels yellow, yellow and red ochre,</td>
</tr>
<tr>
<td>Fini</td>
<td>transparent</td>
<td>Prussian blue, ivory black and vermillion</td>
</tr>
<tr>
<td></td>
<td></td>
<td>glazing paints</td>
</tr>
</tbody>
</table>

*The colours on the palette are directly associated with the subject and the colour scheme of the painting.

As the technical build-up of the painting progresses through its successive stages, the level of complexity increases. The level of complexity should be determined in relation to the standard of 'painting after nature': the exact representation of reality as it is perceived. Furthermore, the final stage of the *fini*, which gives the paint layer its polished look, was considered to be the highest academic standard. In order to achieve this polished look the brushstroke is ‘scumbled’ into the paint. The scumbling or frottis is a wet in wet oil painting technique. In using different forms of scumbling, the painter is able to demonstrate his skills. This technique gives each painting a different appearance, so it would be correct to say that each oil painting is a highly personal demonstration of the technique and aptitude of the painter.
2. Étude, Ébauche and Fini in Manet

What became apparent in the course of our analysis of Manet’s painting technique was not only the influence of his teacher Thomas Couture, but also the personal inventiveness that Manet had embraced as one of his basic principles by not considering étude, ébauche and fini as separate, successive phases in the painting process and choosing to combine them as he saw fit. Of course this adds to the difficulty of investigating the whole range of Manet’s paintings, but within the scope of our study it allows us to assess and compare those paintings that can be considered as ‘fini’ or finished.

The ‘Impressionist’ Painting Style

Manet’s ‘impressionist’ painting style is in fact based on the loose, sketchy technique that is associated with the étude. There is no sign of an ébauche or fini phase at this stage of the painting’s build-up. Manet blocks in the painting in a free, informal style that allows for mistakes because these can still be corrected in the following layers. You could say that the étude serves to establish the foundations of the definitive painting.

In order to increase the durability of the painting and not muddy the colours, excess paint was scraped off with a palette knife, but Manet did not always remove all of it. Sometimes he left some of the paint on his palette knife and pushed these small accumulations back into the forms of the composition, for example into the outlines of a figure. Thus these accumulations, which are part of the étude, could also end up in the final layer of the painting, the fini. These lines are clearly visible on X-ray images. This will be discussed at greater length in § 7.4, see pages 138-143.

This applies to other pupils as well. Couture also taught Puvis de Chavannes the basic principles of étude, ébauche and fini: the same school as Manet but another painter’s handwriting altogether. We have deliberately left out composition and perspective from this part of our investigation. We are focusing on what Manet learned from Couture and the way he dealt with it. In this connection Michael Wilson argues: “The degree of elaboration and finish can vary considerably from painting to painting and even within the same painting. Rarely in fact does Manet employ a consistent handling throughout a picture. Parts will be left sketchy; others, particularly heads and faces, developed in greater detail.” See Wilson, op. cit. (note 11), p. 12.
When Manet decided to paint a subject in the ‘impressionist’ manner, the execution displayed the following characteristics:

<table>
<thead>
<tr>
<th>Impressionist</th>
<th>Choice</th>
<th>Execution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Underpainting</td>
<td>Variable</td>
<td>Scraping</td>
</tr>
<tr>
<td>Outlines</td>
<td>Different widths</td>
<td>Varying colours</td>
</tr>
<tr>
<td>Drawing with paint</td>
<td>Bold and unrealistic</td>
<td>Variable</td>
</tr>
<tr>
<td>Brushstroke</td>
<td>Broad and rough</td>
<td>Spontaneous</td>
</tr>
<tr>
<td>Rhythm</td>
<td>Extremely variable</td>
<td>Chaotic but controlled</td>
</tr>
<tr>
<td>Patches</td>
<td>No halftones</td>
<td>Perfectly placed</td>
</tr>
<tr>
<td>Paint surface</td>
<td>Flowing</td>
<td>Thin impastos</td>
</tr>
<tr>
<td>Build-up paint layers</td>
<td>Directly – wet in wet</td>
<td>Less alterations</td>
</tr>
<tr>
<td>Finish</td>
<td>Mixing on the canvas</td>
<td>Varying quality</td>
</tr>
<tr>
<td>Composition</td>
<td>Minor influence photography</td>
<td>Large areas</td>
</tr>
<tr>
<td>Light and dark</td>
<td>Not true to nature</td>
<td>Hard transitions</td>
</tr>
</tbody>
</table>

**The ‘Naturalistic’ Painting Style**

In Manet’s ‘naturalistic’ painting style the emphasis lays on the revision of intermediate layers and on the finish: the ébauche and the fini. The combination of these two treatments on top of the étude gives the visible end result its typical appearance. According to the academic tradition, areas needed to be deepened or heightened during the build-up of the painting in the ébauche and the fini in order to achieve a natural perspective and texture.

Manet only partially adhered to the rules of the academic finish or fini, which demanded that no visible brushstrokes should remain in the highly polished appearance of a naturalistic painting. In fact, Manet applied visible brushstrokes in the paint surface of the fini. When he worked on naturalistic portraits, Manet mixed the paint layers on the canvas during the painting process and placed hard shadow lines on top of certain areas. These shadows could not be scumbled into the surrounding area and therefore appear to lack nuance. It is as if he had reversed the academic order of the technical build-up of a painting or at least introduced his own variations. The black shadows on the red trousers of Le Fifre are a good example of this painting technique. The black and dark brown areas in the final layer of Manet’s paintings always have an oily texture. This is caused by the ratio of medium and pigments in the mixed paint as well as by the many layers and scrapings. Thus the underlayers and final layer retain a certain greasy appearance.

18 Edmond Bazire writes that Manet needed more than eighty sittings to finish the portrait Le Bon Bock. See Edmond Bazire, Manet, Paris: A. Quantin, 1884, p. 82.
Paintings depicting faces that did not need to be lifelike were mostly painted with a loose stroke and should therefore be classified under the impressionist étude. This effect is nicely demonstrated in La Musique aux Tuileries. Some critics blamed this on clumsiness and ineptitude, but in Manet’s case it was more a question of stretching the limits of the material and of broadening traditional techniques.

When a more naturalistic approach was chosen, the ébauche and the fini were combined in the finish. The execution of the painting then presents the following options:

<table>
<thead>
<tr>
<th>Naturalistic</th>
<th>Option</th>
<th>Execution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Underpainting</td>
<td>Drawn with a brush</td>
<td>Frequent scraping with palette knife</td>
</tr>
<tr>
<td>Outlines</td>
<td>(In)visible</td>
<td>Partially overpainted</td>
</tr>
<tr>
<td>Drawing painting</td>
<td>Powerful and realistic</td>
<td>Clear details</td>
</tr>
<tr>
<td>Brushstroke</td>
<td>Thin and fine</td>
<td>Spontaneous but deliberate</td>
</tr>
<tr>
<td>Rhythm</td>
<td>Harmonious</td>
<td>As in a drawing</td>
</tr>
<tr>
<td>Patches</td>
<td>With halftones</td>
<td>Perfectly placed</td>
</tr>
<tr>
<td>Paint surface</td>
<td>Even and scumbled</td>
<td>Thin</td>
</tr>
<tr>
<td>Build-up paint layers</td>
<td>Layered – wet on dry</td>
<td>Multiple changes</td>
</tr>
<tr>
<td>Finish</td>
<td>Preliminary choice</td>
<td>Even quality</td>
</tr>
<tr>
<td>Composition</td>
<td>Influence photography</td>
<td>Varying</td>
</tr>
<tr>
<td>Light and dark</td>
<td>True to nature</td>
<td>Washed at the edges</td>
</tr>
</tbody>
</table>

We have now neatly categorized the technique of the painter, but this does not mean that we can fathom the highly individual ‘mystique’ of a painting. There is more needed for that. Even so, such outlines are necessary because they give us insight into the complex process of creating a painting and enable us to discuss and objectify the painter’s personal handwriting. In the classification above we have attempted to establish that Manet combined his natural drawing talent and his academic training and education to realize a new vision. This vision would eventually result in what is known as impressionism, but the greatest changes were brought about by Manet’s brushstroke. In fact, Manet essentially altered the order of the academic build-up of a painting and let his personal handwriting prevail – the handwriting that, according to those same academic views, should only appear in the étude and the ébauche and must not be visible in the final layer: the fini.
Manet’s paintings Indienne Fumant une Cigarette and Jeune Dame Couchée en Costume Espagnol date from the same period (1861-1862), depict the same model, and are painted with the same technique, but each display a different style. Both paintings are ‘finished’, but Indienne Fumant une Cigarette looks like an étude/ébauche while Jeune Dame Couchée en Costume Espagnol has the appearance of a fini.
3. Manet’s Brushes

Before we can start analyzing Manet’s painting technique in his works and more particularly in *Jobarde*, we should first take a closer look at Manet’s tools: his brushes. After all, brushes modulate the painter’s handwriting. The individual handwriting of the painter changes according to his choice of brushes. Their formal qualities act as a bridge between the driving ratio of the intellect on the one hand and the individual painter’s handwriting on the other.

The invention of the brush with a mechanically punched tin ferrule in the early nineteenth paved the way for new developments in the technique of painting. This lead to the introduction of the flat brush with stiff hog bristles. Variations in the indentation of the ferrule and the shape of the brush in lead to the development of three basic types of brushes: the rectangular shaped *brosse plate*, the pointed *brosse amande* and the rounded *brosse ronde*.

The variation in width of the ferrule and the length and thickness of the bristles lead to an individual, distinctive stroke for each type of brush. These new possibilities were exploited in full by the impressionists and obviously had a great impact on the end result of the painting. However, there is no evidence that Manet used exceptional brushes. He favoured a brush with short hog bristles. This type of brush is well suited for applying thick paint and impasto and leaves a clear brush mark.

However, Manet chose to work with both new and traditional handmade brushes made from the hair of different animals, for example hair that was taken from the ear of the sable. Sable hair, which came from Russia, was strong and flexible and could be loaded with large quantities of thin paint. Manet often used this type of brush for the outlines of his figures. The excessive use of medium, however, caused ‘natural’ runs of paint on the canvas, which Manet simply left untouched. They would be overpainted during the further completion of the painting anyway.

![Detail from the painting Un Atelier aux Batignolles (1870) by Henri Fantin-Latour. Manet is holding the traditional round-bound brush with round top (brosse amande [A]) and the modern flat bristle brush with shaped rectangular top (brosse plate[B]).](image)

19 We are only concerned with those brushes that are used to apply a stroke, not with brushes that are used for pounding, stippling and blotting.

20 In his *Traité pratique de la peinture à l’huile*, Georges Meusnier writes extensively about brush types and their use.

21 A different kind of brush made of hog bristle had been used since antiquity.
From left to right: 1. palette knife with a straight blade 2. a flat brush called a fan 3. a pointed sable 4. flat bristle with shaped round top (brosse ronde) 5. round-bound bristle with round top (brosse amande) 6. flat bristle with shaped rectangular top (brosse plate)
During his training with Thomas Couture, Manet will undoubtedly have learned which brushes were traditionally used for the étude, the ébauche and the fini. However, Manet’s selection of brushes was not uniquely dictated by tradition. It was largely determined by the dimensions of the canvas, the place of the different paint layers in the build-up, and the intended subject of the painting. For example, according to academic tradition, a broad brushstroke is used in the underlayer. Manet, however, also used it in the final layer and so created a visual shock effect which was the result of a literal increase in scale. Understanding this change of scale is vital for the interpretation of his whole oeuvre. We will deal with this in greater depth in our analysis of Jobarde.

Manet mainly used two tools for the underpainting: the flat brush (brosse plate) and the straight edged palette knife. The flat brush consists of hog bristles with a rectangular top and a metal ferrule. It has the advantage that it can load larger quantities of paint and that it can hold thinner paint than the traditional brush. The short, stiff bristles insure a smooth transfer of thick as well as thin paint.

Manet did not only use the palette knife to scrape away or thin down areas of colour but also to shape outlines, as was stated earlier. In the painting Olympia, traces of a palette knife are visible in the outlines of the bouquet of flowers, see page 91.

---

22 Painters may prefer different type of bristles in a brush. However, the quality of the bristle or hair is vital for the execution. A bristle or hair consists of a top, a belly and a root. The best do not have split ends, their belly can load enough paint and the root forms a hook which is firmly secured behind the string that holds the bristles or hairs together. Selecting the right brush is one of the most important choices a painter has to make.
Édouard Manet, detail Olympia, 1863
The arrow marks traces of a palette knife
4. The Development of Manet’s Painting Hand

Every painter’s handwriting is a combination of invariants and variants. Invariants are the unchanging, ever present elements that are produced by the motion of the painter’s hand and are executed unconsciously. They belong to the (unconscious) routine of a form language that is produced by the individual in combination with his tools. Variants are consciously applied changes of direction that dictate the form of the subject.

Essentially, each movement of the painter’s hand can be reduced to a line (–) or curve (曲线) and to the interaction between these two forms. Prominent invariants and recognizable line variants are defined by their angles and those of curves by their curvature. The definitive shape of an image left by a motion is a combination of line and curvature. The invariants are repeated in each new painting; they are distinctive features of the maker’s handwriting and have been selected on the basis of their form and their motion. This also applies for the variants, but with the essential difference that the objective of the maker’s pictorial vision changes in accordance with his conscious choices. After all, Manet always introduced certain variations to ensure that the end results would not all look ‘alike’. It is therefore vital to identify and gain a full understanding of these two aspects of the painter’s handwriting before we can analyze Manet’s style, or rather, his écriture. As we have seen in § 1.1, see page 79, ‘The Daumier of his Time’, the basis for Manet’s talent and his later craftsmanship was not only his proficiency as a caricaturist but also his draughtsmanship. A painting style that is based on the artist’s drawing skills makes it easier to identify the individual painter’s handwriting. In actual practice this means that the examples that have been singled out for comparison should be visible and easily identifiable.

The analysis and comparison of Manet’s painter’s handwriting as it was found in his oeuvre follow below. The results of the comparison with the painter’s handwriting [that was] uncovered in *Jobarde* are discussed in § 7.1, see pages 120-151, ‘Visualization of the Painting Technique in *Jobarde*’.

Invariant aspects of Manet’s painter’s handwriting are mainly found in the underpainting, the étude. On the one hand, Manet is most free when he is working on the underpainting, while on the other hand he knows that this layer will be smoothed away as he works towards the end result. So his disposition when working on the ground layer could be defined as spontaneous.

This freedom is visible in his informal approach to line drawing. As a rule this leads to a greater number of invariants. Most variants are found in the finish, in which he combined the étude and the ébauche to create the fini. Manet never worked towards a traditional academic fini on the whole painting.

The selection of Manet’s distinctive lines, which spring from so-called long term memory, was made on the basis of their recurrence in a range of his works. These lines therefore belong to the invariants of his technical build-up and handwriting. Manet’s variants clearly reflect his tentative search for solutions during the process of painting; they largely determine the appearance of the end result.

---

23 Here the ‘depth’ of the paint layer – its transparency – is left outside our considerations.
24 Even when the étude and the ébauche are presented as the fini result.
If we now look at Manet’s brushwork, we see that he applies his strokes with his right hand and generally places average pressure on the brush. He chooses not to put too much pressure on the brush in order to achieve greater fluidity.\textsuperscript{25} Manet held the brush in the middle or below the middle of the handle, and pointed it forwards.

In painting research we distinguish between a ‘painted’ painting and a ‘drawn’ painting. In a painted painting the brushwork is ‘scumbled.’ In a drawn painting, the brushwork results in a paint surface that is comparable to the play of lines in a drawing.\textsuperscript{26} As we have indicated earlier, Manet’s brushstrokes are clearly visible and so we are dealing with drawn paintings.

Then there is the concept of spontaneity. This concept is based on Maurits van Dantzig’s theory of pictology.\textsuperscript{27} Van Dantzig presented his findings regarding the painter’s individual handwriting in 1937.\textsuperscript{28} Essentially he concludes that lines produced by a spontaneous brushstroke cannot be imitated without the imitator making visible mistakes. The concept of spontaneity is based on the contrast between fluency of movement and a faltering, irregular brushstroke. Variants that are too short or too disconnected and have no clear beginning or end or distinct relationship with the general tone tonality of the environment, are always at odds with the free variants of the painter’s original handwriting.

In conclusion, we present a list of distinctive features that will allow us to analyze the brushstroke in Manet’s works. These criteria are based on the concept of spontaneity and will be analyzed in those works that are indisputably from Manet’s hand. In the analysis of the painting technique of \textit{Jobarde} the following recurrent aspects were found:

\begin{itemize}
  \item a. Type of line
    This is the form of a movement in one single line
  \item b. Rhythm and speed
    Literally the speed of a brushstroke
  \item c. Length of lines
    The beginning and end of an individual type of line
  \item d. Direction of movement
    Indicating whether there is an (un)conscious preference for a certain direction
  \item e. Regular versus irregular forms
    Curvature of round shapes and angles of lines
  \item f. Negative forms
    The tension of curves and angles
\end{itemize}

\textsuperscript{25} This also explains his preference for very thin paint in the étude.
\textsuperscript{26} Manet’s great examples were Frans Hals and Diego Velázquez, painters who were famous for their form language and who made ‘drawn’ paintings.
\textsuperscript{27} M.M. van Dantzig, Pictology, Leiden: E.J. Brill, 1973, p. 6-11.
\textsuperscript{28} M.M. van Dantzig, Frans Hals, True or False, Amsterdam: H.J. Paris, 1937.
After extensively studying Manet’s brush technique in approximately one hundred and twenty paintings over a period of five years, we have narrowed the number of invariants down to six which we will now describe and set out in a schematic outline.

When the final result is ‘impressionist’, the invariants that are fixed elements of Manet’s handwriting or brushwork can be described as follows:

A.  
Line type: zigzag line moving right  
Rhythm: very loose  
Build-up: mostly found in the étude  
Place: always used to fill in areas of a volume or background  
Start: right  
Place: top  
End: left  
Place: lower  
Transfer: medium pressure  
Transport: brush not empty at the end of the brushstroke  
Form: long with a slight curve  
Tilt: brush in a slight curve to next level  
Angles: Sometimes sharp, sometimes round  
Slant: In one motion light movement becoming heavier to the left  
Brush: flat brush with a rounded top (brosse amande)  
Grip: brush held in the middle  
Posture: brush steered by index finger and thumb  
Control: weight of elbow and wrist  

This type of brushwork appears in the following paintings:

<table>
<thead>
<tr>
<th>Painting</th>
<th>Year</th>
<th>Place</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Indienne Fumant une Cigarette</em></td>
<td>1861</td>
<td>middle left</td>
</tr>
<tr>
<td><em>Portrait de Madame Manet</em></td>
<td>1866</td>
<td>top left background (Lochard nr. 117)</td>
</tr>
<tr>
<td><em>Portrait de Berthe Morisot au Manchon</em></td>
<td>1868</td>
<td>bottom right (Lochard nr. 73)</td>
</tr>
<tr>
<td><em>La Femme à L'Ombrelle</em></td>
<td>1872</td>
<td>middle right</td>
</tr>
<tr>
<td><em>Étude pour le Polichinelle</em></td>
<td>1873</td>
<td>bottom right</td>
</tr>
<tr>
<td><em>La Parisienne</em></td>
<td>1875</td>
<td>middle right (Lochard nr. 38)</td>
</tr>
<tr>
<td><em>Portrait de Carolus-Duran</em></td>
<td>1875</td>
<td>several places</td>
</tr>
<tr>
<td><em>Portrait d’Albert Wolff</em></td>
<td>1877</td>
<td>trousers and background</td>
</tr>
<tr>
<td><em>Portrait de Manet par Lui-Même</em></td>
<td>1878</td>
<td>right arm</td>
</tr>
<tr>
<td><em>La Blonde aux Seins Nus</em></td>
<td>1879</td>
<td>background top right</td>
</tr>
<tr>
<td><em>George Moore au Café</em></td>
<td>1879</td>
<td>in the costume</td>
</tr>
<tr>
<td><em>Femme à l’Épingle d’Or</em></td>
<td>1879</td>
<td>right next to the outlines of the arm</td>
</tr>
<tr>
<td><em>Étude de Femme</em></td>
<td>1879</td>
<td>in the collar</td>
</tr>
<tr>
<td><em>Amazone</em></td>
<td>1832</td>
<td>in the dress and left next to fence</td>
</tr>
</tbody>
</table>

N.B.: Sometimes the zigzag lines intersect and form a double diamond pattern.

For comparison with Jobarde, see pages 142-143.
Detail La Blonde aux Seins Nus. Background top right shows how Manet fills in a volume or background.
B.
Line: broadening line moving right
Rhythm: very loose
Build-up: mostly found in the étude
Place: sometimes in the shape as an outline
Start: moving with the form
Place: almost always at the top
End: almost always at the bottom
Place: lower
Transfer: heavy pressure
Transport: brush empty at the end
Form: straight slightly fluctuating motion
Tilt: none
Angles: none
Brush: round top (brosse ronde)
Grip: brush held in the middle
Posture: brush steered with index finger and thumb
Control: weight of elbow and wrist

This variant appears in:

Portait de Madame Manet 1866 right on the underarm (as an outline)  
(Lochard nr. 117)

Portait de Madame Manet 1866 right on the underarm (as an outline)  
(Lochard nr. 254)

Portait de Monsieur Arnaud à Cheval 1875 on the horse’s legs  
(Lochard nr. 299)

Portait d’Ernest Hoschedé et de sa Fille Marthe 1876 on the costume  
(Lochard nr. 91)

Jeune Fille dans les Fleur 1879 on the dress  
(Lochard nr. 113)

NB: This fluid vertical line is used for a quickly placed mark or for a vertically cross-hatched filling of an area.

For comparison with Jobarde, see pages 135-137.
Édouard Manet, detail Portrait de Clemenceau, 1879-1880
C.
Line: flowing
Rhythm: loose and fragmented
Build-up: in the étude
Place: always as an outline for a volume or in the background
Transfer: medium pressure
Transport: full lines
Form: in accordance with the form of the subject, drawn out line
Tilt: never
Angles: does not always stop
Brush: mainly a brush with a rounded top (brosse langue de chat)
Grip: brush held in the middle
Posture: brush steered by index finger and thumb
Control: weight of elbow and wrist

This variant appears in:

*Indienne Fumant une Cigarette* 1861 left arm
*Portrait de Madame Manet* 1866 as an outline (Lochard nr. 117)
*Portrait de Guillaudin à Cheval* 1875 very slight variations of width outlines (Lochard nr. 88)
*Monet Peignant dans son Atelier* 1874 on the woman (Lochard nr. 281)
*Portrait de Carolus Duran* 1875 several places
*Portrait de Femme au Niche Noir* 1878 on the dress (Lochard nr. 19)
*Jeune Femme dans un Jardin* 1878 on the figure (Lochard nr. 85)
*La Blonde aux Seins Nus* 1879 the upper arms and breasts
*Vase de Jardin* 1879 in the whole picture (Lochard nr. 289)

NB: In *Monet Peignant dans son Atelier* the brush dances along the outlines. *Vase de Jardin* is a good example of a painting in which all three brush movements mentioned above appear in full.

For comparison with *Jobarde*, see pages 128-129.
Detail La Blonde aux Seins Nus. Three places where this type of line occurs
When the final result is naturalistic, the invariant features of Manet’s painter’s handwriting or brushwork can be described as follows:

D.
Line: parallel lines or crosses
Rhythm: very fluid
Build-up: mostly in the étude or the ébauche
Place: always as filling for volume or background
Start: right
Placing: horizontal or vertical
End: left
Placing: horizontal or vertical
Transfer: medium pressure
Transport: full brushstroke
Form: straight
Tilt: uninterrupted
Angles: sometimes swerves of 90 degrees to the left or right
Brush: straight flat brush
Grip: brush held in the middle
Posture: brush controlled by index finger and thumb
Control: weight of elbow and wrist

This variant appears in:

- **Indienne Fumant une Cigarette** 1861 on her dress on her breast
- **Le Vieux Musicien** 1862 on the dress of the figure left
- **Berthe Morisot à l’Éventail** 1872 in the background
- **Amazone à Cheval Prisé** 187? in the background, where it was scraped off (Lochard nr. 48)
- **Le Bateau Goudronné** 1873 horizontal next to the anchor

For comparison with Jobarde, see pages 142-148.
Édouard Manet, Le Bateau Goudronné, 1873

Détail Le Bateau Goudronné
E.
Type of line: flowing
Rhythm: loose, multilayered
Build-up: mostly in the ébauche and the fini
Place: as shadow
Start: right
Place: top
End: left
Place: lower
Transfer: light pressure
Transport: always full and opaque
Form: long and curved
Tilt: almost none
Angles: follow the form
Brush: flat brush with rounded top
Grip: brush held nearer the ferrule
Posture: brush steered by index finger and thumb
Control: weight of elbow and wrist

This variant appears in:

Le Baveur d’Absinthe 1858 in the
Le Chanteur Espagnol 1860 on the trousers\textsuperscript{29}
La Chanteuse des Rues 1862 in the dress
Olympia 1863 in the body
Le Bon Bock 1873 in the coat

Areas that have been filled in with paint are part of the invariant model of the fini.

For comparison with Jobarle, see pages 144-149.

\textsuperscript{29} The entire background of this painting has been overpainted; for the original state of this painting, see the early photograph in Robert Rey, Manet, Paris: Éditions Hypérion, 1938, p. 91.
F.
Line: in painted areas
Rhythm: wet in wet but always diffused
Build-up: appears in the ébauche and the fini
Place: mostly around the head of a figure, very prominent
Start: from every direction
Transfer: light and medium pressure
Transport: always full and opaque
Form: long and curved
Tilt: hardly any
Angles: defines forms
Brush: spread out with hand palm or fingers or blended with a brush
Grip: brush held nearer the ferrule
Posture: brush controlled by index finger and thumb
Control: weight of elbow and wrist

NB: Painted areas are always rubbed out and applied around a figure like a halo. The outlines of a figure interact with the surrounding area, linking the subject to its environment and suggesting motion. This, however, also has the effect of reducing the depth of a painting.

For comparison with *Jobarde*, see pages 124-125.
5. Analysis of the Painting Technique in *Jobarde*

The following analysis of the painting technique of *Jobarde* is based on those aspects that are visible with the naked eye and that display the distinctive features of Manet’s individual painter’s handwriting discussed in the previous paragraphs. In order to establish a connection between the painting technique of *Jobarde* and Manet’s other work we will refer to pictorial concepts and discuss them in relation with his oeuvre. *Jobarde* will then be placed within that general context on the basis of Manet’s painting technique. In § 7, see pages 120-149, we will broaden the scope of our analysis of the painting technique and the painter’s handwriting in *Jobarde* using modern light techniques.

**Étude, Ébauche and Fini**

The absence of a polished, academic fini is a result of Manet’s decision not to consider étude, ébauche and fini as consecutive stages in the build-up of a painting. Either étude and fini were combined in a fini or étude and ébauche were left ‘as they are’ and were presented as a fini. In Manet’s view the painting was then ‘finished.’ These variations form a breach with the official academic style and resulted from Manet’s experimentation with the possibilities that painting as a medium has to offer and his desire for innovation. Manet summed up his views at the end of his life in a statement which was noted by George Jeanniot: “Concision in art is a necessity and a matter of elegance. The concise man makes you think; the verbose man is a bore. Always aim for concision…”30

In *Jobarde*, the horse, which is painted realistically, appears to have been executed in a way that is most in accord with the traditional fini. But on closer observation it becomes clear that the legs of the horse have been for the most part handled as an ébauche, while the harness is executed as a fini. The hands of the Amazon, which have different colours, have been painted as an étude. The sky has the more traditional finish of a fini. The combination of étude and ébauche has been smoothed over with a ‘pounded’ final layer that was loosely applied wet on dry with a medium length brush.

5.1 Composition and Perspective

Anne Coffin Hanson rightly points to the fact that in Manet’s days the term composition had taken on a different meaning: “To ‘compose’ a picture meant to draw the forms and figures which would present the idea through details and gestures.” Traditionally we look at a composition on the basis of the theory of perspective, but as we will see, Manet’s compositions need to be considered from a modern point of view in order to be fully understood.

**Gesture and Pose**

Gesture and pose or ‘houding’ are closely related and make up the pictorial form language of the figures or events depicted in a painting. Pose is a term that was already used in European painting in the seventeenth century. ‘Houding’ is one of the most essential things one can observe in a drawing or painting, because it gives us the same optical experience that we enjoy when looking at things in nature. If ‘Houding’ cannot be found in an artificial image, such drawings or paintings have no reason and appears are more than half dead. Through the lack of ‘Houding’ things appear mixed up, packed together tumbling against us. In such a way that nothing can be more against reason than to place things without ‘Houding’. It is necessary to show what ‘Houding’ is and through which actions it can be obtained. Houding – in order to express the meaning of this art term and the force of its essence – is that which connects everything in a drawing or painting, which makes recede or advance and puts everything in its place, without making it appear closer of further away, nor to make it lighter or darker than its closeness or distance allows. In a way that everything, without confusion, loose from others in its neighbourhood, stands on its own place, and keeps its size and colour, light and shadow. So that one can detect with one’s eyes the space in between, the distance between each object, receding or advancing, as if it were accessible by foot and firmly planted on its place: and this one calls ‘Houding’.

For Manet this view or way of looking still was accurate. After he had studied the old masters this was almost inevitable. Anne Coffin Hanson writes: “Yet an evocation, a mystery, a suggestiveness is nevertheless present in many of Manet’s works, allowing them to provoke a variety of reactions in the spectator.” The suggestive gesture is found in the ‘houding’ of the Amazon. In fact she is tentatively pointing or at least gesturing in the direction of the horse’s pregnant belly. The horse in turn is depicted in a strained or attentive pose but also looks both stubborn and docile.

---

31 Coffin Hanson, op. cit. (note 14), p. 197.
33 Coffin Hanson, op. cit. (note 14), p. 133.
34 See § 7.4, see pages 138-141: X-Ray.
Mixing Background and Foreground and Isolating the Central Subject

In his compositions, Manet generally let the background and foreground merge in such a way that they sometimes became indistinguishable. He did this by using a wet in wet technique to mix areas of the background with the outlines of the figure on the foreground. There is depth in the figure, but not in the surrounding space, which is perceived as a flat surface. Looking at Jobarde, we see that the outlines of the central figure, the Amazon and her horse, merge with the background of the painting. It is as if the central figure has simply been cut out and pasted onto the background. The background and the foreground have almost no depth; extra layers of paint in the same tone as the main figure have even been added between the horse’s legs and the left arm and body of the Amazon, further abolishing the difference between back- and foreground. The academic build-up sequence of the painting has been reversed. This variation in build-up is one of the distinctive features of Manet’s painting technique.
Outlines of Jobarde. It looks as if the central figure was simply cut out and pasted onto the background.
Contradictory Perspective and Adjustment of Perspective

Traditional perspective which, as a rule, defined composition, is absent from Manet’s works; his use of perspective creates some confusion. Manet and his contemporaries incorporated the laws of perspective of the older works they had studied into their own paintings. As was made clear in the first part of this study, the horse depicted in Jobarde is, to a large extent, copied from Velázquez’s El príncipe Baltasar Carlos a caballo (or from the etching that Goya made after this painting). The Velázquez painting had a specific composition and order of perspective which Manet incorporated into Jobarde. Not only the horse has its own individual perspective, but the model and the environment do as well. Three perspectives have been incorporated: the Amazon is rather flat, the horse on the contrary is depicted in strong perspective, and the environment (the hills and the surf line) displays the sort of depth that was achieved in the seventeenth century by applying a build-up that progressed from light to dark to light. The horse is positioned in the foreground, the surf line is placed behind it and in the distance we see the hills with their varying heights. This results in a dynamic of perspective that draws the eyes of the viewer in different directions.

In his 1968 publication, Alain De Leiris argues that there was a “need to capture the activity of the modern world through the activity of normal sight, and a tendency to signal the tension between the illusion of real depth and the reality of the canvas surface.” A similar tension can be seen between the horse and the Amazon in Jobarde.35 The horizon in Manet’s paintings was often placed high on the canvas with a slight curve, especially in his seascapes.36 In Jobarde the curve of the horizon is masked by the hills that block the view. The hill on the right side, which was added at a later stage, corrects the ‘lob-sided’ composition and brings the horse and Amazon at the centre in balance. The horizon in Jobarde was initially drawn much higher on the canvas.37

35 Coffin Hanson, op. cit. (note 14), p. 200, n. 313.
36 Ibidem, p. 201.
Top: Infrared; middle: X-ray; below: normal light. On the right we have outlined how the horse is positioned in the foreground. The surf line is placed behind it and in the distance we see the hills with their varying heights.
The Relation between Detail and Whole

Already in his earliest work, Manet had a particular idea about the relation between the proportions of subjects and figures. This applies for the relation between details and figures as well as the relation between figures and the overall composition of a painting. We can ascribe this characteristic or choice to a conception of perspective and proportions that has its roots in the art of caricature. After all, distortion is not only a way to magnify or reduce the ‘image’, but also to attract attention to the idea that is being presented or to the object of mockery. However, we are more interested in demonstrating that this play with proportions is present in Manet’s paintings. These features are in fact typical of the impressionists, who introduced a more dynamic vision of composition by focusing on different subjects in the same painting. If we take a closer look at the figures in *La Musique aux Tuileries*, for example, we see that the playing children in the foreground are ‘too small’ in relation to the ladies to the left of them in the background, who are ‘too tall.’ The effect is enhanced by the figures in the background: the man with the grey hat standing second from the right is proportionally too big in comparison with the figures at the same level or on the same line in the composition. We can see this play with proportions at the end of Manet’s career in a painting like *L’Asperge*. The rather outlandish asparagus literally seems to be pushing back the edges of the painting. And even when a subject looks ‘normal’ within the overall context of a work, there is always some irregular detail that attracts attention. In *Le Bon Bock*, for example, the hand holding the pipe is too large in relation to the head of the portrayed figure.

In *Jobarde* we see a comparable phenomenon at work. It is very subtle but has a strong optical impact. The elongated form of the Amazon’s body shortens the horse between head and hind quarters, causing the belly of the pregnant horse to look as if it is pushed even further outward. Such distortions stimulate and activate our visual faculties and draw our eyes towards the main subject of the painting.
By changing scales Manet is not only able to magnify or minimize the ‘image’, but also the focus point.


5.2 Light and Colour

*Tonality*

The loss of visual depth is not only a consequence of Manet’s handling of composition, but also of the role of light in his paintings. He visualizes light by juxtaposing colours (in accordance with his impressionist ideas), and not by building them up in layers. In dark areas the light is almost completely absorbed and transitions in volume and tone are hardly discernible. When you give light a different depth or, in other words, a different technical build-up in paint, the texture of the depicted materials also changes.

Anne Coffin Hanson also noticed this in 1966. She writes: “Manet’s handling of black is similarly new and personal. The intense absorption of light by dark colors, particularly dark-colored fabrics, makes it impossible to see changes in value in these colors under many normal light conditions.” This also applies to *Jobarde*: the details that are present in the deep black colour of the Amazon’s costume are almost indiscernible under normal daylight conditions. The other dark areas are handled in a clear and nuanced manner, while the light areas are executed in pure tones and have a sculptural form – as can be seen in the crests on the water and the cuffs and collar of the Amazon’s blouse.

---

35 “*Proust tells the story which concerns the question of values. Couture once asked Manet’s opinion of a portrait, and Manet answered that the color was heavy and the painting encumbered by half-tones. ‘Ah,’ said Couture. ‘You refuse to see the succession of intermediate tones which range between the shadow and the light.’ Manet in turn declared that for him the light presented itself with such unity that a single tone sufficed to render it. Although it might appear brutal, it was preferable to pass brusquely from light to dark, rather than to accumulate things the eye cannot see, and which if included not only weaken the vigor of the light passages but attenuate the color of the shadows.” See Coffin Hanson, op. cit. (note 14), p. 159.

36 Ibidem, p. 203.


41 See § 7.2, see page 128: False Colour Infrared.
Light Sources

Another aspect connected with light is shading. Manet often introduces different light sources in his paintings. This means that the shadows can fall in different directions. In this manner he wanted to visualize the rotation (or movement) of the light source (the sun) and suggest depth. In the years surrounding 1873, Manet is fully focused on working with light, atmosphere and depth. In this context we can quote the following remark: “[T]heir contours consumed by the hidden sun and wasted by space, tremble, melt and evaporate into the surrounding atmosphere, which plunders reality from the figures, yet seems to do so in order to preserve their truthful aspect.”42 Sometimes shadows are overly emphasized, sometimes they have been left out altogether. In Jobarde, the light revolves around the figure, creating an illusion of movement. This is substantiated by the shadow that was discovered behind the horse in the underpainting, as we will see in § 7.5, see pages 144-147. However, it cannot be seen with the naked eye. Why this double shadow was overpainted is a question that must remain unanswered. Perhaps Manet decided that the shadow that is visible directly under the horse would do the required effect.

Blonde versus Earthy

The tonality of Manet’s works is characterized by two types of colour impressions. The first is known as ‘blonde’ and shines outwards, as if everything is bathing in sunlight. The other, which is described as ‘earthy’, is directed inwards and reminds us of interior lighting – which never falls in one direction.43 This does not mean that a blonde work is always situated outdoors or an earthly work always indoors.44 In Jobarde, for example, we can see a blonde sky area, while the Amazon and the horse are executed in earthy tones. See § 4.2, page 48.

---

42 Coffin Hanson, op. cit. (note 40), p. 42.
43 In order to determine the place of one single light source, shadows must be cast in one direction.
44 Once again, there appear to be no fixed rules in Manet’s work: a blonde tonality can be applied in an interior as well as an exterior scene.
5.3 Paint Layer and Brushstroke

Scraping and Mixing

The texture of a painting, its paint surface, is made up of an accumulation of paint layers and can be arrived at in different ways. One of these consists of scraping off and reapplying paint layers. In those areas where colours are mixed in the ébauche, Manet uses the painting as his palette: he ‘scumbles’ the paint wet in wet on the canvas – as opposed to the bold single brushstroke which is mixed on the palette and is often applied on the canvas wet on dry or wet on half dry as a fini. Manet also used texture to give pictorial subjects their right ‘structure’. This is manifest in the gloss on the horse’s coat, the crests on the water, and the silk hat and leather gloves of the Amazon.

In Jobarde, a large number of revisions have been made by scraping off paint. Traces of these revisions have been found mainly in the underlayers. An example of mixing paint on the canvas can be seen in the ground underneath the horse. However, there are also areas in Jobarde where the paint, as was often the case in the year 1873, is applied wet in wet as well as wet on dry.
Surface Texture

Normally, paint was applied with thin strokes in dark areas and with thick strokes in light areas, but as so often, Manet did not always choose to follow those rules, depending on how everything worked out during the technical build-up of the painting. On the basis of the thickness of a paint layer, we can distinguish two types of dark areas in Manet’s work. One is thin and sketch-like, has been applied directly on the canvas and has a clear brush structure. The other has a greasy paint structure without surface brushmarks, is executed in black or brown, consists of several paint layers and is determined by the balance of medium, siccative, diluter and pigment. Manet sometimes added too much siccative, causing the paint surface to crack and form a pattern that is known as asphalt or bitumen craquelure. His greasy structure is mainly found in areas where Manet has scraped off layer after layer of paint and has applied new paint layers after washing the canvas each time to the top ground layer (see for the method page 135). But not every area displays the same craquelure, making it difficult to evaluate or to come to any definite conclusion.

The dark areas of the horse and the skirt of the Amazon in Jobarde have a greasy look and from the fine craquelure we can infer that these areas in the final layer contain too much siccative. The light areas, for example the sky and the hands, are applied in thick strokes, thicker than the dark areas in the painting, as might be expected. They are mixed with a filler, which adds structure to the brushstroke.

Jobarde does not only combine different perspectives, but also incorporates different textures in its irregular final layer.


46 Craquelure is caused by the distinctive chemical and physical behaviour of paint layers. In Manet’s paintings we see a range of different patterns, varying from very fine age cracks to wide drying cracks, mainly caused by repeated revisions of the ground layer or by the balance of the medium and fast-working siccatives in the paint layers.

47 See the K-edge pictures of the barium in § 7.5, pages 144-147: K-Edge.
The Brushstroke and the Scale of the Painting

As was said earlier, Manet sometimes used the brushstroke in an unconventional manner in relation to the scale of the painting. A large or broad brushstroke can be found on small-scale paintings such as L’Asperge (1880). Inversely, there are also large paintings on which the finish is executed with a fine brush tip. Take for example two portraits from circa 1861, Jeune Femme en Costume Espagnol and Indienne Fumant une Cigarette: the same model, the same oil paint technique, but a totally different execution of the painter’s handwriting and, most importantly, a different brush selection. In Indienne Fumant une Cigarette Manet used broad flat brushes (brosse plate) while the different brush sizes used in Jeune Femme en Costume Espagnol have a more subtle relation to the size of the painting and to one another.

The brushes used on Jobarde appear to be reasonably in balance with the size of the painting. A comparable balance between brush sizes and dimensions can also be found in works such as Le Bateau Goudronné, Sur la Plage and Le Bassin d’Arcachon, all dating from the period 1871-1873.

Although the stretcher edges of Jobarde have been cut off, so that its true dimensions can no longer be determined, the subject and the placement of the monogram suggest that the painting was not much larger than it is in its present state. The foreground and the sky display the greatest number of broad brushstrokes, while the horse and the Amazon have been executed with different fine brush types.
6. Pictorial Comparison of Jobarde with Manet’s Oeuvre

In comparing the series of paintings from 1873 and aspects of the painting technique in Jobarde, we base ourselves on the term reciprocity. This term is used to refer to Manet’s working method, which produced a steady flow of new technical combinations and thus lead to a wide variety of possible end results.

<table>
<thead>
<tr>
<th>For Jobarde</th>
<th>paintings from the year 1873</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sky</td>
<td>Les Hirondelles(^45)</td>
</tr>
<tr>
<td></td>
<td>Les Courses au Bois de Boulogne</td>
</tr>
<tr>
<td>Water</td>
<td>Sur la Plage</td>
</tr>
<tr>
<td></td>
<td>Les Travailleurs de la Mer</td>
</tr>
<tr>
<td>Horse</td>
<td>none</td>
</tr>
<tr>
<td>Amazon</td>
<td>none</td>
</tr>
<tr>
<td>Ground</td>
<td>Le Bateau Goudronné</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>For Jobarde</th>
<th>paintings outside the year 1873</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sky</td>
<td>Les Hirondelles</td>
</tr>
<tr>
<td>Water</td>
<td>Sur la Plage</td>
</tr>
<tr>
<td></td>
<td>Les Travailleurs de la Mer</td>
</tr>
<tr>
<td>Horse</td>
<td>L’Exécution de Maximilien(^49)</td>
</tr>
<tr>
<td></td>
<td>Portrait de Guillaudin à Cheval</td>
</tr>
<tr>
<td>Amazon</td>
<td>Femme à l’Épingle d’Or(^50)</td>
</tr>
<tr>
<td>Ground</td>
<td>Le Bateau Goudronné</td>
</tr>
<tr>
<td>Mountains</td>
<td>L’Exécution de Maximilien</td>
</tr>
</tbody>
</table>

Manet also applied the general principle of reciprocity in the overall colour scheme. The overall colour scheme of Jobarde is comparable to:

- *Le Pont d’un Bateau* from 1862\(^51\)
- *L’Exécution de Maximilien* from 1867
- *Intérieur à Arcachon* from 1871\(^52\)
- *Le Bateau Goudronné* from 1873

---

\(^45\) Lochard nr. 324.
\(^49\) Lochard nr. 309.
\(^50\) Lochard nr. 41.
\(^51\) Lochard nr. 252.
\(^52\) Lochard nr. 160.
Édouard Manet, Femme à l'Épingle d'Or
7. Visualization Analysis of the Painting Technique in Jobarre

The visualization of the technical build-up using modern light techniques is a vital part of authentication research. The visualization of (paint) layers in the stratification of the total paint layer can provide additional clues about the painter’s handwriting, his tools and the revisions he made. It can also give insight into potential artificial and/or natural processes that have taken place since a painting was made. Light techniques applied during our research belong to the so-called non-destructive techniques. The outline below lists these light techniques in accordance with the build-up of a painting:

<table>
<thead>
<tr>
<th>Source</th>
<th>Layer</th>
<th>Painting</th>
<th>Stage</th>
</tr>
</thead>
<tbody>
<tr>
<td>UV-fluorescence</td>
<td>top layer</td>
<td>additions</td>
<td>fini</td>
</tr>
<tr>
<td>FC-infrared</td>
<td>top layer</td>
<td>final glazing layers</td>
<td>fini</td>
</tr>
<tr>
<td>Infrared</td>
<td>intermediate layers</td>
<td>underdrawing (painted)</td>
<td>étude</td>
</tr>
<tr>
<td>X-ray</td>
<td>bottom and top layer</td>
<td>priming and build-up</td>
<td>ébauche/fini</td>
</tr>
<tr>
<td>K-edge (ray technique)</td>
<td>intermediate layers</td>
<td>one element (paint)</td>
<td>all</td>
</tr>
</tbody>
</table>
The visualization of (paint) layers that are part of the stratification
7.1 UV-Fluorescence

UV-fluorescence is a surface visualization technique. The wavelength of long wave ultraviolet photography covers the range of the spectrum between 320 and 400 nanometer. When a photograph is taken, the surface of the painting is irradiated with two UV light sources. The colour temperature of UV-scans always varies because the lighting and the pictures are not standardized. Therefore a comparison between two UV-scans, as is the case here, should always be addressed with great caution. This type of scan is mainly used to uncover retouches, varnish layers, partial varnishes and varnish remains. Besides, UV-fluorescence can also reveal restorations as well as the painter’s own later additions in the fini. Non-authentic revisions of the surface such as retouches or varnish layers result in discontinuities in fluorescence and appear as darker or lighter patches.

The UV-fluorescence scan of Jobarde reveals three types of ‘additions.’ First, the dark deep blue coloured patches that indicate later retouches by a restorer [a]. Second, the varnish layer that runs under the horse’s manes [b]. This original layer has been applied after ground layer. We have found similar glazing layers in the fini of several brown and black areas on Le Bateau Goudronné.

---

33 James J. Rorimer, Ultra-Violet Rays and their Use in the Examination of Works of Art, New York: Metropolitan Museum of Art, 1931. Ultra-violet research was developed by the military in the 1910s and 1920s. It only began to be used systematically for painting research many years later.

34 This photograph was made with the museum’s permission.
As described in § 5.1: Mixing Background and Foreground and Isolating the Central Subject.
The distinctive features that can be seen *Le Bateau Goudronné* are also part of the *fini*. The horse’s manes, the anchor and the kettle show that in this case Manet also applied varnish on brown and black areas in wet on dry. This was done to enhance optical depth in shadow areas. Manet almost certainly picked up this method during his training in the studio of Thomas Couture. The flowing line in the varnish layers is also visible in the *fini* of both works. The light green layers on the UV-scan of *Le Bateau Goudronné* are part of the *ébauche* and are comparable to the build-up of *Jobarde*.

The black coloured patches that indicate later retouches by a restorer [a] and the varnish layer that runs on the hull of the ship [b].

**The Painter’s Handwriting in Jobarde under the UV-Fluorescence Scan**

The specific painter’s handwriting cannot be distinguished on the UV-fluorescence scan. What we do see are paint areas as described under line type E. These paint areas are part of the glazing in the *fini*. See § 5.3, ‘Surface Texture’, page 115.
Visualization analysis of the painting technique in Jobarbe

UV-fluorescence scan of Le Bateau Goudronné
7.2 False Colour Infrared

False colour infrared is a technique based on the overlaying of two images and has been used since the introduction of digital imaging: a digital daylight photo is overlayed with a digital infrared photo. This type of image is called ‘false colour infrared’ because the actual picture falls just outside the spectral value of infrared light.

The wavelength of an FC infrared photo is in the 780-900 nanometer spectrum range. In spite of this spectral ‘mismatch’, the image material can be read. The image reveals original varnish layers and finishes that are part of the fini. When we compare the UV-fluorescence scan with the FC infrared photo, we see that the early retouches on the legs of the horse light up in a similar manner on both images.\textsuperscript{35} Differences occur in the glazing of the ground area and the sky.

The yellow areas on the FC infrared photo indicate which areas were applied last [a]. The thickest final layers are visible on the ground and around the horse’s legs. Manet usually applied these layers wet on dry, covering the underlying layers and thus hiding crucial information from view. In such a case an X-ray can be used to complement the image. In the sky we find a thin atmospheric final layer. This layer is remarkable because the top part of the sky area presents a picture that is unusually calm insofar that it lacks Manet’s distinctive brushwork. This was probably done to find an acceptable balance between the loosely painted ground layer and the sky.

A large number of works from 1873 – Sur la Plage, Le Bateau Goudronné, Marine, Plage de Berck-sur-Mer à Marée Basse, Les Travailleurs de la Mer, Les Hirondelles and La Partie de Croquet à Paris – have calm skies in the fini.

\textsuperscript{35} As described in § 5.1, page 106: Mixing Background and Foreground and Isolating the Central Subject.
The Painter’s Handwriting in Jobarde under False Colour Infrared

The specific painter’s handwriting under false colour infrared is visible in for example the hat and the costume of the Amazon. Line type C is the characteristic invariant which appears in the rim of the hat [a]. And the almost invisible bow around the Amazon’s neck and the horse’s hind legs. Line type A is visible in the waistline of the Amazon’s costume.
Visualization analysis of the painting technique in Jobarde

Detail FC infrared photo of Jobarde
7.3 Infrared Reflectography

The long wavelength of the infrared range of the spectrum makes it possible to visualize the underdrawings on a monitor with a so-called vidicon camera.\textsuperscript{36} Long wavelength infrared begins at 780 nanometer. The wavelength for infrared reflectography is in the 1900-2400 nanometer spectrum range. This technique is particularly suited for painted underdrawings in which a pigment with a high carbon resolution has been used. The degree to which the painted underdrawing can be registered depends on the presence of dark carbonaceous pigment in the drawing, the thickness of the paint layer covering the drawing, and the type of pigment used in that paint layer. In \textit{Jobarde} we see an almost final elaboration of the painted underdrawing of the horse and part of the Amazon (the yellow lines). When we compare a work like \textit{Portrait de Guillaudin à Cheval} from 1875 with \textit{Jobarde}, we recognize certain brushstroke invariants, for example the similarity the width of the painted lines [a]. These were later overpainted and thus became invisible to the naked eye.

\textsuperscript{36} G. Wehlte, “Gemäldeuntersuchung im Infrarot,” Maltechnik 61, 1955, p. 52-58. This technique was introduced in the 1950s and was developed by the military industry. The technique was fine-tuned by different research groups, among others in The Netherlands.
Infrared Reflectography of Jobarde
The yellow lines mark the painted underdrawing of the horse and the costume of the Amazon. In various places we see that the horse’s hind quarters were first turned more towards the viewer. This means that several attempts were made to find the optimal outline of the horse’s belly in relation to his overall pose. The rotation of the hind quarters is a reflection of this compositional search. The red lines indicate the places where a palette knife was used. The outlines of the pregnant belly of the horse were also applied with a palette knife, probably to achieve a more subtle effect.

Traces of work with the palette knife are also visible on the ground. The purple lines are the drips of the thinly painted underdrawing. These paint runs are a highly distinctive feature of Manet’s work and can be found in a number of his unfinished paintings, for example in La Femme à l’Épingle d’Or. They were overpainted during the work process and so hidden from view.

The purple lines are the drips of the thinly painted underdrawing

37 Traces of the palette knife were found in almost all the paintings by Manet that we examined.
Detail infrared Jobarde. The yellow lines mark the painted underdrawing of the horse and the costume of the Amazon.

Detail infrared Jobarde. The red lines indicate the places where the palette knife was used.
Outlines that define the form of a figure are executed in different widths and lengths and never fully enclose a figure like they would in a drawing. They are executed in different colours, as is clearly visible in the portrait of George Moore from 1879. These coloured outlines occur either in an area that will later be overpainted or in the background onto which that area is applied. In the last case, reciprocity establishes a visual relation between the subject and the surrounding area, because the depth of the background is either dissolved or reduced.

It appears as if the lines in Jobarde follow the length of the form, this is precisely the method that Manet used in other paintings. The lines follow the form over its entire length. The painted underdrawing does not have to encircle the entire figure, it just sketches the outlines, outlines which could change at any moment during the painting process; for Manet, outlines literally meant liveliness. This reminds us of Manet’s reaction to a comment on the painting Le Skating: “It’s very good but, Monsieur Manet, don’t you think that the outlines are not well enough defined and that the figures dance a bit too much?” Manet replied “They’re not dancing, they’re skating; but you’re right, they do move and when people are moving, I can’t freeze them to the canvas. As a matter of fact, sir, I have been told that the outlines of Olympia are too well defined, so that makes up for it.” In other works we see a similar liveliness of lines and outlines.

---

58 Which does not imply that every painting has coloured outlines.
The images on the following pages show the array of lines that define the different outlines of, among others, the voluminous woolen skirt, which is much longer on one side to accommodate the side-saddle position. These lines also seem to seek out the outer limits. This makes sense because the rotation of the horse’s hind quarters mirrors the outer contours of the skirt.

In the middle of the nineteenth century, M.P.L. Bouvier and L. Osborne wrote standard works on traditional painting technique. Both works go back to the early nineteenth-century ideas about painting technique of J.F.L. Mérimée. The description of the ébauche is particularly interesting. Osborne argues that by scraping away areas of paint with the palette knife, thin tone layers are created that can be used during the further build-up of the painting. Following this, the painting should be cleaned with water and left to dry (in the sun).

Manet largely adopts this medieval treatment of ground layers. There is, however, one important departure from Osborne’s advice. As we can see on various X-rays and unfinished paintings, Manet almost invariably scrapes off paint layers in the painted underground, the étude. In the next phase of the build-up, the ébauche, Manet uses strong siccatives to manipulate the paint layer. The oily dark areas obtain their characteristic aura from this treatment of the underlayers.

**The Painter’s Handwriting in Jobarde under Infrared Light**

One of the invariants of the painter’s handwriting under infrared light is visible in among others the loose skirt of the Amazon: Manet used line type B to draw the initial outline of the dress. In the technical build-up this line is part of the étude, see page 137.

---

61 Coffin Hanson, op. cit. (note 14), p. 143, n. 31.
63 Ibidem, p. 149.
64 Ibidem, p. 166-167.
This infrared image reveals traces of scraping with the palette knife (red lines) which define the form of the pregnant belly in particular.
This infrared image reveals the painted underdrawing (the yellow lines) of the horse and the costume of the Amazon.
7.4 X-Ray

The wavelength of X-rays, a normal procedure to examine paintings, ranges from 0.01 to 4.5 nanometer. X-rays are used to visualize underlying structures in the paint layers, such as revisions in the first ground layer and the underpainting as well as later compositional modifications. Furthermore, the black and white image enables us to examine the variants and invariants of the individual brushstroke. However, this is only possible if these layers contain heavier elements, such as lead, mercury and/or zinc.65

The earliest known X-ray images of paintings by Manet were made in the 1960s and 1970s.66 Actual comparison of these images, however, only begins much later. Anne Coffin Hanson refers to such X-ray images, but she doesn’t reproduce them in her publications. This was probably due to the fact that they weren’t readily available. Michael Wilson, in his Manet at Work, published in 1983, was the first to compare an X-ray photo with a painting and to place the question in a broader perspective.67

65 Alexander Faber, “Eine neue Anwendung der Röntgenstrahlen,” Die Umschau, 18/12, 1914, p. 246-253. X-rays were invented by Carl Wilhelm Röntgen in 1895. This technique was first used for the investigation of paintings in the early twentieth century, when different groups started working on a more systematic way of taking X-rays of paintings.


67 Wilson, op. cit. (note 11).
The X-ray of Jobarde clearly shows revisions in several areas. The repeated alterations in the paint layers clearly stand out, for example where Manet is trying to determine the outlines of the mountains and the water. The X-ray also reveals that the horizon originally extended to the right at a similar angle as the horizon in Velásquez’s painting *El príncipe Baltasar Carlos a caballo*, see § 5.4, pages 65-69.
X-ray Jakevle. The purple lines indicate the line work which is invisible to the naked eye.
The Painter’s Handwriting in Jobarde under X-ray

Several invariants of the painter’s handwriting appear under X-ray, for example in the sky and the mountain. Line type A and D are visible in the sky or background surrounding the Amazon and above the horse’s head. The loose quality of these invariants can be clearly identified by their movement and the informal manner in which they were applied. The lines are juxtaposed or cross-hatched and serve to fill in volumes or background areas. They are executed with a straight flat brush (brosse plate) with occasional 90 degree swerves [a].

The horizontal lines that form the mountains can be defined as line type C. They shape the mountains and are similar in composition to the horizon in Velázquez’s El príncipe Baltasar Carlos a caballo. These sketch-like lines, that are part of the invisible étude, are an excellent example of this type of invariant.

The lines are executed with a straight flat brush (brosse plate)
These images were manipulated in the computer. An X-ray photo is superimposed on a daylight photo. Line types A and D are visible in the sky or background surrounding the Amazon and above the horse’s head.
7.5 K-Edge

K-edge imaging is a technique based on synchrotron radiation. Synchrotron radiation waves cover almost the whole range of the electromagnetic spectrum. With a monochromator this polychromatic radiation can be tuned to one specific wavelength, allowing for one single (paint) substance to be visualized. Paintings can be scanned in order to map the distribution of individual elements. It enables us to visualize specific pigments and obtain information about colours in hidden layers [a]. The possibility to look at a single paint substance (or element) in the build-up of the painting is closely related to the creative process. The results of the K-edge research of Jobarde are documented in appendix C, page 212.

The images of the element barium (Ba) reveal a large area in the ground behind the horse

Left: This image was manipulated in the computer. The K-edge barium image is superimposed on a daylight photo.
Right: *L’Amazone* (water colour). This image shows a shadow in front [2] of and behind the horse [1]. Here Manet worked with two shadows, like in Jobarde.
Jobarde was analysed in 2004 and 2005 using this improved X-ray technique.\textsuperscript{69} The images of the element barium (Ba) revealed a large area in the ground behind the horse. When we mounted this area in an ordinary daylight photograph of the painting, it became clear that we were dealing with a shadow of the horse and the Amazon. This shadow area was painted with a broad, loose brushstroke. We were dealing with a partially overpainted shadow immediately under the horse and, as the photomontage of the barium layer shows, a second shadow behind the horse. This double shadow, or shadow on two sides, corresponds with Manet’s conception of light: “Finally the sky should cover and envelop the whole scene, like an immense, shining canopy whose light plays over all the figures and objects.”\textsuperscript{70} Daylight engulfs the objects in the painting in much the same way as it does in our perception. Manet’s statement is in tune with impressionist ideas about the dynamic experience of light. The second shadow area in Jobarde is a clear demonstration of this conception. In other paintings, for example in Le Buvard d’Absinthe, shadows also fall in different directions, while in La Place de Boulogne some figures have no shadows at all. Perhaps Manet painted shadows as they turned with the sun; in any case they reflect the motion of the sun.

The double shadow found in Jobarde is a clear expression of Manet’s artistic views on light and motion. Why this shadow was overpainted is anybody’s guess. Maybe because it disturbed the compositional balance or drew attention away from the light on the horse’s belly. It is also possible that these shadow areas made the realistic horse look too bulky in the master’s eyes.

The same question could be asked about the sky area, as discussed in the previous chapter. The distribution of lead white in the K-edge image is comparable to that in the X-ray, but this does not explain ‘why’ these areas were overpainted.


\textsuperscript{70} Wilson-Bareau, op. cit. (note 5), p. 172.
The k-edge barium image is laid on top of a daylight photo and visualize the shadow behind the horse.
The Painter’s Handwriting in Jobarde under K-Edge

We have found invariants in the mercury (Hg) and lead (Pb) K-edge images. Mercury is the main component of vermilion, while lead is the main ingredient of lead white. The mercury image shows strong invariants as described under line type D [a]. However, these invariants have been executed with a brosse plate and are part of the overpainting of the mountains in the background. They were probably used to suggest a warm glow. On the lead image we can see the sky that is present under the fini. This is a further clear example of the invariants that make up Manet’s painter’s handwriting.

The mercury (Hg) image of the K-edge
The lead (Pb) image of the K-edge
8. Pictorial Comparison of the Summer of 1873

The art historical research into Jobarde has lead us to date the painting to 1873, the year that also saw a significant change in Manet’s technical conceptions of painting. This change, that occurred between the Salon and the end of the summer, was also corroborated by the results of our research into the painter's handwriting and the technical analysis of Jobarde. Again, Jobarde appears to have been painted in that watershed year.

The outline below will enable us to further pinpoint the date. The period between Le Bon Bock and Les Travailleurs de la Mer, which were both dated by Manet himself, plays a vital role in this period of tension between realism and impressionism. Le Bon Bock was painted in April and May and Les Travailleurs de la Mer in July or August, possibly extending into September: a number of the works that were painted during this period were probably prepared during the summer and finished at a later date in the studio.

Manet’s technical exploration of that tension between a lifelike and realistic and a free and impressionist style is most clearly visible in Le Bateau Goudronné and in Jobarde. The realistic depiction of the boat in Le Bateau Goudronné can be compared to that of the horse in Jobarde and of the face in Le Bon Bock. The workers who are tarring the boat in Le Bateau Goudronné are executed in the same sketchy (or impressionist) manner as the Amazon in Jobarde and the sailors in Les Travailleurs de la Mer.

The analysis of the painting technique in Jobarde has shown that links with Édouard Manet’s personal painter’s handwriting can be found in every stage of the painting’s build-up. Jobarde therefore should be dated to the period between Le Bon Bock and Les Travailleurs de la Mer.

And in our view it should be dated closest to Le Bateau Goudronné.

The eight works listed below are those of which we can say with certainty that they were painted during the summer months of 1873:

- **Le Bon Bock**, dated 1873
  - Oil on canvas
  - 94.6 x 83 cm.
  - Philadelphia Museum of Art, Philadelphia

- **Sur la Plage**, undated
  - Oil on canvas
  - 59.6 x 73.2 cm.
  - Musée d’Orsay, Paris

- **Le Bateau Goudronné**, undated
  - Oil on canvas
  - 59 x 60 cm.
  - The Barnes Foundation, Merion, Pennsylvania

---

74 We have examined the painting technique and painter’s handwriting of Le Bateau Goudronné on two occasions.
Marine, undated
Oil on canvas
50 x 61.5 cm.
Private Collection, New York

Les Hirondelles, undated
Oil on canvas
81 x 65.5 cm.
Private collection

Marine, undated
Oil on panel
20 x 33 cm.
Wallraf-Richartz-Museum, Cologne

Plage de Berck-sur-Mer à Marée Basse, undated
Oil on canvas
56 x 73 cm.
Wadsworth Atheneum Museum of Art, Hartford

Les Travailleurs de la Mer, dated 1873
Oil on canvas
63 x 79.3 cm.
The Houston Museum of Fine Arts, Houston

For the technical material research it is vital that we stick to this order. This means that at least 5 and at the most 10 paintings were made in the period between May and September 1873. It is our opinion that Jobarde was painted just after Le Bon Bock, but before Le Bateau Goudronné.

---

9. Evaluation Painting Technique Analysis

In the following evaluation the results and findings of this part of our research are cited in the order in which they were discussed. These findings are discussed within the context of the status. Each status can then serve to determine the value which establishes the connection between Jobarde and Manet’s oeuvre.

**Negative status.** This is the status that argues against the authorship of Édouard Manet.

* Jobarde is not dated

The fact that Jobarde is not dated is no exception. many of Manet’s works were not dated by him personally

**Positive status.** This is the status that argues in favour of the authorship of Édouard Manet.

* The invariants of Manet’s painter’s handwriting were found in the entire build-up of Jobarde: étude, ébauche and fini
* The invariants of the painter’s handwriting of Jobarde under false colour infrared correspond with Manet’s hand
* The invariants of the painter’s handwriting under infrared correspond with Manet’s hand
* The invariants of the painter’s handwriting under K-edge correspond with Manet’s hand
Neutral status. This is the status that argues neither against nor in favour of the authorship of Édouard Manet.

* The technical build-up of Jobarde is based on the academic principles of étude, ébauche and fini
* The style of Jobarde is both ‘impressionist’ and ‘naturalistic’
* The styles interfere with the academic method: the étude and the fini trade places in the build-up, just like the ébauche and the fini
* The brushes used on Jobarde are similar to the brushes that are used in other works by Manet
* The places where we see different types of brushes in the build-up of Jobarde are similar to the brush selection for similar areas in other works by Manet
* The Amazon is depicted in a tentative pose
* Background and foreground have no depth
* There are several perspectives in Jobarde
* The original horizon was placed much higher
* There is a hidden bow near the neck on the black costume of Jobarde
* The light in the painting comes from different directions
* Jobarde’s tone is both blond and earthy
* Hidden traces of revisions in Jobarde correspond with Manet’s painting technique
* Jobarde displays the same relation between brush size and scale of the painting as Le Bateau Goudronné, Sur la Plage and Le Bassin d’Arcachon
* The dark areas of the paint layer in Jobarde have an oily texture
* There is reciprocity between certain features in Jobarde and a number of Manet’s works
* The invariants of the painter’s handwriting in Jobarde under X-ray correspond with Manet’s hand in other works
* Pictorial comparison of the works painted in the summer of 1873 indicates that Jobarde was painted after Le Bon Bock, but before Le Bateau Goudronné
* The difference in the depiction of the gloves
Jobarde, a Rediscovered Painting
by Édouard Manet

Technical Material Analysis

“In the case of forgers against experts it is a veritable ‘battle of wits’”
Samuel A. Goudsmit
Technical Material Analysis

Technical material research complements art historical and technical painting research, that focus on the chronism of the object of research. For the authentication of paintings the materials that have been used are identified. Next, the places on the painting where they occur are carefully determined. Then, the properties of the identified materials are cross-referenced with the painting technique of the artist in the object of research.

Our technical material research did not restrict itself to an analysis of painting materials, but also focused on the suppliers of painting materials, namely the lead mining industry and the subsequent ore treatment process and production of paints.

1. Painting Materials

Painting materials hold arcane knowledge: understanding the nature of pigments, mediums and siccatives is essential for the artist who wants to realize a non-perishable representation. Pigments in particular are products of their time. They may be of natural origin or have a chemical composition, the range of pigments on offer varies in each period, the supply of base materials may stop as a consequence of war or changing economic or industrial demands, and the production is sometimes discontinued, for example because of their high level of toxicity. Thus a painting carries a certain chemical and physical ‘code’ in it. By applying certain measuring techniques we can determine whether we are dealing with pigments that date from the same time as the object of research. However, not only dating plays an important role in authentication research, but also the places ‘where’ pigments have been applied during the build-up phase of painting, because the order in which they occur depends on contemporary conceptions, learning processes, ‘secret’ recipes, personal preferences and studio routines.

Besides hidden knowledge, painting materials can also reveal the artist’s technical shortcomings. Time has shown that for example some pigment combinations lead to the discoloration of a painting. Of course this was an unwanted natural reaction, as notes in early painter’s manuscripts prove.¹ The identification and interpretation of these chemical or physical changes are an important part of the daily practice of painting restorers and can lead to new art historical insights.²

Another important aspect is the analysis of siccatives and mediums. It focuses on the composition of materials and the places where they occur in the object of research. This can vary according to the painter and according to its place within the chronology of a painter’s oeuvre.

Finally, the study of the natural aging process of materials can also yield valuable information. And although materials were sometimes aged on purpose, artificial aging is clearly distinguishable from natural aging.³

³ The description of detection methods of chemical transformations in paint and medium falls outside the scope of our research.
1.1 Maison Blanchet

In the nineteenth century, the production of pigments for artists boomed as a result of the industrial revolution and developments in chemistry. New colours were being added constantly. The invention of the tin tube in 1841 by John Goffe Rand increased the durability of paints and literally allowed the painter greater mobility. However, this invention wasn’t the result of lofty ideas about providing artists with the means to paint outdoors, but was intended as a solution for the problem of the preservation of paints. Painting was a very popular pastime in France: it was fashionable for members of the bourgeois classes to take up either drawing or painting. The demand for painting materials increased explosively, a demand that could not be met by traditional materials and production patterns.

The chemist shop, where the artist bought his materials until the end of the eighteenth century, passed on its task to the more professional dealer in artist’s materials. By the middle of the nineteenth century these shops, usually called ‘Maisons’, were selling prepared canvas, panels, Bristol board, paper, brushes, paints in tubes and fully equipped paint boxes. The professional artist could also turn to the marchands de couleurs: “These smaller merchants often produced their own paints by hand, something which many artists, including the Impressionists, held in high regard. Renoir is said to have asserted: ‘I, for one, strongly believe that it is more advantageous for a painter to create his own paints or have his apprentice create them for him. Since there are no more apprentices and I prefer to paint, rather than produce paints, I buy them from my old friend Mulard, the column on the rue Pigalle, who makes them for me.’” During the nineteenth century, the number of these marchands de couleurs grew explosively: “[W]hereas there were 13 colormen in Paris in 1796, they were 260 in 1855, then 463 in 1874, and 708 in 1899.” The marchands de couleurs were also often owners of a Maison. These Maisons usually placed stamps on the back of the canvasses or on the stretchers they sold. We have looked at the suppliers that were frequented by Manet. In the publication Impressionism the authors mention that a stamp of the Maison Ange Ottoz was found on the back of the canvas La Musique aux Tuileries (1860). Maison Ottoz was located at rue de la Muchodière 2 from 1857 to 1830. Clotilde Roth-Meyer found a mention of a second supplier in a book by Nathalie Sauvaire, who established a connection between the Maison of the Haro family and Manet’s demands for materials. Haro was located at rue Bonaparte 20 from 1857 to 1867 and at rue Visconti 14 from 1868 to 1882.

---

8 Constantin, op. cit. (note 6), p. 65.
As we have mentioned earlier, Jobarde is mounted on a twentieth-century stretcher, onto which the remnants of a nineteenth-century stretcher have been screwed. These remnants carry the mention: “Blanchet 17, Rue de Grenelle 17.” In her The Barbizon Painters: A Guide to their Suppliers, Stéphanie Constantin mentions that Laurent Blanchet’s art supplies shop was located at that address from 1868 to circa 1885. Between 1885 and 1965 Maison Blanchet was located at three different addresses, among others at rue de Bonaparte 38. The studio at rue de Saint-Pétersbourg 4, where Manet moved in 1872, was three kilometres from the rue de Grenelle.

We decided to check if the archives or records of the Maison Blanchet still existed. During a visit to the Blanchet family in Paris in 2004 we were told that the archives had largely been destroyed, as well as the bills, order forms and commissions from the period between 1870 and 1875. Only a few small recipe books had survived. They contained recipes and technical instructions for almost every great painter from the period between 1835 and 1965. The books also contained loosely inserted autograph notes with instructions about mediums, siccatives and the durability of pigments and remarks on primers and canvas and panel measurements. This confirmed the image of the art supplies dealer as a personal advisor and as someone who caters to special demands. However, the family had no recollection of also working for Manet.

Although the nineteenth-century stretcher bears the mention Maison Blanchet, we have found no concrete evidence of a link between this dealer and Manet.

Inside the twentieth-century stretcher of Jobarde there is a stamp which reads: “Erich Fehlmann Gemälderestaurator 15 dez. 1961.” The restorer Fehlmann probably replaced the nineteenth-century stretcher in 1961, but decided to preserve the information on the old stretcher, see page 26. It seemed a good idea to look if there was a stamp on the canvas that could supply us with additional information. Using a light source, an infrared camera and UV-radiation, we searched for a supplier’s stamp on the back of the original canvas support. This proved not to be the case. The fact that there was only a stamp on the stretcher convinced us that the size of the canvas was chosen by Manet personally and that a stretcher was manufactured that was not substantially larger than the canvas in its present state.

12 Ibidem, p. 66.
13 Ibidem, p. 66.
14 In the case of the painter Théodore Rousseau the Maison Blanchot is mentioned in connection with Manet’s dealer Durand-Ruel. See Constantin, op. cit. (note 6), p. 50.
1.2 Stretcher and Canvas

The nineteenth-century stretcher of *Jobarde* is made of épicea or pinewood. Most of the stretchers from that period were made from this type of broad-nerved softwood. The canvas on which *Jobarde* is painted is described as *à grain* or *lisse*. The edges of the canvas have been cropped, making it impossible to determine the original measurements of the painting. However, the composition, the placement of the monogram, the title and the name of the horse indicate that, considering Manet’s working method, the painting would not have been much larger than it is now.

It is almost impossible to present exact information about the size of most of Manet’s canvasses because they were seldom made according to standard measurements. He invariably adapted the proportions of a painting to its contents and to the type of palette knife and the width of the brush that he used, and the question of size was an inherent part of his ideas about composition. In a conversation with Charles Toché in Venice in 1874, Manet said that he always considered the perspectival relations of the subjects on the canvas in accordance with the overall composition. So the conscious selection of a specific canvas size has a substantial effect on the way the end product is perceived.

The current measurements of the painting are 86.6 x 50.4 cm. If we compare this to the standard sizes of prepared canvasses that were available at the time, we arrive at a standard size of 92 x 60 cm, a so-called Marine number 30. But it is also possible that Manet didn’t adapt standard sizes for his paintings, but simply cut his canvasses from a larger roll. These rolls were available in a maximum size of 10 x 2 meter, were glued and already had one or two coats of primer. Canvas could be cut from the roll in any given size. Subsequently, a pinewood stretcher was made in the desired dimensions. Prepared canvasses, whether they came “from the roll” or not, were already quite popular in the early nineteenth century. They had already received a second, coloured undercoat. This undercoat could be in one of the following five colours: écru (natural), jaune (yellow), rosé (pink), gris clair (light grey) and gris foncé (dark grey). The prepared canvas of *Jobarde* has a gris clair undercoat, which is similar in build-up to that of *Le Bateau Goudronné*. It should be added that such coloured undercoats rarely occur in the paintings Manet made in 1873.

---

18 Ibidem, p. 49.
19 These observations were made with the naked eye.
1.3 Manet’s Palette

Throughout his life, Manet used a palette for the étude and ébauche that was based on the lessons of his teacher Thomas Couture.\(^{20}\) The essence of this palette was its simplicity: “His (Couture’s) foremost aim was freshness and purity of colour, which he sought to achieve by mixing colours as little as possible and by placing on the canvas the exact tint he desired without disturbing it afterwards.”\(^{21}\) When we look at the traditional academic palette of Bouvier from 1832, we arrive at 32 paints. The colour palette consisted of 90 shades and 10 so-called mother paints (paints with no white added). Thomas Couture broke with this tradition and reduced the palette to 20 or at most 25 basic colours.\(^{22}\) Manet’s palette also had a simple composition: he hardly mixed any colours while preparing it.

Manet did not make his own paints, but bought them in tin tubes from his suppliers.\(^{23}\) They were probably manufactured according to his personal wishes by the marchands de couleurs of the Maison. From research and from his unfinished paintings we know that he mixed his paints with thinners and siccatives. In his choice of colour scheme he probably took into account the drying time, fluidity, colour intensity and qualities such as mixability and perishability. These properties of paint were also discussed in Thomas Couture’s studio. It was one of the foundations of Couture’s training programme.

As indicated earlier, the étude and the ébauche are crucial for the end result of Jobarde. Therefore we tried to determine if the colours that generally made up Manet’s palette during those stages of the painting process also occur in Jobarde.

In the second part of this study we have argued that the tonality of Manet’s palette can be divided into three periods: a first period (1859-1865) with a dark palette, a second period (1865-1873) with a dark palette and a third period (1874-1883) with a light palette. Most important for our research is the second period, especially the summer of 1873. The composition of Manet’s palette during that period has been determined on the basis of the following works: Le Bon Bock, Sur la Plage, Le Bateau Goudronné, Marine, Les Hirondelles, Plage de Berck-sur-Mer à Marée Basse and Les Travailleurs de la Mer.

\(^{21}\) Ibidem, p. 69.
\(^{22}\) Which essentially meant that Couture returned to the tradition of the seventeenth-century European masters, which was based on a much more limited range of colours.
\(^{23}\) A picture of Manet’s paint box with tin tubes can be found in Ronald Pickvance, Manet, Martigny: Fondation Pierre Gianadda, 1996, p. 170.
Manet’s paint box with tin tubes
What follows is an outline of the comparison between the 21 individual paint colours that were found in those paintings as well as in Jobarle.

<table>
<thead>
<tr>
<th>Colour</th>
<th>Name</th>
<th>French name</th>
<th>Date of introduction or disappearence</th>
</tr>
</thead>
<tbody>
<tr>
<td>White</td>
<td>Lead white</td>
<td>blanc de plomb</td>
<td></td>
</tr>
<tr>
<td>Yellow</td>
<td>Yellow ochre</td>
<td>ocre jaune</td>
<td>antiquity</td>
</tr>
<tr>
<td></td>
<td>Naples yellow</td>
<td>jaune de Naples</td>
<td>1750</td>
</tr>
<tr>
<td></td>
<td>Chromium yellow</td>
<td>jaune de chrome</td>
<td>1800</td>
</tr>
<tr>
<td></td>
<td>Sienna</td>
<td>sienne naturel</td>
<td>antiquity</td>
</tr>
<tr>
<td>Orange</td>
<td>Chromium orange</td>
<td>orange de chrome</td>
<td>1809</td>
</tr>
<tr>
<td>Red</td>
<td>Red ochre</td>
<td>ocre rouge</td>
<td>antiquity</td>
</tr>
<tr>
<td></td>
<td>Vermillion</td>
<td>vermilion</td>
<td>antiquity</td>
</tr>
<tr>
<td></td>
<td>Carmine red</td>
<td>cochenille</td>
<td>1549</td>
</tr>
<tr>
<td></td>
<td>Alizarin red</td>
<td>laque de garance</td>
<td>antiquity</td>
</tr>
<tr>
<td>Blue</td>
<td>Cobalt blue</td>
<td>bleu de cobalt</td>
<td>1802</td>
</tr>
<tr>
<td></td>
<td>Synth. ultramarine</td>
<td>outremer</td>
<td>1824</td>
</tr>
<tr>
<td></td>
<td>Cerulean blue</td>
<td>bleu de ceruleum</td>
<td>1860</td>
</tr>
<tr>
<td>Purple</td>
<td>Cobalt violet</td>
<td>bleu violet</td>
<td>1861</td>
</tr>
<tr>
<td>Green</td>
<td>Chromium green</td>
<td>vert oxyde de chrome</td>
<td>1862</td>
</tr>
<tr>
<td></td>
<td>Cobalt green</td>
<td>vert de cobalt</td>
<td>1834</td>
</tr>
<tr>
<td></td>
<td>Scheele’s green</td>
<td>vert de Scheele</td>
<td>1830-1880</td>
</tr>
<tr>
<td></td>
<td>Verdigris</td>
<td>terre verte vert-de-gris</td>
<td>antiquity</td>
</tr>
<tr>
<td>Brown</td>
<td>Umber</td>
<td>terre d’ombre naturelle</td>
<td>antiquity</td>
</tr>
<tr>
<td></td>
<td>Ochre</td>
<td>ocre de ru</td>
<td>antiquity</td>
</tr>
<tr>
<td>Black</td>
<td>Bone black</td>
<td>noir d’os</td>
<td>antiquity</td>
</tr>
<tr>
<td>Colour barde</td>
<td>Name</td>
<td>Chemical composition</td>
<td>Manet</td>
</tr>
<tr>
<td>-------------</td>
<td>-----------------</td>
<td>-----------------------------------------------------</td>
<td>-------</td>
</tr>
<tr>
<td>White</td>
<td>Lead white</td>
<td>lead carbonate / 2PbCO(_3).Pb(OH)(_2)</td>
<td>Yes</td>
</tr>
<tr>
<td>Yellow</td>
<td>Yellow ochre</td>
<td>iron / Fe(_2)O(_3).H(_2)O</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td>Naples yellow</td>
<td>lead antimony / Pb(_3)(SbO(_4))(_2)</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td>Chromium yellow</td>
<td>lead chromate / PbCrO(_4)</td>
<td>Yes</td>
</tr>
<tr>
<td>Sienna</td>
<td></td>
<td>iron hydroxide/ Fe(_2)O(_3).H(_2)O</td>
<td>Yes</td>
</tr>
<tr>
<td>Orange</td>
<td>Chrome orange</td>
<td>lead chromate / PbCrO(_4).PbO</td>
<td>Yes</td>
</tr>
<tr>
<td>Red</td>
<td>Red ochre</td>
<td>iron / Fe(_2)O(_3)</td>
<td>Yes</td>
</tr>
<tr>
<td>Vermillion</td>
<td></td>
<td>mercury sulphide / HgS</td>
<td>Yes</td>
</tr>
<tr>
<td>Carmine red</td>
<td></td>
<td>cochineal / C(_2)H(_2)O(_3)</td>
<td>Yes</td>
</tr>
<tr>
<td>Alizarin red</td>
<td></td>
<td>rubia tinctorum/ organic</td>
<td>Yes</td>
</tr>
<tr>
<td>Blue</td>
<td>Cobalt blue</td>
<td>cobalt oxide / CoO.Al(_2)O(_3)</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td>Synth. ultramarine</td>
<td>lapis lazuli / Na,S,Al</td>
<td>Yes</td>
</tr>
<tr>
<td>Cerulean blue</td>
<td></td>
<td>cobalt / CoO.nSnO(_2)</td>
<td>Yes</td>
</tr>
<tr>
<td>Purple</td>
<td>Cobalt violet</td>
<td>cobalt phosphate/ Co(_3)(PO(_4))(_2)</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td></td>
<td>cobalt arsenate/ Co(_3)(AsO(_4))</td>
<td>Yes</td>
</tr>
<tr>
<td>Green</td>
<td>Chrome green</td>
<td>chrome oxide / Cr(_2)O</td>
<td>Yes</td>
</tr>
<tr>
<td>Cobalt green</td>
<td></td>
<td>cobalt oxide / CoO.Al(_2)O(_3)</td>
<td>Yes</td>
</tr>
<tr>
<td>Scheele’s green</td>
<td></td>
<td>copper arsenite/ (AsO(_3))(_2)Cu(_3)</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td></td>
<td>sulphite + AsO(_3)CuH</td>
<td>Yes</td>
</tr>
<tr>
<td>Verdigris</td>
<td></td>
<td>copper acetate / Cu(OH)(_2)</td>
<td>Yes</td>
</tr>
<tr>
<td>Brown</td>
<td>Umber</td>
<td>manganese oxide/Mg</td>
<td>Yes</td>
</tr>
<tr>
<td>Ochre</td>
<td></td>
<td>iron oxide / Fe(_2)O(_3).H(_2)O</td>
<td>Yes</td>
</tr>
<tr>
<td>Black</td>
<td>Bone black</td>
<td>bones / C.Ca(_3)(PO(_4))(_2)</td>
<td>Yes</td>
</tr>
</tbody>
</table>

Most notable in this list is the presence of Scheele’s green, which was taken out of production around 1880 because of its extreme toxicity. In the book *Impressionism*, the authors write: “As Scheele himself pointed out, copper arsenite is exceedingly toxic.” And in reference to the paintings that they examined in The National Gallery of London, they say: “Of the pictures included in the catalogue, Scheele’s green has been identified only in Manet’s *La Musique aux Tuileries*, where it occurs with other pigments in a background glaze. By the late 1870s Scheele’s green was hard to come by.”\(^{24}\) Scheele’s green was also found in *Jobarde*, in the area surrounding the hooves of the horse’s hind legs. The Scanning Electron Microscopy (SEM) and Xrf-measurements of *Jobarde* are included in Appendix 3, see page 264-265.

\(^{24}\) Bomford, Kirby, Leighton and Ashok, op. cit. (note 9), p. 58.
1.3.1 Paint Cross-Sections

Painting authentication research does not restrict itself to the identification of the applied materials. It also focuses on the layers in which they occur. The build-up of paint layers or paint stratigraphy gives insight into the structure of the painting. It allows for cross-references to be made between the properties of the identified materials and the actual technical build-up of the painting.

A cross-section was made of a layered fragment of paint taken from Jobarde (sample #4). It was analysed with light and electronic microscopy, which are used to determine the pigment composition of the individual paint layers. The undercoating proved to be composed of the usual calcium saturated layer of lead white. A visible thin layer of medium-saturated paint with black pigment was found directly on the undercoating. This is the carbon underpainting that is also visible on the IRR-images. The upper layer consists mainly of aluminium (Al), calcium A (Ca), and phosphor (P), which indicates the use of bone black (calcium phosphate) and an aluminium holding substratum of alizarin red that we have already identified.

It is notable that traces of cobalt were found in the top paint layer of Jobarde. Here cobalt is the main ingredient of a rapid drying agent, the siccative. Manet often used this particular method; in that respect he still adhered to Couture’s technical views on materials.25

1.3.2 The Palette of Étude, Ébauche and Fini

We have given an overview of the 21 individual paint colours that occur in the paintings made in the summer of 1873. Then we looked into the composition of the palette during the individual phases of étude, ébauche and fini. Each phase has its own tradition-based colour scheme. On the one hand, this has to do with keeping control of the overall colour scheme of the painting and, on the other hand, with the material properties of the colours. Not all pigments can be combined without risk. For example, although lead white can be applied in every layer, it cannot be mixed with colours containing sulphur or copper. In order to prevent drying, discoloration or muddying, the painter has to obey certain rules that are dictated by the properties of the materials. The complex calibration of personal choices and rules makes the technical painting build-up of each painting unique. Manet’s different palettes for the étude, the ébauche and the fini in the summer of 1873 are as follows:

<table>
<thead>
<tr>
<th>Étude</th>
<th>White</th>
<th>Lead white</th>
<th>blanc de plomb</th>
<th>See pages 228-229</th>
</tr>
</thead>
<tbody>
<tr>
<td>Blue</td>
<td>Cobalt blue</td>
<td>bleu de cobalt</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Green</td>
<td>Cobalt green</td>
<td>vert de cobalt</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Brown</td>
<td>Umber</td>
<td>terre d’ombre naturelle</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Black</td>
<td>Bone black</td>
<td>noir d’os</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

In the étude Manet uses multiple colours for the outlines and the composition. Especially thin, ink-like paints were suited for the étude, because they could easily be scraped off. Following this, a potential revision could be made directly on the remaining traces. The outlines in Jobarde consist of three colours: (lead) white, (bone) black, brown (umber) and (cobalt) blue.

In the *ébauche* Manet used a broader palette for larger areas and patches. Semi-opaque paints were particularly well-suited for this phase. Colours in the *ébauche* are always bright and applied in an almost unmixed state. This straightforward handling of paints allowed for a broad variation of colour depths, depending on whether thin or thick layers were applied.

In *Jobarde* it is the combination of *étude* and *ébauche* that determines the make-up of the palette in this phase. All the colours mentioned above except cobalt green and vermilion occur here. We also see a variation in the thickness of the layers of different shades of colour, especially in the black areas in the Amazon’s dress and the horse’s coat.

---

**Ébauche**

<table>
<thead>
<tr>
<th>Color</th>
<th>Paint</th>
<th>Language</th>
<th>Page References</th>
</tr>
</thead>
<tbody>
<tr>
<td>White</td>
<td>Lead white</td>
<td><em>blanc de plomb</em></td>
<td></td>
</tr>
<tr>
<td>Yellow</td>
<td>Yellow ochre</td>
<td><em>ocre jaune</em></td>
<td>See pages 267-269</td>
</tr>
<tr>
<td></td>
<td>Chromium yellow</td>
<td><em>jaune de chrôme</em></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Sienna</td>
<td><em>sienna naturel</em></td>
<td></td>
</tr>
<tr>
<td>Red</td>
<td>Red ochre</td>
<td><em>ocre rouge</em></td>
<td>See pages 233-234</td>
</tr>
<tr>
<td></td>
<td>Vermillion</td>
<td><em>vermillon</em></td>
<td></td>
</tr>
<tr>
<td>Blue</td>
<td>Synth. ultramarine</td>
<td><em>outremer</em></td>
<td></td>
</tr>
<tr>
<td>Purple</td>
<td>Cobalt violet</td>
<td><em>bleu violet</em></td>
<td></td>
</tr>
<tr>
<td>Green</td>
<td>Chrome green</td>
<td><em>vert oxyde de chrôme</em></td>
<td>See pages 272-273</td>
</tr>
<tr>
<td></td>
<td>Cobalt green</td>
<td><em>vert de cobalt</em></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Verdigris</td>
<td><em>terre verte vert-de-gris</em></td>
<td></td>
</tr>
<tr>
<td>Brown</td>
<td>Umber</td>
<td><em>terre d’ombre naturelle</em></td>
<td>See pages 250-251</td>
</tr>
<tr>
<td>Black</td>
<td>Bone black</td>
<td><em>noir d’os</em></td>
<td>See pages 231-232</td>
</tr>
</tbody>
</table>

---

27 *Boime, op. cit. (note 20), p. 72.*
Manet uses almost the entire colour palette in the *fini*. He alternates between a transparent and an opaque application of paint, allowing the darkest as well as the most intense, brightest colours in the underlayers to play their part in the finish.

Lead white is the dominant pigment in the whites and mixed colours in every layer of Manet’s paintings. Therefore, after having determined the colours of his palette, we have focused our research mainly on the lead white and on the emergence of the lead processing industry in the period surrounding 1873 and the moment lead white paint was used in *Jobarde*.

<table>
<thead>
<tr>
<th>Color</th>
<th>English</th>
<th>French</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>White</td>
<td>Lead white</td>
<td><em>blanc de plomb</em></td>
<td>See pages 239-241</td>
</tr>
<tr>
<td>Yellow</td>
<td>Yellow ochre</td>
<td><em>ocre jaune</em></td>
<td>See pages 259-260</td>
</tr>
<tr>
<td></td>
<td>Sienna</td>
<td><em>sienne naturel</em></td>
<td></td>
</tr>
<tr>
<td>Orange</td>
<td>Chrome orange</td>
<td><em>orange de chrôme</em></td>
<td></td>
</tr>
<tr>
<td>Red</td>
<td>Red ochre</td>
<td><em>ocre rouge</em></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Vermillion</td>
<td><em>vermilion</em></td>
<td></td>
</tr>
<tr>
<td>Blue</td>
<td>Cobalt blue</td>
<td><em>bleu de cobalt</em></td>
<td>See pages 253-254</td>
</tr>
<tr>
<td></td>
<td>Synth. ultramarine</td>
<td><em>outremer</em></td>
<td>See pages 270-271</td>
</tr>
<tr>
<td>Purple</td>
<td>Cobalt violet</td>
<td><em>bleu violet</em></td>
<td></td>
</tr>
<tr>
<td>Green</td>
<td>Chrome green</td>
<td><em>vert oxyde de chrôme</em></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Verdigris</td>
<td><em>terre verte vert-de-gris</em></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Scheele’s green</td>
<td><em>vert de Scheele</em></td>
<td>See pages 264-265</td>
</tr>
<tr>
<td>Black</td>
<td>Bone black</td>
<td><em>noir d’os</em></td>
<td>See pages 242-247</td>
</tr>
</tbody>
</table>
2. Lead Isotopes

One of the most important pigments is lead white, which has been used since antiquity in all kinds of painted works. Lead has four naturally stable isotopes. An isotope is a low-level radioactive atom in a molecule. Lead appears in nature in different isotopic compositions. Lead has five naturally occurring isotopes four of which are stable on geological time scales of 100 million years; $^{206}$Pb, $^{207}$Pb, $^{208}$Pb and $^{204}$Pb.

The isotope $^{210}$Pb is a naturally occurring radioactive isotope that is formed as a decay product of $^{238}$U and ultimately decays to $^{206}$Pb. $^{210}$Pb decays at a rate whereby the time taken for half of the isotopes to decay (half life) is 22 years. Due to the rapid decay of $^{210}$Pb its abundance is sufficiently low (<0.001%) to be ignored in the context of Pb isotope provenance studies. In contrast, three of the five Pb isotopes are the product radioactive decay. $^{208}$Pb is the decay product of $^{232}$Th, which has a half life of 1.14 x 1010 years producing six 4He atoms. $^{207}$Pb is the decay product of $^{235}$U, which has a half life of 7.07 x 108 years producing seven 4He atoms. $^{206}$Pb is the decay product of $^{238}$U, which has a half life of 4.47 x 109 years producing eight 4He atoms. $^{204}$Pb is the only Pb isotope that is not the product of still active radioactive decay and the vast majority was formed by nucleosynthetic processes prior to the formation of our solar system. Hence its abundance, about 1.25%, can be considered essentially constant over geological time scales.

Due to the different geochemical behaviour of the elements U, Th and Pb, geological process such as volcanic activity, sedimentation, weathering etc. cause major fractionation between these elements. Different geology rocks therefore have U/Th, U/Pb and Th/Pb ratios that vary by several orders of magnitude. Commercial lead deposits around the world are formed by different geological processes and at different times. This means that there are very significant variations in the Pb isotope compositions among commercially available lead. A summary of the Pb isotope compositions of some European lead ores is provided in the figure on page 175. The regional variation in the Pb isotope data that characterises lead ores is apparent in this figure but the data also establish that even within one country there can be large isotopic variations, for example Spain.

The mutual isotope ratio of lead ore varies strongly depending on the location. Because the isotope ratio remains almost stable, it basically makes it possible to trace lead white to a historical lead mine.28 Isotope research can also be used to compare the lead white in paintings and to trace identical isotopic compositions, Lead isotopes cannot be selected in advance by hand and cannot be altered by external chemical or physical factors.

2.1 The Context of Lead Isotope Research

The first study on lead isotope research in relation to a historical object was published in 1967. Techniques to identify lead isotopes in lead have been available since the 1960s. The principle of lead isotope mass spectrometry can be used to analyse one of the most common colour pigments: lead white. After 1967, sporadic research was done into stable lead isotopes in art objects. The only articles on lead isotopes are worth mentioning were published in 1970, 1976, and 2005. Most studies concentrated on the grouping of lead isotopes, which could be used to trace the location where the lead ore was originally found. On the basis of the assumption that there was a constant flow of ore from the mining locations to the processing plants and from there as paint to the artists’ studios, art objects were connected to a certain artist or period.

In their 1976 publication Keisch and Callahan argue that there is a clear divide between the pre-industrial and industrial ages in the 1830s. In the course of our investigation we have analysed the lead isotope ratios of more than four hundred samples. The majority of earlier studies qualify this method as a ‘fingerprinting’ of the available lead white and come to conclusions which, according to Keisch and Callahan, should be approached with caution, and rightly so. “The result of these studies led us to conclude that for more recent artists, there was too much variation in the sources of supply in the nineteenth and twentieth centuries and hence in the ratios that could be found in a given artist’s oeuvre and for earlier artists, there was less variation in the source of supply, but an individual artist’s work still reflected the range of ratios typical of the lead available to him. Therefore, as a ‘fingerprint’ method, these measurements are not very practical.”

Keisch and Callahan argue that the chronology of an artist’s oeuvre is important in the context of lead isotope analysis and that measurements should be taken from that oeuvre as comparison material. In our view lead isotope ratios should be seen as an instrument to compare or establish connections between paintings rather than as an isolated ‘fingerprint.’ The almost endless variety of ratios between stable lead isotopes and of possible combinations should be regarded as a code of one batch of lead (white) and as a fingerprint of one mine or location. The location should only be seen as a frame of reference, while that variable of one single isotope within the ratio should be regarded as representative for one batch of lead white – naturally in combination with the other isotopes in that ratio.

---

31 Keisch and Callahan 1976, op. cit. (note 30).
2.2 From Ore to Paint

One of the physical aspects that can be helpful in establishing the correct order in a painter's oeuvre is the use of one tube of lead white in a number of successive paintings. On the average, one tube of lead white would last for five to ten paintings. This depended on the size of the paintings and the thickness of the applied layers of lead white or the number of times colours were mixed. Quantitative aspects such as the time it takes the artist to finish a tube of lead white before start using a new one have hardly been investigated, but they can play a crucial role in answering this question: how does the industrial production and processing of lead powder relate to the similarities or differences in isotope ratios found on a broader selection of paintings by the same master?

All the studies of lead isotopes reveal a great variation in lead white ratios in paintings after 1820. It is important for our study to establish whether the lead isotope ratio varies from tube to tube to such an extent that they each have a unique composition. This could legitimize the connection to the oeuvre of the artist and our object of research. In order to find out to what extent lead isotope ratios differ from one tube to the next, we must first go back in time and retrace the development of the industrial processing of lead ore.

In his 1979 publication *World Non-Ferrous Metal Production and Prices 1700-1976* Christopher Schmitz gives an extensive account of lead production in the period 1850-1899. Lead was, after iron, by far the most extensively mined ore, with a total output of 5,242,000,000 kilos in the last quarter of the nineteenth century. In that period Europe accounted for more than 90 percent of the overall world production. Copper came in a good second and gold mining did not even yield one thousandth of its tonnage. In the second half of the nineteenth century, lead was used as a material in almost every industry, from products for civilian use, such as roofing, medications and cosmetics, to military equipment such as ammunition. The properties of the material, its elasticity and resistance to water and to corrosion as well as its toughness in combination with other metals and the fact that it was relatively easy to process accounted for its popularity.

The explosive increase in the demand for lead ore resulted in the modernization of the mining industry and in a substantial increase of the number of mines. However, not only was the lead mining modernized, but the actual processing, the metal industry, also gained in importance in the early nineteenth century. In 1870, John Percy published a groundbreaking survey of the different methods of lead processing, painting a realistic picture of this almost extinct industry. The fact that lead production was stepped up in the period around 1870 in both Germany and France was probably also a consequence of the Franco-German war. That such banal circumstances also had an impact on the cultural industry is demonstrated by the great variation in of lead isotope ratios found in paintings from that same period.

38 Schmitz, op. cit. (note 34), p. 93.
Prost’s 1924 publication Métallurgie des métaux, autres que le fer supplies us with one of the reasons why there is a larger variety of lead isotopes, as mentioned by Keisch and Callahan. An increasing number of mining developments had to ensure a constant flow of ore to the processing industry. After selection and chemical determination, the ore was molten and prepared in different ways for further processing. As a consequence of the increasing scale of production and the processing methods, lead ore from different locations was mixed together on the plates that were used to produce lead powder through oxidation. However, this was not the end of the production process. In order to produce high quality paint from lead ore, the chemical compound basic lead carbonate $2\text{PbCO}_3\cdot\text{Pb(OH)}_2$ is vital. It is made from the most commonly found lead ore: lead monoxide with a high grade of natural carbonate. There was a further possibility that isotopes were mixed during the melting process because the ore that was treated comes from different mines. This view is corroborated in Métallurgie des métaux, autres que le fer, which also argues that the prices of ore indicate that recycling occurred for economic reasons and that a spread supply was needed to keep production levels up to standard.

There were different ways to process lead into lead powder for paint manufacturing. The three processing methods that were in use in nineteenth-century Europe were all named after their country of origin. There was the old Dutch method, which was famous among painters for its high-quality lead white, but production was labour-intensive and resulted in a low yield. Then there was the German chamber method, known for its bright white colour, its short production time and its high production rate. And finally there was the French precipitation method which had an even higher production rate, but which resulted in a type of lead white that was considered by painters to be of inferior quality because acids were mixed in during the manufacturing process. During processing, the remaining unused lead plates that were left after the conversion of lead into lead powder for paint were melted down, resulting in a unique composition of lead isotopes in the new batch. The variations in the ore supplies from the different mines, the growth in overall production and faster processing and recycling methods were the factors that contributed to the unique lead isotope composition of batches of lead powder produced in the 1870s.

In the lead industry around 1873, the marchands de couleurs were the next link in the process of transforming lead white powder into paint. They ground the pigments with semi-mechanic roller mills that were equipped with non-porous stone cylinders. Again, there was a possibility that different batches of lead powder were mixed together. The lead powder was washed before it was ground to the desired consistency. In the next stage, fillers and mediums were added in the roller mill to produce a semi-fluid substance. High-quality linseed, walnut or poppy oil was then added to produce lead white paint that met artist’s requirements. Roller mills in the period 1870-1875 could produce up to twenty five kilos of lead white paint. Such a batch was enough to fill between 50 and 75 tubes of the lead white paint, depending on the size of the tubes, see page 173.

40 E. Prost, Métallurgie des métaux, autres que le fer, Paris/Louvain: Librairie Polytechnique, 1924, p. 239-419.
41 Ibidem, p. 253-255.
42 Around 1809, the French lead white industry in Clichy tried to improve the old Dutch method and make it more productive. However, the development of the less toxic zinc white paint could no longer be stopped.
44 We were unable to find any statistics relating to the production turnover of colour merchants.
In the third quarter of the eighteenth century, the paint industry was divided into paint factories for industrial use and paint factories for artist’s and ornamental painter’s materials. Basic lead carbonate $2\text{PbCO}_3\cdot\text{Pb(OH)}_2$, however remained the most important ingredient in both processes. Ornamental painters probably used the inferior, cheaper lead paints. Nevertheless, there was an increasing demand for lead white paint from the educated classes. As we have said, the demand for art supplies from amateur painters took off at the beginning of the nineteenth century. This can be deduced from the explosive growth in the number of marchands de couleurs or Maisons.

2.3 From Lead Powder to Paint Tube

If we estimate that a day’s production of all the lead mines in the last quarter of the nineteenth century ran at 57,500 kilos, this means that the production of one mine must have been approximately 1900 kilos a day (though in reality, of course, the overall yield was not evenly divided). Let us assume that there were 300 active mines in that period. Statistics show that there was a large variety of mining and production locations, but that in the end a relatively small amount of the artist’s pigment basic lead carbonate $2\text{PbCO}_3\cdot\text{Pb(OH)}_2$ was purchased by the marchands de couleurs or Maisons for the manufacture of paint. The production, of an average, of 50 paint tubes per batch and the processing time of one tube of paint for each artist can be compared to the daily industrial production in the last quarter of the nineteenth century. When we take a closer look at this on the basis of more ‘definite’ figures, we can compare them to the submissions to the Salons of 1873 (approximately 1491 paintings) and the Salon des Refusés (408 works). This adds up to a total of some 1900 works on canvas, panel and paper. A careful estimate would indicate that lead white will have been used in about 50% of the cases. If we then take into account that approximately 463 marchands de couleurs that were in business in 1874, see page 157, we can conclude that a Maison sold two tubes of lead white paint per artist over a period of one year. This is of course a low estimate for the professional artists of the time, but it does indicate how intensive the trade must have been, certainly if we take into account the thousands of amateur and ornamental painters who also procured their colours from the Maisons. A careful estimate would then point to a turnover of 50 tubes of lead white for each Maison in a 25 day period. But again, this is probably too low. This fully legitimizes the assumption that when Manet or someone else bought one or more tubes from a batch of lead white, the lead isotope ratio of those newly acquired tubes would have a ‘unique’ code. This is in keeping with the findings of Keisch and Callahan that there was an increase in the variation of lead isotopes from the 1830s onwards.

---

46 For example Lefranc & Cie.
47 We have looked at the mining areas in Germany, Austria, Sardinia and France.
48 This accounts for the findings of Keisch and Callahan, op. cit. (note 30).
49 This calculation was made on the basis of a production of one painting measuring 30 x 40 cm a week.
51 As a mixed colour and as an autonomous colour.
52 See Bomford, Kirby, Leighton and Ashok, op. cit. (note 9).
53 See note 30.
The manufacture of paint using roll mills at the Sennelier company, circa 1900, archive of G. Sennelier, Paris

Filling tin tubes with paint at the Sennelier company, circa 1900, archive of G. Sennelier, Paris
2.4 The Comparison of Isotopes in Jobarde and Le Bateau Goudronné

Jobarde was dated by us to the summer of 1873, between Le Bon Bock and Les Travailleurs de la Mer and closest to Le Bateau Goudronné.54 We subsequently filed a request at The Barnes Foundation in Merion (USA) to take a sample from Le Bateau Goudronné. Sample # 1 was identified as lead white, after which the isotope ratio was determined by G. Davies of the Faculty of Earth Sciences of the Vrije Universiteit in Amsterdam using thermal ionization mass spectrometry (TIMS).55 The measured composition was then entered in a data base with various samples from European lead mines. A similar lead isotope analysis was carried out on Jobarde. The isotope ratio of the samples taken from both paintings proved to lie within the instrumental error margin. From this we can conclude that they have an identical composition and that the paintings were made within the same short time span.

<table>
<thead>
<tr>
<th>Isotope ratio</th>
<th>206/204</th>
<th>207/204</th>
<th>208/204</th>
<th>207/206</th>
<th>208/206</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jobarde</td>
<td>18,3772</td>
<td>15,6697</td>
<td>38,5298</td>
<td>0,8453</td>
<td>2,0966</td>
</tr>
<tr>
<td>Stdev</td>
<td>0,0024</td>
<td>0,0011</td>
<td>0,0011</td>
<td>0,0022</td>
<td>0,0022</td>
</tr>
<tr>
<td>Le Bateau Goudronné</td>
<td>18,3788</td>
<td>15,6731</td>
<td>38,5453</td>
<td>0,8454</td>
<td>2,0973</td>
</tr>
<tr>
<td>Stdev</td>
<td>0,0030</td>
<td>0,0016</td>
<td>0,0016</td>
<td>0,0021</td>
<td>0,0021</td>
</tr>
</tbody>
</table>

It is clearly extremely difficult to determine the exact chronology of the oeuvre of most painters. This became apparent when we tried to draw up a frame of reference for our research into Jobarde. The lead isotope analysis, however, has resulted in a sufficient quantity of non-manipulable data to warrant the assumption that Jobarde is part of Manet’s oeuvre. On the basis of Keisch and Callahan we can in fact come to the conclusion that the values of the lead isotopes 206/204 and 208/206 must be dated to the nineteenth century.56 The fact that the lead white in Jobarde comes from the same batch or tube as the lead white in Le Bateau Goudronné is a clear indication that Jobarde was painted in the summer of 1873 by Édouard Manet.

54 See part 2, § 6, pages 118-119: The Pictorial Comparison of the Summer of 1873.
55 “The samples were first transferred to glass vials with a conical bottom. In these vials the binding medium of the paints was dissolved by the addition of a drop of morpholine. Then the samples were repeatedly rinsed with doubly distilled water, in order to remove all organic materials and retain only the inorganic material. The samples were then transferred to PFA beakers in the ‘clean-lab’, and following a series of treatments dissolved in acetic acid, nitric acid, treated with Hbr over AGIX 200-400 mesh, anion exchange columns in accordance with the standard procedure.” Gareth Davies and Joris Dik.
Lead isotope
2.4.1 Protocol Isotope Research

The Pb isotope data reported in the Table, see page 174, are from lead white from the paintings Jobarde and Le Bateau Gourdonné. These data where performed by thermal ionisation mass spectrometry (TIMS) and represent individual analyses. The data as presented includes the two standard deviation error determined from the counting statistics of the individual analyses. Lead is a highly volatile element and hence undergoes mass fractionation with time during TIMS analysis. This is a consequence of the light isotopes being more readily ionised than heavy isotopes. Hence during an individual TIMS measurement Pb isotope ratios vary with time. Standards of known composition and amount are measured to determine the extent of mass fractionation (MF) by TIMS measurement. Samples are therefore analysed under precisely the same conditions as the standards. Identical sample amounts are used following sample concentration determinations by inductive coupled plasma, and the thermal conditions of the analysis are controlled with an infrared pyrometer. Therefore a correction can be applied for the MF. The MF correction is typically in the order of 1.0 per mil per mass unit. However, minor variations in sample and standard loading amounts, loading blanks, the zone refined rhenium filament material and loading chemical leads to a long term error (over > 5 years) in the MF that is in the order of 0.2 per mil per mass unit. The two lead white samples discussed on page 174 were analysed in the same analytical session. This approach helps reduce the error in the MF but it is important to realise that the error induced by MF is substantially higher than that indicated by counting statistics alone.

Methods developed and optimised over the last decade such as the use of a double or triple Pb isotope spike and multi-collector inductive couple plasma mass spectrometry mean that it is now possible to reduce the analytical errors by close to a factor of 10. However, the data obtained by TIMS is undoubtedly of sufficient quality to establish if the two lead white samples are derived from paints with distinct provenance.

The Pb isotope data in the Table record $^{208}\text{Pb}/^{206}\text{Pb}$, $^{207}\text{Pb}/^{206}\text{Pb}$ and $^{206}\text{Pb}/^{204}\text{Pb}$ ratios that are indistinguishable within the counting statistics. Moreover, the $^{208}\text{Pb}/^{204}\text{Pb}$ and $^{207}\text{Pb}/^{204}\text{Pb}$ ratios, although outside error of the counting statistics, are indistinguishable when the error associated with mass fractionation is taken into account. The major conclusion from these data is that: the two analyses are palpably indistinguishable.\(^{57}\)

\(^{57}\)Written report by Gareth Davies, 16 June 2009.
3. Evaluation Technical Material Analysis

In the evaluation the results and findings of this part of our research are cited in the order in which they were discussed. These findings are discussed within the context of the status. Each status can then serve to determine the value which establishes the connection between Jobarde and Manet’s oeuvre.

Negative status. This is the status that argues against the authorship of Édouard Manet.

* none

Neutral status. This is the status that argues neither against nor in favour of the authorship of Édouard Manet.

* connection between Manet and suppliers of artist’s materials
* stamp of Maison Blanchet and address on the stretcher can be dated to Manet’s active period
* underpaint layers from the year 1873 and Jobarde are similar
* colour palette of the year 1873 and of Jobarde are similar
* the uncommon colour Scheele’s green occurs in Manet’s work as well as in Jobarde
* the paint cross-section reveals that there are traces of cobalt in the top layer of Jobarde as the most important ingredient in the siccative, a product that was often used by Manet

Positive status. This is the status which argues in favour of the authorship of Édouard Manet.

* connection between the unique lead white isotope ratio of Jobarde and Le Bateau Goudronné
Conclusion

In the introduction to this publication we have stated that our research into Jobarde aims at giving new impetus to current authentication research by basing our analysis on a combination of the three most fundamental single fields of research. In doing so we were able to trace the ‘natural’ conception of a painting, in which three elements merge at the moment of creation: the intellectual process of the painter which is covered here by art historical research, the craft which is analysed in painting technique research, and the selection of materials which we had investigated with different techniques in the material analysis. Within each of these three sections a wide range of features were subjected to close scrutiny, but always within the context of Manet’s oeuvre as a whole and that of Jobarde in particular. In the evaluation these partial aspects were each assigned a status: negative if there was no reason to assume the authorship of Édouard Manet, neutral if there was neither denial nor confirmation of authorship, and positive if there was cause to assume Manet’s authorship.

During our investigation it became clear that this working method does not only give new impetus to authentication research. At first glance, Jobarde is difficult to place. Especially during art historical research the painting was slow to reveal its secrets and so the neutral status prevailed. From an art historical point of view, Jobarde could therefore be easily written off. However, the neutral status also implied that there were no reasons to question the painting’s authenticity and that these findings weren’t totally without significance, as further research proved. On the contrary, it actually raised the barrier for exclusion, especially when aspects of painting technique analysis and technical material analysis proved to be intertwined with aspects of the art historical research that have a neutral status, and this resulted in an accumulation of positive statuses. As our investigation progressed, this process led to new insights into authentication research in general and into Jobarde in particular.

The first phase of our investigation consisted of art historical research, which was subdivided into five main groups: written sources, provenance, image research, oeuvre research and context. The written sources did not produce any solid facts about Jobarde and were therefore given a negative status. During our research into the painting’s provenance we were able to establish that Jobarde had surfaced on a number of occasions in time. The facts check out insofar as the painting is mentioned by existing experts, but their written reports are not sufficient proof of Manet’s authorship. Image research revealed that Manet returned to the theme of horses and people throughout his entire oeuvre, but that he only worked on the theme of Amazons and riders on horseback during one period, namely from 1872 to 1875. This was a first step towards dating Jobarde, and this was followed up during painting technique analysis. The overall results of provenance and image research produced a neutral status.

Another aspect of image research however, was the investigation of the names, the monogram and the colour signature on Jobarde, in which two features were given a positive status: the monogram on Jobarde and the yellow colour signature. The monogram on Jobarde bears a strong resemblance to the monogram on the small painting L’Asperge (1830). Handwriting expert H. Hardy, who has previously researched the signatures of Rembrandt van Rijn for the Rembrandt Research Project, compared Manet’s autograph letters to the monograms on L’Asperge and Jobarde and came to the conclusion that the monogram on Jobarde was unmistakably in Manet’s hand. Manet’s colour signature, which appears in all his works, was first identified in the 1970s and consists of a small dab of yellow paint applied with a single brushstroke: sometimes bright lemon yellow, sometime ochre. The colour signature on Jobarde can be found on the ground under the horse: an ochre tuft of paint on a boldly executed end layer that was applied in a single session.
Next, we examined the accepted classifications of Manet’s oeuvre. One of the most striking features of *Jobarde* is the combination of two styles, a realistic style for the horse and an impressionist style for the Amazon, which is not unusual in the work of Manet. The question we asked ourselves was how *Jobarde* relates to Manet’s other works. The year 1873 proved to be a turning point in Manet’s subject matter and use of colour as well as in his style. Besides the combination of a realistic and an impressionist style occurs in a number of paintings from that same year. It became apparent that *Jobarde* must be dated to the year 1873. Further research into the technique of paintings that have been unquestionably dated to that year and that depict similar motifs, especially *Le Bateau Goudronné*, confirmed this and narrowed down the date to the late summer of 1873.

One of the characteristics of Manet’s time is the great interest in Spain, which proved to be the key to unravelling the composition and theme of *Jobarde*. Manet was familiar with works by among others El Greco, Goya, Ribera, Murillo, Zurbarán and Velázquez, and he actually visited the Prado in Madrid in September 1865, where he was able to study his favourites, particularly Velázquez. With Manet’s frequent recourse to the old masters and his often applied mirror symmetry in mind we rotated Velázquez’s *El príncipe Baltasar Carlos a caballo* around its vertical axis and compared it to *Jobarde*. Both paintings are after all equestrian portraits and there is some similarity between the mountains in the background of both landscapes. After rotation the similarities between both paintings became even more apparent, down to details such as the remarkable physiology of the horses’ bellies. Besides, more light was shed on the subject of the painting. *Jobarde* appears to represent a lady riding a pregnant horse. If we take into account the meaning of the word ‘joharde’, which is ‘foolish,’ it becomes clear what fate awaits a lady who is not too particular about her morals. However, because these conclusions as well as those from the oeuvre research weren’t supported by hard art historical facts, both aspects were assigned a neutral status.

In the course of our research into Manet’s painting technique, we found evidence of the influence of his teacher Thomas Couture, but it also became clear which principles lay at the foundation of his personal craftsmanship. Manet did not regard the three subsequent stages of the build-up of a painting, *étude*, *ébauche* and *fini*, as separate steps, but applied them simultaneously and sometimes even left out a stage, depending on the subject he was painting. He also didn’t observe all the academic conventions that were required in each stage. So when he painted in the impressionist manner, he laid the emphasis on the *étude*, and when he painted in the naturalistic style he preferred the *ébauche and/or the fini*, he deliberately chose not to work towards a polished finish and left a clearly visible brushstroke, like in an *étude*. Subsequently, we refined the painting technique analysis even further by examining Manet’s brushes and their influence on his painter’s handwriting. Following the classification of those technical features, we proceeded to look if and where they occurred in *Jobarde*. Features such as composition and perspective, light and colour, paint layer and brushstroke displayed clear characteristics of Manet’s handwriting and corresponded to his painting technique in the year 1873.

As a further corroboration, we did not only analyze his painting technique with the naked eye, but also examined *Jobarde* with modern light techniques such as UV-fluorescence, FC-infrared, infrared reflectography, X-ray and K-edge. This gave conclusive evidence that the stages in the build-up, line types, brushstrokes, traces of revisions with the palette knife, pigments and paint layers in *Jobarde* are similar to those found in other paintings by Manet. Furthermore, we established that the painting technique of *Jobarde* most closely resembled that of *Le Bon Bock*, painted in April and May 1873, *Les Travailleurs de la Mer*, painted between July and September 1873,
and *Le Bateau Goudronné*, which was completed in the months between those two paintings. If we take another look at the statuses, we see that the examination of the technical build-up, style and composition, perspective, light and colour, paint layers and brushstroke, and the comparison of *Jobarde* to other paintings from 1873 still yield a predominantly neutral status. However, the number of partial features with a positive status increases substantially if those same features are examined with modern light techniques. So there is no question that Manet’s painter’s handwriting can be traced in *Jobarde*, because certain features of his working method appear not only in the visible top layer, but also in the underlying build-up and texture. These techniques and working methods can only be linked to Manet.

Technical material research complements art historical and painting technique research by identifying materials and the places where they occur in Manet’s paintings. Following this the properties of the identified materials are cross-referenced with the painting technique of the artist in the object of research. The suppliers of artist’s materials and the earliest stages in the processing of those materials, namely the lead mining industry and the subsequent manufacturing process, were all included in our technical material research.

First, we investigated the suppliers of artist’s materials, the Maisons, whose stamps were found on paintings by Manet. They must have had dealings with Manet and so might also furnish new clues for *Jobarde*, but this proved not to be the case – which lead to a neutral status. The remarkable fact that the colour palette of *Jobarde* was entirely in agreement with that of other paintings by Manet was nevertheless given a neutral status because it may have been typical of the time.

We then focused on the comparison of lead isotopes in lead white, which is known as a highly objective method of analysis. Following the findings of Keisch and Callahan, we started from the assumption that the lead isotope ratio should be regarded as a method for the comparison or linking of paintings rather than as an isolated ‘fingerprint.’ We therefore decided to concentrate on charting the lead mining industry and the trade in lead white paint in the period around 1873, the year in which we had already situated *Jobarde*. Keisch and Callahan also indicate that from the 1830s onward there was a growing variation and therefore a greater difference in lead isotopes. Further source research revealed that only a limited number of tubes of lead white have a similar lead isotope ratio. This implies that the ratio of lead isotopes in almost every painting has a ‘unique’ make-up. So the obvious thing to do was to compare the lead isotope ratios of *Jobarde* and *Le Bateau Goudronné*, which had already proved to be otherwise connected to our painting. We asked The Barnes Foundation in Merion (United States) to provide us with a sample for lead isotope research and compared it to the lead isotopes of *Jobarde*. The isotope ratio of the samples of both paintings proved to lie within the instrumental measuring error margin and so led us to the conclusion that they have an identical make-up. *Jobarde* and *Le Bateau Goudronné* therefore must have been painted within the same short time span during the summer of 1873. As a consequence, this analysis was given the positive status.
When we look at the various results of the three fields of research in conjunction with each other, it seems inevitable that we must attribute *Jobarde* to Édouard Manet. The accumulation of positive features in addition to an abundance of neutral results and the lack of negative statuses give a positive foundation to this attribution. Moreover, it is highly unlikely that another painter would choose the same subject matter, colour scheme, style and composition as Manet or exhibit the same painter’s handwriting in every layer of the build-up from the invisible *étude* to the *fini* or make a painting with a tube of paint that came from the same batch as the one used in *Le Bateau Goudronné*.

The question remains why *Jobarde* had escaped attention up to this point, but we can only speculate. Maybe it was simply a personal gift that has long remained in private hands and was cherished by its owners. In any case, we hope that our research will ensure that this gem in Édouard Manet’s oeuvre will now be revealed to the general public.
Appendix A

Report of the analysis of a monogram on a painting which is being investigated in order to establish if it should be ascribed to the painter Édouard Manet

Report number 20007.01.07.01
1. DESCRIPTION OF THE MATERIAL UNDER INVESTIGATION
   1.a. An image of the monogram under investigation
   1.b. Reference material
   1.c. Presentation of the question

2. A CLOSER EXAMINATION OF THE MATERIAL UNDER INVESTIGATION
   2.a. Closer examination of the reference material
   2.b. Closer examination of the monogram under investigation

3. THE ACTUAL COMPARISON OF THE WRITING
   3.a. Methodical aspects
   3.b. Analysis and comparison of the monogram under investigation

4. INTERPRETATION OF THE FINDINGS
   4.a. Introductory remarks
   4.b. Summary and conclusion
1. Description of the material under investigation

Mr. Milko den Leeuw of the Atelier voor Restauratie and Research I received the material which is described below.

1.a. An image of the monogram under investigation

The monogram under investigation is available as a photograph of the original made by Mr de Leeuw. Figure 1 shows this image. The monogram appears on a painting which is being investigated in order to establish if it was made by the painter Édouard Manet.

Figure 1
1.b. Reference material

For the comparative analysis I had several sources at my disposal:
1. Images of paintings, water colours and drawings carrying Édouard Manet’s monogram from three books:

2. A photo taken by Mr Den Leeuw of a detail of the painting *L’Asperge* in the Musée d’Orsay in Paris representing a monogram. Figure 2 is a reproduction of this photo.

![Figure 2](image)

In the reference material in the literature mentioned under 1 I have restricted myself to those reproductions which offer sufficient details.

1.c. Presentation of the question

Mr Den Leeuw asked me to describe the characteristics of the monogram on the painting under investigation and the signatures featured on the paintings that were defined as reference material in the previous paragraph. These signatures are presumed to have actually been placed by the painter Édouard Manet.
2. A closer examintion of the material under investigation

2.a. A closer examination of the reference material

The reference signatures and monograms are available in the form of reproductions. For the time being we have chosen to not study the originals. Earlier research has shown that the characteristics that are used in this type of research for the description of signatures and monograms on paintings can also be determined from reproductions. I will expand on this in chapter 4. Examination of the originals would not provide any further information concerning these characteristics. However, this does not mean that the examination of originals has no added value at all. Additional information may be found in the microscopic details of the brushstroke. However, such an investigation would necessitate a separate study which is beyond the scope of this investigation.

I also want to briefly touch on another problem that pops up during the analysis of signatures on paintings, specifically of signatures that appear on paintings of old masters. With regard to this type of painting, it is in fact difficult to form an undisputed corpus of reference signatures. A signature on the work of an old master can cause all sorts of problems. The signature could be undisputed, but it might also have been restored or touched up. The signature might also have been placed by a pupil, after the example of the master. And finally, there are known examples of initially unsigned works to which a signature was added at a later date. These problems are discussed further in the following publications.1

Questions about the authorship of a signature do not come up so much in the work of nineteenth- and twentieth-century painters because a larger quantity of contemporary and later information about paintings from that era has been preserved. In this case no separate study was made of the authorship of the reference material. We have presumed that a sufficient number of undisputed productions by Édouard Manet can be found in the large collection of reference signatures and monograms that are available.

2.b. A closer examination of the monogram under investigation

The monogram under investigation was also available as a reproduction. The details on this image are much clearer than those on most of the reference reproductions. During my research I have restricted myself to the image of the monogram. I have not seen the actual painting under investigation before analyzing the monogram. This was done in order to prevent the evaluation of the monogram from being consciously or unconsciously influenced by the actual image of the painting.

3. The actual handwriting comparison

3.a. Methodical aspects

Forensic investigation is often applied in court procedures, for example to establish if a signature is authentic or a forgery. In relation to the investigation of paintings, lithographs and etchings forensic graphology has been applied to establish a signature’s authenticity. But signatures on paintings have also been analysed outside the context of the law, for example in the Rembrandt Research Project.

When a signature is placed under a painting – a monogram is seen as an abbreviated version of a signature – we are dealing with a different situation than when a signature is placed with a pen. The motions of normal writing are a combination of the human motor system on the one hand and the mechanical-physical properties of pen, paper and support on the other. When a signature is placed with a brush other mechanical-physical properties come into play. The pliability of the brush for example is different from the hard pen point. And the application of paint on canvas is based on another mechanism than the transfer of ink through the ball of a ballpoint pen. Therefore it is conceivable that the human motor system functions differently when a painter places his signature than when a normal signature is placed. This implies that normal signatures or normal handwriting might be used as material for the comparison of signatures on paintings, although this cannot be ascertained in advance. Reference material in the form of similarly placed signatures on paintings is expected to display similar human motor system characteristics.

Earlier handwriting analysis has shown that the movements of a painter’s signature lead to reproducible and comparable patterns. Apparently regular signing of paintings leads to the development of a goal-specific human motor system. I refer among others to the study of Rembrandt signatures which proved that signatures were reproducible.

In forensic writing analysis handwriting is defined on the basis of a large number of characteristics. These include characteristics that determine the appearance of handwriting, such as the shape of letters, dimensions, slant and in those cases concerning a production consisting of a larger amount of writing, the distance between words and letters, the direction of the baseline, word length etcetera. I refer to the following sources\(^3\) for a more detailed description.

A more detailed comparison of letter shapes or writing parts is based on so-called micro-characteristics. Micro-characteristics are found in the changing curve patterns of the writing line. If we follow the trace of the handwriting in more detail we see components with a variable curve. A straight line for example can change into a curved line and vice versa. And at the top of a letter the upstroke changes into a downstroke. This is accompanied by changes in curve. Experiments and theoretical development show that changes in curves are a reflection of the human motor system during writing. In this motor system two components can be distinguished: changes in curve and changes in line width or material deposits in the line. The latter is a consequence of changing pressure or of the rotation of the pen or brush. I refer to these sources\(^4\) for more information about writing and micro-characteristics.

Once the characteristics of handwriting have been established, we assess if the material under investigation and the reference material the same. This is done by searching for are visual equivalents. If a certain characteristic of the handwriting under investigation is described on the basis of curve and pressure direction it is verified if the reference material contains productions that have the same visual characteristics. This takes into account the variations that occur in both reference material and the material under investigation. In fact an assessment is made if the characteristics of the material under investigation statistically fall within the variation margin of the reference material. If visual equivalents are found, the material under investigation and the reference material are consistent with regard to that specific component. If there are no visual equivalents, we are dealing with a point of difference.

Once the similarities and/or differences have been established, an assessment is made.


3.b. Analysis and comparison of the monogram under investigation

The monogram under investigation can be described on the basis of a number of general writing characteristics and on the basis of micro-characteristics. In Figure 3 points are marked that indicate changes in curve or line width. As we have stated in the previous paragraph, these points reflect the original human motor system.

These characteristics can be described as follows:

1. The monogram makes a fluent impression with a fluent line direction. The tops 2, 6 and 8 are part of a downward stroke;
2. The movement begins with a relatively long and straight sloping upstroke 1-2. The upstroke produces a light material deposit. At 2 the upstroke changes into a downstroke with a sharp hook 2-3-4;
3. On the interval 2-3-4 the line produces a curve, followed by a straight line. At this point the line has an average width;
4. The interval 4-5-6 begins with an opaque line. Around point 5 there is a stronger curve after which there is a decrease in material deposit. The turning point at 6 is relatively sharp, but also rather broad;
5. The downstroke 6-7 progresses in a curve and with an average material deposit;
6. After point 7, on the interval 7-8, the movement goes upward in a slant. The interval 7-8 is therefore almost transparent. Interval 7-8 is slightly curved and results in a light deposit of materials. The transition in 8 is sharp and broad at the same time;
7. On the interval 8-9-10 there is a hooked or swaying movement. The first component, interval 8-9, slopes to the right. At points 9 and 10 we see rounded, broad transitions. On the interval 8-11 we see a full material deposit, except at the final point 11, where the material deposit narrows down to a point.

![Figure 3](image-url)
As for the overall image, the monogram under investigation corresponds with the reference monogram in Figure 2, including the form of the final stroke. But similarities can also be found in the remaining reference material. In one illustration we see that Manet signs with a monogram, a single letter M. This is also the case in an illustration in another book. In some cases Manet also signs with the initials E.M., among others in certain water colours.

There are further equivalents between:
- The reference monogram in Figure 2 on the one hand and the parts 1 through 9 of the monogram under investigation on the other;
- The letter M in the combination of signatures on pages 85, 273, 301 and 313 of the book by Maria Teresa Benedetti and the interval 1-9 of the monogram under investigation, including the length of the first stroke and the line width;
- The letter M in the combination of signatures on page 87, 105, 133 and 139 of the book by Ronald Pickvance and the interval 1-9 of the monogram under investigation;
- The letter M in the combination of signatures on page 217, 282, 283 and 298 of the book by Juliet Wilson-Bareau and the interval 1-9 of the monogram under investigation;
- The equivalents described above refer to the first component of the monogram under investigation that can be read as a letter M. For the component 9-10-11 of the monogram under investigation only the equivalence with Figure 2 has been discussed. But in the remaining reference material there are also equivalents in this respect that the pattern 9-10-11 fits within the range of the variations that occur there. In Figure 4 there are three examples of reference signatures. In part A of the figure, the interval 9-10 is extended, in part B it is shortened and in part C it is lacking. The interval of the signature under investigation falls within that range of variations.

---

6 Maria Teresa Benedetti, Manet, Mila: Skira, 2005, p. 127.
7 Pickvance, op. cit. (note 5).
8 Benedetti, op. cit. (note 6).
9 Pickvance, op. cit. (note 5).
The list of equivalents above clearly demonstrates that high quality similarities with the characteristics of the monogram under research can be found throughout Édouard Manet’s entire oeuvre.

In the next chapter I will evaluate the similarities that were found.
4. Interpretation of the results

4.a. Introductory remarks

In forensic research results are essentially assessed according to a Bayesian model. This model is based on a theorem from probability calculus which was first deduced by Thomas Bayes (1702-1761). When applied in court cases the model in its most simple form states that the possibility that someone is guilty or not depends on a combination of factors or evidence. In the end the judge decides if the final possibility is large or small enough to determine guilt or innocence. The contribution of individual pieces of evidence is determined by a variable which is called the likelihood ratio. This likelihood ratio makes a statement about the strength of the investigation or evidence. More information about the Bayesian model can be found in other sources.\[1^{11}\]

The investigation into the authorship of a certain painting could also essentially be described on the basis of a Bayesian model. A number of investigations and tests are carried out which each have a certain depth. In the case of positive results, these tests can contribute to the hypothesis that we are dealing with a real painting from the hand of the painter. In the case of a negative outcome, the hypothesis is supported that it is not an original painting. Handwriting analysis contributes to the end result. In the following paragraphs we will assess the potential of this test.

In the analysis of a signature in forensic practice the investigator usually finds a combination of similarities and differences. The question is how this combination must be explained. In general the handwriting expert distinguishes the following possibilities.

The authenticity hypothesis
In this explanation the similarities all point in the direction of an authentic signature placed by the signature holder himself. Potential differences might be the result of accidental lapses in the contested signature or of limited reference material.

The forgery or counterfeit hypothesis
In this explanation the similarities that were found are a result of the fact that someone else has forged the signature of the signature holder in question. Where differences with the authentic signature occur the forger hasn’t succeeded in his plan and perhaps he or she has unwillingly reverted to his or her own writing characteristics.

The coincidence hypothesis
In this explanation the similarities that were found with the handwriting of the signature holder are coincidental. Someone else whose handwriting has the same characteristics as that of the signature holder, has placed the signature.

In forensic practice it may happen that a random, unknown person has access to an authentic signature of the signature holder and places a forged signature under a document. If such a possibility is realistic usually cannot be confirmed or ruled out on the basis of technical or other information. The forensic handwriting expert will consider all three hypotheses mentioned above. On the basis of graphological arguments the handwriting expert will try to establish which hypothesis is the most likely.

The signature analysis in the present case is another matter. The monogram in question holds a relatively small amount of graphological information. In such cases there are only limited possibilities to consider all three hypotheses. The overall assessment will therefore have to be made on the basis of all the research results that have been obtained in authentication research. On the basis of technical material research it was established that the painting under investigation must have come from the studio of – in this case – the painter Manet. If in such a case the characteristics of the signature on the painting correspond with those of the signature of Manet, this conclusion acts as an additional argument in authentication research. The essence of this argument is that signature analysis in the present case cannot in itself give decisive proof, but that the graphological arguments can play a complementary role within the framework of the overall findings of authentication research.
4.b. Summary and conclusion

Paragraph 3.b describes the similarities between on the one hand the monogram under investigation and on the other hand the reference material by Édouard Manet. This material consists of a comparable monogram and a series of signatures, sometimes written as a full name, sometimes as initials and sometimes as a monogram. Similarities were established with both the reference monogram and the larger collection of reference material. This establishes that these similarities are not coincidental or one-off. Although part of the monogram consists of relatively simple movements, some parts are of a more complex nature. Among the latter we find the transitions in the tops of the letter M and the transition between the letter M and the hooked final pattern. All these findings can be realistically explained if we assume that Édouard Manet himself has placed the monogram. As a whole the monogram under investigation does not yield enough information to explain these similarities solely on the basis of graphological arguments, as we have argued in paragraph 4.a. However, this may be possible in combination with other findings from the authentication research.

All these assessments lead to the following conclusion:

**Conclusion:**

*For all the characteristics that were analyzed there is similarities between the monogram under investigation on the one hand and the reference monograms and signatures on the other hand. A realistic explanation for these findings is that the monogram under investigation is in Édouard Manet’s handwriting. Whether alternative explanations are realistic or not must be established on the basis of other findings of the present painting authentication research.*

Drawn up in Voorschoten, 4 July 2007,

H. Hardy
Appendix B

Multispectral imaging at 480 dpi with 13 filters including additional infrared data

authors: P. Cotte & M. den Leeuw

1. Introduction

High-resolution spectral imaging allows us to obtain new data in order to study fine art paintings. The main tools available include global spectro-photometry in the visible and near infrared as well as magnification of the details of the painting. A portable nondestructive system makes it possible to produce high-fidelity color images and to consider virtual restoration. This technique has been used to improve knowledge of the world’s most famous painting – the *Mona Lisa*. The first part of this article describes the course of the digitization session:

- Hardware setup.
- Preventive conservation.
- Camera settings and calibration.
- Image acquisition and processing.

In the second part, we assess the performance of digital signal transformation to spectral reflectance and suggest several potential applications regarding this digital original.
2. Experimental
The equipment was set up in the photographic studio several days beforehand in order to design the stand that will hold the painting and carry out a series of preliminary tests. A substitute similar-sized template based on the technical data mentioned in the archives of the work was used to position the camera and lighting system.

2.1 Materials
The high-resolution spectral imaging system (see Figure 1) is based on a CCD sensor array of 12,000 pixels. An accurate step motor system makes it possible to move the sensor during 30,000 vertical lines and to achieve an optimal definition of 360 megapixels for each channel. This 13-channel acquisition system uses Melles Griot interference filters in a half-cylinder and covers the visible spectral range with a 40-nm bandwidth and three additional IR filters with a 100-nm bandwidth. A last position without filters is dedicated to panchromatic acquisition and helps set up the hardware with quick image preview. The filter transmittance varies according to the angle of the incident rays. In order to minimize this spectral displacement, the camera is equipped with a 210-mm long focal length lens with a 10° field of view in addition to a mechanical filter orientation device preserving orthogonality at the optical axis. A set of motors controls the focus for each channel and the movement of the camera body in order to minimize the scale factor resulting from this individual focusing. A high-resolution scanning system equipped with a dedicated synchronized lighting system was developed and patented.

Figure 1: Installation of spectral imaging system.

This lighting system is composed of two elliptical projectors with eight HQI metal discharge lamps and projects a combine narrow light beam synchronized with the CCD sensor displacement. The whole device enables levels of illumination of 100,000 lux to be achieved on documents while featuring excellent homogeneity over 3 meters in height. The advantage of this lighting system is developed in the part dedicated to preventive conservation of the painting. The specific features of the system were described in previous publications. The camera is controlled by a dual-processor Macintosh G4. The camera and lamp controls use a serial connection and the image data are conveyed through low-voltage differential signaling (LVDS) from a proprietary PCI card.
2.1.1 Hardware set up

The copy stand used is a power-driven easel which was modified in order to hold the painting by applying monitored pressure directly onto the frame support. The aim of the specific fastening is to enable positioning of the white calibrated patches and resolution targets required at the image resizing stage. That positioning stage is vital, given that the surface of the painting must be level with the resolution targets. As this surface is not perfectly flat, technical – depth of field and focusing – and aesthetic choices – specular reflections management – were made based on photography-specific methods and the specific behavior of the lighting system.

The distance between the painting and the camera depends on the size of the document to be digitized and the focal length of the lens. The image plane must be parallel to the object plane in order to ensure that the angels are in focus. Such an alignment is carried out using a laser placed on the imaginary object plane and pointed at the CCD’s protection window, perfect geometry depending on the flyback position. The imaging configuration is equivalent to a 45°/0° adjustment on all the edges of the painting, thus making it possible to remove direct specular reflection.

2.1.2 Preventive conservation

In addition to its portable nature, this new painting analysis technique must protect the material’s integrity. All the parameters linked with its potential deterioration have been studied. There are intensity illumination standards that apply to the exhibition of items in museums. These standards usually represent a balance between the limits of discernible details of an item and the latter’s deterioration speed. The photochemical effects of light depend on other factors that may accelerate the process. The presence of oxygen – and therefore oxidation – plays a significant role in the deterioration processes and temperature speeds up chemical reactions. A large proportion of energy UV radiations also modifies the deterioration speed. The synchronized lighting system makes it possible to achieve a high level of illumination, but only on the part of the painting specifically targeted. Light acts through accumulation – deterioration will be the same whether the painting is exposed to a level of illumination of 100 lux during 5 hours or 500 lux during one hour. After having checked reciprocity with a high level of illumination on similar materials and observing no deterioration whatsoever, the lighting was adjusted in order to achieve a maximum level of illumination of 30,000 lux.

The light beam enables maximum lighting on a width of 50 mm, then rapidly decreases to a value lower than 800 lux. The unit of the total exposure dose received by a document is in millions of lux per hour (Mlxh) and the unofficial standard sets the total exposure of a document to 0.36 Mlxh/year. The total exposure dose received by the painting during the digitization session may be calculated. With full knowledge of the total amount of horizontal pixels – n – and total integration time – t – in ms, a total exposure dose in Mlxh is estimated as per the following formula:

\[
DET = \int_0^{779} i(x) \times \frac{n \times t}{3600 \times 10^6} \times 2
\]
\( i(x) \) represents the lighting distribution function on the digitization area. The residual lighting – except for the concentrated beam – is larger than the 987-mm digitization area. The total exposure dose obtained for one shot is 0.023 Mlxh. In comparison, when in its former protective enclosure, the painting was exposed to a level of illumination of 300 lux lighting during 9 hours a day, i.e. a total of 0.0027 Mlxh. A photo of the painting is therefore equivalent to one day of exposure. We shall comment on these results in the section on applications. The spotlights include a preventive conservation device with heat filters at the front and a UV stabilizer directly integrated into the lamp bulbs. The microclimate of the room had been monitored in order to study the evolution of temperature and hygrometric levels. Furthermore, a sensor was placed on the easel in order to describe local fluctuations close to the painting. The balance between temperature (in °C) and relative humidity (RH) was only modified once, in the absence of the painting, when switching on the lighting equipment. After several minutes, adjustment of the air conditioning made it possible to work throughout the entire session at a temperature of 20.7°, with a RH of 52%. On several occasions, an additional temperature adjustment with an infrared thermometer was carried out on the painting itself and no increase of more than 1°C was recorded on the surface.

An ultraviolet radiation measurement was carried out using a radiometer. The processing features integrated into the HQI lamps enable the removal of UVB and UVC that may cause photochemical reactions on the surface of a document. A small quantity of UVA is present to enable digitization through the first filter, the transmittance of which ranges between 380 and 420 nm. The museum UV standards are based on emission in the ultraviolet radiations of traditional incandescent lamps 60-80 \( \text{W/lumen} \) between 300 and 400 nm with an accessibility level of 75 \( \text{W/lumen} \). We recorded a maximum level of 40 \( \text{W/cm}^2 \) at a level of illumination of 30,000 lux in the synchronized beam of the lighting system. Once converted, we obtained a value of 13.4 \( \text{W/lumen} \) – i.e. approx. 6 times lower than the average value.
2.1.3 Targets
Three different targets (see Figure 2) are selected to evaluate system performances: the GretagMacbeth color checker DC target, the CRISATEL project’s acrylic and oil Pébéo charts. The variety and homogeneity of pigments differ from one chart to another. The color checker represents a homogeneous part of the global color space. This makes it possible to compare performance with other spectral imaging systems using it as a standard. The acrylic Pébéo chart has 15 pure pigments among the 117 glossy applications, the remaining 102 being mixtures of pigments achieved from 38 pigments used during the 19th and 20th century. The oil Pébéo chart is similar to the former with modern pigments in an oil-based binder. The test charts were completed by Spectralon reflectance standards featuring the following characteristics: 99, 50, 28 and 12% reflectance and 99% Teflon white.

Figure 2: Targets used to evaluate performance and white calibrated patches.

2.2 Method
During the stage following setup of the equipment, the camera is set using the control software. The aim is to reach a compromise in order to achieve optimal quality in a limited acquisition time, without being able to restart the experiments in the event of mistakes. A high-quality image must be sharp, preserve its initial geometry and feature a low level of noise. In order to achieve these goals, it is necessary to know the behavior of the camera and how each parameter (aperture, gain and integration time) influences the rendering. Once they have been set, the calibration stage records the levels of dark noise, inter-pixel differences, changing lighting and vignetting (cos4 fall-off) of the lens in order to enable relevant adjustment. Lastly, the painting is placed on the easel for the image acquisition process, the meaning of which appears after appropriate processing.
2.2.1 Camera settings

Optical computing revealed a theoretical depth of field of 12.59 mm on the document with a diaphragm set to f/8. The lens is equipped with a symmetrical optical formula and the magnification ratio achieved is 10.5. The chromatic aberrations generate a different focusing value for each filter (see Table 1), focusing is carried out by shifting the lens using a power-driven gear.

Using the ISO 16067 Target, we obtained a resolution indicator MTF (Modulation Transfer Function) equivalent to 51% for spatial frequency equivalent to 16 lp mm⁻¹ (8 pairs of B/W lp mm⁻¹) at 300 dpi. An extrapolation for the real resolution (480 dpi) of 14.6 lines/mm instead of 16 gave an average MTF of 60%, and 99% with software processing.

<table>
<thead>
<tr>
<th>Filters :</th>
<th>No filter</th>
<th>400</th>
<th>440</th>
<th>480</th>
<th>520</th>
</tr>
</thead>
<tbody>
<tr>
<td>thickness (mm) :</td>
<td>6.48</td>
<td>5.32</td>
<td>5.3</td>
<td>5.05</td>
<td></td>
</tr>
<tr>
<td>Image-Lens distance (mm) :</td>
<td>229.8</td>
<td>232.4</td>
<td>231.8</td>
<td>231.7</td>
<td>231.5</td>
</tr>
<tr>
<td>Filters :</td>
<td>560</td>
<td>600</td>
<td>640</td>
<td>680</td>
<td>720</td>
</tr>
<tr>
<td>thickness (mm) :</td>
<td>3.75</td>
<td>4.11</td>
<td>3.8</td>
<td>2.58</td>
<td>4.5</td>
</tr>
<tr>
<td>Image-Lens distance (mm) :</td>
<td>231</td>
<td>231.2</td>
<td>231.2</td>
<td>231</td>
<td>231.8</td>
</tr>
<tr>
<td>Filters :</td>
<td>760</td>
<td>800</td>
<td>900</td>
<td>1000</td>
<td></td>
</tr>
<tr>
<td>thickness (mm) :</td>
<td>4.59</td>
<td>4.8</td>
<td>4.45</td>
<td>4.58</td>
<td></td>
</tr>
<tr>
<td>Image-Lens distance (mm) :</td>
<td>231.9</td>
<td>232.1</td>
<td>232.3</td>
<td>232.3</td>
<td>232.6</td>
</tr>
</tbody>
</table>

Table 1: Image-Lens distance and thickness for each filter.

The lens-to-image distance variations were compared with those of the manufacturer’s technical specifications (see Figure 3). We observed a decrease followed by an increase around a reference position placed at 560 nm. The differences observed are equivalent to the heterogeneous thickness of the filters, the standard deviation of which on all of the 13 filters is $\sigma = 0.90$. The maximum lens-to-image distance observed between filter 560 and filter 1000 is 1.6 mm.

Figure 3: Focus position compare to a reference position (filter 560), black : Manufacturer’s technical datas.
2.2.2 Gain

The electronic system of the camera is based on an integrated circuit designed to capture images and includes signal conversion. Quantification is carried out by an analog-to-digital converter (ADC) on 12 bits. The available programmable gain amplifier enables an amplification range of –6 dB to +42 dB in linear progression.

<table>
<thead>
<tr>
<th>Filters</th>
<th>No filter</th>
<th>400</th>
<th>900</th>
<th>1000</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gain (dB)</td>
<td>Variable</td>
<td>15</td>
<td>9</td>
<td>22</td>
</tr>
</tbody>
</table>

Table 2: Gain setting for each filter.

The choice of this setting (see Table 2) is a compromise which was put in place to carry out digitization in a specific time slot while maintaining high quality. The relation between the gain level and standard deviation of the dark noise – described in the publications relating to the assessment of the camera \(^3\) – makes it possible to set this optimal adjustment. Once the aperture and gain have been set, the system regulates – for a calibrated white target – an exposure time for each filter between 1.3 ms and 200 ms. For the sequence achieved at f/11, the exposure times were doubled and the gain settings retained.
2.2.3 Calibration

Once the parameters are set, the calibration phase may start in order to obtain the same level of response of the camera for each channel. Before placing the painting on the easel, two extra digitization series are required. The aim of the first series is to record a white reference, the spectral nature of which is known and the size of which is similar to the scanning area. The second series is carried out when recording the response of the camera in the dark. A series of factors are determined and applied to the original image. Each of the images derives from a high-definition acquisition comprising the same amount of pixels as the images of the painting. The post-processing sequence starts by removing dark noise from the raw image, compensating inter-pixel differences and adjusting the lack of homogeneity of the lighting and the lens in order to obtain a calibrated image (See Figure 4).

![Figure 4: Calibration process diagram.](image)

Image resizing is required in order to obtain an adaptive method taking into account inconstant distortions in the images – homothetic transformations, rotations and translations. The solution derives from 3D morphing techniques – i.e. homography. This method utilizes points of reference and resolution targets that are present in the various layers. The results achieved with this technique are excellent and the registration problems become invisible on the final images (see Figure 5).

![Figure 5: Resizing example.](image)
Left : 2 layers without correction, right : corrected image.
2.2.4 Image acquisition

After the essential calibration and setting phases, the system is ready to digitize works of art. The entire digitization session lasted 78 minutes. The performances achieved during this photographing session are unique.

Figure 6: The painting.
2.2.5 Image processing: Digital signals to reflectance

From these 13 filters, the camera reflects 13 digital values for each pixel. A reflectance curve depending on the sampling interval needs to be defined on a minimum of 41 values in the 380-780 nm interval. An estimated reflectance curve from the camera is defined using 61 values in the 400-1000 nm interval. Several methods may be used to create these intermediate points: direct or indirect reconstruction and interpolation reconstruction. Direct reconstruction is based on a thorough knowledge of the acquisition system, the implementation of which is tricky due to the determination of the noise. Indirect reconstruction or acquisition reconstruction requires the presence on the images of a standard color test chart. A transfer function between the spectra measured on the test chart and the camera response is generated by extrapolation. Interpolation reconstruction solely focuses on the camera response and does not require any color test chart in the image, but a white reference (see Figure 7). After standardization with this white reference standard, the camera is considered as a spectrum sampler that records a specific point of the curve once every 40 nm in the visible range. We must then interpolate to find the missing points.

Figure 7: Reconstruction process diagram.

In the next section about color performance, we will develop the methods used for taking photos of the painting.
3. Results and applications

Once the images have been processed, the results allow us to rediscover the paint layer. Saving the images requires a 21-GB storage capacity. Through a 40 nm bandwidth followed by a 100 nm bandwidth in the near infrared, the painting reveals new details (see Figure 8). The spectral reconstruction gives access to a high-fidelity digital color original, the performances of which are described in the next part. The nature of the data makes it possible to simulate the lighting of the painting under various illuminants and to suggest virtual restorations. Lastly, the reading of spectral samples allows us to visualize and compare the reflectance curves with typical signatures of a spectra and pigment library. The high definition enables examination of each segment of the painting as a new independent entity, and makes it possible to retrace the pictorial technique and study the patchwork of cracks.

Figure 8: Each channel of spectral acquisition and a reconstruction with daylight illuminant (D65) and false color Infrared.
3.1 Spectral performance

We have described the test targets and reconstruction methods in the previous sections. The spectral data measured by spectro-photometry (d/8° geometry) and estimated by spectral imaging were compared with different indicators: RMS (Root Mean Square) and GFC (Goodness-of-Fit Coefficient). We used CIE equations of color difference $\Delta E_{00}$ and metamer index (D65 $\rightarrow$ A, $\Delta E_{00}$) in order to assess colorimetric accuracy using D65 and a 2° observer (see Table 4). We applied the interpolation method for the reconstruction given that the pigments used in the Pébéo or color checker DC test targets are not representative of the period in which the painting was made. On the other hand, the presence of synthetic pigments with highly selective reflectance curves make these test targets useful for assessing the system performances by increasing the difficulty of the reconstruction.

![Table 4: Spectral and color accuracy with interpolation method.](image)

The results obtained are really excellent given the complexity of the test target used as representative of the 19th and 20th centuries. The interpolation method offering performance stability was described in a previous publication5. The estimated spectral curves are very close to that measured and enable pigment identification. By comparison, here are – for information purposes – the performance values regarding indirect reconstruction of the aforementioned test targets: Colorchecker DC $\Delta E_{00} = 1.22$ (0.12 – 8.1) and Pébéo $\Delta E_{00} = 1.24$ (0.23 – 10.9). For the time being, indirect reconstruction cannot be applied to the painting given that it requires a test target from the time of the painter which we will obtain in the next few months.
3.2 Image rendering and infrared data
Spectral acquisition makes it possible to work out colorimetric coordinates for all illuminants (whether standardized or not) and observers. In the section on preventive conservation, we have worked out the amount of days of exposure in the museum equivalent to the digitization of the painting. This result must be considered in context with the possibility of indefinitely using this digital original under a lighting set-up that is impossible to realize in the museum. Reflectography in the near infrared makes it possible to look into the paint layer using a lower diffusion of the photons on the pigments. The new inaccessible information is as follows:
- Pentimento (see Figures 9 & 10).
- Underlying drawings (see Figures 11 & 12).
- Covered retouching (see Figures 13 & 14).
- Underlying cracks.
- Overpainting.
- Discrimination of similar reflectance curves in the visible range.

![Figure 9&10: Infrared reflectography, overpainting (repaint).](image1)

![Figure 11&12: Infrared reflectography.](image2)

![Figure 13&14: Infrared reflectography, overpainting (in paint).](image3)
3.3 False color infrared data

The processing of infrared images in false colors (see Figure 15) enables easier highlighting of the differences between the visible and invisible image. The sharp focus thus achieved cannot be compared with traditional systems and photographic emulsions sensible to infrared radiations are now almost entirely unavailable.

![False color infrared reflectography.](image)

Figure 15: False color Infrared reflectography.

False color infrared describes in color environment the paint glacis, the underdrawing and pigment discrimination.

Multispectral technique allows to cross infinitively all the data within visible and invisible range to enhance the technique of the painter.
4. Conclusion
The photo of the painting gives significant substance to the curatorial file using a nondestructive and portable technique. This unique system is capable of reproducing a painting accurately and revealing details of its technique applied by the artist. The description of the technical choices makes it possible to sum up the numerous precautionary measures required during the digitization of paintings. This system is currently the only commercially available device dedicated to such use. Its main advantage lies in the fact that this digital original allows the painting to be taken out of its showcase. This different point of view – usually restricted to a privileged few – enables a new understanding along with the opportunity to choose the lighting and restoration hypotheses. The accuracy of the details enabled by the high definition and easy navigation in a digital image leads to a new way of studying. This magnifying effect helps describe the artist’s technique and the condition of the paint layer. The recording of the patchwork of cracks and of the color of the painting at a specific time represents a milestone in the life of the painting. Indeed, a regular reassessment using this tool will enable quantification of the evolution of the materials over time and make it possible to plan conservation schemes with greater accuracy. By digitizing several of works and comparing them on the basis of color and shape criteria, the multispectral data will have even greater significance.

References

Author Biography
Pascal COTTE is the founder and president of various companies specializing in digital imaging since 1980 and has designed and developed numerous R&D systems in the field of electronic imaging. He has invented 6-band and 13-band multispectral cameras and obtained numerous patents in the field of multispectral imaging and lighting systems. Pascal received his bachelor’s degree at the French Lycée in Sao Paulo, Brazil. He then received post-graduate education in computers and electronics followed by optics, light and color in Paris, France.
Visualization of pigment distributions in paintings using synchrotron K-edge imaging

1 Introduction

Soon after the discovery of X-rays in 1896, radiography was applied to the study of historical paintings. Bridgeman reviewed the applications of X-rays with respect to paintings in the early 20th century [1]. Ever since, radiography has been used to visualize the distribution of heavy-metal-containing pigments, e.g. lead white, on paintings. In doing so, the substructure of a painting, including initial sketches, underpainting, and modifications of its composition, can be imaged. The study of these characteristics is of great importance in art historical authenticity research and the detection of art forgeries. Hidden paint layers can be examined for paint pigment throughout the paint stratigraphy. This provides color information on hidden paint layers, which is of great relevance to art historians and painting conservators. The main advantage is the quick data acquisition time and the sensitivity to elements throughout the entire paint stratigraphy. The examination of a test painting is shown and further instrumental developments are discussed.

PACS 07.85.Qe; 07.05.Pj

2 Existing elemental mapping techniques

In the quest for element-specific imaging of paintings, the past four decades have shown the use of two novel visualization techniques. Sayre and Lechtman were the first to describe the application of neutron-induced autoradiography on paintings [4]. This entails the exposure of a painting to a thermal neutron flux in an atomic reactor. The induced radioactivity in the painting is transient and changes in intensity and nature with time. Depending on the half-life time of artificially activated elements, the painting is brought in contact with photographic plates during certain time intervals. This allows the visualization of the elemental distribution over the painting.

The second element-sensitive technique that was developed in the 1990s is X-ray fluorescence spectrometry (XRF). XRF collects data from a single spot, but can be turned
into a two-dimensional mapping technique when collecting data from multiple spot measurements. Scott and Dik have shown the use of this technique in the analysis of a small painting by Frans van Mieris [5, 6]. Recent advances at synchrotron radiation institutes include the development of confocal XRF mapping techniques [7, 8]. Using focusing X-ray optics and detectors, the X-ray fluorescence can be recorded with a spatial resolution down to 15 µm. These techniques are very promising to the cultural heritage field and could lead to a three-dimensional imaging of paint layers through non-destructive analysis.

The main drawback of both XRF and neutron activation is the lengthy period of data acquisition. Neutrons generate long-living radionuclides with exposure times of up to 3 months, which is often an impossible time frame when collaborating with museums to analyze delicate and valuable artworks. Also, XRF can be a lengthy procedure depending on beam size, dwell time, and the size of the area to be scanned. Time of data acquisition will increase with the addition of a third dimension, so that capture of decimeter-scale areas is extremely difficult. Another disadvantage of both techniques is the shielding effect that occurs when a layer of interest is sandwiched between layers of lead white. The signal emitted by that layer is then shielded by the lead and difficult to detect. Thus, there is a need for a technique that allows the quick capture of single pigment distributions throughout the paint stratigraphy over decimeter-scale areas.

3 K-edge imaging

K-edge imaging or dichromography is the process of taking two images, bracketing particularly the threshold (K-edge) energy that is element specific. The technique is based on the principle of the photoelectric effect. This effect, combined with an accurate model of the electronic shells in an atom, predicts the decreasing exponential behavior of the absorption coefficient for X-rays of any element and a discontinuity in correspondence with the interaction and the element’s K electron shell. The energy-dependent X-ray attenuation values are shown for barium and lead in Fig. 1. Also shown are the image’s high and low K-edge energies for these elements. Images of the target object are taken at each of the energies.

The pair of images, which in the ideal case are acquired using a monochromatic X-ray beam, are then logarithmically subtracted to yield two orthogonal images: one is the mapping of the specific element, the second contains the map of the background [9]. The first detailed description of dichromography was given by Jacobson [10]. One of the most common uses of this technique is in the medical field for the study of blood vessel perfusion after the administration of a contrast agent, first described by E. Moniz in 1927 [11].

Hughes et al. [12] extended this technique to quasi-monochromatic X-rays produced by a synchrotron radiation source. The high sensitivity of K-edge subtraction synchrotron radiation coronary angiography to small concentrations of contrast agent has been demonstrated in clinical trials where iodine was intravenously infused [13]. The K-edge subtraction imaging method with synchrotron radiation is also used to study the brain [14] or the concentration of high-Z elements in the brain [15]. Preliminary work on non-synchrotron K-edge imaging work on paintings has been reported by Baldelli et al. [16].

Dichromography can be used to image paintings brush-stroke-by-brush-stroke using the high-Z elements in the pigments. Common elements in painting pigments are cadmium, mercury, lead, antimony, and tin. Pigments that use these elements and their respective K-edge and image H and L energies are shown in Table 1.

If one can generate sufficiently narrow bands of X-ray photon energies, it is possible to image elements in pigments by imaging the canvas at pairs of energies around the K-edge of interest. If these energies are close together (<2 keV apart), it is possible to simply subtract the low image from the high image to produce a K-edge image. The resulting image will be

<table>
<thead>
<tr>
<th>Element</th>
<th>Compound</th>
<th>Common name</th>
<th>K-edge energies (keV)</th>
<th>Image low energy</th>
<th>Image high energy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cadmium</td>
<td>CdS</td>
<td>Cadmium yellow</td>
<td>26.7</td>
<td>26.0</td>
<td>27.4</td>
</tr>
<tr>
<td></td>
<td>CdSe</td>
<td>Cadmium red</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tin</td>
<td>PbSnO₄</td>
<td>Lead-tin yellow</td>
<td>29.3</td>
<td>28.6</td>
<td>30.0</td>
</tr>
<tr>
<td>Antimony</td>
<td>Pb₃SnO₈</td>
<td>Naples yellow</td>
<td>30.5</td>
<td>29.8</td>
<td>31.2</td>
</tr>
<tr>
<td></td>
<td>Pb₂(Sb, Sn)O₄</td>
<td>Potters yellow</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Barium</td>
<td>BaSO₄</td>
<td>Barite, used as pigment lengthener</td>
<td>37.44</td>
<td>36.7</td>
<td>38.1</td>
</tr>
<tr>
<td>Mercury</td>
<td>HgS</td>
<td>Vermillion, cinnabar</td>
<td>83.1</td>
<td>82.4</td>
<td>83.8</td>
</tr>
<tr>
<td>Lead</td>
<td>2PbCO₃·Pb(OH)</td>
<td>Lead white</td>
<td>88</td>
<td>87.3</td>
<td>88.7</td>
</tr>
</tbody>
</table>

TABLE 1 Elements used in common pigments and their X-ray energies
positive for the element of interest and negative for all other materials, since, in general, higher energies will have lower attenuation.

4 Materials and methods

We prepared a test canvas containing a variety of 17th–20th century pigments, with partial overlaps of brush strokes (Fig. 2). Using a palette knife we prepared a lead white ground. Use was made of various commercial paints. Table 2 shows the composition of the areas relevant for this study.

We imaged the test canvas at the European Synchrotron Radiation Facility in Grenoble, France. Use was made of ID 17, the biomedical beamline. This beamline’s primary purpose is for synchrotron-radiation-based medical research involving imaging for diagnosis and irradiation for therapy for pre-clinical and potentially clinical applications. This involves angiography for the heart, brain, and lung [17], diffraction-enhanced imaging (DEI) for breast cancer and cartilage studies [18], and radiotherapy for brain cancers [19].

The ID17 biomedical beamline is one of the two long beamlines of the ESRF; in fact, the imaging experimental station is placed at about 150 m from the source.

The source is a 21-pole wiggler (maximum field 1.6 T) optimized to fulfill the scientific requirements both in imaging and radiation therapy. The wiggler operates at a field of ~0.7 T (gap: 55 mm, critical energy: 16.5 keV) for the imaging program, which provides a good compromise between the available flux and the contributions of the higher-energy harmonics to the beam spectrum. The horizontal X-ray beam

<table>
<thead>
<tr>
<th>No.</th>
<th>Pigment or pigment combination</th>
<th>Elemental composition</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Lead white ground (applied with palette knife)</td>
<td>2PbCO₃·Pb(OH)₃, HgS, 2PbCO₃·Pb(OH)₂, BaSO₄</td>
</tr>
<tr>
<td>2</td>
<td>Vermillion, lead white, barium sulfate lengthener</td>
<td>Pb₃(PO₄)₂, Pb(OH)₂, BaSO₄</td>
</tr>
<tr>
<td>3</td>
<td>Lead white, organic colorant on barium sulfate substrate (covered with cadmium yellow and vermilion)</td>
<td>Pb₃(PO₄)₂, Pb(OH)₂, BaSO₄, organic red, CdS, HgS</td>
</tr>
<tr>
<td>4</td>
<td>Chromium oxide with lead white</td>
<td>Cr₂O₃, 2PbCO₃·Pb(OH)₂, Na-aluminum silicate, 2PbCO₃·Pb(OH)₂</td>
</tr>
<tr>
<td>5</td>
<td>Ultramarine with lead white (right and lower strokes partially covered)</td>
<td>Cr₂O₃, 2PbCO₃·Pb(OH)₂, Na-aluminum silicate, 2PbCO₃·Pb(OH)₂</td>
</tr>
<tr>
<td>6</td>
<td>Ochre with lead white</td>
<td>Fe₂O₃, 2PbCO₃·Pb(OH)₂</td>
</tr>
<tr>
<td>7</td>
<td>Lead white (covered with chromium oxide)</td>
<td>Cr₂O₃, 2PbCO₃·Pb(OH)₂, CdS, BaSO₄</td>
</tr>
<tr>
<td>8</td>
<td>Cadmium red with barium sulfate lengthener</td>
<td>CdS, BaSO₄</td>
</tr>
<tr>
<td>9</td>
<td>Single brush stroke of organic red on barium sulfate substrate (covered with vermilion and small amount of barium sulfate lengthener)</td>
<td>Organic red + BaSO₄, HgS</td>
</tr>
</tbody>
</table>

TABLE 2 Pigment composition
divergence, accepted by the beamline optics, is about 1 mrad; this value, in combination with the large source to sample distance, gives, at the imaging experimental station, a 150-mm-wide and 10-mm-high laminar beam. The main optical elements are bent Laue monochromators which allow selecting quasi-monochromatic beams (0.1%–1% bandwidth) in the energy range 20–90 keV [20].

For this work a Ge detector has been used. Its design is based on a monolithic p-type doping (boron) Ge crystal, 160-mm long, electrically segmented into two rows of 432 parallel strips (350-µm pitch), and cooled at liquid-nitrogen temperature (Eurosys Mesures). The crystal thickness is 2 mm, giving an efficiency of nearly 100% at 33 keV and 45% at 90 keV. The global dynamic range reaches 16 bits, and the integration time can be as small as 1 ms. For this work, integration times between 15 and 40 ms have been used in order to optimize the signal to noise ratio on the images.

The test canvas and all paintings were mounted one at a time on a remotely controlled platform. This platform enabled rotation and translation in a horizontal plane and linear scanning in a vertical direction. The vertical scanning range greatly exceeds the translation range so objects are normally scanned in a vertical direction. Images were taken in strips with 66 pixels of overlap on each edge. Images were acquired using the central 300 pixels of the 432 pixel germanium detector. The pixel dimension is 0.35 mm. Each image stripe was therefore 105-mm wide.

Dark data ($I_0(x,y)$—no incident beam) was taken before and after each image strip. For normalization purposes, a white field ($I_0(x)$) was taken for 100 lines prior to data acquisition of image data ($I(x,y)$). All the data were digitized to 16-bit resolution. Incident radiation flux was approximately 0.1 mGy. The image was converted to attenuation by the following formula:

$$\text{Attenuation} [x,y] = k \cdot \log\left(\frac{I_0(x,y) - I_s(x,y)}{I_0(x) - I_s(x)}\right), \quad (1)$$

where $k$ is an arbitrary constant.

Dynamic white-field variations during the image scan were a major problem. The incident X-ray intensity varied during each scan, not only in total amplitude but also in how it was distributed across the line of detectors. The white-field data cannot be acquired as the image is being acquired, the ideal solution, but just before, with the object positioned out of the X-ray path. These data are then averaged over 100 lines and an array of values, one for each detector, is determined.

Since the image data are subtracted from a constant white-field array, incident radiation intensity variation during the scan creates unavoidable image artifacts. Each strip was individually compensated to attempt to equalize the image attenuation with respect to the other strips and within each strip. This compensation was done by modeling the error in the white field as a second-order polynomial with offset, linear slope, and quadratic components. The coefficients of these compensations were adjusted until the resulting image strips matched where they joined together. These artifacts are a major limitation to the sensitivity of the images. Image artifacts due to mechanical vibration of the crystal monochromator especially at high-energy settings was also problematic. A specialized image-processing filter was developed to reduce these artifacts in the image while minimizing the addition of new artifacts. These image pairs were then converted to attenuation and subtracted to produce the subsequent elemental images.

5 Results

Figure 3 shows all the pigments that are mixed with a barium sulfate lengthener. This is primarily the case in vermillion (2) and cadmium red (8). Barium sulfate was also present as a substrate for organic red colorants (9), covered by a layer of vermillion. Note that individual brush strokes are easily seen, even when covered by other, even higher Z, pigments. Other parts of the painting, such as the wooden stretcher, metallic nails, and temporary fiducial markers are not visible, as only Ba-containing compounds are visualized.

Figure 4 shows the lead white distribution. Different brush strokes and application techniques are easily seen. The priming layers at left were applied with a palette knife while those at the right were applied with a brush. Again, other non-Pb parts of the painting are suppressed and do not interfere with the Pb image.

Figure 5 shows a single-energy radiograph taken at 50 keV, i.e., a traditional X-ray image as obtained by most museum X-ray facilities. The image shows the relative attenuations of the pigments based on their thickness, density, and elemental composition. The image also shows other painting parts such as the wooden stretcher and nails as well as the image fiducials, small plastic rectangular containers containing plasticene and very small (<1 mm) lead spheres.

6 Discussion

$K$-edge dichromography is a relatively common technique in the medical field but, to our knowledge, has never been applied to paintings. As shown in Figs. 3 and 4 the distribution of individual painting pigments can be visualized. As the technique is based on X-ray transmission, pigments in the entire stratigraphy are detected.

Also, the possibility to suppress lead white is of importance. Lead white is usually present in the ground layer and thereby increases the background noise when studying other pigments in traditional X-ray images. Our test canvas contains a lead white ground (1). Nonetheless, the overlapping barium-containing paints are clearly visible in Fig. 3. Thus, pigments can be imaged even when covered by a high-Z paint. On the test canvas, the area where the lead white stripe applied with the palette knife overlaps the horizontal vermillion stripes presents an example of a high-Z paint overlying a lower-density and lower-Z pigment. The lead white layer attenuates up to three times more than the barium lengthener used in the vermillion (31% vs. 10%) yet the $K$-edge image shows negligible reduction in contrast due to the added attenuation. In addition, other parts of the painting such as the nails and wooden stretcher are suppressed, which can help with image interpretation.

The ability to obtain pigment-specific information from hidden paint layers is of great art historical relevance. Notably, the field of digital image reconstructions is expected to benefit
from this development. In recent years, reconstructions of hidden or discolored paint layers have been made in order show the original appearance of degraded or altered paintings [21]. Using K-edge imaging, color-specific information can be integrated into such reconstructions.

Furthermore, K-edge imaging can be used in the conservation of paintings. This concept concerns the detection of craquelure patterns in non-Pb paints. More in general, K-edge imaging can provide information on the condition of hidden paint layers, on which conservation treatment can depend. Detection and visualization of craquelures in inner paint layers are an enrichment for the research on genesis and dating purposes.

The methodology relies on monochromatic X-rays, which are difficult to obtain outside of a synchrotron like ESRF. The beams have to be relatively wide to image realistic strips of the artwork, requiring a special type of beamline, but these are available enough at most synchrotron facilities. Spectral purity directly affects the image quality and resolution. At the beamline and settings we used, the low energies (below about 30 keV) had significant third-harmonic energy content in the incident beam (for example, the third harmonic of 26 keV is 78 keV), which significantly lowers the K-edge image contrast and increases noise. It is desirable to have monochromatic beams for this imaging work. All precautions should be taken to deliver as pure a beam as possible. Various mathematical techniques to compensate for third-harmonic content and improve image contrast have been developed and will be covered in a future study.

Dynamic white-field (incident beam) variations during the image scan also directly affect the image quality, resolution, and sensitivity of this technique. These variations can easily dominate the small elemental signatures. All possible efforts should be made to monitor this variation during and coincident with the image acquisition. Since beam brightness is usually not a problem, this monitoring should be done without impacting the image data quality or statistics.

7 Conclusion

K-edge imaging has proven to be very successful in terms of mapping different elements on a pixel-by-pixel basis. It solves several basic problems that are incurred with other X-ray and neutron techniques. It is very element specific and is a relatively fast technique that provides high image quality and resolution. It can image elements over a wide range and is sensitive to small concentrations. Elements can be imaged easily, even when applied in layers with heavier elements on the outside.

Many useful elements used in pigments have K-edges in the 5–20 keV range, such as chromium (5.6 keV) and zinc (9.65 keV). It would be useful to extend the K-edge imaging work down to these energy ranges.

REFERENCES
1 C. Bridgeman. Stud. Conserv. 9, 135 (1964)
2 E. van de Wetering, Rembrandt’s Hidden Self-Portraits (Museum het Rembrandthuis, Amsterdam, 2003)
3 R. Dirven, K. Wouters, Verloren vondsten (Breda’s Museum, Breda, 2003)
5 D.A. Scott, Archaeometry 43, 475 (2001)
10 B. Jacobson, Azia Radiol. 39, 437 (1953)
11 E. Moniz, Presse Med. 35, 969 (1927)
Joris Dik (*1974, Amsterdam) studied art history and classical archaeology at the University of Amsterdam and received his Master of Arts in 1997. In ’95/’96 he was a Getty Graduate Intern at the J. Paul Getty Museum in Los Angeles. After returning to the Netherlands, he obtained a Ph.D degree in chemistry in 2003. Currently, he is a tenured associate professor at Delft University of Technology, department of materials science, where he heads a research line on materials in art and archaeology.

Kristoph Krug is a scientist with 30 years’ experience in precision instrumentation and x-ray imaging. He is the author of over 20 patents in the field of automated bomb detection in airport baggage using dual-energy x-rays. Other work includes medical imaging such as digital tomosynthesis for SPECT reconstruction, and imaging techniques with synchrotron radiation for paintings and other artworks.
Ever since the discovery of X-rays in 1895, radiography has been an important tool in the study of historical paintings. Bridgeman reviewed the applications of x-rays with respect to paintings in the early 20th century.¹ X-ray radiography is used to visualize the distribution of heavy-metal containing pigments, e.g. lead white, on paintings. In doing so, the substructure of a painting, including initial sketches, underpainting, and modifications of it’s composition can be imaged. Hidden paint layers can be examined for paint structure and characteristics of the ‘handwriting’ and working method of the artist. The technique itself has remained virtually unchanged over the past one hundred years. Yet, the technique also has a number of drawbacks. First of all, the elemental composition of paint covers virtually the entire periodic table of elements. Any elemental composition can be encountered from organic colorants to heavy elements such as lead. The transition metal elements (copper, iron, zinc, cobalt), which occur often in pigments due to their chromatic effects, are very important. A traditional X-ray radiography, however, is only sensitive to the heavy metals, most dominantly Pb in lead white. Therefore, x-ray radiography visualizes an important, but still very limited part of the painter’s palette. In addition, an x-ray image shows the cumulative absorption of the paint, but does not visualize individual pigments. Such imaging of individual pigments, however, is highly desirable as pigments are an important basic component of a painting.

Existing Elemental Mapping Techniques

The past four decades have shown the development of techniques for element-specific imaging of paintings. The first imaging method is known as autoradiography and was introduced by Sayre and Lechtmann.² The technique is based on nuclear activation of paintings, which allows the visualization of different elements. The technique is sensitive to a number of elements, including copper (copper greens), manganese (umber), posphor (bone black) and mercury (vermillion). Imaging of these individual pigments visualizes important features, as e.g. the distribution of manganese represents an image of the underpainting or deadcolouring on 17th century paintings. Autoradiography has been used in a large scale study in the 1970’s at the Metropolitan in New York and is still applied at the Gemäldegalerie in Berlin.³ The second element-sensitive imaging technique is x-ray fluorescence spectrometry (XRF). Mostly known as a form of point examination, the technique can also be used to scan paint areas, resulting in elemental distribution images.⁴,⁵ The main drawback of both XRF and neutron activation is the lengthy period of data acquisition. Neutrons generate long living radionuclides with exposure times of up to 3 months, which is often an impossible time frame when collaborating with museums to analyze delicate and valuable artworks. Also, XRF can be a lengthy procedure when large areas have to be scanned. Another disadvantage of both techniques is the shielding effect that occurs when a layer of interest is sandwiched between layers of lead white. The signal emitted by the layer of interest is then shielded by the lead and difficult to detect. Therefore, there is a need for a technique that allows the quick capture of pigment distributions throughout the paint stratigraphy over decimeter-scale areas.

X-rays and Synchrotron Radiation

In order to understand the new x-ray method for paintings we shortly introduce the two basic methods to generate x-rays. Wilhelm Roentgen discovered the first method in 1895. He built an x-ray tube in which accelerated electrons collide against a metal target. This collision causes

Joris Dik, Kristoph Krug, Milko den Leeuw, Alberto Bravin

the electron to stop suddenly which causes it to emit x-rays at high energies (also known as Bremsstrahlung). Also, through this collision the electrons of the target metal are excited and then fall back to their original position within the atom producing the emission of x-rays. The radiation occurs with a wavelength that is typical for the metal target (also known as Characteristic X-rays). These two types of radiation from an x-ray tube form the basis of x-ray generation for many applications in medicine, materials inspection and the analysis of artworks. The main limitation of x-ray tubes is the fact that intense radiation occurs over a broad spectrum of energies and wavelengths, which cannot be modified easily. This is a major drawback for the analytical capabilities of x-rays generated by x-ray tubes. The second method of x-ray generation takes place in so-called synchrotron facilities or particle accelerators. Here, x-rays are generated through the acceleration of electrons in a spiral motion around a magnetic field. This leads to the radiation of x-rays with superior properties in terms of wavelength and energy flexibility and intensity. In particular, the ability to freely adjust the radiation energy is of importance for the new method discussed here. Although introduced in the 1920’s, the first operational synchrotrons have appeared over the last 10 years. In Europe, the European Synchrotron Radiation Facility (ESRF) in Grenoble, France, is leading the way in synchrotron research.

**Table 1. Elements used in common pigments and their x-ray energies**

<table>
<thead>
<tr>
<th>Element</th>
<th>Compound</th>
<th>Common name</th>
<th>K Edge Energies (KeV)</th>
<th>Image Low Energy</th>
<th>Image High Energy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cadmium</td>
<td>CdS</td>
<td>Cadmium yellow</td>
<td>26.7</td>
<td>26.0</td>
<td>27.4</td>
</tr>
<tr>
<td></td>
<td>CdSe</td>
<td>Cadmium red</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tin</td>
<td>Pb₅SnO₄</td>
<td>Lead-tin yellow</td>
<td>29.3</td>
<td>28.6</td>
<td>30.0</td>
</tr>
<tr>
<td>Antimony</td>
<td>Pb₅SbO₄, Pb₅(Sb,Sn)O₄</td>
<td>Naples yellow, Potters yellow</td>
<td>30.5</td>
<td>29.8</td>
<td>31.2</td>
</tr>
<tr>
<td>Barium</td>
<td>BaSO₄</td>
<td>Barite, used as pigment lengthener of substrate for organic colorant</td>
<td>37.44</td>
<td>36.7</td>
<td>38.1</td>
</tr>
<tr>
<td>Mercury</td>
<td>HgS</td>
<td>Vermillion, Cinnabar</td>
<td>83.1</td>
<td>82.4</td>
<td>83.8</td>
</tr>
<tr>
<td>Lead</td>
<td>Pb₂(OH)(CO₃)</td>
<td>Lead white</td>
<td>88</td>
<td>87.3</td>
<td>88.7</td>
</tr>
</tbody>
</table>

**Figure 1. Barium and Lead Photoelectric Attenuation vs. Energy**

The second method of x-ray generation takes place in so-called synchrotron facilities or particle accelerators. Here, x-rays are generated through the acceleration of electrons in a spiral motion around a magnetic field. This leads to the radiation of x-rays with superior properties in terms of wavelength and energy flexibility and intensity. In particular, the ability to freely adjust the radiation energy is of importance for the new method discussed here. Although introduced in the 1920’s, the first operational synchrotrons have appeared over the last 10 years. In Europe, the European Synchrotron Radiation Facility (ESRF) in Grenoble, France, is leading the way in synchrotron research.

**K-edge imaging**

When a painting is x-rayed, the radiation is absorbed primarily by the dense and heavy elements, such as lead. In general, the absorption of x-rays decreases as the radiation energy increases. However, at certain element-dependent energies, the so-called absorption edges, there is a sudden, steep increase in x-ray absorption with energy. Every element has such absorption edges at particular energies (K, L and M edges). Figure 1 shows the edges for relevant elements such as lead and barium.

In the proposed novel x-ray imaging technique we make use of this element-specific absorption edge at particular energies. K-edge imaging or Dichromography is the process of taking two images, bracketing the
particular absorption-edge energy that is element specific. The first image of the painting is taken slightly below the absorption edge energy, the second image slightly above. The pair of images are then subtracted to yield two images: one is the mapping of the specific element, the second contains the map of the background.\(^7\)

K-edge imaging can be thus be used to image the distribution of individual pigments on a painting. Table 1 lists a number of relevant elements on which K-edge imaging can be performed. Note that the technique is a transmission analysis. Identical to classical X-ray radiography the new technique visualizes the accumulative absorption of all paint layers in a single plane. The technique therefore does not discriminate between lower and upper paint layers. At energies lower than approximately 20 keV, an average painting is no longer transparent for X-ray radiation. Therefore, pigment with a k-edge lower than 20 keV are not suitable for the present K-edge imaging technique.

For reasons explained above, this type of analysis can only be carried out using X-rays with adjustable energies that are also monochromatic, i.e. radiation of a single energy, rather than a broad spectrum of energies. This requires the use of synchrotron radiation, rather than standard X-ray tubes. However, Baldelli et al. have discussed the feasibility of using quasi-monochromatic radiation from X-ray tubes in the study of paintings.\(^8\)

Over the last two decades synchrotron sources have been established worldwide, so that K-edge imaging is in principal available on a regional and national level. SR facilities have welcomed the art and conservation community as a new user group for which dedicated conferences have been held.\(^9\) Table 2 lists the most important European institutions where applications for beamtime can be submitted.

Table 2. Synchrotron Radiation Facilities in Europe

<table>
<thead>
<tr>
<th>Name</th>
<th>Place</th>
<th>Country</th>
<th>Website</th>
</tr>
</thead>
<tbody>
<tr>
<td>ESRF</td>
<td>Grenoble</td>
<td>France</td>
<td><a href="http://www.esrf.fr">www.esrf.fr</a></td>
</tr>
<tr>
<td>Soleil</td>
<td>Paris</td>
<td>France</td>
<td><a href="http://www.synchrotron-soleil.fr">www.synchrotron-soleil.fr</a></td>
</tr>
<tr>
<td>BESSY</td>
<td>Berlin</td>
<td>Germany</td>
<td><a href="http://www.bessy.de">www.bessy.de</a></td>
</tr>
<tr>
<td>DESY</td>
<td>Hamburg</td>
<td>Germany</td>
<td><a href="http://www.desy.de">www.desy.de</a></td>
</tr>
<tr>
<td>SRS</td>
<td>Daresbury</td>
<td>UK</td>
<td><a href="http://www.srs.ac.uk">www.srs.ac.uk</a></td>
</tr>
<tr>
<td>ELETTRA</td>
<td>Triest</td>
<td>Italy</td>
<td><a href="http://www.elettra.trieste.it">www.elettra.trieste.it</a></td>
</tr>
<tr>
<td>PSI/SLS</td>
<td>Villigen</td>
<td>Switzerland</td>
<td><a href="http://www.psi.ch">www.psi.ch</a></td>
</tr>
</tbody>
</table>

Table 3. Pigment Composition

<table>
<thead>
<tr>
<th>No.</th>
<th>Pigment or pigment combination</th>
<th>Elemental composition</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>lead white ground (applied with palette knife)</td>
<td>2PbCO_3·Pb(OH)_2</td>
</tr>
<tr>
<td>2</td>
<td>vermilion, lead white, barium sulfate lengthener</td>
<td>HgS, 2PbCO_3·Pb(OH)_2, BaSO_4</td>
</tr>
<tr>
<td>3</td>
<td>lead white, organic colorant on barium sulfate substrate (covered with cadmium yellow and vermilion)</td>
<td>2PbCO_3·Pb(OH)_2, BaSO_4, organic red, CdS, HgS</td>
</tr>
<tr>
<td>4</td>
<td>Chromium oxide with lead white</td>
<td>Cr_2O_3, 2PbCO_3·Pb(OH)_2</td>
</tr>
<tr>
<td>5</td>
<td>Ultramarine with lead white (right and lower stroke partially covered)</td>
<td>Na-aluminium silicate, 2PbCO_3·Pb(OH)_2</td>
</tr>
<tr>
<td>6</td>
<td>Oxide with lead white</td>
<td>FeO(O) silicates 2PbCO_3·Pb(OH)_2</td>
</tr>
<tr>
<td>7</td>
<td>lead white (covered with chromium oxide)</td>
<td>Cr_3O_4, 2PbCO_3·Pb(OH)_2</td>
</tr>
<tr>
<td>8</td>
<td>Cadmium red with barium sulfate lengthener</td>
<td>CdS, BaSO_4</td>
</tr>
<tr>
<td>9</td>
<td>single brushstroke of organic red on barium sulfate substrate (covered with vermilion and small amounts of barium sulfate lengthener)</td>
<td>Organic red + BaSO_4, HgS</td>
</tr>
</tbody>
</table>

Methods and Techniques

We prepared a test canvas containing a variety of 17th-20th century pigments, with partial overlaps of brushstrokes (figure 2). Using a palette knife we prepared a traditional lead white ground. Use was made of various commercial paints. Table 3 shows the composition of the areas relevant for this study. We also examined a painting by Édouard Manet in the framework of an ongoing authenticity study of that painting. The examinations were carried out at the European Synchrotron Radiation Facility in Grenoble, France. Use was made of ID 17, the biomedical beamline.\(^10\) This beamline’s primary purpose is medical research involving imaging for diagnosis and irradiation for therapy. One of the attractive features of this beamline is its wide energy range (17-90 keV) and its horizontal wide beam (nearly 150 mm), while the vertical size measures a few millimeters. For this reason the paintings were analysed in stripes of 150mm, which were then put together using image processing software. The duration of data acquisition for a single strip at a single energy lies in the minute range. The free geometry of the sample stage can easily accommodate paintings and other large objects, which makes it ideal for technical cultural heritage studies.


10 see note 8.
We used a detector with a pixel resolution of 350 µm². However, two K-edges images have to be superimposed and are then subtracted. This obviously results in the loss of image resolution, notably when the element under study is present in small concentrations. Current experiments to upgrade the instrumental parameters concern the use of a 50 µm² and, importantly, an improved control over the x-ray whitefield. A more elaborate discussion of the fundamentals of the technique, data acquisition, image processing and instrumental improvements will be published elsewhere\(^1\). The main point of the present paper is to disclose the basic method among art historians and conservators.

Results and discussion

Both the test canvas and the Manet painting were examined with K-edge imaging to visualize the distributions for lead (figure 4) and barium (figure 5). For comparison we also include traditional, single energy x-rays of both paintings (figure 6).

Figure 4a shows the distribution of barium (Ba) on the test canvas. Barium is present as barium sulfate, a common pigment lengthener of 19\(^{th}\) and 20\(^{th}\) century paint. This barium lengthener is primarily used with vermilion (2) and cadmium red (8). Barium sulfate is also present as substrate for organic red colourants (9), covered by a layer of vermilion. Note that individual brush strokes are visible, also when covered by other pigments, even of heavier elemental composition. Other parts of the painting, such as wooden stretcher, metallic nails and temporary fiducial markers on the stretcher are hardly visible, as only Ba-containing compounds are visualized (compare to figure 6).

The barium content in the Manet painting proved to be lower than in the test canvas, resulting in the need to boost the contrast for the Ba-image. As a consequence, the interfaces between the 10.5 cm wide bands of data acquisition are visible as image artifacts. Yet, a number of interesting features are visible. First of all, a vertical tear in the canvas left of the seated lady has been filled with a Ba primer. Another, smaller vertical stripe is seen in the horse’s head, which is also a restoration. Left of the lady’s head we notice horizontal stripes. The function of the latter is not clear, but seems to be associated with the ground, the canvas or an adhesive added to the back of the canvas. Of particular interest are characteristics that must be related to the under-painting. Note the shadows around the legs of the horse at the lower part of the painting. Broad brushstrokes indicate the shadow cast by the horse and rider, as the composition is lighted from the left. In addition, the left outlines of the figure and the horse show elevated concentrations of barium, which may also be part of the under-painting. To the left of the horse a number of dots show up, which are related to the sea foam at the beach. The lower line of dots coincides with the present horizon, while the upper line of dots lies much higher. We conclude that the horizon of the painting has been modified. Further research is needed, notably examination of cross-sections, to determine how these barium rich areas...
relate to the elemental composition of the paint layer. Figure 5a shows the lead white distribution of the test painting. The different brush strokes and application techniques can be recognized. The priming layers at the left were applied with a palette knife, while those at the right have been painted with a brush. Other, non-Pb parts of the painting are suppressed and do not interfere with the Pb image. This becomes clear when comparing the Pb image with figures 4a and 6a.

The Pb image of the Manet painting nicely reveals the working method of the painter. The image shows different modifications of the composition. The hind legs of the horse have been repositioned. The horizon of the painting has been changed, both to the left and the right of the horse. This complements the observations made in the barium image. Apparently, the artist was rather concerned with the right setting of the background and the horizon of the dune landscape.

“What can be seen in unfinished works can be confirmed in X-rays of finished ones”, concluded Anne Coffin Hanson on the painting technique of Édouard Manet12. “Manet apparently used the more nebulous relationships of the colors of the underpainting to help him establish the tonalities he sought for the final effect. It is probably quite correct to assume that below the top layer of paint one could find a

This is exactly the case in the painting presented here. Notably around the horses head, the coarse brushwork of the lead white underlayer becomes visible on the x-ray (figure 7). The visible photograph of the corresponding area shows a top layer with a more subtle finishing. This reminds us «how the degree and kind of finish imposed on an image could affect the spectator». It is clear that the moment of this rendezvous is quite early during the daytime and near the seaside in the dunes. And one could say the daylight, or lead white underpainting, is filtered and softened by the top layer of paint. Especially in paintings «in which the eye can’t reach» Anna Coffin Hanson noted that X-ray imaging gives us a look into finished paintings. Most likely the ‘impressionistic’ style of the figure the Amazon and her surrounding air was too overdone in its effect for the viewer. And on top of that we see, «Manet apparently intentionally returned to a more conservative approach in order to succeed in the Salon of 1863». Most paintings of that year such as, ‘Le Bon Bock’ and ‘Tarring the boat’ give us the more traditional painting method of Manet. Because we are able to look inside the painting with the ‘Amazon’ we can see the more popular ‘vivid style’ of Manet which indeed is a so ‘thin and freely painted underlayer’. This is exemplified by a comparison of the details of figure 6 and 7 and the Manet painting of ‘Tarring the Boat’ in figure 8. Also the coarse modifications to the underlaying horizon of the Manet painting are reminiscent to the free painting style of the beach and dune landscape.

13 Ibid.
14 This rediscovered painting of Édouard Manet will be published in 2006.
15 The painting must be dated in the year 1873, the location are the dunes at Berk-sur-Mer.
16 Hanson, p. 166.
17 The Good Bock, 1873, Philadelphia Museum of Art, USA.
18 Tarring the Boat, 1873, The Barnes Foundation, Merion, USA.
The separate visualization of barium and lead visualization thus give us insights into the working method of the Manet painting. In particular, modifications of the painting could be imaged as well as traces of the earliest setup of the painting. These observations will be included in the ongoing authenticity study of the artwork.

**Conclusion**

K-edge imaging has proven to be successful in terms of mapping different elements on a pixel-by-pixel basis. It solves several basic problems that are incurred with other x-ray and neutron imaging techniques. Elements can be imaged easily, even when applied in layers with heavier elements on the outside. It is very element-specific and is a relatively fast technique that provides high image quality and resolution.

Both the test painting and the Manet painting nicely illustrate the full potential of visualizing painting pigments separately in different images. In the present paintings we focused on the distribution of lead and barium, but other elements (see table 1) can also be imaged with this technique. The technique should therefore be of interest in the study of multiple-layered paintings, including paintings with double compositions. In recent years, reconstructions of hidden or discoloured paint layers have been made in order to show the original appearance.
of degraded or altered paintings\textsuperscript{19}. Using K-edge imaging colour-specific information can be integrated into such reconstructions, which is an exciting prospect. Furthermore, K-edge imaging can be used in the conservation of paintings. This notably concerns the detection of craquelure patterns in non-Pb paints. More in general, K-edge imaging can provide information on the condition of hidden paint layers, on which conservation treatment can depend. Detection and visualization of craquelures in hidden paint layers are an enrichment for the research on genesis and dating purposes.

Abstract
X-ray radiography plays an important role in the study of artworks and archaeological artifacts. Regular x-ray photographs show the internal structure of an artwork, which can provide information on genesis, authenticity, painting technique, material condition and conservation history. Transmission radiography, however, does not provide information on the exact elemental composition of objects and heavy metals can shadow or obscure the lighter elements. This paper presents the first-time application of synchrotron-based K-edge absorption imaging applied to paintings. Synchrotron radiation is generated by particle accelerators, which have a superior quality compared to standard x-ray sources. This type of radiation allows us to quickly image the distribution of individual elements over large, decimeter-scale areas. Thus, the distribution of individual pigments on paintings can be visualized, including hidden paint layers. The technique is demonstrated on both a dummy painting and a historical painting attributed to Edouard Manet. The results as well as the potential of the technique are discussed in an art historical and conservation context.

Zusammenfassung
Appendix D

The element research of Jobarde

Minute samples taken from the painting were prepared for using mass spectrometry, scanning electron microscopy and energy-dispersive X-ray spectroscopy (SEM-EDX).

With Scanning electron microscopy (SEM) the sample of the painting is excited by energetic radiation of the beam of the electron microscope. Various energies are detected with dispersive x-ray spectrometry detector: EDX. The combination of elements gives an indication of the used pigment in the painting.

The SEM-EDX results are:

<table>
<thead>
<tr>
<th>Nr.</th>
<th>Place</th>
<th>Colour</th>
<th>Elements(^1)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Hat</td>
<td>Black</td>
<td>C, P, Pb, Ca, Fe, Zn</td>
</tr>
<tr>
<td>2</td>
<td>Flower</td>
<td>Red</td>
<td>C, Hg, Pb, S, Ba, Ca</td>
</tr>
<tr>
<td>3</td>
<td>Glove left</td>
<td>White</td>
<td>Pb</td>
</tr>
<tr>
<td>4</td>
<td>Glove right</td>
<td>White</td>
<td>Pb, Ba</td>
</tr>
<tr>
<td>5</td>
<td>Dress</td>
<td>Brown/black</td>
<td>Pb, C, P, Ca, Na, Al, Si, K, Co</td>
</tr>
<tr>
<td>6a</td>
<td>Belly</td>
<td>Brown</td>
<td>Pb, C, Fe Mg, Si, Al, Ca</td>
</tr>
<tr>
<td>6b</td>
<td>Belly</td>
<td>Brown</td>
<td>Pb, C, Fe Mg, Si, Al, Ca</td>
</tr>
<tr>
<td>7</td>
<td>Sky</td>
<td>Blue</td>
<td>C, Al, Pb, Co, P</td>
</tr>
<tr>
<td>8</td>
<td>Cloud</td>
<td>White</td>
<td>Al, Pb</td>
</tr>
<tr>
<td>9</td>
<td>Colour signature</td>
<td>Yellow</td>
<td>C, Al, Mg, Si, Pb, K, Fe</td>
</tr>
<tr>
<td>10</td>
<td>Spot</td>
<td>Red</td>
<td>C, Al, Hg, Pb, Co</td>
</tr>
<tr>
<td>11</td>
<td>Ground</td>
<td>Green</td>
<td>Cu, As, Na, F, Pb</td>
</tr>
<tr>
<td>12</td>
<td>Ground</td>
<td>Yellow</td>
<td>C, Al, Mg, Si, Pb, K, Fe</td>
</tr>
<tr>
<td>13</td>
<td>Edge</td>
<td>Blue</td>
<td>C, Al, S, Ba, Na, Ca</td>
</tr>
<tr>
<td>14</td>
<td>Mountain</td>
<td>Blue</td>
<td>C, Al, Si, Pb, Fe, Co</td>
</tr>
</tbody>
</table>

Conclusion of the measurements; to this point all identified pigments appear to be consistent with those that might be used in France in 1873. None are of types with known dates of introduction post-1883.

\(^1\) Major, Minor and Traces elements are based on relative peak heights.
<table>
<thead>
<tr>
<th>Nr.</th>
<th>Place</th>
<th>Colour</th>
<th>Elements</th>
</tr>
</thead>
<tbody>
<tr>
<td>1b</td>
<td>Hat</td>
<td>Black</td>
<td>C, O, P, Pb, Ca</td>
</tr>
</tbody>
</table>
Conclusion of the measurement; the signal is strong in Ca = calcium, P = phosphate, C = carbon which forms C.Ca$_3$(PO$_4$)$_2$ and Pb = lead.

Bone black or noir d’os and white lead or blanc de plomb are known since antiquity.
Conclusion of the measurement: The signal is strong in Ca = calcium, P = phosphate, C = carbon which forms $\text{Ca}_2\text{(PO}_4\text{)}_2$ and Pb = lead. The bone black is mixed with lead white or the lead white is from the half dry under layer.
<table>
<thead>
<tr>
<th>Nr.</th>
<th>Place</th>
<th>Colour</th>
<th>Elements</th>
</tr>
</thead>
<tbody>
<tr>
<td>1a.</td>
<td>Hat</td>
<td>Black</td>
<td>C, O, P, Pb, Ca</td>
</tr>
</tbody>
</table>

![Image of a map with annotations:](image-url)
Due to the restriction of measurement of Prussian blue under EDX it is not possible to read out the whole analysis of the sample.\textsuperscript{2} But the conclusion of the measurement might be: the signal is strong in K = potassium, Fe = iron which forms Prussian blue Fe₄[Fe(CN)₆]₃. The Pb = lead is part of the mix in paint. The Prussian blue, \textit{Bleu de Prusse}, is most likely mixed with the black, \textit{noir d’os}, to intensify the color. Prussian blue is in artist pigments known since 1704.

<table>
<thead>
<tr>
<th>Nr.</th>
<th>Place</th>
<th>Colour</th>
<th>Elements</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.</td>
<td>Flower</td>
<td>Red</td>
<td>Hg, Pb, S, Ba, Ca, C, O</td>
</tr>
</tbody>
</table>
Conclusion of the measurement: the signal is strong in Hg = mercury, Pb = lead, S = sulphur which forms HgS or vermilion. The red vermilion is mixed with lead white Pb. Vermilion or *vermilion* is known since antiquity.
Conclusion of the measurement: the signal is strong in Hg = mercury, Pb = lead, S = sulphur which forms HgS. The vermilion is mixed with lead white Pb. The Ba = barium, S = sulphur and O = Oxygen which forms BaSO₄ and comes most likely from the ground layer. This sample shows a mix were the ground layer BaSO₄ is taken into the top part HgS of the sample. BaSO₄ is in use since the early nineteenth century as a white pigment particularly as a paint extender.
Conclusion of the measurement: The signal is strong in Ca = calcium, C = carbon and O Oxygen which forms CaCO₃ or chalk. The chalk is most likely part of the mix in the ground layer CaCO₃ - BaSO₄.
<table>
<thead>
<tr>
<th>Nr.</th>
<th>Place</th>
<th>Colour</th>
<th>Elements</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.</td>
<td>Glove left</td>
<td>White</td>
<td>Pb</td>
</tr>
</tbody>
</table>
Conclusion of the measurement: The signal is strong in Pb which forms Pb = lead.
<table>
<thead>
<tr>
<th>Nr.</th>
<th>Place</th>
<th>Colour</th>
<th>Elements</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.</td>
<td>Glove right</td>
<td>White</td>
<td>Ba, Pb</td>
</tr>
</tbody>
</table>
Conclusion of the measurement: the signal is strong in Ba = barium, S = sulphur and O = Oxygen which forms BaSO₄ and is most likely an extender for the lead white.
Conclusion of the measurement; the signal is strong in Pb which forms Pb = lead.
<table>
<thead>
<tr>
<th>Nr.</th>
<th>Place</th>
<th>Colour</th>
<th>Elements</th>
</tr>
</thead>
<tbody>
<tr>
<td>5.</td>
<td>Dress</td>
<td>Brown/black</td>
<td>Pb, C, P, Ca, Na, Al, Ci, K, Co</td>
</tr>
</tbody>
</table>
Conclusion of the measurement; the signal is strong in Pb which forms Pb = lead.
Conclusion of the measurement; the signal is strong in Ca = calcium, P = phosphate, C = carbon which forms C.Ca$_3$(PO$_4$)$_2$. 
Conclusion of the measurement; the signal is strong in Pb = lead, Ca = calcium and C = carbon. There is a slight notice of P = phosphate and Ba = Barium.

The measurement most likely shows parts of the scraped underground layer of chalk CaCO₃, and the mix of lead Pb and bone black layer C.Ca₃(PO₄)₂ on top.
Conclusion of the measurement; the signal is strong in C = carbon, O = oxygen, Na = sodium, Al = Aluminum, Si = Silicon, Pb = lead and Co = cobalt. The measurement is taken from very small particles in the sample. We did so for checking on elements which ‘out dates’ the used paints. As we saw in the cross section or stratigraphy of the sample the layering is complex due to the *Étude* and *Fine*. The greatest concentration of cobalt was found in the top part of the stratigraphy. Most likely along with the found cobalt goes aluminum and silicon. This combination could make a siccative or drier based on cobalt and silicon.

The signal is strong in P = phosphate, C = carbon which forms C.Ca₃(PO₄)₂. The bone black is mixed with a little lead white or the lead white is from the half dry under layer.

See the cross-section # 4 image below.
Cross-section # 4.
<table>
<thead>
<tr>
<th>Nr.</th>
<th>Place</th>
<th>Colour</th>
<th>Elements</th>
</tr>
</thead>
<tbody>
<tr>
<td>6a</td>
<td>Belly</td>
<td>Brown</td>
<td></td>
</tr>
</tbody>
</table>
Conclusion of the measurement: The signal is strong in Pb which forms Pb = lead.
<table>
<thead>
<tr>
<th>Nr.</th>
<th>Place</th>
<th>Colour</th>
<th>Elements</th>
<th>Instrument</th>
</tr>
</thead>
<tbody>
<tr>
<td>6b.</td>
<td>Belly</td>
<td>Brown</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Conclusion of the measurement; the signal is strong in C = carbon, O = oxygen, Fe = Ferrow, Mg = Magnesium and Si = Silicon.
The measurement shows most likely the pigment burnt umber an iron magnesium oxide Fe₂O₃+MnO₂. Burnt Umber is known since antiquity.
Conclusion of the measurement: the signal is strong in C = carbon and low O = oxygen, Fe = Ferrow, Ca = calcium and Pb = lead. This measurement shows a mixed sample in which we find a strong carbon signal which most likely makes a black bone mix with burnt umber.
<table>
<thead>
<tr>
<th>Nr.</th>
<th>Place</th>
<th>Colour</th>
<th>Elements</th>
</tr>
</thead>
<tbody>
<tr>
<td>7.</td>
<td>Sky</td>
<td>Blue</td>
<td></td>
</tr>
</tbody>
</table>
Conclusion of the measurement: the signal is strong in Al = Aluminum and Co = cobalt. There is a slight notice P = phosphate, Si = Silicon and Pb = lead.

From the analysis we read a cobalt aluminium oxide CoO.Al₂O₃, known as cobalt blue or bleu de cobalt. Cobalt blue came in use as an artist pigment since 1802.
Conclusion of the measurement; the signal is strong in Pb which forms Pb = lead.
Conclusion of the measurement: the signal is strong in C = carbon and low O = oxygen. There is slight trace of Pb = lead. This measurement shows carbon most likely black bone.
<table>
<thead>
<tr>
<th>Nr.</th>
<th>Place</th>
<th>Colour</th>
<th>Elements</th>
</tr>
</thead>
<tbody>
<tr>
<td>8.</td>
<td>Cloud</td>
<td>White</td>
<td></td>
</tr>
</tbody>
</table>
Conclusion of the measurement: the signal is strong in Pb which forms Pb = lead.
The sample is taken from the colour signature. The sample is showing a complex mix of different pigments. The stratigraphy of the cross-section shows a striking example of a yellow and a greenish paint which were pre-mixed on the palette.
Conclusion of the measurement: the signal is strong in C = carbon, O = oxygen, Al = Aluminum, Si = Silicon, Pb = lead, K = potassium and Fe = Ferrow.

The measurement shows Fe₂O₃·H₂O making a yellow ochre mix with lead white Pb. The pigment yellow ochre or ocre jaune and is known since antiquity.
Conclusion of the measurement: the signal is strong in C = carbon, O = oxygen, Al = Aluminum, Si = Silicon and Pb = lead. There is a slight notice of Mg = magnesium, K = potassium and Fe = Ferrow.

The measurement shows \( \text{Fe}_2\text{O}_3 \cdot \text{H}_2\text{O} \) making a yellow ochre mix with lead white Pb and burnt umber an iron magnesium oxide \( \text{Fe}_2\text{O}_3 + \text{MnO}_2 \).
<table>
<thead>
<tr>
<th>Nr.</th>
<th>Place</th>
<th>Colour</th>
<th>Elements</th>
</tr>
</thead>
<tbody>
<tr>
<td>10.</td>
<td>Spot</td>
<td>Red</td>
<td></td>
</tr>
</tbody>
</table>

![Image of a long, thin object with a scale indicating 100 µm and settings XM8922 15.0 KV X250.](image-url)
Conclusion of the measurement: the signal is strong in Hg = mercury, Pb = lead, S = sulphur which forms HgS. The vermilion is mixed with lead white Pb.
The signal is strong in Al = Aluminum and weaker in Co = cobalt but most likely we reed a cobalt aluminium oxide CoO.Al₂O₃ mix with lead white and vermilion.
<table>
<thead>
<tr>
<th>Nr.</th>
<th>Place</th>
<th>Colour</th>
<th>Elements</th>
</tr>
</thead>
<tbody>
<tr>
<td>11</td>
<td>Ground</td>
<td>Green</td>
<td></td>
</tr>
</tbody>
</table>

The diagram shows a cross-section with labeled elements:
- zwarte laag
- bariet
- loodwit
- calciet
- 11: toplaag
- 11: pigm. groen
Conclusion of the measurement: the signal is strong in Cu = copper and As = arsenic making the pigment copper arsenite sulphite \((\text{AsO}_3)_2\text{Cu}_3 + \text{AsO}_3\text{CuH}\).

Most notable is the presence of Scheele's green, which was taken out of production around 1830 because of its extreme toxicity.
Conclusion of the measurement: the signal is strong in Cu = copper and As = arsenic making the pigment copper arsenite sulphite \((\text{AsO}_3)_2\text{Cu}_2 + \text{AsO}_3\text{CuH}\). The signal is strong in C = carbon and Mg = Magnesium. The measurement shows most likely the pigment burnt umber an iron magnesium oxide \(\text{Fe}_2\text{O}_3\text{+MnO}_2\) which occurs in the layer under the copper arsenite sulphite. Further shows signal Pb which forms lead white in the ground layer.
<table>
<thead>
<tr>
<th>Nr.</th>
<th>Place</th>
<th>Colour</th>
<th>Elements</th>
</tr>
</thead>
<tbody>
<tr>
<td>12</td>
<td>Ground</td>
<td>Yellow</td>
<td></td>
</tr>
</tbody>
</table>
Conclusion of the measurement: the signal is strong in C = carbon, O = oxygen, Al = Aluminum, Si = Silicon, Pb = lead, K = potassium and Fe = Ferrow.

The measurement shows \( \text{Fe}_2\text{O}_3 \cdot \text{H}_2\text{O} \) making a yellow ochre mix with lead white
Conclusion of the measurement: the signal is strong in C = carbon, O = oxygen, Al = Aluminum, Si = Silicon and Pb = lead. There is a slight notice of Mg = magnesium, K = potassium and Fe = Ferrow. The measurement shows Fe₂O₃·H₂O making a yellow ochre mix with lead white Pb and burnt umber an iron magnesium oxide Fe₂O₃·MnO₂.
<table>
<thead>
<tr>
<th>Nr.</th>
<th>Place</th>
<th>Colour</th>
<th>Elements</th>
</tr>
</thead>
<tbody>
<tr>
<td>13.</td>
<td>Edge</td>
<td>Blue</td>
<td></td>
</tr>
</tbody>
</table>

![Image of a specimen with labels and measurements]
Conclusion of the measurement: the most likely explanation is an artificial ultramarine mixed with a part of Ba = barium of the ground layer BaSO$_4$.

It is possible that the energy of Zn (zinc) is overlapping Na (sodium). We can read the spectrum as follows Na$_x$Al$_y$Si$_z$O$_{24}$. The pigment artificial ultramarine or outremer is in use as a pigment since 1824.
<table>
<thead>
<tr>
<th>Nr.</th>
<th>Place</th>
<th>Colour</th>
<th>Elements</th>
</tr>
</thead>
<tbody>
<tr>
<td>14</td>
<td>Mountain</td>
<td>Blue</td>
<td></td>
</tr>
</tbody>
</table>

![Image](image.png)
Conclusion of the measurement: the signal is strong in Al = Aluminum and Co = cobalt. There is a slight notice of Si = Silicon, Fe = iron and Pb = lead. From the analysis we reed a cobalt aluminium oxide CoOAl₂O₃ and parts of the top layer lead white.
Conclusion of the measurement: the signal is strong in Pb which forms Pb = lead.
Conclusion of the measurement; the signal is strong in Pb which forms Pb = lead with trace of cobalt aluminium oxide.
Conclusion of the measurement: the signal is strong in Pb which forms Pb = lead, Si = silicon and Ca = calcium.
OBJECT: Jobarde
DIMENSIONS: 86.1 x 51.1 cm
SIGNATURE: `M`, lower left corner, `Beauté` lower right corner
CLIENT: ARR, the Hague, the Netherlands

PURPOSE OF EXAMINATION

The present picture, attributed to Edouard Manet (1832-1883) represents a lady seated on a horse. A scientific examination was carried out to study the materials and techniques that were used in the making of this work of art. Aim of the study was to establish an approximate date of production of the artwork.

MEANS OF ANALYSIS

After visual inspection three microscopic samples were taken from the paint surface of the object (see sample locations on photograph). The samples were examined using a Leitz Dialux EB 20 polarised light microscope (PLM), both in visible light and under UV illumination. A dispersion of the sample was examined in transmitted light using magnifications up to 1000X. Mounting medium for microscope slides was Aroclor meltmount (ND = 1.662). X-ray powder diffraction (XRD) was performed with a Philips 114.6 mm Debije-Scherrer camera. Exposure took place at a voltage of 40kV and a current of 35mA during 2.5h. Radiation was generated with a copper anode (CuKα, λ = 1.54180). Intensity of diffraction maxima was estimated visually.

RESULTS

A sample of white paint was taken from the white sky on the left horizon (sample#1). The sample was examined using XRD and gave a perfect match with the JCPDS file 13-131, identifying the white pigment as lead white.


A few diffraction maxima, which do not belong to the peak list of lead white, seem to suggest the presence of calcite, which could have been used in the priming layer or as lengthener mixed with lead white.

Leaclude white is the most common white painting pigment, which can be found on all paintings. The pigment is still used at present, although alternative white pigments have been used since the mid 19th century, notably zinc white (used after 1845) and titanium white (used after 1915). These latter two pigments, however, were not found in the present painting.

Another sample (#2) was taken from the red flower of the figure’s proper left side. The dis-


\[\text{References}\]


persion of the sample showed large amounts of regular, reddish particles with fairly dark edges showing a high refractive index. Under crossed polars the larger pigment fragments exhibited double refraction of deeply red to orange polarization colours, strongly suggesting the presence of vermillion. 2 Due to the minute size of the sample that was left after PLM, no XRD experiments could be carried out to confirm this identification.

The painting pigment vermillion is ubiquitous throughout the history of European painting. Its presence in the work of Manet has been established earlier at London’s National Gallery on the painting ‘The Waitress’ (cat. No.3835). 3

A third sample was taken from the blue part of the sky (sample #3). The dispersion showed deep blue particles with a low refractive index, exhibiting a nice red colour under the Chelsea filter. Under crossed polars the pigment particles showed no birefringence. These optical properties are typical for the painting pigment ultramarine. 4 In addition, small amounts of an organic red colourant were detected, which was usually added to ultramarine in order to give a warmer hue to the blue colour. No optically active mineral impurities were found, such as calcite, which always occur with the natural mineral form of ultramarine. Hence, the ultramarine in our case is of artificial nature, which is also indicated by the rounded shape of individual crystallites.

Artificial ultramarine was discovered around the 1830’ies. Until that date natural ultramarine was used, which had to be imported from distant places such as Afghanistan. Natural ultramarine had been used since Antiquity and its price had remained extremely high throughout the centuries. Soon after its discovery synthetic ultramarine was produced on a commercial scale and offered at a fraction of the price of natural ultramarine. Earlier studies of Manet’s oeuvre have shown that the artist made of use of this pigment. 5

CONCLUSION

In conclusion, lead white, an organic red lake, vermillion and artificial ultramarine were identified in the white, red and blue paint respectively. The combination of pigments suggests a date of execution after the 1830’s and can be considered typical for the work of Edouard Manet. The presence of vermillion and artificial ultramarine has been found earlier in the artist’s paintings.

Joris Dik
Amsterdam, 25 November 2002

3 ibid., p.178
Analytical report
[Ref.: NE01471.B/12th July 2010]

Samples from a painting by Édouard Manet

A. Introduction

Two samples of paint from a work of 1873 by Édouard Manet had been previously supplied for media analysis (Report NE01471, 26th June 2008). However, at that time only one sample (A.1) gave usable results. Following installation of new equipment the samples were re-run by GC-MS, additional information being found; this is reported here.

B. Methodology and results

The samples supplied had been described as follows:

<table>
<thead>
<tr>
<th>Table 1. Samples</th>
</tr>
</thead>
<tbody>
<tr>
<td>#</td>
</tr>
<tr>
<td>------</td>
</tr>
<tr>
<td>A.1</td>
</tr>
<tr>
<td>B.2</td>
</tr>
</tbody>
</table>

Sample preparation: The original sample preparation involved 200 μl of meth-prep II being added to the paint samples in glass vials. They were heated at 60 °C for one hour in a water bath; after that time the samples were removed from the water bath and left to cool. Once cooled the solution was centrifuged and transferred into 2 cm³ GC-MS autosampler vials for analysis. These had been stored sealed at room temperature since the original analysis in June 2008.

Instrumentation: For this round of analysis a Varian GC-MS system was used, consisting of a 450-GC gas chromatograph, a 320-MS mass selective detector and a Varian MS Workstation Version 6.9.2. The column was a VF-5ms with dimensions 30 m x 0.25 mm i.d. 0.25 μm. The GC temperature program was as follows –

<table>
<thead>
<tr>
<th>Table 2. GC temperature programme</th>
</tr>
</thead>
<tbody>
<tr>
<td>#</td>
</tr>
<tr>
<td>---</td>
</tr>
<tr>
<td>1</td>
</tr>
<tr>
<td>2</td>
</tr>
</tbody>
</table>

The total temperature program comprised of 20 minutes. The split ratio was 50:1 and the injector port temperature was 300 °C. The mass spectrometer was operated in the electron ionisation mode in scan mode with a scan time of 0.5 seconds. The mass range used was 50-500 m/z. Helium was used as the carrier gas with a flow rate of 1 ml/min.
Results obtained were as follows:

<table>
<thead>
<tr>
<th></th>
<th>Methyl ester</th>
<th>Ret. time (min)</th>
<th>Peak Area</th>
<th>Ratios</th>
<th>Identification</th>
</tr>
</thead>
<tbody>
<tr>
<td>A.1</td>
<td>Nonanedioic acid, methyl ester (Azelaic acid)</td>
<td>8.842</td>
<td>$1.766 \times 10^9$</td>
<td>P/S = 2.69</td>
<td>Walnut oil (or linseed/popp oil mixture)</td>
</tr>
<tr>
<td></td>
<td>Hexadecanoic acid, methyl ester (Palmitic acid)</td>
<td>10.955</td>
<td>$7.941 \times 10^9$</td>
<td>A/P = 0.22</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Octadecanoic acid, methyl ester (Stearic acid)</td>
<td>11.923</td>
<td>$2.954 \times 10^9$</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Dehydroabietic acid, methyl ester</td>
<td>13.133</td>
<td>[Not quantified]</td>
<td>P/S = 1.25</td>
<td></td>
</tr>
<tr>
<td></td>
<td>7-oxodehydroabietic acid, methyl ester</td>
<td>14.592</td>
<td></td>
<td>A/P = 0.13</td>
<td>Pine resin</td>
</tr>
<tr>
<td>B.2</td>
<td>Nonanedioic acid, methyl ester (Azelaic acid)</td>
<td>8.842</td>
<td>$3.059 \times 10^8$</td>
<td>P/S = 1.25</td>
<td>Linseed oil</td>
</tr>
<tr>
<td></td>
<td>Hexadecanoic acid, methyl ester (Palmitic acid)</td>
<td>10.957</td>
<td>$2.360 \times 10^9$</td>
<td>A/P = 0.13</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Octadecanoic acid, methyl ester (Stearic acid)</td>
<td>11.924</td>
<td>$1.882 \times 10^9$</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

C. Discussion

In both cases, despite the intervening period, much clearer results were obtained with significantly enhanced quality in detection limits and subsequent quantitation. Although the effects of storage could not be fully gauged, the results are nonetheless plausible. One possible area of concern however might be the degree of oxidation of the dehydroabietic acid (see below).

Previously only sample A.1 gave data, sufficient to determine a P/S ratio of 2.93. The new value determined, 2.69, while slightly different, does not materially change the interpretation. At the same time it has also been possible to determine a P/S ratio for sample B.2, indicating linseed oil. The A/P ratios could now also be determined; in the case of the linseed oil in B.2 the value of 0.13 probably indicates a degree of heat-bodying.

Sample A.1 was also found to contain the components dehydroabietic acid and 7-oxodehydroabietic acid. Diterpenoid acids are the most abundant components of diterpenoid resins, the most important sources of which are members of the Pinaceae, such as pine (Pinus spp.), larch (Larix spp.), spruce (Picea spp.) and fir (Abies spp.).\(^1\) Dehydroabietic acid is known to be relatively stable, but on long exposure to air and light it will oxidise into compounds such as 7-oxodehydroabiatic acid (as found here), 15-hydroxy-dehydroabietic acid and 7-oxo-15-hydroxy-dehydroabietic acid. Some studies have found extensive oxidation to these latter compounds in samples from paintings (such as in the case reported by Pastorova et al just cited) such that little dehydroabietic acid precursor is left. This may be the case here, although the possibility that it is due to in situ oxidation of the sample during storage also exists.

Dr. Nicholas Eastaugh


Coremans, P. Van Meegeren’s Faked Vermeers and De Hooghs. Amsterdam: Meulenhoff, 1949.
Cornelis, I.W. Handschrift en Karakter. Utrecht: H. Honig, 1925.


Articles


Technical Studies


<table>
<thead>
<tr>
<th>Index</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>L’Acteur Tragique</strong></td>
</tr>
<tr>
<td><strong>Allée cavalière au bois de Boulogne</strong></td>
</tr>
<tr>
<td><strong>Les Amandes</strong></td>
</tr>
<tr>
<td><strong>Amazone</strong></td>
</tr>
<tr>
<td><strong>L’Amazone</strong></td>
</tr>
<tr>
<td><strong>Archer Brombert, Beth</strong></td>
</tr>
<tr>
<td><strong>ARRS</strong></td>
</tr>
<tr>
<td><strong>Artax measurements</strong></td>
</tr>
<tr>
<td><strong>L’Artiste</strong></td>
</tr>
<tr>
<td><strong>L’Asperge</strong></td>
</tr>
<tr>
<td><strong>Astruc, Zacharie</strong></td>
</tr>
<tr>
<td><strong>Le Bal de L’Opéra</strong></td>
</tr>
<tr>
<td><strong>Un Bar aux Folies Bergère</strong></td>
</tr>
<tr>
<td><strong>Barnes Foundation (Merion)</strong></td>
</tr>
<tr>
<td><strong>Barret, M.</strong></td>
</tr>
<tr>
<td><strong>Baudelaire, Charles</strong></td>
</tr>
<tr>
<td><strong>Bazille, Frédéric</strong></td>
</tr>
<tr>
<td><strong>Bazire, Edmond</strong></td>
</tr>
<tr>
<td><strong>Beauté</strong></td>
</tr>
<tr>
<td><strong>Berthe Morisot à l’Éventail</strong></td>
</tr>
<tr>
<td><strong>Bibliothèque Nationale de France (Paris)</strong></td>
</tr>
<tr>
<td><strong>Blanc, Pierre M.</strong></td>
</tr>
<tr>
<td><strong>Blance, J.E.</strong></td>
</tr>
<tr>
<td><strong>Blanchet, Laurent</strong></td>
</tr>
<tr>
<td><strong>Blanchet, Maison</strong></td>
</tr>
<tr>
<td><strong>La Blonde aux Seins Nus</strong></td>
</tr>
<tr>
<td><strong>Boime, Albert</strong></td>
</tr>
<tr>
<td><strong>Le Bon Bock</strong></td>
</tr>
<tr>
<td><strong>Bonham’s</strong></td>
</tr>
<tr>
<td><strong>Bouvier, M.P.L.</strong></td>
</tr>
<tr>
<td><strong>Brooklyn Museum (New York)</strong></td>
</tr>
<tr>
<td><strong>brosse amande</strong></td>
</tr>
<tr>
<td><strong>brosse plate</strong></td>
</tr>
<tr>
<td><strong>brosse ronde</strong></td>
</tr>
<tr>
<td><strong>Le Buveur d’Absinthe</strong></td>
</tr>
<tr>
<td><strong>Au café</strong></td>
</tr>
<tr>
<td><strong>Callahan, R.C.</strong></td>
</tr>
<tr>
<td><strong>Callias, Nina de</strong></td>
</tr>
<tr>
<td><strong>Camprubi, Mariano</strong></td>
</tr>
<tr>
<td><strong>Cano, Alonso</strong></td>
</tr>
</tbody>
</table>
Index

caricature 79–80, 110, 278
Carjat, Étienne 18
Cavaliers Espagnols 40
Chantelle, Madame Du 6, 70
Le Chanteur Espagnol 102
La Chanteuse des Rues 102
Chartroule de Montifaud, Marie-Amélie 50
Le Chemin de Fer 45, 54
Le Chien – Donki 41
Le Christ aux Anges 64
Collège Rollin 17, 79
colour scheme 44, 46, 113, 160, 165
colour signature 44–45, 74, 178
Confins, Marguerite de 55–73
Constantin, Stéphanie 157–158
courtisane 72
Couture, Thomas 279
Coyet, Antoine 30
craquelure 115

La Dame aux éventails 45–55
Dantzig, Maurits van 93
Daumier, Honoré 3, 79–80, 92, 280
Davies, G. 174
Dead Toreador 44–45
Déjeuner sur l’herbe 63
Déjouy, Jules 21
Delacroix, Eugène 31, 157
Deux Poires 40
Donki 34, 41
Durand-Ruel archive 16
Durand-Ruel, Paul 2, 6, 16, 19, 23, 46, 158
Duret, Théodore 21, 34, 47, 56, 70, 80

École Nationale des Beaux-Arts (Paris) 23
El Greco 56, 179
Éphrussi, Charles 38
Étapes 19, 52–54
Étude de Femme 94
Étude pour Le Polichinell 94
L’Exécution de Maximilien 19, 118
Exposition Universelle 18, 20
false colour infrared

Fantin-Latour, Henri

Faure, J.B.

Fehlmann, Erich

_Femme à l’Épingle d’Or_

_La Femme à L’Ombrelle_

fini

George Moore au Café

gesture

gloves

Gombrich, Ernst

Goya, Francisco

Guillaudin, Émile

handwriting

Hanson, Anne Coffin

Hardy, H.

Haro, Maison

Hermès equestrian museum (Paris)

Hermès, Monsieur

Les Hirondelles

Hispanism

Hôtel Drouot

Huitres

Impressionism

_Indienne Fumant une Cigarette_

L’Infante Marguerite

infrared reflectography

Intérieur à Arcachon

invariants

_Inventaire Après Décès Édouard Manet_

isotope

Jamot, Paul

Jeanniot, George

_The Jester Pablo de Valladolid_

Jeune Femme dans un Jardin

Jeune Fille Dans Les Fleurs

K-edge-imaging

Keisch, B.

Koëlla Leenhoff, Léon-Édouard

Kunstmuseum Basel
ladies hack 10, 70
lead carbonate 163, 171–172
lead ore 168, 170–171
Leenhoff, Léon 17
Leenhoff, Suzanne 17–18, 21, 32
Leiris, Alain De 108, 280
Le Linge 20
Lochard, Fernand 2, 22, 30, 94, 96, 98, 100, 118
Louvre 33, 56–58, 31
Lumière Technology 6
Manet, Eugène 18, 21, 280
Manet, Gustave 63
Manet à la Palette 64
Manet-Manette 2, 57–58, 62
marchands de couleurs 157, 160, 171–172
Marianna of Austria 59
Marignane, Maurice 24, 26–27, 36
Marine 54–55, 126, 151, 159–160
Meier, J. 24, 28, 280
Melea, Lola 63
Las Meninas 56, 58–59
Mérimée, J.F.L. 135
Meurent, Victorine 63, 73
mirror image 64, 75
mirror symmetry 65, 179
Mlle. V.. in the Costume of an Espade 44
Monet, Claude 19, 41, 46, 98, 281
Monet Peignant dans son Atelier 98
monogram ‘M’ 10, 34, 38
Montijo, Eugénie de 56
Moore, George 32, 56, 94, 134
Morisot, Berthe 41, 94, 100
Murillo, Bartolomé 56, 179
Musée d’Orsay 32, 46, 54–55, 151, 185
La Musique aux Tuileries 36, 110, 157, 163
Nadar, Félix 19, 280
Naturalism 62–63, 68
naturalistic 70, 85–86, 100, 153, 179
Old Masters 18, 48–49, 63–65, 81, 105, 179, 186
Olympia 62–63, 72, 90–91, 102, 134
Osborne, L. 135
Ottoz, Maison Ange 157
<table>
<thead>
<tr>
<th>painting materials</th>
<th>156–157</th>
</tr>
</thead>
<tbody>
<tr>
<td>La Parisienne</td>
<td>94</td>
</tr>
<tr>
<td>La Partie de Croquet à Paris</td>
<td>55</td>
</tr>
<tr>
<td>Percy, John</td>
<td>170, 220</td>
</tr>
<tr>
<td>perspective</td>
<td>65, 73, 84–85, 105, 106, 110, 138, 159, 179–180</td>
</tr>
<tr>
<td>Philip IV</td>
<td>56–59</td>
</tr>
<tr>
<td>pictorial analysis</td>
<td>3, 78–83</td>
</tr>
<tr>
<td>Pierpoint Morgan Library</td>
<td>30</td>
</tr>
<tr>
<td>La Place de Boulogne</td>
<td>146</td>
</tr>
<tr>
<td>Plage De Berck-sur-Mer à Maré Basse</td>
<td>55</td>
</tr>
<tr>
<td>Le Pont d’un Bateau</td>
<td>118</td>
</tr>
<tr>
<td>Pontillon, Adolphe</td>
<td>79</td>
</tr>
<tr>
<td>Portrait d’Albert Wolff</td>
<td>94</td>
</tr>
<tr>
<td>Portrait de Berthe Morisot à l’éventail</td>
<td>41</td>
</tr>
<tr>
<td>Portrait de Berthe Morisot au Manchon</td>
<td>94</td>
</tr>
<tr>
<td>Portrait de Carolus-Duran</td>
<td>94</td>
</tr>
<tr>
<td>Portrait d’Ernest Hoschedé et de sa fille Marthe</td>
<td>96</td>
</tr>
<tr>
<td>Portrait de Faure dans le rôle de Hamlet</td>
<td>58</td>
</tr>
<tr>
<td>Portrait de Femme au Niche Noir</td>
<td>98</td>
</tr>
<tr>
<td>Portrait de Guillaudin à Cheval</td>
<td>98, 118, 130</td>
</tr>
<tr>
<td>Portrait de Madame Manet</td>
<td>94, 96, 98</td>
</tr>
<tr>
<td>Portrait de Manet par Lui-Même</td>
<td>94, 96</td>
</tr>
<tr>
<td>Portrait de Marguerite de Conflans</td>
<td>55</td>
</tr>
<tr>
<td>Portrait de Monsieur Arnaud à Cheval</td>
<td>96</td>
</tr>
<tr>
<td>pose</td>
<td>105</td>
</tr>
<tr>
<td>El príncipe Baltasar Carlos a caballo</td>
<td>59, 61, 65–66, 68–69, 74–75, 103, 140, 142, 179</td>
</tr>
<tr>
<td>Prost, E.</td>
<td>171, 220</td>
</tr>
<tr>
<td>Prado</td>
<td>2, 56, 58–59, 61, 65, 179</td>
</tr>
<tr>
<td>proportion</td>
<td>82, 198</td>
</tr>
<tr>
<td>Proust, Antonin</td>
<td>17–20, 32, 46, 56, 64, 80, 112, 220</td>
</tr>
</tbody>
</table>

| Realism             | 50      |
| Renoir, August      | 2, 24, 56, 74, 157, 279 |
| Ribera, José de     | 56, 179 |
| Rio de Janeiro      | 17, 79 |
| Roth-Meyer, Clotilde | 157 |
| Rouart, Denis       | 23, 31, 33, 40–41, 47, 220 |

<p>| Salon               | 17–20, 49, 47–48, 50–51, 54, 75, 71, 150, 172, 278 |
| Salon des Refusés   | 172     |
| scale               | 13, 90, 116, 151, 171, 197 |
| Scanning Electron Microscopy (SEM) | 163 |
| Scène d’atelier Espagnol | 40 |
| Scheele’s green     | 162–163, 167, 176 |</p>
<table>
<thead>
<tr>
<th>Schmitz, Christopher</th>
<th>170, 281</th>
</tr>
</thead>
<tbody>
<tr>
<td>shading</td>
<td>50, 82, 113</td>
</tr>
<tr>
<td>siccatives</td>
<td>135, 156, 158, 160</td>
</tr>
<tr>
<td>Le Skating</td>
<td>134</td>
</tr>
<tr>
<td>sketchbook</td>
<td>33, 74</td>
</tr>
<tr>
<td>Société Anonyme des Artistes</td>
<td>51</td>
</tr>
<tr>
<td>Spanish Museum (Paris)</td>
<td>17, 56</td>
</tr>
<tr>
<td>status</td>
<td>74, 152, 176</td>
</tr>
<tr>
<td>negative</td>
<td>74, 152, 176</td>
</tr>
<tr>
<td>positive</td>
<td>74, 152, 176</td>
</tr>
<tr>
<td>neutral</td>
<td>164, 246</td>
</tr>
<tr>
<td>stratigraphy</td>
<td>45</td>
</tr>
</tbody>
</table>

| Tabarant, Adolphe     | 18–20, 30, 38, 46–47, 80–81, 281 |
| Tama                 | 34 |
| texture              | 78, 85, 112, 114, 153, 189 |
| Thoré-Bürger, Théophile | 40 |
| Titian               | 63 |
| Les Travailleurs de La Mer | 55, 118, 126, 150–151, 160, 174, 179 |
| Tête de Vieille Femme | 40 |
| Tête du chien ‘Bob’   | 41 |
| Tiges de pivoines et sécateur | 40 |
| Toché, Charles       | 159 |
| tonality             | 113, 160 |
| Toreros en Action    | 40 |
| Trouville            | 24, 26 |

| UV-fluorescence       | 120, 122–126, 179 |
| variants              | 92–93, 138 |
| Vase de Jardin        | 98 |
| Velázquez, Diego      | 56–59, 61, 64, 69, 74, 93, 106, 140, 142, 179, 275, 281 |
| Le Vieux Musicien     | 100 |
| Vollard, Ambroise     | 32, 80 |

| Wildenstein, Daniel   | 23, 31, 33, 40–41, 47, 280–281 |
| Wildenstein, George   | 47 |
| Wilson, Michael       | 30, 34, 138 |
| Wilson-Bareau, Juliet | 17–21, 46, 52, 54–56, 63, 79, 104, 134, 146, 151, 159, 185, 190, 281 |

| X-ray                 | 6, 32, 69, 84, 109, 120, 126, 136–142, 146, 153, 179, 226 |

| Zola, Émile           | 18, 20, 23, 34, 56, 59, 73 |
| Zurbarán, Francisco    | 56, 179 |
Photograph Credits

Atelier for Restoration & Research of Paintings (ARRS) ©; 11, 12, 25, 26, 27, 28, 35, 36, 37, 39, 43, 44, 67, 69, 71, 107, 109, 111, 114, 115, 121, 123, 125, 127, 129, 131, 133, 136, 137, 139, 141, 143, 144, 145, 147, 148, 149, 184, 185, 189, 204, 209, 214, 221, 222, 223, 227.
The Brooklyn Museum of Art in New York ©; 31, 145.
Bonham’s auction in London ©; 33.
The Barnes Foundation in Merion ©; 45, 53, 101, 224.
Kunsthalle Hamburg ©; 51.
Museo Nacional del Prado ©; 60, 61, 66, 69.
Courtesy of Yale University Art Gallery in New Haven ©; 87.
The Art Museum, Princeton University ©; 87.
Wallraf-Richartz-Museum in Cologne ©; 89, 173.
Private collections; 119, 130, 161.

Copyright © 2008 by Milko den Leeuw
First print 2008, second print 2012

ebook 2013 in cooperation with The Royal Academy of Art, London ‘Manet: Portraying Life’ - 26 January - 14 April 2013

Atelier for Restoration & Research of Paintings
Postbox 11574
2502 AN The Hague
Holland

www.arrs.nl

All right reserved.
This book may not be reproduced, in whole or in part, in any form without written permission from the writer.

Printed at DeltaHage, Holland
Grafic Design, Sanne Veenhuijzen
The author Milko den Leeuw is director and co-founder of the Atelier for Restoration & Research of Paintings (ARRS) in The Hague, Holland.

The ARRS, founded since 1991 by Milko den Leeuw and drs. Ingeborg de Jongh, is an internationally operating workshop for technical investigation and conservation/restoration of paintings.

Milko den Leeuw received training in painting conservation, art history and scientific research. One of his teachers was D. van Dantzig, who was specialised on authentication research matters and organiser of the multi-disciplinary symposium ‘Authentication in the Visual Arts’ on March 12, 1977 in the Van Gogh Museum in Amsterdam. Den Leeuw was trained by her in Pictology – an analytical method for attribution and evaluation of pictures.

The ARRS has made a number of breakthrough international publications concerning their new developed techniques in authentication research and rediscoveries of paintings. Recently the almost 20 year running forgery lawsuit concerning the Dutch group ‘Groninger Plough Painters’ was solved by the investigation by ARRS. Several rediscoveries of paintings by important masters were made in conjuction with ARRS.