

Paintings on copper

and other metal plates

PRODUCTION, DEGRADATION AND CONSERVATION ISSUES

La pintura sobre cobre

y otras planchas metálicas

PRODUCCIÓN, DEGRADACIÓN Y CONSERVACIÓN

EDITED BY

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Cross section of a painting on copper from the collection of the Musée des Beaux-Arts de Liège (BAL).

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Diseño y maquetación

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Fotomecánica e impresión

LaimprentaCG

Edita

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ISBN: 978-84-16846-96-2

Depósito Legal: V-191-2017

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Desde la dirección del Departamento de Conservación y Restauración de la Universitat Politècnica de Valencia, es motivo de doble satisfacción presentar esta publicación sobre el simposio “La pintura sobre cobre (y otras planchas metálicas), producción, degradación y conservación”, celebrado en la Universitat Politècnica de València el 27 y 28 de enero de 2017. En primer lugar, por el hecho de haber trabajado conjuntamente en la organización del mismo con dos instituciones con las que nos une un estrecho vínculo profesional e investigador como es la Subdirección de Conservación, Restauración e Investigación de CulturArts (IVC+R) de la Generalitat Valenciana y la Universitat de València (UV). En segundo lugar, y no necesariamente en este orden, por la relevancia que sin duda este simposio va a tener para entender las problemáticas relacionadas con este tipo de obras y hacer balance del estado de la cuestión a nivel internacional.

Las instituciones que tenemos bajo nuestra responsabilidad la obligación de tutelar y formar a los profesionales de la restauración, y de preservar y conservar el patrimonio cultural, nos hemos unido en la organización de este evento que sin duda será un nuevo punto de partida para establecer el estado de la cuestión en los tratamientos de láminas metálicas y su interacción con otros materiales.

Una de las obligaciones de todos los que estamos involucrados en la conservación de obras de arte es el intercambio de experiencias y el debate de criterios en torno a nuestras intervenciones, la reflexión sobre los dilemas éticos y los tratamientos que se aplican en problemáticas similares en diferentes países. En este sentido, esta publicación recoge los trabajos e investigaciones de profesionales de diferentes países, y constituye, por tanto, un compendio actualizado de los tratamientos en el panorama internacional. Una gran parte de los estudios de pintura sobre láminas metálicas centran el foco de atención en cuestiones de caracterización de materiales y aspectos químicos, dejando en un segundo plano de interés los aspectos de intervención práctica que tanto interesan al restaurador, así como otros aspectos relativos a su conservación preventiva y manipulación. Estamos convencidos de que, en este sentido, las jornadas serán especialmente fructíferas.

Asimismo, consideramos necesario agradecer a todos los que han querido compartir y exponer sus trabajos y experiencias en estas conferencias, pues han hecho realidad esta iniciativa y de ellos depende en definitiva el éxito de este simposio y de esta publicación.

Julia OSCA PONS
*Directora del Departamento de Conservación y Restauración de Bienes Culturales
Universitat Politècnica de València*



Esta publicación reúne la intensa labor desarrollada por los investigadores dedicados al estudio de uno de los temas más desconocidos de las técnicas artísticas: la pintura sobre cobre y otras planchas metálicas, así como su producción, degradación y conservación, y ello a pesar de que su práctica estuvo muy extendida entre los artistas por la durabilidad de sus materiales.

La presente publicación es fruto del marco de colaboración establecido entre la Universitat Politècnica de València, la Universitat de València y la Generalitat Valenciana a través del Institut Valencià de Conservació i Restauració. En este sentido, queremos agradecer a las dos universidades el haber contado con nuestro centro para el desarrollo de esta actividad, que potencia aún más nuestra vertiente investigadora.

La oportunidad brindada al Institut Valencià de Conservació i Restauració de participar en la organización del simposio internacional, *‘La pintura sobre cobre (y otras planchas metálicas). Producción, degradación y conservación’*, ha sido uno de los muchos proyectos de investigación y formación a los que hemos dedicado un especial esfuerzo y atención, ya que en él van a participar conservadores, restauradores, científicos, historiadores del arte y perfiles profesionales afines de todo el mundo, dedicados a este singular tipo de patrimonio.

Estos encuentros internacionales permiten establecer vínculos de conexión e intercambio de conocimientos entre profesionales dedicados a la conservación, estudio y preservación del patrimonio artístico de otras partes del mundo, pero siempre buscando un fin común: la salvaguarda del Patrimonio artístico. Y es precisamente ese espíritu el que queda recogido en esta publicación para su conocimiento y difusión. En este sentido, nos gustaría dar un reconocimiento especial a Isabel Horowitz, Jørgen Wadum, Nico Broers, Lydia Pavlopoulou, Leslie Carlyle, Alison Stock, Anne Schmidt y Lucía Martínez, por su contribución a este encuentro con sus interesantes aportaciones.

El enfoque multidisciplinar y metódico de la conservación de estas obras permitirá un conocimiento más profundo de su degradación, de su alteración y de los mecanismos de deterioro, que han sido poco estudiados en el pasado, y que, con estas jornadas y publicación, queremos subsanar esa carencia bibliográfica y documental con la que muchas veces nos encontramos a la hora de afrontar una intervención en una obra de estas características.

Gracias a este encuentro podremos acercarnos mejor a los aspectos histórico-artísticos de la producción pictórica sobre plancha metálica; a la caracterización de los materiales presentes en la pintura sobre cobre u otro tipo de metal; a la interacción entre películas pictóricas de origen natural o sintético y el sustrato metálico; así como a los tratamientos de conservación de obras pictóricas realizadas sobre este tipo de soporte.

Desde el Institut Valencià de Conservació i Restauració de la Generalitat Valenciana deseamos que esta publicación sea de gran ayuda y utilidad para todos aquellos profesionales del campo de la restauración que se dedican al estudio e investigación de las obras de arte pintadas sobre cobre u otro soporte metálico.

Gemma María CONTRERAS ZAMORANO
Subdirectora del Institut Valencià de Conservació i Restauració
IVC. Generalitat Valenciana



La colaboración entre disciplinas e instituciones como herramienta esencial para la Historia del Arte y la conservación preventiva

En los días 27 y 28 de enero del 2017 tendrá lugar el Symposium *Painting on Copper* celebrado en Valencia como fruto de una estrecha colaboración entre la Universitat Politècnica de Valencia, la Generalitat Valenciana a través de la Subdirección de Conservación, Restauración e Investigación (IVC+R) y la Universitat de València, a través de la Facultat de Geografia i Història y, en concreto, con la colaboración de su Laboratorio en Historia del Arte para el Análisis y Diagnóstico de Obras de Arte.

La triangulación de estas tres entidades valencianas se desvela como una acción no solo necesaria, sino fundamental e imprescindible para la buena ejecución de proyectos sólidos y de calidad en los tres ejes fundamentales vinculados a la conservación, el estudio y la restauración de las obras de arte, como lo son la docencia, la investigación y la difusión de los resultados. A ello se une la *praxis* directa sobre la obra de arte en sí, cuyo planteamiento desde la conservación preventiva, el análisis histórico y científico o la restauración requiere, y hoy más que nunca, de una visión conjunta y multidisciplinar que permita la realización de trabajos transversales que contribuyan al avance del conocimiento. Por ello, este primer convenio firmado por las tres entidades supone un significativo hito en la historia de la colaboración universitaria y la administración pública valenciana

El Symposium *Paintings on Copper* pretende acercar y reunir a los principales especialistas en el estudio y análisis de la pintura en soporte de cobre y otras planchas metálicas, y servir de encuentro entre conservadores-restauradores, científicos de la conservación e historiadores del arte con el objetivo de poner en común las principales novedades y los estudios realizados desde la óptica de cada una de las disciplinas bajo perspectivas de perfil interdisciplinar. Hoy más que nunca es necesario hacer hincapié en la necesidad de estos trabajos en conjunto, pues son los que permiten una correcta actuación sobre los bienes culturales. Para lograr esa meta anhelada se erige como imprescindible el desarrollo de una labor de investigación científica y documental que permita documentar la obra y los procesos acometidos, conocer la naturaleza física de las obras de arte y las fuentes históricas que la documentan, así como su correcto análisis histórico-artístico vinculado a su vida cultural. Sólo este conocimiento riguroso y exhaustivo, que va más allá de la recopilación y cobra una singularidad heurística, es la que sentará las bases del respeto a los valores añadidos que toda obra presenta, el *Alterweist*, o valor de lo antiguo que permite comprender cualquier bien artístico como el resultado de un sedimento físico acumulativo de la actividad humana, pues encierra en sí valores culturales, materiales y técnicos.

El trabajo del historiador del arte junto a los profesionales de la restauración y la ciencia de la conservación no puede sino contribuir a enriquecer el estudio y la investigación, objetivos que por sí mismos, de manera aislada son significativos, pero que deben trascender el mundo

de la academia y aproximarse a la sociedad: enseñar, divulgar, defender y conservar el patrimonio artístico, en definitiva, todo lo que tiene que ver con el moderno concepto de “Patrimonio Cultural” -del que el artístico constituye una porción substancial, debe favorecer la creación de puentes conjuntos en la construcción de equipos en los que el historiador del arte ha de estar presente en todas las tareas relacionadas con la custodia o tutela del Patrimonio, desde su conocimiento hasta su gestión, pasando por su conservación, siquiera sea porque las decisiones acerca del patrimonio artístico en cualquiera de esos niveles han de estar basadas en la comprensión histórica de las obras de arte.

Por ello, la importancia de la Historia del Arte se incardina profundamente dentro de lo que Lafuente Ferrari definió como las Humanidades visuales, en el sentido que la historia del arte supone para el hombre del siglo XX algo así como las humanidades del presente, unas humanidades visuales que han venido a desplazar, en cierto modo—con lo que ello supone de importantes consecuencias, para bien y para mal—, a las humanidades clásicas: a las letras propiamente dichas han sucedido las imágenes. Ello otorga singular entidad a la orientación del trabajo del historiador del arte, así como a las cuestiones generales de fundamentación de una disciplina que ha alcanzado parte tan capital en la formación cultural del hombre de hoy. Como ha postulado Jacques Derrida las Humanidades por venir atravesarán las fronteras entre las disciplinas sin que eso signifique disolver la especificidad de cada disciplina dentro de lo que se denomina a menudo de modo confuso la interdisciplinariedad; pues lo realmente necesario es la creación de redes, la investigación colaborativa y el establecimiento de objetivos comunes en un proceso dialógico constante.

Este primer paso fundamental, con la firma del convenio que da lugar a este Symposium, inicia un camino que, aunque transitado, a menudo se ha perdido en sendas desdibujadas o laberínticas. Esperamos que, ahora sea el inicio de otra manera de construir nuevas sendas, basadas en el respeto, la colaboración y la construcción de un futuro común en el que el objetivo sea la correcta salvaguarda de algo tan nuestro como lo es el arte y los testimonios que la creatividad de hombres y mujeres de nuestro ayer nos ha preservado, y los que hoy siguen construyendo y creando los artistas contemporáneos como parte fundamental en la comprensión cultural de lo que somos.

Ester ALBA PAGÁN

*Degana de la Facultat de Geografia i Història
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This publication accompanying the international symposium, “Paintings on copper and other metal plates. Production, degradation and conservation issues”, organized jointly by the Universitat Politècnica de Valencia (UPV), the Universitat de València (UV), and the Subdirecció General del Institut Valencià de Conservació, Restauració e Investigació IVC + R de CulturArts Generalitat, will be covering a wide range of issues relating to the making and preservation of paintings on metal.

Paintings on copper and other metal plates have long been valued as refined and elegant works of art. The practice of painting on copper seems to have appeared in Florence in the third quarter of the sixteenth century and was taken up as a specialty by the circle of Paul Bril in Rome in the 1590s. From there the practice spread, in particular to Prague, Antwerp and Utrecht, but its popularity waned after 1650.

Other metal supports would, in the second half of the 17th century, continue to be employed for large church decorations, such as the lead-tin alloy used for the impressive almost 7 x 4 m altar in St. Stephan's cathedral in Vienna which is composed of 36 sheets soldered together. Equally, tinned-iron plates were used by artists late in the 18th century in Austria, and we still find copper and other metal plates in occasional use for painting supports well into the 19th century.

We may be able to divide paintings on copper and other metal supports into two distinct groups: one motivated by practical concerns, the other by aesthetic goals. Copper or other metals, relatively light-weight and easily transported, were ideal for images such as portraits and religious scenes that needed to travel, (and we see evidence of this travel, particularly from Antwerp, to Spain and from there to the Americas). The second group consists of works by artists of the highest caliber, for whom the choice of copper clearly had artistic meaning.

As a durable, compact support, copper was ideal for mass-produced paintings intended for export; usually the work of minor or anonymous artists, and often reproducing famous compositions. Despite the availability all over Europe and the New World from early in the 16th century of prints made from copper engravings, paintings directly on copper and other metals documented colour and handling beyond what prints could convey.

Both small and large copper plates, as well as composite metal supports, each convey new and challenging preservation issues based on their materials and techniques and/or the environment in which they have been kept.

It is our ambition that this publication will provide an enduring record -although possibly not as durable as the metal sheets themselves-, of the timely and rich discussions between the conservator-restorers, conservation scientists, art historians and other professionals who were assembled together during this symposium in Valencia.

Esta publicación es el resultado del simposio internacional "Pinturas sobre cobre y otras planchas metálicas. Producción, degradación y conservación", organizado conjuntamente por la Universitat Politècnica de Valencia (UPV), la Universitat de València (UV) y la Subdirección General del Institut Valencià de Conservació, Restauració e Investigació IVC + R de CulturArts Generalitat, y en ella se aborda una amplia gama de temas relacionados con la fabricación y conservación de obras pictóricas sobre plancha metálica.

Las pinturas sobre cobre y sobre otras planchas metálicas fueron concebidas como obras de arte refinadas y elegantes. La práctica de la pintura sobre cobre parece surgir en Florencia en el tercer cuarto del siglo XVI llegando a ser una especialidad en el círculo de Paul Bril en la Roma de 1590. Desde allí la práctica se extendió en particular a Praga, Amberes y Utrecht, aunque su popularidad disminuiría a partir de 1650.

En la segunda mitad del siglo XVII se seguirían empleando otros soportes metálicos para decoraciones de grandes iglesias, como la aleación de plomo-estaño utilizada en el impresionante altar de casi 7x4 m de la catedral de San Esteban de Viena, compuesta por treinta y seis planchas soldadas entre sí. Del mismo modo, algunos artistas utilizaron planchas de hierro estañado a finales del siglo XVIII en Austria, e incluso encontramos cobre y otras planchas metálicas de uso ocasional como soporte pictórico hasta bien entrado el siglo XIX.

Podemos dividir la pintura sobre cobre y otros soportes metálicos en dos grupos diferenciados: uno motivado por preocupaciones de índole práctico, y un segundo grupo motivado por aspectos de carácter estético. El cobre u otros metales, relativamente ligeros y fácilmente transportables, resultaban ideales para retratos y escenas religiosas que necesitaban viajar (viajes bien conocidos, especialmente de Amberes a España y de allí a las Américas). El segundo grupo consiste en obras de artistas del más alto nivel, para quienes la elección del cobre tenía claramente un significado artístico.

Como soporte duradero y compacto, el cobre era ideal para pinturas producidas en serie destinadas a la exportación; se trataba generalmente del trabajo de artistas menores o anónimos, que a menudo reproducían composiciones conocidas. A pesar de la disponibilidad de grabados realizados a partir de planchas de cobre en Europa y el Nuevo Mundo desde principios del siglo XVI, la pintura realizada directamente sobre cobre y otras planchas metálicas dan buena cuenta del uso del color y de las habilidades técnicas mucho más allá de lo que los grabados podían transmitir.

Tanto las planchas de cobre pequeñas como las grandes, así como los soportes metálicos, representan nuevos desafíos y problemas de conservación debido a los materiales y técnicas empleados en su producción y/o al entorno en el que se han preservado.

Esperamos que esta publicación se convierta en un documento duradero -aunque posiblemente no tan duradero como las propias planchas de metal-, de las oportunas y ricas discusiones entre conservadores-restauradores, científicos de la conservación, historiadores del arte y otros profesionales que se han dado cita en este simposio en Valencia.

Valencia (España) 17 Enero 2017 - Valencia (Spain) 17 January 2017

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PAINTINGS ON COPPER: A BRIEF OVERVIEW OF THEIR CONCEPTION, CREATION AND CONSERVATION

Isabel HOROVITZ

The Painting Conservation Studio (London, UK)

Introduction

As masterpieces on a small scale, paintings on copper have a broad appeal to the public and especially to collectors. From the time of the earliest known, in Italy in the 1520s, the conception and creation of these paintings are rooted in the ambition and curiosity of artists to innovate both technically and theoretically, to enhance the images and conceits which they, and their influential patrons, were striving to achieve.

The emergence of paintings on copper and other unusual supports arose in the spirit of experimentation in early sixteenth century Italy and spread throughout Europe and Spanish America. This paper does not present a definitive narrative of the practice of painting on copper and other unusual supports, rather it explores the possible contexts in which they appear to have developed. In this sense, the art historical, and technical art historical study of unusual supports has come a long way since a small exhibition in London in 1967 (Hazlitt 1967), and van der Graaf's and Andrews's pioneering work in the 1970s (Van der Graaf 1976, Andrews 1977). The major interdisciplinary research project culminating in the international touring exhibition 'Copper as Canvas' in 1998-9 (Komanecy 1999), focused on a broad range of art historical, technical and economic activity, from which more general Renaissance studies, technical art history and conservation science continue to feed.

Unusual supports

In sixteenth century Italy, Sebastiano del Piombo, Correggio, Parmigianino, Andrea del Sarto, Titian, and others experimented with unusual supports to produce durable paintings with sophisticated effects. Vasari records that around 1530, Sebastiano del Piombo, whose novel techniques had been documented earlier (Hirst 1981: 124), was working 'on stone, marble, porphyry, and similar materials, on which paintings last a very long time' (Vasari, Gaunt (ed.) 1963, vol. 3: 118).

Sebastiano's explorations with enduring materials as supports appear to have a more important significance. His portrait on slate of *Baccio Valori the Elder* c. 1531 (Palazzo Pitti, Florence), was referred to in Borghini's book, *Il Riposo*, published in Florence in 1584, in which Baccio's nephew Valori the Younger, defends the art of painting, as part of the Renaissance debate over the *Paragone*, or hierarchy of different art forms. He not only commends the 'new' support material for its durability but also ascribes to it *nobilità di materia non inferiori all'opere di scultura* (Borghini 1584, vol. 3: 440; Hessler 2006). Sebastiano's use of slate as the support for important portrait commissions was deliberately chosen for its eternal qualities, and by implication the immortality of the sitter, as in his *Portrait of Pope Clement VII* (The J. Paul Getty Museum) of 1531 (Carr 1997: 102).

In Florence, the practice of painting stone, as well as on copper and other metals became highly sophisticated under the Medici, encouraged by the creation in 1588 by Ferdinand I of the Opificio delle Pietre Dure. Slate was particularly suitable for use as a dark background, and there is an intriguing reference by Bocchi, writing in 1591, to Vasari's ownership and display in his house in Borgo S. Croce, Florence, of a night scene on slate: *una notte su lavagna di Leonardo da Vinci meravigliosa* (Weil Garris Posner 1974: 66). Night scenes on slate were produced typically by the Bassano family and Northern artists working in Italy such as Leonaert Bramer (Bowron 1999: 19) and Alessandro Turchi (Verona 1999). Stone was commissioned by wealthy and important patrons, for the creation of extraordinary collections of prized objects (Reifsnnyder 1999). Jacques Stella's particular skills were sought after to paint small religious scenes on touchstone, slate, alabaster and even lapis lazuli, in Rome, and his native France (Collomb 2007: 66-73). In *The Triumph of Louis XIII against the enemies of Religion*, 1642 (Versailles), the brightness of the lapis is used to create a dazzling sky, a precious natural material of an everlasting nature, visually integral to the composition. Even more unusual was Murillo's use of obsidian, a vitreous volcanic rock, which had conceptual significance. *The Agony in the Garden* and *Christ at the Column* (Musée du Louvre, Paris), painted on old Aztec smoking mirrors were possibly special commissions. Murillo left the reflective black stone unpainted to depict the night scenes, perhaps thereby emphasising the desolation of Christ (Meslay 2001: 73-9). Such intense blackness would be difficult to render in paint, and dark painted shadows were known to 'sink' on canvas. Even in the shadows of the flesh, for example in *Christ at the Column*, the dark stone plays a part in the half-tones, creating a striking volume to the forms (Horovitz 2012: 99).

Although there were conceptually significant reasons underlying the use of unconventional supports in specific instances, it is also likely that ease of use or availability accounted for their employment, for example by Andrea del Sarto (Vasari 1868: 259-60; Shearman 1965: 274-5), and Titian (Hope 1980: 122-3, 142). Technical reasons played their part, as stone and slate could be used to create a different surface texture, as Vasari noted 'the stone does not suck up, that is absorb as much as does the panel or canvas, and it is impervious to worms' (Maclehose 1960: 238-9). Rubens repainted his major com-

mission for the Oratorians in the Chiesa Nuova in Rome on slate, in order to reduce the problem of light reflection, recalling how Sebastiano, for similar reasons, had chosen to paint on stone (albeit in the traditional manner of wall painting), in his *Flagellation* in San Pietro in Montorio (Jaffe 1977: 85-99).

Painting on copper

Although intrinsically eternal, stone and slate are heavy and at risk of shattering, whereas small copper plates are easily handled and transportable. The availability and accessibility of copper plates must have been related to their extensive use for engraving and etching. Their use as supports for enamels was widespread in Europe, as exemplified in the work of Jean Fouquet; and Leonardo praised the durability of enamel painting on copper (Richter 1980: 200), however, the practice of easel painting on copper cannot be directly allied with enamelling.

The earliest known examples of painting on copper seem to originate, as with other unusual supports, in Italy. Sebastiano del Piombo's influence in the spread of this practice, highlighted by Vasari, has already been described. At around this time, Parmigianino, who used copper plates for etching, is known to have painted on copper – a portrait on copper is mentioned in the inventory of his patron Francesco Baiardo (Ekserdjian 1997: 175), and a small *Portrait of a Bearded Man* has also been attributed to him (Ekserdjian 2006: 150-1) —. Around 1530-31, Correggio painted his *Magdalen Reading* on copper (missing from the Gemaeldegalerie, Dresden, since 1945). This treasured painting was admired and copied by many later artists, including Wilkie and Mengs (Cunningham 1843, vol. 2: 327-8; Eastlake 1869, vol. 2: 248-9; Meyer 1876: 203-4, 272, 287-8; Horovitz 1999: 84). Wilkie's description of it during his visit to Dresden in the 1820s is very interesting. He said "To those who like pictures in their pristine condition, the *Magdalen* will be highly satisfactory. This is perfect, almost as left by the master, (...) without even varnish. The neck, head, and arms, are beautiful (...) finished with a softness and detail resembling Gerard Dow, or Vanderwerfe". He gives us here, a unique description of the practice and time framework of copper in its essence (Horovitz 2002).

By the 1560s, copper plates were favoured by Allori, Vasari and Bronzino under the court patronage of

Francesco I de' Medici in Florence. Paintings on copper, other metals or unusual coloured stones formed an important part of 'Collectors' Cabinets', which also contained rare natural specimens, including shells and stones. The support could be used to enhance the reflective quality or sheen of a painting – some of the finest paintings on copper were created to dazzle and impress with their jewel-like surfaces –. The practice of painting on copper was soon adopted by Northern artists working in Italy, as noted by Karel van Mander in his *Schilderboek* of 1603–4 (Miedema (ed.) 1994). It spread to other important artistic centres such as Prague, where it thrived under the patronage of Rudolf II, Antwerp, and throughout Europe. The taste for mythological and allegorical subjects, often erotic, flourished in a highly sophisticated court atmosphere, and paintings, for example by Bartholomaeus Spranger, Hans von Aachen and Joseph Heintz, were often commissioned as gifts by patrons looking for high finish, for which copper was suited. The rigidity and smoothness of this support lent itself to sensuous brushwork, albeit on a small scale, to heighten the mood and brilliancy of scenes of amorous couples or female nudes. These images were intended very much for private enjoyment and the exquisite fine detail could be viewed minutely, perhaps even with a magnifying glass (Bowron 1999).

Physical factors were clearly important in the choice of this material as a support, durability remaining a prime reason. Copper was deliberately chosen for a large altarpiece by Veronese's son, Carletto Cagliari, in the Church of San Giobbe, Venice, to mitigate against the effects of the North wind (Boschini 1674: 62). The preference for copper during an artist's learning period was noted by Malvasia, in his *Life of Guido Reni*, who was taught by Calvaert to paint on copper, and the control and tightness of execution which it facilitated made it an excellent support for making reduced copies. The paint can be easily manipulated, and the rigidity of the copper makes it easier for fine detail to be depicted. The paint film retains its saturation – it does not 'sink in' on this non-absorbent surface and become matt, which can obviate the need for a varnish (Horovitz 1999) –. Although artists did not discuss their practical reasons for using copper, we can gain an idea of why they might have found it pleasing from the comments of present-day artists working in a traditional manner on this support, who describe the flow of the paint, the ease of control of the brushwork and the seductive feel of the copper (Horovitz 2002).

Manufacture and preparation of copper plates for painting

The metallic surface of a painting on copper can be evident from a distance, with characteristic ripples and undulations catching the light. The appearance of the painting, whether flat or wavy, is due to the method of manufacture of the sheet.

Jørgen Wadum's ground-breaking studies of individual coppersmiths and copper plate production in sixteenth and seventeenth century Antwerp have revealed much chronological, qualitative and cost data. Given his findings that the cost of thin copper sheets were comparable to oak panel supports, it is not surprising that used printing plates are rarely found to have been employed as painting supports (Wadum 1998, 1999, 2012; Westermann 1999).

Until the late eighteenth century, most plates were produced from hammered sheets of copper, though occasionally, from the early seventeenth century, the sheets may have been rolled as well. An early design of a rolling machine for metal appears in Leonardo's *Codex Atlanticus*, and rolling machinery is illustrated in various early seventeenth century treatises for small scale fine adjustment but probably not for heavy reductions in thickness. The small number of rolling mills known may explain why though it is possible to find rolled sheets of copper being used as painting supports, the majority of plates are hammered (Komaneky, Horovitz and Eastaugh 1998; Horovitz 1999). The use of rolling machines became more widespread only in the 1770s, when sheet copper was produced for sheathing ships (Horovitz 1999; Westermann 1999; Krause 2002).

Examination by x-radiography of the plate can show varying densities in the copper caused by uneven thickness, producing identifiable patterns. A number of different x-radiography techniques may be employed to investigate different aspects of plate manufacture and preparation; x-radiography carried out over different ranges of exposure, time and tube distance may reveal properties such as mottling of the plate, an indication of hammering (Scott 2002: 320). Further information may be gained from a metallurgical examination, studying the crystalline structure of the metal, which might indicate whether rolling, hammering or recent annealing had taken place (Wallert (ed.) 1999: 49).

Documentary sources suggest that copper plates were rubbed and treated similarly to etching plates, but plates

for painting were not polished to a high finish – almost all paintings on copper appear to have a roughened surface to a greater or lesser degree, to provide tooth to accept the paint, increasing the surface area available for bonding. Roughening would also remove the layer of red cuprous oxide (Cu_2O) formed between the surface of the copper and oxygen in the air. Occasionally, the surface was simply scored at intervals, resulting in poorer adhesion of the paint. The surface roughening may be seen under magnification in areas where losses have occurred, and can also be investigated analytically over the whole surface by the use of scanning X-ray fluorescence. Using this technique, evidence of surface roughening of the copper was found in Frans van Mieris' *Pictura* (The J. Paul Getty Museum), where thicker concentrations of lead white were mapped in the micro-ridges of the copper sheet (Scott 2002: 208-9).

Ground and paint layers

After surface roughening, it was usual to apply one or more preparatory layers. In general, written sources imply that the preparation of copper plates was relatively simple, perhaps indicating that artists would prepare the plates themselves rather than buy them ready-prepared. Some writers advised rubbing the plate with garlic, to wet the surface and provide a sticky base. Although a brush was usually employed, fingers were also used to apply the ground to produce a very smooth finish. This method is mentioned in a number of manuals and treatises, for instance by Pacheco (Veliz 1986: 69) who stated that 'metal plates, being smooth and clean, are primed only with one very thin layer of white lead and umber in oil which is put on and spread with the fingers and not the brush'. Treatises by Palomino (1724) and Pernety (1757) gave similar advice. Finger or palm prints have been observed in the ground layer on many copper paintings, including some by Spranger, Heintz, Rottenhammer, and Jan Bruegel I; these artists were influential in the spread of the practice of painting on copper (Horovitz 1999).

In some paintings, the glow of the copper is used to enhance the richness of tone but more usually, a thin preparatory layer covers the copper completely. The grounds of the Northern painters in particular were very thin (as has been found in the examination of cross-section samples), often less than 10 microns thick, consisting of lead white in oil, with admixtures of earth pig-

ments or lamp black (Horovitz 1999; Wallert (ed.) 1999; Martin, Eveno and Le Chanu 1999). The grounds of Pieter Neefs' *Interior of a Church* (National Gallery of Art, Washington DC) and Annibale Carracci's *The Vision of St. Francis* (National Gallery of Canada, Ottawa) both contain a mixture of lead white, calcium carbonate and earth pigments (Horovitz 1999: 68-74, 89-90).

Examination by scanning x-ray fluorescence is a useful technique for investigating paintings on metal. It not only provides information concerning the application of ground layer and pigments used, but can also reveal *pentimenti*, as in the case of Van Mieris' *Pictura* (The J. Paul Getty Museum) (Scott 2002: 320). Since the metal support absorbs radiation strongly, the additional absorption of inorganic pigments cannot be seen by conventional x-radiographic methods. Other analytical techniques for investigating compositional changes include electron emission radiography; this has not often been undertaken as until recently it has required more specialist equipment (Bridgman *et al.* 1965; Buck 1970; De Vries *et al.* 1978; Bjarnhof 1981; Eastaugh 1998; Macbeth 2012: 304).

Documentary evidence that linseed oil was used for both the ground and paint layers has been borne out by examination of paintings (Horovitz 1999). Like many organic materials, linseed oil reacts slowly with the copper plate. A very thin, green transparent layer is formed beneath the ground, visible in microscopic cross-sections, the result of copper in the plate reacting with fatty acids in the oil and diffusing into the lower part of the ground layer. Usually, the green layer can be characterised as a discrete layer, which could be the result of garlic or possibly of a layer of oil or other organic film having been wiped over the copper. However, older cross-section samples have not always been examined with scanning electron microscopy, and the layer structure is probably more complex at the copper-ground interface than has been thought. The excellent condition of many of these paintings and the thinness of the films makes them difficult to investigate. The green layer has been found equally on paintings in good and poor condition, and its role in these specific organometallic adhesion mechanisms is not properly understood. It is likely that copper carboxylates are formed by the contact of copper ions with free fatty acids in the oil and eventually with products formed as a result of oxidation and hydrolysis (Martin *et al.* 1999; Gunn and Martin 2000; Paquette 2004; Gates 2006;

Pavlopoulou and Watkinson 2006). Furthermore, in aged paint films on copper supports, metal soaps produced by the lead white content of the ground layer may contribute to more complicated pigment-medium interactions which require further investigation (Broers 2003; Kolz 2004).

Variations on copper

Occasionally copper plates were coated with silver coloured alloys, which when analysed have been found to consist of tin or lead-tin alloys. This phenomenon is the subject of Schmid's investigations, presented in this symposium (Schmid 2013). Coated copper plates were sometimes used by artists including Elsheimer, Guercino, Domenichino, and Claude. Elsheimer's *The Stoning of St Stephen*, (National Galleries of Scotland) achieves an extraordinary luminosity through the use of a silver coloured metallic coating. In some paintings, however, the effects are not so obvious and the presence of a coating is only found on detailed examination. In paintings examined, there is nothing to suggest that adhesion is influenced by the presence of coatings (Horovitz 1999; Schmid 2013). Domenichino's and Ribera's paintings in the Capella del Tesoro, in the Cathedral of San Gennaro, Naples, are some of the largest on copper (the largest being 3.5 m high) and consist of joined, riveted, plates (Schmid 2013). Tinned copper was stipulated in this commission, and formed an important contribution, conceptually and physically, to the enrichment of the chapel with materials of an enduring nature, in accordance with Counter-Reformation principles (Spear 1982; Bowron 1999). Domenichino suggested changing to canvas due to difficulties in producing sheets this size which did not bulge, however his suggestion was not allowed, confirming the religious and spiritual significance of the materials specified. The extraordinary luminosity of these paintings is entirely in tune with the exuberance of silver and other metalwork of the chapel. The effect is totally consuming, with evocative material used to push artistic boundaries in the propagation of Counter-Reformation faith.

Copper plates were very occasionally covered in gold leaf. Rembrandt's paintings on gold-coated copper, *Old Woman Praying* (Residenzgalerie, Salzburg), *Self-Portrait* (Nationalmuseum, Stockholm), and *Study of a Man Laughing* (Royal Cabinet of Paintings Mauritshuis, The Hague) date from the Leiden period of 1629 to

1630. The paint film is applied directly over the gold leaf, which has been applied over the surface of a lead white in linseed oil ground on the copper. In the painting *Old Woman Praying*, the gold background is particularly effective in giving depth and glow to the red drapery, but is also important in depicting the flesh tones, which despite their apparent thickness, are applied in thin glazes, giving a transparent quality.

In *Study of a Man Laughing*, the gold is used to create highlights and contours as well as to give depth to shadows and dark tones. Rembrandt's interest in metal as a base on which to work both for painting (and print-making) may have related to the special effects that could be created; in these instances it might have enabled him to explore the paint handling on its own, without the influence of support texture or ground absorbency. It has been suggested that these three *tronies* or 'studies' were produced as a set in order to demonstrate to his pupils that style and painting technique were inter-dependent (Broos and Van Suchtelen 2004: 200-4). He used a careful superimposition of brushstrokes to build up translucent wrinkled flesh for the elderly woman deep in prayer, a smooth and blended technique for evoking serious introspection, while laughter and gaiety is shown by sketchy brushwork and flamboyant use of the tip of the brush handle to push aside the paint, revealing the golden underlayer.

The use of gold leaf beneath the whole of a painting is rare. In some paintings on copper by Frans van Mieris, *The Doctor's Visit*, of 1657 (Kunsthistorisches Museum, Vienna) and *Portrait of Florentius Schuyt*, of 1666 (Royal Picture Gallery Mauritshuis, The Hague), the gold has been covered by a ground layer or underpaint, and cannot be seen with the naked eye. Applying gold leaf directly to copper formed part of a long metallurgical artisan tradition, in which Van Mieris, who trained as a goldsmith, would have been proficient (Buvelot 2005). Examination of the *Portrait of Florentius Schuyt*, has revealed that as well as two brownish layers on top of the gold, there is also a yellow earth layer beneath it containing red and yellow earth, chalk and lead white (Broos and Van Suchtelen 2004: 166-7; Mauritshuis conservation file 2001). In 1759 to 1760, John Singleton Copley used gold leaf to provide a translucent glow showing through the paint for several portrait miniatures on copper, first isolating the copper with a yellow ochre ground (Hirschler 1995: 117-25, 192; Fairbanks 1999).

Later interest in painting on copper

The use of copper as a support declined during the eighteenth century in Europe, Robert Dossie in his *Handmaid to the Arts* of 1758, noting that copper plates were only ‘seldom employed but for delicate and elaborate paintings’ (Dossie 1758, vol. 1: 204; Bowron 1999). Nonetheless, some artists employed it occasionally, such as Canaletto, and the Austrian artists Johann Georg Platzer and Franz Christoph Janneck used it almost exclusively. In the Spanish Colonies, the practice continued to flourish where, under the influence of seventeenth century artists such as Mateo Pérez de Alesio and Alonso López de Herrera, Cristóbal de Villalpando executed fine paintings on copper plates as well as fulfilling large scale commissions on conventional supports (Sullivan, E. 1996: 37; Bargellini 1999).

By the 19th century in Europe, Mérimée noted that ‘painting on copper has been given up for some years’ (Mérimée 1839: 222). It is likely that with the expansion of colour merchants’ businesses to produce a full range of artist materials, artists could choose from a wide variety of ready-made, standard-sized painting supports. Yet certain artists in later periods developed a particular interest in the potential of copper and other metal plates as painting supports, notably Blake, Kauffmann, Freud, Kahlo, to name a few (Cross; Holubec; Ormsby 2012).

Preservation

The enduring condition of many paintings on copper can provide unusual insight into the images originally intended and the technical study of these paintings can increase our understanding of how materials influence the image that we see. Copper has particular advantages over canvas or wood, where durability is concerned. Sheets of copper are not sensitive dimensionally to changes in relative humidity (RH), so stresses do not build up as is the case with panels and canvas. There is no need for structural restoration treatment – worked copper sheets provide sound, rigid supports for paintings, although they can flex if they are too soft or thin to support their own weight –. Denting or bending can result from poor handling but other deformations such as concavities are due to the method of manufacture. The advantages of the support, combined with an apparent absence of a glue-size layer and the thinness of most ground and paint films on copper, can account for

the often minimal stress-induced craquelure. In many of the finest examples, craquelure is only observable under magnification, an important feature of their pristine appearance (Horovitz 1999).

Under normal indoor conditions copper does not corrode easily, although above 65 per cent RH, enough moisture may be adsorbed to initiate corrosion. Cracks and micro-fissures in the ground, paint and varnish layers would be capable of providing access to the copper substrate. Corrosion of the copper itself is only occasionally encountered (Bjarnhof 1987; Bush 1993; Everingham 1998), and should not be confused with reactions occurring as a result of interactions between the copper and organic media of the paint film (Scott 2002; Watkinson and Pavlopoulou 2006).

Consolidation

In the past, paintings on copper needing consolidation of the paint film have been treated in much the same way as wooden panels and canvas paintings. However, the French painter Jean-Michel Picault, referring to restoration practices at what would become the Musée du Louvre, noted in 1789, that ‘pictures painted on copper in which only some parts are flaking and falling off, are restored in the most singular and truly incredible fashion. It is the custom, in these instances, to throw away all the parts that are about to be lost in the vulnerable areas (in that they can be detached without much effort). After which, all the parts that are missing the paint layer are filled and painted over...’ (Conti 2007: 244). Indeed, some paintings have a continuous history of flaking. Many are only superficially consolidated and sometimes deterioration can occur as a result of inappropriate consolidants – a wide variety have been used from beeswax, wax-resin mixtures, mastic and stand oil, animal glues, and synthetic adhesives –. Aqueous consolidants carry the risk of inducing corrosion, and the adhesion to metal is non-existent in the case of gelatine and isinglass. Beeswax can become vividly green, leading to corrosion causing the wax to lift. Consolidants classed as suitable for conservation of metals, such as Paraloid B72, B44 or B48, satisfy the basic criteria of stability and good adhesion to copper, although their application is complicated by lack of diffusion into the support and slow evaporation of solvent (Horovitz 1996).

The viscosity of the consolidant in solution will vary between 10–25 per cent, depending on the type of flaking.

Paint delamination on copper most commonly appears as raised, brittle flakes, and the presence of thick and degraded varnish will impede the passage of consolidant. Some paintings exhibit thin curled-up flakes of paint barely attached to the support; others may suffer from blind blisters and cleavage. If the solids to liquid ratio is low, good initial penetration will be achieved, but evaporation of the solvent will be slow and adhesion may never take place. Since the solvent will be in prolonged contact with the ground and or paint layers, it could cause swelling and tests should be carried out. If the consolidant is too viscous, there is a danger that excessive bulk may be introduced, or that adhesion will be uneven beneath blisters. It may be useful to introduce the consolidant by means of a hypodermic needle, and in so doing, to measure the amount being taken up under an area of flaking. The consolidant can be sucked out by means of the syringe action, and then reintroduced more precisely. The double insertion aids capillary action and can produce more even coverage.

For thin, barely attached flakes (following removal of surface dirt with a small sable brush), application of Paraloid B-72 with a small sable brush, followed by holding down with a silicone tipped spatula, can return the lightweight flakes to plane and encapsulate them without any heat. Manoeuvring larger, heavier displaced flakes can be assisted by the use of a vacuum tweezer unit, and more viscous consolidant can be applied to the base of the flake and/or the area of loss before repositioning it (Horovitz 1996, 2012).

Copper is a good conductor and the use of heat in consolidation treatments is problematic as a wide area becomes heated, endangering the probably fragile adhesion beyond the regions being treated. However, some gentle overall heat may be beneficial if warmed consolidants are used since the consolidant will cool rapidly and lose its ability to flow on contact with copper. A warm air pencil and silicone-tipped modeling tools may be preferable to a heated spatula. Some paintings may remain potentially unstable, especially those with friable flakes and blind cleavage, since treatments can be carried out only to the front of the painting, and the consolidant may not penetrate beneath each flake of paint.

Filling

As with consolidants, the range of fillers used has been conventional. Oil putties, chalk and glue, and commercial acrylic based fillers have been typically

used. Provided that the copper base has been sealed with B72, aqueous fillers can be used, and free flowing acrylic gesso fillers can be very suitable for shallow, large area fills, due to their flexibility. Drier formulations of acrylic fillers may be preferable for small, deeper fills.

Varnishing and presentation

In well preserved, three- and four-hundred year old paintings on copper in particular, the absence of an easily visible crackle pattern can affect our acceptance of the balance normally created by the physical appearance of the painting and its age. In restoration, it may be all the more critical to consider the condition of the varnish and its optical effect, and the degree of finish in retouching. A degenerated varnish will almost certainly detract from the image that the artist wished to create with this support. The level of detail which some of these paintings draw us in to look at so closely may require a slightly higher level of saturation than paintings intended to be seen at a distance. But the way in which a varnish behaves optically on metal is different, and even a thin varnish can impart too glossy an effect.

Conclusion

Many European artists from the sixteenth to the eighteenth centuries used copper at some stage of their career. Although specialised in its appeal, copper was used by mainstream and influential artists, from Rubens to Rembrandt, who used it only a few times, to the Carracci, Reni, Guercino and Gentileschi, and especially to Elsheimer, Jan Brueghel I and Bril, whose paintings typify its qualities. Copper was perhaps best suited to the rendition of the precious and the exquisite, rather than a broader, more brushy or painterly technique for more distant viewing. The popularity of Northern seventeenth century painting on copper can perhaps be understood with this in mind, where the sense of the surface of the painting is as important as the depth and harmony, and where the description in paint of objects and nature achieved unparalleled mastery. The excellent state of preservation of some of these paintings can provide good insight into the images originally intended. They were created with extraordinary skill, as masterpieces on a small scale and for close inspection, and if we do look closely, we are left with an even deeper sense of appreciation of their quality and enduring condition.

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