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FOVNDATION
FOR DIGITAL TECHNOLOGY
IN CONSERVATION

Lucida

Discovering an artwork through its surface

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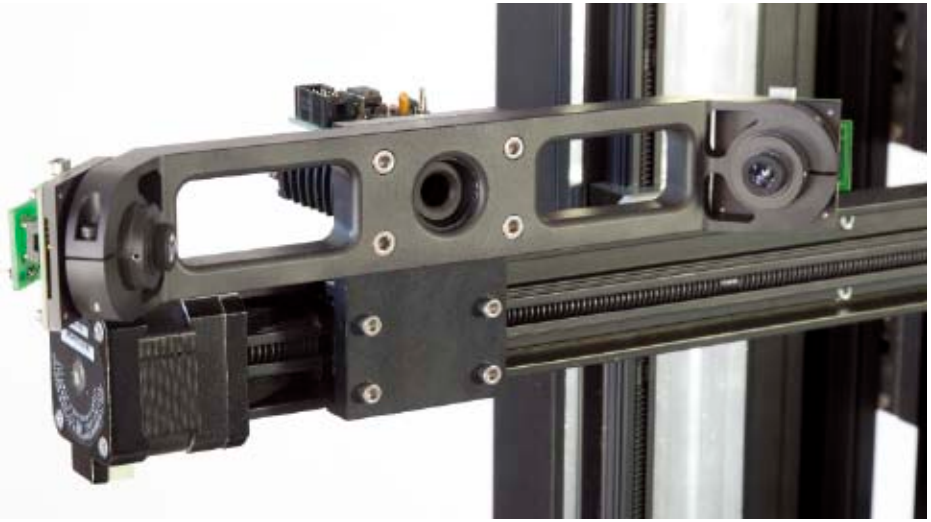

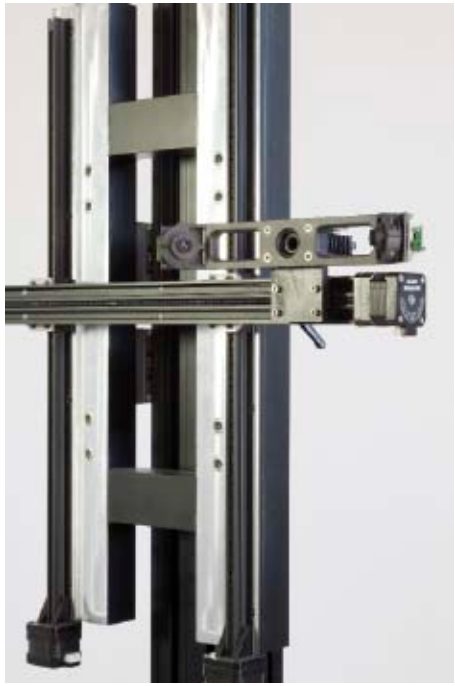

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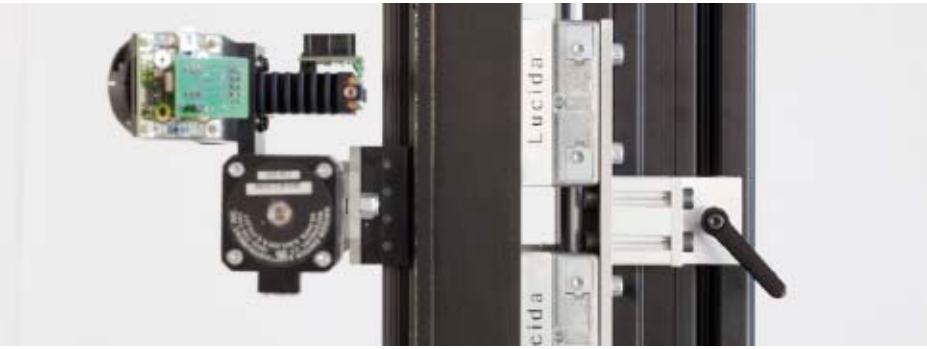


The Lucida is a two camera, one laser scanner with bidirectional recording. It is small, easy to operate and is mounted onto x, y and z axis linear guides, fitted to a rigid lightweight aluminium structure. The intensity of the laser can be increased or reduced and it has software and hardware applications that enable it to record dark and light colours at the same time, high gloss and even reflective materials like gold. The recorded data is dimensionally accurate and bears a close correspondence to the surface of the object being recorded.

The scanning process is controlled from a portable computer through an intuitive and simple user-interface. The depth of field is limited to 2.5 cm but a custom software application allows the user to select specific sections of the target if re-scanning is necessary. Re-scanned data can then be automatically merged with the previous scan. The z axis is mechanical in order to ensure absolutely safe use and avoid any accidental damage in case of a motor malfunction. All stitching is done using an innovative 'switch' between a rendered image and 3D co-ordinates. This approach allows the operation to be done with any standard image-stitching software. All files are saved as raw black and white video data ensuring that they can be processed at higher resolutions in the future as the technology develops. The proof of the quality of the data is that it can be output as a physical form and compared to the original surface. The data from the scanner can be viewed on screen and used for virtual operations but when required it can be re-materialized.

The graphic user interface has been developed with practicing conservators and specialists and is intuitive and easy to operate. The system can be powered by battery or mains electricity to facilitate recording in difficult locations where stable electricity supplies are not available. The batteries can be recharged using solar energy.

Lucida is a high-resolution 3D laser scanner, custom built by Factum Arte with the financial support of the Factum Foundation. Conceived and developed by the artist Manuel Franquelo, this system is the result of more than fourteen years of research in the field of recording the surface of paintings and low-relief objects.

Factum Arte and the Factum Foundation for Digital Technology in Conservation are committed to demonstrating the importance of recording the surface of works of art before and after conservation. Accurate 3D recording will facilitate meaningful monitoring of the condition of the surface and is essential in the compilation of layered archives of different types of data - effectively creating a digital passport for each work. For years it has been common practice to carry out various types of multi-spectral photography in tandem with X Ray, Infra-red and ultraviolet recording to see under the surface and to help identify preliminary drawing, overpainting, infills and previous restorations. The recording of the surface itself has been expensive and the results unsatisfactory - until now.

Factum Foundation has already used the Lucida scanner in the Museo del Prado (Madrid), the National Gallery (London), the Vatican Museums, the Courtauld Institute (London), The Royal Collection (Windsor and Hampton Court) and in other public and private collections. The intention is to make the recording of the surface a standard practice in conservation. The Lucida scanner will be installed both in museums with conservation departments and on site with locally trained operators. The aim is to make the hardware and software for the scanner open source and freely available - this will enable digital recording to be carried out where it is most needed, preserving key historical artefacts and fostering an understanding of the role that technology can play in conservation.

High-resolution 3D data used in conjunction with accepted technologies will transform the way that we monitor and protect our cultural heritage. The Lucida 3D Laser Scanner will not only enable institutions to obtain a permanent record of surface of paintings and low relief carvings at a specific moment in time but will also make it possible to accurately monitor the condition of works sent out on loan, in anticipation of any intervention or restoration and establish a protocol for measuring change and ultimately to make exact replicas – conservation facsimiles that are becoming accepted as an important part of sustainable cultural tourism.

Factum Foundation is committed to providing free software upgrades as and when needed and will be offering training courses to ensure a complete transfer of skills and technology. By finding ways to offer this crucial support it is the Foundation's hope that 3D scanners will become a standard in conservation laboratories around the world. All data collated using the Lucida scanner will remain the property of the custodian/owner of the work of art who will own all rights related to the data and any revenues that the data might generate - from current and future applications.

Recording dark and glossy surfaces
The standard board is a textured and coloured plaster panel (26 x 52 cm) fabricated by Factum Arte to test the performance of different 3D scanning systems. The panel is composed by a combination of various areas with different surface finishing that usually present problems for most commercial scanners.

Firstly, the panel is divided in three sections, each of them with a specific texture and background colour:
A. Low-relief, white matt
B. Cracked surface, white matt
C. Colored surface

Secondly, a few circles were added with different combinations of tone and glossiness:
1. Shine on white
2. Grey 70% matt
3. Grey 90% matt
4. Black matt
5. Glossy on colour
6. Glossy on black

This last combination (Glossy on black) is usually the type of finishing that generates bigger problems for conventional 3D scanners. The tests carried out with the Lucida scanner resulted in a uniform recording of the panel's surface, regardless its colour, glossiness or finishing. Lucida has also obtained high quality data out of gilded surfaces and metal.

Above: colour image of the standard board photographed with raking light to highlight its relief.
Below: 3D rendered data generated with Lucida.

Rubens

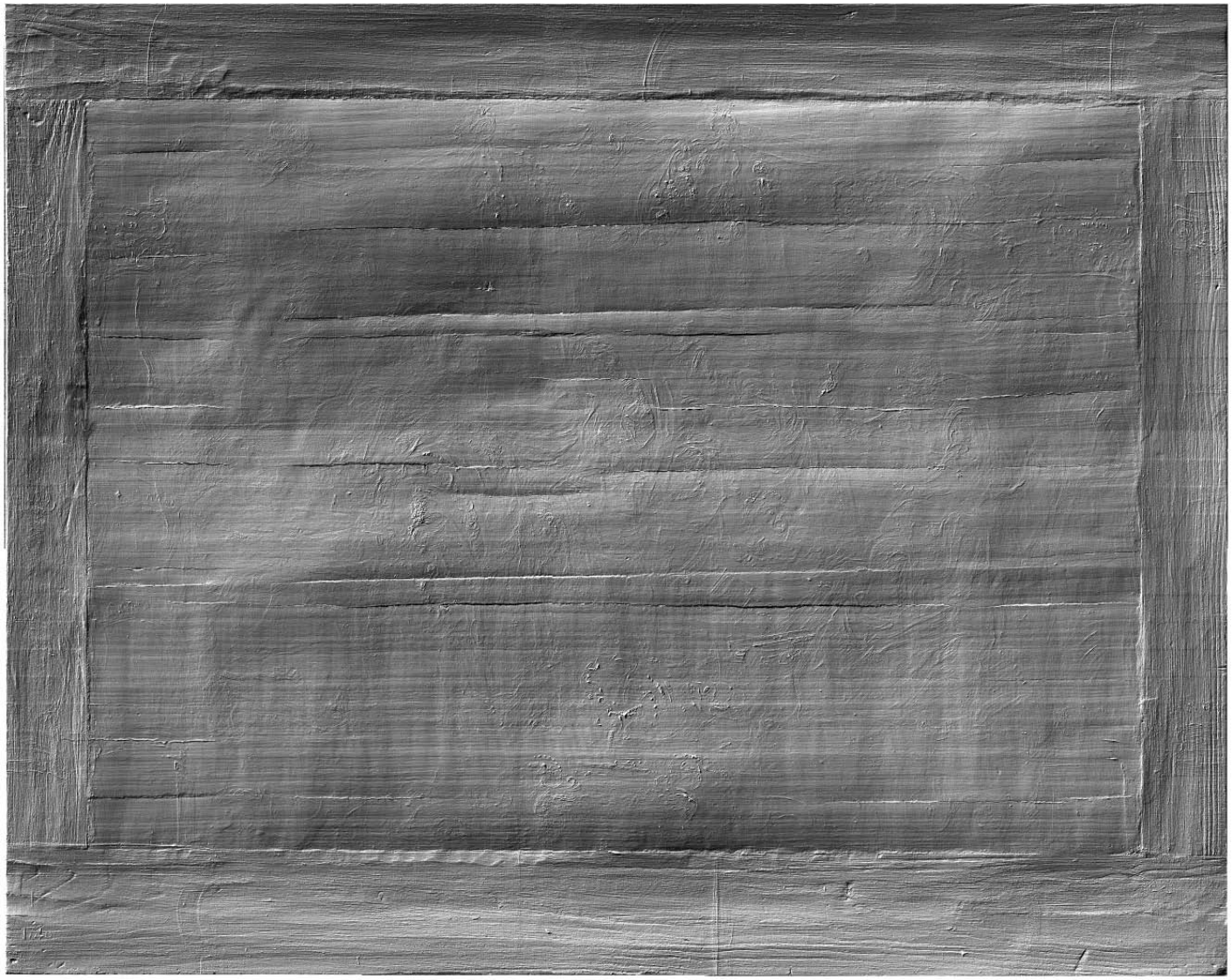
How do you 3D scan a black glossy surface? How do you scan a black glossy surface that is next to a white glossy surface, or a tooled gold surface? Paintings have specific qualities that require focused solutions... Lucida is the 3D scanner specifically created for recording the surface of paintings and low-relief objects.

The Triumph of the Eucharist over Idolatry
The first prototype of the Lucida was used in the Museo del Prado in Madrid to digitise the surface of a painting that was about to undergo a major restoration. This panel (65 x 91 cm) is one of a series painted by Rubens as preparatory sketches for the tapestry cycle The Triumph of the Eucharist. Lucida was used to record the relief of the front of the panel at a resolution of 100 microns. The colour was recorded with a Clauss panoramic photography system.
The 3D information that was obtained is now of great value as the shape, size and texture of the painting changed significantly during the restoration process. It is unusual that size changes dramatically but in this case a previous addition of several centimetres on each side of the painting was removed. The restoration was intended to stabilize the paint and wooden panel before it was exhibited in front of the tapestry that was based on the design. The recording was done in conjunction with the curatorial and conservation teams at the Museo del Prado. The data will now become an important part of the history of the painting and was supplied to the museum both as a digital archive and as a physically routed plaster panel. In line with Factum Foundation's commitment to conservation the copyright on this data and on all future applications of the data belongs to the owner of the artwork.

Rubens, *The Triumph of the Eucharist over Idolatry,* c. 1625, 65 x 91 cm, Museo del Prado, Madrid.

Rubens

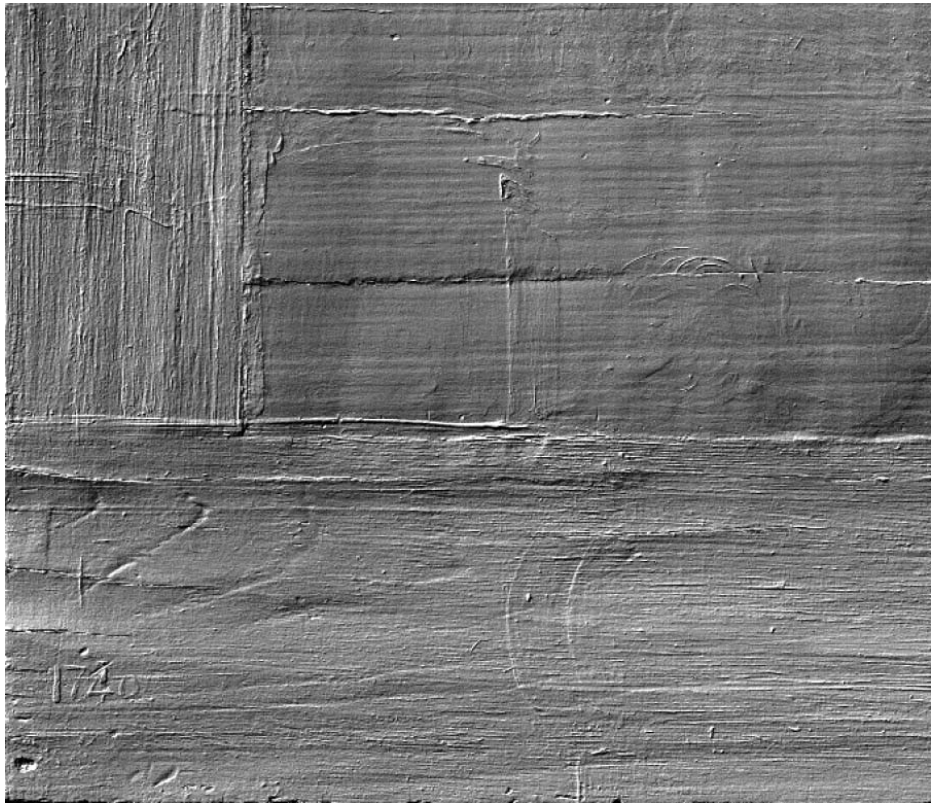
For the 3D recording technology to be meaningful for cultural applications it is essential that the correspondence between the surface and the recording of that surface is as close as possible. Lucida has overcome the problem of contrast and reflection through innovative algorithms designed to reduce noise without altering the characteristics of the texture.



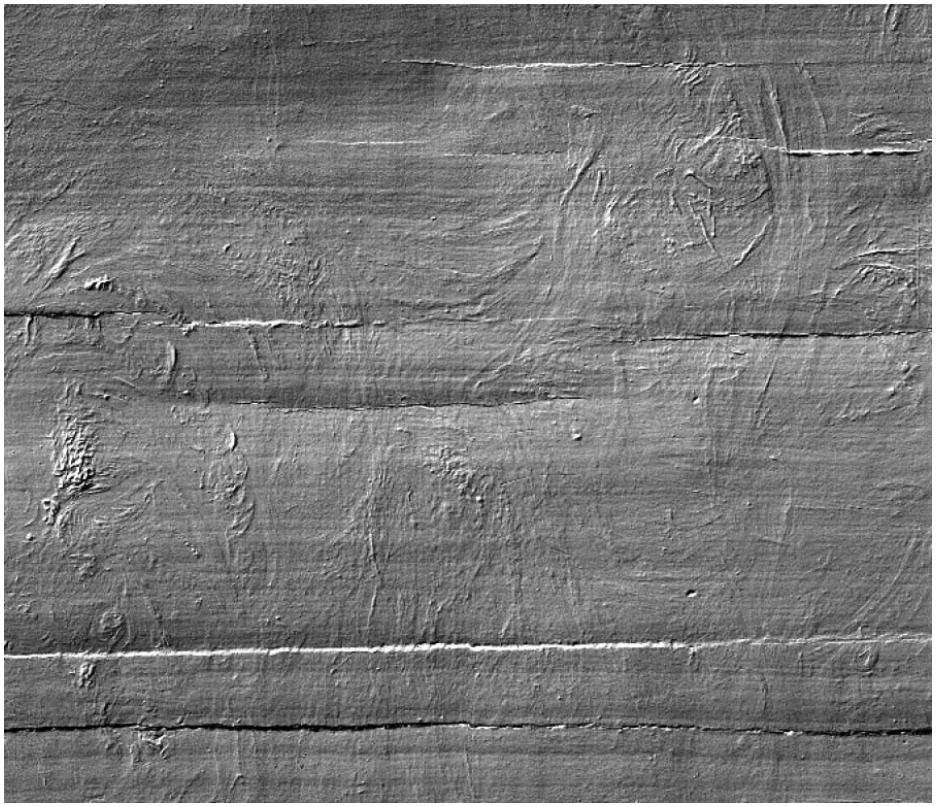
The Triumph of the Eucharist over Idolatry, 3D render.

Rubens

Instead of processing the captured data as it is being recorded, Lucida stores the data as raw tonal video. It will be possible to re-process this 'condensed' data in the future at a higher-resolution and with improved software. This is a unique feature that reflects a deep understanding of the needs of the art conservation community.



The Triumph of the Eucharist over Idolatry, 3D render, detail of the panel's perimeter.



The Triumph of the Eucharist over Idolatry, 3D render, detail of the cracks and paintbrush relief.

Rubens

The 3D information of this painting obtained by Lucida is the only accurate record that exists of the shape and texture of the board before its latest restoration, after which the size and curve of the material have changed significantly. This is why it is essential to record the surface of paintings before and after every restoration process.

The relief data of the painting recorded with Lucida was CNC routed in high resolution, and then reproduced in plaster.

The plaster cast reproduction was included in the exhibition *Rubens: the Triumph of Eucharist* in the Museo del Prado (Madrid) in 2014.

Mappa Mundi

Hereford Mappa Mundi
In early 2013 a team from Factum Arte made a high resolution recording at the request of Hereford Cathedral and the Trustees of the Mappa Mundi. The glass cover is only removed once every two years for inspection. The team used the Lucida 3D scanner mounted onto a custom designed structure to provide absolute safety to the map and a firm platform for the highly accurate no-contact surface scanning process. Each frame is then post-processed creating the high resolution three dimensional record. The three dimensional "map" of the surface of the Mappa Mundi will provides scholars, curators and the public with a safe and previously impossible method of studying this extraordinary object made in about 1300.

From the 3D recording and other methods of forensic study new things are being discovered about the map including the compass point at the centre of Jerusalem and in the centre of the Labyrinth on Crete. With further research it may even be possible to prove that the map was made in Hereford and not Lincoln after all.
Visitors to Hereford the Cathedral, including the blind and partially sighted, will now have an opportunity to explore and experience the map as never before. In addition a new website that features an interactive exploration area for the cathedral's famous Mappa Mundi has just been launched, providing access to the Folio Society digitally enhanced version of the Map and the Factum Arte three dimensional surface scanned.

Lucida 3D scanner recording the Mappa Mundi.

High resolution digital documentation of our shared cultural heritage is an essential part of its conservation. Along with the duty of preserving and disseminating the artworks, we also have the responsibility of digitising, in the most faithful way, their physical characteristics for future generations. Lucida has been designed to help make this possible.

The Hereford Mappa Mundi (c. 1300, 159 x 134 cm) is one of the world's unique medieval treasures.

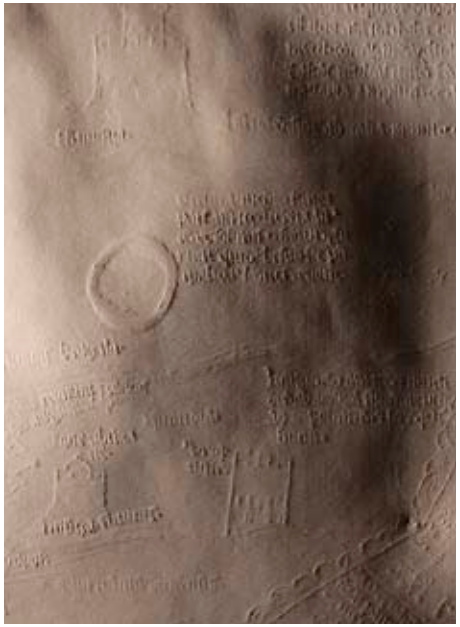
Mappa Mundi

The Mappa Mundi was recorded in 2013 at the Hereford Cathedral. The backboard was then scanned in 2016 with the aim of establishing a comparison between both sets of 3D data.

Lucida is not just concerned with shape, but with both shape and relief, and the complexity of the surface texture. This intimate understanding of surface is leading to new insights about how an artwork has changed, how it has been looked after, how it has been valued and what has been done to it...

3D render of the Hereford Mappa Mundi's surface data.

Mappa Mundi



Mappa Mundi

The goal is the acquisition of a reliable, high-resolution and dimensionally accurate map of the texture that can be studied on screen or re-materialized in the physical domain. If data can be re-materialized with the exact characteristics of the original it is clear evidence of the quality of the data.

Installation of the Mappa Mundi's reproduction in the Hereford Cathedral.

The plaster cast reproduction of the surface turned the Mappa Mundi into a tactile object: the mapping of a map.

Previous pages: Top left: detail of the 3D render generated by Lucida; Top right: CNC routing the surface in high resolution; Bottom left: details of the routed texture in resin; Bottom right: plaster cast of the surface.

Polittico Griffoni

Polittico Griffoni. Digital technology applied to the re-unification of a scattered altarpiece
The restoration of the chapel of Saint Vincent in the Basilica di San Petronio (Bologna) has provided a chance to re-consider an altarpiece originally painted for the chapel, the Polittico Griffoni, one of the most important masterpieces of the Renaissance, painted between 1471 and 1472 by Francesco del Cossa and Ercole de'Roberti. The work was commissioned by the original patrons of the chapel, the Griffoni family, but it was removed, dismembered and sold when the chapel was transmitted to the Aldrovandi family in 1725. Nowadays the surviving 16 panels are conserved in nine museums in different parts of the world.

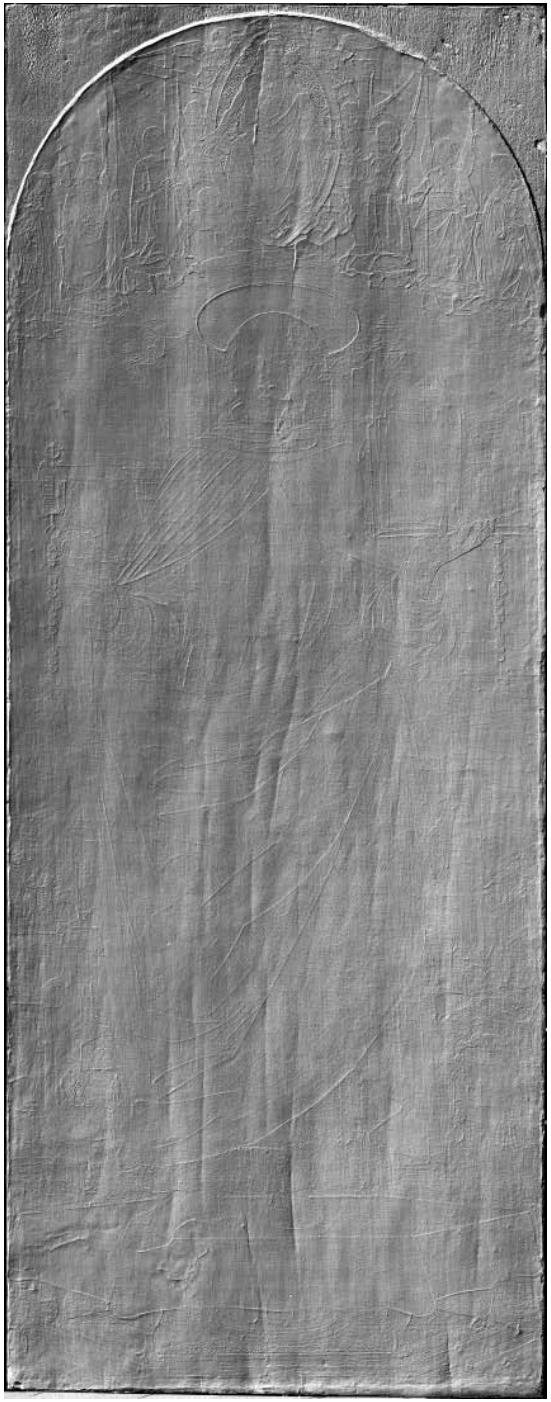
Over the past three years the surface of the panels of the Polittico Griffoni have been recorded in three dimensions, thanks to Lucida. In addition to the 3D scanning the paintings were also photographically recorded at high resolution. For the high-resolution colour recording Factum Arte uses a planar system to record the small panels and a panoramic photographic system record the larger panels. Large numbers of photographs are taken and stitched together using PTGui software. Recent developments in both hardware and software are opening up new possibilities for macro photographic recording that allows the paintings to be studied with forensic accuracy. The resulting archives are evidence that the application of technology can ensure that cultural artifacts can be documented, studied and transmitted in a faithful way.

Above: Polittico Griffoni, one of the suggested reconstructions indicating the relative position of the panels. Next page: Francesco del Cossa, *Saint Vincent Ferrer,* c. 1473, 153 x 60 cm, The National Gallery, London.

Polittico Griffoni

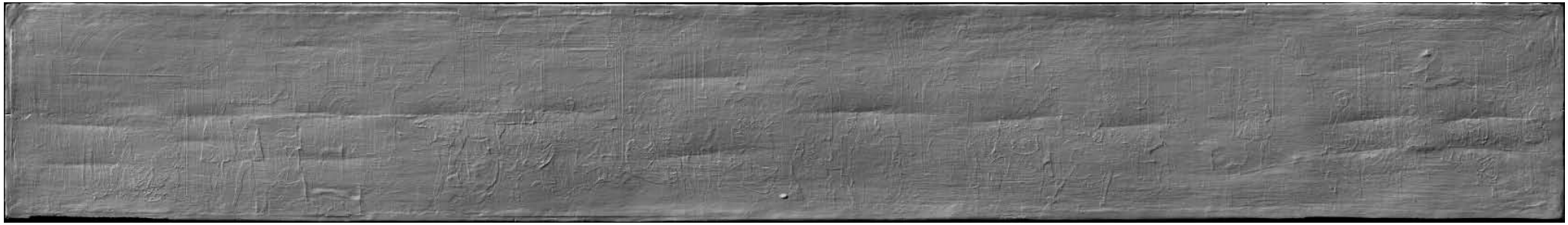
Comparison between 3D render and colour, detail of a gilded area with pouncing marks around the angels' heads.

Next page: 3D render generated by Lucida.

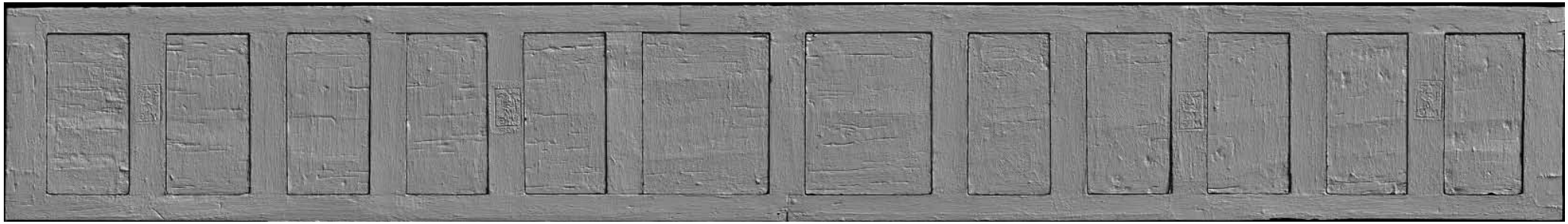


Polittico Griffoni

Ercole de'Roberti, *Stories of Saint Vincent Ferrer*, c. 1473.

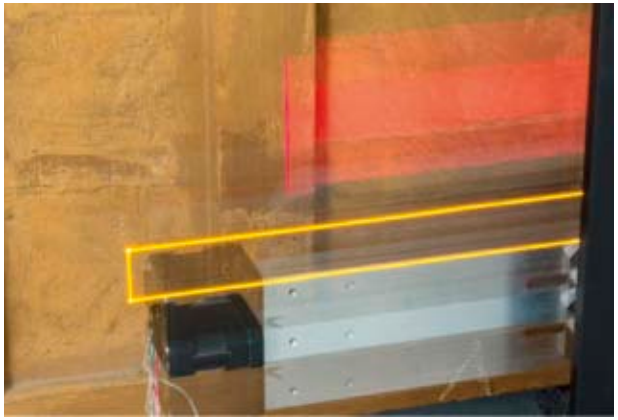


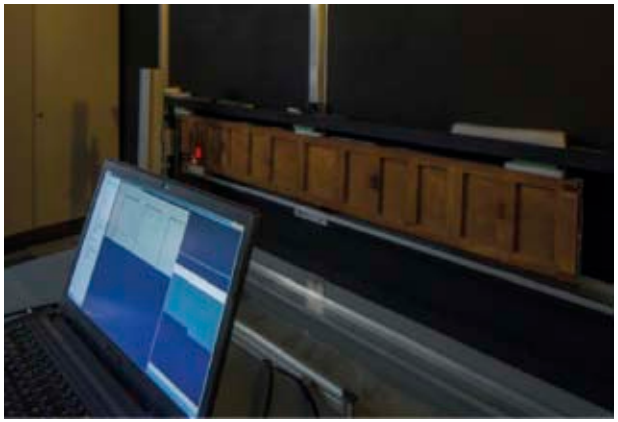
3D render of the panel generated by Lucida.



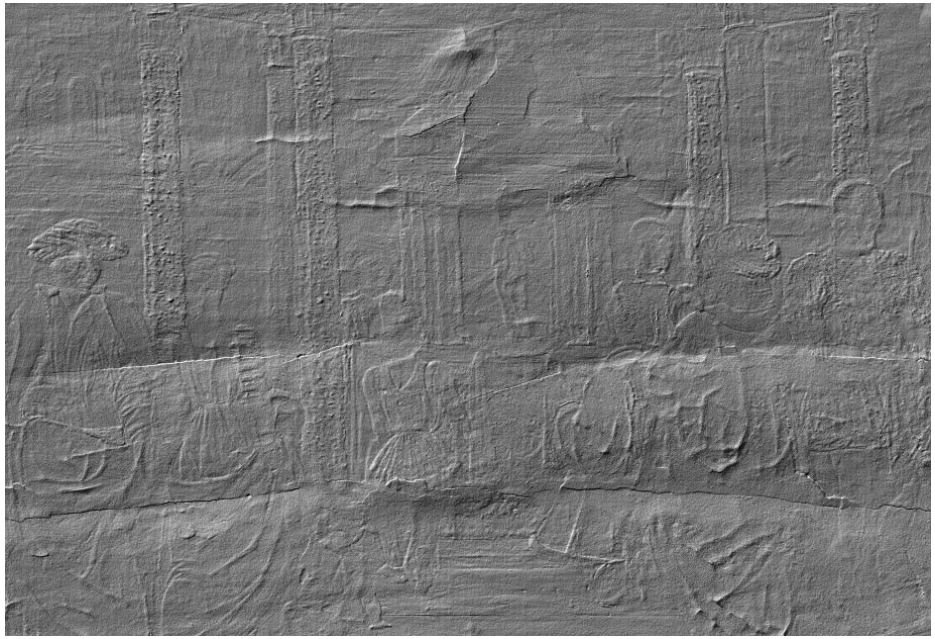
3D render of the panel's back. The modulation corresponds to the pattern of horizontal cracks visible in the front side.

Polittico Griffoni





The front and back of the *predella* were recorded in the Pinacoteca Vaticana in October 2013.



Comparison between 3D and color, detail of the cracks visible in the 3D render of the panel.

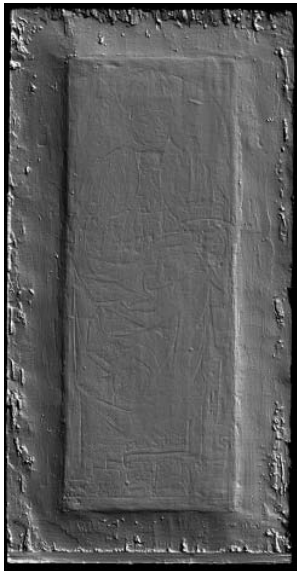
Polittico Griffoni

The 16 panels that once formed the Polittico Griffoni were removed from their original location in the Basilica of San Petronio in Bologna and are now scattered in different museums around the world. A physical reconstruction will be made that will be symbolically 'returned' to Bologna and housed in the 'Griffoni' chapel.

3D data of the *Saint George*'s panel CNC routed into high density resin board, front and back.

Previous page: Top: Ercole de'Roberti, *Saint George*, c. 1472, 26.3 x 9.3 cm, Fondazione Giorgio Cini, Venice, front and back; Bottom: 3D renders generated by Lucida, front and back.

Polittico Griffoni



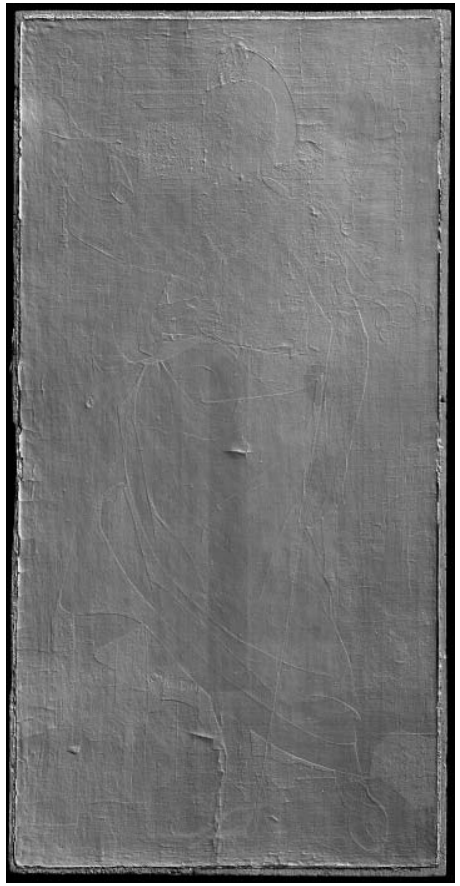
Top: Ercole de'Roberti, *Saint Petronius*, c. 1472, 26.3 x 9.3 cm, Pinacoteca Nazionale, Ferrara, colour and 3D render.
Bottom: Lucida scanning *Saint Anthony the Abbot* at the Museum Boijmans van Beuningen, Rotterdam.

Top: 3D data of Francesco del Cossa, *Annunciation Angel,* c. 1472, diam. 25 cm, routed into gesso coated material.
Bottom: Lucida scanning *Annunciation Angel* and *Annunciation Virgin* at the Museo di Villa Cagnola, Gazzada, Italy.

Polittico Griffoni

The panels in Brera are undergoing restoration to consolidate the paint surface and address the curved nature of the poplar. After the restoration process, the panels will be recorded again, to monitor the changes and establish a comparison that will be of great value for historians, researchers and conservators in the future.

Francesco del Cossa, *Saint John the Baptist*, c. 1472, 112 x 55 cm, Pinacoteca di Brera, Milan.



3D render generated by Lucida.

Francesco del Cossa, *Saint Peter*, c. 1472, 112 x 55 cm, Pinacoteca di Brera, Milan.

3D render of *Saint Peter* obtained by Lucida.

Bellini

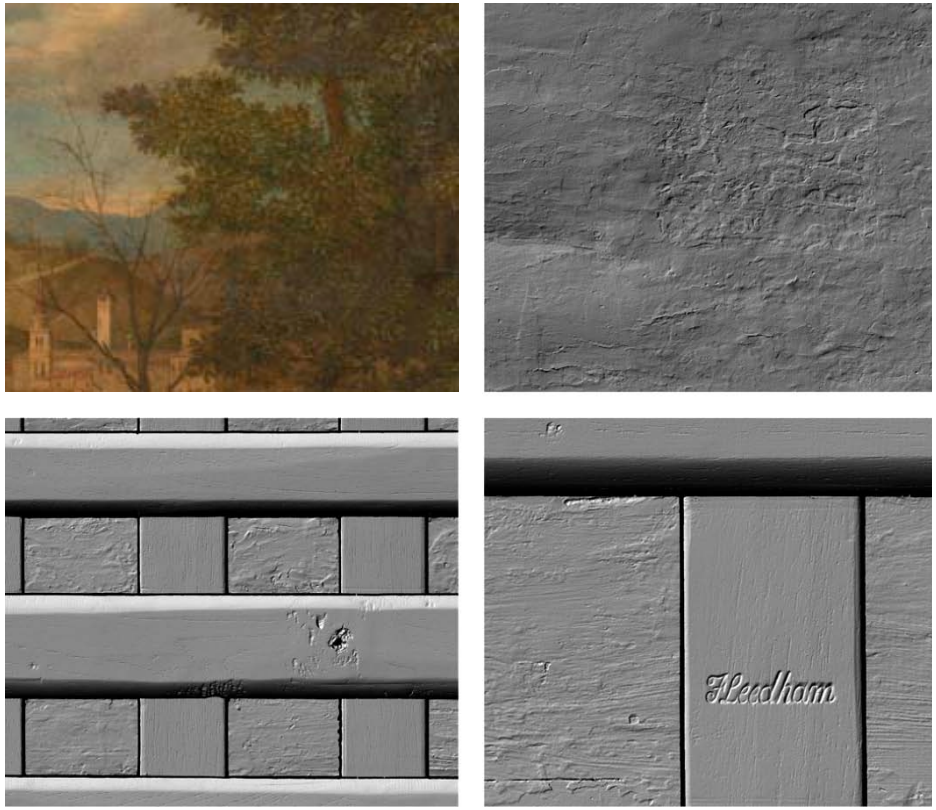
Lucida is now being used at the National Gallery's Scientific Department to record the surface of a work by Bellini as part of its conservation. By scanning the front and back of the painting before, during and after the restoration process, it is possible to keep accurate records of its treatment for current and future applications.

The Assassination of Saint Peter Martyr, 3D render generated by Lucida.

Bellini

The Assassination of Saint Peter Martyr
Following the successful recording of Francesco del Cossa's *Saint Vincent Ferrer* in 2013, the Lucida 3D scanner was back into the National Gallery of London to take part in another major research and conservation project. The Assassination of Saint Peter Martyr (c.1507) by Giovanni Bellini, is the first work to be 3D scanned in high resolution before, during and after a complex restoration process. The first session, consisting on the 3D recording of the front and back of the panel before the restoration, was carried out in late September 2014.
The Factum Foundation and The National Gallery are pioneering the way towards a more comprehensive approach to painting conservation, in which a 3D recording of the state of an artwork is an essential part of its preservation. The data recorded of this important painting with the Lucida 3D scanner, which remains the property of the Gallery, will be enormously helpful not only for researchers and conservators working with this painting now but also as a record for the general public and future generations to come.

Lucida can be especially useful to monitor the changes in the material support of a painting produced by the consolidation treatment of the board. The capacity to capture not only the general shape of the board but also the texture, makes it the ideal tool to understand the small changes on the relief that are part of every restoration process.



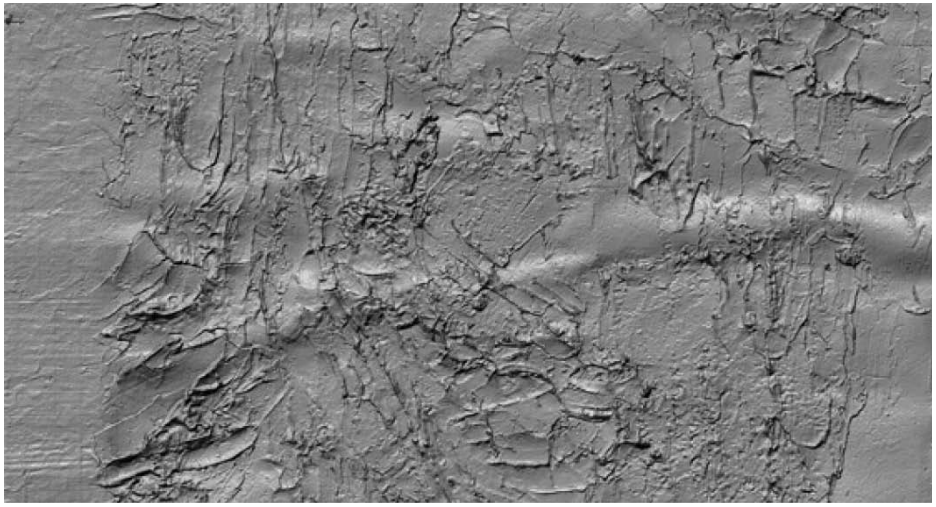
Top: comparison between colour and 3D data, detail.
Bottom: 3D render of the back, details.

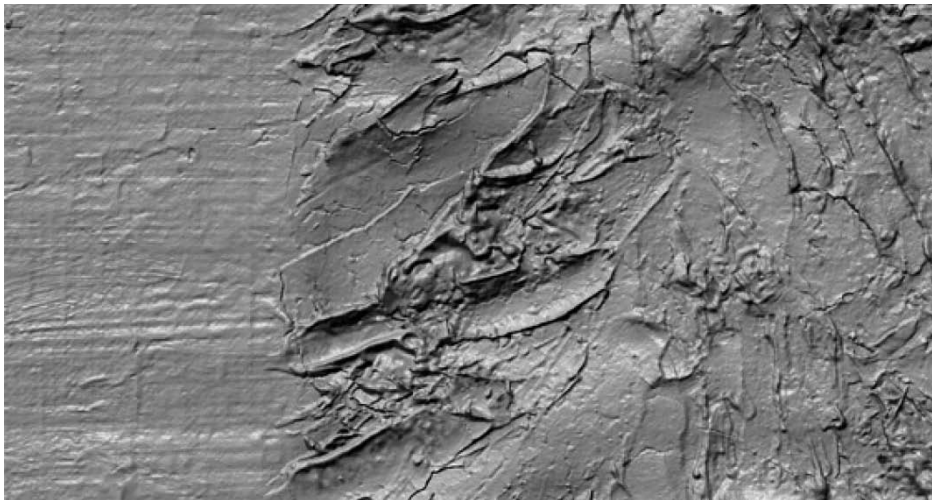
Kirchner

Scanning test, The Courtauld Institute of Art
A series of tests involving the 3D scanning of paintings are being carried out at The Courtauld Institute of Art in London, in order to evaluate the potential of the Lucida scanner to monitor the condition of works of art. This research project, conducted in collaboration with Dr. Christina Young, involves the 3D scanning of five paintings as examples of different techniques and supports. The first painting, a work by German expressionist painter E. L. Kirchner (72 x 92.3 cm, thick oil paint on paper) was recorded in July 2014 to understand its texture the overall deformation of the support.
One of the most interesting tests within this research project will be the systematic high resolution recording of the surface of a large poplar panel under varying degrees of relative humidity. The 3D data obtained with Lucida will enable researchers to measure and monitor the deformation of the support to an accuracy of 100 microns.

E. L. Kirchner, 72 x 92.3 cm, 3D render by Lucida.

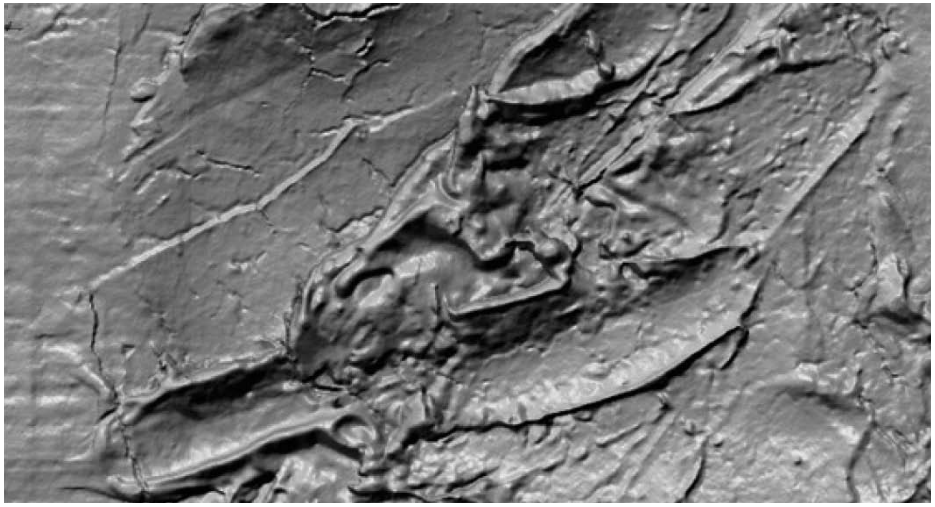
Kirchner





E. L. Kirchner, render of the 3D data in STL format, details.

Lucida allows the 3D data to be viewed as a rendered image so that it can be compared with other layers of 2D information. This permits the user to process the data with image processing software rather than specialized 3D software, which tends to be expensive and requires regular updates. The data can also be exported to different 3D formats such as STL or OBJ.

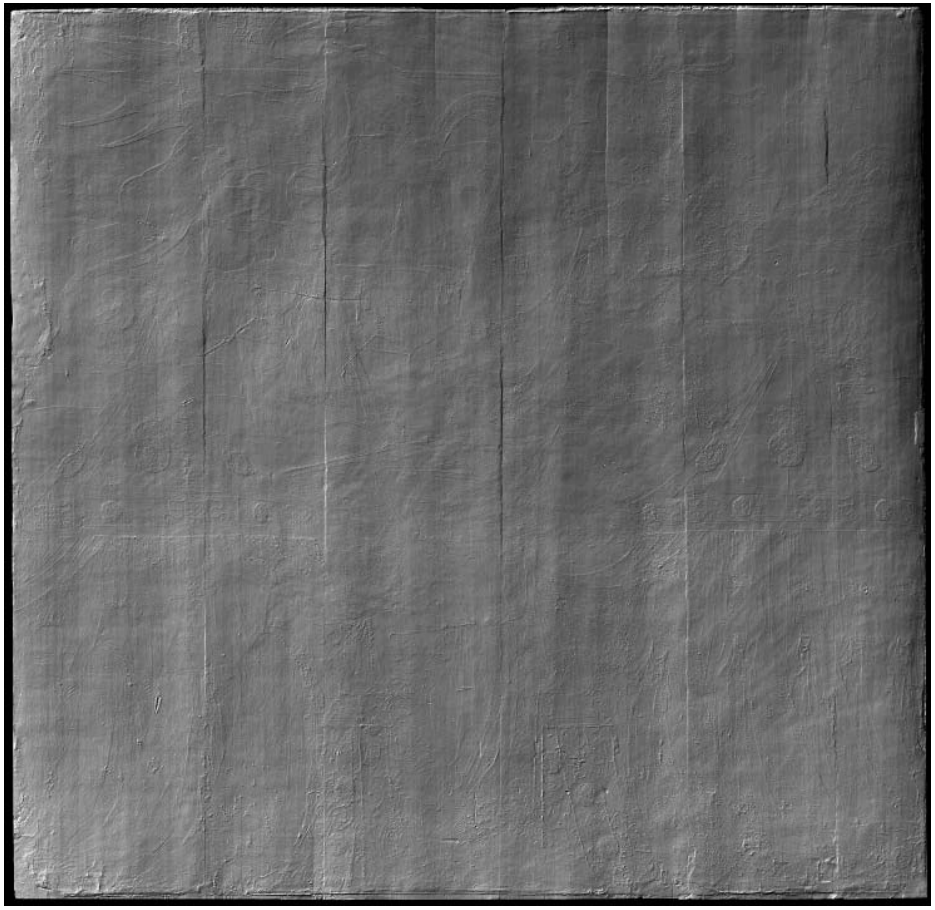


E. L. Kirchner, render of the 3D data in STL format, details.

Royal Collection

A facsimile is an exact replica of a work of art done with the goal of helping the preservation of the original or adding value to it in some way. For the facsimile of a painting (on canvas, board, etc.) to be meaningful the relation between colour and relief should be as complex and rich as in the original.

The Family of Henry VII with Saint George and the Dragon is a work of the Flemish School, of the 16th century which is part of the Royal Collection Trust.

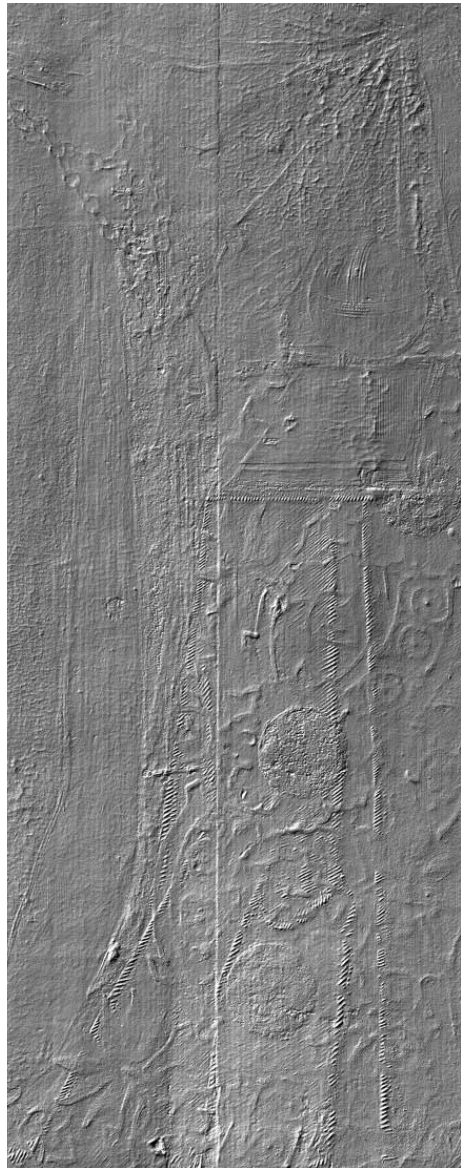


The painting was recorded at Hampton Court Palace in order to make a facsimile for Strawberry Hill House.

Next pages: Comparison between the colour data obtained with panoramic photography and the relief data obtained with the Lucida 3D scanner, two details.

Royal Collection

This painting originally adorned the staircase of Strawberry Hill House before becoming part of the Royal Collection. Factum Arte produced an exact facsimile of the work which has been returned to its original location in 2015. Relief data obtained with the Lucida 3D scanner has been combined with colour photography to create the facsimile.

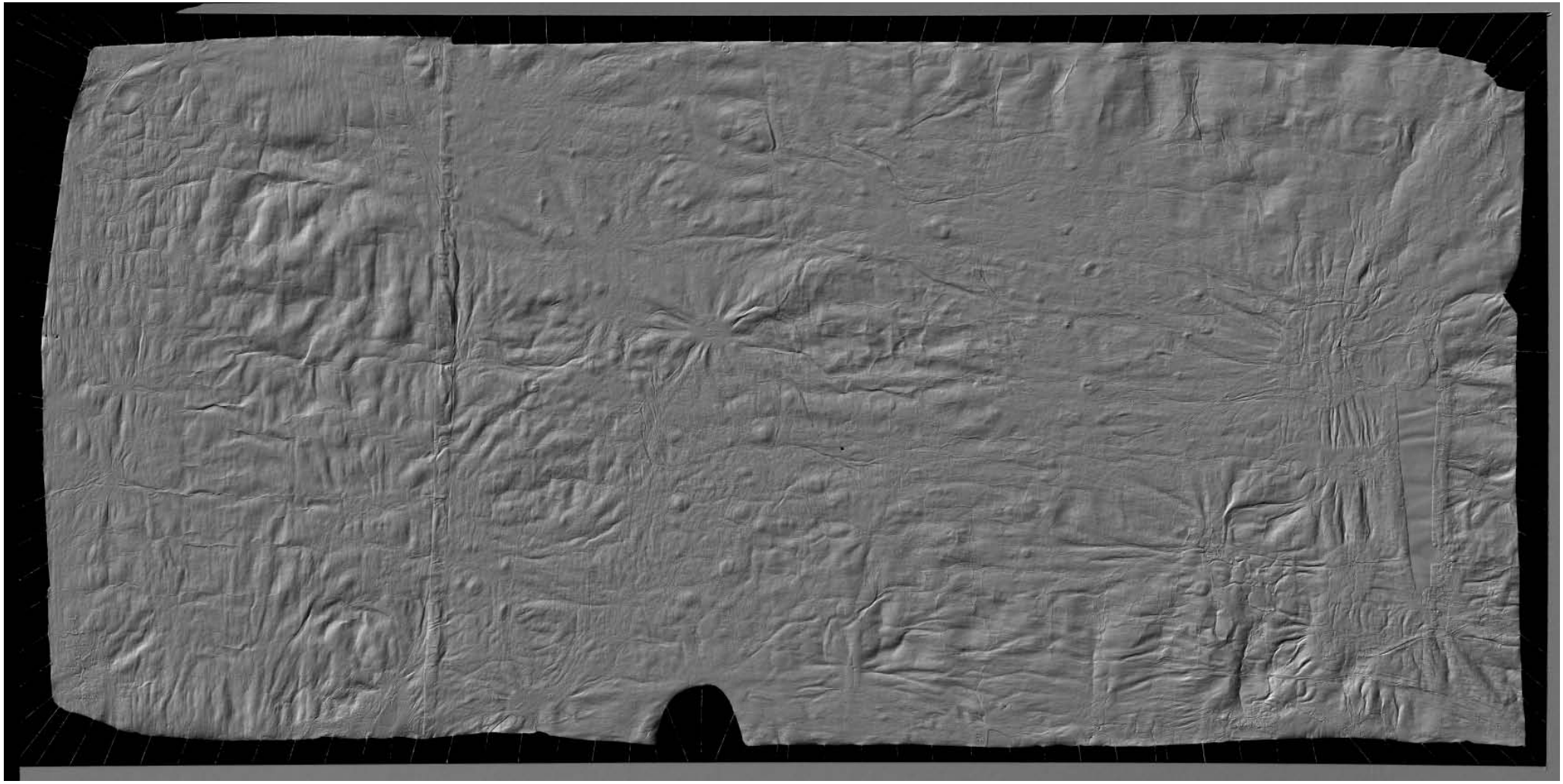


Gough Map

The Gough Map, at the Bodleian Library in Oxford, is renowned internationally as one of the earliest maps to show Britain in a geographically recognizable form. But still questions remain of how the map was made, who made it, when and why... The surface of the map has been 3D scanned for the first time to help unveiling some of these questions.

The Gough Map of Great Britain, original 56 x 115 cm, Bodleian Library, Oxford, combination of 3D render and colour of the front.

Gough Map



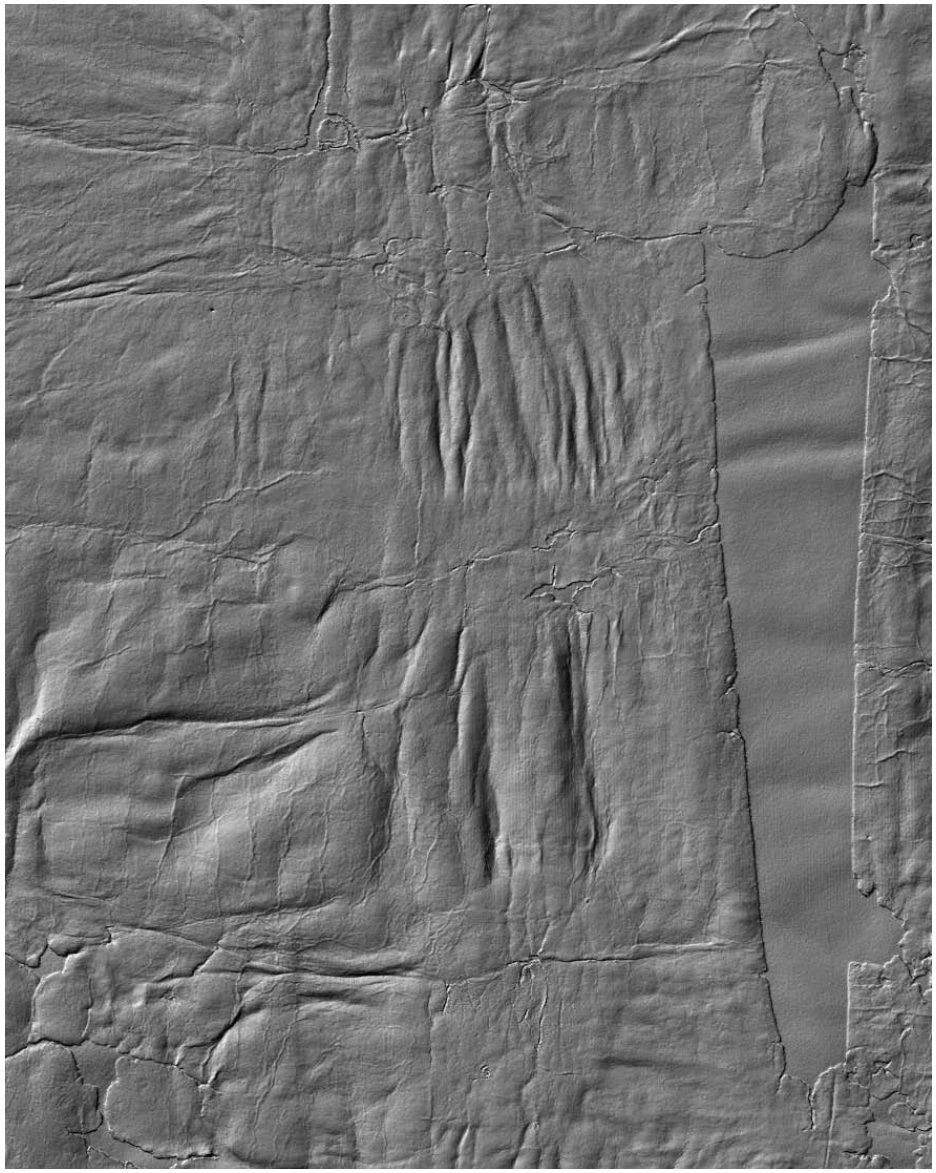
The Gough Map of Great Britain, 3D render of the front by Lucida.

Gough Map

Gough Map of Great Britain
Factum Arte is currently involved in a new initiative involving the Bodleian Library in Oxford and Queen Mary University to scan this precious map. The Gough map is a mid-fourteenth century map of the British Isles, regarded as the oldest route map of the country. Its dating, authorship and function are unknown and the scanning process hopes to shed light on these and many other aspects of its creation.
Factum Arte is committed to demonstrating the importance of digital technology in the analysis and documentation of our cultural heritage. Non-contact, high-resolution 3D scanning will provide valuable data of the subtle relief of the map, which can then be combined with other layers of information such as colour in order to monitor its condition and understand its biography.
Selden Map of China
The Factum Foundation is also examining the Selden Map of China (p. 56-57), another one of the Library's most important but enigmatic maps. Only recently rediscovered, it is also anonymous and dated to the early seventeenth century. It is believed to have been made by a Chinese mapmaker as it shows Southeast Asia and its maritime sea routes.
Factum Arte and the Factum Foundation, working with the Bodleian's Map and Conservation departments as well as in collaboration with other companies, hopes that it may unearth the secrets of two of the history of cartography's most prized maps. Comparing 3D data from Lucida with multispectral recording Damien Bove said: "(...) I'm finally getting around to adding my own marks to yours - to identify both the pinholes and the other features that have left a 3D trace. (...) From all this you can see that your scan has done pretty well - showing a few things we couldn't see before and supporting a few of our assumptions."

Detail of the surface of the Gough Map, recorded with Lucida 3D scanner in January 2015 after restoration.

"(...) I'm finally getting around to adding my own marks to yours - to identify both the pinholes and the other features that have left a 3D trace. (...) From all this you can see that your scan has done pretty well - showing a few things we couldn't see before and supporting a few of our assumptions." Damien Bove, visual artist and researcher.



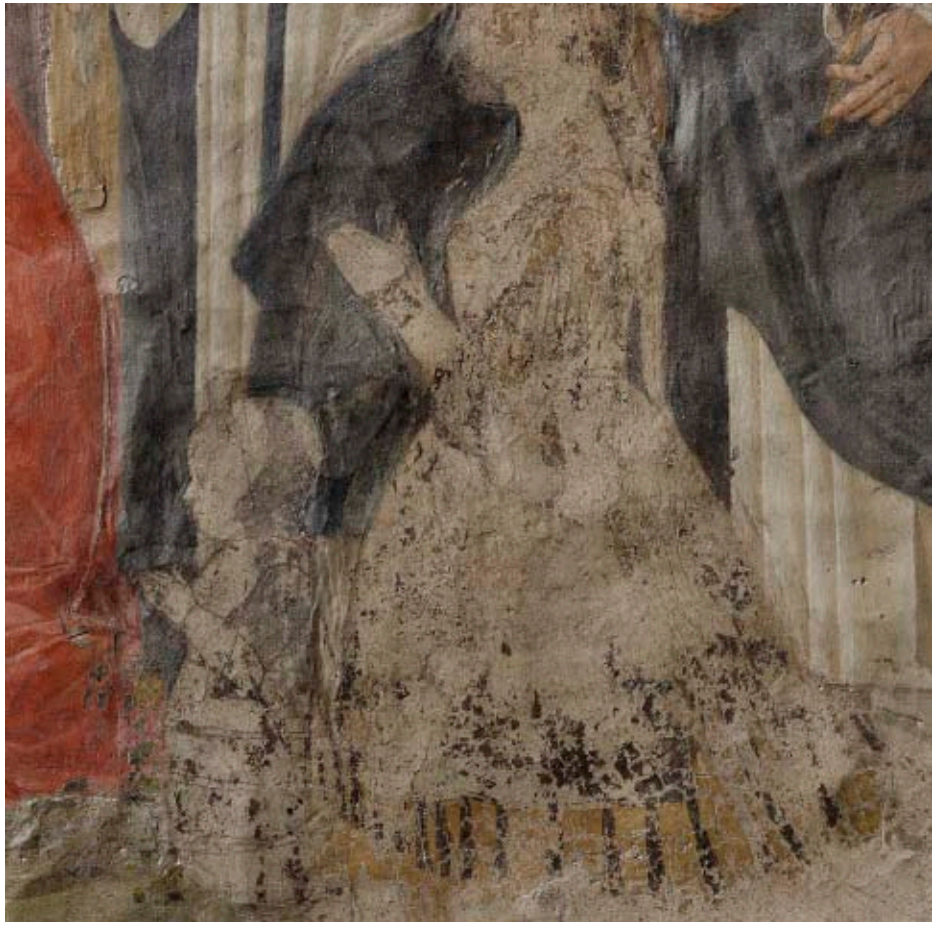
Selden Map

Comparison between colour and 3D data, detail.

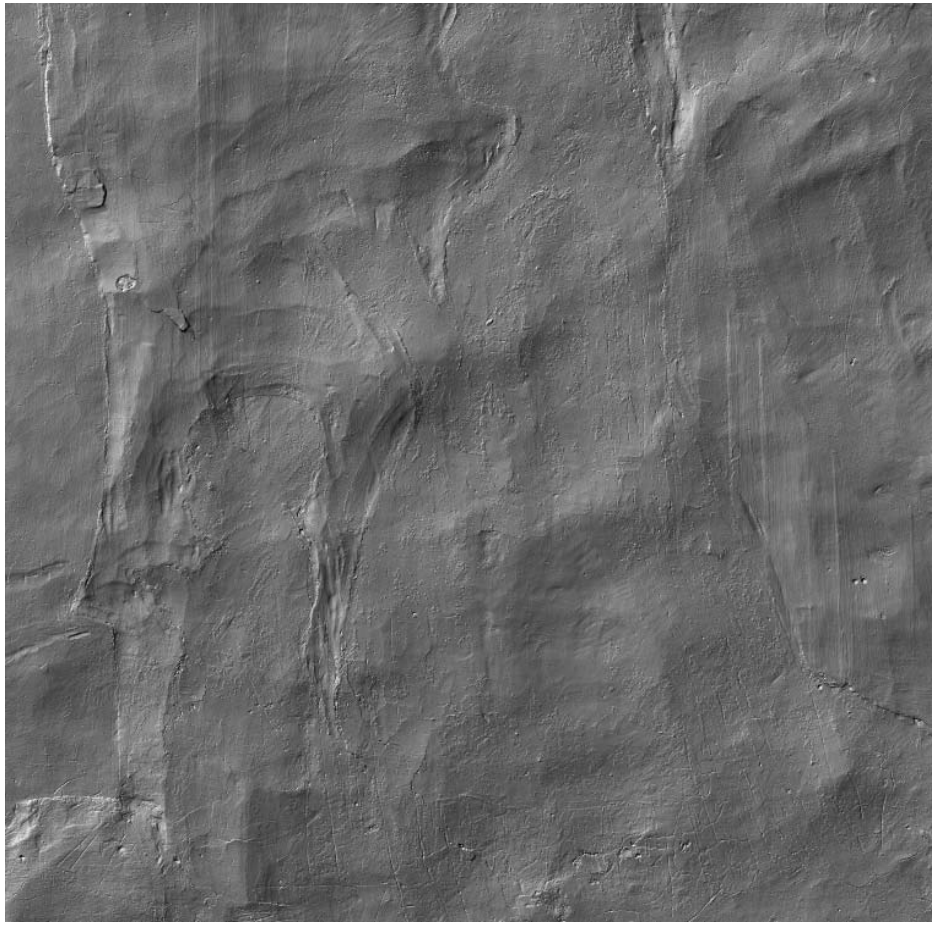
Next page: the Selden Map of China, recorded with the Lucida 3D scanner in January 2015 after restoration.

Crocifissione

A section of 1 sqm of Montorfano's *Crocifissione* was recorded as a demonstration of the possibilities of the Lucida 3D Scanner. The high resolution 3D data that was obtained, in combination with the colour data captured with photography, have made possible the creation of a multilayer archive to inspect and understand the complex relation between colour and relief.



Dontato Montorfano, *Crocifissione*, 1495, Santa Maria delle Grazie, Milan, combination of 3D render and colour data, section of about 1 sqm, detail of Leonardo's addition to Montorfano's fresco.

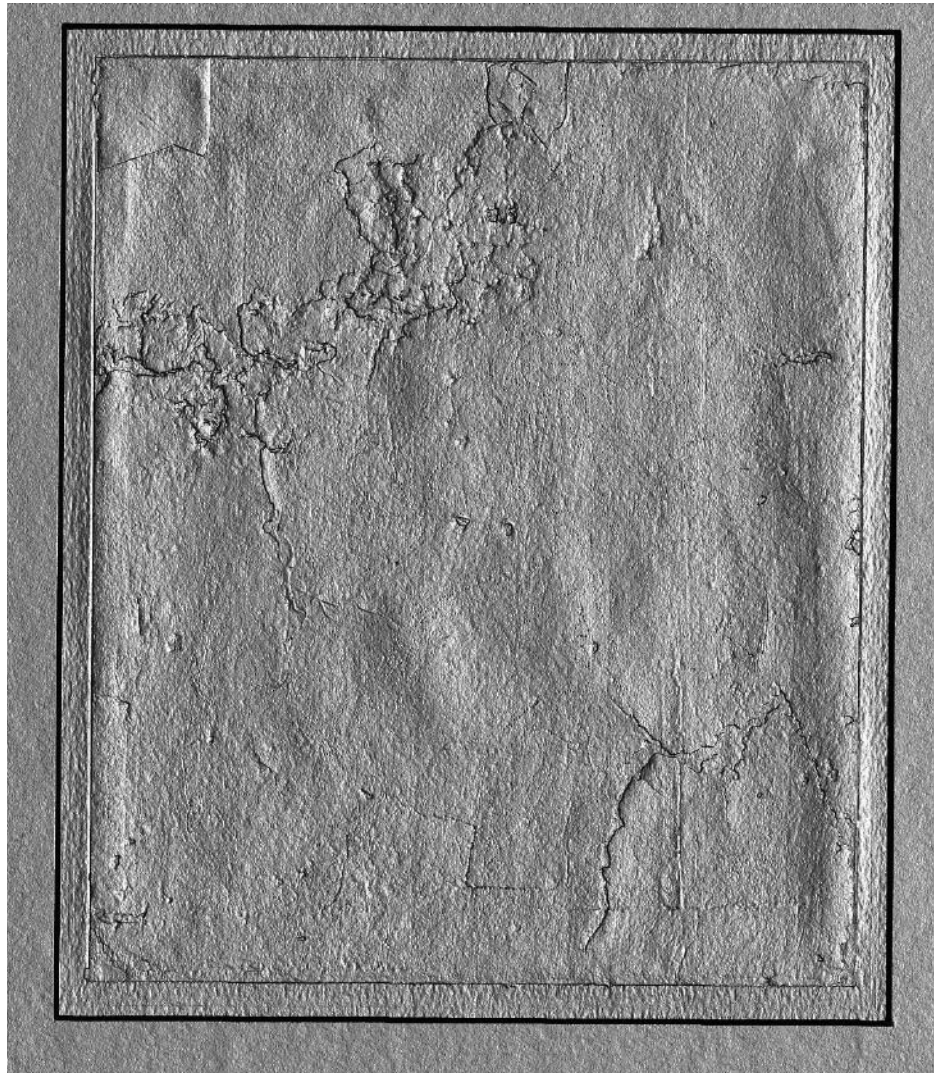


Crocifissione, 3D render generated by Lucida, section of 1 sqm.

Raphael

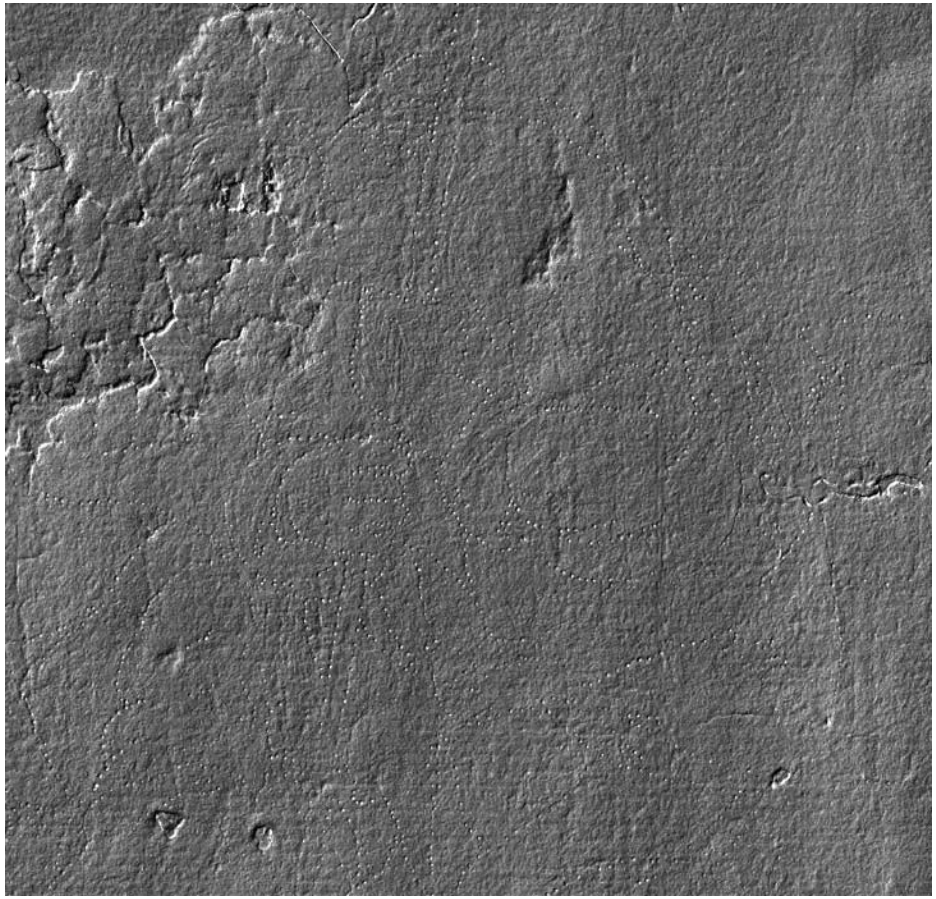
Raphael drawings, Ashmolean Museum
A series of eight original drawings by Raphael, including *The Holy family with Lamb*, 27.5 x 22.7 cm (pictured on the right) were recorded with the Lucida 3D scanner in 2015 at the Ashmolean Museum, University of Oxford. For the first time, high resolution texture data has been obtained out of a very flat surface, so it is possible to see very clearly the pouncing along the drawing lines and other marks in the relief. Different rendering modes have been used to highlight the subtle pouncing marks that are present in the drawing, following the contour lines of the main figures. The conservators in the Ashmolean Museum can check, correct and add more marks and layers of information to these data, especially in combination with other data such as colour, etc. using Factum Foundation's online multilayer browser. This is an ongoing research project that will involve the addition of new layers of information of these drawings, in order to increase the knowledge and disseminate the importance of such important works of art.

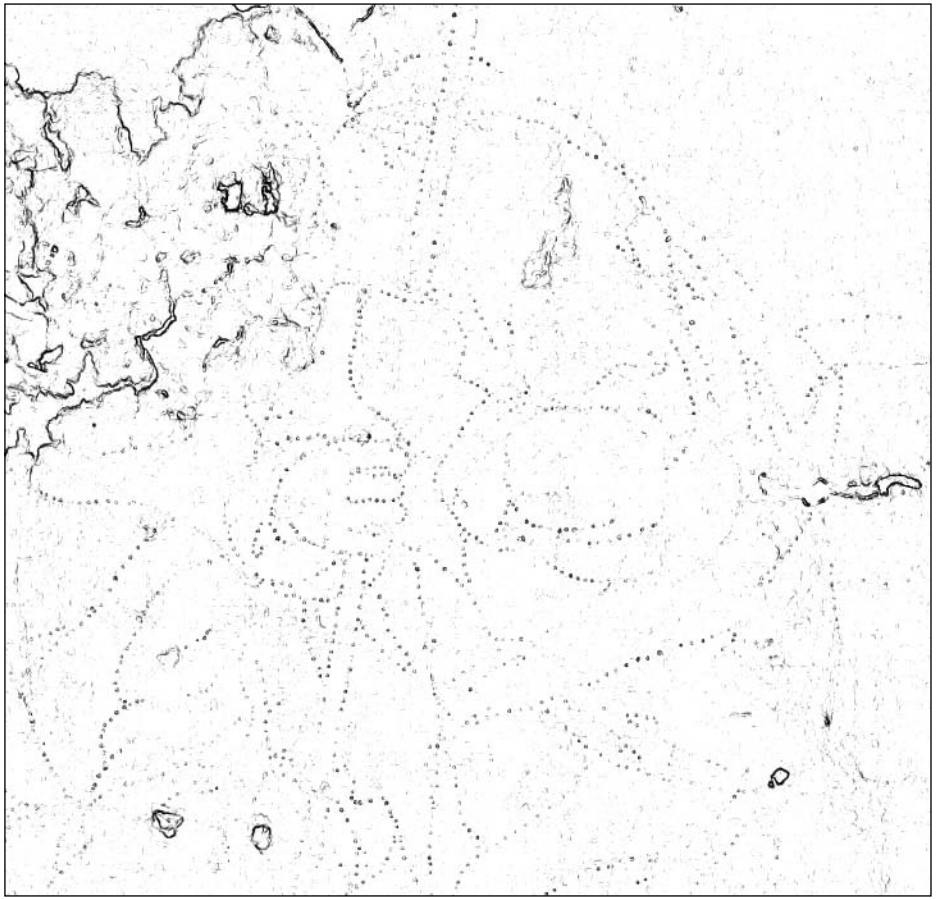
Raphael, *The Holy family with Lamb*, 27.5 x 22.7 cm, Ashmolean Museum, University of Oxford.



3D data of Raphael's *The Holy Family with Lamb*, obtained with Lucida. The 'Specular Enhancement Render' mode has been used in this image to increase the subtle relief of the drawing.

Raphael

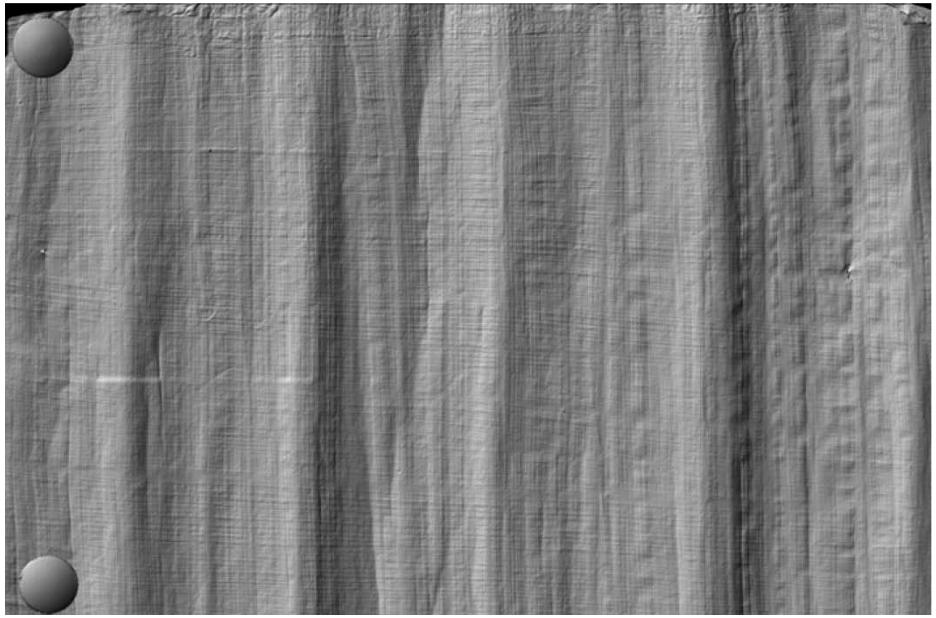




Previous page and above: 3D data of Raphael's *The Holy Family with Lamb*, obtained with Lucida. The pouncing marks that follow the contour lines of the drawing can be highlighted using different rendering modes.

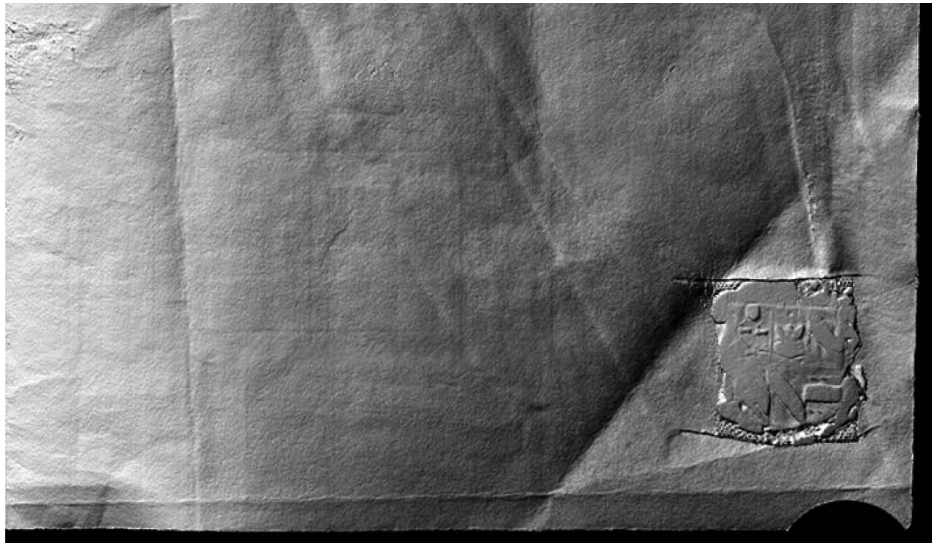
British Library

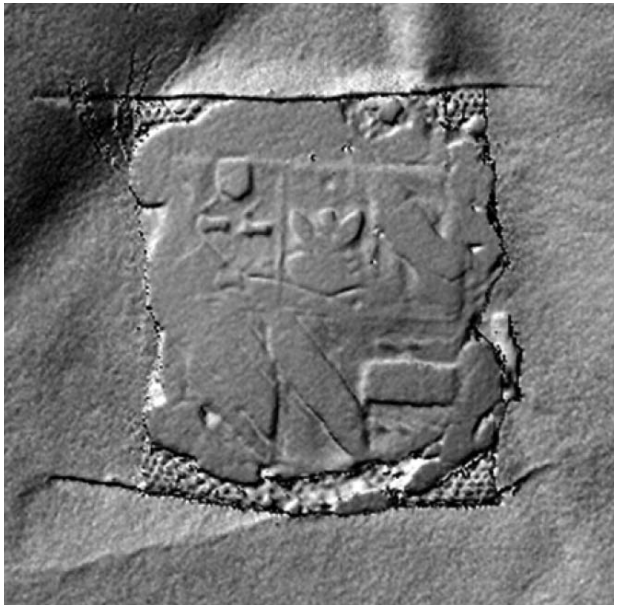
Lucida 3D scanner at the British Library
In June 2015, Imaging Services hosted a demonstration of the Lucida 3D scanner in order to assess it as a tool for deployment at the British Library. Various training samples were provided to be scanned for the demonstration. From the group on loan, 7 items were chosen to demonstrate the variety in the British Library's collections. Since the items needed to be mounted vertically for scanning, this limited the choice to primarily single folios. The items scanned were the following:
Item 1: a modern piece of papyrus
Item 2: a parchment document with a wax seal
Item 3: a piece of hand laid paper with a watermark
Item 4: a document with conservation repairs
Item 5: a black fimo seal
Item 6: a metal seal
Item 7: a large parchment document

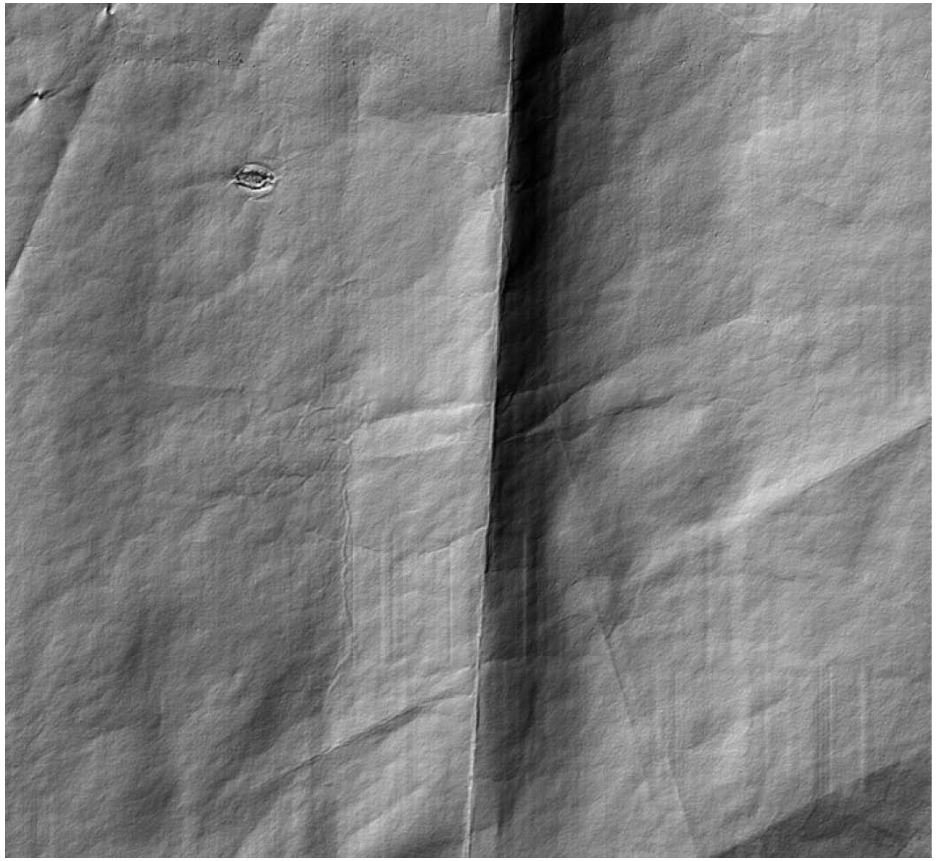


Item 1: a modern piece of papyrus.
Top: 3D render, detail; Bottom: reference photo.

British Library

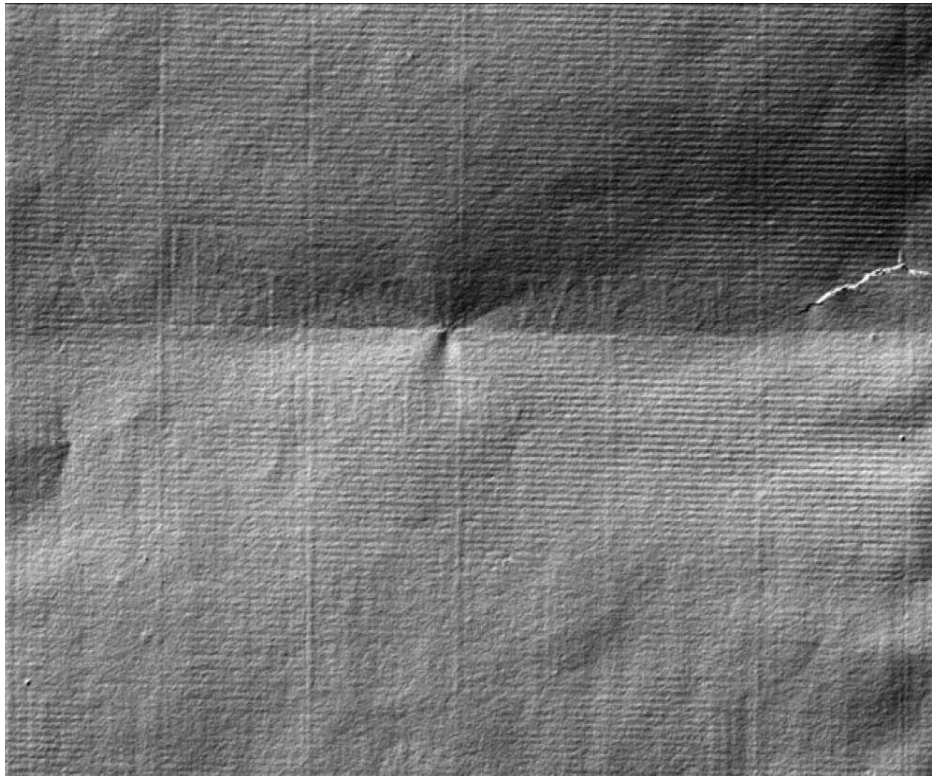




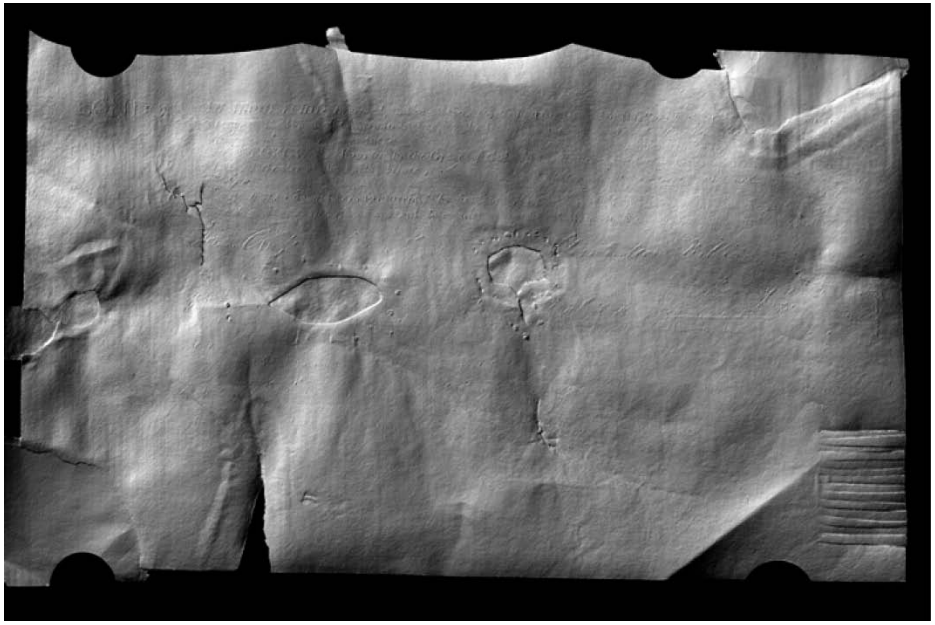


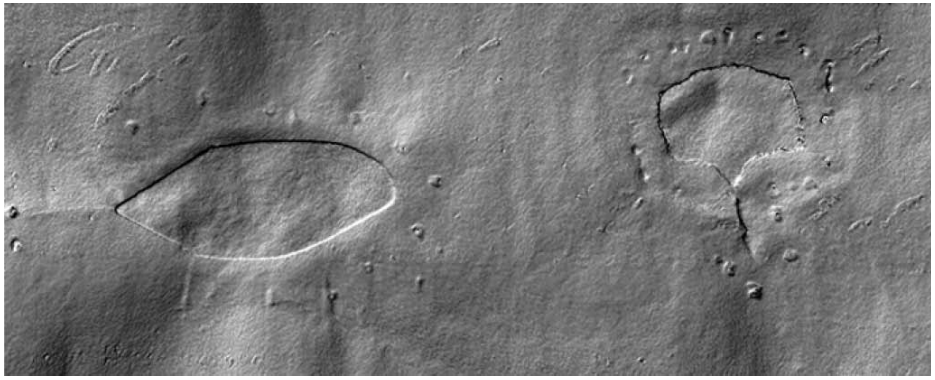
Item 2: a parchment document with a wax seal.
Top: detail of the 3D render obtained by Lucida.
Bottom: reference photo.
Previous page: 3D render, details of the wax seal.

British Library



Item 3: a piece of hand laid paper with a watermark, detail.

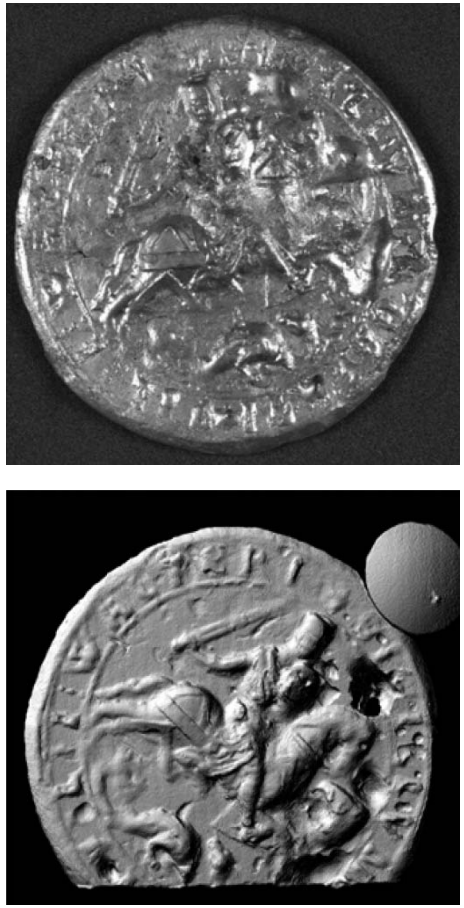




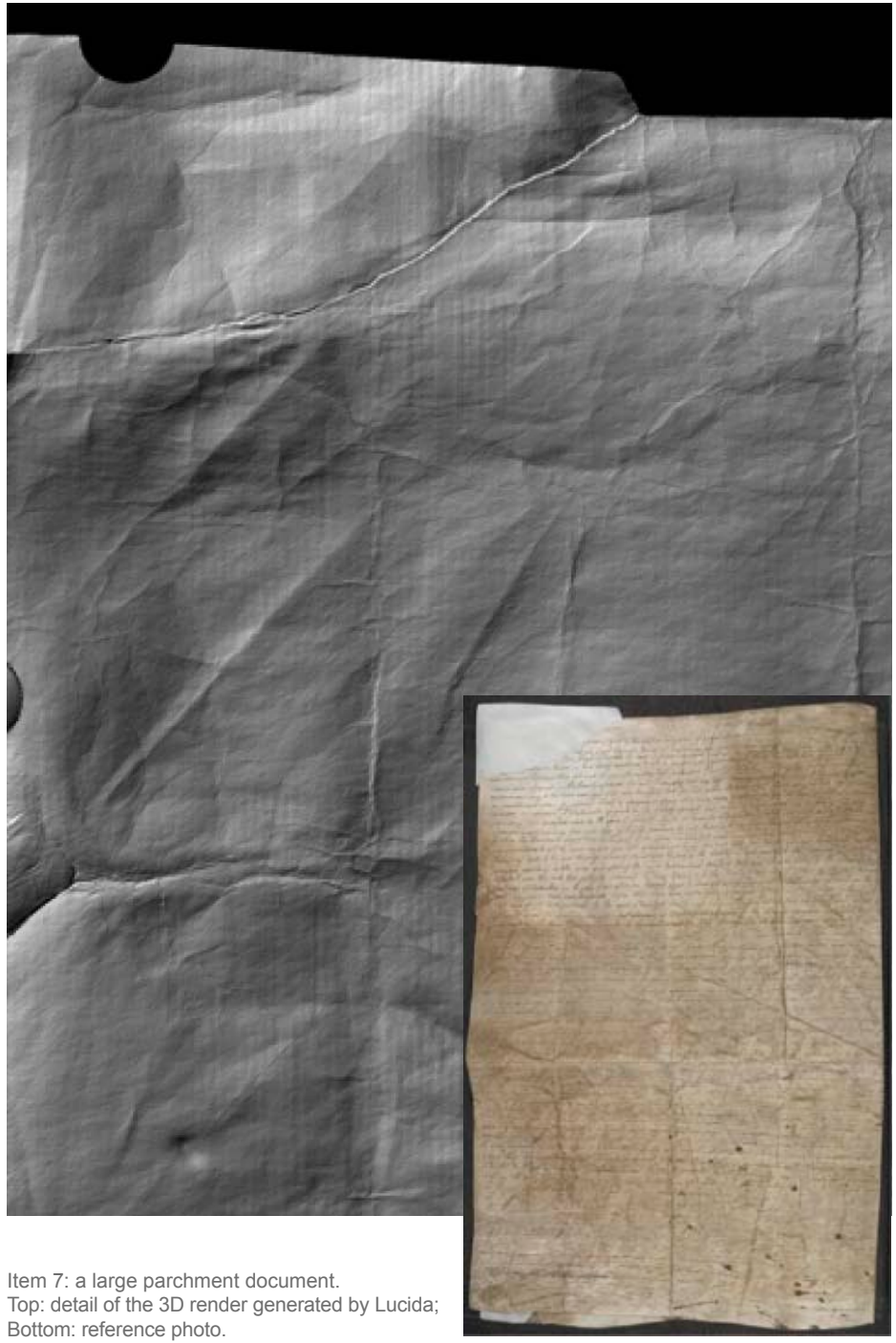
Next page: Item 4: a document with conservation repairs; Top: render of the 3D data generated by Lucida; Middle: detail of the conservation repairs; Bottom: reference photo.

British Library

Item 5: a black fimo seal.
Top: render of the 3D data; Bottom: reference photo.



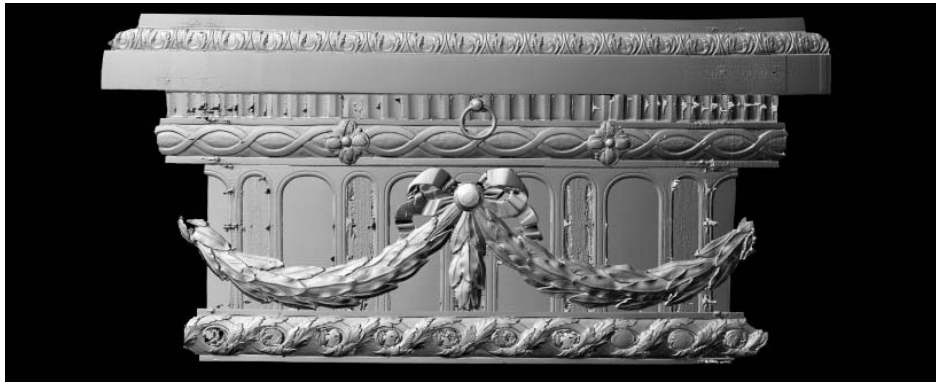
Item 6: a metal seal.
Top: reference photo; Bottom: render of the 3D data.



Item 7: a large parchment document.
Top: detail of the 3D render generated by Lucida;
Bottom: reference photo.

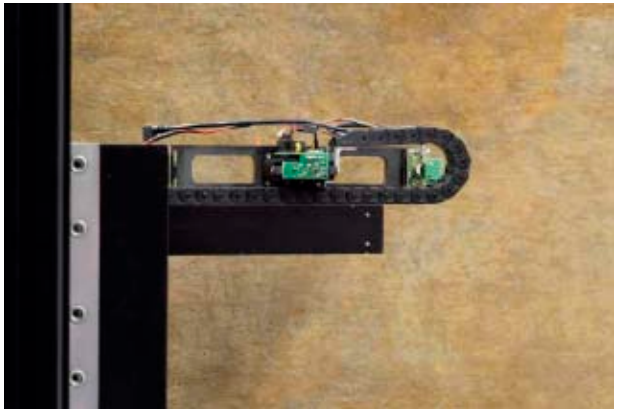
Teschen Table

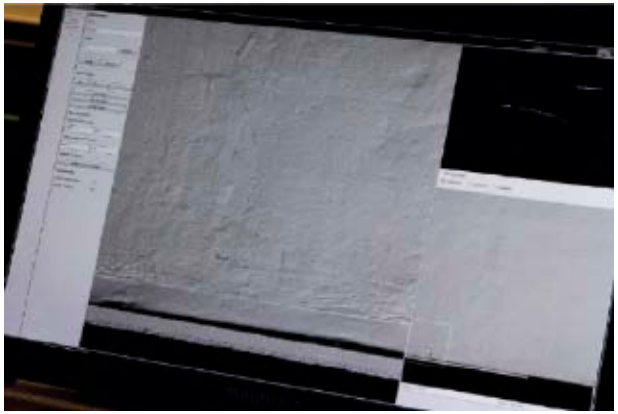
The Teschen Table at the Museé du Louvre
In July 2015 a team from Factum Arte was in the Musée du Louvre recording the Table of Teschen (pictured on the right) in order to make an exact copy that will be shown in the Chateau de Breteuil – its original location since it was given to the family in 1768.
The scanning of the table was carried out using various 3D and colour recording systems. Lucida was used to digitise some of the main decorative motifs across the table's body, as well as one full leg. The recorded data will then be combined with the general 3D model of the object generated with a structured light scanner. Whereas scanning translucent materials such as crystal or some of the stones is an almost impossible task for most 3D scanners including Lucida, this project has demonstrated the ability of the Lucida 3D scanner to record data out of gilded surfaces, with the highest quality and resemblance to the real texture of the object.
In order to record a curved surface that exceeded Lucida's depth of field of 25 mm, various successive scans can be made at different distances, which are then merged in the processing phase to complete the model.



Render of the 3D data of the table's side.

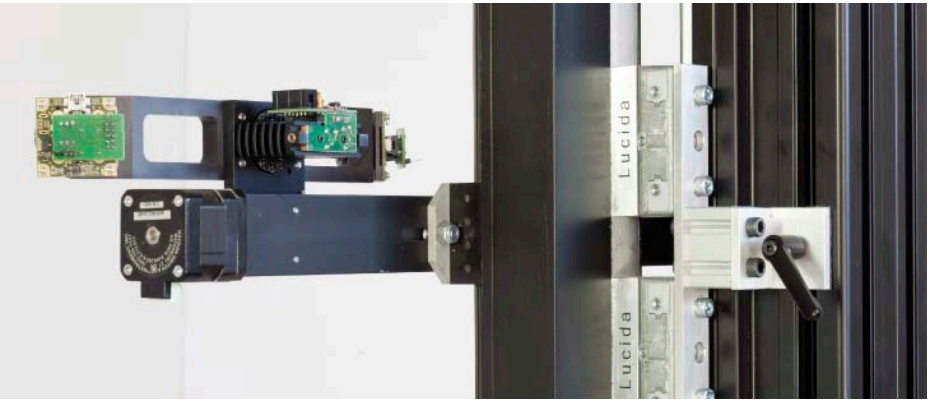
Next page: Left: 3D data of a full leg obtained with Lucida; Right: various close-up photos of the table top.





Technical specifications

Laser diode
Manufacturer and model: Laser Components ADL-65075TA2
Type: Auto Power Controlled Laser Diode. Stable light power output, compact size, high brightness laser light source.
Wavelength: 650 nm
Power: 4 mW
Cameras
Manufacturer and model: IDS Imaging Development Systems UI-1221LE-M-GL
Type of cameras: Black & White
Sensor: CMOS Mono by Aptina Imaging
Lens: Sunex DSL-300 EFL=17.1 f/4.2
Data transmission speed: max 25 Mbytes/s per camera
Interface: USB 2.0
Resolution: 752 x 480 pixels
Microcontroller
Chip: 8-bit Atmel AVR Atmega 328
Clock speed: 16MHz
Operating Voltage: 5V
Linear motion
Manufacturer and model: Haydon Kerk RGS06 Motorized hybrid linear rails & actuators
Scanning features
Depth of field: 25 mm
Maximum scanning depth using Z axis: 500 mm
Distance to the target: 65-90 mm
Maximum scanning area (m2): Only limited by storage capacity and structural frame
Scanning speed (m2/h): ca. 0.25
Data features
File formats: 3D point cloud (RIS), 3D depthmap (TIFF), 2D render (TIFF), raw video (AVI)
Point resolution: 10,000 points per cm2
Megabytes per m2: RIS (420 MB), 3D depthmap 32bit-TIFF (420 MB), 2D render 8bit-TIFF (88 MB), AVI (272 GB)
Software features
OS requirements: Windows XP 32 bits
Computer requirements: 3 USB 2.0 ports
Mechanical features
Frame Manufacturer and model: Standard structural frame by Bosch-Rexroth.
Weight of the whole system: 53 Kg (with 1 m mast and 1.45 m horizontal rail)
Materials: Mostly black painted or anodized aluminum



Credits
Manuel Franquelo: concept and design of electronics, mechanics, optics, and software. Lucida 3D scanner has been fabricated and tested in Factum Arte by Carlos Bayod, Dwight Perry, Jorge Cano, Nicolás Díez, Manuel Franquelo Jr, Guendalina Damone, Enrique Esteban and Aliaa Ismail under the supervision of Manuel Franquelo.

Resources
Lucida user's manuals can be downloaded from Factum Arte's website:

Assembly Instructions
factum-arte.com/lib/kcfinder/upload/files/Lucida/manuals/2015_Lucida_A5_Assembly_Final.pdf

Operator's manual
factum-arte.com/lib/kcfinder/upload/files/Lucida/manuals/2015_Lucida_A5_Operator_Final.pdf