

A COLLECTION OF ESSAYS
FOR FACTUM FOUNDATION

We must expect great innovations to transform the entire technique of the arts, thereby affecting artistic invention itself and perhaps even bringing about an amazing change in our very notion of art.

Paul Valéry, 'The Conquest of Ubiquity', *Aesthetics*, 1928

Digital technologies are profoundly changing how we relate to art, from the ways in which we access and display objects to how we safeguard, restore, archive and even possess them.

The Aura in the Age of Digital Materiality explores themes emerging from the unprecedented potential of the meeting between digital technology and cultural heritage at a time when we are being forced to fundamentally rethink what we value, how and why. It brings together recent projects by Factum and a wonderfully diverse collection of essays, many written especially for this book, by collaborators and friends. Their widely different backgrounds and disciplines only illustrate the importance of this subject and the huge range of its relevance. Contributors include Hartwig Fischer, Director of the British Museum; Mari Lending, the author of *Plaster Monuments: Architecture and the Power of Reproduction*; Nadja Aksamiya, Professor of Italian Renaissance and Baroque art and architecture at Wesleyan University; Egyptologist Nicholas Reeves; Pulitzer Prize-winning author Richard Powers; Shirley Djukurmä Krenak, Indigenous activist from the Upper Xingu; philosophers Bruno Latour, Brian Cantwell Smith and Alva Noë; Simon Schaffer, Professor of the History and Philosophy of Science at the University of Cambridge; architect Charlotte Skene Castling; Jerry Brotton, specialist in cartography and the Renaissance; and Chiara Casarin, Director of the *Musei Civici di Bassano del Grappa*.

Our world is at a crossroads. Not only are people at risk, but our cultural heritage is under threat from lack of resources, natural disasters, climate change, terrorism, mass tourism and war. There has never been a more critical time to use technology for preservation. If these high-resolution methods had been used to record Aleppo before it was flattened, the site of Nimrud or the Bamiyan Buddhas before they were blown up, or Notre Dame before it burned, these examples of human creativity would not have been so completely lost forever. When Dresden was bombed, only photographs and memories remained. In the 21st century, we have the technological means to do so much: we urgently need to act now to record and preserve our cultural heritage for future generations. This book is a thoughtful and provocative call to action.

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THE AURA IN THE AGE
OF DIGITAL MATERIALITY

RETHINKING PRESERVATION
IN THE SHADOW OF AN UNCERTAIN FUTURE



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— DIGITAL TECHNOLOGY
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The project is part of the exhibition

LA RISCOPERTA DI UN CAPOLAVORO

12 March – 28 June 2020

Palazzo Fava, Palazzo delle Esposizioni, Bologna

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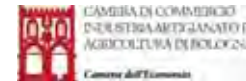


Pontificio Consiglio della Cultura



Chiesa di Bologna

With the contribution of:



A collection of essays assembled by Factum Foundation to accompany the exhibition

The Materiality of the Aura: New Technologies for Preservation

Palazzo Fava, Bologna

12 March – 28 June 2020

'Factum Arte' can be translated from the Latin as 'made with skill'. Factum's practice lies in mediating and transforming material. Its approach has emerged from an ability to record and respond to the subtle visual information manifest in the physical world around us. Hundreds of decisions are embedded as material evidence in the process of making an object of any kind. Archaeologists are trained to read this evidence, as are forensic detectives at a crime scene. Patrick Blackett, an experimental physicist, wrote that his work was to 'cultivate an intimacy with the behaviour of the physical world' – this is an equally good description of Factum's aims.

Credits

This book has been assembled and edited by Adam Lowe, Elizabeth Mitchell, Nicolas Béliard, Giulia Fornaciari, Tess Tomassini, Blanca Nieto and Guendalina Damone.

All projects carried out by the Factum Foundation are collaborative and there are many people to thank. This is not the place to name everyone but some people have done a great deal to make all this work possible including: Charlotte Skene Catling, Otto Lowe, Tarek Waly, Simon Schaffer, Pasquale Gagliardi, Fondazione Giorgio Cini and everyone in ARCHiVè, Bruno Latour, Hartwig Fischer, Jerry Brotton, Roberto Terra, Cat Warsi, John Tchalenko, Manuela Mena, Peter Glidewell, The Griffith Institute, Emma Duncan, Lord Rothschild, Fabia Bromofsky, Ana Botín, Paloma Botín, Lady Helen Hamlyn, Ziyavudin and Olga Magomedov, Rachid Koräichi, Andrew Edmunds, Colin Franklin, Ed Maggs, the Hereford Mappa Mundi Trust, Rosemary Firman, Philip Hewat-Jaboor, Helen Dorey, Peter Glidewell, Purdy Rubin, Fernando Caruncho, Susanne Bickel, Markus Leitner and everyone at the Swiss Embassy in Cairo, Jim Moran, Kathelin Gray, Johnny Allen, Bassam Daghestani, Mohammed Jameel, George Richards, David Coulson and the Trust for African Rock Art, Jeffrey and Veronica Berman, Ben and Donna Rosen, Clark Winter, Mauricio Torres Leclerc, Maria Golia, Anthony Sattin, Nicholas Penny, Mark Leithauer, Carole Patey, Michael Snodin, Silvia Davoli, Bill Sherman, Nico Schwartz, Julian Rothenstein, Ahmed Mater, Larry Keith, Jose Luis Colomer, Richard de Tscherner and the trustees of the Carène Foundation, William Ewing, Paula and Jim Crown, Sir Paul and Jill Ruddock, Jonathan and Jane Ruffer, Lindsay Stainton, Pippa Shirley, Juan Manuel Albendea, Casilda Ybarra, Jorge Coll, Ana Debenedetti, Gabrielle Finaldi, Stephen Clarke, The Gentle Author, Ali AlJuboori, Hansi Escobar, Ramon Blecua, Annette Warren Gibbons, Michael Jones, Rut Ballesteros, Rebecca Foote, Dinah Casson, Fabio Roversi Monaco, Richard Terra, People's Palace Projects, Shobita Punja, Sarah Thomas, Daniel Crouch, Fred Hohler, Sir Charles Saumarez Smith, Michael and Sarah Spencer, Aidan Weston Lewis, Nicholas Kugel, Pilar de la Béraudière, Dario Gamboni, Jorge Otero Pailos, Betsy Bolman, Ken Singer, Chiara Casarin, Matteo Lanfranconi, Mario Matthias Wivel, Chance Coughenour, Anna Somers Cocks, Bernardo Tortorici Montaperto, Clare Foster, Clemens Weijkamp and Raymond op het Roodt, Gabriele Finaldi, Jonathan N. Tubb, Phil Harvey, Roberto Grandi, Roger Law, Sarah Thomas, and many others who care about the preservation of the past.

And, of course, everyone at Factum Arte who works tirelessly to support the Factum Foundation and turn its vision into a reality.

This book is dedicated to Pasquale Gagliardi, who first got the ball rolling

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THE HAND OF THE ARTIST: GRAPH ANALYSIS AND EL GRECO

Adam Lowe

Adam Lowe is the Director of Factum Arte and the founder of Factum Foundation for Digital Technology in Conservation.

The digital recording and digital analysis of El Greco's paintings will significantly enhance our understanding of this artist, famed for his idiosyncratic and highly personal paintings. He is the epitome of the individual artistic genius. Doménikos Theotokópoulos was an artist from Candia (the name given to Crete during its period as a colony of the Republic of Venice) who had worked in Venice and Rome before moving in 1577 to Toledo, where he ran a successful studio until his death in 1614. Artistic practice in Spain in the late 16th century was controlled by strict professional codes. Theotokópoulos worked with a team of painters and assistants including his son, Jorge Manuel Theotokópoulos, who continued to run the workshop for some time after his father's death.

The analysis of the painted surface, recorded using high-resolution 3D laser scanning and confocal profilometry, will provide the data for a new graph-analysis software that is being developed at Case Western Reserve University in Cleveland. This research project is an initiative of the Factum Foundation and Case Western Reserve University, in collaboration with the Fundación Casa Ducal de Medinaceli and The Auckland Project. The analysis involves AI machine-learning (ML) techniques using neural-net methods reacting to the three-dimensional characteristics of the surface relief. The aim is to identify different hands at work during the production (and restoration) of El Greco's paintings. The individual technique of each artist leaves its trace on the painted surface. These traces can be clearly read if they are recorded with enough detail. With El Greco, there are often several hands working together to produce a single coherent and recognisable style.

The Baptism of Christ has already been recorded in the chapel of the Hospital of Cardinal Tavera, Toledo. *The Annunciation*, in the collection of Banco Santander, is scheduled for recording in the spring of 2020. The aim is then to record the other paintings from the Hospital of Cardinal Tavera that are amongst the last produced by El Greco and Jorge Manuel. Permission will be required from the National Gallery of Greece and the Metropolitan Museum to 3D scan the *Concert of Angels* and *The Opening of the Fifth Seal* in their collections. The aim is also to record and analyse two very similar crucifixions by El Greco or his studio belonging to the Cleveland Art Museum and The Auckland Project. The close similarity of these two paintings suggests that El Greco's studio may also have been using a system to improve the speed and accuracy of the copying. This collaboration between institutions will hopefully help establish the importance of recording the surface of paintings and reveal new information about the working practice of El Greco's studio.

OPPOSITE

Colour data for El Greco's
Bautismo de Cristo, 1608.

MACHINE LEARNING TECHNIQUES

Artificial intelligence (AI) for image recognition and image analysis has been successful in recent years, with applications ranging from art to ecology, national security to healthcare. The same techniques for clustering and recognising images can be applied to any 2D array of image data, such as a render of surface topography. In the case of the El Greco paintings, one experiment will be to train a machine learning (ML) algorithm on regions that a specific connoisseur has attributed to El Greco (Category A) vs. regions attributed to his son (Category B). Then we will apply the trained algorithm to the unknown regions. By applying the algorithm to unknown regions, the AI will suggest with a numerically defined certainty that these regions fit best into one of the trained categories (e.g., Category A with 85% certainty). We expect the results to illuminate the physical qualities used in determining attribution, and perhaps lend insight into the role of reconstruction and damage in this determination. Further, information encoded at different length scales within the paintings will contribute to these results. Understanding which length scales the algorithm weighs highly for its determination could result in novel analytical tests for studying paintings. Additionally, we plan to study various imaging modalities, such as panoramic photography, for the ML algorithm, and understand the robustness of the results, so that we can begin to identify the surface information (height, directionality, colour, etc.) contributing to the attribution.

Finally, clustering via AI can be applied to the measurements of the paintings. With clustering, the AI will group similar patches of the paintings with no training. By using various metrics to cluster the data spots or spot sizes, we may see groupings arise within and across the paintings. Then, meaning can be designated to the groupings using knowledge obtained by archival and art-historical research. This method has been known to lend support to conclusions and enlighten new roads of interpretation.

Initial tests on the ability of machine learning to differentiate between artists using surface profile images have been carried out using a methodology developed at Case Western Reserve University in Cleveland. Working with high-resolution 3D recording and data analysis software in a scientifically controlled environment, the team was able to identify the brush-marks made by two different hands with more than 90% accuracy after initial analysis. The three paintings by El Greco contain more 'noise' and have undergone several undocumented interventions that will obscure some data. By use of different models and careful training using sections of each painting, it is hoped that we will be able to allocate characteristic traces to the way each hand applies the paint. It is anticipated that this will reveal the presence of several hands at work on each canvas.

The project aims to offer a unique look at these paintings by El Greco through the filter of cutting-edge technologies. It is hoped that through digital analysis we will provide new data about how works are made, who made them, and how they have been conserved, demonstrating that paintings are both complex and dynamic in terms of content, context and material evidence. The recording and ML analysis will hopefully contribute to the knowledge and appreciation of some of the most representative works of the last stage of El Greco's career. Factum Foundation has been committed from its formation to the recording of the surface of paintings as a way to learn more about their historical and artistic significance. The link with Case Western Reserve University will result in the writing of new software to analyse the 3D information.

OPPOSITE

3D relief data for El Greco's
Bautismo de Cristo, 1608.

