



AIC 2026 FLORENCE

AIC 2026 MIDTERM MEETING
OF THE INTERNATIONAL
COLOUR ASSOCIATION

COLOR AND
CULTURAL HERITAGE

3–4 SEPTEMBER 2026

FLORENCE, ITALY

BOOK OF ABSTRACTS





MIDTERM MEETING OF THE INTERNATIONAL COLOUR ASSOCIATION

3-4 SEPTEMBER 2026, FLORENCE (ITALY)

ORGANIZED BY



International Colour Association
Internationale Vereinigung für die Farbe
Association Internationale de la Couleur



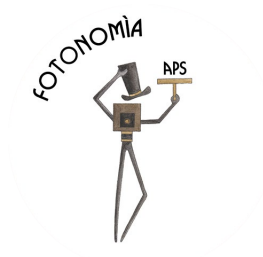
GRUPPO DEL COLORE
ASSOCIAZIONE ITALIANA COLORE



**UNIVERSITÀ
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Welcome message from AIC President Prof. Maria João Durão



Dear Colour Researchers, Colleagues, and Friends,

It is a great honour for me to welcome all participants to the AIC2026 Midterm Meeting in Florence.

This is the second time that the AIC has held a Midterm Meeting in Italy, thanks to the initiative of the *Gruppo del Colore – Associazione Italiana Colore*. The first was held online in 2021 due to the restrictions of the coronavirus pandemic. The *Associazione Italiana Colore* is one of the most active Regular Members of the AIC. Their enthusiasm is evident in their numerous contributions to AIC governance, particularly to the AIC Executive Committee (Maurizio Rossi, former president); the Games and Toys Study Group, chaired by Alessandro Rizzi and Andrea Siniscalco; and their participation in AIC events.

The central theme of the AIC2026 Intermediate Meeting is dedicated to “Colour and Cultural Heritage,” with special sessions on Photography and Colour Cinema, Shedding New Light on Cultural Heritage and the Colours of Historic Cities. The programme is enriched by the invited speakers Marco Leona, Pietro Palladino, and Roberta Piantavigna.

I congratulate the organisers on choosing Florence as location for AIC2026, as it is the epicenter of the Western Renaissance, which revived Classical Antiquity ideals and humanist values. Florence was its epicenter, with a patronage that supported cultural innovation and geniality in the arts, literature, philosophy, science and technology.

I hope that our discussions on cultural heritage- from the scale of painted manuscript to architectural and archaeological sites-, are inspired by the gigantic sculptures that still stand gloriously and all the sophisticated expressions of art, science, and technology that already contain the seed of the future. As we cross the Ponte Vecchio—the bridge where Dante met his beloved Beatrice—we can almost imagine ourselves crossing the Einstein-Rosen Bridge, to observe the past and be able to ask better questions about colour in the future of our planet Earth and beyond.

I would like to express my sincere gratitude to all who worked hard to make this Meeting memorable and successful: General Chairs Marcello Picollo, Alice Plutino, Andrea Siniscalco and the associated committees (Publicity and Social, Publication, Finance and Fundraising), Scientific Committee, AIC Study Groups, session chairs, students who contributed to the AIC Student Paper Awards, other communities of colour, as well as partners, sponsors, and supporters.

Finally, congratulations to all the authors for the high quality of their work.

I wish all attendees a vibrant AIC2026 and a truly rewarding experience in Florence.

AIC President, Prof. Maria João Durão

Welcome message from the President of the Italian Color Association Prof. Andrea Siniscalco



Dear colleagues,

It is with great pleasure that, on behalf of the *Associazione Italiana Colore*, I welcome you to the *Midterm Meeting 2026* of the *International Color Association*.

The Italian Color Association has been working for some time to connect the many scientific, cultural, and professional communities that deal with color in its many aspects. For this reason, we are honored to have organized this meeting on behalf of *AIC*, which, since 1967, has been an essential interdisciplinary meeting point for associations from around the world.

The main theme of this Midterm Meeting is "Color in Cultural Heritage", and few places in the world are as significant as Florence, where science, art, architecture and craftsmanship have shaped one another for centuries.

In this wonderful setting, *AIC2026* invites us once again not to consider color as a parameter to be measured or as an aesthetic quality, but as a raw material, experience and memory; something to be documented, preserved, studied and disseminated.

The contributions presented at the conference decisively reflect this challenge.

Science, art, architecture, restoration, design, and digital technologies mix in a holistic vision of the Color discipline. All in three special sessions: "*Color Photography and Film*"; "*Shedding New Light on Cultural Heritage*" and "*Colors of Historical Cities*".

These contributions show that progress often emerges at the boundaries between disciplines, through dialogue between researchers and professionals.

I want to thank Professor Susanna Caccia Gherardini and the Department of Architecture that is hosting us for the event. I also want to thank all the authors who will help make this meeting inspiring and fruitful.

Thank you to *AIC* and its Executive Board, and above all, to everyone whose hard work made organizing the conference possible: the other conference chairs, Marcello Picollo and Alice Plutino; all members of the various organizing committees: Professor Maurizio De Vita, Filippo Cherubini, Sirpa Salenius, Lisa Vergelli, Sofia Ceccarelli, Vien Cheung; and everyone involved in the logistical work.

Their expertise, commitment and generosity have made this meeting possible. May these pages serve not only as a record of the work presented, but also as a starting point for new questions, collaborations and lasting professional relationships.

I warmly welcome you to Florence and wish everyone an inspiring and fruitful *AIC2026*.

Gruppo del Colore - Associazione Italiana Colore President, Prof. Andrea Siniscalco

Program

03/09/2026 - PLENARY SESSION

The Social Hub Florence Belfiore, Viale Belfiore 55, Florence (Italy)

08:00 Conference participant registration
 09:00 **Institutional greetings**
 09:20 **AIC Study Groups** short presentations
 10:10 Invited Speaker: **MARCO LEONA**
 10:45 Invited Speaker: **ROBERTA PIANTAVIGNA**
 11:35 Invited Speaker: **PIETRO PALLADINO**
 12:10 GdC - Associazione Italiana Colore - **Color Award 2026: CHRISTIAN GRECO**
 12:15 AIC **Student Paper Awards**

03/09/2026 - PARALLEL SESSIONS

Santa Teresa Campus, University of Florence, Via della Mattonaia 8, Florence (Italy)

A1S1 (Room 401) Chair: Alice Plutino - Color Photography and Film

14:30	Bianca Irene Carnesale, Sofia Colombero and Alessandro Rizzi	Colour in Animation: A Case Study of Arcane
14:45	Valentina Rossetto, Jeanne Pommeau, Greta Peruzzi, Lisa Vergelli	Investigating Colour in Lumière Film Stock: Scientific Approaches and New Perspectives
15:00	Iryna Marholina	Discourse on Film Color in the Voices of Soviet Thaw-Era Viewers
15:15	Daniel Vazquez, Antonio Alvarez Fernandez-Balbuena, Anto J. Benítez, Ana Yebra and Manuel Melgosa	The influence of projection screens on the colors of early silent cinema films
15:30	Monia Vadrucchi, Sara Zucchi, Melissa Gianferrari, Chiaramaria Stani, Francesco D'Amico and Elena Correra	Diagnostic Study on Hand-Colored Daguerreotypes from the David Robinson Collection
15:45	Annie-Dominique Denhez	Photography: achromy for polychromy in cretan archaeology, Maraghiannis publishers of Heraklion and Boissonnas publishers of Geneva
16:00	Maja Strgar Kurečić, Lidija Mandić and Nikolina Stanić Loknar	Light Painting in Digital Photography: Techniques, Tools, and Visual Outcomes

A2S2 (Room 402) Chair: Maurizio De Vita - Colors of Historical Cities

14:30	Kine Angelo and Alex Booker	Heritage accuracy in the light of public familiarity: who defines authenticity?
14:45	Juan Serra, Ana Torres, Jorge Llopis and Pedro Verdejo	Methodological Approach to the Chromatic Restoration of Historical City Centers: Case Studies in Valencia
15:00	Mette Bye	Presentation and representation of cultural heritage through color restoration

15:15	Julian Rennie and Alessandro Premier	Colour conservation study of Gummerts Ford's country house: Arden, Havelock North, New Zealand
15:30	Maddalena Branchi and Laura Marchionne	Colour and energy retrofitting in historic built heritage: urban effects and conservation challenges
15:45	Nadia Bouzgarrou, Faten Hussein and Laurent Lescop	Ambient Regeneration of the Carthage Cathedral through HBIM: Color as a Sensitive Heritage Parameter
16:00	Fiona McLachlan	An Evolving Identity Through Colour: Balancing Authenticity and Change
A3S3 (Room 208) Chair: Julio del Hoyo - General		
14:30	Boris Pretzel, Masahiko Tsukada and Satoko Ogura	Uncertainty and Simplified Error Propagation in Colour Difference Measurements
14:45	Benedykt R. Jany	C-Microscopy: A Colorimetric Approach to Microscale Optical Characterization for Materials and Heritage Science
15:00	Gianmarco Borghi, Anna Ryguła, Marco Gargano, Julio del Hoyo and Benedykt Jany	Correlative Colorimetric Microscopy (C-Microscopy) in Heritage Science
15:15	Irene Samaniego Jiménez, Miguel Ángel Herrero Cortell, Marcello Picollo, Margherita Gnemmi, Francesca Caterina Izzo, Laura Osete Cortina, Laura Fuster López and Anna Vila	Shedding light on the study of crack formation and propagation in Las Meninas by Picasso (1957), using non-invasive imaging
15:30	Marco Gargano, Daniele Demonte, Federico Di Iorio, Mattia Morlotti, Sara Bonsignore, Francesca Ferrario and Tiziana Cavaleri	A Standardized Approach to Color Management in UV-Induced Luminescence Imaging for Cultural Heritage Applications
15:45	E. Keats Webb and Jennifer Giaccai	In a New Light: Using Multiband Photogrammetry to Study Pichwai Paintings
16:00	Candela Belenguer-Salvador, Miguel Ángel Herrero-Cortell, Marcello Picollo, Anna Vila and Laura Fuster-López	Coupling MBI, colorimetry and FORS to inform targeted analytical and preservation strategies in the study of failure phenomena in easel paintings Diagnosing Anglada Camarasa's 'Magda Jocelyn' (1904).

03/09/2026 - PARALLEL SESSIONS

Santa Teresa Campus, University of Florence, Via della Mattonaia 8, Florence (Italy)

A1S4 (Room 401) Chair: Laura Bellia - Shedding New Light on Cultural Heritage

16:45	Raffaella Trocchianesi and Francesco Murano	The Narrative Role of Light in the Exhibition Design of 'Sensitive' Museums and Temporary Exhibitions. Design-Driven Projects and Tools
17:00	Nozomu Yoshizawa, Miyu Aoyama, Yuki Oe, Yoko Mizokami and Miho Takashima	Towards a new lighting method for museums considering the optimal brightness for paintings - Painting Classification by Curators -
17:15	Luca Cogo, Claudio Rota, Marco Buzzelli, Simone Bianco and Raimondo Schettini	Object Relighting Using Only Tristimulus Information
17:30	Steve Paolini	"Every color of the rainbow"
17:45	Carmelo Occhipinti	Innocenzo Ringhieri and Sixteenth-Century Debates on Colour: Between Art Criticism and Theory
18:00	Pablo Ixtaina and Carlos Lionel Colonna	Public lighting in historical cities
18:15	Andrea Siniscalco	Lighting in the Quarto Camerino of Villa D'Este in Tivoli: a digital reconstruction

A2S5 (Room 402) Chair: Pietro Matracchi - Colors of Historical Cities

16:45	Vanda Matos and Carlos Alho	Heritage accuracy in the light of public familiarity: who defines authenticity?
17:00	Simona Dukanovic	Methodological Approach to the Chromatic Restoration of Historical City Centers: Case Studies in Valencia
17:15	Akari Kagimoto, Shiho Ota and Shino Okuda	Presentation and representation of cultural heritage through color restoration
17:30	Justyna Tarajko-Kowalska and Przemysław Kowalski	Colour conservation study of Gummers Ford's country house: Arden, Havelock North, New Zealand
17:35	Agata Kwiatkowska-Lubańska	Colour and energy retrofitting in historic built heritage: urban effects and conservation challenges
17:40	Xavière Ollier, Vanessa Lehner and Soizic Boucault	Ambient Regeneration of the Carthage Cathedral through HBIM: Color as a Sensitive Heritage Parameter

A3S6 (Room 208) Chair: Boris Pretzel - General		
16:45	Julio M Del Hoyo, Alessandra Banchelli, Gianmarco Borghi, Anna Klisińska-Kopacz, Anna Ryguta and Paulina Krupska-Wolas	Linking material composition and light sensitivity: Integrating microfading testing for studying heritage colorants
17:10	Alessandra Banchelli, Paulina Krupska-Wolas, Julio M. del Hoyo-Meléndez, Marcello Picollo and Beata Hejmanowska	Microfading testing and colorimetric analysis of Japanese woodblock prints: assessing light stability and chromatic changes in dyes and pigments
17:25	Hilda Deborah, Tanzima Habib, Giorgio Trumpy, Jon Yngve Hardeberg and Börries Brakebusch	Surveying colour management practices in conservation / restoration of cultural heritage objects
17:40	Florent Comte, Marco Gaiani, Anthony Pamart, Livio De Luca, Andrea Ballabeni, Hélène Civalleri and Christophe Besnier	Shapes and colors. A colorimetry-based methodology for the 3D reproduction and evaluation for the purpose of classifying the elements of the Jubé of Notre-Dame de Paris
17:55	Alessandro Farini, Elisabetta Baldanzi, Raffaella Fontana, Antigone Marino, Alessandra Ferlito, Sabrina Maria Sottile, Vanessa Fontani, Amelia Parigi, Massimo Gurioli and Paolo Antonino Grasso	Color assimilation for color restoration
18:10	Riccardo Foschi, Florent Comte, Marco Gaiani, Anthony Pamart, Livio De Luca and Christophe Besnier	A cross-polarised photogrammetric workflow for the digital documentation of the Notre Dame de Paris jubé fragments

04/09/2026 - PARALLEL SESSIONS

Santa Teresa Campus, University of Florence, Via della Mattonaia 8, Florence (Italy)

A1S7 (Room 401) Chair: Andrea Siniscalco - Shedding New Light on Cultural Heritage

09:00	Laura Bellia, Francesca Diglio, Francesca Fragliasso, Antonino Pollio and Maria Francesca Sannino	Experimental analysis of the effects of monochromatic and white light on the fungal growth on paper documents
09:15	Ayşe Nihan Avci	Rethinking Museum Interiors Through Color, Light, and Material: The Case of Erimtan Archaeology and Art Museum
09:30	Gaelle Silvant, Ulysses Jackson and Adrien Lucca	Bridging Colour Science and Conservation Practice: A Transdisciplinary Method for Non-Metameric Retouching
09:45	Shogo Nishi	Stabilizing Low-Luminance Regions in Color-Appearance-Model-Based HDR Tone Mapping

10:00	Shino Okuda, Mana Nishimoto, Satoko Taguchi, Miho Muguruma, Katsunori Okajima, Juan Serra, Daniel Vazquez and Manuel Melgosa	Influence of Lighting Chromaticity on Perceived Season and Time in Joaquín Sorolla's Paintings of Outdoor Scenes
10:15	Misaki Kurosumi, Yuki Oe, Naoki Tsukada, Takumi Fujiwara and Nozomu Yoshizawa	Museum Lighting Under Low Illuminance for the Appearance of Achromatic Prints
10:20	Tatsuki Tsukuda, Kazuto Takase and Nozomu Yoshizawa	Study on Flicker Evaluation Metrics Considering Sensory Characteristics
10:25	Maurizio Rossi and Gianluca Guarini	Using VR for the Reconstruction of Historic Flame-Based Artificial Lighting in Ancient Indoor Spaces: A Case Study
10:30	Paola Bertoletti and Maurizio Rossi	Indoor Artwork Lighting: A Review of Color Rendering, Spectral Power Distribution, CCT, Visitor Perception, and Preventive Conservation
10:35	Ichiro Katayama, Motonori Doi and Shogo Nishi	Brightness Perception of Chromatic Objects with Regular Surface Textures: Effects of Lightness Constancy

A2S8 (Room 402) Chair: Ana Elena Salvi - Colors of Historical Cities

09:00	Nicola Tropeano	Use of red pigmentation on masonry surfaces in medieval buildings in Rome. Selected case studies examined through spectrophotometric analysis
09:15	Karla Maria Muñoz-Alcocer and Maria Luisa Vázquez de Ágredos Pascual	Integrating Biocultural Knowledge & Material Analysis to Trace Spanish Colonial dyes in Chihuahua Architecture
09:30	Susana Coentro, Mathilda L. Coutinho, Fernanda Carvalho, Inês Coutinho, Carla Machado, Marine Cotte, Jessica Hallett and João P. Veiga	The colours of Islamic architectural ceramics: Iznik and Damascus tiles in the Calouste Gulbenkian Museum (Lisbon, Portugal)
09:45	Alba Santo, Irene Centauro and Elena Pecchioni	Colours of Stone and Urban Identity in the Historical City of Florence
10:00	Xavière Ollier and Vanessa Lehner	The Archaeology of Color Serving the Future: Renovating 1960s Utopias
10:05	Leonardo Pestana Collalto Toni, João Carlos de Oliveira Cesar and Beatriz Vianna Pestana	The Changing Colors of The Brutalist Architecture: Using Close Range Photogrammetry to Understand the Chromatic Variation of the SESC Pompéia Building Throughout the Day

10:10	Wen-Yuan Lee, Suchitra Sueeprasan, Neri Chairat, Pitchanuch Wongjariyakasem and Chia-I Liao	Comparative CIELAB Analysis of Sacred and Secular Heritage Sites in Taipei and Bangkok
10:15	Ondrej Virág	Digital Interpretation of the Industrial Heritage of the Atomic Age: Interactive Visualization and Presentation Tools in Architecture
10:20	Vladimír Hain, Roman Hajtmanek and Martin Uhrík	Multidimensional model of historical cities - virtual urban walk

A3S9 (Room 208) Chair: Keats E. Webb - General

09:00	Iva Brlek, Valentina Vragović, Marija Leš and Ivana Čorak Ribić	Dyeing Textiles with Cochineal - Traditional Natural Dye of Animal Origin
09:15	Vanessa Otero, Marlene Miranda, Andreia Ruivo, Márcia Vilarigues and Paula Nabais	Cochineal-Based Colours in Hand-Painted Magic Lantern Glass Slides: Distinguishing Historical Paint Formulations through Material Characterisation
09:30	Seden Odabasioglu	Rouge d'Andrinople: Traces in the Past, Projection into the Future
09:45	Mara Espírito Santo, Paula Nabais, Vanessa Otero, Marcia Vieira, Marta Manso, Joana Sequeira, Sónia Domingos and Dominique Cardon	Beneath the Threads: Colour and Dyeing Knowledge in 18th-Century Portuguese Textiles
10:00	Tiantian Fan and Maria Martone	From China to Europe: Comparing Porcelain Colour Palettes for New Colour-Blocking Strategies
10:15	Paola Artoni, Paolo Bertelli, Angelo Agostino, Kurt Wenner and Dafne Cimino	"Madonnari": technical art history and conservation
10:30	Irene De La Torre Fornés, Ana Torres Barchino, Ignacio Cabodevilla Artieda and Javier Cortina Maruenda	Colour identification of the Nolla mosaic in the Calatayud Palace in Valencia

04/09/2026 - PARALLEL SESSIONS

Santa Teresa Campus, University of Florence, Via della Mattonaia 8, Florence (Italy)

A1S10 (Room 401) Chair: Manuel Melgosa - Color and perception

11:15	John McCann	The different images made by HDR Photography and HDR Human Vision
11:30	Chiara Biguzzi and Edoardo Provenzi	Uncertainty relations for perceived colors
11:45	Alessandro Rizzi	From Color to Color Appearance in Museum's Heritage
12:00	Taiki Hoshino, Wei Li, Midori Tanaka and Takahiko Horiuchi	Impact of Geometric Alignment on Color Perception in Projection-Based Augmented Reality
12:15	Isamu Motoyoshi and Suguru Wakita	Achromatic and chromatic texture spaces in human vision

12:20	Suzuho Tanaka, Chieco Ono, Suzu Tayama, Hikaru Shida, Kazuto Takase and Nozomu Yoshizawa	Neurophysiology-based Visibility Estimation Model Considering Chromatic Adaptation
A2S11 (Room 402) Chair: Laura Marchionne - Colors of Historical Cities		
11:15	Jakub Demčák	Artificial Intelligence in the Architectural Design Process
11:30	Merve Yildiz and Esra Küçükılıç Özcan	Investigating the Relationship Between Building Morphology and Façade Colors Using Machine Learning: The Case of Kuzguncuk
11:45	Anna Marotta	Napoleon's Colors, in the "Retour d'Égypte" Style: Examples from Malmaison
12:00	Abd El Kadermaria Aly	The Semantic Space of the Roman Catacombs: Chromatic Economy and the Reuse of Figurative Models in Late Antique Painting
12:15	Leonardo Pestana Collalto Toni, João Carlos de Oliveira Cesar and Adrien Lucca	Further Analysis on The Expiatory Temple of The Sagrada Família's Colors Through Close Range Photogrametry
12:30	Jorge de Novais Bastos and Ana Santos Guerreiro	The Splendour of Colours in the Lisbon Fronteira Palace Estate
A3S12 (Room 208) Chair: Miquel Angel Herrero Cortel - General		
11:15	Fenella France, Meghan Hill, Pdraig O Machain and Anna Hoffmann	Revealing the Layers of Irish Medieval Manuscripts
11:30	Sara Calandra, Lorenzo Di Bilio, Maria Grazia Fraiese, Michela Luongo, Teresa Salvatici and Alba Patrizia Santo	Investigating Colors in the Cappella dei Magi at the Palazzo Medici Riccardi (Florence, Italy): a non-invasive approach
11:45	Paola Cordera	Color in Context. Reconsidering Display Strategies in Carlo Scarpa's Museums
12:00	Jodi L. Sandford	"The sky's merciless scream of blue" [OF *COLOR] – A Construction Analysis
12:15	Verena M. Schindler	Swiss artist Augusto Giacometti (1877–1947) and his "Blüemlihalle" frescoes
12:30	Sara Waldestam, Kennet Vrågård	NCS Colour AB - Swedish Colour Centre

04/09/2026 - PARALLEL SESSIONS

Santa Teresa Campus, University of Florence, Via della Mattonaia 8, Florence (Italy)

A1S13 (Room 401) Chair: Johnn McCann - Color and perception

14:30	Timo Rieke and Lina Schmidt	Bridging the Gap? The Role of Scientific Colour Knowledge in Design Practice
14:45	Taiyo Abe, Midori Tanaka and Takahiko Horiuchi	Experimental Analysis of the Relationship Between Visual Roughness and Physical Features

15:00	Maggie Maggio and Esther Hagenlocher	Light and Shadow: Exploring Dimensional Color in the Colour Literacy Project
15:15	Qinxin He, Stephen Westland and Soojin Lee	Colour Perception Characteristics Associated with Long-Term Exposure to Low-Illuminance Visual Environments
A2S14 (Room 402) Chair: Agata Kwiatkowska-Lubańska - Colors of Historical Cities		
14:30	Jimena Vanina Odetti, Rebeca Isadora Lozano Castro, Alberto Reyes González, Andrés Enrique Reyes González and Fernando Daniel Valdez Olmos	Color, Arquigraphy, and Urban Memory: A Situated Heritage Intervention in Tampico's Historic Center
14:45	Leonardo Pestana Collalto Toni and Anna Elena Salvi	Memory of Colors in Artacho Jurado's Architecture: A Case Study of The Cinderella Building
15:00	Elif Kaplan and Fazıla Duyan	The Heritage of Blue: Historical Context, Tile Tradition, and Color Symbolism in the Blue Mosque
15:15	Helena Soares	Shared Chromatographies: An Ethical Reading of Heritage in Spaces of Portuguese Influence
A3S15 (Room 208) Chair: Marcello Picollo - General		
14:30	Simone Caglio, Alessandra De Nicola, Maurizio De Rosa, Federica Antonioli, Chiara Da Pieve, Franca Zuccoli and Anna Galli	Colour as Urban Heritage: Scientific Analysis and Public Engagement in the Historical City of Pandino
14:45	Martina Glogar and Ivana Čorak	Heritage whites in contemporary language: Croatian lace and linen mapped to "cloud dancer"
15:00	Ilaria Alessandri	Color as Balance: Capsule Collection "IONIA – Between Balance and Flow"
15:05	Kazim Hilmi Or	Memphis design movement which can be worn: Memphis style eyeglasses
15:10	Maurizio Messa, Davide Molina	Konica-Minolta

04/09/2026 - PARALLEL SESSIONS

Santa Teresa Campus, University of Florence, Via della Mattonaia 8, Florence (Italy)

A1S16 (Room 401) Chair: Alessandro Rizzi - General

16:00	Yu-Chieh Chang and Pei-Li Sun	Deep Learning-Based Light Direction Estimation in Stylized Animation
16:15	Ingrid Calvo Ivanovic	Dialoguing with Colour: A Human–AI Inquiry into the AIC's Immaterial Heritage in the 21st Century
16:30	Amalia Luzzatto	Color: From Traditional Marketing to Experiential and Cultural Marketing

16:45	Renata Pompas	Niki de Saint Phalle: The translation of the chromatic code from art to design
17:00	Ingrid Calvo Ivanovic, Luanne Stovall, Elisa Cordero and Esther Hagenlocker	Local Colour as Material and Immaterial Heritage: a Catalyst for 21st Century Colour Literacy
17:15	Yifei Chen, Sooji Lee, Vien Cheung and Stephen Westland	The Impact of Background Lightness Contrast on Skin Colour Perception: Exploring Absolute vs. Relative Standardisation

A2S17 (Room 402) Chair: Maurizio De Vita - Colors of Historical Cities

16:00	Eleonora Caggiati	The meaning of surface colour in Guido Canali's architectural practice. The dialogue with materials and the study of historical cities
16:05	Racha Ghariri	Colour and Emotion in Architectural Sensory Experience
16:10	Shi-Min Gong, Ching-Chih Liao and Kai-Li Wang	A Study on Extending the Color Imagery of Japanese-Style Architectural Clusters in Taipei to Future Commercial Space Applications
16:25	Michelle Lippi	Brickwork and Chromatic Identity in Central Italy's Historic Urban Landscapes
16:40	Juana Gandino, Ludmila Jael Paroldi Algranati, Rocio Melman, José Luis Caivano, Gabriela Cárdenas and Roberto Lombardi	A Methodological Approach to Chromatic Organization in Clorindo Testa's Domestic Architecture
16:55	Ana Paula Pinheiro and Rui Duarte	The colors of mortar in the Cathedral of Portalegre

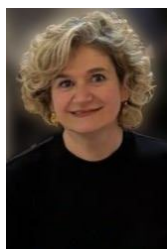
A3S18 (Room 208) Chair: Barbara Cattaneo - General

16:00	Mark Kotterink	A Layered Decision Architecture for Culturally Adaptive and Multisensory Color Selection
16:15	Federica Cocco, Mary Tezzele, Alessandro Bortolotti, Andrea Siniscalco and Riccardo Palumbo	Visual Exploration Patterns in Ettore Spalletti's Installations. A Museum-Based Eye-Tracking Analysis
16:30	Kazim Hilmi Or and Can Bayram Or	From Solar Gold to Liminal Black: A Comparative Chromatic Analysis of Mythological Birds Across World Cultures
16:45	Kyoko Hidaka, Ayako Osaki, Shizu Ara and Hiroko Uchiyama	Sanzo Wada and the Development of Trend Color Systems in 1920s–1930s Japan
17:00	Mari Uusküla	Italian Blue Terms Revisited: A Diachronic and Dialectal View

17:15	Francesca Valan	Colour as an Educational Mediator: Designing Didactic Pathways for the Exhibition “Munch. The Inner Cry”
17:30	Anna Mazzanti, Alice Biancardi and Erica Sterza	BLU-ETRUSCO. From the 1980s to today. Exhibition design, art, communication
17:45	Pina Russo	Color, Light, and Perceptual Experience in Historic Theatre Interiors: A Comparative Study of the Teatro di San Carlo and the Opéra Garnier
17:50	Ruby Kashyap Sood	Phulkari Heritage: The Vocabulary of Colours and Tradition
17:55	Lavinia Nasoni, Barbara Cattaneo, Valeria Arena, Alessandra Santagostino Barbone and Renata Pintus	Chromolithographic Colour at the Turn of the Twentieth Century: Diagnostic Investigation and Technical Sources in a Mucha Poster Printed by Imprimerie Cassan Fils
18:00	Kazim Hilmi Or	Reconstructing, visualizing, or reimagining ancient polychromy
18:05	Flavia Berizzi, Chiara Nenci and Roberto Rosso	A methodological proposal for the faithful reproduction of color, aligned with the Guidelines for 2D and 3D Digitization of Cultural Heritage. Experiences at the Quadreria and the Gipsoteca of the Brera Academy of Fine Arts

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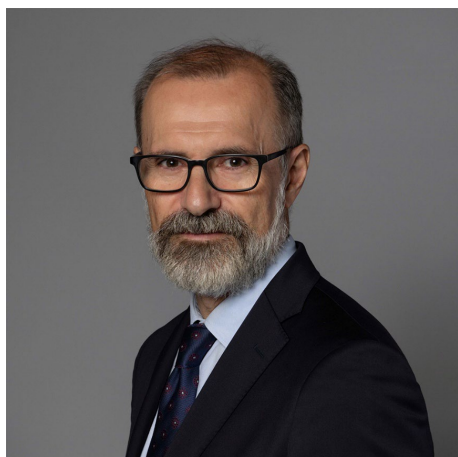
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INVITED SPEAKERS

MARCO LEONA



Head of the Department of Scientific Research at The Metropolitan Museum of Art.

He completed his studies in Italy with a degree in Chemistry and a PhD in Crystallography and Mineralogy from Università degli Studi di Pavia.

Prior to joining the Metropolitan Museum Dr Leona worked at the Freer Gallery of Art in Washington DC, and at the Los Angeles County Museum of Art LACMA. At the Metropolitan Museum of Art, he supervises a team of twenty scientists conducting research on artists' materials and techniques, and on art conservation. From 2009 to 2021 he taught scientific methods to art conservation students as Research Professor at New York University's Institute of Fine Art.

Dr. Leona's research interests include the study of Japanese painting techniques and materials, and the application of Surface Enhanced Raman spectroscopy to the analysis of natural and synthetic dyes. Dr. Leona's work on surface-enhanced Raman scattering has been published in *Angewandte Chemie*, *Analytical Chemistry*, *PNAS*, *Accounts of Chemical Research*, and the *Journal of Raman Spectroscopy*.

Dr. Leona was the co-chair, with Rick Van Duyne, of the 2009 Mellon-NSF workshop on Chemistry and Materials Research at the Interface between Science and Art, and the co- chair, with Heinz-Eberhard Mahnke of the first Gordon Research Conference on Scientific Methods in Cultural Heritage Research, in 2012.

The art and science of color: four thousand years of experimentation and discovery through the collections of the Metropolitan Museum of Art

What have Tutankhamun funerary linens in common with Nadal socks after a Roland Garros final? What can a speck of pink tell us about the mysterious old woman depicted in a first century Roman statue? What contributed, more than Mexican gold to pay Charles V debts to the Augsburg bankers? Why there are no Japanese landscape prints dating to before 1820, and who is really responsible for Hokusai's masterpieces? What is the color of modernity?

The creation of a work of art is a process often depicted as untouched by material constraints. Pure, unfettered inspiration, without the limitations imposed by physics. It should be evident, however, that only with materials having defined physical properties a certain esthetic effect can be obtained. The quest for color, for beauty is a fundamental constant in human history, as well as an economic engine, and an inspiration for art and technology alike.

While we easily recognize that the desire to produce richer and more lively images is a clear driver to seek new materials, on the other side of the world, in mines or forests, or in the crucibles of the alchemist (or of his modern counterpart, the chemist), we often overlook how new materials lead to new esthetics.

Using advanced analytical chemistry we can build a material history of art based on physical evidence gathered from masterpieces spanning four millennia, from ancient Egypt to Modernity, demonstrating that technological developments were not only readily embraced, and often prompted by artists and their audiences, but also that they in turn created new forms of expression.

ROBERTA PIANTAVIGNA



Foto © Don Ross/SFMOMA

Roberta Piantavigna is Head of Conservation at Fondazione MAST (Bologna, Italy), where since June 2024 she leads the management and preservation of the collection. Her practice is informed by previous roles as Photography Conservator at the San Francisco Museum of Modern Art and Andrew W. Mellon Fellow at The Museum of Modern Art, New York, as well as by private conservation practice in Milan and Luxembourg.

She approaches conservation as a reflective and adaptive practice, positioned at the intersection of material care, curatorial thinking, and public engagement. Her work and research focus on the opportunities and challenges of collecting and preserving photography collections while adapting to evolving conservation practices that respond to the variability of artworks, climate change, and the expanding social role of conservation within society.

She has presented at international conferences on technical and theoretical topics, including hinging technique for displaying color photographs, the issue of reprinting photographic artworks, sustainability, and policy-making within contemporary conservation practices. Over the years, she enjoyed sharing her experience and studies with students of international conservation programs in Italy and the Netherlands.

Conserving Contemporary Photography: Knowledge in the Making.

While photography conservation practice has generated a wealth of insightful resources through professional research, scientific collaboration, and conservators' experience, the knowledge surrounding contemporary photography conservation remains fragmented. Rather than being consolidated into a substantial body of reference literature, it is distributed across isolated museum projects and practices, and individual expertise, leaving many of the challenges of preserving contemporary photographic works still underinvestigated.

This keynote invites the audience to recognize this condition and view it as a fertile space for curiosity, experimentation, and collective thinking. Drawing on conservation practice at the intersection of traditional photography and contemporary art, the talk reflects on how the conservator's role entails engaging with uncertainty and adapting to change. It contributes to expanding the understanding of contemporary photographic heritage through approaches and ethics informed by other disciplines within conservation and social studies.

By embracing what has not yet been fully investigated or written, the keynote aims to spark enthusiasm for research, dialogue, and new forms of knowledge-making and sharing in contemporary photography conservation. It calls for an expanded, inclusive, and responsive approach; one that recognizes experiential knowledge as a vital resource and positions conservators as active contributors to the evolving history of photography and to the remit of conservation itself.

PIETRO PALLADINO



Pietro Palladino, Electrical Engineer, registered with the Order of Engineers of the Province of Milan. Owner of a professional firm that has been working in Milan since 1990 in the field of lighting design. Alongside his work as a designer, he also works as a technical consultant for public administrations, manufacturing companies, and cultural institutions. He is the author of several publications, including two lighting manuals.

Involving in heritage lighting, he deals with museum, particularly ancient art, designing dedicated lighting systems and innovative bespoke equipment.

Electrical and Lighting consultant for Duomo of Milan.

Adjunct professor at the Polytechnic University of Milan, where he teaches light design in the Faculties of Architecture and Design. Teacher of the 1° Level Master's Degree in Lighting Design & LED Technology, Poly.Design Milano and of the SSBAP Specialization School of the Polytechnic of Milan. Technical consultant to the Court of Milan, Honorary President of APIL (Italian Association of Lighting Professionals).

Color rendering variations in paintings in function of their surface reflection characteristics

The keynote refers to cases where the color rendering of pictorial works is not attributable to the absorption and dispersion of pigments and/or to the specific properties of the substances present in the pictorial layers. The features considered include surface and interior structures of the painting. These factors can influence the perceived color and color differences between similar objects depicted. It is often difficult to ascertain whether the cause of the observed differences is the consequence of these factors, as well as to evaluate in advance the real changes that they can induce in the colors of the painting.

Surface reflection can vary as a function of the gloss of the painted surface. In reality, materials can present many different types of textures and various evident surface irregularities.

The amount of incident light reflected depends on the ratio between the refractive indices of the two materials at the interface: therefore, in the case of transparent protective layers or protective glasses, perceivable alterations in the color rendering of a painting can occur, as well as unpleasant "shimmering" phenomena.

The study presented is aimed at analyzing the phenomena described above and examining possible solutions to limit color shift in permanent exhibitions.

AWARDS

ASSOCIAZIONE ITALIANA COLORE - COLOR AWARD 2026

CHRISTIAN GRECO



The Premio del Colore, established by the Associazione Italiana Colore, is an annual award honoring individuals who have made outstanding contributions in Italy to culture and science related to color.

For its twelfth edition, the Association is proud to recognize **Christian Greco**, Director of the Museo Egizio in Turin, a leading figure in contemporary Egyptology and museum leadership.

Trained in Classical Literature at the University of Pavia, in Egyptology at Leiden University, and holding a PhD in Egyptology from the University of Pisa, Christian Greco has developed a distinguished international career.

He served as curator of the Egyptian collection at the Rijksmuseum van Oudheden in Leiden, collaborated with the University of Chicago's Epigraphic Survey in Luxor, and, since 2011, has co-directed the Dutch-Italian archaeological mission at Saqqara. Under his leadership, the Museo Egizio has undergone a major process of renewal, consolidating its role as an internationally renowned center for research, education, conservation, and public engagement. His achievements have earned him numerous distinctions, including Best Director of an Italian Museum in 2019 and 2022, the Order of Merit of the Italian Republic in 2020, and Torinese dell'Anno in 2023.

Christian Greco's work combines scholarly rigor, innovative museum practice, and a multidisciplinary vision. This is especially evident in his attention to the material, symbolic, and perceptual dimensions of color in ancient Egypt. From archaeological discoveries and scientific investigations to the identification and classification of pigments, his research reveals color as an essential component of ancient Egyptian cultural heritage.

This approach is exemplified by *Materia. Forma del tempo*, the exhibition he curated for the bicentenary of the Museo Egizio. Developed as a new permanent gallery, it brings together chemists, conservators, archaeologists, and historians to investigate the materials and colors of ancient Egyptian craftsmanship. Studying fragments, stones, wood, painted surfaces, and decorative elements made it possible to reconstruct a scientifically grounded palette of pigments known in history. The research also produced the first comprehensive catalog scientifically classifying pigments and dyes used across different periods of ancient Egyptian history.

Through intellectual rigor, visionary leadership, and an exceptional commitment to making knowledge accessible, Christian Greco has shown how museums can connect the ancient world with the questions, communities, and responsibilities of the present.

For uniting research, teaching, conservation, and public communication, and for his distinctive contribution to understanding color in ancient cultures, the Associazione Italiana Colore is honored to present him with the Color Award 2026.

AIC - STUDENT PAPER AWARDS 2026

The **AIC Student Paper Awards** scheme encourages students to present their work at AIC meetings and benefit from interaction with the international color community.

WINNERS

- **First prize: #125 Object relighting using only tristimulus information**

Luca Cogo, Claudio Rota, Marco Buzzelli, Simone Bianco, Raimondo Schettini

Department of Informatics, Systems and Communications, University of Milano-Bicocca, Milan, Italy

- **Second prize: #51 Study on flicker evaluation metrics considering sensory characteristics**

Tatsuki Tsukuda¹, Kazuto Takase² and Nozomu Yoshizawa¹

¹Department of Architecture, Tokyo University of Science, Noda, Japan

²University of Fukui, Fukui, Japan

- **Third prize: #160 Shedding light on the study of crack formation and propagation in las meninas by Picasso (1957), using non-invasive imaging**

I.Samaniego-Jiménez¹, M.Á. Herrero-Cortell¹, M. Gnemmi², F.C.Izzo², M. Picollo³, L. Osete-Cortina¹, L. Fuster-López¹, A. Vila⁴

¹Instituto Universitario de Restauración del Patrimonio, Universitat Politècnica de València, 46022 Valencia, Spain

²Università Ca' Foscari Venezia, Venice, Italy

³Istituto di Fisica Applicata "Nello Carrara" - Consiglio Nazionale delle Ricerche (IFAC-CNR), Via Madonna del Piano 10, Sesto Fiorentino, 50019 Florence, Italy

⁴Museo Picasso Barcelona, 08003 Barcelona, Spain

HONORABLE MENTIONS

#158 Artificial intelligence in the architectural design process

Jakub Demčák

Slovak University of Technology (Department of Architecture and Design, Institute of Ecological and Experimental Architecture, Bratislava, Slovakia)

#63 Colour perception characteristics associated with long-term exposure to low-illuminance visual environments

Qinxin He, Soojin Lee, Stephen Westland

School of Design, University of Leeds

ABSTRACTS OF THE AIC MIDTERM MEETING 2026

SESSION A1S1 - Chair: Alice Plutino

| Color Photography and Film

List of Abstracts:

[6], [179], [22], [94], [178], [115], [79].

[6] Bianca Irene Carnesale (Department of Science and Technology for the Conservation of Cultural Heritage, Università degli Studi di Milano), Sofia Colombero (Department of Science and Technology for the Conservation of Cultural Heritage, Università degli Studi di Milano) and Alessandro Rizzi (Department of Computer Sciences, Università degli Studi di Milano).

Colour in Animation: A Case Study of Arcane.

Abstract. Colour has always played a central role in human visual communication, serving both as an expressive medium and a symbolic system throughout art history. From prehistoric painting to digital media, colour has shaped perception, emotion, and meaning, functioning as a universal language. In contemporary artistic production—particularly in cinema and animation—colour remains an aesthetic component and also a semantic, psychological, and narrative device. Animation, situated at the intersection of art, science, and technology, can therefore be regarded as a form of intangible cultural heritage: an audiovisual artifact that transmits aesthetic values, collective memories, and symbolic codes, thus contributing to the ongoing construction of cultural identity.

This paper investigates the role of colour in the animated series *Arcane* (2021, Riot Games & Fortiche), as a paradigmatic example of the convergence between traditional artistic sensibility and contemporary digital craftsmanship. Through qualitative and quantitative methods, the study explores colour as a narrative, symbolic, and emotional structure. The analysis examines a range of chromatic strategies, from the contrasting atmospheres of Piltover and Zaun to the symbolic and emotional palettes of the main characters. Golden and blue tones in Piltover convey rationality, progress, and order, while green and black hues in Zaun evoke toxicity, rebellion, and decay. This contrast serves as a metaphor for the duality between control and chaos, privilege and marginality, light and shadow.

The methodology integrates a theoretical framework rooted in art history, colour psychology, and visual semiotics with an empirical investigation based on a perception survey administered to a diverse group of viewers. The questionnaire assesses associations between colours, emotions, and character perception, comparing responses from participants familiar with *Arcane* to those encountering it for the first time. Statistical and qualitative analyses reveal that colour choices strongly influence emotional interpretation and narrative understanding, showing how chromatic structures operate as cognitive and affective cues within the viewing experience.

By examining *Arcane* as a contemporary cultural product, this study contributes to the recognition of animation as a legitimate component of cultural heritage. Colour, in this context, acts as a bridge between traditional artistic practices and digital image-making, carrying forward the expressive legacy of painting into the audiovisual domain. The findings highlight how the aesthetic and symbolic dimensions of colour in animation not only enhance narrative depth and viewer engagement but also participate in broader processes of cultural preservation and transmission. In this sense, *Arcane* exemplifies how the language of colour continues to evolve while retaining its power to embody, communicate, and conserve shared human meanings across media and generations.

Keywords: colour, animation, cultural heritage, visual perception, *Arcane*, digital media

[179] Valentina Rossetto (Cineteca Nazionale), Jeanne Pommeau (Národní filmový archiv, Závěsava 502/5, 140 00 Prague 4, Czech Republic), Greta Peruzzi (Sapienza University of Rome - Department of Earth Sciences) and Lisa Vergelli (Laboratorio di Chimica, Istituto Centrale per il Restauro, via di San Michele 25 –00153, Roma).

Investigating Colour in Lumière Film Stock: Scientific Approaches and New Perspectives.

Abstract. For many years, and despite its historical and aesthetic significance, colour in Lumière film stock has been treated as a marginal issue. As summarised in the contribution “Colours of Early Cinema: The Case of Leopoldo Fregoli’s Films (1897–1899) Through Diagnostic Investigation”, presented at the XX Colour Conference, two main interpretations have long prevailed: Lumière films were considered to be tinted, whereas more recently their colour appearance has been interpreted not as the result of intentional colouring, but rather as a yellowish alteration caused by nitrate degradation. In recent years two studies have employed scientific analyses to investigate the presence of colourants in Lumière film stock and to identify their nature: one conducted by the Cineteca Nazionale in Rome, and the other by the Národní filmový archiv in Prague. The study conducted by the Cineteca Nazionale was carried out in collaboration with the Department of Biology of Sapienza University of Rome and of Chemistry lab of the Istituto Centrale per il Restauro. This research focused on a group of Leopoldo Fregoli’s films (1897–1899), whose light to dark amber appearance could not be correlated with the typical visual and chemical markers of cellulose nitrate decay. A multi-analytical approach based on ATR-FTIR, FORS, Raman and SERS analyses suggested the presence of synthetic dyes, raising the hypothesis of a colouring process occurring prior to filming, probably during the production of the positive film stock. In parallel, in the frame of a PhD thesis started in 2019 looking for the nature and the reason of the presence of colours in Lumière brothers’ film stocks, a study was carried out at the Národní filmový archiv in Prague, in collaboration with the Max Planck Institute (Jena Germany) and the Charles University (Prague, Czechia), explored different diagnostic strategies, including optical microscopy and gas chromatography coupled with mass spectrometry (HPLC-MS) (applied to organic solvent extracts) as well as Raman microspectroscopy (applied both to the films and extracts) applied to a group of films by Jan Kríženecký’s (1898) shot on Lumière stock. These analyses provided further evidence of colour-related organic compounds and manufacturing features, contributing to the discussion on non-declared colour practices in Lumière film production. Building on these findings, this contribution presents a new phase of the research, in which the same multi-analytical protocol, based on ATR-FTIR, FORS, Raman and SERS analyses is extended to the Kríženecký’s. By applying a consistent diagnostic framework to two groups of films sharing the same manufacturing origin this study aims to assess whether the identified colourants are comparable and to address broader technological questions concerning possible colouring modalities, including the use of pre-dyed supports or colouring processes applied prior to the gelatine-silver emulsion layer.

Keywords: Film restoration, Film Preservation, Scientific Analysis

[22] Iryna Marholina (LMU).

Discourse on Film Color in the Voices of Soviet Thaw-Era Viewers.

Abstract. The Thaw marked not only a period in which Soviet public discourse began to loosen after decades of censorship but also, more importantly, a moment when Soviet screens were flooded with an unprecedented variety of color films. These included not only domestic productions but also trophy films, among them German color features brought to the Soviet Union after the Second World War. Soviet audiences welcomed color with considerable enthusiasm, and the written traces they left behind make it possible to examine how viewers understood and responded to this new cinematic medium.

Any study of color must inevitably contend with its unstable nature, and research on color in Soviet cinema, particularly during the post-war and Thaw periods, is no exception. On the one hand, the study of the films themselves is complicated by the fact that the original master positives, produced under the cinematographer's supervision, have not survived and are therefore unavailable in the form originally intended by their creators. On the other hand, even contemporary audiences rarely shared access to a single, uniform version of a film. While color prints were generally screened in major cinemas in Moscow and other large cities, copies distributed to smaller towns and less well-resourced cinemas across the Soviet Union were often printed in black and white. As a result, viewers' experiences of the same film could differ substantially depending on where they saw it. This, together with the abundance of color films, raises the questions of how audiences understood color as a cinematic medium and what discourse it generated — questions that can only be addressed through contemporary written sources.

This paper seeks to identify the principal trajectories of audience discourse on color during the Thaw era by drawing on a wide range of materials — including newspapers, periodicals, diaries, memoirs, and archival transcripts — and interpreting them in the context of the meanings attached to particular color characteristics of the period. By situating this discourse within the broader context of the late Stalinist era and, where relevant, earlier periods preceding the Thaw, the paper also sheds light on the ways in which this discourse emerged and developed.

Keywords: Thaw-Era color film, Color film reception, Soviet color, Viewer perspective

[94] Daniel Vazquez (Complutense University of Madrid), Antonio Alvarez Fernandez-Balbuena (Complutense University of Madrid), Anto J. Benítez (Charles III University of Madrid), Ana Yebra (University of Granada) and Manuel Melgosa (University of Granada).

The influence of projection screens on the colors of early silent cinema films.

Abstract. A previous paper (Heritage 8(12), 532, 2025) analyzed the influence of the spectral power distributions of three projection lamps (carbon arc, Xe, and ultra-high pressure) on the colors of 43 samples in 13 frames of films from the 1910's and 1920's. Reported average color inconstancy values were 3.5, 7.0 and 7.9 CIELAB units for changes from carbon arc to Xe lamp, from Xe lamp to ultra-high performance lamp, and from carbon arc to ultra-high performance lamp, respectively. In this paper, it was assumed projection on an ideal non-fluorescent diffusing screen (constant spectral reflectance factor of 1.0 at all wavelengths of the visible spectrum). However, this assumption of an ideal projection screen with 1.0 reflectance factor is not realistic: Projection onto real screens has always been the supreme manifestation of cinematography, and the digitization of a motion picture should seek to recreate this visual impression. The goal of the current paper is to compare computed color inconstancy values for changes in projections lamps with those associated to changes in projection screens. Specifically, we measured the spectral reflectance factors of three cinema screens (horizontal lengths larger than 480 cm) using a CM-2600d portable spectrophotometer (d/8° geometry, aperture 8 mm, spectral component excluded, 0% ultraviolet, spectral range 360-740 nm in steps of 10 nm). We performed computations of corresponding colors using the two-step chromatic adaptation transform embedded in the current color appearance model CIECAM16 (CIE 248:2022), considering as reference condition the CIE standard illuminant D65 and CIE 1931 standard colorimetric observer. We assumed adapting luminance $L_A = 30 \text{ cd/m}^2$ and a dark surround ($F = 0.8$), following the recommendation made by CIECAM16 for “viewing projected images in a darkened room”. Replacing the ideal projection screen with a constant spectral reflectance factor of 1.0 by the three projection screens measured by us, the average color inconstancy values remained nearly constant (changes of up to 0.2 CIELAB units). However, average color inconstancy values decreased almost linearly up to 1.3 CIELAB units when we considered ideal projection screens with constant spectral reflectance factors decreasing from 1.0 to 0.5. Current results suggest that the influence of projection screens on perceived colors of frames from cinema films is lower than the influence of the spectral power distribution of the light source employed for projection. This conclusion must be tested by future research considering a large number of light sources, film frames and projection screens.

Keywords: Colorimetry, Color inconstancy, CIECAM16, Colored films, Cinema color

[178] Monia Vadrucci (Italian Space Agency), Sara Zucchi (Accademia di Belle Arti di Bologna), Melissa Gianferrari (Accademia di Belle Arti di Bologna), Chiaramaria Stani (Elettra-Sincrotrone Trieste), Francesco D'Amico (Elettra-Sincrotrone Trieste) and Elena Correra (Archivio fotografico della Fondazione Cineteca di Bologna).

Diagnostic Study on Hand-Colored Daguerreotypes from the David Robinson Collection.

Abstract. This study originates from a conservation thesis project at the Academy of Fine Arts in Bologna and focuses on the analysis and characterization of color in daguerreotypes from the David Robinson collection held at the Cineteca di Bologna. David Robinson, a prominent collector of pre-cinema materials, assembled an extensive collection including optical devices, projection instruments, and photographic and graphic materials. Within the photographic section, numerous daguerreotypes are preserved, fourteen of which feature hand-applied coloring. Hand-coloring was introduced to soften the monochrome appearance of daguerreotypes and enhance their naturalism. Among the photographers most closely associated with this practice were Richard Beard, Antoine Claudet, and William Edward Kilburn, all known for developing or refining coloring techniques; works attributed to Beard (Fig.1) and Kilburn (Fig.2) are present in the collection.

The analysis focused on identifying different methods of color application. Historical sources describe both dry and wet techniques, involving pigments either dusted directly onto the plate or applied with a binding medium. The diagnostic campaign aimed to identify the nature of the pigments and binders used. The examined daguerreotypes show chromatic retouching on flesh tones, clothing, and backgrounds, as well as the use of gold for jewelry details. The color palette includes pink for skin and garments, red for lips and small decorative elements, green for clothing and accessories, and blue for garments and backgrounds.

Preliminary observations were carried out using a Dino-Lite microscope (fig.5 and fig.6) under natural and ultraviolet light. Natural light revealed both uniform and irregular pigment distribution, particularly evident in areas such as the lips. Decorative elements appear (fig.3) slightly raised and show fluorescence under UV light, suggesting the presence of an organic binder.

The diagnostic measurements were performed in collaboration with the SISSI-Bio Offline laboratory at Elettra Synchrotron Trieste and CNR Trieste, within the framework of a CERIC Fast Track project. Complementary vibrational spectroscopic techniques were employed: micro-FTIR spectroscopy in reflection mode, OPTIR spectroscopy at submicron resolution, and Raman spectroscopy, integrated with hyperspectral fluorescence mapping. This multi-technique approach enabled non-invasive identification of constituent materials and understanding of historical application techniques.

The analysis identified historically documented pigments: carmine, cerussite (lead carbonate), strontium and lead chromate, shell-gold, all applied with gum arabic as binder. Significant residues of cyanates (compatible with historical cyanide fixing baths) and sulfates (possible residues from the photographic process or degradation products) were detected, with important implications for the long-term conservation of these unique objects.

Keywords: Daguerreotypes, Non-invasive spectroscopic analysis, Historical pigments and binders

[115] Annie-Dominique Denhez (Université Paris-Nanterre, Gruppo del Colore).

Photography: achromy for polychromy in cretan archaeology, Maraghiannis publishers of Heraklion and Boissonnas publishers of Geneva.

Abstract. While the autochrome plate, a non-reproducible process (1904-07), produces a deceptive effect, how can we capture the dazzling polychromy of ancient Cretan art? In September 2025, in Naples, we saw that Pierre Gusman had sought to paint his photographic prints for Pompeii. The Greek photographer Georgios Maraghiannis, from Crete, published the Minoan colours of Thomas Evans' excavations in Crete, Cretan Antiquities, in three phototype albums between 1906 and 1915, primarily for archaeologists. During the same period, Swiss photographer Frédéric Boissonnas disseminated these discoveries through the publication Des Cyclades en Crète au gré du vent (The Cyclades in Crete, Blown by the Wind) in Geneva in 1919, in association with Daniel Baud-Bovy. This subtle achromaticity thus paradoxically spread ancient polychromy before the astonished eyes of a Western audience.

Comparing the two photographers, as well as Gilliéron's watercolours, will help us understand how photographic achromy can satisfy a trained eye in translating ancient colours.

To do this, we will focus on a few archaeological objects: the "Nike of Achermos", "Steatite rhytons found at Haghia Triada", "The Snake Goddess of Knossos and her acolyte (faience figurines)", Candia Museum: "Painted bull's head relief from Knossos", "Throne Room in the Palace of Knossos", fresco known as "The Parisienne", "Sarcophagus of Haghia Triada (Candia Museum)".

These high-quality phototypes demonstrate the need for the photographer-turned-publisher to remain in control of the quality of tonal nuances, before 'black and white' became the norm for contrasted, overly contrasted photography. But also, between the two craftsmen, the Greek and the Swiss, is it a question of seeking the same readership? Does this last point have an impact on editorial productions?

Keywords: photography, achromy for polychromy, archaeology

[79] Maja Strgar Kurečić (University of Zagreb Faculty of Graphic Arts), Lidija Mandić (University of Zagreb Faculty of Graphic Arts) and Nikolina Stanić Loknar (University of Zagreb Faculty of Graphic Arts).

Light Painting in Digital Photography: Techniques, Tools, and Visual Outcomes.

Abstract. Light painting is a photographic technique based on the use of long exposure combined with the controlled movement of a light source or camera. This paper examines light painting as a versatile visual practice situated at the intersection of art photography, commercial photography, and time-based media such as stop-motion animation and video. The historical development of light painting is outlined, followed by an overview of its contemporary applications, with particular emphasis on commercial and digital contexts.

The study systematically categorizes principal approaches to light painting, including object illumination in complete darkness, movement of a light source directed toward the camera, and camera movement in relation to a static light source. The required photographic equipment is analysed, with special attention given to various types of light sources - from handheld flashlights to unconventional sources such as burning steel wool - and the distinct visual effects they produce.

Through the analysis of selected examples, the paper discusses the aesthetic and technical possibilities of light painting and proposes practical guidelines for its application in photographic and audiovisual production. The findings highlight light painting as an adaptable technique that expands the expressive potential of long-exposure photography in both artistic and applied visual media.

Keywords: digital photography, long exposure, light painting

SESSION A2S2 - Chair: Maurizio De Vita

| Colors of Historical Cities

List of Abstracts:

[\[85\]](#), [\[69\]](#), [\[133\]](#), [\[10\]](#), [\[146\]](#), [\[116\]](#), [\[93\]](#).

[\[85\]](#) Kine Angelo (Norwegian University of Science and Technology) and Alex Booker (Norwegian University of Science and Technology).

Heritage accuracy in the light of public familiarity: who defines authenticity?

Abstract. This article examines the heritage conflict surrounding the proposed 2025 façade restoration of Stiftsgården. Built between 1774 and 1778, Stiftsgården is the Nordic region's largest wooden mansion and has served as the official Royal Residence in Trondheim since 1906. The dispute offers a clear example of the tension between historical accuracy and established civic memory. The Directorate for Cultural Heritage, supported by technical analysis from the Norwegian Institute for Cultural Heritage Research (NIKU), proposed restoring the building to its original light-grey colour, arguing that this would recover an intended aesthetic modelled on stone architecture. By contrast, local heritage authorities, local professional expertise, the City Commissioner for Urban Development and much of the public advocated retaining the yellow-ochre colour. Applied during a major restoration in the late 1950s, the yellow-ochre façade has become a defining feature of the cityscape. The local position holds that this colour has acquired its own authenticity through decades of cultural significance, public familiarity and integration within the urban colour environment. Using this case the paper examines concepts of authenticity in the Venice Charter and the Nara Document on Authenticity. It identifies a disconnect between expert-led conservation that privileges the earliest documented layer and socially constructed values that emphasise continuity, context and familiarity. The authors argue that a strictly chronological approach risks overlooking the cumulative value of later interventions that have become integral to local identity. Sustainable heritage management should therefore extend its assessment of authenticity to include public memory, situated expertise and significance within the cultural environment.

Keywords: architectural colour, authenticity, Stiftsgården Trondheim, heritage conservation, local knowledge, Venice Charter, Nara Document

[69] Juan Serra (Universitat Politècnica de València), Ana Torres (Universitat Politècnica de València), Pedro Verdejo (Universitat Politècnica de València) and Ignacio Cabodevilla-Artieda (Universitat Politècnica de València).

Methodological Approach to the Chromatic Restoration of Historical City Centers: Case Studies in Valencia.

Abstract. Color has historically played an essential role in the urban manifestation of architecture, expressing the aesthetic values of a period and the material possibilities of a territory. Restoring the original colors of historical buildings is not merely an aesthetic recovery but a critical effort to reinstate the architectural language and preserve the formal logic defining its design. This communication presents the comprehensive methodology developed by the Color in Architecture Research Group (GICA-UPV) at the Heritage Restoration Institute of the Universitat Politècnica de València, applied to various restoration projects in the historical center of Valencia between 2020 and 2024.

The proposed methodology is founded on a multidisciplinary approach that integrates deep historical analysis, objective in situ registration, and advanced laboratory testing. It begins with documentary research in municipal and professional archives to understand the original material culture and architectural typologies of the era. Unlike other methodologies that often result in unspecific color palettes, the GICA-UPV approach explicitly links color to architectural typology—distinguishing between artisanal, classical, eclectic, and modernist styles—to preserve the original chromatic heterogeneity and the specific identity of each neighborhood.

Technically, the process involves the objective registration of existing colors and stratigraphy using colorimeters (NCS and Munsell systems) and spectrophotometers. This is supported by the extraction of mortar samples for laboratory analysis. Techniques such as Optical Microscopy (OM) and Scanning Electron Microscopy with Energy Dispersive X-ray Spectroscopy (SEM/EDS) are employed to identify the mineralogical composition of mortars and pigments, ensuring that new materials during the restoration are compatible with original construction techniques.

The communication illustrates this methodology through five distinct case studies in Valencia. These include the residential building at Plaza Correo Viejo No. 2, where an original ochre and green palette was recovered ; the eclectic "Palacete Burgos," where specific palettes were devised to resolve inconsistencies between the project design and the built reality ; the bourgeois residence at Calle Cerrajeros 1; the modernist "Casa del Punt de Gantxo," which required preserving iconic red and blue sgraffito ; and the Red Cross building, where a highly chromatic scheme was restored over a whitened facade.

The final stage of the methodology involves the formalization of color charts in standard notation and the creation of intervention sheets to guide the chromatic composition. Crucially, the process includes the supervision of the implementation phase to adjust colors to real-world lighting and observation conditions, ensuring the preservation of the city's historical chromatic values.

Keywords: color, architecture, historical city center, heritage, restoration, Valencia

[133] Mette Bye (Trondheim municipality).

Presentation and representation of cultural heritage through color restoration.

Abstract. In this paper I will address the significance of colour in the presentation and representation of architectural heritage through the discussion of two case studies of monumental, listed buildings in the city of Trondheim, Norway, “Stiftsgården” and “Sukkerhuset”. The buildings color history will be discussed through the perspectives cultural historical significance, architectural style and urban context, as voiced both by the professional community and public opinion.

Color is an important part of architectural heritage, of how we experience architectural icons and cultural environments, how they constitute the image of cities and places, and which stories they tell. Trondheim, Norway, is a city with a long history of colorful architecture. Wooden buildings dominates the historic vernacular while stone buildings were rare and costly, until brick became a standard building material with the fire prevention legislation for the dense city core around 150 years ago. Color was used extensively in the exterior and or interior in both building categories. During the 17th century it became increasingly common to clad the exterior of wooden buildings, and paint them. A proper upkeep of a building required regular re-painting, and the color schemes over time reflect both which materials and pigments were available, and an adaptation to stylistic trends. An examination of the color history of a building therefore can reveal much information, and be an important tool for decisions made in a professionally administered building restoration. An archaeological color survey, if the surface of the building has not been unduly tampered with, give a factual account of a the technical composition of pigments and binders and a chronology of layers. This, together with pictorial documentation and data of the history of use, constitute a basis for decision on color restoration. However, the facts of a building's color history does not necessarily dictate a firm conclusion.

The city has over the recent years seen discussions on the color restoration historic buildings, discussions which also have engaged the general public. Two cases which have been chosen for this study stand out. They both concern monumental, listed buildings which have been subject to a scientific and antiquarian approach to their respective restorations, to the surveys done, and the decisions made. In both cases the facades, materials and colors were examined by conservation professionals, and in both cases the conclusions and choice of a color scheme for the restoration of the building created a conflict both within the professional community, and a public debate where objecting opinions were aired. What information and argumentation prevailed in concluding the color restoration for these two historic architectural icons, and what can we learn from the discussions that followed?

Keywords: Restoration, color history, cultural heritage

[10] Julian Rennie (School of Architecture, Interior Design School at Unitec, Auckland, New Zealand) and Alessandro Premier (School of Architecture and Planning, The University of Auckland, New Zealand).

Colour conservation study of Gummer Ford's country house: Arden, Havelock North, New Zealand.

Abstract. Architect William Gummer (1884-1966) was born in Auckland, New Zealand. He left for the United Kingdom in 1908, studying at the Royal Academy of Arts in London, and qualified as an associate of the Royal Institute of British Architects. He notably worked for Sir Edwin Lutyens (and Daniel Burnham of Chicago). Upon his return home, he set up the architectural practice "Gummer Ford" in 1923 with Englishman C.R. Ford (who had travelled as the youngest member of Scott's Antarctica 1901-04 expedition). In the same year that he set up the practice with Charles Reginald Ford, he married Oiroa Batley, who was the sister of Ami Miriama Chambers (1899-1990). In 1925, Gummer Ford (now part of the family) was commissioned by Maurice and Miriama Chambers to design Arden as their country house in Havelock North, Hawkes Bay, New Zealand. In the opinion of some, Arden has features which appear in houses designed by Ford, indicating the work was a collaboration between the two architects. There are certainly clear similarities in the design and material selection to another homestead designed a few years earlier (1916) by William Gummer alone: Tauroa, also in Havelock North and the subject of another colour study by the same authors. At first sight of Arden (up a long driveway), is a rather grand house sitting on the crest of the hill. The north-facing front facade is symmetrical and well-proportioned; it has been described as "Stripped Classical" in style. The ground-floor arched doorways contrast with the rectangular upper-floor windows and doors. With white plaster finish, arches, and terrace balconies, Arden has an Italianate/Mediterranean look. The goal of this research is to reveal the undoubted significance of this architectural gem within the broader heritage of New Zealand Architecture and to outline a proposal for the conservation of its colours in the near future. The methodology of the study involves a review of relevant literature, archival research (including historic photos and drawings), and on-site analysis. The latter involves the identification of the building colour palette (façade and interiors) by using the NCS Colourpin SE tool. Colour codes will be represented following the NCS 1950 chart and equivalent RGB values. Colours identified will be compared with archive material to better understand its original context. The final colour palette will be useful to practitioners for any future conservation of this important gem of early New Zealand's 20th-century architecture. Expected results include the formulation of some brief guidelines for the colour conservation of the building. This study is part of a broader research project aimed at identifying guidelines for the colour conservation of public and private buildings designed by Gummer and Ford in New Zealand.

Keywords: Colour conservation, Cultural heritage, New Zealand Heritage, Gummer Ford Architects

[146] Maddalena Branchi (Dipartimento di Architettura, Università degli Studi di Firenze) and Laura Marchionne (Dipartimento di Architettura, Università degli Studi di Firenze).

Colour and energy retrofitting in historic built heritage: urban effects and conservation challenges.

Abstract. Colour plays a decisive role in shaping the image of the city and the existing architectural heritage, functioning both as an intrinsic component of the construction system and as a visible expression of materials, historical building techniques, and conservation and transformation processes stratified over time.

Through the characteristics of its construction traditions, historic architecture represents a site of sedimentation of the historical and cultural meanings of the territory, conveying both tangible and intangible identity values. The preservation of these values assumes a central role when confronted with current demands for the energy retrofitting of the existing built environment.

Within the framework of European objectives for decarbonisation and energy consumption reduction, such demands face a building stock that is largely outdated and characterised by significant energy inefficiencies. According to ISTAT data, over 70% of Italian buildings were constructed prior to the introduction of energy regulations in 1976, and more than half of residential buildings fall within energy classes F or G. Despite a recent acceleration driven by building incentive schemes, refurbishment rates remain limited and insufficient to meet European targets for improving the energy performance of the built environment.

In this context, the reuse and energy upgrading of existing buildings emerge as essential strategies for achieving environmental sustainability goals, offering an alternative to replacement-driven approaches or further land consumption. However, when interventions are carried out according to highly standardised solutions, there is a risk of insufficient attention to conservation requirements, potentially leading to alterations in the image and material characteristics of historic architecture.

This scenario highlights the need for a systematic, structured, and long-term sustainable approach capable of integrating energy efficiency objectives with the protection of constructional and material features that define the identity of historic architectural heritage. The contribution thus engages in an interdisciplinary debate addressing how sustainability and conservation can be reconciled within a conscious design approach to the historic built environment, oriented towards safeguarding architectural image, traditional values, and the identity role of architecture for local communities.

The proposed topic connects multiple scales of intervention, from the individual building to the settlement and urban landscape scales, all of which are affected by design choices applied to single architectural artefacts.

Keywords: historic urban fabric, multiscalar approach, compatibility assessment, urban governance, heritage communities

[116] Nadia Bouzgarrou (LARPA- EDSiA-ENAU-UCAR, CRENAU/AAU-UMR_CNRS-ENSA-EDSIS-Centrale Nantes), Faten Hussein (LARPA- EDSiA-ENAU-UCAR) and Laurent Lescop (CRENAU/AAU-UMR_CNRS-ENSA).

Ambient Regeneration of the Carthage Cathedral through HBIM: Color as a Sensitive Heritage Parameter.

Abstract. The Saint Louis Cathedral, in Carthage, exemplifies 19th-century North African eclecticism through its Byzantine-Moorish design articulated by distinctive polychromy as a cultural identity marker. Current Heritage Building Information Modeling (HBIM) practices prioritize geometric and structural accuracy while neglecting intangible sensory dimensions, ambient qualities, chromatic richness, and lived ambiance. Existing semantic HBIM frameworks rarely integrate color as a structured informational layer capable of conveying cultural and historical meaning.

This study presents an experimental methodology currently under development within the BIMASPHERE - Regenerative Ambiances and Cultural Heritage project within which a joint PhD thesis in cotutelle is being conducted, which aims to develop an enriched ambient HBIM model that integrates color as sensitive Heritage Parameter. The workflow starts with comprehensive data acquisition using terrestrial laser scanning (TLS) and digital photogrammetry with colorimetric calibration using standardized color targets. Point cloud resolution directly determines the Level of Detail (LOD) achievable in the final HBIM model, enabling refined geometric accuracy and detailed architectural representation with scientifically validated chromatic data.

The technical innovation lies in transforming raw chromatic information into semantic data within the HBIM model. Using AI-assisted segmentation algorithms, RGB data embedded in the point cloud is analyzed to group points into "chromatic families" that correspond to distinct architectural components. Through this process, color goes beyond its role as mere surface appearance and becomes a structured data point classified as material object families within the HBIM framework. Each chromatic family integrates both the chemical properties of pigments and their symbolic, memorial significance as metadata, allowing multi-dimensional analysis of the building's envelope.

The initial results show the feasibility of this semantic transformation: visual information of a colored pixel on a point can be successfully converted into exploitable architectural and historical knowledge. Preliminary tests demonstrate the methodology's ability to identify patterns of material degradation, distinguish original from restored surfaces, and document the interplay between natural light and polychromatic ornamentation that defines the monument's *genius loci*.

Beyond geometric documentation, this methodology opens new pathways for heritage valorization by establishing a chromatic ontology within HBIM workflows, with potential for future IFC (Industry Foundation Classes) integration. This method preserves the Acropolium's "chromatic soul" as a sensitive heritage parameter not as abstraction, but as operational data informing conservation decisions, enriching virtual heritage experiences, and transmitting the site's unique luminous ambiance to future generations.

Keywords: HBIM, Ambient Regeneration, Chromatic Ontology, Artificial Intelligence, Digital Heritage Conservation

[93] Fiona McLachlan (University of Edinburgh).

An Evolving Identity Through Colour: Balancing Authenticity and Change.

Abstract. The paper considers colour as a potential agent in forging an expression of an evolving identity as part of a retrofitting process.

The imperative to retain more of our existing buildings as a response to the climate emergency, and to extend their useful lives through retrofitting and re-purposing, prompts certain dilemmas over the extent to which they are preserved as ‘authentic’ or subject to change. An understanding of durability, and the care and maintenance of materials and surfaces, is implicit in this emerging discussion. In this respect, the recent book *Material Reform: Building for a Post-Carbon Future* (2024) by Material Cultures is becoming a seminal text. Discussing attitudes to maintenance, they note that contemporary architecture has to negotiate between two equally problematic positions— on one hand we expect buildings to stay pristine, unchanging, the need for ongoing maintenance seen as a result of error, poor design or workmanship. Alternatively, an ‘historical mode’ prioritises the preservation of architectural and cultural heritage of buildings, frozen in time at one particular instance. The authors argue that both positions are equally untenable if we wish to continue to make use of existing buildings for their embodied energy.

Colour enters into this dialogue through a desire to maintain or enhance the established identity and character, or alternatively, to shift the social perception of a place through deliberately novel interventions. The addition of contemporary cladding or coloured insulated render (stucco) may re-clothe the original structure. Even small adjustments to the thickness of walls may be perceptible and, in doing so, alter the appearance. For the most part, change is welcomed as an outward expression of investment, renewal, and rejuvenation. However, examples of poor application of colour used as a low-cost quick fix to ‘cheer up’ dilapidated, weathered, or unloved buildings are numerous.

How significant then is authenticity in the use of colour in architectural retrofit? To what extent can visual change be understood as an evolutionary process? The paper will discuss examples, such as the work of Bolles+ Wilson Architects in the city of Korça, Albania where colour has been used on new and renovated buildings as a signifier of the emerging post-communist era. It will also consider the introduction of a potentially controversial use of colour as part of the renovation and energy retrofit of two large modernist housing blocks in Sheffield and Edinburgh in the UK, both of which have the highest ‘listed’ status for their significance to architectural heritage. The paper will consider how successfully repurposed, or redesigned, architectural projects strike a balance between existing fabric and new interventions that relate intelligently to their continued future use and demand both courage and sensitivity in the use of colour.

Keywords: Architecture, Colour Design, Authenticity, Retrofit, Identity

SESSION A3S3 - Chair: Julio del Hoyo

| General

List of Abstracts:

[\[83\]](#), [\[21\]](#), [\[55\]](#), [\[160\]](#), [\[127\]](#), [\[119\]](#), [\[117\]](#).

[\[83\]](#) Boris Pretzel (Tokyo University of the Arts (retired); Bev/Art;, Victoria and Albert Museum (retired); Imperial College), Masahiko Tsukada (Tokyo University of the Arts) and Satoko Ogura (Tokyo University of the Arts).

Uncertainty and Simplified Error Propagation in Colour Difference Measurements.

Abstract. Given the central role of visual appearance in cultural heritage, colour difference measurements are widely used to assess fading, degradation, and treatment efficacy. However, the apparent ease of modern colorimetry masks the complexity of colour difference metrics and frequently leaves the reporting of measurement uncertainty either neglected entirely or severely oversimplified. This paper analyses spectral and colorimetric measurements from Spectralon standards and Toyo Ink swatches across both benchtop (Shimadzu UV2450) and portable (BYK-Gardner 6834) spectrometers. We demonstrate that, despite CIELAB coordinates being the product of non-linear transforms of directly measurable quantities, simple, uncorrelated error propagation directly from CIELAB coordinates provides a surprisingly robust approximation of fully correlated uncertainty, whereas uncorrelated propagation from directly measurable XYZ tristimulus values typically introduces significant overestimates. Furthermore, we introduce two analytical extensions: (1) using all-possible-pairwise comparisons (N_1 by N_2 colour difference measurements) empirically to validate theoretical uncertainty models, and (2) utilizing the degree of convergence between CIELAB-derived and XYZ-derived correlated uncertainties as a quantitative indicator of dataset quality. Finally, a simple empirical scaling rule is derived to estimate complex ΔE_{00} uncertainties directly from ΔE^*_{ab} .

Keywords: Colour difference, CIEDE2000, Uncertainty, Error, Confidence

[21] Benedykt R. Jany (Marian Smoluchowski Institute of Physics, Jagiellonian University in Krakow).

C-Microscopy: A Colorimetric Approach to Microscale Optical Characterization for Materials and Heritage Science.

Abstract. Colorimetric Microscopy (C-Microscopy) approach presents an accessible, open-access method for microscale optical characterization using standard digital microscopes and free software. By leveraging color-calibrated images, via virtual color checker recovery from single color patches measurements under the microscope, and robust colorimetric calculations, it quantitatively extracts parameters, such as dominant wavelength and excitation purity at the micrometer scale, enabling the detection of subtle variations in pigment composition, surface texture, and microstructure. Systematic uncertainties are assessed via Monte Carlo simulations, ensuring traceability and reliability. Validated on metallic, mineral, and biological samples, including pure gold, microgrooves on copper, Lapis Lazuli, and 3D cell spheroids, C-Microscopy successfully differentiates pigments and reveals microstructural changes. It is also possible to reconstruct full hyperspectral reflectance data cubes (spectral reflectance as a function of x , y , λ) within the approach, supporting comprehensive microscale analysis. Implemented as a suite of Python Jupyter notebooks, the method is reproducible, accessible, and scalable. This approach bridges macroscopic color perception with microscale material characterization, offering a practical and cost-effective solution for materials science and heritage science, giving a possibility to perform colorimetry at microscale.

Keywords: color, colorimetry, microscopy, heritage science, material science, colorimetric microscopy, C-Microscopy, microscale

[55] Gianmarco Borghi (Marian Smoluchowski Institute of Physics, Jagiellonian University in Krakow, Poland), Anna Ryguła (The Laboratory of Analysis and Non-Destructive Investigation of Heritage Objects, The National Museum in Krakow), Marco Gargano (Istituto di Fisica Generale, Università di Milano, Via Celoria 16, 20133 Milano, Italy), Julio del Hoyo (The Laboratory of Analysis and Non-Destructive Investigation of Heritage Objects, The National Museum in Krakow) and Benedykt Jany (Marian Smoluchowski Institute of Physics, Jagiellonian University in Krakow, Poland).

Correlative Colorimetric Microscopy (C-Microscopy) in Heritage Science.

Abstract. The accurate identification of historical pigments in polychrome artworks typically relies on multi-analytical strategies by combining complementary spectroscopic and imaging techniques. This paper presents application of Colorimetric Microscopy (C-Microscopy), based on reflected light Dark Field microscopy, in cultural heritage science, integrated within a Correlative Multimodal Microscopy (CoMic) framework alongside micro-Raman spectroscopy (μ RS). The methodology is grounded in the fundamental physical connection between a material, its microscopic color response, and its vibrational properties, both formally linked through the electronic structure. Based on this premise, we propose a multimodal 2D fingerprinting approach that combines the CIE LCh hue angle (h°) and Raman peak position to create unique diagnostic signatures at the micrometer scale on polished cross-sections. In this workflow, C-Microscopy serves a dual purpose: acting as a rapid screening tool to bypass resin-contaminated regions, and providing a robust preliminary pigment identification based on chromaticity, which is subsequently confirmed by targeted micro-Raman analysis. Three samples were investigated: two laboratory mockups (natural azurite and vermilion in walnut oil) and one historical cross-section extracted from the flesh tones of a Baroque oil painting. Rigorous color calibration ($\Delta\text{RGB} \approx 2.6$, D65 illuminant, CIE 1931 2° observer) and spatial co-registration via the ImageJ/FIJI Correlia plugin enabled reliable pigment identification. Furthermore, C-Microscopy demonstrated as a rapid quality control screening tool, capable of identifying resin-contaminated regions prior to Raman acquisition. These results support C-Microscopy as a low-cost, accessible, and quantitative diagnostic tool for preliminary pigment identification in heritage science.

Keywords: C-Microscopy, Raman spectroscopy, Correlative Multimodal Microscopy, Preliminary pigment identification, Multimodal fingerprinting

[160] Irene Samaniego Jiménez (Instituto Universitario de Restauración del Patrimonio, Universitat Politècnica de València (Valencia, Spain)), Miguel Ángel Herrero Cortell (Dept. Comunicación Audiovisual, Documentación e Historia del Arte, Universitat Politècnica de València), Marcello Picollo (Istituto di Fisica Applicata “Nello Carrara” - Consiglio Nazionale delle Ricerca (Florence, Italy)), Margherita Gnemmi (Department of Environmental Sciences, Informatics and Statistics, Ca’ Foscari University, Venice, Italy), Francesca Caterina Izzo (Department of Environmental Sciences, Informatics and Statistics, Ca’ Foscari University, Venice, Italy), Laura Osete Cortina (Instituto Universitario de Restauración del Patrimonio, Universitat Politècnica de València (Valencia, Spain)), Laura Fuster López (Instituto Universitario de Restauración del Patrimonio, Universitat Politècnica de València (Valencia, Spain)) and Anna Vila (Picasso Museum Barcelona. C/Montcada, 15-23, 08003, Barcelona, Spain.).

Shedding light on the study of crack formation and propagation in Las Meninas by Picasso (1957), using non-invasive imaging.

Abstract. The presence of cracks in modern oil paintings on canvas is a common phenomenon. Cracks and fissures arise from externally applied stresses, the intrinsic degradation of materials, and/or their interaction with the environment. These damage phenomena pose significant challenges for conservators and scientists due to their structural implications and the complexity involved in determining how cracks form and propagate within the painted structure. Such gaps in knowledge often lead to ineffective conservation strategies, resulting in the recurrence of cracking. Accurate diagnosis of a painting’s condition—including the location of cracks and their temporal evolution through systematic condition reporting—is therefore essential for the development of effective conservation approaches.

This contribution presents a detailed study of Las Meninas (oil on canvas, 161 × 129 cm, October 2, 1957) by Pablo Picasso, conducted using non-invasive imaging techniques. The Las Meninas series, consisting of 58 canvas paintings, is preserved in its entirety at the Museu Picasso in Barcelona (Spain). This series is of pivotal importance to the collection, as it is the only complete series from the 1950s, having been donated in full by the artist to the museum. It comprises 45 interpretations of Velázquez’s Las Meninas, 9 paintings of pigeons, 3 landscapes, and 1 portrait, representing one of the most significant bodies of Picasso’s late production.

In this study, the painting's structure and morphology, distribution and location of cracks are assessed using multimodal (reflection, transmission, and luminescence) and multiband imaging techniques (visible, infrared, and ultraviolet).

The application of non-invasive image analysis revealed that black, blue, red, and green paints are the most affected by cracking. Crack morphology is shown to be strongly influenced by the colour used, the direction of paint application, paint density, and the presence of underlying layers. Significance is attributed to the use of black paint, as its presence in underlying layers often induces cracking in the superimposed colours, making it a critical factor in the conservation condition of the artwork.

This colour-based approach to the study of crack behaviour—focusing on crack morphology and location—provides a robust framework for comparison across the entire Las Meninas series preserved at the Museu Picasso in Barcelona. The final aim is to be able to define the most appropriate conservation and exhibition strategies and to gain deeper insight into cracking phenomena in Picasso’s paintings from this period. Furthermore, this study seeks to provide conservators with a visual and practical tool to support the characterization, localization, and interpretation of crack evolution over time.

Keywords: Pablo Picasso, Crack patterns, Color, Multiband imaging, Transmitted light.

[127] Marco Gargano (Department of Physics, Università degli Studi di Milano), Daniele Demonte (Centro per la Conservazione ed il Restauro dei Beni Culturali “La Venaria Reale”), Federico Di Iorio (Centro per la Conservazione ed il Restauro dei Beni Culturali “La Venaria Reale”), Mattia Morlotti (Centro per la Conservazione ed il Restauro dei Beni Culturali “La Venaria Reale”), Sara Bonsignore (Università degli Studi di Genova), Francesca Ferrario (Department of Physics, Università degli Studi di Milano) and Tiziana Cavaleri (Centro per la Conservazione ed il Restauro dei Beni Culturali “La Venaria Reale”).

A Standardized Approach to Color Management in UV-Induced Luminescence Imaging for Cultural Heritage Applications.

Abstract. The use of ultraviolet light, along with infrared and X-rays, was the first imaging analysis method for studying and conserving cultural heritage materials. While the results of infrared and X-ray investigations are presented as grayscale images, UV-induced visible luminescence (UVL), also known as UV-induced fluorescence (UVF), produces color images that represent the different visible emissions related to materials in the painting layers. UVL analysis is usually the first diagnostic approach in conservation interventions, and sometimes the only one, as it allows restorers to begin and guide the restoration treatments. To accurately represent fluorescence phenomena occurring in the most superficial painting layers caused by the combined effect of pigments, varnish and binders, proper color management is essential to correlate what is visible through direct observation under UV light with the acquired image. However, common methods and techniques used for optimal color management in the visible range do not work with UV light. Several approaches are currently adopted by conservation scientists to minimize differences that arise from results obtained under different setup conditions, ensuring the best documentation of UVL fluorescence. The combination of light source, camera model, optical filters, and post-processing methods can produce different results, both within the same laboratory and even more so across different laboratories, given the difficulty of comparing results obtained for materials from the same painting during, for example, an entire restoration intervention, as well as those from different artifacts. This work presents a systematic evaluation of the differences that can arise when considering the most common and current acquisition techniques, quantitatively analyzing the differences in results obtained when raw image post-processing is applied. UVL images of a real contemporary canvas painting were acquired, along with a set of mock-ups, using both continuous and flash lighting in combination with several reference standards for color management. Both off-the-shelf and custom references were used to investigate the variability among these materials and the resulting images. Additional aspects have been considered to evaluate the resulting color of the UVL images not as isolated colors, but with a perceptual approach that accounts for the influence of luminance conditions, which affect the visual context in the mesopic range where scotopic and photopic vision are mixed.

Keywords: UV-induced visible luminescence (UVL) imaging, UVL image color management, Cultural heritage conservation

[119] E. Keats Webb (Museum Conservation Institute, Smithsonian Institution) and Jennifer Giaccai (National Museum of Asian Art, Smithsonian Institution).

In a New Light: Using Multiband Photogrammetry to Study Pichwai Paintings.

Abstract. In preparation for the 2025 exhibition “Delighting Krishna: Paintings of the Child-God,” the National Museum of Asian Art conducted a study of their collection of pichwai including material analysis. As part of the material analysis, multiband imaging was requested as noninvasive techniques to visualize, spatially locate, and differentiate materials and material characteristics on the full paintings. UV-induced visible luminescence (UUVL) imaging was requested for spatially mapping luminescent pigments like Indian yellow and reflected infrared (IR) imaging to investigate the presence of underdrawings and differentiate blue pigments. In addition, point-based and sampling techniques including XRF, Raman, FORS, and FTIR were used in the material analysis.

Nathdwara pichwai are large paintings on unstretched cloth with intricate and vibrant details depicting the life of Krishna that are included as part of the alter in the Pushtimarg Hindu tradition. The pichwai can be large (the largest in the exhibition was 248.6 × 286.7 cm), and a single image of one painting would result in a low-resolution, distorted image that would not fully resolve the details of the composition and materials. Traditional image capture of oversized, mostly flat objects includes challenges from the scale of the artwork, limited space to acquire overall images, and lens and perspective distortions that would result from acquisition of tiled images from non-ideal setups and locations.

Photogrammetry, an image-based 3D reconstruction technique, was used to help overcome these traditional image capture issues for large-scale objects to produce high-resolution, undistorted two-dimensional images, or orthomosaics. Due to the large size and non-rigid nature of the pichwai, a custom setup was developed for the imaging that included the camera being mounted above the paintings, and the paintings being positioned on large chloroplast platform that could be moved under the camera.

Fourteen pichwai were imaged using the custom setup for multiband photogrammetry to produce orthomosaics for three bands—visible light, UV-induced visible luminescence, and reflected IR. The results are being used to map the use of Indian yellow, discriminate between various blue and green pigments and pigment mixtures, explore past conservation treatments, reveal underdrawings, and, overall, complement the material analysis and the study of the use of pigments over time.

Point-based and sampling techniques are necessary for material identification, but multiband imaging complements analytical results by visualizing and spatial locating materials across an entire painting. Multiband photogrammetry allowed for the creation of high-resolution, undistorted images that could resolve the fine composition and material details to support the study of the large pichwai and the understanding of the pigments used to create such intricate and vibrant paintings.

Keywords: multiband imaging, photogrammetry, paintings

[117] Candela Belenguer-Salvador (Universitat Politècnica de València), Miguel Ángel Herrero-Cortell (Universitat Politècnica de València), Marcello Picollo (Istituto di Fisica Applicata Nello Carrara IFAC-CNR), Anna Vila (Museo Picasso Barcelona) and Laura Fuster-López (Universitat Politècnica de València).

Coupling MBI, colorimetry and FORS to inform targeted analytical and preservation strategies in the study of failure phenomena in easel paintings Diagnosing Anglada Camarasa's 'Magda Jocelyn' (1904).

Abstract. Anglada Camarasa (Barcelona, 1871 – Pollença, 1959) stands as one of the most singular figures of early 20th-century European painting. A Catalan artist contemporary to Picasso and Miró, whose career unfolded between France and Mallorca, he forged a highly personal visual language that engaged with the avant-garde currents of his time. His early international recognition followed a decisive stylistic transformation after his first stay in Paris at the turn of the century, where exposure to Post-Impressionism prompted a rethinking of color, materiality, and pictorial surface. Central to this evolution was his experimental use of newly available pigments, resulting in intensely saturated and luminous chromatic effects, becoming a hallmark of his work.

Today, a substantial portion of Anglada Camarasa's oeuvre is preserved in the "la Caixa" Foundation collection in Palma de Mallorca, offering a valuable opportunity to investigate his material practice from a technical and conservation-oriented perspective. This research focuses on material characterization, pigment ageing phenomena, and crack formation mechanisms, essential for understanding both the physical behaviour of the paintings and the long-term implications of the artist's material choices.

This paper presents a technical case study of Magda Jocelyn (1904), a work corresponding to a pivotal moment in the artist's career marked by growing international acclaim. Although the painting may have been reworked at a later stage, consistent with Anglada Camarasa's working methods, it provides insight into his material strategies during a formative period. The study advances the preliminary identification of the artist's palette through the combined application of Multi-Band Imaging (MBI), colorimetry, and Fiber Optic Reflectance Spectroscopy (FORS, 350–2100 nm), highlighting the analytical potential of non-invasive methods in the study of modern paintings.

The investigation was structured in two complementary phases. First, MBI documented the optical responses of selected chromatic areas across ultraviolet, visible, and near-infrared wavelengths, supported by colorimetric measurements providing objective chromatic data. These results were compared with a reference pigment checker to formulate initial hypotheses on pigment composition. In a second phase, FORS was applied to representative color zones to refine these hypotheses through localized spectral analysis.

The results demonstrate the strong complementarity of MBI, colorimetry, and FORS, providing both macroscopic and point-specific insights into the artist's materials. This non-invasive approach enables a robust preliminary understanding of Anglada Camarasa's palette and working methods, supports a deeper understanding of his experimental engagement with color, identifying potential conservation concerns, and guides further targeted analyses and preservation strategies.

Keywords: Multi-Band Imaging (MBI), Colorimetry, Fiber Optic Reflectance Spectroscopy (FORS), 20th century European painting, Anglada Camarasa

SESSION A1S4 - Chair: Laura Bellia

| Shedding New Light on Cultural Heritage

List of Abstracts:

[\[130\]](#), [\[60\]](#), [\[125\]](#), [\[187\]](#), [\[183\]](#), [\[24\]](#), [\[186\]](#).

[\[130\]](#) Raffaella Trocchianesi ([Politecnico di Milano](#)) and Francesco Murano ([Lighting for Art | Politecnico di Milano](#)).

The Narrative Role of Light in the Exhibition Design of 'Sensitive' Museums and Temporary Exhibitions. Design-Driven Projects and Tools.

Abstract. This paper focuses on the narrative role of light in exhibit design for museums and temporary exhibitions. The museum is here understood as a sensitive organism, a dynamic and adaptive environment capable of changing in response to environmental and visitor-related variables.

The paper will consist of a first part (exhibit design-driven), in which the discipline of exhibit design will be addressed starting from the concept of narration and of exhibition design as a 'three-dimensional story' that draws on different languages (formal, material, graphic, chromatic, sonic, multimedia, and luminous), particularly those related to the use of light, to offer a complex, multifaceted, and multisensory cultural experience.

A second part (light design-driven) will highlight some narrative attitudes in which light is used according to specific exhibition codes: shaping, drawing, immersing, punctuating, and according to different application scenarios: uniform lighting of the entire environment, uniform lighting of one or more walls, uniform collective lighting of groups of works, individual lighting of single works, mixed lighting, and graphic lighting. Light is here understood as an element of narration, as one of the variables of the exhibition score (Trocchianesi, 2014). An implementation of this design tool will therefore be proposed: the lighting score, to highlight, study, and calibrate the functional and semantic role of light itself.

In conclusion, a responsive lighting intervention will be illustrated, in which light varies according to environmental and visitor-related factors, applied to the specific context of Mantegna's Camera degli Sposi at Palazzo Ducale in Mantua.

Keywords: Light design, exhibit design, narrative, design tool

[60] Nozomu Yoshizawa (Tokyo University of Science), Miyu Aoyama (Tokyo University of Science), Yuki Oe (The University of Shiga Prefecture), Yoko Mizokami (Chiba University) and Miho Takashima (The National Museum of Western Art).

Towards a new lighting method for museums considering the optimal brightness for paintings - Painting Classification by Curators -

Abstract. Current museum lighting metrics use illuminance; however, luminance distribution needs to be considered to achieve appropriate visibility with minimal light. Previous research has shown that 1) achieving the appropriate brightness for a painting is the most important factor in determining its visual appearance, and 2) experiments using naive participants have demonstrated that the appropriate brightness can be predicted based on individual painting characteristics such as lightness, saturation, and edge. In this study, we report on a brief survey conducted to determine whether museum curators without lighting expertise can accurately predict the required brightness using the method above. Ideally, curators could a) predict the required brightness for individual paintings based on their respective characteristics, b) calculate the luminance distribution of each painting and its background surface using a prediction formula to achieve the required brightness, and c) develop a lighting plan that achieves the luminance distribution. This would ensure the appropriate appearance of each painting and contribute to their conservation by minimizing unnecessary light utilization.

A brief survey was conducted at the National Museum of Western Art, Japan. The participants included nine curators. A total of six oil paintings—three of which were figurative paintings (hereafter referred to as “FP”) and the remaining three were abstract paintings (“AP”)—were used. A sample sheet was prepared as an index to determine the magnitude of lightness, chroma, and edge perception level of each painting. The survey procedure: (1) Each participant was given 10 min to adapt to the light environment. (2) Thereafter, each participant was given 30 s to observe the painting. (3) Each participant then evaluated the painting by referring to the sample sheet. Steps (2)–(3) were repeated for each painting. Evaluation items were “mean lightness,” “difference in mean lightness with that in the high lightness area (hereafter “lightness difference”),” “mean chroma,” “difference in mean chroma with that in the high chroma area (“chroma difference”),” and “maximum edge perception.”

The correct response rates for the evaluation items were 63% (FP) and 78% (AP) for “lightness difference,” 81% (FP) for “chroma difference,” and 81% (FP) and 100% (AP) for “maximum edge perception.” Compared to the control experiment using naive participants, the correct response rates achieved in the survey were higher in all cases. This is attributed to the distinction between the figurative and abstract paintings, which made it easier for the participants to make judgments. In the final presentation, we plan to discuss the deviation of the appropriate brightness for each painting derived from the survey from the correct value as well as the effectiveness of the proposed method under museum lighting. We will also present the extent to which light intensity can be reduced using the proposed method.

Keywords: Museum Lighting, Painting, Curator, Luminance Distribution, Brightness

[125] Luca Cogo (University of Milano-Bicocca), Claudio Rota (University of Milano - Bicocca), Marco Buzzelli (University of Milano - Bicocca), Simone Bianco (University of Milano - Bicocca) and Raimondo Schettini (University of Milano - Bicocca).

Object Relighting Using Only Tristimulus Information.

Abstract. Object relighting from a single color observation is a fundamentally underdetermined problem in color science. In fact, while physically accurate relighting requires knowledge of surface reflectance spectra and illuminant spectral power distributions, most practical imaging and color reproduction workflows operate exclusively in a colorimetric domain.

This work addresses the problem by restricting the available information to the CIE XYZ tristimulus values of an object under a source illuminant and the XYZ white points of the source and target illuminants. Within this colorimetric framework, we investigate a set of relighting strategies formulated as linear transformations in XYZ space, conceptually rooted in chromatic adaptation theory. Their parameters are determined through large-scale numerical optimization on datasets of simulated corresponding colors derived from spectral reflectances drawn from both standard and real-world sources. The reflectances are rendered under a set of illuminants with known spectral power distributions, selected to represent real-world lighting conditions and including standard natural sources, fluorescent illuminants, and LED illuminants. The resulting pairs of CIE XYZ tristimulus values under source and target illuminants enable optimization and evaluation of the proposed relighting strategies by minimizing the average CIELAB color difference with respect to physically based spectral renderings, within a controlled and fully reproducible experimental framework.

The analysis examines the validity and limitations of global tristimulus mappings under both illuminant-independent and illuminant-dependent assumptions, using a unified and reproducible experimental framework. This enables a principled comparison with classical chromatic adaptation transforms and alternative spectral and tristimulus-based relighting approaches, clarifying the conditions under which chromatic adaptation-inspired models can meaningfully approximate illuminant-induced color changes when relighting is constrained to tristimulus information alone.

Keywords: Object Relighting, Chromatic adaptation, Colorimetric mapping

[187] Steve Paolini (Telelumen LLC).

“EVERY COLOR OF THE RAINBOW”.

Abstract. It is widely understood that daylight comprises the full spectrum of visible colors. In contrast, most electric lighting systems utilize only a limited subset of wavelengths, optimized primarily for maximum luminous efficacy. While this approach enhances brightness, it often sacrifices the richness and accuracy with which colors and details are rendered. Incorporating the full spectrum of daylight can significantly enhance the visual appearance of objects and images.

However, daylight itself is not a fixed or uniform standard. It is highly variable and tends to exhibit a strong bias toward higher correlated color temperatures (CCT), frequently exceeding 6500K.

This presentation will examine the spectral limitations of conventional electric lighting and compare them with a range of daylight spectral power distributions. If time and conditions permit, a live demonstration will be included to illustrate key points.

Keywords: Daylight, Spectral Power Distribution (SPD), Correlated Color Temperature (CCT), Color Rendering (CRI)

[183] Carmelo Occhipinti (Università di Roma "Tor Vergata").

Innocenzo Ringhieri and Sixteenth-Century Debates on Colour: Between Art Criticism and Theory.

Abstract. Carmelo Occhipinti's paper aims to reconstruct a chapter now almost completely forgotten in the figurative and theoretical culture of mid-sixteenth-century Bologna, focusing on the figure of the humanist Innocenzo Ringhieri and his reflections on the nature of colour and light. In the treatise on "Cento giuochi liberali d'ingegno" (Bologna, 1551), and in particular in the chapter entitled "Giuoco dei colori", Ringhieri addressed a question already central to Leonardo da Vinci—namely the relationship between colour, light, and darkness—explicitly asking whether night "dims" or even "extinguishes" colours, and thus whether colour should be understood as an intrinsic quality of objects or rather as a condition dependent on environment and illumination.

This issue, far from marginal, permeated the theoretical debates of the period, especially in connection with the theme of the "paragone" between painting and sculpture, that is, the different ways in which pictorial and sculptural works were to be illuminated, a problem already discussed by Leonardo himself. While some authors, such as Giovan Battista Amalteo, adopted an anti-Leonardesque stance by advocating a materialistic conception of vision—arguing that nothing can be seen unless it exists in matter, and that colours cannot be separated from bodies—Ringhieri pursued a more experimental line of thought. In his treatise "Il Sole", published in Rome in 1550, he formulated remarkably modern observations on the decomposition of sunlight, anticipating issues that would find full theoretical articulation only with Newton. Ringhieri described the behaviour of solar rays as they pass through clear glass and generate different colours, and explicitly questioned whether the sun might contain all colours potentially within itself.

Within this framework, colour was defined as a "shadowed light," while light itself was conceived as a "clear colour," a unitary principle capable of virtually containing chromatic multiplicity. This led to a relational rather than intrinsic conception of colour, dependent on lighting conditions, reflection, and the disposition of rays. Such reflections, which both anticipated and in part surpassed Leonardo's own intuitions, had direct implications for the understanding and reception of contemporary pictorial works. In conclusion, the paper proposes a reassessment, in light of Ringhieri's theories, of the problem of the illumination of Nicolò dell'Abate's frescoes—now displayed under lighting systems wholly indifferent to any historical or philological criteria—showing how inappropriate exhibition practices and lighting apparatuses profoundly alter their original chromatic perception, ultimately betraying their figurative intent.

Keywords: Art criticism, Art history, Theory of color and visual perception

[24] Pablo Ixtaina (Laboratorio de Acústica y Luminotecnia LAL CIC) and Carlos Lionel Colonna (Laboratorio de Acústica y Luminotecnia LAL CIC).

Public lighting in historical cities.

Abstract. From 2005 to 2010, high-pressure sodium lamps (HPSL) were gradually replaced by LED in public spaces. Although early LEDs were not always more energy-efficient, the appeal of white light over HPSL's yellow light strongly accelerated the replacement speed.

LED streetlighting uses a blue junction that excites a phosphor coating, creating white light with a strong blue–yellow-green spectrum. This light, although offering good color rendering, differs greatly from daylight and HPSLs. The study proposes that LED lighting may significantly change how colors appear in heritage urban areas, considering that historic facades were originally viewed under sunlight or combustion-based lighting with blackbody-like spectra unlike LEDs.

The experiment measured 15 coating materials: ten cement-based samples (five greyish and five sand-colored) and five reddish surfaces such as bricks and tiles.

The experimental model simulated vertical walls lit from above, with the observer positioned below. To achieve this, the samples were positioned vertically, and the light source fell from above at angles ranging from the normal to the surface up to approximately 45°. The observer, in turn, maintained a viewing angle of 45°, opposite the incident light.

To measure the spectrum of the light sources and the light reflected by the samples, an Avantes AvaSpec-ULS3648 spectrometer was used. Based on the measured spectra, the chromatic parameters of the sources were calculated: correlated color temperature (CCT) and color rendering index (CRI). As for the light reflected by the samples, the chromatic parameters L^* , a^* and b^* were obtained in the CIELAB space. The CIEDE1976 parameter ($\Delta 76$) was used to quantify the color differences of the surfaces, and its scale was used to weight the existing differences.

The light sources used were natural daylight (the blue component of a clear midday sky) and two commercial LED street-lighting luminaires. The luminaires were chosen as warm and cool types, with values that were not very extreme in terms of CCT: Luminaire A, cool light at 5000 K, CRI 75; luminaire B, warm light at 4000 K, CRI 75.

Taking the colors measured under sunlight as reference, the samples showed changes when observed under LED lighting, with $\Delta 76$ values ranging 2.5–5.1 (“noticeable” to “very noticeable”). In qualitative terms, heritage facades will undergo perceptible color variations. The scene will look shifted towards green under cool light, and more “yellowish” for warm light. Seeking a sense of historical preservation, the warm light may be closer to the original scene (non-electric lighting), although the blue content of the LED spectrum moves it further away from incandescent spectra in the CIELAB space.

This study also analyzes low–light-pollution LED luminaires, designed to protect the night sky near major observatories (northern Chile, Hawaii, and the Canary Islands). As they limit blue-light emission, they could be better for lighting heritage areas.

Keywords: Public lighting, Heritage, True colors

[186] Andrea Siniscalco (Design Department, Politecnico di Milano).

Lighting in the Quarto Camerino of Villa D'Este in Tivoli: a digital reconstruction.

Abstract. The digital reconstruction of historical architectural spaces can be pursued through a wide range of techniques, including conventional three-dimensional modelling, laser scanning, and image-based photogrammetry. While these methods provide a precise geometric representation of built environments, faithfully simulating lighting conditions requires additional layers of information. In particular, accurate lighting simulations depend on reliable photometric data describing the luminous behaviour of the light sources involved. Such data are typically stored in standardised photometric files and are obtained through laboratory measurements of lighting devices using instruments such as goniophotometers, which are generally designed for contemporary electric luminaires.

In the frame of a research project dedicated to the digital reconstruction of the “Quarto Camerino” in Villa d’Este, Tivoli, a central objective was the recreation of the original lighting conditions of this Renaissance interior. Archival documents and historical sources indicate that the space was originally illuminated by four mobile candelabra, approximately 1.5 metres in height, in combination with a portable oil lantern. Reproducing this lighting scenario in a digital environment posed several methodological challenges. The original lighting devices no longer exist, as no photometric documentation of these pre-industrial light sources has ever been available. Moreover, the optical behaviour of flame-based sources might be influenced by the properties of the combustible materials, the flame geometry, and the flame's inherent instability over time.

To address these issues, physical replicas of the historical lighting devices were specifically designed and manufactured, with particular attention paid to the selection and preparation of combustible materials in order to approximate the original candles and oil fuels as closely as possible. These prototypes were then measured in a controlled laboratory environment using adapted measurement protocols that account for the limitations of modern photometric instruments when applied to non-electric, flame-based sources. The experimental campaign produced both photometric distributions and spectral power data, enabling a more comprehensive characterisation of the intensity and colour of the emitted light.

The resulting datasets were subsequently integrated into a digital lighting simulation workflow, enabling the reconstruction of the historical illumination of the “Quarto Camerino.” This contribution presents the adopted methodology, discusses the critical issues encountered in measuring flame-based light sources, and reflects on the potential of combining experimental photometry and digital simulation for the study of historical lighting conditions and visual perception in heritage spaces.

Keywords: Short presentation, Light, Colour, Digital reconstruction, Photometry, Colourimetry.

SESSION A2S5 - Chair: Pietro Matracchi

| Colors of Historical Cities

List of Abstracts:

[\[162\]](#), [\[111\]](#), [\[81\]](#), [\[104\]](#), [\[99\]](#), [\[148\]](#).

[\[162\]](#) Vanda Matos (CIAUD, Research Centre for Architecture, Urbanism and Design, Lisbon School of Architecture, Universidade de Lisboa) and Carlos Alho (CIAUD, Research Centre for Architecture, Urbanism and Design, Lisbon School of Architecture, Universidade de Lisboa).

New colours in old European historical centres.

Abstract. Taking as reference the chromatic plans of Turin, Barcelona Terracina, Siena, Vienna, we will focus on Portuguese historical centres, considering the case of Terreiro do Paço, in contrast with Cordoaria Nacional and Queluz Palace, in the Lisbon region. Terreiro do Paço is a monumental complex surrounding a square along the banks of the Tagus River, at Lisbon downtown. Its designation dates to the XVII century, since it included the king's palace (or paço). After the Lisbon earthquake of 1775, which destroyed Lisbon downtown, it was reconstructed according to Marquis of Pombal plan for Lisbon's reconstruction, and the square became a crucial urban centre.

For this study, a methodology of multiple case studies was chosen, also grounded in historical research and information. Terreiro do Paço was photographed in its the current shape and the colour used evaluated regarding its authenticity.

In the late 1940s Raul Lino painted the façades of the monument green, given its proximity to the river Tagus. In 1974 they were painted red. However, in 1994, a discussion on authenticity of the colour of the square led to an exhibition and a journal on the subject. The iconographic reference found in São Luis do Maranhão, in Brazil, helped to set as yellow its colour

Every distinct place has its own colour geography. As claimed by Lenclos, there is chromatic interaction between the geological and climatic conditions, the local building materials, the cultural traditions and the labour of the men. The colour, local or regional, is strongly connected with the territory, constructing the identity of the architecture and urban image of a place. Thus, it is essential to establish principles and rules to operate on the renovation or restauration of the external surfaces of the buildings in the historical centres. The colour plans are fundamental systems which regulate the presence of the colour, its distribution at the urban scale, and at the architectonic scale. The authenticity of the colour of the places in Portugal, including of Lisbon, has been a focus of discussion. The polemic of the polychromatic against the monochromatic resulted in an apology of the withe which became the reference colour for Lisbon and the south of Portugal in Estado Novo (1933-1974). The first local identitarian colour plans in Portugal occurred in the 1980s, in Beja and afterwards in Porto, Coimbra, Lisbon, Sintra, and Évora.

In Lisbon were made chromatic projects of great public impact, namely the one of the repainting Terreiro do Paço in 1994 by DGEMN (General Directorate of the National Edifices and Monuments).

Terreiro do Paço chromatic project is a fundamental mark in the use of principles that guide the conservation operations of revetments of historical edifice, based on the international charters and in the scientific knowledge, supported on iconographic and documental research.

Keywords: Colour, conservation, historical city, authenticity

[111] Simona Dukanovic (Studio D'ART LLC).

Color as Cultural Heritage: Façade Revitalization in the Historic Town of Sremski Karlovci.

Abstract. Sremski Karlovci is a historic town whose architectural identity is strongly defined during the eighteenth and nineteenth centuries as a major spiritual, cultural, and political center of the Serbian population within the Habsburg Monarchy. In this period, the town's protected historic core was formed through intensive architectural activity, establishing an urban matrix and building typologies that have largely been preserved to the present day. Over time, alterations, material degradation, and unsystematic interventions have compromised the original color relationships and visual coherence of the urban fabric. This paper presents a comprehensive approach to the façade and color revitalization of twenty historic buildings in Sremski Karlovci, six of which have been successfully restored to date.

The study examines the documentation, analysis, and interpretation of façade colors, materials, and ornamental features through a combination of archival research, on-site visual surveys, photographic documentation, and material assessment. Additionally, it addresses the design and implementation of façade revitalization projects, emphasizing the identification of historically appropriate color palettes and their practical application. Particular attention is given to the role of color in shaping the cultural and architectural identity of the town, as well as to decision-making processes concerning color selection, material compatibility, and compliance with contemporary conservation requirements, including challenges encountered during execution.

Through comparative analysis of multiple façades, the research highlights recurring chromatic patterns, variations in decorative treatment, and the influence of color on the perception of historic streetscapes. The completed restorations are evaluated in terms of visual impact, authenticity, and contribution to the overall urban character.

The study highlights the significance of color in shaping the visual coherence and cultural identity of historic towns. Using Sremski Karlovci as a case study, it illustrates how façade revitalization informed by historical color research can support the preservation of urban heritage and its identity.

Keywords: Façade Revitalization, Sremski Karlovci, Color

[81] Akari Kagimoto (Nara Women's University), Shiho Ota (Doshisha Women's College) and Shino Okuda (Doshisha Women's College).

Color Characteristics of Kyo-Machiya Façades and a Proposed Color Palette for Streetscape Preservation in Kyoto.

Abstract. In 2007, the City of Kyoto introduced the New Scenic Policy, establishing three key principles: 1) shaping Kyoto's landscape as a historic city with a long-term vision of 50–100 years; 2) recognizing that while buildings are private property, the landscape is public property; and 3) preserving Kyoto's scenery for future generations as a shared responsibility. Kyo-machiya, traditional Japanese wooden shophouses constitute the traditional streetscape of Kyoto. However, the original characteristics of machiya are often lost, and machiya may fail to blend into the surrounding streetscape when they are repurposed for commercial use. This study aims to preserve the streetscape of Kyoto from a color perspective. We conducted a color survey of the façades of Kyo-machiya in central Kyoto.

40 properties were selected for the color survey from the “Streetscape Environmental Improvement Project” and “Buildings and Gardens which Make Kyoto Attractive” both of which are considered to harmonize with the Kyoto streetscape. Visual colorimetry using Munsell color cards was performed on 18 color locations: basic colors (roof, eaves, exterior walls), assorted colors (lattice, doors), trim colors (columns, window frames, fences), accent colors (signs, shop curtains), and the other elements. As a result, a traditional Japanese confectionery shop founded in 1804 exhibited a subdued impression, with all areas maintaining a color saturation of 6 or lower. In contrast, a Japanese restaurant founded in 2003 featured walls consistently painted in red (R), yellow-red (YR) and yellow (Y). The shop curtains stood out as part of the façade due to their high-brightness yellow tones and highly saturated blue (B). Additionally, a store specializing in the manufacture and sale of Japanese painting pigments, founded in the late Edo period, displayed exterior walls in a low-saturation reddish purple (RP), which constituted a distinctive characteristic among the surveyed townhouses. To summarize the color survey results of 40 Kyo-machiya shophouses, roofs and eaves predominantly feature achromatic colors (N) or low-saturation chromatic colors (3 or below), and exterior walls often use low-saturation yellow (Y). Low-saturation oranges (OR) are frequently seen on lattices, doors, and columns. This consistent use of low-saturation basic colors is thought to contribute to the calm streetscape.

Moreover, based on these findings, we propose a color palette as a landscape design tool that considers the preservation of the streetscape. It consists of 25 colors: the basic colors are 8 low-saturation shades of YR, Y, purple-blue (PB), and N; the assorted colors are 8 low-brightness shades of R, YR, Y, and PB; the trim colors are 5 low-saturation shades of R, YR, and red-purple (RP); and the accent colors are 4 shades of Y, B, N1 and N9. This color palette is intended to support the preservation of the streetscape in central Kyoto.

Keywords: Color survey, Streetscape, Kyo-Machiya Façades, Color palette

[104] Justyna Tarajko-Kowalska (Cracow University of Technology) and Przemysław Kowalski (Cracow University of Technology).

Unwanted heritage - color and material compositions of houses and gardens in Hrubieszów (Poland) – analysis and guidelines.

Abstract. The article addresses the issue of color and material compositions of traditional houses and gardens in Hrubieszów – a small town in eastern Poland. Despite its rich cultural heritage, the local colorscape of vernacular architecture is undergoing gradual degradation, e.g., due to the replacement of building materials, incoherent thermal retrofits, and the phenomenon of the so-called "color patchwork". The study aims to identify the preserved traditional color and material palettes – both architectural and botanical – and to formulate guidelines protecting the spatial identity of the city. The analyses and guidelines were conducted across three problem scales: macro (landscape), meso (urban interior), and micro (individual objects and details). In this publication, the authors focus primarily on the micro-scale, within which six characteristic color types of traditional wooden houses were identified. Attention was also drawn to the growing role of multi-colored front gardens, whose visual dynamics provide an aesthetic counterweight to the negative architectural transformations. The formulated guidelines and recommendations regarding the principles of shaping color and material solutions for buildings and gardens aim to give newly established settlements a positive aesthetic value while preserving their cultural identity and facilitating further revitalization processes of the Hrubieszów urban complex.

Keywords: color, material, composition, tradition, house, garden

[99] Agata Kwiatkowska-Lubańska ([Academy of Fine Arts in Krakow](#)).

Chromatic Identity and Materiality: Defining a CMF Palette for Street Furniture in Krakow's UNESCO Heritage Site.

Abstract. Krakow, inscribed on the UNESCO World Cultural Heritage List in 1978, maintains a city center under rigorous heritage conservation. Despite its historic status, the urban landscape continuously integrates modern street furniture—including benches, transit shelters, lighting, and seasonal kiosks. However, these contemporary additions often rely on a design paradigm of strictly replicating historical styles, a practice that limits architectural evolution.

The research project seeks to establish a comprehensive color, material, and finish palette to guide future urban design. As part of the study, existing street furniture was measured and documented using the NCS (Natural Colour System) notation. The scope of the research covers District I (Old Town), specifically the Main Market Square area and the historic Jewish quarter of Kazimierz. The analysis encompasses elements made from diverse materials—such as metal, wood, and stone conglomerates—featuring both natural hues and painted surfaces, located along thoroughfares as well as in pedestrianized zones.

Comparative analysis of other European cities, such as Vienna, demonstrates that modern street furniture can be successfully integrated into historic contexts. A notable example is the "Enzi" benches in the MuseumsQuartier, where colors are selected annually through public voting, temporarily introducing fresh chromatic elements into the historic area.

Utilizing the CMF methodology, this study focuses on the chromatic identity of Krakow, analyzing the relationships between urban elements and their surroundings, including historic facades and traditional paving. The research explores the multi-faceted role of color: from its functional impact on spatial orientation and accessibility to its symbolic resonance within a monumental context. Ultimately, this new palette for the Main Market Square Cultural Park aims to provide designers with an expanded chromatic vocabulary that allows for modern expression while maintaining a profound aesthetic and semiotic respect for Krakow's historical heritage.

Keywords: Color Design, Street Furniture, CMF Design, Urban Heritage, Chromatic Identity, Contemporary Intervention

[148] Xavière Ollier (Nacarat color design / university Toulouse Jean-Jaurès), Vanessa Lehner (Nacarat color design) and Soizic Boucault (Nacarat color design).

Color and Territorial Identity: chromatic chart methodology for the Remarkable Heritage Site of Soorts-Hossegor / France.

Abstract. The study conducted by the agency Nacarat Color Design for the Remarkable Heritage Site (SPR) of Soorts-Hossegor illustrates how chromatic research, when moving beyond simple aesthetic considerations, becomes a fundamental driver of urban cohesion. Faced with the progressive erosion of the identity of this "park-city"—born of the singular fusion between a millennial rural village and a 1930s seaside utopia—the municipality prioritized a scientific and creative approach to stem the standardization of contemporary renovations.

The methodology deployed consisted of replacing the subjectivity of taste, often governed by trends and architectural or chromatic standardization, with the objectivity of measurement. By relying on a comprehensive corpus of in situ photographic surveys, coupled with the systematic use of the Natural Color System (NCS) and in-depth historical research, the agency was able to map the territory's actual chromatic identity. This analytical rigor made it possible to isolate historical colors derived from geology and vernacular materials.

This diagnostic—a true work of "chromatic archaeology," inherited from the work of Dominique and Jean-Philippe Lenclos (Geography of Color) and subsequently adapted—revealed that Hossegor's landscape coherence did not lie in the uniformity of white, but in a complex vibration of "colored whites." These shades were historically conceived to dialogue with the specific luminosity of the Landes region and raw materials such as Rhune stone or brick.

The major interest of this research for the scientific community and practitioners lies in its operational translation. The definition of four prescriptive palettes—general, accent, brick, and contemporary—does not aim to freeze the city in a museum-like past, but to offer a visual grammar for the future. By technically codifying the two-tone schemes necessary for reading the "fern leaf" brick patterns or by defining precise spectra for the integration of modern wood cladding, the agency proves that color is a full-fledged architectural component. This approach makes it possible to stitch the urban fabric back together by reconciling the Basque-Landais regionalist style with contemporary designs, thus transforming regulatory constraints into a shared project tool for a sustainable and authentic restoration of the landscape.

Keywords: Chromatic charter, Remarkable Heritage Site (SPR), Chromatic archaeology, Prescriptive palettes, Basco-Landais style

SESSION A3S6 - Chair: Boris Pretzel

| General

List of Abstracts:

[\[15\]](#), [\[82\]](#), [\[20\]](#), [\[14\]](#), [\[156\]](#), [\[13\]](#).

[\[15\]](#) Julio M Del Hoyo (National Museum in Kraków), Alessandra Banchelli (AGH University of Krakow, Faculty of Geo-Data Science, Geodesy and Environmental Engineering.), Gianmarco Borghi (Marian Smoluchowski Institute of Physics, Jagiellonian University in Krakow, Poland), Anna Klisińska-Kopacz (National Museum in Krakow), Anna Ryguła (The Laboratory of Analysis and Non-Destructive Investigation of Heritage Objects, The National Museum in Krakow) and Paulina Krupska-Wolas (Laboratory of Analysis and Non-Destructive Investigation of Heritage Objects (LANBOZ), National Museum in Krakow.).

Linking material composition and light sensitivity: Integrating microfading testing for studying heritage colorants.

Abstract. The stability of dyes and pigments used in cultural heritage objects depends strongly on their chemical composition and response to light. For this reason, identifying colorants and understanding their behavior under illumination are central concerns in conservation science. Research in this field has traditionally followed two parallel paths: analytical studies carried out directly on artworks, and ageing experiments performed on reconstructed samples using historical materials and methods. Recent developments increasingly combine these approaches, offering a more complete picture of both material identity and vulnerability. Microfading testing (MFT) plays a crucial role within this integrated framework. Its capacity to measure light sensitivity with minimal impact on objects has made it a valuable method for evaluating display risks and predicting color change. When MFT results are interpreted alongside data from imaging, spectroscopic, microscopic, and chromatographic analyses, they reveal patterns in dye and pigment degradation that are not accessible through any single technique alone. By bringing together these complementary methods, researchers gain a deeper understanding of how cultural heritage colorants age and how their stability can be safeguarded. This combined analytical strategy supports more precise conservation decisions and contributes to improving the long-term preservation of light-sensitive materials.

Keywords: Microfading testing, Light sensitivity, Cultural heritage, Colorants, Analytical techniques, Material stability

[82] Alessandra Banchelli (AGH University of Krakow, Faculty of Geo-Data Science, Geodesy and Environmental Engineering.), Paulina Krupska-Wolas (Laboratory of Analysis and Non-Destructive Investigation of Heritage Objects (LANBOZ), National Museum in Krakow.), Julio M. del Hoyo-Meléndez (Laboratory of Analysis and Non-Destructive Investigation of Heritage Objects (LANBOZ), National Museum in Krakow.), Marcello Picollo (Istituto di Fisica Applicata “Nello Carrara” - National Research Council (IFAC-CNR).), Beata Hejmanowska (AGH University of Krakow, Department of Photogrammetry Remote Sensing of Environment and Spatial Engineering.) and Ewa Sobiczewska (Paper and Leather Conservation Studio, National Museum in Krakow).

Microfading testing and colorimetric analysis of Japanese woodblock prints: assessing light stability and chromatic changes in dyes and pigments.

Abstract. Japanese woodblock prints (ukiyo-e) pose a significant conservation challenge due to the photosensitivity of their traditional colorants. While spectroscopic and imaging techniques have been widely applied to identify materials in ukiyo-e, assessments of light stability combined with colorimetric monitoring remain limited. This study applies microfading testing (MFT) to ten woodblock prints attributed to Kitagawa Utamaro from the Feliks "Manggha" Jasieński (1861–1929) collection at the National Museum in Krakow (MNK). MFT is a non-contact, in situ technique combining reflectance spectroscopy with controlled light aging, enabling simultaneous spectral monitoring and photosensitivity assessment without physical sampling. Reflectance spectra (400–700 nm) and CIELAB coordinates were acquired from different color areas during aging, yielding ΔE_{00} trajectories classified according to their fading kinetics and examined through hierarchical cluster analysis (HCA) in relation to previously identified dyes and pigments. Blue-containing areas proved comparatively stable while yellow colorants were the most light-sensitive, with safflower-based reds showing markedly lower stability among red colorants. The resulting exploratory grouping provides a basis for the future development and validation of color-stability models and may ultimately support colorant- and print-specific conservation guidance for the MNK holding and, potentially, other collections sharing comparable traditional colorants.

Keywords: Microfading testing, Light aging, Colorimetric measurements, Hierarchical cluster analysis (HCA), Japanese woodblock prints

[20] Hilda Deborah (Norwegian University of Science and Technology), Tanzima Habib (Norwegian University of Science and Technology), Giorgio Trumpy (Norwegian University of Science and Technology), Jon Yngve Hardeberg (Norwegian University of Science and Technology) and Børries Brakebusch (Brakebusch Conservation Studio).

Surveying colour management practices in conservation/restoration of cultural heritage objects.

Abstract. This work is performed within the context of HORIZON-IA project “Collaborative On-cloud Lab for the conservation and digital restoration of Coloured heritage collectionS (COLOURS)”. The project aims to make a major contribution to the digital transition of cultural heritage conservation and restoration by developing integrated colour analysis and restoration tools tailored to diverse artefacts, including polychrome sculptures, paintings, textiles, historic films and photographs. The tools to be developed are expected to provide high-precision analysis, simulate restoration results with perceptual accuracy, and support interdisciplinary collaboration through hybrid spaces that merge virtual and physical environments. This means that ensuring precise and consistent colour across different devices is a core challenge within the project, making the implementation of a robust colour management workflow non-negotiable.

In this project, we aim for practical effectiveness of the colour management workflow and not just theoretical compliance. Our initial phase involves a comprehensive survey of current practices within the conservation/restoration of cultural heritage objects, to be gathered from an online survey. We will assess the following aspects, among others, covering the capture and reproduction of colour:

- Lighting condition
- Calibration (including use of colour targets)
- Colour management software
- Photo editing software
- Imaging equipment

The survey is expected to provide us with a critical insight into the existing gaps and inconsistencies, as well as the best practices across the field of conservation/restoration. The resulting data will directly inform the design of our colour management workflow for the European Collaborative Cloud for Cultural Heritage, which will be the platform where the decision-making process will happen. The colour management workflow will have to be flexible and practical, yet robust.

Keywords: colour management, conservation/restoration, survey, colour capture, colour reproduction

[14] Florent Comte (CNRS UPR 2002 MAP - Modèles et simulations pour l'Architecture et le Patrimoine), Marco Gaiani (Dipartimento di Architettura – Alma Mater Studiorum Università di Bologna), Anthony Pamart (CNRS UPR 2002 MAP - Modèles et simulations pour l'Architecture et le Patrimoine), Livio De Luca (CNRS UPR 2002 MAP - Modèles et simulations pour l'Architecture et le Patrimoine), Andrea Ballabeni (Dipartimento di Architettura - Università di Bologna), Hélène Civalleri (Inrap, Institut National de Recherches Archéologiques Préventives) and Christophe Besnier (Inrap, Institut National de Recherches Archéologiques Préventives).

Shapes and colors. A colorimetry-based methodology for the 3D reproduction and evaluation for the purpose of classifying the elements of the Jubé of Notre-Dame de Paris.

Abstract. Between February and July 2022, an excavation conducted by INRAP uncovered more than one thousand sculpted fragments from the medieval rood screen of Notre-Dame de Paris. This discovery required the implementation of a large-scale 3D digitization program. Owing to the size and heterogeneity of the corpus—over 700 fragments preserving original polychromy and more than 80 showing remains of gilding—a dedicated methodological framework was developed to achieve precise, consistent, and reproducible image acquisition at scale.

A customized photogrammetric workflow was designed specifically for the documentation of morphologically complex fragments, ensuring high-fidelity texture capture, particularly for polychrome surfaces. This approach demonstrates the potential for large-scale digitization of similarly heterogeneous and fragile heritage materials. It responds to multiple constraints, including: (i) the corpus size, exceeding 1,000 fragments; (ii) the requirements of digital conservation and scientific investigation; (iii) the substantial morphological variation of the objects, ranging from 1 cm³ to 1 m³; (iv) their formal complexity; (v) the presence of polychromy on most fragments; (vi) regulated access to the original material; (vii) the need to conduct stabilization and study of the objects in parallel; and (viii) the mandatory use of image-based digitization workflows imposed by the Aïoli platform and the ERC project nDame_Heritage.

The digitization campaign was complemented by the development of statistical analysis tools applied to the processed datasets, enabling control and calibration of the geometric and colorimetric accuracy of the final digital corpus. Attention was given to the digital restitution of chromatic properties and optical reflectance, as well as to the implementation of colorimetric classification methods. These developments support subsequent digital and physical anastylosis of the reconstructed architectural ensemble.

In support of these objectives, we developed a set of dedicated tools and methods, detailed in the present paper. These include:

- (A) a technique for color correction of textures acquired through image-based digitization, building upon approaches validated in previous research; and
- (B) a color-classification method, implemented in both a manual mode—based on quantitative color-difference metrics—and an automatic mode employing a K-means clustering algorithm.

These functionalities were implemented in two software tools, SHAFT and PRISM. SHAFT was integrated into the nDame photogrammetric pipeline, ensuring seamless use within the broader image-processing workflow. PRISM, by contrast, was developed as a standalone application, designed to provide a rapid and user-friendly solution for archaeologists, conservators, architects, and art historians engaged in the analysis of polychrome heritage materials.

Keywords: Notre Dame de Paris, Archaeology, Historical architecture, Image-based modeling, Color correction, Color management, Color classification

[156] Alessandro Farini (CNR-Istituto Nazionale di Ottica), Elisabetta Baldanzi (CNR-Istituto Nazionale di Ottica), Raffaella Fontana (CNR-Istituto Nazionale di Ottica), Antigone Marino (CNR-ISASI), Alessandra Ferlito (Istituto Centrale per il Restauro), Sabrina Maria Sottile (Istituto Centrale per il Restauro), Vanessa Fontani (Istituto Centrale per il Restauro), Amelia Parigi (Dipartimento di Fisica e Astronomia, Università di Firenze), Massimo Gurioli (Dipartimento di Fisica e Astronomia, Università di Firenze) and Paolo Antonino Grasso (Dipartimento di Fisica e Astronomia, Università di Firenze).

Color assimilation for color restoration.

Abstract. Color plays a fundamental role in the perception, interpretation, and cultural significance of painted heritage. When original pigments are lost or severely altered, conservators face a critical dilemma: how to reintegrate missing chromatic information without compromising the artwork's authenticity or misleading the viewer. The reconstruction of color is never a neutral operation, as it directly affects both aesthetic experience and historical understanding. For this reason, contemporary conservation theory emphasizes the need for reversible, discernible, and ethically transparent solutions.

Among the most widely adopted approaches, techniques such as *tratteggio lineare* address this challenge by avoiding mimetic reconstruction. Instead of imitating the original surface, color is applied through fine, distinguishable strokes, allowing the integration to be visually perceived as non-original at close range while maintaining overall legibility from a distance. These methods rely on the viewer's perceptual mechanisms to reconcile fragmentation and continuity, without producing a false sense of material authenticity.

Here we present a preliminary study investigating the potential application of color assimilation phenomena to pictorial reintegration. Color assimilation occurs when adjacent chromatic elements, arranged in fine spatial patterns, are perceptually blended by the human visual system, generating the impression of an intermediate or unified color. Rather than applying a single homogeneous hue, the proposed approach explores the use of two distinct colors distributed in linear patterns to achieve a perceptual chromatic balance.

The experimental tests were conducted on digital displays, using a high-resolution image of Raphael's *Banner of the Holy Trinity*, currently under conservation at the Istituto Centrale per il Restauro in Rome. The artwork exhibits extensive areas of color loss where the raw canvas is exposed, offering a particularly suitable case study for evaluating perceptual reintegration strategies. The tests focused on assessing the effects of viewing distance, perceptual coherence, and the degree to which the intervention remains clearly distinguishable upon close observation. The results aim to contribute to ongoing discussions on color, perception, and authenticity in cultural heritage conservation, proposing color assimilation as a potential non-illusory yet visually effective approach to chromatic restoration.

Keywords: color assimilation, color restoration, color perception

[13] Riccardo Foschi (Dipartimento di Architettura – Alma Mater Studiorum Università di Bologna), Florent Comte (CNRS UPR 2002 MAP - Modèles et simulations pour l'Architecture et le Patrimoine), Marco Gaiani (Dipartimento di Architettura – Alma Mater Studiorum Università di Bologna), Anthony Pamart (CNRS UPR 2002 MAP - Modèles et simulations pour l'Architecture et le Patrimoine), Livio De Luca (CNRS UPR 2002 MAP - Modèles et simulations pour l'Architecture et le Patrimoine) and Christophe Besnier (Inrap, Institut National de Recherches Archéologiques Préventives).

A cross-polarised photogrammetric workflow for the digital documentation of the Notre Dame de Paris jubé fragments.

Abstract. Between February and July 2022, an excavation carried out by Inrap at the crossing of the transept of Notre-Dame de Paris unearthed an important element of Gothic architecture: the jubé (rood screen), built and sculpted in the first half of the 13th century. Until now, nothing was known about this decorated and carved wall because, like most French rood screens, it was destroyed in the early 18th century.

During the excavation, more than 1000 sculptural fragments were discovered, over 700 of which preserved their original polychromy, and more than 80 retained traces of gilding. The richness and scale of this discovery allow for the first time the reconstruction of the original appearance of Notre-Dame's jubé, a masterpiece of medieval Gothic sculpture.

The rediscovery of such large number of fragments led to an exceptional three-dimensional digitization campaign and the development of a dedicated method for capturing and accurately reproducing artifacts with polychromy and gold leaf decorations, integrated into an innovative customized photogrammetric workflow.

The paper presents the digitization strategy adopted for the gilded fragments using an automated cross-polarized photogrammetric system. The acquisition protocol was calibrated through qualitative and quantitative analyses essential to ensure both geometric and material accuracy in the resulting digital corpus. The cross-polarization technique was employed to faithfully reproduce optical reflections from both Lambertian and metallic surfaces.

The acquisition setup consists of a photographic rig with three DSLR cameras equipped with polarizing filters, pointed at a motorized turntable illuminated by a polarized LED frame. The turntable is controlled by custom software that synchronizes its stepped rotation with the camera shutters for speeding up the acquisition campaign while guaranteeing consistent and precise calibration throughout all the photographic sets.

The stacking and postprocessing of cross-polarized and non-polarized images enable approximating the surface's optical properties as canonical PBR maps, directly usable within conventional rendering engines that support the metallic/roughness workflow. The 3D model is built from cross-polarized images to increase metric accuracy, and the textures are generated by elaborating cross-polarized and non-polarized photographs in the Lab colour space, by subtracting their lightness channels, and stretching their histograms.

This method ensured greater geometric precision by suppressing specular reflections that could interfere with keypoint matching during standard photogrammetric processing, while also producing accurate albedo, metalness, and roughness maps for visually accurate reproduction in digital environments. Three preliminary sample acquisitions enabled precise calibration of the workflow and demonstrated a highly realistic reproduction, achieving near-perfect visual accuracy without any manual adjustment.

Keywords: Notre Dame de Paris, Archaeology, Historical architecture, Photogrammetry, Gold leaf, Specular reflection, Cross polarization

SESSION A1S7 - Chair: Andrea Siniscalco

| Shedding New Light on Cultural Heritage

List of Abstracts:

[78], [70], [66], [50], [102], [58], [51], [86], [106], [92].

[78] Laura Bellia (Department of Industrial Engineering - University of Naples Federico II), Francesca Diglio (Department of Industrial Engineering - University of Naples Federico II), Francesca Fragliasso (Department of Industrial Engineering - University of Naples Federico II), Antonino Pollio (Department of Biology - University of Naples Federico II) and Maria Francesca Sannino (Department of Biology - University of Naples Federico II).

Experimental analysis of the effects of monochromatic and white light on the fungal growth on paper documents.

Abstract. Historical paper documents exposed in museums, libraries, and archives are highly susceptible to biodeterioration, often due to microorganisms like fungi which can cause irreversible damage (staining and/or deteriorating cellulose). Ad-hoc environmental conditions can limit it. In this context, light has a key role. Indeed, research has demonstrated that monochromatic light can inhibit the growth of some species. Ideally, thanks to multi-channel LED systems, it would be possible to customize spectra to maximize color rendering and energy content in wavelengths that inhibit fungi growth, allowing papers to be adequately exhibited and preserved. However, the effects of white light and monochromatic light on microorganisms could be different.

This study assesses if fungal growth under monochromatic radiation is comparable to that occurring under white light characterized by an energy peak at the same dominant wavelength as the monochromatic source.

4 boxes were built, each equipped with a different LED light source: 1) Monochromatic blue (peak at around 465 nm), 2) cool white (peak at around 465 nm - 6266 K Correlated Color Temperature -CCT-), 3) monochromatic red (peak at around 630 nm), 4) warm white (peak at around 630 nm - 2435 K CCT). Light sources were adjusted to ensure uniformity on the horizontal base of each box. The white ones were set to obtain 50 lx average horizontal illuminance (maximum value for photosensitive materials). Spectral irradiance values at the peak wavelengths were recorded, and the monochromatic sources were set to provide the same spectral irradiance at the peak wavelength as that of the corresponding white source (red light for warm light and blue light for cool light). Spore suspensions of *Penicillium chrysogenum* and *Cladosporium cladosporioides* were separately inoculated in Whatman 1 paper samples. Triplicates of the samples of each fungus were put in the 4 boxes for 28 days. The percentages of the area colonized by fungi were weekly measured.

After 28 days, *C. cladosporioides* grew more under white light than under the corresponding monochromatic sources (average colonized area equal to 68.1% and 49.9% under warm white and red sources, respectively, and 36.5% and 30.0% under cool white and blue sources, respectively); *P. chrysogenum* showed a major growth under the blue monochromatic source (colonized area equal to 21.1% and to 5.6% under cool white light), while results for the warm white and red sources were similar (colonized area equal to 2.4% in both cases). Hence, results demonstrate that the growth rate under each light is different according to the species. Consequently, the proper light conditions should be evaluated case by case and shared analysis methods are needed to study the photobiological risk.

The described activities were conducted within the scope of Spoke 5, founded by the Project PE 0000020 CHANGES - CUP [B53C22003780006], PNRR Missione 4 Componente 2 Investimento 1.3– Next Generation EU.

Keywords: light for cultural heritage, fungal growth, light-connected biological risk, paper document preservation

[70] Ayse Nihan Avci (Çankaya University).

Rethinking Museum Interiors Through Color, Light, and Material: The Case of Erimtan Archaeology and Arts Museum.

Abstract. Museums are significant institutions that shape the visitor experience not only through the artifacts they exhibit but also through their spatial configurations, playing a crucial role in the preservation and transmission of cultural heritage. In this context, the use of color, light, and materials emerges as a set of decisive design components influencing perceptual comfort, wayfinding, atmosphere creation, and the legibility of displayed objects. Color is one of the fundamental design tools guiding spatial perception. In museum interiors, the preference for neutral and low-saturation color schemes generally allows exhibited artifacts to stand out more prominently. Lighting, on the other hand, serves a dual function in terms of both conservation and perception. Controlled artificial lighting helps prevent damage to artifacts, while directed lighting enables the establishment of spatial hierarchy. Material selection further contributes to the tactile and visual character of the space while strengthening the relationship between the built environment and its historical context. This study aims to examine the Erimtan Archaeology and Art Museum, located in the Ankara Castle district, within the framework of color, light, and material interaction in interior spaces. The Erimtan Archaeology and Art Museum draws attention through its unique architectural configuration and exhibition approach, formed by the integration of buildings from different historical periods. As a cultural institution, the museum hosts numerous valuable objects from the Roman, Urartian, Hittite, and Byzantine periods drawn from the collection of Yüksel Erimtan, which are displayed using innovative exhibition techniques. Beyond archaeology, the museum also accommodates a wide range of artistic disciplines and interdisciplinary activities developed in line with contemporary museology. The research adopts a qualitative methodology, employing on-site observation, spatial analysis, and a review of relevant literature as the primary data collection tools. The findings indicate that the museum's preference for a neutral and natural color palette, combined with controlled artificial lighting, enhances the perceptual clarity of archaeological artifacts. Moreover, the use of materials such as stone, metal, and wood is shown to create an exhibition language that is both compatible with the historical context and aligned with contemporary display practices. The study demonstrates that the Erimtan Museum provides a strong example of a holistic design approach to the integration of color, light, and materials in cultural heritage buildings.

Keywords: Museum Interior Design, Color Perception, Lighting Design, Material Use, Erimtan

[66] Gaëlle Silvant (ENSAV La Cambre), Ulysses Jackson (Golden Artist Colors Inc.) and Adrien Lucca (Studio Adrien Lucca).

Bridging Colour Science and Conservation Practice: A Transdisciplinary Method for Non-Metameric Retouching.

Abstract. Retouching in ceramic conservation often relies on tacit knowledge, heuristic pigment choices and visual matching under a single illuminant. As a result, metamerism, especially in cobalt-based blues, is a recurrent problem when objects move between studio, storage, photography and exhibition lighting. Although computer-based non-metameric colour formulation has existed since the 1980s, it has rarely been translated into a method that conservators can actually use in practice.

Our approach combines spectrophotometry, a Kubelka-Munk (KM) implementation, and algorithmic colour formulation with studio-tested retouching protocols. Building on a corpus of twelve Delft blue-and-white earthenware plaques, we first characterised their reflectance behaviour, typically showing a similar spectral profile despite large visual variation. We then modelled blue enamel as a transparent colourant over a tinted background, consistent with conservation practice. A spectral database of Golden® acrylic mono-pigment paints was measured and integrated into a KM solver that generated thousands of 2-pigment mixtures (TiO_2 + 2 colourants) optimised for multi-illuminant stability (D65, A, high-quality LED, and fluorescent).

The originality of the work lies in the modelling and in the translation of these computational results into a minimal, reproducible and studio-friendly method. Clustering the algorithm's output, we identified seven robust pigment pairs capable of producing Delft-like blues with minimal metamerism. It is up to the practitioner to decide which one to use. Practical tests under multiple illuminants confirmed that both ceramics and retouching exhibit the same slight, non-perceptible colour shifts (within CIELab acceptable colour difference values), achieving the goal of being “practically non-metameric”, rather than being spectral matches.

This paper therefore presents the results of a collaboration between a colour scientist/artist, a paint producer, and a ceramics conservator that succeeded. We argue that colour practice needs more models of this kind: where scientific tools are adapted to the real constraints of practical work, and where practitioners embodied expertise complement each other. In line with current discussions on the gap between colour science and applied colour practices, our case demonstrates how shared vocabulary, co-developed workflows and methodological transparency make true cross-disciplinary work possible.

The updated version of this publication includes full reproducible documentation (spectral data, KM code, formulation logic) and results from additional tests. We also suggest expanding the method to other cases.

Keywords: Delft Blue, Metamerism, Colour formulation, Retouching, Conservation, Light, Colorimetry, Colour Matching

[50] Shogo Nishi (Osaka Electro-Communication University).

Stabilizing Low-Luminance Regions in Color-Appearance-Model-Based HDR Tone Mapping.

Abstract. High-dynamic-range (HDR) tone mapping must compress scene luminance into a displayable range while preserving perceptually natural appearance. iCAM06 is a widely used color-appearance-model-based HDR rendering method that combines fast bilateral-filter-based decomposition into a base layer and a detail layer with locally adaptive tone compression. In practice, night and backlit scenes containing strong localized light sources may show slight washout in low-luminance regions (hereafter referred to as shadows), where black level and local contrast are subtly degraded. While many refinements of iCAM06 address white-point shift, saturation loss, or halo suppression, luminance-calibrated quantification of overestimation in the base layer within shadows has been limited.

We analyze the base layer produced by the fast bilateral filter using luminance-calibrated HDR photographs from a public dataset (using provided luminance multipliers to recover absolute luminance). Seven representative scenes were selected by scene characteristics. For shadow pixels, we measure shadow base layer lift as the distribution of the log-domain ratio between the base layer luminance estimate and the corresponding physical luminance (CIE XYZ tristimulus Y). We also visualize hazard regions where the base layer estimate substantially exceeds the physical luminance. In addition, we analyze their distances to nearby bright regions (highlights) to characterize where shadow overestimation occurs.

The analysis reveals a reproducible long-tailed behavior in HDR scenes with strong localized light sources and deep shadows. Most shadow pixels remain stable. However, a small subset shows substantial overestimation in the base layer. The base layer estimate can exceed the physical luminance by several tens of percent and sometimes by multiple times. In typical night and backlit scenes, upper-tail values commonly reach about 1.5 to 1.7 times, and some pixels exceed 2 times. In more extreme scenes, the upper tail can approach roughly 4 times. These observations suggest an internal failure mode related to black-halo-type behavior known in local tone mapping.

To suppress this failure mode while preserving the iCAM06 framework, we introduce a shadow-safe constraint inside the fast bilateral filter that caps excessive shadow base layer lift. With the current setting, overestimation is constrained to about 1.4 times. Experiments confirm that the proposed modification substantially reduces the upper tail and extreme outliers of shadow base layer lift, while leaving scenes without prominent shadow instability effectively unchanged. Overall, this work provides a practical luminance-calibrated metric and a minimal, backward-compatible modification for stabilizing low-luminance regions in color-appearance-model-based HDR tone mapping.

Keywords: HDR tone mapping, color appearance model, iCAM06, base-layer lift in shadows, luminance calibration

[102] Shino Okuda (Doshisha Women's College of Liberal Arts), Mana Nishimoto (Doshisha Women's College of Liberal Arts), Satoko Taguchi (Tokyo University of the Arts), Miho Muguruma (Kyoto University), Katsunori Okajima (Yokohama National University), Juan Serra (Polytechnic University of Valencia), Daniel Vazquez (Complutense University of Madrid) and Manuel Melgosa (University of Granada).

Influence of Lighting Chromaticity on Perceived Season and Time in Joaquín Sorolla's Paintings of Outdoor Scenes.

Abstract. LED lighting has been widely adopted in museums to ensure the long-term preservation of artworks. However, the chromatic properties of illumination can significantly influence how paintings are perceived. This issue is particularly relevant for artists who emphasized color under natural light outdoors.

Joaquín Sorolla y Bastida (1863–1923) is a Spanish master painter renowned for his outdoor compositions, known as the “Painter of Light.” We investigated the influence of lighting chromaticity on the perceived season and time of day in paintings, focusing on 3 works by Joaquín Sorolla. Spectral measurements of *Figuras de casacas jugando en un jardín* (1900, Museu de Belles Arts de València), *Sierra Nevada, Granada* (1910, Museu de Belles Arts de València), and *Chicos en la playa* (1909, Museo Nacional del Prado) were performed in their exhibition spaces using a two-dimensional spectroradiometer [SR-5100, TechnoOptis]. Ten correlated color temperatures (CCTs) (from 3000 K to 10,000 K) were combined with two spectral distributions, daylight and LED, resulting in 20 lighting conditions. Daylight spectra were derived from the CIE standard daylight model for CCTs above 4000 K and the Planckian radiator for lower CCTs, while LED spectra were based on a blue LED with yellow phosphor. For the 3000 K and 4000 K LED conditions, the spectral distributions corresponded to LED-B2 and LED-B3 as defined in CIE 015:2018. The vertical illuminance at the center of each painting was set to 200 lx, and images faithfully simulating the paintings’ colorimetric values were displayed on a color-calibrated LCD monitor [ColorEdge CG2700X, EIZO] in a dark room. Twenty Japanese participants with normal color vision and in their twenties (10 male, 10 female) evaluated the perceived time of day and season under each condition. They also assessed the appearance of the paintings using eight bipolar adjective pairs: “Cold–Warm,” “Muddy–Clear,” “Dull–Vivid,” “Artificial–Natural,” “Dark–Bright,” “Blurred–Crisp,” “Static–Dynamic,” and “Gloomy–Cheerful.” In addition, three impression items tailored to each painting were included to reflect its unique visual character, and participants rated their overall preference for each lighting condition.

Across the three paintings, lower CCTs were generally associated with later times of day (e.g., afternoon), while higher CCTs corresponded to earlier times. Seasonal perception varied: in *Figuras de casacas jugando en un jardín*, autumn was consistently dominant regardless of lighting, whereas *Sierra Nevada, Granada* showed strong shifts from summer at low CCTs to winter at high CCTs. *Chicos en la playa* was perceived mainly as summer under all conditions, reflecting the painting’s content rather than lighting.

These findings indicate that lighting chromaticity significantly affects the perceived time of day and season in paintings of outdoor scenes, but the effect interacts with specific paintings’ content.

Keywords: Museum lighting, Lighting chromaticity, outdoor paintings, Joaquín Sorolla

[58] Misaki Kurosumi (Tokyo University of Science), Yuki Oe (The University of Shiga Prefecture), Takumi Fujiwara (Light Meister Co., Ltd.), Naoki Tsukada (Light Meister Co., Ltd.) and Nozomu Yoshizawa (Tokyo University of Science).

Museum Lighting Under Low Illuminance for the Appearance of Achromatic Prints.

Abstract. Museums increasingly require lower illuminance levels for exhibitions to prioritize the conservation of valuable cultural assets and delicate artworks. This study aims to determine whether a lighting method considering luminance and the luminance ratio is applicable within conservation-oriented low-illuminance exhibition spaces, and to examine a method for predicting artwork brightness and preference. In this paper, we report a subjective evaluation experiment on a light-sensitive achromatic copperplate print characterized by intricate linework and a broad lightness range. Eighteen experimental conditions were established by combining three background wall colours (white [N9], gray [N5], and black [N2]) and six lighting conditions. The lighting methods consisted of five patterns that combined three types of fixtures: spotlight only, profile spotlight only, ambient light only, ambient light plus spotlight, and ambient light plus profile spotlight. The vertical illuminance and correlated colour temperature at the center of the print were set to 30 lx and 4000 K. For the "ambient light only" condition, an additional level of 50 lx was included. The luminance ratio of the artwork to the background was calculated for each condition. This ratio (the average artwork luminance divided by the average luminance of the background surface within the horizontal and vertical fields of view) ranged from approximately 0.6 to 103.

The participants were 21 Japanese university students in their 20s. After adapting for 10 min in an adjacent room with white walls and a wall illuminance of 150 lx, they observed the print in the mock exhibition space (W 4500 mm x D 4500 mm x H 4500 mm) for 30 s under each condition. They evaluated the visual appearance using 12 items: nine items for overall impression (e.g., preference, naturalness, and visibility) and three items on the visibility of details.

Based on the experimental results, an evaluation structure for prints under low illuminance was constructed, linking appropriate artwork brightness to visual preference, consistent with previous studies. In this experiment, there was a linear relationship between the brightness level and appropriate brightness. Additionally, under low-illuminance conditions, when the background area was defined as the forward 180° visual field (excluding the illuminated area in the "spotlight only" condition), a positive correlation was observed between the luminance ratio of the artwork to the background and the evaluated brightness level. Consequently, a brightness prediction formula was constructed using the luminance of the artwork and the background as variables. Thus, the results demonstrate the possibility of predicting the brightness level from the luminance ratio and, subsequently predicting the preference of the artwork's appearance using the evaluation structure. These findings will enable longer exhibition periods for highly light-sensitive objects.

Keywords: museum lighting, low illuminance, print, exhibition, conservation, luminance ratio

[51] Tatsuki Tsukuda (Tokyo University of Science), Kazuto Takase (University of Fukui) and Nozomu Yoshizawa (Tokyo University of Science).

Study on Flicker Evaluation Metrics Considering Sensory Characteristics.

Abstract. Widespread adoption of LED lighting improves efficiency but introduces with temporal light modulation (TLM), or flickering, from power circuits and dimming methods. Unlike traditional metrics measuring physical amplitude, the current standard, short-term flicker severity (P_{st}^{LM}), models perceptual responses based on standard observers' temporal contrast sensitivity. Our field surveys in indoor facilities in Japan identified specific areas where P_{st}^{LM} values exceeded the visibility threshold of 1.0, highlighting real-world visual risks. Furthermore, its validity for individuals with low neurological thresholds remains unverified, leaving latent risks unaddressed. This study evaluates how high-frequency TLM parameters affect flicker visibility across diverse sensory differences, verifying the applicability of P_{st}^{LM} to propose inclusive lighting guidelines.

A paired comparison experiment evaluated 27 conditions combining correlated color temperature (2700, 5000, 6000 K), frequency (70, 80, 90 Hz), and modulation depth (2, 6, 10%). These frequencies avoid the 15-60 Hz seizure risk band. Based on the Adolescent/Adult Sensory Profile (AASP), 26 students in their early 20s without epilepsy or migraine history were categorized into a "Low Threshold" group (n=8, sensory sensitivity or sensation avoiding) and a "Control" group (n=18).

The results revealed distinct perceptual differences. The Control group showed increased flicker visibility only at 6000 K. Conversely, the Low Threshold group exhibited a stepwise increase in flicker visibility from 2700 K to 6000 K. This group also experienced a marked increase in discomfort at 6000 K. For deskwork, however, both groups rated 5000 K as most tolerable. An examination of the relationship between P_{st}^{LM} and flicker visibility scores revealed a stratified distribution based on color temperature. At identical P_{st}^{LM} values, flicker visibility increased at 6000 K, especially in the Low Threshold group. Recalculating vertical eye illuminance using the cone-fundamental-based spectral luminous efficiency function ($V_{(F,10)}(\lambda)$) indicates that effective stimulus intensity delivered to the luminance channel increases under high CCTs, even under constant standard illuminance. These empirical findings suggest that standard P_{st}^{LM} predictions may underestimate flicker visibility under high-CCT and broad-field conditions, highlighting the potential benefit of considering broad-field spectral sensitivity and individual threshold variations in future metric designs.

Keywords: Temporal Light Modulation (TLM), Flicker, Sensory Sensitivity, P_{st}^{LM}

[86] Maurizio Rossi (Politecnico di Milano) and Gianluca Guarini (Independent Architecture & Planning Professional).

Using VR for the Reconstruction of Historic Flame-Based Artificial Lighting in Ancient Indoor Spaces: A Case Study.

Abstract. The present study examines the digital reconstruction of historic artificial lighting in ancient indoor spaces by simulating flame-based light sources within a real-time rendering environment. The research focuses on the Quarto Camerino of Villa d'Este in Tivoli as a case study, aiming to virtually recreate the lighting conditions generated by oil lamps and candles that were likely used in the space during its original historical configuration.

Central to the proposed methodology is the reconstruction of light emission based on experimental data derived from photometric and radiometric measurements of physical flame prototypes. Luminous intensity distributions are used to describe the spatial emission characteristics of sources, while spectral measurements are employed to derive chromatic information and accurately manage color appearance within digital environments. This data-driven approach allows the simulation to move beyond purely visual approximation, ensuring both quantitative and qualitative plausibility in terms of illuminance levels, light distribution, and color rendering.

Unity3D is adopted as the real-time simulation platform to integrate measured lighting data with dynamic behaviors typical of flame sources. Temporal variations in luminous flux are introduced algorithmically to reproduce the stochastic nature of flame flicker, contributing to a more realistic perception of historic lighting conditions. Simplifications in the representation of light emission are deliberately applied to maintain computational efficiency, while preserving the essential perceptual and physical characteristics of flame-based lighting.

Three-dimensional modelling of luminaires and architectural elements is treated as a supporting component of the workflow, providing geometric context for the lighting simulation without being the primary focus of the research. The results demonstrate how the integration of photometric and radiometric measurements within a real-time engine can support the virtual reconstruction of historic artificial lighting, offering a valuable tool for the study, interpretation, and communication of light in cultural heritage contexts.

Keywords: Historic lighting reconstruction, Flame-based light sources, Real-time lighting simulation, Unity3D, Cultural heritage

[106] Paola Bertoletti (Politecnico di Milano) and Maurizio Rossi (Politecnico di Milano).

Indoor Artwork Lighting: A Review of Color Rendering, Spectral Power Distribution, CCT, Visitor Perception, and Preventive Conservation.

Abstract. Light is a decisive mediator between artwork and viewer: it shapes color appearance, detail legibility, and the perceived atmosphere of the exhibition, while potentially contributing to photodegradation. Museum lighting therefore requires balancing perceptual quality with conservation risk, reconciling curatorial intentions, visitor needs, and preventive conservation guidelines within the same design framework. This review synthesizes research on color rendering and correlated color temperature (CCT) for indoor exhibition lighting by linking (i) measurement and evaluation criteria, (ii) perceptual outcomes for visitors, and (iii) conservation constraints for different classes of works. After outlining key fundamentals relevant to artwork presentation—spectral power distribution (SPD), material reflectance and surface properties, metamerism, and chromatic adaptation—it compares metrics used in practice, from CRI to more recent systems that separate fidelity and gamut (e.g., IES TM-30), and discusses their known ambiguities when applied to heterogeneous artistic materials and context-dependent appearance judgments. Particular attention is given to how these metrics support or fail to support evidence-based design decisions in real museum practice. CCT is examined not as a sufficient descriptor but as a perceptual cue whose effects on saturation, chromatic balance, and atmosphere depend strongly on spectral shape, highlighting the need for SPD-aware specifications and for moving beyond CCT-only prescriptions. On the conservation side, the literature is reviewed in terms of SPD, exposure dose, and material sensitivity, discussing current mitigation strategies (LED spectral design, filtering, and exposure management). While guidelines provide illuminance limits and operational recommendations, open questions remain on source selection and on museum-specific metrics that integrate rendering, preference, and long-term risk. Finally, evidence from psychophysical studies and museum case studies is mapped to visitor outcomes (legibility, saturation, aesthetic satisfaction), showing how spectral variations can influence interpretation and curatorial intent. The review concludes by proposing an integrated decision framework for indoor artwork lighting and by identifying key gaps for future research: adequacy of existing metrics when applied to art, shared protocols for perceptual evaluation in museum-like conditions, and robust, practice-oriented descriptors of spectrum that extend beyond CCT and support both conservation and visitor experience.

Keywords: Museum lighting, Color rendering, Correlated color temperature (CCT), Spectral power distribution (SPD), Preventive conservation, Visitor perception

[92] Ichiro Katayama (Kindai University), Motonori Doi (Osaka Electro-Communication University) and Shogo Nishi (Osaka Electro-Communication University).

Brightness Perception of Chromatic Objects with Regular Surface Textures: Effects of Lightness Constancy.

Abstract. It was previously confirmed that white real samples with regular surface textures are perceived as brighter and whiter than their average luminance would suggest. This study investigated whether chromatic real samples with regular surface textures are perceived as brighter than their average luminance, like white samples.

A chromatic textured sample (standard stimulus) with regularly arranged surface undulations simulating fabric and a flat sample of the same color without texture (comparison stimulus) were juxtaposed across a partition in an observation box, and each sample was illuminated with independent white LED light sources in the box. The standard stimulus was illuminated at a constant illuminance, and the observers adjusted the illuminance of the comparison stimulus until its brightness matched that of the standard stimulus. The luminance of the comparison stimulus at the match point (subjective equivalent luminance) was recorded. The subjective equivalent luminance was also measured for flat samples similarly. Ten observers (men and women in their twenties) with normal color vision and normal visual acuity (including corrected vision) participated.

Both the textured and flat samples were 50 mm squares, produced using a three-dimensional printer and painted red, yellow, green, or blue with high-chroma matte spray paint. Two-dimensional luminance distributions were obtained using a luminance-calibrated hyperspectral camera. Under constant illuminance, the ratios of the average luminance of textured samples to that of flat samples were 0.66, 0.62, and 0.61 for red, green, and blue, respectively, and 0.78 for yellow, indicating that textured samples had lower luminance due to shading caused by the unevenness of the surface. Colorimetric measurements showed that the L^* values of red, green, and blue samples were approximately 50, whereas that of the yellow sample was approximately 85.

The visual evaluation experiment revealed that, for all colors, the mean subjective equivalent luminance values of both the textured and flat samples were nearly identical. The mean subjective equivalent luminance was 1.46, 1.52, and 1.56 times the average luminance of the textured samples for red, green, and blue, respectively, and 1.18 times for yellow. Regardless of hue, low-lightness textured samples showed a pronounced tendency to be evaluated as brighter compared to their average luminance.

These findings demonstrated that, in chromatic objects, surfaces with regularly arranged undulations that create shadows are perceived as brighter than their average luminance would suggest, like white objects. This phenomenon is thought to stem from lightness constancy, whereby regular low-luminance areas caused by surface texture are perceived not as low-lightness regions but as low-illuminance regions on a surface of uniform lightness. Furthermore, this effect was found to depend more on lightness than on hue, becoming more pronounced in low-lightness objects.

Keywords: texture, chromatic color, average luminance, subjective equivalent luminance, lightness constancy

SESSION A2S8 - Chair: Ana Elena Salvi

| Colors of Historical Cities

List of Abstracts:

[98], [17], [128], [96], [110], [155], [123], [149], [163].

[98] Nicola Tropeano ([Sapienza Università di Roma](#)).

Use of red pigmentation on masonry surfaces in medieval buildings in Rome. Selected case studies examined through spectrophotometric analysis.

Abstract. AIC Student Paper Awards

The study of medieval surface finishes has provided significant insights into specific treatments that characterize Roman buildings from the 11th to the 13th century. Among these, particularly noteworthy are treatments that employ plaster to simulate different surface coatings through worked or painted finishes.

Numerous fragments of painted faux curtain walls preserved in medieval buildings in Rome are primarily distinguished by the material they were intended to imitate. This research identifies and analyses treatments simulating brick curtain walls and those imitating stone blockwork.

Building upon a typological characterization of medieval surface treatments documented in Rome, this contribution presents the results of analyses conducted on selected case studies featuring the use of red pigmentation on the masonry surfaces of medieval buildings. The painted false brickwork cases exhibit variability in their technical and chromatic characteristics. In some cases, the finish consists solely of a layer of red-pigmented plaster, sometimes accompanied by surface incisions, like in a fragment preserved on a trifora of the bell tower of the church of S. Giorgio in Velabro. In other instances, light-coloured false joints are applied as displayed on the pentafore of the cloister of the abbey of S. Paolo delle Tre Fontane. Further examples display alternating horizontal bands of two distinct colours, one lighter and one darker, intended to reproduce courses of bricks, and overlapping mortar joints as observed in a fragment in the second courtyard of the basilica of Ss. Quattro Coronati.

This paper presents the analysis of some case studies carried out through a systematic review of the existing literature for each building examined. This was followed by on-site investigations, which included architectural surveys, detailed photographic documentation of the surface finishes, and diagnostic analyses. These investigations aimed to achieve a deeper understanding of the analysed treatments from a material, technical, and constructive perspective, with a particular emphasis on their chromatic properties. Spectrophotometric measurements were employed to record and analyse the colorimetric data of the surfaces. This specific diagnostic method allows not only to document the scientific definition of colorimetric data, but also to compare different surfaces that exhibit similar colours. Finally, the research aims to explore chronological reports and different states of conservation of medieval surface treatments.

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Keywords: medieval surface finishes in Rome, painted faux curtain walls, red pigmentation

[17] Karla Maria Muñoz-Alcocer ([Instituto Nacional de Antropología e Historia](#)) and Maria Luisa Vázquez de Ágredos Pascual ([Universitat de València](#)).

Integrating Biocultural Knowledge & Material Analysis to Trace Spanish Colonial dyes in Chihuahua Architecture.

Abstract. This article presents advances in archaeometric research on the selection of colorant materials used in the architectural decoration of Jesuit churches in the central region of the former province of Nueva Vizcaya (17th–18th centuries). Based on previous multi-analytical studies (FORS, XRF, ATR-FTIR, UV-Vis), two case studies are analyzed: the church of the mining town of Cusihiuriachi and the visita mission of Santa Ana and San Joaquín, in La Joya.

In Cusihiuriachi, despite the local abundance of yellow earths, a yellow colorant likely not native to the region was identified. This suggests a technical and symbolic selection associated with the knowledge and circulation of high-value materials such as indigo (*Indigofera* spp. Several species) and cochineal (*Dactylopius coccus*), which were also found in the polychrome ceiling. The review of analytical data points to the possible use of *Tagetes erecta*. Although all three colorants were present in the broader region, their use as dyes in this context had not previously been documented, suggesting they may have been imported for use in the ceiling's decoration.

In contrast, in La Joya, an alternative blue pigment was employed, probably derived from *Atriplex fruticosa*, a native plant better suited to the local economic conditions.

This article proposes a mapping of available materials and a spectral comparison with botanical and colonial bibliographic references, contributing new elements to understand chromatic decisions as the result of technical adaptation, knowledge transfer, and territorial management in Jesuit sacred art.

Keywords: Polychrome ceilings, Jesuit missions, *Atriplex fruticosa*, *Tagetes erecta*, colorants, Chihuahua

[128] Susana Coentro (VICARTE & DCR - NOVA FCT), Mathilda L. Coutinho (HERCULES - Évora University), Fernanda Carvalho (CENIMAT & VICARTE - NOVA FCT), Inês Coutinho (VICARTE & DCR - NOVA FCT), Carla Machado (VICARTE - NOVA FCT), Marine Cotte (ESRF & LAMS - CNRS), Jessica Hallett (Calouste Gulbenkian Museum) and João P. Veiga (CENIMAT & DCR - NOVA FCT).

The colours of Islamic architectural ceramics: Iznik and Damascus tiles in the Calouste Gulbenkian Museum (Lisbon, Portugal).

Abstract. Iznik and Damascus tiles are among the most notable manifestations of the artistry and technical innovation in Islamic architectural decoration, featuring colourful, unique mineral-based underglaze decorations. These tiles exhibit a variety of designs, predominantly floral and geometric patterns that incorporate cultural influences from both Chinese porcelain and Islamic motifs, dating from the late 15th to the 17th centuries. They also used a variety of colour schemes, combining well-known colourants, such as cobalt- or copper-based pigments, with less widespread ones, such as black iron chromites and the bole red characteristic of 16th-century Iznik tiles.

The Calouste Gulbenkian Museum, in Lisbon, houses an impressive collection of Iznik and Damascus tiles and is considered one of the most important European repositories of this type of ceramics. Using a representative selection of tiles from the Calouste Gulbenkian Museum's collection, this study focused on the colours of Iznik and Damascus tiles, namely the different colour palettes associated with chronological and provenance aspects, and the pigments used to obtain them.

The analytical methodology combines non-invasive in situ material and optical characterisation (colourimetry, optical microscopy, p-XRF, μ -EDXRF, hyperspectral imaging) with small, millimetre-scale samples from selected fragments, analysed as polished cross-sections in the laboratory (SEM-EDS, μ -Raman) and at the large-scale facility ESRF (μ -XRD, μ -XANES). By merging scientific analysis with historical research, this comprehensive approach aims to reveal not only the "recipes" used to create these colours but also the skilled techniques employed by Iznik and Damascus artisans, highlighting their mastery of both materials and methods.

This study is part of the GLAZE project – "The Art & Science of Iznik Tiles" – funded by the Portuguese Foundation for Science and Technology (2023.16519.ICDT | LISBOA2030-FEDER-00753900).

Keywords: pigments, glaze colours, glazed tiles, Iznik ceramics, bole red

[96] Alba Santo (Dipartimento di Scienze della Terra, Università di Firenze), Irene Centauro (Dipartimento di Scienze della Terra), Elena Pecchioni (Dipartimento di Scienze della Terra, Università di Firenze) and Teresa Salvatici (Dipartimento di Scienze della Terra, Università di Firenze).

Colours of Stone and Urban Identity in the Historical City of Florence.

Abstract. Colour is a key component of cultural heritage and plays a crucial role in defining the identity and recognisability of historical cities. Beyond architectural forms and artistic styles, the chromatic character of urban landscapes is largely determined by the natural materials used in construction, particularly stone. The colour of the rocks, deriving either from their intrinsic mineralogical properties or from later processes of weathering and decay, contributes to the visual coherence of historic centres and represents a tangible link between natural resources, cultural practices and urban development. Florence, whose historic centre was designated a UNESCO World Heritage Site in 1982, provides a significant case study for the analysis of colour in historical cities. The city preserves an exceptional architectural heritage spanning from the Middle Ages to the modern period; despite this stylistic diversity, Florence presents a distinctive and harmonious chromatic identity rooted in the widespread use of local stone materials. The urban colour of Florence is primarily characterised by the warm ochre tones of the medieval Pietraforte sandstone and the bluish-grey hues of the Renaissance Pietra Serena sandstone. These dominant colours are enriched by the white of marbles, the green of serpentinites, and the reddish shades of limestones, along with other natural lithotypes such as Breccia di Seravezza, granite, Nero di Colonnata, and Alberese limestones. Artificial materials, including plasters, mortars, and occasional bricks, further contribute to the overall chromatic harmony of the historical fabric. To move beyond a purely descriptive approach and to objectify this chromatic identity, the study integrates colorimetric analyses aimed at defining the spectral signatures of the stone materials, with particular attention to the effects of alteration and decay on colour perception. Most of the stones employed in Florentine architecture are sourced either from outcrops within the territory surrounding the city or from various locations across Tuscany, revealing a close relationship between geology, material availability, and historical construction practices. As a result, the colour of the built environment emerges as an expression of local cultural heritage rather than a purely aesthetic choice. Florence can therefore be interpreted as an open-air repository of urban colour, illustrating how the chromatic properties of rocks play a fundamental role in shaping the identity of historical cities and in preserving their cultural significance over time.

Keywords: Colour of stone, Cultural heritage, Historical cities, Chromatic identity

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The Archaeology of Color Serving the Future: Renovating 1960s Utopias.

Abstract. Introduction: This presentation examines the structuring role of color in the urban fabric through two 1960s-70s "urban utopias": Bron-Parilly (Rhône) and L'Arlequin (Grenoble). Analyzing their genesis and Nacarat's recent strategies, we demonstrate how color shifts from a militant artistic gesture to an essential tool for urban regulation.

1. The Genesis: Humanizing Industrialization In the era of "box frame" industrialization, color became necessary to humanize spaces. At Bron-Parilly, architect René Gagès and painter Claude Idoux theorized color as a "mobile element" vital to architecture, while Jean Amado anchored art in the material. At L'Arlequin, the AUA team conceived color as the neighborhood's "genetic code"—a strong urban signal intended to structure social spaces and forge a legible city image.

2. The Diagnostic: An Archaeology of Color Time has tested these visions. At Bron-Parilly, the original polychromy was erased by grey refinishing as early as 1967, invisibilizing the architectural gesture just as the highway split the site. At L'Arlequin, thermal renovations now threaten the ensemble's coherence. Nacarat's diagnostics perform an "archaeology of color" to rediscover initial intentions (hierarchy, rhythm) and understand current drifts (standardization, loss of meaning).

3. The Charter: Renovating the Utopia Contemporary intervention seeks resonance, not pastiche. For Bron-Parilly, the Color Master Plan restores coherence through precise "user guides" that accompany densification. For L'Arlequin, the charter adapts the historical palette to technical constraints (insulation), serving as a mediation tool to ensure chromatic diversity remains a social bond.

Conclusion: Recovering the initial design logics allows color to guide future architectural quality, intelligently accompanying new technical standards. Beyond aesthetics, this restitution restores dignity to these neighborhoods and their inhabitants.

Keywords: Urban utopia, Archaeology of color, 20th Century Heritage, Urban renewal, Color chart, Large housing estates

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The Changing Colors of The Brutalist Architecture: Using Close Range Photogrammetry to Understand the Chromatic Variation of the SESC Pompéia Building Throuout the Day.

Abstract. Built in 1986 in São Paulo by the Italo-Brazilian architect Lina Bo Bardi, SESC Pompéia is a Brutalist sports and cultural complex that repurposes and revitalizes part of a former drum factory. The cultural center is currently listed at both the municipal and federal levels as a historical and cultural heritage site due to its cultural and architectural significance within Brazilian architecture. The complex is composed of two major sectors: the first, cultural in nature, includes a restaurant, exhibition spaces, a theater, and a public square, and occupies the renovated facilities of the former factory, characterized by a horizontal scale and subdivided into multiple volumes. The second sector, dedicated to sports and administration, occupies two new reinforced-concrete buildings located in the southern portion of the site. This second ensemble, of a more vertical scale, consists of prismatic concrete buildings connected by large pedestrian bridges that span over the projection of a small stream, an area that cannot be built upon. Above this stream, the architect designed a wooden deck, regarded by city residents as their “beach,” where people sunbathe on towels and in swimwear. The complex came to be known as the “Citadel of Freedom.” The entire ensemble is served by service installations painted in primary colors, complemented by green—the only secondary color employed—as well as by the orange hue of the bricks from the former factory. Among the colors applied in the project, red stands out, used in the structural elements of the roofs, in large exposed pipes, and in the muxarabis (a wooden lattice screen positioned in the building’s huge apertures) that ventilate the interior of the large sports volume. It is noteworthy to observe the relationship between the complex and the sun, which illuminates this urban beach and tints the concrete buildings with a range of hues—from neutral gray to golden tones and even bluish shades—as the hours of the day progress. Through a chromatic survey conducted using close-range photogrammetry—a methodology previously studied by the authors and published at the 16th Congress of the International Colour Association, held in Taipei in 2025—this research seeks to understand the hues imparted to the reinforced-concrete sports buildings of SESC Pompéia by natural daylight throughout the course of the day, comparing their tones through chromatic tables, photographs, and digital point-cloud models. Based on a methodology involving systematic photographic surveying, data processing through photogrammetric computation, the export of chromatic-spatial information into data tables, and the subsequent analysis of hues, the present study aims to shed light on the multichromatic character of an architecture often regarded as monochromatic due to its extensive use of reinforced concrete and the effects of the chromatic constancy.

Keywords: Color survey, SESC Pompeia, Lina Bo Bardi, Brutalist Architecture, Chromatic constancy

[123] Wen-Yuan Lee (Department of Digital Media Design, Tatung University), Suchitra Sueeprasan (Department of Imaging and Printing Technology, Chulalongkorn University), Neri Chairat (Department of Imaging and Printing Technology, Chulalongkorn University), Pitchanuch Wongjariyakasem (Department of Imaging and Printing Technology, Chulalongkorn University) and Chia-I Liao (The Graduate Institute of Design Science, Tatung University).

Comparative CIELAB Analysis of Sacred and Secular Heritage Sites in Taipei and Bangkok.

Abstract. This study investigates the distinction between structural and intentional colors in heritage environments through a cross-cultural comparative analysis of Taipei and Bangkok. Adopting a 2×2 matrix (sacred/secular × Taiwan/Thailand), the research combines in-situ observation using standardized RAL color swatches with quantitative CIELAB colorimetry. Color similarity was quantified using the ΔE^*ab formula, followed by hierarchical clustering.

The analysis yielded a six-cluster solution that effectively captured chromatic patterns. Chi-square tests and Cramer's V revealed that the functional distinction between structural and intentional colors emerged as the strongest discriminator, surpassing the influence of national or sacred/secular boundaries. These findings underscore the critical role of design intent in shaping environmental color usage.

As an exploratory study, this research also demonstrates pedagogical value by engaging students in cross-cultural color observation and experiential learning.

Keywords: Structural colors, Intentional colors, Cross-cultural comparison, Heritage sites, Hierarchical clustering

[149] Ondrej Virág (slovak).

Digital Interpretation of the Industrial Heritage of the Atomic Age: Interactive Visualization and Presentation Tools in Architecture.

Abstract. This dissertation investigates methods of digital interpretation of industrial heritage through advanced visualization technologies, with a particular focus on the Atomic Age as a defining cultural, technological, and architectural phenomenon of the 20th century. The Atomic Age embodies a complex synthesis of scientific innovation, industrial production, and architectural representation, whose physical structures and symbolic meanings are increasingly threatened by material degradation, ideological marginalization, and limited public accessibility.

The principal objective of the research is to design, implement, and verify a methodological framework for the presentation and interpretation of Atomic Age industrial heritage using a combination of physical architectural models, augmented reality (AR), virtual reality (VR), and real-time interactive digital environments developed in Unreal Engine. These tools are conceived not merely as instruments of documentation, but as interpretative media capable of communicating the multilayered spatial, technological, and historical dimensions of nuclear-related architecture.

The dissertation culminates in the development of an interactive exhibition prototype that facilitates an immersive and multidimensional perception of selected Atomic Age sites. The proposed methodology aims to expand conventional approaches to architectural representation and heritage presentation, contributing to architectural research, heritage preservation strategies, education, and public engagement through the application of contemporary digital technologies.

Keywords: Atomic Age, Digital interpretation, Augmented reality, Virtual reality, Unreal Engine, Interactive visualization, Exhibition design, Science, Industrial heritage

[163] Vladimír Hain (Slovak University of Technology in Bratislava Faculty of Architecture and Design), Roman Hajtmanek (Roman Hajtmanek, Assoc. prof., Institute of Ecological and Experimental Architecture, FAD STU in Bratislava, SR) and Martin Uhrík (Martin Uhrík, Assoc. prof., Institute of Ecological and Experimental Architecture, FAD STU in Bratislava, SR).

Multidimensional model of historical cities - virtual urban walk.

Abstract. The paper “Multidimensional Model – Virtual Urban Walk” focuses on the research and application of innovative educational methods in the field of spatial design, particularly architecture, urbanism, and design. Its primary objective is the integration of these methods into contemporary educational curricula through so-called vertical studios, which emphasize the application of new technologies in presenting the historical, contemporary, and future development of urban settlements.

The chapter presents a case study of historical and contemporary examples demonstrating a replicable teaching method and educational tool referred to as virtual renewal. Comparable projects worldwide are often described as digital reconstruction. This virtual recovery approach has proven to be an effective learning method, successfully tested in collaboration with students, including during the pandemic period. Through this method, students are able to study architectural works directly within their real urban context and verify the current condition of structures in situ using the Urban Walk – Interactive Planning Method in combination with the Before–After Method.

The multidimensional model was tested in the area surrounding the former Apollo refinery and the Winter Harbour in Bratislava—an urban zone affected by several historical disasters, including wartime bombing during World War II and the demolition of significant industrial heritage a decade ago, of which only fragmentary remnants remain. Despite these losses, the area’s development potential was later recognized, and it has since become one of the most economically valuable parts of the city.

The creation of a multidimensional model requires the application of various digital mapping and visualization methods, including virtual and augmented reality technologies. Multidisciplinary cooperation is an essential component of such assignments, serving not only as a synergistic element within a complex design process but also as a key educational principle. Through the multidimensional model, the case study reinterprets the history of industrial cultural heritage that can no longer be physically restored, making it accessible to contemporary audiences. The model enables interactive spatio-temporal design, exploration of alternative urban development scenarios across past, present, and future contexts, and provides an illustrative example of former industrial brownfield conversions. Additionally, in the field of design, the use of augmented reality and virtual urban walks allows for the presentation of both micro- and macro-scale environments.

As a practical interactive tool, the multidimensional model also serves the general public by raising awareness of lost heritage and offering alternative approaches and potential strategies for the reconstruction and transformation of urban structures.

Keywords: Multidimensional model, Virtual urban walk, Digital restoration, Industrial heritage, Gamification

SESSION A3S9 - Chair: Keats E. Webb

| General

List of Abstracts:

[\[89\]](#), [\[171\]](#), [\[31\]](#), [\[154\]](#), [\[16\]](#), [\[109\]](#), [\[59\]](#).

[\[89\]](#) Iva Brlek (University of Zagreb Faculty of textile technology), Valentina Vragović (University of Zagreb Faculty of textile technology), Marija Leš (University of Zagreb Faculty of textile technology) and Ivana Čorak Ribić (University of Zagreb Faculty of textile technology).

Dyeing Textiles with Cochineal - Traditional Natural Dye of Animal Origin.

Abstract. This study investigates the applicability of the natural dye of animal origin, cochineal (*Dactylopius coccus*), in textile dyeing with the aim of achieving varied colour reproduction. Cochineal is a natural red dye obtained from the dried bodies of female insects traditional to Central and South America, and was historically used for textile dyeing before the introduction of synthetic dyes in the nineteenth century.

Although synthetic dyes largely replaced natural dyes due to their lower cost and ease of application, their long-term negative effects on human health and the environment have led to renewed interest in natural colouring agents. Cochineal is biodegradable, non-toxic, and capable of producing a wide range of red to purple hues, depending on fibre type, dye concentration, pH, and the use of mordants.

This research is set within the context of increasing environmental awareness, renewed interest in traditional dyeing techniques, and the search for sustainable alternatives to synthetic dyes in contemporary textile production.

The experimental part of the study involved dyeing cotton and wool fabrics using commercially available cochineal dye. Dyeing was carried out with and without different metal mordants in various concentrations. The influence of fibre type, dye concentration, and mordant application on colour development was analysed. Colour measurements were conducted using a remission spectrophotometer according to the CIELab colour system. The colour parameters for lightness (L^*), saturation (C^*), hue (h°), and a^*/b^* coordinates were determined spectrophotometrically using the dyed samples and the results were compared with the Pantone catalogue.

The results indicate significant differences in dye uptake between fibre types, dye concentration, and mordant used. Wool samples exhibited intense colour at higher concentrations. This behaviour is attributed to the chemical and morphological properties of protein fibres, which allow stronger interactions with natural dyes compared to cellulose fibres such as cotton. The effect of mordants proved complex; while mordants generally improve dye fixation, in some cases they altered hue and reduced colour intensity due to interactions with the dye molecule and changes in bath chemistry.

The study demonstrates that natural dyes such as cochineal have considerable potential for sustainable and specialised textile applications, although precise reproduction of standardised colour systems remains challenging. The findings highlight the importance of an individualised approach to dyeing processes and suggest that, under specific conditions, effective dyeing can be achieved with reduced chemical input. This contributes to the development of environmentally responsible textile production and supports the renewed integration of natural dyes into contemporary design practices. Examples of completed cases, i.e. applications of this optimised process, will be presented in this paper.

Keywords: natural dye, cochennille, mordants, textile, Pantone

[171] Vanessa Otero (LAQV-REQUIMTE R&D Unit and Department of Conservation and Restoration of the NOVA University of Lisbon), Marlene Miranda (Department of Conservation and Restoration of the NOVA University of Lisbon), Andreia Ruivo (VICARTE R&D Unit and Department of Conservation and Restoration of the NOVA University of Lisbon), Márcia Vilarigues (VICARTE R&D Unit and Department of Conservation and Restoration of the NOVA University of Lisbon) and Paula Nabais (NOVA School of Science and Technology (FCT)).

Cochineal-Based Colours in Hand-Painted Magic Lantern Glass Slides: Distinguishing Historical Paint Formulations through Material Characterisation.

Abstract. Magic lanterns were the first form of image projector and had a profound impact on global socio-cultural, scientific and educational practices from the 17th to the early 20th century. The earliest images were created by hand-painting directly on glass, a demanding technique that required high artistic skill to produce miniature paintings using transparent and highly luminous colours capable of achieving strong visual impact when projected under light. Red hues were frequently obtained using organic colourants, notably cochineal-based lake pigments, valued for their chromatic intensity but inherently vulnerable to light-induced degradation.

Throughout the 18th and 19th centuries, watercolours were highly recommended for painting magic lantern slides, with several producers and suppliers further advising the use of materials manufactured by Winsor & Newton (W&N), a leading colourman of the 19th century. From 1863 onwards, dedicated materials for painting on glass became commercially available in W&N catalogues. These sources document a wide range of colours associated with cochineal-based colourants, namely Carmine, Crimson Lake and Purple Lake.

This paper presents results from the project Magic Lantern: Study Safeguard, Uses and Reuses in 19th Century Portugal (<https://www.magica-project.com/>), which established an integrated methodology for the material characterisation of hand-painted magic lantern glass slides. A multi-analytical approach combining Energy-Dispersive X-ray Fluorescence Spectrometry (EDXRF), Optical Microscopy, UV-Vis Spectroscopy (transmission and reflectance mode), Raman and Infrared spectroscopies was applied to slides from Portuguese collections. Cochineal-based colours were among the most frequently identified colourants in red and purple paint layers within a set of approximately one hundred analysed magic lantern slides.

This study goes beyond the identification of cochineal-derived colourants to address the challenge of distinguishing different historical cochineal-based paint formulations. To this end, the Winsor & Newton (W&N) 19th Century Archive Database will be investigated as a key resource for accessing detailed information on the commercial preparation of artists' materials in the 19th century, with particular focus on cochineal-based watercolour formulations. Selected lake pigment and watercolour recipes will be reconstructed with high historical accuracy and analysed using a multi-analytical approach. Comparison between reconstructed paints and historical objects will enable the identification of markers associated with specific formulations. Distinguishing these formulations is essential for understanding differences in optical behaviour, ageing patterns and degradation susceptibility among visually similar red hues, and provides a robust foundation for future conservation strategies tailored to hand-painted magic lantern slides.

Keywords: Magic Lantern Glass Slides, 19th century, Cochineal, Watercolours, Painting materials characterisation

[31] Seden Odabasioglu (Marmara University).

Rouge d'Andrinople: Traces in the Past, Projection into the Future.

Abstract. Rouge d'Andrinople is the internationally known name of the historical color first produced in Adrianople (now called Edirne, a city in Türkiye) in the 15th century during the Ottoman era. Two paint masters obtained this color as a natural dye as "brighter than brick red" from a plant called 'rubia tinctorum'. In the 18th century, the formula was taken to and produced in France and referred to as 'Rouge d'Adrianople'. Thereafter, it had an impact on Europe, particularly England, that a competition was organized to determine the best and most accurate way to obtain this color.

Red and its shades had a special place in Ottoman culture and it is known that the production of red dyes was controlled by the state in the 18th century. Edirne was one of the cities in which red dyes were produced. Red was used on clothes, miniature paintings, traditional handicrafts and decoration of buildings. Wood carvings covered with lacquer were called 'Edirnekârî', which was a technique originated in Edirne and later applied to many buildings in various cities. Rouge d'Andrinople, also known as 'Turkish Red' or 'Edirne Red' was applied to wooden household items, ceilings, doors, windows, pulpits and tiles in buildings and also carpets and fabrics.

This color, which involved a very laborious natural dyeing process and required a great deal of effort and money, was the subject of espionage and rewards were offered to those who solved its secret. It was highly popular in the textile industry until the Industrial Revolution. After the Revolution, its popularity declined due to the discovery of synthetic colorants and increase in factory production and the difficulty of its formula. Synthetic dyes are widely used because they are easily available and economical, but natural dyes are gaining increasing attention because they are not harmful to health and are environmentally friendly. Thus, natural dyeing methods have begun to be redeveloped, considering new energy-efficient dyeing and repeatable color tone development processes.

This study focuses on the use of Rouge d'Adrinople in Ottoman culture, particularly in buildings, and traces the trail of this color in the history which faded away later. Since 2017, the color has begun to attract renewed interest from various disciplines, and considering Edirne's city identity, a trend has emerged to project this deep-rooted color into the future. It can be applied to various surfaces (e.g., as flat paint, on textile products, printing, ceramic and wood) and, because it is resistant to sunlight and water, has great potential for use in contemporary design, particularly in interiors. Therefore, this potential is discussed in this study considering both the trend and sustainability aspects of the color. Efforts to revive the use of this color will vitalize contemporary cultural forms based on the lost cultural heritage and traces of Edirne Red.

Keywords: Rouge d'Andrinople, Edirne Red, natural dye, cultural heritage, color in interior design

[154] Mara Espírito Santo (NOVA School of Science and Technology (FCT)), Paula Nabais (NOVA School of Science and Technology (FCT)), Vanessa Otero (NOVA School of Science and Technology (FCT)), Marcia Vieira (NOVA School of Science and Technology (FCT)), Marta Manso (NOVA School of Science and Technology (FCT)), Joana Sequeira (University of Minho, Portugal), Sónia Domingos (DGLAB - GENERAL DIRECTORATE FOR BOOK, ARCHIVES AND LIBRARIES) and Dominique Cardon (Centre National de la Recherche Scientifique (CNRS)).

Beneath the Threads: Colour and Dyeing Knowledge in 18th-Century Portuguese Textiles.

Abstract. Colour played a central role in the economic, symbolic, and material culture of early modern Europe. In Portugal, wool production flourished during the 18th century under royal patronage, with major manufacturing centres such as Covilhã, Portalegre, and Fundão contributing to national textile output. However, despite this rich historical legacy, one essential aspect of the craft has largely faded from both collective memory and written sources: textile dyeing knowledge.

This presentation draws on research carried out within the recently funded ERC project SCARLET: Study and Interpretation of Historical Natural Dye Formulations for Modern Textile Design, which investigates how knowledge of natural dyeing of wool cloths circulated across Europe and reached Portugal between the 15th and 18th centuries, bridging historical sources and scientific experimentation.

Recent research at the National Archive Torre do Tombo (Lisbon) has brought to light a collection of more than 200 textile samples produced at the Royal Factory of Portalegre between 1775 and 1780. Submitted to the Chamber of Commerce for quality evaluation, these samples document the range of colours manufactured and provide rare material evidence of late 18th-century dyeing practices in Portugal.

Within the chromatic range documented by these samples, the present study focuses on red hues, among the most technically demanding, economically valuable, and symbolically charged colours of the period. In the absence of detailed Portuguese written sources on dyeing and considering the documented presence of foreign master dyers in Portuguese royal manufactories, French and Spanish treatises are used as proxy sources to investigate the technical knowledge circulating in Portugal during the 18th century. By combining material examination of historical textiles with experimental reconstructions based on historical dyeing sources, this research uses colour as a lens through which to explore technical practice and cultural exchange. A multianalytical approach was employed, integrating high-performance liquid chromatography (HPLC-DAD), energy-dispersive X-ray spectrometry (EDXRF), molecular fluorescence in the visible and colorimetry to study and compare historical and reconstruction samples. The results highlight recurring patterns in colouring materials and dyeing strategies within the red palette, while also revealing variations that reflect the circulation and local adaptation of technical knowledge.

By approaching colour as both a material and cultural phenomenon, this study offers new insights into the role of material evidence in recovering lost craft knowledge and enriching the interpretation of textile heritage, highlighting the value of interdisciplinary approaches for understanding cross-cultural exchanges of technical knowledge in early modern Europe.

Keywords: Historical textiles, Natural dyes, 18th century, Multi-analytical methodology

[16] Tiantian Fan (Wuhan Donghu College, Wuhan, China) and Maria Martone (Sapienza, Università di Roma).

From China to Europe: Comparing Porcelain Colour Palettes for New Colour-Blocking Strategies.

Abstract. This study compares Chinese and Neapolitan royal porcelain colour systems through four pilot samples. An image-based protocol combining multiclass segmentation, pixel counting, KDE, median sRGB palettes, and proportional colour blocking identifies four chromatic logics: tonal blue modulation, turquoise-green dominance, a white matrix with polychrome accents, and concentric hierarchy. The method enables comparative analysis of colour proportions, spatial distribution, and visual roles without claiming absolute colourimetric measurement. A QR-linked motion-graphics video summarises the workflow.

Keywords: Chinese porcelain, Capodimonte porcelain, image-based colour analysis, proportional colour blocking, motion graphics

[109] Paola Artoni (Museo dei Madonnari), Paolo Bertelli (Aroma Itinerarium Salutis), Angelo Agostino (Chemistry Department, University of Turin), Kurt Wenner (independent researcher) and Dafne Cimino (Department of Applied Science and Technology, Politecnico di Torino).

“Madonnari”: technical art history and conservation.

Abstract. In the hamlet of Grazie di Curtatone (Mantua, Italy), a pavement art festival of the “Madonnari” has been held since 1973 on August 15 for the Feast of the Assumption, making it the oldest event of its kind in the world. Grazie is recognized as the birthplace of this devotional art, reinforced by the presence of a dedicated museum. Rooted in Italian folk traditions, these dry-pastel works are inherently ephemeral, created to last only for the duration of the feast.

In 2023, a chemical characterization of the Madonnaro artist’s colors was presented for the first time. The study compared homemade and commercial formulations, identifying their principal binders and pigments.

This multidisciplinary work has been further enriched with insights into:

- a. The materials of the Madonnari’s art developed in direct response to the street itself, with pavement as the original support. Irregular paving often made drawing difficult, leading artists to adopt rigid portable surfaces that could be placed on the ground while remaining more suitable for drawing. On smoother surfaces, legislation frequently equated street art with vandalism, and pushed artists toward removable supports such as canvas. These solutions preserve the visual impression of a flat street surface while allowing the work to be quickly removed. Some such works have since entered museum collections at the request of local communities or event organizers.
- b. From homemade to industrial pastel. Historically, the Madonnari’s materials shifted from homemade formulations to commercially produced pastels, including costly professional brands increasingly used from the 1980s onward. During this same period, Master Madonnaro Kurt Wenner refined his own pastel formula, drawing on a study of historical art recipes.
- c. Durability of materials. The Madonnari’s works can remain on pavement for several days and are often surprisingly stable when transferred to supports. Inert materials such as chalk and some pigments mainly organic are unstable outdoors yet highly permanent under conservation, while oxide pigments are both durable and permanent.
- d. Observation of case studies from the Madonnari Museum. This collection includes works executed on clay, paper, wooden panels, and synthetic canvases. Originating over forty years ago, these pieces provide a valuable foundation for a systematic study of the ageing of this art.
- e. Key aspects of pastel restoration. As a relatively recent addition to museum collections, Madonnari art presents new conservation challenges due to the diversity of its techniques and materials. A typical stratigraphy includes a preparation layer, one or more image layers of chalk or pastel, and occasionally a surface varnish or fixative. As in traditional works, the preparation layer enhances adhesion and contributes to physical, chemical, and mechanical stability, while surface varnishes have already caused alterations in some works.

Keywords: Madonnari, Museo dei Madonnari, Devotional Art, Pavement Art, Ephemeral Art, Pastel conservation, Pastel restoration, Pigments, Varnishes

[59] Irene De La Torre Fornés (Heritage Restoration Institute_UNIVERSITAT POLITÈCNICA DE VALÈNCIA), Ana Torres Barchino (Heritage Restoration Institute_UNIVERSITAT POLITÈCNICA DE VALÈNCIA), Ignacio Cabodevilla Artieda (Heritage Restoration Institute_UNIVERSITAT POLITÈCNICA DE VALÈNCIA) and Javier Cortina Maruenda (Heritage Restoration Institute_UNIVERSITAT POLITÈCNICA DE VALÈNCIA).

Colour identification of the Nolla mosaic in the Calatayud Palace in Valencia.

Abstract. Nolla mosaic is a ceramic tile that began to be manufactured in the Meliana factory in Valencia at the end of the 19th century and became popular at the beginning of the 20th century, mainly as flooring in bourgeois residences in the eastern regions of Spain. This mosaic is composed of small pieces of various geometric shapes (mainly squares, triangles, rhombuses and hexagons) and a limited number of shades for each shape, but whose combination generated an infinite number of designs. Originally, the colour palette of Nolla mosaic tiles was limited, consisting of nine shades (black, brown, grey, beige, orange, red, green, blue and white). Later, in the 20th century, gradations of these colours were added, as well as new shades, predominantly high brightness colours. Thus, the production of Nolla mosaic tiles can be classified into three major periods in the company's history: the first stage (1860-1879), the second stage, which is the most characteristic (1879-1920), and the third stage (1920-1977), each with its own characteristic colour scheme. The modular pieces were used to compose designs previously defined in commercial catalogues, or new exclusive compositions were designed at the request of customers, due to the versatility offered by their modular concept. This paper, part of the research carried out by the Colour in Architecture Research Group (GICA) at the Heritage Restoration Institute of the Universitat Politècnica de València, presents a chromatic identification of the shades of Nolla ceramics in NCS System notation, taking the Calatayud Palace in Valencia as a case study. This palace, designed in the early 20th century by architect Juan Luis Calvo Catarineu in an eclectic style, is part of the bourgeois architectural heritage of the city of Valencia and preserves stoneware mosaics from Nolla's second production period in its noble rooms. For this study, three rooms on the mezzanine floor and four rooms on the first floor paved with Nolla mosaic tiles were selected, excluding rooms with hydraulic tile coverings. For each of these rooms, files were created showing their location on the building's floor plan, a photograph of their flooring, the composition of their ceramic tiles and the chromatic measurement of their different shades, obtained using the NCS colorimeter. A limited colour palette has been identified for each shade, revealing a certain variety due to the industrial production method used for the pieces, which were fired in coal-fired kilns. Thus, by documenting certain shades of the stoneware pieces contained in the Palace of Calatayud, this study provides information on the colour scheme that characterises Nolla stoneware mosaics. The aim is to contribute to the knowledge and appreciation of this ceramic cladding, considered an integral part of the architectural and cultural heritage of the monuments and residences it covers – particularly in the Valencia region – to which it lends elegance and distinction.

Keywords: Nolla Mosaic, ceramics, Calatayud Palace, Colour, Valencia

SESSION A1S10 - Chair: Manuel Melgosa

| Color and perception

List of Abstracts:

[9], [95], [11], [184], [45], [65].

[9] John McCann (McCann Imaging).

The different images made by HDR Photography and HDR Human Vision.

Abstract. When someone mentions Florence, a memory image pops in my head. It is a wide-angle view of the city on a sunny day with big clouds and big shadows with Brunelleschi's Dome at the center. It is seen from a place near the location of Lucia Ronchi's 1987 AIC Meeting. Also near where Pope Urban VIII sent Galileo for life. My memory of Florence is an HDR view from Arcetri.

My talk describes the differences between the image I saw from that HDR scene, and today's HDR photographs of it. To be more precise, I will describe what we know about HDR human vision, and compare it with HDR photography. Their pipeline processes are different.

In vision's first step, the scene's entire light field (radiance of all objects) is transformed by vision's Optical Glare Spread Function. All radiances reaching the retinal receptors have undergone unique scene-dependent changes. Receptors independently adapt to the quanta catch of the visual pigments. The neurons in the retina, optic nerve and cortex are a cascade of spatial comparisons that generates edges, orientations, intraocular disparities, colors. In short, radiance controls the quanta catch of the light captured, but vision uses many different spatial comparisons to generate appearances. Accurate Scene Radiances do not reach the retina. Retinal quanta catch does not reach neurons. Neurons process spatial comparisons and abandon radiances.

I grew up believing that photography accurately captured and accurately reproduced all scene radiances. As a college freshman I learned that was nonsense. I met Edwin Land.

Photography's Glare is different, but substantial. Colorimetry has the hidden assumption of Zero glare that limits its use to single spots of light (Inaccurate for HDR scenes). Digital pixels use Bayer Pattern spatial processing, but does not mimic vision's scene-dependent spatial image processing. Multi-image segmentation + image fusion (iPhone) introduced a different kind of spatial processing with great success. HDR photos introduce pixel-by-pixel LUTs based on overall image analysis. Its goal is the best dramatic rendering of glare-transformed scene captures. Experiments comparing all real-scene-HDR appearances with HDR photos appearances are not available-yet.

Since the earliest work of Mees, Photography's goal has always been to transform the scenes' captured record into the most agreeable rendition for the viewer. AgX films applied the same Tone Scale to all parts of the scene. Ansel Adams (Zone System) introduced scene-dependent transformation. Land & McCann calculated spatial transformations that mimicked human vision. They measured observed matches of all image segments. They trained their spatial model to give each image segment the same appearance as observed matches.

What is the goal of your next Photograph: A dramatic standard rendition; or mimicking appearances of the scene; or something else? Regardless, please do not think photographs are an accurate rendition of all scene's radiances!

Keywords: human spatial color vision, photography, rendering in reproductions particularly in rendering fine art, optical veiling glare, human neural pathway for vision (receptors to appearance), spatial comparisons control color appearances, colorimetry predicts color matches not appearances

[95] Chiara Biguzzi ([Alma Mater Studiorum - Università di Bologna](#)) and Edoardo Provenzi ([Université de Bordeaux](#)).

Uncertainty relations for perceived colors.

Abstract. In this contribution, we present a refinement of the uncertainty relations for chromatic opposition predicted by the quantum information–based color perception model of Berthier and Provenzi, which constitutes an alternative to the classical colorimetric framework proposed by the CIE. Within this approach, chromatic information is encoded in quantum states, while human observers are modelled as quantum effects. Perceived colours emerge from the action of effects on states through quantum measurement. We show that the intrinsic uncertainty relations for chromatic states, established in a 2021 work, can be extended to post-measurement chromatic states. In particular, we prove that, for observers adapted to near-achromatic illuminants, this extension involves an additional term proportional to the norm of the corresponding effect. Finally, we remark that hue cancellation experiments provide an experimental procedure to test these predictions and deviations from the intrinsic uncertainty relations can be exploited to associate a given human observer with a specific quantum effect. It is clear that a better theoretical knowledge of individual color perception may lead to better suited color representations that will benefit, for instance, digital restauration.

Keywords: Perceived colors, Uncertainty relations, Quantum information, Quantum states and effects

[11] Alessandro Rizzi (University of Milan).

From Color to Color Appearance in Museum's Heritage.

Abstract. In fine art's paintings vocabulary, a replica is a copy "made by the same hand as the original". It is the best possible copy, made with the same materials, with the painter matching every appearance, everywhere in the image. A replica is perfect if the painter cannot see any difference between his original and his replica.

While the original matched everything, a reproduction does not. The reproduction can be recognized if viewed by someone familiar with the original. Any Google search using the name of a famous painting will instantly display a very large array of different copies that are recognizable, but have very different appearances. None of them approach the quality standard of a painter's "replica".

A reproduction has none of the restrictive requirements of a replica. Typically, it is a AgX film or digital image made with commercial photographic systems. Almost all digital cameras use R,G,B lookup tables that introduces the same efficient colorimetric adjustment to every pixel in a scene. (Scene Independent Images (SINDI)). Thirty years ago, SINDI technology that made the same identical color correction to every pixel was the only practical option at the birth of digital cameras.

SINDI cameras do not mimic human vision because they are designed to make a preferred rendition of the scene. Popular cameras make images with a bluer sky, greener grass, and better colors than their scenes. While a painter's replica has rendition accuracy as its goal, SINDI cameras have enhancement for its goal for reproductions. SINDI image enhances some image segments, but distorts others. SINDI cannot match the appearance of every original segment,

Human vision ignores the light falling on the observers eye ($W \cdot sr \cdot 1.m^{-2}$). Instead it builds appearances up from ratios of responses from receptors and a cascade of neural spatial comparisons (all dimensionless numbers).

Mimicking human vision requires a Scene Dependent Image (SDI) calculation. Namely, an efficient way to build appearances by comparing every pixel with every other pixel in the image. (For example, SDI processes accurately match all Lightness Illusions (Simultaneous Contrast, Land's Mondrians, and Adelson's CheckerShadow.)

At first glance, individual comparisons of 10^6 pixels with 10^6-1 pixels seems impractical. Nevertheless, multi-resolution spatial comparisons algorithms (available for nearly 50 years) have the computational efficiency to make mimicking vision practical.

Museums make extraordinary efforts on provenance history. Should Museums consider, making reproductions' appearances - a kind of scientific visual provenance? Visitors can compare a Museum's reproduction with the Museum's original. Will visitors say that their reproduction approaches the quality of a replica?

Using SDI, rather than SINDI can make reproductions much better because they have set their goal to mimic human vision so to assess scientifically its visual provenance.

Keywords: color appearance, museums, cultural heritage restoration, cultural heritage reproduction

[184] Taiki Hoshino (Chiba University), Wei Li (Chiba University), Midori Tanaka (Chiba University) and Takahiko Horiuchi (Chiba University).

Impact of Geometric Alignment on Color Perception in Projection-Based Augmented Reality.

Abstract. The digital reconstruction of cultural heritage often relies on Augmented Reality (AR) to overlay lost colors or textures onto weathered physical artifacts. However, achieving accurate color reproduction in AR is challenging due to the perceptual complexity of additive light mixing. While traditional color appearance models assume simple physical addition, recent studies, such as those by Hassani (2019), suggest that the human visual system performs a weighted summation (perceptual discounting) of the foreground and background, rather than a linear addition. This phenomenon, often linked to color scissioning, can lead to significant shifts in perceived color, potentially misrepresenting the original appearance of historical objects.

Our previous research demonstrated that in Optical See-Through (OST) AR, accurate geometric alignment (registration) between the virtual foreground and the physical background significantly mitigates these perceptual shifts, causing the visual system to treat the combined light as a single, integrated surface (Li et al., 2026). This study extends that investigation to Projection-AR (Spatial AR), a modality frequently used in museums and heritage sites to "re-color" physical exhibits without requiring wearable displays.

We constructed an experimental system using an LCD projector (EPSON EH-TW7100) to project virtual stimuli onto a physical background consisting of nine printed color patches. To analyze the relationship between geometric alignment and color perception, we conducted a color-matching experiment with five observers across four lightness levels ($L^* = 50, 78, 93, 120$) and six hues (Red, Yellow, Green, Cyan, Blue, and Magenta). Observers adjusted the color of a projected test patch to match a target stimulus under varying alignment conditions, ranging from precise registration to controlled spatial offsets.

Initial results indicate that even subtle misalignments trigger a "scissioning" effect, where the observer perceives the projection and the background as distinct layers, leading to a measurable shift in color appearance. Conversely, when perfectly aligned, the perceptual weighting coefficients remain close to unity, confirming that precise registration is a critical factor for authentic color reproduction. These findings provide essential guidelines for the use of projection mapping in cultural heritage, ensuring that the digital restoration of artifacts remains perceptually faithful to the intended historical palette.

Keywords: color appearance, augmented reality, geometric alignment, color matching, projection mapping

[45] Isamu Motoyoshi (The University of Tokyo) and Suguru Wakita (The University of Tokyo).

Achromatic and chromatic texture spaces in human vision.

Abstract. The visual world is replete not only with color but also with textures. In natural environments, textural qualia provide the fundamental basis for the richness and realism of our perceptual experience.

Unlike color, texture perception is traditionally considered to be so complex that it is governed by extremely high-dimensional information. However, akin to objects and faces, the final percept of a texture may rely on a more compact representational space at higher levels of visual processing. If such a space exists, it would enable us to describe, predict, and control any texture as effectively as we do in color space.

Recently, we derived a compact 16-dimensional “texture space” based on the unsupervised learning of natural image statistics (Wakita & Motoyoshi, 2025). Using just 16 coordinate values, this model could accurately describe and generate the appearance of any given natural texture (e.g., gravel, fabric, grass), and predict the perceived similarity between different textures as judged by human observers. Moreover, VEP analysis revealed a strong representational similarity between this texture space and VEP signals, enabling us to recover the 16 coordinate values and reconstruct photorealistic texture images directly from VEP signals. These results suggest the existence of a compact set of neural codes that universally represent complex textures in the human visual cortex. However, these findings were obtained exclusively for achromatic texture images.

If such a compact space also exists for colored natural texture images, we could obtain a unified representational space that quantitatively describes both color and texture perception. To explore this possibility, we performed similar learning on RGB natural texture images. However, we were unable to obtain a low-dimensional space integrating color and texture; this color-texture space required over 100 dimensions to predict perception with sufficient accuracy. More importantly, we found that observers had substantial difficulty in judging the similarity between colorful textures. For example, among three texture images A, B, and C, it was frequently observed that A was judged similar to B in terms of color, but similar to C in terms of texture. This suggests that the perception of texture and color may be based on independent neural representations even at higher processing stages in the visual system.

Keywords: texture space, color space, natural image statistics, computational model

[65] Suzuho Tanaka (Tokyo University of Science), Chieco Ono (Tokyo University of Science), Suzu Tayama (Tokyo University of Science), Hikaru Shida (Tokyo University of Science), Kazuto Takase (Tokyo University of Science) and Nozomu Yoshizawa (Tokyo University of Science).

Neurophysiology-based Visibility Estimation Model Considering Chromatic Adaptation.

Abstract. Visibility is a fundamental factor in evaluating visual environments. Previously, an edge-detection algorithm was developed based on neurophysiological models to estimate visibility while considering chromatic differences. However, this algorithm did not fully incorporate the effect of an observer's chromatic adaptation state. This study aims to extend this algorithm by proposing a model that predicts visibility under adaptation to the illuminations with different chromaticities. Specifically, a normalization function is introduced at the cone-response stage, and the semi-saturation constants of L-, M-, and S- cones are adjusted based on each adaptation state. This reproduces adaptation mechanisms such as cellular adaptation, photopigment bleaching, and saturation. The adapted signals are used as inputs to the lateral geniculate nucleus (LGN), preceding edge-detection mechanisms in the primary visual cortex (V1). The validity of the proposed model is examined through subjective evaluation experiments on edge visibility under various adaptation conditions.

In the experiment, participants first observe a white hemispherical space with a radius of 4000 mm. The space is illuminated by red, green, blue, or 5000 K lighting, and the wall luminance is set to either 10 or 100 cd/m². Based on the model proposed by Valeton, cone bleaching time was calculated, and a 250-second observation period was defined as the adapted state. After adaptation, the board in front of the participant is removed, and a target stimulus (20–26 cd/m²) is presented on a monitor placed directly behind it. The target comprises two adjacent colors, and the participants evaluate the visibility of the boundary between them. The colors were drawn from red, green, and blue hue ranges. Three conditions were defined where luminance was identical between the two sides while chromaticity differed. In addition, one condition per hue was defined where chromaticity was identical but luminance differed, and three conditions where both luminance and chromaticity differed while the hue remained the same, resulting in six and nine conditions, respectively. Eighteen participants in their twenties took part in the experiment.

Although not all conditions showed statistically significant differences, a tendency was observed: under conditions where the target colors are highly saturated, the edge visibility ratings are higher when the chromaticity of the adapting illumination is similar to the hue of the target. By contrast, when the target colors have low in saturation, the highest ratings are obtained under adaptation to 5000 K illumination. These tendencies suggest that edge visibility varies depending on adaptation conditions and indicate the potential to extend the existing algorithm using the proposed method.

The results of this study are expected to contribute to visibility simulations of environments illuminated by chromatic lights.

Keywords: Visibility, Edge Detection, Neurophysiology-Based Model, Chromatic Adaptation

SESSION A2S11 - Chair: Laura Marchionne

| Colors of Historical Cities

List of Abstracts:

[\[158\]](#), [\[131\]](#), [\[132\]](#), [\[136\]](#), [\[153\]](#), [\[168\]](#).

[\[158\]](#) Jakub Demčák (Slovak University of Technology).

Artificial Intelligence in the Architectural Design Process.

Abstract. Generative artificial intelligence is increasingly used in architectural design for conceptual exploration, image generation, and the production of multiple design alternatives. Its influence, however, extends beyond the visual appearance of generated outputs. Generative AI not only responds to architectural design intentions; its outputs can also participate in their formation. When those intentions are not sufficiently articulated before generation, the color, materiality, atmosphere, and formal qualities introduced by early AI-generated outputs may compete for the designer's attention and influence subsequent decision-making. Their visual persuasiveness can redirect the design trajectory before a stable architectural position has been established, shifting the architect from actively directing the process toward responding to generated possibilities. This paper investigates these effects on decision-making and examines recurring behavioral patterns that emerge within AI-assisted architectural design processes.

The study builds on experimental workshops conducted with architecture students, in which generative AI tools were integrated with digital modeling, visualization, and material fabrication. The research analyzes the relationship between architectural intention, prompt formulation, generated imagery, and subsequent design decisions. Attention is given to two workshop cases developed in Granada and Innsbruck, where AI-generated outputs were translated into spatial concepts, digital models, and clay prototypes.

The analysis is structured around four recurring behavioral patterns identified in the documented design processes: Conceptual Drifting, Translating, Splitting Agencies, and Curatorial Assembling. These patterns describe how designers negotiate between initial intentions and qualities introduced by generative outputs. Within these processes, color operates together with materiality, atmosphere, and form as part of the visual specificity through which generated outputs attract attention, suggest contextual compatibility, and influence subsequent design decisions. These qualities also reveal the distributed character of design agency, as decisions emerge through interactions among prompts, model inference, group selection, material constraints, and contextual interpretation.

The paper argues that the visual qualities of AI-generated outputs—color, materiality, atmosphere, and form—shape design decisions from the earliest stages. Without clear intentions and evaluation criteria, visually persuasive images may redirect the design trajectory and imply architectural resolution before spatial, material, and contextual issues are addressed. Architectural authorship therefore depends on the designer's ability to critically guide and translate generated possibilities into coherent decisions.

Keywords: generative artificial intelligence, architecture, color, patterns, prompt choreographies, generative design, Granada

[131] Merve Yildiz (Yildiz Technical University, Department of Architecture) and Esra Küçükkılıç Özcan (Yildiz Technical University, Department of Architecture).

Investigating the Relationship Between Building Morphology and Façade Colors Using Machine Learning: The Case of Kuzguncuk.

Abstract. Urban identity is a multi-dimensional construct in which architectural morphology and color play a crucial role in visual perception. This identity forms a visual language that integrates the city's physical character with social memory. Therefore, the preservation of urban identity requires not only the maintenance of structural forms but also the unaltered transmission of social and cultural memory to the future.

While there are numerous studies in the literature on urban morphology and color analysis separately, research investigating the relationship between these two dynamics is limited. This study aims to fill this gap by systematically analyzing the interaction between building morphology and façade colors. For this reason, Kuzguncuk—one of Istanbul's characteristic neighborhoods known for its unique architectural fabric and rich color diversity—has been designated as the study area.

Within the scope of the research, the buildings in the region were examined within the framework of parameters such as registration and maintenance status, functional use, number of floors, façade material, and location. In addition, traditional bay windows (cumbas) as façade forms reflecting the characteristic fabric of the region, as well as the symbolic qualities and promotional impacts of the buildings, were included in this analysis process. In addition to these morphological analyses, the colors used on the building façades were measured with a spectrophotometer based on a 2-degree observer angle and classified according to the Munsell Color System based on hue-value-chroma components.

The research is conducted with a methodology consisting of data collection, measurement, classification, and analysis stages. All gathered data are analyzed using machine learning algorithms to determine the relationship between building characteristics and the colors used. By evaluating the findings obtained from the investigations, an urban color planning model based on scientific foundations is proposed for the preservation of urban identity in similar settlements.

Keywords: Urban Identity, Machine Learning, Munsell Color System, Spectrophotometer, Building Morphology

[132] Anna Marotta (Politecnico di Torino).

Napoleon's Colors, in the "Retour d'Égypte" Style: Examples from Malmaison.

Abstract. From Pompei, with the temples of Paestum, to Greece and Egypt, archaeological discoveries marked the entire 18th century. Many publications were published during the same years (including Le Roy, 1758 and the English Stuart and Revett, 1762). This culture profoundly influenced the aesthetics of the 18th century, becoming a model for artists of the time. As the culmination of Neoclassicism, the Empire Style dominated French and European art during the first quarter of the century. The undisputed protagonist was Napoleon, who recognized art's role in spreading his political fortunes. The empire lasted from 1804 to 1814: the expedition to Egypt in 1798, accompanied by a corps of scholars and researchers of local monuments, helped lay the foundation for the creation of the language of this style. The publication of the "Voyage dans la basse et haute Égypte" (Denon) made Egyptian stylistic motifs (created by the architects Charles Percier and Pierre Fontaine) very popular, who - with the Jacob brothers, cabinetmakers - they were commissioned to restore and redecorate the Château de Malmaison in 1798 by Josephine Beauharnais, the future empress. An elegant neoclassical blend of Greco-Roman and Egyptian forms and motifs became known as the Retour d'Égypte style. A key objective of the expedition was to include in the French invasion force more than 160 scholars, almost all members of the Commission des Sciences et des Arts, led by Joseph Fourier, who also became head of the Institut d'Égypte (Gillispie, 1994). Many became members of the institute. Accounts of their work range from archaeological explorations to studies of the natural history of Egypt and of chemical and physical phenomena, with naturalists engaged in zoological and botanical studies. The work of the members of the Commission produced a monumental Description de l'Égypte, in two editions: the first between 1808 and 1813; the second between 1820 and 1830. Among the indirect sources cited, the Dictionary of Napoleon, by Jean Tulard, appears indispensable. Regarding examples of experiences with suggestions and references to "Egyptian color," between the material and the immaterial (including symbols), the following relevant methodological approaches will be explored in this paper: color in the image of the Emperor, from his dress code to his pictorial representations (Jerome, Vernet, and others). This will be followed by color in Malmaison: hues in furnishings, fabrics, and curtains, all the way to the furniture, made of mahogany with Egyptian decorations in gold and bronze. The whole thing will be rounded out with an analysis of fashion.

Keywords: Color in the Retour d'Égypte Style, Napoleon, Malmaison, Chromatic culture in the 19th century: direct and indirect sources, Napoleon's Egyptian campaign

[136] Abd El Kadermaria Aly (Università degli Studi di Milano - La Statale).

The Semantic Space of the Roman Catacombs: Chromatic Economy and the Reuse of Figurative Models in Late Antique Painting.

Abstract. The paper analyses chromatic choices in Late Antique catacomb paintings, placing them at the centre of a system in which material, economic, and technical factors intertwine with symbolic, theological, and perceptual concerns. Against a long-standing scholarly tradition that has often interpreted catacomb painting as marginal or technically regressive, privileging archaeological approaches at the expense of chromatic analysis (e.g. Wilpert; Grabar; Testini), this study proposes to read colour as a deliberate design element and as an integral component of the construction of the hypogean architectural space. Drawing on examples from the catacombs of Callistus, Priscilla, and Domitilla, the analysis of pigments and painting techniques shows how the recurrent use of red and yellow ochres, carbon black, and lime white responds to criteria of availability, durability, and cost, without entailing expressive impoverishment. On the contrary, the drastic selection and polarisation of the palette favours an approach based on flat areas of colour and sharp contrasts, which no longer aims at describing bodies and spaces naturalistically, but at ensuring legibility, isolating figures semantically, and producing immediate symbolic intelligibility (e.g. Ling; cf. Brecolaki). The selective use of red in martyrdom scenes and of green in contexts of eschatological hope suggests that colour assumes an active semantic role. Since no explicit theoretical statements on colour by these early Christian communities have survived, such interpretations cannot be demonstrated directly but must be formulated as historically grounded hypotheses. Here textual evidence becomes methodologically crucial. By reading the visual material against early Christian texts and through the tools of cognitive semantics and cultural lexicography (LECOBI method), it is possible to reconstruct part of the semantic horizon within which these chromatic choices could be perceived.

Through this interdisciplinary, text-based approach, colour emerges as a mediating tool between Roman pictorial tradition and Christian figurative innovation, particularly evident in the reuse of figurative models such as the Good Shepherd and the Orant (cf. Elsner; Brandenburg). In these cases, chromatic simplification is not an impoverishment but a strategy of semantic transformation: figures cease to function as scenes or characters and become visual types and image-signs, in which colour replaces modelling and depth with symbolic clarity. Finally, the paper reflects on the implications of these dynamics for conservation and contemporary interpretation, showing how the loss or alteration of colours—especially in light backgrounds and red fields—structurally affects the historical and semantic understanding of these environments, and confirming the need for integrated approaches combining material analysis, text-based critical interpretation, and digital tools (see Brandi; e.g. De Vita).

Keywords: Colour perception, Roman catacombs, Late Antique painting, Visual semantics, Cultural heritage, Hypogean space

[153] Leonardo Pestana Collalto Toni (Faculty of Architecture and Urbanism of the University of São Paulo – FAUUSP, Brazil), João Carlos de Oliveira Cesar (Faculty of Architecture and Urbanism of the University of São Paulo – FAUUSP, Brazil) and Adrien Lucca (ENSAV La Cambre & Studio Adrien Lucca).

Further Analysis on The Expiatory Temple of The Sagrada Família's Colors Through Close Range Photogrammetry.

Abstract. The Expiatory Temple of the Sagrada Família, designed by Antoni Gaudí in Barcelona, was conceived as a physical representation of the life of Christ. Accordingly, every element, ornament, and spatial configuration was designed to integrate form and symbolism within its architecture. This integration was achieved through the deliberate and sophisticated use of architectural tools – such as structure, space, light, and color – articulated in an interconnected manner to convey Christian philosophy through architectural expression. Within its interior, one finds perhaps one of Gaudí's most powerful syntheses of light, color, and symbolism, where large lateral stained-glass windows bathe the sacred space in a shifting spectrum of colors ranging from violet to red, passing through shades of blue, green, yellow, and orange. These colors are distributed throughout the temple according to the position of the stained-glass windows and the direction of the light source, in order to emulate the natural tonal qualities of sunlight in outdoor environments throughout the day. Consequently, a significant portion of the interior chromaticism of the Sagrada Família is defined by incident light filtered through multicolored stained glass, rather than by the natural color of the finishing materials. In 2023, a close-range photogrammetric survey was conducted to record the colors projected within the interior of the temple, since other methods of chromatic measurements – such as sample fans or handheld color readers (e.g., Colorpin or Nix devices) – are unable to capture this type of chromatic composition. The interior space of the temple was documented through more than 2,700 photographs, which were subsequently processed using Metashape software to generate a point cloud comprising over 1,500,000 individual points, from which sRGB color data and spatial position were extracted and analyzed. The initial results of this analysis were presented at the 16th Congress of the International Colour Association, held in Taipei in 2025. The present research aims to further develop the processing and analysis of the data obtained in this survey and to use different colourspace conversions for the space-chromatic analyses that were initially conducted in sRGB: linearization in CIE XYZ (for luminance), chromaticity maps and color cluster groups in the CIE u^*v^* diagram, $L^*u^*v^*$ and $L^*a^*b^*$ colourspaces and their polar representations $L^*C^*h^\circ$ (1976). Based on the application of this new procedure, its results will be compared with those obtained in the analysis presented at the AIC2025 through graphical representations and chromatic tables. Moreover, the sRGB colourspace gamut is sometimes too small to represent accurately the chromatic coordinates of colored light projected on stone, a spectral solution to overcome this limitation will be discussed.

Keywords: Chromatic Survey, Close Range Photogrammetry, The Expiatory Temple of The Sagrada Familia, Antoni Gaudí

[168] Jorge de Novais Bastos (Faculdade de Arquitectura - Universidade de Lisboa) and Ana Santos Guerreiro (Faculdade de Arquitectura - Universidade de Lisboa).

The Splendour of Colours in the Lisbon Fronteira Palace Estate.

Abstract. After a period of nearly thirty years of battles between the Portuguese and Spanish armies, the Lisbon Peace Treaty (Feb. 1668) was finally signed between both countries. The Count D. João de Mascarenhas which played an important role in the different battlefields of the Restoration Wars, decided to improve his humble “hunting lodge” in the Benfica Lisbon outskirts. The Count wanted to host cultural events and hunting parties for his friend, the King Peter II.

Around 1670 the Count ordered a Palace to be built inspired in the Italian Mannerist Arch. Sebastiano Serlio treatises in his estate located in Benfica. The architectural enthusiasm experienced by this Art's Patron during the extensive construction nearly brought him to financial exhaustion. A grandiose ensemble - Palace, gardens and surrounding constructions constitutes a unique example of a 350 years continuously inhabited private space.

During this construction period, the Italian Prince Cosimo III de Medici visited the construction site and the impressions being recorded mentioned the surprise the guests experienced. The grandiose masterplan that D. João de Mascarenhas was implementing had a global approach with the interior Palace spaces extended to great outdoors through the east and north loggias.

A special space, the iconic Room of the Battles located in the piano nobile well deserves a visit. The existing glazed tiles wall panels – “azulejos”, vividly depict major battle events which occurred between both armies. This highly decorative material, is used both indoors and also in the outdoor spaces.

The outdoor walls painted with traditional vivid colors - indigo blue and the rose of Goa provide a dynamic visual experience that is enhanced with the sound of water running in the fountains and the light being reflected on ponds surfaces.

A unique architectural ensemble arises amidst an existing farming space. This study main purpose is to present a transitional moment from a war time period to a sublime cultural heritage achievement made by a remarkable Patron of the Arts, the Count D. João de Mascarenhas.

Keywords: Heritage, Azulejos, Traditional Colours, Architecture, Water fountains, Palace, Gardens

SESSION A3S12 - Chair: Miquel Angel Herrero Cortel

| General

List of Abstracts:

[\[72\]](#), [\[142\]](#), [\[29\]](#), [\[88\]](#), [\[122\]](#).

[\[72\]](#) Fenella France ([Library of Congress](#)), Meghan Hill ([Library of Congress](#)), Padraig O Machain ([University College Cork](#)) and Anna Hoffmann ([University College Cork](#)).

Revealing the Layers of Irish Medieval Manuscripts.

Abstract. Heritage scientists, historians, and humanists have been collaborating to illuminate the richness of Irish history by uncovering the hidden layers of medieval Irish manuscripts. Using portable, noninvasive imaging and spectroscopic techniques, researchers have revealed evidence of parchment manufacture, scribal and artistic practices, and the composition of inks and pigments. These material insights have substantially expanded the understanding of the Irish manuscript tradition, demonstrating that what is not written—the physicality of the manuscript itself—can be as historically significant as the text it carries.

This work began with the Inks&Skins interdisciplinary project and continues under the McCarthy MSI initiative, initially focusing on the materiality of late medieval Gaelic manuscripts. The immediate success of this research led to its expansion into manuscripts dating from the 6th to the 17th centuries, encompassing a wide range of textual genres and functions. Multispectral imaging (MSI), utilizing wavebands from 365 to 940 nm in reflected, transmitted, and raking illumination modes, formed the foundation of the investigation. Image processing techniques such as principal component analysis (PCA) proved particularly effective in recovering previously illegible text obscured by aging, environmental damage, and deliberate staining. Beyond textual recovery, MSI revealed parchment scraping patterns, ruling lines used in scribal and illustrative preparation, and variations in ink that indicate multiple phases of authorship and production.

By mapping the distinct spectral responses of materials across each manuscript, MSI guided targeted point-based analyses, including X-ray fluorescence (XRF) and fibre optic reflectance spectroscopy (FORS), enabling efficient characterization of colour palettes. These analyses identified both organic and inorganic materials, some anticipated, others unexpected, and in several cases suggested the use of locally sourced materials.

The corpus studied includes the Cathach, a late sixth-century insular psalter and the oldest extant Irish manuscript; the Stowe Missal (c. 792), an illuminated manuscript written primarily in Latin with some Old Irish; Leabhar na hUidre (c. 1100), the oldest surviving manuscript written entirely in the Irish language; the Book of Uí Mhaine (c. 1390), a large vellum manuscript of poetry and Irish tradition; Leabhar Breac (c. 1408), the largest Irish vellum manuscript produced by a single scribe, containing marginalia with notes on the place of writing and the weather; and the Book of Lismore, a late fifteenth-century Gaelic manuscript notable for its heavy staining. Viewed collectively, these manuscripts chart evolving manuscript practices while also reflecting broader societal and political transformations across medieval Ireland.

Keywords: Heritage Science, Multispectral Imaging, Medieval Irish Manuscripts

[142] Sara Calandra (Department of Earth Sciences, University of Florence), Lorenzo Di Bilio (Metropolitan City of Florence), Maria Grazia Fraiese (Metropolitan City of Florence), Michela Luongo (Department of Earth Sciences, University of Florence), Teresa Salvatici (Department of Earth Sciences, University of Florence) and Alba Patrizia Santo (Department of Earth Sciences, University of Florence).

Investigating Colors in the Cappella dei Magi at the Palazzo Medici Riccardi (Florence, Italy): a non-invasive approach.

Abstract. The present study focuses on the application of non-invasive analytical techniques for the characterization of surface materials of the 15th-century frescoes in the Cappella dei Magi. The artwork, attributed to Benozzo Gozzoli (Florence, 1420 – Pistoia, 1497) and completed in 1459, is preserved at the Palazzo Medici Riccardi in Florence, Italy. The cycle of paintings covers three of the chapel's walls depicting the Procession of the Magi, with angels in adoration flanking the altar and additional scenes above the sacristy doors.

As part of a broader diagnostic campaign aimed at updating the conservation framework of the chapel, non-invasive investigations were carried out to gain a deeper understanding of the painting technique and the organisation of the working days (giornate). The analytical approach combined observations in raking light and ultraviolet (UV) light, photogrammetry, infrared thermography (IRT), digital microscopy, and portable X-ray fluorescence spectroscopy (pXRF).

For the first time, pXRF was used for multi-element analysis on the Cappella dei Magi frescoes, benefiting from its non-destructive nature and ease of application. The combined application of spot and map analyses provided new insights into the composition of the pigments. Spot analysis yields localised, point-specific data, while mapping offers a broader overview of the distribution of elements across the surface of the artefact. The selection of analytical points was guided by a comprehensive review of historical sources, previous diagnostic campaigns, and restoration documentation.

The analytical data enabled the identification of the main pigments used by the artist, including white, red, blue, green, and ochre hues, as well as different materials used for the gilded surfaces. The results highlighted the complexity of the mixed painting technique employed by Benozzo Gozzoli, the careful subdivision of the giornate, and the use of precious pigments and metal foils, including, presumably, lapis lazuli, malachite, and gold leaf.

The results provide valuable information to support future conservation strategies.

Keywords: Cappella dei Magi, Gozzoli frescoes, non invasive-approach, pXRF analyses

[29] Paola Cordera (Politecnico di Milano).

Color in Context. Reconsidering Display Strategies in Carlo Scarpa's Museums.

Abstract. Postwar Italian museums have been widely examined for their unconventional use of materials – e.g., wood, reinforced concrete, and steel – and for how such devices, with their inherent tones, reshaped exhibition practices in historic settings. Carlo Scarpa stands at the center of this scholarship: his craftsmanship, spatial strategies, and rigorous detailing have been extensively analyzed. Yet amid this attention, the chromatic dimension of his museum practice remains strikingly underexplored. Scholarship has tended to focus on constructional elements, scenography, and lighting, leaving the role of color only marginally addressed, despite its relevance within broader museological discussions on vision, legibility, and the shaping of visitor experience. This omission is particularly notable given that projects were inserted into historic buildings, where chromatic decisions inevitably engaged with preexisting surfaces, patinas, and architectural rhythms. In such contexts, even slight adjustments in color could recalibrate the visual hierarchy between artworks and their setting – a challenge central to mid-century debates on how to display objects within complex or inherited environments.

This paper brings color to the forefront of Scarpa's design, situating it within broader postwar reflections on how exhibition settings influence the perception of artworks. In this respect, his work aligns with international exhibition models emerging since the 1930s, such as those pioneered at the Museum of Modern Art in New York. Within this museological context, debates increasingly emphasized the creation of visually coherent display environments, in which background treatments and perceptual cues were deliberately managed to guide the visitor's encounter with objects.

At Palazzo Abatellis in Palermo, Scarpa's introduction of colored panels recalibrates the dialogue between artworks and their architectural setting. These chromatic surfaces create a mediating interval that enhances the legibility of sculptural items while respecting the historic character of the building. At the Castelvecchio Museum in Verona, his approach becomes increasingly experimental. Red and blue fields, tinted partitions, and shifts from saturated to more restrained tones reveal an iterative method in which color is continually tested against both individual artworks and the unfolding spatial sequence. Chromatic choices shape emotional register, spatial rhythm, and the visibility of objects, functioning as adjustable variables within the display.

Rather than functioning as a marginal aspect of material finish, color actively constructs the perceptual and interpretive conditions of display. Integrated by Scarpa into the same field of decisions as space and light, chromatic modulation becomes central to how artworks are seen. This perspective deepens our reading of his practice and contributes to broader discussions of postwar museography and the display of cultural heritage today.

Keywords: postwar museography, exhibition design, visitor experience, cultural heritage display

[88] Jodi L. Sandford (retired University of Perugia).

“The sky's merciless scream of blue” [OF *COLOR] – A Construction Analysis.

Abstract. This study discusses one of the ways in which we conceptualize color through the linguistic construction [OF *COLOR]. OF is the most frequent preposition to be used with basic color terms, followed by IN and WITH (as emerged in the Corpus of Contemporary American English). OF is also the eleventh most frequent word in English (as listed in <https://frequencylist.com>). [OF *COLOR] is a construction where *COLOR stands for any color term or color dimension reference that can fill that slot. It is the realization of the specific IDENTITY image schema that OF indicates. Image schemas, together with conceptual metaphor, conceptual metonymy, and conceptual integration are the four fundamental cognitive operations we constantly apply to understand and express our experience, as has been amply ascertained in cognitive linguistic research. The Cognitive Linguistics approach is based on the conceptual nature of language and how it serves us to structure our experience of the world. Duly the primary perceptual embodied experience of COLOR and SEEING directly involve the development of conceptual metaphors and, therefore, the establishment of a process of mapping between the source domain of COLOR/SEEING as the basis of our experience SEEING IS COLOR and GOOD IS COLOR. I have investigated how COLOR serves not only as a source domain, as a substance/object and a light/object, but also as the target domain, as in: COLORS ARE LOCATIONS, POSSESSIONS, and ENTITIES. The IDENTITY image schema considered here in collocation with OF serves as the link to OBJECTS, POSSESSIONS, ENTITIES. It thus follows that COLOR may be conceptualized through OF according to the image schemas: IDENTITY, and EXISTENCE. These emerge through a series of the 17 different senses of OF (see dictionary.com). Of may be used as a function word to indicate origin or derivation: a type of blue; component material, parts, or elements or the contents: shades of black; the whole that includes the part denoted by the preceding word: a drop of red; and a characteristic or distinctive quality or possession: a woman of color. This paper presents corpus data on the polysemy of this COLOR construction. A summary of results from the COCA query for [OF *COLOUR], show the total occurrences of the collocation, that is colour terms when collocating with OF. The frequency of the specific collocation hits of “of and the colour term”, and the specific Mutual Information score, which gives a measure to the likelihood of the collocation, to then analyse the various functions of OF in this construction. To conclude the analysis proposes a cognitive mapping of the construction processing and evolution to describe the data.

Keywords: Color construction, Conceptual metaphor, Image schemas, Cognitive linguistics, Color term collocation, Corpus analysis

[122] Verena M. Schindler (Art and Architectural Historian; Chair of AIC Study Group on Environmental Colour Design).

Swiss artist Augusto Giacometti (1877–1947) and his "Blüemlihalle" frescoes.

Abstract. The entrance hall of the Zurich City Police Station has undergone transformation, evolving from a gloomy space into an Instagram hotspot and popular location for TikTok videos. Following extensive restoration work from 2016 to 2019, the frescoes adorning the walls and vaulted arches now stand out, showcasing stylised floral motifs and repetitive geometric patterns in warm reds and ochres. These intermingle with orange-red and brown areas, as well as the complementary colours of green and blue. The six rather monochrome red murals depicting different professions stand in contrast to the vibrant ceiling paintings. The result is a vivid and colourful atmosphere.

This presentation explores the influence of his training on his artistic creations. He studied at the Zurich University of the Arts from 1894 to 1897 and then completed his studies with Eugène Grasset in Paris from 1897 to 1901, followed by a period in Florence.

Another area of interest is the colour wheel, a key working tool created by Augusto Giacometti around 1907 which demonstrates his intensive exploration of colour. Inspired by scientific colour theory, Giacometti used the wheel to analyse colour compositions and develop new colour combinations for his works, particularly his famous stained glass windows and murals. He also analysed pigments such as lead and chrome, which discoloured over time. Thanks to his pioneering colour research, he is considered to be the first abstract painter in Switzerland.

This presentation also covers the restoration work. Giacometti produced colour templates at the original scale for his fellow artists. The paintings were created using the 'al fresco' technique. This method requires speed and precision. However, due to their limited experience, Giacometti's collaborators did not always implement the templates satisfactorily, as was evident during the restoration process. They often used the 'al secco' technique instead. One type of damage was cracks in the paintwork where the artists had finished one day's work and started again the next day. Completed in 1925, the work was added to the inventory of protected objects of cantonal importance in 1981. The initial design included gold inlays in the ceiling painting, but these had to be abandoned for financial reasons.

Augusto Giacometti is less renowned than his relative, Alberto Giacometti, who is famous for his iconic bronze sculptures of extremely elongated and thin figures. Augusto was born and raised in Stampa, a village in the mountainous Val Bregaglia region of Switzerland, just like all the other members of the Giacometti family. However, he would later move to Zurich, where he would settle permanently in 1915. Although he was known as 'the master of colour' during his lifetime, it is only recently that he has gained international recognition, largely thanks to social media.

Keywords: Oral presentation, restoration, frescoes, Augusto Giacometti, colour theory, abstract painting, instagrammable object, TikTok spot, Zürich

SESSION A1S13 - Chair: Johnn McCann

| Color and perception

List of Abstracts:

[\[12\]](#), [\[32\]](#), [\[76\]](#), [\[63\]](#).

[\[12\]](#) Timo Rieke (HAWK University of Applied Sciences and Arts, Hildesheim) and Lina Schmidt (RAL Colours, Bonn).

Bridging the Gap? The Role of Scientific Colour Knowledge in Design Practice.

Abstract. This exploratory survey examines which forms of knowledge inform colour decisions in design practice and how scientific colour research is used within this wider knowledge repertoire. Thirty-seven practitioners from German-speaking professional networks participated. The results reveal a clear pattern: practitioners rely primarily on situated, material and experience-based forms of knowledge, while scientific studies rank 7th of 11 sources of influence, with a markedly polarised distribution. The main barriers were limited time, accessibility, and insufficient fit with concrete project situations. The findings also reveal a utility paradox: simplified colour-effect claims were often criticised as context-dependent or reductive, yet more than half of respondents used them at least occasionally in client communication. This suggests that epistemic credibility, pragmatic utility, and communicative utility do not necessarily coincide. Respondents preferred context-specific, visually prepared, situated, and practice-informed research, particularly methods, tools, conditional statements, and documented case studies. The study therefore reframes the relationship between colour science and design practice as a problem of translation and integration, calling for context-sensitive and co-produced forms of evidence that can be adapted within practice.

Keywords: colour design, colour science, knowledge transfer, research-practice gap, evidence-based design, inter-disciplinary research

[32] Taiyo Abe (Chiba University), Midori Tanaka (Chiba University) and Takahiko Horiuchi (Chiba University).

Experimental Analysis of the Relationship Between Visual Roughness and Physical Features.

Abstract. 1. Introduction

Object appearance significantly influences impressions, with perceived roughness and glossiness being particularly important in color and cultural heritage. While many studies use CG stimuli, research on real objects is essential for a realistic understanding. Building on Tanaka et al.'s (2023) glossiness prediction model, this study clarifies the relationship between perceptual evaluation and physical features, specifically for the perceived roughness of real objects.

2. Experiment

The study used 149 real samples (e.g., resin, metal, wood) with 2.5D shapes and diverse visual characteristics like texture and transparency. Physical features were measured using three instruments:

- Gloss Meter (Rhopoint IQ-S, Konica Minolta, Inc.) measured gloss, haze, and distinctness-of-image (DOI).
- Spectrophotometer (CM-5, Konica Minolta, Inc.) measured CIE Lab* and spectral reflectance to assess light scattering.
- 2D Spectroradiometer (SR5100, TechnoOptis Co., Ltd.) calculated Gray Level Co-occurrence Matrix (GLCM) features (contrast, dissimilarity, entropy, etc.), which correlate with surface roughness.

Perceived roughness was evaluated under diffuse and directional D65 lighting using magnitude estimation. This preliminary report uses the author's data; the final paper will present results from five observers.

3. Results and Discussion

Correlations between roughness and features varied by lighting:

- Diffuse lighting: entropy and dissimilarity showed positive correlations, suggesting luminance non-uniformity is a key cue.
- Directional lighting: contrast and dissimilarity correlated, implying emphasized shading influenced perception.
- Diffuse + directional light: the correlations weakened, suggesting roughness judgment became complex and difficult to explain with a single feature.

4. Summary

This study revealed that feature quantities contributing to perceived roughness differ by lighting condition. Future work will increase the number of evaluators and features to analyze the relationship in detail and construct a perception model.

Keywords: visual roughness, shitsukan, appearance, physical features

[76] Maggie Maggio ([Inter-Society Color Council Colour Literacy Project](#)) and Esther Hagenlocher ([University of Oregon](#)).

Light and Shadow: Exploring Dimensional Color in the Colour Literacy Project.

Abstract. This proposed talk examines dimensional color as an active perceptual phenomenon, shaped by light, shadow, material, and spatial context. Drawing on the architectural explorations and experiments of the late Lois Swirnonff, the presentation will connect her investigative practice to the Perceiving Cornerstone exercises of the Colour Literacy Project (CLP), positioning both as complementary frameworks for understanding color as relational, temporal, and embodied.

Lois Swirnonff's work occupies a critical intersection of color theory, architecture, and perception. Through architectural experiments—temporary, often modular spatial constructs—Swirnonff encouraged her student to explore how color emerges through interaction rather than remaining a fixed property. Her use of layered planes, shifting light conditions, and chromatic intervals recognized shadow not as the absence of light, but as an active agent that alters hue, lightness, and chroma. Color, in her work, is inseparable from dimension: it expands, recedes, vibrates, and dissolves depending on the viewer's movement and the behavior of light.

The CLP's Perceiving Cornerstone exercises similarly emphasize color as a lived experience. Following an introduction to the perception triangle, the exercises encourage participants to notice subtle chromatic shifts, edge interactions, simultaneous contrast, and the influence of illumination and context. The Perceiving Cornerstone encourages attentiveness to how color behaves in real environments—particularly in transitional zones where light meets shadow.

This talk proposes a dialogue between Swirnonff's spatial experiments and the Light and Shadow exercises of the CLP's ABC Pathway. By expanding and customizing the basic orange cube exercises for interior and architectural students and analyzing light and shadow in selected architectural works, the presentation will demonstrate how both of these hands-on practices reveal dimensional color as a dynamic system. Light and shadow function as structuring forces, shaping chromatic relationships and activating spatial awareness. In this framework, color becomes a means of navigating space, not merely decorating it.

Attendees will be invited to reconsider conventional, surface-based approaches to color education in favor of a more immersive and three-dimensional understanding. The presentation will include visual documentation, analytical diagrams, and guided perceptual prompts adapted from the CLP, offering practical tools for educators, designers, artists, and researchers.

Ultimately, *Light and Shadow: Exploring Dimensional Color* argues for color literacy that is spatially grounded and perceptually framed. By bridging Lois Swirnonff's architectural legacy with contemporary perceptual training, the talk underscores the importance of learning to see color as an event—one that unfolds through light, shadow, and our human presence in space.

Keywords: Dimensional Colour, Architectural Colour, Colour Perception, Colour Education

[63] Qinxin He (University of Leeds), Stephen Westland (University of Leeds) and Soojin Lee (University of Leeds).

Colour Perception Characteristics Associated with Long-Term Exposure to Low-Illuminance Visual Environments.

Abstract. Colour perception is not a uniform visual process. It is influenced by individuals' long-term visual experience and environmental exposure. Existing research on colour perception has predominantly focused on the general population. In contrast, the colour vision of occupational groups who work for extended periods under non-natural illumination or low-illuminance conditions has received limited systematic investigation. As a result, empirical evidence regarding the colour perception characteristics of such groups, and their differences relative to standard populations, remains insufficient. To address this gap, this study compares colour perception across groups with different long-term visual environments under varying lighting conditions.

Two groups of participants were recruited, with 30 participants in each group. The standard group consisted of individuals who study or work under typical indoor lighting conditions. The specialised group comprised individuals with long-term occupational exposure to low-illuminance environments, the majority of whom were miners. All participants completed the experimental tasks under two lighting conditions. These included a typical indoor illumination condition and a controlled dim-light condition. The experimental protocol included the Munsell 100 Hue Test. This test was used to assess overall hue discrimination performance and the distribution of hue-ordering errors. In addition, a unique hue task was employed to measure participants' subjective localisation of the unique hues (red, yellow, green, and blue).

By comparing performance across groups and lighting conditions, this study examines the potential effects of long-term visual environment exposure on hue discrimination accuracy, error patterns, and the perceived locations of unique hues. The findings are expected to contribute to a better understanding of group-level differences in colour perception associated with prolonged exposure to atypical visual environments. They may also provide empirical evidence to support colour design and visual display optimisation for special occupational populations.

Keywords: Colour perception, Group differences, Lighting conditions, Unique hue, Long-term visual environment exposure

SESSION A2S14 - Chair: Agata Kwiatkowska-Lubańska

| Colors of Historical Cities

List of Abstracts:

[\[7\]](#), [\[39\]](#), [\[113\]](#), [\[118\]](#)

[\[7\]](#) Jimena Vanina Odetti (Tecnológico Nacional de Mexico / Instituto Tecnológico Jose Mario Molina Pasquel y Henriquez. Puerto Vallarta), Rebeca Isadora Lozano Castro (Universidad Autónoma de Tamaulipas. Facultad de Arquitectura, Diseño y Urbanismo: Tampico.), Alberto Reyes González (Tecnológico Nacional de Mexico / Instituto Tecnológico Jose Mario Molina Pasquel y Henriquez. Puerto Vallarta), Andrés Enrique Reyes González (Tecnológico Nacional de Mexico / Instituto Tecnológico Jose Mario Molina Pasquel y Henriquez. Puerto Vallarta) and Fernando Daniel Valdez Olmos (Tecnológico Nacional de Mexico / Instituto Tecnológico Jose Mario Molina Pasquel y Henriquez. Puerto Vallarta).

Color, Arquigraphy, and Urban Memory: A Situated Heritage Intervention in Tampico's Historic Center.

Abstract. This paper presents a situated and inclusive approach to the chromatic and arquigraphic conservation of historic urban façades, based on a collaborative intervention in the Historic Center of Tampico, Tamaulipas, Mexico. The project focuses on the preservation of arquigraphy—understood as a multilingual system of textual and graphic messages inscribed on architectural surfaces—and its chromatic identity as material and symbolic expressions of collective memory.

Using a systemic qualitative methodology, the study integrates iconographic and chromatic analysis, regulatory review, and ethnographic fieldwork to identify a deteriorated heritage façade with exposed graphic elements. The intervention is structured in three stages: (1) theoretical and technical diagnosis, including the identification of chromatic content and graphic inscriptions; (2) design and implementation of a participatory workshop involving local actors, institutions, and students; and (3) execution of a graphic and chromatic restoration, including vector-based redrawing and color application aligned with the building's historical and cultural context.

The project proposes a chromatic palette rooted in the plural identity of Tampico's cosmopolitan history, informed by field research and color scanning technologies. It also explores the potential of arquigraphy as a tool for inclusive heritage conservation, bridging architectural aesthetics, graphic design, and community engagement. The intervention is supported by local planning and heritage institutions and includes the training of undergraduate students in heritage technologies and visual analysis.

This contribution aligns with the theme “Colors of Historical Cities” by offering a Latin American perspective on chromatic justice, urban memory, and visual identity. It advocates for interdisciplinary strategies that respect local narratives and foster sustainable preservation practices through color and design. The project demonstrates how color and graphic inscriptions can serve as catalysts for cultural dialogue, historical recognition, and participatory urban care.

Keywords: Chromatic identity, Arquigraphy, Urban heritage, Participatory conservation, Visual memory

[39] Leonardo Pestana Collalto Toni (Faculty of Architecture and Urbanism of the University of São Paulo – FAUUSP, Brazil) and Anna Elena Salvi (General Coordinator of the Course of Architecture and Urbanism of the University Paulista – UNIP, Brazil).

Memory of Colors in Artacho Jurado's Architecture: A Case Study of The Cinderela Building.

Abstract. In a country where there are constant attempts to erase history in all areas, preserving buildings or monuments becomes an unusual challenge. Even more so when the work was not designed by a trained architect. This is the case of the builder João Artacho Jurado, a self-taught builder who constructed houses and buildings in the city of São Paulo, Brazil, during the 1950s and 1960s. At the time, radical modernist architects dismissed his architecture for being too colorful and ornate. This is one of the reasons why, in many cases, the colors used by Artacho in many buildings were obscured by the white paint so highly praised by modernist architects, who failed to consider that the photos in foreign magazines were still in black and white and therefore the use of color was not assumed. The Bauhaus and the neoplasticists admittedly used color; even Le Corbusier had produced palettes that he considered harmonious. Today, its architecture is highly valued by the same architects who criticized it, and in some of its buildings, there are professionals who are concerned with restoring the original colors used by the builder. In light of the current reduction of chromatic richness in contemporary Brazilian architectural projects—aside from a few exceptions, such as the work of Fernando Peixoto or Ruy Ohtake—and the apparent reluctance of architects to experiment with more saturated or higher-contrast chromatic compositions in their designs, the work of Artacho Jurado can serve as a reference for other possibilities on adopting a multicolored design strategy in architectural practice. To this end, this article proposes an analysis of one of his most significant projects, the Cinderela Building, built between 1951-56 in the Higienópolis district of São Paulo, Brazil. The building, characterized by the use of multicolored tiles and perforated elements on its façade, once displayed substantial chromatic richness in its interiors as well—today limited to a few areas after numerous interventions. Following initial investigations and the restoration of some of its common areas, led by Anna Elena Salvi, the building is now undergoing a new and more extensive chromatic investigation, with the aim of restoring its spaces according to the architect's original design. Through historical and iconographic research, as well as chromatic investigations involving stratigraphic probing in key environments, this article seeks to uncover the original chromatic schemes of Cinderela Building. The results will be presented in the form of pictures, chromatic tables and digital simulations of its interiors restored in accordance with the original chromatic design.

Keywords: Artacho Jurado, Color survey, Architecture restoration, Memory

[113] Elif Kaplan (Fenerbahçe University) and Fazıla Duyan (Dogus University).

The Heritage of Blue: Historical Context, Tile Tradition, and Color Symbolism in the Blue Mosque.

Abstract. The Sultanahmet Mosque, one of the most prominent monuments defining Istanbul's skyline, was commissioned by the Ottoman Sultan Ahmed I between 1609 and 1616. Designed by Sedefkâr Mehmed Ağa, a student of the Great architect Sinan, the building is adorned with over 20,000 handmade tiles exclusively produced in the workshops of Iznik and Kütahya, enveloping the domes and wall surfaces like a jewel. These exquisite tiles, dominated by cobalt blue and turquoise tones, exhibit a seamless visual integrity with the hand-painted ornamental decorations of the same hues that embellish the domes and arches, creating a profound perception of a 'blue atmosphere' for the visitor. As a result of this powerful integration of colour with spatial identity, the edifice/building became known as the 'Blue Mosque' in Western literature, a title that has, over time, transcended its original name and garnered iconic global fame.

Turkish tile art, dating back to the Karakhanids, one of the first Turkish states, continued its development in the architecture of the Great Seljuk and Anatolian Seljuk empires, carrying this deep-rooted heritage into the Ottoman period and opening the doors to a new and magnificent era in architectural ornamentation. In Turkish architectural heritage, the use of tiles was not merely a structural element or decorative covering, but also a means of purifying a space from its worldly weight and achieving spiritual depth. The dominance of tiles, and especially blue, in Turkish culture is rooted in an ancient historical process. The origin of the colour "Turquoise" (Turkish Blue) entered world literature through the Turks' skill in using this colour in their art. The sanctity of the sky, stemming from the "Sky God" belief in Central Asia, merged with Islamic art and reached its most mature form in this structure.

The mosque's tiles, produced in the 16th and 17th centuries in workshops in Iznik and Kütahya, cover the upper parts of the mosque's walls and extend to the domes, using blue, red, turquoise, and black colors on a white background. The use of cobalt blue and turquoise in Iznik tiles, combined with the light filtering through the 260 windows on the upper levels of the Blue Mosque, creates a perception of a "bright and airy sky" inside the mosque. This architectural formation and the effect of blue, representing the infinity, peace, and divine purification of the colour, are integrated with the Turks' belief in the "Sky God."

This study analyses the use of blue in the Sultanahmet Mosque, known as the Blue Mosque, through its historical context, tile production techniques, and colour codes in Turkish culture. The study examines how the predominantly blue compositions in the tiles transform spatial perception. Structurally, the building is presented as the most outstanding example of how colour choices in traditional Turkish art can transform a cultural heritage into a global symbol.

Keywords: Blue Mosque, Sultanahmet Mosque, Colour symbolism, Tile art, Ottoman architectural Heritage

[118] Helena Soares (Universidade de Lisboa, Lisbon School of Architecture).

Shared Chromatographies: An Ethical Reading of Heritage in Spaces of Portuguese Influence.

Abstract. The colour of a place carries memories, materials and landscapes. It expresses ways of living, cultural sensibilities and systems of representation. In territories where cultures have encountered and influenced one another over time, colour emerges as a visible trace of these relationships, revealing how places embody historical, affective and sensorial layers. At once material and symbolic, colour contributes to the construction of collective spatial identity, reflecting both cultural continuities and transformations. This project aims to explore colour as a marker of a plural cultural landscape, not as a vestige of the past, but as an active presence in the identity of place. With a close attention to local gestures and continuities, the goal is to value colour as shared, symbolic and sensorial heritage.

The study seeks to analyse the presence and use of colour in architectural and urban contexts marked by Portuguese influence, examining the relationship between colour, local materials and processes of cultural appropriation and adaptation. It also aims to contribute to the appreciation of colour as a sensory and identity-based heritage phenomenon, encouraging reflection on its role as a point of contact between the tangible and the intangible, the past and the present, the local and the global.

The methodology is exploratory and qualitative, based on research journeys and direct observation in selected territories, such as Goa, Ilha de Moçambique, Macau, Olinda and São Tomé, where portuguese presence and intercultural coexistence have shaped the built environment. Visual records (photography, drawing, video), field notes, informal interviews and architectural analysis will be used. The approach is inspired by Satish Kumar's "reverential ecology" — soil, soul and society — as a way of engaging with territory through respect, attentiveness and ethical connection between landscape, community and heritage.

The pilot project will begin in Goa, due to its historical relevance and symbolic density. The research expects to identify recurring chromatic patterns, relationships between local materials and the use of colour, as well as traces of cultural interactions in the aesthetic composition of spaces. The outcomes will contribute to the development of a sensitive, visual and reflective archive, recognising colour as both legacy and intercultural language.

To acknowledge colour as heritage is to acknowledge the gaze as a form of knowledge. This project proposes an approach to colour that weaves together aesthetics, memory, place and affect. More than cataloguing surfaces, it seeks to listen to the chromatic silence of places, revealing how colour, so often rendered invisible in heritage narratives, can return to us plural, profound and dialogical histories. In mapping these geographies of colour, an interior geography is also drawn: one that links the gaze to the place.

Keywords: Chromatography, Colour-Light-Materiality, Place, Reverential Ecology, Interculturality

SESSION A3S15 - Chair: Marcello Picollo

| General

List of Abstracts:

[\[134\]](#), [\[161\]](#), [\[75\]](#), [\[3\]](#).

[\[134\]](#) Simone Caglio (Department of Materials Science, University of Milano-Bicocca), Alessandra De Nicola (Department of Human Sciences for Education “Riccardo Massa”, University of Milano-Bicocca), Maurizio De Rosa (Department of Human Sciences for Education “Riccardo Massa”, University of Milano-Bicocca), Federica Antonioli (Department of Human Sciences for Education “Riccardo Massa”, University of Milano-Bicocca), Chiara Da Pieve (Department of Materials Science, University of Milano-Bicocca), Franca Zuccoli (Department of Human Sciences for Education “Riccardo Massa”, University of Milano-Bicocca) and Anna Galli (Department of Materials Science, University of Milano-Bicocca).

Colour as Urban Heritage: Scientific Analysis and Public Engagement in the Historical City of Pandino.

Abstract. L’Anticamera della Cultura 2.0 is an interdisciplinary project for the restoration of two fully frescoed rooms in the Visconti Castle of Pandino (Lombardy, Italy) and their return to the community; through colour as a key component of historical urban identity, we aim to investigate material heritage and social experience, with the castle as a central node within a broader urban context. Funded by Fondazione Cariplo under the Luoghi da rigenerare programme, the project integrates colour science, conservation diagnostics, urban heritage studies, and participatory cultural practices.

From a scientific standpoint, non-invasive investigations were carried out on the castle’s wall paintings using multispectral imaging, reflectance spectroscopy, and colourimetric documentation. These analyses support conservation strategies and historical interpretation by identifying original materials, chromatic schemes, stratigraphic relationships, and alteration processes. Hypotheses on the original appearance of the colours of the decorated walls have been made with the help of restorers who, starting from the original materials, have created useful samples both for studying the ageing processes and for getting ideas of the possible chromatic rendering. Beyond the monument scale, the results contribute to understanding how colour participates in the visual continuity and historical stratification of the urban environment.

In parallel, the project developed public-facing activities explicitly focused on colour, addressing audiences of different ages and backgrounds. Educational workshops, guided visits, and hands-on laboratories encouraged participants to observe, measure, and interpret colour in architectural surfaces and public spaces. By translating scientific methods into accessible experiences, these activities promote awareness of colour as a shared urban heritage and as a dynamic interface between material history and contemporary perception.

The integration of scientific research,, and inclusive engagement demonstrates how colour can function simultaneously as an object of study and as a medium for participatory social communication.

Keywords: wall paintings, multispectral imaging, reflectance spectroscopy, colorimetry, urban identity, public engagement, conservation

[161] Martina Glogar (University of Zagreb Faculty of Textile Technology) and Ivana Čorak (University of Zagreb Faculty of Textile Technology).

Heritage whites in contemporary language: Croatian lace and linen mapped to “cloud dancer”.

Abstract. White is a timeless carrier of light, a surface that reveals (or suppresses) the full spectrum depending on its material structure, finish and illumination. Pantone's colour of the year 2026, white named “Cloud Dancer” (PANTONE 11-4201), is positioned as a versatile base that lets other colours and meaning come forward. White is also, a powerful symbolic and material element of Croatian cultural heritage. Croatia's textile heritage carries white as both craft and code: UNESCO-recognized lacemaking, most prominently Pag needle lace, Lepoglava bobbin lace, and Hvar aloe lace, have long been produced in fine, light threads and closely tied to regional identities and dress culture. In parallel, Croatian folk costumes across regions commonly contain and are based on white, where whiteness becomes the visual ground for embroidery, silhouette, and symbolism. Importantly, “heritage white” is not unique: fibre origin, yarn characteristics, lace openness and historical preparation/bleaching practices generate a spectrum of whites, from warmer natural flax shades to cooler, brighter whites. Beyond textiles, Croatian coastal heritage is also visually shaped by white materials. Most notably light limestone such as Brač stone in Dalmatian architecture reinforce white as a cross-material cultural presence that spans cloth, stone, and the built environment. White in Croatia also operates as a national visual code: the red–white chequerboard at the centre of the coat of arms (and echoed in the flag) positions white as an active sign of identity rather than a neutral background. Together with the material whites of lace, linen, and limestone cityscapes, this symbolism reinforces white as a unifying thread across textiles, built heritage, and contemporary colour communication.

The paper proposes to translate the culturally embedded whites of Croatian lace and linen into today's design language through spectral and colorimetric mapping, and synthesizes the results into a dual-white palette for interior textiles, supported by pattern/texture translation from lace motifs and linen structure. A set of heritage textile whites will be analysed, including samples of Pag and Lepoglava lace and traditional linen textiles associated with Slavonia and Baranja. Samples will be spectrally measured and colorimetrically defined, then categorized using reflectance features and derived CIE colour coordinates. Quantitative and qualitative comparisons against PANTONE 11-4201 “Cloud Dancer” will position heritage whites within a contemporary reference language. The results will be presented as a spectral/colorimetric map. Based on this mapping, an interior-textile design application will be proposed, that pairs Cloud Dancer as a contemporary base white with a selected heritage linen/lace white, translating lace motifs and linen structural textures into white-on-white pattern design.

Keywords: cultural heritage, Croatian lace and linen, whites, spectral reflectance and colorimetry, PANTONE 11-4201 Cloud Dancer

[75] Ilaria Alessandri (Università degli Studi di Firenze).

Color as Balance: Capsule Collection "IONIA – Between Balance and Flow".

Abstract. This research investigates the role of color as a cognitive, cultural, and design-driven device within the capsule collection IONIA – Between Balance and Flow, inspired by the symbolic universe of League of Legends. In a context where digital aesthetics and fashion design increasingly intersect, Ionia is adopted as a model of dynamic balance: a visual synthesis of meditation and conflict, nature and spirituality. The collection is grounded in the hypothesis that the chromatic principles embodied by this region and its champions can be translated into the language of contemporary prêt-à-porter, generating an aesthetic capable of merging videogame imagery with the psychology of perception.

The theoretical framework draws on the reflections of Goethe and Albers, for whom color functions as interaction and relational experience, as well as on the sociological perspectives of Entwistle and Kawamura, who define the dressed body as a semantic and social space. Within this framework, color operates not as ornamentation but as an identity code and a mediating tool between the individual and the collective. The project also considers cosplay as a practice of aesthetic translation: a process through which digital imaginaries are embodied in the physical body, influencing the fashion system and opening new forms of cultural hybridization.

A chromatic analysis of Ionian champions—from Ahri and Akali to Irelia, Rakan, and Xayah—reveals how each palette articulates psychological tensions and symbolic values such as discipline, metamorphosis, duality, and emotional balance. These interactions inform the construction of the collection, in which fluid silhouettes and lightweight structures interpret the dialectic between stability (balance) and transformation (flow). Color thus emerges as a medium capable of evoking the state of dynamic concentration described by Csikszentmihalyi, offering the audience—young creatives and professionals—an aesthetic experience that integrates interiority with social function.

The capsule demonstrates how digital worlds can serve as symbolic archives for rethinking contemporary design practices. Translating Ionian philosophy into fashion design entails recognizing the body as a narrative site, where balance is not a static condition but a continuous process of self-construction. The adopted methodology, based on comparative visual analysis and perceptual color studies, confirms the potential for a productive dialogue between videogame imagination and material design practice, in which color operates as a bridge between emotion, form, and identity.

Keywords: Color as Cultural Balance in Fashion Design, Videogame Color Aesthetics and Wearable Identity, Chromatic World-Building between Digital Media and Fashion, Digital-to-Material Color Translation, Balance and Flow as Chromatic Design Principles, Cultural Value of Color in Contemporary Capsule Collections

[3] Kazim Hilmi Or (*Private Office of Ophthalmology*).

Memphis design movement which can be worn: Memphis style eyeglasses.

Abstract. Background: The Memphis Group (1980–1987), led by Ettore Sottsass in Milan, defined postmodern design through vibrant colour palettes, geometric forms, and playful material juxtapositions that rejected minimalist restraint. In recent years, this visual vocabulary has transitioned from furniture and decorative objects into wearable artefacts—most notably eyewear—creating new forms of chromatic and structural expression. This review investigates how Memphis design principles have been adapted to eyeglass and sunglass frames, linking colour science, material innovation, and aesthetic theory.

Methods: A systematic literature review was conducted across design history, colour-science publications, and eyewear industry sources, complemented by qualitative visual analysis of collections explicitly referencing Memphis aesthetics. Representative case studies, such as the FACE À FACE collection, were examined to illustrate chromatic and material strategies. The analysis framework encompassed (i) colour coordination and contrast, (ii) geometric and structural design, (iii) material layering and transparency, and (iv) ergonomic and optical functionality. Colourimetric data from manufacturers were compared with qualitative design statements.

Results: Memphis-inspired eyewear employs high-saturation primaries (red, yellow, cyan) and strong complementary contrasts, often realised through layered acetate or transparent insets that evoke the Memphis ethos of “visual shock.” Frames exhibit geometric experimentation—hexagonal, asymmetric, or faceted structures—translating architectural motifs into wearable design. Case studies reveal that advances in acetate bonding and hinge precision enable such expressive forms without compromising optical integrity. While ergonomics and lens performance remain stable, increased design complexity raises production costs. From a colour-science perspective, maintaining visual legibility requires careful moderation of chromatic intensity on small-scale surfaces.

Conclusions: The adaptation of Memphis design to eyewear exemplifies the convergence of aesthetic innovation and optical functionality. A movement once confined to furniture and interiors now thrives in wearable form, preserving its distinctive postmodern language. Technological progress in materials has enabled the practical realization of this expressive vision. Future research should address perceptual responses to bold eyewear—colour preference, visual comfort, and sociocultural signalling—and evaluate the optical implications of complex frame geometries. Memphis-style eyeglasses thus stand as a paradigm of how design history, colour science, and wearable technology co-evolve.

Keywords: Memphis design, eyewear, chromatic contrast, acetate layering, geometric forms

SESSION A1S16 - Chair: Alessandro Rizzi

| General

List of Abstracts:

[\[151\]](#), [\[137\]](#), [\[189\]](#), [\[188\]](#), [\[129\]](#), [\[61\]](#).

[\[151\]](#) Yu-Chieh Chang ([National Taiwan University of Science and Technology](#)) and Pei-Li Sun ([National Taiwan University of Science and Technology](#)).

Deep Learning-Based Light Direction Estimation in Stylized Animation.

Abstract. Estimating light source direction from 2D images is critical for visual compositing, relighting, and scene understanding. However, traditional physics-based approaches encounter significant challenges when applied to non-photorealistic rendering (NPR) and stylized animations due to quantized shading, simplified material properties, and non-physical lighting cues. This study presents a data-driven approach using convolutional neural networks (CNNs) to regress 3D illumination vectors from stylized 2D imagery, with specific applications to commercial 3D billboard display alignment. A synthetic dataset was constructed in Blender across diverse object geometries, light source positions, surface colorings, 5-level posterization (cel-shading), and complex stylized backgrounds. We systematically evaluated CNN backbones (VGG16 and ResNet18) and explored input channel representations in the CIELCh color space combined with binary object masks. Experimental results demonstrate that lightweight architectures like ResNet18 achieve high precision with an average angular error of approximately 6 degrees on untextured models. While cel-shading and complex animation backgrounds disrupt spatial luminance gradients and increase error rates, isolating the target object via a binary mask significantly restores prediction accuracy. Furthermore, lightness (L^*) proved to be the primary diagnostic feature, whereas chroma (C^*) introduced interference. Consequently, the (L^* , L^* , mask) channel configuration emerged as the optimal input strategy, offering a robust solution for automated lighting coherence assessment in stylized commercial display installations.

Keywords: light direction estimation, non-photorealistic rendering, image color analysis, stylized animation

[137] Ingrid Calvo Ivanovic (Design Department, Universidad de Chile).

Dialoguing with Colour: A Human–AI Inquiry into the AIC’s Immaterial Heritage in the 21st Century.

Abstract. Since its foundation, the International Colour Association (AIC) has functioned not only as a platform for scientific exchange but also as a living repository of shared values, epistemologies, and approaches to understanding colour. While its conference proceedings are typically treated as technical outputs, this paper reads the proceedings from 2000 to 2025 as an archive of collective immaterial heritage, where colour knowledge is continuously produced, negotiated, and transmitted. The study introduces a human–AI dialogic methodology. Using a document-grounded conversational AI assistant, the corpus of proceedings was interrogated through iterative dialogue. The AI functions as a mediating partner, enabling the researcher to explore patterns, tensions, and implicit values embedded in the archive. Conversation itself is treated as a research method, supporting reflective synthesis across heterogeneous texts and revealing the AIC’s evolving collective knowledge.

The methodology comprised four phases. First, theoretical framing established concepts such as dialogism, immaterial heritage, more-than-human inquiry, and colour knowledge, guiding corpus delimitation and AI selection. Second, corpus construction involved collecting, merging, and preparing digital proceedings, treated as a bounded cultural archive reflecting the community’s values, perspectives, and shared experiences. Third, dialogic querying consisted of iterative sessions with refined questions focused on temporal developments, recurring tensions, values, assumptions, and shifts in language. Finally, interpretive positioning ensured that the researcher retained responsibility for framing, selecting, and interpreting outputs.

The results highlight the AIC’s immaterial colour heritage, showing how colour functions as a cultural practice through recurring and emerging themes, values, epistemologies, and tensions. Four thematic clusters were identified: (a) identity and purpose, revealing how the community defines its goals and role; (b) epistemologies of colour, exposing the assumptions governing what counts as valid knowledge; (c) language, metaphors, and conceptual frames, illuminating how colour is described and shared; and (d) emergences, absences, and tensions, highlighting gaps and future directions.

These findings suggest that the AIC’s heritage resides in shared vocabularies, recurring problem framings, evolving ethical concerns, and the negotiation between objectivity and lived experience. By making these patterns visible, the study demonstrates that AI-assisted dialogic methods can contribute to cultural heritage research—not by replacing human interpretation, but by creating reflective surfaces for collective memory. This work invites the colour research community to reflect on its own legacy and explore how human–AI collaboration may support the preservation, interpretation, and evolution of colour knowledge as immaterial heritage.

Keywords: colour knowledge, colour epistemologies, immaterial heritage, colour as heritage, colour research, human–AI collaboration, dialogic inquiry

[189] Amalia Luzzatto (Accademia del Lusso, Milano).

Color: From Traditional Marketing to Experiential and Cultural Marketing.

Abstract. The evolution of marketing beyond the traditional 4Ps model and the subsequent 4Cs reflects a structural shift in the way firms create value and build relationships with consumers. The rise of experiential, relational, and cultural approaches—together with the digitalization of touchpoints and the increasing adoption of purpose-driven branding—has redirected managerial focus from the management of marketing levers toward the design of meanings, experiences, and identities. In line with the transition from product-oriented to consumer-centered models, formally articulated by Lauterborn (1990), marketing theory increasingly acknowledges the value of levers capable of shaping perception, experience, and meaning-making processes. Within this framework, the present study examines color as a strategic lever in contemporary marketing, adopting an approach that recognizes its functional role in consumer value creation. Through a critical review of the literature in marketing, perceptual psychology, and design studies, the research highlights how color operates as a cognitive, emotional, and symbolic device, influencing brand perception, consumer experience, and decision-making processes. The findings demonstrate that color plays a central role in the construction of customer experience, in the design of digital touchpoints, in cultural branding strategies, and in value-oriented marketing practices. Specifically, color emerges as a tool for cognitive orientation, an emotional trigger, and a cultural code capable of conveying social and value-laden meanings consistent with brand positioning. The study argues that, in post-4P and post-4C marketing paradigms, color should be regarded as an integrated strategic variable, capable of contributing to value creation, identity coherence, and competitive differentiation. The conclusions offer both theoretical and managerial implications for a conscious and systemic management of color within marketing and communication strategies.

Keywords: Color, Strategy, Marketing, Consumer Experience

[188] Renata Pompas ([Accademia del Lusso](#)).

Niki de Saint Phalle: The translation of the chromatic code from art to design.

Abstract. The contemporary fashion landscape is characterized by a profound osmosis of identity between the languages of fashion and visual arts—a phenomenon in which the sartorial product transcends its functional use to become a vehicle for complex narratives. Clément Delépine (Art Basel, Paris) stated: "Art and fashion share the same visual language; they tell stories. Art has something to teach fashion shows, because it is now evident that the garment alone is no longer enough." Starting from this reflection, this paper analyzes color as a semiotic and design bridge.

The case study examined concerns an educational project developed at the Accademia del Lusso in Milan, stemming from the analysis of the retrospective exhibition dedicated to Niki de Saint Phalle (1930–2002) at the "MUDEC Museum of Cultures" in Milan. The artist's work, defined by a dreamlike quality and a bold, symbolic use of colors, was adopted as a paradigm for the design of a printed textile collection.

The research was structured through a rigorous methodology of observation and deconstruction of the artist's chromatic code. This process led to the synthesis of a collective Color Chart - intended as an aesthetic reference canon - and its subsequent breakdown into individual palettes, capable of translating Saint Phalle's visual emotionality into digital textile design projects.

The work presented here describes the stages of this chromatic translation, demonstrating how color coding can transform artistic inspiration into a replicable and coherent design system for the fashion industry.

Keywords: Color Analysis, Textile Design, Niki de Saint Phalle, Color Education, Color Chart

[129] Ingrid Calvo Ivanovic (Design Department, Universidad de Chile), Luanne Stovall (Department of Arts and Entertainment Technologies, University of Texas at Austin), Elisa Cordero (Escuela de Diseño, Facultad de Arquitectura y Artes, Universidad Austral de Chile) and Esther Hagenlocker (Department of Interior Architecture, University of Oregon).

Local Colour as Material and Immaterial Heritage: a Catalyst for 21st Century Colour Literacy.

Abstract. This paper examines the role of local colour as both material and immaterial heritage, proposing its study and activation as a means to strengthen design education's engagement with place, identity, and ecological awareness. Through three university-level teaching experiences conducted in Italy, Chile, and the United States, the paper analyses how colour observation, collection, and interpretation can foster renewed perceptions of colour as a living cultural resource and as an agent of socio-environmental care.

The first experience, in Italy, engages students in the systematic documentation of chromatic qualities within urban, natural and built environments. In this context, colour functions as a tool for care—supporting practices of attention, reciprocity, and situated understanding. Through field observation and experiential methods, students explore how local chromatic phenomena mediate relationships between humans, communities, and ecosystems, particularly in response to contemporary socio-ecological challenges. The second experience, in Chile, invites students to identify and gather colours embedded in their immediate surroundings—plants, architectural surfaces, materials, and urban textures. By recognising colour as both tangible, rooted in material pigments, and intangible, carrying symbolic, cultural, and identity-based meanings, students construct chromatic archives that guide subsequent design strategies. These archives reveal how local colour can be mobilised to blend with, differentiate from, or critically engage the surrounding context. The third experience, in the United States, positions colour heritage as a foundation for creating “spaces of identification” that reflect the cultural and environmental character of the Pacific Northwest. Students examine the interactions between colour, landscape, and cultural narratives, uncovering colour's transformative potential in shaping supportive and culturally resonant environments. This multidisciplinary inquiry highlights colour's capacity to articulate identity and contribute to healthier, place-anchored futures.

Taken together, these experiences demonstrate that cultivating colour literacy through local chromatic investigation strengthens students' ability to design with awareness, empathy, and contextual sensitivity. Grounded in the framework of the Colour Literacy Project (CLP)—a twenty-first-century initiative that positions colour as a meta-discipline bridging science, design, the arts, and the humanities—this work advances a future-oriented approach to colour education. By foregrounding experiential learning and the real-world impact of colour, the CLP underscores colour's role as a powerful medium through which we understand, shape, and care for our world.

Keywords: local colour, colour heritage, colour literacy, design education, immaterial heritage

[61] Yifei Chen (University of Leeds, School of Design), Soojin Lee (University of Leeds, School of Design), Vien Cheung (University of Leeds, School of Design) and Stephen Westland (University of Leeds, School of Design).

The Impact of Background Lightness Contrast on Skin Colour Perception: Exploring Absolute vs. Relative Standardisation.

Abstract. Neutral grey backgrounds are routinely used in psychophysical studies of colour perception, yet the choice of “standard grey ($L^*=50$, $a^*=b^*=0$)” is often made pragmatically rather than theoretically. In work related to skin colour, this is particularly problematic: perceived lightness, redness and yellowness of skin-like colours may depend not only on the stimulus coordinates themselves, but also on their contrast to the surround that might cause assimilation or contrast effects when evaluating by human observers. Adaptation-level theory, introduced by Helson (1948), holds that perceptual judgements are referenced not to absolute stimulus values but to an internal, context-dependent “adaptation level” that acts as a neutral point. This neutral level is determined by the ensemble of stimuli (range, background, anchors); the crispening effect heightens sensitivity for stimuli near the surround, so changes in configuration shift vision in psychophysical experiments. Visual experiments therefore cannot assume a fixed state of adaptation: observers re-adapt as context changes. This study explores a fundamental methodological question: should background standardisation in colour research be based on an absolute grey, or on a relative (contrast-matched) grey whose lightness covaries with the stimulus?

To explore the question, methodology is structured into four pilot experiments (Exp1 – Exp4), each examining how background conditions affect colour perception, with a focus on skin-colour-like stimuli. Exp1 and 2 use ‘reference colour patches’ (red, yellow, green, blue matching skin colour patches lightness and chroma), while Exp 3 and 4 extend this work to 6 inclusive skin colour patches as clustered by L’oreal in 2025.

The findings will provide practical, evidence-based recommendations for background control in future skin colour research. In particular, the preferred background strategy can be directly applied when designing experiments on skin colour evaluation (e.g., health, attractiveness, evenness), when constructing or validating skin colour charts for cosmetics. Establishing whether an absolute grey or a contrast-matched grey yields more stable and discriminative judgements for skin-like patches will inform how facial stimuli are presented, how “neutral” surrounds are defined in personal colour analysis, and how future standards for skin colour imaging and display calibration might specify background conditions to improve reliability and cross-study comparability.

Keywords: skin colour perception, adaptation level, background contrast, neutral grey, psychophysics, absolute or relative standardisation

SESSION A2S17 - Chair: Maurizio De Vita

| Colors of Historical Cities

List of Abstracts:

[\[166\]](#), [\[112\]](#), [\[144\]](#), [\[169\]](#), [\[143\]](#), [\[108\]](#).

[\[166\]](#) Eleonora Caggiati ([Università degli Studi di Firenze](#)).

The meaning of surface colour in Guido Canali's architectural practice. The dialogue with materials and the study of historical cities.

Abstract. The work of architect Guido Canali (1935-) demonstrates the importance of studying historical buildings when choosing the colour of façades. The surface of façades is in fact the result of the complex analysis of multiple elements. In the book 'L'immagine della città storica. Intonaci, colori, finiture di facciata' (1989), Parma is placed within the context of a broader debate. However, the issue of building colour is addressed only in relation to the restoration of existing architecture, without considering the construction of new projects within the urban landscape.

Guido Canali's focus on this issue emerges when analysing some residential buildings in the historic centre of Parma. For a three-storey residential building, known as 'Casa Rossa' (1967-1971), the architect chose to paint the brick walls in red earth, as well as the reinforced concrete structural frame. The result is a uniform volume from a chromatic point of view. Aware that architecture is based on knowledge of materials, the bricks are painted in a colour between 'Rosso Inglese' and 'Terra di Siena', which ultimately harmonises the new project with the colour of the buildings in the neighbourhood. This is a reminder of a tradition that, according to Guido Canali, also stems from the construction expertise of the neoclassical period, to which he dedicated two contributions between the 1960s and 1970s. Even in his most recent project for the Santa Teresa residential complex (2013-2020), the architect chose different colours to distinguish the elevations of the volumes, which derive their planimetric scheme from the study of 'lotto gotico'. In the northern block facing the river, he studied the ochre colour spectrum to achieve a result that matches the yellow plaster of the house nearby, which he himself had restored a few decades earlier. The material of the building facades is, in fact, a tangible historical memory.

This contribution therefore aims to highlight the design choices that characterise Guido Canali's architecture. Direct dialogue with the architect will help to reconstruct the critical motivations that guide his work.

Keywords: Guido Canali, Parma, residential buildings

[112] Racha Ghariri (Departement of Architecture -University of Mostaganem).

Colour and Emotion in Architectural Sensory Experience (for short presentation).

Abstract. This research explores the role of colour as a sensory and emotional component of architectural experience, focusing on the relationship between the chromatic character of urban environments and inhabitants' emotional responses. The study is situated within the broader framework of colour research in architecture and urban design, with particular attention to the continuity and transformation of historical colors in contemporary contexts.

The investigation takes the city of Béchar, in south-western Algeria, as a case study. This Saharan city presents a distinctive chromatic identity shaped by its natural landscape, its vernacular earthen architecture, and the persistence of historical colors that continue to influence the perception of the built environment. Rather than considering colour as a purely visual attribute, the research approaches it as part of a multisensory architectural experience, closely linked to memory, culture, and emotion.

The methodological approach combines an analysis of the chromatic character of the city with an exploration of inhabitants' emotional reactions and colour preferences. By examining both the physical chromatic environment and the subjective responses it generates, the study seeks to understand how long-term exposure to specific colour ranges contributes to the formation of site-specific emotio-chromatic patterns.

The research suggests that colour–emotion relationships in architecture cannot be fully explained by universal models alone, but are strongly influenced by local context, cultural background, and the presence or absence of certain colours within everyday environments. In this sense, historical colors play a key role in shaping contemporary sensory experiences and emotional responses. The study aims to contribute to a more context-sensitive understanding of colour in architecture and to support the development of chromatic approaches that respect local identity and sensory experience.

Keywords: Architectural sensory experience, Historical colors, Urban identity, motio-chromatic patterns

[144] Shi-Min Gong (Department of Commercial Design, Ming Chuan University), Ching-Chih Liao (Department of Commercial Design, Ming Chuan University) and Kai-Li Wang (Department of Commercial Design, Ming Chuan University).

A Study on Extending the Color Imagery of Japanese-Style Architectural Clusters in Taipei to Future Commercial Space Applications.

Abstract. Japanese-style buildings constructed during Taiwan's Japanese colonial period (1895–1945) have recently been adaptively reused as cultural and commercial spaces, becoming representative examples of urban regeneration. This study investigated four Japanese-style buildings in Taipei to examine color applications during adaptive reuse and propose color design principles for future reuse projects. A field survey was conducted to identify historical and adaptive-reuse colors. Then, using 11 basic colors proposed by Berlin and Kay, 45 color samples with different brightness and saturation were generated and applied to realistic interior scenes. Thirty observers evaluated the samples using a seven-point Likert scale in terms of color harmony, historical atmosphere, cultural ambience, commercial acceptance, modernity, and preference. The results showed that historical colors were mainly warm hues with medium-to-low chroma, while adaptive-reuse colors maintained a warm color with higher lightness and chroma. Brown colors closest to the historical colors received the highest ratings for color harmony, historical atmosphere, and cultural ambience, whereas high-chroma blue, green, and purple received the lowest ratings. For commercial spaces, high-lightness yellow, white, gray, and low-chroma orange were the most preferred colors.

Keywords: Taiwan, Japanese-style architecture, color imagery, commercial and cultural spaces, color application

[169] Michelle Lippi (Sapienza Università di Roma - Dipartimento di Storia, Disegno e Restauro dell'Architettura).

Brickwork and Chromatic Identity in Central Italy's Historic Urban Landscapes.

Abstract. This paper investigates the role of fired-clay brickwork as a constitutive material in the chromatic identity of historic cities located between the Chienti and Potenza river valleys, in central Marche (Italy), an area characterised by strong material, constructive, and landscape coherence. Urban centres such as Tolentino, San Severino Marche, Caldarola, Treia, Urbisaglia and Macerata present an urban landscape distinctly defined by the warm tonalities of brick masonry, resulting from a long-standing building tradition that has shaped the perception and character of historic urban fabrics.

The diffusion of brick masonry in this area is closely related to its geomorphological conditions, marked by the widespread presence of rivers, lacustrine basins, and shallow groundwater systems, which over time favoured the accumulation of clay deposits in the subsoil. The availability of raw material oriented local building techniques toward the systematic use of brick masonry, determining not only recurring structural solutions but also a specific chromatic definition of the historic city, recognisable both in ordinary architecture and in monumental structures.

The seismic nature of the territory represents a further determining factor in the historical development of these urban landscapes. Major earthquakes, including the event of 14 January 1703, caused extensive destruction and subsequent reconstruction campaigns. These processes reinforced brick masonry as a preferred building system due to its accessibility, economic viability, and consolidated technical expertise, often leading to a reorganisation of urban fabrics and strengthening material and chromatic unity.

An additional impulse to the dissemination and refinement of brick construction can be identified in the second half of the fifteenth century. Notarial sources document the presence of Lombard master builders active in local construction sites, whose technical knowledge—rooted in Northern Italian traditions—likely contributed to the diffusion of more advanced brick-building techniques and significantly influenced the architectural language and urban image of the area.

Methodologically, the research adopts an integrated approach combining archival and notarial analysis with the stratigraphic reading of architectural surfaces in relation to urban fabrics. This framework allows colour to be interpreted not merely as a perceptual attribute, but as a material and historical stratification shaped by resources, techniques, and long-term transformation processes.

Within this theoretical perspective, the paper addresses conservation and restoration as critical practices aimed at preserving the historic city as a unified organism. Safeguarding material authenticity and chromatic coherence emerges as a key issue in protecting the identity of historic urban landscapes, beyond the scale of individual monuments.

Keywords: Historic urban landscape, Brick masonry, Chromatic identity, Urban conservation, Central Italy historic landscape

[143] Juana Gandino (Universidad de Buenos Aires, Faculty of Architecture, Color Research Program), Ludmila Jael Paroldi Algranati (Universidad de Buenos Aires, Faculty of Architecture, Color Research Program), Rocio Melman (Universidad de Buenos Aires, Faculty of Architecture, Color Research Program), José Luis Caivano (Universidad de Buenos Aires, Faculty of Architecture, Color Research Program), Gabriela Cárdenas (Universidad de Buenos Aires, Faculty of Architecture, Color Research Program) and Roberto Lombardi (Universidad de Buenos Aires, Faculty of Architecture, Color Research Program).

A Methodological Approach to Chromatic Organization in Clorindo Testa's Domestic Architecture.

Abstract. In studies of modern architecture, color is rarely addressed as a central object of analysis and even less as a phenomenon intrinsically linked to light, morphology, and spatial organization. As a result, conventional approaches tend to treat color as a stable material attribute, overlooking its relational and perceptual nature.

This paper is framed within the ongoing research project Clorindia domestica, which investigates chromatic organization in Clorindo Testa's domestic architecture through relational and perceptual theoretical and methodological frameworks. In this context, chromatic organization in Testa's domestic works operates as a dynamic system, where color actively mediates between form, light, shadow, and landscape. In this context, defining chromatic identity as a cultural heritage value remains a challenge, since color varies according to light, context, and time.

Focusing on domestic works outside the canon of monumental and public architecture, the paper situates color within a field where heritage value is still emerging rather than fully established. In this context, chromatic identity proves especially vulnerable, making the need for relational and system-based methodological approaches more explicit as analytical tools for understanding chromatic identity in modern architecture.

A methodological system based on the unfolding of exterior surfaces is developed to represent chromatic relations synchronically. By applying inherent color under full light conditions and perceived color according to surface orientation and self-shadowing, the method reveals color as a continuous relational field rather than a collection of discrete surfaces. This representational approach allows the identification of chromatic invariants that structure the architectural and landscape identity of the works.

Shifting the focus from chromatic values to chromatic relations, the proposed method enables a comparative reading of the selected works and reveals operative consistencies in Testa's domestic architecture. This perspective contributes to current debates on modern architectural heritage without reducing chromatic identity to prescriptive or normative definitions, proposing instead an understanding of color not only through object-based and material-centered paradigms, but also as a cultural and disciplinary value that emerges through interaction. In this sense, domestic modern architecture is situated within a critical heritage threshold where perception, environment, and architectural form remain inseparable.

Keywords: Color perception, Relational chromatic systems, Modern architecture, Perceptual organization, Architectural morphology

[108] Ana Paula Pinheiro (Color and Light Research Group, Lisbon School of Architecture, Universidade de Lisboa, Lisbon, Portugal) and Rui Duarte (Universidade de Lisboa).

The colors of mortar in the Cathedral of Portalegre.

Abstract. Mortars have been used as a binding agent in construction for centuries. Consisting mainly of air lime and dolomitic lime, they can bind other elements, allowing for better aggregation. The analysis of their components is essential when working on heritage buildings. Selecting mortars requires scientific knowledge to identify their authenticity and colors, and to match them with the products to be applied. Knowledge of the components—grain size, color, and percentages of the constituent elements—is a technical and cultural principle that responds to the building's cultural significance, ensuring its identity and authenticity.

The intervention in the Cathedral of Portalegre involved historical research and scientific studies, which, together with archaeology, identified the colors and materials deposited over time. The mortars to be used were subjected to diagnostic tests to determine their characteristics. The micro-plastering with granite lime (constituent elements/percentages) was analyzed by a specialist laboratory, and the chromatic tests on the mortars restore the authenticity of the building.

Additives for coloring mortar, composed of a pigment, meet legal standards for products intended to increase the strength and plasticity of the mixture, providing a better finish and greater hardness to the final surfaces. Discussion of these matters was a constant feature of the process, which involved technicians, builders, and DRCALEN (Alentejo cultural heritage). The results obtained involved different processes for applying the mortars and controlling their color. The use of faux finishes in plasterwork to imitate stone was a technique to be preserved, as was the opening of “windows” in the plaster to reveal the underlying paint that had been hidden in the 1940s to convey an idea of austerity.

The filling of joints (marble and granite), the resealing of granite and marble joints, and the finishing of joints underwent chromatic and technical control to ensure consistent performance over time. The color of the cloister plasterwork was tested to enhance the relationship with the white plastered background walls and white marble paneling. In the cloister chapel, the frescoes and paintings on the plasterwork were revived, restoring their original appearance.

The colors of mortar in the Cathedral of Portalegre offer valuable insights into the monument’s architectural history and material culture. Through careful observation and analysis, mortar chromaticity emerges as a key element in heritage interpretation and conservation planning.

Keywords: Historic mortars, Color analysis, Architectural conservation, Cathedral of Portalegre, Authenticity

SESSION A3S18 - Chair: Barbara Cattaneo

| General

List of Abstracts:

[\[91\]](#), [\[90\]](#), [\[5\]](#), [\[23\]](#), [\[135\]](#), [\[190\]](#), [\[114\]](#), [\[138\]](#), [\[177\]](#), [\[77\]](#), [\[4\]](#), [\[173\]](#).

[\[91\]](#) Mark Kotterink ([Independent Researcher](#)).

A Layered Decision Architecture for Culturally Adaptive and Multisensory Color Selection.

Abstract. Contemporary professional color selection across architecture, healthcare, product design, and visual communication continues to rely predominantly on intuitive or stylistic judgment, despite decades of validated research in color psychology, perception, and cross-cultural studies. This persistent disconnect between research-based color science and applied practice has resulted in fragmented methodologies and limited reproducibility across professional contexts.

This paper presents the Color Experience System (CES), a systematic framework that integrates established color science, cross-cultural research, and multisensory perception into a coherent, evidence-based methodology for professional color selection. Rather than introducing new color theories, the framework synthesizes peer-reviewed findings into an operational structure that enables context-specific and culturally adaptive decision-making.

CES is structured as a layered decision architecture (three layers). The first layer addresses cultural and contextual differentiation through six empirically validated cultural clusters (EUW, NAM, LAM, APA, MNA, AFR), reflecting documented regional variation in color perception and preference. The second layer integrates multisensory perception using Steiner's twelve-sense framework, translated into operational parameters through phenomenological and neuropsychological research. The third layer maps these contextual and sensory parameters onto quantifiable color specifications using CIE LCh* coordinates and empirically derived threshold ranges.

Across multiple professional domains, the framework demonstrates how validated relationships between physical color parameters, perceptual responses, and cultural context can be systematically organized into reproducible decision pathways. By structuring semantic color concepts across cultural, sensory, and physical dimensions, CES enables consistent translation from research evidence to applied color decisions while remaining compatible with established colorimetric standards.

This contribution addresses a long-standing gap in color science between extensive empirical research and its practical implementation. The proposed framework offers a transparent, research-grounded methodology for culturally adaptive and multisensory color selection, supporting further empirical validation and interdisciplinary collaboration within the color research community.

Keywords: color decision, cultural color perception, multisensory perception, color semantics

[90] Federica Cocco (Department of Neuroscience, Imaging and Clinical Sciences, University G. d'Annunzio of Chieti-Pescara.), Mary Tezzele (Department of Neuroscience, Imaging and Clinical Sciences, University G. d'Annunzio of Chieti-Pescara.), Alessandro Bortolotti (Department of Neuroscience, Imaging and Clinical Sciences, University G. d'Annunzio of Chieti-Pescara.), Andrea Siniscalco (Politecnico di Milano) and Riccardo Palumbo (Università degli Studi "G. d'Annunzio" Chieti - Pescara, Italy).

Visual Exploration Patterns in Ettore Spalletti's Installations. A Museum-Based Eye-Tracking Analysis.

Abstract. Ettore Spalletti (1940-2019) created immersive installations blending painting, sculpture, and architecture through subtle chromatic gradations, atmospheric azzurrite blues and luminous pigment pastes, inspired by Abruzzese landscapes like Maiella mountain, the Adriatic Sea, and Bella Addormentata views from his Cappelle sul Tavo (Pescara) museum-studio. These enveloping spaces dissolve indoor-outdoor boundaries, generating profound perceptual experiences that invite both holistic and analytic engagement. This study examines perceptual differences between 5 art experts (trained curators/historians) and 10 non-expert enthusiasts (N=15) during a 15-minute task in Spalletti's ecologically valid museum-studio: 3 minutes of free gallery exploration followed by 4-minute sequential viewings of a site-specific spatial installation, a 2D painting, and a 3D sculpture. Wearable Tobii Pro Glasses 2 eye-tracking captures fixations, saccades, pupil dilation, and scanpaths; the UCL Aesthetic Experience Toolkit (brief 6-item and extended 12-item Likert 1-5 scales) measures post-visit psychological well-being (profundity, novelty, arousal, valence); qualitative interviews explore motivations and perceptions. The research addresses how visual attention varies between frequent and occasional visitors to contemporary art, whether enthusiasts adopt a global-to-detail scanning hierarchy akin to 2D art observation, and if differences emerge in fixation count, saccade patterns, and dwell time based on artwork familiarity, spatial context, and narrative elements. Results indicate experts will exhibit hierarchical top-down scanning, starting with global layouts before targeting diagnostic details like chromatic transitions and spatial edges, contrasting non-experts' diffuse bottom-up exploration with prolonged peripheral dwells and higher entropy. Spatial installations should maximize engagement; 2D paintings will sharpen experts' color discrimination via targeted saccades to pastel modulations; 3D sculptures will enhance volumetric parsing, with experts showing superior region-of-interest coverage. Significant correlations are anticipated between observation time, pupil dilation, and explicit pleasantness ratings, revealing how Spalletti's light-activated environments amplify expertise-driven processing. Our findings hold practical implications for optimizing exhibition spaces: data-driven curatorial sequences (immersive spatial openings for novices, transitioning to detailed 2D/3D for experts) to maximize mixed-audience engagement; targeted lighting on key chromatic transitions; museal training programs teaching hierarchical scanpaths; therapeutic architecture leveraging Spalletti-style environments to reduce stress via modulated arousal; and standardized eye-tracking protocols to valorize Abruzzese cultural heritage in regional museums. By bridging empirical aesthetics with Spalletti's legacy, this work advances visitor-centered design in contemporary art spaces

Keywords: color perception, art, preference, eye tracking, behaviour

[5] Kazim Hilmi Or (*Private Office of Ophthalmology*) and Can Bayram Or (*Artist*).

From Solar Gold to Liminal Black: A Comparative Chromatic Analysis of Mythological Birds Across World Cultures.

Abstract. Background: Mythological birds occupy a central position in many cultural and religious systems, where color functions as a highly codified symbolic resource for articulating cosmological structures, divine attributes, and social hierarchies. Despite the ubiquity of chromatic motifs in avian mythic narratives, a comprehensive and analytically rigorous synthesis of color symbolism across world traditions remains lacking. This review addresses this gap by situating mythic bird coloration within the broader frameworks of color science, anthropology, and comparative mythology.

Methods: The study employs an interdisciplinary methodology that integrates philological examination of textual sources, iconographic and artistic analysis, cross-cultural motif comparison, and conceptual frameworks from cognitive semiotics. In addition, recent digital humanities practices—including spectral modeling, digital reconstruction of mythic imagery, and geocultural mapping—inform the comparative analysis. Data were synthesized from more than thirty cultural regions, including East and South Asia, the Near East, Africa, Europe, and the Indigenous Americas.

Results: Four global chromatic regimes emerged consistently across traditions: (1) solar-fire palettes (gold, red, orange) associated with vitality, divine kingship, and cyclical regeneration; (2) liminal-dark palettes (black, deep blue) linked to prophetic insight, storm power, and mediation between worlds; (3) purificatory-light palettes (white, silver) representing healing, moral purity, and benevolent divine intervention; and (4) iridescent or multicolored palettes, expressing cosmic totality, transcendence, or all-encompassing knowledge. Regional variations—such as Mesoamerican turquoise-green or East Asian five-phase coloration—demonstrate the interplay between universal chromatic archetypes and culturally specific cosmological models.

Conclusions: The review shows that mythical bird coloration operates as a form of visual theology, providing a condensed symbolic language through which cultures articulate metaphysical concepts and spiritual authority. The findings underscore the importance of color as both a universal cognitive category and a culturally situated semiotic system. The study advocates for expanded interdisciplinary research integrating digital visualization, pigment analysis, and cognitive-linguistic approaches to further elucidate the role of color in shaping mythological meaning.

Keywords: Mythological birds, Color symbolism, Comparative mythology, Chromatic semiotics, Global cosmology

[23] Kyoko Hidaka (Joshibi University of Art and Design), Ayako Osaki (Joshibi University of Art and Design), Shizu Ara (Joshibi University of Art and Design) and Hiroko Uchiyama (Joshibi University of Art and Design).

Sanzo Wada and the Development of Trend Color Systems in 1920s–1930s Japan.

Abstract. Sanzo Wada (1883–1967) has been primarily known as a painter and designer in Japanese art history. However, his most significant contribution was his leadership in color standardization during the 1920s and 1930s. This presentation re-examines Wada's pivotal role at the Dyeing Art Research Institute, established in the mid-1920s with support from Takashimaya Department Store. It highlights how his efforts directly led to the founding of the Japan Standard Color Association in 1927, which is the predecessor of the current Japan Color Research Institute.

During the 1920s, major department stores, including Takashimaya, were actively promoting modern lifestyle culture. The Dyeing Art Research Institute served as a collaborative platform that brought together artists, craftsmen, chemists, and commercial planners. Among its notable achievements were the creation of the "500 Standard Japanese Color Cards" (1929) and the publication of the "Comprehensive Guide to Color Combination" (1933–1935). These color charts and publications are recognised as among the earliest systematic attempts at color standardisation in Japan. In 2010, Gentaro Omi reprinted the Comprehensive Color Combination Guide in a popular edition.

As an advisor to Takashimaya's Hyakusen-kai (Hundred Selections Committee), Sanzo Wada integrated insights from European color theories, gained during his studies abroad, with traditional Japanese dyeing techniques. This combination allowed him to forecast and promote Japan's fashionable colors. His expertise laid the groundwork for Intercolor's global dissemination of trend colors in the 1960s.

From a cultural heritage perspective, Wada's achievements represent more than technical standardization—it embodies the preservation and reinterpretation of traditional Japanese color aesthetics within a rapidly modernizing society. The 500 Standard Japanese Color Cards and the Comprehensive Guide to Color Combination are not only design tools but also cultural artifacts that document Japan's negotiation between tradition and modernity. By institutionalizing color knowledge, Wada ensured that historical dyeing practices and indigenous color sensibilities were archived and transmitted to future generations, while simultaneously aligning them with global design movements such as Art Deco.

This presentation re-evaluates Sanzo Wada as a pioneer of Japanese color design by tracing the evolution from department-store trend-color promotion to the formalization of color standardization. It also highlights the uniquely Japanese model of trend color dissemination, which originated in department stores, and the establishment of a color research institution focused on dyeing.

(Oral Presentation)

Keywords: Sanzo Wada, Trend Color, Color Standardization, Japanese Design History, Department Stores

[135] Mari Uusküla (Tallinn University).

Italian Blue Terms Revisited: A Diachronic and Dialectal View.

Abstract. Italian has an unusually differentiated lexical system within the blue domain. This paper examines the historical development of this system by analysing data from the Sprach- und Sachatlas Italiens und der Südschweiz (AIS) and comparing them with contemporary findings, which have primarily focused on the basic status of Italian colour terms. The historical evidence suggests that the question is more complex, as Italian dialects displayed highly variable two- and three-term systems, with considerable variation in both lexical composition and referential meaning. The Florentine variety provides a particularly revealing example. Whereas contemporary studies have identified three basic colour terms, blu, azzurro and celeste, the AIS records only two terms for blue in Florence: blu and turchino. By contrast, the historical configuration recorded in Cagliari already resembles the contemporary distinction between azzurro and blu. The findings indicate that the contemporary Italian blue system did not develop from a uniform earlier division, but arose through uneven regional development, lexical diffusion and the increasing influence of Standard Italian.

Keywords: the language of colour, colour semantics, basic colour terms, dialectal variation, diachronic development, Italian

[190] Francesca Valan ([Francesca Valan Studio](#)).

Colour as an Educational Mediator: Designing Didactic Pathways for the Exhibition “Munch. The Inner Cry”.

Abstract. Colour represents a fundamental component of visual language and a powerful tool of cultural mediation between artworks and audiences. In contemporary art exhibitions, educational pathways contribute to transforming museum visits into active learning experiences, fostering visual literacy, critical thinking, and personal interpretation.

Museum education research recognises art museums as parallel educational systems capable of promoting observation, dialogue, and aesthetic judgment through direct engagement with original artworks. Within this framework, this contribution presents an educational project developed for the exhibition “Munch. The Inner Cry”, dedicated to Edvard Munch and produced by Arthemisia.

Hosted in Milan and Rome, the exhibition recorded more than 530,000 visitors and involved over 3,500 school classes, confirming the relevance of educational mediation within large-scale temporary exhibitions.

The didactic pathway was conceived and designed as a system of five thematic stations, structured as transversal and modular tools. Together, they addressed key dimensions of Munch’s use of colour: the shift from descriptive to expressive and symbolic chromatic systems; the analysis of the artist’s palette and its psychological meanings; the relationship between colour, space, and inner experience; the role of material experimentation and surface treatment as expressive parameters; and the tactile exploration of texture through embodied practices.

The project demonstrates how an integrated approach between curatorial practice, museum education can enhance audience engagement and foster deeper encounters with art, reinforcing the role of exhibitions as spaces of visual, material, and symbolic learning.

Keywords: museum education, colour, colour design, Edvard Munch, didactic pathways, visual literacy

[114] Anna Mazzanti (Politecnico di Milano), Alice Biancardi (Politecnico di Milano) and Erica Sterza (Politecnico di Milano).

BLU-ETRUSCO. From the 1980s to today. Exhibition design, art, communication.

Abstract. The paper focuses on the communicative and expressive value of the colour blue in exhibit design and the arts. It starts from the case study of the “Anima Etrusca” exhibition set up at San Gimignano, (3 July 2025–11 January 2026), which reinterpreted and updated a complex and innovative exhibition experience from the 1980s: the 1985 “Etruscan Project”, which took place in Tuscany and other regions of Etruria. Eight exhibitions were organised, along with an international conference and numerous communication activities to update and raise awareness of the civilisation of the ancient Italic people among a wide audience. The project was a pioneer in the renewal of exhibition design, communication and sponsorship strategies, as well museographic and exhibition enhancement. The documentation that has come down to us shows how the use of colour was a fundamental component in the revitalisation of exhibitions related to Etruscan archaeology and beyond. The evocative exhibition of today “Anima Etrusca” attempted a critical reading and analysis on various levels of that complex initiative and its prospects over time, updating and verifying the themes that emerged at the time. The colour blue, persistent and constant from then until the recent exhibition, can represent a common thread connecting multiple aspects, as it is a constant on several fronts, from installations to artistic, photographic and video production, publishing and communication, also characterising some of the contemporary events that reactivate the intangible cultural heritage handed down by the Etruscan people. Blue represents an expressive colour from the economic boom of the 1980s and mass communication to the present day.

We submit for oral presentation.

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Keywords: Exhibit Design, Art, Blue, Etruscan Heritage, Communication Strategies

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Color, Light, and Perceptual Experience in Historic Theatre Interiors: A Comparative Study of the Teatro di San Carlo and the Opéra Garnier.

Abstract. Historic theatre interiors represent a complex cultural heritage, resulting from historical, artistic and functional stratifications. In these spaces, color and light, wisely coordinated with the architecture, decorative elements and materials, play a fundamental role in defining the perceptual quality of the theatrical space. Color is not a merely decorative attribute, nor is artificial light a neutral means of illumination but both, mediating between form and materiality, can structure spatial hierarchy through a specific perceptual and luministic experience and contribute to the construction of the cultural identity of the place.

Through a comparative analysis, this study investigates the relationship between color, light and architectural design in the historic interiors of the Teatro di San Carlo in Naples and the Opéra Garnier in Paris, which represent exemplary approaches to theatre interior design, where chromatic choices and lighting systems are essential for defining their architectural and cultural identity.

The Teatro di San Carlo (1737), part of the UNESCO World Heritage site of Naples' Historic Centre, reflects a chromatic balance coherent with the Italian tradition of compositional uniformity and acoustic-spatial harmony, where color, decorative elements and materials favor continuity and spatial unity. The Opéra Garnier (1875), a monument historique since 1923, adopts a more elaborate and scenographic chromatic and lighting system, aimed at amplifying the grandeur and scale of its audience spaces.

The research adopts an interdisciplinary methodology based on historical analysis, chromatic and material study of surfaces and examination of the spatial design of the two theatres. Particular attention is given to the different types of artificial light and color palettes, as well as to the properties of materials — including ornamental stuccoes, painted decorations, fabrics and textural finishes — in order to highlight how color and lighting are essential for structuring spatial hierarchy and enhancing perception in historic theatre interiors.

Recent restoration interventions in both theatres were also analysed, providing new data on the type and layering of color on surfaces and on historical lighting conditions. The comparison between conservation practices and contemporary lighting technologies demonstrates how chromatic and lighting choices influence the contemporary perception of theatre interiors and the transmission of their cultural value. In this regard, the study highlights how different chromatic and lighting strategies produce specific perceptual and interpretative effects on the theatrical space, influencing contemporary understanding of historic theatrical heritage and contributing to the debate on its sustainable valorisation.

Keywords: Historic theatre interiors, Cultural heritage, Spatial perception, Cultural identity, Chromatic design, Lighting design

[177] Ruby Kashyap Sood (National Institute of Fashion Technology).

Phulkari Heritage: The Vocabulary of Colours and Tradition.

Abstract. India is known for its intricate and breathtaking handmade textile traditions across the world. Since antiquity, the maker's hand skills with such dexterity to create exquisite textiles represent the rich culture and tradition of a place and community. One such alluring embroidered textile of India is 'Phulkari' from Punjab. These hand-embroidered head-coverings or shawls were made by the women in the family for their progeny, a legacy that has passed on from one generation to another.

In the past, the women in Punjab assembled together and handcrafted a beautiful Phulkari for their daughters, drawing inspiration from nature and daily objects. The rural life and the scenic beauty of the region contributed to the development of patterns filled-in with vivid colours. It is interesting to note the ingenuity and creativity of women, who used their imagination to embroider motifs without even tracing the designs on the material. The untwisted silk threads were used to embroider on a coarsely woven khaddar to produce fascinating textiles, most of the time completely covering the base material. The Phulkari and the elaborate Bagh, known by various names according to the design, colour combinations, and purpose, were reserved for special occasions. As the tradition continues, the intricately embroidered Phulkari, a labour of love, is a must in weddings and other auspicious ceremonies in the Punjabi community, be it in India or across the globe.

The vibrant threads of Phulkari carry a fascinating story of colours, each with a unique symbolic meaning waiting to be unravelled. Women were primarily in charge of choosing the designs for Phulkari, who embroidered these tales. They used colour schemes to bring charm and beauty to their work, with small changes in colour or pattern depicting changes in the rhythm of life.

In Phulkari, solid colours are used for the base, while colourful threads are used for embroidery. Traditional base fabric colours include red, brown, off-white, black, or blue. The traditional colours used for the pat thread included golden yellow, red, crimson, orange, blue, white, violet, green, and dark brown. Dark blue or black were only used minimally for specific motifs. The number of colours in the embroidery varies from one to five to seven in traditional Phulkaris and Baghs.

The research attempts to capture the relevance of colours as part of the rich heritage of this region. The objectives entail historical documentation of the vivid phulkari textiles available in museums and prized possessions of the women of the community. Further, the study will delve into colour symbolism from the past and its connotation in today's time. The research endeavours to disseminate about the embroidered craft that has evolved over a period of time.

Keywords: Hand embroidery, Heritage, Colour Symbolism, Phulkari

[77] Lavinia Nasoni (freelance conservator), Barbara Cattaneo (Opificio delle Pietre Dure), Valeria Arena (Ufficio restauri - Direzione regionale Musei Veneto), Alessandra Santagostino Barbone (freelance conservation scientist) and Renata Pintus (Opificio delle Pietre Dure).

Chromolithographic Colour at the Turn of the Twentieth Century: Diagnostic Investigation and Technical Sources in a Mucha Poster Printed by Imprimerie Cassan Fils.

Abstract. At the end of the nineteenth century, chromolithography represented one of the most advanced colour printing technologies, combining industrial efficiency with a high degree of technical and chromatic control. Despite its central role in fin-de-siècle visual culture, this phase of chromolithography remains comparatively under-investigated from a technical perspective, as it coincides with a crucial transitional period in which artisanal practices coexisted with emerging industrial production systems. This paper presents an interdisciplinary study of a chromolithographic poster designed in 1896 by Alphonse Mucha for the Imprimerie Cassan Fils, today preserved in the Salce Collection (Treviso), with particular emphasis on diagnostic analysis integrated with contemporary technical literature.

Historical manuals and trade publications were examined to reconstruct the chromolithographic workflow of the period, focusing on ink manufacture at the intersection of craft and industry, colour separation strategies, printing sequences, registration systems and the gradual transition from stone to metal matrices. These sources provide an essential framework for interpreting the material complexity of chromolithographic posters produced during this hybrid technological phase.

The core of the study is a comprehensive diagnostic campaign aimed at identifying the constitutive materials and execution technique of the artwork. Non-invasive and micro-analytical methods—including multispectral imaging, optical microscopy, X-ray fluorescence, Raman spectroscopy, FTIR spectroscopy and SEM–EDS—were employed to characterise pigments, binders, paper support and printing layers. Diagnostic data enabled the reconstruction of colour stratigraphy and the printing sequence, allowing a direct comparison between historical prescriptions and material evidence.

The results reveal a strong correspondence between technical literature and observed practices, while also highlighting specific adaptations in ink composition, layering and colour application attributable to the production choices of the Cassan Fils workshop and to Mucha's distinctive approach to chromatic design. By addressing a transitional and still underexplored phase in the history of colour printing, this study demonstrates how chromolithographic colour emerged from the interaction between artistic intent, evolving industrial processes and material constraints, contributing to a deeper understanding of fin-de-siècle chromolithography and its conservation.

Keywords: Chromolithography, Diagnostic analysis, Alphonse Mucha, Fin-de-siècle posters

[4] Kazim Hilmi Or (*Private Office of Ophthalmology*).

Reconstructing, visualizing, or reimagining ancient polychromy.

Abstract. Background: Research on ancient polychromy has expanded significantly over the last two decades, challenging long-standing assumptions about the achromatic appearance of classical and other ancient artworks. Increasingly, interdisciplinary studies demonstrate that sculpture, architecture, and ritual objects across diverse cultures were originally vividly painted. As a result, polychromy has become central to debates on materiality, perception, and cultural identity in antiquity. However, the field remains fragmented, with methods and interpretative frameworks distributed across art history, conservation science, archaeology, and digital heritage studies.

Methods: This review synthesizes scientific, physical, and digital approaches used to reconstruct, visualize, or reimagine ancient polychromy. It surveys fifteen major projects from 2000–2025—including *Gods in Color*, *CHROMA*, Acropolis polychromy programs, Terracotta Army pigment research, Maya chromatic reconstructions, and VR-based heritage models—and analyzes the underlying methodologies. These include multispectral and hyperspectral imaging, Raman and XRF spectroscopy, UV-induced fluorescence mapping, 3D photogrammetry, machine-learning pigment classification, physical repainting of replicas, projection mapping, VR/AR visualizations, and digital-twin color simulations.

Results: Across the reviewed initiatives, a clear methodological convergence emerges. Scientific imaging enables increasingly accurate detection of pigment residues and stratigraphy; 3D-based digital twins integrate spectral, geometric, and contextual data; immersive visualization techniques broaden interpretative possibilities while maintaining evidentiary transparency. The comparison reveals both shared achievements—such as improved pigment identification, more nuanced color reconstructions, and enhanced accessibility—and persistent challenges, including chromatic uncertainty, limited pigment preservation, and the need to distinguish between evidence-based reconstruction and speculative visualization.

Conclusions: Contemporary polychromy research has shifted from isolated pigment analysis toward holistic, multimodal reconstruction frameworks that integrate material, perceptual, and cultural dimensions of ancient color. Digital twins and immersive visualization now complement physical reconstructions, enabling reversible, data-rich, and critically annotated models of ancient chromatic practices. The review concludes that future progress will depend on standardized documentation protocols, transparent uncertainty modeling, and interdisciplinary collaboration between conservation scientists, art historians, computer scientists, and cultural-heritage practitioners. These developments collectively signal a paradigm shift: polychromy is no longer a marginal curiosity but a foundational component of understanding ancient visual cultures.

Keywords: Ancient polychromy, Multispectral imaging, Color reconstruction, Digital heritage, Immersive visualization

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A methodological proposal for the faithful reproduction of color, aligned with the Guidelines for 2D and 3D Digitization of Cultural Heritage. Experiences at the Quadreria and the Gipsoteca of the Brera Academy of Fine Arts.

Abstract. With the aim of reinvigorating the digitization and valorization of its historical heritage, the Brera Academy of Fine Arts - which has been committed to the careful inventory and documentation of its collections for several decades - has launched an extensive photographic documentation campaign of the entire Quadreria and the three-dimensional survey of a selection of historical plaster casts, as part of IartNET, a project funded by the PNRR, aimed at creating an interoperable database and an English-language web portal to collect and preserve open-access content on cultural heritage and ongoing educational, artistic, and research projects at Italian AFAM institutions, contributing to the digital transition, networking capacity, and increased international visibility.

The know-how acquired in recent years through educational protection and enhancement projects has led to a progressive updating of the modus-operandi, aligning them with the most up-to-date technological and methodological standards defined by the Piano Nazionale di Digitalizzazione del Patrimonio Culturale (PND) drafted by the Istituto Centrale per la Digitalizzazione del Patrimonio Culturale (ICDP) – Digital Library of the Ministry of Culture (Linee guida 2022).

From acquisition standards to colour profile management, from calibration to metadata management, the development of dedicated protocols has made it possible to leverage the specificities of the various media treated, standardizing the digitization process, both two- and three-dimensional, to ensure the accurate recording of material and technical characteristics and the faithful reproduction of the original chromatic characteristics.

Essential bibliography:

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Keywords: HD & High-Res photography, 3D survey, Close-range photogrammetry, Digital replica, Guidelines, Digital Library