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SOMMARIO | SUMMARY

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Editorial

With the publication of no. 8, the *"Cultura e Scienza del Colore - Color Culture and Science"* journal has completed its fourth year of life. For two years the journal has published only articles in English or bilingual. The ethical code, the peer review process and the detailed instructions for authors are available on the website. Each article is indexed by a DOI code and for each published article the dates of reception, review and acceptance are declared, in addition to any sources of funding and any conflicts of interest. All of these criteria, with others already introduced for some time, will allow us in the 2018 to start the procedure to request to be included in international indexing databases.

The journal is published by a multidisciplinary association that has in the topic of color its point of reference. Also in this issue there is a clear example of *multidisciplinary* integration. Michela Rossi, Maria Pompeiana Iarossi and Giampiero Mele, in their paper " *Principles and applications. Consistency and experimentation in the work of Piero Bottoni, from the Cromatismi to Sesto San Giovanni"*, analyze the work of the architect Piero Bottoni, through the tools of investigation of the *representation*, from the *"Cromatismi"* presented at the III Biennial of Monza in 1927, to the town hall of Sesto San Giovanni in the 60s. In the paper *"Colour quantity contrast in Itten's Theory: Spectrophotometry for verifying statements"*, the authors Agapito Di Tommaso, Vincenzo Garro, Anna Maria Gueli, Sabina Martusciello, Maria Dolores Morelli and Stefania Pasquale, elaborate on the paternity theme of the concept of color quantity contrast of the six primary colors of Itten's theory, through an *historical and metrological* analysis, starting from Schopenhauer's writings. Desirée Sabatini, Ivano Forte, Ilma Schiavitti, Mauro Sabatini and Alessio Pietrini in their research *"The recovery of the original colour of the archive material: the digital colour correction of the ancient anti-Semitic discourse of the Duce in 1938"* deal with *digital color*, illustrating the scientific and methodological assumptions that have been used in the digitalization and restoration of a 1938 film preserved at the Archivio Storico Luce. In the paper *"The meanings of the red"* Anna Luana Tallarita continues her historical research on red. Lynne Bartlett in *"An overview of the history of the use of color in jewelery"* presents an interesting historical analysis of the *materials* and processing methods used in the creation of jewels from prehistoric times to today. In the article *"Color as a mass product. Designing of the*

Con la pubblicazione del n 8, la rivista *"Cultura e Scienza del Colore - Color Culture and Science"* ha completato il suo quarto anno di vita. Da due anni la rivista pubblica solo articoli in lingua inglese o bilingue. Sul sito sono disponibili il codice etico, il processo di peer review e le istruzioni dettagliate per gli autori. Ogni articolo è indicizzato da un codice DOI e per ogni articolo pubblicato vengono dichiarate le date di ricezione, referaggio e accettazione, oltre alle eventuali fonti di finanziamento ed eventuali conflitti di interesse. Tutti questi criteri, oltre ad altri già introdotti da tempo, ci consentiranno dal 2018 di avviare la procedura per richiedere di essere inseriti nei database di indicizzazione internazionali.

La rivista è edita da una associazione multidisciplinare che vede nel tema del colore il suo punto di riferimento. Anche in questo numero abbiamo un chiaro esempio di integrazione *multidisciplinare*. Michela Rossi, Maria Pompeiana Iarossi e Giampiero Mele, nell'articolo *"Principi e applicazioni. Coerenza e sperimentazione nell'opera di Piero Bottoni, dai Cromatismi a Sesto San Giovanni"* analizzano, tramite gli strumenti di indagine della *rappresentazione*, il lavoro dell'architetto Piero Bottoni, dai *Cromatismi* presentati alla III Biennale di Monza del 1927, al palazzo comunale di Sesto San Giovanni degli anni '60. Nell'articolo "*Il contrasto di quantità nella Teoria di Itten: la spettrofotometria per la verifica degli enunciati"*, Agapito Di Tommaso, Vincenzo Garro, Anna Maria Gueli, Sabina Martusciello, Maria Dolores Morelli e Stefania Pasquale, tramite un'analisi *storica e metrologica*, partendo dagli scritti di Schopenhauer, trattano il tema della paternità del concetto di contrasto di quantità dei sei colori primari della teoria di Itten. Desirée Sabatini, Ivano Forte, Ilma Schiavitti, Mauro Sabatini e Alessio Pietrini nella ricerca *"Il recupero del colore originale dei materiali d'archivio: la correzione digitale del colore dello storico discorso antisemita del Duce, nel 1938"* si occupano di colore digitale, illustrando i presupposti scientifici e metodologici che sono stati utilizzati nella digitalizzazione e restauro di un filmato del 1938 conservato presso l'Archivio Storico Luce. Nell'articolo "*Le significazioni del rosso"* Anna Luana Tallarita prosegue le sua ricerca storica sul colore rosso. Lynne Bartlett in *"An overview of the history of the use of colour in jewellery"* presenta un interessante analisi storica dei *materiali* e metodi di lavorazione utilizzati nella realizzazione dei gioielli dalla preistoria ai giorni nostri. Nell'articolo *"Colour as a mass*

interior paint collection for the Polish market", Agata Kwiatkowska-Lubanska, presents a research on the color palettes proposed in the period 2011-2013 by the two main Polish paint producer, sold directly to the consumers for *interior design.* Finally, Daria Casciani, Fulvio Musante and Maurizio Rossi present the research *"Exploring the relationship between LEDs Lighting, Urban materials chromaticity and People: measurements, design and evaluation"* in the area of *lighting design and metrology*, linking the new LEDs sources with the urban materials and the perceptive evaluation of the users.
In the columns, Renata Pompas presents the review of the book Cromorama by Riccardo Falcinelli, while Michela Lecca with Osvaldo da Pos, in the Communications and Comments column, present a scientific bibliographic dissertation on the difference between the physiological color sensation and the cognitive color perception.

Editor in chief
Maurizio Rossi

product. Designing of the collection of interior paint colours for the Polish market", Agata Kwiatkowska-Lubanska, presenta una ricerca sulle palette di colori proposte nel periodo 2011-2013 dai due principali produttori polacchi di vernici, vendute direttamente ai consumatori per il *design di interni*. Infine Daria Casciani, Fulvio Musante e Maurizio Rossi presentano la ricerca *"Exploring the relationship between LEDs Lighting, Urban materials chromaticity and People: measurements, design and evaluation"* nell'area del lighting *design e metrologia,* ponendo in relazione le nuove sorgenti LED con i materiali urbani e la valutazione percettiva dei fruitori.
Nelle rubriche, Renata Pompas presenta la recensione del libro Cromorama di Riccardo Falcinelli, mentre Michela Lecca con Osvaldo da Pos, nella rubrica Communications and Comments, presentano una dissertazione scientifico bibliografica sulla differenza tra la sensazione cromatica fisiologica e la percezione cromatica cognitiva.

Editor in chief
Maurizio Rossi

Principles and applications. Consistency and experimentation in the work of Piero Bottoni, from the "Cromatismi" to Sesto San Giovanni

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ABSTRACT

Among the architects who linked their name to the affirmation of the Modern Movement in Italy, Piero Bottoni (1903-1973) applied the color as a substantial element of the project and colorful facades enhanced the plastic nature of architecture. The research aims to verify the role of color along the architect's work, comparing the archive material with the evidence in his last building. The concept of earlier writings reflects a strong relationship with urban space. In the exhibition of the *"Cromatismi architettonici" (architectural chromatics)* at the III Triennial of Monza (1927) the color is the link between the building and the city. The archive material emphasises the Bottoni's consistency in the use of color in the recurring characters of written theorisation, drawings and finally in the design behind the construction. The six watercolors for the exhibition document a chromatic research that is free from cultural models of the time and focus on the integration between the shape of the road and color, in which the architectural elements marge into the chromatic hues that underline the facades with tones and combinations unusual in architecture; the progressive lightening towards the top exasperate the *"depth"* of the urban road in the *"ascent"* towards the sky of the buildings making up the modern city. Thirty years later, he resumes the same compositional scheme for horizontal chromatic bands in the project for the municipality of Sesto San Giovanni (1961-71).

KEYWORDS

Color design, architectural color, urban color, civic architecture, Piero Bottoni.

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Principi e applicazioni. Coerenza e sperimentazione nell'opera di Piero Bottoni, dai "Cromatismi" a Sesto San Giovanni

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1. A THEORETICAL PREMISE: THE BEGINNINGS OF THE "CROMATISMI ARCHITETTONICI"

In historical literature, architecture has always expressed the art of form and space, as opposed to painting, defined as the art of color. Although the presence of color was important in the aesthetic characterisation of buildings, for the mimesis or the emphasis of architectural structures, it was not a fundamental consideration in the theory of the project. In fact, the culture of academic derivation was permeated by the Platonic conception that recognised in the *form* a substantial value of reality, identifying it as the true essence of architecture; *color* was instead connected to the variability of the phenomenal world, as a feature of the materials or the attribute of superficial appearance (Cremonini,1992).
In any case, this was an inevitable but *"secondary"* factor, which did not alter the quality of the project. In addition, it was the competence of different craftsmen, whether it was the result of the materials used or the result of the last finishing treatment and therefore did not *"belong"* to the actual project, which concerned the *construction.* This accessory conception finds a confirmation in the different nature of the *drawing*, considered capable of representing the concepts and therefore the language of the project, and of painting, which instead expressed its visual experience, feelings and passions (Rossi, 2010).
When at the beginning of the 20th century artistic avant-gardes promote the renewal of the arts with the search for an encompassing piece of art capable of bringing together the formal assumptions of other works, architecture is the art that can best incorporate the characters of the other disciplines: the fragmentation of the spatial box recalls the plastic value of sculpture, while the psychological research of the *Gestalt* transforms color into a "*constructive"* element of space. Color also becomes the substitute for the plastic decoration (Droste, 2002; Scheper, 1989).
From this point of view, the various architectural avant-gardes are in agreement; it could not be otherwise, because this was in the premise of the *Gesamtungswerk*, but the real renewal of architecture promoted by the Modern Movement had other priorities, of a functional and constructive nature. It was also less free from the conditioning its own historical literature, which was configured as a programmatic theoretical treatise that went beyond the technical knowledge of painters (Polano, 1979; Klee, 1984).
The relationship of the authors of the Modern Movement with color is contradictory, conditioned by the attitude of Le Corbusier, who like many others was also a painter, who first

1. LE PREMESSE TEORICHE: L'ESORDIO DEI "CROMATISMI ARCHITETTONICI"

Nella trattatistica storica l'architettura ha sempre espresso l'arte della forma e dello spazio, in contrapposizione alla pittura, definita come arte del colore. Sebbene la presenza del colore fosse importante nella caratterizzazione estetica degli edifici, per la mimesi o il risalto dell'articolazione architettonica, esso non era però materia di trattazione fondamentale nella teoria del progetto. Infatti la cultura di derivazione accademica era permeata dalla concezione di derivazione platonica che riconosceva alla *forma* un valore sostanziale della realtà, individuandola come vera essenza dell'architettura; il *colore* invece veniva ricondotto alla variabilità del mondo fenomenico, come carattere proprio dei materiali o come attributo dell'apparenza superficiale (Cremonini,1992).
In ogni caso si trattava di un fattore inevitabile ma *"secondario"*, che non alterava la qualità del progetto. Inoltre esso era competenza di artigiani diversi, sia che fosse la conseguenza dei materiali usati, sia che fosse il risultato dell'ultimo trattamento di finitura, e quindi non *"faceva parte"* del progetto vero e proprio, che riguardava la costruzione. Questa concezione accessoria trova una conferma nella differente natura del *disegno*, ritenuto capace di rappresentare i concetti e quindi linguaggio del progetto, e della pittura, che invece ne esprimeva l'esperienza visiva, i sentimenti e le passioni (Rossi, 2010).
Quando a inizio '900 le avanguardie artistiche promuovono il rinnovamento delle arti con la ricerca di un'opera d'arte totale capace di riunire i presupposti formali delle altre, l'architettura è quella che si presta meglio ad inglobare i caratteri delle restanti discipline: la frantumazione della scatola spaziale richiama il valore plastico della scultura, mentre le ricerche psicologiche della *Gestalt* trasformano il colore in un elemento *"costruttivo"* dello spazio. Esso diventa anche l'elemento sostitutivo della tanto avversata decorazione plastica (Droste, 2002; Scheper, 1989).
Da questo punto di vista le diverse avanguardie architettoniche sono concordi; non poteva essere diversamente perché era nelle premesse della *Gesamtungswerk*, ma il vero rinnovamento dell'architettura promosso dal Movimento Moderno aveva altre priorità, funzionali e costruttive. Esso era anche meno libero dal condizionamento della sua letteratura storica, che si era configurata come una trattatistica teorica programmatica che andava oltre il sapere tecnico del know-how dei pittori (Polano, 1979; Klee, 1984).

proclaims the *"law of the white lead"* (Le Corbusier, 1973) and then theorises and experiments with the properties of the *"architectural colors"* (Le Corbusier, 2006).
So, many celebrated the purity of the white wall, which emphasises the essence of the structure like Brunelleschi had already done, while others have followed their taste for color, engaging in painting like the masters of the Renaissance: Leonardo, Raphael, Bramante, Michelangelo. Someone, more tied to avant-garde research, also paints architecture, most often without leaving a clear trace in the design work.
Today, almost a century away, rebuilding the role of color in the renewal of architecture requires an archaeological reconstruction based on the comparison between the evidences of the drawings, the findings on the field and the original documents, not just those related to the project. This research can facilitate a better understanding of the relations between the twentieth-century architecture and the other arts, often considered as self-contained.
In Italy, the Milan School underlines the awakening of the attention to the use of color in the interiors and in the details, which is expressed in the works and evidenced in the final drawings of the project, mostly in the prospects.
Piero Bottoni was most sensitive to this topic, and explored it on an urban scale with an astonishing consistency over time, as evidenced by the comparison between his early writings and the masterful mature work of the Town Hall of Sesto San Giovanni at the gates of Milan [1]. Like Luciano Baldessari [2], in his early years he pursues both his education as an architect and the practice of painting [3], which will leave a clear mark with the role attributed to color in his subsequent works. Attention to color emerges from his early study notebooks, which contain numerous chromatic annotations related to both building materials and landscape. Since the beginning, his work claims a strong relationship with color, which enter originally in the contemporary debate (Colonnese, 2016). Later, the theme of color characterises the entire Bottonian work, interweaving with the mosaic technique, which allows a gradual transition between the different shades also in the coverings of buildings (Tonon, 2013).

In April 1928, Bottoni participated in the Italian Exhibition of Rational Architecture in Rome, with the study of the use of color in urban scenery (Meneghetti, 1983), confirming his adherence to rationalist ideas precisely through the proclamation of his chromatic conception with the 6 watercolors already presented the year before at the III Triennial of Monza, described in the notes to the *"Cromatismi Architettonici"*,

Il rapporto degli autori del Movimento Moderno con il colore è contradditorio, condizionato dall'atteggiamento di Le Corbusier, che come molti altri fu anche pittore, che prima proclama la *"legge della biacca"* (Le Corbusier, 1973) e poi teorizza e sperimenta le proprietà dei *"colori architettonici"* (Le Corbusier, 2006).
Così molti hanno celebrato la purezza della parete bianca che sottolinea l'essenzialità della struttura come già aveva fatto Brunelleschi, mentre altri hanno assecondato il loro gusto del colore, cimentandosi nella pittura come i maestri del Rinascimento: Leonardo, Raffaello, Bramante, Michelangelo. Qualcuno, più legato alle ricerche delle avanguardie, dipinge anche l'architettura, il più delle volte senza lasciare una traccia evidente negli elaborati progettuali.
Oggi, a quasi un secolo di distanza, ricostruire il ruolo del colore nel rinnovamento dell'architettura richiede un lavoro di ricostruzione archeologica basato sul confronto tra le evidenze del disegno, del rilievo e i documenti originali, non solo relativi al progetto. Questa indagine può favorire una migliore comprensione dei rapporti della cultura architettonica novecentesca con altre le arti, spesso considerate come a sé stanti.
In Italia, la scuola milanese evidenzia il risveglio di un'attenzione all'uso del colore negli interni e nel dettaglio, che si esprime nelle opere e trova documentazione nei disegni delle viste finali dei progetti, per lo più prospettive.
Piero Bottoni fu uno degli esponenti più sensibili al tema, che declinò soprattutto a scala urbana con una sorprendente coerenza nel tempo, come si evince dal confronto tra gli scritti giovanili e la magistrale opera matura del Municipio di Sesto San Giovanni alle porte di Milano [1]. Anche lui, come già Luciano Baldessari [2], negli anni giovanili affianca la formazione da architetto alla pratica della pittura [3], che poi lascerà un segno evidente proprio nel ruolo assegnato al colore nell'opera successiva. L'attenzione al colore emerge sin dai taccuini di studio giovanili, nei quali si trovano numerose annotazioni cromatiche riferite sia ai materiali della costruzione e sia al paesaggio. La sua opera architettonica denuncia sin dagli esordi un rapporto con il colore che si inserisce in modo originale nel dibattito contemporaneo (Colonnese, 2016). In seguito il tema del colore caratterizza l'intera opera bottoniana, intrecciandosi con la tecnica del mosaico, che permette una transizione graduale tra le diverse tonalità anche nel rivestimento degli edifici (Tonon, 2013).

Nell'aprile del 1928 Bottoni partecipò alla I Esposizione Italiana di Architettura Razionale a Roma con lo studio sull'uso del colore nelle quinte urbane (Meneghetti, 1983), confermando l'adesione alle idee razionaliste proprio

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defined by the author as *"constructive value of color"* [4]. He adopted a theoretical-experimental perspective for his research on the use of color in architecture by referring to Le Corbusier, who in choosing colors in architecture seems to be the main reference of Baldessari as well (Rossi, 2013). The use of color as an element of the urban scale, which was already promoted at the beginning of the century by Bruno Taut, constitutes the original feature and became the pretext of the encounter with Le Corbusier.

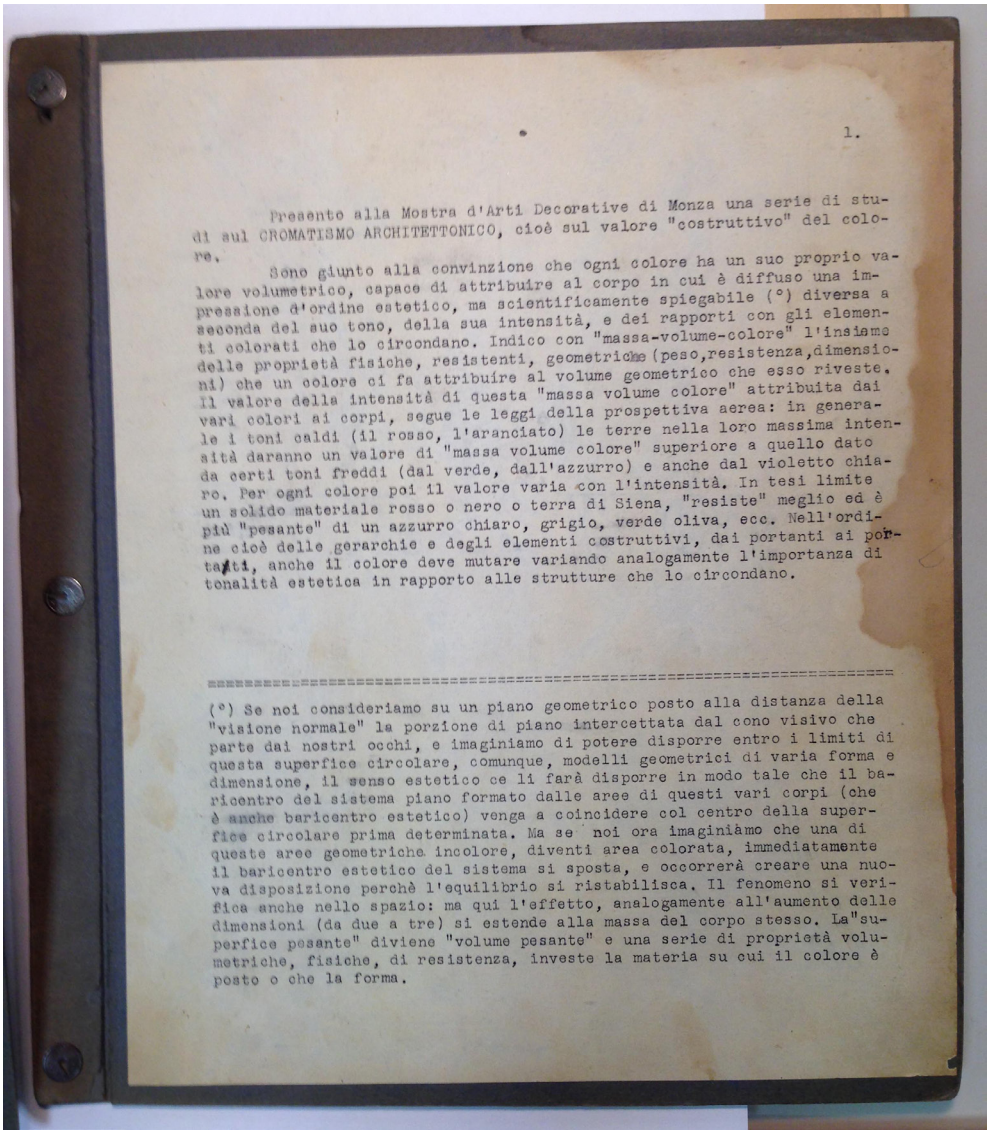
2. FROM THE DRAWING TO THE PROJECT: COLOR IN ARCHIVE DOCUMENTS

The Bottoni archive at the Politecnico di Milano [5] provides a fundamental contribution to the architect's study. It keeps the projects documented by drawings, models and other paper documents, writings, notebooks and even some paintings.

In particular, the relationship of Bottoni with color finds an exemplary expression in the coherence

attraverso la proclamazione della sua concezione cromatica coi 6 acquerelli già presentati l'anno precedente alla III Triennale di Monza, descritti nelle note ai *"Cromatismi architettonici"*, definiti dall'autore come *"valore costruttivo del colore"* [4]. Egli diede un taglio teorico-sperimentale alla sua ricerca sull'uso del colore in architettura rapportandosi a Le Corbusier, che nella scelta delle tinte in architettura sembra essere il principale riferimento anche di Baldessari (Rossi, 2013). L'uso del colore come elemento a scala urbana, già caldeggiato all'inizio del secolo da Bruno Taut, costituisce la caratteristica originale e divenne il pretesto dell'incontro con Le Corbusier.

2. DAL DISEGNO AL PROGETTO: IL COLORE NEI DOCUMENTI DI ARCHIVIO



1.

Presento alla Mostra d'Arti Decorative di Monza una serie di studi sul CROMATISMO ARCHITETTONICO, cioè sul valore "costruttivo" del colore.

Sono giunto alla convinzione che ogni colore ha un suo proprio valore volumetrico, capace di attribuire al corpo in cui è diffuso una impressione d'ordine estetico, ma scientificamente spiegabile (°) diversa a seconda del suo tono, della sua intensità, e dei rapporti con gli elementi colorati che lo circondano. Indico con "massa-volume-colore" l'insieme delle proprietà fisiche, resistenti, geometriche (peso,resistenza,dimensioni) che un colore ci fa attribuire al volume geometrico che esso riveste. Il valore della intensità di questa "massa volume colore" attribuita dai vari colori ai corpi, segue le leggi della prospettiva aerea: in generale i toni caldi (il rosso, l'aranciato) le terre nella loro massima intensità daranno un valore di "massa volume colore" superiore a quello dato da certi toni freddi (dal verde, dall'azzurro) e anche dal violetto chiaro. Per ogni colore poi il valore varia con l'intensità. In tesi limite un solido materiale rosso o nero o terra di Siena, "resiste" meglio ed è più "pesante" di un azzurro chiaro, grigio, verde oliva, ecc. Nell'ordine cioè delle gerarchie e degli elementi costruttivi, dai portanti ai portati, anche il colore deve mutare variando analogamente l'importanza di tonalità estetica in rapporto alle strutture che lo circondano.

(°) Se noi consideriamo su un piano geometrico posto alla distanza della "visione normale" la porzione di piano intercettata dal cono visivo che parte dai nostri occhi, e imaginiamo di potere disporre entro i limiti di questa superfice circolare, comunque, modelli geometrici di varia forma e dimensione, il senso estetico ce li farà disporre in modo tale che il baricentro del sistema piano formato dalle aree di questi vari corpi (che è anche baricentro estetico) venga a coincidere col centro della superfice circolare prima determinata. Ma se noi ora imaginiàmo che una di queste aree geometriche incolore, diventi area colorata, immediatamente il baricentro estetico del sistema si sposta, e occorrerà creare una nuova disposizione perchè l'equilibrio si ristabilisca. Il fenomeno si verifica anche nello spazio: ma qui l'effetto, analogamente all'aumento delle dimensioni (da due a tre) si estende alla massa del corpo stesso. La"superfice pesante" diviene "volume pesante" e una serie di proprietà volumetriche, fisiche, di resistenza, investe la materia su cui il colore è posto o che la forma.

Figure 1 - Piero Bottoni, typed draft for "Cromatismi architettonici". (Archivio Bottoni [Bottoni Archive] - Politecnico di Milano)

Figura 1 - Piero Bottoni, Bozza dattiloscritta per i "Cromatismi architettonici". (Archivio Bottoni – Politecnico di Milano)

L'archivio Bottoni conservato presso il Politecnico di Milano [5] è la tappa fondamentale per lo studio dell'architetto. Esso conserva i progetti documentati da disegni, modelli con

between the beginnings and the conclusion of his architectural work, represented respectively by the watercolors of the *Cromatismi architettonici* and by the monumental project for the City Hall of Sesto San Giovanni, which is evidenced by 556 drawings, a model and 268 written documents (the last of which is his professional bill) [6].
Archive files, published and unpublished, clarify what is summarised in the captions of the original watercolors. The texts are part of the contemporary debate of Rationalist Architecture, and between 1927 and 1928 were published several times in different languages: Italian, French and German. This gives an idea of how much the author was decided in the battle for a constructive use of color in the design of the contemporary city [7].
Bottoni complains about the absence of Italy from the exhibition *"die Farbige Stadt"* organised by the Kunstgewerbe Museum in Zurich, mentioning, for example, the attention to color of German and Swiss associations and the lively debate between critics and the public. The notes are his answer: on the one hand, they explain the watercolors and the experimentation on the constructive value of color, on the other they become his manifesto, which closes with an appeal to chemists, builders, architects and aesthetes. He states that

> *"...each color has its own volumetric value, capable of attributing to the body on which it is diffused a different aesthetic appearance that differs depending on the tone, its intensity, the relationship with the colored elements surrounding it."*

He names *"color volume mass"* the set of physical properties that a color gives to the geometric volume it covers, the constructive value of which then follows the laws of aerial perspective. The highest constructive value is given by warm colors, while cool colors make the architectural volume evanescent. The hot-cold contrast of color becomes a *"resistance"* factor:

> *"A dark red or sienna solid is heavier and resists better than with a light blue, grey, olive-green ...".*

Therefore, his is not about coloring architecture but designing colorful architectures, by controlling the spatial effect that color generates in the urban space. This requires technical and static knowledge, and hence a more architectural rather than pictorial sensitivity.
Bottoni therefore mentions the essential stages of history, recalling the red-white contrast of Lombard architecture [8] and the white-grey one of Brunelleschi's style, in which color matching highlights the constructive elements, pointing

altri documenti cartacei, gli scritti, i taccuini e anche alcuni dipinti.
In particolare, il rapporto di Bottoni con il colore trova una esemplare espressione nella coerenza tra gli esordi e la conclusione della sua opera architettonica, rappresentati rispettivamente dagli acquerelli dei *Cromatismi architettonici* e dal monumentale progetto per il Municipio di Sesto San Giovanni, del quale si conservano 556 disegni, un plastico di studio e 268 documenti scritti (l'ultimo dei quali è la parcella) [6].
I documenti d'archivio, editi e inediti, chiariscono meglio quanto riassunto nelle didascalie originali degli acquerelli. I testi rientrano nel dibattito contemporaneo dell'Architettura Razionalista e tra il 1927 e il 1928 sono stati pubblicati più volte, in diverse lingue, italiano, francese e tedesco. Ciò lascia intuire quanto l'autore fosse deciso nella battaglia per un uso costruttivo del colore nella progettazione della città contemporanea [7].
Bottoni lamenta l'assenza dell'Italia dalla mostra *"die Farbige Stadt"*, organizzata dal Kunstgewerbe Museum di Zurigo, citando ad esempio l'attenzione al colore delle leghe tedesche e svizzere e la vivacità del dibattito tra critica e pubblico. Le note sono la sua risposta: da una parte spiegano gli acquerelli e la sperimentazione sul valore costruttivo del colore, dall'altra diventano il suo manifesto programmatico che si chiude con un appello a chimici, costruttori, architetti, esteti. Egli afferma:

> *"…ogni colore ha il suo proprio valore volumetrico, capace di attribuire al corpo in cui è diffuso un'impressione di ordine estetico diversa a seconda del tono, della sua intensità, del rapporto con gli elementi colorati che lo circondano…".*

Quindi definisce *"massa volume colore"* l'insieme delle proprietà fisiche che un colore conferisce al volume geometrico che riveste, il cui valore costruttivo segue poi le leggi della prospettiva aerea. Il valore costruttivo maggiore lo hanno i colori caldi mentre le tinte fredde rendono evanescente il volume architettonico. La contrapposizione del colore caldo–freddo diventa un fatto di *"resistenza"*:

> *"Un solido rosso scuro o terra di Siena è più pesante e resiste meglio di azzurro chiaro, grigio, verde oliva…".*

Non si tratta quindi di colorare l'architettura, ma di progettare architetture colorate, controllando l'effetto spaziale che il colore genera nello spazio urbano, cosa che richiede conoscenze di tecnica e di statica, e quindi una sensibilità più architettonica che pittorica.
Bottoni cita quindi le tappe essenziali dalla

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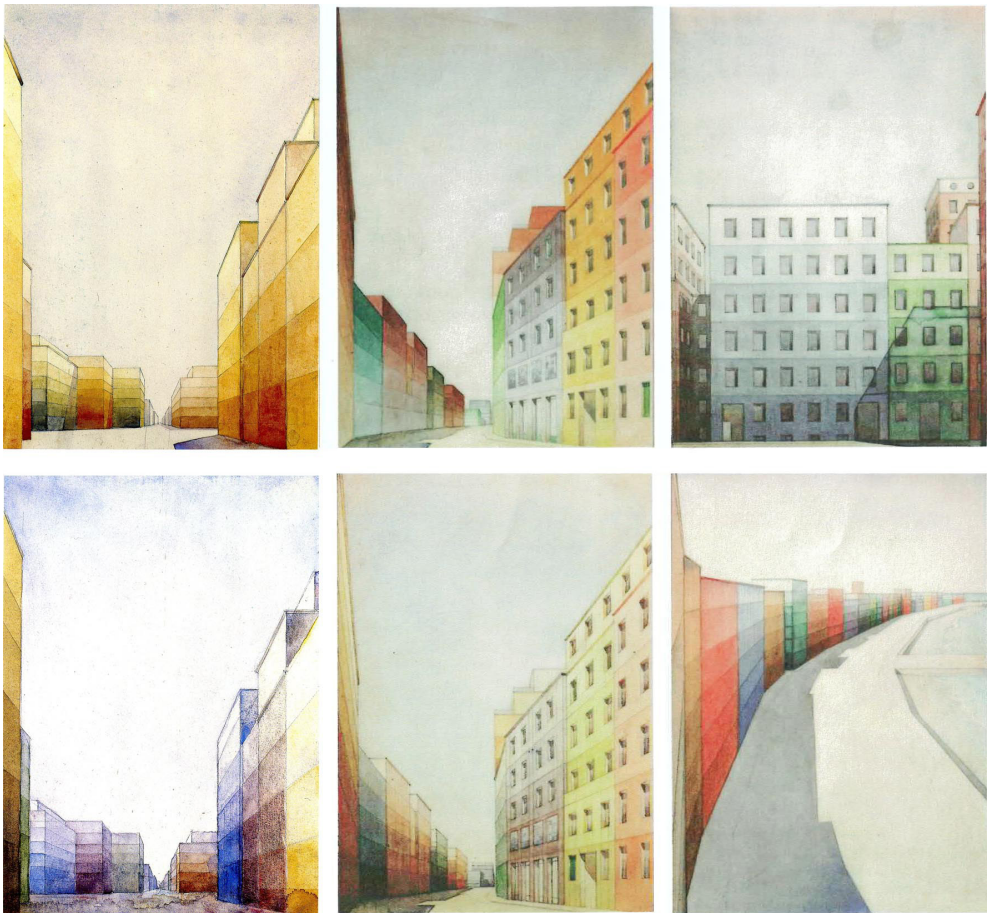

Figure 2 - Piero Bottoni, Watercolor of Cromatismi architettonici (24,8x18,1 cm). (Archivio Bottoni – Politecnico di Milano)

Figura 2 - Piero Bottoni, Acquerelli dei Cromatismi architettonici (cm. 24,8x18,1). (Archivio Bottoni – Politecnico di Milano)

out that the neutral color of grey ages kills the colorful life that is lived in streets and squares.
The use of watercolor anticipates the subsequent research, free from the dominant models of visual culture of the contemporary Italian architecture [9]. He experiments with a new integration between form and color on road fronts, where the tint erases the architectural detail and emphasises the built volumes, interpreting in the tectonic sense the *"constructive value"* of color that Le Corbusier, theorising his *Policromie Architecturale* (Le Corbusier, 2006), attributes to surfaces rather than to volumes. This particular use of color on the fronts of buildings emphasises the relationship between urban space and architecture. Bottoni tests unusual shades and tones in constructions, with a gradual lightening towards the top that exalts the depth of the road in the skyline of contemporary buildings. This solution re-adapts to the urban landscape Leonardo's theory of aerial perspective and adopts a constructive use of color that directly refers to the statements of contemporary avant-gardes (Serra Luch & Garcia Codoñer, 2009).
The watercolors are the tool for verifying the use of color by direct comparison between 4 different situations, two of which are compared in different conditions, changing the sunlight or the direction of color gradation in the same urban context. The other two solutions experiment with a bolder color scheme and a single partition

storia, ricordando il contrasto rosso-bianco dell'architettura lombardesca [8] e bianco-grigio di quella brunelleschiana, nelle quali l'accostamento dei colori evidenzia gli elementi costruttivi, sottolineando come il colore neutro delle epoche grigie uccida la vita coloratissima che si vive nelle strade e nelle piazze.
L'uso dell'acquerello anticipa la ricerca successiva, libera dai modelli dominanti della cultura visiva dell'architettura italiana contemporanea. Egli sperimenta un'inedita integrazione tra la forma e il colore nei fronti stradali, dove la tinta annulla il dettaglio architettonico per sottolineare le masse dei volumi costruiti, interpretando in senso tettonico il *"valore costruttivo"* del colore che Le Corbusier, teorizzando la sua *Policromie Architecturale* (Le Corbusier, 2006), attribuisce alle superfici piuttosto che ai volumi. Questo particolare uso del colore sui fronti degli edifici sottolinea così la relazione tra lo spazio urbano e l'architettura. Bottoni prova tonalità e sfumature inusuali nel costruito, con un graduale schiarimento verso l'alto che esalta la profondità della strada nella corsa verso il cielo degli edifici della città contemporanea. Questa soluzione riadatta alla situazione urbana la teoria leonardesca della prospettiva aerea e adotta un uso costruttivo del colore che rimanda direttamente agli enunciati delle avanguardie contemporanee (Serra Luch & Garcia Codoñer, 2009).
Gli acquerelli sono lo strumento di verifica

facing the waterfront. The chromatic research thus interweaves the use of color with the brightness of the road and the correction of the visual perception of the urban space. The author explains that these are situations imagined to study the relationship between vacuum and color together with the *"position values"*, in relation to the two rhythms that characterise the scanning of the architecture: the vertical one marked by color and the horizontal one marked by the intensity; then he notes that the downward gradation lowers the apparent centre of gravity, giving balance to the masses while the opposite would give light to narrow streets, but would *"remove density from the matter of lower floors"*, contradicting the statics.
The interest for color marks the conception of the building as part of the city, an essential part of the road and the urban landscape, establishing a closer relation between them [10].

3. THE CONFIRMATION OF MATURITY: THE TOWN HALL OF SESTO SAN GIOVANNI

Thirty years later, at the top of his professional activity, Bottoni resumes the same color model in the project for the Town Hall of Sesto San Giovanni (1961-71) (Cerruti,1967; Tonon, 1990; Tonon, 2007; Tonon (ed), 2011). The building is documented in its every stage and aspect by the material kept at the Piero Bottoni Archive [11]. Archive activities testify to the evolution of the color concept and, at the same time, the permanence of the peculiar and original characters of Bottoni's research, through the comparison between documents and works: the written theory, the experimentation on the drawings and the design as a concrete response to defined needs and issues.
Indeed, this assignment represents an extraordinary opportunity for the architect to fully experience the application of his ideas about color in architecture in the definition of the complex destined to become the new *agorà* of the city, already renamed the *"Stalingrad of Italy"*, in which the values of civil participation blend with those of labour and industrial production, where the use of color refers a strong symbolic value as well.
The municipal complex is located on an artificial hill surrounded by a green area and consists of a basement with garages and warehouses, supporting the building hosting the council hall and the main offices, a 12-floor office building and an additional body with an elongated shape on a single floor for the register office.
Within this composition of the architectural complex, the chromatic treatment of each building serves as a language capable of defining and communicating its identity, along

dell'uso del colore attraverso il confronto diretto di 4 situazioni diverse, due delle quali vengono confrontate in differenti condizioni, cambiando il soleggiamento o la direzione di degradazione dei colori allo stesso contesto urbano. Le altre due soluzioni sperimentano un accostamento di colori più audace e una strada con una sola quinta affacciata al lungomare. La ricerca cromatica intreccia quindi l'uso del colore alla luminosità della strada e alla correzione della percezione visiva dello spazio urbano. L'autore spiega che si tratta di situazioni immaginate per studiare il rapporto tra il vuoto e il colore insieme ai *"valori di posizione"*, rispetto ai due ritmi che caratterizzano la scansione dell'architettura: quello verticale marcato dal colore e quello orizzontale dall'intensità; quindi nota che l'intensità degradante verso l'alto abbassa il baricentro apparente, conferendo equilibrio alle masse mentre il contrario darebbe luce alle strade strette, ma *"toglie consistenza alla materia dei piani bassi"*, contraddicendo la statica.
Nell'interesse al colore si delinea la concezione dell'edificio come parte della città, parte essenziale della strada e del paesaggio urbano, che lo accomuna e lo avvicina [10].

3. LA CONFERMA DELLA MATURITÀ: IL MUNICIPIO DI SESTO SAN GIOVANNI

Trent'anni dopo, all'apice sua attività professionale, Bottoni riprende lo stesso modello di colore nel progetto per la sede del Comune di Sesto San Giovanni (1961-71) (Cerruti,1967; Tonon, 1990; Tonon, 2007; Tonon (ed), 2011) documentato in ogni sua fase ed aspetto dal materiale custodito presso l'Archivio Piero Bottoni [11]. Le attività d'archivio testimoniano l'evoluzione del concetto di colore e, insieme, il mantenimento dei caratteri peculiari ed originali della ricerca di Bottoni, attraverso il confronto tra documenti e realizzazioni: la teoria scritta, la sperimentazione nel disegno e la progettazione come risposta concreta a richieste e problemi definiti.
In effetti, questo incarico rappresenta per l'architetto un'occasione straordinaria per sperimentare compiutamente l'applicazione delle riflessioni iniziate nel '27 con i Cromatismi alla definizione del complesso destinato a divenire la nuova *agorà* della città, già ribattezzata la *"Stalingrado d'Italia"*, in cui i valori della partecipazione civile si fondono con quelli del lavoro e della produzione industriale.
Il complesso municipale si colloca su una collina artificiale circondata da un'area a verde ed è articolato in un basamento con le autorimesse ed i magazzini, sul quale poggiano il palazzetto contenente la sala consiliare e gli uffici di

with the specific purpose of each part.
The protagonist role assigned to color immediately appears on the facades of the official building, which, in keeping with the tradition of the Lombard *"Broletto"*, appears as a compact volume, leaning on a low porch. While the first version of this building, dated November '63, showed brick faces, it now appears completely covered by a mosaic of ceramic tiles, with a sequence of saturated tones of pure colors [12].
These, in accordance with Bottoni's rule of giving greater weight to the building through an ascending chromatic gradient, modulate from the black-brown of the lower bands to the upper fire red, orange and yellow hues under the roof, separated by the longitudinal cut of a continuous window. A choice of colors which, as a whole, appears to suggest the image of a steel casting, accentuated by the brightness of the ceramic material, which the use of a glossy enamel also in the construction of the model already shows to be an important requirement pursued by the designer.
The technical documentation in the Archives reveals that this impression of graduation, surprisingly, springs from the use of tiles with only 8 colors. In addition, each tile is not faded, but has a constant tonality over its entire surface [13]. The color modulation is therefore obtained during the laying of the mosaic, alternating, in increasing proportions, tiles of the initial color with those of the next color.
In addition, this color gradation of the cladding is not uniformly applied along all fronts, but changes according to the identity and use of the different parts of the building behind each facade.
In fact, the black-brown bands, which appear almost as the natural upward shade of the deep porch, along the long sides of the building take an upward slope, marking the external profile of the sloped public seating area in the council hall. The volume of the latter, intended

rappresentanza, un edificio per uffici alto 12 piani ed un corpo di fabbrica, di forma allungata ed ad un solo piano, per l'anagrafe.
Entro questa composizione del complesso architettonico, il trattamento cromatico di ogni edificio funge da linguaggio capace di definirne e comunicarne l'identità, con la specifica ragion d'essere di ciascuna delle parti.
Il ruolo di protagonista assegnato al colore appare immediatamente nelle facciate del palazzetto di rappresentanza che, in omaggio alla tradizione dei broletti lombardi, si presenta come un volume compatto, appoggiato su un basso portico. Mentre però la prima versione del novembre '63 di quest'edificio presentava i fronti di laterizio, esso appare ora completamente rivestito da un mosaico di piastrelle ceramiche, con una successione di toni saturi di colori puri [12].
Questi, in conformità con la regola bottoniana di conferire maggior gravità all'edificio attraverso una gradazione cromatica ascendente, modulano dal nero-bruno delle fasce inferiori verso le soprastanti campiture rosso-fuoco, arancio, fino al giallo sottostante la falda del tetto, separato dal taglio longitudinale di una finestratura continua a nastro. Una scelta di colori che, nel suo insieme, appare destinata a richiamare immediatamente l'immagine della colata d'acciaio, accentuata dalla lucentezza del materiale ceramico, che l'utilizzo di uno smalto lucido anche nella realizzazione del plastico di studio già denuncia come requisito importante perseguito dal progettista.
La documentazione tecnica rinvenuta in Archivio rivela che questa impressione di gradualità, sorprendentemente, scaturisce dall'impiego di piastrelle con solamente 8 varietà di colore e ciascuna non sfumata, ma con tonalità costante su tutta la sua superficie [13]. La gradualità della modulazione cromatica è perciò ottenuta durante la posa in opera del mosaico, alternando, in proporzioni crescenti, piastrelle del colore iniziale a quelle del colore successivo.

Figure 3 - Piero Bottoni, City Hall of Sesto San Giovanni (1961-71), study model (Archivio Bottoni - Politecnico di Milano) and photomodeling test for a three-dimensional display

Figura 3 - Piero Bottoni, Municipio di Sesto san Giovanni (1961-71), plastico di studio (Archivio Bottoni – Politecnico di Milano) e prova di fotomodellazione per visualizzazione tridimensionale in rete

to embody the apotheosis of civil participation values, visibly explodes in the pure red of the facade, dominating the convex head of the building, marked only by the two large windows, surrounded by white marble frames, set to illuminate the benches of the city council from the back.
The facades of the opposite head, corresponding to the prospect of the executive offices, have openings with no protrusions and show an ascending gradient characterised by a sharper transition towards the brighter shades of yellow. Also within the building, the color has the task of becoming a messenger of the place's civil

Inoltre, questa gradazione cromatica del rivestimento non è applicata uniformemente lungo tutti i fronti, ma si modifica in relazione all'identità e all'uso delle diverse parti dell'edificio retrostanti ogni facciata.
Infatti, le fasce nero-brune, che appaiono quasi come la naturale continuazione verso l'alto dell'ombra del profondo portico, lungo le fiancate dei lati lunghi dell'edificio assumono un andamento inclinato verso l'alto, denunciando all'esterno il profilo della gradinata per il pubblico della sala consiliare. Il volume di quest'ultima, destinata a incarnare l'apoteosi dei valori di partecipazione civile, esplode visivamente

Figure 3 - Piero Bottoni, City Hall of Sesto San Giovanni (1961-71), study model (Archivio Bottoni - Politecnico di Milano)

Figura 3 - Piero Bottoni, Municipio di Sesto san Giovanni (1961-71), plastico di studio (Archivio Bottoni – Politecnico di Milano)

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value. Indeed, in the hall, a particular emphasis underlines the centrality of the space between the circumference of the council benches and, in front, the concave profile of the public seating area. Bottoni places a circular figure on the mosaic floor, whose margin assumes wooden gradations ranging from black to red and yellow, to symbolically identify the place of participatory democracy, with the image of the mouth of the blast furnaces in the foundries on which Sesto at the time founded its economy.

The circular shape comes back in the shape of the planter seat that protects the aeration chimney for the garages in the basement. In this case, the red ceramic mosaic, joining the black-brown metallic finishes, almost seems to evoke the form of an eruption crater and the underground igneous universe of the Vulcan myth, affirming more explicitly the bond with the metallurgy world.

In contrast to the multifaceted and translucent volume of the executive building and placed parallel to it, stands the tower dedicated to the administrative offices, connected to the executive parts by a low transverse body.

This is a rectangular building, which projects itself outwards with a polygonal head with marked chamfered corners.

The planimetrical conformation offered the designer the opportunity to give the building a considerably different character according to the observation point, by means of a constructive and chromatic treatment of the long facades that is different from that of the head.

In fact, for those who come from Via Cesare da Sesto, the proximity of the multifaceted and translucent volume of the executive building with the high grey shape of the office building recalls the *Broletto* with its civic tower. However, the greater visual dynamic energy given by the chamfering of the head, together with the large wording at the top of the tower, with hues that once again fade from brown to fire red, impose

in facciata nel rosso puro, che domina il rivestimento della testata convessa dell'edificio, marcata solo dalle due grandi vetrate, riquadrate da cornici di marmo bianco, poste ad illuminare da tergo i banchi con gli scranni del consiglio comunale.

Le facciate della testata opposta, corrispondente all'affaccio degli uffici direzionali e di rappresentanza, hanno invece aperture prive di sporti e mostrano una gradazione ascendente caratterizzata da un più rapido trascolorare verso i toni luminosissimi del giallo.

Anche all'interno dell'edificio, al colore viene demandato il compito di farsi messaggero del valore civile del luogo. Infatti, all'interno della sala, una particolare enfasi sottolinea il carattere di centralità dello spazio compreso tra l'arco di circonferenza dei banchi consiliari e, di fronte, l'andamento concavo della tribuna per il pubblico.

Qui, Bottoni colloca sul pavimento a mosaico una figura circolare, il cui margine sfuma nelle gradazioni ignee che vanno dal nero al rosso e al giallo, ad identificare simbolicamente il luogo dell'esercizio della democrazia partecipata, con l'immagine della bocca degli altiforni delle fonderie su cui Sesto all'epoca fondava la propria economia.

La sagoma circolare torna poi nella forma del sedile-fioriera che protegge il camino di aerazione per le autorimesse collocate nel basamento. In questo caso il mosaico ceramico rosso, unendosi al nero-bruno delle finiture metalliche, sembra quasi evocare la forma del cratere eruttivo e l'universo igneo sotterraneo del mito di Vulcano, affermando più esplicitamente il legame con il mondo della metallurgia.

In contrappunto al volume poliedrico e traslucido del palazzetto direzionale e disposta parallelamente ad esso si erge la torre per gli uffici amministrativi, collegato a quelli direzionali da un basso corpo trasversale.

Si tratta di un edificio a sviluppo planimetrico

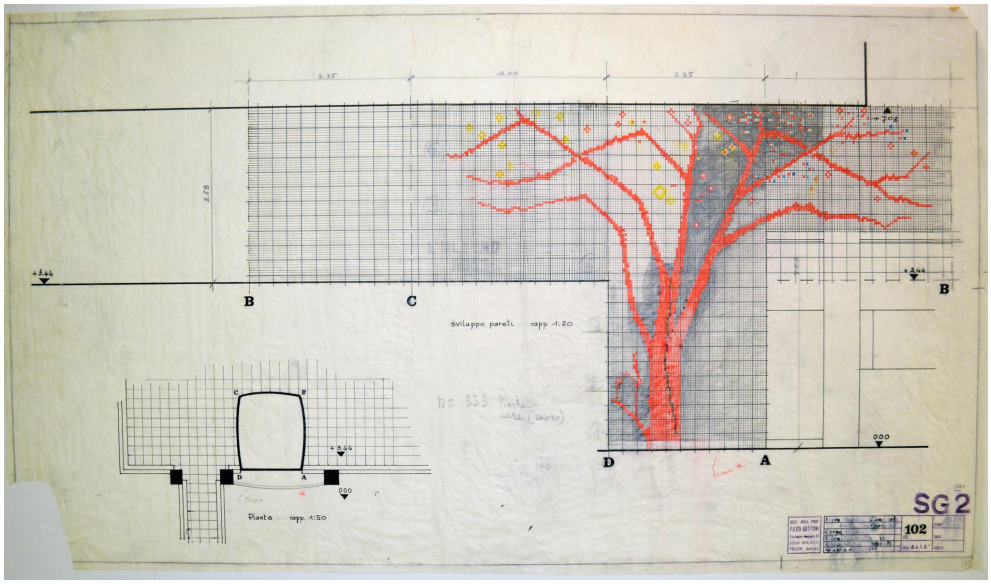

Figure 5 - Piero Bottoni, City Hall of Sesto San Giovanni (1961-71), executive drawing of the mosaic in the porch (Archivio Bottoni - Politecnico di Milano)

Figura 5 - Piero Bottoni, Municipio di Sesto San Giovanni (1961-71), disegno esecutivo del mosaico nel portico (Archivio Bottoni – Politecnico di Milano)

an almost mythical image of the productive world, with the name of the factory at the top of the flaming chimney.
If instead the office tower is seen from the other two roads (via Oriani and via Modena) it appears as one of the urban scenes described by the *Cromatismi*.
The emphasised horizontal partition, obtained by concrete stringcourses, marks the ascending desaturation gradient from the brown color of the lower floors to the pinkish beige nuance of the top.
The materiality effect determined by the adoption of an earthy and warm chromaticity is accentuated by the shape of the walls that, between the stringcourses, show a marked upward flaring and are covered with plates of cement *concretum* texture-finished so grossly that its consistency recalls the iron melting residues. Although the color gradation is similar to the ascending color lightening in the *Cromatismi*, this effect draws a new strength from the play of light and shadow of the facade.
In addition, if we observe the stringcourses closely, we can see that these are not just overly protruding cornices, since within their projection they host, in addition to the copper eaves, also skylights that, thanks to the flaring of the underneath walls, always provide the view of the sky from inside the offices, thus endowed with a source of natural light from above.
Therefore, if the chromatic treatment of the facade confirms the ascendant desaturation studied in the early years, the color modulation - which in the *Cromatismi* was applied to flat and continuous facades - it is rhythmically marked by the deep shadow that the constructive element of the stringcourse-skylight, with the purpose of bringing natural light inside the rooms, projects on the outer front.
In fact, the *"naturalness"* of the workplace seems to be recalled by the large decorative mosaic depicting on a black background a tree that, from the ground level, rises to reappear on the office floor.
Another natural element like the fire seems to come out of the black-red-red decoration of some false ceilings, to recall once again the shapes and colors of the metallurgical world.
The base, faithful to Le Corbusier's definition of *terrain artificiel*, presents the two free fronts lined with embossed concrete slabs, almost to show, with an ostentation of materiality, their own technical role as containment wall of the hill.
Along one of the sides where the base is buried into the green meadow of the artificial hill, the slope of the access ramp is sided by a sequence of slabs of *brut* concrete, which make up the Monument to Resistance, a sort of linear narrative, scratched on the grey and already rough surface, which accompanies the rise of

rettangolare, prospettante all'esterno con una testata resa poligonale dal marcato smusso degli angoli.
Tale conformazione planimetrica ha offerto al progettista la possibilità di conferire all'edificio un carattere notevolmente diverso a secondo del punto di osservazione, mediante un trattamento costruttivo e cromatico delle facciate lunghe differente rispetto a quello della testata.
Infatti, per chi arrivi da via Cesare da Sesto, la prossimità del volume poliedrico e traslucido del palazzetto direzionale con l'alta sagoma grigia dell'edificio per uffici rievoca la memoria del Broletto con la sua torre civica. Tuttavia il maggior slancio visivo provocato dallo smusso della testata, unitamente alla collocazione in sommità della torre della scritta *"Il Comune"*, realizzata a caratteri cubitali e con cromie che ancora una volta trascolorano salendo dal bruno al rosso fuoco, fanno sì che s'imponga l'immagine quasi mitizzata del mondo produttivo, con il nome della fabbrica riportato in cima alla ciminiera fiammeggiante.
Se invece la torre per uffici viene vista dalle altre due strade di arrivo (via Oriani e via Modena) essa si presenta come una delle quinte urbane descritte dai *Cromatismi.*
L'accentuata partizione orizzontale, affidata a marcapiani di cemento, scandisce la gradazione ascendente per de-saturazione del color bruno dei piani più bassi, fino alla *nuance* beige rosato della sommità.
L'effetto di materialità determinato dall'adozione di un cromatismo terroso e caldo è accentuato dalla conformazione dei muri che, tra un marcapiano e l'altro, presentano una marcata svasatura verso l'alto e sono rivestiti da lastre di *concretum* cementizio strollato così grossolanamente che la sua consistenza ricorda i residui di lavorazione per fusione dei materiali ferrosi. Sebbene le fasce di gradazione cromatica riprendano l'alleggerimento ascendente del colore nei *Cromatismi*, tale effetto trae un vigore nuovo dal gioco di luci ed ombre della facciata.
Inoltre, se si osservano da vicino le fasce marcapiano, si può rilevare che non si tratta solo di cornicioni più sporgenti del consueto, poiché nel loro aggetto alloggiano, oltre che i canali di gronda di rame, anche dei lucernari che, grazie alla svasatura dei muri sottostanti, consentono sempre la vista del cielo dall'interno degli uffici, dotati così anche di una fonte di luce naturale zenitale.
Perciò, se il trattamento cromatico delle facciate riconferma la desaturazione ascendente studiata negli anni giovanili, la modulazione del colore – che nei *Cromatismi* era applicata a facciate piane e continue - è scandita ritmicamente dall'ombra profonda che l'elemento costruttivo del cornicione-lucernario, con lo scopo di portare la luce naturale all'interno degli ambienti, proietta

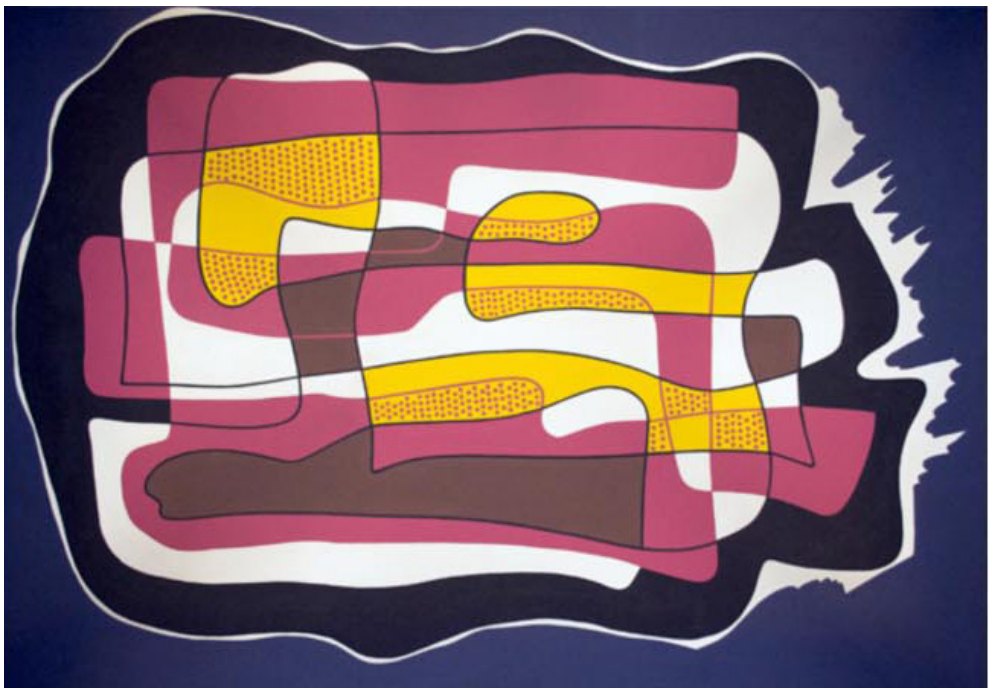

Figure 6 - Piero Bottoni, City Hall of Sesto San Giovanni (1961-71), pictorial decoration

Figura 6 - Piero Bottoni, Municipio di Sesto San Giovanni (1961-71), decorazione pittorica

which we can better understand the system of relationships in which, for Bottoni, color, as an ornamental attribute of buildings, becomes a tool for shaping the urban landscape.
Its constituting elements - the house, the public building, the workplaces and the monument - define their identity by references and allusions that recalling the play of forms and volumes under the sunlight (Le Corbusier, 1973) enunciated by Le Corbusier, who since 1828 had appreciated his research on color [14]. In the response of Bottoni, paraphrasing the work of the Swiss architect, the cathedrals consciously choose not to be white anymore, letting the sunlight reflect on the proud reds of the glossy surfaces or the Lombard mist underline the natural fading of the rising facades (Le Corbusier, 2003).

4. CONCLUSIONS

The two buildings of the town hall of Sesto San Giovanni interpret almost antithetically the tectonics of color enunciated forty years before in the *"Cromatismi architettonici"*: on the one hand, the tonal sobriety of the opaque and rough surfaces of the browns and grey of the office tower, on the other the shine and the saturated colors of the ceramic cladding that envelops the lower body housing the executive spaces. The palace, with its glittering colors, expresses the institution and represents the values in which the community recognised its identity.
The chromatic hues of the ceramic cladding remained unchanged due to the characteristics of the material that guarantee color stability over time.
Today, the decline of the steel industry has crumbled the myth of the Stalingrad of Italy,

un albero che, dalla quota del terreno, ascende poi per ricomparire fino al piano degli uffici.
Ed è ancora un elemento naturale come il fuoco che sembra affacciarsi dalla decorazione in nero-bruno-rosso di alcuni controsoffitti, a ricordare ancora una volta le forme e i colori ignei del mondo metallurgico. Così il basamento, fedele alla definizione lecorbusieriana di *terrain artificiel*, presenta i due fronti liberi rivestiti di lastre di cemento goffrato, quasi mostrare con l'ostentazione della materialità il proprio ruolo tecnico di muro di contenimento del terreno della collina.
Lungo uno dei lati in cui il basamento s'interra nel prato verde della collina artificiale, la pendenza della rampa d'accesso è affiancata da una sequenza di lastre di cemento *brut*, che compongono il Monumento alla Resistenza, una sorta di racconto lineare, impresso a graffi sulla superficie grigia e già scabra, che accompagna la salita dalla strada alla quota della piazza comunale, sagrato laico per la lucentezza focosa del palazzetto con il sedile-fioriera.
E' proprio questo spazio pubblico aperto il luogo da cui si può meglio cogliere il sistema di relazioni in cui per Bottoni il colore, da attributo ornamentale degli edifici, si trasforma in strumento di costruzione del paesaggio urbano. In esso, gli elementi costitutivi – la casa, l'edificio

the chromatic language expresses a system of values that testifies to the history of the city.

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CONFLICT OF INTEREST

The author declares that nothing has affected his objectivity or indipendence in the production of this work. Neither the author nor his immediate

pubblico, i luoghi di lavoro e il monumento – definiscono la loro identità per rimandi ed allusioni che richiamando il gioco di forme e volumi sotto la luce del sole (Le Corbusier, 1973) enunciato da Le Corbusier, che fin dal '28 aveva apprezzato la sua ricerca sul colore [14]. Nella risposta di Bottoni, parafrasando l'opera dell'architetto svizzero, le cattedrali scelgono consapevolmente di non essere più bianche, lasciando che la luce del sole si rifletta sui rossi orgogliosi delle superfici lucide o che la foschia lombarda assecondi il naturale trascolorare delle facciate che salgono (Le Corbusier, 2003).

4. CONCLUSIONI

I due edifici del municipio di Sesto San Giovanni interpretano in modo quasi antitetico la tettonica del colore enunciata quarant'anni

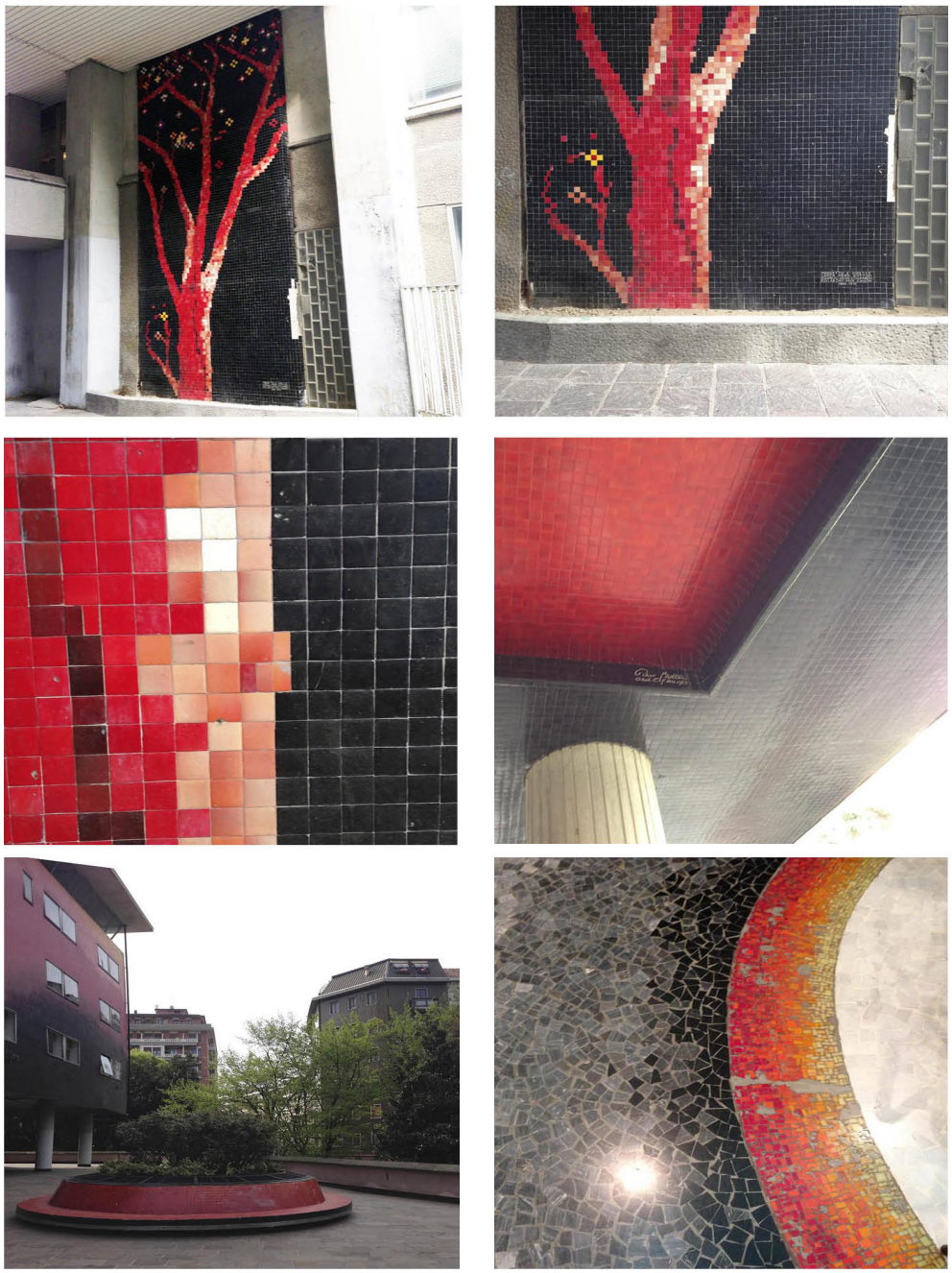

Figure 7 - Piero Bottoni, City Hall of Sesto San Giovanni (1961-71), decorative details

Figura 7 - Piero Bottoni, Municipio di Sesto San Giovanni (1961-71), particolari decorativi

family member have any financial interest in the people, topics or companies involved by this article. Neither the author nor his immediate family member had a professional relationship with the people and companies cited in this article. Neither the author nor his immediate family member are involved in a legal dispute with the people and the companies cited in this article.
No conflict of interest including financial, personal or other relatiohsjip with other people and organization within three years of beginning the submitted work that could inappropriately influence, or be perceived to influence, this work.

NOTES

[1] Piero Bottoni (1903-1973) was one of the founders of the Italian Movement for Rational Architecture (MIAR) before joining the Congrès International of Modern Architecture (CIAM), of which he was the Italian delegate until 1951, participating in the III edition in Brussels (1928) and the IV in Athens (1933).

[2] Luciano Baldessari (1896-1982), originally from Rovereto, was introduced to formal arts by Depero, who was his first master of design.

[3] Prior to his graduating at the Polytechnic School of Architecture in Milan (1926), Bottoni was professor of architectural design at the Academy of Fine Arts in Milan.

[4] Architettura e arti decorative, VII [1927-1928].

[5] Directed by G. Consonni and G. Tonon.

[6] Archivio Bottoni, Politecnico di Milano, Work 428 - City Hall of Sesto San Giovanni (Mi), 1961-71, collaborator Antonio Didoni.

[7] Archivio Bottoni: text drafted by Bottoni on the occasion of the Die Farbige Stadt exhibition in Zurich in August-September 1927, published as s substantially identical work with the title Cromatisme Architectural, in "Das Werk", year XV, n. 7, July 1928, pages 219-221; Farbengebung in der Architektur, in Die Farbige Stadt, no. 3, March 3, 1928, pages 65-70; cyclostyled in Italian and presented as an annex to the watercolors on color at the 3rd International Exhibition of Decorative Arts in Monza, May-October 1927, published under the title Die Farbenwirkung in der Architektur, in the «Süddeutsche Maler-Zeitung», year XXVII, n. 12, June 1928, pp. 191-192; unpublished illustrative notes to Cromatismi architettonici, 1927.

[8] = "of Lombard tradition", an adjective used in the historical-artistic context with reference to the thirteenth century. cf. De Mauro Dictionary.

[9] "With "color-mass-volume" I identify the set of physical, resistant, geometric (weight, strength, size) properties that color makes us attribute to the geometric volume it covers. The intensity value of this "color mass volume" attributed by the various colors to the bodies follows the laws of aerial perspective: ..., (Bottoni in the typed text).

[10] Without knowing him, Bottoni writes to Le Corbusier to present his research and the master replies with a letter (January 15, 1928) in which he appreciates the work by reiterating the role of color in the definition of urban space conceived as "an open room" with the description of his

prima nei "Cromatismi architettonici": da una parte la sobrietà tonale delle superfici opache e scabre dei bruni e dei grigi della torre degli uffici operativi, dall'altra la lucentezza e i colori saturi e puri del rivestimento ceramico che avvolge il corpo basso che ospita gli spazi di rappresentanza. Il palazzetto, con i suoi colori sgargianti esprime l'istituzione e rappresenta i valori in cui si riconosceva la collettività.
Il cromatismo del rivestimento ceramico si è mantenuto inalterato grazie alle caratteristiche del materiale che garantiscono la stabilità del colore nel tempo.
sulla facciata esterna.
A condizioni di *"naturalità"* del luogo di lavoro sembra, in effetti, alludere anche il grande mosaico decorativo raffigurante su fondo nero
Oggi che il declino della siderurgia ha sgretolato il mito della Stalingrado d'Italia, il linguaggio cromatico esprime un sistema di valori che testimonia la storia della città.

NOTE

[1] Piero Bottoni (1903-1973), fu uno dei fondatori del Movimento italiano per l'architettura razionale (MIAR) prima di aderire al Congrès internationaux d'architecture moderne (CIAM), di cui fu il delegato italiano sino al 1951, partecipando alla III edizione a Bruxelles (1928) e alla IV ad Atene (1933).

[2] Luciano Baldessari (1896-1982), originario di Rovereto fu introdotto alle arti formali da Depero, che fu il suo primo maestro di disegno.

[3] Prima di laurearsi alla Scuola superiore di architettura del Politecnico di Milano (1926), Bottoni divenne professore di disegno architettonico presso l'Accademia di Belle Arti di Milano.
[4] In Architettura e arti decorative, VII [1927-1928], pp. 80-85.

[5] Diretto da G. Consonni e G. Tonon.

[6] Archivio Bottoni, Politecnico di Milano, Op. 428 - Palazzo comunale di Sesto San Giovanni (Mi), 1961-71, collaboratore Antonio Didoni.

[7] Archivio Bottoni: testo ciclostilato steso da Bottoni in occasione della rassegna Die Farbige Stadt di Zurigo nell'agosto-settembre 1927, pubblicato sostanzialmente identico col titolo Cromatisme Architectural, in «Das Werk», a. XV, n. 7, luglio 1928, pp. 219-221; Farbengebung in der Architektur, in «Die Farbige Stadt», n. 3, marzo 1928, pp. 65-70; ciclostilato in italiano presentato come allegato degli acquarelli sul colore alla III Mostra internazionale delle arti decorative di Monza, maggio-ottobre 1927, pubblicato col titolo Die Farbenwirkung in der Architektur, in «Süddeutsche Maler-Zeitung», a. XXVII, n. 12, giugno 1928, pp. 191-192; note illustrative inedite ai Cromatismi architettonici, 1927.

[8] = "di uso lombardo", aggettivo usato in ambito storico-artistico in riferimento al XIII secolo. Cfr. Dizionario De Mauro.

[9] "indico con "massa-volume-colore" l'insieme delle proprietà fisiche, resistenti, geometriche (peso, resistenza, dimensioni) che il colore ci fa attribuire al volume geometrico che esso riveste. Il valore dell'intensità di

intervention in Pessac, where the sienna facades of fix the space as firm points while the pale green ones mingle with the landscape.

[11] The archive of the project for the Sesto San Giovanni Municipal Building is composed of: 556 drawings, 527 photographic documents (consisting of prints and negatives) and 268 written documents. Of these, the first is the letter by which on July 4, 1960 the head of the Demographic Office transmits "...the list of offices considered necessary for a decent accommodation of our services [...], July 4, 1960; the last is the professional bill issued by Bottoni on December 17, 1971 for the supervision of the installation of mobile walls and office cabinets.

[12] first draft of the project, corresponding to drawings no. 1-60, Fondo Piero Bottoni work 428, City Hall of Sesto San Giovanni (MI), 1961-71. For the description and dates of the different drafti stages of the project, see Tonon G. (1990) e Tonon G. (2007).

[13] correspondence between April 22 and June 30, 1965 between the designer, the municipal administration and the company Italmosaic of Milan, for the supply and laying of a facade cladding made of 1000 square meters of 5 x 5 cm tiles, enameled with selenium and assorted in 8 color shades as per the sample. The tiles would be provided by the company already assembled in approximately 10,000 numbered sheets (Bottoni Archive, work 428, folders X-XV).

[14] correspondence documented at the Archivio Bottoni, Politecnico di Milano

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questa "massa volume colore"attibuito dai vari colori ai corpi segue le leggi della prospettiva aerea:…, (Bottoni nel testo dattiloscritto dei Cromatismi architettonici).

[10] Senza conoscerlo, Bottoni scrive a Le Corbusier per presentargli la sua ricerca e il maestro gli risponde con una lettera (15 gennaio 1928) nella quale apprezza il lavoro ribadendo il ruolo del colore nella definizione dello spazio urbano concepito come "camera aperta" con la descrizione del suo intervento a Pessac, dove le facciate terra di Siena fissano lo spazio come punti fermi mentre quelle verde pallido si perdono nel paesaggio.

[11] Il fondo relativo al progetto del Palazzo comunale di Sesto San Giovanni si compone di: n. 556 disegni, n. 527 documenti fotografici (costituiti da positivi e negativi) e n. 268 documenti scritti. Di essi, il primo è costituito dalla lettera con cui in data 4 luglio 1960 il capo dell'Ufficio Ripartizione Uffici demografici trasmette "… la distinta degli uffici ritenuti necessari per una decorosa sistemazione dei servizi [...], 4 luglio 1960; l'ultimo è invece la parcella emessa da Bottoni il 17 dicembre 1971 per la direzione lavori delle pareti mobili e degli armadi per uffici.

[12] Si tratta delle prime redazioni del progetto, corrispondenti ai disegni nn. 1-60, Fondo Piero Bottoni op. 428, Palazzo comunale di Sesto San Giovanni (Mi), 1961-71. Per la descrizione e datazione delle diverse fasi di redazione del progetto, cfr Tonon G. (1990) e Tonon G. (2007).

[13] Si tratta della corrispondenza intercorsa tra il 22 aprile e il 30 giugno del 1965 fra il progettista, l'amministrazione comunale e la ditta Italmosaic di Milano, per la fornitura e la posa come rivestimento delle facciate di 1000 mq di piastrelle da cm 5 x 5, smaltate al selenio ed assortite fra 8 tonalità di colore come da campione, fornite dalla ditta già assemblate in circa 10.000 fogli numerati (Archivio Bottoni, Fondo Bottoni, op. 428, cartelle X-XV).

[14] corrispondenza documentata all'Archivio Bottoni conservato presso il Politecnico di Milano

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Colour quantity contrast in Itten's Theory: Spectrophotometry for verifying statements

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ABSTRACT

Colour quantity contrast originates from the quantitative ratio of two or more colours and no color stands out more than another if such report is balanced. Considering how the intensity parameter, defined as the brightness refers to a gray background of medium brightness, the values of the mutual relations between primary and secondary colours of subtractive synthesis: yellow: purple: blue: orange: red: green, reported by Itten that are attributed to Goethe are in order: 9:8:6:3:4:6. It is worth mentioning in this context that a detailed research on this matter leaves rather suppose that the authorship of these values is attributed to Schopenhauer. He however did not base its considerations on the intensity but the amount of energy that reaches the retina of the viewer. The study had as main objective the verification of this statement concerning the relationship between the three primary and three secondary subtractive synthesis colours through the specification of the colour using the spectrophotometric method. The results have confirmed what was expected in terms of quality of performance values of mutual relations of the six colours but showed a quantitative difference than the sestina, 9:8:6:3:4:6, reported by Itten.

KEYWORDS

Colour, Colour quantity contrast, Colour contrast, Itten, Schopenhauer, Complementary colours

Italian translation provided:
Il contrasto di quantità nella Teoria di Itten: la spettrofotometria per la verifica degli enunciati

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1. INTRODUCTION

The colour quantity contrast theory is born from the reciprocal quantitative relationship among two or more colours and it is generally attributed to Goethe. Itten himself fostered this idea attributing him the authorship.
Johannes Itten, in his book *"The Art of Color"* (Itten, 1997), described in detail the seven contrasts existing between colours. The last one was the quantity contrast that arose from the reciprocal quantitative relationship between two or more colours. According to Itten, two factors determined the effect of a colour: its luminous intensity and the size of the colour field. Because Itten was not able to measure these two parameters, especially the first one, in the absence of appropriate instruments, the only way to evaluate them was to compare them to a neutral background of medium luminosity. Referring to the studies carried out by Goethe, Itten reported a numerical scale of easy-to-use light values. However, he admitted that the hypothesized values were only approximate, relying only on the observing eye, even if adequately trained.
The values of the reciprocal relationships of colour brightness, according to Itten, would have been the following:

yellow	:	orange	:	red	:	violet	:	blue	:	green
9	:	8	:	6	:	3	:	4	:	6

According to Itten,

> *"to translate the brightness values in harmonious values of quantity, the numeric ratio has to be inverted: so, yellow, for example, being three times brighter, should have a surface three times smaller than his complementary violet colour"* (Itten, 1997).

From this perspective, the quantity relationships available for complementary colours are the following:

yellow : violet	=	1/4 : 3/4
orange : blue	=	1/3 : 2/3
red : green	=	1/2 :1/2

and so the harmonious proportion of the primary and secondary colours are:

yellow	:	orange	:	red	:	violet	:	blue	:	green
3	:	4	:	6	:	9	:	8	:	6

The Figure 1(a) shows Itten's chromatic reel with twelve colours, the Figure 1(b) the same reel in which the surfaces of primary and secondary colours are illustrated with the respective harmonious quantity values; in Figure 1(c) the

1. INTRODUZIONE

La teoria del contrasto di quantità nasce dal reciproco rapporto quantitativo tra due o più colori ed è generalmente attribuita a Goethe. Lo stesso Itten ha alimentato questa idea, attribuendogliene la paternità. Nel suo libro Arte del colore Johannes Itten (Itten, 1997) descriveva dettagliatamente i sette contrasti esistenti tra i colori. L'ultimo era, appunto, il contrasto di quantità che nasceva dal reciproco rapporto quantitativo tra due o più colori. Secondo Itten due fattori determinavano l'effetto di un colore: la sua intensità luminosa e le dimensioni del campo colorato. Non potendo misurare i due parametri indicati, specialmente il primo, in assenza di strumentazioni idonee, l'unico modo per poterli valutare era quello di confrontarli tra loro su di uno sfondo neutro di media luminosità. Riferendosi agli studi effettuati da Goethe, Itten riportava una scala numerica dei valori di luminosità di uso molto semplice, pur ammettendo che i valori ipotizzati erano solo approssimativi dovendo sempre affidarsi solo all'occhio dell'osservatore, quantunque adeguatamente educato.
I valori dei rapporti reciproci della luminosità dei colori, secondo Itten, sarebbero stati dunque, nell'ordine, i seguenti:

giallo	:	arancio	:	rosso	:	viola	:	blu	:	verde
9	:	8	:	6	:	3	:	4	:	6

Secondo quanto sosteneva Itten,

> *"per tradurre i valori di luminosità in valori armonici di quantità, i rapporti numerici vanno invertiti: cioè, il giallo ad esempio essendo tre volte più luminoso dovrebbe occupare una superficie tre volte più piccola del suo complementare viola"* (Itten, 1997).

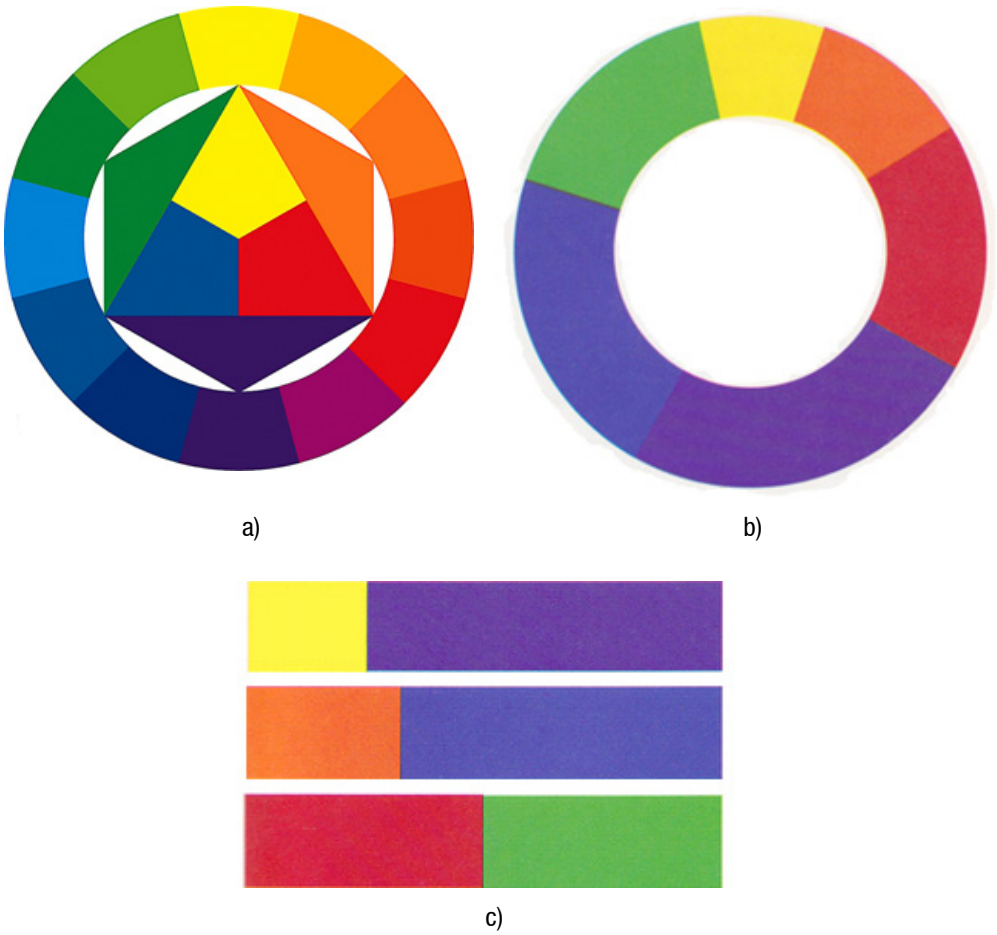
In tale ottica, i rapporti di quantità validi per i complementari sono i seguenti:

giallo : viola	=	1/4 : 3/4
arancio : blu	=	1/3 : 2/3
rosso : verde	=	1/2 :1/2

e pertanto le proporzioni armoniche dei colori primari e secondari sono:

giallo	:	arancio	:	rosso	:	viola	:	blu	:	verde
3	:	4	:	6	:	9	:	8	:	6

Nella Figura 1(a) è riportato la prima ruota cromatica di Itten a dodici colori; nella Figura 1(b) si osserva la stessa ruota in cui le superfici dei soli sei colori primari e secondari sono illustrati con i rispettivi valori armonici di quantità; in



a) b)

c)

Figure 1 - (a) Itten's chromatic disc; (b) Itten's disc with the harmonious quantity values; (c) relationships between the harmonious values and the related complementary ones.

Figura 1 - (a) disco cromatico di Itten; (b) disco di Itten con i valori armonici di quantità; (c) rapporti tra i valori armonici dei complementari abbinati

relationships between the harmonious values and the related complementary ones are presented.

According to Itten, once established the proportions illustrated in Figure 1c, the harmonious quantity created an effect of stasis and quiet.

This research starts from some studies conducted by Schopenhauer in which he presented his theory concerning the relative relationships between colours. After a critical review of the Itten hypothesis, the goal of this work is the experimental checking of the colour quantity contrast according to Schopenhauer's theory.

The colour specification through spectrophotometric analysis simulates the visual perception of the human eye *(actio retinae).* For this reason, the measurements were carried out with this methodology on the samples prepared *ad hoc*.

The samples were designed to calculate the harmonious quantity values of the six primary and secondary colours of the subtractive synthesis for performing the comparison with the values attributing to them both by Itten and Schopenhauer.

In the following paragraphs, the research's successive steps will be described. First, in paragraph 2, the statements representing

Figura 1(c) sono indicati i rapporti tra i valori armonici esistenti dei complementari abbinati.

Itten affermava che i rapporti armonici, una volta stabilite le proporzioni illustrate in Figura 1c , creavano un effetto di stasi e di quiete.

Il presente lavoro prende spunto da alcuni studi di Schopenhauer dedicati al colore in cui è presente la teoria da questi formulata, in epoca precedente ad Itten, sui rapporti relativi tra i colori. Dopo aver valutato criticamente l'ipotesi di Itten, obiettivo della ricerca è stato la verifica sperimentale del contrasto di quantità secondo la formulazione di Schopenhauer.

Considerato che la specificazione del colore tramite il metodo spettrofotometrico a contatto simula il processo di percezione visiva dell'occhio *(actio retinae)*, le misure sono state realizzate con questa metodologia su campioni appositamente preparati. Tali campioni sono stati realizzati al fine di calcolare i valori armonici di quantità di sei colori primari e secondari della sintesi sottrattiva per poi eseguire il confronto con i valori loro attribuiti tanto da Itten quanto da Schopenhauer.

I paragrafi che seguono descriveranno tutte le fasi del lavoro di ricerca. Dapprima, nel paragrafo 2, verrà analizzato l'enunciato che rappresenta la base teorica del presente lavoro. Successivamente, verrà presentato il modus operandi nella preparazione dei campioni

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the theoretical basis of the work will be analysed. Then, the sample preparation and the spectrophotometric method respectively will be presented in paragraphs 3.1 and 3.2. The results will be discussed in paragraph 4 while the conclusions and perspectives of the work will be summarized in paragraph 5.

2. THE ANALYSIS OF THE STATEMENTS

Without prejudice regarding the importance of Itten's theory on the seven colour contrasts, this study is focused on a hypothesis of authorship of the statement on the contrast of a quantity different to Itten's one. There is no evidence in Goethe's works about colour of the reciprocal relationships and the series attributed to him by Itten. Also Goethe's table, representing the colour reel with surfaces and parity ratios between them, confirms what has been highlighted so far (Goethe, 1997).
Starting from the hypothesis that Itten's theory of quantity contrast could not be attributable to Goethe, it is permissible to inquire into the authorship of the statement. The answer is, in our opinion, in the Schopenhauer work. In fact, in the first edition, in Latin, of his writings (Schopenhauer, 1830), the young German philosopher, probably taking a cue from Aristotle (Giannantoni, 1973), describes in detail the relationships between the primary and the secondary colours as following:

> *"…Ruber igitur cum viridi colore illius actionis sunt exacte dimidiatae: ejiusdem vero duas tertias exhibit aurantiacus; coeruleus autem, utpote hujus complementum, tertiam duntaxat: flavus denique tres quartas, et proinde complementus ejus, violaceus color, quartam modo partem…".*

In the edition of 1859 (Schopenhauer, 2002) Schopenhauer, sustaining his thesis, inserted a schema in which, in addition to black and white, corresponding respectively to the 0 and 1 values, the relationships among the hues were:

black		0
violet : yellow	=	1/4 : 3/4
cyan : orange	=	1/3 : 2/3
green : red	=	1/2 :1/2
white		1

An eminent confirmation of what has been observed can be found in Rudolph Arnheim (Arnheim, 2005), who faithfully reports the schema, clearly attributing to Schopenhauer the authorship of statement.
Also Renato Troncon, curator of the Italian edition of the *"Theory of colours"* of Goethe (Goethe, 1987)

2. ANALISI DEGLI ENUNCIATI

Fermo restando l'importanza della teoria di Itten sui sette contrasti dei colori, questo studio riporta l'attenzione su un'ipotesi di paternità dell'enunciato sul contrasto di quantità diversa da quella formulata da Itten. In nessuno degli scritti di Goethe dedicati al colore si trova evidenza dei rapporti reciproci e della serie attribuitagli da Itten. Anche la tavola di Goethe, rappresentativa della ruota dei colori a noi pervenuta con superfici e rapporti paritetici tra loro, conferma quanto fin qui evidenziato (Goethe, 1997).
Partendo dall'ipotesi che la teoria di Itten del contrasto di quantità possa non essere attribuibile a Goethe, è lecito interrogarsi sulla paternità dell'enunciato. La risposta si trova, a nostro avviso, nell'opera di Schopenhauer. Infatti nella prima edizione in latino di alcuni suoi scritti (Schopenhauer, 1830), il giovane filosofo tedesco prendendo probabilmente spunto da Aristotele (Giannantoni, 1973), descriveva dettagliatamente il rapporto esistente tra colori primari e secondari come segue:

> *"…Ruber igitur cum viridi colore illius actionis sunt exacte dimidiatae: ejiusdem vero duas tertias exhibit aurantiacus;coeruleus autem, utpote hujus complementum, tertiam duntaxat: flavus denique tres quartas, et proinde complementus ejus, violaceus color, quartam modo partem…".*

Nella seguente edizione del 1859 (Schopenhauer, 2002), Schopenhauer, a supporto della sua ipotesi, inseriva uno schema in cui, con l'aggiunta degli estremi del nero e del bianco, a cui faceva corrispondere rispettivamente i valori 0 ed 1, i rapporti tra le tinte erano:

nero		0
violetto : giallo	=	1/4 : 3/4
azzurro : arancione	=	1/3 : 2/3
verde : rosso	=	1/2 :1/2
bianco		1

Un'autorevole conferma di quanto fin qui osservato, la ritroviamo in Rudolph Arnheim (Arnheim, 2005) che riporta fedelmente questo schema, attribuendo esplicitamente a Schopenhauer la paternità dell'enunciato.
D'altra parte, anche Renato Troncon, curatore dell'edizione italiana della *"Teoria dei colori"* di

said:

> *"La concezione di Itten presenta tuttavia un motivo che non è di origine Goethiana ma va fatto risalire a Schopenhauer".*

After an accurate analysis of the schema previously exposed, a detail, not reported by Itten, important for the experimental check of the colour quantity contrast, was found. In the schema, in fact, not only the six primary and secondary colours of subtractive synthesis are described but also the black and white not as colours but as *"limits"* (Schopenhauer, 2002).
Furthermore, this schema compares the retinal action of each colour respect to its complementary one and with respect to black, supposing its zero value.
Schopenhauer (Schopenhauer, 2002) himself stated that

> *"The precision of the fractions discovered by me..is..intuitive; remains subject of immediate judgment, and it has to be assumed as evident in itself; it is in fact difficult and perhaps impossible, to demonstrate it".*

Schopenhauer, in fact, did not have the technical instrument suitable to make the measurements and he formulated his statement on visual observation of each colour.
Instead, today, we have the skills and the instruments allowing us to accurately study this field.
Therefore, in this research work, the goal is to experimentally verify the schema suggested by Schopenhauer.

3. MATERIALS AND METHODS

3.1 THE ANALYSED SAMPLES

In order to check on a wide set of materials the effectiveness of our thesis, two different categories of samples of six primary (yellow, magenta, cyan) and secondary (orange, violet and green) hues of subtractive synthesis have been prepared.
Liquitex Ink, LeFranc&Burgeois Flasche and Maimeri acrylic and Van Dyck Ferrario and Maimeri oil industrial products belong to the first category. They were painted on a hardbound support Acrylic Pad Galeria of Winsor &Newton 300 g/m^2.
The only acrylic Maimeri was diluted with 20% in weight of water, while both two oils (Van Dyck Ferrario and Maimeri) were diluted with 20% in weight of oil.
Each colour was painted with three coats with a brush of natural bristle directly on hardbound support without any preparation.
With the same aim, the second category of

Goethe (Goethe, 1987), afferma:

> *"La concezione di Itten presenta tuttavia un motivo che non è di origine Goethiana ma va fatto risalire a Schopenhauer".*

In seguito ad un'accurata analisi dello schema precedente riportato, si è notato un particolare, non riferito da Itten, di fondamentale importanza ai fini della verifica sperimentale del contrasto di quantità. Nello schema, infatti, sono riportati non solo i sei colori primari e secondari della sintesi sottrattiva, ma anche il nero ed il bianco, non in quanto colori ma come paletti di confine (Schopenhauer, 2002).
Tale schema, inoltre, mette a confronto l'azione sulla retina di ogni colore rispetto a al suo complementare e rispetto a quella del nero, ipotizzata di valore zero.
Lo stesso Schopenhauer (Schopenhauer, 2002) affermava che

> *"L'esattezza delle frazioni da me scoperte...è...intuitiva; rimane oggetto del giudizio immediato e deve essere assunta come evidente di per sé; è infatti difficile, e forse impossibile, dimostrarla".*

A quei tempi, infatti, non si disponeva degli strumenti tecnici idonei alla misurazione ed egli formulò il suo enunciato sulla base della sola osservazione visiva di ogni colore. Oggi, invece, disponiamo di competenze e strumentazione che consentono di effettuare con precisione questa indagine.
In questo studio proponiamo, pertanto, una procedura applicativa per verificare lo schema suggerito da Schopenhauer.

3. MATERIALI E METODI

3.1 I CAMPIONI ANALIZZATI

Ai fini di valutare su un ampio spettro di materiali la validità della tesi sostenuta, sono stati realizzati due differenti macrocategorie di campioni delle sei tinte primarie (giallo, magenta e ciano) e secondarie (arancio, viola e verde) della sintesi sottrattiva. Tutti i secondari sono stati ottenuti dalla miscela in rapporto 50:50 in peso dei relativi primari.
Alla prima categoria appartengono i prodotti industriali acrilici, nello specifico, Liquitex Ink, LeFranc&Burgeois Flasche e Maimeri e i prodotti ad olio, in particolare, Van Dyck Ferrario e Maimeri. Essi sono stati stesi su un supporto cartonato Acrylic Pad Galeria della Windsor &Newton da 300 g/m^2.
L'acrilico Maimeri è stato diluito con 20% in peso di acqua, mentre i due oli (Van Dyck Ferrario e Maimeri) con 20% in peso di olio.
La stesura del colore è avvenuta mediante

samples was realized through powdered pigments. The primary pigments used by Itten were: ultramarine blue (codex CTS 0561), cinnabar (codex CTS 0607) and zinc yellow (codex CTS 0557) (CTS site, 2017). In this type of samples, for blue ones, specific quantity of green pigment (emerald green), for yellow ones, of red pigment (cinnabar), was added.
The pigments, after mixing with vehicle, in ratio 1:3 (pigment:vehicle) were painted on support prepared by Zecchi (codex Zecchi 4700) (Zecchi site, 2017). The employed vehicle was the casein (Matteini, 2004), a phosphoprotein obtained from milk in the form of colloidal dispersion, (codex Zecchi 2050) (Zecchi site, 2017).
The goal was to obtain samples having, in terms of colour coordinates, the theoretical values of CIELAB hues (Oleari, 2008). For example, the blue was obtained such as to have a* coordinate equal to zero and the value of b* negative as high as possible.
In total, thirty-six samples were obtained: six yellow paintings, six orange, six violet, six cyan, six green respectively for three types of vehicles: acrylic, oil and casein.

3.2 THE SPECTROPHOTOMETRIC ANALYSIS

The spectrophotometric analysis was carried out in two laboratories: PH3DRA (*Physics for Dating Diagnostics Dosimetry Research and Applications*) labs of the Catania University and BENECON labs of Napoli University.
In both laboratories, the analysis were performed by Konica Minolta spectrophotometer, CM 2600d model, with measurement geometry d/8°, selecting an area of 6 mm in diameter (SAV, *Small Average Value*) following a specific standard protocol (Burrafato, 2005). The results are related to the D65 illuminant and the CIE 1931 standard colorimetric observer (2° standard observer). It is normally used for the printing colour quality control.
Data were obtained from repeated measurements (5 different acquisitions) and the elaboration regarded SPEX/100 values (*SPecular component EXcluded and UV included*).
The acquisition were made using software SpectraMagic® (Konica Minolta site, 2017) and the data were elaborated with the Origin® software (OriginLab site, 2017).
The scale adjustment represents a very important step (Gueli, 2014) and it was performed using the White Calibration Plate (CM-A145) as a target for the maximum lightness and the device CM-A32 for the minimum lightness.
The results were elaborated focusing the *Spectral Reflectance Factor* (SRF%) trend in the visible region and the colour CIELAB coordinates (Oleari, 2008).
The total uncertainty associated with each measurement was calculated according to the

tre passaggi con pennello in setola naturale direttamente su cartoncino senza preparazione.
La seconda categoria di campioni è stata realizzata mediante pigmenti in polvere sempre con lo stesso obiettivo. I pigmenti primari di Itten utilizzati sono: blu oltremare (codice CTS 0561), cinabro (codice CTS 0607) e giallo di zinco (codice CTS 0557) (CTS site, 2017). Questi, ad eccezione del rosso, sono stati corretti con quantità note di pigmento verde (verde smeraldo), per il blu e di pigmento rosso (cinabro), per il giallo.
I pigmenti, mediante la miscelazione con il legante, in rapporto 1:3 (pigmento:legante) sono stati stesi su tele preparate con gesso (codice Zecchi 4700) (Zecchi site, 2017). Il legante utilizzato è la caseina (Matteini, 2004), una fosfoproteina ottenuta dal latte in forma di dispersione colloidale, usato fin dai tempi antichi (codice Zecchi 2050) (Zecchi site, 2017).
Il fine è quello di ottenere dei campioni che rispecchino, in coordinate cromatiche, i valori teorici delle singole tinte per il sistema CIELAB (Oleari, 2008). Il blu, ad esempio, è stato ottenuto in modo tale da avere coordinata a* nulla ed il più alto valore possibile di b* (negativo).
In totale, sono stati ottenuti trentasei campioni: sei campiture gialle, sei arancioni, sei magenta, sei viola, sei ciano e sei verdi rispettivamente per i tre tipi di legante: acrilico, olio e caseina.

3.2 LE MISURE SPETROFOTOMETRICHE

Le misure spettrofotometriche sono state eseguite presso due laboratori: i laboratori PH3DRA (*Physics for Dating Diagnostics Dosimetry Research and Applications*) dell'Università degli Studi di Catania e quelli della BENECON dell'Università degli Studi di Napoli.
In entrambi i laboratori, le analisi sono state condotte tramite spettrofotometro Konica Minolta, modello CM2600d con geometria d/8°, selezionando un'area di misura di diametro 6 mm (maschera *Small Average Value*, SAV) e seguendo un preciso standard di laboratorio (Burrafato, 2005).
Per l'esecuzione delle misure, è stato selezionato l'illuminante D65 e l'osservatore standard 2° del 1931 che è solitamente usato per la valutazione del colore nei controlli di qualità di stampa.
Per ogni campione sono state fatte cinque acquisizioni mediante il software SpectraMagic® (Konica Minolta site, 2017) e i dati sono stati elaborati con il software Origin® (OriginLab site, 2017). Le elaborazioni hanno riguardato i valori SPEX/100 (*SPecular component EXcluded and UV included*).
L'adjustment della scala rappresenta uno step di fondamentale importanza (Gueli, 2014) ed è stato realizzato usando lo standard White Calibration Plate (CM-A145) come target per il massimo di luminosità e il device CM-A32 per il

propagation uncertainty theory, as the square root of the squaring sum of standard deviation and instrumental error. This last contribution was estimated on the basis of CIELAB coordinates measured on *White Calibration Plate*.

4. RESULTS AND DISCUSSION

The thirty-six samples, prepared according to the procedure described in paragraph 3.2, were analysed by spectrophotometric measurements performed at Catania and Napoli Universities. Each sample was analysed with the same type of instrumentation and following the same experimental parameters illustrated in paragraph 3.2.

Tables 1 and 2 show the average values with related errors of colour coordinates for the six Yellow (Y), Orange (O), Magenta (M), Violet (V), Cyan (C) and Green (G) samples prepared with acrylic, oil and casein vehicles, respectively in the two laboratories.

As said in the introduction, this study is born from the hypothesis according to which the Itten primary and secondary hues are in a specific relationship, as is illustrated with the values and the related sum in the first column of Table 3.

In order to compare the data of colour coordinates experimentally measured and those hypothesized in Itten statement, the percentage ratio between each reciprocal values of brightness colours, reported by Itten and intuited by Schopenhauer, and the sum of values of brightness of the six colours are calculated and reported in the second column of Table 3.

Furthermore, for each sample of Tables 1 and 2, minimo di luminosità.

Sono stati elaborati degli spettri in cui è analizzato l'andamento del Fattore di Riflettanza Spettrale (*Spectral Reflectance Factor*, SRF%) nella regione del visibile e le coordinate di colore nello spazio CIELAB 1976 (Oleari, 2008).

L'errore totale, associato ad ogni misura, è stato calcolato, secondo la teoria di propagazione dell'errore, come la radice quadrata della somma in quadratura della deviazione standard e dell'errore strumentale. Quest'ultimo contributo è stato stimato sulla base delle coordinate CIELAB misurate sul *White Calibration Plate*.

4. RISULTATI E DISCUSSIONE

I trentasei campioni, preparati secondo le modalità descritte nel paragrafo 3.2, sono stati analizzati mediante misure di spettrofotometria a contatto eseguite presso i laboratori dell'Università degli Studi di Catania (UniCT) e quelli dell'Università degli Studi di Napoli (UniNA). Ogni campione è stato analizzato con lo stesso tipo di strumentazione e utilizzando i medesimi parametri sperimentali descritti nel paragrafo 3.2.

Nelle Tabelle 1 e 2 sono elencati i valori medi delle coordinate cromatiche con i relativi errori ottenuti per i sei campioni di colore giallo, arancione, magenta, viola, ciano e verde, stesi mediante legante acrilico, olio e caseina rispettivamente nei due laboratori coinvolti.

Come dettagliato nell'introduzione, il presente lavoro nasce dall'ipotesi che le tinte primarie e secondarie di Itten stiano in un rapporto preciso descrivibile con le cifre riportate nella prima

ACRYLIC - ACRILICO									
Hue	Liquitex Ink			Lefranc			Maimeri		
Cromia	L*±δ	a*±δ	b*±δ	L*±δ	a*±δ	b*±δ	L*±δ	a*±δ	b*±δ
Y - Giallo	92,8±2,8	-15,1±0,5	87,0±3,4	89,2±2,7	-1,6±0,5	103,0±3,2	90,8±2,7	-7,5±0,9	101,7±3,0
O - Arancione	41,1±1,4	56,7±1,8	23,6±0,8	52,4±1,6	48,6±1,6	43,3±1,5	56,2±1,7	60,1±1,9	49,8±1,5
M - Magenta	43,4±1,8	62,6±2,3	4,0±2,2	43,8±1,3	66,0±2,0	-4,3±0,3	51,9±1,6	68,9±2,1	18,2±1,0
V - Viola	33,1±1,1	18,6±0,6	-24,8±0,8	36,4±1,3	11,0±0,4	-37,7±1,3	41,2±1,2	13,1±0,4	-21,8±0,7
C - Ciano	54,4±1,6	-17,7±0,6	-32,8±1,1	44,2±1,3	-24,5±0,8	-30,3±1,0	53,5±1,6	-12,6±0,4	-25,4±0,8
G - Verde	54,9±1,7	-46,3±1,4	9,6±0,4	47,2±1,4	-46,0±1,4	28,2±0,9	53,7±1,6	-33,9±1,6	22,2±0,8

Table 1 - Average values and related errors of L* a* b* for all samples analyzed at Catania University labs prepared with acrylic, oil and casein.

Tabella 1 - Valori medi e relativi errori di L*a*b*per tutti i campioni analizzati a UniCT stesi con acrilico, con olio e caseina.

OIL - OLIO						
Hue	Van Dick Ferrario			Maimeri		
Cromia	L*±δ	a*±δ	b*±δ	L*±δ	a*±δ	b*±δ
Y - Giallo	91,9±2,8	-14,2±0,6	91,6±2,8	88,3±2,7	-4,0±0,6	99,2±3,0
O - Arancione	56,1±1,8	60,1±2,0	41,1±1,2	46,4±1,5	62,3±1,9	37,4±1,2
M - Magenta	51,0±1,8	74,9±2,3	6,2±2,6	42,8±1,4	70,7±2,1	0,9± 1,2
V - Viola	29,2±2,2	18,9±1,6	-36,8±1,1	21,0±0,7	10,7±0,4	-21,8±1,4
C - Ciano	41,8±2,1	-5,6±2,1	-47,4±1,6	25,7±1,2	-6,1±1,0	-24,5±1,2
G - Verde	45,6±1,4	-56,1±1,8	6,6±0,5	32,8±1,1	-36,9±1,5	4,7±0,3

Hue Cromia	CASEIN - CASEINA		
	L*±δ	a*±δ	b*±δ
Y - Giallo	70,1±2,3	13,0±0,8	62,2±2,3
O - Arancione	53,1±1,6	33,7±1,0	38,4±1,2
M - Magenta	43,5±1,3	44,1±1,3	25,2±0,8
V - Viola	30,1±1,0	-0,3±0,1	-7,3±0,5
C - Ciano	33,1±1,1	0,3±0,1	-25,4±0,8
G - Verde	40,7±2,0	-21,8±0,7	8,5±0,6

Table 2 - Average values and related errors of L* a *b* for all samples analyzed at Napoli University labs prepared with acrylic, with oil and casein

Tabella 2 - Valori medi e relativi errori di L*a*b*per tutti i campioni analizzati presso UniNA stesi con acrilici, con olio e caseina

ACRYLIC - ACRILICO									
Hue Cromia	Liquitex Ink			Lefranc			Maimeri		
	L*±δ	a*±δ	b*±δ	L*±δ	a*±δ	b*±δ	L*±δ	a*±δ	b*±δ
Y - Giallo	90,4±2,7	-6,2±0,6	94,0±3,1	86,4±2,6	8,5±0,4	100,8±3,1	88,6±2,7	1,7±0,1	100,5±3,0
O - Arancione	40,9±1,3	51,4±1,6	21,9±0,7	52,6±1,7	45,3±1,4	43,2±1,5	55,3±1,8	56,1±1,7	47,9±1,7
M - Magenta	42,3±1,3	55,0±1,7	2,5±0,4	42,8±1,3	57,7±1,8	-6,8±0,3	50,9±1,5	64,5±1,9	14,2±0,6
V - Viola	33,8±1,0	14,3±0,4	-24,3±0,7	37,5±1,3	2,1±0,1	-33,6±1,3	42,0±1,3	9,6±0,3	-22,0±0,7
C - Ciano	57,2±1,7	-26,3±1,0	-27,7±0,9	47,0±1,5	-35,8±1,2	-23,6±0,7	55,0±1,7	-18,5±0,6	-21,8±0,7
G - Verde	55,1±1,7	-45,7±1,4	12,6±0,4	47,3±1,4	-39,3±1,3	28,6±0,9	53,8±1,6	-0,3±0,9	23,4±0,7

OIL - OLIO						
Hue Cromia	Van Dick Ferrario			Maimeri		
	L*±δ	a*±δ	b*±δ	L*±δ	a*±δ	b*±δ
Y - Giallo	90,2±2,7	-6,3±0,5	92,9±2,8	86,5±2,6	3,9±1,1	99,2±2,9
O - Arancione	55,8±2,1	53,0±2,0	39,3±1,2	48,2±1,6	54,8±1,8	37,6±1,1
M - Magenta	50,1±1,6	66,2±2,0	2,8±0,9	43,2±1,5	61,9±1,9	-2,1±1,2
V - Viola	29,5±1,3	13,0±0,6	-33,8±1,8	24,3±1,0	4,5±0,5	-23,5±1,5
C - Ciano	45,5±1,4	-20,9±0,8	-39,4±1,3	32,5±1,1	-24,6±1,1	-20,7±0,9
G - Verde	48,5±1,5	-56,7±1,8	11,5±0,3	36,4±1,4	-42,9±2,3	9,1±0,7

Hue Cromia	CASEIN - CASEINA		
	L*±δ	a*±δ	b*±δ
Y - Giallo	68,4±2,1	12,7±0,5	60,6±1,9
O - Arancione	53,6±1,6	30,5±1,0	37,6±1,2
M - Magenta	43,9±1,3	40,8±1,2	23,6±0,7
V - Viola	34,8±1,3	4,7±0,1	-7,4±0,3
C - Ciano	36,6±1,1	-4,6±0,1	-23,8±0,7
G - Verde	33,6±1,1	-21,3±0,6	17,1±0,6

the ΔE* value with respect to the device for black used in the scale adjustment was calculated.
In the following text, the ΔE* such obtained is called ΔE^*_0.
In particular, first of all, the ΔE^*_0 was calculated starting from the L*, a*, b* coordinates and then the percentage of each ΔE^*_0 with respect to the sum of ΔE^*_0 of the six colours.
Then, the value of ΔE^*_0 in thirty-sixths is reported.
The obtained data are presented, with the related error, with the theoretical values, in Tables 4 and 5 respectively for the laboratories at Catania and

colonna della Tabella 3 la cui somma è 36. Al fine di poter confrontare i dati delle coordinate cromatiche specificate sperimentalmente e quelli ipotizzati nell'enunciato di Itten, si è calcolato il rapporto percentuale tra ognuno dei valori reciproci di "luminosità" dei colori riportati da Itten e intuiti da Schopenhauer e la somma dei valori di "luminosità" dei sei colori (seconda colonna della Tabella 3).
Per ciascuno dei campioni delle Tabelle 1 e 2, inoltre, è stato calcolato in trentaseiesimi il valore di ΔE* rispetto al nero di calibrazione. Considerato che quest'ultimo rappresenta lo zero in termini di luminosità, nel testo seguente

Hue Cromia	Absolute reciprocal value of Itten brightness (in thirty-sixths) Valori reciproci assoluti di luminosità Itten (in trentaseiesimi)	Relative reciprocal value of brightness (in %) Valori reciproci relativi di luminosità (in %)
Y - Giallo	9	25
O - Arancione	8	22
M - Magenta	6	17
V - Viola	3	8
C - Ciano	4	11
G - Verde	6	17
Total - Totale	36	100

Table 3 - Reciprocal values absolute and relative of Itten brightness

Tabella 3 - Valori reciproci assoluti e relativi di luminosità Itten

Napoli Universities.
The data illustrated in Tables 4 and 5 were also elaborated as a histogram (Figure 2) realized starting from the values, obtained in the two laboratories and then averaged, of the thirty-six samples prepared with the different vehicles. In the same histogram, the theoretical values of Itten/Schopenhauer were listed.

il ΔE^* così ottenuto è denominato ΔE^*_0.
Nello specifico, è stato dapprima calcolato il ΔE^*_0 a partire da ogni terna L*,a*,b* e poi la percentuale di ogni ΔE^*_0 rispetto alla somma dei ΔE^*_0 dei sei colori. Il valore di ΔE^*_0 così ottenuto è stato poi espresso in trentaseiesimi.
I dati ottenuti sono presentati, con il relativo errore, insieme ai valori teorici, nelle Tabelle 4 e

Hue Cromia	Theoretical values - Valori teorici	Liquitex Ink - Inchiostri Liquitex	Lefranc acrylic - Lefranc acrilici	Maimeri acrylic - Maimeri Acrilici	Van Dick oil - Van Dick olio	Maimeri oil - Maimeri olio	Casein paintings - Stesure pittoriche con caseina
Y - Giallo	9	10,0±0,3	10,1±0,3	9,9±0,3	9,4±0,3	11,4±0,3	9,6±0,3
O - Arancione	8	5,8±0,2	6,2±0,2	7,0±0,2	6,6±0,2	7,4±0,2	7,5±0,2
M - Magenta	6	5,9±0,2	5,9±0,2	6,4±0,2	6,5±0,2	7,1±0,2	6,8±0,2
V - Viola	3	3,5±0,1	4,0±0,1	3,5±0,1	3,6±0,1	2,8±0,1	3,1±0,1
C- Ciano	4	5,1±0,2	4,4±0,1	4,4±0,1	4,6±0,1	3,1±0,1	4,2±0,1
G - Verde	6	5,6±0,2	5,3±0,2	4,9±0,1	5,2±0,2	4,3±0,1	4,8±0,1

Table 4 - ΔE^*_0 in thirty-sixths and the related errors calculated for all samples analysed at Napoli University

Tabella 4 - Coefficienti reciproci ΔE^*_0 in 36mi con i relativi errori calcolati per tutti i campioni analizzati presso UniNA

Hue Cromia	Theoretical values - Valori teorici	Liquitex Ink - Inchiostri Liquitex	Lefranc acrylic - Lefranc acrilici	Maimeri acrylic - Maimeri Acrilici	Van Dick oil - Van Dick olio	Maimeri oil - Maimeri olio	Casein paintings - Stesure pittoriche con caseina
Y - Giallo	9	10,3±0,3	10,2±0,3	9,9 ±0,3	9,9±0,3	9,9±0,3	9,14±0,3
O - Arancione	8	5,5±0,2	6,3±0,2	6,8±0,2	6,6±0,2	6,6±0,2	7,4±0,2
M - Magenta	6	5,5±0,2	5,5±0,2	6,2±0,2	6,4±0,2	6,4±0,2	6,6±0,2
V - Viola	3	3,5±0,1	3,9±0,1	3,6±0,1	2,5±0,1	2,5±0,1	3,7±0,1
C- Ciano	4	5,4±0,2	4,9±0,1	4,6±0,1	4,9±0,1	4,9±0,1	4,5±0,1
G - Verde	6	5,8±0,2	5,2±0,2	4,9±0,1	5,8±0,2	5,8±0,2	4,4±0,1

Table 5 - ΔE^*_0 in thirty-sixths and the related errors calculated for all samples analysed at Catania University

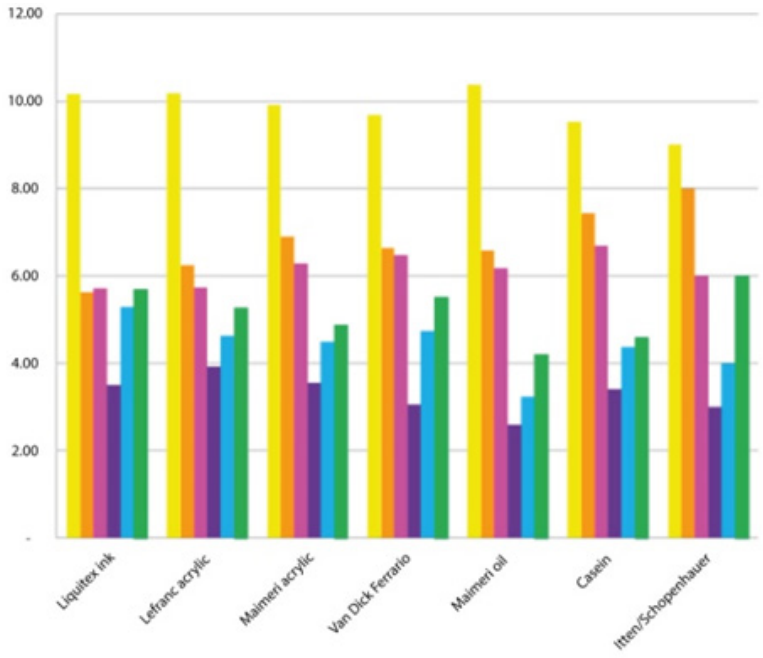
Tabella 5 - Coefficienti reciproci ΔE^*_0 in 36mi con i relativi errori calcolati per tutti i campioni analizzati presso UniCT

From Figure 2, it is possible to highlight that the yellow measured is always greater than expected, while the orange and the green measured are always less than expected.
A further elaboration of the results was made in the Figure 3. It is evident that the sum of three pairs of complementary colours is not always constant, as supposed by Itten and Schopenhauer. The sum of the complementary yellow + violet, also, is always greater than the other two hypothesized.

5 rispettivamente per i laboratori dell'Università degli Studi di Napoli e di Catania.
I dati riportati nelle Tabelle 4 e 5 sono stati ulteriormente elaborati in una rappresentazione grafica ad istogramma (Figura 2) realizzata a partire dai valori, ottenuti nei due laboratori e mediati, dei trentasei campioni preparati con i diversi leganti. Nel medesimo istogramma, inoltre, sono riportati anche i valori teorici di Itten/Schopenhauer.
Dalla Figura 2 si evince che il giallo misurato è sempre maggiore di quello ipotizzato, mentre

Figure 2 - Histogram obtained with averaged ΔE^*_0 in thirty-sixths values of Catania and Napoli Universities in comparison with theoretical ones.

Figura 2 - Istogramma dei ΔE^*_0 in 36mi mediati misurati da UNICT e UniNA confrontati con i rapporti teorici di Itten/Schopenhauer



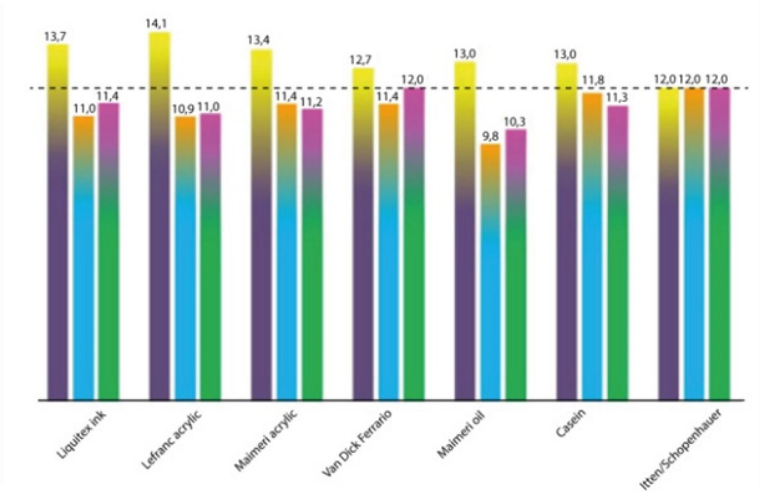


Figure 3 - Comparison between the averaged sum of complementary coefficients ΔE^*_0 measured and the relative theorized by Itten/Schopenhauer.

Figura 3 - Confronto tra le somme dei coefficienti medi misurati ΔE^*_0 in 36mi dei complementari e quelle teoriche di Itten/Schopenhauer.

5. CONCLUSIONS

On the basis of which said until now, the authorship of the statement, regarding the relationship of quantity of the six primary and secondary colours of subtractive synthesis of Itten, in his book *"The art of Colour"*, is not attributable to Goethe but to Schopenhauer.
The research work, based on colour specification measurements on samples ad hoc prepared, in two different laboratories, allow us to obtain two important results. On the one hand, the study confirms as expected in terms of the qualitative trend of values of reciprocal relationships of the six colours. On the other hand, it puts in evidence a quantitative difference, respect to the six colours theorized by Itten, in the quantity contrast.
Because the importance of the results obtained and foreseeable fallout in several fields, the present research work needs to be explored more deeply by increasing the number of colours and supports samples, improving the preparation steps, and optimizing and standardising the

l'arancio e il verde misurati sono sempre inferiori a quelli ipotizzati.
Un'ulteriore elaborazione dei risultati è stata fatta nella Figura 3 in cui è evidenziato come la somma delle tre coppie di complementari non è sempre costante come ipotizzato da Itten e Schopenhauer. La somma dei complementari giallo + viola, inoltre, è sempre maggiore rispetto alle altre due ipotizzate.

4. CONCLUSIONI

Sulla scia di quanto argomentato in questo articolo, la paternità dell'enunciato, riguardante il rapporto di quantità dei sei colori costituenti i primari e i secondari della sintesi sottrattiva riferita da Itten nel suo libro "Arte del colore", non andrebbe attribuita a Goethe ma piuttosto a Schopenhauer. Il lavoro realizzato, basato su misure di specificazione del colore di provini appositamente preparati, in due differenti laboratori di ricerca, ha permesso di ottenere due importanti risultati. Da un lato lo studio ha, infatti, confermato quanto ipotizzato in termini

colour coating method in order to achieve a quality surface and homogeneity better than the one obtained.

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CONFLICT OF INTEREST

The authors disclose any actual or potential conflicts of interest including financial, personal or other relationships with other people or organizations within three years of beginning the submitted work that could inappropriately influence, or be perceived to influence, their work.

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di andamento qualitativo dei valori dei rapporti reciproci dei sei colori, dall'altro ha evidenziato una differenza quantitativa, rispetto alla sestina definita da Itten, nel contrasto di quantità. Data l'importanza dei risultati a cui si è giunti e delle prevedibili ricadute in molti ambiti, il presente lavoro richiede di essere approfondito mediante un aumento del numero di campioni di colori e di supporti, migliorando la loro preparazione, ottimizzando e standardizzando il metodo di stesura dei colori al fine di ottenere una maggiore omogeneità superficiale che la manualità della tecnica utilizzata non ha assicurato.

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The recovery of the original colour of the archive material: the digital colour correction of the ancient anti-Semitic discourse of the Duce in 1938

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Il recupero del colore originale dei materiali d'archivio: la correzione digitale del colore dello storico discorso antisemita del Duce, nel 1938

ABSTRACT

The work in question is a digital colour correction experiment on a 35 mm film, a documentary from the Archivio Storico Luce. This is the speech pronounced by Benito Mussolini in Piazza dell'Unità, in Trieste, on September 18th, 1938. The film is a positive duplicate made in nitrate of cellulose, scanned in full HD with resolution 1920 x 1080 at 25 fps. The interventions, with the help of the software PFClean, were aimed to solve problems related to a strong flickering and a lack in distribution of light and dark gradations, which led to a faded and low-contrast image. In order to bring back to life the initial splendor, the digital intervention was performed using both historical and technical information. Our first goal was to keep the colouring and lighting of an outdoor shot, with a shot in full day that detects strong contrasts of light. Further, we tried to recover part of the original colour with a colour correction aimed to globally adjust the brightness and the gradation of black and white, while on the more faded photograms a contrast mask was applied. The applied interventions have allowed the documentary to return to the right gradation of light with qualitative results that are comparable to the original image.

KEYWORDS

light; colour; full hd; contrast; gradation; colour correction; contrast; documentary; Mussolini; Archivio; Luce; digital; film; restoration; speach; dark; black; white; positive; nitrate; Trieste; 35 mm; PFClean;

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In particular, he concentrated his interests on the application and in the comparative analysis of the most important digital restoration software.

1. INTRODUCTION

Colour is one of the main problems when faced with a film and video restoration work but, at the same time, it is also the main reason for restoring it. Not by chance, colour correction, a key factor in the *Digital Intermediate* process, is now also considered the central stage of the entire restoration work, since it allows the film to re-acquire the right light gradation with quality results comparable to the original image and therefore closer to the artist's vision. Not always, however, one focuses on the scientific investigation preceding the colour correction, which instead contributes significantly to the success of the subsequent digital intervention; we refer to the steps of analysing the original media and therefore, as in the case study that we want to submit here, to the classification of the film type, the supervision of the scanning [1] and conversion of signals from analogue to digital, technical features that are added with the digital operator's examination, who only with all these elements is able to choose the algorithms dedicated to restoring the original colour and subjectively manipulate the parameters available. Taking into consideration an analytical study of all these factors, it is possible to apply a correct method of digital colour restoration avoiding the falsification of the original colour. The digital colour correction experiment presented here concerns a 35 mm film, which is part of a precious and special collection: this is a historical documentary of the *"Archivio*

1. INTRODUZIONE

Il colore rappresenta uno dei principali problemi da affrontare quando ci si trova di fronte ad un lavoro di restauro cinematografico e video ma, allo stesso tempo, è anche il principale fattore per cui viene operato un restauro. Non a caso la color correction, centrale nel processo del *Digital Intermediate*, viene oggi considerata anche la fase centrale dell'intero lavoro di restauro, permettendo al film di riacquisire la giusta gradazione di luce con risultati qualitativi paragonabili all'immagine originale, e quindi più vicini alla visione dell'artista. Non sempre, però, ci si sofferma sull'indagine scientifica precedente alla correzione colore, che invece contribuisce notevolmente sulla riuscita del successivo intervento digitale; ci si riferisce alle fasi di analisi del supporto originale e quindi, come nel *case study* che si vuole presentare, alla classificazione della tipologia della pellicola, alla supervisione del processo di scansione [1] e della conversione dei segnali da analogici a digitali, caratteristiche tecniche che si sommano conseguentemente con l'esame dell'operatore digitale, che solo con tutti questi elementi è dunque in grado di scegliere gli algoritmi dedicati al ripristino del colore originale e manipolare soggettivamente i parametri a disposizione. Prendendo in considerazione uno studio analitico di tutti questi fattori è possibile dunque applicare una corretta metodologia del restauro digitale del colore senza commettere delle falsificazioni della colorazione originale.

Figure 1 - *Documentary on Benito Mussolini's Speech in Trieste*, original frame.

Figura 1 - *Documentario sul Discorso di Benito Mussolini a Trieste*, fotogramma originale.

Storico Luce". Luce is one of the internationally renowned archives and keeper of the vast film and photographic heritage produced in Italy, especially in the period between 1925 and 1965 [2].

These are mainly non-fiction products, and therefore news, documentaries and repertoire, which may not always be subject, due to their content and technical features, to the commonly adopted digital colour correction of films. Regarding the content, this is quite a special occasion: the historical speech given by Benito Mussolini in Piazza dell'Unità, in Trieste on September 18, 1938; it is an original copy of the medium-length film, other than the one kept in the Luce archives, where there are no images of what is in fact the crucial moment of all the irredentist itinerary of Mussolini. Indeed, when Mussolini starts his speech from the raised stage in front of the government building, a cut suddenly projects the viewer after the end of the speech, with the Duce going to the shipyard *Fabbrica Macchine Sant'Andrea*, for the normal continuation of its itinerary.

We do not know if this gap is the result of a precise choice in the editing of the time or it is a cut made later. Certainly, this curious absence is connected with the decade old question about the lack of concrete documents produced or preserved by Luce regarding the anti-Semitic turn of the Fascist regime. The archive has, however, recently recovered a positive duplicate that, at the end of the 1970s, the *Archivio Cinematografico Nazionale della Resistenza* (National Resistance Cinema Archive) of Turin had acquired from a private collector, which features the 18 minutes absent in the original negative, the only surviving filmed testimony

L'esperimento di correzione digitale del colore che si presenta ha come oggetto una pellicola 35 mm., che fa parte di una collezione preziosa e particolare: si tratta di un documentario storico dell'*Archivio Storico Luce*, uno degli archivi più noti a livello internazionale e custode del vasto patrimonio filmico e fotografico prodotto in Italia, soprattutto nel periodo tra il 1925 e il 1965 [2].

Si tratta di prodotti soprattutto non di fiction, e quindi cinegiornali, documentari e repertorio, che non sempre possono sottostare, per natura di contenuto e realizzazione tecnica, alla metodologia cinematografica più diffusa per la correzione del colore digitale. Per il contenuto è da considerarsi prioritaria la particolarità del girato, si tratta dello storico discorso pronunciato da Benito Mussolini in piazza dell'Unità, a Trieste, il 18 settembre 1938; è una copia originale del mediometraggio diversa da quella conservata presso gli archivi del *Luce*, dove non sono presenti le immagini relative a quello che è difatti il momento cruciale di tutto l'itinerario irredentista di Mussolini. Infatti, quando Mussolini dà inizio al proprio discorso dal palco rialzato posto davanti al palazzo del Governo, un taglio proietta all'improvviso lo spettatore già a discorso terminato e con il Duce diretto verso il cantiere navale *Fabbrica Macchine Sant'Andrea*, per il normale proseguimento del suo itinerario.

Non sappiamo se questa lacuna sia dovuta ad una precisa scelta nel montaggio dell'epoca o se si tratti di un taglio posteriore all'originale del negativo; certo è che questa curiosa assenza si relaziona con il decennale interrogativo sulla mancanza di concreti documenti realizzati o conservati dal *Luce* intorno alla svolta antisemita del regime fascista. L'archivio ha però di recente recuperato un duplicato positivo che alla fine

Figure 2 - *Documentary on Benito Mussolini's Speech in Trieste*, original frame.

Figura 2 - *Documentario sul Discorso di Benito Mussolini a Trieste,* fotogramma originale.

of the racial politics of the Fascist regime. This implies, unless this is a working copy, an initial printing of the full speech and a later surgical cut made in the middle of the original negative. From a more technical point of view, therefore, this is a positive duplicate (35 mm) in cellulose nitrate: conserved under fortuitous circumstances for many decades prior to the acquisition into the archive, it has suffered a hugely negative impact on the quality of the film; in addition to dirt and dust, almost all of frames are subject to defects and abrasions of the emulsion and the support, with significant loss of photochemical image. There are countless white vertical lines in multiple consecutive frames throughout the film, often caused by the projector's sprocket teeth, and, as a sign of repeated public projections, subjected to constant light pumping as well as damaged joints, due to the coarse overlapping of film sections or glue or scotch tape residues used to make the junctions; there are also tears and lacerations that occasionally cross the entire frame area.

These poorly maintenance conditions have resulted in a significant decay in image quality: whitish moisture spots are repeated throughout the film, considerable shifts of light within a frame, a clear indication of colour decay: whites and blacks are attenuated, the contrast is reduced to a minimum, making a number of frames difficult to view and sometimes giving, at times, the perception of poorly focused images.

Entrusted to the Archivio Luce, the film has been subjected to preservation operations such as joint repair and cleaning and washing of the film to remove part of the dirt. It was then scanned at Full HD 1920x1080 resolution with ProRes codec and sub-sampling 422, making it available for digital restoration. All 35 mm films produced before 1950 were made on a highly flammable nitrate support, and the reprint on safety film has guaranteed long-term safety, but has not eliminated the problem of retaining the original medium. In addition, it is necessary to preserve the vintage copy, as it is the one that allows the transmission of the image and the only form under which the audio-visual material has come to us.

This paper documents the phases that have characterised the colour correction process on the film presented; the material on which the works have been carried out is a scanned copy, as already mentioned, with Full HD resolution of 1920x1080 at 25 fps. Frame analysis has highlighted problems linked to a strong flicker and poor distribution of light and dark gradations, therefore creating a faded, low contrast image where medium tones prevail. To re-establish the initial splendour, the digital intervention has been performed using both historical and technical information, relating to the support,

degli anni Settanta l'*Archivio Cinematografico Nazionale della Resistenza* di Torino aveva acquisito da un collezionista privato, dove sono presenti i 18 minuti assenti nel negativo originale, unica superstite testimonianza in immagini in movimento della politica razziale del regime fascista. Ciò lascia intendere, a meno che non ci si trovi di fronte ad una copia di lavorazione, una iniziale stampa del discorso integrale e solo successivamente un taglio chirurgico operato nel cuore del negativo originale. Dal punto di vista più tecnico si tratta, dunque, di un duplicato positivo (35 mm) in nitrato di cellulosa: conservato in modo quantomeno fortunoso per molti decenni prima dell'acquisizione in archivio, presenta ingenti danni per quanto concerne la qualità della pellicola; oltre che da incrostazioni di sporco e polvere, la quasi totalità dei fotogrammi è soggetta a guasti ed abrasioni dell'emulsione e del supporto, con rilevanti perdite di immagine fotochimica. Sono visibili innumerevoli righe bianche verticali in più fotogrammi consecutivi lungo l'arco di tutto il film, spesso causati dai denti dei rocchetti di un proiettore, e possibile indizio di una sua ripetuta proiezione ad un pubblico, sottoposto ad un costante pompaggio luminoso nonché giunte danneggiate, per la grossolana sovrapposizione dei lembi della pellicola o per residui di colla o scotch utilizzati per effettuare la giunta stessa; non mancano nemmeno gli strappi e le lacerazioni che attraversano occasionalmente tutta l'area del fotogramma.

Le sopraccitate scarse condizioni di corretta conservazione hanno prodotto un significativo deperimento della qualità dell'immagine: macchie biancastre di umidità si ripetono lungo tutto l'arco del film, sbalzi di luce all'interno di un'inquadratura considerevoli, chiaro indizio di decadimento del colore: i bianchi e i neri sono attenuati, il contrasto ridotto al minimo, tanto da ridurre molti fotogrammi ad una visione problematica e dando, a tratti, la percezione di scarsa messa a fuoco dell'immagine.

Affidata all'*Archivio Luce*, la pellicola è stata sottoposta ad operazioni di preservazione come la riparazione giunte e la pulizia e lavaggio della pellicola per rimozione di parte dello sporco, e in seguito scansionata a risoluzione Full HD 1920x1080 con codec ProRes e sotto-campionamento 422, rendendola disponibile per il restauro digitale. Tutti i film in 35 mm prodotti prima del 1950 sono stati realizzati sul supporto in nitrato, altamente infiammabile, e la ristampa su pellicola di sicurezza ha garantito la salvezza a lungo termine, ma non ha eliminato il problema della conservazione del supporto originale. Inoltre, occorre conservare la copia d'epoca perché è quella che consente la trasmissione dell'immagine e rappresenta l'unica forma sotto la quale l'audiovisivo è arrivato fino a noi.

Figure 3 - *Documentary on Benito Mussolini's Speech in Trieste*, original frame.

Figura 3 - *Documentario sul Discorso di Benito Mussolini a Trieste,* fotogramma originale.

provided by the *Istituto Luce*. The frames have been restored with the PF Clean software, with which it has been possible to intervene both globally, by modifying the general parameters on one or more frames, and locally, acting on certain areas, more or less large, of individual frames. Various operations were required to recover part of the original colour.

2. HISTORICAL NOTES AND THE EDITING OF THE DOCUMENTARY

On September 18, 1938, in Piazza dell'Unità, Trieste, Mussolini announced the issuance of racial laws and the beginning of an active anti-Semitic policy by the fascist regime, with a historical discourse focused precisely on the *"Jewish problem"* for which it was necessary to awaken a *"clear and severe racial awareness"* in defence of which, following the model of Hitler's Germany, segregation laws would soon be applied in Italy as well.

Mussolini's agitated discourse, aimed at sanctioning the definitive and irreversible racial twist in the policies of the Fascist regime, welcomed by the cries of jubilation of the immense crowd gathered in Piazza dell'Unità, could not truly surprise the Jews, bombarded for at least a year with growing anti-Semitic propaganda, and who had seen the storm coming for a few weeks: in July of '38 there was the first publication of the Race Manifesto (Armani, Betta and Fiamingo, 2007), and in the early days of September the first laws were issued, those directed against foreign Jews and those that removed the Jews from schools. The choice of

Questo lavoro documenta le fasi che hanno caratterizzato il processo di *color correction* sulla pellicola presentata; il materiale sul quale si è lavorato è una copia scansionata, come già anticipato, a risoluzione Full HD 1920x1080 a 25 fps. L'analisi dei frame ha evidenziato problemi legati ad un forte flickerio e una scarsa distribuzione delle gradazioni di chiaro e scuro, favorendo quindi un'immagine sbiadita, a basso contrasto dove prevalgono i toni medi. Per ritrovare lo splendore iniziale, l'intervento digitale è stato eseguito utilizzando come riferimento sia le informazioni di carattere storico, sia quelle tecniche, relative al supporto, fornite dall'*Istituto Luce*. I fotogrammi sono stati restaurati con il software *PF Clean* con il quale è stato possibile intervenire sia a livello globale, inteso come la modifica dei parametri generali su uno o più frame, che a livello locale, agendo quindi su determinate aree, più o meno grandi, dei singoli frame. Per recuperare parte del colore originale sono state necessarie diverse operazioni.

2. CENNI STORICI E MONTAGGIO DEL DOCUMENTARIO

Il 18 settembre 1938, in piazza dell'Unità a Trieste, Mussolini annunciò l'emanazione delle leggi razziali e l'inizio di un'attiva politica antisemita da parte del regime fascista, attraverso uno storico discorso incentrato proprio sul *"problema ebraico"*, di fronte al quale sarebbe stato necessario risvegliare una *"chiara e severa coscienza razziale"* in difesa della quale, seguendo il modello della Germania hitleriana, ben presto si sarebbero applicate le leggi di

the city of Trieste was totally intentional: in his speech, Mussolini strictly linked the adoption of racial politics to the development of an imperial policy carried out by Fascism. Mussolini's trip to Trieste was only the first stage of a journey undertaken with propaganda clamour in the areas of World War I, naturally seen under a strongly nationalistic perspective.

In Trieste, among other things, there was a strong adherence to fascist nationalism, the degeneration of the old irredentist spirit of the city before it became Italian. Many Jews in Trieste were among the irredentists, and this deep conviction greatly facilitated their adhesion to the fascist ideology, as was the case in the rest of Italy, when part of the Jewish population saw in Fascism the natural evolution of nationalism (De Felice, 2005). Now Mussolini's racial politics had cut them out of any sense of national belonging, tying in a definite way fascist nationalism to anti-Semitic racism. The Duce spoke in a city where the Jewish presence was undoubtedly very strong and profoundly rooted; it was also the city from whose port ships sailed loaded with Jews from the East who fled from persecution to the land of Israel: the same Trieste had been nicknamed the Gate of Zion (Ovadia, 1999), and in this sense, Mussolini's choice of launching his anti-Semitic turn from the historic port of the Venezia Giulia region was extremely symbolic.

Only the sound track of Benito Mussolini's speech at Piazza dell'Unità has been for decades kept and distributed. Although the operators of *Istituto Luce* had followed and recorded the Duce's journey through Venezia Giulia and Veneto, the negative of the medium still preserved at the archives of the *Luce* does not include the images of what was in fact the crucial moment of the irredentist itinerary of Mussolini.

The editing of the documentary allows the viewer to follow all the steps of the lavish arrival of the Duce in the port of Trieste; then it shows panoramic sequences and his transfer on a convertible car to the centre of the city: when Mussolini finally reaches Piazza dell'Unità, and after greeting the crowd with a waving hand, he starts his talk from the raised stage in front of the palace of the Government. When the plot finally gets to the top of the climax, a cut suddenly projects the viewer after the speech with the Duce directed to the shipyard *Fabbrica Macchine Sant'Andrea*, for the normal continuation of his itinerary.

A precise choice in the editing of the time? An unexpected absence, subsequent to the original cut of the negative? How does this curious absence relate to the decade-long question about the lack of concrete documents produced or preserved by the Luce about the anti-Semitic turn of the Fascist regime? Thanks

segregazione anche in Italia.

Il concitato discorso di Mussolini, volto a sancire la definitiva e irreversibile svolta razziale nella politica del regime fascista, accolto dalle grida di giubilo della immensa folla radunata in piazza dell'Unità, non poteva in vero cogliere totalmente di sorpresa gli ebrei, bombardati da almeno un anno di crescente propaganda antisemita, e che avevano visto scatenarsi la tempesta già da alcune settimane: al luglio del '38 risaliva la prima pubblicazione del Manifesto della Razza (Armani, Betta and Fiamingo, 2007), e nei primissimi giorni di settembre erano state emanate le prime leggi, quelle rivolte contro gli ebrei stranieri e quelle che allontanavano gli ebrei dalla scuola. La scelta della città di Trieste non fu di certo casuale: nel suo discorso Mussolini legava strettamente l'adozione di una politica razziale allo sviluppo di una politica imperiale da parte del Fascismo. Il viaggio di Mussolini a Trieste era solo la prima tappa di un percorso intrapreso con clamore propagandistico nelle zone della Prima guerra mondiale, viste naturalmente in un'ottica fortemente nazionalista.

A Trieste tra l'altro era forte l'adesione al nazionalismo fascista, degenerazione dell'antico spirito irredentista della città prima che diventasse italiana. Tra gli irredentisti era stata elevata anche la presenza degli ebrei di Trieste, e questa profonda convinzione facilitò di molto l'adesione degli stessi all'ideologia fascista, come accadde anche nel resto d'Italia quando parte della popolazione ebraica vide nel Fascismo la svolta naturale del nazionalismo (De Felice, 2005). Ora la politica razziale di Mussolini li tagliava fuori da ogni senso di appartenenza nazionale, legando in modo indissolubile il nazionalismo fascista al razzismo antisemita. Il Duce parlava in una città nella quale la presenza ebraica era quindi indubbiamente molto forte e profondamente radicata nel tessuto cittadino; era inoltre la città dal cui porto salpavano navi cariche di ebrei provenienti dall'Est che fuggivano dalla persecuzione verso la terra d'Israele: la stessa Trieste era stata soprannominata La Porta di Sion (Ovadia, 1999), e, in questo senso, appare perciò enormemente simbolica la scelta di Mussolini di lanciare la svolta antisemita proprio dallo storico porto della Venezia Giulia.

Del discorso pronunciato da Benito Mussolini in piazza dell'Unità è stata per decenni custodita e diffusa la sola traccia audio: nonostante gli operatori dell'*Istituto Luce* avessero seguito e ripreso gli spostamenti del Duce nel suo viaggio attraverso le terre della Venezia Giulia e poi nel Veneto, nel negativo del mediometraggio tuttora conservato presso gli archivi del *Luce* non sono pervenute le immagini relative a quello che è difatti il momento cruciale di tutto l'itinerario

to the exchange of information between the *Archivio Nazionale Cinematografico della Resistenza* (National Film Archive of Resistance) of Turin and the *Istituto Luce*, the 18-minute copy kept in Turin and absent from the original negative was recovered, with Mussolini's full speech. The positive duplicate stored in Turin is a 35 mm cellular nitrate film with no significant narrative gaps, with the only loss of few frames that does not interfere with the continuity of the narration.

3. THE FORMATION OF THE IMAGE ON THE FILM: DEVELOPMENT AND FIXING

The documentary is impressed on a 35 mm nitrate film, whose usability is guaranteed by a photochemical process that takes place in the film itself when it is exposed to light. On the film substrate, i.e. the nitrate layer, the oldest of the media dating back to1861, when it was created with the reaction between nitric acid and cellulose flakes. It was gradually improved over time, a mixture of silver halide crystals was emulsified and dosed according to the type of film to be made. Their size varied depending on the desired sensitivity of the film. Such silver crystals absorb the light energy by triggering the transformation of silver in metallic silver: the crystals thus exhibit microscopic black dots in proportion to the absorbed light and are not visible to the naked eye on the film.
This is defined as a latent image, since it is there but cannot be seen, so a development phase is necessary for the image to be revealed.
During development, only the sensitised crystals, those affected by light, will react by turning into metallic silver and will become completely black; a greater amount of light hitting the surface of the film determines a stronger darkening. The main component for film development is the so-called *detector*. The development is also very sensitive to physical changes, i.e. the immersion time in the detector bath and the temperature. These two parameters are used to correct the density and contrasts in order to obtain the best photographic response. Obviously, the increase in immersion time and temperature will result in increased density and contrast, while decreased time and temperature will have an inverse effect. If we have, in fact, exposed the film to excessive light we could balance that by reducing these parameters; in the reverse case of a lack of exposure, we could try to balance it by increasing those parameters.
At this point, it is necessary to eliminate the crystals that have not been hit by light through a second development step, which is defined as fixing; this is a chemical treatment that allows us to stabilise the image obtained, unalterable

irredentista di Mussolini.
Il montaggio del documentario permette allo spettatore di seguire tutte le fasi dello sfarzoso arrivo nel porto di Trieste del Duce; seguono sequenze panoramiche e del trasferimento in auto scoperta verso il centro della città: quando Mussolini raggiunge finalmente piazza dell'Unità e, dopo aver salutato con un cenno della mano la folla festante, dà inizio al proprio discorso dal palco rialzato posto davanti al palazzo del Governo, ovvero quando la trama si appresta finalmente a raggiungere l'apice del climax, un taglio proietta all'improvviso lo spettatore già a discorso terminato e con il Duce diretto verso il cantiere navale *Fabbrica Macchine Sant'Andrea*, per il normale proseguimento del suo itinerario.
Una precisa scelta nel montaggio dell'epoca? Un'assenza imprevista e posteriore all'originale taglio del negativo? In che modo questa curiosa assenza si relaziona con il decennale interrogativo sulla mancanza di concreti documenti realizzati o conservati dal *Luce* intorno alla svolta antisemita del regime fascista? Grazie allo scambio di informazioni tra l'*Archivio Nazionale Cinematografico della Resistenza* torinese e l'*Istituto Luce*, viene recuperata la copia torinese di 18 minuti assenti nel negativo originale, con il discorso di Mussolini in forma integrale. Il duplicato positivo custodito a Torino è un 35 mm in nitrato di cellulosa che non presenta significative lacune narrative, ossia perdita di alcuni fotogrammi che non inficiano la continuità dell'intreccio.

3. LA COSTITUZIONE DELL'IMMAGINE SULLA PELLICOLA: SVILUPPO E FISSAGGIO

Il documentario è impressionato su una pellicola nitrato 35 mm, la cui fruibilità viene garantita da un processo fotochimico che avviene nella pellicola stessa quando essa viene esposta alla luce. Sul supporto della pellicola, ossia il nitrato, il più antico dei supporti scoperto nel lontano 1861 per la reazione tra acido nitrico e fiocchi di cellulosa poi via via migliorato nel tempo, viene dispersa (emulsionata) una miscela di cristalli di alogenuro d'argento, la cui quantità viene dosata in base al tipo di pellicola che si vuole realizzare e le cui dimensioni variano in funzione della sensibilità della pellicola che si vuole ottenere. Tali cristalli di argento assorbono l'energia della luce innescando la trasformazione dell'argento in argento metallico: i cristalli presentano così dei microscopici puntini anneriti in rapporto alla luce assorbita e che non sono visibili ad occhio nudo sulla pellicola.
Questa si definisce immagine latente, in quanto c'è ma non si vede, ed è quindi necessario

by light, by immersing the material in a *fixing bath*, containing substances that make silver salt soluble.
Transforming the silver halide crystals (insoluble) that have not been affected by light into soluble silver complexes that go from the film to the fixing bath is of paramount importance, since if these crystals are not eliminated, when exposed to light they would also slowly become metallic silver, practically destroying the image. Obviously, the metallic silver crystals originated in the development process and constituting the image remain unchanged, while the silver in the fixing solution is normally recovered by electrolysis from the fixing bath itself.
Knowing the film in its physical characteristics by following this perspective enables us to fully understand the entire digital restoration process that will take place following the slow and progressive decay of the film, ranging from the acquisition of the material to colour correction and digital cleaning [3].

4. THE DIGITAL RESTORATION WORKFLOW

In a restoration project that begins by scanning a film, the workflow is usually based on the creation of a DPX or Cineon image sequence, i.e. a sequence of uncompressed 10-bit logarithmic files that can faithfully return the information about the grey scale of the three RGB channels within the range of the film and at the same time flexible with respect to variations in information regarding colour, colour space and colour patterns. As described in section 1.2 of the *"Revision of ANSI/SMPTE 268M-1994"*:

This flexible and resolution-independent file format describes pixel-based images with attributes defined in the header of the binary file. Each file represents a single image with up to eight image elements. The image elements are defined as a single component (e.g. luma) or multiple components (such as red, green, and blue) (SMPTE 268M, 1992) .

However, given the type of codec and format, and taking into account the machines available for the task, the restoration project in this case was set in an 8-bit linear RGB colour space. Choosing a chromatic workspace is an essential step in the colour management of a project. Although it is always advisable to work in a 16-bit linear colour space, which provides more tones in the shadows than an 8-bit space, this type of choice has guaranteed tonal adherence to the original file without range variations; in addition, by performing operations in a linear colour space, we have avoided artefacts such as irregular edges, halos and uneven margins,

passare alla fase dello sviluppo affinché tale immagine venga rivelata.
Durante lo sviluppo solo i cristalli sensibilizzati, quelli colpiti cioè dalla luce, reagiranno trasformandosi in argento metallico e diventeranno completamente neri; tanto più forte sarà l'annerimento quanto maggiore è stata la quantità di luce che ha colpito la superficie della pellicola. Il componente principale per lo sviluppo della pellicola è il cosiddetto *rivelatore*. Lo sviluppo, inoltre, è molto sensibile alle variazioni di tipo fisico, ovvero tempo di immersione nel bagno rivelatore e temperatura. Questi due parametri vengono utilizzati per correggere la densità e i contrasti in modo da ottenere la migliore risposta fotografica. Ovviamente l'aumento del tempo d'immersione e della temperatura produrranno un aumento della densità e dei contrasti, mentre la diminuzione provocherà un effetto inverso; se abbiamo, quindi, di fatto, esposto la pellicola eccessivamente alla luce potremmo aiutarci riducendo tali parametri, nel caso inverso, di una carente esposizione, potremmo tentare di recuperare aumentando i parametri stessi.
A questo punto è necessario eliminare i cristalli che non sono stati colpiti dalla luce attraverso un secondo passaggio successivo allo sviluppo, che viene definito come fissaggio; si tratta di un trattamento chimico che permette di rendere stabile, quindi inalterabile alla luce, l'immagine ottenuta, immergendo il materiale in un *bagno di fissaggio*, contenente sostanze che rendono solubile il sale d'argento.
Trasformare i cristalli di alogenuro d'argento (insolubili) che non sono stati colpiti dalla luce in complessi di argento solubili che passano, in quanto tali, dalla pellicola al bagno di fissaggio è di fondamentale importanza, poiché se tali cristalli non venissero eliminati, poi, esposti alla luce, si trasformerebbero anch'essi lentamente in argento metallico, distruggendo di fatto l'immagine. Ovviamente restano del tutto inalterati i cristalli d'argento metallici originati nel processo di sviluppo e che costituiscono l'immagine, mentre l'argento in soluzione nel fissaggio viene normalmente recuperato tramite elettrolisi dal bagno di fissaggio stesso.
Conoscere la pellicola nelle sue caratteristiche fisiche seguendo tale prospettiva consente di comprendere al meglio tutto il processo di restauro digitale che avverrà a seguito del lento e progressivo decadimento della pellicola, che va dall'acquisizione del materiale fino alla *color correction* e alla pulizia digitale [3].

4. IL WORKFLOW DEL RESTAURO DIGITALE

In un progetto di restauro che prende il via dalla scansione di una pellicola, il *work flow*

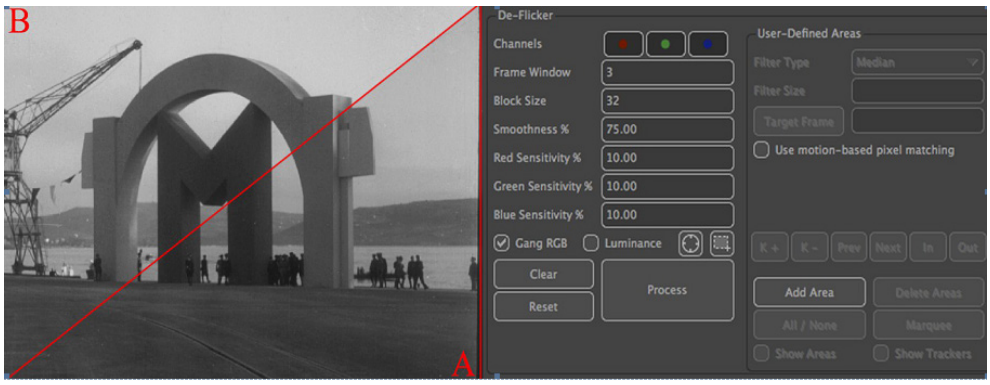

Figure 4 - *Automatic Deflicker intervention*

Figura 4 - Intervento di De-Flicker automatico

Figure 5 - *Automatic Deflicker intervention*

Figura 5 - Intervento di De-Flicker automatico

which appear with the fusion of high-contrast and saturated colours.

Following the acquisition of the material, we enter the restoration phase, through which we try to bring the film as close as possible to its original status. There are essentially three different moments: analysis of the material, disturbance detection, and direct intervention with restoration tools. All this was done with the use of *PFClean*, a software that can offer a semi-automated initial analysis of the frames, followed by a finishing work using specific tools. The first operation that has been performed was the analysis of the reel to identify any disturbances [4]. As one can imagine, this procedure is a fundamental step for digital restoration, as it allows us to determine where and how we will need to intervene in the next steps. The second operation has been the organisation of the material, by dividing the reel into scenes through the *Scene Cut,* a process that allows us to the split the reel into clips automatically, based on the detected brightness variations. Although the clips obtained in most cases correspond to actual scene changes, it is imperative to carry out a manual control to correct inaccurate cuts and to substantially customise the entire *Scene Cutting* process, based on the contents of the processed movie. These operations have allowed us to apply the right corrections based on the disturbances found. In particular, we have carried out a homogenisation

è solitamente basato sulla creazione di una sequenza di immagini DPX o Cineon, vale a dire una sequenza di file logaritmici a 10 bit non compressi, in grado di restituire fedelmente le informazioni relative alla scala di grigio dei tre canali RGB all'interno del gamma della pellicola e allo stesso tempo flessibili a variazioni di informazioni colore, spazio colore e modelli colore. Come scritto al punto 1.2 della *"Revision of ANSI/SMPTE 268M-1994"*:

Questo file format, flessibile e a risoluzione indipendente, descrive immagini basate su pixel con attributi definiti nell'*header* del file binario. Ogni file rappresenta una singola immagine con un massimo di otto elementi d'immagine. Gli elementi d'immagine sono definiti come un singolo componente (per esempio luma) o più componenti (ad esempio rosso, verde e blu) (SMPTE 268M, 1992).

Tuttavia, dato il tipo di codec e di formato, e tenuto conto delle macchine a disposizione per il lavoro, il progetto di restauro in questo caso è stato impostato in uno spazio colore RGB lineare a 8 bit. La scelta di uno spazio cromatico di lavoro è un passo essenziale nella gestione del colore in un progetto. Nonostante sia sempre consigliabile lavorare in uno spazio colore lineare a 16 bit, in modo di avere più toni nelle ombre rispetto ad uno spazio a 8 bit, questo tipo di scelta ha garantito aderenza tonale con il file

Figure 6 - *Original frame and restored frame*

Figura 6 - Fotogramma originale e fotogramma restaurato.

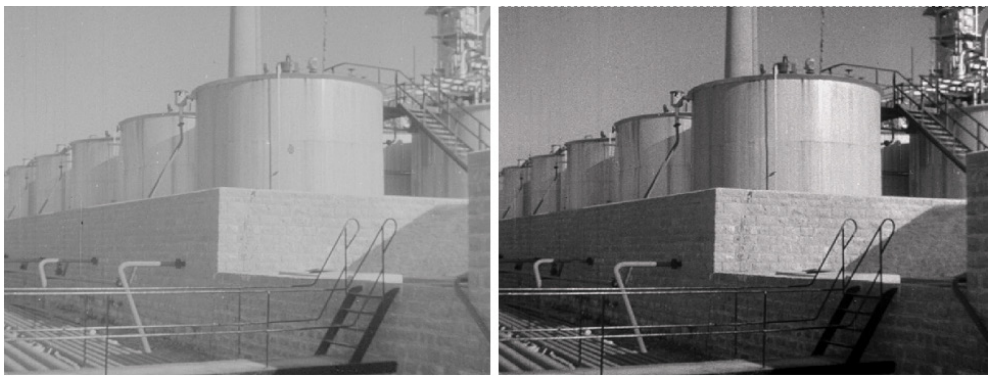

Figure 7 - *Original frame and restored frame*

Figura 7 - Fotogramma originale e fotogramma restaurato.

Figure 8 - *Original frame and restored frame*

Figura 8 - Fotogramma originale e fotogramma restaurato.

Figure 9 - *Original frame and restored frame*

Figura 9 - Fotogramma originale e fotogramma restaurato.

of brightness (medium tones, high and low lights) and of black and white gradation at the global level, while on more faded frames (Mussolini's close-ups) a contrast mask has been applied for a selective intervention. In addition, on the shots with varying light density between the frames, a filter has been applied for a more homogeneous brightness, based on a reference frame.

For a first global intervention regarding the application of the restoration tools, we have chosen the *Deflicker* tool, which has allowed us to remove the low frequency fluctuations of the image brightness from the clips. This tool has automatically analysed each frame of the clip

originale senza operare variazioni di gamma, inoltre eseguendo operazioni in uno spazio cromatico lineare, abbiamo evitato artefatti quali bordi irregolari, aloni, margini sbavati, che appaiono quando vengono fusi colori a elevato contrasto e saturazione.

A seguito dell'acquisizione del materiale, si entra nella fase del restauro vero e proprio con la quale si cerca di riportare la pellicola il più possibile vicino a come era in origine.

Si possono distinguere sostanzialmente tre momenti differenti: analisi del materiale, individuazione dei disturbi, e intervento diretto con gli strumenti di restauro. Tutto questo è stato

to determine the necessary corrections and brightness curves; these curves were then used to manually intervene in certain areas where automatic processing failed to fully correct the brightness swings.
The second global correction has been made on the black and white gradation, through the *Movie Grade* tool, in particular by combining two different adjustment modes: the first called *Wheel / Trackball mode* to directly intervene on luminance, balance, contrast and saturation; the second, *Histogram Mode*, to intervene on the overall colour range, obtaining a re-mapping of black and white points in a more or less narrow range. For a more detailed intervention on the single frame, especially on Mussolini's close-ups, we have chosen to use the *Sharpen* tool, a contrast mask that has made it possible to provide a greater definition to the areas that appeared to be particularly faded and not contrasted enough, thus providing a greater focus and returning a sharper image. The mask has been applied in such a way as to have constant parameters in all the clips containing the Duce's close-ups.
Both the preservation and the digital restoration process, therefore, are applied and are considered to be fundamental insofar as long as they guarantee the possible return of the film to its original status, when it was not yet compromised by its progressive decay.

The restoration work described above has been carried out within the Department of Art and Performing Arts History, Sapienza University of Rome, with the help of four Apple iMac workstations.

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CONFLICT OF INTEREST

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eseguito con l'impiego di *PFClean*, un software in grado di offrire un lavoro semiautomatizzato iniziale di analisi dei frame, a cui fa seguito un lavoro di rifinitura finale grazie a specifici *tools*.
La prima operazione che è stata effettuata è l'analisi del rullo al fine di individuare i disturbi presenti [4]. Come si può intuire, questa procedura rappresenta una fase fondamentale per l'attività di restauro digitale, poiché permette di stabilire dove e come si dovrà intervenire nei passaggi successivi. La seconda operazione effettuata è stata l'organizzazione del materiale, tramite la suddivisione del rullo in scene attraverso lo *Scene Cut*, processo che permette la suddivisione automatica del rullo in clip, a seconda delle variazioni di luminosità rilevate. Sebbene le clip ottenute corrispondano nella maggior parte dei casi ai reali cambi di scena, è comunque imprescindibile un controllo manuale che consenta una correzione dei tagli imprecisi ed una sostanziale personalizzazione dell'intero processo di *Scene Cut*, in base al contenuto del filmato elaborato. Queste operazioni sono state utili per poter applicare le giuste correzioni a seconda dei disturbi riscontrati, in particolare è stata effettuata una omogeneizzazione della luminosità (mezzi toni, alte e basse luci) e della gradazione di bianco e nero a livello globale, mentre sui fotogrammi che risultavano maggiormente sbiaditi (primi piani di Mussolini) è stata applicata una maschera di contrasto che ha permesso, quindi, un intervento selettivo. Inoltre, sulle inquadrature che presentavano delle variazioni di densità di luce tra i vari frame di una medesima scena è stato applicato un filtro che ha permesso di rendere omogenea la luminosità, sulla base di un fotogramma di riferimento scelto.
Per un primo intervento a livello globale che concerne l'applicazione degli strumenti di restauro, si è scelto di utilizzare il *tool Deflicker* con il quale è stato possibile rimuovere dalle clip le fluttuazioni a bassa frequenza di luminosità dell'immagine. Con questo strumento è stato analizzato automaticamente ogni frame della clip per determinare le correzioni necessarie e le curve di luminosità; tali curve sono poi state utilizzate per intervenire manualmente su determinate aree nelle quali l'elaborazione automatica non è riuscita a correggere integralmente gli sbalzi di luminosità. La seconda correzione a livello globale è stata effettuata sulla gradazione di bianco e nero, tramite il tool Film Grade, in particolare utilizzando una combinazione di due differenti modalità di regolazione: la prima chiamata *Wheel/Trackball mode* per intervenire direttamente sulla densità di luminosità (Luminanza), sul Bilanciamento, sul Contrasto e sulla Saturazione; la seconda, *Histogram Mode*, per intervenire sul range totale del colore, ottenendo una ri-mappatura dei

the submitted work that could inappropriately influence, or be perceived to influence, this work

NOTES

[1] Where it is not possible to personally follow the scanning process of the original film, it is still necessary to make sure that the technical parameters are consistent with the digital conversion of the media.

[2] Between 1927 and 1945, the Istituto Luce, founded by Luciano De Feo in 1924, produced the Cinegiornale Cinematografico Luce, which provided daily news of Italian life covering current affairs, politics and international news, with an inclination for war news.

[3] Regarding the documentary, it should be pointed out that with this term we want to indicate the digital colour correction process, omitting the aspects of colour correction in the analogue system.

[4] In addition to this colour intervention, the digital restoration has included steps to stabilise the reel and remove dirt, spotting and scratches.

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FILMOGRAPHY

Documentario sul Discorso di Benito Mussolini a Trieste (Documentary on Benito Mussolini's Speech in Trieste), cellulose nitrate film kept at the Archivio Storico Luce (Luce Historical Archive).

punti di bianco e nero in un range più o meno ristretto. Per un intervento più dettagliato sul singolo fotogramma, in particolare sui primi piani di Mussolini, si è scelto di utilizzare lo *Sharpen*, una maschera di contrasto che ha permesso di restituire maggiore definizione alle aree che apparivano particolarmente sbiadite e poco contrastate, dando quindi una impressione di maggiore messa a fuoco e restituendo un'immagine più nitida. La maschera è stata applicata in modo tale da avere parametri costanti in tutti i fotogrammi della clip che mostravano i primi piani del Duce.
Tanto la preservazione quanto l'intervento di restauro digitale, dunque, nascono e si rivelano fondamentali nella misura in cui garantiscono l'eventuale ritorno della pellicola al proprio stato originario, quando essa non risulta ancora compromessa dal suo progressivo decadimento.

Gli interventi di restauro descritti sono stati effettuati all'interno del Dipartimento di Storia dell'Arte e dello Spettacolo, Sapienza Università di Roma, con l'ausilio di quattro workstation Apple iMac.

NOTES

[1] Dove non è possibile seguire personalmente il processo di scansione della pellicola originale è comunque necessario assicurarsi che i parametri tecnici siano consoni alla conversione digitale del supporto.

[2] Tra il 1927 e il 1945 l'Istituto Luce, fondato da Luciano De Feo nel 1924, ha prodotto il Cinegiornale Cinematografico Luce, che rappresentava la cronaca quotidiana della vita italiana con servizi dedicati all'attualità, alla politica e alle notizie internazionali e con una predilezione per le notizie concernenti la guerra.

[3] Rispetto al documentario, va precisato che con tale termine si vuole indicare il processo di correzione colore digitale, tralasciando quelli che sono gli aspetti della correzione colore nel sistema analogico.

[4] Oltre all'intervento di colore descritto, il restauro digitale ha compreso interventi di stabilizzazione e rimozione di sporco, spuntinature e graffi.

The meanings of the Red

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Italian translation provided:
'Le significazioni del rosso'

ABSTRACT

Femininity is strongly linked to the symbolism of red as a color tied to fertility and blood that is poured into life for conception and not for death. Symbol to the feminine world, one thinks of the many heroines of Rosamunda's fairy tales in Snow White, from the Lovely Sleeping to Little Red Riding Hood, all have the red color symbol.The red symbol of the fire of the Holy Spirit also inspiresand infuses knowledge of the Apostles, the color of fire is a symbol of knowledge, think of the myth of Promētheús that brings the fire to the men and the apple of the tree of knowledge in 'Eden that is red as red is the God of Genesis called: Lord of Fire. Red is linked to war because it is the color that metal takes when it is placed in the furnace, in fact the choice to identify with the name of Mars the red-colored planet is due to iron oxides prevalent on its surface.

KEYWORDS

Femininity, Red, Symbol, Knowledge

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1. THE FEMININE AND THE RED

Red is linked to war because it is the color that metal takes when it is placed in the furnace, in fact the choice to identify with the name of Mars the red-colored planet is due to iron oxides prevalent on its surface. In the alchemical symbolism one of the phases of the alchemical process is red: *rubedo*, so called for the high temperatures during this time. It represents sulfur and with the white color symbolizing mercury forms a pair of opposites whose union is called: *alchemical weddings* (Foschi, 2000). In the myths inherent in the creation of the world, red is present, for example, in Genesis where the individual is molded with red clay (Gen.1, 26; 2,7), in fact, Adam means the soil, reddish ground: Adamah with the semitic root 'DM be red. The myths are followed by historical epochs and different cultures by assuming the vital and mortal connotations of this archetypal color. Symbolism is sung in the myths of every corner where humanity is present, in terms of color and, in particular, red. In the mesothotic myth of Tiamat, the goddess is cut off because blood can make the earth fertile for animal creations. In the red-blooded Hodiod theogony, giants were born, within a symbology where blood spill was conceived only through ritual actions. Femininity is strongly linked to the symbolism of red as a color tied to fertility and blood that is poured into life for conception and not for death. Until the 19th century. The wedding dress was red [1], where the female red is a symbol of the cave, the uterus. Red is the carnation symbol of Diana, the goddess of hunting, loved by a young pastor before seduced him and then abandoned him to despair and from those tears flowers originated precisely carnations characterized by a spicy and sensual aroma. Even the Christian tradition links the tears of Mary at the foot of the Cross the birth of red carnations. In Irish myths is linked to the symbol of red water, the *banshee* [2], a legendary creature with eyes always red because of tears. It is noted that red is very related to the feminine world, one thinks of the many heroines of Rosamunda's fairy tales in Snow White, from the Lovely Sleeping to Little Red Riding Hood, all have the red color symbol. The symbology associated with red apple, a true manifestation of pomegranate, for example in Snow White's story, is the transition to the fertility stage of the woman and the appearance of the red blood. As the myth of Persephone staying in the kingdom of the dead is the representation of the woman who becomes fertile, in the myth the pomegranate [3] will be the symbol that will force her to stay in the kingdom of the dead. But Medusa's myth is aimed at the appearance of fertility, where red is in that case a symbol of life, fertility and rebirth.

1. IL FEMMINEO E IL ROSSO

Il rosso è legato alla guerra perché è il colore che il metallo assume quando è posto nella fornace, infatti la scelta di identificare con il nome di Marte il pianeta dal colore rosso è dovuto agli ossidi di ferro prevalenti sulla sua superficie. Nel simbolismo alchemico una delle fasi del processo alchemico è del colore rosso: la *rubedo*, così chiamata per le alte temperature durante questo raggiunte. Rappresenta lo zolfo e con il colore bianco che simboleggia il mercurio forma una coppia di opposti la cui unione viene denominata: *nozze alchemiche* (Foschi, 2000). Nei miti inerenti la creazione del mondo il rosso è presente ad esempio nella Genesi dove l'individuo è plasmato con argilla rossa (Gen.1, 26;2,7), infatti Adamo significa del *suolo, terra rossastra*: *Adamah* con la radice semitica '*DM essere rosso*. I miti si susseguono per epoche storiche e culture diverse assumendo le connotazioni vitali e mortali di questo colore-archetipo. La simbologia si sussegue tramandata nei miti di ogni angolo dove l'umanità sia presente, per quello che riguarda il colore e in particolare il rosso. Nel mito mesopotamico di *Tiamat* la dea si fa tagliare la testa perchè il sangue possa rendere fertile la terra per la creazioni degli animali. Nella teogonia di Esiodo dal sangue rosso nacquero i giganti, entro una simbologia dove il versamento del sangue è concepito solo attraverso azioni rituali. La femminilità è fortemente connessa alla simbologia del rosso, in quanto colore legato alla fertilità e al sangue che si versa per la vita per il concepimento e non per la morte. Fino al XIX sec. l'abito da sposa era rosso [1], dove il rosso femminile è simbolo della caverna, dell'utero. Rosso è il garofano simbolo di Diana dea della caccia, che amata da un giovane pastore prima lo seduce e poi lo abbandona alla disperazione e dalle cui lacrime nacquero dei fiori appunto i garofani caratterizzati da un aroma speziato e sensuale. Anche la tradizione cristiana collega alle lacrime di Maria ai piedi della Croce la nascita dei garofani rossi. Nei miti irlandesi è legata al simbolo dell'acqua rossa la *banshee* [2], leggendaria creatura dagli occhi sempre rossi per via delle continue lacrime. Si nota come il rosso sia molto legato al mondo femminile, si pensi alle tante eroine delle fiabe da *Rosamunda a Biancaneve, dalla Bella Addormentata a Cappuccetto Rosso* tutte hanno come simbolo il colore rosso. La simbologia legata alla mela rossa [3], manifesto in vero del melograno, presente ad esempio nella storia di Biancaneve rappresenta il passaggio alla fase della fertilità per la donna e la comparsa del mestruo che è rosso-sangue appunto. Come il mito di Persefone che soggiorna nel regno dei morti è la rappresentazione della donna che diventa fertile, nel mito sarà il melograno

2. FROM PHOENIX TO SHAMANIC RITUALS: MEANING RED

The red symbol of the fire of the Holy Spirit also inspires and infuses knowledge of the Apostles, the color of fire is a symbol of knowledge, think of the myth of *Promētheús* [4] that brings the fire to the men and the apple of the tree of knowledge in 'Eden that is red as red is the God of Genesis called: *Lord of Fire*. Moses will see him as an ardent tree of a red and perpetual fire [5]. Red is the color that strongly characterizes China and is largely present in its mythology. *Huo-pu's*, the minister of fire, has red hair and beard, which is nevertheless represented by the Arab Phoenix [6] rising from the ashes of its red fire, whose precept is Post Fata Resurgo [7] that after death comes back to rise. One of the Greek names to say red is, in fact, φοινικοῦς, -ῆ, -οῦν Foinikus, a symbol of the followers of the Sun God which it represents. The Phoenix [8] has a beautiful plumage made of red feathers in the body and rosy pens to cover a part of the blue tail, wings are purple and gold as the neck in its iconic representation in the imagination of the myth that characterizes it [9]. The Arabian Phoenix [10], symbol of death and resurrection is also associated with Osiris, the figure of Jesus Christ and the Holy Spirit, which is fire and light symbolized by red as the ceremonial color present in many religions [11]. The poet and writer Dante Alighieri will describe it as follows:

> *[...] That the phoenix more and more resurfaces, when at the fifteenth appressed grass drifts in its life does not pass, but incense salt of tears and amomo, and nard and myrrh are the last bands.* (Hell XXIV, 107-111).

The magical-religious shamanic rituals of many cultures have in their foundations the presence of red color; *Shamanic* is defined as a series of ritual complexes present in different cultural contexts, by chronology and geographical position, characterized by a series of specific rituals and symbolic common traits (Mastromattei, 1995). In these rituals, blood plays a role of considerable importance, either physically used or with substitute elements that represent it through its red color, resulting in the use of red ocher [12]. Various shamanic traditions have contact with blood as a triggering of initiatory illness that comes as a result of symptoms and phenomena that reveals itself in an individual's life without warning, making him a shaman. Initiations and rites of passage are everywhere associated with isolation and suffering, symbol of death and ritual rebirth. The shaman inviting spirits to nourish his body and blood leads back to the bond he establishes il simbolo che la costringerà al soggiorno nel regno dei morti. Ma il mito di Medusa si rivolge alla comparsa della fertilità, dove il rosso in tal caso è simbolo di vita, di fertilità e di rinascita.

2. DALLA FENICE AI RITUALI SCIAMANICI

Il rosso-simbolo del fuoco dello Spirito Santo inspira altresì il sapere e infonde la conoscenza sugli Apostoli, il colore del fuoco è simbolo della conoscenza, si pensi al mito di *Prometheús* [4] che porta il fuoco agli uomini e alla mela dell'albero della conoscenza nell'Eden che è rossa come rosso è il Dio della Genesi denominato: *Signore del Fuoco*. Mosè lo vedrà come un albero ardente di un fuoco rosso e perpetuo [5]. Il rosso è il colore che fortemente caratterizza la Cina e ampiamente presente nella sua mitologia. *Huo-pu* dai capelli e la barba rossi è il ministro del fuoco, questo è nondimeno rappresentato dall'Araba Fenice [6] che rinasce dalle ceneri del proprio fuoco rosso, il cui precetto è Post Fata Resurgo dopo la morte torno ad alzarmi [7]. Uno dei nomi greci per dire rosso infatti è φοινικοῦς, -ῆ, -οῦν Foinikus, simbolo dei seguaci del dio Sole che appunto rappresenta [8]. La Fenice ha uno splendido piumaggio fatto da piume rosse nel corpo e penne rosee a ricoprire una parte della coda azzurra, le ali sono di porpora e oro come il collo nella sua rappresentazione iconica nell'immaginario del mito che la caratterizza [9]. L'Araba Fenice simbolo della morte e risurrezione [10] è associata altresì ad Osiride, alla figura di Gesù Cristo e allo Spirito Santo che è fuoco e luce simboleggiata dal rosso quale colore cerimoniale presente in numerose religioni [11]. Il poeta e scrittore Dante Alighieri così la descriverà:

> *[...] che la fenice more e poi rinasce, quando al cinquecentesimo appressa erba ne biada in sua vita non pasce, ma sol d'incenso lacrima e d'amomo, e nardo e mirra son l'ultime fasce.* (Inferno XXIV, 107-111).

I rituali sciamanici magico-religiosi di molte culture hanno come fondamento la presenza del colore rosso; sono definiti *sciamanici* una serie di complessi rituali presenti in contesti culturali differenti tra loro, per cronologia e posizione geografica, caratterizzati una serie di tratti specifici rituali e simbolici comuni (Mastromattei, 1995). In questi rituali il sangue ricopre un ruolo di notevole importanza, adoperato materialmente o con elementi sostitutivi che lo rappresentino attraverso Il suo colore che è rosso, riconducendo all'uso dell'ocra rossa [12]. Diverse tradizioni sciamaniche, presentano il contatto con il sangue come scatenante della

Figure 1 - Oil and acrylic paint on canvas and various materials:from left to right La Donna and Le Maschere. Al.Tallarita 2014.

Figura 1 - Pitture olio e acrilici su tela e vari materiali. Da sinistra a destra La Donna e Le Maschere. Al.Tallarita 2014.

with them at the time of initiation. The concept of pure and impure is vital in this initial trauma of the initiatory process and subsequent shamanic profession, where blood and its representation through red is one of the magic substances for excellence (Propp, 1976). This color tied to the shamans is found manifest in some South-Siberian (Marrazzi, 1984) Turkish songs, the blood often recurs, reciting a few lines: *black lake formed by the tears of the eyes, red lake formed by the blood of the chest* [13]. According to Rong culture, for example, the demon that infects the house is urged to move away inviting him to drink red blood and eat red meat to leave and leave the house free. In Nepal, between the Tamang, at the end of a ritual in honor of the spirits of the clan, a dough of rice, the flesh and blood of a red cock sacrificed for the occasion was offered to the spirits of the dead. For Dharmaphala in magical rituals, a blood supply is symbolically performed with a cup filled with a colored red liquid that represents it (De Nebeskj-Wojkowitz, 1975).

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CONFLICT OF INTEREST

I don't have actual or potential conflicts of interest, including financial, personal or other relationships with other persons or organizations within three years after the commencement of the work submitted, which may unduly influence or be perceived to influence the work.

NOTES

[1] The Queen Victoria at his wetsuit for the white with the orange holes. White in India is the habit of widows in many parts of Africa is the color of mourning, the twentieth

malattia iniziatica che si presenta a seguito di sintomi e fenomeni che svelandosi nella vita di un individuo senza alcun preavviso, ne fanno uno sciamano. Iniziazioni e riti di passaggio sono ovunque associati a isolamento e sofferenza, simbolo di morte e rinascita rituale. Lo sciamano che invita gli spiriti a nutrirsi del suo corpo e del suo sangue riconduce al legame che egli instaura con questi al momento dell'iniziazione. Il concetto di puro ed impuro è vitale in questo trauma iniziale del processo iniziatico e della successiva professione sciamanica, dove il sangue e la sua rappresentazione attraverso il colore rosso è una delle sostanze magiche per eccellenza (Propp, 1976). Questo colore legato agli sciamani lo si ritrova manifesto in alcuni canti turchi sud-siberiani (Marrazzi, 1984) il sangue ricorre sovente, recitano alcuni versi: *nero lago formato dalle lacrime degli occhi, rosso lago formato dal sangue del petto* [13]. In base alla cultura Rong ad esempio il demone che infesta la casa è pregato ad allontanarsi invitandolo a bere il sangue rosso e mangiare la carne rossa per andar via e lasciar la casa libera. In Nepal tra i *Tamang* al termine di un rito in onore degli spiriti del clan un impasto di riso, carne e sangue di un gallo rosso sacrificato per l'occasione veniva offerto agli spiriti dei morti. Per i *Dharmaphala* nei rituali magici si esegue simbolicamente una offerta di sangue con una coppa riempita di un liquido colorato di rosso che lo rappresenta (De Nebeskj-Wojkowitz, 1975).

NOTE

[1] La regina Vittoria alle sue muta per il bianco con i fori d'arancio. Quello bianco in india è l'abito delle vedove in molte parti dell'Africa è il colore del lutto, il Ventesimo sec lo impone caduto il costume della verginità.

[2] La banshee più famosa si chiamava Aibhill e proteggeva gli ÔBrien. Stando alla leggenda, nel 1014 il re Brian Boru si gettò nella battaglia di Clontarf pur sapendo di andare incontro a morte certa, dal momento che la notte precedente Aibhill gli era apparsa mentre lavava i panni dei soldati finché l'acqua non si tingeva completamente

century imposes the fall of the costume of virginity.

[2] The most famous banshee was called Aibhill and protected ÒBrien. According to the legend, in 1014 King Brian Boru threw himself into the battle of Clontarf, knowing that he was going to meet certain death, since the previous night Aibhill had appeared to him as he was washing the soldiers until the water was completely dyed of blood vermilion color

[3] The symbolism of the apple is related to pomegranate. Domain symbolism on the world sometimes takes on an erotic value. Among the most noteworthy symbols are the apple eaten by Adam and Eve but with controversial explanations the boss of discord that would give rise to the war of Troy after the judgment of Paris the pies of the Elders guarded by a dragon in a garden at the confines of the world , the mystical apples that give the name to Avalon Island of Apples, the poisoned apple offered by the stepmother in Snow White and the one put by William Tell on her son's head. Remember the boss of mystery discord in which the apple engraved to the most beautiful, thrown by Eris, goddess of discord, on the table of the wedding banquet of Peleo and Teti, the cause of the dispute between Era, Aphrodite and Athena. Zeus resigned to Parid Prince of Troy, who voted for Aphrodite, who had promised Elena's love, and that was the cause of the war that had arisen. Also Golden Apple is an element that appears in some myths and legends as well as in the stories of Nordic literature. In the painting on the theme of the artist Edward Burne-Jones (1833-1898), the Garden of the Hesperides 1869-1873 painted the Esperides dressed in red.

[4] Prometheús friend of men, devised a stratagem to drive the gods the privilege of the fire. He challenged the inevitable revenge of the gods to shine the darkness of humanity. He was punished by Zeus, but not tamed in his emotional intent, though he was punished hard on the cliff and devoured by the birds of prey.

[5] Moses in the Old Testament. Chapter III of the Exodus, God calls Mose on Mount Oreb, from the middle of a bush burning alive, but without consuming he hears the voice of God who tells him the job of saving the Jews from slavery in Egypt. On that occasion, God confides to Moses his name: I am He Who am (Exodus 3. 14).

[6] The ancient Egyptians were the first to speak of Bennu, who then became Greek in the Greek legends. In Egypt it was usually depicted with the Atef crown or with the solar disk emblem. For the Egyptians it was a sparrow, for the first dynasties or a herd of herons, nor did it resurface from the flames but from the waters.

[7] In Greek myths but not only was a fabulous sacred bird, it looked like a real eagle The ancients identified it with the golden pheasant and the Bible, with ibis or peacock. Others, with the pink heron or cinereo heron. The volatile to represent it is the Garzetta which is similar to heron. As a symbol of the rising and setting sun, the Phoenix was presiding over the royal jubilee. Collies that re-emerged for the first time, was associated with the planet Venus Star of the Morning, a manifestation of the resurrected Ishiris.

[8] This represented BA's soul of the sun god RA, of which he was the hieroglyphic emblem.

[9] A long tapered beak, long paws, two long feathers, a rose and a blue sliding softly down the head or erect on the top of the head and three long feathers hanging from the tail pierced a rose, a blue and a red-fire.

[10] Every morning at dawn he bathed in the water and sang such a wonderful song that the sun god stole his boat or his chariot in Greek mythology to hear it. Every 500

del colore vermiglio del sangue.

[3] La simbologia della mela è legata al melograno. Simbolo del dominio sul mondo, assume talvolta una valenza erotica. Tra le simbologie più note si ricordano la mela mangiata da Adamo ed Eva ma con spiegazioni controverse il pomo della discordia che avrebbe dato origine alla guerra di Troia dopo il giudizio di Paride i pomi delle Esperidi custodite da un drago in un giardino ai confini del mondo, le mele mistiche che danno il nome ad Avalon Isola delle Mele, la mela avvelenata offerta dalla matrigna a Biancaneve e quella posta da Guglielmo Tell sulla testa del proprio figlio. Si ricordi il pomo della discordia mito in cui la mela incisa Alla più bella, lanciata da Eris, dea della discordia, sul tavolo del banchetto di matrimonio di Peleo e Teti, causa della lite fra Era, Afrodite e Atena. Zeus si astenne fu chiesto a Paride principe di troia, che votà per Afrodite che le aveva promesso l'amore di Elena, e cio fu causa della guerra che si scatenò. Inoltre La mela d'oro è un elemento che appare in alcuni miti e leggende come anche nei racconti della letteratura nordica. Nel quadro sul tema l'artista Edward Burne-Jones (1833–1898) The Garden of the Hesperides 1869-1873 dipinge le Esperidi vestite di rosso.

[4] Prometheús amico degli uomini, escogitò uno stratagemma per carpire agli dèi il privilegio del fuoco. Egli sfidò l'inevitabile vendetta degli dèi per rischiarare le tenebre dell'umanità. Fu punito da Zeus, ma no domati nel suo intento emotivo, se pur duramente punito sulla rupe e divorato dai rapaci.

[5] Mosè nel vecchio testamento. III capitolo dell'Esodo, Dio chiama Mose sul monte Oreb, dal mezzo di un cespuglio che bruciava a fuoco vivo, ma senza consumarsi egli ode la voce di Dio che gli comunica l'incarico di salvare gli Ebrei dalla schiavitù in Egitto. In quella occasione Dio confida a Mose il suo nome: Io sono Colui che sono (Esodo 3. 14).

[6] Gli antichi egizi furono i primi a parlare del Bennu, che poi nelle leggende greche divenne la fenice. In Egitto era solitamente raffigurata con la corona Atef o con l'emblema del disco solare. Per gli egizi era un passero, per le prime dinastie o ad un airone cenerino, inoltre non risorgeva dalle fiamme ma dalle acque.

[7] Nei miti greci ma non solo era un uccello sacro favoloso, aveva l'aspetto di un'aquila reale Gli antichi la identificavano col fagiano dorato e nella Bibbia, con l'ibis o col pavone. Altri, con l'airone rosato o l'airone cinereo. Il volatile idoneo a rappresentarla è la Garzetta che è simile all'airone. Quale simbolo del sole che sorge e tramonta, la Fenice presiedeva al giubileo regale. Colei che ri-sorge per prima, venne associata al pianeta Venere Stella del Mattino, manifestazione dell'Osiride risorto.

[8] Questa rappresentava l'anima BA del dio del sole RA, di cui era l'emblema in geroglifico.

[9] Un lungo becco affusolato, lunghe zampe due lunghe piume una rosa ed una azzurra che le scivolano morbidamente giù dal capo o erette sulla sommità del capo e tre lunghe piume che pendono dalla coda piumata una rosea, una azzurra e una color rosso-fuoco.

[10] Ogni mattina all'alba faceva il bagno nell'acqua e cantava una canzone così meravigliosa che il dio del sole arrestava la sua barca o il suo carro, nella mitologia greca, per ascoltarla. Ogni 500 anni, la Fenice sentiva sopraggiungere la sua morte si ritirava in un luogo appartato e costruiva un nido sulla cima di una quercia o di una palma. Qui accatastava le più pregiate piante balsamiche con le quali intrecciava un nido a forma di uovo, grande quanto era in grado di trasportarlo (cosa che stabiliva per prove ed errori) . Infine vi si adagiava,

years, the Phoenix felt his death come to a secluded place and built a nest on the top of an oak or palm tree. Here she packed the most valuable balsamic plants with which she had an egg-shaped nest, as large as she was able to carry it (which she established for tests and mistakes). Finally he lay down, let the rays of the sun burn him, and let himself be consumed by his own flames. Because of the cinnamon and myrrh that burns, the death of a phoenix is often accompanied by a pleasing fragrance. A small larvae (or an egg) emerged from the cumulus of ash, which the sun's rays grew rapidly until transformed into the new Phoenix in three days, after which the young and powerful Phoenix flared to Eliopoli and lay above it 'sacred tree, it is also said that from the throat of the Phoenix came the breath of life as reported by Cheremone stoic philosopher initiated in Egyptian mysteries or by Orapollo lived under Zenone. Phenicism is one of the manifestations of the sun as interpreted by Sordon, bearing a late handwriting of the name Osiris consisting of an eye and a scepter.

[11] It tells the myth of creation that phoenix was the vital force that originated from the aquatic Chaos on the primordial hill at the origin of times. It is said that the Bennu created himself from the fire that burned on the summit of the sacred willow of Heliopolis. Just as the sun is always the same and rises only after the previous sun has gone down, Fenice always had one copy at a time. Hence the appellativo sempre eradem: always the same.

[12] The ocher: these are clay silica blends and iron oxides and / or hydroxides. From the geological point of view, ochers are secondary deposits formed by erosion from rocks of various kinds, enriched with ferrous base particles. While the simple use of color can be dated at least 400,000 years ago. The paintings dating back to at least 30,000 years ago, think of rock paintings in the caves of Lascaux (southern France). around 80,000 years ago, finds at the Blombos cave in two pieces of red ocher decorated with geometric motifs. Beyond the Blombos graffiti, the first and most important artistic expressions are undoubtedly considered the rock paintings created in the same caves.

[13] Quoted in the representation of the progeny of Arlik Qan, where the eldest Arka Solton, brings the smallpox and dwells in a lake. Marazzi, U. Testi dello sciamanismo, Torino, UTET, p.115

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lasciava che i raggi del sole l'incendiassero, e si lasciava consumare dalle sue stesse fiamme. Per via della cannella e della mirra che bruciano, la morte di una fenice è spesso accompagnata da un gradevole profumo. Dal cumulo di cenere emergeva poi una piccola larva (o un uovo) , che i raggi solari facevano crescere rapidamente fino a trasformarla nella nuova Fenice nell'arco di tre giorni, dopodiché la nuova Fenice giovane e potente volava ad Eliopoli e si posava sopra l'albero sacro, per altro si dice anche che dalla gola della Fenice giunse il soffio della vita (il Suono divino, la Musica) che animò il dio. Ma nella antica tradizione riportata da Erodoto, la fenice risorge ogni 500 anni, come riportato da Cheremone filosofo stoico iniziato ai misteri egizi o da Orapollo vissuto sotto Zenone. La fenice è una delle manifestazioni del sole come interpretato da Sbordone che riporta una grafia tarda del nome di Osiride costituita da un occhio e uno scettro.

[11] Narra il mito della creazione che la fenice fu la forza vitale che all'origine dei tempi sorse dal Caos acquatico sulla collina primordiale. Si dice infatti che il Bennu abbia creato sé stesso dal fuoco che ardeva sulla sommità del sacro salice di Eliopoli. Proprio come il sole che è sempre lo stesso e risorge solo dopo che il sole precedente è tramontato, di Fenice ne esisteva sempre un unico esemplare per volta. Da qui l'appellativo semper eradem: sempre la medesima.

[12] Le ocre. Si tratta di miscele di silice argilla e ossidi e/o idrossidi di ferro. Dal punto di vista geologico le ocre sono depositi secondari formatisi per erosione da rocce di vario tipo, arricchiti di particelle a base ferrosa. Mentre il semplice impiego del colore è databile ad almeno 400. 000 anni fa. Le pitture risalenti ad almeno 30. 000 anni fa, si pensi alle pitture rupestri nelle grotte di Lascaux (Francia meridionale). A circa 80.000 anni fa risalgono i ritrovamenti presso la caverna di Blombos in di due pezzi di ocra rossa decorati con motivi geometrici. Al di là dei graffiti di Blombos, le prime e più importanti espressioni artistiche sono senza dubbio da considerare le pitture rupestri, create nelle stesse grotte.

[13] Citato nella rappresentazione della progenie di Arlik Qan, dove il primogenito Arka Solton, porta il vaiolo e dimora in un lago. Marazzi, U. Testi dello sciamanismo, Torino, UTET,p.115

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An overview of the history of the use of colour in jewellery

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ABSTRACT

From ancient times rare and beautiful coloured materials have been prized and worn as adornment and/or indications of status.

In early societies these materials would have been 'found' objects such as shells and feathers but as technologies advanced metals were used extensively.

For thousands of years jewellers created beautiful objects using a range of metals with limited colours: yellow, red and white. Whether the yellow was high purity gold or bronze, or the white was silver, platinum or a base metal alloy, the visual impact was essentially the same. Other materials were needed to expand the palette to colours such as blue, purple and green.

This paper outlines the materials and methods that were used from the earliest known examples to recent decades.

Historically gemstones and vitreous enamels provided jewellers with a wide range of colours. The Ancient Egyptians used turquoise, lapis and coral with gold to produce vibrant multi-coloured jewellery. The Romans had a particular fondness for emeralds, sapphires and pearls while the Anglo-Saxons produced amazing jewellery featuring red garnets and blue enamel. Magnificent mediaeval jewels, mostly royal status symbols, incorporated rubies, emeralds, sapphires and diamonds with fine enamels. By the eighteenth century new sources of gemstones, particularly from S America, made jewellery more affordable and subject to changes in fashion. Over the ensuing decades fashionable jewellery veered from almost monochrome, diamond-set designs to multi-coloured, multi-gemstone pieces. The Victorians used an amazing array of gemstones, with rare and unusual species particularly prized.

The mid-twentieth century saw the introduction of metals that could be coloured such as anodised aluminium and a new metal, titanium, which enabled jewellers to produce multi-coloured pieces without the use of gemstones or enamel.

KEYWORDS

colour, jewellery, gemstones, titanium, aluminium

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Lynne Bartlett is a jewellery designer/maker. Having originally studied chemistry and worked for many years in the Chemical Industry, jewellery is her second career. The use of colour in jewellery has been a dominant theme in her work and she currently uses titanium and dyed anodised aluminium. Her doctoral thesis at the University of the Arts London (2010) studied the surface of coloured titanium.

1. INTRODUCTION

From ancient times rare and beautiful coloured materials have been prized and worn as personal adornment, indication of status and/or for supposed protective or amuletic purposes. This paper outlines the ways in which colour has been incorporated into jewellery from the earliest times to recent decades. Consideration is given to the colours of the most commonly used metals, gemstones in various forms, vitreous enamel, anodised aluminium and, finally, the interference colours of titanium. However as an overview it is not possible to include information about the cultural significance of the colours used, the sources of the gemstones or more modern coloured materials such as plastic.

Of all the elemental metals only two, gold (yellow) and copper (red) are intrinsically coloured. All the others such as silver, iron, nickel, etc. are white or rather various shades of grey. Regardless of the workability, strength or cost, the aesthetic appearance is equivalent. Whether the yellow was high purity gold or bronze, or the white was silver, platinum or a base metal alloy, the visual impact was essentially the same. Gold may be manipulated by alloying to produce a range of colours namely white, yellow, red and green but the variations are subtle. Vibrant colours can only be introduced by the incorporation of other materials in a piece of jewellery and it is the range and use of these coloured materials such as gemstones and enamels that are the focus of this paper. But to cover such a vast subject means that only a glimpse of the methods and materials that have been used can be provided. Examples have also been limited to Europe and the ancient civilisation of the Middle East that have most influenced the development of European jewellery.

2. EARLY ADORNMENT

In early societies *'found'* objects such as shells, seeds and coloured stones were used as adornment and examples have been found in graves dating back to 30,000 BC (Phillips, 1996). Necklaces from ancient cities in what is now Iraq illustrate how the materials were fashioned and drilled so that they could be worn. In later periods found objects were augmented by beads fabricated from ceramic and glass. Coloured beads with varying degrees of shaping have continued to be a significant jewellery item over the centuries.

With technological advances metals began to be used extensively. Gold was particularly prized for its colour, immutability and the relative ease with which it could be worked. Highly sophisticated gold jewellery has been excavated from Sumerian tombs dating from 2500 BC in ancient Iraq. This jewellery also incorporates coloured gemstones such as lapis lazuli, garnet, turquoise and cornelian, which were fashioned into both simple and complex shapes as shown in Figure 1. For example from 3000 BC turquoise beads were combined with garnets and gold. Typically beads were fashioned into biconical shapes but there are also examples of more elaborate gem cutting from Ur where gemstones were cut and polished to set as inlay into metal brooches (Tait, 2006) The gemstones were mostly opaque and surely prized for their intense colours.

The Ancient Egyptians used turquoise, lapis and coral to produce vibrant multi-coloured jewellery and also created beads with similar appearance from glazed composition and faience, Figure 2. As glass became more available in the Egyptian New Kingdom (ca 1567-1085 BC) it was used to imitate natural stones as well as in fine inlay, which could be argued as the precursor to true enamel. Jack Ogden (Ogden, 1982) gives a good overview of ancient sources of metals and gemstones and how they were worked.

3. GREEK AND ROMAN JEWELLERY

Gold working spread around the Eastern Mediterranean and examples of fine gold work are known from Crete, Mycenae and Etruria. The emphasis in this work was in the many sophisticated techniques that were used to embellish the gold surfaces. Gemstones are relatively rare but examples of an early type of dark blue enamel have been found in Mycenean tombs in Cyprus dating from the thirteenth century BC (Tait, 2006).

Greek jewellery, drawing on this legacy of fine workmanship, is characterised by the use of gold. Only in the Hellenistic period (from 325 BC) is there an increased use of coloured gemstones with fine quality cabochon cut garnets and transparent gems such as amethyst and emerald (Higgins, 2006).

The Roman conquest of the Hellenistic world and establishment of the Empire (27 BC) resulted in jewellery in a similar style with the accent on gold work. But this developed into a much more polychrome style.

The Romans had a particular fondness for emeralds (in crystal form), sapphires and pearls as shown in Figure 3. Mummy portraits show how these items were worn. Almost all the forms of jewellery that are worn in the twenty-first century had their origin in the Roman period. Romano-British jewellery reflects a merging of the 'standard' Roman jewellery with the added influence from the strong Celtic metalworking traditions. In particular colour was incorporated

not only from the example of Roman gemstone use but also from the Celtic technique of enamelling on bronze, Figure 4.

4. ANGLO-SAXON AND BYZANTINE JEWELLERY

The colour palette changed over the centuries and between different cultures. As shown in Figure 5, the Anglo-Saxons produced amazing jewellery featuring red garnets and blue enamel (Care Evans, 1989). The technique of inlaying thin slices of garnet into cells of gold, backed with textured gold foils, is thought to have its origins in Southern Russia around 300 AD and to have spread with migration of the Gothic tribes throughout Western and Northern Europe (Kidd & Webster, 2006). These jewels show a great sophistication in gem cutting and gold working. In Northern Europe during the ninth and tenth centuries there is an increasing use of silver but in the Eastern Mediterranean the rise of a particular Byzantine style of highly coloured jewels featured gold cloisonné enamelled work, Figure 6.

5. MEDIEVAL JEWELLERY

In the early thirteenth century gold was used to set polished gemstones of different colours in simple brooch forms, which also had a practical purpose. Subsequently goldsmiths demonstrated their skill by creating intricate high-relief gold work which was covered in enamel and enhanced with gemstones. These highly decorative jewels were particularly

(1)

(2)

Figure 1 - Carved lapis and gold beads from Ur, 2500 BC.

Figure 2 - Collar of glazed composition beads from Egypt, 2020 BC.

(3)

(3)

Figure 3 - Gold bracelet with emeralds and pearls from Roman Egypt, 1st century AD.

Figure 4 - Copper alloy brooch with red and blue enamel Faversham,UK, 1st-2nd century AD.

(5)

(6)

Figure 5 - Gold shoulder clasp with garnet inlay and blue enamel Sutton Hoo Treasure England 7th century AD.

Figure 6 - Gold reliquary cross with cloisonne enamel Constantinople, 11th century AD.

All images in Figs 1-7 courtesy of the British Museum, London

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Figure 7 - Enamelled gold hat badge with rubies and diamonds Spain or Italy 1526-75.

Figure 8 - Enamelled gold pendant with baroque pearl, pearl drop and emerald Europe late 16th century.

(7)

(8)

Figure 9 - Brooch with diamonds set in silver and Hessonite garnets set in gold Europe ca 1700.

Figure 10 - Base metal earrings with Blue Creeper bird heads England 1872.

(9)

(10)

Figure 11 - Anodised and dyed aluminium earrings Jane Adam ca 1995.

Figure 12 - Heat-coloured titanium neckpiece Lynne Bartlett 2013.

All images in Figs 8-10 courtesy of the V&A Museum, London

(11)

(12)

important as hat badges worn by men, Figure 7. Such magnificent mediaeval jewels were mostly royal status symbols, indications of piety or princely gifts (Somers, 1980). The allegorical scenes depicted in the chased and engraved gold were embellished with rubies, emeralds, sapphires and diamonds and with fine enamels. Even pendants that incorporated imitation

gemstones are finely enamelled on the reverse. Unusual materials and large gems were particular prized and baroque pearls (Philips, 2000) were often used as the bodies of animals Figure 8. In the early fourteenth century gem cutting became more elaborate and faceted stones started to be used extensively. There are examples of other styles of gem cutting such as amethyst and agate cameos.

Much more information from the fifteenth century onwards can be gleaned from the portraits of the period. Many artists were also jewellery designers and faithfully represented the jewels worn by their sitters. In London we have a fine collection of jewellery from the late sixteenth and early seventeenth centuries in the Cheapside Hoard (Forsyth, 2013). The Hoard includes many finished pieces incorporating enamelled gold chains set with sapphires, emeralds, garnets and diamonds, carved amethysts and emerald earrings and gold rings set with rubies and other gemstones. It also contains many unset gemstones with a particularly large number of cabochon garnets. The range of materials used shows how extensive the trade in coloured gems had become and indicates the popularity of multicoloured jewellery in the period.

6. EIGHTEENTH AND NINETEENTH CENTURY

By the eighteenth century new sources of gemstones, particularly diamonds, emeralds and topazes from S America, were extensively used as in Figure 9. The increased availability and hence reduced price of these gemstones made jewellery more affordable, especially for the growing affluent middle class, and designs and materials became much more subject to changes in fashion. Over the ensuing decades fashionable jewellery veered from almost monochrome, diamond-set designs to multi-coloured, multi-gemstone pieces and this cycling of styles has continued through the twentieth century.

The Victorians used an amazing array of gemstones, enamels and other materials, with rare and unusual species particularly prized Figure 10.

In the late nineteenth century new metals such as platinum and aluminium were increasingly used but both were essentially white metals. The strength of platinum made it an ideal material for 'invisible' settings in which the gemstones played the major role in the design of the piece. Initially the whiteness of the metal and its relative lack of tarnish meant that it was used as a setting for diamonds replacing the mixed gold and silver settings of early diamond-set jewels but designers at the prestige fine jewellery houses such as Cartier increasingly used multi coloured gemstones.

Aluminium, when it was first produced in the mid-nineteenth century, was treated as a novel material set in gold mounts. The isolation of the pure metal was very difficult and small ingots of the purified metal were shown at the Paris exposition in 1855. It is perhaps not surprising that the modernising nephew of Napoleon Bonaparte, Napoleon III, ordered the fabrication of aluminium utensils and is reported to have eaten from an aluminium plate in preference to a gold one (Venetski, 1969). Other special uses for aluminium included the cap on the top of the Washington Monument which was cast from aluminium in 1884 because of its whiteness and resistance to tarnish (Dix, 1934). The statue of Eros at Piccadilly Circus was cast in aluminium in 1893.

As new processes for aluminium production were developed, the metal became readily available and was used for general construction and the growing aeronautical industry in the twentieth century.

7. TWENTIETH CENTURY

Metals that could be coloured were introduced in the twentieth century.

In 1923 anodising of aluminium was developed to provide protection from corrosion of seaplane parts. The process thickened the natural aluminium oxide layer on the surface to provide a durable hard layer. When first created the thin porous oxide layer on the surface of the metal is very receptive to dyes and a wide range of patterning techniques can be used to produce what is effectively a coloured metal surface. Dyed anodised aluminium jewellery was probably first produced in the USA but of particular note is the work of the UK jeweller, Jane Adam an example of which is shown in Figure 11.

Colours may be bright or subtle and, as the pigments are fixed in the thin adherent oxide layer on the surface of the metal, they are very durable. The lightweight of aluminium and the broad range of decorative possibilities have made it a significant material for the twentieth century jeweller.

An area of colour that has not been covered so far is patination. Examples exist from antiquity of metal sculptures that have been coloured in this way and historic armour used 'bluing' to provide multicoloured surface decoration (Tellez, 2011). However, as much historic jewellery has been buried, it is often not possible, even if the underlying metal has survived, to be sure if the whole surface was coloured.

The twentieth century saw the introduction of a new metal, titanium, whose colour could be said to be produced by a form of patination, i.e.

oxidation. Industry values titanium for its unique combination of high strength and low weight, and although this has been exploited by a few designer/makers, it is titanium's colour potential that most attracted jewellers to the material and led to its expanding usage through the 1970s and 1980s. The thin oxide layer produced on the surface of the metal by heat or anodising resulted in a wide range of interference colours. Various ways of preventing oxygen reaching the surface by masking were used to produce stunning optical effects. Research has established (Bartlett, 2009) that the use of titanium for designed jewellery was a technical innovation, pioneered in the UK and instigated by the titanium metal producers.

Early users of titanium tended to use coloured pieces in a similar way to gemstones by setting them in silver frames or fixing them with silver pins. However the strength of titanium meant that very thin sections could be cut as integral pins. Its biocompatibility also meant that integral ear wires could be produced without the problems that have been associated with the use of non-precious metals for such a purpose.

One of the pioneer jewellers who first used titanium at Birmingham (1965-1968) was Ann Marie Shillito. The first identifiable piece of designed titanium jewellery is a belt buckle. Another artist of note in the early decorative use of titanium was Pietro Pedeferri, a University researcher in electrochemistry in Milan, he was inspired by the colour possibilities of the metal to produce wonderful compositions on titanium. In this case he used flat sheets of titanium as a canvas.

By the early 1970s titanium had become a regular product used in Jewellery courses. However its popularity peaked in the late 1980s and it is only in recent years that its use has been revived, Figure 12.

8. CONCLUSION

This rapid survey has provided an outline of various materials and methods that have been used to incorporate colour into jewellery over many centuries. Jewellers have been shown to readily incorporate new materials and exploit new sources of valued gemstones as they become available while building on the legacy from previous periods. Precious metals and gemstones continue to provide the most desired raw materials for the manufacture of jewellery but whatever the material, colour continues to be a major factor in jewellery design and new coloured materials are eagerly adopted.

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CONFLICT OF INTEREST

The Authors declare that there is no conflict of interest.

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Colour as a mass product. Designing of the collection of interior paint colours for the Polish market

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ABSTRACT

The paper concerns the issue of using colour in contemporary Polish residential interiors based on the example of design and sales of paint collections by selected Polish manufacturers. The collections of colours, which usually contain between 40 and 60 shades, constitute a popular offer for the customers who do not employ interior designers and feel no need for more advanced colour selection from mixers. A collection of colours with a rather small number of shades makes it easier for the customers to choose the colour and is an economically beneficial alternative to mixing colours based on the currently used colour systems.

Designing colour collections for two large Polish companies over several years has allowed me to make certain interesting observations concerning the specific colour preferences of the Polish customer, based on both sales results and the colour trends established by the Polish market, which are often different from the trends of Western Europe. The presentation will recognise the changes made to the collections in the years 2011, 2012, and 2013 – which will reflect both the changing colour trends and the local colour traditions or inclinations resulting from climatic, historical, and economic conditions.

KEYWORDS

Colour design, colour in architecture, colour in interiors

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1. HISTORICAL BACKGROUND

Colours used in interiors, in a particular country, are connected with such factors as local tradition, materials and dyes, as well as colour preferences of its residents which reflect the surrounding flora, climate and landscape, as well as colour symbolism, and various aspects of material culture. In Poland, during the period of the communist regime, economic problems caused that the opportunities of buying elements of interior design were very limited. Paints produced by the state companies available on the market were also of a very narrow range of colours. More demanding consumers who wanted to stand out against all-pervasive mediocrity were forced to turn to house painters who helped them achieve exceptional colours depending on their individual needs by mixing pigments. On the other hand, in public buildings and facilities, a typical combination of colours was used, which caused that staircases in residential buildings, as well as school interiors, public administration buildings and health service facilities looked almost identical. At the same time, the economic and political crisis of the 1980s leading to the political transformation in 1989 caused that most buildings were left non-renovated, and it brought about general dullness of surroundings.

2. COLOUR STANDARDS IN POLAND

Thus, craving for colour was one of the effects that a capitalist system brought in towns. State companies like *Zjednoczenie Przemysłu Farb i Lakierów Polifarb* were divided and taken over, in part, by foreign companies; what was left originated Polish local brands. In the 1990s, the Natural Colour System was introduced in Poland due to the efforts of Janusz Konaszewski and Ryszard Bojar, and it became the most popular standard of colour notation. Then, there were initiated works concerning the creation of the first Polish pallet of colours. The Color Koncept Studio of Ryszard Bojar prepared a set of interior and elevation colours inspired by the colours of the Polish landscape. For a year, a team consisting of Ryszard Bojar, Violetta Damięcka, Krystyna Arska, Agnieszka Putowska, Sylwia Dobrowolska examined selected regions of Poland in a manner inspired by *Geography of Colour* by Philippe Lenclos (Lenclos, Lenclos 2008) and it resulted in a selection of several dozen of colours grouped in four categories: yellow (G90Y-Y50R), red (Y60R-R10B), blue (R20B-B10G), green (B50G-G80Y) and off-white (c=00, c=02)[2].

3. COLOUR IDENTITY

The search for the colour identity of the Polish territory was also based on references to folklore tradition that had generated a number of original patterns in many regions. In her doctoral dissertation titled *Colours in rural architectural and landscape complexes*, with special emphasis put on the southern Poland area, (Tarajko, 2005) Justyna Tarajko points out a range of hues and colour sets used in rural houses of the Krakow and Sandomierz areas, as well as of the Podhale and the Powiśle regions. The analysis includes dyes and sets of colours, as well as regular ornaments used both inside and outside buildings. The application of dyes produced from local clay and lime, along with natural colours of wood, created a pallet of colours well harmonized with the surrounding flora and natural scenery. However, when traditional wooden architecture was replaced with a chaotic pseudo-modern one, particularly in places where there were no area development plans, it brought about visual chaos, especially in terms of colours.

4 COLOUR OUTSIDE

On the other hand, natural colours of brick and stone, as well as colour sets resulting from the combination of those materials, have been largely predominant in urban architecture, particularly in the area of southern Poland. Jurassic limestone has been a building material particularly popular in Małopolska, and it was obtained in the form of limestone bricks used for secular and sacred buildings from the Middle Ages, through the Gothic, Renaissance, and Baroque era, nearly to modern times (Rajchel, 2004). The combination of dark red bricks and warm white lime is a characteristic element of the architecture of the Krakow area landscape. Limestone has also been used in the form of cobblestones, frequently combined with a porphyry material. The precincts of the St. Mary's Basilica in Krakow are a perfect example of this usage. Light yellow dolomite has also been a popular material which greyed under the influence of atmospheric factors. A lot of architectural elements, both inside and outside, have been made with yellow and grey Subcarpathia sandstone, sometimes with a reddish hue. There could also be found dark brown or rust-coloured sandstone, depending on the location of the deposit where it was extracted. At present, in spite of the fact that natural stone is not so popular in architecture anymore, it should be noticed that warm colours of yellowish, reddish and beige hues are still preferred both for interior and external designs, as it has been shown, among others, in research conducted at the Academy of Fine Arts in

Krakow (Zeszyty Naukowe Katedry Przestrzeni i Barwy, 2010).

5. COLOURS FOR INTERIOR DECORATION

A necessity of choosing colours for interior decor causes a lot of problems for people who are not professionals in the field of design and architecture. Therefore, the experience of Polish companies shows that extensive colour charts derived from a standard colour notation system (NCS, Munsell, ACC) are solutions rather for designers and architects than for an average consumer. That is why, in the early 1990s, collections of ready-made colours appeared in the offer of many companies. In many cases, a proposed set of colours was created without designer's participation, being a result of experience of a sale department, and it included pastel colours (without addition of black). of a distinct chromatic hue which looked good in small colour samples - yellow, green and orange. These were the colours which were supposed to help people overcome the dullness of concrete buildings typical of the architecture of the Communist period having such bad connotations. *The Global best selling colours* (The Global best selling colours, 2008) research which was carried out by the Akzo Nobel Decorative Paints company in 2008 proved that, in comparison to the residents of Western European countries, the Poles show a much stronger tendency to use pure colours, warm in particular, but they reject achromatic and cold colours. Moreover, the analysis carried out for marketing purposes by Fabryka Farb i Lakierów Śnieżka showed that, in 2010, the best selling colours for interiors were warm hues of beige, yellow, and orange: 1 – desert flower (NCS 1510 – Y40R), 2 – sunshine (NCS 1040 Y10R), 3 – scorching savannah (NCS 0515 Y40R), 4 – hot summer (0550 Y30R).

6. COLOUR NAMES

Names constitute an important element of a set of ready-made colours; names should be associated with common experience of colours and usually connected with observations of nature, changing seasons or semi-precious stones. Names given to particular colours stimulate imagination and, at the same time, facilitate remembering paint hues. Here are some examples of names of the collections available on the market: *Colours of Nature* (FFiL Śnieżka), *Colours of the Elements* (Bolix), *Seasons* (Nobiles), *Garden of Colours* (Jedynka), *Magic of Refined Colours* (FFiL Śnieżka), *Decoral – Fashion* (Decoral), *Colours of the World* (Dulux). An analysis of different names of colours included in these collections makes one aware that there are no names of colours in the Polish language connected with architecture or local pigments. At the same time, the real hues corresponding to names like Bunch of Roses, Spring Leaf, Mountain Crocus, Field of Sunflowers or Juicy Apricot are a lot more vivid than the colours of paints bearing those names. This confirms that an average consumer has a taste for pure and bright colours which are not always suitable for interior usage. The conducted study also shows that descriptive names have a clear advantage over the numeric notations resulting from the adopted system.

7. COLOUR TRENDS

Collections of ready-made colours are annually updated so that companies could have a chance to announce current colour trends for a given year. However, in this case, the scope of changes is very limited due to the fact that consumers are accustomed to particular colours, and due to their reluctance to be driven by trends while changing interior designs. As it has been shown by the research carried out by the Institute of Industrial Design in Warsaw in 2011, the basic reasons for choosing interior colours are as follows: individual colour preferences of consumers (48%), price (18%), colours of other furnishings (15%), family and friends' advice (8%), designs derived from the interior and architectural magazines (5%), sale special offers (4%), others (2%). Therefore, in spite of the fact that some companies announce colour trends each year, in fact, they are mostly based on the same shades, juxtaposed in different combinations, alternatively supplemented with a few season hues. Having participated many times in groups setting trends in ready-made colours for various Polish brands, I must state that these trends are mainly of marketing character and are based on the experience of large European concerns. New colours are introduced in a very limited range so as to preserve the basic character of the collection and reduce the risk factor to the maximum. New colour trends are often intended for colours produced in mixers, but not for those sold as ready-made ones. It is the effect of the situation where the consumers interested in new trends are those who can afford to buy more expensive brands and seek advice from an interior designer.

8. DESIGNING OF COLOUR COLLECTIONS IN POLAND

In 2011, I started cooperation with the Śnieżka company - a producer of interior paints available on the Polish market and in other countries of Eastern Europe. As their consultant, I was

responsible for redesigning the *Colours of Nature* collection, and I participated in the creation of the Satin brand newly introduced onto the market. The company offers products in the medium price segment, and those products constitute a representative reflection of an average Polish consumer's preferences. *Colours of Nature* is a collection existing on the market since 2004, and in the beginning it consisted of 40 colours; in the successive stages, it was extended to 53 colours in 2014. At first, it was divided into five hues: yellow, orange, red, green and blue (combined with purple), and it only included colours having the dominant content of white (NCS S0505 – 0540), derived from a limited number of colour triangles. In 2007, it turned out that the collection clearly lacked warm neutral colours: off-white, beige and brown. The range of colours was extended and arranged in the following groups: neutral, yellow, red and orange, green, as well as blue and purple. The brand offered only one hue of warm grey. In 2011, because of the increasing popularity of cool and neutral colours, I suggested that a separate line of colours should be added to the collection. However, when research was conducted, it turned out that this type of changes would not be accepted by consumers. In subsequent years, three cool greys appeared gradually on the market, but their sale is mainly connected with consumers coming from big cities. Moreover, four colours of the blue and purple group were phased out.

In 2012, the Greinplast company from Rzeszów requested my help in the creation of a new brand of ready-made colours of paints for residential interiors. The company, which addresses its products to architects and construction companies, previously used a wide range of NCS colours, mixed according to the consumers' needs. However, at the request of individual consumers, a decision was made to extend the offer by about 40 ready-made paints. The subject of the project was both designing a series of colours, their names, and suggested combinations, as well as preparing sample applications of the colours in residential interiors on the basis of photos coming from a bank of photographs. The Greinplast company sells its products in southern Poland; therefore, colour preferences of residents of that region were of special importance when choosing the colours. A set of different kinds of construction and finishing materials, as well as paints traditionally used in the architecture of the region, became the base for the choice of colours for the collection. The following materials were chosen (among others): Jurassic limestone, Subcarpathia sandstone, alabaster, marble from the Świętokrzyskie region, and porphyry from the region of Krzeszowice, as well as ceramic brick, and concrete. Colours were analysed on the basis of NCS, and it led to the creation of a set of about 120 colour samples. The final collection, introduced onto the market in the autumn of 2013, consists of 40 colours divided into five hue lines. Because of the fact that the collection is mainly addressed to a group of architecture and construction professionals, the company decided to introduce sixteen neutral colours: eight warm and eight cool hues. The proposed names are directly related to the architectural materials and pigments. A summary of sales results planned for the autumn 2014 will enable the company to verify the colours of the collections.

9. CONCLUSIONS

A study of the Polish market carried out through a period of the previous four years allows us to draw conclusions concerning both consumer preferences in connection with the range of colours used in interiors, as well as directions of changes to which those preferences succumb. Colour notation based on NCS allows one to determine the scope of the changeability of colour features like whiteness, blackness and chromaticity. The offer available on the paint and coating market, which is becoming better and better, causes that consumers are more aware and demanding, and in the future it may lead to more common usage of a wider pallet of colours (of the NCS for instance) obtained in paint mixers, and thus, to the improvement of the appearance of private flats or public buildings and facilities..

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CONFLICT OF INTEREST

The author declares no conflict of interest including financial, personal or other relationship with other people and organizations within three years of beginning the submitted work that could inappropriately influence, or be perceived to influence, this work.

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Exploring the relationship between LEDs Lighting, Urban materials chromaticity and People: measurements, design and evaluation

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ABSTRACT

The aim of the research was to define urban lighting design insights, by reflecting on the relationship between urban material properties (chromaticity and spectral reflectance) and specific LEDs based lighting spectral emissions to enhance the nightly image of cities and to achieve efficient solutions. A preliminary selection of urban material, representative of different "urban colourscapes", was then followed by the definition of several lighting receipts (illuminants) which were defined by three research hypotheses. An exploratory perceptive user assessment was set up and performed to derive some insights about the transformation of the user's perception about the same material with different SPDs, to significantly enhance the attractiveness and appeal toward the architectural and urban surfaces.

KEYWORDS

Lighting Design, Urban Material, SPD, textures, Spectral Reflectance, Chromatic Saturation, LEDs

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1. INTRODUCTION

The literature review defines the *"urban colourscape"* (Lancaster, 1996) as the colour summation of the exposed elements perceivable in urban public spaces (Yin, 2003), both the natural objects (e.g. urban bare land, rocks, grass, rivers, trees etc.) and the artificial ones referring to urban buildings, structures, roads and furniture (Xiaomin and Yilin, 2009). It is defined both by urban single colours and by the whole visual effect made by the contrasts of different layers of the city and the general environmental luminosity (Valan, 2011). The urban colourscape influences the urban culture and style. The 75% of the main visual leading tonality is made from the combination of the hue of the walls, dependent by the inherent colour of building's materials or by surfaces paints (Bagordo, 2012). Several studies show that, the great part of historical urban colour is mainly dependent by the inherent colour of building's materials decided for their cheapness and easiness to be found, such as yellow or white paint (Bagordo, 2012). In more modern urban constructions, with new technologies and new materials, also new colours are used, following the fashionable trends in architecture with saturated coloured coats or luxurious façade surfaces and materials (Borsotti, 2012). The majority of available studies about this topic focused on the urban chromatography during the daytime, forgetting the importance of designing the chromatic image (Nasar, 1998; Lynch 1960) of the city by night (CIE 136 – 2000; Bellia, Agresta and Pedace, 2013) due to the use of artificial lighting design to shape the distinctive quality of the space. This is important to ensure the city beautification (Schanda, 2001), to increase the navigation in the urban nightscape (Van Santen, 2006) and to provide energy efficiency. This paper aims at investigating the urban colourscape by night, considering issues related to urban materials, lighting design practice and LEDs lighting technologies. The hypothesis is that, as LEDs based lighting fixtures are becoming more powerful, efficient and more sophisticated in terms of the provided different spectral power distribution (SPD), the urban lighting design could take into account users' experiences of the urban chromatography during the night-time.

2. RESEARCH AIM

Considering the fact that there are few studies exploring the topic, this research was aimed at pioneering the exploration of the relationship between urban material properties (chromaticity and spectral reflectance) and specific lighting spectral emissions that could enhance the visual appearance of facades, external walls and street surfaces. The study was performed through objective and subjective evaluations, by using both the quantitative and qualitative analytical method. The research hypothesis is that LEDs based lighting systems, applied in the urban space, can be customized for enhancing the perceived brightness, colour rendering and saturation of colours of materials of a specific urban space and, at the same time, achieving the scope of energy efficiency by wisely manipulating the SPD.

3. RESEARCH METHODOLOGY

A two steps investigation about urban materials and LED's based lighting systems was performed:

- Phase one: collection and preparation of highly recurrent urban materials that were grouped into clusters and measured into a laboratory set up.
- Phase two: definition of lighting receipts specific for the different categorized chromatic samples followed by an exploratory subjective assessment with users.

4. URBAN MATERIAL SELECTION

The investigation was performed with a preliminary survey about the most representative urban materials used in Europe, both traditional and modern ones, by collecting samples to be tested into a laboratory set up. The selection was aimed at covering a wide range of chromaticity: stones, bricks along with natural, varnished and treated (oxidated) metals. A small range of materials (20 samples) was measured (Figure 1).

4.1 URBAN MATERIAL MEASUREMENTS

Measurements of the spectral reflectance of surfaces (Figure 1) were performed using the Minolta Photospectrometer CM-700d. Each material was measured several times in different points of the surface because colours changed significantly in the same sample. After the calibration test, each measure was repeated five times to derive a mean measurement (Casciani, Musante and Rossi, 2014).

4.2 URBAN MATERIAL CLUSTERING

Depending on spectral reflectance, materials were clustered in different categories:

- *yellowish and reddish toned ones*, such as Bricks, Cor-Ten Steel, Dark and Light Brass;
- *reddish materials*, such as Porphyry Stone and red (RAL 3020) varnished

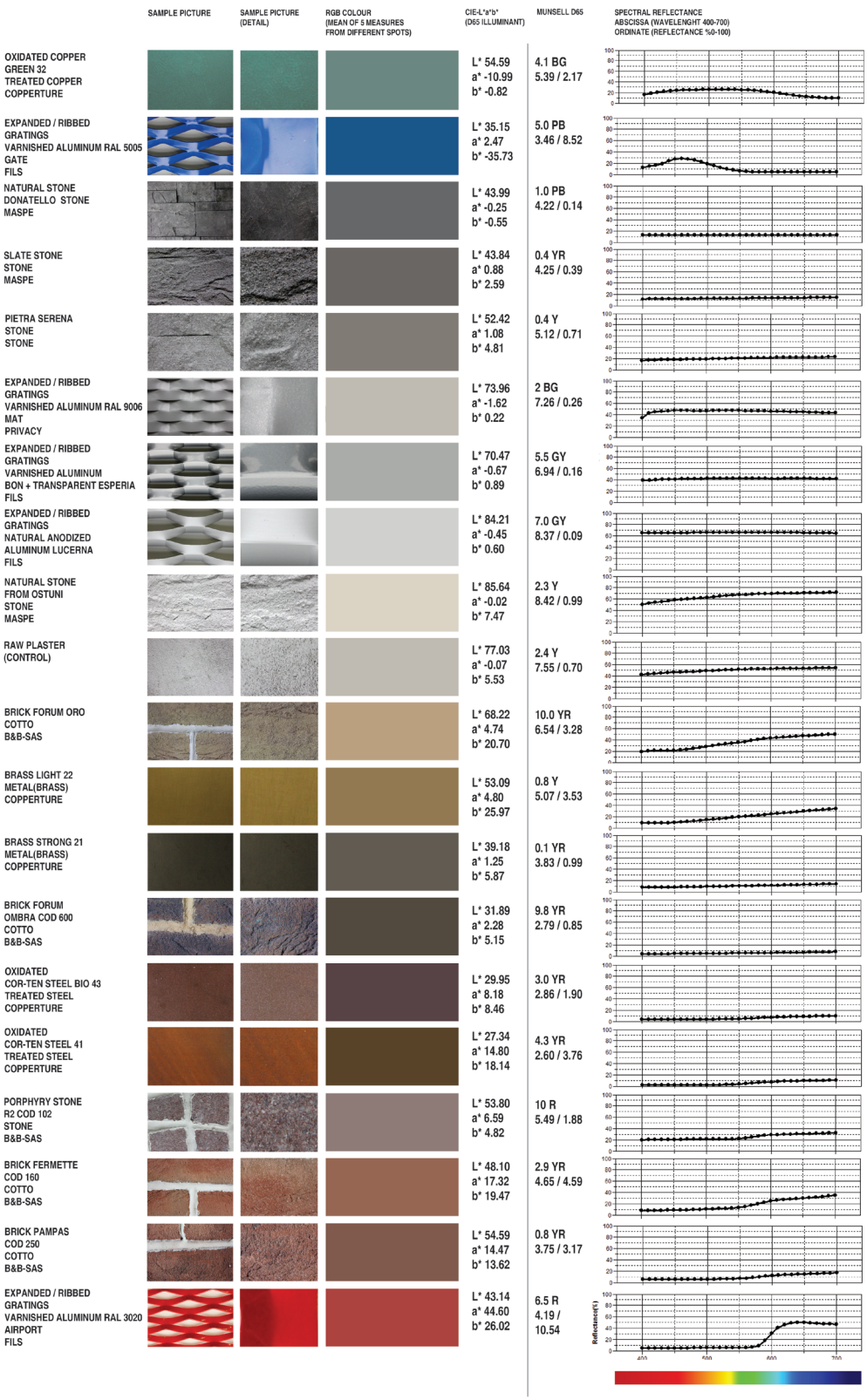

Figure 1 - Diagram of selected urban materials: two pictures of the sample under natural lighting, the correspondent measured colour given as a RGB uniform colour, the correspondent in the CIE L*a*b*, the corresponding Munsell chip plate when samples were lit by D65 illuminant and the measured spectral reflectance.

Aluminium;

- *green-bluish materials*, such as Green Oxidated Copper and blue (RAL 5005) varnished Aluminium;
- *clear grey materials*, such as Plaster, natural Aluminium, anodized Aluminium, clear (RAL 9006) varnished Aluminium, Ostuni stone;
- *darker grey and black ones*, such as Pietra Serena Stone, Slate Stones.

5. CUSTOMIZING THE SPECTRAL POWER DISTRIBUTION

Recently, the necessity to have a better method for characterizing the colour rendering quality of LEDs has increased the debate about the effectiveness of the traditional colour rendering metric (CIE-CRI) (Schanda, 2002; Bodrogi et al., 2005; Davis and Ohno, 2005). The traditional CIE-CRI is a fidelity metric, used to measure the

ability of a light source to render a defined set of colour's samples in comparison to a reference illuminant (Commission Internationale de l'Eclairage, 1995). On the other hand, *"fidelity"* is not always the desirable property of a light source, because, in some situations, the colour saturation is preferred (Judd, 1967; Smet et al., 2011; Houser, Tiller and Hu 2004). In relation to this, some studies were recently performed in residential and retail contexts (Knight, 2013; Rea and Freyssinier, 2013), showing that a wide range of chromaticity can appear *'white'* or *'minimal tint'* and that such chromaticity do not belong to the Black Body Locus (BBL). With illuminants with chromaticity below the BBL, colours of the items appeared more striking and white objects appeared brighter. In this regard, LEDs can perform a sharp spectral variation, optimizing their SPDs in order to maintain high CRI while increasing the ratio between the lumen output and the optical power of the light source (Luminous Efficiency of Optical Radiation, LER).

5.1 SELECTING THE METRICS OF COLOUR RENDERING INDEX

In order to design a set up for a perceptual evaluation of the appearance of urban materials (and their colours) in relation to different SPDs, a set of illuminants for two different values of correlated colour temperatures (CCT), 3000K and 5000K, were designed to compare different CCTs and different SPD, in order to obtain better chromatic rendering or more vivid colours in relation to red/orange and green/blue materials or to render more luminous and texturized the appearance for the grey ones.
For the evaluation of colour rendering, three different indices have been considered:

- CRI (R_a) for the evaluation of colour fidelity;
- CQS (Q_a) (Davis and Ohno, 2010) which uses the saturated chromatic samples and does not penalize the increase in the score of saturation without tint distortion. Some illuminants were built to maximize several chromatic samples in relation to the previous clustered categories (e.g. red, red/yellow, green/blue). The CQS method defines the gamut area scale Q_g that is calculated as the relative gamut area formed by CIELAB a*, b* coordinates of the 15 colour samples illuminated by the test illuminant. The Q_g value is normalized by the gamut area produced by the CIE D65 and multiplied by 100.
- TM-30-15 is a standard for quantifying colour rendering properties of light sources, published by the Illuminating Engineering Society in 2015. This Technical Memorandum describes a method for evaluating light source colour rendition, quantifying the fidelity (closeness to a reference) through a Fidelity Index (R_f) and gamut (increase or decrease in chroma) through a Gamut Index (R_g) of a light source (TM-30-15, 2015). The method also generates a colour vector graphic that indicates average hue and chroma shifts, which helps in interpreting the values of R_f and R_g. This graphical representation is very useful to understand the difference between two SPDs with the same value of R_g index (i.e. 100) in rendering the appearance of different colour samples. In particular, $R_g > 100$ means an average increase in saturation; $R_g < 100$ means an average decrease in saturation.

6. EXPLORATORY SUBJECTIVE ASSESSMENT OF LIT MATERIALS

6.1 DESIGN OF THE EXPERIMENT: MATERIALS SELECTION AND LIGHT BOOTH

The second part of the research about the relationship of lighting and urban materials was focused on testing a smaller amount of material samples under different lighting conditions in a controlled experimental light booth equipped with LED lighting sources. In each different categorized chromatic and material cluster, the most representative samples were chosen in order to represent different hues (red/yellow/green-blue/clear grey) but also different application in the city (facade, pavement, basement, monuments, roofs) (Figure 2).
The light booth is a small chamber (80x76x58cm) with internal surfaces in achromatic medium grey ($\rho = 0.36$) and LEDs lights sources placed at the top of the booth. It is equipped with 5, separately controllable channels: Phosphor converted cold white (5000K), Phosphor converted warm white (3000K), generic Red LED with a dominant wavelength of 624 nm and a typical Spectral Half-width (nm) $\Delta\lambda_{1/2}$=20 nm, generic Green LED with dominant wavelength of 505 nm and a typical Spectral Half-width (nm) $\Delta\lambda_{1/2}$=30 nm, generic Blue LED with dominant wavelength of 455 nm and a typical Spectral Half-width (nm) $\Delta\lambda_{1/2}$=20 nm.
The intensity of each colour is set up by a PWM constant voltage LED driver controlled by the DMX protocol: the DMX controller is an electronic board connected to a laptop through an USB port. A dedicated software running on the laptop was used to select the required lighting mixture for the experiment (Figure 3). The average illuminance measured on the surface of the sample was about 70 lux which

Figure 2 - Selected urban materials for the experiment from left to right: Oxidated Copper Green, Ostuni Natural Stone, Brick Forum Oro, Brick Fermette Cod 160, Porphyry Stone

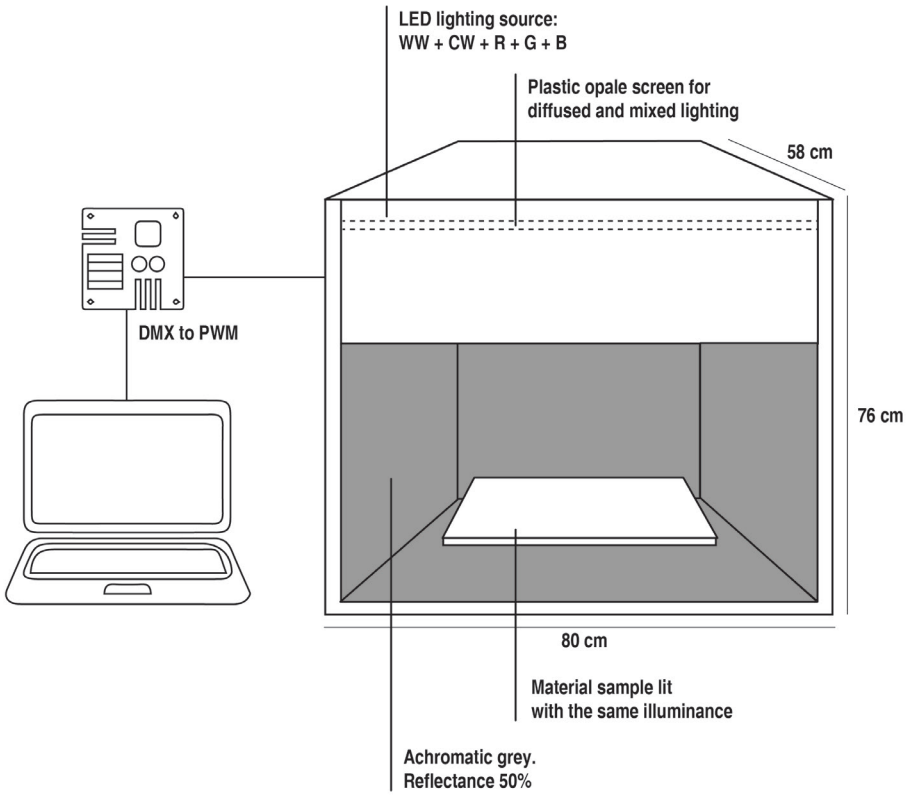

Figure 3 - Lighting booth set up: main features and dimensions

was considered a suitable average value for architectural lighting in urban spaces.

6.2 DESIGNING THE ILLUMINANTS: EXPERIMENT HYPOTHESIS

To properly evaluate the gamut area (tint distortion and increase/decrease of saturation), it is important to select colour samples whose reflection's spectra cover all real current and future pigment absorption's spectra to preclude gaming. Gaming means that the SPD of an illuminant could be tailored in order to improve the score of the index, but do not improve the fidelity of a specific colour plate: in fact it is possible to introduce a small perturbation in the visible spectrum to exploit specific details of the reflectance samples used for colour rendering index calculation (Smet et al., 2013). For this reason, TM-30 colour sample dataset has been chosen for evaluating the gamut area of each proposed illuminant.

Hypothesis 01:
High colour rendering of the materials

Two illuminants with a high value of CRI and CQS (at least 90) and with different colour temperatures were proposed (3000K-5000K). In particular for the high colour rendering 3000K illuminant (Figure 4):

- Q_1>90 and Q_2>90 for materials clustered in Red group;
- Q_7>90;Q_8>90 for materials in Grey group;
- Q_2>90;Q_3>85;Q_4>90 for Yellow-Orange group;
- Q_{10}>95;Q_{11}>95;Q_{12}>95 for Green/Blue group.

For the high colour rendering 5000K illuminant (Figure 5):

- Q_1>90 and Q_2>85 for materials clustered in Red group;
- Q_7>90;Q_8>90 for materials in Grey group;
- Q_2>85;Q_3>90;Q_4>95 for Yellow-Orange group;
- Q_{10}>85;Q_{11}>85;Q_{12}>95 for Green/Blue group.

For both the illuminants, the main colour rendering differences were located in the green sample (Q_6), the orange sample (Q_2) and light blue (Q_{11}) sample, so it was expected a good colour rendering for red and yellow materials (bricks and porphyry stones) and for green/bluish ones (oxidized copper plate). All the illuminants developed according to the

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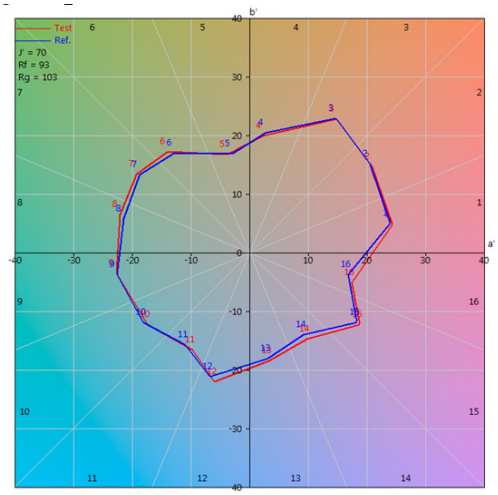

Figure 4 - (left) TM-30 Gamut Area Plot: Test is a 3000K illuminant (high fidelity colour rendering index); Reference illuminant is a blackbody at 3000K

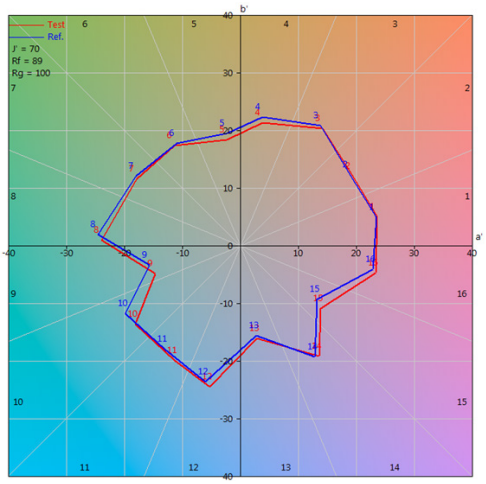

Figure 5 - (right) TM-30 Gamut Area Plot: Test is 5000K illuminant (high fidelity colour rendering index); Reference illuminant is daylight at 5000K

hypothesis 01 were constrained to be near the BBL ($\Delta u'v'<0.01$). This hypothesis was defined for permanent floodlighting of historical buildings and monuments whose image should be preserved and whose colours and textures of original material should be rendered in their original and true majesty (Schanda, 2001).

Hypothesis 02:
Enhance colour saturation for more vivid and luminous appearance of the material

The use of more saturated coloured lighting in the city was hypothesized useful for creating more interesting, pleasurable experiences, for accenting elements, enhancing volumes and in particular the architectural materials, for creating a more pleasant environment (Gardner, 2006; Van Santen, 2006; Schwendinger, 2009). Three different illuminants were designed: 3000K, 3149K and 5000K, for obtaining more vivid colours in red/orange and green/blue materials and more luminous and texturized appearance for the grey ones. To reach this scope, a set of SPD with enhanced gamut area and low colour distortion were designed (CQS>80): on the basis of the literature review, the chromaticity of this light source was placed below the BBL on CIE 1976 (u',v') colour space. In relation to this, some works were recently published showing that a wide range of chromaticity can appear *'white'* or *'minimal tint'* and that such chromaticity do not belong to the BBL (Knight, 2013; Rea and Freyssinier, 2013).

The warm illuminant (3000K) with high saturation was designed to increase the saturation for colour samples in the orange-red, blue and green area. This illuminant was expected to increase the lightness and to enhance the perceived saturation of yellow/orange/red and green/bluish materials (Figure 6).

The warm illuminant (3150 K) with moderate saturation was designed with high values of CQS for the samples Q_1>95 (deep red), Q_4>90 (gold yellow) and Q_{12}>90 (deep blue). This illuminant was expected to increase the lightness and to enhance the texturization of clear/white/grey materials (Figure 7). The main difference between this illuminant and the previous one is the value of CIE colour rendering index, which is R_a=67 for the high saturation SPD and 95 for the other.

The cold illuminant (5000 K) with high saturation was designed with a low value of fidelity colour rendering index (R_a=67) and an increase of saturation for colour sample in the orange/red, azure, violet and in the green area (Figure 8).

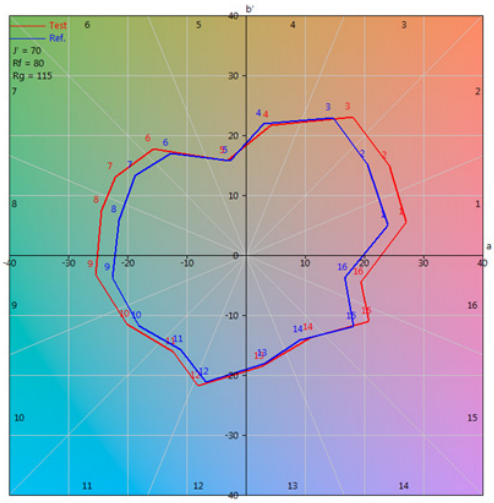

Figure 6 - (left) TM-30 Gamut Area Plot: Test is 3000K illuminant (high saturation); Reference illuminant is a blackbody at 3000K

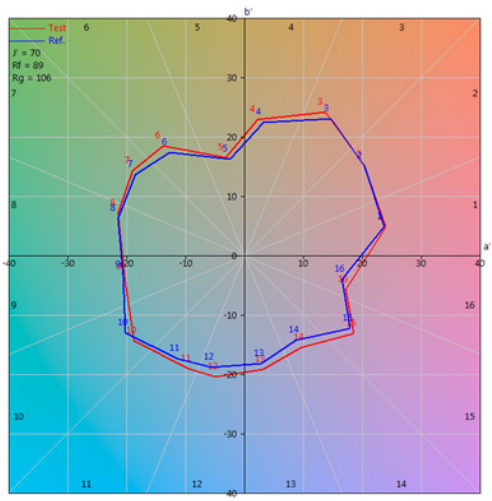

Figure 7 - (right) TM-30 Gamut Area Plot: Test is 3150K illuminant (moderate saturation); Reference illuminant is a blackbody at 3000K

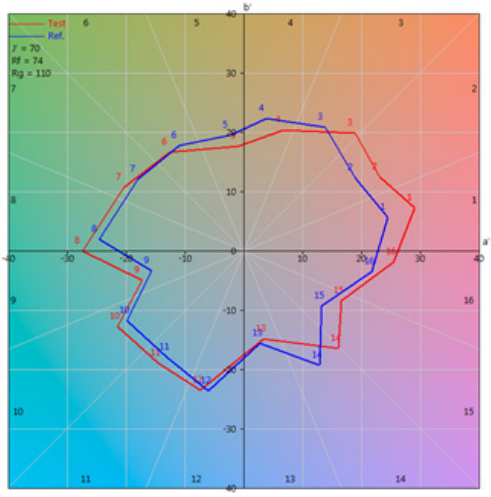

Figure 8 - TM-30 Gamut Area Plot: Test is 3150K illuminant (moderate saturation);
Reference illuminant is daylight at 5000K

Lighting receipts (illuminants)

LEDs lighting receipts were both based on the previously described hypothesis and were conceived in order to perform the lighting perception assessment with the users. The reference illuminants were designed in two CCT and with a standard CRI (A1 @ 3000K CRI 84 and B1 @ 5000K CRI 80) and were compared for each material in order to understand people inclination in choosing one CCT or another (the results of this part of the experiment are not discussed in this paper).

The illuminants with high CRI (93) were also designed in two different CCT (A2 @ 3000K and B2 @ 5000K) and compared with the reciprocal reference illuminants. The illuminants with a SPD with enhanced gamut area and low colour distortion were designed in the two CCT (A3 @ 3000 and B3 @ 5000K) and were used in comparison with the reciprocal reference illuminants for coloured materials. More than this, a moderate saturated warm illuminant (C3 @ 3150K) was designed to be compared with clear achromatic materials. The horizontal illuminance (E_h) values were set up and measured to be equal throughout the experiment and between the different illuminants (Figure 9).

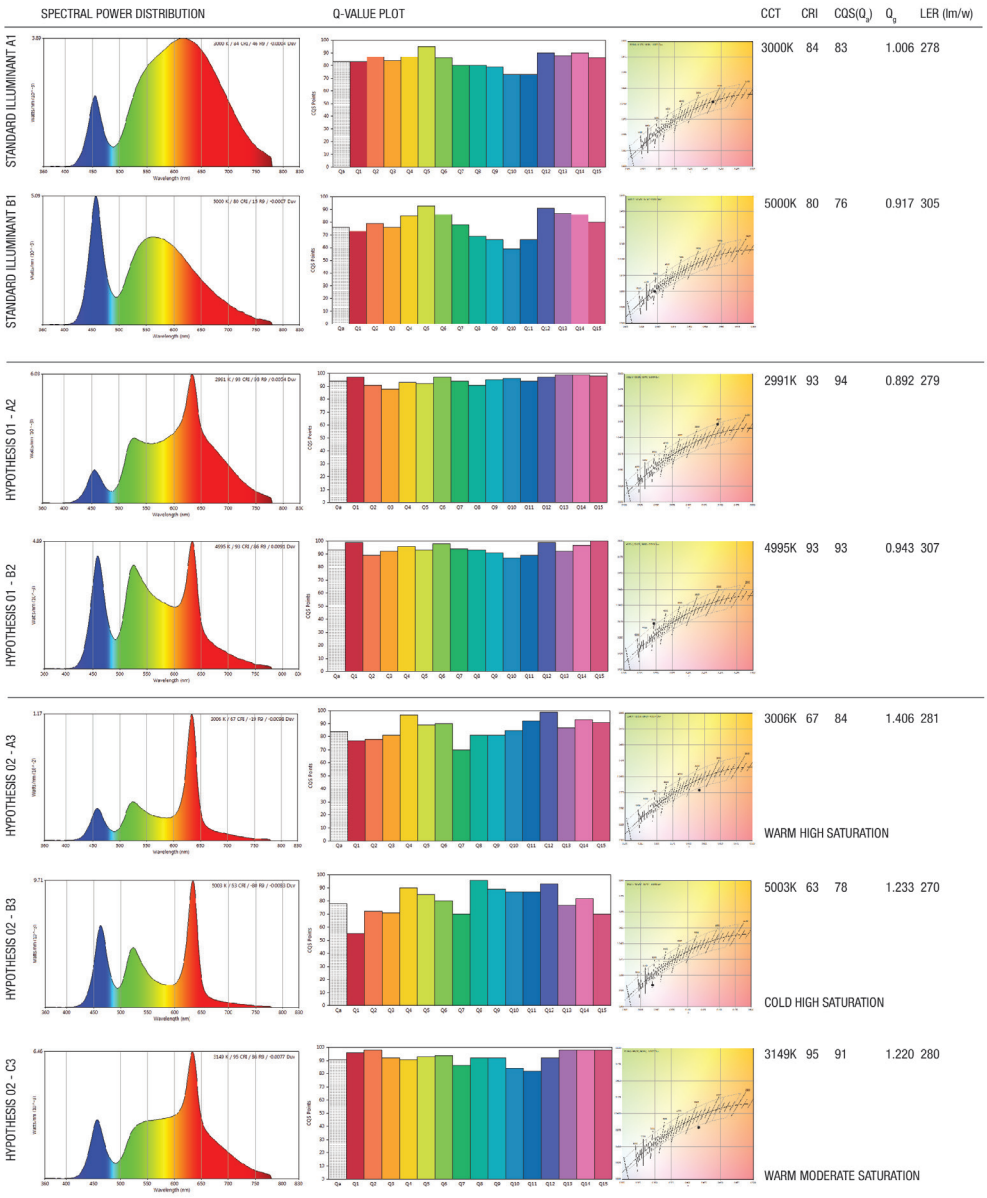

Figure 9 - Representation of selected SPDs for reference illuminants, hypothesis 01 and hypothesis 02

6.3 LIGHTING ASSESSMENT

In order to test the lighting influence in perceiving urban materials and to investigate the impact of the lighting design on the appearance of materials, a qualitative and quantitative cross-cultural investigation from users perspective was conducted. 26 volunteering normal colour vision students (53% Male – 47% Female; average age 28 years old; 40% Italy, 13.3% Brazil; 13.3% Lebanon; 33% Ecuador, Colombia, Philippines, Turkey, France) participated to the test. The test consisted in watching the selected 5 materials [Figure 2] under 7 different lighting conditions (illuminants) coupled in opponents for a pairwise comparison:

- Reference Illuminant (A1-B1) vs Hyphotesys1 (A2-B2);
- Reference Illuminant (A1-B1) vs Hypothesys2 (A3-B3-C3).

Participants were adapted to each lighting condition and were asked a series of questions in order to assess the naturalness of the appearance (e.g. realism and colour fidelity), the enhancement of texturization (e.g. tri-dimensional appearance), the enhancement of colours vividness (e.g. saturation) and the augmented luminosity (e.g. brightness) of materials. An Ishihara test was performed preliminarily to check eventual colour blindness between participants. During the perceptive tests, the order of the questions and materials was randomized.

7. RESEARCH RESULTS

A preliminary elaboration of data was performed with a statistical analysis (Likelihood ratio) in order to identify the main perceived differences between the lighting receipts. The quantitative statistical data were supported by qualitative reflections derived from the interviews performed during the experiment. This was aimed to depict a more complete and clear understanding of the relationship between lighting and urban material perception from the user perspective. Qualitative descriptions were re-written, analysed and mapped in relation to statistical elaborations (Table 1).

The naturalness and realism of urban materials

The coloured (red, yellow, green/bluish) and the achromatic urban materials, under the illuminants with high CRI (A1 @ 3000K and B1 @ 5000K), were not perceived as more natural and better rendered by the participants. The majority of them *"could not notice a big, appreciable difference"* and showed problems in remembering the colour rendering of the material in natural conditions (*"under the sunlight"*). Participants noticing the realism of materials enhanced by the illuminant with high CRI perceived it as *"improved if compared with the previous (reference) one"*, *"looking more natural"*, gaining in *"three-dimensionality and depth of the grouts"* in comparison to the reference one, which was perceived more *"flat and uniform"* (e.g. Porphyry Stone). On the other hand, other participants perceived the materials under the high CRI illuminants as deviating the real colours by oversaturating in the yellow bands and lacking naturalness (e.g.Ostuni Natural Stone).

Saturated and vivid urban materials

All the coloured urban materials (red, yellow, green/bluish) under the illuminants with high saturation (A3 @ 3000K and B3 @ 5000K) were perceived as more vivid, more saturated and generally more colourful. In comparison to the

Table 1 - Statistical elaboration of data with *p≤0.05 **p≤0.01 ***p≤0.001 level of significance

LIGHTING RECEIPTS – ILLUMINANT COMPARISON WITH MATERIALS				PERCEIVED COLOUR FIDELITY AND REALISM	PERCEIVED COLOUR SATURATION AND BRILLANCE	
MATERIALS	REFERENCE ILLUMINANT	HYPHOTESYS 1	HYPHOTESYS 2	(%) RATING MORE NATURAL LOOKING MATERIALS IN HYPHOTESYS 1	(%) RATING MORE VIVID MATERIALS IN HYPHOTESYS 2	(%) RATING MORE LUMINOUS MATERIALS IN HYPHOTESYS 2
Oxidated Copper Green	A1	A2	A3	30**	90***	100***
	B1	B2	B3	62.5	100***	100***
Ostuni Natural Stone	A1	A2	C3	19.23***	-	96.15***
Brick Forum Oro (yellow)	A1	A2	A3	30.77***	92.30***	96.15***
Brick Fermette Cod 160 (red)	A1	A2	A3	46.15	100***	100***
Porphyry Stone	A1	A2	A3	20**	90**	90**
	B1	B2	B3	25**	75**	87.5***

reference illuminants, almost all the participants noted an *"enhancement of hue"*, an *"enrichment of chromatic rendering"*, an *"evidently saturation of colours"* that were *"better perceived"* as more *"saturated, vibrant, vivid"*: *"it looks more vivid, is like photography, better to look at, pleasant for the eyes"*. Urban materials appeared *"flat, pale and lifeless"* under the reference illuminants; meanwhile under the saturated illuminants they were perceived as *"more appealing"*, giving a *"chromatic balance"* and *"doing justice"* to the colours of the urban materials. In addition to this, *"when compared with the whiter grouts"*, many participants noticed different hues that were unperceivable before.

Brighter, more luminous and textured materials

All the coloured urban materials (red, yellow, green/bluish) and also the achromatic ones under the illuminants with high saturation (A3 @ 3000K, B3 @ 5000K and C3 @ 3149K) were perceived as more luminous and brighter, even if several participants explained that phenomena as a change in the CCT. The achromatic clear sample of material looked *"evidently whiter"* and details stood out in a more striking way. In fact, participants noted that the texturization was improved under the saturated illuminant: *"You notice more the imperfection"* and it was more evidenced the *"texturing and grit"*, meanwhile with the reference illuminants the material appears *"smooth"*. *"Grain becomes easier and faster to be perceived"* with the saturated spectrum that makes the materials *"less flat and with more details"* (e.g. in Porphyry Stone) by *"standing out more the three dimensions"*.

8. DISCUSSION, LIMITS AND FURTHER STEPS

This experimental study was conceived as a work about both measuring the properties of urban materials and hypothesising different lighting conditions to enhance their appearance properties. The study was also aimed at exploring the chromatic differences between urban and architectural materials in order to explore the urban colourscape at night, which is a particular topic of research in its infancy stage, from what stems from the literature review. More than this, the experiments highlighted the importance of the lighting conditions in which the urban materials are perceived: manipulating the SPD with specific characteristics can significantly change the user's perception of the same material and enhance the attractiveness and appeal toward the architectural and urban surfaces. All the hypotheses about the illuminants were derived both from lighting design practice and also from experimental studies conducted in different contexts (retail and domestic environments). In this regard, this experiment conducted on the urban material could be considered pivotal and the first on its genre for the applicative sector. The user assessment has been useful to confirm several hypothesis about the relationship between LEDs lighting, urban materials and people perception. Further steps of this study would provide a wider sample of participants to the experiment and the inclusion of experts' point of view on the topic. As a preliminary statement, this study can conclude that there is a wide margin for sophisticating and customizing the lighting receipts for specific urban materials in order to create better, more expressive and appealing nocturnal cities.

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CONFLICT OF INTEREST

The author declares that nothing has affected his objectivity or independence in the production of this work. Neither the author nor his immediate family member have any financial interest in the people, topics or companies involved by this article. Neither the author nor his immediate family member had a professional relationship with the people and companies cited in this article. Neither the author nor his immediate family member are involved in a legal dispute with the people and the companies cited in this article. No conflict of interest including financial, personal or other relationship with other people and organization within three years of beginning the submitted work that could inappropriately influence, or be perceived to influence, this work.

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Renata Pompas

REVIEW

Riccardo Falcinelli, CROMORAMA. How color changed our gaze. Einaudi Stile Libero Extra, Torino, 2017.

The topic of color recently evokes great public interest, prompted by several articles (as the weekly column *"Shades"* of the newspaper La Repubblica) various publications and books. Riccardo Riccardo Falcinelli, visual designer and professor of Psychology of Perception at Isia University in Rome, after eight years of work, wrote, illustrated and made the layout of his book, original in its content and packaging: the bibliography is displayed in a vertical band along with the text, the footnotes are in the footers,

L'argomento colore conosce ultimamente un grande interesse da parte del pubblico, sollecitato da numerosi articoli (si pensi alla rubrica "Sfumature" pubblicata settimanalmente dal quotidiano La Repubblica) pubblicazioni varie e libri.
Riccardo Falcinelli, visual designer e professore di Psicologia della percezione presso la facoltà Isia di Roma, ha scritto illustrato e impaginato in otto anni di lavoro un libro originale nel contenuto e nella confezione: il testo è accompagnato nella banda verticale dai richiami bibliografici, le nota sono a piè di pagina, l'apparato figurativo si presenta sotto forma di composizioni di dettagli di immagini diverse, accostate per suggerire confronti e assonanze. Il corposo testo (470 pagine) è suddiviso in quattro parti i cui titoli sono poetici, piuttosto che sistematici.

- *"Parte prima Sguardi"*, introduce l'argomento cardine del libro su come il nostro sguardo sul colore cambi nel tempo in relazione alla società. Comprende tre sottocapitoli: *"Giallo industriale. La società del design"*. *"Rosso unito. L'occhio del XXI secolo"*. "*Nero articolato. Possibilità del colore industriale"* i cui argomenti variano dalla moderna normalizzazione e serializzazione industriale del colore in opposizione agli effetti dinamici del colore pre-industriale, dalle tecniche grafiche di sovrastampa usate nell'illustrazione, alla costruzione dell'immaginario cromatico dei consumatori.

- *"Parte seconda Storie"*, comprende otto sottocapitoli.
"Azzurro costoso. Coloranti e pigmenti prima

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the figurative apparatus takes the form of compositions of different image details, matched to suggest comparisons and assonances. The full text (470 pages) is divided into four parts whose titles are poetic, rather than systematic.

• *"Part One Looks"* introduces the book's key topic as how our view of color changes over time in relation to society. It includes three subchapters: *"Industrial Yellow. The society of design"*. *"Solid Red. The Eye of the 21st Century"*. *"Articulated Black. Possibility of the Industrial Color"* whose subjects range from modern normalization and Industrial color serialization in contrast to the dynamic effects of pre-industrial color, the overprinting graphic techniques used in the illustration, and the construction of the consumer's chromatic imagination.

• *"Part Two Stories"*, includes eight subchapters.
"Expensive blue. Dyes and pigments before modernity" illustrates the history of some pigments and the artists who used them.
"Symbolic purple. Ideas and Myths of the Ancient World" tells about recipes and relationship between color matter and its symbolism.
"Spectral Indigo. The era of revolutions" recalls the color diagrams, the opposition between Newton's physical theories and Goethe's phenomenological ones, the luck of Chevreul's book and the applications made by painters at that time.
"Blue Bovary. Wearing to love and to signify" investigates the hidden meaning of blue in literature.
"Mauve modernity. The Birth of consumption and stardoms worship" tells the spread of purple and lilac trend and the oil painting tubes marketing, focused on how trends influence behaviours and consumption.
"Illegal green. The fable of the primary colors" describes the different color mixing over time, concluding that *"there are no primary colors in themselves, because they are not natural values but a mere technological and cultural conventions"*.

della modernità" illustra la storia di alcuni pigmenti e degli artisti che ne facevano uso.
"Porpora simbolico. Idee e miti del mondo antico" parla di ricettari e relazione tra la materia colorante e il suo simbolismo.
"Indaco spettrale. L'epoca delle rivoluzioni" ricorda i diagrammi di colore, l'opposizione tra le teorie fisiche di Newton e quelle fenomenologiche di Goethe, la fortuna del libro di Chevreul e le applicazioni che ne fecero i pittori dell'epoca.
"Blu Bovary. Vestirsi per amare e per significare" indaga sul significato recondito del blu in letteratura.
"Malva modernità. La nascita del consumo e del divismo" narra la diffusione della moda del viola e del lilla e la commercializzazione dei colori a olio in tubetto rivolgono l'attenzione all'influenza delle mode sui comportamenti e i consumi.
"Verde illegale. La favola dei primari" descrive le differenti mescolanze di colori che nel tempo, concludendo che *"non esistono i primari in sé, giacché non si tratta di valori naturali, ma di una mera convenzione tecnologica e culturale"*.
"Ciano litografico. Breve storia delle tecnologie cromatiche" mostra come l'evoluzione della tecnologia della stampa, della fotografia e delle pellicole filmiche a colori, abbiamo mutato lo sguardo sui colori del pubblico.
"Grigio armonico. Grandi ideali per la vita quotidiana" confronta le teorie sull'armonia cromatica che ritiene rifiutino indirettamente il relativismo culturale del pensiero moderno.

• *"Parte terza Artefatti"*, comprende anch'essa otto sottocapitoli.
"Marrone neuronale. Come il cervello costruisce il colore" si focalizza sulle scienze cognitive e l'elaborazione psicologica del colore.
"Viola spezzato. La luminosità e le tinte" distingue la luce come *"qualità dello spazio"* dalla luce come *"qualità delle tinte"* nelle arti visive, le teorie della prospettiva cromatica e della luminosità delle ombreggiature.

"Lithographic Cyan. Brief History of Chromatic Technologies" shows how the evolution of printing technology, photography and color motion picture film, have changed the way people look and see the colors.
"Harmonic gray. Great Ideals for Daily Life" compares the theories on chromatic harmony that, according to him, indirectly reject the cultural relativism of modern thought.

• *"Part Three Artifacts"* also consists of eight subchapters.
"Neuronal brown. How the brain builds color" focuses on cognitive sciences and the psychological processing of color.
"Broken Violet. Brightness and hues" distinguishes light as *"space quality"* from light as *"hues quality"* in visual arts, the theories of the chromatic perspective and the brightness of the shadows.
"Simultaneous Sky blue. The fundamental chromatic contrasts" recalls the seven color contrasts of Itten, theorizing and proposes to gave them two more names: *"chromaticity contrast"* (between a single color and black and white) and *"pair contrast"* (between two solid hues, flat and homogenous colors that contend the field with equal dignity).
"Significant Red. The Colors of Things" analyzes the narrative aspects of color by distinguishing the function of *"role"* (the position within a system) and of *"symbol"*.
"Sour Green. The to drink and to eat colors" denies the universal properties of synesthesia whose semantics is, first of all, activated through memories and analogies.
"Colonial Beige. And other marketing issues" analyzes the color function of making a brand memorable and acting as product customization.
"Moral White. Today's myths, born yesterday" tells the contrast of color and non-color in cinema, photography, and television.
"Green Vertigo. The woman who lived twice" analyzes the meaning of the narrative contrast of ruby red and emerald green in Hitchcock's movie.

"Celeste simultaneo. I contrasti cromatici fondamentali" riprende i sette contrasti di Itten e ne aggiunge altri due che propone di chiamare: *"contrasto di cromaticità"* (tra un singolo colore e il bianco e nero) e *"contrasto di coppia"* (tra due tinte unite, piatte e omogenee che si contendono il campo con pari dignità).
"Rosso significante. I colori delle cose" analizza gli aspetti narrativi del colore distinguendo la funzione di *"ruolo"* (la posizione all'interno di un sistema) e quella di *"simbolo"*.
"Verde aspro. Colori da bere e da mangiare" smentisce l'universalità delle proprietà sinestetiche dei la cui semantica funziona innanzitutto per ricordi e analogie.
"Beige coloniale. E altri problemi di marketing" analizza la funzione del colore di rendere memorabile una marca e agire come personalizzazione dei prodotti.
"Bianco morale. Miti d'oggi, nati ieri" racconta la contrapposizione del colore al non-colore nel cinema, nella fotografia, nella televisione.
In *"Verde vertigine. La donna che visse due volte"* analizza con cura il significato della contrapposizione narrativa di rosso rubino e verde smeraldo nel film di Hitchcock.

• *"Parte quarta Percezioni"*, comprende 5 sottocapitoli più l'Epilogo.
"Arancio bollente. Vedere la temperatura" partendo dall'analisi cromatica di alcuni famosi film, ne analizza la temperatura cromatica e quella emotiva.
"Turchese registrato. Il copyright sulle percezioni" affronta il nuovo problema del possesso di alcune sostanze coloranti, tramite brevetto.
"Rosa pesca. Il problema dell'incarnato" analizza il conflitto tra *"colore articolato"* (composto da più gradazioni e tridimensionale) e tinta unita a cui l'industria cerca di sopperire con le finiture.
"Blé omerico. Un'ipotesi per la percezione" partendo da quanto scritto da Gladsone sull'assenza del blu in Omero, conduce una riflessione sulla possibilità di

• *"Part Four Perceptions"*, includes 5 subchapters plus the Epilogue.
"Boiling orange. See the temperature", starting from the chromatic analysis of some famous movies, analyzes chromatic and emotional temperature.
"Registered turquoise. The copyright on perceptions" faces the new problem of possessing certain coloring substances, by patent.
"Peach pink. The problem of the incarnate" analyzes the conflict between *"structured color"* (with several gradations and three-dimensional) and solid color to which the industry tries to compensate with finish.
"Homeric Blé. A hypothesis of perception", starting from what Gladsone noticed about the lack of the color blue in Homer, leads to reflection on the possibility of naming the colors.
"Yellow Judah. Technology and look" associates the colors with the material they are conveyed by and up to the bright colors, deep and shiny of the screen we are daily in touch with.
The *"Epilogue"*, lastly, summarizes the thesis of the whole book: if modernity has tried to standardize colors, on the other hand, it is not possible to standardize the gaze, which depends on the time and place, history and society.
At this last part follow two Appendices, which deal with *"Scientific Concepts"* and *"Principal Chromatic Models"*. The iconographic note, the iconographic list, the bibliography.

Falcinelli writes about his own work:

> *"This is not a historical essay but a narrative (...) the history story of our modern gaze, and how it is formed."*

I think that Falcinelli (1973) has published a full text written and illustrated with a fluid narrative flow and with the typical *"back and forth"* style, son of the digital revolution.

nominare i colori.
"*Giallo Giuda. La tecnologia e lo sguardo"* associa i colori al materiale con cui sono veicolati, e sino ai colori luminosi, carichi e brillantissimi degli schermi con cui siamo quotidianamente in contatto.
"Epilogo" infine riassume l'assunto di tutto il libro: se la contemporaneità ha cercato di standardizzare i colori non è invece possibile standardizzare lo sguardo, che dipende dal momento e dal luogo, dalla storia e dalla società.
A questa ultima parte seguono due Appendici, che riguardano *"I concetti scientifici"* e i *"Principali modelli cromatici"*. La Nota iconografica, l'Elenco iconografico, la Bibliografia.

Falcinelli scrive di questo suo lavoro:

> *"Questo non è un saggio storico ma un racconto (…) la storia del nostro sguardo moderno, e di come si è formato".*

Io penso che Falcinelli (1973) abbia edito un testo corposo scritto e illustrato con un flusso narrativo ininterrotto e con un andamento back and forth figlio della rivoluzione digitale.

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COLOUMN

Communications and Comments

"Carpet" by Giuseppe Ungaretti

Every color expands and lays
on the other colors
To be more alone if you look at it.

"Tappeto", Giuseppe Ungaretti

Ogni colore si espande e si adagia
negli altri colori
Per essere più solo se lo guardi.

"L'Allegria - da Ultime", Milano 1914/1915

In this column, we would like to propose a novel topic, which could be of interest for the wide community of color scholars: a joint analysis of the human color sensation and perception from the view-points of the phycologists, color scientists, literature scholars and artists. In this framework, many issues have to be addressed, first of all the definition of color sensation and color perception. In the following, we report some general considerations and observations that do not pretend to grasp the complex meaning of color sensation/perception, rather they would like to become a starting point of a more detailed discussion among the color scholars and in particular among the members of the Gruppo del Colore-Associazione Italiana Colore.

Color sensation and perception are considered subsequent processes of human color vision. Nevertheless, these terms are often used improperly, sometimes they are even erroneously employed as synonyms, creating ambiguities and misunderstanding. This confusion is well described by the words of the English philosopher John Stuart Mill (1806 – 1873), which wrote:

> *"We have a name for the objects which produce in us a certain sensation: the word white. We have a name for the quality of those objects, to which we ascribe the sensation: the name whiteness. But when we speak of the sensation itself […], language, which adapts itself for the most part only to the common uses of life, has provided us with no single-worded or immediate designation"* [1].

In 1953, the Committee on Colorimetry of the Optical Society of America proposes the following definitions [2]: color sensation is a *"mode of mental functioning that is directly associated with stimulation of the organism"*, while color perception is a *"mode of mental functioning that includes the combination of different sensations and the utilization of past experience in recognizing the objects and facts from which the present stimulation arises."*

More recently, in 1988, Jonathan C. Fish claims [3]:

> *"Physiologists have shown that light reflected from a dab of paint and entering the retina of the eye results in the discharge of electrical signals that are transmitted to certain regions of the brain causing the occurrence of colour sensations […]. These sensations are one meaning of the term colour. But since other meanings are commonly given to it, […] it is sometimes helpful to refer to the sensation of colour as psychological colour".*

Fish clearly states that the expression *"color sensation"* is often used to indicate both the sensorial stimulation (i.e. color sensation is the result of the propagation of an electrical signal from the eyes to the brain) and its psychophysiological interpretation (i.e. the so-called *"psychological color"*), dependent on aesthetic issues [4], involving subjective

experience and cultural heritage.

The conception that sensation and perception are two very distinct features of our sensory experience is very diffuse: generally, sensation is considered to be more peripheral, local, fragmented, while perception is more central, organized, and global. This idea has entered and is still popular in the Anglo-Saxon tradition based on Helmholtz's neuropsychological theories [5], stating that visual receptors are linked to the cortex by single neurons, isolated from each other, with the task of bringing peripheral, unmodified information to the cortex. According to Helmholtz, the central neuron system would have the task of organizing and interpreting these data, based on past experiences, hypotheses to be verified, mathematical and statistical knowledge, or even on other sensorial information, e.g. tactile sensation. The conclusions are that in the sensory data, '*local Information'* are poor and disorganized, and that perception – which is driven by brain activity - is the full stage of organization where objects, events, meanings, etc. appear. A departure from this theory is proposed by Gibson [6]: he considers the brain activity fundamental for perception, but he states that all the information needed to perception is already present in the stimulation. An alternative approach to this theory is that the organization responsible for the *'last stage perception'* does not necessarily require cognitive additions, but derives from its own nervous system operations, dictated above all by genetic components aimed at creating a perceptive phenomenal world, sufficiently simple to make the resultant behaviour fitting the environment. For instance, following the work of Hering [7] , color constrast would be a side-to-side inhibitory neural phenomenon instead of a scientific knowledge of colour blends, as proposed by Helmholzt. Obviously, no interaction between perceptual organization and higher-level cognitive activity is excluded, but these are not necessary [8]. A modern possibility of saving the distinction between sensation and perception is given by Katz's suggestion [9] of evaluating and comparing differently coloured areas by observing them in *'reduction'* condition. Reduced colours are seen through a hole made on a white (or black) screen: in this case, the term reduction means simplifying the context of each coloured area to make it as simple and uniform as possible so that any observed differences cannot depend on the context.

Since anything we observe always appears to be organized in a basic way according to the figure-background categories, even those that we call sensations appear to be somehow organized, and therefore should be called perceptions. The conclusion is that retaining the original distinction of sensation-perception would only make sense of wanting to insist on the original Helmoholtzian theory, unless one understands sensation as a perception in a reduced context.

The debate between Anglo-Saxon and American theories opens the problem to determine which features are captured and/or involved in color sensation and in color perception.

Retinex theory by Edwin H. Land and John J. McCann [10] , as well as many studies conducted by the artists of the Pointillisme trend and the poetry by Giuseppe Ungaretti (1888-1970) opening this column, consider spatial information as an element highly relevant to color sensation (and thus to color perception). Before Retinex, the human color vision system was supposed to catch colors similarly to a camera, in the sense that the human color sensation derived by observing a point in the scene would correlate with the scene reflectances [11]. Land and McCann conducted a series of experiments that strongly contradicted this belief, showing that human color vision is a spatial, local process, as illustrated by the simultaneous

Figure 1: A color chart of healthy fruits and vegetables, adapted from http://www.rawayurveda.com/4974/eat-a-rainbow-food-color-chart/

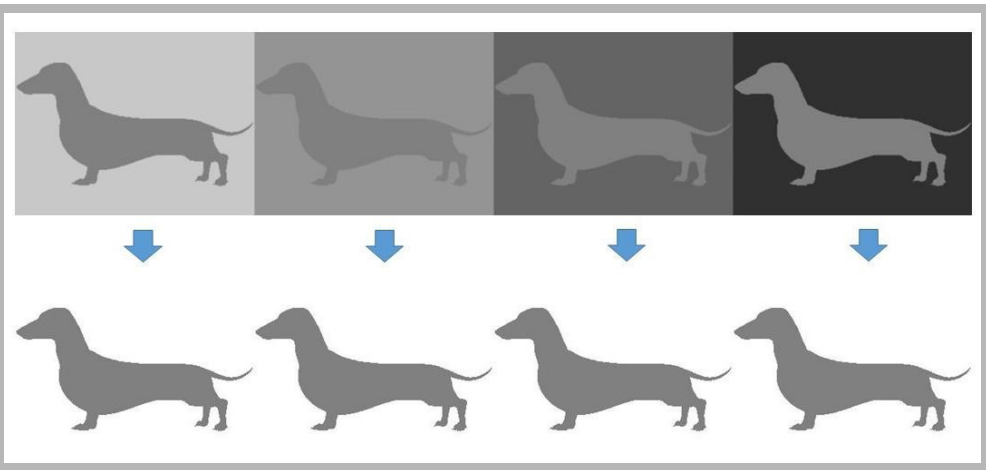

Figure 1 - Simultaneous contrast: the same dachshund looks differently colored when displayed on background with different grey-level intensity (on top). As matter as fact, the dachshund color is constant (on bottom).

contrast (see Figure 1). This spatial color interaction is well described by the poetry *"Tappeto"* by Ungaretti. He was one of the most important leaders of the literary movement Hermeticism, characterized by a concise, piping style reflecting the prostration state of the human soul after the experience of the First World War and Fascismus. In *"Tappeto"*, Ungaretti describes the color sensation derived by observing a carpet. Carpets were for Paul Gaugin the objects most suitable to study color effects, as he wrote in some scattered notes:

> *"You all, painters, searching for a color technique- let analyze the carpets and find out all you need"* [12].

In *"Tappeto"*, the spatial element influencing the color sensation is the distance at which the single color composing the carpet is viewed: in line with Retinex theory, the color sensation at a point changes by enlarging the field of view, thus by changing the locality of the observation with the possible inclusion of more colors. This issue is also at the basis of Impressionism, Pointillism, and Divisionism: these are painting techniques where the objects composing an imaged scene are represented by small brush strokes, with no shading and no color gradient. In particular, Pointillism, introduced in 1880s by the painters Georges Seurat (1859 – 1891) and Paul Signac (1863 –1935), depicts the observed scene as a set of patterns composed by many small, distinct dots of color. Seurat and Signac were strongly interested in color science, and their point-based painting technique grounds on the human capability of eyes and mind to blend spatially adjacent color spots, sensing novel tones and shades.

On the contrary, Anglo-Saxon theory negates the presence of distance information in color sensation, and supposes that the depth information mainly comes from other sensorial experiences: brain adds more information from other sources, so that what is seen may appear very different upon the way it is observed.

As matter as fact, the considerations reported in this column rely on studies carried out in the 19th and 20th centuries: did the technological novelties of the 21st century change the meaning of color sensation and perception? In case, how? *Could we still say, as Fish, that "colour science and colour art are, for the most part, on separate paths"*? What is the feeling of the Gruppo del Colore? How can its members contribute to clarify the concept of color sensation and perception and to detect the features more relevant to color vision?

Once again, we think that the complex world of color has been not yet fully investigated and more efforts should be done to achieve a better color understanding: now, we give the floor to the reader.

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[4] From its etymology Aesthetics means Sensation, from the greek αἴσθησῐς: 1. Perception from the senses, feeling, hearing, seeing; 2. Perception by the intellect as well as the senses; 3. That which is perceived: scent; 4. Ability to perceive: discernment; 5. Cognition or discernment of moral discernment in ethical matters (wiktionary.org). Therefore there is no great distance between aesthetics and sensation. Fish, as most people today, not only considers aesthetics as personal experience (sensation) but also exprression of cultural heritage.

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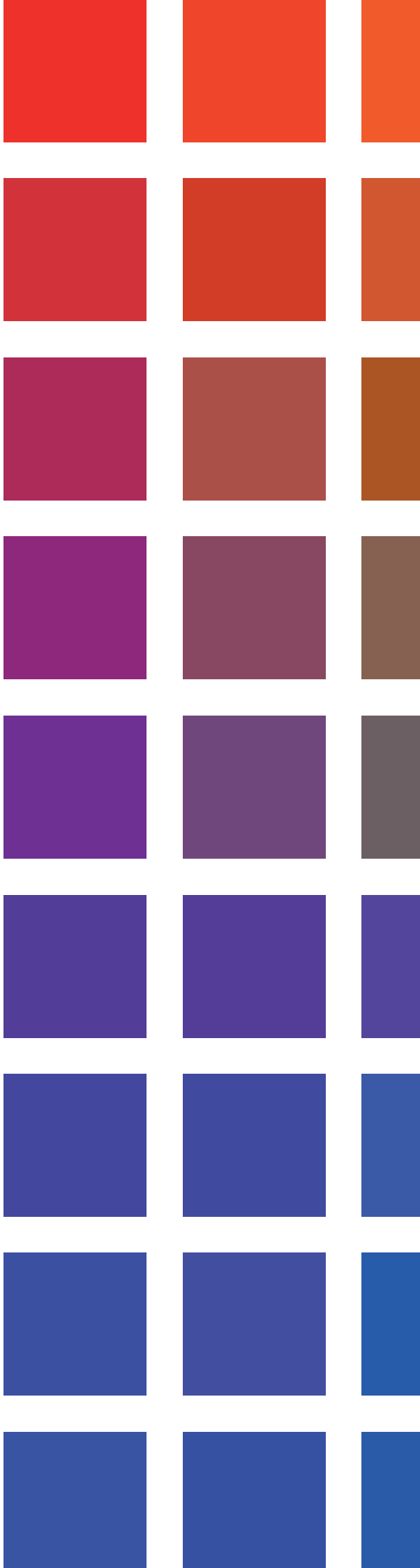

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