Color Culture and Science
Cultura e Scienza del Colore

CCSJ

Volume 11

Number 1

2019

ISSN

2384-9568

COLOR CULTURE AND SCIENCE (CCSJ)
CULTURA E SCIENZA DEL COLORE
jcolore.gruppodelcolore.it
ISSN 2384-9568
DOI: 10.23738/CCSJ.00
ANCE E227716
ROAD: the Directory of Open Access scholarly Resources
Registrazione presso il Tribunale di Milano n. 233: 24/06/2014
Volume 11, number 1, July 2019, DOI 10.23738/CCSJ.110100

PUBLISHER
Gruppo del Colore – Associazione Italiana Colore
www.gruppodelcolore.org
Registered office: Piazza Carlo Caneva, 4 - 20154 Milan (IT)

PEER REVIEW PROCESS
All articles submitted to the " Color Culture and Science Journal are peer-reviewed according to the following procedure:
First review level
The Associate Editors evaluate each article in order to determine if the topic and content are of interest to the journal. Once the article passes the initial review, the Associate Editors select several referees in the Editorial Board based on their expertise in a particular subject area or topic.
Second review level
Each article is reviewed by two or three referees and submitted to a double-blind peer review process where both the authors and the reviewers are kept anonymous. Referees are asked to evaluate the manuscript based on the following criteria:

- Originality
- Relevance to journal's aims and scope
- Technical merit and/or validity
- Soundness of methodology
- Completeness of the reported work
- Conclusions supported by the data
- Correct acknowledgment of the work of others through reference
- Effectiveness of the manuscript (organization and writing)
- Clarity of tables, graphs, and illustrations
- Importance to color researchers
- Relevance to color practices

If the article is accepted with major revisions by the referees, the author(s) are asked to improve the article according to the suggestions of the referees. The revised article will then be submitted to a further review.
After collecting the referees' reports, the Associate Editors make a recommendation on the acceptability of the article to the Editor-in-Chief.

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Editorial

Having reached the sixth year of life of the "Color Culture and Science Journal" (CCSJ) it is important to recall the meaning of the concept of double open access underwhich our journal is managed and published: the magazine is completely free for both readers and authors. In a time in which, in order to make money, there are publishers who publish journal and organize conferences without making any control over scientific contents (Bauer et al. 2018a, 2018b)(Vite, 2018), it is important to emphasize that our policy is diametrically opposed and this is possible thanks to the scientific volunteer work that is guaranteed by some members of the Associazione Italiana Colore, which is a charity.

In the previous editorials I described the steps of the evolution process, for the scientific internationalization, which led the journal to be completely in English language and to apply the double blind peer review. The journal is continuing on this path, as the new online organization of papers of this issue shows only in part, such as the top of an iceberg. Indeed, below the surface, we are migrating the online journal management system from Joomla to OJS in order to better support the peer review process. This also to provide all the information regarding the papers published in the journal, in a more structured way, through compatibility with “Open Archives Initiative Protocol for Metadata Harvesting”.

Alongside this process, we renewed the board of the associate editors, involving a greater number of international experts for the scientific evaluation and management of the peer review process. The journal is published by a multidisciplinary association that has its points of reference in the themes of color, light and the linked technical-scientific, cultural and professional sectors. Also this issue is an example of multidisciplinary integration. As the Associazione Italiana Colore is a regular member of Association Internationale de la Couleur (AIC) we involved experts from the AIC in the CCSJ. The new associate editors are:

José Luis Caivano, former president of the AIC, of the Universidad de Buenos Aires (AR), for the topics in the context of color and culture: arts and crafts, history, philosophy, aesthetics, ethno-anthropology, graffiti, geology, sociology, lexicology, semantics, anthropology of vision, food culture and heritage.

Vien Cheung, vice-president of the AIC, of the University of Leeds (UK), for the topics of color and digital: reproduction, management, digital color correction, image processing, graphics, photography, film and video production, printmaking and 3D print, artificial vision, virtual reality, multispectral imaging, data visualization. And also for the topics of color and design: furniture, CMF design, fashion, textiles, textures, cosmetics, food design, museography.

Marco Gaiani, of the Alma Mater Studiorum Università di Bologna (IT), for the topics in the wide context of color and environment: representation and drawing, urban planning, project of color, architecture, interior design, landscapes & horticulture, color and architectural syntax, territorial identities, biodiversity.

Robert Hirschler, chair of the AIC study group on Color Education (BR), for the topics on color and education: pedagogy, didactics of color, aesthetic education, artistic education, color naming.

Marcello Picollo, president of the GdC-Associazione Italiana Colore, of the Institute of Applied Physic Nello Carrara-CNR (IT), for the topics that deal with color and restoration: archaeometry, painting materials, diagnostics and techniques of conservation, restoration and enhancement of cultural heritage.

Verena M. Schindler, chair of the AIC study group on Environmental Color Design (CH), for the topics regarding color and production: food and beverages, agriculture, textiles, plastic materials, ceramics, paints, gemology, color in the food industry.

Alessandro Rizzi, former president of the GdC-Associazione Italiana Colore, of the Università degli Studi di Milano (IT), deal with the topics on color and physiology: mechanisms of vision in their experimental and theoretical aspects, deficiencies, abnormalities, clinical and biological aspects, synesthesia, health, well-being. And also the topics on color and psychology: phenomenology of colors, color harmonies, color & form, perceptive, emotional, aesthetic and diagnostic aspects.

Maurizio Rossi, former president of the GdC-Associazione Italiana Colore, of the Politecnico di Milano (IT), for the topics on color and lighting: metamerism, color rendering, adaptation, color constancy, appearance, illusions, color memory and perception, color in extra-atmospheric environments, lighting design, lighting technologies, visual comfort.

Renzo Shamey, of the North Carolina State University (USA), is the expert on the fundamental topics of color and measurement, instrumentation: colorimetry, photometry and color atlas: method, theory and instrumentation; quality control and food coloring, dyes, organic and sustainable color.

Francesca Valan, color designer (IT), for the topics of color and communication, marketing: graphics, communication, packaging, lettering, exposure, advertising.

July, 2019
The Editor-in-Chief
Maurizio Rossi

References

Bauer, P., Krause, T., Kropshofer, K., Langhans, K., & Wagner, L. (2018). Das Schein-geschäft. Angriff auf die Wissenschaft. Süddeutsche Zeitung. Retrieved from https://projekte.sueddeutsche.de/artikel/wissen/angriff-auf-die-wissenschaft-e398250/?reduced=true

Bauer, P., Krause, T., Kropshofer, K., Langhans, K., & Wagner, L. (2018, September 21). I predatori della scienza. Internazionale, (1274). Retrieved from https://www.internazionale.it/sommario/1274

Vite, F. (2018, September 22). I predatori della scienza. Retrieved 18 July 2019, from Il sito di Franco Vite website: https://francovite.info/2018/09/22/i-predatori-della-scienza/

Contemporary architecture and colour: final definitions for mapping intent

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ABSTRACT

The focus of this study is to define and map out design intent using *occurrences of practice* that are strongly representative of the adoption of chromatic devices intended as instruments capable of identifying and making legible (in previous contributions we talked about *amplification of meaning*) the conceptual principles that define the foundation of the design process of an architectural project, as well as to keep them explicit in their formal outcomes.

KEYWORDS Architecture, Color, Mapping intent

RECEIVED 16 October 2018; **REVISED** 15 February 2019; **ACCEPTED** 25 February 2019

CITATION: Borsotti, M. (2019). Contemporary architecture and colour: final definitions for mapping intent. Color Culture and Science Journal, 11(1), 7–18. https://doi.org/10.23738/CCSJ.110101

1. Introduction

This text illustrates the third and final contribution – the first and second appeared in *Colour and colorimetry* VIII (Borsotti in Rossi, Siniscalco, 2012) and *Colour and colorimetry* X volumes (Borsotti, in Rossi, Marchiafava, 2014) – on the reflection that, moving between identification of contemporary paradigmatic case studies and hypotheses of classification of their outcomes within defined areas referring to common attitudes, look at the use of colour as a true design tool; a real "material" for the realisation of an architectural program.

The focus of this study is to define and map out design intent using *occurrences of practice* that are strongly representative of the adoption of chromatic devices intended as instruments capable of identifying and making legible (in previous contributions we talked about *amplification of meaning*) the conceptual principles that define the foundation of the design process of an architectural project, as well as to keep them explicit in their formal outcomes.

This is an exploration which undoubtedly moves beyond the common concept that, in contemporary architectural production, the use of colour is a choice of pure and simple superficial finish, applicable, case by case, according to extemporaneous aesthetic matrices. The use of colour should, instead, be recognised as a fundamental tool for tracing, with regards to the recurrence of mutually assimilable solutions, the emergence of trends inscribed within precise design communication intentions.

After retracing and defining a few potential scenarios such as *iconic urban*, *spot colour*, *palette colour*, *differently residential colour*, *perspective colour*, *edge colour*, *immersive colour* and *translucent colour*, here is an outline of the remaining possible categories. (Borsotti in Rossi, Siniscalco, 2012) (Borsotti, in Rossi, Marchiafava, 2014)

First of all we must underline the necessary premise that the results of this study do not claim to define a definitive tool for the use of colour in architecture, since this remains, above all, an expression and representation that adheres to geographic and temporal socio-cultural and traditional phenomena, as well as the consequence of the availability of different materials and technologies and the direction of various cultural trends, inevitably linked to the make-up of each designer's personal aesthetic sensibility.

The categories here illustrated, derive, rather, from an in-depth reflection that seeks to outline the main profiles of the vast contemporary landscape of colour presence in architecture, a research field rarely defined within an overall critical vision and where, instead, homogeneous areas of design practice emerge that should brought back to clear and circumscribable backgrounds and precise intent.

2. Container colour

Architects have always been fascinated by the concept of the container, attempting to grasp how much its characteristics, measurements and constructive structure and standardised volume can become a prefabricated cellular space, easily transportable and aggregable, how to preserve potentially decisive declinations for the definition of modular and serial habitable environments.

Then there is a further suggestion that comes from the quasi-urban image offered by the transit and storage piers, where the containers, are piled up in large quantities, drawing intricate paths made by large, compact masses.

In the numerous and intriguing attempts to transform these visions into an applied architectural project, the presence of colour, already implicit in the original model, plays a fundamental role.

On the one hand, the use of the "container icon" preserves the distinction of the basic module, establishing a communicative system of immediate and evident readability that leads back the inhabitable aggregation within its dimensional and structural components and, on the other, defines a clear recognisability of its modularity, which helps to make the architectural fronts more dynamic allowing for a very strong "personalisation" of the housing aggregates.

A paradigmatic example of this architectural choice is the *housing complex* built in Carabanchel (Madrid, Spain) by *Amann-Canovas-Maruri Architects*, where the entire building is designed according to overlapping linear sequences of environments created with metalworking structures, the colours of which have been chosen by the building users themselves.

The alternating rhythm of empty and full, defined by the insertion of terraced spaces between one residential module and the other, is strongly emphasised by these chromatic sequences which, to better preserve their nature of compact coloured backgrounds, do not even suffer the interference of full-height windows. These, in fact, are cleverly integrated into the metal structure of the external cladding, while the intermediate string courses, dark and thick, define the linear syntax of a supporting grid on which the individual housing units, each one recognisable by its own colour, appear literally

"supported", within a sort of optical play on structural equilibrium.

This principle affirms the architectural breakdown of the volumes into the summation of their constitutive industrial parts, revealing the desire to produce a habitable system according to the *box-in-box* principle, where colour is precisely the revealing tool of this choice. There are many illustrious examples prior to this.

Take for example the most apparent experiments of the so-called *Container City* of *Trinity Buoy Wharf* (2001) in London, as well as the sophisticated concepts in Holland, *MVRDV*, such as *Silodam* (2002) or the *Cancer Centre* (2005) both in Amsterdam, which converge towards their great *Container City* project, a potential "cargotecture" for Rotterdam city, consisting of 3500 used containers.

Even when the base matrix of the container is more a conceptual and ideological reference than a direct structural reality, the iconic force of its presence remains fundamental and is explained precisely by the free chromatic assemblage that underlies it, as it happens, for example, in the *Box 298* office building designed by *Andrade Morettin Arquitetos Associados* in Vila Madalena (São Paulo, Brazil).

Here, indeed, the stated intent to improve the visual perception of the space and place where the building is located, adopts the *container colour* array to mark, according to a vertical "cascade" sequence (as in a three-dimensional game of Tetris), coloured surfaces made by corrugated sheet that saturate the full portions of the building, thus reinforcing the presence of the large glazed partitions, sometime left free to generate empty terraced spaces.

3. Deep colour

A chromatic insertion is often used, in the overall system of a building, as a planning tool to define its constituent rhythm. The presence of a colour, a fact that is inevitably evident and immediately readable, acts, indeed, as a real visual *marker* the task of which is to highlight and "bring out", right on the surface of the building, the geometric rules which give shape to the construction of the conceptual design of the project.

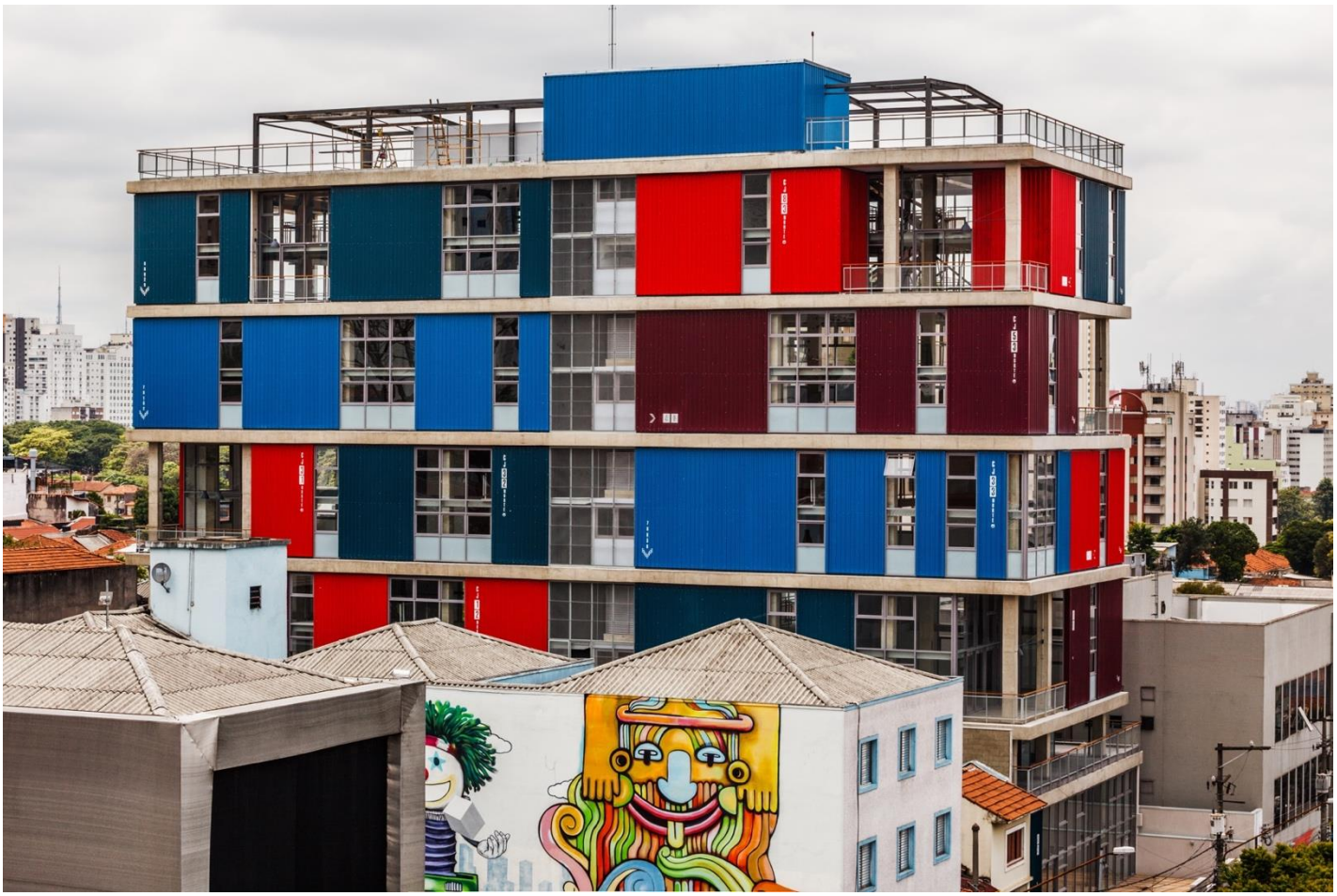

Fig. 1. Box 298 office building, Vila Madalena (São Paulo, Brasil, 2009). Courtesy by Andrade Morettin Arquitetos Associados©, Nelson Kon photographer©.

The chromatic intervention arises as an action that must be coordinated with the understandability of the design principles that drive the creation of the entire architectural structure and help to maintain its evidence. The opportunity offered by the chromatic definition of architectural elements (clearly attributable to the sequence of empty and full spaces that characterise the assembling phase of the geometrical elements, as well as of the structural components) therefore represents a powerful instrument of explicit representation of the linguistic rules that are at the heart of the project. A paradigmatic example is the realization of the new volume of the *Gymnasium of the Middle School complex* in Riva San Vitale (Switzerland), designed by architects *Durisch and Nolli*. Here we find a double-body building where the inner and self-supporting one, which houses classrooms and sports equipment, is completely included within an external casing, which assumes the task of designing a compact and homogeneous façade. The great formal clearness of this external body, a rectangular base prism with a double-height portion, is marked by a linear succession of thick, high and narrow slabs, which make the façade dynamic, making the constructive system clear, where once again the theme of the concrete pillar-lintel is proposed, taken from the existing middle school. The presence of this system is reproduced on the façade through the repetition of an identical module, which can be assembled to infinity, the rigorous consistency of which is underlined and modelled by the insertion of a lively chromatic palette applied just on the inner faces of pillars, to underline the vacuous portions. It is this continuity, immutable in its measurements, but vivaciously varied in its colours, that immediately makes the reading of the geometric coherence of the whole system apparent.

A different model of composition characterises another *municipal building for sporting activity*, designed by *GANA Arquitectura* in Vélez-Málaga (Spain), consisting of a compact and translucent space that takes the shape of from a homogeneous one with an alternation of prismatic bodies.

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Fig. 2. Gymnasium of the Middle School complex, Riva San Vitale (Switzerland). Courtesy by Durisch and Nolli architects©, Tonatiuh Ambrosetti photographer©.

In this example as well, the rhythm generated and the reading of the full and empty spaces that distribute the mass of the building, otherwise marked by an almost impenetrable material-visual consistency (which also integrates the opening surfaces, of which only the frames are distinguishable) is affirmed by the use of a strong chromatic presence, realised by using bright ochre yellow, bringing out an effect of extreme dynamism of the volume's depth and its luminous contrasts.

Emmanuelle Moureaux, whose work is intrinsically linked to the use of colour as an essential part of her conceptual development process of the architectural idea, presents a research path that explores the emotional and perceptive potential of chromatic/architectural systems. In her work this system is defined by involving lines and surfaces to reach a more three-dimensional vision, where it is not simply the linear extension that is marked, but the volumetric depth of the building.

In this way, the colour properly assumes the role of marker element capable of unveiling the geometric and rhythmic matrix of the alteration of an initial primary stereometric volume. "I use colours as three-dimensional elements, like layers, so as to create spaces, not as a final touch applied to surfaces ». (Moureaux, n.d.)

Fig. 3. Sugamo Shinkin bank, Tokiwadai (Tokyo, Japan, 2010). Courtesy by Emmanuelle Moureaux architecture+design©.

Fig. 4. Sugamo Shinkin bank, Nakaoki (Kawaguchi, Japan, 2014). Courtesy by Emmanuelle Moureaux architecture+design©.

The offices of the *Sugamo Shinkin bank* at Tokiwadai (Tokyo, 2010) and at Nakaoki (Kawaguchi, 2014) could be interpreted as the positive or negative of the same architectural reasoning: the thought of how to treat the volume, in the case of the first building an excavation and subtraction process of cubic and splayed portions of the volume while in the second an extrusion and addition of equally cubic jutting out elements, is revealed and emphasised by the use of colour.

Colour is used where the homogeneity of the basic stereometric matrix is undermined and it enhances the perceptive depth of a volumetric system that seeks a strong dynamic tension in space, involved and reshaped in its physical depth.

4. Expressive colour

Colour is an essential part of a large number of artistic phenomena, thus, without delving too deep into field definitions that refer to other disciplines, we can reasonably state that colour marks and substantiates in itself the artistic presence as instrument and expression of relationships between nature and abstraction, between representation and suggestion.

It is therefore particularly interesting to observe what happens when artists and architects meet each other in the field of architectural design, finding in the chromatic device a common field of comparison. It is also interesting to verify how often, in the variety of experiments and experiences, it is possible to find such a

constant in the intense expressive use of the colour, aimed to the valorisation of cultural and territorial content.

Analyzing some of the numerous traceable case studies, in fact, it is possible to notice how the use of color (a natural act for an artist), when applied to architecture often takes on large scale connotations (both dimensional and social), activating as a "highlighter" that underlines and reveals the role of architecture, the built environment, even in its most urgent critical issues, integrating with it to generate new, unexpected and sometimes fascinating conditions of livability.

Particularly paradigmatic, not just for its expressive power, is the work by artist *Pipilotti Rist* and architect *Carlos Martinez*, both Swiss, in the *Raiffeisen Square* in St. Gallen (Switzerland, 2003-2005), shaped as a place which, while remaining entirely an urban system integrated into the city, assumes the disruptive and poetic force of a permanent installation stretched across a vast scale, combining these two souls, apparently distant, precisely through the implementation of intense monochromatic intervention.

A large red surface covers and defines a broad portion of the city, incorporating everything, from the road surface to urban furniture, to cars and fountains, creating uniformity between the more typical elements, often in disorder and dissonance, of the cityscape with those that are, instead, elements of a more interior domestic character, such as sofas, and tables. All these presences come together to form, finally, “soft” in their form and substance, thanks to the use of a rubbery material, composed of various layers of rubber granules, glue and particular colour choices.

The result is a “different” urban space, strongly abstract, yet concretely linked to well-defined functions, explicitly cited with nomenclatures that refer to old and new attitudes of the public place: “reception”, “foyer”, “sculpture park” and “reading corner”.

The large square and the streets nearby become a unifying vision, a different way of understanding the “urbanity”, imbued with a habitable comfortable interior and the colour is its most obvious statement: a poetic expression that also becomes a critical reflection on the daily reality of the conformation of the contemporary city.

Although included into a completely and dramatically different urban context, the intervention that the multidisciplinary collective *Boa Mistura* realised in 2012 at the favela Vila Brasilândia of São Paulo (Brazil), take form from a very similar conceptual assumption.

Conceived as a recognisable sign of the affirmation of a collective conscience, this urban artistic intervention subverts the apparent rules of a disadvantaged everyday life, replacing them with the deeper values of its daily experience, represented by the discovery of words chosen to represent the feelings that the inhabitants of the favela share.

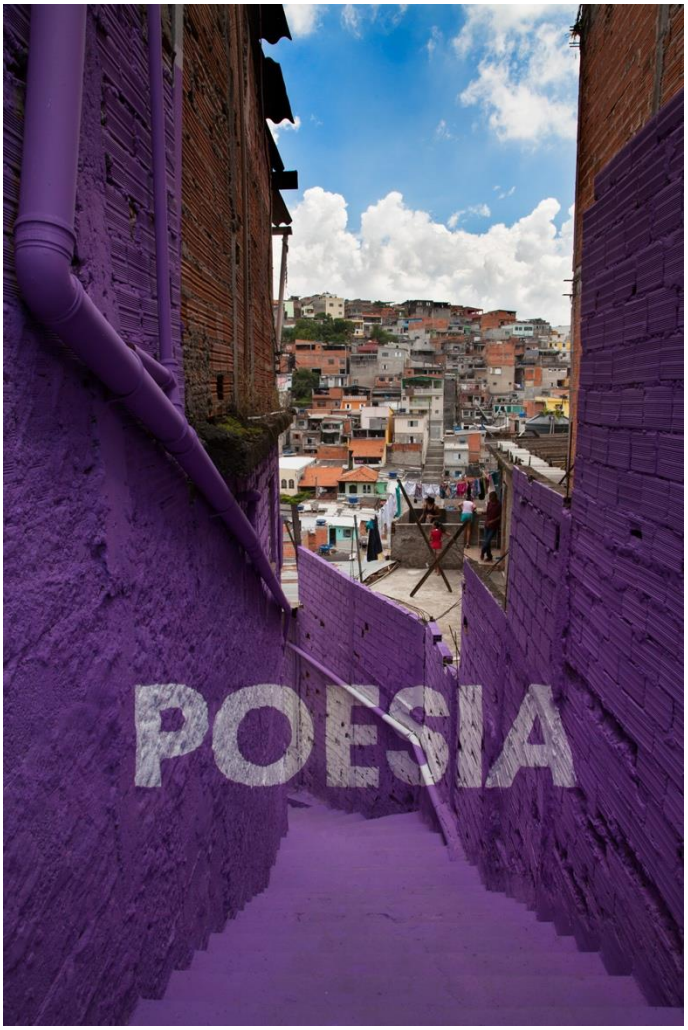

Fig. 5. Luz Nas Vielas (Poesía), favela Vila Brasilândia, São Paulo (Brazil, 2012). Courtesy by Boa Mistura©.

In this way, an alternative model of humanity is opposed to an urban failure that transforms the architecture of living, (here uncertain, minimal and self-built), by introducing a poetic reaction. Again, colour is the medium, powerful and immediate, used to initiate this reaction, a bearer of identity and territorial affirmation.

Luz nas vielas (Light in the alleys) is a collective intervention that involved the inhabitants of the favela in all phases of its implementation. People are encouraged to paint alleys and streets with vivid and bright colours, applied by brush and roller directly on the improvised conglomerates that make up its houses, to redefine them, through large chromatic backgrounds from which emerge graphic signs that, by adopting the technique of

anamorphism, in a single fleeting point of view, conquer form and legibility of words.

«The project aims to respond to this characteristic spatial complexity [defined] by narrow, winding corridors that connect the upper and lower urban areas, known as "vielas". Flattening the perspective from one point (anamorphism), the words "beleza", "firmeza", "amore", "doçura" and "orgulho" are read and framed by a flat colour, which covers all the building materials in the same way, democratising space. For us, these words are the best portrait of the favela». (Boamistura, n.d.)

The many works of urban re-interpreting *Boa Mistura*, almost always adopt the convergence of writing and colour in order to literally return the words themselves to places, transforming them from unfinished or forgotten landscapes into narrative spaces. The colour intervention is no mere application tool. It is a clear stance: its use, its presence, redefines the spaces by enveloping them in a renewed spatiality.

In the intervention carried out for the restructuring of the *Mercado de la Cebada*, in Madrid (Spain, 2013) the two main façades and the six large concrete domes of the public building, built in 1958 and, at that age, in a state of serious architectural decay, have been transformed by the disruptive appearance of colour, which characterises each dome with a different shade, and by the appearance of the writing "Llena la vida de color" (Fill life with colour) and "colour".

The latter again takes shape on the domes thanks to the anamorphism. The artistic-architectural action expresses the intent to restore visibility to the building and thus reaffirm its social role, subverting the process of abandonment that had brought it to the brink of demolition and, instead, supporting the process of recovery.

"We have changed the colour of each dome, thereby modifying the landscape of the area. Colours show optimism and somehow highlight what is happening on the market.". (Boamistura, n.d.a)

Fig. 6. Luz Nas Vielas (Poesía), favela Vila Brasilândia, São Paulo (Brazil, 2012). Courtesy by Boa Mistura©.

Fig. 7. Luz Nas Vielas (Orgulho), favela Vila Brasilândia, São Paulo (Brazil, 2012). Courtesy by Boa Mistura©.

Colour, therefore, is a visual structure capable of activating narratives that intersect with the physical substance of the architecture, with its being a form that occupies and modifies space, but also a fragile trace of individual and collective histories, perpetually exposed to erosion of matter as well as multiple and often contradictory or insensitive interests (such as flows of economic interests).

A chromatic intervention can disturb the rules of everyday life, it can destabilise the constructed landscape by transforming some of its consolidated components (often made invisible by a process of careless additions) into a vibrant presence, into truly evocative manifestos.

This is why *Amanda Williams*, an African-American visual artist with an architect's background, works on old houses destined for demolition in the South Side of Chicago – an artistic action that takes the name of *Color (ed) Theory Series* – repainting them completely, intervening on each one with a single bright colour, belonging to a signature palette of eight colours, to claim its existence and, in a way, to honour the buildings' last moments.

«I wanted to mark the final act of the end of the era of a black space (...) the architecture in some neighbourhoods is characterised by a process of removal, not addition». (Sargent, 2015)

These are artistic acts which do not intervene in the architectural project, but in the architectural reinterpretation of the existing signs, in order to clearly mark their imminent end and trace their historical significance within the urban landscape. At the same time these acts aim to generate questions about the dynamics that have progressively erased a "black" neighbourhood (today there are over five thousand lots stripped of human and architectural presence), whose final moments are celebrated by using colour, which elevates them to the temporary rank of works of art, for their value as fragments of the cultural memory of traditionally African-American spaces.

"What colour is urban? What colour is gentrification? What colour is privilege? What colour is poverty? Looking for answers, I painted abandoned houses in the South Side of Chicago using a monochromatic colour palette that is culturally coded (...) I am working on a system that imagines original ways to build new narratives for landscapes with zero value, which will allow them to free themselves from the identity of the victim and embrace the role of active protagonist». [7]

5. Conclusions

The three instances of this investigation into the use of colour in contemporary architecture (see note 1) have helped to circumscribe some common design methods, where chromatic intervention represents the foundation of the project's intention and become a fundamental tool of its realisation. Now, we can draw a number of overall conclusions that stem from the study as a whole.

First of all, we can confirm that there is a close relationship between the foundational conceptual intent of some design processes and the identification of the use of colour as a programmatic choice deemed necessary in order to sustain and explain these intentions.

Colour, therefore, must be seen as an integral part of the idea of architecture, and not as a mere accessory. Furthermore, we have seen some design process areas where colour finds a clear correspondence with its final

configuration in view of the overall architectural intervention realised and with the ideal objective with which they were conceived and realised, thus defining the research field itself.

Fig. 8. Mercado de la Cebada, Madrid (Spain, 2013). Courtesy by Boa Mistura©.

The many categorisations referred to, in fact, identify some of the main thematic areas in which they find obvious application:
- the *urban iconic* (colour as a concrete element of affirmation of recognisability within the urban fabric) and the *immersive colour* (colour as a prevalent and all-encompassing component) represent two, sometimes overlapping, attitudes, where architecture defines its own evident role in the context through a predominant chromatic presence: here colour engages the whole building affirming its indisputable iconic presence.

Therefore, through colour, a principle of unequivocal and evident relationship is established between the architectural complex and its context. We can also say that the *different residential colour* (the intensive use of colour devices characterising the new concept of *social housing*) is a category that has the same intention of self-affirmation, developed, not by chance, in a specialised typological field.

Here, in fact, colour (usually satisfying a need for personalisation and recognition relating to the individuality of a single complex inhabitant) is used, instead, to underline and unequivocally support the strongly experimental and innovative character of these new housing forms.

- the *spot colour* (colour as an architectural marker, that clearly defines the fundamental elements of a design) places the chromatic intervention at the heart of the visual-interpretative system of an architectural complex, recognising it as a *mediator* capable of underlining all the devices of the architectural composition and form, adopted in the definition of the building.

It acts as a sort of “architectural-scale highlighter”, which underlines the project’s “key words”, according to an overall and omni-comprehensive process of which the *perspective colour* (colour as an exaltation of the three-dimensional depth of the space), the *edge colour* (colour as a reinforcement of the margins) and the *deep colour*

(color as a scan of empty and full spaces) are not so much sub-categories, rather they are more specifically adjectivisations, which consolidate and provide a better and more spontaneous understanding, precise ideological-conceptual choices. In these categories, therefore, colour seems to be a code that truly declares architectural principles.

- the *palette colour* (color as a "palletised" -colour communication system) and the *container colour* (colour that states the principle of the "box in a box") represent the most multicolour and geometric outcomes of "coloured architecture".

In this case we are faced with an architecture punctuated by the adoption of modules (in the first case more related to the façade while more connected to compositional choices in the second case) the repetition of which is emphasised by the continuous combination of different colour shades.

The resulting visual impact is expressed in the clear reading of the rhythmic scanning of a composition and in the perception of a potentially infinite tension of these chromatic sequences. These ones are also present in the assembly phase of their parts, thanks to the visibility of the margins defined by the geometric meshes adopted, which, in the case of the *container colour*, also often have a three-dimensional correspondence (hence "habitable").

- the *translucent colour*, apparently unrelatable to the previous categories, is in the same conceptual framework that thinks about the material nature of colour and its density, exploring its inherent potential in the transition from compact texture (which delineates and delimits a surface) to a porous and "traversable" system (for light, reflections, images).

Here, there is an intentionality to delve deeper into the idea of spatiality, designed as a layering of layers, which, as on a computer screen, are distinguished and managed through the attribution of different colours. In brief, these are three categories that meditate on the visual and perceptual physicality of colour as "building material".

- the *expressive colour*, finally, enters the "middle world" where architecture meets art, to see how urban and territorial redesign contexts, in the vastness of their experiences and situations, often find a place of convergence in the use of colour, which adheres to the construct following and formalising the intuitions of the artist.

Thus are triggered phenomena of reinterpretation of the constructed landscape, which amplify the artistic sensitivity to the definition and virtual (and sometimes real) change of its spatiality, thanks to the chromatic addition. This modifies the usual point of view, exposing its weaknesses and hypocrisies through the grafting of different narrative phenomena, sometimes innovative, but more often "dormant". Colour as an affirmation, even a political one, of the architecture's role.

Conflict of interest declaration

All authors of the Color Culture and Science Journal (CCSJ) are requested to disclose any actual or potential conflict 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. The Conflict of interest declaration must be included in the paper and states if no financial/personal interests have affected the objectivity of the author(s), or if there are, the source and nature of the potential conflicts. Authors must state explicitly whether potential conflicts do, or do not exist.

Funding source declaration

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Notes

[1] M. Borsotti (2012). *Architetture contemporanee e colore: amplificazioni di senso*. In: M. Rossi, A. Siniscalco. *Colore e Colorimetria. Contributi Multidisciplinari Vol. VIII* A. Alma Mater Studiorum, Università di Bologna, Facoltà di Ingegneria, Bologna, 13/09/2012 - 14/09/2012, p. 315-322, Milano: Maggioli Editore, ISBN: 8838761361 and Borsotti, M. (2014). *Architetture contemporanee e colore: altre amplificazioni di senso*. In Rossi M., Marchiafava V. (Ed), *Colore e colorimetria. Contributi multidisciplinari. Vol. X A. Atti della Decima Conferenza del Colore*. Università degli Studi di Genova. (pp. 511- 518) Santarcangelo di Romagna (RN): Maggioli. ISBN 978-88-916- 0437-8

[2] *idem*

[3] Emmanuelle Moureaux, *Shikiri. Dividing and creating space through colors*. *See*: Retrieved from: http://www.emmanuellemoureaux.com/shikiri/ (consulted 1/4 2016)

[4] Retrieved from: http://www.boamistura.com/luz_nas_vielas.html (consulted 1/4 2016)

[5] Retrieved from: http://www.boamistura.com/color.html (consulted 1/4 2016)

[6] Antwaun Sargent, *Amanda Williams' Color Theories*. Retrieved from: http://www.interviewmagazine.com/art/amanda-williams-color-theories/ (consulted 1/4 2016)

[7] Amanda Williams, *Color(ed) Theory Series*. Retrieved from: http://awgallery.com/section/373029-Color-ed-Theory-Series.html (consulted 1/4 2016)

Short biography

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References

Boamistura (n.d.) *"Luz nas vielas" (Light in the alleyways).* Available at: http://www.boamistura.com/#/project/luz-nas-vielas-2 (Accessed: 10 October 2018)

Boamistura (n.d.a) *Llena la vida de color. The dome*. Available at: http://www.boamistura.com/color.html (Accessed: 10 October 2018)

Borsotti, M. (2012) 'Architetture contemporanee e colore: amplificazioni di senso', in: Rossi M., Siniscalco A. (ed.) Colore e Colorimetria. Contributi Multidisciplinari Vol. VIII, A. Santarcangelo di Romagna (RN): Maggioli, p. 315-322. (ISBN: 8838761361)

Borsotti, M. (2014) 'Architetture contemporanee e colore: altre amplificazioni di senso', in Rossi M., Marchiafava V. (ed), Colore e colorimetria. Contributi multidisciplinari. Vol. X A. Atti della Decima Conferenza del Colore. Santarcangelo di Romagna (RN): Maggioli, pp. 511- 518. (ISBN 978-88-916- 0437-8)

Moureaux E. (n.d.) *Concept*. *Shikiri. Dividing and creating space through colors.* Available at: http://www.emmanuellemoureaux.com/shikiri/ (Accessed: 10 October 2018)

Sargent A. (2015), *Amanda Williams' Color Theories*. Available at: http://www.interviewmagazine.com/art/amanda-williams-color-theories/ (Accessed: 10 October 2018)

Williams A. (n.d.) *Work*. *Color(ed) Theory Series*. Available at: https://awstudioart.com/section/373029-Color-ed-Theory-Series.html (Accessed: 10 October 2018)

Anderson Feisner E., Reed R. (2004), Color Studies. London: Fairchild Books

Albers J. (2013) Interaction of Color: 50th Anniversary Edition. Yale: Yale University Press

Arnheim R. (2008) Arte e percezione visiva. Nuova versione. Milano: Feltrinelli

Birren F. (1961) Color Psychology and Color Therapy. A factual study of the influence of color on human life. Seattle: University Books

Brusatin M. (2000), A History of Colors. Torino: Einaudi

Falzone P. (2008) Colore Architettura Ambiente. Roma: Edizioni Kappa

Glasner B., Schmidt P. (eds.) (2009), Chroma: Design Architecture & Art in Color. Basel: Birkhäuser.

Goethe von, J. W. (1987), La teoria dei colori: lineamenti di una teoria dei colori. Milano: Il saggiatore

Itten, J. (1961) The Art of Color: the subjective experience and objective rationale of color. New York: John Wiley & Sons

Komossa S., Rouw K., Hillen J. (2009). Colour in contemporary architecture. Amsterdam: Sun Publishers

Linton H. (1999) Color in Architecture: Design Methods for Buildings, Interiors, and Urban Spaces. New York: McGraw-Hill.

Porter T., Mikellides B. (eds.) (2009). Colour for Architecture Today. New York: Taylor & Francis

Rahim A. (2001) Contemporary Tecniques in Architecture, New York: JohnWiley & Sons

Sandu Cultural Media (eds) (2012), Color and Space. Berkley/Hamburg: Ginko Press

Color emotion as a feasible tool in a participatory project for a Primary School

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ABSTRACT

The experimentation conducted during a participatory pilot research project in a Primary School in Milan, explored the use of emotional associations of color through the identification of evocative terms, or "emotion words", together with color combinations and images of projects in specific contexts, as a basis for comparison, discussion and verification, and, to conclude, for development of project hypotheses. Even if we cannot, on a numerical level, consider significant the reference sample used within the participatory process, both in the preliminary and in the verification phase of the methodological assumptions, the results of the experimentation led us to assume that the design methodology we identified and adopted proved to be functional in order to facilitate comparison and verification within the participatory process and subsequently develop design hypotheses based on the same comparison and verification.

KEYWORDS color emotion, color design, color preference, color in educational environments

RECEIVED 16 May 2019; **REVISED** 04 June 2019; **ACCEPTED** 20 June 2019

CITATION: Boeri, C. (2019). Color emotion as a feasible tool in a participatory project for a Primary School. Color Culture and Science Journal, 11(1), 19–27. https://doi.org/10.23738/CCSJ.110102

1. Introduction

The evaluation of the emotional response to color, or "color emotion", has been the focus of a great number of researches, and can be divided into two broad categories, as noted by Gao and Xin (2006): one related to the aesthetic experimentation of color, or color preference, which addresses the color evaluative dimensions, and the other related to the color descriptive dimensions, linked to connotations like warm or cool, light or dark, heavy or light, etc.

A few of these studies evaluated emotional color preferences and associations in children (Boyatzis and Varghese 1994; Burkitt et al. 2003; Pope et al. 2012). These studies suggested that the positive or negative emotions associated to color depended on the individual child's personal experience (Boyatzis and Varghese 1994). Children tended to associate their favorite colors with the positive characters of a drawing and the least preferred to the negative characters of a drawing (Burkitt et al. 2003) and also to associate their preferred colors with positive feelings (Pope et al. 2012).

In particular, the study of Boyatzis and Varghese (1994) investigated the color preferences in children aged 4-5 and 6-7 years, compared to nine different colors and the emotional reactions they had to each of these colors, expressed verbally. The study showed that the emotional associations elicited in the children by the selected colors were mostly positive. The percentage of positive emotional responses was higher for the bright colors (pink, red, yellow, green, purple, and blue) than for the dark colors (black, brown, and gray). The positive emotions mentioned by the children were codified as happiness, strength, and excitement and the negative ones as sadness, anger, and boredom (Boyatzis and Varghese 1994, p. 80).

Some of these studies focused on children preferences in pre-school indoor environments using, for this purpose, the image of a digitally manipulated school space to create different color alternatives (Read and Upington 2009; Dalirnaghadeh 2016).

In the study by Read and Upington (2009) the colors of the photographic image of an interior corner of a child development center were modified using the following colors: purple, blue, green, yellow, orange, red, and gray, of which, however, the various manipulation results were not provided, nor a more precise coding on the adopted lightness and saturation levels. The study showed that the red image was the most selected as a first choice, followed by the purple one, which was the favorite of the girls. The gray image was mostly selected as the last choice.

In the study by Dalirnaghadeh (2016), only the walls of the photographic image of the environment were modified using a high and low saturated red, a high and low saturated blue, and a high and low saturated gray (but since they were achromatic grays it would be more correct to say a light and a dark gray), and a white. The study showed that the high saturated blue was the most preferred and was associated with the positive emotion of happyness and the high saturated red the least preferred and associated with the negative emotions of anger (Dalirnaghadeh 2016, p. 80). As for the achromatic schemes, the results suggested that the most preferred classroom was the one with the white, which was associated with happiness, while the one with the high saturated gray was the least preferred, and associated with anger (Dalirnaghadeh 2016, p. 82).

Among the aims of these studies, we may also see the opportunity for discussion, with respect to the value of the context in which the preferences of color are expressed, and hence on the possible design implications related to this research area.

In the study by Park (2014), the correlations between color attributes and color preferences in children were analyzed using scale models of rooms. As stated by the same Park, compared to the numerous studies on color preferences that made use of small color samples, his study focused on the environmental effects of color through physical simulation models in order to investigate the color preferences in a real context.

As noted by Küller (1981), with regard to the studies conducted on color preferences, one of the most critical issues is linked to the fact that most of these studies are without contextualization, and the other to the fact that most of these studies focus on preference or meaning of single colors rather than color combinations.

This is the background to the experimentation we conducted during a participatory pilot project in a primary school in Milan, which explored the possibility of using emotional color associations, through the identification of connotative terms or "emotion words" to be associated with color schemes, and images of projects in specific contexts, as a basis for comparison, discussion and verification, and, as a final point, to develop of design hypotheses.

2. The pilot project "Let's design the school together"

The pilot project "Let's design the school together", concerning the participatory planning of the school environments of a primary school belonging to the

"Istituto Comprensivo Luigi Cadorna" in Milan, had as a main goal the identification of innovative criteria for the design and redevelopment of schools. The two-year long project was completed in 2018. The salient points of the design method adopted focused on a participatory planning with children, teachers and parents and a design by a multidisciplinary team of architects, designers and engineers [1].

The participatory project was carried out through design workshops with children and questionnaires addressed to children and adults [2]. The analysis of the state of the art and the results of the participatory methods produced a number of "design responses", regarding both the architectural works and the space refitting, and the qualitative interventions related to furnishing solutions, materials, light and color. The latter were developed for each individual area of expertise, and in working groups interspersed with moments of comparison and sharing [3]. Each work group was provided with a summary of the outcomes of the design workshops made with children and the project questionnaires, as a basis to create the design concepts that would later be submitted to the school community and, following discussion and verification, become project proposals.

Briefly, the school was built in 1932, and houses today a primary school and a preschool, which are part of the "Istituto Comprensivo Luigi Cadorna", plus a municipal micro-nursery. About 500 pupils attend the school, including primary and preschool. The building consists of three floors above ground and a basement. The access is from a raised ground floor where the office block and the meeting rooms, the kindergarten, the micro-nursery and one of the two gyms are located. On the first floor there are the classrooms of the primary school, the second gym, the laboratories and the library. On the second floor are the remaining classrooms of the primary, other laboratories, the literacy classrooms, a large multi-purpose hall and the school of Italian for mothers. In the basement there are the refectory and the technical and storage rooms, a small gym and a multifunctional space used for exhibitions, workshops, meetings, gatherings, parties, etc. The school is also equipped with outdoor spaces.

3. The color project and the design methodology adopted in the participatory process

The operative methodology explored within the participatory pilot project for the Cadorna primary school was based on the need, on the one hand, to translate the desires expressed or that could possibly be expressed during the participatory process and, on the other, to build a basis for comparison, discussion and verification on which to develop the design hypotheses.

Within the various questionnaires given to each work group in the form of a summary of the results, specific questions on color were provided. In particular, in the questionnaire relating to "My class" the children in a third grade class of an average age of 8 years, were asked to answer the question "Do you like colors?" and all the fourteen answers were positive. Another of the questions asked the children "What color would you like in your class?" and of the fourteen answers given, most expressed a preference for two colors (10), followed by a preference for single colors (3) and then for four colors (1). The overall results showed how the most mentioned color was light blue (Table 1).

6	5	5	4	3	2	1	1
LIGHT BLUE	YELLOW	WHITE	RED	GREEN	BLUE	PURPLE	BLACK

Table 1 – The color named by the children sample in answer to the question "What color would you like in your class?". (Multiple color choices are reported).

Other specific questions about color were addressed to the children of the same class, within the section of the questionnaire "How is your school when you enter the building?" One of the questions asked, "What color would you like to have in the corridors and throughout your school?" From the fifteen answers given, we observed that most children responded with a polychromatic meaning by repeatedly using the term "rainbow" (6) in addition to one answer that read "all" (1). The overall results showed that most children responded "rainbow" (6), followed by red (2 red, 1 dark red, 1 fiery red), sea green (1), blue and purple (1) (Table 2).

6	4	1	1	1	1	2
RAINBOW	RED	PURPLE	BLUE	SEA GREEN	ALL COLORS	OTHER

Table 2 – The color named by the children sample in answer to the question "What color would you like to have in the corridors and throughout your school?". (Multiple color choices are reported).

Within the section "What would I like to do at school?" there were other specific questions about color directed to the association between colors and particular activities such as studying, resting and playing (Table 3).

Therefore, the analysis of the questionnaire summaries offered us the possibility of assessing the children's

responses not only in terms of preferences accorded to a single color, but also in presence of recurring multiple choices of colors as well as of choices of multiple color combinations.

TO STUDY	(16 responses)			
8	7	3	2	3
RAINBOW | ALL COLORS | MULTICOLOR	RED	LIGHT BLUE	GREEN	OTHER
TO RELAX	(17 responses)			
8	4	3	2	2
LIGHT BLUE	GREEN	BLUE	YELLOW	OTHER
TO PLAY	(17 responses)			
6	6	4	3	2
GREEN	RED	BLUE	LIGHT BLUE	OTHER

Table 3 – The color named by the children sample in answer to the questions "What color would you like to have in your school to study?", "The color to relax?", "The color to play?". (Multiple color choices are reported).

This datum, together with the partiality of the rather small sample offered by the results of the questionnaires, inspired us to identify and explore a methodology that would allow us to base the design hypotheses not so much on the individual and specific color preferences detected and detectable but on the possibility of translating and summarizing the desires and suggestions expressed, specifically by children, through keywords associated to multiple color combinations.

3.1. *Method and materials*

The method we identified, consists (a) in the possibility to analyze and synthesize the recurring descriptions and suggestions given by the children in the questionnaires to express how they would like their school spaces to be in evocative terms or "emotion words"; (b) to associate the identified "emotion words" with 4-colors palette examples, suggesting possible application scenarios through the use of illustrative and contextualised images; and, finally, (c) to subject them to verification and discussion.

The analyses of the descriptions and suggestions most used by children in the questionnaires to express how they would like their school spaces were summarized in the "emotion words" soft, natural, warm and rainbow (Fig. 1). The first two referred to "The school I want" and hence they summarized the wishes expressed by the children about how they would like the spaces of their school to be. Instead, the word "Warm" referred to "The school as it is" and thus summarized a positive connotation used to describe how the school was perceived. Finally the term "Rainbow", in the double meaning of polychromatic and transformable, referred directly to the color preferences expressed by the children and to a recurring description they used to describe how they would like their school spaces to be.

Each of these "emotion words" was associated with an exemplifying 4-colors palette, and a specification of the hue, lightness and saturation attributes that eventually characterized the palette, using the visual representation of the NCS, Natural Colour System, color circle and color triangle. The palette was developed using as a reference source the literature and experimental research that addresses the synesthetic and emotional associations of color (Kobayashi 1991; Mahnke 1996; Tornquist 1999; Riccò 2005, 2008; da Pos 2007; Boeri 2019).

For each "emotion word", we suggested some possible combinations with materials, shapes and finishes (Fig. 2) and, in a additional table, we associated illustrative images, related to school environments, and selected for their affinities with the color palettes and the sensory characteristics described (Fig. 3).

Figure 1 – The "emotion words" that were identified to summarize the recurring descriptions and suggestions used by the children to describe the school spaces and how they would like them to be.

The illustrative tables prepared in this way were object of comparison, discussion and verification during a round table with students, teachers and parents and open to the territory [4]. In this phase of discussion and verification, new questionnaires were also prepared, and each work group was given the opportunity to formulate specific questions consistent with the different design approaches and methods adopted. In the case of color, the questions formulated were directed to verify the methodological assumptions and the design objectives and, therefore,

above all the selected "emotion words" and the proposed associations with the color [5].

SOFT	Children (5 responses)			
2	1	1	1	
WHITE	RED	BLUE	LIGHT BLUE	
SOFT	Adults (10 responses)			
4	3	1	1	1
LIGHT BLUE	PINK	WHITE	BLUE	YELLOW
NATURAL	Children (5 responses)			
3	2			
GREEN	LIGHT BLUE			
NATURAL	Adults (10 responses)			
7	1	1	1	1
GREEN	LIGHT BLUE	BLUE	BEIGE	BROWN
WARM	Children (5 responses)			
3	2			
YELLOW	RED			
WARM	Adults (10 responses)			
5	4	4		
YELLOW	RED	ORANGE		

Table 4 – The color named by the children and adults sample in answer to the questions related to the color associations with the selected keywords. (Multiple color choices are reported).

In particular, the participants were asked what color they associated with the "emotion words" soft, warm and natural. The questionnaire was completed by 5 children (belonging to the same third grade class who had participated in the previous questionnaires), and 10 adults (mainly parents of children attending the school). From the answers to the questionnaires filled in by the children, we could observe a congruence between the colors associated with the warm and natural "emotion words" and the suggested palette – for the warm, the most mentioned colors were respectively yellow and red and for the natural, green and light blue – while the association of color with the soft appeared to be more heterogeneous and there was no congruence with the suggested palette (Table 4). From the answers of the questionnaires completed by the adults, we observed an analogous congruence between the colors associated with the warm and natural "emotion words" and the suggested palette – for the warm, the most mentioned colors were yellow, red and orange, and for the natural, green – and a certain congruence with the suggested palette for the soft, as regards the parameter of lightness and saturation (Table 4).

Although the number of participants in this questionnaire should be considered rather small, we decided to proceed with the formulation of the design hypotheses, consolidating the identified "emotion words", and possibly rereading the related chromatic-sensorial scenarios, seen as flexible matrices on which we could develop the emotional identity of the environments and then combine this identity with other design implications related to the functionality of color in school environments.

3.2. *Design hypotheses*

The proposed design hypotheses dealt with logic of recognition of the different functional distributions in which the school plans are organized, and of the different sections in which the school plan is divided. Each section was characterized by the presence of a dominant color that made it recognizable among the others. That dominant, for the two floors housing the primary school classrooms, was identified in the conjugation of the two "emotion words" Warm and Rainbow, defining the following 4 colors to differentiate the four sections: yellow, orange, red, purple, while the basement was identified also by the "emotion word" Natural, in addition to the previous Warm and Rainbow, defining thus 4 other colors to differentiate the existing 4 sections: yellow, yellow-green, green-yellow, green (Figs. 4-5).

Within this logic, the design and illustrative hypotheses relating to the specific areas of the school were formulated. For example, within the standard classroom and relative relaxation area, it was foreseen that each dominant could be flexibly used according to different, potentially even alternative, distribution forms (Fig. 6). The color palette developed for the classroom was based on the "emotion word" Warm, while for the relaxation area there was a different color palette based on the two "emotion words" Natural and Soft, offering a different color saturation and lightness on the yellow-green and blue-green shades.

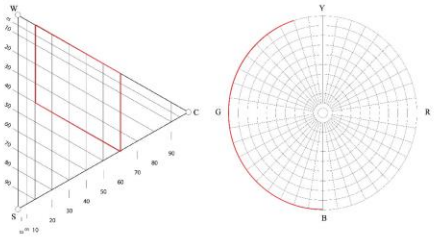
NATURAL

"Classroom of aquarium and plants"

But could you tell how the floor is made in the classroom and how would you like it?
Marble but I would like parquet. Marble and I would like aquarium. A rainbow floor.

How would you like to stay to be more focused and concentrated?
Within the grass. In the grass.

[The school I would like, Excerpts from the children's questionnaires]



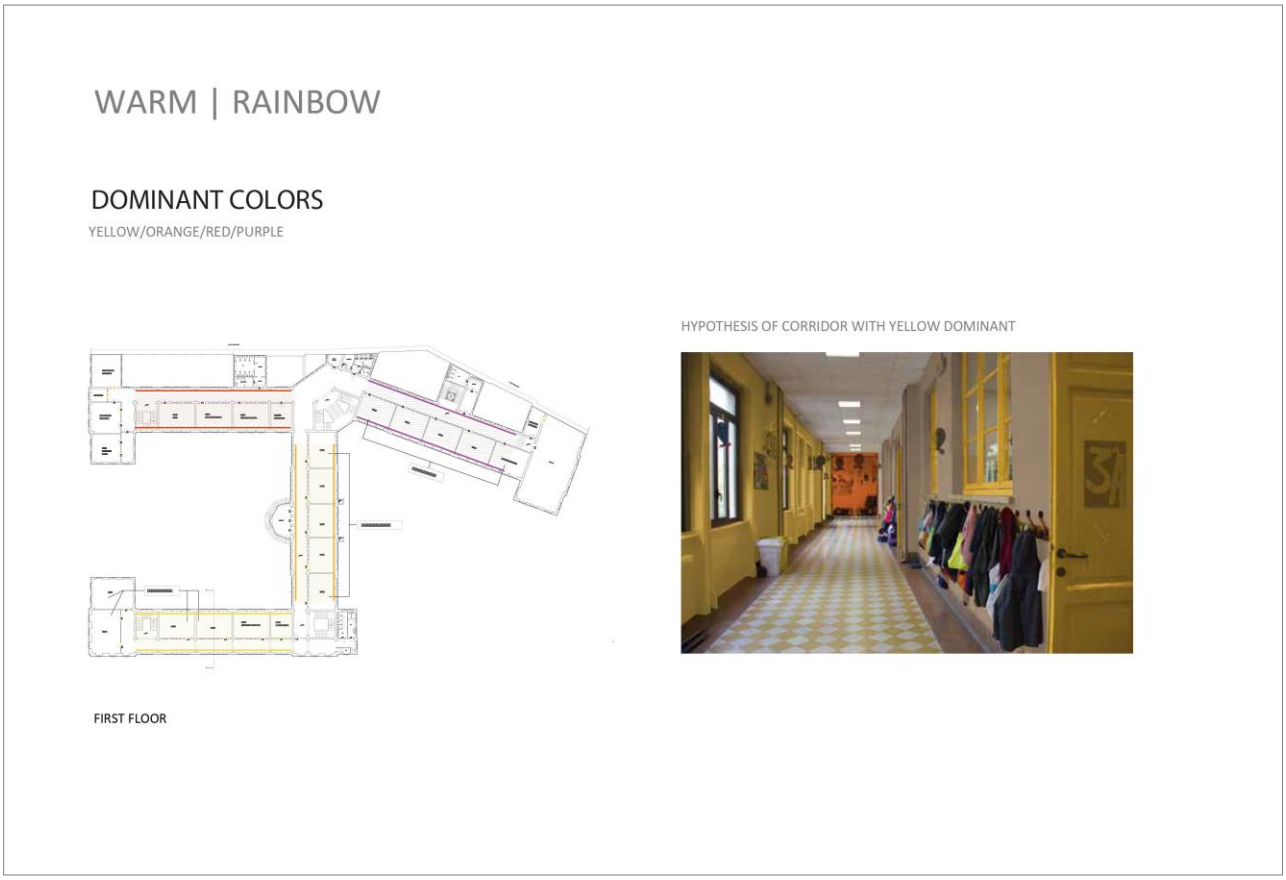
COLOUR	MATERIAL	SHAPE	FINISH
green blue-green	wood	organic	matte transparent

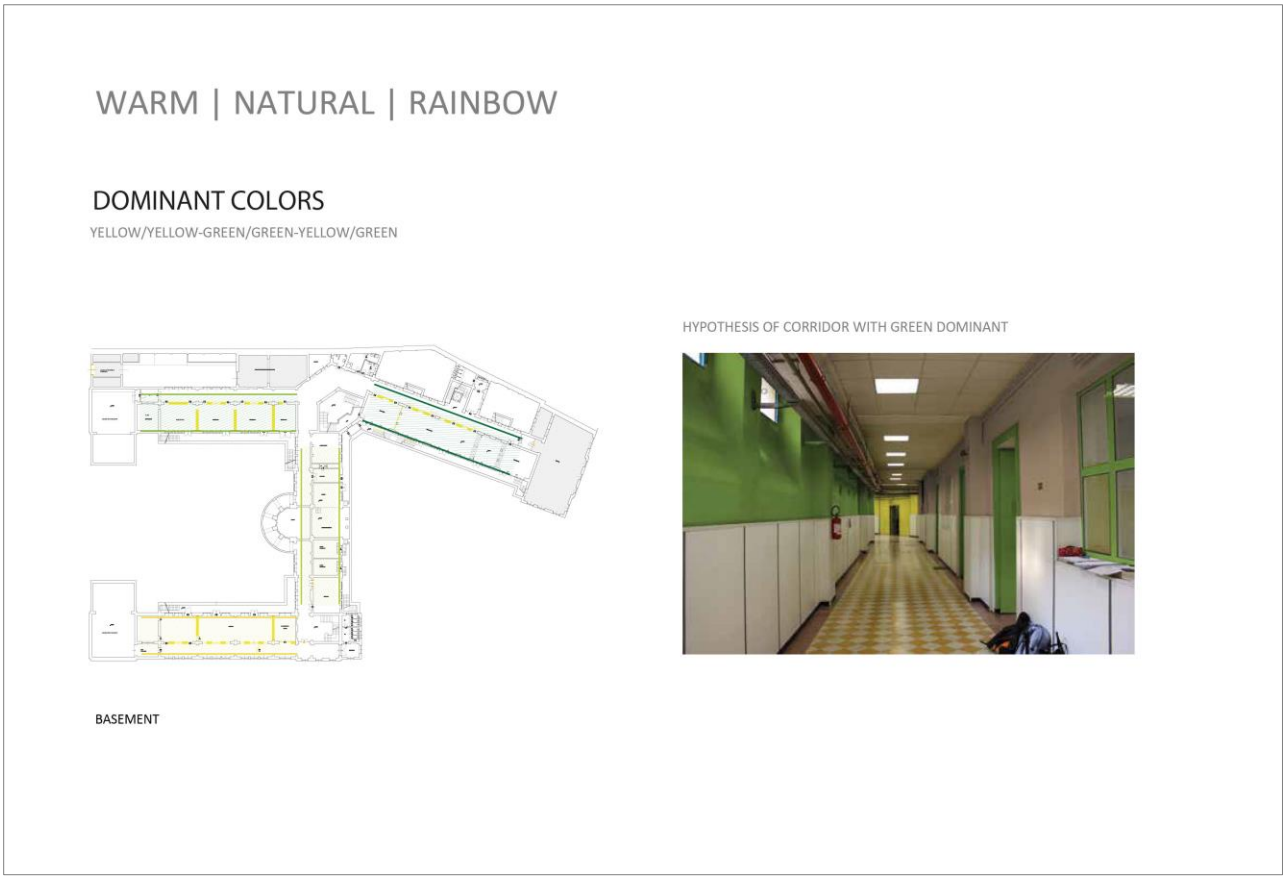
NATURAL

"Classroom of aquarium and plants"

Taktik Design, Sainte-Anne Academy, Quebec, 2015
McBride Charles Ryan, PEGS Junior School, Melbourne, Australia

Figures 2-3 – An example of the tables showing, for each "emotion word", the associations with exemplifying 4-colors palettes, the possible associations with materials, shapes and finishes and image examples related to school environments.





Figures 4-5 – The color concept developed for the Cadorna Primary School.

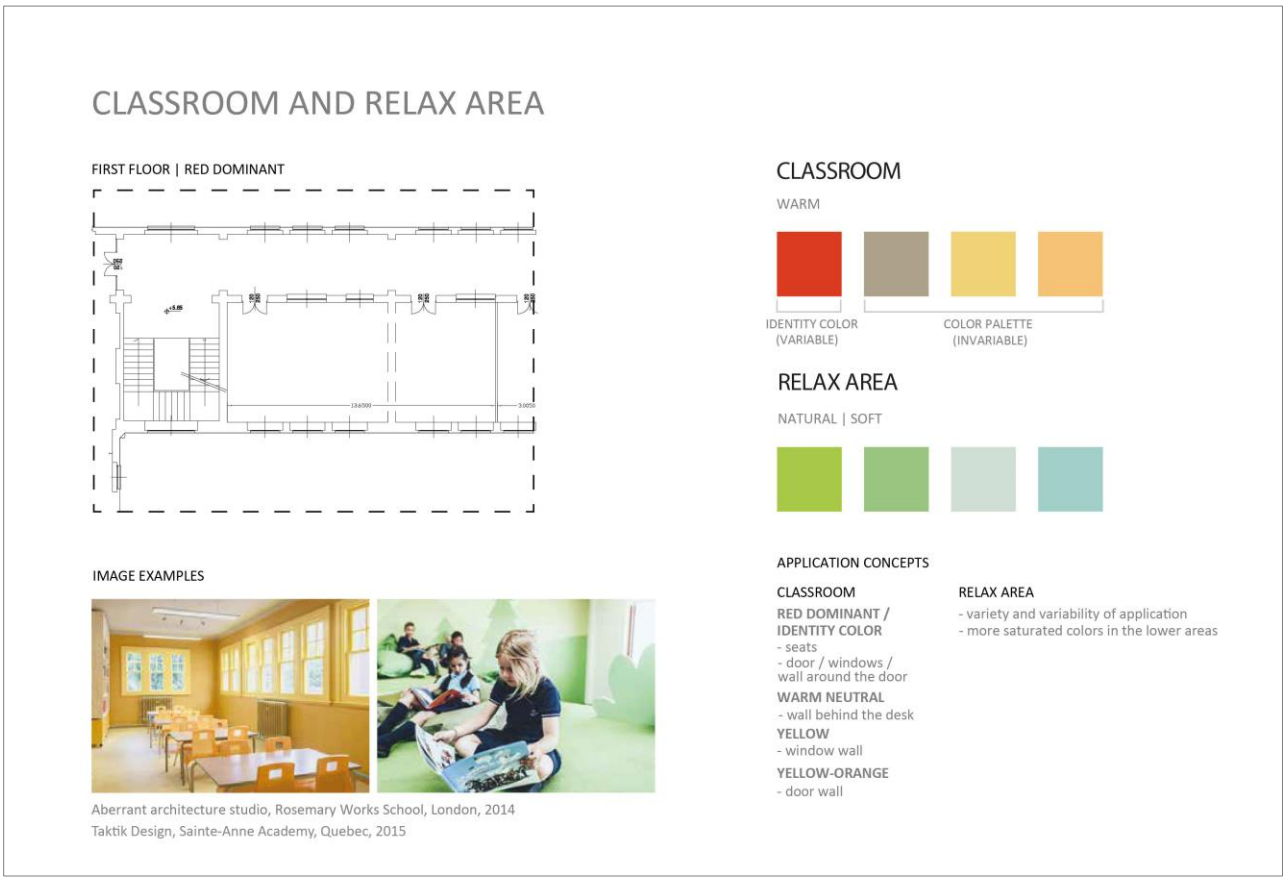


Figure 6 – The design hypotheses for the standard classroom and the relative relaxation area.

4. Results and discussion

The experimentation conducted during the participatory pilot project for the Cadorna Primary School explored possible design applications in the area of research called “color emotion”, having as a main goal the possible implementation of polychromatic settings in school environments based on color preferences and emotional responses. To this purpose, the “emotion words” we selected to summarize the most recurrent descriptions and suggestions used by the children involved to describe how they would like their school environments to be, turned out to be an optimal tool to build associations of color combinations, related to possible chromatic-sensory scenarios and illustrative images of real environments, as a basis for comparison, discussion and verification, and, therefore, for the development of design hypotheses.

Even if we cannot, on a numerical level, consider significant the reference sample used within the participatory process – both in the preliminary and in the verification phase of the methodological assumptions –, the results of the experimentation led us to assume that the methodology we identified and adopted proved to be functional in order to facilitate comparison and verification within the participatory process and subsequently develop design hypotheses based on the same comparison and verification.

The design implications raised by the experimentation contributed to frame color preferences and emotional responses to color in terms of combinations of multiple colors, and also highlighted the need, for the purposes of the possible design applications in this area of research, for greater contextualization, as Küller (1981) observed, also in reference to the preference accorded to the use of color combinations.

A second aspect raised by the experimentation was related to the possibility of using color preferences in order to promote a greater, and desirable, participation by children, in the design and configuration of school environments (Read and Upington 2009; Gaines and Curry 2011). In this experimentation, the role of color within the participatory process was understood on the basis of the attribution and association possibilities that can be established between the “emotion words” and the color-sensory scenarios. Thus attributing the function of conveying the visual, sensory and meaningful qualities upon which to build the emotional identity of school environments to color.

5. Conflict of interest declaration

The author declares no conflict of interest related to this publication.

6. Funding source declaration

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sector.

7. Short biography of the author(s)

Cristina Boeri - Architect PhD, her activity in the research, teaching and professional sectors, deals with aspects related to the color perception and design. Since 2001, she carries out educational and research activities in the Color Lab of the Department of Design of the Politecnico di Milano. She is adjunct professor of Color and perception at the School of Design, Politecnico di Milano.

Notes

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[2] The design workshops and questionnaires have been designed and edited by Linda Poletti.

[3] Working group for color: Cristina Boeri with the collaboration of Chiara Iemmolo.

[4] Round table "Let's design the school together", December 5, 2017, Aula delle Culture, Scuola Cadorna, Milan.

[5] The development, collection and synthesis of the questionnaires was edited by Linda Poletti.

References

Boeri, C. (2019) 'An educational experience on the exploration and experimentation of colour associations and relationships', Journal of the International Colour Association, vol. 24, pp. 1-10.

Boyatzis, C. J. and Varghese, R. (1994) 'Children's Emotional Associations With Colors', The Journal of Genetic Psychology, 155(1), pp. 77-85.

Burkitt, E., Barrett, M. and Davis, A. (2003) 'Children's colour choices for completing drawings of affectively characterised topics', Journal of Child Psychology and Psychiatry, 44(3), pp. 445–455.

Dalirnaghadeh, D. (2016) The Effect Of Chromatic And Achromatic Color Schemes On Children's Emotions In A Preschool Classroom, Master's Thesis, Department of Interior Architecture and Environmental Design, İhsan Doğramacı Bilkent University, Ankara.

da Pos, O. and Valenti, V. (2007) 'Warm and cold colours' in Guanrong, Y., Haisong, X. (eds.), AIC2007 Color Science for Industry, Proceedings of the AIC 2007 Midterm Meeting, Color Association of China, Hangzhou, pp. 41-44.

Gaines, K. S. and Curry, Z.D. (2011) 'The Inclusive Classroom: The Effects of Color on Learning and Behavior', Journal of Family & Consumer Sciences Education, 29(1), pp. 46-57, Available at: http://www.natefacs.org/JFCSE/v29no1/v29no1Gaines.pdf (Accessed: 25 February 2019).

Gao, X-P. and Xin, J. H. (2006) 'Investigation of Human's Emotional Responses on Colors', Color research and application, 3(5), pp. 411-417.

Kobayashi, S. (1991) Color Image Scale. Kodansha.

Küller R. (1981) Non-Visual effects of light and colour. Annotated Bibliography. Stockholm: The Swedish Council for Building Research.

Mahnke F. (1996) Color, Environment and Human Response. New York: Van Nostrand Reinhold.

Park, J. G. P. (2014) 'Correlations Between Color Attributes and Children's Color Preferences', Color research and application, 39(5), pp. 452-462.

Pope D.J., Butler H. and Qualter P. (2012) 'Emotional Understanding and Color-Emotion Associations in Children Aged 7-8 Years', Child Development Research. doi:10.1155/2012/975670.

Read, M. A. and Upington, D. (2009), 'Young Children's Color Preferences in the Interior Environment', Early Childhood Educ J, 36, pp. 491-496. doi: 10.1007/s10643-009-0311-6.

Riccò, D. (1999) Sinestesie per il design. Milano: Etas.

Riccò, D. (2005) 'Sinestesie del colore: fra ricerca e sperimentazione didattica per il design di comunicazione', in Prima conferenza nazionale del Gruppo del Colore, Andrea Raggi (ed.), Colore e colorimetria: contributi multidisciplinari, Pescara, 20-21 ottobre 2005, Firenze: Centro Editoriale Toscano, pp. 315-322.

Tornquist, J. (1999) Colore e Luce. Teoria e pratica. Milano: Istituto del Colore.

'Khrôma' the first software for management of the Color and Decoration Plan for small historic villages

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ABSTRACT

The 'Khrôma' project is aimed at creating the first software for the management of the Color and Decoration Plan that can be applied to small historic villages. As is well known, Italy is made up of many small historic villages that are described as "minor historical towns". They have been suffering for decades from a state of abandonment.

The total lack of awareness of the importance of buildings within a wider historical-artistic context has generated the development of a methodology that can guide the qualitative and cultural appearances of the construction sites: namely, the Color Plan. However, the drafting of the Color Plan always requires competent professionals who are able to read and interpret the indications provided by the plan: this is the most important critical issue that makes the color plan an ineffective tool in the hands of nonexperts.

An integral management on a digital platform would enable the application of the color plan for small historic villages, and would thus permit improved accessibility to the application of the plan as compared with the methodology currently in use.

The proposed ‘Khrôma’ software has the possibility to customize the functions and the database adjusting them to a territorial application on a specific area in question; its features include simple and intuitive graphical interface, independent functioning and accessibility that does not depende on any digital device.

Thanks to ‘Khrôma’ software, it will be possible then to introduce a simplification in any given technical-bureaucratic procedure that can then be communicated to citizens as information regarding the upgrading process to their territory.

KEYWORDS color, plan, digitization, architecture, Khrôma, software

RECEIVED 19 April 2019; **REVISED** 05 May 2019; **ACCEPTED** 24 May 2019

CITATION: Cherubini, F., Cherubini, A., Cucci, C., Picollo, M., & Stefani, L. (2019). ‘Khrôma’ the first software for management of the Color and Decoration Plan for small historic villages. Color Culture and Science Journal, 11(1), 28–34. https://doi.org/10.23738/CCSJ.110103

1. Introduction

Italian cities have been in crisis for decades because the resident communities have not been able to express the real potential that has been recognized for centuries in urban areas and that is linked to the value of local identity. The ancient cities were required to represent the power of those who governed both them and the social (and therefore economic) level of the inhabitants: the image of a rich, lively and powerful city corresponded to high levels of care and exploitation of the urban fabric, and the role of cities in extensive areas was declared by means of urban quality.

In the modern cities, this awareness for the collective heritage has re-proposed ancient meanings of belonging and identity for all citizens, who find in the safeguarding of their traditions and in the promotion of their specificities an effective response to the banalization processes of the global market. For several decades, however, there has been a gradual loss of these types of knowledge in all parts of Italy and also in many parts of Europe: industrial processes have proposed materials and techniques that have simplified traditional local regulations, thus changing the appearance of buildings, which have gradually been stripped of their “skin” and consequently made them more commonplace; this inevitably leads to the cancellation of the ancient language of architecture. It then seems evident that the authentic appearance of the complex and varied language of architecture will be respected only if the original techniques and materials that are still present and testified to are re-appropriated.

The protection of these values was already identified and well described in the 1987 Washington Charter [1], which complemented the 1964 Venetian "International Charter on the Conservation and Restoration of Monuments and Sites" [2].. Therefore, it is of fundamental importance to preserve the authentic aspect of the complex and varied language of architecture that is respected only if the original techniques and materials, still present and witnessed in the historical centers, are reappropriated.

A "preventive maintenance program" is necessary in order to safeguard the entire heritage of knowledge and languages and to determine a qualitative outcome for the restoration of every single building.

At present, the complete lack of awareness concerning the importance of buildings within a wider historical-artistic context has generated the development of a methodology that can guide the qualitative and cultural appearances of the construction sites: namely, the Color Plan. The 'Color Plan' recognizes the historic rules of "doing" by re-approaching the material culture and a respect for traditions and for experiences handed down for centuries but abruptly interrupted starting from the post-war years in the name of a "modernity" that, from this point of view, has only impoverished us in cultural and qualitative terms.

Moreover, as also recommended by UNESCO in its guideline, 'the Historic Urban Landscape,' implimented on 10 November 2011 [3], it is not only a question of protecting the intrinsic aspect of a single building or a small village / complex of houses but in a more general sense preserve that historical / urban aspect that characterizes Italian landscape.

The Color Plan is still the most suitable instrument for developing the valorization and promotion policies of historical architecture [4].

2. The Color Plan

The drafting of a Color Plan, whether it be for a very small village or for a large city, involves levels of knowledge of the place, the (overall) buildings and the materials that can only be attributed to an expert technician. These re-qualification plans develop issues that concern the maintenance status of the historic center, indicating critical points and unexpressed potentials.

It will thus be necessary and essential to define how a Color Plan is drawn up and implemented. In addition to a knowledge of the place in historical-artistic and architectural terms, the research involved generally collects also traditional models of reference in order to reconstruct rules for the maintenance of the historical urban background.

These elements can be briefly summarized as follows:

- an abacus of materials and techniques
- an abacus of the ornamentation elements
- an abacus of the elements of urban decoration
- a color abacus
- a technical report
- etc.

This classification, which may seem reductive, actually makes it possible for a room, a space or even a single building to be correctly coded.

If we take into consideration the color plans for the smaller historical centers (both those under UNESCO’s protection and those that are not), where the number of variables is less than that of large urban cities where elements of other cultures have always been incorporated, it is possible to think up a digital

transposition of the Color Plan. The software in question, i.e. the subject of this project, is known as 'Kroma'. It is important to remember that in Italy the number of small, inhabited centers is extremely high (about 6000 villages have less than 5000 inhabitants) and these small hamlets often are not protected by any specific legislation, although the distinguishing characteristics of the builiding type and urban specificities to be protected may be recognized.

2.1. *The Color Plan: critical issues*

Color plans count on graphic tables, reports and rules, for a correct application of these methodologies. These may “range” from rough indications to specific ones.

However, it is obvious that the critical aspects of this approach are indeed inherent in this system.

In fact, the drafting of the Color Plan requires competent professionals who are able to read and interpret the indications provided by the plan. In addition, the application phase of the plan itself requires various meetings with the Municipal Administration in order to identify and find a point of agreement between the 'request' of the citizens/ technicians and the 'requirements' of the indications indicated in the plan.

One of the most important critical issues of the Color Plan is based on this last step. This 'necessary' step with the Local Administration often slows down the procedures, and at times discourages citizens from participating in an improvement to the place in which they live.

3 Objectives of the Khrôma software

The mission of the 'Khrôma' project is to make the application of the Color Plan accessible to non-experts as well as professionals (in a first moment exclusively for the smaller historical centers, where the number of variables is lower).

By digitally fixing the constraints indicated by the Color Plan, the goal is to enable accessibility to this plan by maintaining an active participation of the citizens involved. Thus, even in the absence of qualified experts, individual citizens could become active participants in the redevelopment process, by going to operate independently but at the same time guided, on a digital platform.

4. Description of the project

Managing the final results of the analyses of the graphic tables, of the relationship between the Color Plan, of the abacus of the elements and of the colors, is often quite difficult for those who are not qualified experts.

The 'Khrôma' project aims to achieve the 'participation' objective through a flexible, but controlled, interaction between the citizens and the program itself. In any case, the software needs an existing Color Plan that can indicate the general or specific constraints on the territory and the types of architecture submitted to analysis. This is necessary because the indications regarding colors, façades, type of materials, the various abacuses of the elements, and the decorative elements need to be previously analyzed and selected by the experts. Therefore, it would be necessary to interpolate these elements, link them together, and then transfer them to a digital platform.

The goal is to design a ‘digital’ container (not content) that would incorporate the analytic which can and must pertain only to a professional in charge of drawing up the color plan; it is the task of the professional to dictate criteria and rules with relative variations that the plan imposes and the program accepts.

The program is structured within three macro areas.

The first macro area is characterized by the identification and collection of data, by means of the compilation of a questionnaire, of the citizen / professional worker / company who assumes responsibility for the entire work process (fig. 1). The process takes place by means of digital procedures that by now already exist in most of the so-called digital administrations (digital signature, etc.).

The second phase, the most important one, consists of identifying the building that is the object of the construction works, and of loading the graphic interface by means of which the user can manage the guided design process (fig. 2).

At a subsequent stage, however, it would be necessary to develop a rigorous integration with the GIS software, which already contains the most common operations related to geographical analysis, including a direct connection to the Khroma software. This would allow the gathering of all data concerning the Color Plans loaded on the platform and would provide the graphic interface necessary for the users’ participation in the redevelopment process.

Some examples of interaction between GIS and color plans aleady exist (particularly interesting is the project for the municipality of Priverno in Lazio [11]) but none of the programs include a study concerning the interaction with users by means of a graphical interface such as the Khroma.

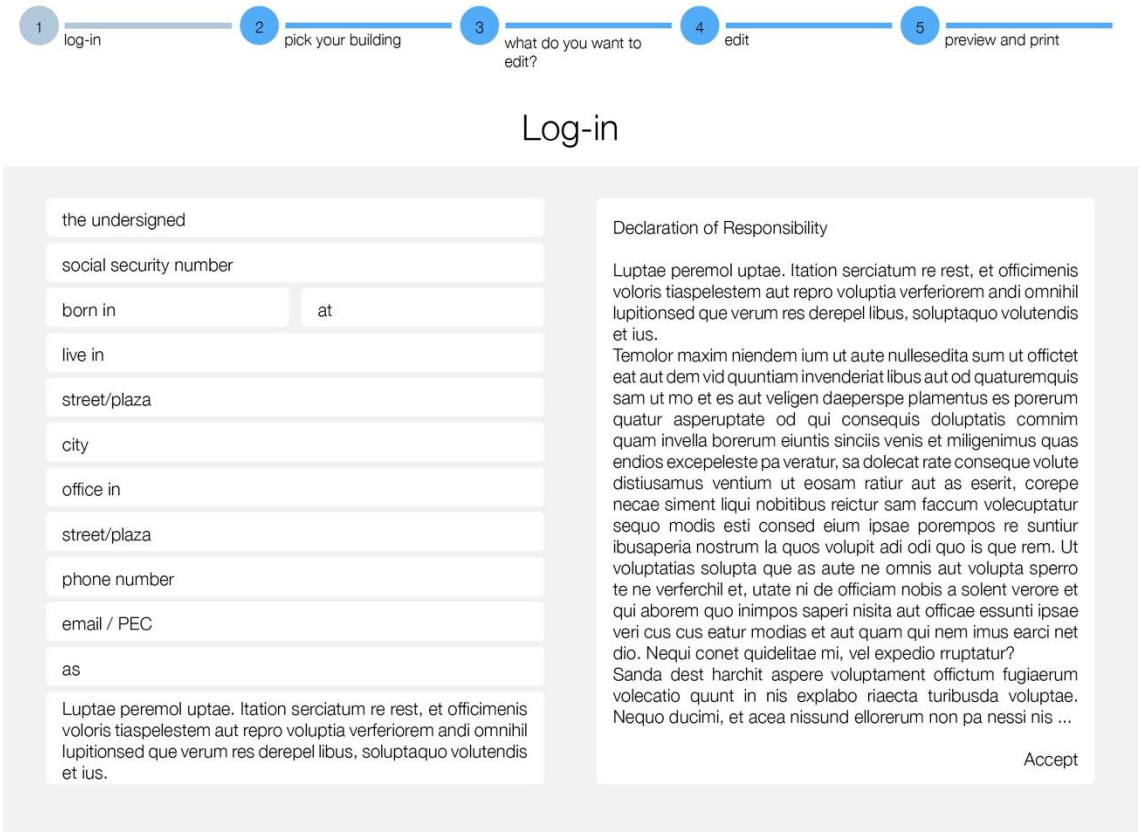

Fig. 1. First screenshot 'Khrôma' the first software: data collection and responsibility assumption.

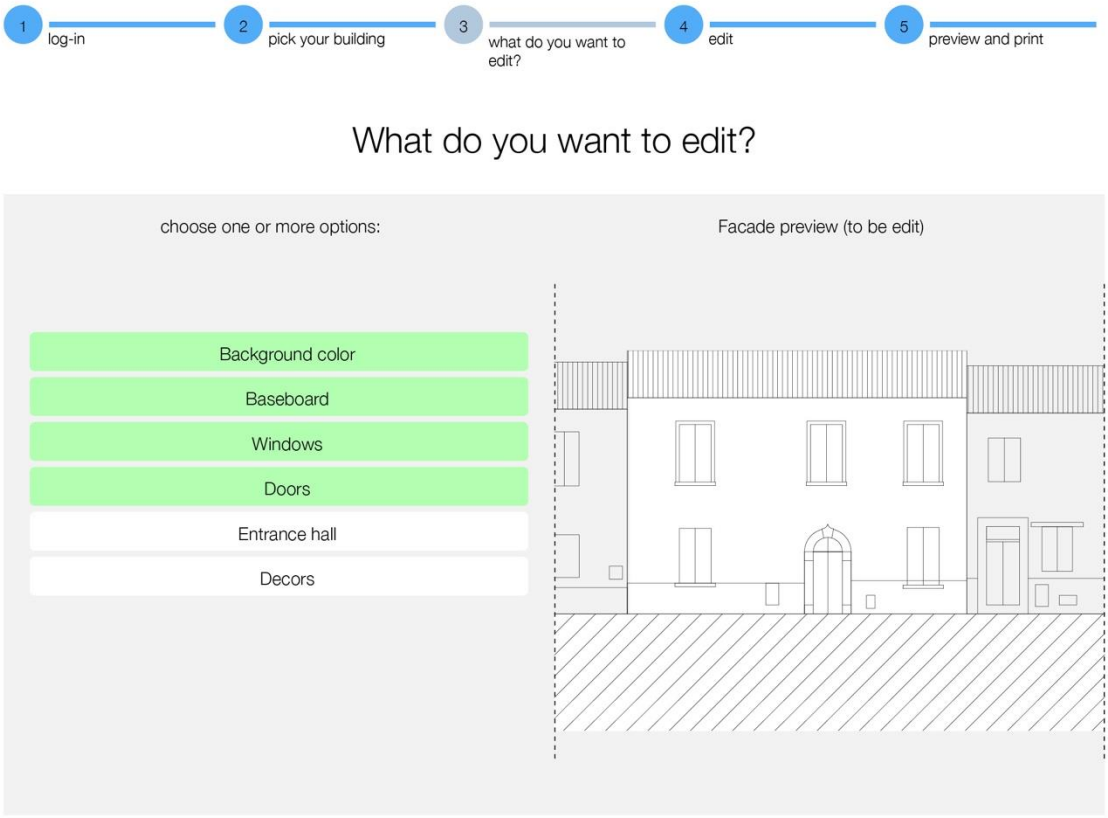

Fig. 2. Preload of graphic interface with iron wire visualization and selection of elements to be modified.

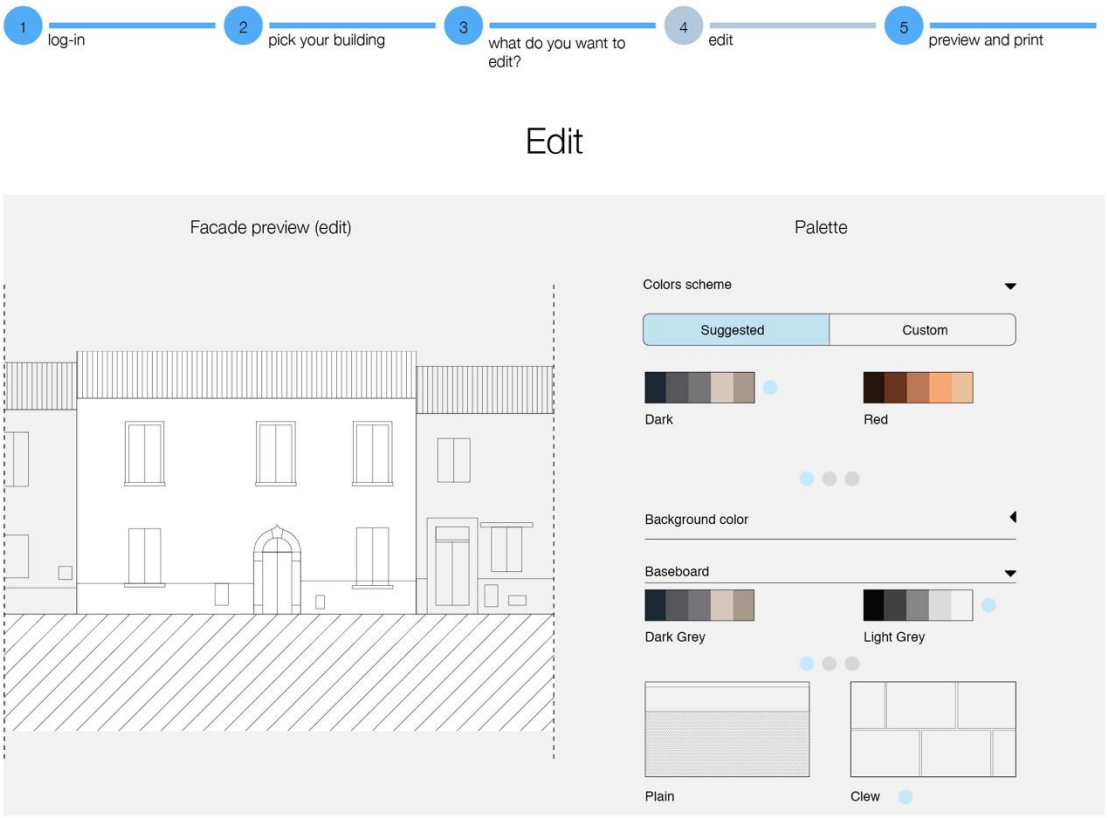

Fig. 3. Preloading elements of the Color Plan.

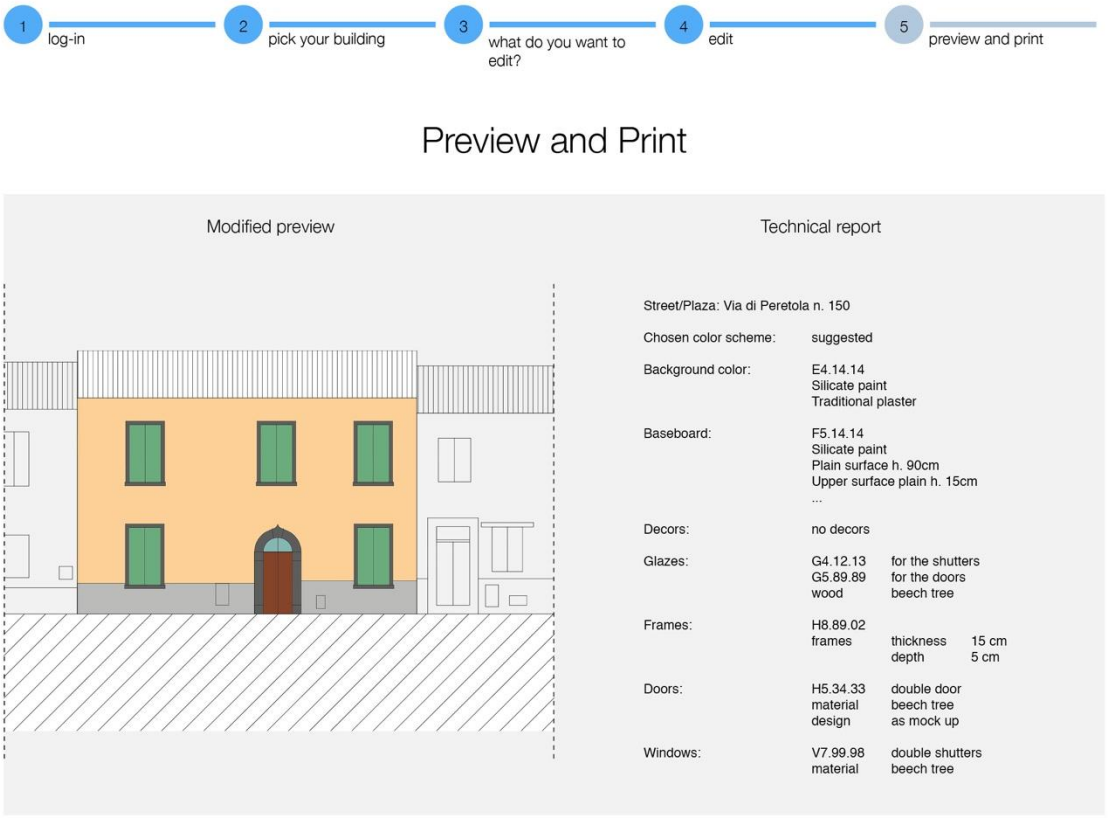

Fig. 4. Facade unit diagram and related technical report.

Once the building has been identified, the program automatically uploads a schematic diagram of the façade so the user can immediately receive graphic correspondence on a screen.

The following step provides the possibility of selecting only the elements that need to be modified in such a way that the program can automatically preload all possible permitted variants (colors, decorations, etc.) only for that façade. It is also possible, by means of the drag and drop system, to choose from among this series of elements, thus providing the user with a guided procedure that is already pre-authorized by the Local Administration (fig. 2 and fig. 3). The third and last step makes it possible to summaries data by printing a diagram of the façade and the design indications to be followed during the execution phase (fig. 4). The printing of the final report is very important, because it contains all the technical data necessary for performing a perfect job. The color codes and the relative coding system, materials and application techniques, any attentions to be taken into account during the work phases, etc., will be indicated in the said report. The main idea is, in fact, to provide a complete package with which, by printing both the façade color scheme and the technical report, the user can provide any operational-type company with all the details necessary for carrying out the work.

It seems evident that more than the color printing of the facade, which serves merely as an example, it is the technical relationship that is of fundamental importance. It entails all the details that range from the colorimetric indications to materials to be used in the intervention to those that guide how the work should correctly be realized. It is worth remembering that the program would be implemented in small villages with mostly significant technical-administrative inadequacies.

Moreover, since these small villages are not directly under the protection of specific regulations, unlike, for instance, the historic center of Florence safeguarded by UNESCO, they risk losing their distinctive features due to bureaucratic inertia.

It then becomes the task of the professionals in charge of specific projects, together with the Municipal Administration, to control that the work performed corresponds to the requirements indicated in the technical plan.

Moreover, the software application has the following characteristics:

• the possibility of customizing the functions and the database based on the territorial application area in question (the possibility of introducing any element of an abacus, color, single elevations and multiple façade units, etc.)

• independent functioning (cloud software available 24/7)

• accessibility from any digital device

• simple and intuitive graphical interface

5. Conclusions

The 'Khrôma' project is aimed at creating the first software for management of the Color and Decoration Plan, i.e. one that can be applied to all small historic villages. As we have seen, starting from an analysis of the territory, it has been verified that the smaller historic villages have common characteristics that depend on the location of the place (for purposes of colors, abacus, materials, etc.). These characteristics, which are easily identifiable and classifiable only for these particular types of small towns, would enable an integral management on a digital platform and thus permit improved accessibility to the application of the plan as compared with the methodology currently in use.

Thanks to this software, it will be possible to introduce a simplification in a given technical-bureaucratic procedure that can then be communicated to citizens as information regarding the upgrading process to their territory.

6. Conflict of interest declaration

All authors declare that they do not have any conflict of interest realated to this paper.

7. Funding source declaration

All authors declare that they have no grant was received related to the activity published in this paper.

8. Short biography of the author(s)

Filippo Cherubini - is a technician at the “Nello Carrara” Institute of Applied Physics, National Research Council, Italy. He has a Bachelor of Science degree in Architecture and two postgraduate course at the University of Florence. His interests include environmental restoration and architectural color studies.

Andrea Casini - MSc in Physics in 1968, has been a researcher at IFAC-CNR from 1972 to 2010. Expert in signal and image processing, for many years he has been developing imaging spectroscopic methodologies for the study of works of art in the "Integrated spectroscopic methods for the diagnostics and monitoring of cultural and environmental heritage" project, with which he continues to collaborate as associate researcher.

Costanza Cucci - got her Physics “Laurea” and Ph.D. in Conservation Science at the Florence University.

Currently she is a researcher at IFAC-CNR. Her research focus is on spectroscopic techniques and data-processing algorithms applied to the fields of cultural heritage, environmental monitoring, and safety food controls.

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Lorenzo Stefani - is a technician in telecommunications at IFAC-CNR. He is in charge of the development of hardware and software for computer-controlled instrumentation for the non-invasive and in situ study of artworks.

References

[1] https://www.icomos.org/en/what-we-do/focus/179-articlesen-francais/ressources/charters-and-standards/159-charter-for-the-conservation-of-historic-towns-and-urban-areas

[2] https://www.icomos.org/charters/venice_e.pdf

[3] https://whc.unesco.org/en/hul/

[4] Casolari Massimo, Biasutti Giulia, Parma città che cambia tra identità e innovazione, Maggioli Editore S.p.A., 2006 [pag. 161-166]

[5] Centauro A.G., Chiesi D., Grandin N.C., Caselli G., Tazioli R., Bassi S., Opus Studiorum/1, tecnologie e conservazione degli apparati pittorici e del colore nell'edilizia storica, Firenze, Lalli editore, 2008

[6] Centauro A. G., Chiesi D, Grandin N. C., Opus Studiorum/5, centro storico di Firenze metodologie ed applicazioni di restauro nella manutenzione dei fronti edilizi urbani, Firenze, Lalli editore, 2011

[7] Centauro A. G., Grandin N. C., Restauro del colore in architettura dal piano al progetto, Firenze, Pacini Editore, 2013

[8] Rossi M., Marchiafava V., Colore e Colorimetria Contributi Multidisciplinari Vol. XI A, Gruppo del Colore – Associazione Italiana Colore, 2015 [pag. 201-2 e pag. 299-308]

[9] Marchiafava V., Colore e Colorimetria Contributi Multidisciplinari Vol. XII A, Gruppo del Colore – Associazione Italiana Colore, 2016 [pag. 221-223]

[10] Raggi A., Colore e Colorimetria Contributi Multidisciplinari, 2005 [pag. 303]

[11] http://priverno.risviel.it/

[12] Bianchietti F., La facciata nell'edilizia storica: il Piano del Colore di Verbania, materiali e superfici di recupero della città storica, Milano, Vangelista, 1993

[13] Di Campli A., Di Toro G., Normativa tecnica d'attuazione del Piano del Colore del centro storico di Sant'Eusanio del Sangro, Sant'Eusanio del Sangro, 2006

[14] Erario P., Regolamento del colore della città di Manduria, Taranto, 2007

[15] Piemontese L., Progetto Piano del Colore: i piani del colore della provincia di Latina, Roma, Gangemi, 2006

The Tropical Aquarium: a case of polychrome decoration in the architecture of the early 1900s

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ABSTRACT

The study involved the analysis of the polychrome ceramic decoration of the Tropical Aquarium, a building located inside the *Mostra d'Oltremare* in Naples. The ornamentation was created by the majolica factory *Ceramica di Posillipo*, and specifically by Paolo Ricci, an eclectic artist of the 1900s. The use of stereoscopic photogrammetry allowed to survey the work as a whole, identifying the main colours used while also preserving the three-dimensionality of the relief figures. The study focused on the definition of the work's stylistic and chromatic features, aiming at the preservation of its decorative setup.

KEYWORDS Ornament, Ceramic Tiles, *Mostra d'Oltremare*

RECEIVED 30 March 2019; **REVISED** 04 May 2019; **ACCEPTED** 18 June 2019

CITATION: Giannattasio, C. (2019). The Tropical Aquarium: a case of polychrome decoration in the architecture of the early 1900s. Color Culture and Science Journal, 11(1), 35–40. https://doi.org/10.23738/CCSJ.110104

1. Introduction

Colour has always been a characterizing and fundamental element in architecture, be it used for decoration or for different purposes. However, at the beginning of the 20th century, with the rationalist movement, the purity of shapes and geometries was preferred to the use of colour and decorations. In many cases, in fact, these assume a more marginal role, sometimes going so far as to be completely excluded from architecture. Such a style also caught on in Italy, where its canons sometimes underwent different influences, linked to the cultural and traditional context. In Naples, for example, at the *Mostra d'Oltremare* exhibition center, polychrome ceramic wall tiles are used, both indoors and outdoors. The study focused on the analysis of the decoration on the vestibule of one of the exhibition buildings, i.e. the Tropical Aquarium. Its design was entrusted to architect Carlo Cocchia, while the polychrome majolica decoration was created by Paolo Ricci of the *Ceramica di Posillipo* factory. The three-dimensional decoration was reconstructed using stereoscopic digital photogrammetry and subsequently analyzed in order to define the main hues and stylistic features typical of the abovementioned building.

Fig. 1. View of the main front of Tropical Aquarium. The building currently hosts the Boccioni art school.

2. A look into the life of Paolo Ricci

An eclectic author of Apulian origin, Paolo Ricci was born in Barletta in 1908 and moved to Naples to study in 1918. Here, in addition to developing a Marxist, antifascist view, he came into contact with the thriving Neapolitan artistic scene of the time, meeting Vincenzo Gemito first in 1923, and then Luigi Crisconio in 1927. In 1929, he approached the Circumvisionist group, without becoming directly involved in it. Here, he met Carlo Cocchia, with whom he collaborated on the *Mostra di Oltremare e del Lavoro Italiano nel Mondo* for the creation of the work at hand. Also in 1929, along with Guglielmo Peirce and Carlo Bernari, he wrote the manifesto of the *Unione Distruttivisti Attivisti* (UDA), thus coming into contact with the avant-gardes. Between 1930 and 1931, during a period in Paris, he delved into themes and connections with contemporary artists such as Pablo Picasso, Piet Mondrian, Ossip Zadkine, Le Corbusier and others. Over the years, he exhibited at the first Rome Quadriennale (1931) in many editions of the *Sindacali Campane*. In 1938, he began working with the majolica factory *Ceramiche di Posillipo*, founded the previous year by patron Giuseppina De Feo, engineer Paolo Marone and sculptor Antonio De Val. The factory became a meeting point for Neapolitan artists of the time such as Carlo Cocchia, Edoardo Giordano, Aniello Antonio Mascolo and others. Also noteworthy is Ricci's communist and anti-fascist political ideology, which led him to be arrested on two different occasions (1932, 1943), and his relationship with contemporary intellectuals who used to gather at Villa Lucia, including Benedetto Croce, Alfonso Gatto and many others. Foreign artists and authors of international caliber were also frequently hosted in the villa, such as David Alfaro Siqueiros, Nicolás Guillén, Pablo Neruda and others. At the end of the Second World War, Ricci began writing for several newspapers, including *La Voce* and *L'Unità*, and took part in several international exhibitions: the Venice Biennale (1948, 1950, 1952), the Rome Quadriennale (1948, 1951,1955, 1959, 1965); he also exhibited in Prague in 1949 and in Berlin in 1951. In the post-war period, he further collaborated with architects Carlo Cocchia and Luigi Cosenza. Ricci died in 1986, after a long and artistic career and a copious critical and literary production.

3. The *Mostra d'Oltremare*: birth and decline

Commissioned by Mussolini in 1936 and provided for in the 1936-39 General Urban Development Plan (PRG) written by Luigi Piccinato, the fairground of the *Mostra delle Terre Italiane di Oltremare* was born in 1937 to host the *Esposizione Tematica Universale*. In particular, the first triennial exhibition revolved on the celebration of the regime's colonial policy. Contemporary to the Neapolitan fairgrounds is the *Parco dell'Esposizione Universale di Roma*, later named EUR, in whose project Piccinato himself was involved.

Over a million square meters were planned for the creation of the Naples compound and construction was completed in just sixteen months. Part of the surface allotted in the PRG remains unused, but was nevertheless reserved for future developments. In fact, the area was supposed to host the exhibition *Lavoro*

degli Italiani d'Oltremare. Various architects of the Naples region participated in the design of the pavilions, including Carlo Cocchia, who oversaw the Restaurant-Pool complex and the well-known *Fontana dell'Esedra*, in addition to the building under examination. The exhibition was inaugurated in 1940 and closed after only one month following Italy's entry into the war. The damage caused by the bombing was considerable and a rebuilding of the compound was necessary in the early 1950s. In 1952, the first *Mostra Triennale del Lavoro Italiano nel Mondo* was inaugurated and the *Mostra d'Oltremare* had a new image that united two souls, one more rationalist and one more traditional.
It is currently in a state of total neglect.

4. Analysis of the work

The present study focuses on the analysis of the decoration placed on the vestibule of the Tropical Aquarium. Designed by Carlo Cocchia, the facility was built in 1938 as a complement to the *Villa Comunale*'s aquarium. The volume is regular and square, in line with the dictates of the rationalist movement. The anonymity of the building is interrupted by a polychrome representation in ceramic tiles placed on the main elevation (8.10m high and 10.75m wide). The covering was manufactured by the *Ceramiche di Posillipo* factory, but the design and construction were carried out by Paolo Ricci, a friend and colleague of Carlo Cocchia. The composition depicts a marine scene, portraying real and fantastic figures, including seahorses, fishes, mermaids and tritons. These representations are typical of *Ceramiche di Posillipo* in particular, and of the Campanian tradition in general.

4.1. *Working methodology*

In order to best define the formal and stylistic peculiarities of the work in question, a photogrammetric survey was carried out. The digital stereoscopic photogrammetry process has allowed us to obtain a three-dimensional result, both in terms of point cloud and structured mesh, and to keep the colourimetric information intact. The 3D model was used to build orthophotos, so that the metric information of the complex could also be preserved. Thus, it was possible to best define the colours used and stylistic features.

4.2. *Colourimetric features*

The dynamism of the scene is created by the alternation between flat drawings and three-dimensional figures realized through the *mezzotondo* technique. However, the most important aspect of the work is undoubtedly the use of colour. In fact, while the building appears as a white polyhedron, the vestibule is completely detached from the rest by way of its polychromy. At a first analysis of the work, it can be seen that five colours were used: blue, yellow and red, white and copper green. If the choice of the first four shades of color may depend on an influence that Ricci had during a contact with the authors of De Stijl, the green copper is a distinctive sign of *Ceramiche di Posillipo*, as can be seen in other works by the same factory, and of Campanian tradition in general. It should be added, however, that the color shades used are many, unlike Neoplasticism where the use of color was limited to a single shade.

Fig. 2. Colourimetric features. On the left, the orthophoto of the façade*, obtained by digital photogrammetry. On the right, the main color tones used within the composition.*

4.3. *Composition of the work*

The composition in its entirety is depicted on 25 x 25 cm tiles forming an orthogonal grid. Leaving out the three-dimensional figures, the grid thus formed makes it possible to detect the prevalent colours and their function in the scene: while white mainly functions as foundation on which the other colours rest or mix, copper green is used to define the work's outline. The three-dimensional figures do not respect such regularity in the single tile, as the figures' plasticity does not allow the definition of all

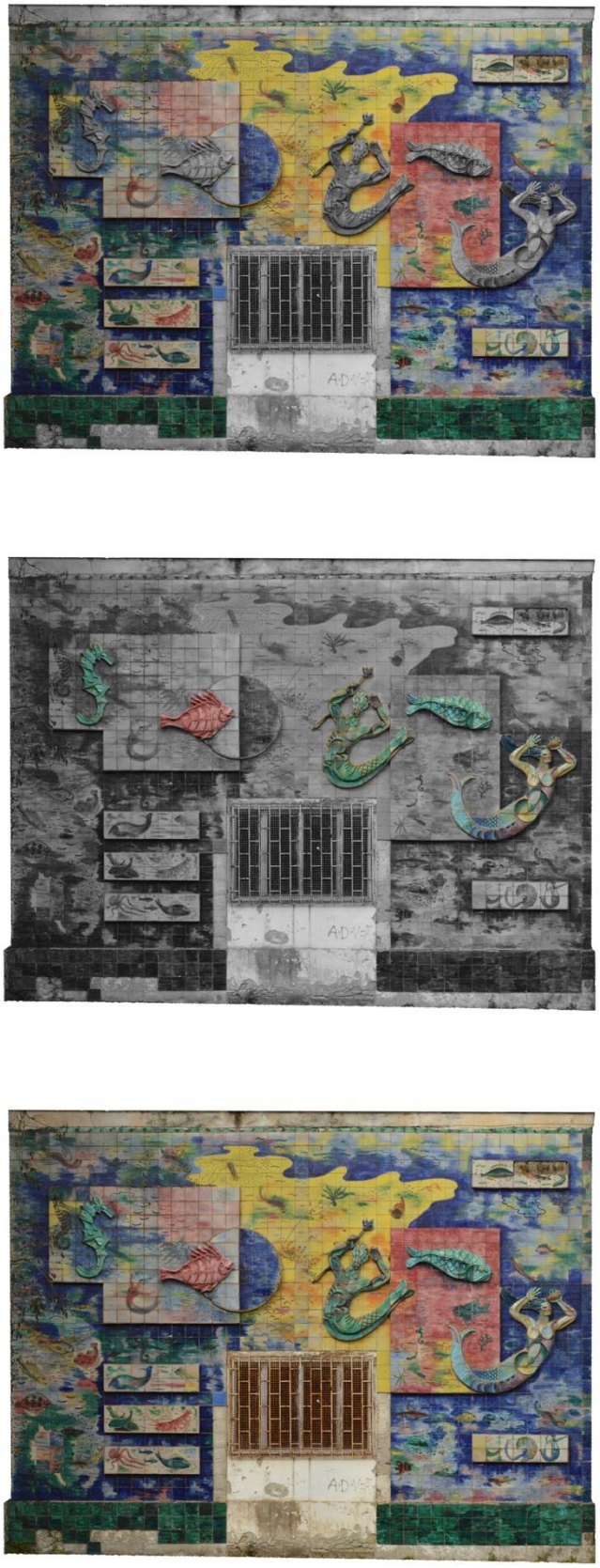

Fig. 3. Composition of the work. On the top, the orthophoto of the façade without the three-dimensional figures; On the center, the orthophoto of the façade only with the three-dimensional figures. On the bottom, the orthophoto of the façade of the building.

the pieces within the predetermined measure. If, however, the figures are added to the pre-established study grid, it can be seen that a good number of them are in copper green. This color is not therefore relegated to being the mere frame of the work, but has the function of expressing the dynamism and complexity of the whole facade. One should also dwell on Ricci's stylistic choice. The style of the flat tiles is typical of the *Ceramiche di Posillipo* factory, while the three-dimensional figures conform to the modern movements and artistic groups of the time. During his trip to Paris, Ricci was probably influenced by contemporary authors such as Pablo Picasso or Ossip Zadkine (think, for example, of the stylized figures reminding of a Cubist and abstract fashion). Finally, one must consider the importance of Naples as a cultural and innovative center in the first half of the 1900s. Among the artists who visited the city in the first half of the century is also David Alfaro Siqueiros, who was a guest at Villa Lucia. Siqueiros was an exponent of Mexican Muralism, a movement within which some analogies with the work in question can be found. These include the use of primary colours, main figures in relief, compact walls without openings. Consider for example the mural "*El pueblo a la universidad, la universidad al pueblo*" (1952 - 1956) by Siquieros himself, on the facade of the Rectorate of the Universidad Nacional Autónoma de México in Mexico City: the building was declared "artistic monument of the nation" in 2005.

Fig. 4. View of the work of David Alfaro Siqueiros "El pueblo a la universidad, la universidad al pueblo" (1952 - 1956) (Source: Wikimedia Commons).

5. Conclusions

Paolo Ricci's Tropical Aquarium is a masterpiece in its complexity and originality. First of all, the work intends to detach itself from the rationalist movement: the ornament is not superfluous but an integral part of the building, being a representation of the function of the building itself. Secondly, the complex loses its anonymity through the juxtaposition of a polychrome ceramic decoration, typical of the Campanian tradition, on the vestibule. Such a design choice infused new life to the material: from captive and recluse within the walls, it breaks out free and becomes the center of the work itself. This solution was also used later by Paolo Solieri in Vietri sul Mare for the design of the Solimene factory: the front of it is in fact covered with circular modular elements in orange and copper green, as used by Ricci in the Tropical Aquarium. The artist designed a work of extraordinary beauty using polychrome ceramics, creating a decorated prospectus that at the same time breaks with the traditional stylistic canons for the representation of two-dimensional and three-dimensional figures. The Tropical Aquarium's current state of conservation of is precarious, as can be seen from the loss of material and the discontinuities in the composition. Due to its uniqueness and peculiarity, Paolo Ricci's work should be safeguarded, protected and valorized before it is irreversibly lost.

Conflict of interest declaration

The author declares that there is no actual or potential conflict 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 his work.

Funding source declaration

The author declares that he is a PhD student with a fellowship at University of Naples Federico II.

Short biography of the author

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Fig. 5. View of the main front of the Solimene factory in Vietri sul Mare, designed by Paolo Solieri.

References

Napolitano G. (2003) 'La ceramica di Posillipo, 1937-1947: un viaggio nell'immaginario e nella memoria della città di Napoli nella prima metà del Novecento, Salerno: Provincia', Assessorato ai beni culturali, turismo e spettacolo; Raito, Vietri sul Mare: Centro studi salernitani Raffaele Guariglia, pp 39 - 89.

Giordano P. (1994) 'Napoli Guide di architettura moderna', Roma: Officina Edizioni, XXVII - XXX, pp. 42 - 45, 54 - 57.

Ricci P. (1987) 'Paolo Ricci: opere dal 1926 al 1974', Napoli: Electa.

Franco M., Ricci D. (2008), "Paolo Ricci", Napoli: Electa.

Siola U. (1990) 'La Mostra d'Oltremare e Fuorigrotta", Roma: Electa, 1990.

Stenti S., Cappiello V. (1998) 'Napoli guida: 14 itinerari di architettura moderna', Napoli: CLEAN, 1998, pp 116 - 129.

Fratta A. (2004) 'Il patrimonio architettonico dell'ateneo fridericiano', Napoli: Arte Tipografica.

Vv.Aa. (1941) 'ARCHITETTURA - I Mostra delle Terre Italiane d'Oltremare - fascicolo monografico', n 1/2, Milano.

Mollo L. (2011) 'Note su architettura e tecnica della Mostra delle terre italiane d'Oltremare a Napoli', Aversa, Capri: Atti del IX Forum Internazionale Le vie del mercante S.A.V.E. Heritage.

Caterina G., Nunziata M. (1987) 'Carlo Cocchia Cinquant'anni di architettura 1937-1987' Genova: SAGEP Editrice.

Carpiceci M. (2012) 'Fotografia digitale e architettura', Roma: Aracne.

Giordano M., Barba S. (2012) 'Le geometrie del decoro architettonico', Fisciano: Cues, pp 79-146.

https://www.storiacity.it/guide/707-acquario-tropicale-di-fuorigrotta-a-napoli

http://www.napoliontheroad.com/pesacanepadiglioni3.htm

https://upload.wikimedia.org/wikipedia/commons/6/69/El_pueblo_a_la_universidad%2C_la_universidad_al_pueblo.JPG

Evolution of colours in football shirts through colorimetric measurements: Fiorentina's case.

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ABSTRACT

Football fans express their identification with their team especially with colours of football shirts. The respect of “tradition” is something so important that very small changes can provoke anger in fans, who express their opposition in news and social media. This could create problems for merchandising. Fiorentina (Florence’s football team) wears purple shirts, very uncommon in football world. In collaboration with Fiorentina Museum we have measured, with two different spectrophotometers, colours of shirts from the fifties to nowadays. We have evaluated the problems related to ageing and we have measured different points from the same shirts, different shirts from the same season and details different from the purple colour (e.g white used for numbers). Measurement show a clear change in colour during the considered years, strictly related with the introduction of colour television and new strategy of merchandising. Furthermore it is evident that every kit manufacturer prefer creating its own colour despite the existence of an “official” Fiorentina’s colour. Such measurements, made on shirts of proved authenticity, permit to improve the analysis about “historical shirts”, helping to discriminate between authentic or fake shirts: an important topic because an original shirt from Fiorentina first Italian league winner season could be sold for 5000 €. One example of very well done fake shirts is illustrated.

KEYWORDS colorimetry, purple, colour in textiles, colour in sports, aging of textiles

RECEIVED 05 June 2017; **REVISED** 11 September 2018; **ACCEPTED** 23 May 2019

CITATION: Farini, A., Baldanzi, E., Raffaelli, M., & Russo, F. (2019). Evolution of colours in football shirts through colorimetric measurements: Fiorentina’s case. Color Culture and Science Journal, 11(1), 41–46. https://doi.org/10.23738/CCSJ.110105

1. Introduction

Colours of shirt for football teams are a very important part in the process of identification from fans. A football club can change every player, president, trainer and this is completely acceptable for every fan, while a change in colour could be considered as a betrayal of its history. This could create problems for merchandising (Derbaix and Decrop, 2011). Fiorentina (Florence's football team) is one of the few teams in the world wearing purple shirts (Salvi and Savorelli, 2009). Probably for this reason shirt's colour is a very sensitive topic for Fiorentina's fans.

In the recent years the introduction of high definition colour television and new strategy of merchandising have assigned an important role to shirt's colour. Checking and reproduction of official colours of a football team is nowadays very important.

2. Material and Methods

Thanks to the help of Museo Fiorentina (www.museofiorentina.it) we have received at our lab 50 original shirts belonging to different sport seasons. Every shirt is called using the year of the second part of the season; as an example, the shirt used during the season 1958-1959 will bel called 1959. We have measured every shirt using a Minolta spectrophotometer CM-2500c with 10 nm of resolution, 45°/0° geometry optics and 360-740 nm wavelength range. We have checked our measurements using, on three samples, a very accurate instrument: a Perkin Elmer spectrophotometer lambda 900 with an integrating sphere. The measurements of the two instruments agree within the experimental error (CM-2500c has a repeatability of ΔE^*_{ab}=0.04 and an inter-instrument agreement ΔE^*_{ab}=0.06): we decided to use CM-2500c that permits to see the exact point of measurement. This peculiarity is very useful, because it permits to measure also shirts where some colour are present in a very small area. In order to apply some colorimetric formulas we have used some algorithms from (Westland et al) and some others written by ourselves.

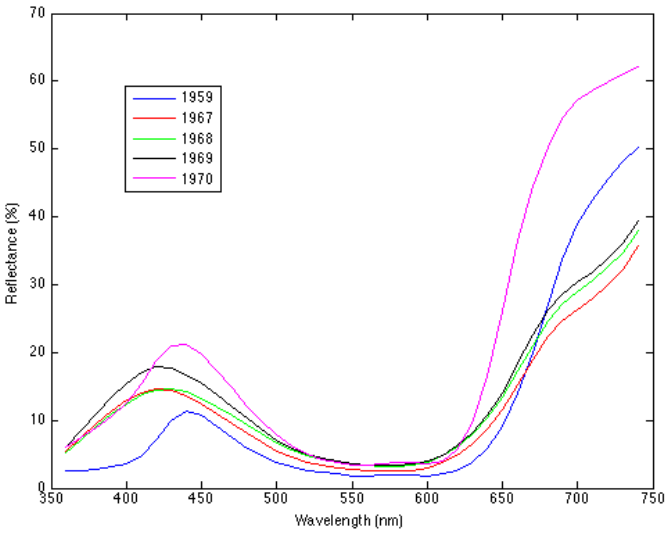

Fig. 1 – Reflectance spectra for 1959-1967-1968-1969-1970.

Fig. 2 – Fiorentina's shirt for season 1958-1959.

Ageing is a real problem in this kind of measurements. Nowadays every shirt is used only one time but during the 70's and before every shirt could be used and washed many times during a season, producing a degradation in colours. Furthermore, old shirts could be inhomogeneous in colours: in order to check this hypothesis, we have measured the same shirt (1959, the oldest available where the ageing problem should be greater) in ten different points apparently of the "same purple". The results expressed in the CIELAB system with 2° observer and D65 illuminant are are L^*=25.1±0.7, a^*=27.9±0.7, b^*=-42.4±0.9.

3. Experimental Results

For every shirt we can examine the reflectance spectrum and the colour coordinates. Here we present only some data in order to present the variability trough years: a complete report will be published in the future together with some psychophysical measurements that want to investigate if every Fiorentina shirt could be called "purple" nowadays. In Fig.1 the reflectance spectra of 1959 (the oldest shirt available at Museo Fiorentina when we made the measurements) 1967, 1968, 1969, 1970 are shown. The first 4 shirts are very dark (shirt of 1959 is presented in Fig.2). This is a typical feature of the shirts in the "golden age" of Fiorentina (Fiorentina won the championship in 1955-1956 and 1968-1969): a radio show devoted to Fiorentina is called "Viola Scuro" (Dark Purple in Italian) in order to create a link with these famous years. The 1970 shirt is redder and less dark.

1982 (Fig.3) is a very famous shirt for the history of Fiorentina because in that year many football team decided to renovate their shirt and their logo. Probably we can define 1982 as the first year of the "modern football". The year before Fiorentina's logo was completely renewed with an overlap between the traditional red fleur-de-lis and a capital "F", for Fiorentina. Supporters disliked it when it was introduced, but the logo remained until 1990. In the same year for the first time in Italy a sponsor name was allowed on the shirt.

1982 is the brightest shirt in Fiorentina history. Its difference is evident looking at Lightness, but also looking at reflectance spectra (Fig.4).

Fig. 3 - Fiorentina's shirt for season 1981-1982.

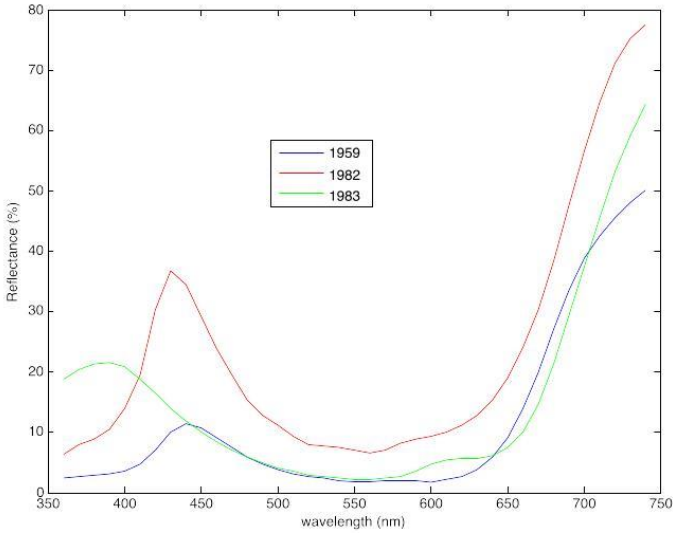

Fig. 4 – Reflectance spectra for 1959-1982-1983. 1982 is brighter compared with 1959 (that we can consider the golden standard) but also with 1983.

Another important year was 1978 because for the first time on Fiorentina's shirt appeared the logo of the "technical sponsor": Adidas. The "technical sponsor" is the factory producing shirt, socks, shorts and other part of the kit and should not be confused with the main sponsor previously cited that could be completely unrelated with football's world. In 1979 Adidas produce the first synthetic shirt (until that year the shirts were made using wool). Despite these great changes reflectance spectra are quite similar (Fig.5) because probably Adidas made a big effort to maintain the same colour.

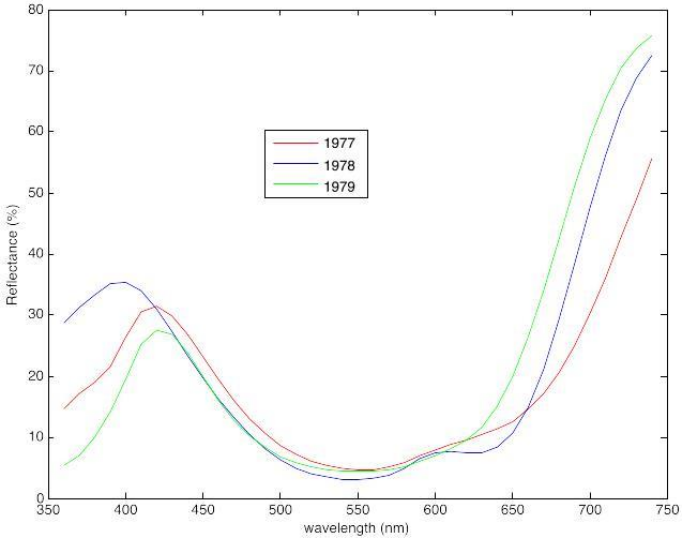

Fig.5– Reflectance spectra for 1977-1978-1979.

Transforming the CIELab coordinates into CIELCh coordinates (Wyszecki and Stiles) it is possible to study the evolution of the hue. We have calculated ΔH^*_{ab} (variation in the hue) using as reference point 1959 shirt. Using this approach, it is very evident the change in hue happened in 1970 (Fig.6).

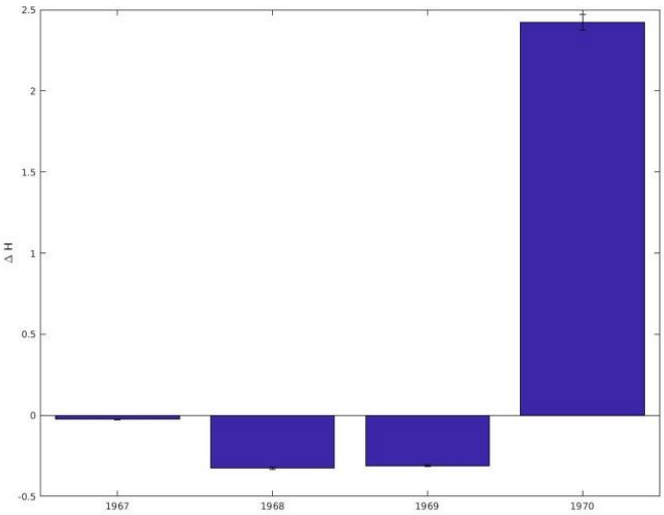

Fig.6– ΔH from 1959 evaluated for 1967, 1968, 1969. In 1970 there is a big change in hue.

But particularly interesting is the relationship between technical sponsor and hue. Every technical sponsor tends to use a "proprietary" purple, realising its own colour. Looking at Fig.7 we can note that there is a good correspondence between technical sponsor and hue.

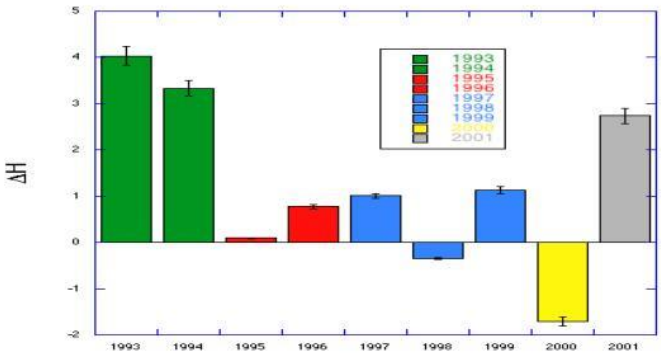

Fig.7– ΔH from 1959 evaluated for seasons from 1992-1993 to 2000-2001. At the same colour correspond the same technical sponsor

This behaviour is also evident looking at season from 2002-2003 to 2012-2013 (Fig.8).

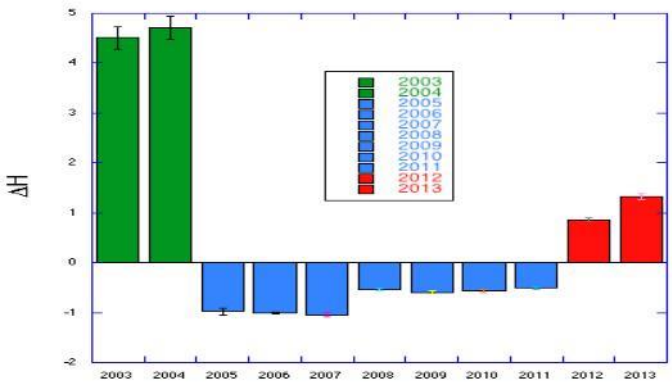

Fig.8– ΔH from 1959 evaluated for seasons from 2002-2003 to 2012-2013. At the same colour correspond the same technical sponsor

3.1. *Comparison between authentic and fake shirts*

Colorimetric analysis could be very useful also to distinguish authentic historical shirt from fake shirt. An authentic Fiorentina's shirt for example from 90's can be evaluated 300 €, but a shirt from 60's can be sold at 5000 € and this evaluation provokes a big market for fake reproduction. Recently we have examined a shirt pretending to be an original shirt from season 1969-1970. Comparing this shirt with two original shirts from Museo Fiorentina (Museo Fiorentina receives some shirts directly from players admitted to the Hall of Fame) we have noticed that the red of the fleur-de-lis in the tested shirt is completely different (ΔE_{ab}=9.3) from the red of the two original shirts. Instead the red of the two original shirts is the same (ΔE_{ab}=0.7). Obviously this is not a decisive proof, because in those years, before the introduction of official technical sponsor, some differences could be due to different suppliers. But it is a hint that, together with the analysis of textiles and weave, can help an expert in his/her evaluation.

4. Conclusions

Through the years purple in Fiorentina's shirts is changed in many different ways. While the first shirts are dark, nowadays we can see very bright shirts that result pleasant on the TV screen. A definitive Fiorentina's purple do not exist: every technical sponsor creates its own purple. A colorimetric analysis could be useful in order to discriminate between authentic and fake shirts.

We have inserted in this paper data regarding some interesting periods for Fiorentina's shirts. People interested to the whole archive of data can contact the authors.

5. Conflict of interest declaration

The authors state that no actual or potential conflicts of interest exist 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.

6. Funding source declaration

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sector.

7. Acknowledgment

The authors want to thank Museo Fiorentina for having made available the shirts and especially its president David Bini for his willingness. He also helped us with many historical data about Fiorentina's shirts.

8. Short biography of the author(s)

Alessandro Farini - is a physicist with PhD in Optics. He is the head researcher of the VisionLab at the CNR-National Institute of Optics in Florence, lab devoted to Applied Psychophysics. Farini's research work is addressed to lighting, ophthalmic optics and colorimetry. He is teaching Geometrical Optics and Physical Optics at the University of Florence, degree in Optics and Optometry. Farini is involved in science outreach.

Elisabetta Baldanzi - Degree in Physics at Pisa University with a thesis entitled "collisional Coupling between the Stark components in the rotational spectrum of CH3F", Scholarship in Science Communication at the National Institute of Physics of Matter in Genoa, Targetti Foundation Lighting Academy Coordinator. Currently at the National Institute of Optics of the National Research Council based in Florence in the Laboratory of Ergonomics of View, research on issues related to psychophysics of vision, lighting and ophthalmic optics.

Marco Raffaelli - achieved in 2013 his bachelor degree in Optics and Optometry at the University of Florence, with a thesis entitled: "Photometric and psychophysical characterization of some mobile phone displays". Since November 2013 he has been working at the CNR-INO of Florence as diagnostic technician for the non-invasive study of artworks and as collaborator with the laboratory of psychophysics of vision.

Francesco Russo - was born in Florence and studied as an electrical expert at the Meucci Institute in Florence. He took a degree certificate in optics and optometry at the university of Florence in 2014 and, in the same year, the optical diploma at Vinci. He has been employed of

Gestione Silo (Florence) since 2015. This paper concerns his degree thesis.

References

(Derbaix and Decrop) Derbaix, Christian, and Alain Decrop. "Colours and scarves: an ethnographic account of football fans and their paraphernalia." Leisure Studies 30.3 (2011): 271-291

(Salvi and Savorelli) S. Salvi and A.Savorelli, “Tutti I colori del calcio”, (Le Lettere, Firenze, 2009).

(Wyszecki and Stiles) Wyszecki G. and Stiles W.S. (*Color Science - Concepts and Methods, Quantitative Data and Formulae* (2nd ed.). Wiley-Interscience, London, 2000

(Westland et al.) Westland S., Ripamonti C. and Cheung V. *Computational Colour Science Using MATLAB.* Wiley, London, 2012

Painted or not painted? Discovering color traces of ancient stones

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ABSTRACT

Although many ancient civilizations are known to have made use of polychromy on sculptures and in general on stone artifacts, today much of these colours went lost. For this reason, in the minds of a very large majority, the original stones have remained un-coloured until today. The small amount of these traces lead to a new approach for their characterization in order to limit sampling and hopefully, avoiding it. The non-invasive approach permits the examination of a very large number of artworks with a virtually limitless number of analytical acquisitions allowing to perform measurements *in situ*. Already during the measurement process, this approach leads to a fundamental exchange of views among scientists, archaeologist, conservators and art hystorians.

The application of protocols based on imaging techniques (i.e. UV Fluorescence, Visible Induced Luminescence-VIL) integrated with data obtained from single spot techniques such as X-Ray fluorescence (XRF), Fibre Optic Reflectance Spectroscopy (FORS) and Total Reflection Infrared Spectroscopy (TR FTIR), provides high-quality information. In this paper some examples of analyses conducted in different contexts from museums to archaeological sites will be presented. These analyses are included in a wider research project aimed to enlighten the use of colours on the sculptures in ancient time and to better define materials used in the past.

KEYWORDS ancient stone, polychromy, integrated protocols, archeometry

RECEIVED 08 April 2019; **REVISED** 21 May 2019; **ACCEPTED** 06 June 2019

CITATION: Bracci, S., Magrini, D., & Bartolozzi, G. (2019). Painted or not painted? Discovering color traces of ancient stones. Color Culture and Science Journal, 11(1), 47–56. https://doi.org/10.23738/CCSJ.110106

1. Introduction

In recent years, a strong interest about the residual polychromy on marble statuary emerged. Although many ancient civilizations used polychromy on stone sculptures and architectural elements, today only a few, almost invisible, traces of these colours survive. As a result of these losses, in the minds of a very large majority of people, sculpture and monuments are considered not to have been coloured since their creation.

Understanding ancient polychromy is indeed a crucial issue since the lack of attention to this theme leads to a significant misunderstanding of both the artwork itself and of the artistic culture it represents.

A correct reading of the original aspect of an artwork is often difficult due to the small amount and condition of the colour remainings. This is linked to the vicissitudes the sculptures underwent over the centuries, such as exposure to harsh environment or burial. In some cases, the polychromy did survive over the centuries, only to be extensively removed after hasty archaeological excavations, in order to reveal the Neoclassical white «pure form» of the sculpture.

The debate on the polychromy of ancient sculpture was already active in the nineteenth and early twentieth century, but only in 1982 it did a breakthrough in the studies with the research project initiated by von Graeve on the polychromy of ancient sculptures (Von Graeve 1985).

From then on, the issue of colour received a growing interest. In archaeology, a rising importance was given to the role of colour in understanding ancient cultures. Furthermore, the technological development of non-invasive or micro-invasive tools supported these emerging archaeological ideas with archaeometric studies.

These new studies and collaborations were particularly evident starting from the travelling exhibition Bunte Götter, Munich (2003-2004); I colori del bianco, Rome (2004); ClassiColor, Copenhagen (2004). This exhibition was born by the collaboration among V. Brinkmann, J. Østergaard and P. Liverani (Brinkmann and Wünsche 2004), pioneering scholars in this field. This high-profile exhibition of painted Greek and Roman casts, carefully studied and reconstructed by experts from across Europe, attracted extensive media attention and turned out a renewed interest in sculptural polychromy in both popular and academic circles. This international initiative set the scene for a number of important projects, leading to a very noticeable increase in documentation and publications (Giachi et al. 2007, Liverani 2009, Liverani and Santamaria 2014).

2. Methodological approach

The archaeometric studies allow gathering information about the material composition and the state of conservation of polychrome marble artworks. The small amount of these coloured traces lead to a new approach for their characterization. In addition, since traces of polychromy are rare and fragile survivals, non-invasive methods are always preferable. In this way, the residues of polychromy remain intact for future generations.

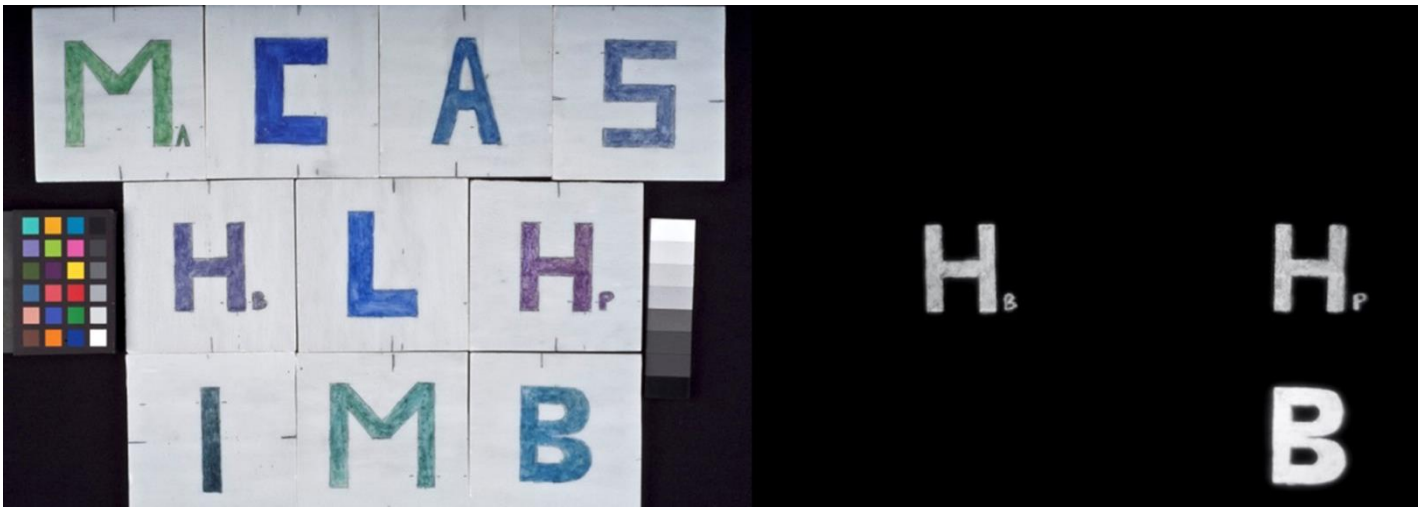

Fig. 1: Visible (left) and VIL (right) images of marble mock-ups painted with different pigments (tempera): M=malachite; C=Cobalt Blue; .A=Azurite; S=Smalt; H_B= Han Blue; L=Lapis lazuli; H_P= Han Purple; I=Indigo; M=Maya Blue; B= Egyptian Blue.

A non-invasive approach permits the examination of a very large number of artworks with a virtually limitless number of analytical acquisitions allowing to perform measurements *in situ*. Already during the measurement process, this approach leads to a fundamental exchange of views among scientists, archaeologists, conservators and art hystorians.

The non-invasive scientific protocol proposed, is characterized by the combination of complementary analytical techniques. The procedure strarted with a preliminary documentation of the surfaces by means of multiband imaging. This survey is based on photographic techniques using different radiations (Fischer and Kakoulli 2006, Dyer and Sotiropoulou 2017, Dyer et al. 2013, Cosentino 2014). UV fluorescence (UVf) (or more correctly, Ultraviolet-induced visible luminescence (UVL) was used to spatially characterize the presence of organic and inorganic materials. Visible Induced infrared Luminescence (VIL) was used to locate and identify the blue pigment Egyptian blue. VIL is a photographic technique developed at the British Museum in 2009 that can detect the Egyptian blue which is a calcium-copper based pigment ($CaCuSi_4O_{10}$) (Accorsi et al. 2009, Verri 2009).

Egyptian blue is often preserved in extremely small quantities in the porous surfaces of ancient objects, which makes it hard – if not impossible – to identify the pigment even with a microscope. The pigment has, however, the unique property of absorbing visible light and emitting it as infrared radiation. The luminescence emitted by the pigment grains can be recorded with an infrared camera. The technique thus exploits the powerful emission identifying single particles of Egyptian blue, which would be otherwise undetectable (Verri 2010). The luminescence phenomenon is illustrated in Figure 1 where the image in visible light and the VIL image of marble mock-ups painted with different blue/green pigments are compared. The white glow represents Egyptian blue (B) and two Chinese pigments (Han Blue and Han Purple) while the others pigments almost disappeared.

The efficacy of a multi-analytical approach is evident in Figure 2 in which an area of a decoration on a sarcophagus with tiny trace of polychromy is investigated under different wavelengths and filters combinations (Iannaccone et al. 2015).

Addressed by the imaging results, analyses by X-Ray Fluorescence Spectroscopy (XRF) (Karidas et al. 2006, Shugar 2012), UV-VIS Reflectance Spectroscopy (FORS) (Bacci 2000) and Total Reflection Infrared Spectroscopy (TR-FTIR) (Miliani et al. 2012) are performed in order to gain molecular and elemental information on a wide range of inorganic and organic painting materials, including most pigments, colorants and binders (Iannaccone et al. 2015, Liverani et al. 2017).

Today, despite important results achieved within the last few years, research on ancient polychromy is still at an early stage and shows some obvious limitations pertaining to the transferability of methodologies or findings (Gasanova 2018). Some interdisciplinary teams already integrate analytical and archaeological competences. One example is the work done at the Ny Carlsberg Glyptotek in Copenhagen, within the framework of the Tracking Colour project (Østergaard 2010). In the published reports (Ny Carlsberg Glyptotek 2013), a multidisciplinary approach to study a large group of materials is highlighted.

The same approach, a collaboration with archaeometric competencies and the archaeological ones, drove our researches in the last years (Iannaccone et al. 2015, Liverani et al. 2017, Noferi 2017). In this paper some examples of findings in different contexts from museums to archaeological sites will be presented.

Fig. 2: Example of application of imaging technique on a polychrome marble sarcophagus. a) Visible image; b) UV image where the fluorescence of red lake is visible; c) VIL image where Egyptian blue particles (not visible at naked eye) are instead clearly visible.

2.1 Technical information

Multiband imaging (UV and VIL)

For the investigation two camera were used: a Canon EOS 7D with a resolution of 18 Megapixel and a modified Canon EOS 400D with a resolution of 10.10 Megapixel. Both cameras mounted a Canon EFS 18-135 mm f/3,5-5,6 IS lens with different filters on varying of every photographic technique applied. Different filters were applied also on the two flashes Quantum Qflash T5dR thus providing the proper radiation.

Fiber Optics Reflectance Spectroscopy (FORS)

FORS spectra were acquired in the range 350-900 nm using an Ocean Optics (mod. USB2000) instrument, equipped with optic fibers and a tungsten lamp as source. All the measurements were performed with 2x45°/0° configuration, allowing to work in diffuse reflectance by collecting the light scattered at 45° with respect to the incident light (avoiding specular reflected light) from an area of 2 mm in diameter. Each acquired spectrum is the average of 30 acquisitions. A Spectralon© tag was used as reference.

Fourier Transform Total Reflection Infrared Spectroscopy (TR FT-IR)

Infrared measurements were carried out by means of a portable Bruker Optics ALPHA FT-IR Spectrometer equipped with SiC Globar source and a DTGS detector. All spectra were acquired in total reflection mode, collecting 128 scans, with a resolution of 4 cm^{-1} on the 7500-375 cm^{-1} range and a measuring spot of 5 mm in diameter. The collected IR spectra were processed using OPUS 7.0.122 software.

X-ray fluorescence (XRF)

For X-ray fluorescence measurements, a portable XRF spectrometer (Bruker, Tracer III SD) with micro X-ray tube with rhodium anode was used. The analysis was performed in the following conditions: 40 keV - 12 µA. The irradiated area was about 12 mm^2. The spectrometer was equipped with an SDD detector (FWHM < 145 eV at 100.000 cps) cooled with a Peltier cell. Acquisition time for each spectrum was 60 s.

3.Examples of colour traces studies

3.1. Catacombs

The first case-study here presented is a sarcophagus with strigilated lateral parts and a central scene depicting two figures (a male and a female and several other objects and animals). It is preserved in the Catacomb of St. Pamphilus, on the *Via Salaria Vetus*, at the deepest level.

Fig. 3: Visible (left) and UV fluorescence (right) images of red lake on Olimpus Antistianus and Irene.

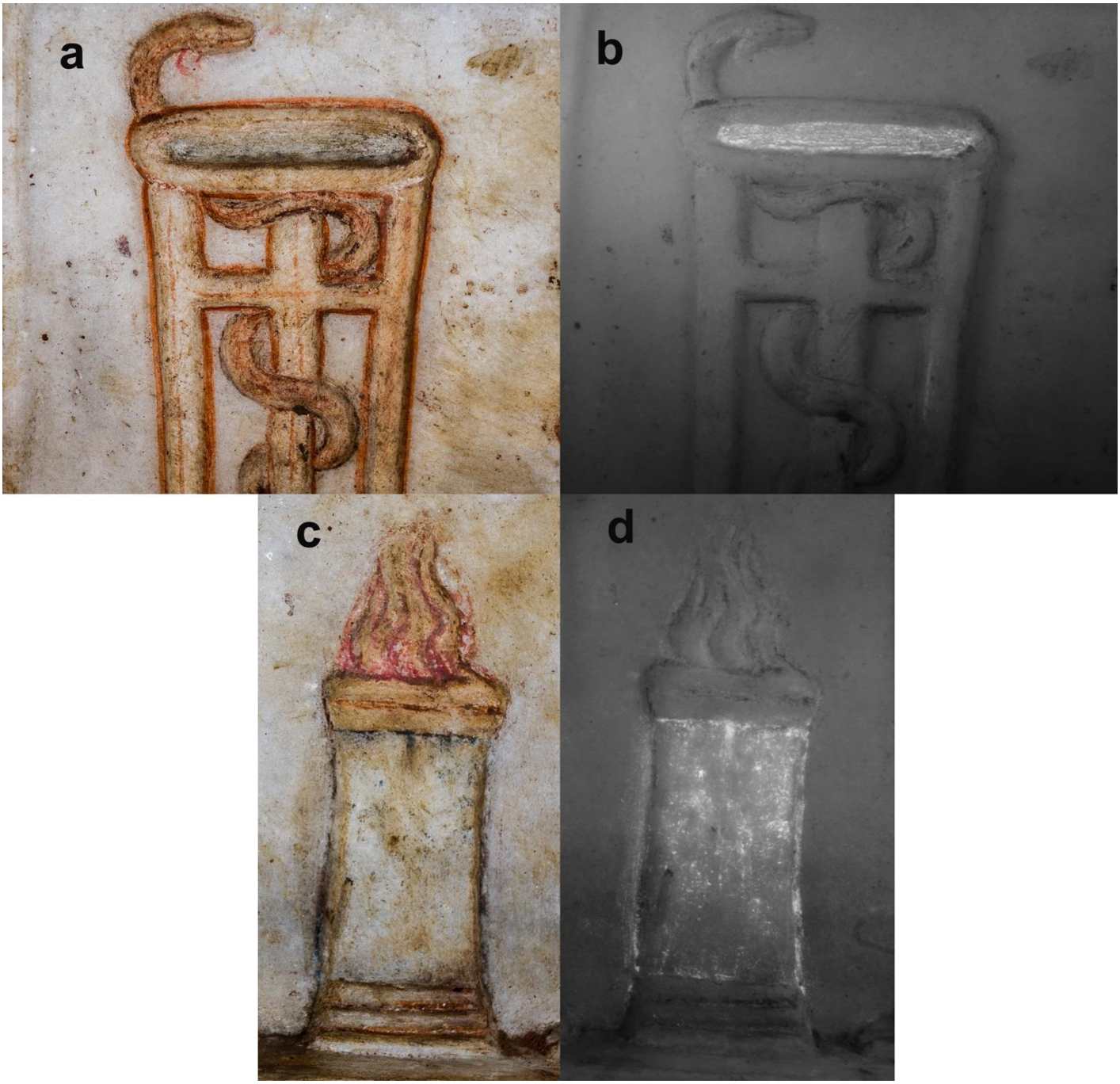

Fig. 4: Visible (a,c) and VIL (b,d) images of some details of the Antistianus sarcophagus

In the slab showing the *dextrarum iunctio* between Olympus Antistianus and his wife Octavia Irene, the surface revealed traces of red and blue colours, slightly visible to the naked eye, especially on the robes and the altar. All the red traces showed a characteristic ultraviolet pink-orange fluorescence (Fig. 3) that it is usually associated with red lake pigments such as madder lake enabling to hypothesize the use of a red lake for creating the red details.

Analyses using the VIL technique revealed the presence of Egyptian blue in some specific part of the bas relief such as the basin or the pillar of the flame (Fig. 4).

Data acquired with other spot techniques (XRF, FORS) confirmed the findings and the hypothesis drawn by observing UVf (data not shown) and VIL images. In this case, micro-climatic conditions of the catacombs are suitable for the preservation of colours on stone.

Temperature and humidity are constant and the lighting is limited to the duration of either visits or inspections. These conditions facilitate the conservation of polychromy, allowing deep investigations that can highlight important details about the technique used by the old master painters.

3.2. Outdoor and indoor statuary

Etruscan Gens Statlane's sarcophagi, are part of the Florence National Archaeological Museum collection, currently preserved in the courtyard of Villa Corsini, located close to Sesto Fiorentino. These sarcophagi are dated back to the first half of the third century BC.

The group consists of ten sarcophagi. Among all the sarcophagi, only the VIL survey performed on sarcophagus of Vel Statlane (Fig. 5) highlighted an interesting residue of Egyptian blue on the lower part otherwise not visible at naked eye.

Conversely, the sarcophagus belonging to Ramtha Ziltna (Fig.6), is the only one, among those analysed, showing the presence of red lake. The characteristic red/pinkish fluorescence, under UV light, appears on the belt and the ribbon of the woman portrayed on the lid. FORS spectra acquired on this area confirmed this hypothesis.

Fig. 5: Sarcophagus of Vel Statlane, son of Sethi, 275-250 BC, Villa Corsini, Florence (left) and VIL image of a detail of the lower slab (right).

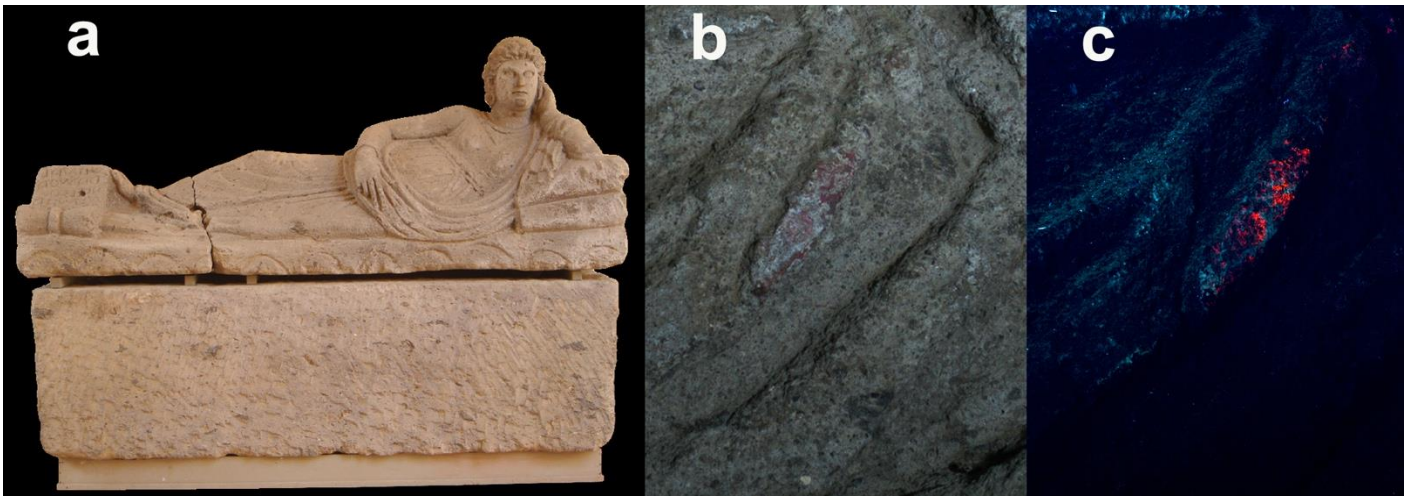

Fig. 6: Tomb II, female sarcophagus of Ramtha Ziltna, 260-50 BC, Villa Corsini, Florence (a), visible (b) and UV fluorescence (c) images of the detail of the ribbon.

Fig. 7: Headless Cuirassed Emperor (a) at the Archaeological Museum of Grosseto, macro image of residual gold (b) and VIL detail of the cuirass (c).

On other sarcophagi belonging to this group also traces of red and yellow ochres were identified (data not shown). The rare traces, almost invisible, discovered during the study did not allow us to establish with certainty the extent of polychromy, but for sure the sarcophagi were painted. This is also confirmed by the documentation of the excavation and by the observations

of scholars shortly after the excavation. The sarcophagi were always described as polychrome artifacts.

The poor conservation of polychromy may be correlated to the lithotype used (Nenfro stone, Tuff), that is coarse and prone to disaggregation but also to the stressful conservative history. Indeed, after the excavation, at the beginning of 20th century, the sarcophagi were displayed in the courtyard of the museum, exposed to light and rain for more than 50 years, where in 1966 they also suffered the dreadful event of the flooding in Florence.

3.3. Excavated statuary

An interesting example of residual polychromy is represented by the Headless Cuirassed Emperor (Fig. 7a), belonging to early Imperial cycle from the *Augusteum* of Rusellae (Roselle, Grosseto) exposed in the Archaeological Museum of Grosseto. Tiny traces of gold have been discovered on the drapery (Fig. 7b), and traces of Egyptian Blue survived on the cuirass (Fig. 7c).

Also in this case few traces of colour/decoration were identified but they were enough to confirm the practice of painted and coloured statues. Even in this case the poor conservation of polychromy, apart from other reasons, is surely closely related to conservative history. From documents found during the study it emerged that after the excavation (in the 1950s) the statues were cleaned by immersing them in tanks with sodium hypochlorite and "heavily brushed" to remove the excavation earth.

4. Virtual reconstruction of the ancient colour

Digital reconstruction of ancient polychromy is a relatively recent issue in the history of archaeological and architectural heritage documentation. It emerged as a result of new interest in the experimental archaeology and the technological development of computer graphic tools.

The standard research activity has been recently supported by the development of experimental approaches, often based on digital technologies to propose and assess reconstruction hypotheses. Those hypothetical reconstructions of the original colours and decorations, previously exemplified on physical replicas of objects, are now moving to the digital media. They are usually reproduced on digital photorealistic three-dimensional models, obtained with scanning technologies (Siotto et al. 2014). The colour reconstructions, based on the results of scientific analysis and archaeological data, allow the visualization of the original appearance of the artwork helping scholars to understand how and why colour was used to decorate or finish the artworks.

Anyway, the reconstruction of the original polychromy is not yet a consolidated subject of research; a lot of work still has to be done to improve our knowledge of the methods and techniques of colour application on polychrome artworks (Østergaard 2010).

In addition, the virtual reconstruction becomes more difficult in the context of ancient polychromy, because just tiny and deteriorated samples are usually found.
Today, MeshLab software (MeshLab 2019) was used to support the polychrome reconstruction stage and Blender (Blender Python API 2019) (or, rather, a combination of MeshLab and Blender) was used to achieve a more sophisticated visual presentation of the current and reconstruction ancient colour (Siotto et al. 2015).

Previous projects tried to realistically simulate the original colour of the works of art. An interesting example was the one supervised by Prof. Paolo Liverani, which returned a 3D model of the Augusto di Prima Porta at Vatican Museum, complete with its decorative apparatus (Liverani 2004). In 2002, the Stone Restoration Laboratory of the Vatican Museums started a careful and painstaking cleaning which has brought back to light many traces of colour that were no longer visible. To understand the nature and the composition of the pigments, they were subjected to a scientific examination by analytical techniques. The results of these investigations showed that colours were applied on the clothing, on details of the armour, on the hair and on details of the eyes but not on the skin or on the ground of the armour.

On the basis of these evidences, a complete reconstruction of the colours was prepared on a plaster cast. The surviving traces are sufficient to permit the colours to be reconstructed over most of the surface. The missing parts were supplemented in a hypothetical manner based on the logic of the use of colours on the statue and on comparisons with roughly contemporary portraits (Liverani 2011).

5. Conclusions

The detailed knowledge of an artwork or archaeological artefact, in terms of its composition, is a prerequisite condition for any research in art history or archaeology as well as for any conservation-restoration procedure. The scientific approach here presented represents a strategic tool for achieving a complete awareness of the residual polychromy on ancient statuary; it will open up new understanding of original polychromy, supporting more

correct and conscious restoration procedures (e.g. in the case of the archaeological excavations or programmatic operations in the museum collections). The aim is to develop a broader awareness of residual polychromy to be shared with the research groups active in this field on the national and international scene, with the museums and institutions involved in conservation of cultural heritage and for educational purposes with non-specialist public.

The technical examination is based on the use of several non-invasive methods. In this way, a very large number of artworks with a virtually limitless number of analytical acquisitions can be analysed. This approach leads also both to the reduction of the sampling activity and to a fundamental exchange of views among scientists, archaeologist, conservators and art hystorians already during the measurement process.
One still open issue is represented by the assessment of the reliability of the digital colour reconstructions. Until now it has not been possible to create realistic renderings that take into account the effect of colour with the material (marble or other supports) and light.
Further improvement could be dedicated to testing the actual system to assess the effectiveness and limitations to recreate a hypothesis of the original colour (on the digital reconstruction).

Very often the extent of the surviving pigments/colour is too small to allow a satisfactory reconstruction of original appearance. The latter is a combination of several parameters, such as pigments but also binders, thickness, preparation layers, etc.) that are not always known. So the reconstruction is something very risky that can easily turn into a modern reinterpretation.

6. Conflict of interest declaration

All authors states that there is no conflict of interest.

7. Funding source declaration

The authors declare that no funding was received neither in the course of the study nor during the assembly of the manuscript.

8. Acknowledgments

The authors would like to acknowledge Paolo Liverani for the collaboration on the Cuirassed Emperor and the Olimpo Antistianus Sarcophagus. For the latter we thanks Barbara Mazzei responsible of the Commission of Sacred Archeology of the Vatican for the access to Catacombs. Claudia Noferi, Carlotta Cianferoni of the National Archeological Museum in Florence for the access to the Etruscan Sarcophagy.

9. Short biography of the authors

Susanna Bracci - She is Senior Researcher at ICVBC-CNR. She is leading the ICVBC Mobile laboratory for the in-situ diagnostics of works of art including paintings, frescoes and glasses (mosaics and stained glass windows). In this framework special attention is devoted to the color traces on statues and architecture.

Donata Magrini - She is a Conservation Scientist at ICVBC-CNR. Her research activity is mainly aimed at investigating methodologies for diagnosis and monitoring the state of conservation of cultural heritage, with special attention to paintings, frescoes and stones. In this context, she is involved in the application of non-invasive techniques (UV-Vis-NIR spectroscopy, XRF, FT-IR and imaging) to study residuals of original polychromy on stone.

Giovanni Bartolozzi - He is a Conservation Scientist at IFAC-CNR. His research activity is focused on the diagnostic for Cultural Heritage (wall paintings, easel and canvas paintings, contemporary artworks). He is expert in both non invasive and invasive spectroscopic techniques (FORS, UV-Vis-NIR, FT-IR).

References

Accorsi, G. Verri, G. Bolognesi, M. Armaroli, N. Clementi, C. Miliani, C. Romani, A. (2009) 'The exceptional near infrared luminescence properties of cuprorivaite (Egyptian Blue)' *Chemical Communications*, pp. 3392-3394.

Bacci, M. (2000) 'UV-VIS-NIR, FT-IR, and FORS spectroscopies in *Modern Analytical Methods' in Art and Archeology, Chemical Analyses Series*, Vol. 155, Ciliberto E., Spoto G. editors, pp. 321-361.

Blender Python API (2019), Available at: http://www.blender.org. Last access march,13 2019.

Brinkmann, V. and Wünsche, R. (2004) 'Bunte Götter. Die Farbigkeit antiker Skulptur'. *Munich: Staatliche Antikensammlungen und Glyptothek*, ISBN 3-933200-08-3

Cosentino A.: (2014) Identification of pigments by multispectral imaging; a flowchart method. Heritage Science 2014 2:8.

Dyer J, Verri G, Cupitt J.(2013) Multispectral imaging in reflectance and photo-induced luminescence modes: a user manual. http://www.britishmuseum.org/pdf/charisma-multispectral-imaging-manual-2013. pdf. Accessed 20 may 2019.

Dyer J. and Sotiropoulou S. (2017) A technical step forward in the integration of visible‐induced luminescence imaging methods for the study of ancient polychromy, *Heritage Science* 5:24

Fischer C., and Kakoulli I., (2006), 'Multispectral and hyperspectral imaging technologies', In Conservation: current research and potential applications, *Reviews in Conservation*, 7, pp. 3-16.

Gasanova S., Pagès-Camagna S., Andrioti M., Hermon S. (2018) Non-destructive in situ analysis of polychromy on ancient Cypriot sculptures, *Archaeol Anthropol Sci* 10:83–95.

Giachi, G et al. (2007) 'Indagini analitiche sul sarcofago delle Amazzoni' In *Il sarcofago delle Amazzoni*, Bottini, A. and Setari, E. eds, Electa, Milano. pp. 132-166.

Iannaccone R., Bracci S., Cantisani E., Mazzei B., (2015), 'An Integrated Multi-methodological Approach for Characterizing the Materials and Pigments on a Sarcophagus in St. Mark, Marcellian and Damasus Catacombs.' *Applied Physics A*, 121 (3), pp. 1235-1242.

Karidas, A.G. Brecoulaki H. Bourgeois, B. Jockey, Ph. (2006), 'In situ XRF analysis of raw pigments and traces of polychromy on marble sculpture surfaces. Possibilities and limitations' *Non-destr Exam Cult Objects Adv X-ray Anal*, pp. 42-62

Liverani, P. (2009) 'Osservazioni sulla policromia e la doratura della scultura in età tardoantica' in *Proceedings of Symposium Il Colore nel Medioevo. Arte, simbolo, tecnica*, Andreuccetti P.A. and Lazzareschi Cervelli I. editors, vol.4, Fondazione Cassa di Risparmio di Lucca, Lucca, pp. 9-22.

Liverani, P. (2011) 'Augustus of Prima: Report on the Polychromy', Available at: http://www.digitalsculpture.org/augustus/liverani.html. Last access march,13 2019.

Liverani P., and Santamaria U. editors, (2014), Diversamente bianco. La policromia della scultura romana, Edizioni Quasar Roma.

Liverani, P., (2004), 'I mille colori delle statue classiche. Ai Musei Vaticani ricostruite le colorazioni originali di opere risalenti all'antica Grecia e alla Roma imperiale', In *I colori del bianco policromia nella scultura antica*, AA.VV., Catalogo esposizione (Musei Vaticani 17 novembre gennaio 2005), Roma, De Luca Editori 'Arte.

Liverani, P. Bracci, S. Iannaccone, R. Lenzi, S. Magrini, D. Mazzei, B. (2017) 'Colours in the dark: new researches into catacombs' *Polychromy in Ancient Sculpture and Architecture*, pp.94-105, ISBN 978-88-8347-997-7.

MeshLab (2019), Available at: http://meshlab.sourceforge.net. Last access march,13 2019.

Miliani, C. Rosi, F. Daveri, A. Brunetti B.G. (2012) 'Reflection infrared spectroscopy for the non-invasive in situ study of artists' pigments', *Applied Physics A*, 106 (2), pp. 295-307.

Noferi, C. Bracci, S. Iannaccone, R. Lenzi, S. Magrini, D. (2017), 'Consideration on Polychromy from a group of nenfro sarcophagi at the Archaeological Museum in Florence, from Gens Statlane Tomb in Tuscania (Viterbo)'. In *Polychromy in Ancient Sculpture and Architecture*, pp. 27-34, ISBN 978-88-8347-997-7.

Ny Carlsberg Glyptotek (2013) Tracking colour. Available at: http://www.trackingcolour.com /(Accessed: march,13 2019).

Østergaard, J. S. (2010), 'The Copenhagen Polychrome Network: A research project on ancient Greek and Roman sculptural polychromy in the Ny Carlsberg Glyptotek'. In *Circumlitio: The Polychromy of Antique and Medieval Sculpture, Proceedings of the Johann David Passavant Colloquium* V. Brinkmann, O. Primavesi, and M. Hollein Editors., Hirmer, Munich, pp. 324–337

Shugar A. N. and Mass J. L. Editors, (2012), Handheld XRF for Art and Archeology, Studies in Archeological Science 3., Leuven University Press (Belgium), ISBN: 978 90 5867 9345

Siotto, E. Dellepiane, M. Callieri, M. Scopigno, R. Gratziu, C. Moscato, A. Burgio, L. Legnaioli, S. Lorenzetti, G. Palleschi, V. (2014), 'A multidisciplinary approach for the study and the virtual reconstruction of the ancient polychromy of Roman sarcophagi', *Journal of Cultural Heritage* 15, pp. 1–8.

Siotto, E. Callieri, M. Dellepiane, M. Scopigno, R. (2015), 'Ancient polychromy: study and virtual reconstruction using open source tools' In *ACM Journal on Computing and Cultural Heritage (JOCCH)* 8, 3, 16: pp. 1-20.

Verri G. (2009) 'The spatial resolved characterization of Egyptian Blue, Han Blue and Han Purple by photo-induced luminescence digital imaging', *Analytical and Bioanalytical Chemistry* 394(4), pp. 1011-1021.

Verri G., (2010), 'The 'Treu Head': a case study in Roman sculptural polychromy', *The British Museum Technical Research Bulletin*, 4, pp. 39-54.

von Graeve, V., (1985) 'Marmobilder aus Herculaneum und Pompeji', in *Ricerche di pittura Ellenistica, Quaderni dei dialoghi di archeologia* 149, Rome, pp. 227-251.

Industrial colour invention: a comparative analysis from the perspective of the colourist designer

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ABSTRACT

In this article a comparative study of two different colour invention processes in the paint and coatings industry from the perspective of the colourist designer is presented.

Our research is based on a thorough analysis of colour communication tools and on empirical data from interviews with actors of two leading companies from Latin America and Europe.

In both processes we find two distinct sets of expertise. In the first one we identified, the primary driving expertise is from the field of engineering and marketing. In the second one, we find the expertise of the colourist designer, from the field of applied arts, supported by marketing considerations in an iterative process.

In our work we study how these different approaches impact the resulting colour palettes, that is, the product ranges reaching the market.

Our results point out an ongoing evolution in the invention of colours, strongly linked to the introduction of the artistic sensitivity of the colourist designer, in an industrial context.

KEYWORDS colourist designer; paint and coatings industry; colour invention; colour communication tools; comparative analysis.

RECEIVED 26 July 2018; **REVISED** 20 October 2018; **ACCEPTED** 10 January 2019

CITATION: Perdomo, L. (2019). Industrial colour invention: a comparative analysis from the perspective of the colourist designer. Color Culture and Science Journal, 11(1), 57–66. https://doi.org/10.23738/CCSJ.110107

1. Introduction

Colour communication tools, known as fan decks in the industrial context, have an essential role to play for market success in the paint and coatings industry.

In this article we present a comparative study of two different approaches to develop and communicate colours in the paint and coatings industry and the resulting colour communication tools from the perspective of the colourist designer.

Colour invention processes in this industry have to take into account a variety of considerations and constraints from vastly different domains and contexts. Among these there is the field of marketing, corresponding to a mostly empirical, sales-oriented approach to colour, having received considerable attention from the scientific community (Journal of International Marketing, 1993 - 2012) over the last decades. On the other hand, approaches of chromatic design from the field of applied arts have not been studied in an industrial context from the perspective of poietics. This study aims to partially close this gap.

Our research is firmly based in the framework of *action research in arts* (Liu, M., 1997 ; Caumon, C., et al., 2016), based on *interviews* (ethnological approach, see Copans, J., 2011) with the main actors involved in the design of these tools - and their analysis from the perspective of *poietics* (Passeron, R., 1989, 1996).

The key actors and the colour palettes themselves will be our main object in this study that is based on data from two paint and coatings companies who are market leaders in their respective territories. We are going to designate the first one as Company A (operating in Latin America), and the second one Company B (operating in Europe).

The fan deck as a colour communication tool of reference in every paint and coatings industry is designed to carry out a particular function, which is not only to simply communicate colours and to facilitate the act of selling them but to activate the imagination of a specific user. The analysis of these tools allows us to identify the main interests, questions and concerns involved in every phase of the creative processes, supported by interviews we conducted with the relevant creative actors.

The key actors involved in these processes develop colour communication tools following their individual methods to optimally address the specifics of their market environment and its particular cultural traits. The interviews we conducted allowed us also to gain unique insights into how the results of market research impacts the individual creative process in each company and how it drives localised colour innovation processes adapted to the respective market environments.

It is important to say that our interest is not only about cultural influences that we identify at the heart of the creation of each tool, or the strong impact of the sensible and differentiated perception of colour individual to each actor and her or his specific set of expertise. Our main interest is, firstly, to investigate how an actor from an artistic background, the colourist designer, operates under the constraints of an industrial environment. Secondly, how the very different background of another actor (engineering/marketing) in the equivalent position at another company influences his creative process. Both creative settings have - to the best of the author's knowledge - never before been investigated in the field of poietics.

Identifying the impact of two markedly different sets of expertise of the involved actors helps us to respond to our final interest, which is to identify the artistic complexity that is involved in the process of defining colour phenomena in this industry.

The art of placing colours together will allow us to understand better how today's key actors manipulate colour parameters, how they interpret them but especially how all of this will help us in our intention to evolve today's creative process by implementing in the industry creative methods of the colourist designer's scientific and practical expertise.

Questioning and analysing our own perspective and the professional experience from the field of engineering and marketing will lead us to new insights in a field still little explored from the perspective of poietics.

2. Methodology

We have conducted, in a first step, interviews with the key actors involved in the design of colour palettes and the corresponding fan decks as they are the most important colour communication tools in both companies. The detailed interviews allowed us to gain a deeper understanding of the terrain and have provided the data for a direct comparison of the actors' expertise and the importance of their artistic approaches.

In a second step, a detailed analysis of both companies' main fan decks has allowed us to build hypotheses about how the act of creation and the individual perspective of the involved actors reflects their specific expertise as well as the cultural environment of the respective target markets.

Considering the complexity of the colour phenomenon (Pogacar, V., 2012; Ladnytska, O., et al., 2015), the analysis of colour communication tools in an industrial

environment implies a significant reflection on categorisation and classification. The objective of our analysis has thus been to identify the main systematics employed: systems of classification (chromatic groups), a quantitative analysis of the colours present in the considered tools and the used approaches of nomination and codification (we base ourselves on the anthropologic work of (Berlin & Kay, 1969), always taking into consideration the whole creative process.

As a reference and to determine the colorimetric limits specific to each chromatic group, we use the NCS (Natural Colour System). Our chromatic data is translated using the NCS Digital Atlas and the NCS colour palette itself to identify where the chromatic groups (colours) are located in a Standard Color Space. We take into account both the horizontal, which is identical to the chromatic circle, showing the hue, and the vertical section of the colour space, corresponding to the nuance.

Our general approach is expressed in the words of René Passeron (René Passeron, 1989) as, "*a normative reflection on the act of creation*" in the context of our research in between the realm of the arts and the industry.

It is in this manner that the confrontation of the creative reflection we find in each terrain with our own creative process makes us consider the specific codification and classification of each terrain as a key factor in our analysis of how these different approaches impact the resulting colour palettes that reach the market.

3. Results I - Analysis of the interrelation between creative process and communication tools

In this section we give an overview of how Company A and Company B function when it comes to the development of their colour palettes and the design of their fan decks. Communicating on all aspects of colour and identifying the most appropriate qualifiers and nuances that correspond to the specificities of a given market are the key principles when it comes to the operating modes (*opus operandi* (Passeron, 1989)) playing an essential role in each reflection about colour.

Following our analysis of the conducted interviews, the actors involved in the creative process agree with regard to the analysed tool appearing in the industry as an essential element that has to help and guide every customer or professional to make a colour choice. However, it is interesting how, in the case of company B, we can identify an approach in which the fan deck is seen as a tool that is endowed with the power to bring a poetic aspect into people's lives by proposing a unique system of nomination in combination with a simplified system of codification.

In comparison, in the case of company A we find a tool of similar general characteristics that has, however, been designed from a point of view closer to the fields of engineering and marketing and in which, instead of proposing only one system of colour nomination, two different numeric systems of colour codification can be found, and furthermore a more poetic system of colour names. This particular choice has been made to appeal at once to the three major user groups of the tool. These two different methodologies, each one developed over a period of one year of analysis and practical experiments and corresponding to mostly marketing-oriented strategies bring up a variety of questions about the position of the poetic dimension in each creative process and its impact on the final result.

Paint & Coatings Industry	**Company A (Latin America)** **colour tool created in 2014**	**Company B (Europe)** **colour tool created in 2015**
EXPERTISE OF THE CREATIVE ACTOR	Engineering & marketing	Colour design & fine arts
COLOUR COMM. TOOL - CLASSIFICATION	8 chromatic groups (pastels, reds, oranges, yellows, greens, blues, purples, neutrals-earthy)	8 chromatic groups (whites, reds, oranges, yellows, greens, blues, purples, neutrals)
COLOUR COMM. TOOL - NOMINATION	3 different codes : 2 numerical codes + 1 descriptive code	1 numerical code

Table 1 - Analysed properties of industrial colour communication tool design processes

Anticipating the specific function of each of the tools helps the creative actors to define its performance, at the same time transforming a multitude of colours, taking into account either cultural particularities - the dominating factor we identify in company A (creative actor expert in marketing/engineering) - or taking a more scientific approach, such as we find in company B (creative actor expert in arts/colour design). It is understandable that marketing aims to respond to cultural particularities, since its principal objective is customer satisfaction (Madden, T., et al., 2000), contrary to the artistic approach that aims for creative freedom.

For a paint and coatings company, developing a unique colour tool including a proprietary codification and/or nomination system represents a significant investment, thus this step is taken typically only by companies that enjoy a solid market position. This is the case for both of the companies that are the object of our study. According to our interviews, the decision to create their own colour systems has been taken after long years of experience. For years, each of them worked with adopted systems and eventually with various suppliers from different parts of the world. The fan deck of company A was conceived in 2014 and it represents the first own tool developed by the company. This is the case as well for company B (first proprietary fan deck and colour classification system developed in 2015, described as an international colour system).

In *Table 1* we identify the main characteristics that are the focus of our study and that we consider as the principal factors involved in the design of the considered colour communication tools. Note that it is the very existence of these tools that renders accessible industrial colour universes to an objective analysis. As the author of (Guy Lecerf, 2014) puts it, "*the activity of the industry [makes us] think colour as something objective. [...] Colour [in the industry] becomes a phenomenon accessible to analysis, classification and reproduction*". However, being subject to methods of widespread mass market communication, it is inherently designed to appeal to a large number of individuals, for whom colour has to be perceived as something subjective that brings poetics into their everyday lives. It is in the presence of this tension between objectivity and subjectivity that the design process of colour palettes and the analysed tools takes place. Note that the categorisation into chromatic groups as well as the system of nomination/codification are the company's.

To first better understand how colours are structured in the industry and to identify how international colour systems influence the classification of colours in each tool, we analysed every chromatic group (eight in total) among the 1407 colours of company A and the 1650 colours of company B (a total of 3057 colours).

3.1 Fan deck company A (Latin America) – 1407 colours (colour tool A)

The colour tool A features a cover full of coloured flat geometric shapes, mostly triangular. The colours, mapped into the NCS Colour Space, have a saturation between 70% and 90%. The fan deck is of standard size of 4,7x26cm (in comparison with some other industry fan decks which measure 5x20,3cm, 5x22,8cm, 5,1x25,4cm, 5x26,5cm and 5x29,2cm) and starts off on the first pages with a succinct explanatory introduction to the basics of colour theory based on the chromatic circle, followed by an explanation of the colour codes employed throughout the tool.

It is starting from the softness and delicacy of pastel colours that our chromatic voyage then begins. Using the NCS colour system as a reference, we observe that the whole chromatic range of the corresponding colour family of the NCS colour circle (reds, oranges, yellows, greens, blues and violets) are covered in the same order as we find it in multiple *cross-cultural investigations which have typically found a wide variation in Color-naming systems* (Bornstein, 1973).

Every colour is situated at the top of the grey scale within the NCS colour triangle (which are the whites (W)), having less than 10% of black (S) and a saturation (C) between 2% and 10% for every colour. (see fig. 3)

Inside this group we also identify, in exactly the same order, the chromatic groups that constitute the corpus of the tool with the exception of the neutral-earthy colours group which appears at the end and represents the largest chromatic group.

It should be noted that in the neutral-earthy colours group we also identify the entire chromatic range of the NCS colour circle. This time, in the NCS colour triangle we see that the lightness of every colour is situated between white (W) 10% and black (S) 100%). In contrast to that, the saturation value (C) falls between 2% and 20% for every colour, rendering this family of colours rather greyish and dark.

As mentioned above, the development process of this tool is conducted by a creative actor whose formal expertise is based in engineering, complemented by professional experience in the colour industry in a marketing context.

Colour as an *objective entity* (Guy Lecerf, 2014) has to correspond to customer needs identified by market

research conducted by the company A [1]. However, not only colours corresponding to these objective requirements can be identified in the analysed tool. The sensibility of its creator expresses itself by the choice of an at the same time rhythmic and linear ordering of colours inside every chromatic group. This approach appears to be very intuitive, as colours can be found without intricate knowledge of the underlying systematic.

The overall ordering of colours clearly makes reference to the Newtonian colour circle, a universe intuitively familiar to a large part of the population, irrespective of culture, religion or education. Each page contains different samples with the same hue, from the lightest to the darkest. In this way pages with light colours (high lightness and medium saturation) and bright colours (high lightness and saturation) are confronted with pages with more vivid colours (medium lightness and high saturation) and dark and deep colours (low lightness and saturation), creating a colour symphony where far reaching delicate harmonies are enriched by more tonic and dominant notes. This is confirmed in our comparative analysis where chromatic groups proposed in the fan decks have been located in the NCS Colour Space as illustrated in our case study of the chromatic group of yellows (see section 4.1).

The rhythm is always systematic, but the transitions from one group to the following are always smooth, giving the impression of a continuum of gradually shifting shades. Another important point of the analysis, as we mentioned above, is the colour nomination. The chosen method is to confront descriptive codes with numerical codes. This multiple colour identity responds at once to the variety of potential users of the tool (numerical codes tend to dominate in professional environments, while in retail typically descriptive nominations are preferred) and reinforces each colour's brand identity.

3.2 Fan deck company B (Europe) – 1650 colours (colour tool B)

The second fan deck, also roughly following the standard size of this kind of tools (5,3x31cm) but a little larger than the colour tool A, exhibits distinctly different features in several aspects. Even if both tools use geometric shapes - mostly triangular - for their cover, this one only shows different shades of blues, purples and reds, with a saturation (C) between 40% and 70%. These colours (more sophisticated than those of the fan deck A) are applied in a gradient fashion leading to a 3D effect pattern that is then expanded on the back page of the tool in green, yellow and orange shades. But even if they respond to the same demand and we see a similar physical appearance, a simple look at the tool reveals that we are exploring a very different colour universe.

The first five pages present an introduction to the general spirit of the tool that includes an explanation of the system of classification used (how colour families are grouped, how the colours of each family are divided into different levels of saturation (from bright to shaded colours), how each page contains different samples with the same hue, from the lightest to the darkest, with exception of the whites - the best selling group - where the colour samples are bigger than the other ones in order to improve visualisation), and leaves the reader with the impression that we are inside a systematic classification that however tries to leave freedom and breathing space to the imagination of the user.

The first chromatic group also begins with soft and delicate shades, this time named 'whites'. In comparison with colour tool A, this first group does not introduce the whole range of colours that we find in the tool as it covers only five colour families of the NCS colour circle (-G80Y, -G90Y, -Y, -Y50R, -R). As the pastel group of tool A, in the NCS colour triangle, they are all situated at the top of the grey scale (W), this time having less than 5% of black (S) and of saturation (C).

This first group corresponds to what is designated in French as '*blancs colorés'*, i.e. we do not find pastels declined in different colour families here, but this first chromatic group is about the coloured lightness provided by the white, in a quite subtle way. Then, in the next group, subtle reds appear, followed by oranges, yellows, greens, blues, purples, ending with the group of neutrals. As for the colour classification inside every chromatic group, each page contains, similar to the first fan deck different samples with the same hue, from the lightest, on top of the page to the darkest. The difference here is that each chromatic group is divided into different levels of saturation and lightness. From bright colours to rich (high saturation and lightness medium and high), light (medium saturation and high lightness), muted and shaded (low saturation and all levels of lightness) colours. As a consequence of this choice, the rhythm present in the transitions from one chromatic group to another is markedly less subtle and more abrupt. The gradually changing shades we find in the tool A in the transitions between groups can be found here in the ordering of colours inside each chromatic group. A colour symphony is also experienced in here, but the difference is that there are no tonic and dominant notes that disrupt the rhythm, leading to a harmonic, smooth and delicate composition in perfect accordance with consumer preferences.

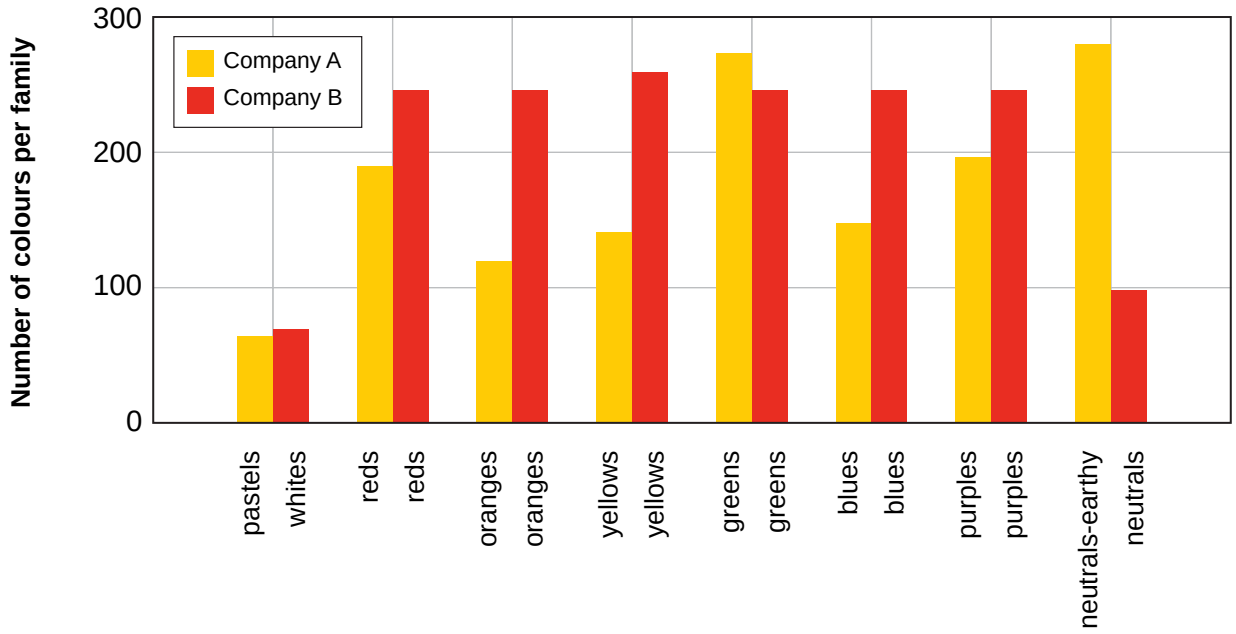


Figure 1 - Number of colours per chromatic group, (company A (1407 colours) vs. company B (1650 colours))

4. Classifying colours

In our study we could identify how the repartition of colours in the fan decks of both companies into eight chromatic groups exposes in a first regard repetitive standards in colour classification. However, in the further course of our analysis, we could identify more subtle differences that constitute a clear divergence in the way of classifying colours.

While we find a common general pattern of classification in both tools that we designate “standard pattern” for the sake of this analysis, the colour fields within each chromatic group are of different sizes.

4.1 Case study of the chromatic group of yellows

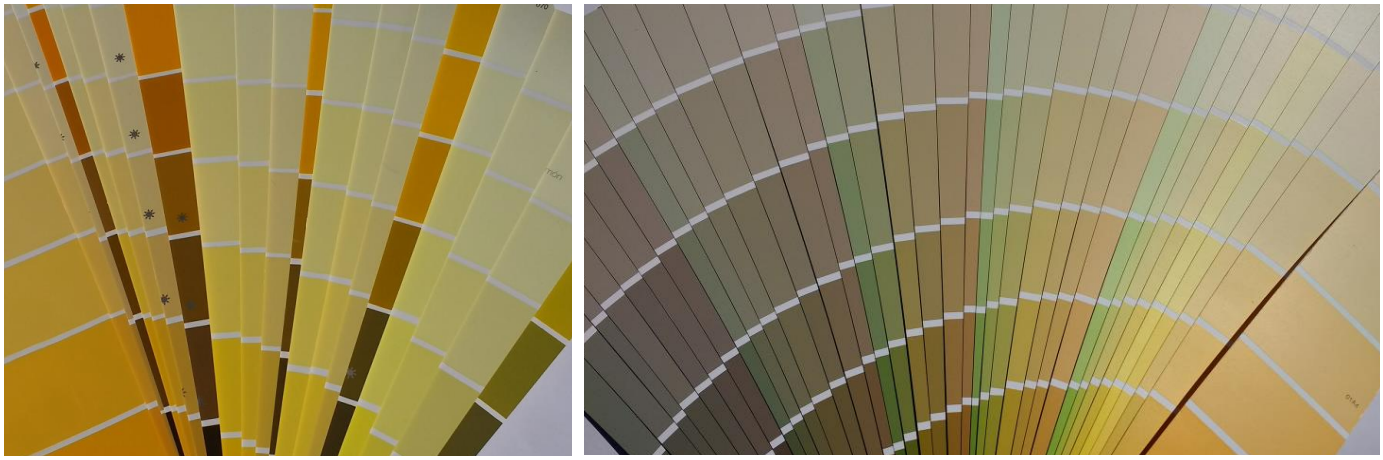
From figure 1 we pick as an example the chromatic group of yellows. In our visible spectrum, from shortest to longest wavelength, yellow (with a predominant wavelength of roughly 560–590 nm) is the colour between green and orange. When the three parameters of the colour differ (Hue Saturation Lightness, known as HSL), the shades of yellow show a chromatic group particularly fluctuating, which makes it transition into another chromatic group. We identify this situation in the NCS Colour Space where the yellow family is represented with the letter -Y but it is also possible to identify a letter-number combination -GY and -YR. This means the yellow is also part of the green (G) and red (R) colour family (hue).

In our experience as colourist designer, usually, when it comes to choosing a yellow in a colour palette, this chromatic group is typically the smallest one offered by the industry, probably due to yellow not being a very dominating colour, so that even moderate variations rapidly introduce ambiguous colours that tend to transition into other chromatic groups, e.g. we find a certain ambivalence between yellow-oranges and yellow-greens.

Rearranging shades of yellow from different chromatic groups, in both colour palettes we find multiple alternative classifications of yellows (see fig. 2).

In the NCS colour circle, Company A proposes a chromatic group composed of a range from -G70Y (70% of yellow and 30% of green) to -Y20R (colour with 80% of yellow and 20% of red), i.e. we find yellow colours that fluctuate between greens, and pure yellows up to oranges.

Company B, on the contrary, expands the spectrum and proposes a group ranging from -G40Y (40% of yellow and 60% of green) to -Y20R (80% of yellow and 20% of red). This example shows a significant reinterpretation by the creative actor of what we know as the traditional colour circle (see fig. 3).



Company A Company B

Figure 2 - Detail of chromatic group of yellows (company A (140 yellow colours) vs. company B (259 yellow colours))

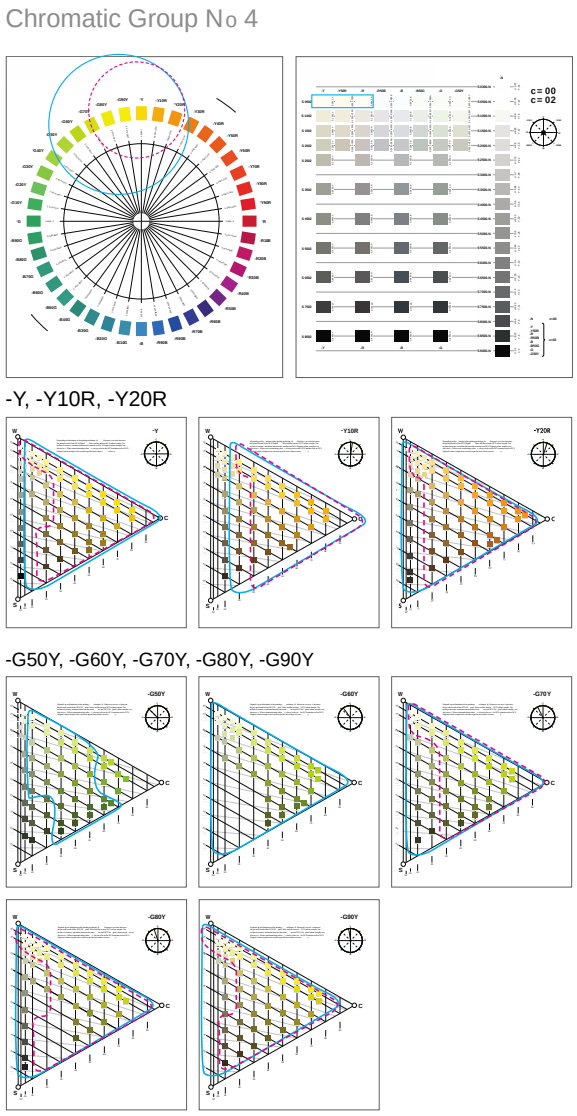


Figure 3 - Detail of chromatic group of yellows from company A vs company B situated inside the NCS Colour Space

The total difference in terms of quantity of colours between the two palettes to the other one is less than 250 colours (~17%). In the group of yellows from the fan deck of company A, we find a hundred and forty (140, ~10% of the total number of colours) colours and two hundred fifty-nine (259, ~16 % of the total number of colours) colours in the fan deck of company B, a significant difference both in total and with respect to the size of the respective fan deck.

The way of classifying the colours of the yellow group in the fan deck of Company A, exposes a research of the colour quality in a quite specific and what appears to be deliberately limited way.

Yellow tones (~52%) show only subtle variations towards the orange (~34%) and the green shades (~14%) and the dominant colours in the group are light and pale colours (high lightness and medium and low saturation). This classification appears to work in the market and provides also a basis to rationalise the selection of a particular set of colour choices. The way colours are thought here is completely objective. Its attributes seem to be based on cultural considerations (Madden, T., et al., 2000). We feel a strong relation between the territory and the need to simplify the parameters of the palette to render it as a whole more accessible and to simplify its communication.

Considering the fan deck of Company B, we notice that, as a colour expert from the field of applied arts, the colourist designer explores every possibility that helps to enrich and explore every shade of the colour group. This becomes evident not only by the classification of colours

according to their standard parameters (HSL), but also by the visible impact of artistic sensitivity and imagination. Yellow tones (~43%) in this group are more varied, alternating yellow greenish tones (~46%) and yellow orange tones (~11%), showing and further exploring the characteristic vivid, dynamic influence of yellow.

However, colour as an objective entity, conceived to be part of an industrial system, plays an important role in the act of classifying colours from an artistic expertise. Inside a normative sector, the sensible perspective of the colourist designer is nourished by a multitude of stories, dreams and experiences, always keeping in mind that the focus in an industrial context lies almost always on proposing a common model for everyone to render colour communication easier and neutral.

The case study of the chromatic group of yellows exposes two of so many different existing possibilities of seeing and associating colours. This case study, however, is only a first step and is followed by an analysis of the process of naming and codifying every colour.

5. Naming colours

For the two analysed colour palettes, both companies have developed their own colour classification systems instead of adopting an existing standard proposed by companies specialised in the design of colour communication tools.

The relationship between colours and language was important for both creative processes. This relationship has been questioned from different domains of research. For example, the anthropological method, *Basic Colour Terms* (1969), where the authors Brent Berlin and Paul Kay (Berlin, B., Kay, P., 1999) state that there are 11 fundamental colour terms that exist in every culture: white, black, red, green, yellow, blue, brown, purple, pink, orange and grey. This model, formalised solely based on language, has generated a controversial debate in the colour research community. In our particular case, comparing the chromatic groups identified in our study with the eleven “basic colour terms”, we see a great deal of agreement, but also differences, providing an example of how a specific creative and cultural environment generates a specific narrative, expressed by a specific set of colour terms.

The direction we have identified in the corpus of the two colour palettes analysed from a linguistic point of view (Berlin, B., Kay, P., 1999) reduces the 11 basic colour terms in the fan deck A to six basic colour terms (reds, oranges, yellows, greens, blues, purples) and in the second one (fan deck B) to seven basic colour terms (whites, reds, oranges, yellows, greens, blues, purples) (see fig.4). However, we could easily recognise the 11 basic colour terms inside every chromatic group of both fan decks. Is this configuration of having only 8 chromatic groups specific to the terrain of the paint and coatings industry? Would it be possible for the industry to create its own ‘universal’ classification without taking into account the culture of the consumer?

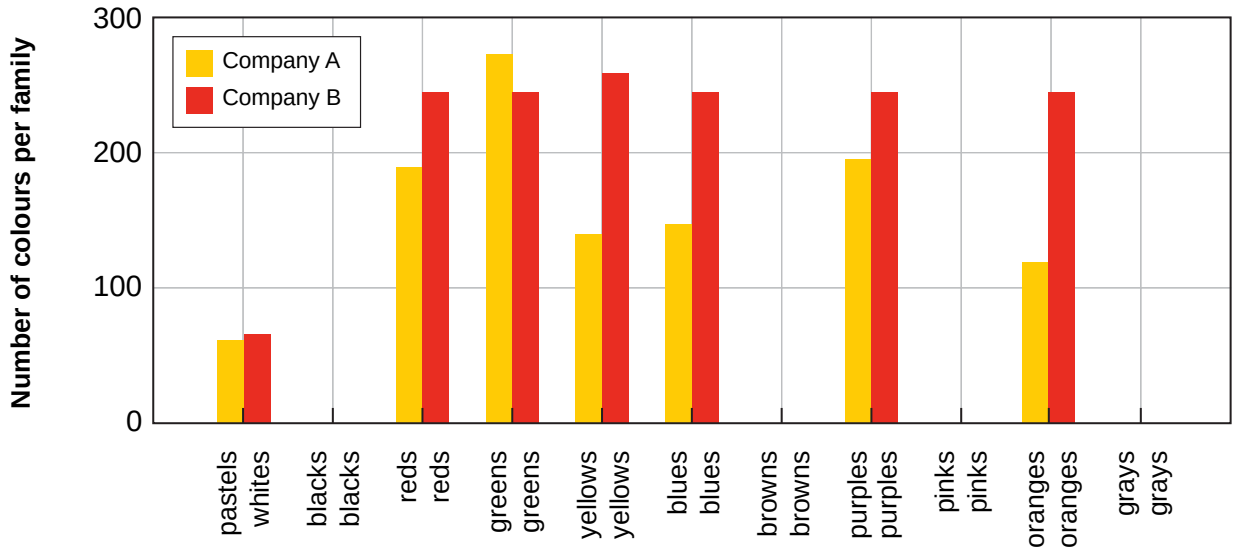


Figure 4 - Number of colours per chromatic group based on Basic Colour Terms.

Company A (Latin America) marketing expertise	Company B (Europe) colour design expertise
Rayo de Sol AM005 – T 41N – 48 – 100T	01A5
Oro Azteca AM006 – D 41N – 65 – 100D	01A6
Hojas de Oro AM007 – D 45N – 75 – 100D	01A7

Table 2 - Example of naming colours in the yellow group

Returning to our case study of the group of yellows, studying the colour codification helped us as well to identify how the same colour assumes different identities in different terrains. In tab. 2 we show three examples of very similar colours (mapped to the NCS) and their respective codes in both fan decks.

For the company A, proposing three different codifications for each colour, answering to three different user groups, shows the diversity of the tool in terms of fulfilling its primary function.

A strong, threefold colour identity is build, providing a guide to the imagination of the user. As such, it appears that colour is thought of as rather objective entity, even if a descriptive code is proposed, introducing poetic aspects. For company B, we are confronted with a numerical code system, structuring the tool in a rigorous, however easily accessible manner. Colour is approached from a rather subjective perspective.

We make the hypothesis that omitting a descriptive code implies putting fewer constraints on the imagination of the user of the tool. This is directly related to an aspect of great interest in the field of poietics, the possibility to free up the imaginary by artistic means in an industrial context, in contrast to marketing-centered approaches and their inherent tendency to strongly constrain the imaginary (Lecerf, 2014).

Finally, questioning the organisation of colour in lexical terms involves thinking of the existence of multiple ways of conceiving colour. Naming colours in the industry implies a reflection between linguistic norms and colour sensitivity so it can be applied to form chromatic groups. So, the question that remains open in relation to our own expertise is: can we propose new meaningful ways of classifying and naming colours that open up the imaginary?

6. Discussion and further research

The paint and coatings industry, according to the results of our analysis, offers a promising field of investigation for the colourist designer questioning creative processes in the invention of colour.

Based on the framework of action research in arts and adopting creative methods from the field of poietics, even if the results of this study indicates that further insights (such as comparing in a more measurable manner the speed or duration spent on determining each chromatic group of each fan deck which could help us to identify possible mistakes or miscommunications during the creative processes), could be gained by closer In-situ examination of the creative process of each actor. Analysing two different sets of expertise and the colour communication tools resulting from their application has allowed us to gain a deeper understanding of the role our field of research as colourist designer can play in this context.

We identified distinctly different creative approaches of the involved actors, intimately linked to their expertise and artistic priorities. Without the necessity of judging the quality of a particular tool our work clearly exposes how the artistic sensibility of each actor permeates and becomes apparent in the details of a tool designed in both cases primarily for purely commercial purposes, widening our perspective as colourist designers.

Based on this analysis and our ongoing exchange with key actors, we can state that our study about colour classification and nomination inside the industry is a first

approach towards a new definition of the meaning of a chromatic group in an industrial context today.

As a further extension of our work, it would also be interesting to bring together the colour charts that both companies have produced over the last two decades. The gathering of these tools could allow us to identify the colours belonging to each chromatic group to be able to build a chromatic circle specific to the context of the decorative painting industry in the 21st century. The resulting circle could be used to make comparisons with the chromatic circles proposed in the past, but it could above all become a representative object not only of the considered industries but of the chromatic identities of the corresponding territories.

According to a study by Borstein (1973), in South America, 9 of the 12 Indian cultures considered used one word for both green and blue. It would be interesting to perform a deeper analysis of the way in which Company A develops colour names and codes, considering that with exception of the group of neutral-earthy colours, the greens are the largest group, covering colorimetric values from two different colour families according to NCS.

Furthermore, important structural questions remain open when it comes to colour invention in the industry. Does more potential lie in proposing new methods for the creative individual, playing such a dominant role today? Or does it lie in creating new models of interaction between key actors providing different sets of expertise to enrich and widen the diversity of the artistic process? These questions, among others, will guide our future research efforts.

7. Conflict of interest declaration

The author declares that nothing has affected her objectivity or independence in the production of this work. The author has no financial interest in the people, topics or companies mentioned this article. So, no conflict of interest exists.

8. Funding source declaration

The research was partially supported by the Institut des Amériques and the University Toulouse Jean Jaurès (France).

9. Acknowledgment

The author would like to thank both companies who provided the invaluable and useful information that forms the basis of this research.

10. Short biography of the author(s)

Lina Perdomo - is a colourist designer and PhD candidate at the University Toulouse Jean Jaurès in Toulouse, France. Her research is focused on creative colour development processes in an industrial context from the perspective of the colourist designer applying the approach of poietics and action research.

Notes

[1] Three main groups of customers have been identified: 1) the one who is afraid of too much colour and who therefore prefers to stay in the areas of light colours (pastels), 2) the one who has a favourite colour, so he must be guided in his specific chromatic group and finally 3) the one who likes colours but does not like taking risks so he prefers neutral-earthy colours.

References

Berlin, B., Kay, P. (1999) Basic Colour Terms, Their Universality and Evolution. Stanford: CSLI publications.

Caumon, C., Houssard, F., Lecerf, G., Ling, L., Ollier, X. (2016) Recherche action par la création artistique et design. Saint-Denis: Connaissances et Savoirs, pp. 21.

Copans, J., (2011) L'enquête ethnologique de terrain: L'enquête et ses méthodes. 3e édition, Paris : Armand Colin

Ladnytska, O., Tsurkan, M., (2015) Linguistic Aspects of Colour in Ian McEwan's 'Atonement'. Science and Education a New Dimension. Philology, III(16), Issue: 70

Lecerf, G., (2014) Le coloris comme expérience poétique. Paris: L'Harmattan, pp. 71-72.

Liu, M., (1997) Fondements et pratiques de la Recherche-Action, Paris : éditions l'Harmattan

Madden, T., Hewett, K., Roth, M., (2000) Managing Images in Different Cultures : A Cross-National Study of Color Meanings and Preferences. Journal of International Marketing : Vol 8, No 4, pp. 90 -107

Passeron, R., (1989) Pour une philosophie de la création. Paris : Klincksieck, pp. 21, 54.

Passeron, R., (1996) La naissance d'Icare. Éléments de poïétique générale. Cachan (Val de Marne) : ae2cg éditions

Pogacar, V., (2012) Periodic colour model. Journal of the International Colour Association : 9, 5-19

How the colours of objects and light affect human emotions, performance and health. The need for a holistic approach to design indoor environment.

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ABSTRACT

Colours and lights have been shown to influence mood and performance, "cool colours" like blue and green are relaxing and peaceful to the eye, whereas "warm colours" such as red and yellow seem activating and arousing. Cool light, rich in short wavelength radiations, has also a significant effect in terms of circadian rhythm synchronization by inducing melatonin suppression.

For colours to be used in industrial objects, social and cultural factors also play a significant role.

The choice of colours in indoor environments, for both objects and light, should thus be done considering all these aspects. However, these different approaches lead to different points of view and to hardly comparable results. Also, the design process is unique and the final user is not able to distinguish between colour perception, visual and non visual effects of light as well as messages that can be expressed by means of colour patterns.

It appears necessary to establish reciprocal interactions among the different disciplines involved in the choice of objects and light colours, and namely among researchers in medical science, psychology, lighting and industrial design, in order to assess an interdisciplinary methodology that can be applied to indoor design.

KEYWORDS Identity, Quality, Visual Context, Indoor Environment, Perception, Properties, Circadian cycle

RECEIVED 24 September 2018; **REVISED** 17 May 2019; **ACCEPTED** 03 June 2019

CITATION: Barbato, G., Bellia, L., & Morone, A. (2019). How the colours of objects and light affect human emotions, performance and health. The need for a holistic approach to design indoor environment. Color Culture and Science Journal, 11(1), 67–73. https://doi.org/10.23738/CCSJ.110108

1. Introduction

Colours and lights have an influence on humans' mood and performance (Bourgin and Hubbard, 2016; Ou et al. 2004). Indeed, in an indoor environment, walls and furniture colours affect the perception of the space and induce different psychological states (Yildirima et al. 2007). In the scientific literature several experiments have been carried out to study colour preferences and emotional effects, also looking at different contexts and application. Despite the use of different methodologies and visual tasks, findings are generally in agreement in asserting that "cool colours" like blue and green are relaxing, calming and peaceful, whereas "warm colours" such as red and yellow result activating and arousing (AL-Ayash et al. 2016).

All experimental research performed on the circadian effects of light demonstrate that cool light, rich in short wavelength radiations, has a greater effect in terms of melatonin suppression (Brainard et al. 2001). Blue enriched light, i.e. lights with a great amount of short-wavelength radiations and CCT greater than 10000K have a positive effect both on seasonal affective disorder (bright light reduces SAD symptoms) and on cognitive performances in educational and office environments, stimulating attention and alertness (Thapan e al. 2001; Viola et al. 2008).

From the above considerations it seems that the choice of colours in indoor environments, either for objects and for lights, should be done considering both their physiological and psychological effects. Actually, things are much more complicated because it should be also taken into account that, in the choice of colours for objects and specifically industrial objects, social and cultural factors play a big role.

Despite those different approaches lead to different points of view and to hardly comparable results, we must not forget that the design process is unique and that the final user, i.e. an observer in an indoor environment. is not able to distinguish between colour perception, visual and non visual effects of light as well as messages that can be expressed by colour patterns, whatever the application can be (office, shop, school, hospital, etc.). On the contrary, they globally perceive whether the lit environment is pleasant and suitable, for the specific activity to be performed, regardless of the specific strategy the designer could have adopted.

Given these premises, it appears necessary to establish reciprocal knowledge and interactions among the different disciplines involved in the choices for objects and light colours, and namely among researchers in medical science, psychology, lighting design and industrial design. The aim of this paper is to discuss these interactions, by comparing the different approaches, in order to find some common grounds and develop integrated research activities.

2. Objects colours: identity and quality

Colour represents the first visible item of the identity of a product. It characterizes the quality and therefore it is the subject of a complex cultural assessment, which over the years has been substantially changed (Pine, 1993). The approach to colour should also be framed within the more general definition of industrial product quality.

For decades, the idea of product quality has been associated exclusively to performance aspects. Over time the increase of the cultural dimension in all product activities and consumer patterns has shifted the focus towards more complex and less immediate aspects than those purely functional in defining the qualitative components of a product (Carmagnola, 1991; Garvin, 1988).

A first phase of motivation in colour choice is related to the need for early serial industrialization.

The role attributed to the choice of colours in the production in this period of history, can be synthesized by the famous phrase of one of the protagonists of mass production, the American industrialist Henry Ford. He summarized with the following sentence the need to limit colour choice and to adjust its production process which was characterized by a single assembly line: "Any colour in the choices of a car is permissible, as long as it's black".

It was precisely through this peremptory affirmation of Henry Ford, about the lack of choices other than black, that started the first theoretical formulations of those principles of standardization at the base of mass production.

The monochrome trend in the early mass industrialization, the “only black” of “Fordism”, launched a message of product longevity, opposed to the polychromy transience which expressed the rise, in the same period, of the fashion phenomenology. However, it is precisely around the expressive power of colour that the gradual overcoming of “Fordism” occurred, replaced by a plurality of languages. Attention to the chromatic expression has gradually focused towards the search for an interaction between the user and the product that has been a central point of the various theories of colour, starting from the one by Johannes Itten and the painter and his student Josef Albers who, in order to summarize this process, introduced the concept of "epidermis of materials" (Albers, 1963). Since the first half of the 20th

century, just starting from Itten's colour research within the Bauhaus educational programmes, a specific attention to colour themes in industrial production has been confirmed. A very interesting field in which these transformations can be observed is that of the typewriter. At the beginning of the mechanization of writing, between the first and second decade of the last century, we find machines with some common features in all production systems: strong mechanical standardization and the exclusive use of the fired enameled black colour for the frame (Giedion, 1948). When in the early 1930s many European engineering industries decided to launch the first portable typewriter for private users, the first tangible sign of this little revolution was just assigned to the colour. To the traditional and exclusive black of the first series, a wide variety in the choice of colours was added. In 1932, for example, Olivetti launched its first laptop for home use, the MP1, it was built in seven colours: red, blue, light blue, brown, green, grey and ivory. The first customization in the industrial production season had started. The small mechanics began to enter homes through the lightness of colour, by adapting to the variability of domestic furniture. The first portable Olivetti of the thirties and forties will be followed by Nizzoli's "Letter 22", which will be one of the Italian design icons of the 1950s. Nevertheless, it is thanks to the post-rationalist revolution of the sixties that product hyperchromatization was used as a metaphor for the Young Revolution. In 1968, the "Valentine" by Ettore Sottsass and Perry King represents the most evident case of POP culture chromatic exacerbation. For the first time, an industrial object, just like any other item of clothing would do, adheres both to the worlds of production and communication (Brusatin, 1983).

This opens a road, which leads to present days, where the translucent white colour and the brushed aluminium of Jonathan Ive's Apple products finishing is the main iconic brand identity element and, more than any other, is the true image of modernity (Castelli, 1999).

It is due to this ideological character assumed by colour in relation to the product, it is through this subject that it is possible to recognize the border between the product and the brand in current industrial production. Studying the different ways how an object, as well space, from a physical matter, becomes the privileged place of brand communication, one discovers that colours represent the matter that formalizes this step, and it can be also considered as the threshold point between the abstract and the real physical space.

The chromatic experience allows us to understand the first transformation of goods, from necessary objects for basic needs to desired dream objects. Around the mid-19th century in Paris, with the "Passages", indoor malls were created. A busy social area with shops, cafés and theatres. Here the skylight, covered with thin layers of glass filtering the natural light, emitted a bluish colour cast that surrounded people, goods and architectures, placing spaces and products in an immaterial and oneiric dimension (Codeluppi, 2000).

After this first example, colour, owing to its mnemonic strength, has always been, starting with the primary red Coca Cola label, and together with the logo, the main element of brand recognition. In addition, colour is one of the elements around which a brand name in a shop is characterized.

3. Light and objects colours

As far as interior objects and walls colours are concerned, architects and interior designers should take into account lighting, both for its spatial and spectral characteristics. Nevertheless, human visual system is characterized by a good "colour constancy", this is true especially for daylight whereas, in presence of electric light, sources SPDs can sometimes significantly affect colour perception. Indeed, light stimuli that reach the eyes are a combination of sources SPDs and materials spectral reflectance and transmittance; however, this is not sufficient to predict how the colours are perceived and whether they appear pleasant and realistic. The visual context in which objects are observed and human visual system adaptation have a big influence in object perception.

In the lighting design practice, the chromatic characteristic of light sources are synthesized by two main parameters: correlated colour temperature (CCT) and colour rendering index (CRI). Before the diffusion of LEDs, these parameters were quite indicative and useful for lighting designers to determine their choices, but modern standards now call them into question.

Spectra rich in short wavelengths in the visible range are characterized by high CCTs (cool light), whereas spectra rich in long wavelengths correspond to low CCTs (warm light). Daylight is characterized by different CCTs, depending on the solar position on the sky vault, cloudiness, and if considering only the sky or the sun or both. D65 standard daylight illuminant CCT is 6500 K, whereas north blue sky CCT is between 10000K-20000K and, if considering sunset/sunrise light, very low CCT values are attained, around 3000K. As typical indoor electric light sources are concerned, incandescent halogen lamps CCT values range between 2700K - 3000K, fluorescent lamps are available at different CCTs, between 2700 K and 6500 K as well as LED sources, which can reach even higher values (7500 K). Moreover

white tuning LED light sources currently available allow to change SPDs according to users' preferences or to change other conditions, such as light scenes, time of the day, illuminance levels, etc. In designing an indoor lighting system, besides luminaires dimensioning and photometric choices, CCT is a topic of concern. (Kruithof, 1941) established correlations between illuminances and preferred CCTs, and more recently, (Viénot et al. 2009) demonstrated that, with LED sources characterized by very high CRIs, most results are in agreement with Kruithof's original findings, but with some exceptions, concluding that more researches are necessary. Moreover, since the advent of LEDs, the colour rendering index (CRI) has revealed some shortcomings and for this reason new indices were proposed as in (Li et al. 2012; Smet at al. 2019) and a CIE Technical Committee (TC 1-90) was established in order to produce the Technical Report "CIE 2017 Colour Fidelity Index for accurate scientific use". Basing on some of the findings obtained by these researches, the ANSI/IES TM-30-18 Standard (ANSI/IES, 2018) proposes a method for evaluating light source color rendition, quantifying both average properties (color fidelity, gamut area) and hue-specific properties (fidelity, chroma shift, hue shift) of a light source. This Standard, characterized by an objective and statistical approach without considering subjective evaluation, has been currently adopted in the USA and in other countries. At the same time researches from all over the world proposed other indexes useful to describe the "colour quality" of a light source (Teunissen, 2016; Lin et al. 2016; Smet et al. 2016; Jost-Boissard et al. 2015). From the above considerations it can be stressed that, when speaking of "colour of light", many aspects are involved and that the final effect is done by the combination of light and spectral properties of materials. The question is: "given the great availability of spectra, what is the best light for a given environment?". But at the same time: "what are the best colours for objects and walls in a given environment?".

These two questions cannot be formulated separately, probably a better question is "what is the best combination of light and objects colours?". The possible answers are not easy, because if on one side cultural and social choices are performed, on the other material and lighting technologies offer new capabilities.

Even with an attempt of a brutal simplification, for example in the choice of "warm" and "cool" colours both for objects and for light, many contradictions arise: red colour, for example is often associated to danger and alerting, whereas blue-green colours are chosen in hospitals walls because inducing peacefulness and calmness feelings.

However, considering also non visual effects of light, which will better examined in the following section, it has been proven that, under the same other conditions, cool light sources are more effective than warm ones in melatonin suppression (Rea et al. 2010). Furthermore (Viola et al. 2008) demonstrated that exposure to blue-enriched white light during daytime work hours improves subjective alertness, performance, and evening fatigue. Physiology of vision, effects of light on health and psychological aspects are to be considered as well, and easy results are not so immediate.

4. Visual and non visual effects of light stimuli

Visual and non visual effects of light occur by stimulating different parts of the eye- brain system. In the case of vision, light falling on objects activates a photo-transduction process, photo-receptors in the retina transform the physical signal into an electrochemical one which then activates the neural-vision process.

Specific properties of objects also determine the characteristics of the light which activates the eye-brain system. The final product of vision is what is called "perception", physical properties of the external world are "seen" as objects by the brain. Perception is acquired using both intensity variation of the light and its spectral variation leading respectively information on luminance and chromatic characteristics (Moutossis, 2016). Sensitivity to luminance and chromatic characteristics are advantageous for an organism, allowing information helpful in a visually noisy environment; Indeed primates have three different types of light-sensitive cone cells, instead of two as in other mammals, that allow a better colour discrimination. Furthermore, colour vision gives what are probably the most important signals for the psychological characterization of the perceived object. Colour gives information about vital signals, sexual signals for reproduction, as well as information on health and emotional states.

The non visual signal is central for the synchronization with the external timing of light and dark, which organizes the life and behavior of the living species, and photosensitive retinal ganglion cells (ipRGCs) that contain the photopigment (melanopsin) are mainly responsible for the information regarding light (Graham and Wong, 2016).

These cells are able to incorporate light signals over an extended period of time resulting in an increase of sensitivity during prolonged light stimulation, ipRGCs are most sensitive to wavelengths that are in the blue region (λ max = 482– 484 nm) of the light spectrum which is also close to the light spectrum (λ max = 459 nm) responsible for melatonin suppression.

Current light environment however differs radically from the one animal species and our ancestors experienced during evolution. The most dramatic changes occurred at the end of the nineteenth century with the introduction of electric light that has produced an artificial prolongation of natural daylight and the suppression of the seasonal lighting cycle, with important changes in human behavior and physiology (Wehr et al. 1993).

Furthermore, in recent years the "artificial light revolution" together with the progressive reduction of the natural light exposure due to energy saving building design, has produced a significant variation of the natural 24 h light/dark cycle leading to around-the-clock artificial lighting that differs markedly in spectrum, intensity and temporal patterns compared to natural lighting.

Daytime sunlight is necessary for circadian clock synchronization as well as for vitamin D synthesis, a regulator of several biological processes, and nighttime darkness is also necessary for melatonin synthesis, the hormone which contributes to regulating the physiological processes occurring within the so called biological night. Thus the 24 h external day/night cycle synchronizes the suprachiasmatic nuclei that regulate the circadian oscillation of human activity and rest (Smolensky et al. 2015).

Currently available light sources (LEDs) are often rich in short wavelengths in the visible spectrum (improperly called "blue light") and even low intensity of such blue light is capable to attenuate or suppress melatonin synthesis producing a significant sleep disturbance. This light spectrum, on the other hand is capable of reducing sleepiness effects and thus can be used to alert subjects when this effect is necessary (Lockley et al. 2006; Phipps-Nelson et al. 2009; Sahim and Figueiro, 2013).

Non visual effects of light can be analyzed by measuring or calculating spectral irradiances at the eye-level and, especially in indoor environments, they depend not only on light sources SPDs but also on spectral reflectance of walls and furniture: in other words they depend also on walls and furniture colours. As a general rule, in order to achieve very comfortable visual conditions, it's recommended to avoid that direct light from light sources strikes on observers' eyes, so often indirect light, as a result of multiple reflections, assumes a relevant role in affecting spectral irradiances at the eyes level (Bellia et al. 2017).

Obviously both visual and non visual effects of light depend also on intensity besides SPDs. Indeed, the choice of surfaces and furniture colours with different reflectance factors affect the amount of light reaching the eye. Light colours for walls are to be preferred for most applications, in order to increase adaptation luminance and illuminances both for visual comfort and energy saving.

5. Conclusions

When we look at an object located in an environment, the colours of both these components should be considered, since the object transmits a message and the environment has a specified identity. The light stimuli at the eye are given by the radiations coming from the object and from its surroundings (context). In this phase, lighting (i.e. primary sources) takes up a relevant role as well as the spectral optical properties of the lit surfaces. Given these stimuli, the human visual system performs an adaptation involving all eye components (pupil diameter, rods and cones pigmentation or de-pigmentation, lens thickness, etc.), then sensorial cells (rods, cones, ipRGCs) transduce these stimuli into electric signals and neuro-transmitter cells send these signals, properly processed, to the brain cortex. Through very complex mechanisms these signals are sent to different brain and body areas, for different purposes, like the regulation or activation of the circadian rhythm, or the perception of the object and its surroundings, also involving different cognitive activities. So, a physical stimulus (light) coming from the surrounding environment is processed by the eye-brain system in multiple ways in order to guarantee survival and for other secondary purposes. This can be the reason why light signals, received by different areas, could induce contrasting effects: a cool light could be "melatonin suppressing", throughout ipRGCs-SCN pathway, but at the same time being perceived as relaxing throughout the eye-brain cognitive processes. This complexity is accentuated by personal experiences as well as by subjective cultural and social backgrounds.

For these reasons, when approaching the theme of the choice of objects and light colours for indoor environments in order to obtain proper visual conditions, enhance human performances, regulate circadian rhythms, satisfy esthetical, cultural and social expectations, it is very difficult to find a solution that fulfill all the requirements and at the same time result satisfactory for most people. As for all complex problems, each of the factors that concur to a good environmental quality and to visual aspects should be addressed . Indeed, these factors involve very different branches of knowledge, as medical science, psychology, interior design, lighting design, as well as the technology of materials and lighting. Considering only some of these branches and neglecting the others could lead to great mistakes. One initial obstacle is that nomenclature and language for the different branches sometimes strongly

differ, creating communication problems. On the other hand, many intersections can be detected and the same subject of study, and can be seen by different points of view that, altogether, can better explain some phenomena or harmonize apparent contrasts.

It appears thus necessary a really "human focused" methodology which bonds knowledge from the different fields to produce an environment able to satisfy those several needs. An ideal indoor design should consider not only the daylight availability, the electric light and its possible manipulations to guarantee the adequate photometric parameters for the room's purposes, but also the window design, the interior colour of walls and furniture, and all these variables should be fine tuned to allow the comfort and wellness of the final client that is the human being. Experimental procedures on colour/light manipulation that take into account the human factors should be further implemented to better understand effects of such physical entities on emotion and cognitive performances

6. Conflict of interest declaration

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

7. Funding source declaration

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sector.

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References

AL-Ayash A., Kane R. T., Smith D. (2016) "The Influence of Colour on Student Emotion, Heart Rate, and Performance in Learning Environments," Colour Research & Application, vol. 41 196–205.

Albers J.(1963) Interaction of Colours, Yale University Press, New Haven.

ANSI/IES (2018) TM-30-18 IES Method for Evaluating Light Source Color Rendition. Illuminating Engineering Society. ISBN-13**:** 978-0-87995-379-9.

Bellia L., Pedace A., and Fragliasso F. (2017) "Indoor lighting quality: Effects of different walls colours," Lighting Research and Technology, vol. 49, n.1, 33-48.

Bourgin P., Hubbard J. (2016) "Alerting or Somnogenic Light: Pick Your Colour,"PLoS Biology. 14(8): e2000111. doi:10.1371/journal.pbio.2000111.

Brainard G.C. et al. (2001) "Action Spectrum for Melatonin Regulation in Humans: Evidence for a Novel Circadian Photoreceptor," Journal of Neuroscience, vol. 21, no. 16, 6405-6412.

Brusatin M. (1983) Storia dei colori, Einaudi, Torino.

Carmagnola F. (1991) Luoghi della qualità. Estetica e tecnologia del postindustriale, Edizioni Domus Academy, Milano.

Castelli C.T. (1999) Transitive Design. A design Language for the Zeroes, Electa, Milano.

Codeluppi V. (2000) Lo spettacolo della merce. I luoghi del consumo dai Passages ai Disney World, Bompiani, Milano.

Garvin D.A. (1988) Managing Quality, The Free Press, New York.

Giedion S. (1948) Mechanization Takes Command. A Contribution to Anonimous History, Oxford: University Press, New York.

Graham D.M., Wong K.Y. (2016) "Melanopsin-expressing, Intrinsically Photosensitive Retinal Ganglion Cells (ipRGCs)".In Kolb H, Fernandez E, Nelson R, editors. Webvision: The Organization of the Retina and Visual System [Internet]. Salt Lake City (UT): University of Utah Health Sciences Center; 1995-2008 Aug 1 [updated 2016 Nov 2].

Jost-Boissard S., Avouac P., Fontoynont M. (2015) "Assessing the colour quality of LED sources: Naturalness, attractiveness, colourfulness and colour difference," Lighting Research and Technology, vol.47 n.7, 769-94.

Kruithof A.A. (1941) "Tubular luminescence lamps for general illumination," Philips Techn. Rev. 1941, vol. 6, 65-96.

Li C., Luo M.R., Cui M.C. (2012) "The CRI-CAM02UCS colour rendering index," Colour Research & Application, vol. 37 n.3, 160-167.

Lin Y., He J., Tsukitani A., Noguchi H. (2016) "Colour quality evaluation of natural objects based on the Feeling of Contrast Index," Lighting Research and Technology, vol. 48, n.3, 323-339.

Lockley S.W., Evans E.E., Scheer F. A. et al. (2006) "Short-wavelength sensitivity for the direct effects of light on alertness, vigilance, and the waking electroencephalogram in humans," Sleep. vol.29, n.2, 161-8.

Moutossis K. (2016) "The machine behind the stage: A neurobiological approach toward theoretical issues of sensory perception," Frontiers in Psychology 7, 1-9.

Ou L., Luo MR., Woodcock A., Wright A. (2004) "A study of colour emotion and colour preference. Part I: Colour emotions for single colours," Colour Res Appl, vol.29, 232–240.

Phipps-Nelson J.I., Redman J.R., Schlangen L.J., Rajaratnam S.M. (2009) "Blue light exposure reduces objective measures of sleepiness during prolonged nighttime performance testing," Chronobiol Int. vol.26, n.5, 891-912.

Pine J.B. (1993) Mass Customization - The New Frontier in Business Competition, Harvard Business School Press, Boston MA.

Rea M.S., Figueiro M.G., Bierman A., and Bullough J.D. (2010) "Circadian light," Journal of Circadian Rhythms, vol. 8, no. 2.

Sahin L., Figueiro M.G. (2013) "Alerting effects of short-wavelength (blue) and long-wavelength (red) lights in the afternoon,"Physiol Behav. vol.27;116-117:1-7.

Smet K.A.G, Ryckaert W.R, Pointer M.R., Deconinck G., and Hanselaer P. (2010) "Memory colours and colour quality evaluation of conventional and solid-state lamps," Optics Express, vol.18, n.25, 26229-26244.

Smet K.A.G., Schanda J., Whitehead L., and Luo M.R. (2013) "CRI2012: A proposal for updating the CIE colour rendering index," Lighting Research and Technology, vol. 45, n.6, 689-709.

Smolensky M.H., Sackett-Lundeen L.L., Portaluppi F. (2015) "Nocturnal light pollution and underexposure to daytime sunlight: Complementary mechanisms of circadian disruption and related diseases," Chronobiol. vol.32, n.8, 1029-48.

Teunissen C. (2016) "Characterizing colourfulness and gamut area of white-light sources in addition to colour fidelity," CIE x043:2016 Proceedings of the 4th CIE Expert Symposium on Colour and Visual Appearance , Prague, Czech Republic, 236-246.

Thapan K., Arendt J, and Skene D.J. (2001) "An action spectrum for melatonin suppression: evidence for a novel non - rod, non - cone photoreceptor system in humans," Journal of Physiology, vol. 535(1), 261-267.

Vienot F., Duranda M.L. and Mahler E. (2009) "Kruithof's rule revisited using LED illumination," Journal of Modern Optics, vol. 56, n. 13, 1433-1446.

Viola A.U., James L.M., Schlangen L.J. and Dijk D.J. (2008) "Blue-enriched white light in the workplace improves self-reported alertness, performance and sleep quality," Scandinavian journal of work, environment & health, 297-306.

Wehr T.A., Moul D.E., Barbato G., et al. (1993) "Conservation of photoperiod-responsive mechanisms in humans," Am J Physiol. 265, R846-857.

Yildirima K., Akalin-Baskayab A., Hidayetoglu M.L. (2007) "Effects of indoor colour on mood and cognitive performance," Building and Environment, vol. 42, 3233–3240.

Semantic resonance to light sources of different correlated colour temperature

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ABSTRACT

New light sources are nowadays used as a consequence of energy saving problems and developments of illumination technology. Their quality is evaluated in terms of their rendering capabilities and of people preferences. The research is focused on the psychological reaction of young participants to the environmental lighting of three rooms expressed by subjective measures of a list of associable qualities. We then describe how observers can distinguish different qualities of interior lightings. One room was lighted by a halogen lamp, and two other rooms by LED lamps. Walls were white and a rather large coloured Mondrian was hung at a wall. A group of 370 high school students volunteered in the experiment. Their task was to evaluate the quality of the three illuminations by using a semantic differential. Evaluations were performed in small groups or individually, and data were collected for each participant. Many students left the experiment after performing their task in one or two rooms only. Therefore, data from 197 students who completed the task in all the three rooms were considered. An ANOVA shows that the halogen lamp receives evaluations significantly different from the other two light sources. The two LEDs received equal evaluations in seven scales and significantly different in other three scale. A factorial analysis identifies three factors; in relation to all of them the halogen lamp significantly differs from the LEDs, while the two LEDs differ one from the other only in two factors. In conclusion naive young participants can consistently evaluate personal psychological reactions to lights and discern the qualitative features of the lightings; evaluations are not consistent with the differences in CCT of the three sources but seem affected by other lighting characteristics; some evaluations seem to depend on participants' psychological context.

KEYWORDS LED, CCT, lighting quality, psychological reaction, semantic differential

RECEIVED 15 September 2018; **REVISED** 10 June 2019; **ACCEPTED** 27 June 2019

CITATION: Fiorentin, P., da Pos, O., Pedrotti, E., & Metellini, A. (2019). Semantic resonance to light sources of different correlated colour temperature. Color Culture and Science Journal, 11(1), 74–81. https://doi.org/10.23738/CCSJ.110109

1. Introduction

We are today aware that on the one side energy resources are limited, and on the other side energy production goes with more or less detrimental alterations of the environment. The actual and universal problem is then how to prevent environmental damages by reducing energy consumption without worsening machinery performances. In the specific case of light production, we face the challenge of maintaining good quality of artificial light by developing new technologies to spare electricity consumption. If technological problems are to be solved inside engineer frames of reference, evaluation of the light quality involves psychological disciplines since the final user is the human observer.

Research in the field of illumination covers a very wide spectrum of topics, roughly divided between physical factors and psychological effects, many times both. The subjective aspects of illumination, that is the psychological reactions to the different variables characterising both indoor and outdoor llighting, become more and more relevant because the final users are human persons. Some research works are addressed to general aspects of environmental illumination (CIE 212:2014; Sansoni, Mercatelli, Farini 2015), other research deal with diffuse vs accent illumination or their interaction (Tantanatewin, Inkarojrit 2016), interactions between surface colour and illumination, illumination for different purposes (Jin et.al. 2015), CCT and CRI (Farini 2015). A critical item in many researches is the use of simulation (scenes projected in a screen, Tantanatewin, Inkarojrit 2016) vs real environment (a small room in Jin et al. 2015).

We are also conscious that various illumination devices differently affect colour appearance and the problem of evaluating the perceived quality of the light sources arises not only in terms of their rendering capabilities but also of people preferences (Thornton 1974; Yildirim et al. 2011). This research aims to describe how observers can distinguish different interior lightings in terms of their own peculiarities and of the psychological effects they generate in people.

2. The experiment

The experiment was performed in the frame of the cultural event “EXPERIENCING: an Interactive Scientific Exhibition - Energy and Life”, held in Padua in 2015, inside the series of annual events “EXPERIENCING” which started in 2002 to promote science in higher grade schools.

2.1. *Participants*

About 10000 students attended the one month event and about 370 students, nearly half male and half female, from 15 to 19 years old, agreed to be accompanied by a guide and take part in the experiment. They could perform the experiment either singularly or in small groups of 10 people on the average. As many participants left the experiment before judging the lightning of all the three rooms, only data from the 197 participants who completed the experiment were used in the analysis.

2.1. *Material*

The experiment was carried out in three small rooms (about 2 x 3 m) with white walls (Figure 1); in each room a coloured Mondrian (50 x 50 cm) was hanging on one of the longer wall and a computer with a CRT monitor was placed on a small white shelf fastened horizontally on a short wall. The monitor was used to show the items of a semantic differential and record the participants’ answers. The luminaires were placed above the door facing the other short wall. Three kind of light sources were installed, one halogen lamp, one medium CCT (Davis and Ginther, 1990) LED lamp, and one higher CCT LED lamp with the characteristics shown in table 1. As usual, halogen source presents a more diffuse light, while LEDs are a bit more directional, even if in any case the light direction is controlled either by a reflector or by lenses. This fact is highlighted by the lowest illuminance value for the haloghen source.

In the entrance room a commercial viewing booth with different light sources was placed on a table; a large poster was hanging on the wall above and showed the main characteristics of the cabinet sources and the ways of measuring them by appropriate instruments.

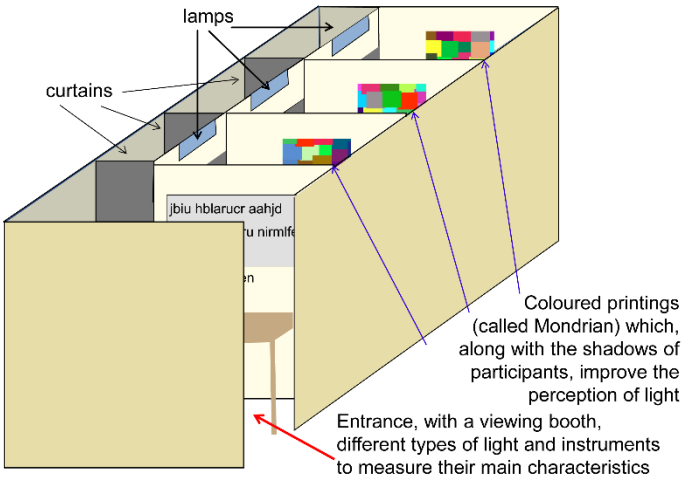

Fig. 1. The rooms where the experiment has been performed.

room	source	Watt	CCT	CRI	lm	lx on the wall	efficiency
1	halogen	150	3000K	98	3000	about 400	21 lm/w
2	LED-A	35	3080K	80	3100	about 500	89 lm/w
3	LED-B	35	3890K	80	3230	about 600	92 lm/w

Tab. 1. Specifications of the three light sources.

The evaluations of the lights illuminating the rooms were performed by using 10 verbal semantic scales (CIE 212: 2014; Osgood et al. 1957; Snider and Osgood 1969). Four scales were referring to the observer feelings: 1) calm – agitated; 2) relaxed – tense; 3) speedy – slow; 4) passive – active (original Italian scales: calmo – agitato; rilassato - teso; veloce - lento; passivo - attivo). The other six scales were referring to the characteristics of the light: 5) interesting - boring; 6) strong – weak; 7) warm – cold; 8) desirable – undesirable; 9) brilliant – dull; 10) violent – soft (original Italian scales: interessante – noiosa; forte – debole; calda - fredda; desiderabile – indesiderabile; brillante - smorta; violenta – gentile).

The items were presented in the monitor screen with an invitation to save the subjective evaluations. Participants could move a slider in the position between the two extremes which expressed their choice in the scale continuum; their decision was therefore based only on the visual appreciation of the two distances of the slider from the extremes (Figure 2). Later that position was decoded as a measure of the distance from the two extremes (in the example the slider shows a choice of 80% calm vs 20% agitated).

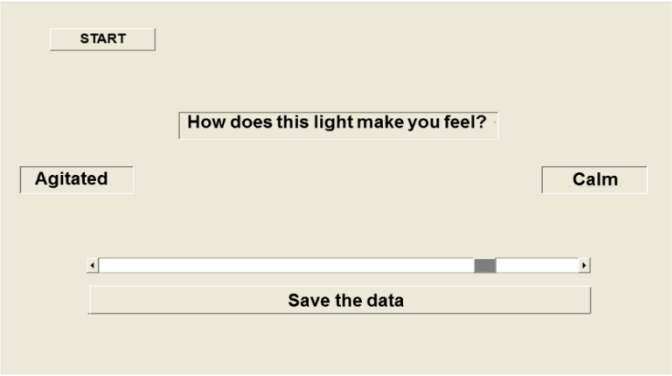

Fig. 2. The display used to register the participants' evaluations of the semantic differential.

2.3. *Procedure*

First, participants were led to the entrance of the experimental place and shown different kinds of illumination inside a viewing booth. Then the guide taught them about the main features of those light sources, like the physics of the production of the light, the measure of its power in watt, its luminous flux in lumen, its correlated colour temperature in kelvin, and its luminous efficiency. Lastly participants were instructed about their task which was to give a subjective evaluation of the quality of three different lights in three rooms, and that this evaluations would be structured in a series of bipolar scales of adjectives referring both to the quality of the light and to the feelings they would experience under that light. Their answer had to be expressed by appropriately using the mouse. The three rooms were visited in random order and at the end they could leave their email address to receive the results of the research.

3. Results

3.1. *Analysis of variance*

The three room illuminations (Figure 3) were globally judged significantly different ($F_{2,392} = 93{,}14$, $p < 0.00001$). Specifically, the halogen illumination was judged significantly different from the LED-A ($p < 0.00001$) and from the LED-B ($p < 0.00001$), while the LED-A source did not appear significantly different from the LED-B source ($p > 0.421$).

Of course, the scales were evaluated in a significantly very different way ($F_{9,1764} = 18.53$, $p < 0.00001$), but there was an important interaction between scales and sources ($F_{18,3528} = 101{,}09$ $p < 0.00001$), which is of great interest for the purpose of the experiment.

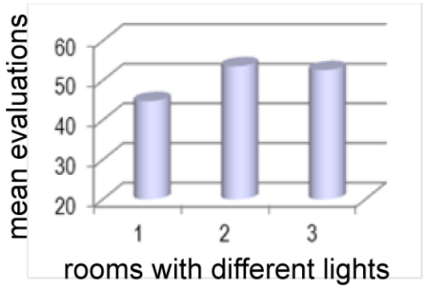

Fig. 3. Global evaluation of the three illuminations.

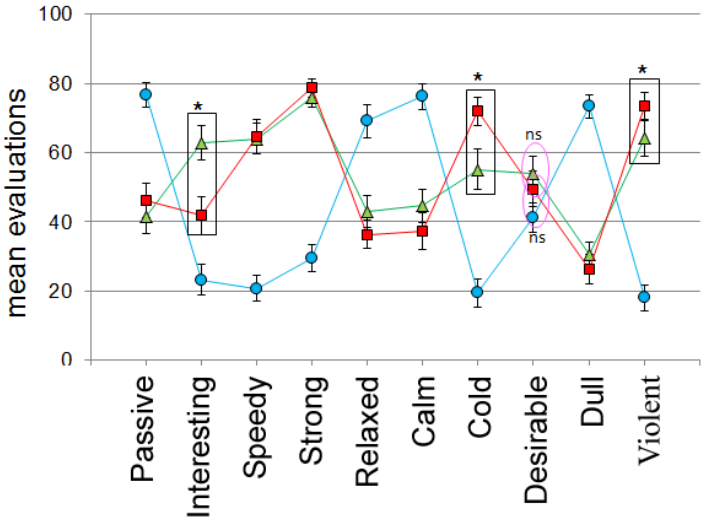

Fig. 4. Mean evaluations given by the participants to the semantic scales as a function of the three light sources. Blue circles: halogen lamp; green triangles: LED-A; red squares: LED-B.

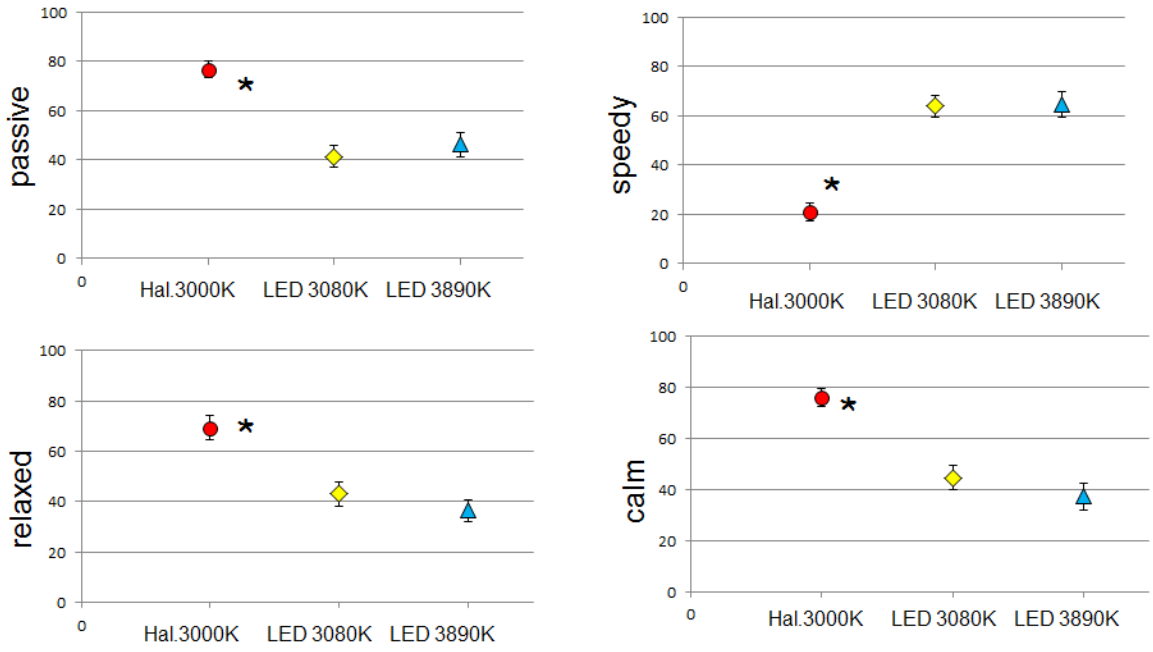

Fig. 5. Mean evaluations of the subjective effects elicited by the different light sources on the observers. Error bars = confidence intervals (mostly hidden by symbols). Stars = significantly different ($\alpha < 0.05$).

An overall view of the interactions between lights and semantic scales is presented in Figure 4, where the halogen light is connoted in a very different way from the other two LED sources, which on the other side show some differences one from the other.

An analytical presentation of the results relative to the single scales is following to show how participants exhibit different reactions as a function of the different light sources.

Figure 5 shows the results of an analysis of variance (ANOVA) relative to the psychological effects induced by the tested lights as they were evaluated by the participants. The data are derived from the answers to the question “How does this light make you feel?”. From the results it appears that the halogen illumination is perceived as inducing a state of more serenity ($p < 0.00001$), calmness ($p < 0.00001$), relax ($p < 0.00001$), passivity ($p < 0.00001$) in opposition to the LED lights which are judged to elicit tension, excitement, swiftness, dynamism. On the other side both LED lights are similar in these psychological effects.

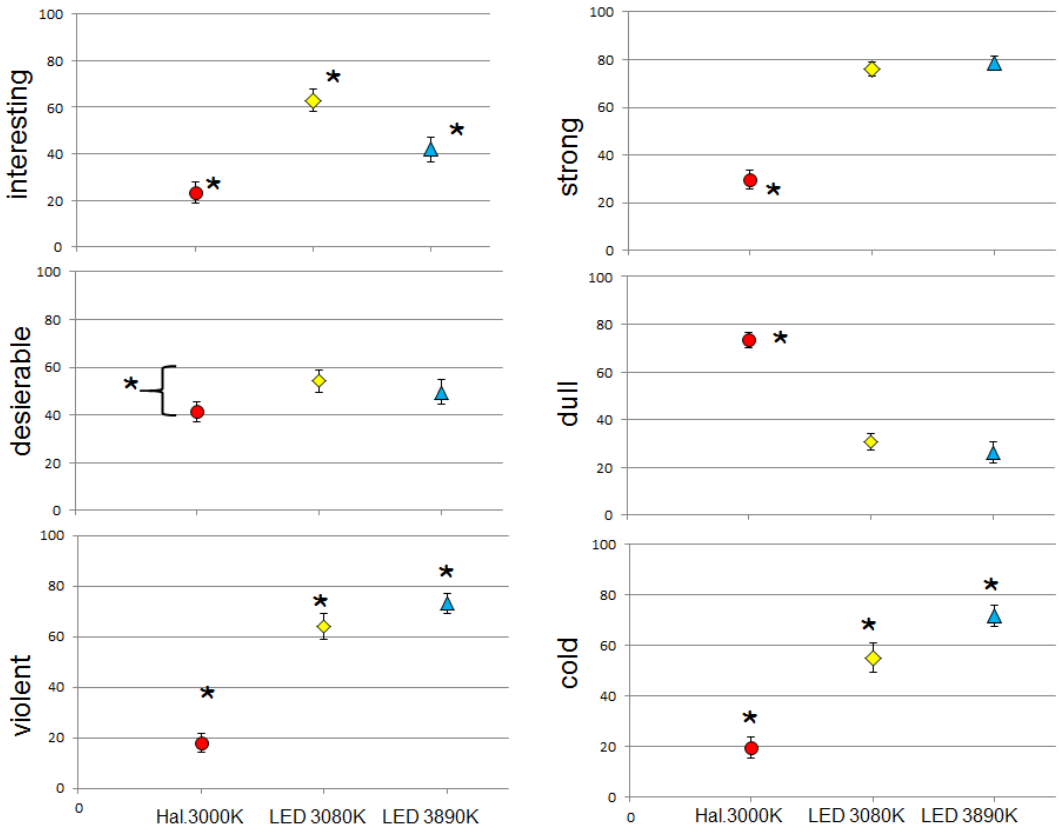

Fig. 6. Mean evaluations given by participants relative to the characteristics of the different light sources. Error bars = uncertainty intervals (mostly hidden by symbols). Stars = significantly different ($\alpha < 0.05$). Braket= the significantly different pair.

These results are in agreement with what can be expected in relation to the halogen light source, whose rather warm light is largely preferred by most people in interior environments, where it gives an intimate atmosphere, and favour convivial, comfortable, tender interpersonal relationships. The association with candle lights, flames in the fireplace, or sunset light is based on the similar psychological effects they initiate. On the other side cool light as that often emitted by LEDs is generally considered unfriendly, although stimulating and speeding up, and therefore considered positive in specific circumstances. It is worth to note, even if CCT is a very important factor in driving people feeling, it is not the only cause. There are other factors to consider also in our experiment, one of them is the uniformity of the light. Differences between the results related to the considered sources can be partially associated also to the more uniform and soft lighting provided by the halogen source, with respect to LEDs.

Figure 6 shows the results relative to the qualities which participants ascribed to the different lights. The data are derived from the answers to the question “How do you estimate this light?” followed by the corresponding semantic scales Again the halogen illumination is perceived quite differently from the other LED illuminations, but at their turn these are not always judged in the same way. The halogen illumination always appears significantly less interesting ($p < 0.00001$), weaker ($p < 0.00001$), warmer ($p < 0.00001$), less desirable ($p < 0.00001$), duller ($p < 0.00001$) and softer ($p < 0.00001$) than the other LED lights.

The LED lights moreover significantly differ one from the other in interest ($p < 0.00001$) being the LED-A (3080K) more interesting than LED-B (3890K), in temperature ($p < 0.00001$) with the LED-A (3080K) warmer than LED-B (3890K), and in violence ($p < 0.044$) with the LED-B (3890K) more violent than LED-A (3080K).

As before, results relative to the halogen source are in agreement with the common consideration of appearing warmer ($p < 0.00001$), weaker ($p < 0.00001$), and softer ($p < 0.00001$). On the other side the interesting ($p < 0.00001$) appearance of the LED light may be justified in this context where young people are visiting a science exposition of their works, and therefore feel rather excited and inclined to arousing lights. Worth of note the halogen light is only considered more desirable than the LED-B

($p < 0.001$), and the LED-B appears significantly less interesting than the halogen ($p < 0.00001$), but cooler (($p < 0.00001$) and more violent ($p < 0.044$) than the LED-A.

3.2. *Factorial Analysis*

A more synthetic view of the results is given by a factorial analysis, which has been performed on the row data. The principal component analysis, with Varimax rotation and Kaiser normalisation, was carried out on the raw data, and the resulting factor loadings (cumulative variance = 73. 3) are shown in Table 2.

scales	C1	C2	C3
active-	-,658	-,402	-,306
boring-	-,049	,878	,208
slow-	,595	*,518*	,102
weak-	*,573*	,649	-,143
tense-	-,745	-,108	,280
agitated-	-,652	-,436	,325
warm-	,853	,014	,037
desirable-	-,103	,108	,920
brilliant-	-,410	-,749	,043
soft-	,769	,308	-,200

Tab. 2. The factor loadings of the three principal components of the factorial analysis.

The three factors, shown in Table 3, can be interpreted as: 1- “arousal”; 2- “vivacity”; 3- “evaluation” based on the semantic scales which characterise each factor.

Factor 1 - Arousal		Factor 2 - Vivacity		Factor 3 - Evaluation	
Cold	**Warm**				
Violent	**Soft**				
Tense	**Relaxed**				
Active	**Passive**				
Agitated	**Calm**				
Speedy	**Slow**	*Speedy*	***Slow***		
		Interesting	**Boring**		
		Brilliant	**Dull**		
Strong	***Weak***	Strong	**Weak**		
				Desirable	**Undesirable**

Tab. 3. The semantic scale characterising the three factors.

The factorial structure seems quite coherent and well-fitting the characteristics of the lights as emerged in the previous analysis of variance. An arousal factor is quite common in this kind of research, with the peculiarity of including together the Osgood’s [3,4] activity and potency factors which often are separate. Moreover this factor includes semantic scales related to both the subjective psychological effects (relaxed – tense; calm – agitated; passive – active; slow – speedy) and the qualities attributed to the lights (cold – warm; violent – peaceful).

The vivacity factor includes only scales which deal with the qualities of the lights (strong – weak; brilliant – dull; interesting – boring).

The evaluation factor, which concerns the positivity of the light, is saturated by one scale only (desirable – undesirable) which again is related to the quality of the light.

An analysis of variance on original data weighted by the factorial coefficients has been performed to see how participants judged each illumination on the basis of the criteria expressed by the three factors, and the results are plotted in Figure 7.

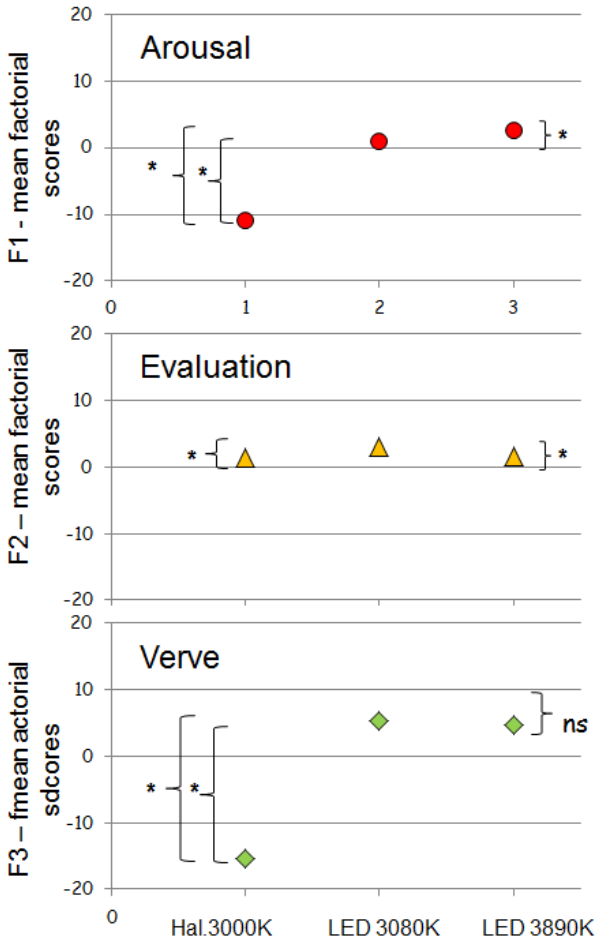

Fig. 7. Factorial scores relative to each factor plotted as a function of the rooms’ illumination.

All three illuminations appear significantly different one from the other when judged on the basis of factor 1, that is their arousal power evaluated by participants is different ($p < 0.00001$ in all the three cases); moreover the halogen lamp receives much lower evaluations in absolute value than the other two LED lights. When the lights are evaluated on the basis of factor 2 the halogen light appears connoted significantly less vivid than the LED-A ($p < 0.00001$) but not the LED-B light ($p < 0.44$), and the absolute values of the three evaluations are very close.

Lastly on the basis of factor 3 the halogen light is significantly different from both the LED-A ($p < 0.0023$) and the LED-B ($p < 0.00001$), with its absolute value much lower, while the LED-A and LED-B do not significantly differ, in agreement with the ANOVA results.

4. Conclusions

Noteworthy is that the students are for the first time performing the task requested by the experiment, nevertheless they show great discriminative ability, and also a great consistency. In fact, the dispersion of the results is quite low (in the displayed diagrams confidence intervals are most often smaller than the size of the symbols), thus favoring a good statistical significance. The results demonstrate a clear ability of participants who are able: 1) to recognize and evaluate different personal, psychological reactions to lights; 2) to estimate different qualitative characteristics of the light sources.

The research aimed to highlight how young naive people perceive, discriminate, and judge indoor illuminations produced by different light sources. The attention was focused on the halogen and LED sources, because of the large difference in their spectral power distribution, and the widespread impression that the incandescent sources like the halogen ones are presently preferred by most people.

The first result that emerges is that the three lights are well distinguishable, especially the first vs the other two. Despite both the halogen and the LED-A sources have an almost indistinguishable colour temperature (CCT 3000K-3080K), the two illuminations are always significantly discriminated on all semantic scales, with consideraby different absolute values. Obviously, the same discrimination also takes place between the first and the third illumination, justified by the fact that the sources differ both in type and in the corresponding colour temperature, although not by much (CCT 3000K vs 3890K). The second and the third lighting are not confused, even if the sources are of the same type (LED) and of different, although small, correlated colour temperature (CCT 3080K vs. 3890K): the discrimination, however, occurs only on some semantic scales: interesting-boring, warm-cold, violent-soft. This result challenges the relevance of the CCT in connoting the relevant characteristics of a light source as some subjective characteristics seem to be quite independent from CCT. Some significant quality of the light described by the spectral power distribution (SPD) is probably lost when the CCT is considered.

This research has not investigated the colour rendering properties of the light sources. Nevertheless, the concept of colour rendering was presented and the CRI (colour rendering index, CIE 13.3: 1995) of each source was analysed in the introductory step of the experiment. Moreover, participants were shown three Mondrian (one per room) with the same colours but in a different spatially organized way (always random, anyway) in order to compare the possible colour differences caused by different sources, even if unconsciously.

These overall results agree quite well with the general impression that people have without scientific investigations, and the advantage of the experimentation is to supply a scientific confirmation the current conceptions, and to highlight unexpected aspects. In our case the desirability appears to be low for the light that gives calm, and high for that exciting: the hypothesis is that the situation makes desirable a light with characteristics appropriate to the circumstances. In particular, students who go together to see a show of scientific experiments, perhaps having presented their well accepted works, are not in a state of tranquillity, but rather activated, and therefore prefer an arousing lighting like that produced by LEDs, especially if in those moments they are sensation seeking. It is very likely that in other circumstances the desirability goes calming lights. To be verified.

Conflict of interest declaration

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. The authors state that financial/personal interest have not affected their objectivity. The authors state explicitly that potential conflicts don't exist.

Funding source declaration

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Short biography

Pietro Fiorentin is associated professor of “Electrical Measurements” and “Light Engineering and Photometry” at the University of Padova. He is responsible of the Photometric Laboratory dealing with external and internal lighting, with particular care to the colour rendering. He studies also the effect of artificial lighting on the night sky luminance, phenomenon known as “light pollution”.

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Ariella Metellini was born near by Treviso (I) in 1945. She got a degree in physics at Padova University in 1970. From 1970 up to 2001 she had a stable position as a teacher of mathematics and phisics in un agronomical school. After retirement, at the end of 2001, she was responsible of the scientific interactive show "Sperimentando" that is now at the 18th edition.

References

CIE 13.3: 1995, ‘Method of measuring and specifying colour rendering properties of light sources (E)’. ISBN: 978 3 900734 57 2

CIE 212:2014, ‘Guidance towards Best Practice in Psychophysical Procedures Used when Measuring Relative Spatial Brightness’. ISBN 978-3-902842-51-0

Davis, R.G. and Ginther D.N. (1990) ‘Correlated color temperature, illuminance level, and the Kruithof Curve’, Journal of the illuminating Engineering Society, 9, 27:38. DOI: 10.1080/00994480.1990.10747937

Farini, A. (2015). Color Rendering of Light Sources. In Sustainable Indoor Lighting (pp. 77-85). Springer, London.

Jin, C., Noguchi, H., Qiu, J., Wang, H., Sun, Y., & Lin, Y. (2015, November). The effect of color light combination on preference for living room. In Solid State Lighting (SSLCHINA), 2015 12th China International Forum on (pp. 139-142). IEEE.

Sansoni, P., Mercatelli, L., & Farini, A. (2015). Sustainable indoor lighting. London: Springer.

Osgood, C.E., Suci, G., Tannenbaum, P. (1957). The measurement of meaning. Urbana: IL: University of Illinois Press.

Snider, J.G., Osgood, C.E. (1969) Semantic Differential Technique: A Sourcebook. Chicago: Aldine.

Tantanatewin, W., & Inkarojrit, V. (2016). Effects of color and lighting on retail impression and identity. Journal of Environmental Psychology, 46, 197-205.

Thornton WA (1974) A validation of the color-preference index. Journal of the Illumination Engineering Society 4:48–52

Yildirim, K., Hidayetoglu, M. L., & Capanoglu, A. (2011). Effects of interior colors on mood and preference: comparisons of two living rooms. Perceptual and Motor Skills, 112(2), 1-16

Millennial pink: gender, feminism and marketing. A critical Analysis of a color trend

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ABSTRACT

The "millennial pink" refers to a specific range of pink shades which became widely popular towards the end of the year 2015. This trend stormed both the world of fashion and the world of design, and was widely spread through social networks and especially on Instagram. The millennial pink was named after its users — a generation of young people born between 1980 and 2000 — the so-called "millennial generation," whose main feature is their knowledge of new technology and their extensive use of the internet.

Pink but not really, millennial pink could be described as almost pink. Since it is not one color but a wide range of pale pink, the most accurate description would be pinkish beige, or even salmon. Above all, millennial pink pretends to bear a meaningful message: this color aims at disassociating itself from the feminine symbolism usually attached to the pink color, and pretending to be a "genderless color."

I intend to analyze this trend through the lens of gender studies, as it appears that millennial pink, far from being genderless, is actually a new form of gendered marketing. Indeed, the use of feminist concepts (empowerment, body-positivism) and the use of a strategy based on the association of so-called masculine images with a so-called feminine color allows marketers to seduce the younger generation, seen as consumers sensitive to feminism as well as queer theories.

KEYWORDS Millennial pink, Gender marketing, Femvertising, Queer marketing, Color trend, Color symbolism

RECEIVED 31 March 2019; **REVISED** 22 May 2019; **ACCEPTED** 02 July 2019

CITATION: Bideaux, K. (2019). Millennial pink: gender, feminism and marketing. A critical Analysis of a color trend. Color Culture and Science Journal, 11(1), 82-89. https://doi.org/10.23738/CCSJ.110110

1. Introduction

The “millennial pink” refers to a specific range of pink shades which became widely popular towards the end of the year 2015. This color was named after its users, a generation of young people born between 1980 and 2000. The so-called “millenial generation” main feature is their knowledge of new technology and their extensive use of the internet. Fashion journalist Véronique Hyland was the first to assign a name to this color in an article published on The Cut website on August 2, 2016. In the article, she describes how this trend stormed both the world of fashion and the world of design, and was widely spread through social networks and especially on Instagram (Hyland, 2016).

This trend first spread through fashion. Major brands, from haute-couture (Gucci, Balenciaga, Valentino, etc.) to ready-to-wear (Adidas, Converse, Reebok, etc.) released pink designs. The trend then reached the design and architecture sphere, which was already influenced by the emerging “Scandinavian pink” mostly through Nordic furniture. Surprisingly, the millennial pink became a trend in the gastronomy and cooking world. Eventually, pink images of “fooding” got huge on social networks, with an ever-growing amount of rosé pictures and rosé cocktails, beetroots, strawberries, pitayas and other radish dishes. The millennial pink craze even reached tourism, and the Australian Pink lake since became a very attractive destination for millennials.

The millennial pink definitely forms a new approach to pink, as it no longer refers to its popular gendered symbolic inherited from the twentieth century (Paoletti, 2012). Therefore, it is not a new pink, but it is a sub-category of pink grouping a set of hues, intended to dissociate itself from a so-called feminine archetype that embodies the princess pink, or the Barbie pink. Fashion journalists have difficulties trying to describe the millennial pink, mostly because it is actually not a color. It is a set of shades of pink, a color chart of pale pink, beige pink and salmon, that I tried to determine from a hundred images collected on the internet (fig. 1).

More than a color, the millennial pink is above all an idea. French color historian Michel Pastoureau says that colors first are a concept, then an idea and finally an intellectual category (Pastoureau, 2010). It is a non-feminine pink, a “not-pink pink” (Mitchel, 2017), that is located in areas of the color spectrum where it is difficult to describe the hues. These pale hues are thus paired with so called gender-neutral colors, such as whites, beiges, oranges and grays.

Fig. 1. Color chart of millennial pink obtained from the collection of one hundred images answering the keyword “millennial pink” on the internet (Google images), September 2017 (© Kévin Bideaux).

2. The Origins of the Trend

Since millennial pink is more a zeitgeist than an actual object, its "history" is quite hard to map out. To achieve a global understanding, the study of this particular color in itself must be paired with a study of how this trend was formed, and more particularly in its relationship with fashion and design.

The internet is the backbone of today's development of musical and visual micro-trends. The mainstreaming of the « millennial pink » on the internet — and especially on the website Tumblr (millennial pink also is sometimes called "Tumblr Pink") — could be connected to the growth of the seapunk movement (Stuhr-Rommereim and Mollichi, 2014) as well as the vaporwave (Tanner, 2015). These two micro-genres of electronic music framed a visual aesthetic putting pink color as a driving element.

But what seems to have definitely launched the millennial pink is its "Color of the Year" nomination by the most influential Trend office: the Pantone Color Institute. Since 2000, Pantone appoints a "Color of the Year" based on a multimodal trend analysis. Obviously, the "Pantone propaganda" bears a strong power over the growth of a trend (Lo, 2016), and the nominated color always hits the worlds of fashion, design and graphics, whether immediately or a few months later. Unexpectedly, the 2016 winner is not one, but two colors: Pantone announced on December 3, 2015 that "Rose Quartz" and "Serenity" (a shade of blue) were both elected colors of the year (fig. 2).

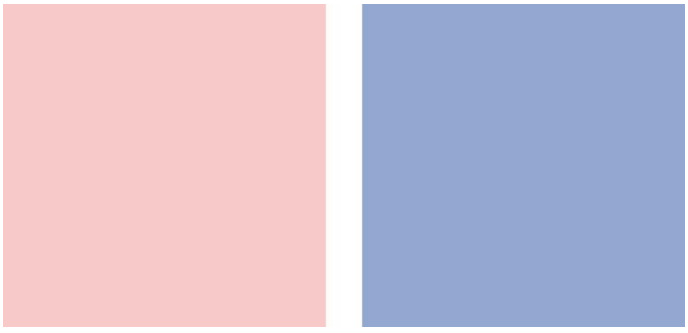


Fig. 2. "Rose Quartz" (PANTONE 13-1520) and "Serenity" (PANTONE 15-3919), elected Color of the Year 2016 by Pantone (© Kévin Bideaux).

Beyond their relaxing qualities and the visual contrast that is played between these two tones, it is the pair of colors traditionally gendered that we are dealing with: in the West world, the blue is for boys and the pink is for girls. However, the press release announcing the election of the duo Serenity-Rose Quartz still claimed an overcoming of the sexual dichotomy by the appropriation of its chromatic symbols (Pantone, 2015).

It is common to believe that fashion is a reflection of societal advances (Erner, 2008, p.52), therefore Pantone's pink and blue would echo the social movements towards gender equality, transgender people rights and same-sex marriage. Accordingly, they would become the emblem of a younger generation supposedly less inclined to categorization and more opened to gender fluidity. Then, Rose Quartz should be understood as subversive, since it shifted the popular view on pink by splitting with its feminine symbolism to make it the very color of feminism — which was traditionally the violet (Habib, 1988) —, of sex equality, and even of the neutral. To do so and in order to achieve a renewal, its association with the world of little girls and princesses must be relinquished.

3. Pink, Feminism and Marketing: when Rihanna sells feminism

From the very beginning, the millennial pink was associated with the feminine gender and it was very quickly presented as a feminist color that would celebrate the return of a strong femininity — asserted by a traditionally feminine color now presented as a positive value —. Pink but not really pink, millennial pink would embody the color of compromise. It is aimed at women who do not want to choose between traditional femininity and radical feminism.

The digital revolution has given feminism a worldwide visibility that disclosed phenomena such as street harassment (Cochrane, 2013). Called "cyber-feminists," "feminists 2.0," or "techno-feminists," the internet campaigns of the youngest generations commonly wave pink as a rallying color. Many artists also use pink as a color of femininity in a strong and positive way, like Signe Pierce, Ambivalently Yours, Lora Mathis, etc.

It is no coincidence that millennial pink appeared at the same time as "pop feminism" which spread mainly through the singers Beyoncé, Miley Cyrus or Nicki Minaj (Djavadzadeh, 2017). Several feminist movements of the 2000s also took up the pink as a symbol of political demands: the Gulabi gang in India which campaigned against domestic violence towards women adopted pink sarees to be singled out as members (Berthod, 2012) (fig. 3); or the "pussyhats," an American movement of feminists who demonstrated against the presidential campaign of Donald Trump, and whose distinctive sign is a pink woolen hat in the form of cat ears (Hestir, 2018). These feminist groups are creating a shift in the feminine

stereotype of pink from gentleness and passivity toward force and rebellion (fig. 4).

Fig. 3. Some women activists of the Gulabi Gang in Bundelkhand, a rural region of India, 2009 (© Blindboys.org/Flickr).

Fig. 4. Feminist activists at the Washington Women March against the president Donald Trump, 2017 (© Thirty Two/Wikimedia Commons).

The (re)politicization of pink goes hand in hand with the millennial pink trend, and many brands took advantage of the acknowledgment of pink as the color of feminism, even post-feminism. Millennial pink is thus used in marketing strategies that since about 2014 have appropriated the feminist struggles to sell products to female consumers, vastly educated to feminist theories. These consumers also do not hesitate to denounce sexism in marketing, and particularly in advertisement. This new strategy is called “femvertising” (contraction of “feminism” and “advertising”), and consists in using feminism to sell, by exploiting the feminist concept of empowerment and body-positivism, by playing with gender stereotypes using a queer aesthetic, or by reclaiming the codes of girl power (Milcent, 2017, p.20).

Therefore, Rihanna, who holds strong feminist positions, does not hesitate to appear in pink. In September 2016, she collaborated with the sportswear brand Puma for a ready-to-wear collection. Almost exclusively pink, the collection “Fenty x Puma” was based on the millennial pink trend and took the codes of femvertising by offering outfits that combined sports activities with femininity inspired by Rococo, using fabrics such as lace or chiffon. Rihanna uses here the concept of empowerment developed by feminism to make a marketing surplus for her collection, and for the brand Puma: one can be a feminine woman and have so-called male activities or characteristics. The pink initially used in gender marketing to provide a product in a line dedicated to women, becomes here a feminist marker, pushing women to choose the pink product because it is feminine, and no longer to select passively because the products for women are usually pink.

However, it should be remembered that the goal of advertisers is to sell their products. It is to seduce consumers that marketers have to borrow the codes of feminism, in an “attention economy” that dominates in contemporary consumerism (Franck, 2014). Indeed, a societal commitment of a brand can capture this attention and be taken into account in a market strategy (Benhamou and Diaye, 2016), and pink is an effective communication tool to display such progressiveness.

4. Can Millennial Pink be Masculine?

When Apple released the “rose-gold” color of the iPhone 6S in September 2015, this new color challenged the internet, because Apple seemed to offer for the first time a smartphone to only one part of the population: women (fig. 5). Since colorful objects are strongly associated with the feminine in the West, the men who dare to wear pink clothes or to have pink accessories are still few. This new color is considered too feminine and not manly enough, and very quickly, media and web forums asked themselves the question: can men have a pink iPhone? (Blanchard, 2015). Medias even suggested to rename it “bros’ gold” to reassure the consumer that the purchased product is intended for him (Chmielewski and Deamicis, 2015).

Fig. 5. IPhone 7 "Rose Gold", successor of the iPhone 6S, 2016 (© MacRepairDundee /Wikimedia Commons).

The choice of color in marketing, whether in terms of product, packaging or communication, has a great influence on consumers (Kacha, 2009). Pink is massively used as a signifier of femininity and is applied on about every marketable product. By targeting a female audience, the pink product keeps, at the same time, the male clientele away. Therefore, during the designing conception of the product, the customer's gender is always addressed, and it is strongly recommended to ban pink if the target audience is a male clientele (Bartow, 2008).

The Nazis used pink during the Second World War and its re-appropriation by gay communities make also pink a color of ambiguity and homosexuality (Mollard-Desfour, 2002). Indeed, by becoming the feminine color, pink has become an anti-masculine color, which, when associated with a man or a boy, may cause an alteration of his manhood and create a suspicion of homosexuality. It can also lead to homophobic reactions, sometimes violent (Ben-Zeev and Dennehy, 2014).

Since the twenty-first century, the contrasts between men and women's clothing are fading, including the gender segmentation of pink for girls (Guionnet and Neveu, 2009, pp.44-45). According to the executive director of Pantone Color Institute Leatrice Eisemann, the gender division tends to fade in fashion, which would coincide with the social movements that have been moving toward gender equality since the 1970s. Because it splits with the feminine connotations usually associated with pink, the millennial pink is considered as the "new neutral" and perceived by several media as an androgynous color (Landry, 2017; Hoare, 2017).

Furthermore, if the media are not slow to take an interest in the appearance of Drake with a pink jacket, Justin Bieber with a pink hoodie, or Kanye West who often appears in pink, the extension of millennial pink to the male wardrobe is seen by some media as a feminization of men's fashion, a movement from feminine to masculine often at work when it comes to unisex fashion. It must also be added that we must not confuse sex and sexual wear of clothing, and there are always women's and men's cuts, in addition to unisex cuts (Guionnet and Neveu, 2009, p.46): if men wear more and more pink, it colors either costumes (fig. 6) or streetwear.

5. The Color of the "Buzz"

It is by combining masculinity and pink that brands are best at attracting attention: the contrast between the association of a feminine color and masculine figures attracts the eye while conveying a queer message of displacement of the stereotypes. For example, German artists EVA & ADELE have made pink the emblematic color of their gender subversion (Wuerges, 2016) (fig. 7).

This will always be a form of irony that plays on the contrast between the female color and the man who wears it, pink being "still a symbol of femininity and likely to remain so for time" (Paoletti, 2012, p.99). This process is not new, and already in 2005 Le Stade Français, the French rugby team, was noticed by choosing to wear pink jerseys.

So, when the singer Zayn Malik appeared on his Instagram account with pink hair, it is mainly because he intended to draw attention to him after the release a few days earlier of his new single. Still, Charli XCX's "Boys" video might not have been as successful if it did not show men dressed in pink and doing so-called feminine activities such as washing dishes, participating in pajamas party, or cuddling a stuffed animal.

Fig. 6. The young Spanish film-maker Eduardo Casanova at Premios Goya, 2017 (© Ruben Ortega/Wikimedia Commons).

Fig. 7. The German artists EVA & ADELE at the Venice Biennale, 2009 (© Arben Llapashtica/Wikimedia Commons).

If the trend of the millennial pink took so much scale and evolved so quickly, it is because the idols of millennials, very active on social networks, play with this trend too. They drain around them a stream of media relaying their adherence to the fashion of the moment. Any appearance of a star in pink is subject to "buzz," that is to say, a viral media communication that focuses all the attention, especially on the internet, for a very short period of time. It is a vivid promotional tactic for the media. When they publish their articles, they get the number of views needed on their pages to be adequately paid by advertisements. In the meantime, artists draw attention to themselves and to the products they potentially need to sell.

In addition, pink is generating interest in terms of communication: it attracts the eye as much as it arouses curiosity. Pink tones attract more attention than more saturated shades or than blue or green shades (Lindsey et al., 2010), and in the specific context of the internet, red, purple or pink images, seem to have a better chance of being propagated on Pinterest social network (Bakhshi and Gilbert, 2015).

The success of millennial pink lies in its ability to capture the consumer's attention aesthetically, symbolically and politically. A brand like Acne was able to own the benefits by adopting a pink powdered visual identity in 2007, before the golden age of the trend color. When walking the street with a tote bag from Acne, the customers catch the eye on them, and thus contribute to promote the brand. An increased phenomenon when it comes to male customers, since the chromatic contrast doubles as a symbolic contrast, which not only attracts attention but also spreads the values of a brand that seems to want to break the gender roles.

6. Conclusion

If Pantone ranks colors behind the declared values of gender division, we must keep in mind that fashion has always made gender division a central concern (Agacinski, 1998, p.20). It is a product of class division and is primarily intended for elites (Simmel, 2013, pp.10-13).

Moreover, if the millennials live in an era that legalized same sex marriage and brought LGBT characters to television (Sense 8, Transparent, etc.), it is also a generation that has seen the rise of conservatism and even extremism in several countries (USA, Brasil, Pakistan, etc.). Furthermore, debates around gay marriage revealed that homophobia was rooted in different strata of society. Pink can therefore also be used with blue by a conservative movement (La Manif pour Tous, #rosaeazul) to symbolize the importance of gender difference, heterosexuality and nuclear family model (fig. 8).

Fig. 8. The activists of La manif pour tous campaigning against same-sex marriage in Paris, 2014. They use the gendered code blue-for-boys/pink-for-girls to defend a traditional family model where parents are heterosexuals (© Peter Potrowl/Wikimedia Commons).

The recovery of millennial pink and its so-called feminist values by brands is only the development of a new form of gender marketing called “femvertising,” which uses feminists’ concepts to generate profits, proceeding in the same time to the depoliticization of the color (Erner, 2008, p.42). Furthermore, if brands choose to focus the concept of "gender neutrality" around the only color so strongly associated with the feminine, it is to play precisely with this symbolic

Moreover, if they share a certain number of common traits, the generation Y is in no way a homogeneous whole (Dagnaud, 2013, p.8). By standardizing a generation under the same banner, Pantone's trend erases the inequalities between individuals and presents gender equality as an achievement reached by all, which is not yet the case.

Conflict of interest declaration

The author states that no actual or potential conflicts of interest exist 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.

Funding source declaration

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sector.

Acknowledgment

The author thanks Olivier Thuillier and Marie-Dominique Gil for helping with the translation and correction of this article.

Short biography

Kévin Bideaux is a PhD candidate in gender studies and art at the University of Paris 8, and a visual artist. He conducts research on the history of the color pink and its symbolism of femininity, sexuality and homosexuality, as well as on its use by visual culture. He is a member of the Centre Français de la Couleur.

References

Agacinski S. (1998). Politique des sexes. Paris: Le Seuil.

Bartow, A. (2008). ‘Trademarks, Commoditization, Gender, and the Color Pink’, text of the paper presented at the annual conference of The Law and Society Association. Montreal: Hilton Bonaventure.

Bakhshi, S. and Gilbert, E. (2015). ‘Red, Purple and Pink: The Colors of Diffusion on Pinterest’, PLoS ONE, 10(2), e0117148. doi: 10.1371/journal.pone.0117148.

Benhamou, S. and Diaye, M.-A. (2016). Responsabilité sociale des entreprises et compétitivité. Évaluation et approche stratégique. Paris: France Stratégie.

Ben-Zeev, A. and Dennehy, T. C. (2014). ‘When boys wear pink: A gendered color cue violation evokes risk taking’, Psychology of Men & Masculinity, 15(4), pp.486-489. doi: 10.1037/a0034683.

Berthod, A. (2012). Sampat Pal, Warrior in a Pink Sari: The Inside Story of the Gulabi Gang as Told to Anne Berthod. New Delhi: Zubaan.

Blanchard, K. (2015). ‘Men, Don’t Fear the Rose-Gold iPhone. An ambivalent guy grapples with the question of what it means for a man to carry a pink phone’, The Wall Street Journal. Available at: https://www.wsj.com/articles/men-dont-fear-the-rose-gold-iphone-1444922471 (Accessed: 02 March 2019).

Chmielewski, D. and Deamicis, C. (2015). ‘Apple iPhone 6s Buyers, Rose Gold Is Bros' Gold’, Re/code. Available at: https://www.recode.net/2015/9/25/11618916/apple-iphone-6s-buyers-go-for-the-rose-gold (Accessed: 02 March 2019).

Cochrane, K. (2013). ‘The fourth wave of feminism: meet the rebel women’, The Guardian. Available at: https://www.theguardian.com/world/2013/dec/10/fourth-wave-feminism-rebel-women (Accessed: 2 March 2019).

Dagnaud, M. (2013). Génération Y. Les jeunes et les réseaux sociaux, de la dérision à la subversion. Paris: Presses de Sciences Po.

Djavadzadeh, K. (2017). ‘The Beyoncé Wars : le Black feminism, Beyoncé et le féminisme hip-hop’, Le Temps des médias, 29, pp.159-176. doi:10.3917/tdm.029.0159.

Erner, G. (2008). Sociologie des tendances. Paris: PUF.

Franck, G. (2014). ‘Chapitre 2. Économie de l'attention’, in Citton, Y. (ed.), L'économie de l'attention. Nouvel horizon du capitalisme ? Paris: La Découverte, pp.55-72.

Guionnet, C. and Neveu, E. (2009). Féminins/Masculins. Sociologie du genre. Paris: Armand Colin.

Habib, C. (1988) ‘Souvenirs Du Féminisme’, Esprit, 139(6), pp.3-17.

Hestir, K. L. (2018). Ode to the Women's March: or the Great Pink Pussyhat Protest. Scotts Valley: CreateSpace.

Hoare, J. (2017). ‘Millennial Pink, what the hell is it anyway?’ Glamour. Available at: http://www.glamourmagazine.co.uk/article/millennial-pink (Accessed: 2 March 2019).

Hyland, V. (2016). ‘Is There Some Reason Millennial Women Love This Color’, The Cut. Available at: https://www.thecut.com/2016/07/non-pink-pink-color-trend-fashion-design.html (Accessed: 2 March 2019).

Kacha, M. (2009). La couleur, variable d’action marketing, PhD thesis in Management Science. Nancy: Nancy 2 University.

Landry, V. (2017). ‘Qu’est-ce que le “Millennial Pink” ?’, Métro. Available at: http://journalmetro.com/plus/tendances/1109602/quest-ce-que-le-millennial-pink/ (Accessed: 2 March 2019).

Lindsey, D. T., Brown A. M., Reijnen, E., Rich, A. N., Kuzmova, Y. I. and Wolfe, J. M. (2010). 'Color Channels, Not Color Appearance or Color Categories, Guide Visual Search for Desaturated Color Targets', Psychological Science, pp.1208-1214. doi: 10.1177/0956797610379861

Lo, K. Y. K. (2016). 'The Propaganda of Pantone: Colour and Subcultural Sublimation', LOKI Design. Available at: https://www.lokidesign.net/journal/2016/2/22/the-propaganda-of-pantone-colour-and-subcultural-sublimation (Accessed: 2 March 2019).

Milcent, L. (2017). Le sexisme dans la publicité, une idée dépassée ?, rapport d'Atelier d'Environnement Professionnel. Nantes: Université de Nantes.

Mitchell, N. (2017). 'The Real Reason No One Can Shut Up About Millennial Pink', Appartment Therapy Available at: http://www.apartmenttherapy.com/the-real-reason-no-one-can-shut-up-about-millennial-pink-244900 (Accessed: 2 March 2019).

Mollard-Desfour, A. (2002). Le Rose : Dictionnaire de la couleur, mots et expressions d'aujourd'hui, XXe-XXIe siècle. Paris: CNRS.

Pantone (2015). 'Pantone Reveals Color of the Year for 2016: PANTONE 15-3919 Serenity and PANTONE 13-1520 Rose Quartz', Pantone. Available at: https://www.pantone.com/about/press-releases/2015/color-of-the-year-2016 (Accessed: 2 March 2019).

Pastoureau, M. (2010). Les Couleurs de nos souvenirs. Paris: Le Seuil.

Paoletti, J. B. (2012). Pink and Blue: Telling the Boys from the Girls in America. Bloomington et Indianapolis: Indiana University Press.

Simmel, G. (2013). Philosophie de la mode. Paris: Allia, 2013.

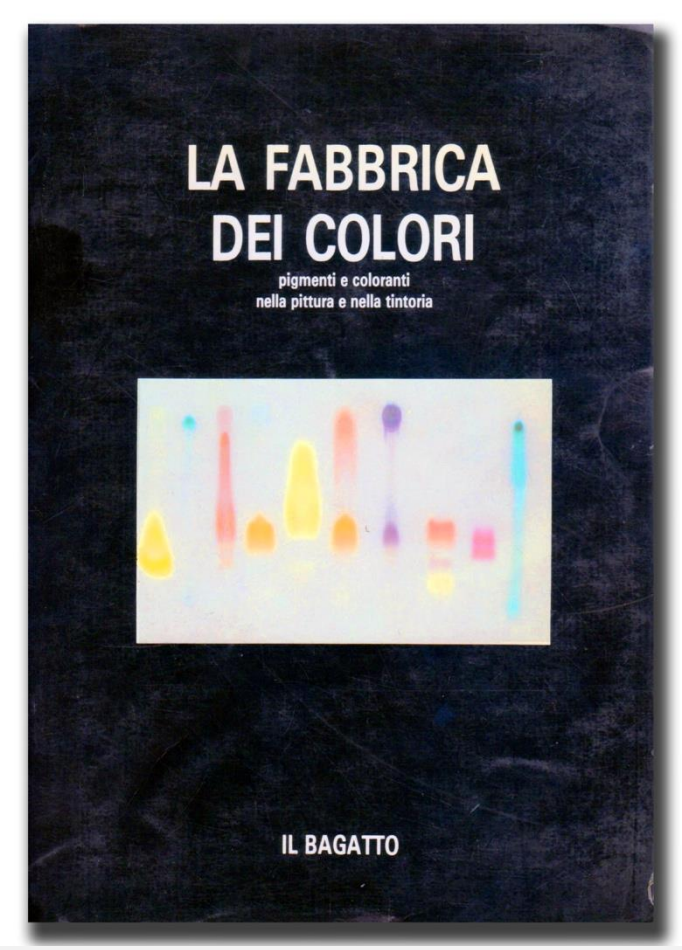
Stuhr-Rommereim, H. and Mollichi, S. (2014). 'Limelight on the butterfly's wing: seapunk and other structural colorations', Fungiculture. Available at: http://www.fufufo.com/post/seapunk/ (Accessed: 2 March 2019).

Tanner, G. (2015). Babbling Corpses. Vaporwave and the commodification of ghosts. Alresford: Zero Books.

Wuerges, M. (2016). 'In the Studio: EVA & ADELE', Collectors Agenda. Available at: https://www.collectorsagenda.com/en/in-the-studio/eva-adele (Accessed: 2 March 2019).

REVIEW: Two books that describe pigments and dyes, in a different and complementary way.

Renata Pompas



La fabbrica dei Colori, pigmenti e coloranti nella pittura e nella tintoria. (T*he factory of colors, pigments and dyes in painting and dyeing*). Il Bagatto, Roma, 1986. (pages 578)

This book, which was published with the CNR contribution, is the result of a group work, coordinated by the professors Corrado Maltese (chair of History of Modern Art) and Franco Salvetti (Chair of General and Inorganic Chemistry), from the “La Sapienza” University, of Rome.

It is a rich and complex text, divided into eight sections entrusted to different authors, who analysed pigments and dyes, described the materials, the production techniques, their history and application in painting and in textile dyeing. (Including numerous examples of over-dyes, or mixing of dyeing colors, to obtain the desired gradation, which debunk the myth of only-one dye substance used at a time).

The sections

- **Whites and Blacks**, by Simona Rinaldi, is divided in four sub-chapters.
  1. From prehistoric times to the Middle Ages, the whites made from calcium carbonate.
  2. Rise and fall of lead white, from the Classical Age to the XIX century.
  3. The alternatives to lead white, from 1750 to today.
  4. The black pigments in the history of painting.

Among the about thirty whites taken into consideration - from the Medieval ones, obtained from the shell of oysters and eggs, or marble, bones, etc..., to those of the XIX century – we can also find their presence in some very famous paintings. Of the black colors analysed it is described theirs processing technique starting from the prehistoric black carbon products.

- **Reds,** by Giuliana Quartullo, is divided into three sub-chapters.
  1. The origin, manufacture and use of the red colour, from its appearance in history, to the first half of the XVI century.
  2. The red color processing technique in the 1550-1700 period.
  3. The red colour synthesized in the laboratory and in the painter's palettes, during the industrial Age.

The various reds colours and pigments are well described in their differences, including the best known, cited in various painting and dyeing treaties, such as: cinnabar, realgar, reds lands from madder, Turkish red (much envied by Napoleon), and kermes, also known as Venetian scarlet.

- **Browns and Oranges**, by Annamaria Milaneschi, is divided into three sub-chapters.
  1. Brown and orange pigments known since the antiquity.

2. Brown and orange pigments introduced between the XV and XVIII centuries.
3. Brown and orange pigments of industrial Age.

Among the about twenty colors described, there are also: the ochre lands of prehistoric times, the tannins from roots barks leaves and different fruits, the bitumen processing, the "mummy" pigment, the orange of chromium, cadmium and antimony, up to the dyes of synthesis.

In the part dedicated to the application of these products to painting, the author describes the damages suffered by some French paintings of the XIX century, in which bitumen altered their surface with cracks, similar to sores.

- **Yellows**, by Rita Pietropaoli and Annamaria Milaneschi, analyses about twenty colors, included in three sub-chapters.
  1. The origin, processing technique and use of yellow, starting from its presence in history, to the Greeks and Romans times.
  2. The yellow in the Middle Age and Renaissance Age.
  3. Yellow after 1700, synthesized in laboratory and present in the industrial Age palette.

Among the curiosities is interesting the history of the saffron and curcuma use, not just as fabric dyes, but also as pigments for miniatures and watercolours.

A sub-chapter is dedicated to gold, both as precious mineral reduced in thin laminae or powder, as well as artificial inorganic pigment used in mosaic, called "purpurine, porporin or Purpureus colour", perhaps because in the illuminated pages it was painted on a purple background.

- **Greens**, by Susanna Occorsio, is divided into three sub-chapters.
  1. The origin, processing technique and use of green, from its appearance in history, to the first half of the XVI century.
  2. The green processing technique during the 1550-1700 period.
  3. The green synthesized in laboratory and present in the industrial Age palette.

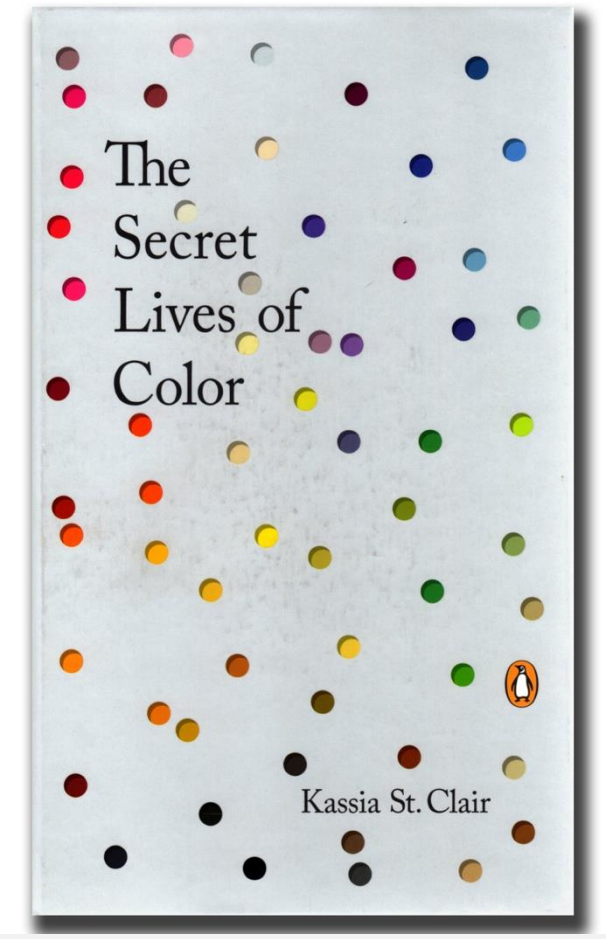
Among the about thirty greens analysed, many of them are included in the “Verdigris” term; in addiction it is interesting to know that a green of synthesis was already produced in ancient Mesopotamia and Egypt.

- **Ultramarine blue**, by Federica Costantini Scala.
  1. The natural ultramarine blue.
  2. The artificial ultramarine blue.

Among the curiosities the news that the “Società di Sviluppo per l'Industria Nazionale” (Company of development for the National Industry) in 1824 offered 6000 francs to those who were able to develop an industrial system to produce the artificial ultramarine blue, at a cost not exceeding 300 francs per kilo.

- **Blue**, by Gabriella Minunno, is divided into two sub-chapters.
  1. From the origins to XVIII century. The grinding of azurite, so much used by painters, is at the origin of different changes of shades of its hue: it darkens or veers towards the green, transforming itself into malachite, as it happened in so many medieval frescoes and oil paintings. The same problem occurred in with the "enamel blue", composed by a potassium glass grounded and mixed with oil, which was produced in Venice with the name of "Sapphire Blue"; also this colour presents today important discolourations. A paragraph is dedicated to the "Egyptian blue" and an other to the "Maya Blue". Among the several names with which the woad dye was indicated, are mentioned recalled “vitrum, glastum, uvatum, guadum, guaro, pastello, falso indaco”.
  2. Pigments and dyes of the industrial Age. Many are also the names with which the "Prussian blue" appeared on the market.
- **Purple**, by Cinzia Virno, is divided into five sub-chapters. This name is used to indicate a wide range of shades, from pink violet, to blue violet, including all intermediate passages.
  1. The purple of the Ancients. The paragraph analyses the extraction process from the different types of murex, and the falsifications obtained by the use of many colouring substances.
  2. The purple among the Classical Age, the Byzantines and the Renaissance Age.
  3. Other substances producing purple dyes.
  4. The purple of the Central America Indians. Of this sub-chapter is interesting the description of cotton hank dyeing process, respecting molluscs which weren't destroyed.
  5. The modern purple.

In addiction the book provides a rich documentation: each color is described with the different chemical compositions, terminologies and applications, and each chapter is concluded with a list of paintings, in which the colors analysed are present.



Kassia St Clair, The secret Lives of Colour. John Murray / Pinguin Books, 2017. (pages 320).

Of this book I happened to buy first the original version, and then his translation into Italian: *Atlante sentimentale dei colori. Da amaranto a zafferano 75 storie straordinarie.* (Utet – DeA Planeta Libri S.r.l., Milano, 2018). The first surprise was when I compared the first three pages of the colours (the Pantone color wheels) of the two editions: they are dull and flat in the Italian edition, intense and three-dimensional in the English one, with obvious differences (see for example the brown).

The translator – Claudia Durasanti – writes in the note that she had to solve the problem of the cultural and linguistic differences in the names of colours, like for example the term “purple”, that – she writes – for English people is a violet shade, but for Italians is “red” (*N.d.R.*? *Red the definition: jakubmarian.com/difference-between-violet-and-purple “Purple occupies the space between red and blu more closer to red, instead Violet is more closer to blue”).* She also mentions the case of the Whitby's “jet Black” used in English jewellery, that in Italian she translates as “gaietto”: a term now in disuse.

But let's come back to the book: the author describes 75 colors , corresponding to 75 headings monthly written by the author for the Elle Decoration magazine, in each of which the author describes a colour nuance. In addition to six introductory chapters: Perception- as we see the colours. An arithmetic matter – the light. The palette – artists and their pigments. Vintage colours – a map to the nuances.

Chromophilia, Chromophobia – The colour is political. Colour in reality – does the language create the nuances that we see?

The choice of the colors made by the author, seems to depend on their name, sometimes of scientific derivation (Alizarin, Cobalt, crocus sativus, etc...), sometimes of industrial derivation (Prussian blue, fuchsia, etc...), other timeS historical (Isabel, shocking pink, Dutch orange, flea, etc...), or according to the name of the different materials (ivory, chalk, woad, etc...), or even imaginary name as Italian name “buio” (N.d.R.?) in English “dark”.

This is a book that has been very successful, it has been translated into 12 languages, including: Spanish, German, Chinese, Russian, Korean, Dutch and Romanian. It is treated also as a pleasant editorial "object", rich in anecdotes, curiosities and historical references, written in a fluid and pleasant way, that left me... a little confused.