Color Culture and Science
Cultura e Scienza del Colore

Special Issue on FRCC2019

Editors: Verena M. Schindler, Yulia A. Griber

CCSJ

Volume 12

Number 1

2020

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 12, number 1, March 2020
DOI 10.23738/CCSJ.120100

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 from 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 the 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.

Country codes compliant with ISO 3166-1 alpha-2 standard

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Editorial

The First Russian Congress on Color (FRCC2019) was held at Smolensk State University on 18–20 September 2019. Smolensk is one of the oldest cities of European Russia and is located on the Dnieper River. The congress was organized by the Smolensk State University, the Research and Education Center 'Color Lab' of Smolensk State University, and the Study Group on Environmental Colour Design of the International Colour Association. Famous Russian scientists and colour experts from around the world presented their latest findings in such fields as, e.g., psychology, sociology, political science, literary studies, gender studies, philosophy, art history, product design, art, architecture, urban design, landscape architecture and colour vision. Over the three days of the conference, participants delivered sixty-eight presentations in Russian and English in three different forms: as oral presentations, Skype talks, and posters. In total, more than 300 people from nineteen regions of the Russian Federation and twenty different countries participated in the congress.

This special issue of Colour Culture and Science gathers together a selection of extended papers presented at the First Russian Congress on Color, which were published in Volume 1 of The Scientific Notes of the Color Society of Russia, Smolensk State University Press. All contributions of this special issue have been double-blind peer reviewed, revised, and rigorously edited to ensure a high quality standards. We warmly thank the twenty-two reviewers for their excellent work.

The first four papers cover relevant topics related to colour in architecture and the urban environment:
Karolina Białobłocka (Poland) discloses precious archive documents she unearthed about colour design proposals for Warsaw's historic Market Square, which was restored after World War I, and later rebuilt after its complete destruction in World War II.
Aline Barlet, Audrey Bousigues and Alice Herbert (France) analyze the colours of distinct new buildings that mark transition zones in the urban fabric and contribute to the development and modernization of the French city of Bordeaux.
Alessandro Premier (New Zealand) explores the colours of temporary and permanent textile architectural envelopes/façades of the 21st century including tensile structures, architectural installations, and buildings around the world.
Beichen Yu and Simon Bell (United Kingdom) identify a new trend in the design of public and semi-public space whereby saturated colours are used to meaningfully impact an urban place. The so-called 'new phenomenon' is analyzed in the context of the visual culture of the new digital society.

The next two papers deal with colour in interior architecture:
Ichraf Aroua and Faten Hussein (Tunisia) inquire into the effects of colour in delivery and maternity spaces in France and Tunisia via on-site colour analysis, surveys, and electrodermal activity tracking of women giving birth. Their aim is to identify elements that are fundamental to creating an ambience in harmony with function, shape, texture, and the cultural context.

Cristina Boeri (Italy) employs colour emotion theory to develop an educational approach to colour design for interior space.

The next four papers concern themes in different fields of research, such as fashion, perfume packaging, ceramics, and art:
Milena Quattrer, Welton Fernando Zonatti and Anna Paula Silva Gouveia (Brazil) make use of subtractive colour theory in their practical colour exercises for fashion courses to deal with colour contrast and colour harmony.
Camila Assis Peres Silva and Clice de Toledo Sanjar Mazzilli (Brazil) show research results based on their experiments concerning the relationship between the perceived fragrance of perfumes and the chromatic lightness of primary packaging.
Carla Lobo (Portugal), explores the history of ceramic products, their migration over the centuries, and how foreign colours merge with local conditions to form a very distinct chromatic 'DNA marker'.
Yulia Kovanova (United Kingdom) discusses colour from an ecological perspective as developed through a gradualist and non-divisional approach and her own artworks.

We wish you a very interesting, instructive, and joyful time reading!

January, 2020
Guest Editors of this special issue on the FRCC2019
***Verena M. Schindler**, Art and Architectural Historian, Zollikon (Switzerland)*
***Yulia A. Griber**, Smolensk State University, Smolensk (Russia)*
Co-chairs of the Study Group on Environmental Colour Design of the International Colour Association (AIC)

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Three colour design proposals for the Market Square in Warsaw

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ABSTRACT

Research on the history and theory of colour planning in the built environment has been undertaken as the need to regulate colour and has become crucial as the proliferation of unlimited hues of artificial paints that, when applied without guidelines, may easily lead to visual chaos in the built environment. This particular study concentrates on colour planning for the Market Square in Warsaw. The methodology employed included archival research and field studies. As a result, two colour design proposals from 1928 and 1951–53 were discovered, analysed and compared with the recently applied colour scheme supervised by the Monument Conservation Board. This paper investigates how the colour design proposals were developed and applied, and finally, what atmosphere a coherent colour design proposal creates in a historic representative square. The results achieved also indicate that the analysed colour schemes provided a warm and welcoming atmosphere that was balanced with features of elegance and ceremony. Additionally, the designs deepen the theoretical knowledge on colour planning and may help to establish guidelines on colour.

KEYWORDS Colour, Colour Planning, Architecture, Urban Design, Warsaw

RECEIVED 29 October 2019; **REVISED** 30 November 2019; **ACCEPTED** 17 December 2019

1. Introduction

A market square, usually a rectangular square surrounded by dwellings that house workshops on the ground floor with flats above, is a very characteristic feature of a Central European city or town. Rooted in the Middle Ages, a market square has been the centre of an average Polish town for many centuries, and up to now, most of the market squares in Poland kept their original, historical urban shape. Over the centuries, however, façades have often been rebuilt in different architectural styles and colours have been adjusted to the new circumstances, accidentally or planned.

In recent years, many attempts have been undertaken to refurbish Polish market squares and research on colour planning for market squares has been conducted in search for how colour was treated and applied in those refurbishments. The colour design proposals discussed in this paper were examined in order to establish the ways colour has been organized in terms of composition within such an important urban area. In essence, this paper enquires into what role colour plays, what image colour helps to create, and finally, how colour contributes to physical ease and well-being of both inhabitants and visitors.

So far, a few examples of colour planning for Polish market squares have been presented in the literature. An attempt to coordinate colour in Wroclaw was discussed in earlier studies (Białobłocka 2017, Białobłocka and Urland 2019). The main ideas of a colour design proposal for Płock were briefly analysed by Romuald Kozioł (1964). Colour and historical preservation of cultural heritage was the subject of the conference 'Polychromies and sgraffito on the façades of Old Town centres rebuilt after 1945' that took place in Warsaw in 2015. In the conference proceedings, apart from discussing conservation issues, a few examples of colour planning were described such as selected issues related to colour design proposals for Gdansk's Old Town (Kriegseisen 2015, Kołodziej and Brzuskiewicz 2015), Warsaw's Old Town (Kania 2015), and Lublin's Old Town (Żywiecki 2015).

In this paper, the case study of Warsaw is discussed (Białobłocka 2019). Two different colour design proposals for the Market Square are analysed from the point of view of the colour composition and further compared with the newly restored situation.

2. Methodology

The methods employed included archival research, interviews with people responsible for colour protection in Warsaw, and field studies. Archival materials included architectural designs and written sources such as comments in the press and building regulations. Private communications with public officials took place in September 2010 and archival research and fieldwork were conducted in summer 2017.

Regarding archival materials, research was carried out in August 2017 in the following archives and museums in Warsaw: Archiwum Akt Dawnych, Archiwum Akt Nowych, and in the Archiv of the Muzeum Warszawy. Archival material including designs from 1928 and 1951 were discovered in the Museum of Warsaw. Furthermore, nine protocols on the polychrome restoration of 1953 were found in the archive Archiwum Akt Dawnych.

In regard to potential comments in the press, the main professional magazine on architecture of that period *Architektura* did not include articles on colour design proposals for Warsaw. General comments on the reconstruction of the Old Town after World War II were published in daily local newspapers, e.g., *Trybuna Ludu* and *Stolica* [7] (Huml 1978). The examined building regulations did not include regulations on colour.

The current colour scheme was discussed with the public officials from the Warsaw Monument Conservation Board in 2010. Fieldwork that analysed recently applied colours was conducted in August 2017 under different daylight conditions, in the morning, midday and evening.

The most important findings up to the present day include the discovery of two different colour schemes for Warsaw's Market Square. The initial idea was to gather together the data according to a questionnaire established for a research project in the attempt to analyse colour in the built environment. The questions on the form covered the sources of inspiration, the design methods, and the implementation of the colour plan. The findings, however, were limited; they provided data on the design principles but little information on the initiation and implementation of the colour design proposals. Further examination of scattered sources is required to deepen the understanding of what inspired the colour concepts and how the colour plans were implemented.

3. Colour planning for Warsaw's Market Square

3.1. *The 1928 colour planning*

Successful attempts to coordinate colour within the Old Town of Warsaw (Stare Miasto) were made in 1928. Initiated by the Society for the Preservation of Historical Monuments, a commission responsible for the polychromy scheme was appointed in 1928.

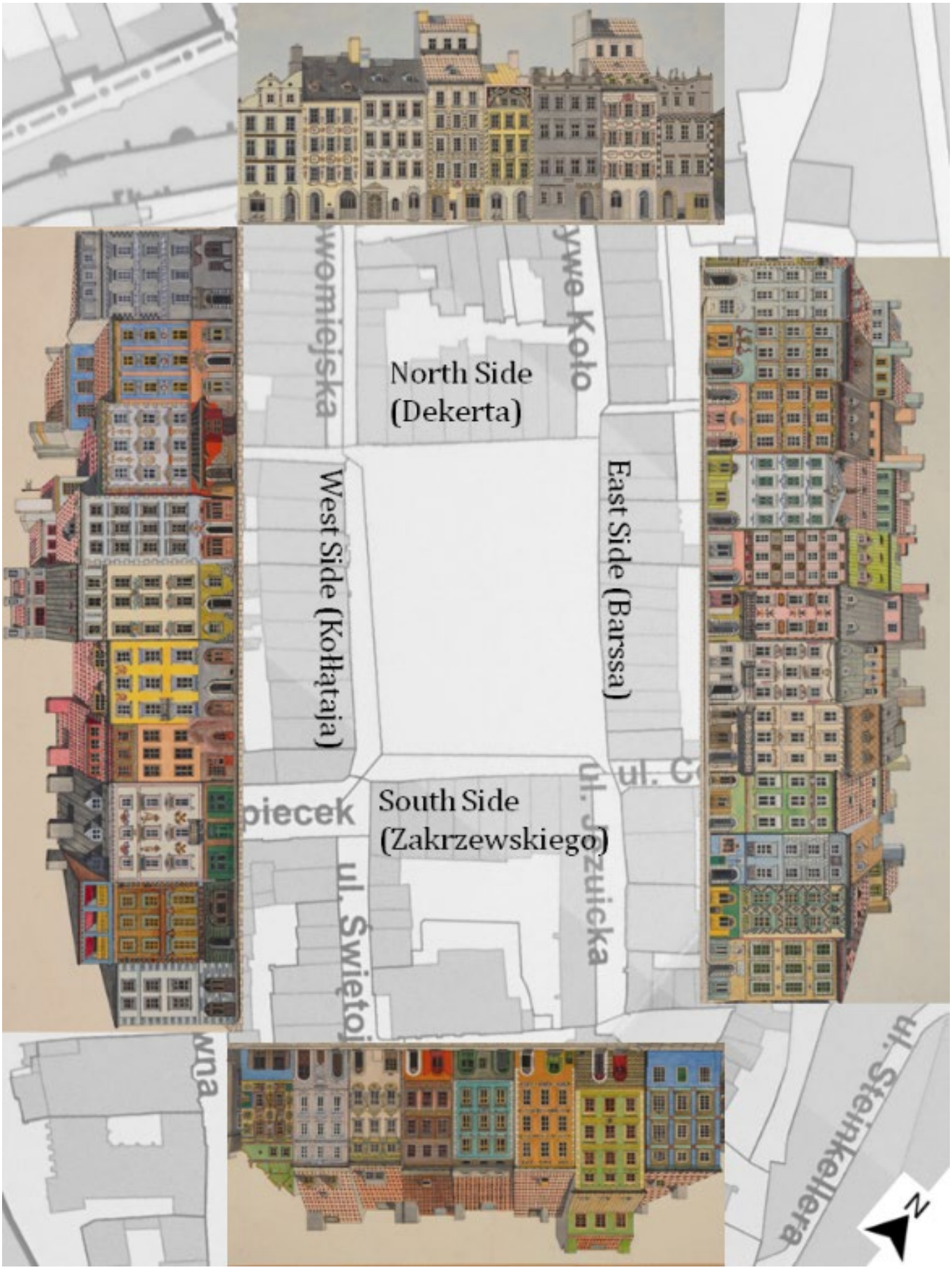

Fig. 1. The 1928 colour design proposal for all four sides of the Market Square, Warsaw. Source: Muzeum Warszawy, call number: MHW 15965-68. Author unknown. Photo: Rafał Chmielewski.

Bohdan Urbanowicz (1911–1994), who was a painter, architect and professor at the Academy of Fine Arts in Warsaw, pinpointed an increasing degradation of the historic Old Town in the 1920s. The reasons he identified for the initiative of repainting the buildings surrounding the square on all four sides were the poor results of illegal works carried out by the house owners (Urbanowicz 1953:143). At that time, in the 1920s, the properties were privately owned, yet, due to their historic value, the Market Square was listed in the building conservation inventory and, in fact, any work, including colour, had to be conducted in cooperation with the respective conservation units. The 1928 colour design proposal for the Market Square was honorarily created by a group of seventeen artists under the leadership of the well-known Art Deco painter Zofia Stryjeńska (1891–1976) (Kania 2015:9). The art historian, critic and professor Irena Huml (1928–2015) also indicates that the group of artists contributed greatly to the renovation of the Market Square's building façades as the artists not only conceived the colour design but also offered it to the City Council (Huml 1978:174). The commission accepted the design which was implemented in the same year (1928).

The base of the 1928 colour design proposal was a sketch by Zofia Stryjeńska that indicated what colours the façades had to be painted and the artists of her team designed the details (Kania 2015:11). Regarding the composition of the colours, each side of the square is treated differently (Fig. 1).

Named after Jan Dekert, the north side (Strona Dekerta), shows building façades painted alternately with two light colours, which are nuances of yellow and grey. Apart from grey, the following colours are applied on darker architectural details: black, blue, brown, green and red. As a rule, one colour is applied to the wall surfaces, whereas two or three different colours are used on the details. Ground floor levels are not differentiated from the upper levels. The chromatic lightness is a feature that differentiates this row of buildings from the other colourful rows [1].

Named after Hugo Kołłątaj, the west side (Strona Kołłątaja) is characterized by strongly contrasting light and dark colours. Unsaturated and highly saturated colours are applied in an irregular way. Three façades are monochromatic, painted either blue or bluish grey; four façades are enriched with wall paintings; and three façades are covered with strong, contrasting colours, i.e., brown-orange and blue, yellow and blue, and peachy and blue [2].

Named after Ignacy Zakrzewski, the south side (Strona Zakrzewskiego) is characterized by the use of various strong colours as each building is painted differently, either with light or dark colours. Five façades are two-colour, two façades make the impression to be monochromatic, yet small surfaces are enriched with different colours, and one façade is covered with wall paintings [3].

Named after Franciszek Barss, the east side (Strona Barssa), shows similar colourfulness as a main feature. The thirteen façades are painted green, bluish grey, orange, pink and yellow with no obvious rhythm. The architectural details are painted either a neighbouring shade of the hue applied to the façade surface or a contrasting hue. [4].

In regard to the colours used on the walls, two groups of colours dominate in this colour design proposal: 'warm' saturated yellows, oranges and peachy pinks co-exist with 'cold' light greys, beige-greys and bluish greys. Greens are applied only on a few elevations (Fig. 2).

A characteristic feature of the 1928 design was its colourfulness, i.e., the use of vivid hues and contrasting colour compositions that was inspired by the Expressionist art movement and folk art (Kania 2015:9)

The colour design described above was implemented using Keim mineral colours and was officially presented to the nation on 11 November 1928, the 10th anniversary of the National Independence Day. In the press, the main complaint was the lack of colour harmony. A further criticism concerned the lack of reference to the original, historical colours. Yet a torrent of harsh criticism received a new colour design in post-war years under different political circumstances (Kania 2015:10, Urbanowicz 1953:146).

Fig. 2. Details of all the building façades above the ground floor level facing the Market Square from the 1928 colour design proposal.

3.2. *The 1951–53 colour planning*

New attempts to coordinate colours of the Market Square buildings took place 1951–53 in the post-war reconstruction of Warsaw's Old Town (Stare Miasto). Colour planning was part of a much bigger reconstruction project of the Polish capital that had been devastated in the 1944 Warsaw Uprising. The historic city centre was rebuilt and the gradual reconstruction was presented yearly to the nation on the 22 July, the National Day of the Rebirth of Poland, which was introduced as a public holiday by the socialists in 1945 in replacement of the National Independence Day of 11 November.

As in 1928, after the war, the area of the Old Town was listed in the conservation inventory and for this reason the development plans had to be approved by the Monument Conservation Office. However, the ownership changed from private to public and due to the prevailing political system, all the designs had to be additionally approved by committees consisting of not only designers and public officials but also members of the Party.

In short, designs had to follow the rules of art recognized by the Party. Due to the official political doctrine, the Old Town was to be reconstructed as a residential area in an architectural style rooted in the Polish tradition and embellished with Social Realism decor. As the official doctrine valued only Gothic, Renaissance and Neo-Classical architecture, it is not surprising that the pre-war polychromy created by Art Deco and Modernist artists was not acceptable. In contrast to the 1928 proposal (perceived as not consistent, with too many bright colours with high saturation and underlining the independence of the artists), the new colour design was to be the result of a collective work: harmonious, with light colours and gilding sparkling in the sun. In the protocols, the term 'pastel' is often used to describe hues with high value and low saturation making feel the colours pale, soft and delicate. In accordance to the official political doctrine, the scheme aimed to create the atmosphere of a happy workers' housing estate (Zbiegieni 2015:49, Kania 2015:17).

The analysis of written sources does not provide information on the compulsory use of certain hues and shades. A uniform colour composition honouring historical colours was the aim, but it rather seems that the whole idea consisted of emphasising the success of socialist doctrine and had to differ from the previous colour design created under the capitalist system twenty-five years earlier. The final colour scheme, especially the range of hues applied and their degree of saturation was also a result of the limited availability of paints and their low quality.

One of the first designs was made by the Miastoprojekt Group who presented a uniform colour design proposal kept in grey shades with tints, whereas the design by the Wojciech Jastrzębski team was kept in light colours commonly used in the 19th century (Kania 2015:13–14, Urbanowicz 1953:149).

The 1951 design by PKZ, Pracownia Architektury, consists of fifteen drawings for the Old Town including the north side (Strona Dekerta) [5]. According to the drawing, the façades should be either two-colour (six façades) or three-colour (two façades). The walls were to be painted one single hue and the architectural details a different hue, such as in five cases, in which the selected hues are expressed in terms of opposite sensations, i.e. a warm hue on the walls and a cool hue on the architectural details. The categorization of warm and cool colours, as recorded in the meeting minutes, is a way to describe hues with reference to their psychological effects on people rather than using colour attributes. The drawing was coloured using the aquarelle technique, and as such it provides the feeling of a somehow uniform, light colour composition. The rhythm is introduced by the alternate, but not consequent, use of warm and cold hues applied to the façades and the architectural details.

In regard to the colour composition, the colours for the building façades are described on the drawing (from left to right): carmine red with grey ground floor; yellow; grey; green with gilding; pink with light yellow ground floor; grey-green with gilding; orange; and, bluish grey with gilding (Fig. 3).

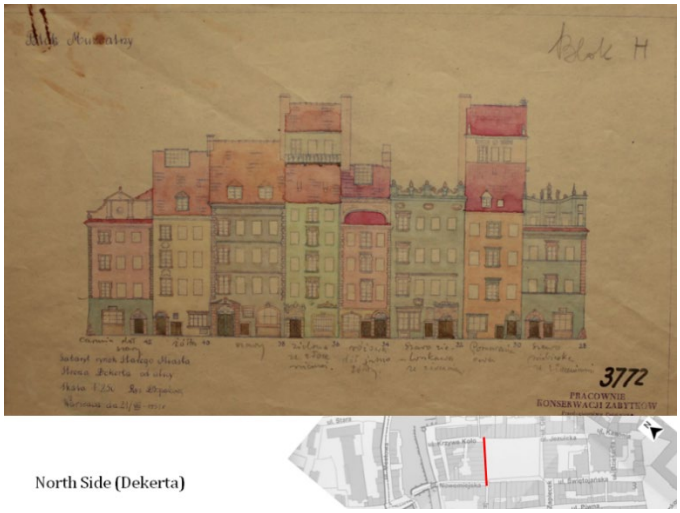

Fig. 3. The design preserved in the museum provides information on colours for the Dekert's side, which is indicated on the city plan below. Author of the drawing: PKZ Pracownia Architektury. Source: Muzeum Warszawy. Call number: MHW 130/Pl.

The team led by the painter Jan Sokołowski that based its concept on the previous greyish design by the

Miastoprojekt Group, developed the idea of the so-called colour discretion and the horizontal sgraffito decorations. The realization of the design was supervised by the Capital Reconstruction Office, directed by Warsaw's first chief architect Józef Sigalin (1909–1983). Committee members included the main city conservator Piotr Biegański (1905–1986), the general conservator Jan Zachwatowicz (1900–1983), the chief designers Jan Sokołowski (1904–1953) and Mieczysław Kuźma (1907–1983) as well as the Minister Aleksander Wolski (1913–1988) who represented the investor, this is, the state. The nine protocols dated from 29 April 1953 to 17 July 1953 communicate the discussions that concentrated on the improvement of the design proposal led by Jan Sokołowski, mainly on the façade colours applied and the amount of surface decorations [6].

Several comments and suggestions were made during the meetings. For example, the meeting minutes of 29 April 1953 reveal that the preliminary idea of this design based on the use of intense colours (colours with high saturation) worried some committee members who found it too dark but expressed fears that the introduction of lighter colours could lead towards the destruction of Sokołowski's design idea, whereas others claimed that the design was too light, too 'pastel'. It appeared that the 1:100 scale designs were too pale, whereas the detailed 1:20 scale designs were too colourful. In the end, it was decided that colours have to be better harmonized and elaborated decorations to be limited to a smaller number of façades [6].

The meeting minutes of 11 May 1953 reveal that the improved design treats the four sides of the Market Square in different and contrasting ways. Painted dark greys and greens with gilded decorations and ornaments, the north side, or Dekert's side, was the most valuable and noteworthy. The east side, or Barss' side, was painted with warm hues complementing the greys. Rich in architectural details, the south side, or Zakrzewski's side, was painted with light cool blues, whites and greens. And the west side, or Kołłataj's side, was characterized by shades of pink, red and purple. Moreover, on each side a distinct accent colour enhanced the central façade of the building row by lightening colours with the addition of white. Bohdan Urbanowicz mentions that the whole colour scheme also was harmonized by applying dark brown to the window frames of all buildings (Urbanowicz 1953: 151).

During the other meetings, selected colours as well as sgraffito and fresco decorations were discussed on-site. Colours and decorations were kept repainted in order to achieve a harmonized and discreet colour scheme that eventually satisfied the Committee [6].

Finally, in the early summer 1953, the improved colour design proposal was implemented using the technique of pigmented plaster, sgraffito and wet fresco. The completed reconstruction of the oldest part of Warsaw was officially celebrated on 22 July 1953. In the press, the work was described as a positive achievement. The general monument conservator and architect Jan Zachwatowicz described the whole reconstruction of the Old Town as a step forward in building socialism. He explained that by incorporating the valuable past achievements of Warsaw's Old Town into the new, the socialist capital followed the development rules of socialist culture using the national culture in a creative way [7].

3.3. *Current colours of Warsaw's Market Square, analysis of 2017*

The currently applied colour scheme is not accidental but planned since the buildings in Warsaw's Old Town are listed by the Warsaw Monument Conservation Board. Since 2 September 1980, it is a UNESCO World Heritage Site and as such the colours of the façades are supervised by the Warsaw Monument Conservation Office. For the reason that historical archive material is very limited due to the destruction of the city of Warsaw during World War II, based on a private conversation with public officials from the Monument Conservation Board, we know that the Monument Conservation Office utilised the colour design of the early 1950s as a basis for the refurbishment of the historic town.

Currently, the Dekert's side (north side, numbers 28–42) is a multi-coloured composition with one monochromatic and seven two-colour façades. The façades are of various hues with no visible rhythm: two shades of grey, creamy, brown and yellow, two shades of red, and two shades of green (Fig. 4).

The Barss' side (east side, numbers 2–26) provides a feeling of balance in terms of colours used. The façades are monochromatic and the use of colours is limited to warm hues discriminating the façades by introducing various shades of the same colour family.

The Zakrzewski's side (south side, numbers 1–13) gives the impression of a uniform colour composition for two reasons. Firstly, the façades are two-colour with the architectural details being painted lighter and warmer hues, and secondly, the colours are limited to warm shades.

Similarly, the Kołłątaj's side (west side, numbers 15–31) is perceived as a uniform colour composition. The row of buildings is covered with shades of warm hues, with the exception of two buildings painted grey.

Regarding the colours applied to the external walls, the range of warm red, maroon, yellow and brown dominates. Cold hues such as grey-green, olive and blue are applied only on a few elevations (Fig. 5).

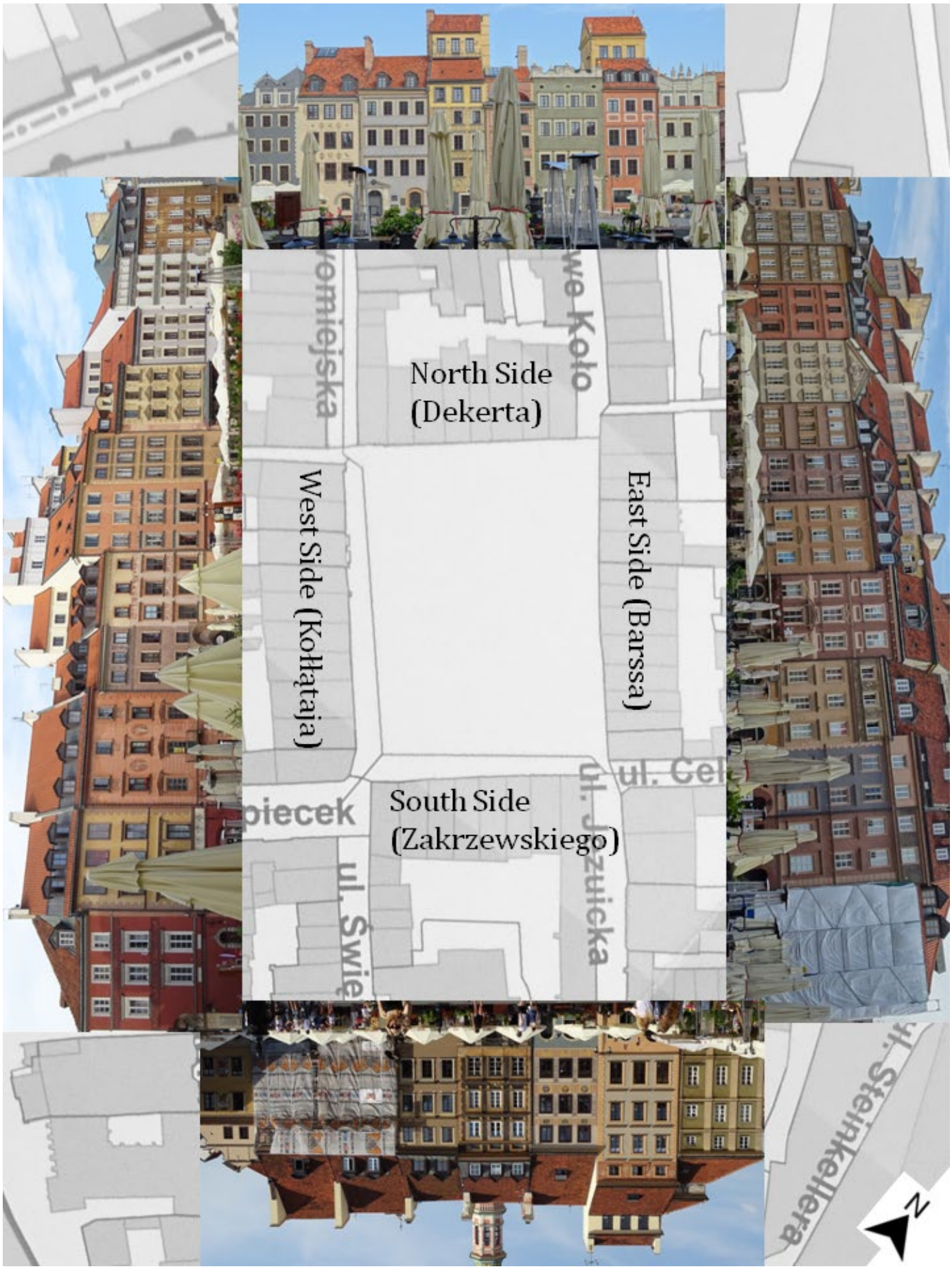

Fig. 4. Colours of the buildings of the four sides of Warsaw's Market Square as of August 2017. Photos by the author.

Fig. 5. Details of the façades above the ground floor of all the buildings facing the Market Square. Photos by the author made in 2017.

4. Conclusions

Archival research revealed the existence of two different colour design proposals from 1928 and 1951–53, and the current colour scheme was discussed with public officials. Both colour design proposals were created as part of post-war reconstructions and aimed at commemorating the victory as well as emphasising the strength of the nation. Yet, they were designed under different political circumstances that influenced the artistic creation.

Furthermore, both colour design proposals were conceived as complex colour schemes by groups of artists, whereas the currently applied colours are a result of paint investigation and archival research coordinated by the Monument Conservation Board in Warsaw.

In all three cases, colours were designed for a protected area and for this reason they had to follow the conservation doctrines that generally aimed to reconstruct original forms. The designs had to be approved by public officials from conservation offices. However, the colour schemes differ: the 1928 one was the boldest in terms of the use of colour and also was influenced by contemporary art movements; the 1951–53 one aimed to emphasise the character of the buildings and honour the historical colours in the framework of the prevailing political doctrine; and, in current colour schemes, historical colours are valued most, but due to limited original material, the colours of the early 1950s are treated as a base for the restoration.

In regard to the design principles, the comparative study of these two different colour design proposals and the currently applied colour scheme that is supervised by the local Monument Conservation Board shows similarities and differences.

The 1928 colour design proposal was characterized by multi-colourfulness and the application of saturated colours (strong, vivid colours) that are associated with gaiety and cheerfulness. Judging by the available drawings and descriptions, the second attempt to coordinate colour made in 1951–53 provided a more balanced solution: still colourful in terms of hues, but limited in terms of lightness and saturation and balanced with grey that is associated with elegance and ceremony. And the current colour scheme as of 2017 is again dominated by warm colours that are associated with joviality, and partially balanced with grey that is associated with elegance.

The colour designs discussed indicate that warm hues are widely used and in parallel with the application of grey. In this way, the feeling of cheerfulness is balanced by dignity and ceremony. Regarding the comfort of passers-by, it was provided partially by the application of red and orange associated with enjoyment, but the feeling of tranquilly was limited as the use of blue and green was limited (Fig. 6).

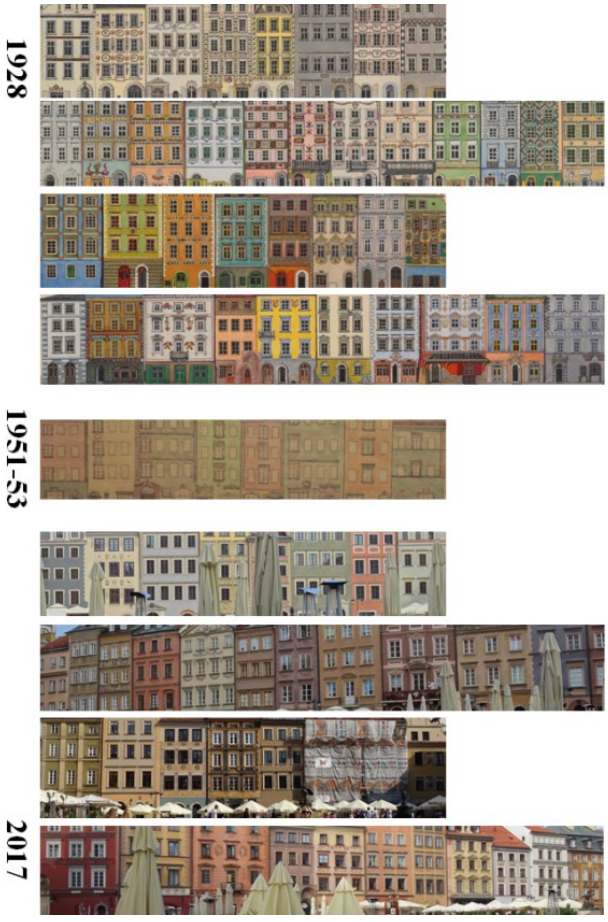

Fig. 6. The colours of the façades as of 1928 (design), 1951–-53 (design) and the current situation of 2017.

5. Conflict of interest declaration

The author declares that she has no conflicts of interest.

6. Funding source declaration

The author received no specific funding for this work.

7. Short biography of the author

Karolina Białobłocka is an architect and researcher on theory and history of architecture. Her research interests focus on the correlation between art and architecture, with special interest in colour. Her previous research project concentrated on historical colour schemes of Lower Silesian architecture and current research focuses on guidelines on colour in urban planning. She obtained a doctoral degree from the Wroclaw University of Science and Technology in 2015.

Notes

[1] Archival document, Muzeum Miasta Warszawy, call number: MHW 15965 Rynek Starego Miasta, strona północna /Dekerta, after 1929, author unknown.

[2] Archival document, Muzeum Miasta Warszawy, call number: MHW 15966 Rynek Starego Miasta, strona zachodnia /Kołłątaja, after 1929, author unknown.

[3] Archival document, Muzeum Miasta Warszawy, call number: MHW 15967 Rynek Starego Miasta, strona południowa /Zakrzewskiego, after 1929, author unknown.

[4] Archival document, Muzeum Miasta Warszawy, call number: MHW 15968 Rynek Starego Miasta, strona wschodnia /Barssa, after 1929, author unknown.

[5] Archival document, Muzeum Warszawy, call number: MHW 130/Pl.

[6] Protocols of committee meetings related to the polychromy of Warsaw's Old Town preserved in Archiwum Akt Dawnych in Warsaw (call number: 771 /Zespół 27 Wydziału Architektury zabytkowej Biura Odbudowy Stolicy Urzędu Konserwatorskiego na m. st. Warszawę z lat 1945–1953):

'Protokół Kolegium Opiniodawczego w sprawie odbudowy Starego Miasta zwołanego z inicjatywy Konserwatora na m. st. Warszawę w dniu 29.04.1953'; 'Protokół komisji do oceny projektów polichromii Rynku Starego Miasta z dnia 11.05.1953'; 'Protokół kolegium w sprawie polichromii Rynku Starego Miasta z dnia 15.05.1953'; 'Protokół posiedzenia Kolegium Opiniodawczego w sprawie polichromii Rynku St. Miasta z dnia 23.05.1953'; 'Protokół posiedzenia Kolegium Opiniodawczego w sprawie polichromii Rynku Starego Miasta w Warszawie z dnia 1.06.1953'; 'Protokół Kolegium Opiniodawczego w sprawie polichromii Starego Miasta z dnia 1.07.1953'; 'Protokół Kolegium Opiniodawczego w sprawie polichromii Starego Miasta z dnia 6.07.1953'; 'Protokół Kolegium Opiniodawczego w sprawie polichromii Starego Miasta z dnia 11.07.1953'; 'Protokół Kolegium Opiniodawczego w sprawie polichromii Starego Miasta z dnia 17.07.1953'.

[7] Historical articles in magazines and daily newspapers:

Zachwatowicz, J. 'Odbudowa Starego Miasta w Warszawie'. *Trybuna Ludu*, nr. 202; 22 lipca 1953; Gomulicki J. (1953) 'Trzy oblicza Rynku Staromiejskiego', *Stolica*, 30 (292); Klinger K. (1953) 'Malarskie rozwiązanie rynku staromiejskiego', *Stolica*, 37 (299); Kożmiński K. (1953) 'Polichromia Rynku Staromiejskiego Warszawy', *Dziś i jutro*, 26; Urbanowicz, B. (1953) 'Dwie polichromie starego rynku', *Ochrona Zabytków*, 2–3, pp. 21–22.

References

Białobłocka, K. (2017) 'Competitions for colour schemes for streets and squares in Germany in the 1920s'. Journal of the International Colour Association, 20, pp. 28–39.

Białobłocka, K. and Urland, A. (2019) 'Does colour planning matter? Reflection on the impact of colour coordination and planning in Poland and Slovakia'. Architecture and Urban Planning. Technical Transactions, 6, pp. 17–36.

Białobłocka, K. (2019) 'Colour Planning for the Market Square in Warsaw'. Proceedings of the First Russian Congress on Color. Schindler, V. M. and Griber, Y. A. (eds.) The Scientific Notes of the Color Society of Russia, 1, Smolensk: Smolensk State University Press, pp. 19–24.

Huml, I. (1978) Polska sztuka stosowana XX wieku. Warszawa: Wydawnictwa Artystyczne i Filmowe.

Kania, J. (2015) 'Malowane dzieje. Powojenne polichromie warszawskiego Starego Miasta: twórcy, dzieła i archiwalia'. Polichromie i sgraffita na fasadach ośrodków staromiejskich odbudowanych po 1945 r. Jagiellak, A. and Świątek, P. (eds.) Warszawa: Biuro Stołecznego Konserwatora Zabytków, pp. 9–30.

Kriegseisen, A. (2015) 'W poszukiwaniu straconego koloru. Wystrój barwny zachowanych i odbudowanych fasad głównego i starego miasta Gdańska'. Ibid, pp. 101–116.

Kołodziej, J. and Brzuskiewicz, B. (2015) 'Kształtowanie tożsamości miejsca poprzez konserwację istniejących i wykonywanie nowych dekoracji artystycznych dla fasad kamienic odbudowywanych po 1945 roku na obszarze Głównego Miasta w Gdańsku'. Ibid, pp. 117–132.

Kozioł, R. (1964) 'Generalna Koncepcja Kolorystyczna Płocka'. Architektura, 6, pp. 253–254.

Wierzbicka, B. (1995) 'Polichromia Rynku Starego Miasta w 1928 roku'. Historyczne place Warszawy. Urbanistyka. Architektura. Problemy konserwatorskie. Wierzbicka, B. (ed.) Warszawa: Towarzystwo Opieki nad Zabytkami, pp. 122–134.

Zbiegeni, A. (2015) 'Rastauracja elewacji frontowych kamienic Strony Dekreta na Rynku Starego Miasta siedziby głównej Muzeum Warszawy'. Polichromie i sgraffita na fasadach ośrodków staromiejskich odbudowanych po 1945 r. Jagiellak, A. and Świątek, P. (eds.) Warszawa: Biuro Stołecznego Konserwatora Zabytków, pp. 43–58.

Zielińska-Meissner U. (2011) 'Krajobraz Warszawski, czyli o barwach dawnej Warszawy', Krajobraz Warszawski. Magazyn Urbanistyczno – Architektoniczny, 127, pp. 1–12.

Żywiecki, J. (2015) 'Jak Nowe Stare miasto. Polichromie i sgraffita z 1954 roku na elewacjach staromiejskich kamienic w Lublinie'. Polichromie i sgraffita na fasadach ośrodków staromiejskich odbudowanych po 1945 r. Jagiellak, A. and Świątek, P. (eds.) Warszawa: Biuro Stołecznego Konserwatora Zabytków, pp. 147–166.

Color as a sign of urban transition in the city of Bordeaux

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ABSTRACT

Color in architecture, despite its functions as a signal, a landmark and a symbol, remains largely absent at both the urban level and at the building level. The trend is towards the color chart, seeking harmony, but which sometimes gives way to monotony. In the case of a heritage city such as Bordeaux, the question of the use of color has also to cope with the UNESCO World Heritage protection of a large part of the city. Actions are limited by a concern for the relationship with what exists already, and as a result, respect for the historic and visual context gives rise to architectures that are discreet, or sometimes even banal. Nevertheless, there are designers in Bordeaux who dare to use color. Most colored buildings are part of a specific program or are in a key location in the city. By analyzing some urban and architectural examples, we show that buildings may be located in places of urban divide or that color may be used to identify a specific function. Logically, the further we move from the historic city center, the more colored buildings we encounter, yet colors nevertheless seem to be complex to manage. However, by determining the predominant colors and identities of a place, it is possible to focus a project more precisely and make it easier for residents to appropriate the space.

KEYWORDS Color, Architecture, Heritage, Function, Visual Integrity

RECEIVED 15 October 2019; **REVISED** 16 December 2019; **ACCEPTED** 07 January 2020

1. Color and architecture

Color is an integral part of our daily lives. Color conveys codes, taboos, and prejudices that we adhere to without knowing it. It influences our environment, our behavior, our language and our imagination (Déribéré 1964).

In every country in the world, since prehistoric times, man has been attracted by color, creating symbolic messages around it that have been passed down through the ages in diverse activities and have become imprinted in his subconscious.

In the field of architecture, while color is ubiquitous in interior decoration, it is more unusual to find it used on façades, apart from the color of the materials themselves.

1.1. *The many functions of color in architecture*

Color in architecture becomes a signal in our environment when it contrasts with its urban context.

Color can assume different functions in architecture. When used as a landmark, it helps to find a place, and gives a city 'legibility' as described by David Lynch (1960). When used as a symbol, it becomes a collective sign, the result of an historical-social convention. It mobilizes people around a community identity, a basis for recognition and membership of a group (Soulié 1988). The color of buildings and urban spaces enables us to find our way, to find our identity, and to dream.

However, above all, color is the means by which the architect is able to express his sensitivity, his tastes, and his desires. Following trends is therefore neither an obligation nor a necessity. Today, however, the color chart is widely used and restricts the possible color choices for architectural façades, seeking harmony and thus giving way to repetition and sometimes monotony.

1.2. *Patrimonialization and coherence: many channels of vigilance*

Many cities that are UNESCO World Heritage Sites, such as Bordeaux, are 'living historic cities' and continue to evolve.

As a result, the aim of the approach proposed by UNESCO (2011) is to ensure that contemporary interventions blend harmoniously with heritage in a historic framework. In the case of Bordeaux, as described by Callais and Jeanmonod (2017), UNESCO recommends a degree of vigilance regarding "the coherence and unity of the ensemble of classical and neoclassical buildings […] and the quality of the public spaces." Some buildings, however, are colored with different and remarkable colors contrasting with the dominant colors of the surrounding context. Some other buildings are of natural materials, contributing to a rather monochrome landscape.

In order to respect the requirement to maintain a relationship with the existing architecture, the city of Bordeaux is well equipped with tools and experts.

We should mention the CLUB (Local Bordeaux UNESCO Committee), which has an advisory role in architectural and urban projects.

The PSMV (Safeguarding and Enhancement Plan) deals with the area within the protected perimeter, and the PLU (Local Urbanism Plan) with heritage throughout the rest of the city and protection of the areas around historic monuments across virtually the entire city.

The ABF (Architect for the Buildings of France) supervises all projects carried out within the protected areas.

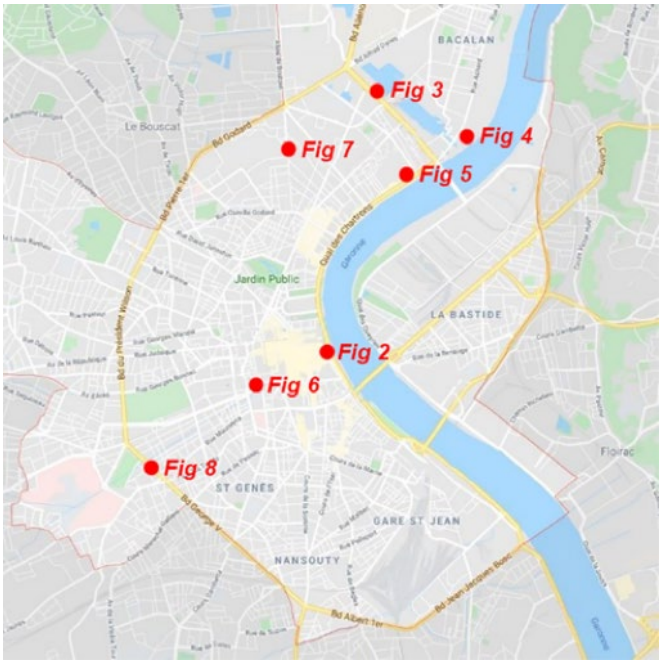

Fig. 1. Location in Bordeaux of buildings discussed.

1.3. *Color and visual integrity in Bordeaux*

Today, the only projects that are permitted are those which are simple and unremarkable in style, with a stone façade, and which do not disrupt the landscape, or projects whose architectural quality can allow for a degree of individuality, especially through color, and particularly in the case of public facilities.

In some cities, UNESCO experts have refused projects because they detracted from the city's visual integrity. This is defined as the means of "identifying, conserving and managing historic areas within their broader urban contexts, by considering the interrelationships of their physical forms, their spatial organization and connection, their natural features and setting, and their social, cultural and economic values." (UNESCO 2011).

However, being listed as a World Heritage Site is not necessarily a constraint to architects' creativity. Some designers venture to use color, whether at the urban scale or the architectural scale.

In this paper we explore the various manifestations of color to be found in the city of Bordeaux and identify their specific features by analyzing a few examples (Fig. 1).

2. The colors of the city

When we talk about color in a city, we must first distinguish between short-lived color and long-lasting color.

Short-lived color lasts for only a short time and includes advertising posters, paintings, street art, shop signs, etc. These colorful elements are ubiquitous in urban space and may even be predominant in relation to the color of the architecture. Therefore, short-lived color should not be neglected in the case of a global approach of color in urban areas.

Long-lasting colors give a place its chromatic identity, whether the colors are natural or created artificially using dyes. Jean-Philippe Lenclos (1982) talks about the "Geography of Color" as the result of close interactions between the use of materials found on-site and the application of colors linked to local traditions.

In Bordeaux, the stone has a range of hues, associated with different local quarries, and these dominate the landscape of the historic center, giving it its homogeneity (Fig. 2).

However, Bordeaux history shows that it was not always like that. In the Middle Ages, colors were only on public monuments and homes were characterized by half-timbered façades. Bordeaux was then the city of wood.

Then, the façade coatings from the 14th to the 19th centuries, as well as natural or varnished brick introduced by the Art Nouveau and Art Deco movements of the early 20th century, led to the colors of Bordeaux, in a city of stone mostly built in the 17th,18th and early 19th centuries.

Fig. 2. Bordeaux, city of stone. Photos © A. Herbert.

Subsequently, the Modern Movement was accompanied by two postures regarding the use of color in architecture. On the one hand, architects such as Adolf Loos (1913), defending the notion of truth in architecture, claimed that ornament (and thus color) was a crime and therefore refused to apply color to natural building materials. Some decades earlier, John Ruskin (1880:137) stated: "I think the colours of architecture should be those of natural stones; partly because more durable, but also because more perfect and graceful." Yves Charnay (2017), however, claims that material alone does not explain the use of the restrained stone colors. Rather moral and ideological reasoning going back to the 12th century has profoundly influenced French culture. Cistercians, thus, in contrast to Abbot Suger of St Denis, regarded color and ornament as representations of vanity but associated color of natural materials with truth and beauty.

On the other hand, color could be used to mark volumes or to make architecture more abstract such as promoted by the Dutch art movement De Stijl. In La Cité Frugès in Pessac, Le Corbusier used color to enhance space because "gray cement houses make an unbearable compressed clump, without air" (Barba and Peinado 2017).

Therefore, Bordeaux has been marked by different architectural styles over time, bringing other new colors to the architecture.

Now, when an urbanization or architectural project is carried out, color is used either to enable the project to merge into its setting, or to differentiate it. Although stone is the predominant material in Bordeaux, building in stone or respecting the stone color tones is not a stipulation in the planning documents.

Although there is no stipulation, a certain hierarchy emerges in Bordeaux, linked to the nature of the urban landscapes and the degree of heritage protection. The further we move from the historic center, the more freedom we see in the choice of colors.

For example, the Bassins à Flots district is differentiated from the historic city (Fig. 3). It has uniformity through its dominant material, metal. The colors of the metal cladding are varied, ranging from blue-gray to azure through black. The city of stone and the city of metal are adjacent yet differentiated, while both have the same underlying principle, that of unity.

Fig. 3. The Bassins à Flot district: two apartment buildings. Photos © A. Herbert.

Architects are rational in justifying their choice of colors for a project. This was the case for the wine museum Cité du Vin (2016) designed by Agence XTU (Fig. 4), whose "golden highlights evoke the blond (golden) stone of the Bordeaux façades."

Fig. 4. Cité du Vin. Photo © A. Herbert.

To objectify the choice of colors as much as possible, it is interesting to understand the surrounding colors in which the project is created. In this way, the colors of a building can be defined more precisely according to the approach to be adopted (tone on tone, contrast, and more).

Despite the development of these methods, color still eludes us and always has an element of subjectivity.

However, by determining the dominant colors that identify a place, as can be carried out for example using Lenclos' method (1982), one can position oneself more rightly within a project. This enables a better appreciation of the color context. The color choice is then not just a personal but a more objective, issue. Color is complex to manipulate, this is why there are different systems and tools available, such as color charts, to help deal with color in the city, especially in a historic city.

The complexity of the issue lies in the balance between the preservation of a chromatic identity and creative freedom.

3. Colored architectures

Differentiating a building from its context is not a straightforward process, nor is it without repercussions; the decision must justify the risk, otherwise it can result in the city being less legible with many landmark buildings.

Noury (2008:124) points out that, "Regarding colored architecture, there are two ways in which it can be embedded into its surroundings: integrating a new building into the urban landscape by harmonizing shades of color, or making a new construction contrasting visually with its environment."

In Bordeaux, we find that most contemporary colorful buildings are part of a specific program or are in a key location in the city.

3.1. *Color as transition in the city*

The Hotel Seeko'o, located at the corner of Cours Edouard-Vaillant and Quai de Bacalan, was completed in 2007 by King Kong Architects (Fig. 5).

The remit was to produce a high-end hotel, and this building aspires to be seen and to be a reference point in the city. What is striking at first is its large volume made up of perfectly smooth white Corian©. According to the architects, the project was designed on the scale of the city and connections between the neighborhoods.

Fig. 5. Hotel Seeko'o. Photo © A. Herbert.

Although a large part of the Bordeaux quayside offers up a uniform landscape, the urban fabric in this part of the city is "freer and less ordered", according to Costedoat (2007). Traditional in terms of its urban location yet contemporary in its architectural style, construction material and color, the Seeko'o perfectly masters its role in the transition between the classical city and the renewal taking place in the northern neighborhoods.

Square Pey Berland also illustrates this urban transition (Fig. 6). Designed in 2006 by architects Arsène-Henry and Triaud, this building contains apartments, offices and shops and is located at the junction between the traditional

city and the largely concrete-dominated ensembles in the Mériadeck district.

Fig. 6. Square Pey Berland. Photo © A. Bousigues.

With its façade cladding with Brazil stone colored brown ochre, it has been nicknamed the 'gingerbread' building. When the sun shines on it, the block looks very bright.

This is a very heterogeneous building in a heterogeneous place, creating the link between the classical city and the modern city, and is a reference point in the landscape.

Finally, the Arc-en-Ciel Building, designed by the architect Bernard Bühler, is also located at the edges of different sections of the city, between the city of stone and some of the new urban ensembles (Fig. 7).

Fig. 7. Arc-en-Ciel building. Photo © A. Herbert.

As its name suggests ('rainbow' in French), the specific feature of this social housing complex is its aesthetics, defined, beyond its overall form, by glass strips in a dozen different and contrasting colors which alter the perception of natural light. The architect justified this approach by the need to enhance social housing, which, in his opinion, is usually "sad and somber".

Although the intentions of the architect, here or in other examples, are to enhance social housing and make it an enjoyable place to live, it can be argued that paradoxically, this addition of color may in itself be stigmatizing. Indeed, the use of color is often reserved for this type of housing.

3.2. *Color as a means of identification*

Putting color on the front of one's home is a means of appropriation; it makes the building stand out from the rest. This color is a sign of identification for its occupants, it defines a unique space, their home; a customized dwelling which seems to be everyone's dream.

If we consider collective housing, then the theory is quite different. The occupants are distanced from these issues and the framework for decision-making seems to give the architect sole responsibility for this choice.

If we look at the different stages in the design of the façades of the Stadion building, we see how this decision-making takes place in a way that is becoming more and more widespread (Fig. 8).

Fig. 8. The Stadion. Photo © A. Bousigues.

The Stadion is a collective housing building containing 15 homes, built by LS Architects and Associates in 2011 on one of the Bordeaux boulevards. The site marked by a great architectural diversity, even with the presence of buildings with exceptional architecture, legitimizes the proposal of a unique building in terms of color. On its contemporary façade, volumes are highlighted in gray and yellow. These colors were chosen after a three-way discussion between the architect, the city's architect-consultant and the client. The objective was to use a material that would enhance the aesthetic aspect of the building while being resistant and affordable financially.

3.3. *Color and materiality*

The colors on the façades of the Stadion are used differently. The reconstituted fiberboard panels, the main constituent element of the façade, are through-dyed in gray. The manufacturer guarantees the consistency of the

material over time, especially its weather resistance. Meanwhile, the loggias are painted yellow. By its very nature, paintwork requires maintenance. It is much less long lasting and is therefore easier and less costly to change over time.

According to Van Doesburg's definition (1924), the yellow on this façade is a decorative color, a means of decorating the surface, as a simple addition or ornamentation; the gray, however, is a plastic color as it becomes a material of expression and has "a value equivalent to all materials such as stone, iron, glass."

4. Conclusion

This analysis of some urban and architectural examples shows that in a UNESCO World Heritage city the use of color in architecture is associated as much with the architect's position and reputation, as with the building's location in the city or its function.

Designers opting for color in architecture often feel the need to justify and rationalize their choice, in particular by focusing on the existing environment. Yet the color choice is usually influenced by subjectivity and hence by the architect's own taste, or the tastes of other players in the city who intervene at different stages of the project.

Colored buildings may be few and far between in the city of stone, but they are often to be found in places of urban divide between two landscapes. The further we move from the historic center, the more colored buildings we come across. Color is also used to identify a building, to distinguish it from others, to allow its appropriation by adopting shades that are thought to be appreciated by the citizens concerned.

In any case, colors seem to be complex to manage (Servantie 2007). Nevertheless, by determining the predominant colors and identities of a place it is possible to focus a project more precisely, thus making it easier for residents to appropriate the space.

In the case of Bordeaux, it seems that the acceptance of a colored building depends of its level of adaptation regarding the territory concerned more than the use of a common reglementation for all the city.

5. Conflict of interest declaration

The authors declare that nothing affected their objectivity or independence and original work. Therefore, no conflict of interest exists.

6. Funding source declaration

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

7. Acknowledgment

The authors wish to thank Chantal Callais and Thierry Jeanmonod, who initiated this study, as well as the architects who agreed to answer our questions, allowing us to collect the data needed to finalize this work.

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References

Barba, J. J. and Peinado, I. (2017) Le Corbusier's Cité Frugès: prototype city of workers in the 1920's. Metalocus, 8 October 2017, https://www.metalocus.es/en/news/le-corbusiers-cite-fruges-prototype-city-workers-1920s. (Accessed: 16 December 2019).

Callais, C. and Jeanmonod T. (2017) Bordeaux, la fabrique d'un patrimoine: Paysages d'une 'cité historique vivante'. Bordeaux: ensapBx.

Charnay, Y. (2017) 'Paris, une ville lumineuse aux couleurs discrètes,' Environmental Colour Design: Theory and Practice, Schindler, V. M. and Griber Y. A. (eds.) Social Transformations, 27, Smolensk: Smolensk State University Publishing House, pp. 37–49.

Costedoat, D. (2007) Hôtel Seeko'o, atelier d'architecture King Kong. Bordeaux: Overworld.

Déribéré, M. (1964) La couleur. Paris: Presses Universitaires de France.

Cité du Vin (2016) Available at: www.laciteduvin.com/fr/explorez-la-cite-du-vin/architecture/edifice (Accessed: 12 December 2016).

Lenclos, J. P. and Lenclos D. (1982) Les couleurs de la France: maisons et paysages. Paris: Le Moniteur.

Loos, A. (1913) 'Ornement et Crime.' Les Cahiers d'aujourd'hui, 5, pp. 247–256.

Lynch, K. (1960) The Image of the city. Cambridge, MA: Massachusetts Institute of Technology Press.

Noury, L. (2008) La couleur dans la ville. Paris: Le Moniteur.

Ruskin, J. (1880) The seven lamps of architecture. Mineola NY: Dover Publications.

Servantie, M. P. (2007) Chromo-Architecture: l'art de construire en couleur. Paris: Alternatives.

Soulié, L. (1988) 'Contre les rues supermarchés.' Parinaud, A. (ed.) La couleur et la nature dans la ville: murs peints, sols, fontaine' Paris: Editions du Moniteur.

UNESCO. Recommendations on the historic urban landscape (2011) Records of the General Conference 36th Session, Vol. 1. Paris: UNESCO, pp. 57–62.

Van Doesburg, T. (1924) 'La signification de la couleur en architecture.' La Cité, 4(10), pp. 181–187.

Colour design of textile architectural envelopes: an initial study

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ABSTRACT

Textile materials are now widely used in the construction of architectural envelopes. Even if a wide range of colours is available today, only few of them seem to be preferred by the designers. A better understanding of this phenomena could be achieved through the study of the use of colour in relation to these architectural artefacts. In order to do so, the paper aims to show some of the interactions between the colour of textile architectural installations and some of the components that affect their design, in particular: form, function, lighting technologies and the context. The methodology of the research is based on a selected sample of buildings. These buildings have been investigated according to their surface colours and a set of other criteria. The results showed that white is the most widespread colour for this type of buildings. White seems to be strategic for enhancing complex and irregular forms and as a background for light projections, especially when the building needs to be highlighted in the context. Multi-coloured surfaces seem to be preferred in temporary installations as well as in suburban or rural contexts. In general, the expected lifespan of these buildings and of their materials seems to be very important for the colour choice. This initial study is dedicated to architectural designers interested in the use of textile materials for the building envelope.

KEYWORDS Textile Architecture, Textile Materials, Colour Design, Architectural Design

RECEIVED 08 October 2019; **REVISED** 25 November 2019; **ACCEPTED** 27 November 2019

1. Introduction

In the last decades textile materials, due to the evolution of textile composites, are more widely utilised in architectural applications (Fritz 2011). Current textile composites are used for the design of the whole building envelope, as well as for canopies, tensile structures, claddings and solar shading devices. The colour of architectural textile materials has always had an important role in different cultures (Gasparini and Zennaro 2007). Without going too far back in time, in modern Western society, we may say that high-tech textiles architectures (Chilton 2010) are mainly characterized by whitish colours. Even today, a simple Google search with the keyword 'textile architecture' will produce a predominant number of whitish installations (Fig. 1). However, since textiles are filters for the daylight, white is the colour that allows a good diffused light into the building (Schock 2001).

In the last years, like for many other types of architectural claddings (Zennaro 2014), we have seen an increasing use of highly coloured architectural textile surfaces. These 'new' colours could be permanent (e.g. with high saturation) or temporary (e.g. light projected, light emitted), as for some types of textiles (Ritter 2013). The choice of colour could be made according to the function of the textile object and other criteria (Premier 2012). The investigation sought to better understand and discuss the use of colour in relation to some of the features of the architectural design of buildings, especially when colours other than white and grey are used.

Fig. 1. China Corporate United Pavilion of Expo Milano 2015 in Italy, designed by the Architectural Design and Research Institute of Tongji University Ltd. A typical example of whitish textile surface. Photo © Alessandro Premier.

2. Research background

Textile materials are often used in temporary installations where colour is strategic for visual impact (Fig. 2), but they are also used in claddings and shading devices with the same purposes (Fig. 1, Table 1). The colour is strongly influenced by the form of the object, that can be regular or irregular (Trautz 2009). Regular forms (based on primary solids or their combinations) or irregular forms (free-forms, parametric, hypersurfaces) (Oosterhuis 2012) can produce different interactions with colour. A typical example is the *chiaroscuro* effect played by white or greyish volumes. Another important aspect is the function of the object: building envelopes, claddings, solar shadings and canopies have all different needs when dealing with colour design, especially if we consider the intended use of the artefact. The functions of a textile envelope can be: cladding, shading and shelter (Chilton 2010). Surface texture quality can be an additional element of complexity. The colour of textiles can also be affected by the integration of lighting technologies. Often, the object becomes a screen for night-light projections and this can be strongly related to the temporary nature of the object itself (e.g., designed for a specific event) or to the use of textiles as a screen (Fig. 2). Another important criterion is the chromatic relationship between the object and the surrounding environment. Colour can be used to merge the object into the context or to highlight it. For instance, urban areas can be affected by saturated colours (Fig. 3) as well as suburban areas, where the greyscale predominates (Premier 2012). Three different types of context have been identified: urban, suburban and rural (Nguyen and Teller 2016) and two different strategies have been associated to them: to blend or to highlight the building into the context.

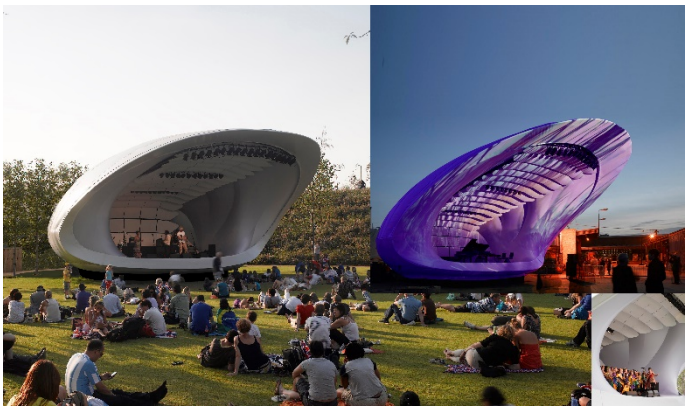

Fig. 2. Soundforms Pavilion, Olympic Park, London, 2012. The white cladding becomes a surface for light projections. Photo © Nick Guttridge (Courtesy of ES Global Ltd).

Fig. 3. SelgasCano Pavilion, Bruges, Contemporary Art and Architecture Triennial, 2018. A temporary installation with a 'one colour' envelope. Design by Lucía Cano, José Selgas. Photo © Iwan Baan (Courtesy of SelgasCano).

3. Objectives

The aim of this paper is to discuss some of the interactions between the colour of textile architectural installations and some features of their design. In particular, the research is targeting the relationships between colour and form, function, temporary lighting technologies and context. This without neglecting other important criteria as location, lifespan and materials that will be the subjects of further investigations. This study could be useful for designers interested in the chromatic design of textile surfaces for architecture, to identify under what circumstances and with which modalities is possible to use certain colour strategies in order to obtain specific results. In particular, this study aims to question some of the reasons that may underlie the choice of colours or colour combinations that are different from the white or grey scale.

4. Method

The research is based on a sample of buildings built between the years 2000 and 2018. The information on these buildings was collected from 2009 to 2019 for a series of more than thirty articles developed for the Italian magazines Tenda In & Out, and Tenda International (Tenda in & out 2018). A final limited selection of twenty-eight textile architectures and shading skins has been identified according to the objectives of the research. The buildings have been studied according to their surface colour, the form of the building, the function of the textile material, the implementation of light projections and the colour strategy for the context. A comparison between the materials of the fibres' coating has been added. The goal was to identify a set of relationships between the surface colour and the criteria shown in Table 1, in order to better identify the colour strategies adopted for environmental design.

BUILDINGS	**Colour category**	Whitish One colour Multiple colours
	Form	Regular Irregular
	Function	Cladding Shading Shelter
	Fibres coating	PVC PTFE GFRP PVDF Other
	Lifespan	Permanent Temporary
	Lighting technology	Yes No
	Context	Urban Suburban Rural
	Context strategy	To merge To highlight

Table 1. The criteria of the research.

The study of the surface colours was developed using the database of pictures provided by the designers of the case studies. The images were processed using Adobe Photoshop: RBG values were sampled and the colours were sorted using the closest NCS colour codes (Arbab et al. 2018) (Table 2). This process allowed us to identify three colour categories for these textile surfaces: whitish, one colour, multiple colours.

	Building	Function	Colour category	RGBs	Lighting	Context
1	Chanel Mobile Art Pavilion	Cladding	Whitish		NO	Urban
2	Burnham Pavilion	Cladding	Whitish		YES	Urban
3	Gardens by the Bay	Shading	Whitish		NO	Urban
7	Soundforms	Cladding	Whitish		YES	Urban
8	Zurich Headquarters	Shading	Whitish		NO	Urban
11	Outdoor Room	Shelter	Whitish		NO	Suburban
13	Expo 2015 China CCUP Pavilion	Cladding	Whitish		NO	Suburban
21	2018 Bruges Triennale Pavilion	Shelter	One colour		NO	Urban
22	Le Albere	Shading	One colour		NO	Suburban
23	Ark Nova	Shelter	One colour		NO	Rural
28	Cressy School	Shading	Multiple colours		NO	Suburban

Table 2. Buildings: excerpt from the synoptic table.

The other criteria of the research were collected in a synoptic table and studied using a MS Excel sheet. Year and location of the buildings have been considered. A comparison between the identified colours and the other criteria has been carried out. The data have been collected in charts in order to study these relationships.

5. Results and discussion

As predicted, the majority of the case studies had whitish surfaces (from white to light grey). This is the most widespread colour range of textile membranes for architecture. There were seventeen case studies with a whitish coloured envelope. Six case studies used a single colour surface (not in the greyscale) and a further five demonstrated the use of multi-coloured combinations.

5.1. *Colour and form*

The comparison between the three colour categories and the form of the buildings has shown that whitish surfaces seem to be the most frequent solution for complex and irregular forms. The *chiaroscuro* play of volumes and shapes is certainly enhanced by a 'one colour' surface, and above all, white. This is also connected to the wide use of whitish surfaces in Modernist architecture (Klinkhammer 2004). The combination of form and whitish surfaces is also related to the fact that these buildings maintain lower surface temperatures in hot climates, thus allowing better indoor performances. In regard to the location, twenty-one case studies were in Europe, four in Asia, two in the US and one in Africa. Wide literature is dedicated to the use of light/cool colours and coatings in warm climates (Synnefa et al. 2007).

The use of white, like the use of other colours, might be related to communication purposes. For instance, if we consider the CCUP Pavilion at Milan 2015 Expo (Fig. 1), the choice of the whitish envelope might be related to the symbolic objective of the design. The pavilion was called 'Seeds of China' and drawing on the symbolism of the seed, it interpreted the idea of a group of Chinese companies that wanted to show their 'values' of conservation of natural resources and food security. The image of power that arises from the breaking of ground to the sprouting of seeds has inspired the design of form and colour of the CCUP Pavilion (Wang 2015).

5.2. *Colour and function*

The study of the relationships between colour and function of the textile surface shows that, although whitish colours are the most widespread for all the three functions, there seems to be a strong preference for their use in claddings. In the cladding category there are no 'one colour' surfaces. In addition, the substantial balance of the three colour categories for the shading function seems to be relevant. In the design of shading devices, greyish and dark surfaces allow a higher performance of the combination window-shading device (Carlo Giovanardi & C. snc 2017). This could be a motivation behind the colour choices for the 'shading' function. Three out of four case studies with 'multiple colours' surfaces had shading devices. An example of a façade with multi-coloured shading is the School Centre in Cressy (Fig. 4).

Fig. 4. School Centre in Cressy (CH) (2002–2006) designed by dl-a (designlab-architecture). An example of a façade with multiple colours. Photo © Fausto Pluchinotta (Courtesy of Serge Ferrari).

The building is characterized by a double skin glass façade that guarantees a rational management of the heat exchange between building and environment. The outer skin is configured as a structural glass cladding (spider-glass façade). The façade is coloured by the presence of vertical awnings installed in the cavity between the two skins. The façade is thus defined by the vertical bands marked by the different colours of the awnings. The fabric used is a Soltis 92 by Serge Ferrari suitable for façade applications (Serge Ferrari SAS 2012). The chromatic alternation of vertical bands plays a contrast between cold and warm colours: green, yellow, orange, light blue, beige (Fig. 4). At night, the double skin lights up depending on the energy accumulated during the day. The light filtered by the coloured shading devices is reflected on the internal walls of the building, creating a complex play of colours (Premier 2012). This is allowed by the function of the building (an early childhood centre) where colour has a strategic importance for learning (Zennaro 2015). On the contrary: whitish surfaces allow a diffused daylight into the building and the light is not affected by any coloured filter. This use of whitish colours for shading is essential where high accuracy on colour rendering is needed. For instance,

in museums (to appreciate paintings and other artworks), in libraries (to facilitate reading) and in offices (especially where people work with images).

Among the shelters there is a clear prevalence of 'one colour' solutions. Examples of non-whitish 'one-colour' shelters are the water pavilion by SelgasCano (Fig. 3) and the Ark Nova pavilion by Arata Isozaki and Anish Kapoor (Fig. 5).

Fig. 5. Lucerne Festival Ark Nova. 2015 Installation in Fukushima. Design by Arata Isozaki and Anish Kapoor. Photo © Yu Terayama (Courtesy of Lucerne Festival Ark Nova).

5.3. *Colour and lighting technology*

The comparison between the colours and the presence of lighting technologies shows that only whitish surfaces are used as screens for night-light projections (Fig. 2). It is evident that a whitish colour, or a neutral light grey, is better suited as a screen for bright chromatic projections. In fact, with these technologies and with smart-textile technologies almost any colour is achievable and it is possible to use these colours only when it is needed (Gasparini 2017). At certain times or in a specific place (e.g. if we talk about temporary architectures) it might not be appropriate to have a brightly coloured cladding and with these on-off technologies the problem is easily manageable. It goes without saying that highly saturated surfaces are not the best option for colour rendering in light projections.

5.4. *Colour and context*

The data regarding the context in which the buildings were located show that in urban areas, as city centres or historical centres, there are only 'whitish' and 'one colour' surfaces, while in the other contexts the other colour strategies are quite well distributed, even if there is a higher percentage of whitish surfaces. This data can be related to the fact that in city centres, 'multiple colours' surfaces are often not allowed for preservation reasons, while in other areas this is possible.

An example of 'one colour' surface in an historical context is the water pavilion designed by SelgasCano (Fig. 3). The water pavilion was built for the Bruges 2018 Triennale in Belgium. Launched in 2015, in its second edition (2018) it focused on the topic of the 'Liquid City', with reference to the Bruges watercourse network and according to the famous concept of liquid modernity (Bauman 2000). The pavilion, located in the canal called Coupure, was a temporary floating installation and served mainly as a platform for bathing and sunbathing. The installation consisted of a structure composed of steel bars covered with a fluorescent pink-orange vinyl membrane. The waterproof cladding was mounted on a floating wooden platform painted in yellow in order to stand out against the dark water of the canal (Premier 2019). Natural light passed through the skin of the pavilion creating a surprising and unsettling atmosphere that changed the usual perception of the old city. The structure had two irregularly shaped openings at the ends and curved around a void in the centre of the platform to form a tunnel through which visitors could move freely. The Spanish architects José Selgas and Lucía Cano are mainly known for the 2015 Serpentine Pavilion in London (Premier 2018). Their work is characterized by the use of polymer-derived materials and highly saturated colours.

5.5. *Context strategy*

The general result of the context strategy was a balance between the buildings designed to stand out from their context and buildings designed to merge into the context: fifteen buildings were considered 'highlighted', while thirteen buildings were considered 'merged' into their context. These results should be compared with the surface colour, the building form and the presence of lighting technologies. It was found that colour is not the only strategy used by designers to achieve one of the two objectives. For instance, amongst the whitish surfaces, ten buildings out of seventeen were designed to be highlighted in the context. This result was achieved mainly through unusual and irregular forms; an example being the Chanel Mobile Art Pavilion designed by Zaha Hadid. Some of these buildings were highlighted in the context only by the use of lighting technologies: for example, is the envelope of the Luanda Multisports Pavilion in Angola with its sandy colour during the day and the coloured lights during the night (Fig. 6). On the contrary, amongst the 'one colour' surfaces four out of six buildings were designed to merge into the context. This was achieved by the use of unsaturated or brownish colours.

Fig. 6. Luanda Multisports Pavilion by Berger Arquitectos. Photo © Berger Arquitectos.

5.6. *Coating and lifespan*

Amongst the case studies, twenty buildings (71%) involved PVC coated textiles; only three involved PTFE coatings; individual case studies involved PTE, PVDF, ETFE, GFRP and aluminium mesh. The results did not show any evident relationship between the colour and the coating of the fibres. Likewise, permanent and temporary buildings were equally distributed amongst the three colour categories. However, many considerations can be made on the use of these materials, their colour and the lifespan of the object.

First, in permanent buildings greyish surfaces could be preferred because they show less stains and dirt, while white surfaces highlight the stains and dirt more. Discoloration of PVC coatings is also a well-known issue (Yousif and Hasan 2015), thus white can be generally favourable also for this reason. Another reason that could be related to the choice of whitish or greyish surfaces is the cost: higher request/quantity means lower prices according to economy of scale (Azcarate 2014). Thus, if white is the most utilised colour, this is likely also to happen in the future.

PVC is the most frequent coating material. The PVC coated polyester fabric is a common material in tensile structures. Its durability is guaranteed for ten years. It is presented in a wide variety of colours and is suitable for digital printing. Texyloop® technology has been developed to recycle these types of fabric. (Serge Ferrari SAS 2019). The PVC coating contains UV stabilizers against yellowing and fading, fireproof and anti-fungicide additives (Serge Ferrari SAS 2017).

6. Conclusions

This project is a small part of a wider research endeavour, focussed on solar shading devices, started by the author twelve years ago. The limited number of twenty-eight selected buildings is due to the specific features necessary for the study: textile materials and additional functions (claddings and shelters). The number of buildings will be extended in the future to develop all the topics that emerged from this initial study. The goal of this study was to highlight and discuss some of the interactions between the colour of textile architectural installations and some features of their design. In particular, the research targeted the relationships between colour, form, function, lighting technologies and context. Three colour categories were identified: whitish surfaces, ‘one colour’ surfaces and ‘multiple colours’ surfaces. The whitish surfaces were the most widespread for all types of applications: some considerations on the reasons for the choice of this color have been presented. The three colour categories were then compared with the other criteria of the research (Table 1). Some results are summarized below.

Colour and form. White seems to be more used for irregular forms: in those situations, form (not colour) is the main tool to highlight the building in the context.

Colour and function. There is a fairly regular distribution of the three colour categories for shadings. In shadings, multi-coloured solutions seem to be more frequent, but this strategy can be adopted only for some types of buildings.

Colour and lighting technologies. Whitish surfaces are better suited to the integration with lighting technologies and light projections. In those situations, temporary colours are used to highlight the building, but only at night. The building might merge into the context during the day.

Colour and context strategy. Multi-coloured surfaces seem to be not particularly common in urban centres, but they can be easily integrated in other contexts.

Colour and lifespan. In temporary buildings the colour choice can be adapted to a wider range of chromatic schemes. The lifespan of the material is also very important for the colour choice. Generally, whitish and greyish colours are more durable than others.

This paper voluntarily omits some aspects related to the history and culture of colour of textile materials presented by the author in other publications. Further research can be carried out on the choice of colour in relation to the performances of these materials in specific climate zone.

7. Conflict of interest declaration

The author declares that he has no conflicts of interest.

8. Funding source declaration

The author received no specific funding for this work.

9. Acknowledgment

This research has been carried out using the material developed by the author in a number of articles for the magazines Tenda in & out published by Maggioli. I thank the designers and the companies cited in the article for providing drawings and technical data related to projects and materials.

10. Short biography of the author

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References

Arbab, S., Brindle, J. A., Matusiak, B. S. and Klöckner, C. A. (2018) 'Categorisation of Colour Terms Using New Validation Tools: A Case Study and Implications'. I-Perception, 9(2). doi.org/10.1177/2041669518760043.

Azcarate Aguerre, J. F. (2014) Façades as a Product-Service System The potential of new business-to-client relations in the façade industry. Thesis in Master of Science and Building Technology. TU Delft. https://repository.tudelft.nl/islandora/object/uuid:0aca38e7-81ae-4ca7-9b1f-ffcf0f2e33fc?collection=education

Bauman, Z. (2000) Liquid modernity. Cambridge, UK: Polity Press.

Carlo Giovanardi & C. snc. (2017) Screen SG 989.

Chilton, J. (2010) 'Tensile structures – textiles for architecture and design'. Textiles, Polymers and Composites for Buildings, Pohl G. (ed.) Cambridge, UK: Woodhead Publishing, pp. 229–257. doi.org/10.1533/9780845699994.2.229.

Fritz, S. (2011) 'The very fabric of architecture: textile use in construction'. Architonic, 20 August 2011. Available at: https://www.architonic.com/en/story/susanne-fritz-the-very-fabric-of-architecture-textile-use-in-construction/7000625 (Accessed: 28 April 2019).

Gasparini, K. (2017) 'Media-surface design for urban regeneration: the role of colour and light for public space usability'. Journal of the International Colour Association, 17, pp. 38–49.

Gasparini, K. and Zennaro, P. (2007) 'Colore e design nella produzione di schermature solari tessili'. Il colore nella produzione di architettura, Zennaro, P. (ed.) Verona: Ipertesto Edizioni.

Klinkhammer, B. (2004) 'Creation of the Myth: “White” Modernism'. 92nd ACSA Annual Meeting, Miami, FL, pp. 429–434.

Nguyen, N. L., and Teller, J. (2016) Colour in the urban environment: a tool for the chromatic analysis of spatial coherence. Liège: University of Liège. https://orbi.uliege.be/handle/2268/20175.

Oosterhuis, K. (2012) 'Simply complex, toward a new kind of building'. Frontiers of Architectural Research, 1(4), pp. 411–420. doi.org/10.1016/J.FOAR.2012.08.003.

Premier, A. (2012) Superfici dinamiche: le schermature mobili nel progetto di architettura: innovazione tecnologica, architectural design, sostenibilità. Milan: Franco Angeli.

Premier, A. (2018) 'Outdoor textile design: manufatti leggeri e materiali innovativi'. Tenda in & out, 2, pp. 40–49.

Premier, A. (2019) 'Architetture tessili per eventi culturali'. Tenda in & out, 1, pp. 80–87.

Ritter, A. (2013) 'Architectural applications of smart textiles'. Multidisciplinary Know-How for Smart-Textiles Developers, Kirstein, T. (ed.) Cambridge, UK: Woodhead Publishing, pp. 468–488. doi.org/10.1533/9780857093530.3.468.

Schock, H.-J. (2001) Atlante delle tensostrutture. Milan: Utet Scienze Tecniche.

Serge Ferrari SAS (2012) Soltis 92.

Serge Ferrari SAS (2017) Precontraint 702 S2 & 702 Fluotop T2.

Serge Ferrari SAS (2019) Soltis Horizon 86. Transparency and Natural Light.

Synnefa, A., Santamouris, M. and Apostolakis, K. (2007) 'On the development, optical properties and thermal performance of cool colored coatings for the urban environment'. Solar Energy, 81(4), pp. 488–497. doi.org/10.1016/j.solener.2006.08.005.

Tenda in & out (2018) Tenda International–Tendain. Available at: Maggioli: http://www.tendain.it/rivista-international/ (Accessed: 20 July 2019).

Trautz, M. (2009) 'The application of folded plate principles on spatial structures with regular, irregular and free-form geometries'. Proceedings of the International Association for Shell and Spatial Structures (IASS) Symposium 2009, Evolution and Trends in Design, Analysis and Construction of Shell and Spatial Structures, Domingo A. and Lazaro C. (eds.), Valencia: Universidad Politecnica de Valencia, pp. 1019–1031.

Wang, J. (2015) Seeds of China. Exploring the Design of China Corporate United Pavilion Expo 2015. Available at: http://finance.cnr.cn/zt/mlsb/gd/20151228/t20151228_520955141.shtml (Accessed: 8 October 2019).

Yousif, E. and Hasan, A. (2015) 'Photostabilization of poly(vinyl chloride) – Still on the run'. Journal of Taibah University for Science, *9*(4), pp. 421–448. doi.org/10.1016/j.jtusci.2014.09.007.

Zennaro, P. (2014) 'Il ruolo del colore nella costruzione'. Archi: Rivista Svizzera Di Architettura, 2, pp. 45–49.

Zennaro, P. (2015) Il colore delle scuole. Rimini: Maggioli.

Emerging colours: new trends, demands and challenges in contemporary urban environments

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ABSTRACT

The concept of colour in urban settings has traditionally been associated with architectural colour palettes or urban colour planning. However, in contrast to the generally whitish or grey architectural environment, the use of saturated colours presented in dramatic ways has emerged as a trend in urban settings since the beginning of the 21st century. This study examines this globally occurring 'colourful' phenomenon and argues that emerging colours have distinct features, varying from design intentions to design impacts. Focusing on projects in urban public space, this paper positions the phenomenon in the contemporary urban context and attempts to explain the conditions and driving forces behind it. By exploring the use of saturated colours in a context, we argue that colour has been engaged as an active design element to respond to the demands and challenges of contemporary urban environments. Furthermore, new demands can be observed that accelerate the spread of the use of emerging colours globally. We suggest that it is time for a critical review and evaluation of the phenomenon as part of understanding contemporary urban and landscape design culture. Such an understanding will allow us to have updated references for environmental colour design in contemporary urban contexts, and to use colour effectively.

KEYWORDS Saturated Colour, Environmental Colour Design, Contemporary Urban Environment

RECEIVED 14 October 2019; **REVISED** 27 November 2019; **ACCEPTED** 04 December 2019

1. Introduction

Colour has always been a controversial aspect within the history of architecture in Western culture. With prejudices about colour and uncertainty when using colour in architectural design, the general image of built environments has been whitish or grey (although there are notable exceptions), especially since the advent of the Modernist era in architecture (Batchelor 2000:21–48). However, since the beginning of the 21st century, more colourful expressions have emerged in urban environments. Unlike the conservative colour palettes in traditional environmental design, such as colours inherent in materials or prevalent neutral tones, the 'new' colours are vivid and bright and easily stand out from their surroundings. Apart from the use of colour on architectural façades, these emerging colours have also spread to urban environments through forms of street art, temporary installations, and urban and landscape design.

Aware of the inspiring ways colour is being used, some studies have explored these 'new' colours in urban environments from different perspectives. For example, Borsotti (2019) focuses on the use of strong colours in contemporary architecture with the intention of chromatic interventions and argues that colour serves different functions and should be considered as an integral part of architectural design. Boeri (2017) considers colour in association with different components of the urban environment and proposes to understand colour from the perspective of placemaking (transforming spaces into living places), which can play a role in city transformation and urban colour planning. Despite these differences in focus, researchers acknowledge the changing role of colour and emphasise the need to look into the function of 'new' colours in urban environments.

To investigate how the 'new' colours interact with contemporary urban contexts from a design perspective, we focus on an assessment of design projects in urban public space, in which the outcome of the colour design is a collective decision and responds to specific demands. Therefore, in this paper, the phrase 'emerging colours' mainly refers to the growing number of urban and landscape design projects in urban public space characterised by saturated colours that are distinct from and sharply contrast with their surroundings. Through the comparison between examples of the new phenomenon and traditional environmental colour use, notable differences and tendencies of colour design in contemporary urban environments can be identified.

2. Colour design as a new phenomenon

In this paper we identify and present three main aspects to illustrate the features and trends of the emerging colours in urban public space. New phenomena and design decisions about the use of colour can be considered to be a result of constant interactions within contemporary urban settings.

2.1. *The role and functions of colour*

Architectural colour design and urban colour planning are the two major branches of traditional environmental colour design in urban contexts, which have been profoundly influenced by the historical perspectives on colour in architecture. In architectural discourses, colour has been deemed secondary to form (Braham 2002) and a less important element of visual design which mainly serves decorative purposes (Caivano 2006). For many architects, colour is an intractable element that should be carefully controlled, while 'safe' colour palettes are generally preferred (McLachlan et al. 2015). Researchers and practitioners have both looked for the principles of integrating colour into the environment to create harmony, which in many cases, means that colour is an unobtrusive element in the design. Nevertheless, in nature, a wide range of colours can coexist, and different colour combinations are considered as an intrinsic and regional feature, which gives character to landscapes (Bell 2019). Although the potential and function of colour in environments has been revealed in many studies (e.g., Lenclos and Lenclos 2004; Swirnoff 2000; Mahnke 1996), the role of colour generally remains ambiguous in many architectural practices compared to other design elements such as form, scale and shape.

Nevertheless, instead of being used submissively, the role of colour has been redefined in the emerging phenomenon in which colour has been used as an effective tool to achieve specific design intentions. Since the 1960s fresh views and open attitudes towards bold and saturated colours have been introduced to the public through numerous art and design movements. The general acceptance and greater freedom of using colour have inspired more colourful expressions in urban environments. With the recognition of the potential and effects of colour, designers have begun to endow it with specific roles and functions in urban public space over the last few decades. Learning from previous movements, such as Supergraphics during the 1960s, saturated colours have been increasingly used in urban environments for different occasions due to their ability to attract attention, communicate visually and provide instant changes. The 1984 Summer Olympics in Los Angeles is a good example to show how vivid colours on a large scale interact with urban settings. As an instant and inexpensive

approach, colourful installations transformed the entire city into a venue for the celebration, while bright colours were also embedded in signage designs for wayfinding (Jerde 2019).

Since the 2000s, more urban and landscape design projects started to involve saturated colours in ordinary situations, while the budget is no longer the determinant for selecting bright colours. Examples can be found in many urban interventions such as Superkilen Park (2012) in Copenhagen, Pink Street (2011) in Lisbon, and Garscube Landscape Link (2010) in Glasgow, where vibrant colours were introduced to raise attention and claim the renewal of the places. The distinct colour features transformed monotonous sites from being a 'nowhere' into places with a new identity. Bright colour palettes applied at large scale are believed to have positive psychological effects (McMorrough 2007), which assist the process of urban intervention to generate a better ambience.

In other design practices, colours have been selected not only for their attractive appearance but also for their capacity to build connections and associations, which allows colour to serve different intentions simultaneously. Colour has always been applied as a powerful tool for visual communication and to increase publicity. Like the famous case, Coca-Cola red, colour has been widely used to represent a brand or a product in advertisements. In the new phenomenon, these functions of colour have been introduced to the field of urban and landscape design to serve design intentions.

A key example of this branding role of colour is the fourth edition of Pigalle Basketball Court (2017) in Paris, delivered right after the announcement of the new 2017 Nike and Pigalle fashion collection, which refers to the colour palette from the fashion collection (Fig. 1). Dramatic hues have been applied to this urban space in an attempt to define a new dynamic sports environment for the local community, while at the same time carrying out the function of promotion.

The popularity of this colourful court on the web and in a real place increases the publicity for the fashion collection that shares similar hues. The colour palette creates connections between fashion products and urban public space and plays a definitive role in attracting attention and branding.

The associations between colour and contemporary cultural icons make particular colours or colour combinations a powerful tool for communicating and publicizing ideas in urban environments. The art installation, Pink Balls, became a landmark during the annual celebration in the Gay Village of Montreal (2011–2016). Over a hundred thousand pink balls suspended above the street created a stage for people to enjoy and celebrate their culture. Inspired by the rainbow flag of the LGBTQI community, the colour pink has been upgraded to six hues from the rainbow spectrum in the latest version (Cormier 2017–2019). The bright hues create an atmosphere of celebration while the symbolism of colour in this given context expresses the intention of supporting the diversity in society. The vibrant colours with embedded meanings not only appeal to groups who share the same culture but also general audiences who enjoy the colourful scene.

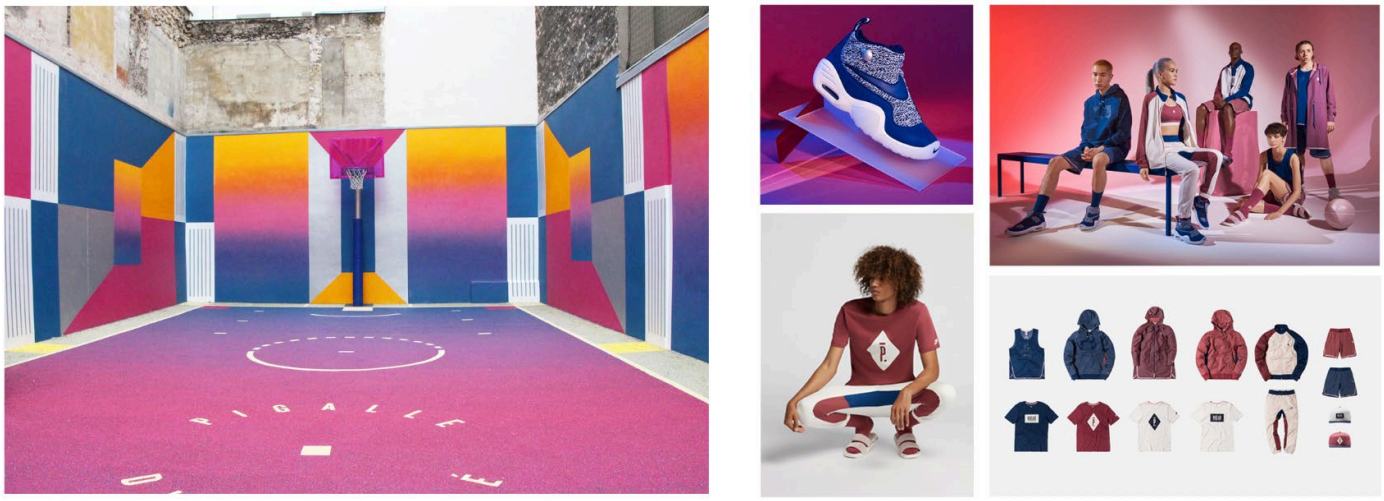

Fig. 1. Pigalle Basketball Court, 2017 (left). Photo © Beichen Yu. A selection of images from the search result of 'Pigalle Nike 2017' (right).

The above-mentioned examples show that the design of colour responds to contemporary urban settings directly, and saturated colours are selected intentionally to provide solutions for specific situations. Instead of being an inconspicuous element in the built environment, the new colour scheme often creates a distinct contrast to the original colour palette in order to facilitate instant changes and new functions within the space. In this emerging phenomenon, the decision of colour is no longer limited by the framework for colour design in architecture and urban colour planning but is open to a broader range of options based on a better understanding of the role and function of colour in urban public space.

2.2. *The participants of colour design*

In traditional environmental colour design, architects and professionals from relevant backgrounds are in charge of colour decisions, and in general, they tend to prefer neutral colours and 'safe' colour palettes despite the significant changes in architectural styles (McLachlan et al. 2015). Doherty (2011) argues that not many opinions on the use of colour are heard from urbanists and that artists appear to be more comfortable with colour than urbanists. It is unfair to assume that most architects are less familiar with chromatic expressions compared to designers or artists despite the fact that they receive more colour training during their education than architectural students (McLachlan 2013). However, it is notable that professionals from different disciplines may have different ideas and expertise in using colour. Over the last two decades, creative groups from diverse backgrounds have begun to express their opinions about colour in urban environments. The increasing number of interdisciplinary collaborations in urban and landscape design and the popularity of public art encourage the appearance of new colour expressions. The saturated colour palettes that have usually been used in interior design, graphic design, fashion and art have been introduced to the urban realm, which blurs the boundary between urban environmental colour design and colour design of other disciplines.

Fig. 2. Yellow is the core identity colour of Southbank Centre's complex, 2019 (Photo © Beichen Yu).

Designers from other creative backgrounds have brought their principles and strategies to colour design in urban environments. The entrances and staircases of the Southbank Centre in London were coloured bright yellow as part of the rebrand project of 2017 (Fig. 2). Also appearing on posters, billboards and a website, together with the typography, the bright yellow has been introduced as the core identity colour of the new brand (North 2017). The strategy of using distinct and coherent colour in visual identity design has been applied to public space, which makes it stand out as an integral part of branding.

With the popularity of large-scale installations, artists have made the urban public space a stage to exhibit their use of colour. Artists such as Carlos Cruz-Diez, Morag Myerscough and Felice Varini mark the urban landscapes with their signature colour palettes. Besides expanding the range of colour choices, designers and artists also introduce their frequently associated materials and skills into the urban environment to generate different colour effects. Thus, media such as acrylic paint, PVC and fabrics allow the colours to be presented in various forms and locations rather than being restricted to architectural façades. Since colour design can be carried out by different disciplines, corresponding reference systems should be built to evaluate the emerging colours in urban environments.

2.3. *The target groups*

Jean-Philippe Lenclos explored the associations between regional colour palettes and local identities with his concept of 'The Geography of Colour' (Lenclos and Lenclos 2004). Colour has long been used as a way to express cultural identity and to maintain a sense of place within a community in vernacular architectural environments. Lenclos' studies imply that the communities that created colour expressions in their environments were often the potential audiences (the target group). Since the 1960s, studies on environmental colour design have explored the relationship between architectural colours and elements including space, form, structure, light and function (e.g., McLachlan et al. 2015, Nemcsics 1993), principles for urban colour planning (e.g., Brino 2009; Spillmann 2009) and environmental colour design in a contemporary context (e.g., Lenclos 2009, Porter and Mikellides 2009). However, with respect to colour preferences in practice, traditional environmental colour design, especially in the urban context, usually considers the general public to be an audience rather than a co-designer.

However, in many recent cases, colour design is tailored to the preferences and identity of specific groups. For example, when introducing trendy elements from popular culture among young people, sports courts around the

world, such as basketball courts and skate parks, have been cost-effectively renovated using dramatic colour schemes, which seem to be welcomed by young people. The colourful environments also accommodate and encourage other popular activities among the younger generations, such as taking selfies and making YouTube videos.

Road crossings and pathways may engage eye-catching colours as a reminder for both motorists and pedestrians of road safety. Bright colours are designed to raise attention when travelling through traffic and work as a signage for wayfinding. In contrast to the grey traffic roads, the applied vibrant colours help to claim the territory for pedestrians and cyclists in car-dominated cities (Fig. 3).

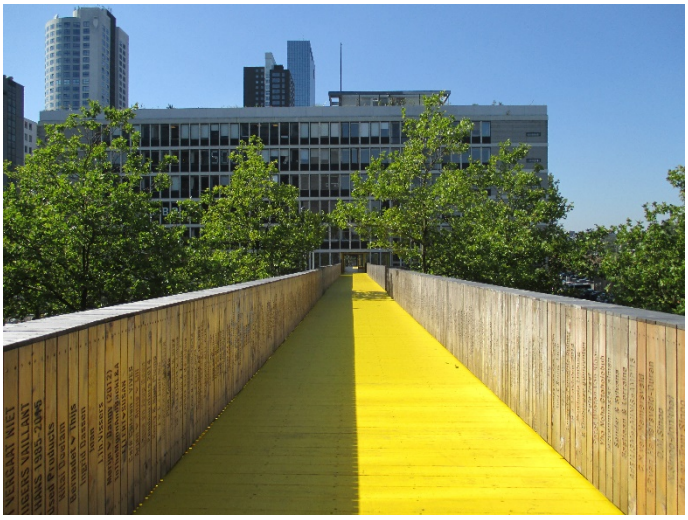

Fig. 3. The pedestrian bridge Luchtsingel in Rotterdam, 2015 (Photo © Nanda Sluijsmans/Wikimedia Commons).

Exaggerated colour expressions can also be used to attract tourists who are looking for photogenic scenes. The increasing flows of visitors can invigorate an area by bringing more opportunities to local business and improving public safety based on Jane Jacobs' 'eyes on street' theory (1961). Last but not least, these emerging colours in urban public spaces interact intensively with current Internet culture. Besides the actual users of the physical space, the aim of attracting the attention of potential online audiences is embedded in the colour design with the function of branding and promotion.

Eye-catching colours or colour palettes are selected in urban design to create an 'Instagrammable' scene that helps to promote the spread of images on social media. Bright colours create a strong and recognizable identity to a place in no time and new hashtags for people to communicate online. The fast spread of the colourful images on social media, in turn, attracts people to visit the place. Moreover, the popularity of certain colours or colour combinations online also influences the decisions about colour in design projects. By responding to the online colour trends, pink, red and rainbow colours can be seen around the world in urban design projects despite their different geographical locations and other regional factors.

3. Reasons behind the emerging colours in urban environments

Based on the discussions above, we suggest that there are four main reasons behind the increase of colourful places in urban environments in the 2000s.

3.1 Preconditions for the emerging colours

First, above all, the improvements in technology for colour application provides the conditions for more varied colour expressions in outdoor environments. The availability of pigments and coloured materials that are resistant to water and weathering, as well as to wear and tear by feet, enables the colour application to meet the design requirements. A wide range of materials available in different colour options gives designers the freedom to experiment with the performance of colour in a given urban space.

Second, the widespread love of saturated colours which has grown since the 1960s has been reinforced by the current Internet Culture during the 2000s. Both general audiences and designers seem to have more positive attitudes towards having brighter and more vivid colours in urban environments. With the increasing participation of artists and designers from different backgrounds in environmental colour design, fresh perspectives of colour and new colour palettes have been introduced to urban public spaces.

3.2. Demands of the emerging colours

The two reasons mentioned above are the preconditions for this phenomenon, while one of the driving forces behind the emerging colours is that, when used strategically, colour can meet different demands in contemporary urban environments. Public spaces always play a significant role in the social and economic life in the city. Gehl and Gemzøe (2001:10) further explain the traditional functions of urban public space and state that "public space has always served as a meeting place, marketplace and traffic space." However, in contemporary urban contexts, public spaces are endowed with more sophisticated roles and are expected to respond instantly to different requirements.

Unlike the traditional public spaces which have specific functions and fixed property, many urban public spaces nowadays are required to accommodate various activities

such as pop up events, art exhibitions or commercial promotions at one or different times. As a design element, colour can transform a place in a short time and provide a new identity for the corresponding role of the urban public space. Moreover, with the rapid growth of modern cities, more undefined or underutilised spaces are appearing in urban environments. In many modern cities, places such as roundabouts, underpasses, parking lots and utilitarian paths can often be undesirable or even unpleasant for urban residents. Irrespective of the existing conditions, the application of vibrant colours can bring positive changes and a new image to urban voids by generating new attractions, activities and psychological comfort. Besides being applied in urban intervention projects, saturated colours also emerge in contemporary urban environments because of their capacity to facilitate visual communication. Many urban design projects use striking colours in branding, wayfinding and publicising ideas in public spaces where the exchange of information is becoming more frequent and more intense.

Last but not least, as discussed in the preceding section, another noteworthy reason behind the rapid growth of the phenomenon is the rising influence of Internet Culture since the 2000s. Saturated colours in urban public spaces meet the enormous upsurge in demand for photogenic scenes on social media. Due to instant broadcasting online, the popularity of colourful scenes inspires and encourages similar cases to be created worldwide. Being aware of the positive influence and potential impact, more and more designers have begun to include colours which are popular in social media in their designs to reproduce that success in different locations. The preferences and demands of saturated colours in Internet Culture, in a way, promotes the widespread presence of saturated colours in contemporary urban public spaces.

4. Concerns and discussions

Despite the positive changes brought about by increasing colour expression in our cities, there are a few concerns that we wish to address regarding this emerging phenomenon. With the development of pigments, the application of colour has been used as a fast and cheap method to provide immediate changes in current practices. A wide range of bright colours has been used on building façades in slums or declining regions such as Santa Marta in Brazil (Flecha et al. 2017) and panel buildings in Tirana, Albania (Guaralda 2009) to provide quick improvements to existing environments. Although the selection of colours and the way to present colour is more precise with the consideration of specific design intentions in urban and landscape design, there are other potential impacts on urban environments that can result from this upsurge in saturated colours.

As mentioned above, with the influence of the Internet, projects with distinct colour features are likely to attract more audiences and become known to people around the world. Aware of the benefits of using saturated colours, especially colours trending online, similar colour expressions tend to be reproduced in different locations, regardless of the context. In some situations, colour design has become a trademark of the designer or the project while alienating it from the local context (e.g., The Umbrella Sky Project 2012–2019). ‘Successful’ colour palettes or approaches to colour design are produced as a tool kit that can be applied to anywhere in need of a new stimulus. Homogenised colour expressions can mask the sophisticated details in the original environments and hide or suppress regional identity, which may reduce the connections between the place and local culture.

Another concern is the impact of the emerging phenomenon on the daily lives of local communities. With the specific intention of attracting tourists and broad online promotion, a place with attractive colour features can suddenly become a new landmark and a must-visit place for photo shooting. The over-popularity of the site may contribute to the potential issue of mass tourism that has been frequently discussed in recent years. Amsterdam City Council in the Netherlands removed the famous ‘I amsterdam’ letters from outside the Rijksmuseum in order to reduce the tourist overload and call for more attention to the place instead of using it merely as a selfie background (Hitti 2018) (Fig. 4).

Fig. 4. The ‘I amsterdam’ letters attract tourists who take pictures and selfies, 2016 (Photo © Tobias Niepel/Wikimedia Commons).

A massive influx of tourists is not only harmful to the authenticity of the place but also creates conflicts of interest between local communities and visitors. As a

successful icon of the media branding campaign, the Pink Street in Lisbon is considered to be a strategy to promote a tourist-oriented nightlife spot and bring income to the city (Nofre et al. 2018). However, the increasing popularity of the site among tourists and the lack of regulations have already caused negative social and spatial impacts on neighbours and their liveability, especially at night (Nofre et al. 2018). Therefore, we suggest that designers should consider the local context and have a better overview of sustainable development and potential negative impacts when introducing distinct and appealing colour features to urban public spaces. Conversely, the application of colour can be used strategically to divert the flow of tourists to lesser-known places, and the negative influences on residential areas and overloaded attractions can be limited by controlling the timespan of the project.

5. Conclusions

By investigating colour design in contemporary urban environments, our study identified a design phenomenon characterised by the use of saturated colours in urban public spaces. Since the beginning of the new millennium, more vibrant colour expressions are increasingly appearing in many cities around the world. Compared to the traditional environmental colour design, colour has been used as an active design element to respond to new challenges and demands in urban public spaces.

Although we can catch a glimpse of the importance and the potential of the phenomenon by observing and summarising current examples, many crucial issues remain unclear. Studies are required to help us better understand this phenomenon by exploring the relationship between the 'emerging colours' and traditional environmental colour design, its impact on social and economic lives, and the guidelines for the application of saturated colours in urban environments. Hence, we suggest that systematic research on the phenomenon is necessary to clarify the functions and the impact of the 'new' colours, which will provide references for understanding and evaluating the phenomenon as part of contemporary urban and landscape design.

6. Conflict of interest declaration

The authors state that no actual or potential conflict of interest exists including financial, personal or other relationships with other people or organizations within the three years prior to 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

Batchelor, D. (2000) Chromophobia. London: Reaktion Books Ltd.

Bell, S. (2019) Elements of visual design in the landscape. 3rd ed. London: Routledge.

Boeri, C. (2017) 'Color loci placemaking: the urban color between needs of continuity and renewal'. Color Research and Application, 42(5), pp. 641–649. doi.org/10.1002/col.22128.

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

Braham, W. W. (2002) Modern color, modern architecture: Amédée Ozenfant and the genealogy of color in modern architecture. Aldershot: Ashgate.

Brino, G. (2009) 'Italian city colour plans (1978–2007)'. Colour for architecture today. London: Taylor and Francis, pp. 30–35.

Caivano, J. L. (2006) 'Research on color in architecture and environmental design: Brief history, current developments, and possible future'. Color Research and Application 31(4), pp. 353–363. doi.org/10.1002/col.20224.

Cormier, C. (2017–2019) '18 Shades of Gay', Montréal (Québec), Canada'. Claudecormier.com. Available at: https://www.claudecormier.com/en/projet/18-shades-of-gay/ (Accessed: 20 August 2019).

Doherty, G. (2011) New geographies 3: Urbanisms of color. Cambridge, Mass.: Harvard Graduate School of Design.

Flecha, A., Jönsson, C. and Dornan, D. (2017) 'Visiting murals and graffiti art in Brazil'. Murals and Tourism: Heritage, Politics and Identity, Skinner, J. and Jolliffe, L. (eds.) London: Routledge, pp. 180–196.

Gehl, J. and Gemzøe, L. (2001) New city spaces. Copenhagen: The Danish Architectural Press.

Guaralda, M. (2009) 'Urban identity and colour: the case of Tirana, Albania'. Spectrum e-news, 2009 (December), pp. 13–14.

Hitti, N. (2018) 'Amsterdam council removes "I amsterdam" sign after it becomes selfie spot'. Dezeen. Available at: https://www.dezeen.com/2018/12/05/i-amsterdam-sign-removed-council-mass-tourism/?fbclid=IwAR1RNTpl2KspHD9duivyV0nQ3qVSeomnU89t73jIt1DSl00T19t7t07QYRA (Accessed: 26 September 2019).

Jacobs, J. (1961) The death and life of great American cities. New York, NY; Harmondsworth: Random House.

JERDE (2019) 1984 Olympics Los Angeles, California. Available at: https://www.jerde.com/places/detail/1984-olympics (Accessed 25 September 2019).

Lenclos, J. P. (2009) 'The globalisation of colour'. Colour for architecture today. London: Taylor and Francis, pp. 84–87.

Lenclos, J. P. and Lenclos, D. (2004) Colors of the world: the geography of color. New York, NY: W. W. Norton.

Mahnke, F. H. (1996) Color, environment, and human response: An interdisciplinary understanding of color and its use as a beneficial element in the design of the architectural environment. New York, NY: Van Nostrand Reinhold.

McLachlan, F., Neser, A., Sibillano, L., Wenger-Di Gabriele, M., Wettstein, S., and Whyte, I. (2015) Colour strategies in architecture, Basel; Zurich: Schwabe Verlag in association with Haus der Farbe.

Mclachlan, F. (2013) Architectural colour in the professional palette. New York: Taylor and Francis.

McMorrough, J. (2007) 'Blowing the lid off paint: the architectural coverage of Supergraphics'. Hunch (Rethinking Representation), 11, pp. 64–67.

Nemcsics, A. (1993) Colour dynamics. New York: E. Horwood.

Nofre, J., Martins, J., Vaz, D., Fina, R., Sequera, J. and Vale, P. (2018) 'The "Pink Street" in Cais do Sodré: urban change and liminal governance in a nightlife district of Lisbon'. Urban Research and Practice, pp. 1–19.

North (2017) 'A serif rises in the south'. [online] Underconsideration.com. Available at: https://www.underconsideration.com/brandnew/archives/new_logo_and_identity_for_southbank_centre_by_north.php (Accessed: 27 September 2019).

Porter T. and Mikellides, B. (eds.) (2009) Colour for architecture today. New York: Taylor and Francis.

Spillmann, W. (2009) 'Unity in diversity at Kirchsteigfeld, Potsdam'. Colour for architecture today. London: Taylor and Francis, pp. 36–38.

Swirnoff, L. (2000) The color of cities: an international perspective. New York: McGraw-Hill.

Color analysis of birth space ambiances

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ABSTRACT

Color is an integral component of architecture. It is an expressive element which deals with lighting distribution and many other aspects. It has a preponderant role in defining and personalizing the character of space and its ambiances. In this study, we will focus on women in labor and how users perceive colors in such specific spaces through the sensitive experience carried out in birth institutions, how color can be integrated in the birth space, how it takes part of a special event, and how it modifies women perception. Our research is at the crossroads of several disciplines. It focuses on analysis of stress levels for women in labor in different obstetric spaces, using Electrodermal Activity (EDA) tracking that evaluates the arousal via skin conductance measurements. This quantitative study will be correlated to a qualitative one which is based on a descriptive approach that consists in the analysis of the role of color in birth ambiances by using photos of different birth spaces and information collected in different surveys. Thus, the goal of this paper is to identify ways of choosing colors in the obstetric space and search for appropriate ambiances to improve a well-being experience of giving birth without stress and anxiety.

KEYWORDS Ambiances, Birth Space, Color, Birthing Women, Electrodermal Activity

RECEIVED 15 October 2019; **REVISED** 28 November 2019; **ACCEPTED** 04 December 2019

1. Introduction

Through cultures, color manifests itself as a deep inherent quality linked to the substances of objects and not as a superficial mark (Tornay 1978). It is used to identify groups, to convey symbolic meanings and to experience an aesthetic pleasure. It is a component of the social and physical world around us. It doesn't occur taken alone but it is associated to objects and events. Its perception depends heavily on the context (social, spatial, temporal, ambiant, functional).

Color takes shape only when it begins to be perceived as a quality of a specific context. It is an expressive element in the design of life space which deals with lighting distribution. In primates, space perception is multisensory. Ambiances solicit different senses, essentially through visual perception; color gives a sensual visual perception of space. It is one of different aspects of visual perception through which, in other primates, the exploration of any space begins. Indeed, colors have an influence on the ambiance. An ambiance is born so of singular relationships between materials, lights, colors and individuals (CAUE de l'Ain 2011:4). That is how it contributes to shaping the living environments.

Color is considered as a tool that influences the user's perception and behavior (Tofle et al. 2004, Dalke et al. 2006, Çiçek and Gökçakan 2016). Thus, color has an important role in the user's space experience. Color reveals certain meanings and symbolism in a close relation to psychological and physiological effects that it produces. Each color is associated with a certain mood, a certain environment that affects the user's space perception and emotion. It plays a role in creating ambiance of pleasure, excitement, content and comfort for a user that supports the function of a space.

Popular culture suggests that color prompts different human responses: psychological, biological, and behavioral (O'Connor 2011). Color can be considered as a therapy. It can play a role in the healing process. Some architectural and interior design books, such as Kopacz (2003) and Mahnke (1996), and technical reports such as those by Hill (2008), provide information related to the role of color psychology and color therapy in architecture (O'Connor 2011).

Color is a specific architectural variable that can be modeled to provide different space ambiances. Nowadays, we notice the use of colors in healthcare environment. There is considerable agreement among architects, interior designers, and medical doctors that color may promote the well-being of the hospital users. Indeed, color facilitates the spatial orientation and wayfinding of patients in the hospital (Dalke et al. 2006). According to Smets (1969), colors can affect the time experience of a hospital stay that is felt by patients. He compared the time spent under two different lights, red and blue. Patients under the red light reported a shorter estimate of time spent than those who were under the blue light (Ghamari and Amor 2016).

Several studies have been conducted on the effects of color on the user's ambiance perception. Küller et al. (2009) and AL-Ayash et al. (2015) demonstrated that a red room is more psychologically arousing than a blue room, which is perceived as pleasant, calming, and interesting. Thus, color is important since it has the ability to heal and to comfort. Yellow and red promote exchanges and excitement, while blue and green soothe and relax patients (Sternberg 2009:40).

In terms of ambiance, color creates 'welcoming', 'homey' and 'pleasurable' ambiances to ease the stress of patients by the use of warmer colors, to improve satisfaction and help patients sleep (Dalke et al. 2006). Birth space and birthing women represent a pertinent research case and we will explain in this paper how color design influences the sensitive experience of birthing women.

2. Method

This study is at the crossroads of several disciplines. In order to understand the deep relationship between color in birth space, the event of birth and women perception, we varied the methods. Our research is composed of two parts: a qualitative study which will be correlated to a quantitative one. When choosing the fields of study, two different cultures are taken into consideration to explore a diversity of color space experiences, which are the French and the Tunisian ones (Fig. 1).

Fig. 1. Hospital birth space in two different cultures: French (left) and Tunisian (right).

2.1. Qualitative approach

The qualitative study is based on a descriptive approach. The descriptive method is adopted to analyze the colors used in three different French birth spaces situated in Grenoble. We chose to analyze a delivery room and a maternity room of a hospital maternity, a clinic maternity and a birth center. The process of analysis begins with collecting photos and information in a survey. The process depends on the identification of the properties of colors used, its ambiance as well as its effects on women during the birth event. Further, and by adopting a transposition of the results of the French qualitative study, we selected Tunisian maternities that have the same architectural and ambiant characteristics as identified in the French ones.

2.2. Quantitative approach

We carried out our quantitative study that focuses on the analysis of stress levels (Hussein et al. 2015, Hussein et al. 2016) for women in labor in the Maternity and Neonatology Center of Tunis, using Electrodermal Activity (EDA) tracking that evaluates the arousal via skin conductance.

In this second part of our study, a multidisciplinary experimental protocol of two components is applied. It is organized as follows: A spatial characterization consists of analyzing colors used and capturing the emotional state of women in labor using Electrodermal Activity tracking. In addition, the sensitive experience of women in labor has been recorded through surveys.

To realize this experimental protocol, a wearable biosensor device called E4 was used that measures emotional states (stress, excitement, happiness, and more). Its data can be visualized by the software 'E4 manager' (Fig. 2). Our target population was five women in labor aged between 25 and 32 years.

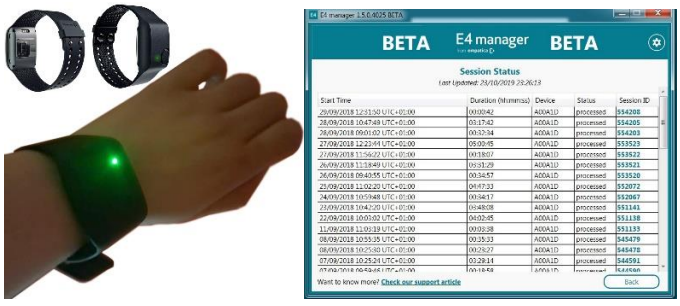

Fig. 2. Wearable biosensor device 'E4' (left) and its software 'E4 manager' (right).

In this paper, we will present the results of one case that is representative of all those studied, and which shows how we can detect objectively the effect of an ambiance (light, color, odor, sound) on women in labor, and how an architect can model a conception of space taking into consideration those parameters. The E4 sensor was worn by each woman in the delivery room and the measurements stopped when she was transferred to a maternity room. The itinerary chosen to be analyzed was during the transfer from the delivery room to a maternity room. It takes about ten minutes. During this time, a record of the woman's feelings toward the ambiance, and specially the colors, was done by taking notes and comments.

3. Results and discussion

In our field study, we focus on the sensitive experience of birthing women in birth space in two different spatial, social and cultural contexts.

3.1. French experience

During our qualitative study in the French field, we visited, photographed and analyzed from the architectural and ambiant viewpoints three different types of space. We carried out surveys and did ethnographic observations to identify the relationship between space, color and the user's perception. The French maternities were: Maternity of the University Hospital Center, Maternity of Clinic Belledonne, and the Birth Center 'La Maison'.

Beginning with the Maternity of the University Hospital Center (Fig. 3), the colors used in the delivery and labor rooms were white, a warm shade of yellow and a grey with low value of blackness. When asked, a woman who was giving birth there said, "Yellow is a brilliant and happier color, the color of the sun, of joy; it makes the room shine." While another woman explained her dissatisfaction with the grey color: "The spaces are good enough... apart from the delivery room. It is grey and austere. It depressed my husband too."

Some research done by Nikolic and Nikolic (2012) and by Tofle et al. (2004:58) proved that yellow evokes energy, dynamism and excitement, and its brilliance is most often associated with the sun. It stimulates the activity of women in labor. By contrast, another study highlighted that yellow should not be used in maternity units as it hinders the diagnosis for jaundice (Dalke et al. 2006).

In physiologic delivery rooms, a light blue-green color was added to previous colors. It is a great choice for creating a natural ambiance. The light blue-green color gives the impression of being in a garden. It has a calming effect. Research shows that green, the color of plants and nature, represents growth and life (Tofle et al. 2004). In the maternity rooms a light pink color was chosen for the walls with white and grey for the flooring.

This combination creates a pleasant ambiance. It symbolizes nature and flowers, creating a calm and fresh ambiance.

In the Maternity of Clinic Belledonne, which is a private healthcare space (Fig. 4), shades of a light pink color were used for the delivery room in order to offer to women in labor an ambiance of intimacy and warmth, in the opinion of midwives. Pink is one of the warmer colors traditionally recommended for maternity units (Dalke et al. 2004). One of the reactions of a birthing woman was: “The delivery room has very bright colors, it has different colors: a pink, a green and the blue turquoise; beautiful colors.”

Fig. 3. The use of colors in the Maternity of the University Hospital Center, Grenoble: a. labor room, b. delivery room, c1. and c2. physiological delivery rooms, d1. and d2. maternity rooms. Photo: Ichraf Aroua, 2017.

In the physiologic delivery room, a dominance of grey is observed with a touch of green. Indeed, studies of Nikolic and Nikolic (2012) showed that the green has a positive effect on the reduction of anxiety and pain. On the contrary, greenish colors were not prescribed in a lactation room because they were linked to an operating theater (López-Tarruella et al. 2018). Grey is a neutral color; it is used to create a neutral ambiance, to highlight the green color. In order to create a more upbeat ambiance (Dalke et al. 2004:17), it is not recommended to use it as a single color in a hospital space.

For the maternity rooms, orange was used. This color is particularly popular and recommended for maternity units. It symbolizes energy and power; it evokes warmth, comfort, and reassurance (Tofle et al. 2004:50, Dalke et al. 2004:20). A recent study about the influence of environmental color in lactation rooms showed that warm colors, especially yellow and orange, tend to score highly for cosiness. As well, they are considered to be the homiest colors (López-Tarruella et al. 2018).

In spite of the positive effects of orange color in a birth space showed by some studies, its perception is still subjective. For example, a woman giving birth there was not satisfied with the use of orange. She said, ”The orange paint on the wall... It’s really very concrete; it is not something that is warm and welcoming… It is orange… like it explodes in my face.”

This showed that the color effects on a woman are something personal, related to one’s taste and background.

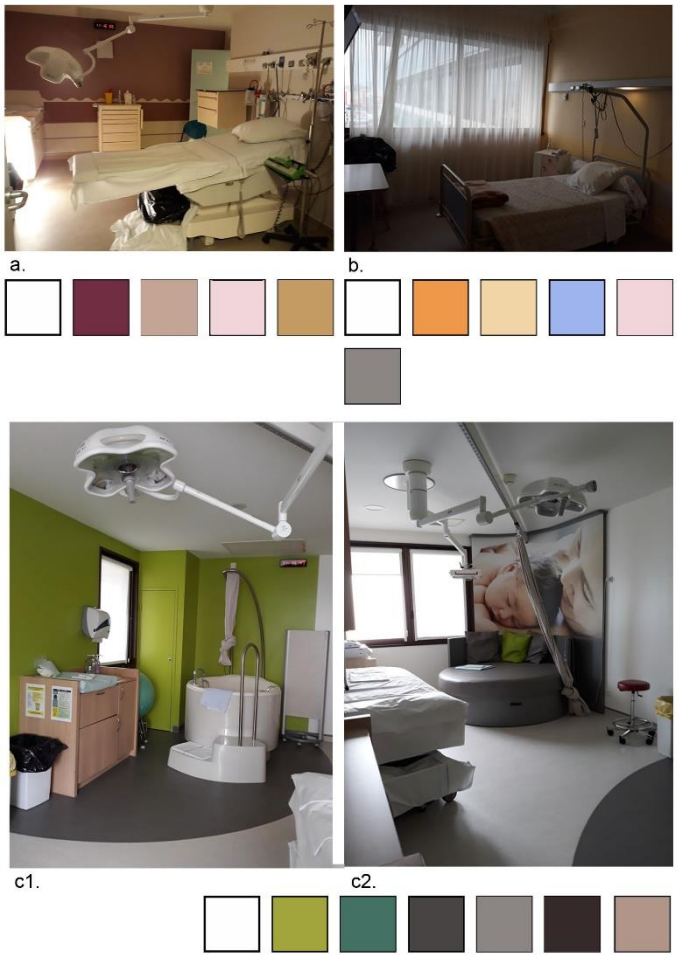

Fig. 4. The use of colors in the Maternity of Clinic Belledonne, Grenoble: a. delivery room, b. maternity

room, c1. and c2. physiological delivery rooms. Photo: Ichraf Aroua, 2017.

In the two previous maternities, the medical ambiance was really present. White dominated the walls and furniture. It had a clinical appearance; neutral and without vitality. Other colors were used partially. While among patients, 'whiteness' connoted cleanliness and hygiene (Dalke et al. 2004:19).

Fig. 5. The use of colors in the Birth Center 'La Maison', Grenoble: a1. and a2. delivery rooms, b1. and b2. living rooms. Photo: Ichraf Aroua, 2017.

The Birth Center 'La Maison' (Fig. 5) is considered as the recent form of birth space, which is seen as an alternative to giving birth at home. In this space, childbirth is considered as a natural process. It is characterized by a familiar and warm ambiance by using residential furniture. Adding to that, the use of green, blue, pink and orange creates a welcoming and homey ambiance. The choice of color responds to these needs. The wall covered with wallpaper has a variety of shades ranging from white to grey. While interviewing the architect Isabelle Chameroy of the Birth Center, she justified her color choice by the fact that this variety of colors gives a woman in labor a sense of security and tranquility. A study confirms that it is recommended to ensure a distinct variety of colors to provide enough visual interest (Dalke et al. 2004:19). An interviewed woman was satisfied with the chromatic ambiance: "I found the maximum of privacy in this room; it is warm and colorful."

3.2. Tunisian experience

Since a safe and satisfying birth experience depends strongly on the level of stress experienced by the birthing woman, we had to verify objectively the impact of color parameter in modeling birth space ambiances, and thus affecting the perception of birthing women. Observations collected from our qualitative study on the French fields had to be completed by a quantitative study based on stress level evaluation. Detecting situations of stress due to an obsolete control of colors and light in birth environments is the ultimate goal of this correlation between qualitative and quantitative parts of our research.

To identify stress situations due to color and light parameters in birth spaces, we selected a Tunisian field of study where architectural design represents most of the recommendations picked up in French maternities: Maternity and Neonatology Center of Tunis. It deals with medical aspects needed in labor/obstetric spaces and friendly and warm ambiances needed in maternity rooms. Figure 6 shows the time-space interval chosen to be studied in this part, which is the time of transfer of a woman from the maternity room to the labor room, because of the variety of color and light ambiances. The delivery room is painted white. In the hall of the delivery block a linear touch of pink is added to the white walls. In the corridor, most of the walls are covered with traditional blue faience. Finally, in the maternity room, only white is present.

A 25-year-old birthing woman who had a vaginal delivery without epidural is chosen as a case study to detect stress situations due to specific color and light ambiances. Figure 7 represents the curve of her Electrodermal Activity (EDA).

In this EDA curve, we identify different stress peaks due to an increased stress level in the delivery room; some are related to the colors used, others to many physical parameters (mainly some sounds of clinical staff and monitoring machines). At the same moment of those stress peaks, the birthing woman complained about the white color. It was confirmed by the comments of the birthing woman. When interviewing her about the space ambiance, she showed her dissatisfaction with the white color frequently used in delivery rooms: "White color

makes me feel cold and its neutral aspect is not cheerful; it is unpleasant." The white color and bright light characterizing the hospital birth environment increased anxiety and fear for birthing women.

Fig. 6. The use of colors in the Maternity and Neonatology Center, Tunis: a. delivery room, b. hall, c. corridor, d. maternity room. Photo: Ichraf Aroua, 2018.

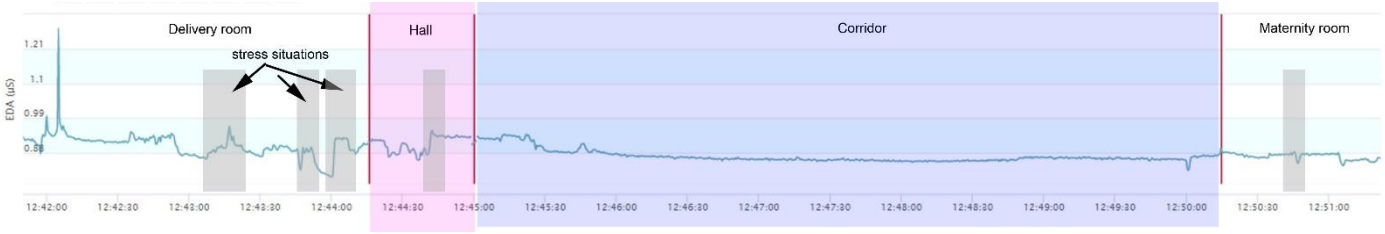

Fig. 7. Electrodermal Activity (EDA) curve of a birthing woman.

We note on the EDA tracking that stress peaks persisted in the hall of the delivery block despite the use of a pink touch. It might be as a consequence of the use of white color and bright light. This was confirmed by the comment of the woman: "Despite the presence of the pink, it feels white and pale. I cannot forget that I am in a hospital."

In the corridor, a slight decrease of the intensity of the EDA is observed; then it stays constant until the entrance of the woman in the maternity room. In the corridor, there exists a combination of white and blue colors but the light is less bright and less intense. The wall cladding is a typical design used in many Tunisian homes, so color did not play a major role here in decreasing anxiety of a birthing woman. Architectural materials evoking home design also played a role. These results are confirmed by the woman's comment: "For me, the corridor is more pleasant by the faience colored blue which makes me feel at home."

In the maternity room, we detected on the EDA tracking a peak of stress and it might be a consequence of artificial light. At this moment, the birthing woman asked to turn off the light and to open the window. Many scientific studies showed that artificial light stimulates the cortex, provoking the release of adrenalin and inhibiting the physiology of birth (Silva and Shimo 2017, Jenkinson et al. 2014). Being able to adjust the lighting also provides the opportunity to change the mood. More than half (56%) of women placed high importance on being able to control the brightness of the light in their birth room (Newburn and Singh 2003:6). Thus, brighter light can encourage activity and lower lighting can create a greater sense of privacy.

Color and light are an intrinsic characteristic of the visual sensations since they shape the relation between birthing women and their surrounding environment. They are a powerful factor in the recognition of objects and their delivery experience.

4. Conclusion

In this paper, we highlight a pertinent and original approach of detecting stress situations in birth space experienced by birthing women. There is the need for specific architectural design recommendations. In the light of the interest given to the question of birthing women and the birth experience in maternities, this study is pertinent as it shows the importance of careful coloring and lighting design in making the birth environment less or more clinical, affecting strongly the sensitive experience of such specific space users.

The analysis of the comments of women highlights that the perception of colors in space is more subjective than objective. It depends on the woman's personal experience, her background and her culture. In the case of the Tunisian maternity, women disapproved the use of white. For them it was cold and unpleasant, while a French woman perceived it as a symbol of hygienic and aseptic ambiance. We also observed that the use of monochromatic color schemes represents a bad choice for birth space because the positive effects of color are closely associated with there being several colors in the same space.

According to the results of the measurement of stress levels, we observed that every color creates a particular ambiance in a birth environment. It has a significant role in shaping the mood of women: stimulating or calming. The complexity of the hospital space showed that the stress situations can be caused not only by colors but also by other components such as sounds and smells, which may contribute to creating an uncomfortable ambiance.

The affective dimension of this study represents a new response that shows potential on the perceptual dimension of a given category of birth space users. The aptitude to personalize a given color design while considering age, culture, physical and mental capacities of birthing women is an important step forward. Such an objective would be aligned with a global well-being.

5. Conflict of interest declaration

The authors declare no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

6. Funding source declaration:

Financial support was provided by the Tunisian Ministry of Higher Education and Scientific Research.

7. Acknowledgment

We are particularly grateful to Professor Jean-Pierre Péneau for framing this study, and to Signals and Systems Team (U2S) from the National School of Engineering of Tunis (ENIT) for providing the E4 device and helping to analyze EDA data.

8. Short biography of the authors

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Their interests are focused on the altered perception in the urban and architectural space and the complexity of ambiances.

References

AL-Ayash, A., Kane, R., Smith, D. and Green-Armytage, P. (2015) 'The influence of color on student emotion, heart rate, and performance in learning environments', Color Research and Application, 41(2), pp. 196–205. doi: 10.1002/col.21949.

CAUE de l'Ain (2011) Couleurs, lumières, matières: ambiances et cadres de vie. Bourg-en-Bresse: CAUE de l'Ain.

Çiçek, N. and Gökçakan, K. (2016) 'Characteristics of colours, interior design and their psychological and physiological effects', The Turkish Online Journal of Educational Technology, November 2016 (Special Issue), pp. 425–430.

Dalke, H., Little, J., Niemann, E., Camgoz, N., Steadman, G., Hill, S. and Stott, L. (2006) 'Colour and lighting in hospital design'. Optics and Laser Technology, 38(4-6), pp. 343–365. doi: 10.1016/j.optlastec.2005.06.040.

Dalke, H., Littlefair, P. and Loe, D. (2004) Lighting and colour for hospital design. London: TSO (The Stationery Office).

Ghamari, H. and Amor, C. (2016) 'The role of color in healthcare environments, emergent bodies of evidence-based design approach'. Sociology and Anthropology, 4(11), pp. 1020–1029. doi: 10.13189/sa.2016.041109.

Hill, T. R. (2008) Using color to create healing environments. Atlanta, GA: Little Fish Think Tank/Dupont.

Hussein, F., Layeb, S., Ghozi, R. and Jaidane, M. (2016) 'The sonic ambiance as a transforms operator of our cities and our architecture. The case of autistic children and elderly'. Ambiances, tomorrow. Proceedings of the 3rd International Congress on Ambiances, September 2016, Volos, Greece, pp. 177–182. hal-01409725.

Hussein, F., Ghozi, R., Jaïdane, M. and Péneau, J. (2015) 'Detecting hazardous situations faced by presbycusic pedestrians in cities: an audio-texture approach', Ambiances.revues.org. doi: 10.4000/ambiances.485.

Jenkinson, B., Josey, N. and Kruske, S. (2014) Birth Space: An evidence-based guide to birth environment design. doi: 10.13140/RG.2.1.3962.8964.

Kopacz, J. (2003) Color in three-dimensional design. New York: McGraw-Hill.

Küller, R., Mikellides, B. and Janssens, J. (2009) 'Color, arousal, and performance: a comparison of three experiments', Color Research and Application, 34(2), pp. 141–152. doi: 10.1002/col.20476.

López-Tarruella, J., Llinares Millán, C., Serra Lluch, J., Iñarra Abad, S. and Wijk, H. (2018) 'Influence of color in a lactation room on users' affective impressions and preferences', Health Environments Research and Design Journal, 12(2), pp. 55–70. doi: 10.1177/1937586718796593.

Mahnke, F. (1996) Color, environment, and human response. New York: Wiley.

Newburn, M. and Singh, D. (2003) Creating a better birth environment. London: National Childbirth Trust.

Nikolic, O. and Nikolic, V. (2012) 'The application of color in the hospital interior'. Proceedings of the IV International Symposium for Students of Doctoral Studies in the Fields of Civil Engineering, Architecture and Environmental Protection, Niš, Serbia, pp. 199–205.

O'Connor, Z. (2011) 'Colour psychology and colour therapy: Caveat emptor'. Color Research and Application, 36(3), pp. 229–234. doi: 10.1002/col.20597.

Silva, M. and Shimo, A. (2017) 'Lighting impact on the emotional expression of pregnant women: a randomized clinical trial'. Acta Paulista de Enfermagem, 30(3), pp. 217–226. https://dx.doi.org/10.1590/1982-0194201700034.

Smets, G. (1969) 'Time expression of red and blue'. Perceptual and Motor Skills, 29(2), pp. 511–514. doi: 10.2466/pms.1969.29.2.511.

Sternberg, E. (2009) Healing spaces: the science of place and well-being. Cambridge, MA: Belknap Press of Harvard University Press.

Tofle, R. B., Schwarz, B., Yoon, S. Y. and Max-Royale, A. (2004) Color in health care environments. San Francisco, CA: Coalition of Health Environments Research.

Tornay, S. (1978) 'De la perception des couleurs à l'aperception symbolique du monde'. Communications, 29, Image(s) et culture(s) pp.119–140. https://doi.org/10.3406/comm.1978.1437.

An educational experience about color emotion and its design implications

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ABSTRACT

The paper presents the context, contents and results of an educational experience conducted within the Shapes, Surfaces and Colours module of the Master in Furniture Design by Poli.Design, Politecnico di Milano, in December 2018. This experience is part of a color design education research project with the aim to explore, evaluate, experiment and systematize design implications offered by the evaluation of the emotional response to color in design education and professional practice.

Besides the educational purposes, this experience allowed us to verify, evaluate and compare the presence of associative recurrences between a selection of emotion words and color attributes, firstly with an initial exploration without using color samples, and secondly with the construction of contextualized 4-color combinations. Finally, in a process of student-learning and experimentation that moves from abstraction and generalization towards design contextualization, the possibility of using such experiences and connotative associations to build the emotional character of an interior space was explored.

The results of this experience contribute to validating the design opportunities offered by the possibility of dealing with the evaluation of the emotional response to color in terms of color attributes, and thus of color combinations. In addition, the use of such associative assumptions to build the emotional character of an interior space seemed to be a useful educational and methodological tool to relate color to the other design components—shape, material and surface, in particular—and to show the potential value of a design process structured around color and the sensorial and emotional qualities of the environment.

KEYWORDS Color Design Education, Color Emotion, Color Association, Color Combination

RECEIVED 16 October 2019; **REVISED** 28 November 2019; **ACCEPTED** 15 December 2019

1. Introduction

The evaluation of the emotional response to color, or 'color emotion', concerns both the aesthetic experience of color and the connotative experience of color in relation to concepts such as warm or cool, light or dark, heavy or light (Sivik 1970, Gao and Xin 2006). As Lars Sivik (1970:43, 1989:132) points out, the prerequisite for this type of studies lays in the fact that people prove to be sufficiently concordant in their connotative experiences and opinions about color.

As Ou et al. (2004a:232) observe, early studies on single-color emotion were concerned with the possibilities of reducing a large number of color-emotion scales into a smaller number of categories, or *factors*, by using the semantic differential method introduced by Osgood et al. (1957). These studies also revealed connections between these *factors* and the three color attributes, generally defined as hue, brightness or lightness for object colors, and chroma or saturation (Wright 1962) [1].

As noted by Küller (1981:162) regarding this area of research and compared to the numerous studies conducted on single-color-without-context, only few studies were concerned with color combinations.

Among the studies focused on the implications of using not just single colors but combinations of two or more colors, Sivik and Hård (1989) investigated how different dimensions of meaning can show varying degrees of relationships with different kinds of 4-color combinations. Kobayashi (1991) proposed a systematic classification of color combinations using 130 basic colors to create different 3-color combinations and 180 matching image words. Ou et al. (2004a, 2004b) conducted a study on both single colors and 2-color combinations in relation to those color-emotion scales that were most used in previous studies.

Within this framework, the educational experience carried out within the Shapes, Surfaces and Colours module of the Master in Furniture Design by Poli.Design, Politecnico di Milano, enabled students to experiment and evaluate the design implications related to the emotional response to color in terms of 4-color combinations, and provided the possibility of using such experiences and connotative associations to conceptualize the emotional character of an interior space.

This experience is part of a color design education research project with the aim to explore, evaluate, experiment and systematize the design implications offered by the evaluation of the emotional response to color in design education and professional practice. The research project is focused on the possible relationships between the approaches, methods and outcomes of color research that deals with color emotion and the approaches, methods and tools developed in the field of design research and practice that deals with color and the emotional and sensorial qualities. In this regard, note the methods and tools developed in the field of CMF design (colors, materials, finishes) and Qualistic by Clino Trini Castelli (Castelli 1995, 1999) and the Color Image Scale by Shigenobu Kobayashi (Kobayashi 1991). The research outcomes may highlight aspects of development in the area of color research oriented to possible design applications in terms of the contextualization and usability of the research results.

The educational experience presented here follows the results of a previous didactic experimentation (Boeri 2019) that allowed exploring and evaluating the possibility of establishing associative recurrences between a selection of 'evocative terms' and 4-color combinations developed by the students drawing from an almost unlimited number of color samples.

Numerous studies on single color emotion (Ou et al. 2004a, Gao and Xin 2006, Da Pos and Valenti 2007), color pairs (Ou et al. 2004b) or 4-color combinations (Sivik and Hård 1989) are based on a predefined number of color samples.

In the experimentation presented in this paper students were first asked to establish associations between a selection of connotative terms, in the form of pairs of opposites, and color attributes in absence of color samples, and then to establish associations between one or two of the connotative terms selected and 4-color combinations drawing from the 1,950 standard colors of the NCS system, which leads to an even higher number of color combination possibilities (Sivik and Hård 1989).

In a process of learning and experimentation that moves from abstraction and generalization towards design contextualization, the possibility of using such experiences and connotative associations to build the emotional character of an interior space was explored.

This contribution presents the contents and methods of this teaching experience and the student-learning results in order to evaluate the associative recurrences and relevancies between the selected terms and the color attributes.

2. Contents and method

The teaching experience planned within the Shapes, Surfaces and Colours module of the 1st level Specializing Master in Furniture Design, Learning from the Italian experience, by Poli.Design, Politecnico di Milano, was conducted by the author in December 2018, over a period

of 3 days and covering a total of 21 hours. The color course was organized to offer students theoretical contents on color and practical color design implications. Following a teaching method that had already previously been partially tested (Boeri 2019), twenty-four students from different nationalities were asked to proceed in two phases. The first phase was configured to allow students to explore and experiment with the design implications of the 4-color combinations associated with a selection of connotative terms, or 'color emotion words' (Nakamura et al. 2005), chosen on the basis of their recurrence in the literature addressing the emotional response to color, or color emotion, (Ou et al. 2004a:233), and their relevance to possible design developments [2]. The terms selected in the form of pairs of opposites were: *classic–modern*, *cool–warm*, *dynamic–quiet*, *hard–soft*, and *heavy–light*. The second phase was conceived to experiment and evaluate the possibility of applying the associations and 4-color combinations previously developed to build the emotional character of an interior space.

The two phases were developed following a process of student-learning and exploration that moves from a rather abstract and general content towards a specific contextualization in a student's design project (Fig. 1).

In summary, the students were first asked to place each of the proposed emotion words within an organized map with a vertical axis of lightness and a horizontal axis of saturation forming four quadrants. Each axis is further subdivided into 10 equal steps, with 0 at the intersection of the axes and increasing to 10 at the periphery. Additionally, the two quadrants to the left are characterized by the association *cool* and the two quadrants to the right with the association *warm*. The association with cool and warm is taken as an indicator of an evaluation concerning also the hue attribute (Fig. 2).

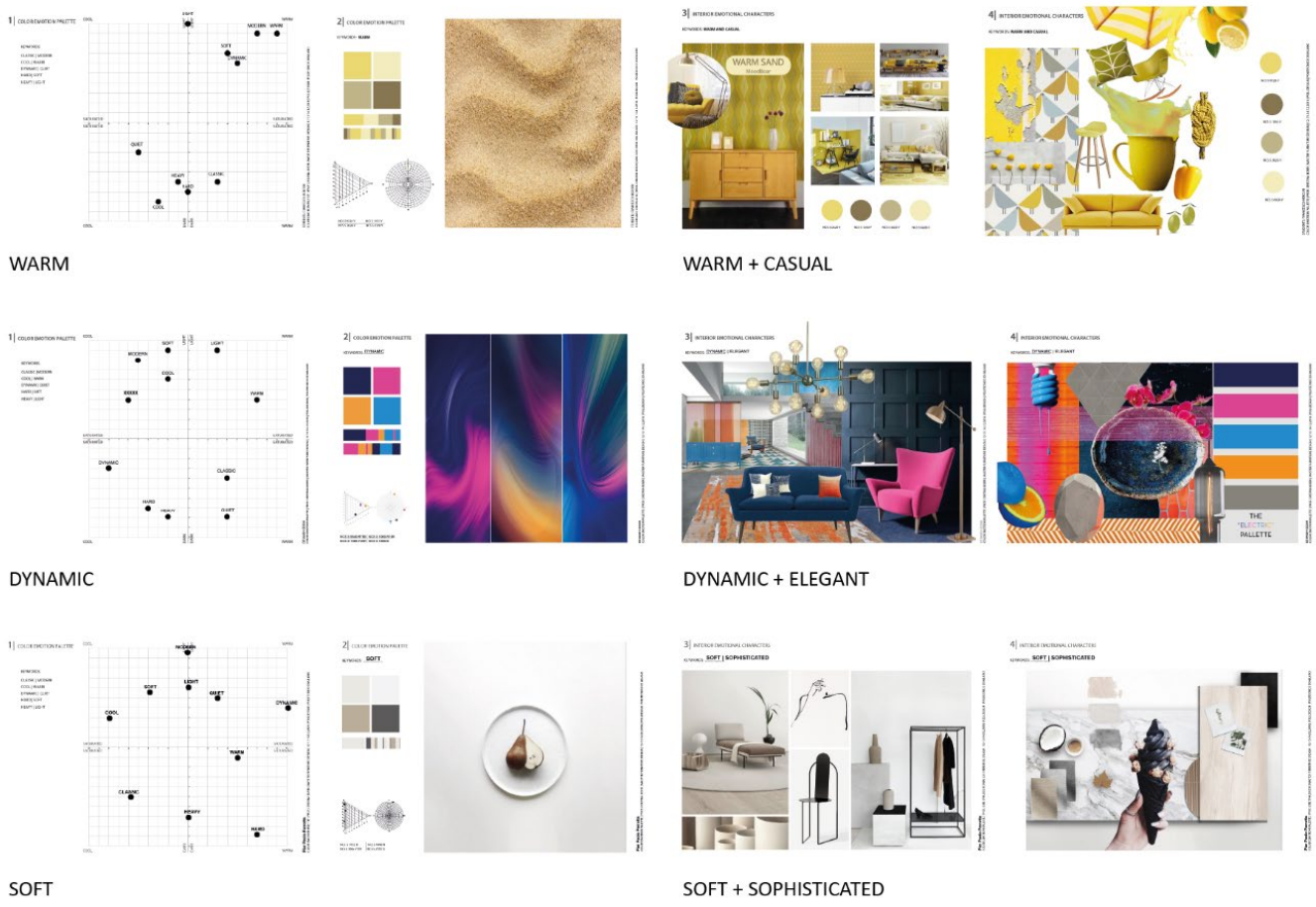

Fig. 1. On the horizontal rows are shown three students' work, produced in the course's 1st phase (two plates left) and 2nd phase (two plates right) of the Shapes, Surfaces and Colours *module (Professor: C. Boeri) of the Master in Furniture Design, Poli.Design, Politecnico di Milano (Director of the Master's course: A. Deserti; Co-Director: F. Zurlo). Students: Francesco Mercuri, Devanshi Doshi, Pier Paolo Perrotta.*

The visual organization and the terminology represented in the map of color attributes is designed to help students complete the required task. It takes into consideration that this may be the students' first exposure to color attributes and associations. The map and the emotion words were explained to the students in advance. This task had a dual purpose: on the one hand, to invite students to explore all the proposed words before proceeding to the choice of the ones they wanted to develop; and, on the other hand, to evaluate the possibilities of establishing associations between emotion words and color attributes in the absence of color samples.

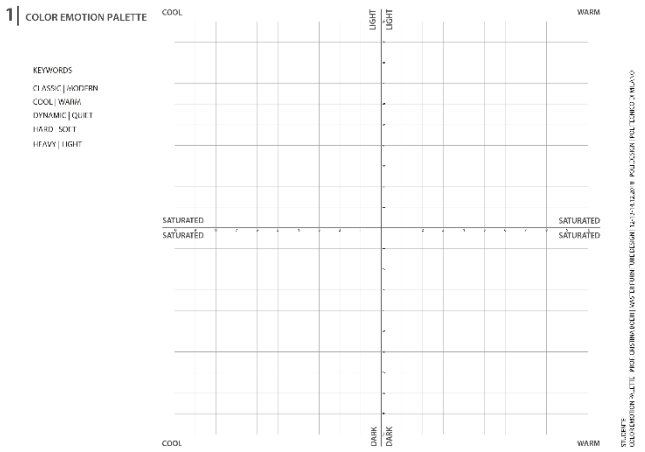

Fig. 2. The map provided to the students to explore and evaluate the associations that can be established between the selected word pairs and the color attributes. At the intersection of the axes there is a medium gray (= 0), at the ends of the axes the maximum lightness, darkness or saturation (= 10).

Subsequently, the students were asked to freely choose one or two emotion words from those proposed and then build 4-color palettes associated with each word using the visual selection from the NCS 1,950 standard color samples and the NCS Navigator. The pre-set plate supplied to the students envisaged that for each palette there would also be some evocative images useful to contextualize the palette in relation to the sought after association, the visual hierarchies that each color can take inside the palette and the characteristics of each color and color combination with respect to the color attributes using the NCS color circle and NCS triangle (Fig. 3 a, b).

Fig. 3 a, b. Two examples of students' 4-color palettes associated with the word 'cool'. Students: Natalia Arkharova, Firas Abu Dahab.

In a second phase the students were asked to apply the associations they found between the emotion words and the palettes previously developed to build the emotional character of an interior space. In summary, the students were asked to develop two mood-boards able to describe and synthesize through images the emotional and sensory characteristics of an interior space, referring to the domestic or retail environment, using as main reference the emotion word and the relative color palette already developed, and declined according to a further connotation to choose from within a new selection of the proposed word pairs: *casual–elegant*, *playful–serious*, *simple–sophisticated*. Divided into two plates, the task initially involved the construction of a mood-board aimed at creating a strongly evocative 'character' of an interior environment related to the selected emotion words, and subsequently at conceiving an inspirational material-chromatic scenario (Fig. 1, two plates right).

The students' works were analysed in part during the course to provide a basis for verification, comparison and

shared discussion with respect to the results produced, and in part in retrospect, to verify, evaluate and compare the presence of associative recurrences between emotion words and color attributes both with respect to the initial exploration, without color samples, and to the colors and organisational schemes used for the construction of the 4-color combinations.

3. Results and discussion

The initial map results, in relation to a total number of 17 works submitted, were visually rearranged to show the presence of possible associative recurrences in relation to the lightness and saturation attributes and the cool–warm polarity, for each emotion word (Fig. 4).

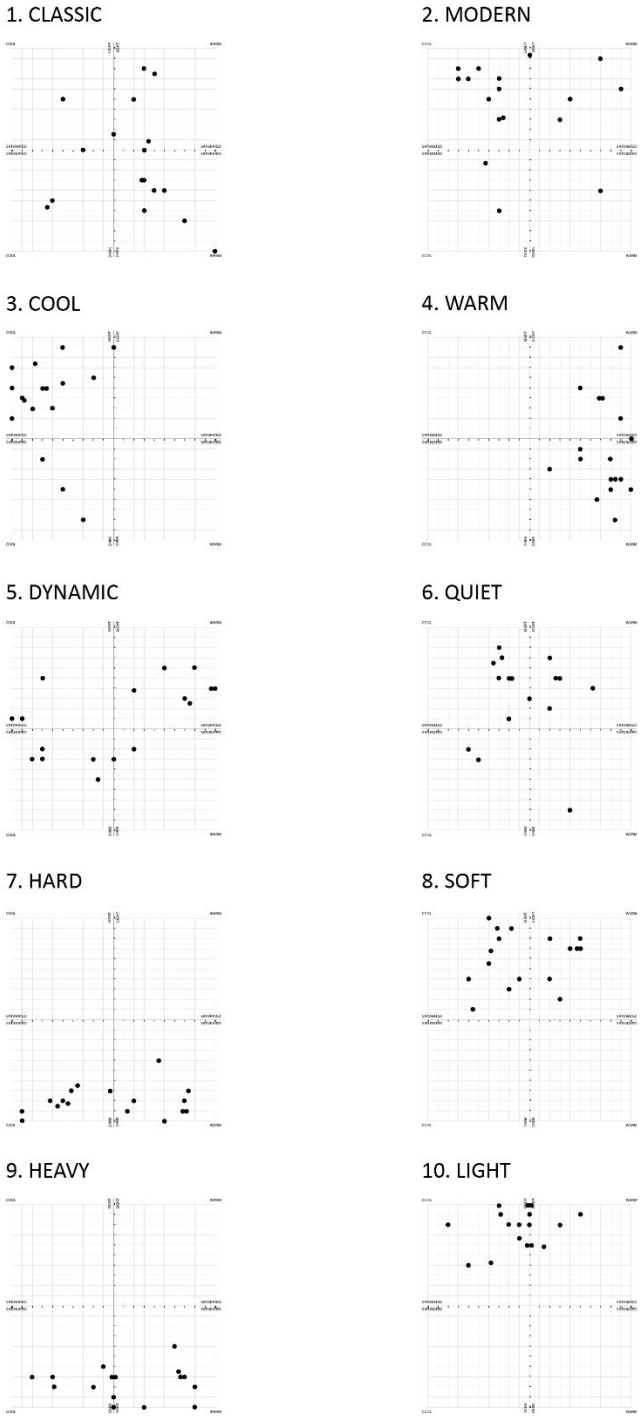

Fig. 4. The maps with the results from 17 works submitted were visually rearranged to show the presence of possible recurrences in relation to the attributes of lightness and saturation and to the cool and warm connotations for each word. One submission was incomplete in that it did not include 'quiet' and 'heavy'.

The results show for the *classic–modern* polarity a concentration of associative evaluations in relation to the cool–warm polarity, with *(1) classic* that presents a greater concentration of evaluations in the quadrants connoted with warm (Fig 2, right half of the map) and *(2) modern* in those connoted with cool (Fig. 2, left half of the map), and, for *modern* also appears a concentration of evaluations in relation to the quadrants connoted with light (Fig. 2, upper half of the map ranging from 0 = medium gray to 10 = maximum lightness). The *cool–warm* polarity (in addition to the obvious correspondence with the cool and warm halfs) shows on the map a concentration of associative evaluations related to the lightness attribute with *(3) cool* that presents a greater concentration of evaluations in the quadrant connoted with light and cool and *(4) warm* in the quadrant connoted with dark and warm. The *dynamic–quiet* polarity shows a concentration of associative evaluations in relation mainly to the saturation attribute, with *(5) dynamic* that presents a greater concentration of evaluations in the saturated areas (5–10) and *(6) quiet* that presents an even more evident concentration of evaluations in the desaturated areas (0–5). The *hard–soft* and *heavy–light* polarities show a concentration of associative evaluations mainly in relation to the lightness attribute, with *(8) soft* and *(10) light* that present greater concentrations of evaluations in the quadrants connoted with light, and *(7) hard* and *(9) heavy* in those connoted with dark (Fig. 2, lower half of the map ranging from 0 = medium gray to 10 = maximum darkness). In addition, *(10) light* presents a greater concentration of evaluations on the vertical gray axis and in the lightness areas (6–10) and is related to the cool connotation compared to *(8) soft* that presents a greater distribution on the upper half of the map.

The results of the analysis of the colors and organisational schemes used for the construction of the 4-color palettes, carried out in retrospect on a total number of 37 works, were visually synthesized using the NCS triangle and NCS circle to show the presence of possible recurrences and their relevance in terms of hue and/or nuance (Fig. 5).

Taking into account the number of works that could be analysed for emotion words, the most relevant results show: for *(1) classic* a recurrence of color combination schemes based on hue analogies and a concentration of the mostly used hues in an area of the circle between Y and R20B; for *(3) cool* a recurrence of color combination schemes based on hue analogies and a concentration of the mostly used hues in an area of the circle between R90B and B20G; for *(5) dynamic* a recurrence of color combination schemes based on the differentiation of hues (at least 2 hues) and a concentration of the mostly used hues in three areas of the circle, between Y and Y30R, between Y90R and R10B, and between R70B and B; for *(6) quiet* a recurrence of color combination schemes based on nuance analogies and a concentration of the mostly used nuances in an area of the triangle with blackness between 05 and 20 and chromaticness between 0 and 30; for *(8) soft* a recurrence of color combination schemes based on nuance analogies and also on hue analogies with at least two hues identical or closely located on the circle, and a concentration of the mostly used nuances in an area of the triangle with blackness between 05 and 30 and chromaticness between 0 and 30; for *(9) heavy* a recurrence of color combination schemes based on nuance analogies and a concentration of the mostly used nuances in an area of the triangle with blackness between 40 and 90 and chromaticness between 0 and 40; for *(10) light* a recurrence of color combination schemes based on nuance analogies and hue analogies and a concentration of the used nuances in an area of the triangle with blackness between 05 and 30 and chromaticness between 0 and 30; for *(2) modern* any recurrence in the color combination schemes appears; for *(4) warm* and *(7) hard* the colors and organizational schemes that can be analyzed refer to single works; and, for *(4) warm* a color combination scheme based on the same hue Y and for *(7) hard* a color combination scheme based on the analogy of 3 nuances characterized by blackness between 60 and 90.

The comparison of the results of the analysis of the colors and organisational schemes used for the construction of the 4-color palettes (Fig. 3 a, b) with the results of the initial exploration inserted on the maps (Fig. 4) allows us to observe and evaluate the presence of possible coherences with the associative evaluations emerged between emotion words and color attributes. In particular, the development of the 4-color palettes associated with the *classic–modern* polarity shows a coherence with the associative evaluation mainly in connection to cool and warm limited to the emotion word *(1) classic* and with reference to the hue attribute with a concentration of the mostly used hues in one area of the circle, between Y and R20B that correspond to the so-called ‘warm hues’ (Wright 1962, Da Pos and Valenti 2007). As well, the development of the 4-color palettes associated with the emotion word *(3) cool* shows an associative evaluation in connection to the hue attribute with a concentration of the mostly used hues in an area of the circle, between R90B and B20G that correspond to the so-called ‘cold hues’ (Wright 1962, Da Pos and Valenti 2007). The development of the 4-color palettes associated with the *dynamic–quiet* polarity shows a coherence with the associative evaluation mainly in connection to the saturation attribute especially for the emotion word *(6) quiet*. The development of the 4-color palettes associated with the *hard-soft* and *heavy–light* polarities show coherences with the associative evaluations mainly in connection to the lightness attribute.

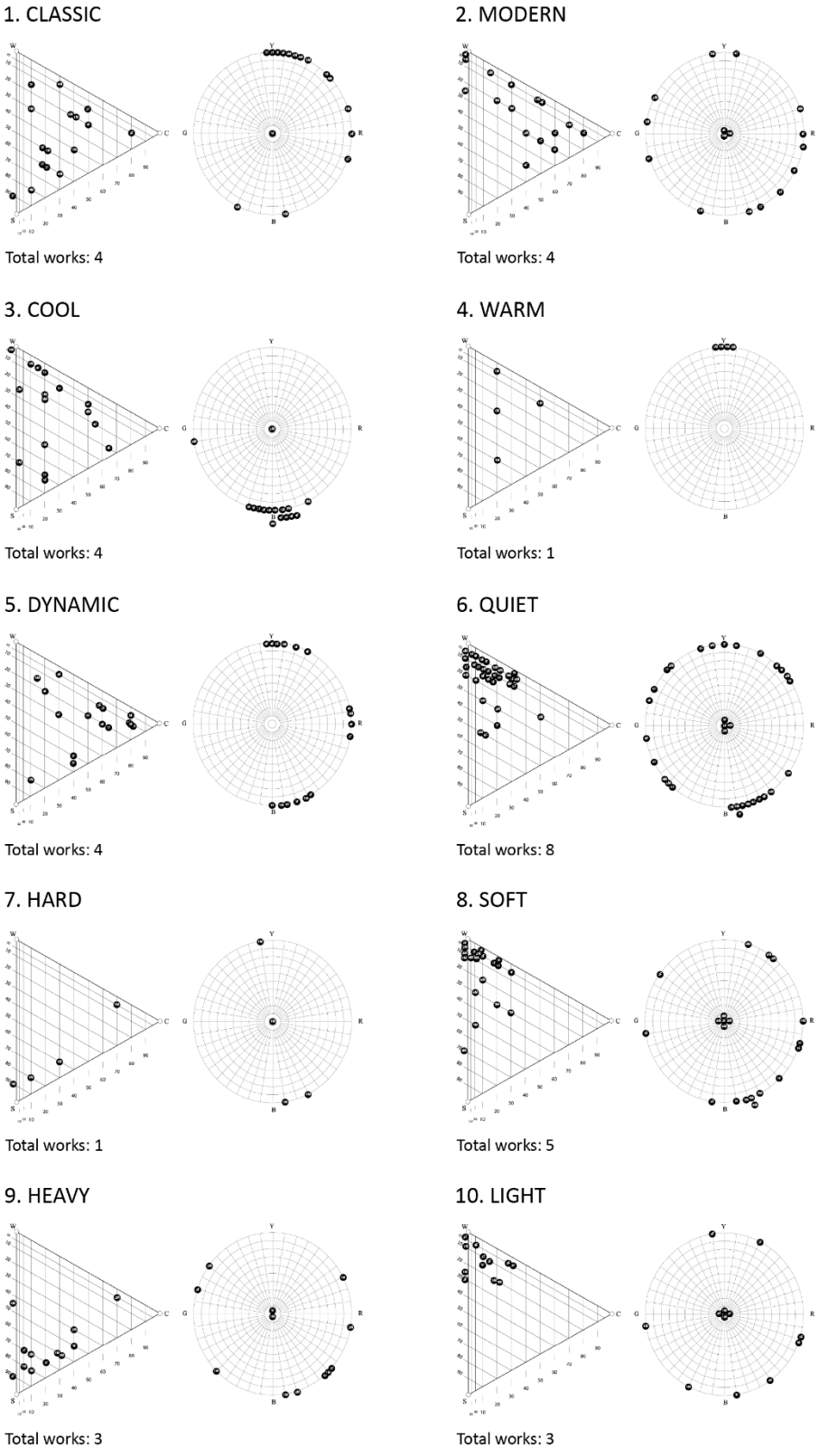

Fig. 5. The results of the analysis of the colors and the patterns used for the construction of the 4-color combinations associated with the selected emotion words, conducted on a total number of 37 works, were visually synthesized using the NCS triangle and NCS circle. The 4-color combinations associated with each emotion word can be identified by the letter F = female or M = male and a progressive number (visible enlarging the image).

Compared to previous studies, these results seem to confirm for the *hard–soft* and *heavy–light* polarities the connection to the lightness attribute (Ou et al. 2004a, Gao and Xin 2006). While for the *cool–warm* polarity the results of the palette developments seem to confirm the connection to the hue attribute (Wright 1962) but not the connection with both hue and chroma (Ou et al. 2004a, Da Pos and Valenti 2007) or with chroma only (Gao and Xin 2006). In addition, the connection to the lightness attribute that emerged from the initial exploration with the map, does not appear relevant in previous studies (Da Pos and Valenti 2007).

These results lead to some considerations with respect to the method adopted concerning the possibility of establishing associations between the selected connotative terms or emotion words and the color attributes both in absence of color samples and in presence of a high number of color samples and an even higher number of color combination possibilities (Sivik and Hård 1989). This way of proceeding, according to the students' design training, contribute to validating the design opportunities offered by the possibility of dealing with the evaluation of the emotional response to color in terms of color combinations.

The considerations on the outcomes of the second phase, related to the contextualization of the emotion words and their related 4-color palettes, are limited to a didactic evaluation of the experimented design process. Design students are generally used to work with the possibilities of establishing associations between concepts, key words and visual syntheses. In the design process proposed in this experience the use of the evaluation of the emotional response to color allowed students to explore and evaluate a systematic approach to these associative experiences, starting from color in order to define the sensorial and emotional qualities of the environment.

4. Conclusions

The results of this educational experience and experimentation contribute to validating the design opportunities offered by the possibility of dealing with the evaluation of the emotional response to color in terms of color attributes, and thus of color combinations. In addition, the use of such associative assumptions to build the emotional character of an interior space seemed to be a useful educational and methodological tool to relate color to the other design components, in particular shape, material and surfaces, and to show the potential value of a design process structured around color and the evaluation of the emotional qualities of the environment.

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

Cristina Boeri is an 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

[1] For color attribute definitions see Kuehni, R. G. (2003). Color Space and Its Divisions. Color Order from Antiquity to the Present. Hoboken: Wiley and Sons. In this paper, the terms used to define the color attributes in the respective studies reported have been kept.

[2] Compared to the ten bipolar color-emotion scales used in the experiment of Ou et al. (2004a:233) as the most frequently used in early studies (warm-cool, heavy-light, modern-classical, clean-dirty, active-passive, hard-soft, tense-relaxed, fresh-stale, masculine-feminine, and like-dislike), the opposites *warm-cool*, *heavy-light*, *hard-soft* were selected; *modern-classic* was preferred to modern-classical; *dynamic-quiet* was preferred to active-passive.

References

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

Castelli Trini, C. (1995) 'States of domesticity', The Dream of Power: Reality and Utopia in Home Automation, Casciani, S. (ed.) The new living and light series from BTicino and CMF project from Clino T. Castelli. Milano: Città Studi edizioni, pp. 69–79.

Castelli Trini, C. (1999). Transitive design. Milano: Electa.

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

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. Tokyo: Kodansha International.

Kuehni, R. G. (2003) Color space and its divisions: color order from antiquity to the present. Hoboken: Wiley and Sons.

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

Nakamura, T., Sakolnakorn, P. N., Hansuebsai, A., Pungrassamee, P. and Sato, T. (2005) 'Emotion induced from colour and its language expression' AIC 2004 Color and Paints, Proceedings of the Interim Meeting of the International Color Association, Caivano J. L. and Struck H.-P. (eds.) Porto Alegre: Associação Brasileira da Cor, pp. 328–331.

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

Ou, L-C., Luo, M. R., Woodcock, A. and Wright A. (2004a) 'A study of colour emotion and colour preference. Part I: Colour emotions for single colours', Color Research and Application, 29, pp. 232–240.

Ou, L-C., Luo, M. R., Woodcock, A. and Wright A. (2004b) 'A study of colour emotion and colour preference. Part II: Colour emotions for two-colour combinations', Color Research and Application, 29, pp. 292–298.

Sivik, L. (1970) 'Om Färgers Betydelse' [English Summary: Colour Connotations and Perceptive Variables]. Stockholm: Swedish Colour Center.

Sivik, L. (1989) 'Research on the meanings of color combinations' AIC Color 89, Proceedings of the 6th Congress of the International Color Association, 2, Buenos Aires: Grupo Argentino del Color, pp. 130–132.

Sivik, L. and Hård, A. (1989) 'On studying color combinations: some reflexions and preliminary experiments'. Färgrapport 22, Stockholm: Scandinavian Colour Institute.

Wright, B. (1962) 'The influence of hue, lightness, and saturation on apparent warmth and weight', The American Journal of Psychology, 75(2), pp. 232–241.

Color Lab IFRJ: practical color exercises for fashion courses

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ABSTRACT

This paper is part of a research project called Color Lab IFRJ (Laboratório de Cor – IFRJ, in Portuguese) that aims, among other things, to analyze and propose practical color exercises for fashion courses at the Federal Institute of Rio de Janeiro – IFRJ Campus Belford Roxo. One of the main objectives of Color Lab IFRJ was to develop and to adapt teaching procedures to the Campus reality, helping to increase the understanding of color theory concepts for fashion courses. In this sense, two practical exercises called 'Color Book', 'Paper Dolls' and 'Jenifer's Look' were proposed in order to analyze and to explore the interaction of colors in fashion design. With practical exercises like those, the teacher has taken up important questions of color theory with the students such as color dimensions, color contrast, and chromatic harmonies. These practical exercises provide students with color tools and knowledge that can consciously and objectively be applied in fashion design.

KEYWORDS Color Education, Color Literacy, Practical Exercises, Fashion Design, Doll

RECEIVED 07 October 2019; **REVISED** 25 November 2019; **ACCEPTED** 27 November 2019

1. Introduction

Color is a valuable tool for visual artists, stylists, fashion designers, architects, and many others. The analysis of an anonymous questionnaire completed by freshman students of the Federal Institute of Rio de Janeiro – IFRJ Campus Belford Roxo shows that students find that color theory is important for fashion design projects. However, research shows that the students start attending fashion courses of IFRJ Campus Belford Roxo with very superficial knowledge regarding color theory and have difficulty in understanding and differentiating basic concepts of color theory and working with color spontaneously or intuitively (Quattrer and Gouveia 2018:1). Still according to previous research, in Brazilian Elementary School and Middle School, color is treated with less importance when compared to other contents of the Art curriculum, which contributes to the perpetuation of conceptual problems in color education (Quattrer 2019:83).

It should be noted that IFRJ Campus Belford Roxo has suffered over the last few years with funding cuts and this has had a negative impact on new Campuses such as IFRJ Campus Belford Roxo, which is located in one of the poorest areas of the state of Rio de Janeiro. The lack of physical space and material resources for teaching color theory is a challenge. The IFRJ Campus Belford Roxo fashion courses are composed of students of very different ages. For example, some students are still in high school while others have completed high school some forty years ago.

In this sense, the teaching experience of the authors, in agreement with Hirschler, Lopes and Oliveira (2011) and Bergström (2002), points out that the path to a successful experience on color education in Arts and Design courses at different levels – high school, graduation, and post-graduation – is to demonstrate to students the intellectual challenge of studying and working with color through practical exercises of investigation and chromatic analysis. Therefore, the act of creation is a very important factor for color theory understanding in the IFRJ Campus Belford Roxo fashion courses and the creative process is fundamental.

2. Objectives

The research project called Color Lab IFRJ (Laboratório de Cor – IFRJ, in Portuguese) was created in order to analyze and propose practical color exercises for fashion courses of IFRJ Campus Belford Roxo and, among other things, to support the cataloging activities of Modateca IFRJ's fashion collection.

Due to the lack of physical space and material resources for teaching color theory at the IFRJ Campus Belford Roxo, one of the main demands of Color Lab IFRJ is to develop and adapt teaching procedures to the Campus' reality, which is to help increase the understanding of color theory concepts for fashion courses.

3. Method

In order to achieve the objectives of the Color Lab IFRJ project and to establish the selection criteria for color theory concepts to be applied in practical exercises of chromatic composition for fashion courses, theoretical support was sought from authors concerned with color education in Arts and Design: Albers (2009), Berns (2016), Frova (2008), Gage (2000), Guimarães (2004), Monzeglio (1972) and Munsell (2019).

The practical exercises 'Color Book', 'Paper Dolls' and 'Jenifer's Look' were structured in order to explore the interaction of colors in fashion design and to collaborate in the fixation of basic concepts of color theory, for example, primary and secondary colors, dimensions of color (hue, value and chroma), color contrast and color harmony.

3.1. *Color Book*

From the above-mentioned authors and the didactic experiences in color teaching, a practical and individual exercise of research, selection and comparison of color samples of paper, fabric and trims called 'Color Book' was structured and applied to fashion students throughout color theory classes (Fig.1).

Fig. 1: Details of students' Color Books elaborated with paper and fabric samples and fashion trims in the Color Theory class, offered in the Fashion Course of IFRJ Campus Belford in 2018. Photo: Milena Quattrer.

From the theory of color perception and color contrast, three basic criteria were established for the elaboration of the Color Book: (i) it should be divided into sections, each intended for one type of material (paper, fabric, trims, etc.); (ii) the pages should be white or black without any lines, since they are the base for gluing the color samples; (iii) and, the color samples of paper and fabric must be the same size and measure at least 2 cm x 2 cm.

It should be mentioned that the selection and organization of the color samples is up to the student, who should justify it at the time of evaluation of the exercise. But it is worth saying that students are also instructed to search colors from the contents of color theory studied in each class. And it has proven to be an interesting challenge for them, who often choose to organize color samples based on the dimensions of color (hue, value and chroma) and to construct color palettes from the concepts discussed in class.

One of the color palettes commonly elaborated by students is based on warm and cool colors. This distinction refers to the qualification of colors as warm or cool following psychological and cultural interpretations. According to Albers (2009:80), in the Western tradition, yellow, red, orange, as well as their respective variations are commonly accepted as warm colors. While blue, green and violet, and their respective variations are commonly considered cool.

However, such interpretations are relative and a certain color may appear warmer or cooler according to its chromatic composition. For example, a red can be warm or cool depending if the red is tending to yellow or tending to blue. Moreover, it is important to point out that the relationship between color and meaning is not arbitrary or accidental, it is part of a cultural context that, according to Heller (2014), can be understood from the historical tradition and psychological symbolism. In this sense, according to Gage (2000:22), "colors seem 'warm' or 'cool' only metaphorically." Since, when it comes to the visible spectrum, already studied by the students, wavelengths for blue-violet have the highest warming capacity, while the wavelengths for red have the lowest. If necessary, the teacher can revisit this concept with the students.

3.2. *Paper Dolls*

A practical exercise with paper dolls and paper samples was structured in order to contribute to the understanding of the concept of chromatic harmony. It is applied in parallel to the Color Book exercise and before the exercise Jenifer's Look.

Carried out under the supervision of a teacher, students are oriented to develop a color composition for paper dolls based on the concepts of chromatic harmony by affinity and harmony by contrast using only paper samples (Fig. 2).

Fig. 2: Details of students' exercises on color composition with paper dolls elaborated with paper samples in the Color Theory class, offered in the Fashion Course of IFRJ Campus Belford in 2019. Photo: Milena Quattrer

Color harmony by affinity is the coordination of analogous hues or similar color shades. And the opposite of harmony by affinity is harmony by contrast, which refers to the coordination of contrasting hues and/or color shades. These are: (i) black and white contrast; (ii) value contrast; and, (iii) hue contrast. The black and white contrast occurs through the coordination of achromatic or neutral colors (white, black, and their lightness variations (i.e. gray scales). The value contrast concerns combining light and dark colours, i.e., when a saturated hue is coordinated with white, black or gray. Finally, the hue contrast refers to the coordination of different hues (one of the strongest of its kind occurs when complementary saturated hues are used, e.g., yellow and violet).

This exercise has proven to be very relevant for the teacher to clarify some doubts about the dimensions of color. The teacher revisits the concepts like primary and secondary colors, dimensions of color, and color contrast. These important concepts were presented and discussed previously with features such as: (i) a color wheel of subtractive mixtures adapted from Itten (1961), in which the three primary colors magenta, yellow and cyan are used (hue variation), (ii) two scales of value (chromatic and achromatic), and (iii) a chroma scale (saturation variation).

Especially, it could assist the teacher in explaining the concepts and characteristics of hue and in differentiating monochromatic and achromatic concepts. It is necessary to clarify that in fashion design it is common to use the term 'monochromatic look' to refer both to the use of shades of one hue and the use of black, white, and gray only. However, the teaching experience of the authors points out that for teaching purposes it is important to clarify and differentiate the concepts of monochromatic and achromatic.

So, in IFRJ Campus Belford Roxo Color Theory classes, the term monochromatic look is used only to refer to a set of samples varying in value or saturation but of constant hue. And, the term achromatic is used just to refer to a set of samples varying from white to black through gray – the latter obtained from the mixture of white and black.

3.3. *Jenifer's Look*

A practical group exercise with doll's costume design was structured to be applied after the Paper Dolls exercise in order to explore the interaction of colors in fashion design and to collaborate in reviewing and applying basic concepts of color theory. The exercise was named Jenifer's Look (Look da Jenifer, in Portuguese) from the doll's label used when the exercise was first applied in 2018. At this time, an Instagram profile was created to make public on social media the students' projects (@lookdajenifer) after a student's request. In order to expand the diversity of bodies and skin colors to reflect the diversity of the IFRJ Campus Belford Roxo students, in 2019 Barbie® dolls with different skin colors and body types were acquired with the research project funding.

Carried out under the supervision of a teacher, during the Jenifer's Look exercise students are oriented to develop in group a color composition for doll costume design with different types of clothes, footwear and fashion accessories using low-cost materials like fabric samples and fashion trims. The color palette for doll costume design should follow some criteria pre-set by the teacher such as be in line with the previously defined main theme and be based on chromatic harmonies by affinity and/or contrast (Fig. 3). At this stage, chromatic harmonies by affinity and/or contrast content has already been studied in previous exercises.

Fig. 3: Students' color palettes for doll costume design developed using Color Cards in the Color Theory class, offered in the Fashion Course of IFRJ Campus Belford in 2019. Photo: Milena Quattrer.

It is also important to point out that color trends content is often previously discussed with students through a chromatic research exercise called 'Moodboard' that is a simplification of a Fashion Moodboard commonly used by fashion professionals. In the Moodboard exercise the group of students makes use of a system of guiding signs and codes, such as keywords, images, color palette, textures, materials, among other inputs.

Thus, students are aware of the main color trends in fashion when choosing the color palette. However, for didactic purposes, students are encouraged to investigate chromatic harmonies beyond the color palettes presented by color trend agencies and associations.

It is noteworthy that for the Jenifer's Look exercise the chromatic composition is more important than the modeling or the quality of workmanship. This is because at this stage some students do not have sufficient knowledge of modeling and sewing. So, the teacher evaluates the students' progress both as a group and individually from the pre-established criteria: (i) the application of chromatic harmonies (Fig. 4) and (ii) the adequacy of composition to the main theme.

Fig. 4: Students coordinating fabrics in gray, yellow and magenta for doll costume design in the Color Theory class, offered in the Fashion Course of IFRJ Campus Belford in 2018. Photo: Milena Quattrer.

Finally, after completing the exercise, students are invited to present their chromatic compositions to other students and the teacher. At this point the student group points out and justifies its choices and the dolls are photographed (Fig. 5). It is a substantial moment for the whole class and a moment of reflection on color choices and on metamerism and color inconstancy.

Fig. 5: Doll costume design developed by students in 2018 and 2019, in the Fashion Course of IFRJ Campus Belford. Photo: Milena Quattrer.

4. Conclusion

Color theory classes have been offered as part of IFRJ Campus Belford Roxo fashion courses since the second half of 2017. From the analysis of the students' midterm exams (MV1) and final exams (MV2) over the last two years, it was possible to reassess and change the didactic sequence of the pratical exercises Color Book, Paper Dolls and Jenifer's Look.

As said earlier, students start attending fashion courses of IFRJ Campus Belford Roxo with very superficial knowledge regarding the color theory, and the lack of physical space and material resources for teaching color theory is a challenge. In this sense, Color Book, Paper Dolls and Jenifer's Look have proven to be an important didactic resource for discussing in a playful way relevant questions and concepts about color theory, such as color dimensions, color contrast, and types of chromatic harmony.

Moreover, exercises like these have been shown to be very attractive and thought provoking for students. With the help of these exercises, students are consciously and objectively trained to perceive how color is an important resource in fashion design.

5. Conflict of interest declaration

The authors declare that there is no conflict of interest regarding the publication of this paper.

6. Funding source declaration

This research was supported by Programa Institucional de Incentivo à Produção Científica, Tecnológica e Artístico-Cultural (PROCIÊNCIA) of Federal Institute of Rio de Janeiro (IFRJ).

7. Acknowledgements

We thank our colleague Amanda Olívia Silva from IFRJ Campus Belford who greatly assisted the students in modeling and sewing.

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References

Albers, J. (2009) A Interação da Cor. São Paulo: Martins Fontes.

Bergström, B. (2002) 'Creative Colour Education', AIC 2001, Proceedings of the 9th Congress of the International Colour Association Chung R. Y. and Rodrigues A. B. J. (eds.) Bellingham, WA: SPIE, 4421, pp. 963–966.

Berns, R. S. (2016) Color science and the visual arts: a guide for conservators, curators, and the curious. Los Angeles: Getty Publications.

Frova, A. (2008) Luce, colore, visione: perchè si vede ciò che si vede. Milano: BUR Scienza.

Gage, J. (2000) Color and meaning: art, science, and symbolism. Berkeley: University of California Press.

Guimarães, L. (2004) A cor como informação. São Paulo: Annablume.

Heller, E. (2009) Psicología del color. Cómo actúan los colores sobre los sentimientos y la razón. Barcelona: Gustavo Gili.

Hirschler, R., Lopes, L. C. and Oliveira, D. F. (2011) 'Light and colour in the classroom: demonstrations from physics to the interaction of colours', AIC 2011 Interaction of Colour and Light, Proceedings of the Midterm Meeting of the International Color Association, Schindler V. M. and Cuber S. (eds.) Zurich: pro/colore, pp. 169–172.

Itten, J. (1961) The Art of Color: The Subjective Experience and Objective Rationale of Color. New York: Reinhold.

Monzéglio, E. (1972) Interpretação do significado de módulo/cor: contribuição ao estudo da cor e sua aplicação na programação de mensagens visuais. Ph.D Diss., University of São Paulo.

Munsell Color Blog (2019). How Color Notation Works. Available at: https://munsell.com/about-munsell-color/how-color-notation-works/ (Accessed: 25 November 2019).

Quattrer, M. (2019) A cor no livro didático de Arte. Ph.D Diss., Universidade Estadual de Campinas, Instituto de Artes, Campinas, SP, Brazil.

Quattrer, M., and Gouveia, A. P. S. (2018) 'Exercises of chromatic investigation and analysis on color education', Color Research and Application 43(6), pp. 851– 856. doi.org/10.1002/col.22282.

Does chromatic lightness have an impact on the perceived odor of Brazilian perfumes?

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ABSTRACT

This paper presents results of experiments carried out between 2013 and 2016, in which we searched for correspondences between the olfactory stimuli of perfumes and the visual stimuli of their primary packaging. In the present study, we explore a potential correlation between colors and smells. The chosen methodology consisted of analyzing colors from two different points of view: first, how companies use colors to represent smells; and second, how consumers perceive fragrances and how they correlate them to colors. We called these two approaches the 'representation of colors' and the 'perception of colors.' Our method also entailed searching online for catalogs of fragrance companies and selecting those that use colors associated with fragrance families. In order to investigate the consumer's perception, we carried out sensorial experiments in which a group of people performed a blind analysis of four Brazilian perfumes. Quantitative and qualitative explorations were conducted. Basic statistics were used that confirmed companies' practices. The research results concluded that consumers not only associate specific colors to fragrances, but they may associate the lightness of a color to the intensity of a fragrance. For example, participants of the experiments perceived a fragrance as softer attributing the softness to the lighter colors of the packaging. The results presented in this paper could be useful for designers and marketers because they highlight the importance of the correspondences between the senses, as well as the correlation between color and odor intensity.

KEYWORDS Perfume, Color, Brazil, Perception, Packaging

RECEIVED 26 October 2019; **REVISED** 28 November 2019; **ACCEPTED** 02 January 2020

1. Introduction

This study inquires into the role of design in the perfumery industry, in particular into the impact of color and shape upon fragrances. A multisensory approach in the field of Perfume Packaging Design was used, with focus on the hypothesis that potential associations between smell, colors and shapes exist. The experiments on the correspondence between visual and olfactory stimuli of perfumes were carried out between 2013 and 2016 (Silva 2017). Two types of experiments were conducted exploring the representation of smells and the perception of smells.

We know that verbalizing a smell is not an easy task. For those working in the fragrance market, however, it becomes a necessity. Our research has been encouraged by literature describing research employing a multisensory approach (Demattè et al. 2006, Gilbert et al. 1996, Hanson-Vaux et al. 2013, Joutsela 2010, Kim 2008, Moeran 2011, Spector and Maurer 2012).

Joutsela (2010) supports the idea that different sensory stimuli must be used in packaging design in order to impact the consumer on mulitple levels. In the present research concerning perfumes, it is crucial that elements such as shape and colors be in synergy with the sensations that the fragrances supposedly evoke. As previously discussed (Silva and Mazzilli 2016), research in the field of experimental psychology also shows that a consonance between stimuli can enhance one's perception and consequently the communication.

Gilbert et al. (1996), a group of researchers from Givaudan-Roure Fragrances Company, performed an experiment in order to find correspondences between vision and olfaction. Participants of their experiment were asked to associate odor stimuli with Munsell color chips. Beyond the correspondences found, the researchers identified a potential relationship between color lightness and odor intensities. Based on these results, we selected a group of colors considering lightness variation. Demattè et al. (2006) from the Department of Experimental Psychology at the University of Oxford in England confirmed the correspondences previously verified by Gilbert et al. (1996). The researchers from Oxford suggested that the establishment of such associations comes from people's lived experiences. Based on this, we decided to combine questions including both visual responses (color chips) and verbal responses (words).

Another experiment on the correpondences between colors and odors was carried out by researchers from the Department of Psychology, Neuroscience, and Behavior at McMaster University in Canada (Spector and Maurer 2012), which helped us shape our own experiment. For example, we instructed participants not to identify odors, but to smell them and give a visual response that best matched. We also asked participants about the difficulty of establishing such sensory relations and if that association made any sense. To do so, we used the Likert Scale to score responses along a range from 1 to 7 specifying the level of agreement or disagreement.

Regarding research on perfumery, we refer to the work of Kim (2008) and Moeran (2011) that most influenced this research. Both discuss the relationship between colors and odors (fragrances). Morean (2011) investigated, moreover, how fragrances are verbalized. Their research reinforces the relevance of relatively stable correspondences between fragrance, colors, shapes and words.

Finally, the research results at University of Oxford found correspondences between shapes (angular versus rounded) and odors (Hanson-Vaux et al. 2013). In that experiment, participants were asked to associate odors used in wine production with shapes. As part of the results, lemon and cedar odors were associated with the angular shapes and violet and vanilla with the rounded shapes. These results make us wonder whether perfumes that contain such ingredients could be associated to these same forms. Could the citrus perfume be associated with angular shapes? What about floral perfumes? Could they be associated with rounded shapes?

As far as perfume packaging is concerned, we expect it to express the effects that the fragrance in question intends to evoke. Furthermore, the packaging designer should be knowledgeable about the effects of smells and the meanings people attribute to them in order to effectively represent them visually and thus establish a good communication with the consumer. Multisensory research on perfumery packaging design in Brazil is still in its early stages. This paper consists of an initial and exploratory discussion.

1.1. *Multisensory approach and synesthesia*

Although synesthesia is related to the multisensory approach that we propose in this paper, our approach does not refer to neurologically based, genuine synesthesia (Domino 2009:599), which is a clinical picture being involuntary, constant and consistent, rather it relates to a cross-modal experience (Demattè et al. 2006, Domino 2009, Ramachandran and Hubbard 2001), also called cognitive synesthesia or commonly defined as pseudo-synesthesia (Sanz and Schindler 2010). According to Sean Day (2016)—who in 1992 established an international e-mail forum on synesthesia and in 2016 helped form the International Association of Synaesthetes, Artists, and Scientists (IASAS)—there are at least

seventy-three different types of synesthesias. Those categories related to the sense of sight are the most representative. In a survey of 1,143 genuine synesthetes, it was found that more than half of them (61.26%) experienced a grapheme-color synesthesia, in which a letter or number triggered the perception of a color. The percentage decreases, however, when it comes to the phenomenon in which smell stimulates vision. According to Day, odor–vision synesthesia corresponds only to 6.13%. Individuals with odor–color synaesthesia experience color sensations when they smell odors (Speed and Majid 2018).

Nevertheless, research in the field of neuroscience has also described and investigated sensory features in one modality that are associated with sensory features of another modality. Encouraged by these cross-modal correspondences, we decided to explore possible associations of smells with colors and shapes.

1.2. *The sense of smell*

Smell is a sensation that manifests itself through the sense of smell and is essential for the survival of humans and other living species. This is an important sense, e.g., for recognizing relatives, searching for a readily reproducible mate, or for locating food. However, smelling abilities have been declining over time in favor of the senses of vision and hearing. As with Jonathan H. Turner (2018:97), the evolution of mammal's biological structure has converted them from 'an olfactory-dominant to a visual-dominant animal'.

As stated by the Brazilian communication and semiotics professor Lucia Santaella, although the senses mix with each other, the complexity of human physiology imposes a sort of hierarchy between the senses. 'There is a clear decreasing degree of complexity that goes from sight to hearing, to touch, to smell, and to taste' (Santaella 2005:73). According to her, while the first three senses react to physical stimuli, smell and taste react to chemical stimuli. Vision would be more connected to the brain and to the perceptive act than olfaction. Furthermore, by developing language and writing, humans distanced themselves from animals using much less the sense of smell as a means of communication.

Despite this, smells can unconsciously influence humans and their personal and societal relationships. Scientists found that under the influence of past experiences, a smell can arouse positive or negative emotions or memories. As with Wolfe at al. (2012:420), an odour usually smells good when it is familiar and bad when it is unfamiliar. These scientists believe that, when something smells bad, we tend to repel it because we rate it as dangerous. Otherwise, a good smell can evoke memories or associations that have a positive emotional value, e.g., inviting us to approach a potential partner.

In our daily lives, nonetheless, smells are fundamental. Our smelling abilities are innate and correlated with the other senses. Through the complex interrelationship of all the senses, we succeed in understanding reality: 'Thought itself is intersemiotic and this quality is materialized in languages and their hybridization' (Plaza 1987:30). Our study is based on the premise that the correspondences between the senses are complex and need to be further explored by collecting data on the correlation of smell and vision.

1.3. *Perfumery industry and the contribution of color*

This paper addresses fragrance–color correspondences applied to perfume packaging. On the interface between basic needs and subjective desires, perfumes exert special power over men and women. For example, we do not depend on scents for basic and daily hygiene, but most of the personal care products include fragrance ingredients.

Brazil has a large perfumery market that has been considered as one of the largest consumer markets in the world (Armstrong 2017). Given this context, we explore perfumes and their powerful potential to communicate by the means of packaging design. It is known that the first contact of the consumer with a perfume is through its packaging. At the moment of purchasing a fragrance the subjective choice is decisive. Thus, the product designer must understand olfactory stimuli in order to be able to translate them into a persuasive and attractive visual language.

We have chosen two features of what we consider the most important elements of the visual language of perfume packaging: colors and shapes. The present paper, however, focuses on the associations of perfume with color only. In perfumery, colors play a substantial role in catalogs of fragrance suppliers to distinguish the different olfactory groups and types of ingredients. In the perfumery industry the use of a fragrance wheel is now a common practice to classify frangrances. The diagram (Fig. 1) by the British fragrance historian and taxonomist Michael Edwards (b. 1943) is 'one of the world's most comprehensive references for commercial fragrances, simplifying the classification process and showing relationships among fragrance families' (Donna 2014:28). It shows the relationships among four main olfactory groups (floral, oriental, woody and fresh), whereby neighboring circle sectors imply to share similar olfactory characteristics. The four perfumes selected for our experiments belong to each of these main groups.

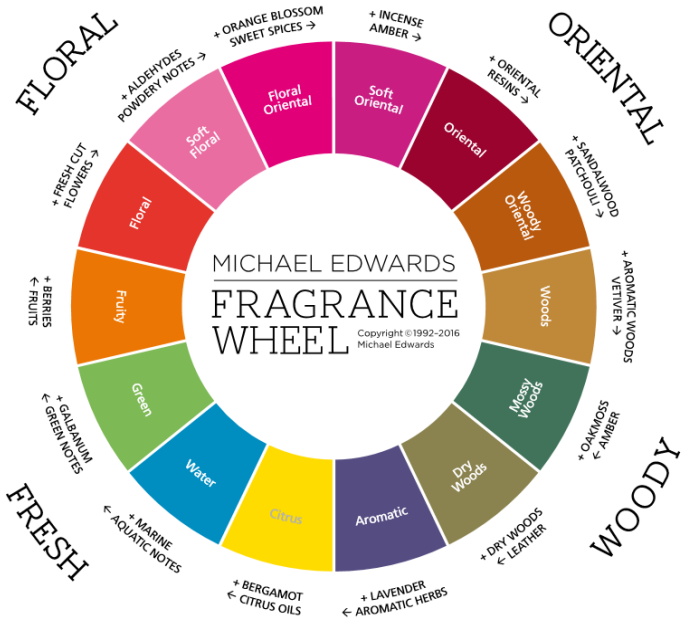

Fig. 1. Colors representing the olfactory families in the fragrance wheel by perfume historian and taxonomist Michael Edwards.

By investigating the colors used by fragrance companies and suppliers, we have identified a trend in selecting a range of analogous colors to represent certain fragrance families. We selected eight representative companies from France, Spain, Italy, Switzerland, USA and Brazil. We also selected the olfactory families they used in common. From saved images and screen captures of the companies' websites, we selected colors using the color capture tool (dropper) of Adobe Illustrator software. We then elaborated a comparative table of the colors used by the different companies as presented in Figure 2. These results were the basis for investigating people's perception of colors and perfumes through the sensory experiments described in the next section. What kind of colors would best represent specific fragrances?

Fig. 2. Colors used by perfumery companies (horizontal rows) to represent some of the olfactory families (vertical rows).

2. Correspondences between vision and olfaction: sensory experiments

During the months of January and March 2015, we performed sensorial experiments in the Laboratory of Sensory Analysis of the Faculty of Pharmaceutical Sciences of the University of São Paulo (FCF/USP). The experiment consisted in the investigation of the relationship that the participants would establish between a fragrance from a blind olfactory stimulation and a color chosen from a randomly organized color range. In order to study four different olfactory stimuli, we selected four commercially marketed perfume products belonging to the citrus, floral, woody and oriental olfactory families.

Furthermore, we prioritized the investigation for each of the four olfactory stimuli. For this purpose, we divided the research into eight sessions of experiments, subdivided into two groups. Group 1 collected associations of smells with colors and Group 2 collected associations of smells

with perfume bottle and cap shapes. The present study concerns only Group 1. Given the exploratory nature of the research, we worked with a convenient sampling. Given the location of the Laboratory in the University of São Paulo's Chemistry Complex, the majority of university students being from biological and exact sciences might have influenced the quality of the sample. We had the voluntary involvement of 345 participants, including undergraduate and graduate students, as well as USP staff and visitors. Importantly, this research did not delimit any specific audience. There was no intention through the samples to reflect data of a specific population.

We summoned the participants through a poster placed in the building of the Faculty of Pharmaceutical Sciences, on the same day as the experiments took place. As inclusion criteria, we considered fit healthy subjects over eighteen with normal color vision and smell, i.e., they should neither have color blindness nor anosmia (complete or partial loss of smell). As exclusion criteria, we did not accept people with a clinical condition compromising their sense of smell (e.g. flu, rhinitis, and sinusitis) or vision (e.g. conjunctivitis). There were no volunteers with this picture. Regarding color vision, despite the claim of normality, we applied a Color Blindness Test before the experiment. Even if we identified abnormalities, the participant could proceed with the experiment. Participants who were identified as colorblind had their data recorded but it was not included in the analysis. Finally, the experiments presented a minimal risk to the participants, since we used perfumes regularly marketed in Brazil.

The perfumes selected for analysis belong to the company O Boticário, because of its popularity and geographical coverage. It is noteworthy to emphasize, however, that the company neither participated in this research nor collaborated in the development of the present work. All the perfumes had the same concentration of cologne deodorant. We based our research on the descriptions that the company provides on its official website as selection criteria. We selected Free perfume to represent the citrus family; Floratta in Rose, to represent the floral family; Malbec Duo, to represent the woody family; and Coffee Man Seduction, to represent the oriental family. In order to test the participant's color associations with these four perfumes (Group 1), we designed a chart with 39 randomly distributed colors.

2.1. *Fragrance characteristics*

Fragrance companies commonly use two ways to describe a perfume. They describe its ingredients and how they are organized. These are known as the olfactory notes of a perfume. They also use verbal metaphors to suggest what the fragrance in question may evoke on consumers. With regard to the olfactory notes of a perfume, fragrances are divided into starting or top notes (the first to be perceived), which are the most volatile, followed by body or heart notes, which embody the perfume, and finally the base or base notes, which as its name suggests, is the base of a fragrance. These last ones are notes of greater weight and durability. Concerning the metaphors, it is common to find advertising discourses indicating specific consumer behaviors, male or female gender, situations of use, and sensations these fragrances may elicit.

The citrus perfume, Free, has in its composition the ingredients: bergamot, lemon, orange, juniper and lavender as top notes; geranium, jasmine, carnation, pine, sage and sagebrush as heart notes; oakmoss, cedar, vetiver and musk as base notes. In its advertising, the company correlates the citrus or fresh top notes to a sense of freedom and energy. The base of woody notes is associated to a discreet touch of sensuality. The fragrance is also associated to the sensation of joy, enthusiasm, refreshment, independence and positivity.

The floral perfume, Floratta in Rose, has in its composition the ingredients: orange blossom, lime, yellow fruits and orchid headspace [2] as top notes; blue rose living, fresh rose, otto natural rose, ylang and gardenia as heart notes; musk accord and woody notes as base notes. According to the company's advertising discourse, this perfume is indicated for charming women. Floratta in Rose is defined as a delicate, feminine and romantic fragrance.

The woody perfume, Malbec Duo, has in its composition the ingredients: bergamot, persian lime, lemon, violet leaves, fig, plum, star fruit, rose pepper, cardomom and saffron as top notes; rose, iris, geranium, malbec headspace, chocolate note, cassis and oak as heart notes; and cedar, vetiver, patchouli, amber, moss and musk as base notes. Malbec Duo was launched as a special edition in 2011 on the occasion of Father's Day and, according to the company, due to sales success the perfume was maintained until 2016 (O Boticário 2014, O Boticário 2016). According to fragrance specialist Renata Aschar (Brasil Essencia 2019), Malbec Duo was created for powerful and naturally sophisticated men who wish to provoke, conquer and make their mark. Moreover, according to her, it is 'sophisticated and intense like a good wine'.

The oriental perfume, Coffee Man Seduction, has in its composition the ingredients: bergamot, mandarin brazil, apple and nutmeg as top notes; muguet, jasmin, cedar and sandalwood as heart notes; and patchouli, amber, musk, vanilla and gourmand as base notes. This perfume is defined as striking and engaging. It is destined for men. The company suggests that this perfume evokes a unique sensory experience, due to the contrasting combination of fruity notes and warm woody and oriental notes

harmonized by an exclusive extract of Arabica coffee and liqueur notes.

2.2. *Correspondences between colors and smells*

One of the multisensory research studies that most attracted our attention and interest was the one entitled 'The Effect of Color Design on Fragrance Association' (Kim 2008). The study conducted by the Korean researcher Yu-Jin Kim investigated the relationship between different colors and the intensities of fragrances. Based on her experimental results, Kim confirmed interactions between vision and olfaction in perfumery. She tested over 200 fragrances. The associations obtained between colors and fragrances in her experiments were based on the real color of the perfumes. Kim analyzed each fragrance in three stages in order to capture the best results: top notes, heart (middle) notes, and base notes. The time intervals set for the experiments were '0 minute, 2 minutes, and 30 minutes' (Kim 2008). For the analysis the consumer received a color scale that varied in hues and shades. As a result, Kim observed that the base notes, which were less volatile, were associated with lighter shades of colors than the volatile top notes. Kim argued that the appropriate combination of fragrances and colors elevated the consumers' interest in perfumes and even influenced their buying decisions.

In this paper we decided to investigate the first impact of a fragrance and the associations that it evokes. We discuss the method, material and part of the results obtained in the experiments carried out with Group 1, i.e., the experiments with smells associated to colors. Unlike Kim (2008), we did not set a time limit. Each participant could take as long as he or she deemed necessary. The average time was 20 minutes to answer the entire questionnaire, with the initial minutes dedicated to the fragrance experimentation.

In Group 1, each participant was asked what color (only one) would best represent the fragrance (Question 1). We asked the participant to state the degree of difficulty in establishing such an association (Question 2) and how much this association makes sense (Question 3). The participant was also asked to state the degree of familiarity with the stimuli (fragrance) (Question 4) and what the fragrance reminds him/her or if he/she is familiar with (Question 5). Finally, we asked each participant to associate the fragrance with words: Question 6 allowed an open answer. In Question 7 the participant should freely select one of twenty predefined words.

In each session, the participant went through four steps:

Step 1 - Initial Contact: Basic instructions on the topic of sensory analysis were provided to stakeholders who volunteered at the lab door. After agreeing to participate, we sent the candidates to one of the seven booths of the Sensory Analysis Laboratory located at FCF/USP.

Step 2 - Informed Consent (IC): Once accommodated in the booth, the participant received two copies of the IC, to read and sign. They could choose to keep one copy with them.

Step 3 - Preliminary Questionnaire: The participant received a questionnaire (habits and personal data) with seven questions. In addition, those who participated in Group 1 also underwent a simplified vision test (6 cards) adapted from Dr. Shinobu Ishihara's original book (Ishihara 1972:4).

Step 4 - Sensory Analysis: Participants received an olfactory strip with the fragrance to be tested and the questionnaire. In addition, each participant of Group 1 received a color chart.

The color chart (Fig. 3) with 39 randomly distributed colors presented to the participants in Step 4 consisted of colors based on the CMY color wheel (Fig. 4). We selected primary, secondary and tertiary colors to compose the main group of 12 hues, which we called the 'main' colors. Then, varying by 50% towards white, we defined a second group of 12 colors as 'light' tones (inner circle). Again, varying the main group by 50% percent towards black, we defined a third group of 12 colors as 'dark' tones (outer circle). In Figure 5, we list the 36 colors in a table and added three neutral colors (white, gray and black). We grouped the colors in two different ways. The vertical rows show the value (lightness) variation (light, main and dark) and the horizontal rows show five groups of hue variation. Finally, we assigned each color a three-digit identification number generated by a randomization program.

Fig. 3. The color chart with 39 randomly distributed colors presented to the participants.

Fig. 4. Three concentric color circles based on 12 hues located on the middle circle and numbered 1 (primary colors), 2 (secondary colors) and 3 (tertiary colors). Variations of these 12 hues called here 'main' colors are the 'light' tones (inner circle) and the 'dark' tones (outer circle).

Ranges of colors	Light tones	Main colors	Dark tones
Range 1 Bluish	983	681	486
	503	910	230
	638	713	576
Range 2 Pink and lilaceous	864	524	186
	499	101	995
	321	970	459
Range 3 Yellowish to reddish	874	889	976
	663	307	123
	764	512	624
Range 4 Greenish	515	751	483
	431	425	903
	725	508	817
Range 5 Neutrals	863	192	741

Fig. 5. Colors listed, but randomly presented to the participants, together with the questionnaire.

3. Results and discussion: experiments with colors and smells

In the experiments with colors and smells (Group 1), we obtained 175 volunteers for all four fragrances. Each fragrance was separately tested in four sessions, one per day. We did not control the frequency of each participant, admitting, therefore, the possibility of participating in all four sessions. The results of the simplified color vision test indicated a suspicion of color blindness in the case of two participants. Therefore, we are considering for this discussion only 173 participants: 42 participants for citrus fragrance; 41 for floral fragrance; 45 for woody fragrance; and 45 for oriental fragrance.

In Group 1, the main purpose was to identify if the colors mentioned by the participants would match those used by fragrance companies. The first question posed was "What color best matches the fragrance you smelled?" Responses pointed not only to recurrent hues, as we can see for citrus and floral fragrances (Table 1), but to recurrent tones (Table 2).

	Citrus	Floral	Woody	Oriental
Range 1 Bluish	10%	5%	25%	23%
Range 2 Pink and lilaceous	13%	**53%**	20%	30%
Range 3 Yellowish to reddish	20%	23%	33%	20%
Range 4 Greenish	**58%**	18%	20%	23%
Range 5 Neutrals	0%	3%	3%	5%
	100%	100%	100%	100%

Table 1. Hue families associated with each fragrance.

	Citrus	Floral	Woody	Oriental
Light tones	37,5%	**70%**	32,5%	**62,5%**
Main colors	32,5%	25%	15%	15%
Dark tones	30%	5%	**52,5%**	22,5%
Total	100%	100%	100%	100%

Table 2. Main colors and tones associated with each fragrance.

These results induced us to inquire into why the tones would have any relation with fragrances. Then we decided to correlate the responses to Question 1 with the answers of Questions 6 and 7. In Question 6, participants had to freely associate one to three words to the fragrance that best matched the tested fragrance. In Question 7, participants were required to select as many words as they wished from twenty predefined words that best described the tested fragrance. Considering the fact that naming a smell is not an easy task (Wolfe et al. 2012), we selected five categories usually associated to fragrances when verbalizing the experiences. These five categories where subdivided into twenty words: gender (1. female; 2. male); olfactory family (3. woody; 4. citrus; 5. floral; 6. oriental; 7. fruity); fragrance intensity (8. strong; 9. mild); temporality (10. young; 11. old); and synesthesias (12. dry; 13. wet; 14. hot; 15. fresh; 16. sour; 17. oily; 18. bitter; 19. sweet; 20. spicy).

The results show that participants who mentioned a light tone in Question 1, also attributed 'mild' to the test perfume in Question 7. We deduced that a potential correspondence between color lightness and odor intensity might exist. Taking this into consideration, we selected all the answers of the participants, in which the word 'mild' was mentioned. The following discussion considers 74 out of a total of 173 answers: 12 participants associated mild with the citrus fragrance; 22 with the floral fragrance; 16 with the woody fragrance; and, 24 with the oriental fragrance. In order to protect personal data of the participants, we assigned to each participant a number preceded by the letter 'N' (Number). For example, to show the 12 results of the citrus fragrance analysis, the first participant is identified with N1, the second with N2, and so on until N12.

3.1. *Chromatic lightness and odor intensity*

3.1.1. *Citrus fragrance*

In the experiment, 6 out of 12 participants who attributed the mildness quality to the citrus fragrance also associated light tones as the best match (Fig. 6). These are N3, N4, N5, N8, N9 and N10, which corresponds to 50% of relationships matching lightness with mildness. The result increases to 83.33% when considering the four attributions to the main colors (N1, N2, N6 and N7).

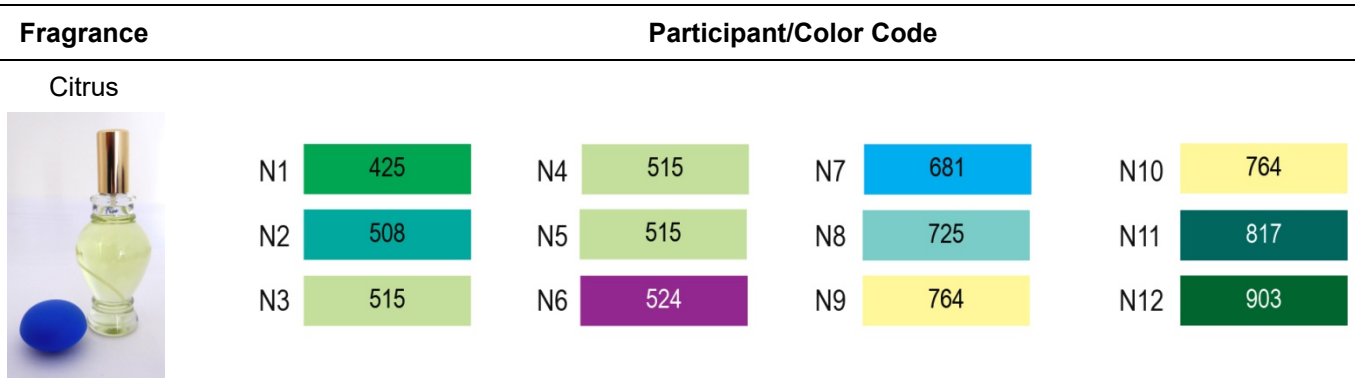

Fig. 6. Colors associated to the citrus fragrance when it was perceived as mild.

3.1.2. *Floral fragrance*

In the experiment, 15 out of 22 participants who attributed the mildness quality to the floral fragrance also designated light tones as the best match (Fig. 7). These include N3, N4, N6, N7, N8, N9, N10, N12, N14, N15, N16, N17, N18, N20 and N21. Moreover, one participant (N19) appointed white as best match, despite not being a hue in itself, because white represents one of the extremes of the value scale. However, in this analysis white is considered a light tone. Taking all this into account, 72% of relationships matched lightness with mildness. The percentage increased to 90.90% when considering the four attributions to the main colors (N1, N5, N11 and N22).

Fragrance	Participant/Color Code			
Floral 	N1 101	N7 499	N13 624	N19 863
	N2 186	N8 499	N14 663	N20 864
	N3 321	N9 499	N15 663	N21 864
	N4 321	N10 503	N16 725	N22 889
	N5 425	N11 508	N17 725	
	N6 431	N12 515	N18 764	

Fig. 7. Colors associated to the floral fragrance when it was perceived as mild.

3.1.3. *Woody fragrance*

In the experiment, 8 of 16 participants who attributed the mildness quality to the woody fragrance also indicated that a light tone is the best match (Fig. 8). These are N4, N5, N6, N9, N10, N12, N15 and N16, which correspond to 50% of relationships matching lightness with mildness. The percentage is further increased to 68.75% when considering the three attributions to the main colors (N1, N8 and N13).

Fragrance	Participant/Color Code			
Woody 	N1 101	N5 321	N9 515	N13 713
	N2 186	N6 431	N10 515	N14 817
	N3 230	N7 459	N11 576	N15 864
	N4 321	N8 512	N12 663	N16 983

Fig. 8. Colors associated to the woody fragrance when it was perceived as mild.

3.1.4. *Oriental fragrance*

In the experiment, 16 out of 24 participants who attributed the mildness quality to the oriental fragrance also declared a light tone as the best match (Fig. 9). These are N1, N2, N3, N4, N5, N6, N8, N9, N10, N12, N14, N16, N17, N19 and N21. Similarly, as in the experiment with floral fragrance, one participant (N20) appointed white as best match to the oriental fragrance. Taking all this into account, 67% of relationships matched lightness with mildness. The percentage increases to 83.33% when considering the four attributions to the main colors (N13, N14, N22 and N23).

Fragrance	Participant/Color Code			
Oriental 	N1 321	N7 486	N13 713	N19 764
	N2 321	N8 499	N14 725	N20 863
	N3 321	N9 499	N15 681	N21 864
	N4 321	N10 515	N16 725	N22 889
	N5 321	N11 624	N17 725	N23 970
	N6 431	N12 663	N18 741	N24 995

Fig. 9. Colors associated to the oriental fragrance when it was perceived as mild.

3.2. *Discussion: representation versus perception*

The results of our experiment show that light tones were mostly attributed to the floral fragrance (72%), second to the oriental fragrance (67%) and equally to the citrus and woody fragrances (50%). By adding the main colors to the light tones, the top result still remains the floral fragrance (90.90%), followed by the oriental and citrus fragrances (83.33%), and last is the woody fragrance (68.75%). Conclusively, we can say that a floral fragrance is maily perceived as mild and mostly associated with light tones.

By analyzing the colors associated with the four fragrances we can suppose that the perceived odor intensity may also influence the color choice for perfume bottles. If we have a unified perception of the world, it makes sense to think that people correlate the mildness quality of an odor with the mildness (lightness) of a color. This is somehow in line with what the researchers Gilbert et al. (1996) pointed out regarding the correspondences between softness and lightness identified in their experiment with odors.

Concerning the use of colors in perfume bottles we noticed a low correspondence among the colors chosen by the participants to represent the woody and oriental perfumes. Their primary packaging (perfume bottles) is a very dark color (black for woody and black coffee brown for oriental). Indeed, we did not present to the participants the same dark colors as used on these packaging. There were other options of dark colors they could choose, but the participants of our experiment perceived the possible use of light colors (50% for woody and 67% for oriental). As well, the hue families chosen by the participants do not match those used in the packaging. We infer that packaging designers may have chosen the colors associated with the main ingredients of the oriental fragrance (coffee) and woody fragrance (wood and wine). We could also infer that these colors were selected by the designers so as to communicate the sensations the company wished to elicit, that is, sophistication and masculinity. According to psychological and historical color studies, darker colors are usually associated to men, luxury and sophistication (Heller 2013, Pastoureau 2011).

The visual representation of a fragrance can serve different purposes (Silva 2012). The colors of a perfume packaging might relate to the brand, the concept companies want to convey, the ingredients that compose the fragrances or even the effects those fragrances might have on people. It can be a combination of all these elements as well. Although we know that the perception of a smell varies from person to person, the results presented here point to the relationship that a color can have with the perceived intensity of a perfume.

4. Final considerations

These research results show how important it is to confront the visual representations already existing in a product category with the perception of consumers, especially when it comes to fragrance products with complex formulations such as perfumes. It is a market practice to classify perfumes into olfactory families. However, within the same olfactory family we can find different nuances of smells. In the same way, we should consider colors. Designers should avoid a cursory glance at the color field. As observed from the experiments, it is possible that the dimensions of value (lightness) and chroma (saturation) exert more influence on a person's perception than color itself (hue). Therefore, while dealing with the psychological effects of color, one should consider the science of color with greater depth and not just color as a set of words to which certain attributes are associated. From then on, the designer would expand the possibilities of visual expression and multisensory correspondences.

5. Conflict of interest declaration

The authors declare that there is no conflict of interest regarding the publication of this paper.

6. Funding source declaration

The research was supported by Fundação de Amparo à Pesquisa do Estado de São Paulo (FAPESP) from 2014 to 2015. The financial support allowed full study dedication. As well, it provided international engagement such as being a visiting scholar at Oxford Lab of Experimental Psychology in June 2014.

7. Acknowledgment

We wish to thank Professor Inar Alves de Castro and her team for the support and for providing the Sensory Analysis Laboratory of the Faculty of Pharmaceutical Sciences of the University of São Paulo (FCF/USP) to perform the experiments.

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Notes

[1] For the oriental family we also consider the categories of amber, tobacco, spices and animal. According to Osmoz—share your fragrances, a social platform for fragrance and perfume consumers—'oriental compositions draw their richness and sophistication from precious substances such as amber, resin, tobacco, spices, exotic woods and animal notes' (Osmoz 2019a).

[2] According to Osmoz (2019b), headspace is an extraction method. It is a technique that 'allows for preserving the flower's delicacy and rarity'.

References

Brasil Essencia (2019) 'Malbec Duo'. Available at: https://www.brasilessencia.com.br/perfumes/o-boticario/999-o-boticario-malbec-duo/ (Accessed: 20 December 2019).

Armstrong, K. (2017) 'Americas–Brazil: Fragrance Market Report 2017'. Cosmetics Business, 17 May 2017. Available at: https://www.cosmeticsbusiness.com/news/article_page/Americas_Brazil_Fragrance_Market_Report_2017/129109 (Accessed: 23 November 2019).

Day, S. (2016) 'Demographic aspects of synesthesia'. Available at: http://www.daysyn.com/Types-of-Syn.html (Accessed: 23 November 2019).

Demattè, M. L., Sanabria, D., and Spence, C. (2006) 'Cross-Modal Associations between Odors and Colors', Chemical Senses, 31, pp. 531–538.

Domino, G. (2009) 'Synesthesia'. Encyclopedia of creativity, Runco, M. A. and Pritzker, S. R. (eds.) California: Academy Press, 2, pp. 597–604.

Donna, L. (2014). 'Fragrance perception: is everything relative?', Perfumer&Flavorist. Available at: http://www.fragrancesoftheworld.com/downloads/Fragrance%20Perception%20-%20Is%20Everything%20Relative.pdf (Accessed: 23 November 2019).

Edwards, M. (2019) 'Fragrances of the world'. Available at: https://www.fragrancesoftheworld.com/ (Accessed: 23 October 2019).

Gilbert, A. N., Martin, R. and Kemp, S. E. (1996) 'Cross-Modal Correspondence between Vision and Olfaction: The Color of Smells', American Journal of Psychology, 109(3), pp. 335–351.

Hanson-Vaux, G., Crisinel A. S. and Spence, C. (2013) 'Smelling Shapes: Cross-Modal Correspondences between Odors and Shapes', Chemical Senses, 38(2), pp. 161–166.

Heller, E. (2013) A psicologia das cores: como as cores afetam a emoção e a razão. São Paulo: Gustavo Gili.

Ishihara, S. (1972) The series of plates designed as a test for colour-blindness, Tokyo: Kanehara Shuppan.

Joutsela, M. (2010) 'Multisensory Persuasion and Storytelling through Packaging Design', Proceedings of the 17th IAPRI World Conference on Packaging. IAPRI–International Association of Packaging Research Institutes.

Kim, Y. J. (2008) 'The Effect of Color Design on Fragrance Association', Proceedings of the 6th Design and Emotion Conference 2008. Hong Kong. Available at: https://zenodo.org/record/2596181#.Xf7a9kf0nIU (Accessed: 27 April 2014).

Moeran, B. (2011) 'The Colours of Smell: Perfume Advertising and the Senses', Proceedings of the 110th Annual Meeting of the American Anthropological Association, Montreal, Canada. Available at: http://www.aaanet.org/meetings/index.cfm (Accessed: 27 April 2014).

O Boticário (2014). Perfumes fora de linha, Reclame aqui. Available at: https://www.reclameaqui.com.br/boticario/perfumes-fora-de-linha_8784301/ (Accessed: 20 December 2019).

O Boticário (2016). Produto Fora de Linha DE NOVO!!!, Reclame aqui. Available at: https://www.reclameaqui.com.br/boticario/produto-fora-de-linha-de-novo_17305236/ (Accessed: 20 December 2019).

Osmoz (2019a) 'Olfactory Groups'. Available at: http://www.osmoz.com/encyclopedia/olfactory-groups/1/oriental (Accessed: 23 October 2019).

Osmoz (2019b) 'Orchid'. Extraction Method. Available at: http://www.osmoz.com/encyclopedia/raw-materials/floral/18/orchid-phalaepnosis-corningiana (Accessed: 20 December 2019).

Pastoureau, M. (2011) Preto: História de uma cor. Tradução de Lea P. Zylberlicht. São Paulo: Editora Senac São Paulo.

Plaza, J. (1987) Tradução intersemiótica. São Paulo: Perspectiva.

Ramachandran, V. S. and Hubbard, E. M. (2001) 'Synesthesia: A Window into Perception, Thought and Language', Journal of Consciousness Studies, 8(12), pp. 3–34.

Santaella, L. (2005). 'Matrizes da linguagem e do pensamento: sonora, visual, verbal: aplicações na hipermídia', São Paulo: Iluminuras/FAPESP.

Sanz, J. C. and Schindler, V. M. (2010) 'Environmental colour design and synaesthesia in food-related contexts' Proceedings of the AIC 2010 Color and Food. Interim Meeting of the International Color Association. Buenos Aires: Grupo Argentino del Color and Nobuko, pp. 345–348.

Silva, C. A. P. (2012) 'Perfume, história e design: o papel das embalagens no mercado brasileiro de perfumaria', Master dissertation, Universidade do Estado do Rio de Janeiro, Rio de Janeiro.

Silva, C. A. P. (2017) As cores e as formas dos cheiros: as correspondências entre os sentidos do olfato e da visão em frascos de perfumes, PhD dissertation, Universidade de São Paulo, São Paulo.

Silva, C. A. P. and Mazzilli, C. de T. S. (2016) 'A Multisensory Approach for Perfume Packaging Design', The International Journal of Designed Objects, 10, pp. 7–19.

Spector, F. and Maurer, D. (2012) 'Making Sense of Scents: The Colour and Texture of Odours', Seeing and Perceiving, 25, pp. 655–677.

Speed, L. J. and Majid, A. (2018) 'Superior Olfactory Language and Cognition in Odor-Color Synaesthesia', Journal of Experimental Psychology: Human Perception and Performance, American Psychological Association, 44 (3), pp. 468–481.

Turner, J. H. (2018) 'Discovering human nature through cross-species analysis', Oxford Handbook of Evolution, Biology, and Society, Hopcroft, R. L. (ed.) Oxford University Press, pp. 89–112.

Wolfe, J. M., Keith, R. K., Levi, D. M., Bartoshuk, L. M., Herz, R. S., Klatzky, R. L, Lederman, S. J. and Merfeld, D. M. (2012) Sensation and Perception. 3rd ed. Sunderland, MA: Sinauer Associates.

Ceramic products and their chromatic 'DNA' markers

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ABSTRACT

Originally produced with local raw materials and manufactured by ancestral processes, ceramic products have always been the result of knowledge transmitted from generation to generation. These artefacts reflect and reinterpret traditional, individual and collective formal vocabularies, integrating fragments of the day-to-day life of the local society, which conferred a geographical and sociocultural singularity revealing their local, regional, and national identities.

From intrinsic to extrinsic characteristics, from raw materials to formal language, it is possible to find a plethora of combinatorial markers that characterize and differentiate these ceramic products – in other words, their 'DNA'. Among such DNA markers, colour has been a geographical and cultural 'locator' par excellence of ceramic products: either by the colouration of raw materials, or inks or glazes, or by adopted colour schemes, which reflect not only the local availability of pigments and oxides, but also local preferences and culture. Furthermore, the characteristics of firing, an alchemical process, revealing a myriad of chromatic solutions based on acquired and arcane knowledge, confer a unique character to such ceramic products.

The present globalization era has given way to the emergence of 'transgenic' ceramics, uprooted from their origins. Despite the resurgence of the appreciation of local knowledge and traditions as a reaction to this scenario, can we still identify clear references to their origin – ceramic chromatic DNA markers – even if these artefacts are the result of this 'transgenic mutation'? The study substantiates that colour, as a DNA marker of ceramic products still exists, and is associated to cultural identity.

KEYWORDS Colour, Ceramics, Product Design, Cultural Identity, Local

RECEIVED 23 October 2019; **REVISED** 29 November 2019; **ACCEPTED** 04 December 2019

1. Introduction

Today we are witnessing the desire to recover and revitalize local identities, bringing them back up to date so they can emerge as current experiences. The evolution of the genetic code of ceramics is materialised in new shapes and visual syntaxes, where structural common denominators – DNA markers – are recognised through their colour.

Common on-site denominators regarding different ceramics have been identified and considered as DNA markers. Such denominators gather unique information that is printed in the core of local ceramic production throughout generations.

These DNA markers are visible in ceramic products' specific characteristics, including: the raw materials; affording technical characteristics (hardness, thermal and abrasion resistance); visual features (texture and colour); the product's shape and size; the graphic elements; the pattern layout design; the colours and adopted colour schemes. These markers reflect not only the local availability of pigments and oxides, but also local preferences and culture. The combination of these markers results in distinctive formal languages, or DNA 'matrices' that enable us to visually recognize the origins of a certain ceramic product.

2. Methodology

The conceptual framing of the study, as well as the operational constructs, are centred on the characteristics of ceramic artefacts (colour, brightness, materiality), and the territory where they are created and produced.

For the present study, a practice-based methodology is adopted which includes the following process phases:

a. Visual and photographic survey: The analytical-descriptive process of the visual features of ceramic products is related to the local natural environment, traditions and popular formal vocabulary.

b. Use of digital tools: Picular, an app that associates keywords with images available on Internet, is used to create a colour scheme with which to gauge if the visual imagery regarding the ceramic product of a given origin corresponds to reality.

c. Bibliographic review: A holistic approach to the subject is essential to the grounds for the assumptions set out.

3. Ceramic colour

Ceramic colour is impacted by three factors: 1) raw materials; 2) firing; and 3) decoration.

First, the combination of the raw materials that forms different ceramics (earthenware, terracotta, stoneware and porcelain) gives rise to the intrinsic colour of the ceramics (warm white, red, light yellow and cool white, in particular). The presence of certain compounds in clays such as iron oxide will contribute to the red of the terracotta, and the introduction of kaolin will contribute to the purity of the white porcelain.

Fig. 1. Ceramic colour features (top, from left to right): a. Ceramic raw materials and the effects of temperature on the ceramics' colour body; b. ornamental patterns with glazes (transparent, semi-transparent and opaque glazes). Other decor techniques (bottom, from left to right): hand painted in-glaze pigment; slip pipette underglaze; stencil brush; brush on fired glaze. Photo: Carla Lobo.

Second, firing atmosphere and temperature determines not only the type of molecular structure of the ceramic product but can also directly influence the colour of the ceramic and its decoration. In the case of ceramic bodies rich in iron oxide, an increase in temperature represents a decrease in the luminosity of the red, and the characteristic red of the terracotta turns dark brown, in a reductive firing atmosphere (with little oxygen) the same red clay turns black (Fig. 1a). The colouring agents used in the decoration change significantly under the action of heat, and at lower temperatures (around 1000°C) a varied and more saturated chromatic palette is possible than at 1400°C, where most of the oxides and pigments are significantly altered, and the chromatic palette tends to be less saturated. Ceramic glazes show a high chromatic durability after being subjected to high temperatures. According to Fairman and Hemmendinger (1998), the chromatic variation reported in colorimetric terms was

considered insignificant. For over 20 years, there was no change in values higher than 0.5 CIE LAB units was found.

Third, as far as decoration is concerned there are multiple possibilities ranging from glossy or matte coloured glazes, transparent or opaque glazes (Fig. 1b), the underglaze and in-glaze inks and coloured slips that can be applied over the biscuit fired (fired ceramic body) or over the glaze in a wide range of colour combinations (Fig. 1c).

The extrinsic colour is determined by the combination of the colour(s) of the glaze(s), paints and slips, and the ceramic body. When the glaze is opaque, the colour of the piece will be the colour of the glaze; when the glaze is transparent, the perceived colour will be the combination of the colour of the glaze and the colour of the ceramic body. The thicker the layer of glaze, the more saturated the perceived colour will be. When there is decoration, the chromatic intersection is even richer, involving the colour of the ceramic body, the colour of the glaze and the colour of the paints and slips.

The different ways of articulating these factors together with specific colour schemes define the chromatic characteristics of ceramic products. This singular composition is transversal to the region's ceramic artefacts and defines the chromatic DNA of its ceramics.

4. Cultural colour schemes: unique or a fusion?

The discovery of the maritime routes between Europe and the Far East in the 15th century boosted the spread of Oriental products in countries with ports along these routes. Chinese porcelain achieved great success in European markets, with a strong influence on European ceramic production. Portugal and The Netherlands were two important distribution centres along these routes. Clear influence of Chinese porcelain in both countries' ceramics can be found in both the formal vocabulary and in the colours used (Fig. 2 and Fig. 3).

Other ancient routes, such as the Silk and Spice land routes, explain clear similarities between the different chromatic palettes of pottery – intense blues and yellows found in the Middle East (Uzbekistan, Iran and Egypt) were also found in North African pottery (Tunisia and Morocco) and further to the Iberian Peninsula and Italy. The island of Mallorca, in the Western Mediterranean region, was the starting point for the Arab-influenced plates manufactured in Spain to reach Italy, where they were an inspiration for the Majolica (phonetic deformation of the name of the island of Mallorca) of Urbino (Costa 2000). The 15th and 16th centuries Iberian sea journeys took the ceramics' shapes and colours to Central and South America, where even today traces of this legacy exist, both in terms of heritage as well as within the current artistic and industrial production, particularly in Mexico and Brazil (Fig. 2).

Fig. 2. Chinese porcelain influence (from left to right): 19th-century Chinese porcelain; 18th-century Delft tiles; 17th-century Portuguese tiles; Moorish-influenced Moroccan tiles, early 20th century; Spanish tiles (Photo: Carla Lobo). And 18th-century Mexican tiles (Photo: mexicanarchitecture.org).

In the early days of glazed ceramics production (6th century B.C.), the glazes were transparent, so the colour of the ceramic body could be seen. Only white porcelain, after being baked, was close to the idea of the white 'canvas' for paintings. To get the same contrast, a white slip was used on the ceramic body in order to hide the colour of the ceramic paste, which was then covered by a transparent lead glaze. This was not ideal once the transparent lead glaze turned yellowish the white slip background. In the 9th century, the discovery of tin as a white colorant for glazes, allowed its use as a base for decoration, closer to porcelain.

The oxides used to give colour to the glazes, which are also used in the stains applied to the motifs painted on the glazes, were naturally selected for their resistance to the high temperatures inherent to ceramic production. Before industrial alternatives to natural oxides were found, the colouring sources of glazes were common in all countries that produced glazed ceramic products, and it was possible to distinguish which ones had this natural resource, and those that imported it, by the abundant or scarce presence in the pieces they produced. For example, since 2000 B.C. cobalt blue, a natural resource in the Persian region, was very common in ceramic artefacts. In Europe, it began to be widely used only in the 13th century.

4.1. *Materials and place*

Local variations in raw materials impact their appearance. For example, Chinese kaolin creates a whiter porcelain than Portuguese kaolin. Dutch cobalt blue is different from Middle Eastern, Mexican and Chinese cobalt blues, as seen in Figure 2. In 14th century China, local cobalt produced a greyish, unsaturated blue, compared to Middle Eastern blues. Cobalt was therefore imported from Persia, added to the local cobalt, and produced a more saturated and visually rich colour. (Trindade 2009) (Fig. 3).

Fig. 3. Cobalt blue and its use in different places (from left to right): 19th-century Chinese pot; 17th-century Turkish tiles (Photo: Carla Lobo); 18th-century Dutch plate (Photo: © Jenny Jensen). And 19th-century Portuguese plate (Photo: Carla Lobo).

Likewise, the minerals in the water used in the ceramic manufacturing process impact the tonality of the ceramic body, glazes and paints. Even if the raw materials are the same, the resulting colour can vary, and is intrinsically related to the specificity of place (Swirnoff 2000, Finlay 2002). Swirnoff emphasises the link between raw materials and local colours, relating colours present in the local environment to cultural sensitivities to colour. There are chromatic preferences, intrinsic to socio-cultural heritage and clearly related to soil composition, flora, climate and the quality of local light. These factors along with formal vocabulary reflect culture and folklore, create specific chromatic syntaxes in harmony with the setting, enabling us to identify their origin (Lobo and Durão 2011, Shu 2009, Weston 2008).

This perspective may explain why cobalt blue entered Portugal in the 13th century, via Spain, brought by Iraqi refugee potters who travelled through North Africa until they reached the Iberian Peninsula. Its use in Spanish ceramics was not as intensive as in Portugal, with green, yellow, manganese and white (of the same origin as cobalt) forming the base of the Spanish palette rather than blue (Trindade 2009). In Portugal, however, cobalt blue became one of the most significant colours in the national colour vocabulary and was found in artefacts from all regions of the country, although more common in certain geographical areas and product typologies (Fig. 3, Fig. 5 b and Fig. 6 d).

Picular was used in an attempt to establish a connection between the collective imagery of ceramic colour from a country, and its ceramic creation and production. The colour schemes on the left of Figures 4a, 4b, 5a and 5b were reached using the name of the country and 'ceramic' as keywords. Comparing these colour schemes with photos of ceramic artefacts from the same countries, allowed to conclude that a local chromatic identity may exist.

Fig. 4. Ceramic colour imagery (from left to right): Country comparisons of Picular ceramic colour schemes with ceramic artefacts: a. Turkish ceramic colours: Turkish creamer, early 20th century (Photo: © Kütahya Tiles and Ceramics Collection Courtesy of Suna and İnan Kıraç Foundation Pera Museum) and tiles, 18th-century (Photo: Carla Lobo); b. Moroccan ceramic colours: Moroccan pot (Photo: Compliments of Morocco Travel Blog and Magazine 2013) and tiles, 15th-century (Photo: Carla Lobo).

Fig. 5. Ceramic colour imagery (from left to right): a. Dutch ceramic colours: Dutch plate, 18th-century (Photo: © Jenny Jensen) and tiles (Photo: Carla Lobo); b. Portuguese ceramic colours: Portuguese plate, early 20th century, and tiles, 17th century (Photo: Carla Lobo).

4.2. *Portugal as a case study, a brief approach*

Through trade and its geographical location, Portugal has benefited from a range of inputs from different countries and cultures to generate a very specific and diversified chromatic language, specific in each ceramic typology, and in different geographical parts of the country. Different chromatic syntaxes can be found in ceramic artefacts, from tiles to utilitarian and decorative crockery, which may also include figurative elements. These syntaxes are directly related to the raw materials available in situ and to local preferences.

The blue and white tiles, in the 16th century (Fig. 2 and Fig. 6c), or the blue, white and yellow ones, more popular in the 17th century, as seen in Figure 5b, are the most common colour schemes. Although other colour schemes have also prevailed (cobalt blue, iron or antimony yellow, Manganese purple or brown and copper green) since their proliferation at the beginning of the 17th century, these

were the first to be recognised as the prevailing colour scheme of the Portuguese tile – as their chromatic DNA marker.

In the northern and southern parts of the country red clay is very common; this is the reason why utilitarian pottery predominates, which is decorated with white slip in the north, and with a wide and quite saturated colour palette in the south. Figure 6 a and c show examples of northern and southern Portuguese pottery respectively.

In the Centre of the country we find greater diversity: from the red clay bricks and tiles to the white earthenware decorated in blue and white, or with transparent coloured glazes (Fig. 6 b and b respectively). Here there is an important utilitarian and decorative ceramic centre, Caldas da Rainha. In addition to its own formal vocabulary, the coloured transparent glazes are unique and an unmistakable reference to the identity of the glazed Caldas pottery. The raw materials used to colour the local lead glazes (characterized by deep colours, an intense shine and a unique depth, only possible by the presence of lead) came from the local workshops. The lead came from waste pipes and was the base of all the glazes, the iron that made the 'honey yellow' colour came from the blacksmiths' workshops, others such as copper, manganese and cobalt oxides (green, brown and blue) had to be acquired (Horta 2014). Even today these four colours, which later included 'cherry red', are recognised as being the colours of the Caldas Glazes, colour markers of the ceramics of the region. Figure 6 b shows an example of such work.

Fig. 6. Portuguese ceramic colour schemes (from left to right): a. Traditional red clay slipware (north of Portugal); b. Caldas da Rainha coloured glazes (Photo: Carla Lobo); c. Red pottery from the Alentejo (south of Portugal) (Photo © Heranças do Alentejo); d. 18th-century tiles in Lisbon (Photo: Carla Lobo).

5. New syntaxes, same identity: colour as a DNA marker of ceramic products

We highlight some transnational examples, where the projects' authors clearly assume the role of colour as a DNA marker:

Figure 7a presents "Ceramic House" by Wang Shu and Zhou Wu (ceramist), in Jinhua, China, 2006. The house is covered in "ceramic tiles that were the products of Youse (ceramic color)" (Shu 2009), glazed in 40 colours extracted from the chromatic palette of traditional Zhejiang ceramics (mainly celadon greens and browns) in order to create the perfect adaptation of architecture to the place, while also respecting and appreciating the local identity. "Colors are arranged irregularly, however it presents all the colors in Chinese ceramic" (Shu 2009:83).

Figure 7b presents Oceanário, tile cladding by Ivan Chermayeff, in Lisbon, Portugal, 1998. In this work, the decision to use blue and white tiles, developed from Moorish inspiration motifs, was based on the recognition of the tile as a native material of Lisbon architecture, namely the cobalt blue and white pattern tiles. The wavy surface of the tile alludes to the seas and oceans, where the cobalt blue is applied with a sponge to reinforce the irregularity of the water surface. The selection of patterns is based on the assumption of establishing a scale of light gradients, from white to dark blue, which enable the construction of images perceived as volumetric through the optical mixture of these gradients. This chromatic and formal vocabulary creates a coating that offers a moving observer different perceptions of the surface depending on the distance and angle it is viewed.

Figure 7c presents Barro Preto by Atelier Bizarro, in Vila Real, Portugal, 2017. Returning to an ancestral Portuguese technique of burning pieces in a reductive atmosphere, which gives them a black colouration, the

studio developed a set of pieces with functions that are appropriate to the current modi vivendi, where the most obvious characterisation factor is the dark/black ash of the pieces. This technique has been part of UNESCO's list of intangible cultural heritage since 2016.

Figure 7d presents work by Cerâmica do Cabo, in Pernambuco, Brasil, 2006–2018. This project focussed on social integration and sustainability, where "Each piece is developed from the appreciation of popular knowledge, the recognition of traditions, skills and the use of materials, […] (creating) product lines where shapes, textures and colours reflect the cultural and social values of the respective communities" (Imaginário, 2006:29). Several coloured glazes were developed, but only one was chosen, as it was compatible with the ceramic body. It was a simple and accessible formula that was easy to apply and with guaranteed results in firing without the artisan having to resort to experts from outside his or her community (D'Garcia 2019). This is how "Pernambuco blue" was born, which today is synonymous with Cabo dinnerware.

These examples show a direct link between ceramic colour and local identity, from the point of view of the persistence of these colour palettes over time and their roots (Ceramic House, Oceanário and Bisarro); and, as in the case of Pernambuco Blue, the creation of a product where colour is one of the most outstanding factors, along with its originality and the ease with which it is recognised and associated with the production of a demarcated origin.

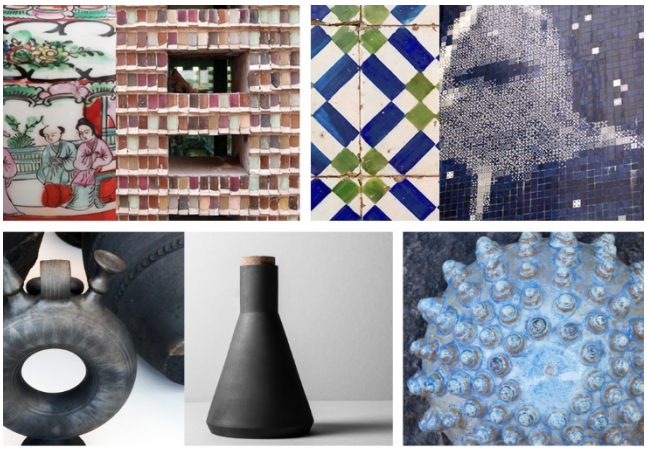

Fig. 7. New Syntaxes, same identities (top, from left to right): Chinese vase (Photo: Carla Lobo); Ceramic House (Photo © Evan Chakroff); 19th-century Moorish-inspired tiles; Oceanário de Lisboa (Photo: Carla Lobo). And (bottom, from left to right): Traditional black pottery from Bisalhães (Photo: Carla Lobo); Pitcher from Bisarro (Photo © Bisarro); Pernambuco Blue (Photo © Cerâmica do Cabo).

6. Final remarks

We can say that colour of ceramic artefacts is clearly linked to the place where they were produced. Furthermore, colour is only one of the characteristic aspects of these artefacts, closely linked and dependent on other tangible aspects (such as materials and manufacturing process), and intangible aspects (such as traditions and culture).

It was possible to locate the origin of materials, colour schemes and formal vocabulary and how they have been adapted to local specificities, namely tangible and intangible aspects, creating specific chromatic syntaxes and defining local chromatic DNA markers.

The formal vocabularies of each region, the way they articulate the particular knowledge inherent to each stage of the process of conception and the manufacture of these artefacts, are the aspects that define the DNA of their ceramics. In the specific case of colour, from the composition and firing of the ceramic paste to the quality of the ceramic surface and glazes, and from the decoration techniques to the colour schemes, an infinite number of potential solutions is possible, and is determined by the specific knowledge of each production nucleus.

The comparison between the popular imagery of colour schemes of local regions identified through Picular and the selected images of ceramic artefacts from the same regions showed common elements – their chromatic DNA markers – that express the colour identity of ceramics from the formal and visual points of view.

This paper presents the first steps of an ongoing research. Though some evidences show that colour as a DNA marker of ceramic products may exist, many possible starting points have been raised.

7. Conflict of interest declaration

The author certifies that she has no affiliations with or involvement in any organization or entity with any financial interest, or non-financial interest in the subject matter or materials discussed in this manuscript.

8. Funding source declaration:

The author received no funding for this work.

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Areas of interest: Colour, Ceramics, Product Design and Public Spaces.

References

D'Garcia, G. (2019) 'Azul Pernambuco'. Private communication. Available from the author.

Fairman, H. S. and Hemmendinger, H. (1998) 'Stability of ceramic color reflectance standards. Color Research and Application. 23(6), pp. 408–415.

Finlay, V. (2002) Colour: travel through the paint box. London: Sceptre.

Horta, C. (2014) Manuel Mafra (1831–1905) e as origens da cerâmica artística das Caldas da Rainha. Doctoral thesis. Universidade de Lisboa. http://hdl.handle.net/10451/11311.

Imaginário Pernambucano: design, cultura, inclusão social e desenvolvimento sustentável. (2006) Recife: Zoludesign. https://www.oimaginario.com.br/producao-academica (Accessed: 12 June 2019).

Lobo, C. and Durão, M. (2011) 'Conservation of architecture, urban areas, nature and landscape heritage 2011'. Conservation of Architecture, Urban Areas and Landscape. Proceedings of the Second International Conference on Conservation of Architecture, Urban Areas and Landscape. Amman: CSAAR Press, pp. 207–222.

PICULAR (2019) Sweden: Futurememories.

Trindade, R. (2009) 'Imagens de azul. Evidências do emprego do azul cobalto na cerâmica tardo medieval portuguesa'. Revista de História da Arte, 7, pp. 236–263. https://issuu.com/ihafcshunl/docs/rha-7 (Accessed: 15 August 2019).

Shu, W. (2009) 'Desde la tierra a la cerámica, una construcción viva'. Ensayos sobre arquitectura y cerámica, Vol. 2., Guisado J. (ed.) Madrid: Mairea Libros, pp. 19–36.

Swirnoff, L. (2000) The color of the cities: an international perspective. New York: McGraw Hill**.**

Costa, L. Verdelho da (2000) 25 séculos de cerâmica. Lisboa: Estampa Editorial.

Weston, R. (2008) Materials, form and architecture. London: Laurence King Publishing Ltd.

Approaching ecological ambiguity through a non-divisionary understanding of colour in art

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ABSTRACT

In the face of the current ecological uncertainty, we are often confronted with discomforting ambiguity: the boundaries across human and nonhuman worlds continue to blur. In response, the discourse of environmental humanities looks at reframing existing approaches of being in the world. It proposes a focus on 'entanglements', which prefigures turning away from individualistic and discordant thinking towards a mode of operating that highlights connection and relationship. Much like every aspect of our interconnected world ecology, colour too is subject to the current environmental crisis. With unprecedented rates of extinction, we are losing colours and unique colour combinations in our environment. Though colour is an ambiguous, unstable and constantly shifting phenomenon, colour studies have traditionally favoured a divisional approach, dividing the spectrum into categories and individualised colours. In this drive towards divided categories, we often forget that we are dealing with one spectrum, and that strict division is artificial. A non-divisional approach to understanding colour falls closer to the natural aesthetic experience of the visual field and corresponds with the interconnected ecological approach. The author aims to link this non-divisional approach in colour to 'entangled' environmental thinking and examine this through art practice as an effective tool for comprehending invisible ecological interconnectedness in the time of the 'Anthropocene'. The article concludes that colour offers a powerful tool for exploring ecological entanglements, offering entry into positive ambiguity.

KEYWORDS Ambiguity, Art, Colour, Ecology, Entanglements

RECEIVED 01 November 2019; **REVISED** 06 December 2019; **ACCEPTED** 07 December 2019

1. A spectrum of life

Environmental humanities has emerged as a response to the growing environmental challenges facing life on earth today, out of the need for a more balanced approach to environmental issues. The interdisciplinary nature of the field, combining the humanities with social and environmental sciences, calls for new ways of understanding humanity's place within the world: it aims to resituate the human within the wider ecological structure, challenging a pervasive anthropocentric ontological exceptionalism. The key proposition of the environmental humanities is to focus on entanglements between human and other-than-human agencies, moving away from the divisionary individualistic mode and towards interdependencies. Entangled relations between human and non-human worlds are situated at the core of environmental humanities approach (Rose et al. 2012).

Emerging out of biology, ecology offered a specific study of the interrelatedness of all organisms and their physical surroundings. However, despite the deepening of human knowledge in this area, our connection with the surrounding world has dissipated further. One of the world's leading anthropologists, Tim Ingold (2018), feels that science has lost the radical ecological awareness it previously had. Once championed by science, this awareness, Ingold believes, has found a home in the arts. Within this context, exploring the notion of ambiguity through art practice could be an effective way of looking at the challenging and multifaceted contemporary ecological situation. In their book *Rethinking Pluralism: Ritual, Experience, and Ambiguity*, Adam Seligman and Robert Weller argue that "all quests for certainty contain inherent dangers and limitations." The authors do not deny the construction of categories as invalid or incorrect, "Constructing categories is one of the fundamental skills that make up our human capacity for culture," but wonder "how to live with ambiguity while still retaining order" (Seligman and Weller 2012:13).

Exploration of the ambiguous is especially important now that humanity has stumbled into the age of the 'Anthropocene', defined as the epoch in which humans have become the dominant global geophysical force (Steffen et al. 2007). One of the foremost contemporary thinkers on the state of ecology today, Timothy Morton, argues that we live in a time of ambiguity and a resultant anxiety. He notes that, "the basic affect of an ecological era – that is, the era we have been realising we have been inhabiting, namely the Anthropocene – is anxiety" (Morton 2018a:232). Morton, suggests that ambiguity is precisely what we need to expose ourselves to today, "True and false might not be that different," says Morton, "Ambiguity is the space in which really true things can be said. Ambiguity isn't vagueness, ambiguity is an accuracy signal" (Morton 2018b, video file 00:32:16). Within this context, contemporary art practice and colour explored through a non-divisionary approach could contribute towards these important discussions and help unravel the more 'entangled' thinking on being a part of the world.

2. The in-betweenness of things

Through the normative objective, and hence disconnected, scientific approach, with division into lists and taxonomies, a separation between the human and the rest of the world becomes formally established in our thinking. Art practice, with its core methodology of paying and directing attention, through openness to and abiding by the unknown, has the capacity, as a shared experience, to help bridge the perceptual gap that has grown out of the disconnection inherent in taxonomic methods.

Exploring the in-betweenness of things and how seemingly separate objects, bodies and phenomena are entangled, a number of authors within the environmental humanities looked at various 'borders' and what re-formulation of those might reveal. This opens up new possibilities of viewing and conceptualising some of the most pressing environmental and social issues today.

A time of ambiguity may be a time when outcomes are not easily anticipated. Now, more than ever, we are all aware of the rapid changes around us, but often unaware of how we should act. So, how do we allow ourselves to find comfort in the ambiguous? How could art practice and the exploration of colour and its dynamics aid this? In what way can the environmental humanities provide a powerful platform for this inquiry?

The notion of entanglements could serve as a way into the space of ambiguity, in which art can physically manifest this ambiguity in relatable and emotionally resonant ways. Timothy Morton talks about art as a powerful tool for 'ambiguity tolerance training' (Morton 2017). Artistic practice lends itself perfectly as a platform for exploring the ambiguous. "Uncertainty is typically not desirable in everyday experiences, but uncertainty in the form of ambiguity may be a defining feature of aesthetic experiences of modern art" (Jakesch and Leder 2009:1). Artistic practice also offers a powerful tool for visualising the ecological entanglements which might not be obvious, or even visible to the human eye.

There is a discrepancy between what happens within the environment and what we perceive as happening, with a large number of signals remaining unnoticed or misunderstood. Anthropologist, cultural ecologist and philosopher David Abram argues that a crisis in perception is one of the key reasons for ever-growing environmental

concerns. Reciprocity is one of the ways in which Abram describes that ongoing interconnection, revealing the interdependencies between human and other-than-human worlds (Abram 1997).

If we need to break the restrictive conceptual and, more importantly, perceptual borders that maintain the threats, in order to generate an entangled state of being, then contemporary art practice, together with environmental humanities, becomes a powerful tool to help break these borders.

The colour scientist and semiotician José Luis Caivano proposed a new approach for understanding colour – a gradualist hypothesis – whereby the focus lies on "The moments of transition, gradations and transformations that allow moving from one category to another, with a better understanding of how the relationships are produced and the ways in which those differences occur" (Caivano 2018:1). Rather than employing divisional approaches to understanding colour, and visual phenomena in general, Caivano's gradualist method rejects the traditional focus on divisional categorisation and so falls closer to the natural experience of the visual field and how life on earth operates from the ecological perspective.

Colour, as one of the key instruments of visual perception, explored through contemporary art practice, offers a powerful tool for visualising the ecological entanglements which might not be obvious, or even visible to the human eye. A deeper exploration of the non-divisionary nature of colour could enable further insight into ecological entanglements, as well as offer artists a way of contributing to this understanding through the use of colour in works which seek to engage with entangled being.

3. Colour extinction

Colour plays a key role in the aesthetic experience of visual perception and as a way of reading an environment and orienting within it. It is also a means of communication between the different species – between human and non-human worlds. Understanding colour has most often been approached through the process of breaking the visual field down into categories, those of individual colours. While this divisional, micro-perspective has proven enlightening, the inclusion of a macro-perspective – investigating colour as a boundless spectrum – might offer a more holistic understanding of colour, articulating the interconnectedness of all things as observed through ecology.

This interconnectedness we often fail to perceive when reality superficially appears to be so separated, leading to actions which are as destructive to ourselves as they are to the conceptualised 'other'. As a species, we have a strong desire to resolve things, to understand, to uncover, to divide into categories. These categories are expanded and divided in increasing complexity as fields of knowledge develop. We also know, however, that there are many unknowns, and there always will be. The balance is too often skewed towards maintaining definition and classification, rather than also accepting that reality can be ambiguous, and the borders are somewhat enforced. Ambiguity isn't simply a blockage in the workings of knowledge caused by the lack of information necessary for classification, but also a vantage point to reconsider assumptions already made in the rush to certainty.

Colour and its dynamic nature might be a very useful tool for shared extrication from such assumptions in understanding ecology, with contemporary art practice attuned to ecological concerns enabling a productive platform for exploration. Often perceived as a background, static property of objects, the influence of colour within the larger environmental context is rarely seen. In this crucial time of pressing environmental changes, there may be wide-ranging insights from greater exploration and analysis of spatial colour distribution. How can artists use colour to produce a particular effect, which in turn might present new insights about environmental processes and enhance people's awareness of their environment.

In 2017, the European Space Agency reported that the colour loss of the Great Barrier Reef – or coral bleaching – can now be observed from space (ESA 2019). Knowing that, in nature, colour developed as a result of evolution to support life processes, the presence of colour, its richness and vibrancy, can be seen as a signifier of life (Buether 2014). As species disappear, we lose the colours, and especially the particular colour combination of the departed organism. As an example, the Carolina parakeet, a small neotropical parrot, which before 1918 spanned the forests of the United States, was the only indigenous species of the neotropical area within the US, and one of the only two indigenous parrot species in the US. Its tantalising combination of a unique proportion of greens, yellows, reds and pale pink will no longer brighten the forests – having been declared extinct in 1938.

The species loss over the last few decades has been so extreme that scientists are now considering we might be in the midst of the sixth mass extinction (Barnosky et al. 2011). Thinking of these losses, it raises the question of how many colours and colour combinations we have already lost. Are the sci-fi visions of dystopic future with their achromatic landscapes our destined future? With a great number of species already gone, and a large number

of those entangled with us, might we soon be caught in the same vortex.

4. Artistic propositions

The author's recent work exploring ecological entanglements took the form of a series of art pieces investigating ecological interactions through colour and its spatio-temporal dynamics, reconsidering perceptual boundaries in search of new possibilities of how spaces are shared with non-human others. A series of abstract interactions entitled 'Grey to Blue: Ecological Entanglements' is explored through sculptural, photographic, moving image and sound-based works, drawing attention to the role of colour in the living world, while highlighting ecological loss and absence.

These works articulate a positive ambiguity of representation, showcasing organisms in interconnected relationships and interacting with the environment, translated into indistinct colour forms that release our perception from preconceived separateness and division.

Taking inspiration from the natural world, these artistic propositions deal with the removal of borders and boundaries to create positive ambiguity. Each artwork explores how everything is entangled, the in-betweenness of things and how seemingly separate objects, bodies and phenomena relate.

Fig. 1. Detail of 'Torch Ginger | Lesser Violetear' installation, 2019.

A sculptural installation (Fig. 1) comprised of thin multi-coloured wooden rods looks at the interaction of a hummingbird and its flower as the bird enters the flower to feed on nectar. The coloured lines representing the flower interpenetrate the colours of the hummingbird, creating one entangled spatial experience that absolves the audience of any need to distinguish one organism from another, accentuating the intractable relationship rather than binary forms. The audience can walk through the piece, thereby entering the hummingbird-flower experience and experiencing a frozen moment of ambiguity that conveys ecological interaction outside of feeder/food or sentient life/non-sentient life definitions.

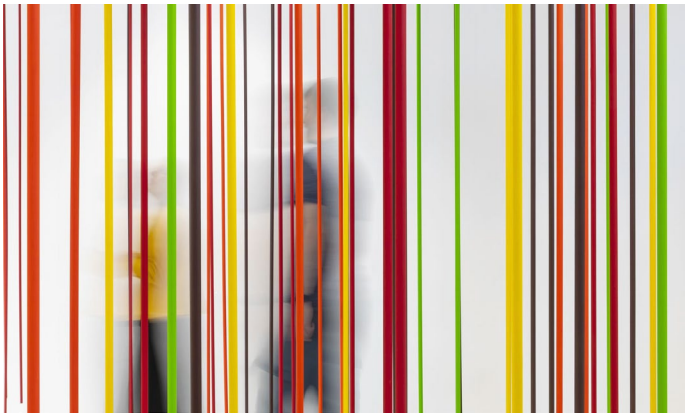

Fig. 2. Detail of 'Pawpaw | Dark Flower Scarab Beetle' sculptural installation, 2019. Photo: Kenny Lam.

Another installation (Fig. 2) considers how flowers attract insects through their shape and colour. Two-metre long rods, suspended vertically and painted in the colours of a pawpaw flower, open wide to allow visitors to enter the flower, duplicating the insect's journey. This is the first piece experienced by the audience immediately upon entering the space, in which they mimic the path and colour attraction of the insect, without foreknowledge of the meaning, as an introduction to the proposition of entangled ecology of equal forms.

A pile of soil spanning almost six metres in length is studded with casts of avocado stones of different shapes and sizes (Fig. 3). The sculptures are absolutely white; their hue is missing – reflecting the extinct large mammals who would swallow and distribute the avocado stones. Thousands of years ago, these great giants, such as the six-metre-tall giant sloth, would be attracted by the ripe avocados and mangos, swallowing the entire fruit with its pit, helping the plant to disperse its seeds far and wide.

Fig. 3. Detail of 'Avocado | Giant Sloth' installation, 2019. Photo: Machal Jesionowski.

Those animals are long gone, yet the fruit has not caught up to this reality and continues to call for its lost partners. This collapse of deep time into a single representation brings the audience closer to a past that is directly linked yet feels impossibly distant. In the modern age of ever-shortening immediacy, it is perhaps the understanding of these direct links over deep time that could counter ecological anxiety.

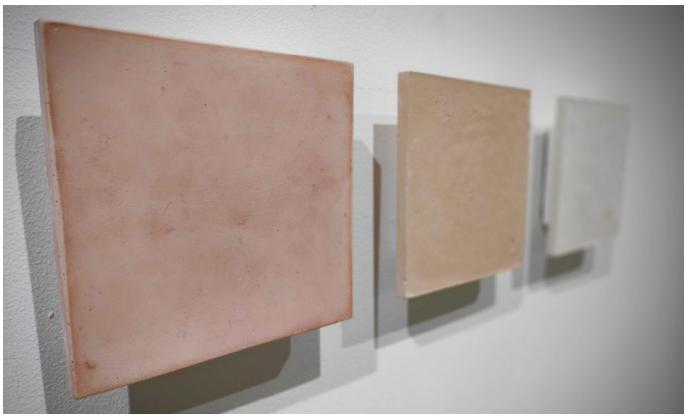

Fig. 4. Part of 'Avocado | Giant Sloth' installation, 2019. Photo: Michal Jesionowski.

As the hue left the avocado pits, the actual avocado dye became one of the components of the three plaster casts on the wall overlooking the soil (Fig. 4). This piece shows the various shades that can be derived from avocado dye. With the giant mammals gone, it is the role of the human as a surrogate to continue the work of helping these plants disseminate.

A long strip of instant photos (Fig. 5), suspended from the gallery ceiling and continuing on the floor, examines the changing colours of a mango as it ripens and spoils – from greens to yellows, oranges and reds. The mango fruits are lying on the forest floor waiting for their great giants, slowly transforming, slowly losing colour.

Fig. 5. Part of 'Mango | Stegomastodon' instant image installation, 2019.

The images are of an actual mango fruit as its colour changed, taken with in-camera blur. The details of the mango skin are removed, giving focus to the shifts in colour. Hidden behind the changing colours, that fade out to the grey and black of mould, is the death of a relationship that flowered through evolution, now disrupted in a portent of further disruption inevitable through ecological collapse.

Fig. 6. 'Red Silky Oak | Swallow-tailed Hummingbird' installation, 2019. Photo: Kenny Lam.

In a dark space is a blurred video of a brightly coloured swallow-tailed hummingbird and a red silky oak flower projected onto an imposing fractured 'screen' made of suspended paper tubes (Fig. 6). As the hummingbird feeds from the flower, the border between each organism is obscured to the point of near-imperceptibility – only the colour and movement betrays a possible separation. Accompanying the visual is a sound piece, a shimmering interpretation inspired by the sound of a hummingbird that carries the audience through the columns in a path within the hummingbird-flower relationship.

The lights piece (Fig. 7) is looking at the relationships between bees and flowers through colour and movement – as a single bee flits from flower to flower in search of nectar. The lights are mapped to the bee's movement, while the colour of the flashing light is that of the flower, so the piece creates an experience of a bee-flower as one entity – alive only in coexistence.

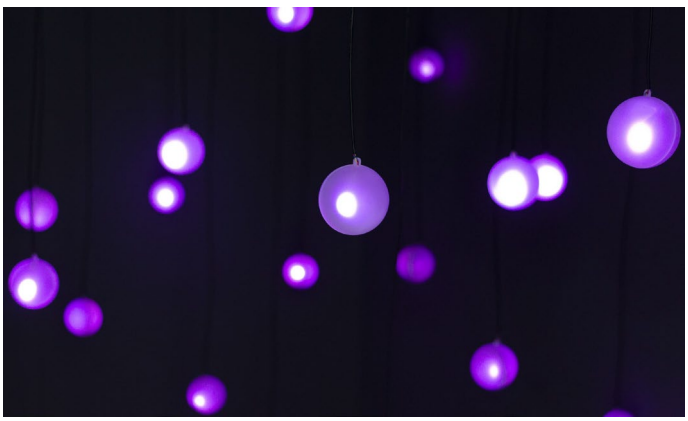

Figure 7: 'Purple Coneflower | Rusty Patched Bumblebee' installation, 2019. Photo: Kieran Gosney.

5. Resting in the unknown

The world operates as one interconnected ecology, yet we fail to see the connections. There is a discrepancy between what we perceive as happening in the environment and what actually occurs, with a large number of visual signals remaining unnoticed or misunderstood. This misconception left us in the space of ambiguity and led us into an environmental crisis, with the planet now largely contaminated by industrial pollution and species disappearing at an unprecedented rate.

Contemporary art practice has a crucial role to play in this time of environmental urgency, when an increased understanding of often invisible processes happening within the environment is a requirement. Focusing on the gradualist approach to colour, alongside the idea of entanglements, has the potential to rearticulate the role and possibilities of contemporary art practice within the larger perceptual reframing efforts in response to key environmental issues. In paying closer attention to entanglements and recognising how interdependent we are in the wider web of life, the agency of the human can be reconsidered and de-centred.

Searching for that moment of ambiguity, resting in it, living in it, and finding comfort – oscillating at the biting point between sharpness and blur; like settling down in a foggy land, where the spaces between – the invisible – thicken, masking body and landscape; looking for those spaces, spending time in them, where thoughts do not fail to grasp onto separated elements; then slowly, as the fog dissipates, one might still embody that feeling of togetherness, fully entangled, and proceed the journey in gratitude and in kind to that larger self. This oscillation is what might allow us to be present in the world of forms and move into the fully entangled and interconnected experience of life as ecology describes it, but which is too challenging to perceive merely through the senses. Vision is what so often misleads us, like the elusive and ambiguous nature of colour as light. As much as it is wonderful to hold onto something, there is value in learning to completely let go in the unknown, to trust, and act with care and attention.

6. Conflict of interest declaration

The author certifies that she has no actual or potential conflict of interest, including financial, personal or other relationship with other people or organisations in the prior three years that could inappropriately influence, or be perceived to influence her work, and no financial/personal interests have affected the objectivity of the author.

7. Funding source declaration

The author received funding from Edinburgh College of Art, the University of Edinburgh, Scotland for the PhD research related to author-initiated investigation of this topic.

8. Acknowledgment

Many thanks to Edinburgh College of Art, the University of Edinburgh and Hope Scott Trust for supporting the development, production and presentation of the work for the exhibition. In planning and developing the installations, the author worked in collaboration with architects Yipei Tan and Xinren Zhou, as well as Shona Yu for the video projection screen. The sound was composed by Lars Koens. The light installation was produced in collaboration with Siyao Zhou. Technical assistance through the exhibition was provided by Kieran Gosney and Vajid Ali.

9. Short biography of the author

Yulia Kovanova is a Siberian-born, Scotland-based artist and researcher. Her practice currently focuses on the investigation of ecology of colour and its dynamics, the ideas of spatio-temporal borders and perceptual boundaries. She often takes an interdisciplinary approach, working across a range of media, including moving image and sculptural installations, and through collaborative practice.

References

Abram, D. (1997) The spell of the sensuous: perception and language in a more-than-human world. New York: Vintage Books.

Barnosky, A. D., Matzke, N., Tomiya, S., Wogan, G. O. U., Swartz, B., Quental, T. B., … Ferrer, E. A. (2011). 'Has the Earth's sixth mass extinction already arrived?' Nature, 471(7336), pp. 51–57. doi: 10.1038/nature09678.

Buether, A. (2014) 'The function of colour – an introduction to colour theory and a definition of terms', Colour: design principles, planning strategies, visual communication, Buether, A. (ed.) Munich: Institut für internationale Architektur-Dokumentation, pp. 7–20.

Caivano, J. L. (2018) 'Colour from a gradualist perspective'. Proceedings of the International Colour Association (AIC) Conference. Newtown, NSW: International Colour Association, pp. 31–38.

European Space Agency (2017). Sentinel 2 captures coral bleaching of great barrier reef, e-ESA. Available at: https://www.esa.int/Our_Activities/Observing_the_Earth/Copernicus/Sentinel-2/Sentinel- 2_captures_coral_bleaching_of_Great_Barrier_Reef (Accessed: 20 January 2019).

Ingold, T. (2018) 'From science to art and back again: the pendulum of an anthropologist'. Interdisciplinary Science Reviews, 43(3–4), pp. 213–227. doi: 10.1080/03080188.2018.1524234.

Jakesch, M. and Leder, H. (2009) 'Finding meaning in art: preferred levels of ambiguity in art appreciation'. Quarterly Journal of Experimental Psychology, 62(11), pp. 2105–2112. doi: 10.1080/17470210903038974.

Morton, T. (2017) 'Timothy Morton in conversation with Verso Books'. YouTube. https://www.youtube.com/watch?v=1AEy2KmHwh0 (Accessed: 15 November 2018).

Morton, T. (2018a) 'This is not my beautiful biosphere', A cultural history of climate change, Bristow, T. and Ford, T. H. (eds.) London: Routledge.

Morton, T. (2018b) 'Being ecological | Timothy Morton | RSA Replay'. YouTube. Available at: https://www.youtube.com/watch?v=d_5UWI-SEVE (Accessed: 26 March 2019).

Rose, D. B., Dooren, T. V., Chrulew, M., Cooke, S., Kearnes, M. and Ogorman, E. (2012) 'Thinking Through the Environment, Unsettling the Humanities'. Environmental Humanities, 1(1), pp. 1–5. doi: 10.1215/22011919-3609940.

Seligman, A. B. and Weller, R. P. (2012) Rethinking pluralism: ritual, experience, and ambiguity. New York: Oxford University Press.

Steffen, W., Crutzen, P. J. and Mcneill, J. R. (2007) 'The Anthropocene: are humans now overwhelming the great forces of nature?' AMBIO: A Journal of the Human Environment, 36(8), pp. 614–621. doi: 10.1579/0044-7447(2007)36[614:taahno]2.0.co;2.

COLUMN: BOOK REVIEWS

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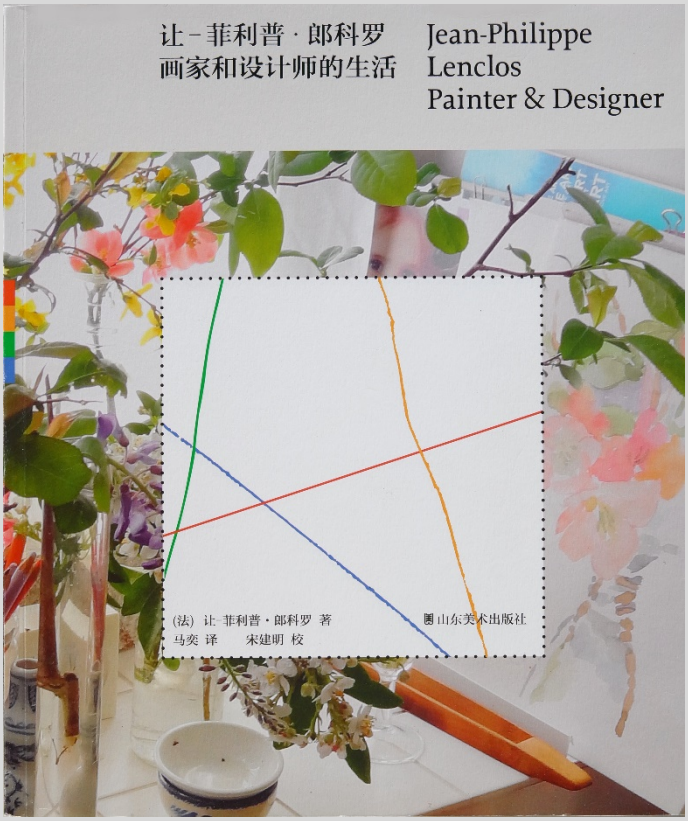
These reviews of three books – Jean-Philippe Lenclos: Painter & Designer (2017), Colour Strategies in Architecture (2015), and Farbraum Stadt: Farbkultur in Winterthur (2019) – address colour in urban and architectural design.

Jean-Philippe Lenclos: Painter & Designer (2017)

The cover of this book shows a glass vase on a table with a bouquet forming a natural colour palette including bright yellow forsythia, purplish wisteria, branches of an orange-red flowering Japanese ornamental apple tree and of a white blooming cherry tree, and black-brown shoots with green leaves. On the right, a watercolour depicts the colour harmony of the natural floral arrangement. At the top, the word 'art' repeated on a sky-blue background is perceptible as well as the photograph of a young person whose eyes enigmatically peer in between the leaves. In the centre, a rather dominant white square pierces this picture like a window which – according to ancient Feng Shui beliefs – clears the path for the dragon, symbol of positive energy and good luck. Four threads or lines cross in the opening to represent the intersection of different spiritual forces: red stands for design, blue for research, green for teaching, and yellow for art. These are Jean-Philippe Lenclos' four fields of activity that comprise the four main chapters of the book. They are preceded by a chapter on his biography (childhood and youth) and followed at the end of the book by a chronology of events.

The graphic design and layout were realized by the Chinese graphic designer Yuan Youmin, Professor at the China Academy of Art. The preface is by colour designer Jianming Song, who was Lenclos' first Chinese student at the École nationale supérieure des Arts Décoratifs (EnsAD) in Paris in 1985 and who published the first book on Lenclos' work in China in 1988. Song's wife Di Yin, who also studied for one semester with Professor Lenclos, founded her own agency Plough Color Research Co. Ltd. in Hangzhou and financially supported this publication. Cloé Pitiot, Curator at the Department of Design, Centre Georges Pompidou, who since 2018 has been a curator at the Musée des Arts Décoratifs de Paris, wrote the introduction.



Jean-Philippe Lenclos: Painter & Designer. 2017. Text by Jean-Philippe Lenclos. Preface by Jianming Song. Introduction by Cloé Pitiot. Jinan: Shandong Fine Arts Publishing House. ISBN 978-7-5330-6201-9 (Chinese/English)

Translated into English and Chinese, the main text is by French colour designer, researcher, artist, and teacher Professor Jean-Philippe Lenclos. The book is beautifully illustrated with approximately 730 images.

In the first chapter, we learn that he studied at the Art School in Lille, then cabinet-making at École Boulle in Paris and also at EnsAD before sailing from Marseille to Japan where he enrolled at the Kyoto School of Art for two years – a crucial, shaping experience in his biography.

The second chapter focusses on his work as a designer. For ten years he was artistic director of the paint company Peintures Gauthier before creating supergraphics and founding his own agency Atelier 3D Couleur in Paris in 1978. The Atelier's focus was on colour design in urban planning, architecture, and for industrial sites. Another important focus was on research on colour, materials, and new technologies in industrial

design including products, cars and textiles. The third chapter is dedicated to his famous concept 'The Geography of Colour', a systematic methodology he developed to study the colours of a village, town, or region. The fourth chapter is about his thirty-five years of teaching colour at EnsAD and includes his students' work.

The absolutely remarkable and longest chapter is the fifth, which describes his artistic research. He explores the properties of colours through his drawings, watercolours, and oil paintings. His artistic work creates vibrant optical patterns that capture light, rhythm, and movement similar to reflections on the surface of water. He deals with the fragile chromatic transformation of natural objects over time, beginning with very concrete examples and going beyond to the amazingly abstract play of colours and forms. Fascinating secrets are revealed by this formerly unpublished material.

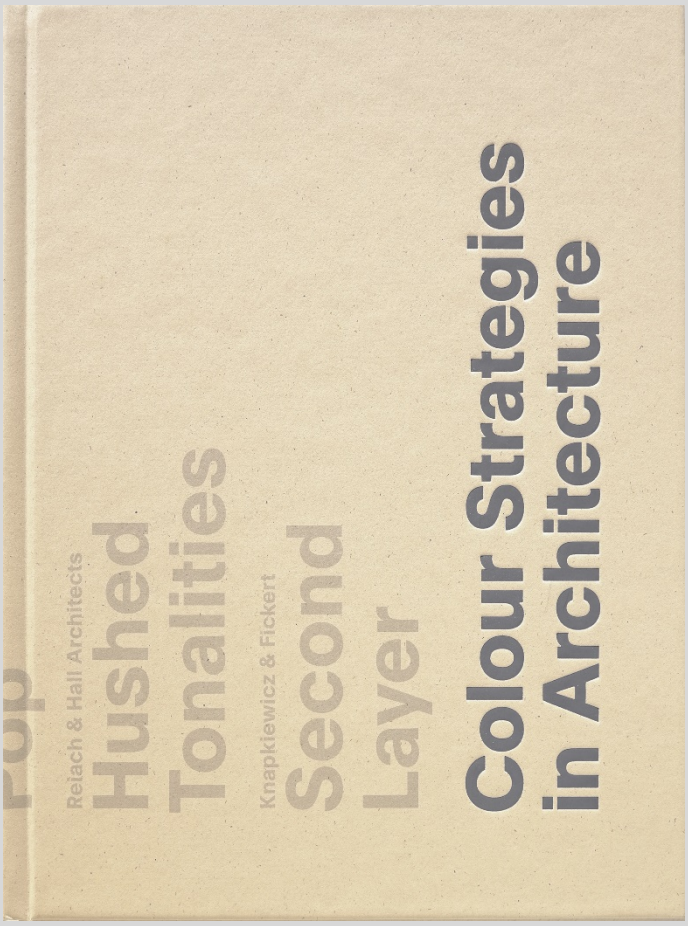
As a conclusion, there is a timeline of his professional activities such as talks, publications, and exhibitions.

This is a splendid book on the work of Jean-Philippe Lenclos who not only furthered the profession of colour designer by creating a new dimension, but also influenced researchers, scholars, artists, and designers beyond France on an international level while serving as a leader and mentor, which is still true today.

Fiona Mc Lachlan et al.: Colour Strategies in Architecture (2015)

Colour Strategies in Architecture is the outcome of a fortuitous encounter of three of the authors who initially crossed paths at the Midterm Meeting of the International Colour Association in 2011 in Zurich. As a result, Haus der Farbe (House of Colour – Professional School for Design in Craft and Architecture) in Zurich and the University of Edinburgh started a four-year interdisciplinary research project that investigated the strategic use of colour within architectural design practice.

Any material decision in architecture is tacitly a decision about colour, but the use of colour is not necessarily a strategic one. Most of the time people are not aware of how different colours shape a building in a distinct way. Colour has its own inherent qualities and is a key factor in creating the specific aesthetic and spatial experience of space. Whether natural materials, pigmented layers, or finishes are applied, they define the relationships between planes, volumes, and details contributing to a particular atmosphere.



Colour Strategies in Architecture. 2015. Texts by Fiona McLachlan, AnneMarie Neser, Lino Sibillano, Marcella Wenger-Di Gabriele, Stefanie Wettstein. Preface by Iain Boyd White. Basel: Schwabe Verlag in association with Haus der Farbe Zurich. ISBN 13: 978-3-7965-3421-8 (English)

The research method was based on the discursive analysis of hand-painted samples (around 380) as well as on the development of an accessible way of communicating and disseminating the different approaches and findings. More specifically, the closely observed colours were studied and interpreted with the aims, first of all, of understanding and identifying the colour characteristics of a building or part of it; secondly, studying the colour strategy applied; and, thirdly, describing and discussing the context and approach in an illustrated essay.

The book includes a selection of six different architectural practices that constitute the six chapters of the book and are titled the same as the essential aspects of the six depicted colour strategies:

Painterly Promenade is the colour strategy attributed to the work of Lux Guyer (1894–1955), a pioneer female architect based in Zurich;

Holistic Interplay is the implicit colour strategy captured in the Philharmonie and Staatsbibliothek in Berlin by Hans Scharoun (1893–1972);

Tectonics Clarified is the colour strategy illustrated by two Edinburgh housing projects by Basil Spence (1907–1976);

Immersive Pop is the colour strategy identified in the design of several underground stations in West Berlin by Rainer Rümmler (1929–2004);

Hushed Tonalities is the colour strategy of the subtle and timeless approach of Reiach & Hall Architects, whose firm was established in 1965; and,

Second Layer is the colour strategy exemplified in two housing projects in Zurich by contemporary Swiss architects Knapkiewicz & Fickert.

The findings of the fourteen case studies are summarized as a 'colour portrait' (tableau) and the colour strategy is visualized in a second larger unfolding plate. Such plates recall the 2010 publication *Farbraum Stadt: Box ZRH*, which includes ninety-six colour portraits of selected buildings in Zurich built over a century.

In the conclusion the authors write that their expectations will have been fulfilled if the study encourages the strategic use of colour in architecture.

The essays are highly interesting colour-centred analyses of architectural spaces. Professionals will prove if the methodology developed in the book becomes the key to successful colour strategies in architectural practice.

The plates are also currently travelling through Europe as an exhibition.

Andres Betschart et al.: Farbraum Stadt: Farbkultur in Winterthur (2019)

The history of the city of Winterthur goes back to the Roman era, but the city itself was granted borough rights only in 1264. As in most Swiss cities, the ancient city core is colourful. Each building façade is a different colour and this contributes to the creation of the particular ambience of this public space. In the preface, Winterthur's Mayor Michael Künzli claims that the book *Farbraum Stadt: Farbkultur in Winterthur* (Colour Space and City: Colour Culture in Winterthur) and its colour charts are useful as a basis for discussing colour, making sound colour decisions, and drawing attention to characteristic colour features and local colour traditions.

Released as a boxed set, the publication contains a book, a folded leaflet, and three folded posters. There are several essays in the book. In one, architect Stefan Gasser claims that colour regulations are important and describes how a façade that was recently painted vibrant

Farbraum Stadt: Farbkultur in Winterthur. 2019. Texts by Andres Betschart, Stefan Gasser, Basil Marty, Marcella Wenger-Di Gabriele, Stefanie Wettstein, Jasmin Widmer. Preface by Michael Künzli. (Neujahrsblatt der Stadtbibliothek Winterthur; Bd. 356.2019) Winterthur: Stadtbibliothek Winterthur, ISBN 978-3-908050-44-5; Zürich: Chronos Verlag, ISBN 978-3-0340-1509-7 (German)

orange prompted immediate criticism from many inhabitants. (In his essay, the author, however, does not mention whether or not the owner was forced to repaint the façade.) Gasser also describes how in 1943 Winterthur's city core became a protected zone – including in terms of colour design – and that the Urban Planning Act of 1975 states that the overall colour character should be preserved in the old city centre.

In another essay, art and architectural historians Basil Marty and Jasmin Widmer point out that colour regulations are not a contemporary invention citing a dispute in 1629. The authors examine additional archival documents from 1648, 1810–1818 and 1926 discussing the historical development of colour in urban planning and social impact of colour on architecture.

In a third essay, historian Andres Betschart explores the 1910s and 1920s colour movement launched by Bruno Taut in Germany and how the 1926 exhibition *Die farbige Stadt* (The Colourful City) at Winterthur's Gewerbemuseum was immensely popular. Betschart includes reproductions of autochromes by photographer Hermann Linck as well as the 1926 colour design proposal for one of Winterthur's main streets by artist Willy Dünner, whose mixed technique colour plates constitute the folded leaflet of the published set.

The main chapter – and purpose of the book – is presented by Marcella Wenger-Di Gabriele and Stefanie Wettstein, who studied different districts to establish

colour charts as visual means of communication. These colour charts are included in the publication as folded posters. The first one relates to the old city centre and the urban core of a selected district. The second poster presents the colour charts of two heterogeneous districts. And, the third summarizes the colours of two garden cities. As directors of the Haus der Farbe in Zurich, the authors developed a methodology and criteria to identify 'good quality' colours, i.e., colours that are typical and also well-fitted to a particular context. The colour charts represent a selection of the existing colours. As cultural and aesthetic judgements evolve over time, new additional colours can be chosen on the basis of and in harmony with the colour charts. The charts seem to represent the immediate appearance of the different colours on the façade surface (page 82, Fig. 7). This raises an issue explored by Karin Fridell-Anter in her study of 2000, whereby she demonstrated that façade colours shift greatly in terms of lightness and chromaticness when seen from a distance, as is usually the case. A further issue is that some of the colour charts include not only the colours of paint or plaster, but also of stone and of natural and varnished wood. Are the authors correct in suggesting that dark brown could be applied on a plaster façade? Under the keyword 'façades', the nature of the material associated with each colour is not explicitly stated. In one of the charts there are browns, dark browns, dark greens, and almost blacks, which are extremely somber colours for a façade and are generally responded to with harsh criticism from local residents. The colour charts are also problematic insofar as there are no reference numbers and dark colours are difficult to discriminate. Concerning the colour charts of the heterogeneous city quarters, colours of natural materials, textiles, concrete, and paint fuse together. Does the printed version make them appear harmonious? Including the turquoise blue colour of existing buildings (pages 106–107) makes no sense as it would actually destroy the intended harmony. If these colour charts should be the basis for discussing colour, how do we deal with such colours? In sum, a useful colour chart for practical colour application entails much more than just analysing and summarising existing colours.

The conclusion is by city architect Jens Andersen, who deals with the colour charts in daily practice.

The book is nicely illustrated with contemporary photographs by Michael Erik Haug.