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

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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.

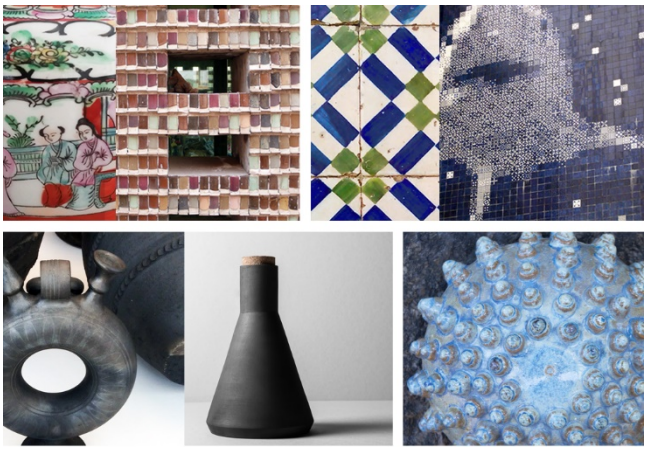

Fig. 7. New Syntaxes, same identities (top, from left to right): Chinese vase (Photo: Carla Lobo); Ceramic House (Photo © Evan Chakroff); 19th-century Moorish-inspired tiles; Oceanário de Lisboa (Photo: Carla Lobo). And (bottom, from left to right): Traditional black pottery from Bisalhães (Photo: Carla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

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

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