Popular Dwelling Chromaticism

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Abstract

This article presents a method to define popular houses' façades chromaticism, based on an analogy between colours and musical notes. The starting point is a musical scale composed by twelve notes (including the semitones), and a twelve colour set, obtained by mixing chalk to a very cheap pigment, called *"pó xadres"*, arranged around Holzel's colour wheel. The 72 colour full range palette is obtained by reducing the saturation of the original colours, and then associating the lowest notes to the most saturated colours, while the acute ones should correspond to the clearest. Starting from these assumptions, the popular dwelling chromaticism is performed according to various generative criteria, showing that, for every applied algorithm, a specific result is obtained. One among these methods adopts the plant as a piano roll, proposing each unit to be painted in the colour of its corresponding note. Under this optic, if music composition is based, in its essence, on the ability of manipulating very precise numerical relationships, the examples presented in this paper show that creative solutions should be achieved in architecture using similar equations to deal with space/shape issues, including colour modular coordination principles in the design process.

1. Premises

The colour has always been one of the greatest protagonists in the perception phenomenon, being often used as a reference to describe a place, to provide an indication, to identify a specific house among its neighbourhood. (Figure 1)

Figure 1 – Example of colour use in popular houses façades in Brazil

In fact, all around Brazil, especially in small villages, the use of colour is deeply inscribed into the constructed environment, maybe resulting from the appropriation process of the bright colours present in nature. This pre-existing context needs to be taken into account when distributing the colour settings into a given space, being the

reference to define the palette.

By the other hand, popular dwelling projects, sponsored by government social housing programs, are generally painted in white, resulting into completely uncharacterized spaces, of an exasperating monotony, in which the inhabitants are not able to distinguish their own house from their neighbor's. (Figure 2)

Figure 2 – An example of popular dwelling project in João Pessoa - Brazil

The contribution of this study is to present a creative innovation method to be applied in popular dwelling design, to define houses façades chromaticism, based on an analogy between colors and musical notes. The first step is to determine an initial palette, and then establish the equivalence between it and a musical scale. The following step, using the global plan as a piano roll, aims to find out which note each house represents, to finally paint each unit in the colour of its corresponding note. Two different procedures will be exposed along this paper, chosen among the infinite range of generative algorithm that could be created for this specific purpose.

2. An analogy between colours and musical notes

Both colour and music are inherently intangible. They are not substances, but just waves traveling. Color and music also operates as a language and are often used as such. In spite of being difficult to compare such different physical features, like colour and sound, a vast literature is available about this subject. Both Pedrosa (1989) [1] and Grandis (1985) [2] describe the analogies proposed by Newton and Goethe, who considered colour and sound as vibration phenomena, although in different frequencies. (Figure 3)
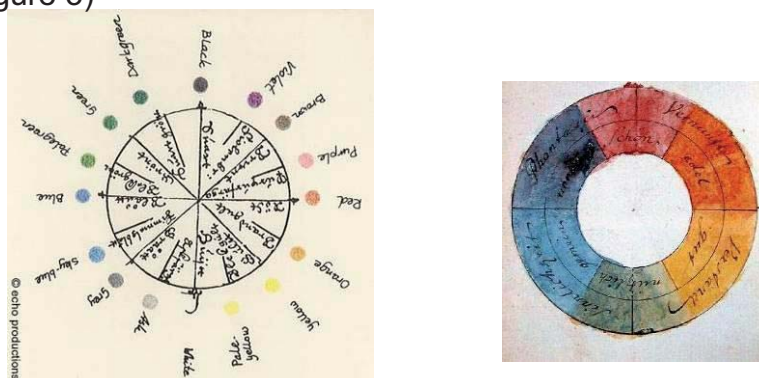

Figure 3 – Forsius's and Goethe's colour wheels, conceived in 1611 and 1810 respectively

Machado (1993) [3] refers to synaesthesia, an unified theory of all sensory perception and Lagresille (1983), *apud* Sanz (1985) [4], establishes a parallel between musical octaves and the brightness of colours, proposing to associate the lowest notes to the most saturated colours, while the acute ones should correspond to the clearest. The relationship between sound frequencies and colours wavelength adopted in this paper, is that one established by Dauven (1970) *apud* Gyorgy Doczi [5], that creates a correspondence between a musical scale, composed by twelve notes (including the semitones), and a twelve colours palette, arranged around Holzel's colour wheel. (Figure 4)
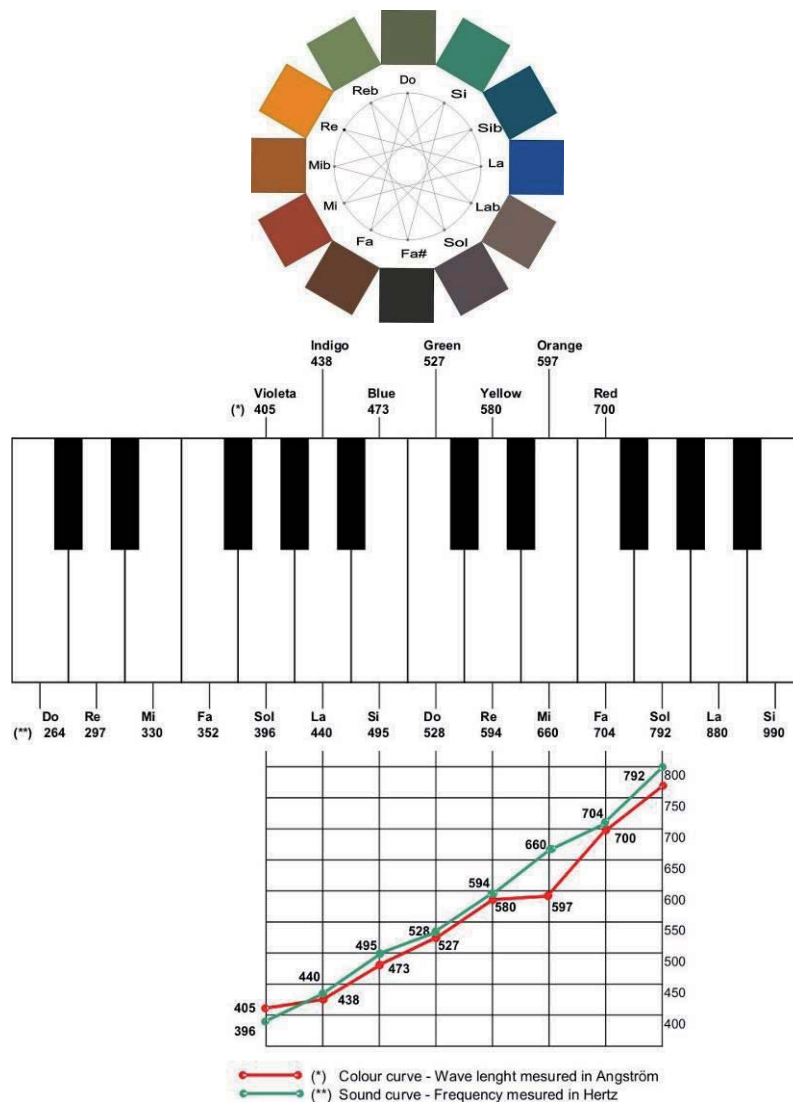
Figure 4 – Dauven's correspondence between colours and musical notes
Font – Gyorgy Doczi - The power of limits

More recently Semir Zeki`s [6] studies on colour perception and Antonio Damasio's [7] work on relations between colour recognition and language, memory and sound, reveal how important is the colour environment to stimulate the human brain and therefore implement life quality. Another original comparison between music and architecture is given by Matila Ghyka's [8] when he refers to architecture as a frozen music, and by Mandelbrot's [9] studies on fractals, to revisit the possibilities of establishing analogies between colour and music.

As music is, in essence, a sensorial experience, derived from very precise numerical relationships, also the colour, which can be studied through the same mathematical equations, can consequently be modulated and controlled through similar procedures. Coincidentally scale, harmony, tone and chromaticism apply to both areas, showing the similarity between the musical coordination systems and colour modulation, which could result into creative solutions to handle the two key elements in design -- shape and colour - within the same principles of modulation and components coordination.

3. The global plan design

The starting premise to design the dwelling global plan was to avoid the orthogonal grid, obtained by the endless multiplication of individual properties (see Figure 2). These rectangular lots were substituted by a neighborhood unit based on the equilateral triangle, where several houses were grouped, now regarded as small condominiums, which maintain in its interior common areas, a kind of public-private yards, where leisure activities can be performed. (Figure 5)

Figure 5 – A seven houses neighbourhood unit grouped in an equilateral triangle lot

From this shape, a wide variety of solutions can be obtained, like diamond-shaped and hexagonal street distribution. The following examples show different variations of spatial organization. (Figure 6)
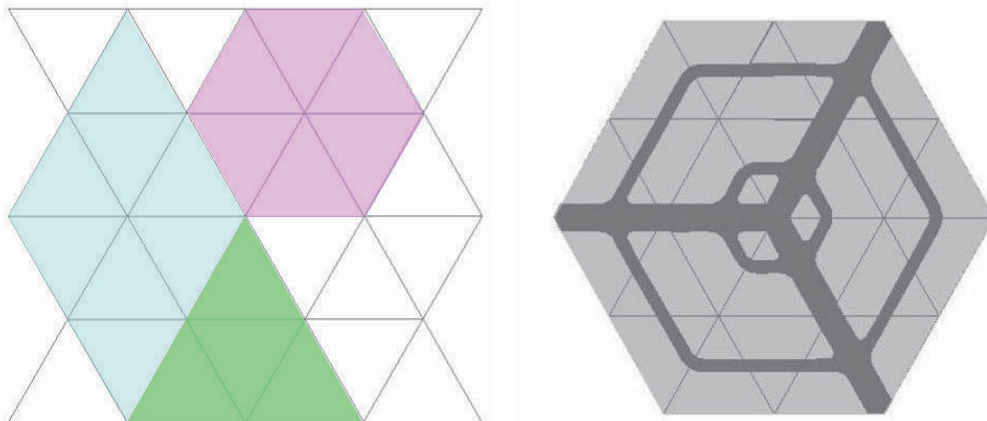

Figure 6 – Examples of street distribution obtained by assembling equilateral triangle standard lots

The analogy between the urban solutions showed above and Islamic mosaic is easily perceived, inducing to establish a method to introduce the colour into the design process. The analogy between colours and musical notes that will be described in this paper is only one among the multiple aspects of geometry and space interaction, as described by Leite [10] in the analysis of the Alhambra patterns. (Figure 7)

Figure 7 – Example of a wall mosaic in Alhambra – Granada, Spain

4. The colour palette definition process

To paint the houses façades the most economical material was used, *chalk paint* mixed to a pigment called *"chess powder"*, very popular in Brazil, which can be easily found in any construction material store, all over the country. To fix the colour on the wall surface, cooking oil was used.

To determine the exact pigment proportion of each colour, the first step was to identify the amount necessary to achieve the sample saturation, from which onward any increase did not produce colour variation. It was also observed that to obtain significant results the pigment amount to be added to samples had to follow a geometric progression of ratio 2. Among the available colours of *chess powder*, five of them were selected: black (BK), blue (BL), green (GR), yellow (YL) and red (RD), from which a 72 colours chromatic palette was obtained using the rules above described. (Figure 8)
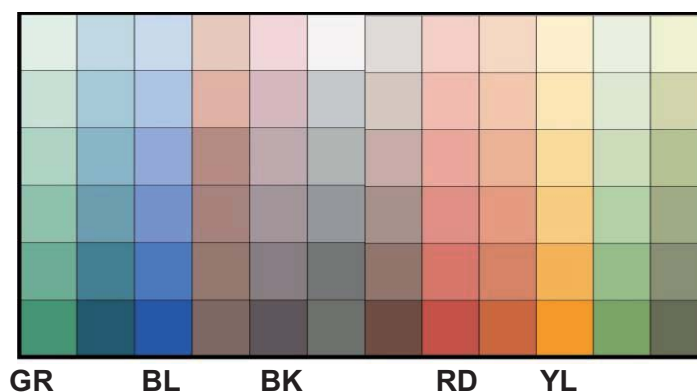
Figure 8 – The 72 colours palette obtained by mixing "chess powder" pigment to chalk paint

To transpose the sample colours to the computer screen it was necessary to fix their parameters of CMYK, where C represents the value of Cyan, M is the amount of Magenta, Y estimate the Yellow and K indicates the amount of Black. It is important to outline that this transposition was visual based, trying to keep the result as faithful as possible to the original colours.

5. Popular dwelling chromaticism

The next step was to establish the correspondence between the palette colours and the musical notes. With this purpose the colours were distributed around the Holzel colour wheel. The sequence so obtained was then associated to the first octave. After that, based on Lagresille analogy which establish to associate the lower notes to the more saturated colours and the high notes to the lighter colours, six different colour wheels were created, each one corresponding to a different octave, so totalizing the 72 sample colours. (Figure 9)
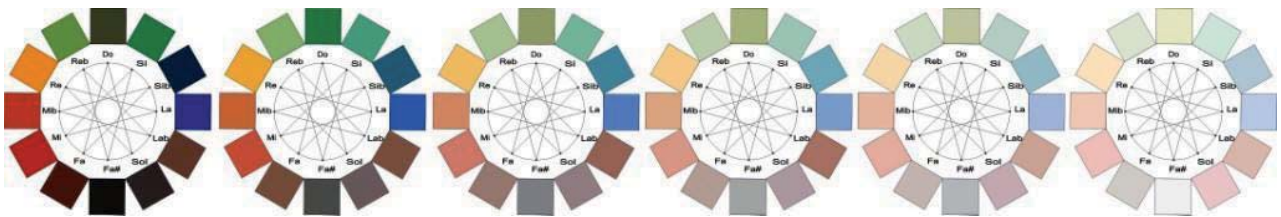

Figure 9. Chromatic circles corresponding to six music octaves

The colour set can also be represented through a rectangular matrix, where the columns stay for the notes and the rows indicates the octaves. (Figure 10)
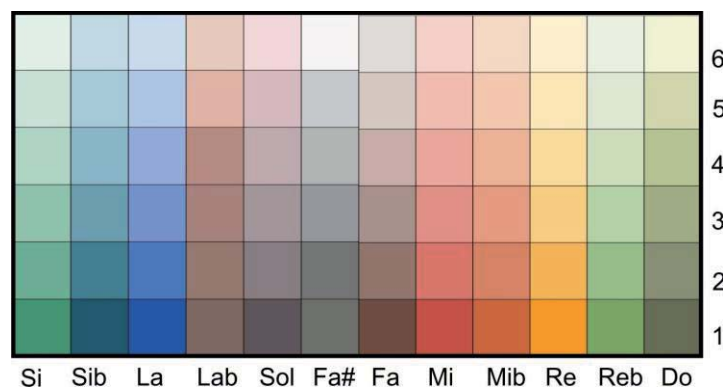

Figure 10 - Chromatic matrix representing the six music octaves

5.1. First painting method by using the houses location as a piano roll

After having established the 72 colour sample palette and determined its correspondence to the musical notes, a first application was implemented based on the analogy between the houses location and a piano roll. To apply this method a trapezoidal urban distribution was chosen, consisting of 24 neighborhood units (see Figure 5), totalizing 192 houses. (Figure 11)

Figure 11 – Houses distribution into the neighborhood lots

In order to prepare the plan to be used as a musical score, the X axis was associated to time, while the Y axis was assigned to frequency. Thus, the plant was divided into nine vertical bars and, horizontally, in six octaves, each one containing twelve lines corresponding to the notes position. Moreover the twelve neighborhood lots formed by the equilateral triangles (see Figure 5) were associated each one to a different instrument, so resulting into twelve musical phrases of seven or nine notes each, depending on how many houses were positioned in that particular triangle. (Figure 12)
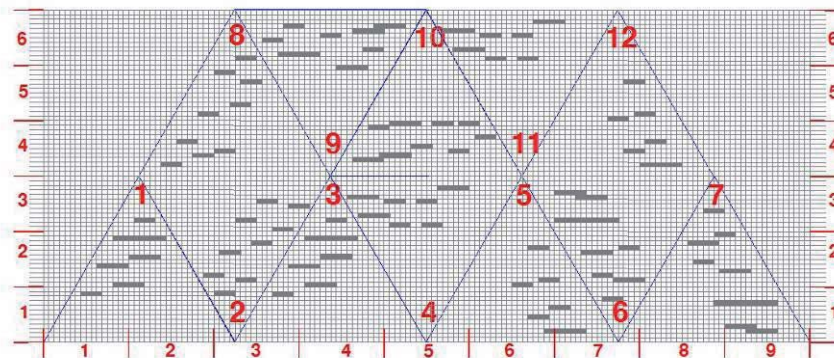

Figure 12 – The piano roll showing the notes and their duration

The resulting music is presented in the above diagram, where the position of each house identifies, on the Y axis (octave), the correspondent note, being its duration defined by the projection on the X axis (time). The interesting aspect of this experience is that the urban global plan represents the piano roll of the musical composition, establishing a direct correspondence between the houses position and the notes which they actually represent. Finally, each house was painted in the colour of its corresponding note, so obtaining the colour variation shown below. (Figure 13)

Figure 13 – The colour variation resulted by applying of the first painting method

5.2. Second painting method by using the perfect fifth scale

After having analyzed the result of the first coloring experience, it was found that only part of the 72 colours of the palette repertoire were actually used, due to the fact that the houses did not necessarily occupy all possible positions in the piano roll. To solve this problem it was decided to try a second painting method, with the premise that each colour of the palette had to be used at least once. To do that, the starting point was the perfect fifths scale, below represented. Following the notes sequence: Do, Fa, Sib, Mib, Lab, Reb, Fa#, Si, Mi, La, Re, Sol, all the notes will be considered, without making any repetition. (Figure 14)
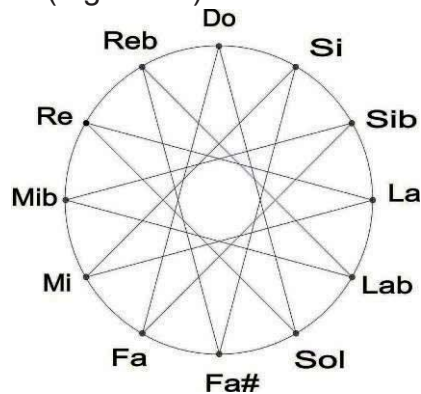

Figure 14 – The perfect fifths scale showing that all notes are considered

The next step consisted in applying this sequence to the urban global design. To do that the plan was overlapped by six concentric circles, each one corresponding to an octave, and then, starting from the bottom left corner and following the cock wise direction, each house was assigned to the corresponding note. After having repeated this procedure for the six circles, all the notes/colours were used at least once. (Figure 15)
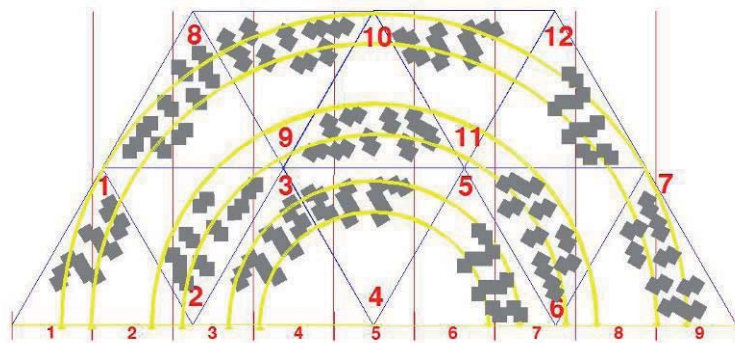

Figure 15 – The perfect fifths scale painting method applied to the global urban plan

Comparing the result thus obtained to the previous one, the colour distribution follows a circular pattern, instead of the horizontal colour stratification of the first method. The position of the clearest houses in the central part of the plan is due to the fact that these correspond to the higher octaves. A different result should have been obtained inverting the octaves position, making them to grow from the periphery towards the center. (Figure 16)

Figure 16 -The perfect fifths scale and the resulting chromaticism

6. Conclusions

The painting façades methods presented in this article try to rescue the use of colour in popular dwelling, widely present in vernacular architecture, and extremely important to give each house its own identity. By the other hand, the proposed colour palette, obtained by mixing the chalk paint to the "*chess powder*" pigment, faithfully reproduces the predominant colours in the inland regions of Brazil, where people have little access to industrialized products. To finalize, it is evident that the proposed analogy between colours and musical notes can be further explored in then future, in order to define new colour generative algorithms, following the research development suggested by Caivano[11] [12], having creativity as the only limit.

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