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Colorarch: A Colour-Combination App Running Le Corbusier's Salubra Colour Keyboards

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ABSTRACT

We have developed a mobile App that allows end-users to choose from the 312 four-colour combinations put forward by Le Corbusier in the colour keyboards commissioned by Salubra in 1931 for its painted wall paper collection. These combinations are shown in a standard colour notation such as Natural Colour System (NCS). The application allows you to browse the colour space NCS, which is shaped like a double inverted cone and to observe the spatial position of each of the 32 Salubra colours, addressing three perceptual variables: hue, blackness and chromaticity. Users can select any of the colour combinations with 1, 2, 3 or 4 targets, evaluate its position in the NCS solid and determine if combination criteria exist based on the similarity of hue, blackness or chromaticity, or on the contrast among any of these perceptual variables. One can also assessed if the colours belong to the same hue range or are complementary, if they share the same value of blackness or have contrast, if they are bold or dull colours (low chromaticity), etc. The application also indicates the recurrence of each pair of two colours from the total of 1248 matched pairs in the Salubra keyboards. Any recurrence reflects Le Corbusier's interest in said colour combination, whether it was a usual pairing throughout the Salubra charts or whether on the contrary, it was uncommon. In short, our application identifies the colour combinations put forward by Le Corbusier in 1931 for the Salubra colour keyboards, and shows the colour combination criteria in a visual colour space that customers may browse in order to select their preferred palette. This App was a result of earlier research by the authors about the "colour combination criteria in Le Corbusier's Purist architecture based on Salubra claviers from 1931", and published in Colour Research and Application (© 2015 Wiley Periodicals, Inc. Col Res Appl, 41, 85–100, 2016).

1. EARLIER RESEARCH INTO THE 1931 SALUBRA COLOUR KEYBOARDS

In 1931, the Salubra wallpaper manufacturer (Basel, Switzerland), commissioned Le Corbusier to compile an architectural colour chart, with a second version being completed in 1959. The first was conceived as a harmonic series, similar to the way in which the keys of a piano are organized, thus the name colour keyboards. In 1997, both colour charts were republished with an unpublished text by Le Corbusier (1931: 94-143) Architectural Polychromy, which dates back to late 1931 and early 1932, without doubt the most important document for understanding colour in the designs of the Swiss architect. A number of authors have carried out in-depth studies of the Salubra colour charts: JL. Caivano (2007) explains how it is organized and how it functions; M. Colli (1987) organizes the colours into keyboards; A. Ruegg (1997) undertakes an in-depth analysis of the colour charts in addition to the Architectural Polychromy text while J. de Heer (2009) carries out an exhaustive study of the chromatic aspects in the writings and Purist architecture of Le Corbusier, attested to by the high degree of freedom in the use of colour in the projects built that went beyond the Salubra claviers. Our research is innovative because it graphically shows, with supporting statistical data, some of the principles of Le Corbusier's colour preferences, such as the combination of colours with equal chromaticity, his interest in a certain contrast in blackness, or the frequent contrasting of cool and warm colours, something slightly different to the contrasting of complementary colours.

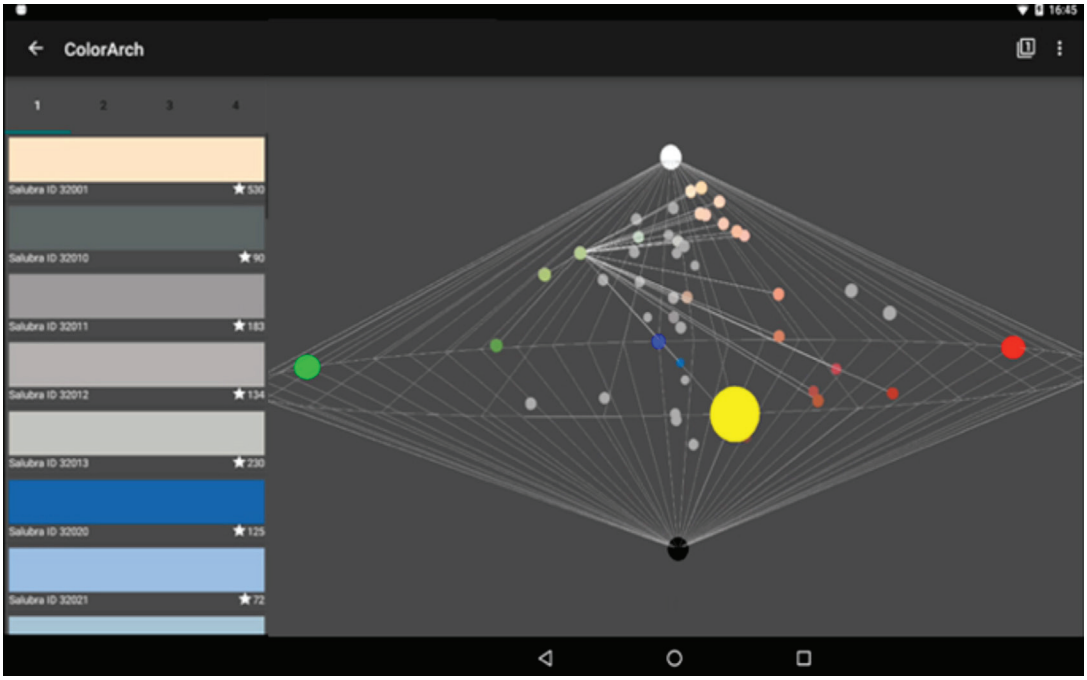

Figure 1. Screen shot of the ColorArch App interface showing the Navigation Drawer with the 63 Salubra colours sorted by preference, and the 3D NCS colour space showing the selected green and all its combinations. See how it works at https://youtu.be/EHq-ib3UsAo

2. REVIEW OF SIMILAR COLOUR-COMBINATION APPS

Certain applications enable users to combine colours to generate personalized colour palettes that can then be outputted to standard design programs. Some of the better known ones are as follows: Adobe Kuler, Paletton, NCS Navigator tool or Coolors. Other applications allow users to create a colour palette from a photograph, such as: Photocopa or Copaso. There are also specialized paint business applications where you can colour the interior of virtual space or photograph: Tollens, Bruguer Visualizer, Valentine colour planner, etc.

Nevertheless, said applications organize the colours according to the laws of contrast and harmony based on the classical theories of colour, but not on the aesthetic sensitivity of an internationally acclaimed architect and with buildings that can attest to it. Furthermore, there are no Apps like ColorArch that allow you to combine colours in 3D. Although colours are always described in variables of perception (tone, saturation and luminosity), the applications that combine colours can only do so with 2D drawings, and enable users to modify the variables individually, or two by two, but never simultaneously and in three dimensions.

In addition, the colours in other Apps appear in sRGB (screen colour) format, or even in the colour notation of the paint company itself. sRGB cannot be considered a "stable" colour space because it varies from one viewing device to the next, the graphics card, colorimetric purpose and other colour-management factors. The use of a standard colour notation system (NCS, Munsell, etc.), irrespective of the device, enables users anywhere in the world to get the exact colour supplied by any company for any support.

3. DESCRIPTION OF THE COLORARCH APP

ColorArch allows users to select a combination of colours following a set of criteria employed by a renowned architect and presently the Le Corbusier module is available. The application facilitates an accurate colour notation using a standard notation system such as the NCS (Natural Colour System), which enables one to standardize colour to such an extent that the end user can approach a supply company and be assured of a perfect match between the selected colour and that employed by the referred architect. The accuracy of the colour notation has been attested to in earlier research, studying the original colours and measuring them with the help of specialized equipment. In the case of Le Corbusier, taking measurements with the help of a Konica Minolta CM 100spectrophotometer at the Le Corbusier Foundation in Paris from the original colour charts conserved there.

Upon opening the application, users can select the architect/designer of their choice and the colours to be used. In the case of Le Corbusier, users can select from a drop-down menu in a "Navigation Drawer" one of the 43 Salubra 1931 colours. Le Corbusier suggested combining 3 or 4 colours from 13 colour charts called "colour keyboards", for their similarity to a piano. Each one of these "colour keyboards" received its own name to identify it: wall, sky, space, etc.

Selecting one of the colours, all colour combinations where that colour is present appear, sorted in order from most to least preferred by Le Corbusier. A text shows the name of the colour in the original Salubra notation and optionally in NCS. In addition, it provides the name of the keyboard to which that colour combination belongs. The Navigation Drawer can be tucked away to one side to enable users to navigate through a 3D model that represents a colour space. The 3D model can be navigated and enables users to select any of the 43 spheres. Upon doing this, a series of lines indicate the colours with which said colour can be combined. The rest of the spheres appear "deactivated" and greyed out. By moving the 3D model, users can evaluate the preferred colour combination criteria of Le Corbusier.

4. DISPLAY OF THE SALUBRA COLOUR COMBINATIONS

Viewed straight on, the 3D model enables users to see if Le Corbusier preferred to combine colours with others of a similar blackness, using a harmonic criteria based on "high colour ranges" (light colours), "low colour ranges" (dark colours) or "medium colour ranges"; or whether he was looking for chiaroscuro contrast between the selected colours. Viewed from above, the model gives users an insight into whether the architect in question preferred to combine colours with others of a similar chromaticity or brilliance (equidistant from centre of the colour wheel), or contrasted with regard to the chromaticity (at unequal distances from the centre of the colour wheel). Viewed from above, the model also enables users to understand if Le Corbusier preferred to combine colours with others of a similar tone, in other words with similar angular distances from the centre of the colour wheel, or on the contrary, with colours from the other side of the colour wheel. For the latter, users can see the use of complementary colour combinations such as red-green, yellow-violet, blue-orange, or conversely, cold-warm colour contrasts etc.

5. CONCLUSIONS

ColorArch is an App developed in Android that can be downloaded free of charge from Google Play and facilitates the work of architects, designers and end users when deciding on the finishes for a building, following the rules of colour combination attested to by icons from the world of architecture. In this way, the colour sche-

mes of the great master architects become universally available, are normalized, and are at the finger tips of the general public.
From an educational perspective, even today there are still too many professionals who are unaware that modernist architecture did not exclusively use the colour white. It is essential that the colour schemes used by the modernist masters are put into the spotlight in order to guide professionals when making colour-based decisions. And ColorArch could be just the ideal tool to do this.

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Sensory compensation media for color detection in the environment

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ABSTRACT

The human visual system consists of a series of complex tasks specific organs for capturing and decoding of color that allows us, among other sensory stimuli interact with the environment around us. However, when we are deprived of the visual stimulus, we are limited in much of our daily tasks. For several authors (Cattaneo & Vecchi, 2011; Kosslyn (1973, 1980, 1994, 2006), Pylyshyn, (1973, 1981, 2003)), lack or deficiency in the functioning of the visual apparatus, does not mean that the subject does not you can respond to a visual stimulus, however, these authors acknowledge the existence of sensory Compensations, i.e., the body derives visual stimuli to other sensory devices. Cattaneo et al. make a review of the most appropriate sensory offs between the other senses (touch, hearing, taste and smell), reviewing previous experiences made with people with total or partial visual impairment, concluding that both stimuli haptic and auditory offset sensorially of best visual stimuli. On the other hand, Kosslyn and Pylyshyn state that, although a person can be prevented from seeing through sensory compensation added to the record of previous experiences, the subject is able to generate pictorial or descriptive imagery.

This research is the result of an initial search to establish possible sensory compensation through the design of technological devices to which I call media compensation. That name is meant as specialized extension that allows ridding the body for performing other tasks (McLuhan (1962, 1964); Hall, (1959)). Both, Hall and McLuhan recognized as technological support a natural extension as both sensory bodies for the subject's interaction with their environment. In this case, preliminary tests hereby focus on the recognition of three basic levels: Color, Form and Distance.

Using techniques and algorithms of Computer Vision, experiences of recognition are performed both video and images in order to recognize certain color ranges, factors that could alter this measurement, the selection of the location of the body where sensory compensation will be made and finally the choice of suitable electronic components to carry out such compensation.

While recognizing color, digital devices, is not new. Various techniques and instruments have been developed with the passing of the years to capture and detection of colors (colorimeters, scanners, etc.) However, when it comes to emulate the functions of the eye in humans, capture conditions must they are conditioned otherwise. Moreover, the choice of components (cameras and sensors) is conditional on performance aspects of hardware and environmental conditions where the capture and detection is performed. This paper reports the first experiences focused exclusively on color recognition and behaviour of the hardware devices in order to reach the most accurate measurement possible.