



# APPLICATION OF COLOR IN LE CORBUSIER'S SWISS PAVILION BASED ON THE 1931 SALUBRA COMBINATIONS

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*'Colour is intimately attached to our being; each one of us has perhaps their colour; if we often ignore it, our instincts cannot be mistaken.'*

*Le Corbusier*

#### APLICACIÓN DEL COLOR EN EL PABELLÓN SUIZO DE LE CORBUSIER A PARTIR DE LAS COMBINACIONES SALUBRA DE 1931

Las combinaciones 'Salubra 1931' son unas cartas de color desarrolladas por el arquitecto suizo Le Corbusier (1887-1965) en 1931. Estas cartas están compuestas por 43 colores y conforman 12 planos de color y 312 combinaciones. Este trabajo tiene como objetivo analizar las 312 combinaciones de color a partir de la creación de renders virtuales del proyecto de 'El Pabellón Suizo' de Le Corbusier para así evaluar las preferencias de color. Otro de los objetivos principales es profundizar en el conocimiento del papel relevante que el color tuvo en la arquitectura del maestro suizo. Para ello, se emplea un proceso riguroso de control del color durante el desarrollo del trabajo hasta obtener una aplicación digital que permita evaluar la percepción de distintos aspectos reseñados por Le Corbusier en sus textos teóricos.

A través de este trabajo, concluimos que las cartas Salubra de 1931 son una herramienta muy importante para entender el pensamiento de Le Corbusier y la manera en que aplica el color a la arquitectura. Además, el factor de las preferencias de color ha dado resultados interesantes que podrán usarse más adelante en futuras investigaciones.

Palabras clave: color; arquitectura; Le Corbusier; Salubra 1931; preferencias de color



#### APLICACIÓ DEL COLOR AL PAVELLÓ SUÍS DE LE CORBUSIER A PARTIR DE LES COMBINACIONS SALUBRA DE 1931

Les combinacions "Salubra 1931" són unes cartes de color desenvolupades per l'arquitecte suís Le Corbusier (1887-1965) en 1931. Aquestes cartes estan compostes per 43 colors i conformen 12 pianos de color i 312 combinacions. Aquest treball té com a objectiu analitzar les 312 combinacions de color a partir de la creació de renders virtuals del projecte de 'El Pavelló Suís' de Le Corbusier per a així avaluar les preferències de color. Un altre dels objectius principals és aprofundir en el coneixement del paper rellevant que el color va tindre en l'arquitectura del mestre suís. Per a això, s'empren un procés rigorós de control del color durant el desenvolupament del treball fins a obtenir una aplicació digital que permeti avaluar la percepció de diferents aspectes ressenyats per Le Corbusier en els seus textos teòrics.

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Paraules clau: color; arquitectura; Le Corbusier; Salubra 1931; preferències de color

#### APPLICATION OF COLOR IN LE CORBUSIER'S SWISS PAVILION BASED ON THE 1931 SALUBRA COMBINATIONS

The "Salubra 1931" is a color chart conceived by the Swiss Architect Le Corbusier (1887-1965) in 1931. It is compound of 43 colors and made of 12 keyboards and 312 color combinations. The aim of this work is to analyse the 312 combinations by creating virtual renders of Le Corbusier's project "The Swiss pavilion" in a way to evaluate color preferences. Furthermore, the main objective is also to delve deeper into the knowledge of the relevant role that color had in the Le Corbusier's architecture. In order to do so, a rigorous process of color control is applied during the development of the work until obtaining a digital application that enables us to evaluate the perception of different aspects outlined by Le Corbusier in his theoretical texts.

Through this work, we have concluded that the Salubra 1931 is an important tool to understand Le Corbusier's thinking and his way to use color in architecture. Moreover, the factor of color preferences has given interesting results that may be used later in further researchers.

Keywords: color; architecture; Le Corbusier; Salubra 1931; color preferences

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## 1.BACKGROUND INFORMATION

### 1.1. COLOR IN MODERN ARCHITECTURE

Color concepts are shaped by many factors, from the memorable color distinctions dictated by visual perception to the specifics of material production, climate, geography, and culture, including the particular dynamics of commercial markets and cultural evolution. This work deals about the condition of modern color, and identifies the key concepts with which it was shaped when the color became an important issue in architecture that helped each project to define and describe its architectural features.

In the latest decades of the history of architecture, color has been usually considered a secondary aspect, but through the 19th and early 20th centuries it became an explicit issue of debate, inspired by the experiments of scientists and motivated by the close interaction among the artistic and architectural avant-gardes. Through that period, discussions about color were integral to the formation of a modern architecture, reaching a point of crisis and conclusion in the (mostly) white walls of the seventies, with an evident blindness towards the colors of the 1920s and 1930s.

Broadly stated, the origins of modern color lie in the nineteenth century with the steady refinement of scientific theories of color perception and the remarkable development of techniques for producing new colors and colorful materials. Previous color practices had been shaped by the limited palette of colors available and constrained by the slower pace of innovation and growth. The new possibilities were encountered on a variety of fronts, and involved a back-and-forth between artists, scientists, and manufacturers.

The revolution in modern painting was directly influenced by their reading of new theories of visual perception and their encounter with new colors and techniques of color production. Architects were involved in their own experimentation, they explored color effects and techniques in projects through the “*century of color*”. The term International Style<sup>1</sup> was first used in 1932 by Henry-Russell Hitchcock and Philip Johnson in their essay titled “*The International Style: Architecture Since 1922*”, which served as a catalogue for an architectural exhibition held at the Museum of

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<sup>1</sup> The Editors of Encyclopaedia Britannica and See Article History, “International Style | Architecture | Britannica.Com,” accessed April 19, 2019, <https://www.britannica.com/art/International-Style-architecture>.

Modern Art in New York. As conclusion of the thought of these authors, we can say that there are three principles that define the new modern architecture: the lack of decoration, the conception of volume instead of a mass and the replacement of axial symmetry by regularity. These principles accompanied by the use of new materials such as steel, concrete or glass, made clearly recognizable the characteristics that a building must meet to be identified as modern<sup>2</sup>.

But if we focus on studying more deeply on the subject of color, according to Johnson and Hitchcock's ideas, in the initial period of the modern movement, "*white stucco was omnipresent*", while evolving this period, we are able to differentiate three trends according to how the color evolves in them. The Neoplasticism developed in Netherlands, as well as the Expressionism developed in Germany, use the primary colors in small areas, while the Purism, which shows its greatest growth in France, color large areas of a more neutral tone. Despite this, we have to recognize that that "*most of the walls were still white.*"

We accept that color plays a role in modern architecture but we must recognize that it usually does so in the form of "flat colors" or homogeneous colors (with no changes in hue, value or chroma all along its surface) or the need to integrate "*the color concepts from the very early stages of the building conception.*"<sup>3</sup>

While some generations of architects have made statements such as "*modern architecture should have no color except for the colors of natural materials, whites or grays*"<sup>4</sup> or trying to "*reach the purity of shapes, color should be rejected to avoid distortions.*"<sup>5</sup> there have been others who have denounced the false belief that modern architecture only used white color. This is the case of the Swiss master, Le Corbusier, whose buildings "*were never white, anyway all*"<sup>6</sup> Le Corbusier puts value on color and encourages us to use it, but always under very specific pretexts. The Swiss

master insists that the introduction of color in an architectural work must be thorough, rigorous and harmonious with what the building wants to express. The color cannot interfere in the architecture, must complete it and help to interpret it. He aims to "reject the colors that can be qualified as non-architectural, better than that, make a research and choose those colors that can eminently be called architectural, and restrict to them"<sup>7</sup>.

"*Color in modern architecture is provided in a consistent manner with the composition of form and space, so we can say that it conforms*"<sup>8</sup> Clear example of this, is the work of Le Corbusier, where the Swiss architect display the colors to emphasize and have more presence in the geometry of the volumes. He tries to transform inner spaces by the color, and he gets it. But the color "*not only conforms, also transforms*"<sup>9</sup> when it is added *a posteriori*. This way to add the color remember us the 19th century color conceptions, which were added a posteriori and not always were consistent with the composition of shapes and it should not be a surprise that Le Corbusier provides colors *a posteriori* in buildings, since Purism considers the idea of form precedes color.

"*Either a priori or a posteriori addition, the fact is that modern architects usually observe the following principle: the color is spread over a whole architectural element (wall, floor, pillar, window, etc.) and does not change its hue, value, or chroma all along the surface.*"<sup>10</sup> The principle of "flat colors" is shared both by Le Corbusier, Rietveld and Taut. Even Johnson and Hitchcock proposed it as a criterion for "modernity," considering that "it is important that the surface is flat, not concave or convex, since otherwise the effect would be colorful and the impression of multi-directional tensions would be lost."

The way in which Le Corbusier understands color and how he tries to make his contribution to this topic in modern architecture, is focus on the perceptions of colors. Instead of being interested just in the color and his applications, he puts on value how each color is perceived. Le Corbusier is training and studying the possibilities that could be generated by color in his emerging and recognized architecture. In 1931, the Swiss master developed an original color chart collection for

<sup>2</sup> Hamed Niroumand, M.F.M. Zain, and Maslina Jamil, "Modern Architecture in the 21st Century," *Advanced Materials Research* 457–458 (January 2012): 403–6, <https://doi.org/10.4028/www.scientific.net/AMR.457-458.403>.

<sup>3</sup> Juan Serra, "The Versatility of Color in Contemporary Architecture," *Color Research & Application* 38, no. 5 (October 1, 2013): 344–55, <https://doi.org/10.1002/col.21734>.

<sup>4</sup> José Luis Caivano, "Research on Color in Architecture and Environmental Design: Brief History, Current Developments, and Possible Future," *Color Research & Application* 31, no. 4 (August 2006): 350–63, <https://doi.org/10.1002/col.20224>.

<sup>5</sup> Teresa. Táboas Veleiro, *El Color En Arquitectura* (Edici3n do Castro, 1991).

<sup>6</sup> Cramer N. It was never white, anyway. *Architecture* 1999;88:88–91

<sup>7</sup> Arthur Rügge, *Polychromie Architecturale : Le Corbusiers Farbenkavaturen von 1931 Und 1959 = Le Corbusier's Color Keyboards from 1931 and 1959 = Les Claviers de Couleurs de Le Corbusier de 1931 et de 1959*, n.d.

<sup>8</sup> Serra, "The Versatility of Color in Contemporary Architecture."

<sup>9</sup> Serra.

<sup>10</sup> Serra.

architecture which is completed in 1959 with a second version. These color pallets are named "Salubra 1931" and "Salubra 1959". The ones from 1931 are known as "*Les Claviers de Couleur*" which means "keyboards of color".

<sup>11</sup> Fig. 1



<sup>12</sup> Fig. 2



## 1.2. STUDY OF SALUBRA COLOR KEYBOARDS AND THEIR COMBINATIONS

"Modern architecture developed between 1920 and 1960 was erroneously identified with the almost exclusive use of white color, and it was exemplified with the Purist architecture of Le Corbusier"<sup>13</sup>. Le Corbusier decides to study deeply the architectural color, but his intention was not to predict the human answer to the color combinations, he tries to establish his own criteria in a specific color grouping, based on his personal preferences. That is the reason why, in 1931, the Swiss Salubra Wallpaper Company, commissioned him to make a first color chart collection for architecture which is completed in 1959 with a second version. The first of these collections was thought as a harmonic series, in a similar way to the distribution of the sounds in a piano, and hence its designation as *claviers de couleurs*<sup>14</sup> In 1997, both color collections, Salubra 1931 and 1959, are reissued together with Le Corbusier's unpublished text *Polychromie architecturale*<sup>15</sup>, dated between late 1932 and early 1933. This is, without doubt, the most important document for understanding the color in the work of the Swiss master.

We focus on the first Salubra color collection from 1931, which is the culmination of the reflection on Purist polychromy and the searching for harmony laws. The second collection contains significantly fewer colors, and the most important difference between first version (1931) and second one (1959), is that in the latest one there is not a combination criterion for selecting colors.

Le Corbusier does not conceive the Salubra 1931 charts as an open system that could serve to combine any color of nature. Instead they are a sort of manual, very well delimited, with only 43 colors, which all have guarantees to be "appropriate for architecture" and which he determines how to combine them.

<sup>11</sup> Fig.1. The colour keyboards of 1931. <https://www.lescouteurs.ch/en/the-colours/colour-keyboards/>

<sup>12</sup> Fig.2. The colour keyboards of 1959. <https://www.lescouteurs.ch/en/the-colours/colour-keyboards/>

<sup>13</sup> Juan Serra, "Il Mito Del Colore Bianco Nel Movimento Moderno | Juan Serra - Academia.Edu," accessed April 21, 2019, [https://www.academia.edu/3521991/Il\\_mito\\_del\\_colore\\_bianco\\_nel\\_Movimento\\_Moderno](https://www.academia.edu/3521991/Il_mito_del_colore_bianco_nel_Movimento_Moderno).

<sup>14</sup> Serra, "The Versatility of Color in Contemporary Architecture."

<sup>15</sup> Rüegg, *Polychromie Architecturale : Le Corbusiers Farbenklaviaturen von 1931 Und 1959 = Le Corbusier's Color Keyboards from 1931 and 1959 = Les Claviers de Couleurs de Le Corbusier de 1931 et de 1959*.

The first Salubra collection of colored papers has 12 different color charts named claviers, and provides an exact criterion to choose them, in groups up to four colors. Each one of them consists of three background colors that we will name *valeurs de fond* by following Le Corbusier's nomenclature, and two horizontal strips of color tones placed in a sequence that resembles a keyboard. To facilitate the selection of colors, charts are accompanied by two white cardboards which allow isolating two *valeurs de fond* together with one or two color tones, so that the selected colors, with a maximum of four, should be observed isolated with a white cardboard. The fact that the cardboards are white is not a chance, and we will insist on the importance of white as a previous color, necessary for the architectural polychromy in Le Corbusier's thinking.<sup>18</sup> After extracting all possible color combinations in the collection, it is ended up being 312 combinations of four colors (1248 pairs of colors). In the different color charts, it seems evident that the *valeurs de fond* give the "pitch" to each clavier, and they are somehow linked to the names that identify them: Space; Sky; Velvet I and II; Masonry I and II; Sand I and II; Landscape; and Checkered I, II, and III. By means of an associative mechanism, the *valeurs de fond* are linked to a concept, an idea of secondary order. Thus, the blue colors are associated with the concepts of "Sky" and "Space," the ochre colors with the "Sand," the red ones with "Masonry," and the green ones with "Landscape."<sup>19</sup>

Each colour of wallpaper from the collection should be used to 'paint' the architecture, but that did not mean that all combinations were equal. Each keyboard had a fixed pattern of fundamental tones and colour keys. As a result of the design of the keyboard, in other words, of the choice and ordering of the fundamental tones and the colour keys - as well as the use of the template - Le Corbusier determined that certain combinations could occur while others could not.

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<sup>18</sup> Rüegg, *Polychromie Architecturale : Le Corbusiers Farbenklaviaturen von 1931 Und 1959 = Le Corbusier's Color Keyboards from 1931 and 1959 = Les Claviers de Couleurs de Le Corbusier de 1931 et de 1959*. Rüegg.

<sup>19</sup> Juan Serra et al., "Color Combination Criteria in Le Corbusier's Purist Architecture Based on Salubra Claviers from 1931," *Color Research and Application* 41, no. 1 (2016): 85-100, <https://doi.org/10.1002/col.21940>.

### 1.3. STUDY OF THE TEXT "POLICHROMIE ARCHITECTURALE" BY LE CORBUSIER

*'The polychrome organization of a building, in other words, the colour scheme applied to certain specific walls and spaces, remains obscure if one does not know the criteria and way in which Le Corbusier conceived and divided his colours'*<sup>20</sup> For Le Corbusier, the way in which the distribution of colors in a building finally formed was completely different from the first way in which the design of the building appeared on the drawing board. The physical presence of the architect and the direct visibility of the architecture were the most important instruments in determining the color. These are the ideas that Le Corbusier expressed in his text 'polychromie architecturale'.

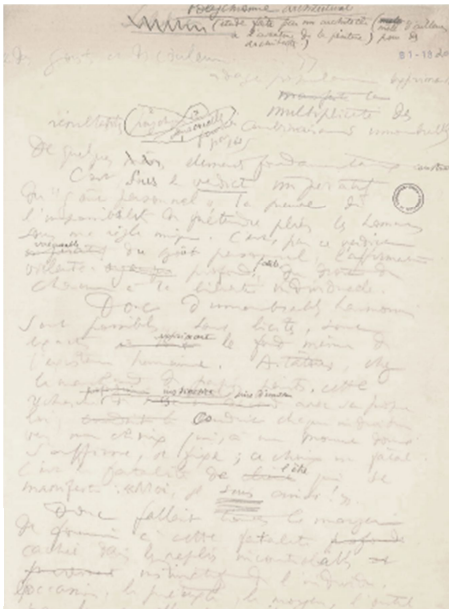
The text 'polychromie architecturale' was written by Le Corbusier, but for unknown reasons, it was never published during Swiss master's lifetime. In the archives of the Foundation Le Corbusier, there are two versions of the text, one written by hand and the other typed. The original version is just a manuscript, but some corrections and additions have been made to the typed version, giving an explanation of the colour keyboard of the Salubra wallpaper. The 'definitive' typed version, was first time published in a book entitled *'Kleur en architectuur'* by Jan de Heer. The same text appeared in English, French and German in the book *'Le Corbusier, Polychromie architecturale'* by Arthur Rüegg in 1997.

We do not know when is dated the first original version, nevertheless it seems to have been written as an introduction to the Salubra wallpaper, and therefore must have been written toward the end of 1931, the time at which the first Salubra collection appeared. This text entitled 'Salubra' and outlined by Le Corbusier, pretends to address the dilemma of wallpaper selection. There are two widespread opinions about the color selection criteria. On the one hand, it is lawful to think that the customer should have the freedom to choose the color according to their tastes. But on the other hand, the color must be chosen with wisdom, taking into account the understanding and the requirements of the architecture. These cultural considerations about polychromies in architecture were valued by Le Corbusier. Based on this topic the additions to the manuscript were undoubtedly written in at least three more stages. These later elaborations and improvements did produce the

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<sup>20</sup> Jan de Heer and George. Hall, *The Architectonic Colour : Polychromy in the Purist Architecture of Le Corbusier* (010 Publishers, 2009), p.120

21 Fig.3



most detailed article by Le Corbusier on architectonic use of colour, but the conciseness of the 'source' text had vanished.

In its ultimate form, 'Polychromie architecturale' consists of four sections without a title or numbering. The first one consists in an extensive introduction, where the original 'Salubra text' is opening. The second section tries to deepen the importance, and above all, the meaning that polychromy has in relation to architecture. Next section is a list of three most important examples of polichromie in his own work. And finally the text concludes with the last section as an explanation of the future functioning and intention of Salubra Keyboards. Nevertheless, what should be noted in this text, is that it is not simply an introduction to the Salubra letters, the text tries to show the wisdom in the use of color from years of experience and study. Above all, it motivates the commercialization of architectural polychromy as wallpaper.

The limitations of the Salubra collection palette are motivated directly in the introductory section to 'Polychromie architecturale' to answer the dilemma between the customer choice of wallpaper and the laws of architecture. *'The urge toward systemization thus emanated from, on the one hand, the laus of architecture and, on the other, the internal necessity to find a system for colour as had been earlier expressed in the desire for a piano*<sup>22</sup>. That idea is where we can find the difference between 'Polychromie architecturale' and the rest of previous texts about colour choice. Even though it can be observed that there are substantial differences between the gammas in Purist painting and the colour choice in the Salubra collection, could we say the criterion for the colour choice in 'Polychromie architecturale' resembles that in 'Le purisme'. Purism assumed a painting style to work with volumes, and looked for colors that would do that persecution full justice. Three gammas were defined but a clear preference for the large gamma was always expressed. In a way, the same thing happens with "Polychromie architecturale", where the criterion for the choice of color was determined. Also from some restrictions that the architecture imposes on the color, one works with a gamma as main and two more as complementary. This gives a constant feeling of variation, but it really works on a main gamma, as in purism.

<sup>19</sup> Fig. 3. Manuscript of 'Polychromie architecturale' Fondation Le Corbusier B1-18-20-001, 1933

<sup>22</sup> Jan de Heer and George. Hall, *The Architectonic Colour : Polychromy in the Purist Architecture of Le Corbusier* (010 Publishers, 2009), p.144

Le Corbusier wrote in the fourth section of 'Polychromie architecturale', that, for the Salubra palette, the 'noble range' had been selected, with the following colours: white, black, ultramarine, blue, English green, yellow ochre, natural terra-sienna, a vermilion, a carmine, English red, and burnt terra-sienna. In the Salubra keyboards themselves, two umbra colours appear to have been added to this series, whereas black was absent, having made way for a dark-grey. White was also missing. With this distinction between colours and values, extending from white to black, Le Corbusier seems to mean the range of lightness of a colour. From the infinite series of lightnesses of a colour, he chose a number of expressive samples, and accommodated these in the Salubra palette. In the fourth section, he wrote: '*And for each of these tones, I researched, from the mural point of view, the most efficient values.*'<sup>23</sup> We can say that Le Corbusier was able to recognize a relationship between architectural laws and the differentiated luminosity of color. '*The full colours in the palette display strong mutual differences in terms of lightness*'<sup>24</sup> We see in Le Corbusier an interest in understanding the play of light and shadow. We know that when applying a color in a plane on which no light is shed, the shadow will darken that color and appear mixed with black, and the intention of the Salubra keyboards was to take into account all these considerations.

But apart from the treatment of light, it should be noted that some colors appear as main. The Salubra collection contains 43 colors, all of them derive from 14 initial colors, which we could call main colors. '*From each one of these main colors, Le Corbusier obtained several extra nuances by adding white pigment and moving the main colors to a softer version with just three or four steps*'.<sup>25</sup> Therefore, we find groups of colors that had been originated from the same main color, and we will say that belong to the same pigment-hue family. With the aim of ordering and classifying these families of colors, each original color from the Salubra Keyboards is provided with a numeric identifier of three numbers, corresponding with the main colors and resulting in a total of 14 pigment-hue families. '*Selecting these 14 pigment-hue families and not any other, Le Corbusier wants to avoid colors that are not fully "architectural" which can neutralize the visual effect of architectural forms*'<sup>26</sup>. Conveniently, Le Corbusier tends to combine the greens with the blues and browns and oranges with the reds.

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<sup>23</sup> Rüegg, *Polychromie Architecturale : Le Corbusiers Farbenklaviaturen von 1931 Und 1959 = Le Corbusier's Color Keyboards from 1931 and 1959 = Les Claviers de Couleurs de Le Corbusier de 1931 et de 1959.*

<sup>24</sup> Heer and Hall, *The Architectonic Colour : Polychromy in the Purist Architecture of Le Corbusier.* p.145

<sup>25</sup> Serra et al., "Color Combination Criteria in Le Corbusier's Purist Architecture Based on Salubra Claviers from 1931."

<sup>26</sup> Serra et al.

For the Swiss master, blue and red formed an essential pair in his color system, not only because of the optical effect, but also because of the sensations that each of these colors produces psychologically. He defends that blues and greens, colors of nature, transmit peace, order, tranquility, rest... while the warmer tones, reds, make us feel the strength, action, power.

### PSYCHOLOGICAL ASPECTS

One of the most important topics that 'Polichromie architecturale' contains, is the question concerns the origins of the idea for the color 'keyboard'. To answer this question, of course we have to analyze the relationship between painting and music. '*Color is the keyboard, the eyes are the harmonies, the soul is the piano with many strings. The artist is the hand that plays, touching one key or another, to cause vibrations in the soul*'<sup>27</sup> was said by Kandinsky who thinks that color also had the ability to put viewers in touch with their spiritual selves. He believed that yellow could disturb, while blue awakened the highest spiritual aspirations.

The terms of tone and harmony that are used to define colors and their relationships have been inherited from music. Due to the existing relationships between the different sensory modalities analogies can be established between the visual and musical tones for thinking in the aesthetic experience. The analogy with music and the search for this aesthetic experience, is what leads Le Corbusier to seek harmony in the relationship between colors. And that search for harmony, that interest in the emotions that color causes in people, leads us to one of the most important themes of the text 'Polichromie architecturale', the associative character of color, '*evocative nature, always symbolic*'<sup>28</sup> character.

We can conclude that '*in 'Polychromie architecturale', 'colour was situated on the side of subjectivity, of the associative, of the instinctive. And perhaps we ought to understand from this that polychromy in*

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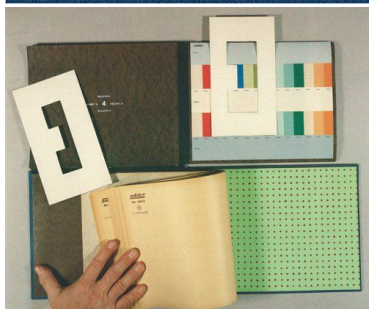
<sup>27</sup> Wassily Kandinsky and Michael Sadleir, *Concerning the Spiritual in Art* (Dover Publications, 1977).

<sup>28</sup> 1887-1965. Le Corbusier et al., *Le Corbusier before Le Corbusier : Applied Arts, Architecture, Painting, Photography, 1907-1922* (Yale University Press, 2002). <https://store.bgc.bard.edu/le-corbusier-before-le-corbusier-applied-arts-architecture-painting-and-photography-1907-1922-edited-by-stanislaus-von-moos-and-arthur-ruegg/>.





<sup>29</sup> Fig.4



<sup>30</sup> Fig.5

the lyricism of architecture of the 'Five points' immediately intervened in sentiment' <sup>31</sup>. In the words of Le Corbusier, leaving aside the play of light-dark, the correction of volumes through color and the laws of architecture, the Swiss master said: 'Colour is intimately attached to our being; each one of us has perhaps their colour; if we often ignore it, our instincts cannot be mistaken.' <sup>32</sup>

But despite this subjective character of which the Swiss master endows color, he is not really worried about the preferences. In his way of understanding the discipline the most important fact was to settle what he considered an architectonic palette distant from subjective preferences by the owners or final users. He invented these pianos to be used in architecture and not to be observed or evaluated in an abstract vision on a screen. He argues: 'To the legitimate claim of the client that "there is no accounting for tastes..."', the architect replies "all right, but I will keep you in the architectural plan of which I measure, more or less consciously, the realities", <sup>33</sup> That's why we doubt about the usefulness of using Le Corbusier's colours to ask for preference. Maybe to find the point of working for Le Corbusier we should look for the terms that Le Corbusier used in his famous text Polychromie Architecturale, and ask observers about this specific questions that the Swiss architect was worried about. Throughout the text we find the following adjectives, expressions and statements that bring us closer to the thinking of the Swiss teacher.

*Richness, opulence* <sup>34</sup>

*Signification* <sup>35</sup>

*Drab, unpleasant, hollow, non-expressive* <sup>36</sup>

<sup>27</sup> Fig.4. Le Corbusier-Polychromie architecturale: Farbenkaviaturen Von 1931 Und 1959 (BIRKHÄUSER) Hardcover Edition

<sup>28</sup> Fig.5. Le Corbusier-Polychromie architecturale: Farbenkaviaturen Von 1931 Und 1959 (BIRKHÄUSER) Hardcover Edition

<sup>31</sup> Heer and Hall, *The Architectonic Colour: Polychromy in the Purist Architecture of Le Corbusier*. p.152

<sup>32</sup> Rüegg, *Polychromie Architecturale: Le Corbusiers Farbenkaviaturen von 1931 Und 1959 = Le Corbusier's Color Keyboards from 1931 and 1959 = Les Claviers de Couleurs de Le Corbusier de 1931 et de 1959*.

<sup>33</sup> Le Corbusier, 'Polychromie architecturale' p.97

<sup>34</sup> Le Corbusier, 'Polychromie architecturale' p.97

<sup>35</sup> Le Corbusier, 'Polychromie architecturale' p.97

<sup>36</sup> Le Corbusier, 'Polychromie architecturale' p.97

*Blue creates space* <sup>37</sup>

*Red fixes the presence of the Wall* <sup>38</sup>

*Blue is calming* <sup>39</sup>

*Red is exciting* <sup>40</sup>

*Light side: warmth, gaiety, joy, violence* <sup>41</sup>

*Shadow side: freshness, serenity, melancholy, sadness* <sup>42</sup>

*Sentimental well-being* <sup>43</sup>

*Strongly characterised colours reveal the character of a society: youthfulness, power, physical action, vitality and optimism* <sup>44</sup>

*At the other extreme, where the mind game predominates (...) The color quits its din, goes out, even disappears totally, grey, indifferent install: calm, serach for calm, need of calm* <sup>45</sup>

*The serach for space, for light, for joy, for strength, for serenity, invites us to call for color, daughter of light* <sup>46</sup>

*Blue acts on the body as a calmativie, red as a stimulant. One is rest, the other is action. (..)*

*Blue- space, red-fixity of the plan* <sup>47</sup>

*Something softened, calmed, entrancing* <sup>48</sup>

*Colour expresses life* <sup>49</sup>

*To choose, one has to feel not successively, but synchronically. To choose, one has to see what it is about and the eye has to be like an agile tool in the serve of a deep instinct* <sup>50</sup>

*Satisfaction, effusion* <sup>51</sup>

*Serene or happy atmospheres. Not sad.* <sup>52</sup>

*Space, Sky, Velvet, Sand, Wall, Landscape.* <sup>53</sup>

*In the palette named "checkered" one should not look here for order or intention but content oneself with finding in it arbitrary meetings, curious, sharp, shoking* <sup>54</sup>

*I had made a selection guided by only architectural preoccupations* <sup>55</sup>

*Satisfaction* <sup>56</sup>

The previous terms give us from Le Corbusier, allow us to ask specific perceptive questions. We can discuss about the sense of distance, atmosphere, etc. In other way is interesting how the name of each palette is linked with the name of the piano: Space, Sky, Velvet, Sand, Wall, Landscape. And of course, how depending on the presence of blue/red our perception of calm/excitement, is diferent. From these terms given by Le Corbusier, maybe we can study ¿The character of a society? Which are the color combinations that better fit with each society country.

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<sup>37</sup> Le Corbusier, 'Polychromie architecturale' p.99

<sup>38</sup> Le Corbusier, 'Polychromie architecturale' p.99

<sup>39</sup> Le Corbusier, 'Polychromie architecturale' p.99

<sup>40</sup> Le Corbusier, 'Polychromie architecturale' p.99

<sup>41</sup> Le Corbusier, 'Polychromie architecturale' p.99

<sup>42</sup> Le Corbusier, 'Polychromie architecturale' p.99

<sup>43</sup> Le Corbusier, 'Polychromie architecturale' p.101

<sup>44</sup> Le Corbusier, 'Polychromie architecturale' p.101

<sup>45</sup> Le Corbusier, 'Polychromie architecturale' p.103

<sup>46</sup> Le Corbusier, 'Polychromie architecturale' p.113

<sup>47</sup> Le Corbusier, 'Polychromie architecturale' p.115

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<sup>48</sup> Le Corbusier, 'Polychromie architecturale' p.119

<sup>49</sup> Le Corbusier, 'Polychromie architecturale' p.131

<sup>50</sup> Le Corbusier, 'Polychromie architecturale' p.135

<sup>51</sup> Le Corbusier, 'Polychromie architecturale' p.135

<sup>52</sup> Le Corbusier, 'Polychromie architecturale' p.136

<sup>53</sup> Le Corbusier, 'Polychromie architecturale' p.137

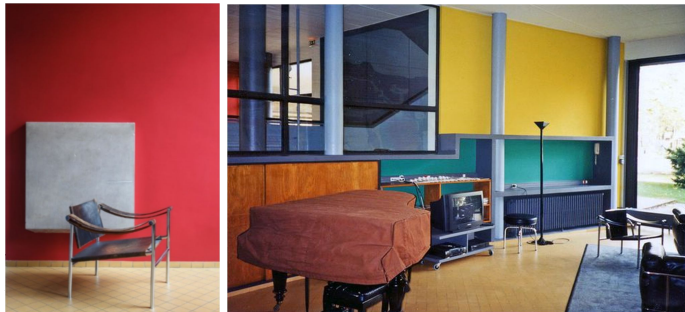
<sup>54</sup> Le Corbusier, 'Polychromie architecturale' p.137

<sup>55</sup> Le Corbusier, 'Polychromie architecturale' p.141

<sup>56</sup> Le Corbusier, 'Polychromie architecturale' p.141



<sup>57</sup> Fig 6,7,8



#### 1.4. STUDY OF THE SWISS PAVILION AND ITS DIFFERENT CHROMATIC PROPOSALS

##### THE PAVILION

'A hand-written page has been added to the typed version of *'Polychromie architecturale'*. This sheet is an insert in the first example entitled *'Colour Modifies Space'*. Here, Le Corbusier discussed the case of a small square room, very probably a student room in the Pavillon Suisse.'<sup>58</sup> There were two buildings from the early 1930s for which Le Corbusier had prescribed the use of Salubra wallpaper: *'the Clarte building'* in Geneva and *'the Pavillon Suisse'* in Paris. We will pay attention to the second one.

The Pavillon Suisse is a housing complex for students in the 'Parisian Cite universitaire'. According to 'Oeuvre complete'<sup>59</sup>, the pavilion was designed between 1930 and 1932. Le Corbusier and his cousin Pierre Jeanneret, made the Swiss Pavilion the testing ground for their vision of collective housing and their theories of contemporary construction: strength of the lower structure in reinforced concrete, industrial prefabrication of the floors, carefully researched sound insulation and a highly functional room layout planned in collaboration with interior designer Charlotte Perriand. The Swiss Pavilion is a building with forty-two rooms for students, a lounge area, an entrance hall, an office and an apartment for the director. The architect's proposals managed to expand this programme a little, particularly by adding ample circulation space. In spite of the limited dimensions 2.8m x 6m, the strength of the design lies in the room layout, furniture and natural light from the south-facing horizontal windows. The rooms are all basically identical despite of the colors. The spatial combinations and architectural expression were very new; they were inspired by the latest concepts and to some extent by the "five points of a new architecture" defined by Le Corbusier and Jeanneret in 1927. Given the difficult ground conditions (the site was formerly a quarry), the architects opted to limit the number of piles (19m deep) for the foundation and to feature this technical aspect by elevating the main building above ground level, on what they called an "artificial ground" supported by the exposed pile foundation. Above the massive pillars in reinforced concrete,

<sup>55</sup> Fig .6.7.8. Photographs of the interior of the Swiss Pavilion. <https://es.wikiarquitectura.com/edificio/pabellon-sui-zi/>

<sup>58</sup> Heer and Hall, *The Architectonic Colour : Polychromy in the Purist Architecture of Le Corbusier*. p. 140

<sup>59</sup> 1887-1965. Le Corbusier et al., *Œuvre Complète* (Birkhäuser, 1999), <https://www.degruyter.com/view/product/200493>.



the floors were built with a lightweight steel frame, clad in brick, artificial stone and abundant glazing.

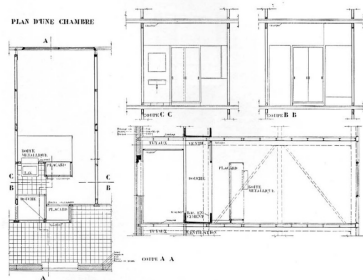
The cell room of the Swiss Pavilion wanted to place itself in the center of the garden, making its occupants part of both the city and the countryside. On the other hand, Le Corbusier bet on hygiene as an element of progress and made an emblem of them his student cells, incorporating the individual shower into them, an unusual case in the habitat and in the hospitality of his time. Le Corbusier understood, then, the interior adequacy of the Pavilion as a true architectural problem. On the one hand, he conceived the fixed elements as furniture-architectures, whose function was to articulate the spaces. On the other, he wanted to make furniture a small scale architecture, either by projecting them or by choosing them for their rationality and for their aesthetics, and complementing them with their own designed furniture, made together with Charlotte Perriand (Barsac 2015). All this gives us a succession of fifteen rectangular rooms per floor, a total of forty-five rooms, each one with approximate dimensions of 3x5,15 m, where each is equipped with a bathroom with shower, a bed, a desk, a bookcase and one panel that divides the spaces.

It is possible to research the architectonic application of the Salubra collection in a little more detail because the studies on the use of color in Swiss Pavilion building have survived. The painted polychromy of the building extends throughout the whole interior. In the archives of the Fondation Le Corbusier, there are four designs for student rooms with polychrome variants from the early 1930s<sup>61</sup>. The floor plan of the storeys shows that the rooms were mirrored two by two, and situated next to one another on the corridor. All sketches were made of a single room, as a central perspective, looking inward from the external wall which was made completely of glass and therefore could remain unpainted. As the intake document shows, the rear wall was dark-grey in every room, the external wall was of glass and the floors of the student rooms were alternately green or brown. It means that three surfaces still remained to be painted, namely, both side walls and the ceiling. Seventeen of the forty-five rooms have the maximum polychrome difference of three differently coloured walls. However, this occurred with some restriction, and with only two exceptions, as only one coloured wall was deemed acceptable in a room in addition to grey and white. In contrast, thirteen rooms were

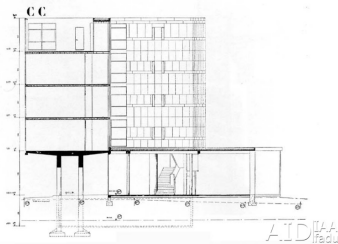
<sup>58</sup> Fig. 9. Photograph of the exterior facade of the Swiss Pavilion.

<sup>61</sup> Heer and Hall, *The Architectonic Colour: Polychromy in the Purist Architecture of Le Corbusier*, p.157

**CU**2686 CHAMBRE TYPE ÉCH. 1:20



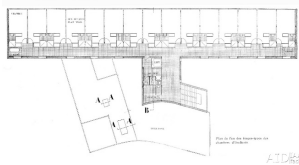
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<sup>62</sup>Fig. 10

<sup>63</sup>Fig. 11

<sup>64</sup>Fig. 12



monochrome grey, disregarding the floor. According to the intake document, the palette for the total project consisted of white, three grey values, three red values, three blue and two green, amounting to twelve colours in total<sup>65</sup>. Apparently the apple of the color was randomly distributed among the rooms, but the question is whether or not the colour schemes support the architectonic ordering. The rooms are placed symmetrically in pairs, it is striking that the thirteen monochrome rooms are the left ones and all rooms that show maximum polychromy are those on the right. Although it seems to be a pattern, it is not strictly enforced so we cannot consider it.

Le Corbusier in his text 'Polychromie architecturale' dedicates a section to dealing with the relationship between color and space to which he titled 'color modifies space' and in which he intimately links the Swiss pavilion. If the four walls are painted the same tone, the form of the room remains intact, instead of that, the form of the room will be totally maintained, revealed, if the ceiling is painted white. If the ceiling is of the same tone as the wall, the impression is totally modified; in words of Le Corbusier: 'I can modify or accentuate the characters at will: these are the very resources of polychromy.'<sup>66</sup> For example, he immersed the room in monochrome grey in order to enclose the room in a dome form, and then he made the ceiling white or 'gris plus pale', so that the space became more transparent. Equally often he assigned the walls various colours so that the room was deformed, room after room. It was as if he wished to install a samples card of all available possibilities throughout the Pavilion.

<sup>60</sup> Fig. 10. Floor plan of the Swiss Pavilion. AID. Archivo de imagines digitales. <http://www.aidfadu.com>

<sup>61</sup> Fig. 11. CU2686: Type plant of student rooms of the Swiss Pavilion. AID. Archivo de imagines digitales. <http://www.aidfadu.com>

<sup>62</sup> Fig. 12. CU2789: Cutting section of student rooms of the Swiss Pavilion. AID. Archivo de imagines digitales. <http://www.aidfadu.com>

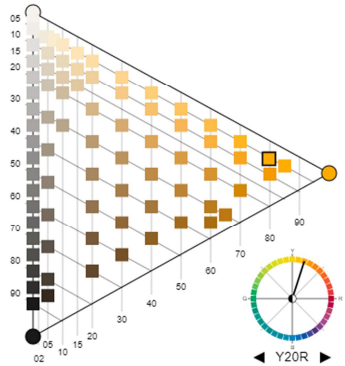
<sup>65</sup> Heer and Hall, *The Architectonic Colour: Polychromy in the Purist Architecture of Le Corbusier. The Architectonic Colour: Polychromy in the Purist Architecture of Le Corbusier* p.158-159

<sup>66</sup> Le Corbusier, 'Polychromie architecturale'

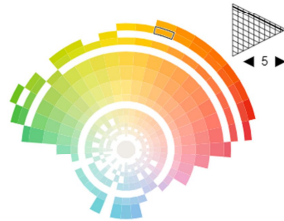
NCS notation



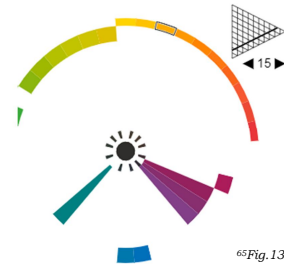
Chromaticness



Blackness



Whiteness



<sup>65</sup>Fig.13

## 1.5. NATURAL COLOR SYSTEM (NCS) COLOR NOTATION SYSTEM

The Natural Color System (NCS), is a visual language of colors, based scientifically on the visual perception of color. *"NCS, Natural Color System, is a way to describe and order, by means of psychometric methods, the characteristic relationships between all possible color percepts of the "surface mode."*<sup>67</sup>

*"The NCS system allows you to describe any imaginable surface colour and be given a NCS-notation. This has made the colour system a global standard for the definition, quality assurance, and communication of colour."*<sup>68</sup> NCS is based on Hering's phenomenological analysis of the characteristic relationships of color percepts and on the postulate of the six elementary color sensations, the *NCS elementary colors*. These have no resemblance to each other-while all other color percepts show more or less characteristic resemblance to them. These varying resemblances, which are possible to quantify, are called *NCS elementary attributes*.

The system starts from six elementary colours, which are perceived by human beings as being "pure". The NCS elementary colors, designated with capital letters, are as follows: White (W); black/Swarthy (S); Yellow (Y); Red (R); Blue (B); Green (G). White and black are called achromatic and the others chromatic elementary colors.

Beginning with the elementary colors, it is possible to construct a three-dimensional descriptive model called the NCS color space, which includes the whole "color world" and makes it possible to describe any conceivable color percept. All imaginable surface colors can be placed and thus be given an exact NCS-notation. For the sake of clarity, it is usually shown in two projections: the color circle and the color triangle.

The NCS color circle shows the hue. By taking a horizontal view through the color space, we see this circle where the four chromatic elementary colors (yellow, red, blue and green) are placed like the points of the compass with the space between them divided into 100 equal steps. The color family

<sup>65</sup> Fig.13. NCS navigator. Natura Color System. <https://ncscolour.com/>

<sup>67</sup> Hård, Sivik, and Tonquist.

<sup>68</sup> "NCS – We're All about Colour," accessed April 21, 2019, <https://ncscolour.com/>.

R90B, for instance, has 90% resemblance to blue and 10% resemblance to red. It is a slightly reddish blue color so it is almost a pure blue color.

The NCS color triangle shows the nuance of a color. It is a vertical section through the color space. Here you find different nuances of the actual blue hue R90B. The base of the triangle is the grey scale from white (W) to black (S) and the apex of the triangle is the maximum chromaticness (C) within each hue, in this case R90B. The chromaticness specifies how strong the color is. Colors of the same hue can have a different blackness, chromaticness or whiteness values, which is different nuances. The scales for blackness, whiteness and chromaticness are divided into 100 steps, which as well as in the color circle can be perceived as percentages. In the triangle is the nuance 1050 selected.

## 2.OBJECTIVES

The aim of this project is to deepen in the knowledge of color in the work of Le Corbusier to put in value the role that color can play in the construction of modern architectural space and its value as an outstanding plastic variable. This research aims to find common characteristics between different chromatic compositional systems in modern architecture, discussing the validity of some widespread ideas about it, such as the creation and application of the Salubra keyboards developed by Le Corbusier.

*Find out the color composition for the Swiss Pavilion*

The first and one of the most important objectives is to find out what were the original colors in which Le Corbusier thought for the Swiss pavilion. We know that the Swiss master develops the Salubra wallpapers with the intention of applying them also in that project. Through bibliographic research we intend to understand how these keyboards would have been applied, which and in what way would each of the combinations be applied.

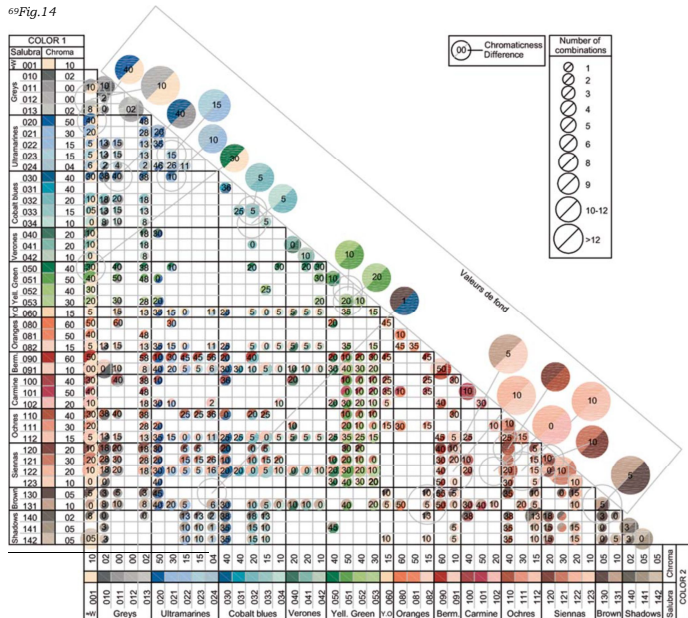
*Development of alternative chromatic proposals for the Swiss Pavilion*

The aim of this work is complete and develop new alternative chromatic proposals for the case of Swiss Pavilion. From the colors proposed by Le Corbusier and their way of combining them, it is intended to general all these combinations according to their criteria and apply them on a three-dimensional model of one of the individual rooms of the Swiss pavilion.

*Creation of a web portal*

To conclude the study, we intend to create a web site where the alternative proposals that we have created based on the bibliographical references of 'Polichromie architecturale' by Le Corbusier are exposed. It is intended with these chromatic proposals already applied to the three-dimensional model, that users from several countries reflect their preferences and see which proposal is more accepted and if this has something to do with the cultural aspect of each user.

Fig.14



### 3.METODOLOGY

To reach the objectives we follow the following methodology:

1. Collection of Data and relevant information about the antecedents

Bibliographic review of the information contained in some of the main databases and repositories, with special reference to the various articles written by Professor J. Serra in collaboration with Y. Gouaich and B. Manav

Documentation of some of the most important modern artistic and architectural movements related to color in Europe.

Meetings with specialists and architects involved in research on color and architecture. Juan Serra Lluich, who is a Titular Professor and Permanent Researcher at the Polytechnic University of Valencia and member of the Color Research Group of the Instituto de Restauración del Patrimonio at the UPV. Yacine Gouaich, who came from *University Abdelhamid Ibn Badis of Mostaganem*, in Algeria and now he is collaborating with *UPV* in the research of polychromy in architecture.

2. Analysis and structure of the information

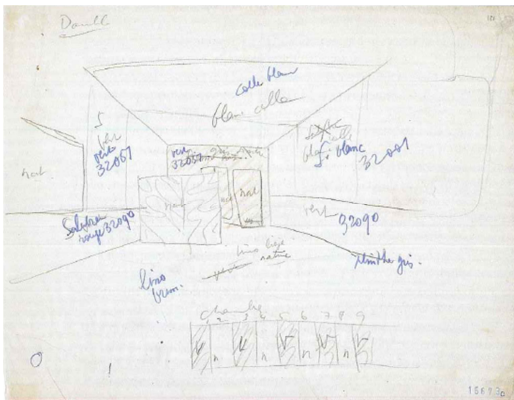
The original colors proposed in the Salubra keyboards by Le Corbusier are identified in a standard color notation system (Natural Color System). Once the colors have been identified, to digitize them, we turn the original colors into the Adobe RGB 1998 color space. NCS Navigator and Pantone Color uncoated tools are used. Once the 43 colors proposed by Le Corbusier have been digitized, a list is made in Excel, where the 312 possible combinations are generated from the system that Le Corbusier proposes to combine them.

<sup>68</sup> Fig.14. All Salubra pairs of colors, showing the NCS chromaticness difference between them. Serra et al., "Color Combination Criteria in Le Corbusier's Purist Architecture Based on Salubra Claviers from 1931."

<sup>69</sup> Fig.15. Pavilion Suisse. Colour design for student rooms. FLC15673C. Handmade sketch by Le Corbusier that has served as a reference for the application of color combinations in this project.



Fig.15



### 3. Selection of a case study

A relevant work of Le Corbusier is selected with respect to the use of color and to be used as a case of study. The Swiss pavilion is considered to be the work in which Le Corbusier himself proposes the use of his Salubra keyboards. Formal and chromatic information is collected regarding the building under study: comments, architect's texts, photographs, etc. Colored elements are also identified. The original colors are identified from previous studies and images of the spaces. It is intended to find the exact or almost exact colors of the building.

### 4. Representation of color using three-dimensional models

Subsequently, a more comprehensive approach is made by redrawing the planimetry of the room. To ensure the understanding of the room on which the chromatic proposals are to be applied, a 3D virtual model is built with the help of AutoCAD computer drawing software. From this work, the three-dimensional model is rendered with the Rhinoceros 3D program, without applying colors, simply with the textures of the materials.

### 5. Color incorporation

Subsequently and from the previously generated color combinations by Excel, these combinations are applied one by one through the Photoshop postproduction program, resulting in 312 images, each possible combination of the Salubra keyboards. We combine those images with the render of the room of the Swiss Pavilion, and finally we get 312 images of the room with the colors combined as Le Corbusier thought.

### 6. Creation of a web portal

A web page is made from the 'Google Forms' platform that allows the creation of a portal to create and analyze surveys. On the website you can see all the color proposals ordered according to the Salubra keyboards. This tool allows us to carry out some studies about color preferences between different cultures, to start between Spanish, Algerian and Turkish. The expected result is a complete study of the psychological aspects that the letters have on groups of people from different cultures belonging to the architectural guild.

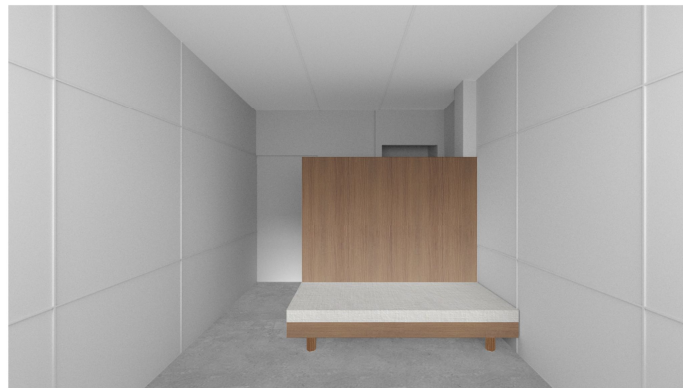
#### 4.RESULTS

Below are all the results that have been obtained throughout the performance of this work. All of them of own elaboration and obtained thanks to all the previous information that has been consulted and that thus appears in the bibliography.

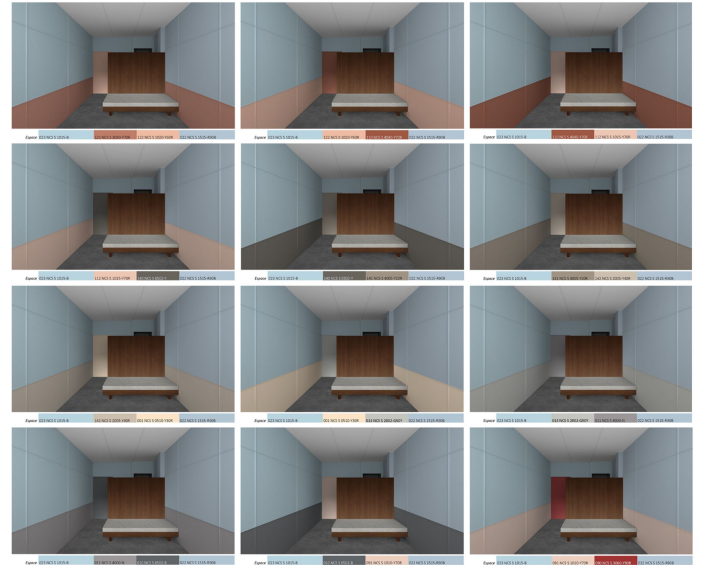
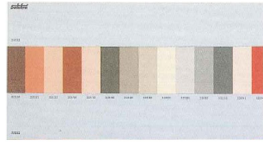
The first part of the results has been extracted from an Excel document previously created and provided to me by Juan Serra with a list of the color combinations of the Salubra cards from Le Corbusier. From this initial Excel document, I performed the task of converting colors from NCS to the RGB color notation system. From this document and with the colors in digital format it has been possible to create the subsequent virtual models.

- List of color combinations from Salubra cards in Natural Color System.....45
  
- Three-dimensional model, drawn with AutoCAD computer drawing software and rendered with the Rhinoceros 3D program, without applying colors.....46
  
- Three-dimensional model, drawn with AutoCAD computer drawing software and rendered with the Rhinoceros 3D program, applying Salubra 1931 color combinations.....47-94
  
- Web portal to evaluate and analyse the color proposals ordered according to the Salubra keyboards <https://lecorbusiercolors.blogs.upv.es/>.....95-100

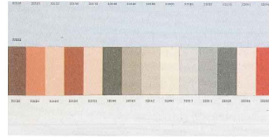
Clavier	Fondo 1	Color ton 1	Color ton 2	Fondo 1
Espace	023 NCS S 1015-B	120 NCS S 6020-Y80R	121 NCS S 3030-Y70R	022 NCS S 1515-R90B
Espace	023 NCS S 1015-B	121 NCS S 3030-Y70R	122 NCS S 1020-Y60R	022 NCS S 1515-R90B
Espace	023 NCS S 1015-B	122 NCS S 1020-Y60R	110 NCS S 4040-Y70R	022 NCS S 1515-R90B
Espace	023 NCS S 1015-B	110 NCS S 4040-Y70R	112 NCS S 1015-Y70R	022 NCS S 1515-R90B
Espace	023 NCS S 1015-B	112 NCS S 1015-Y70R	140 NCS S 6502-Y	022 NCS S 1515-R90B
Espace	023 NCS S 1015-B	140 NCS S 6502-Y	141 NCS S 4005-Y20R	022 NCS S 1515-R90B
Espace	023 NCS S 1015-B	141 NCS S 4005-Y20R	142 NCS S 2005-Y40R	022 NCS S 1515-R90B
Espace	023 NCS S 1015-B	142 NCS S 2005-Y40R	001 NCS S 0510-Y30R	022 NCS S 1515-R90B
Espace	023 NCS S 1015-B	001 NCS S 0510-Y30R	013 NCS S 2002-G50Y	022 NCS S 1515-R90B
Espace	023 NCS S 1015-B	013 NCS S 2002-G50Y	011 NCS S 4000-N	022 NCS S 1515-R90B
Espace	023 NCS S 1015-B	011 NCS S 4000-N	010 NCS S 6502-B	022 NCS S 1515-R90B
Espace	023 NCS S 1015-B	010 NCS S 6502-B	091 NCS S 1010-Y70R	022 NCS S 1515-R90B
Espace	023 NCS S 1015-B	091 NCS S 1010-Y70R	090 NCS S 3060-Y90R	022 NCS S 1515-R90B
Espace	022 NCS S 1515-R90B	120 NCS S 6020-Y80R	121 NCS S 3030-Y70R	024 NCS S 0804-B50G
Espace	022 NCS S 1515-R90B	121 NCS S 3030-Y70R	122 NCS S 1020-Y60R	024 NCS S 0804-B50G
Espace	022 NCS S 1515-R90B	122 NCS S 1020-Y60R	110 NCS S 4040-Y70R	024 NCS S 0804-B50G
Espace	022 NCS S 1515-R90B	110 NCS S 4040-Y70R	112 NCS S 1015-Y70R	024 NCS S 0804-B50G
Espace	022 NCS S 1515-R90B	112 NCS S 1015-Y70R	140 NCS S 6502-Y	024 NCS S 0804-B50G
Espace	022 NCS S 1515-R90B	140 NCS S 6502-Y	141 NCS S 4005-Y20R	024 NCS S 0804-B50G
Espace	022 NCS S 1515-R90B	141 NCS S 4005-Y20R	142 NCS S 2005-Y40R	024 NCS S 0804-B50G
Espace	022 NCS S 1515-R90B	142 NCS S 2005-Y40R	001 NCS S 0510-Y30R	024 NCS S 0804-B50G
Espace	022 NCS S 1515-R90B	001 NCS S 0510-Y30R	013 NCS S 2002-G50Y	024 NCS S 0804-B50G
Espace	022 NCS S 1515-R90B	013 NCS S 2002-G50Y	011 NCS S 4000-N	024 NCS S 0804-B50G
Espace	022 NCS S 1515-R90B	011 NCS S 4000-N	010 NCS S 6502-B	024 NCS S 0804-B50G
Espace	022 NCS S 1515-R90B	010 NCS S 6502-B	091 NCS S 1010-Y70R	024 NCS S 0804-B50G
Espace	022 NCS S 1515-R90B	091 NCS S 1010-Y70R	090 NCS S 3060-Y90R	024 NCS S 0804-B50G
Ciel	033 NCS S 1515-B50G	120 NCS S 6020-Y80R	121 NCS S 3030-Y70R	032 NCS S 2020-B30G
Ciel	033 NCS S 1515-B50G	121 NCS S 3030-Y70R	122 NCS S 1020-Y60R	032 NCS S 2020-B30G
Ciel	033 NCS S 1515-B50G	122 NCS S 1020-Y60R	110 NCS S 4040-Y70R	032 NCS S 2020-B30G
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Ciel	033 NCS S 1515-B50G	112 NCS S 1015-Y70R	140 NCS S 6502-Y	032 NCS S 2020-B30G
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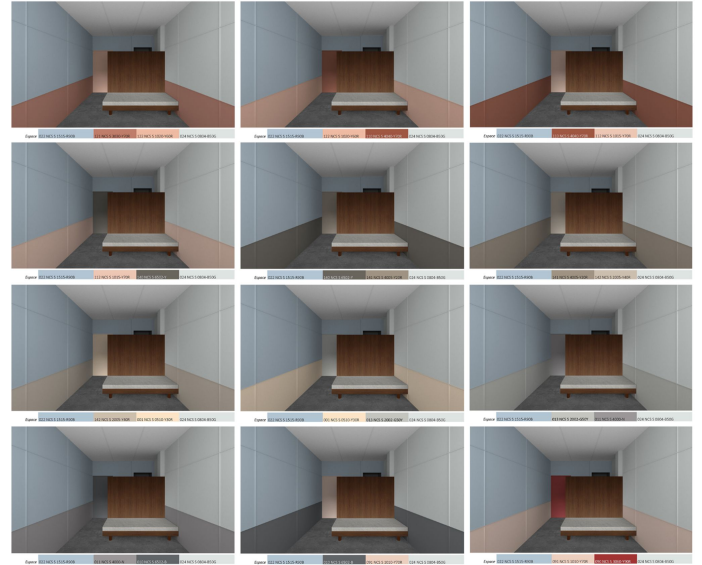
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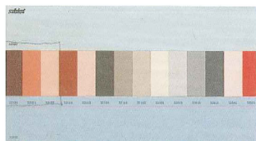
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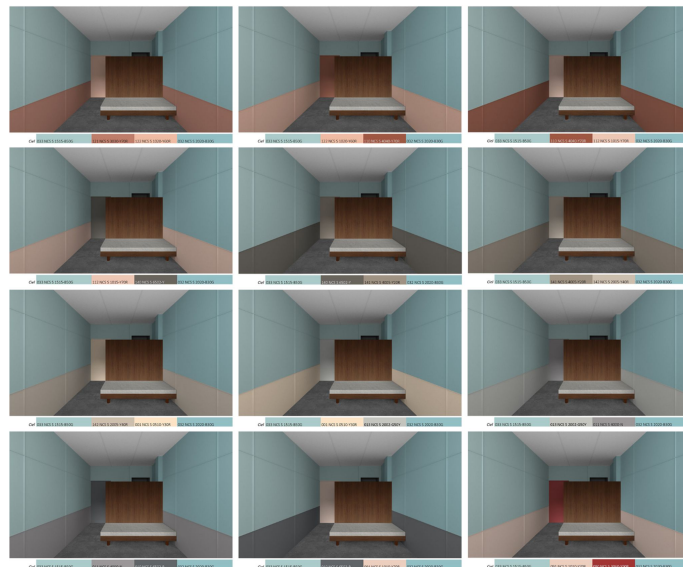
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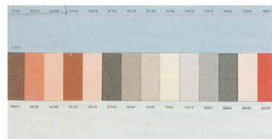
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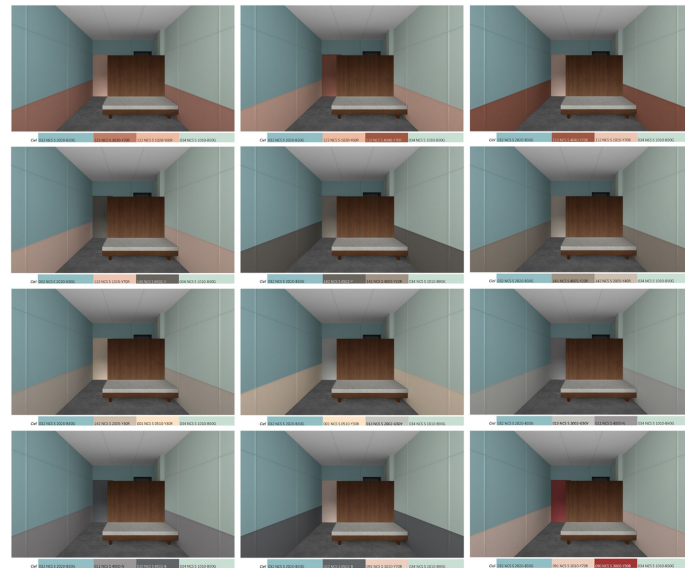
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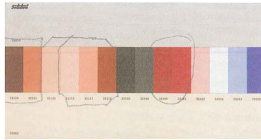


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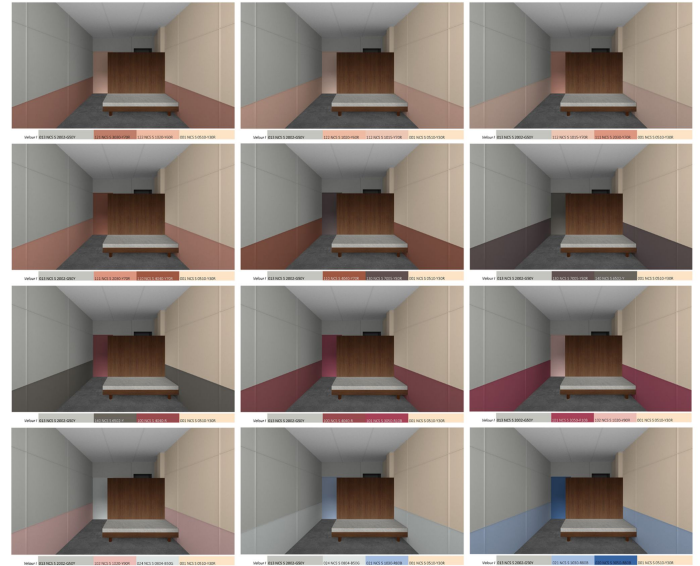




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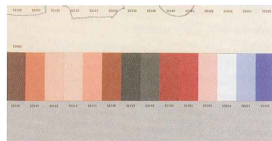


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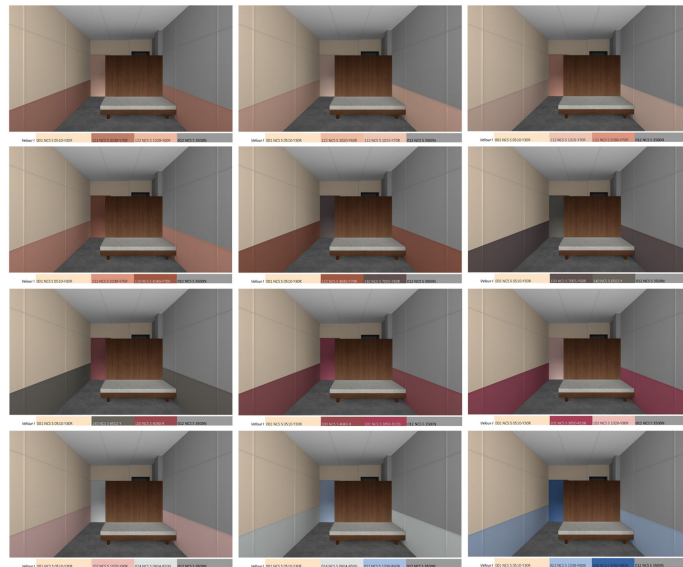




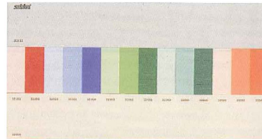
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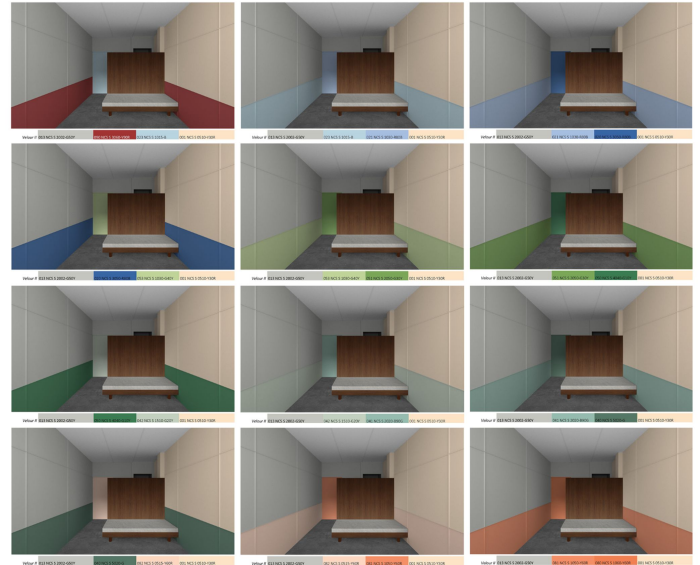
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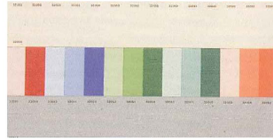
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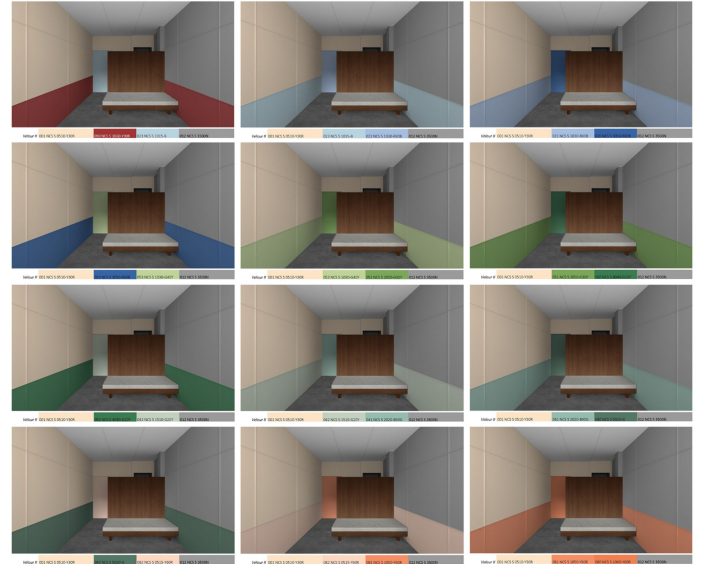
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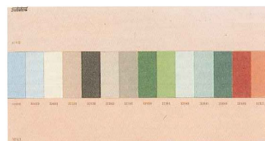
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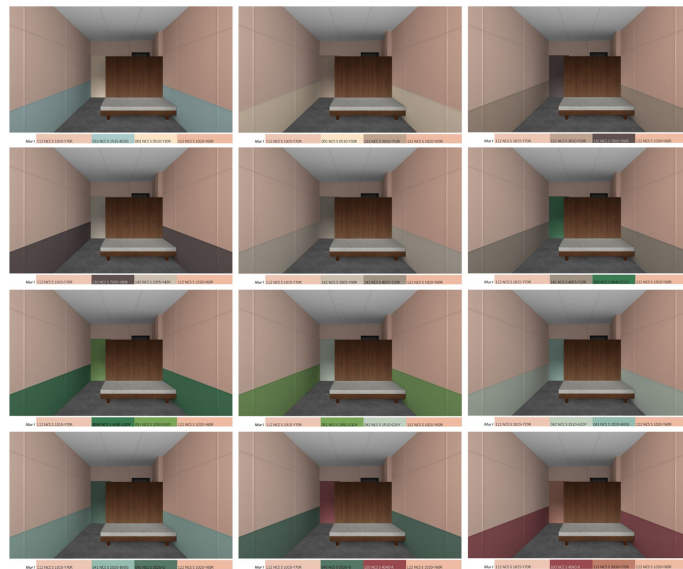
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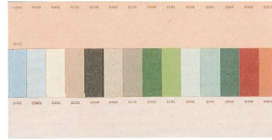
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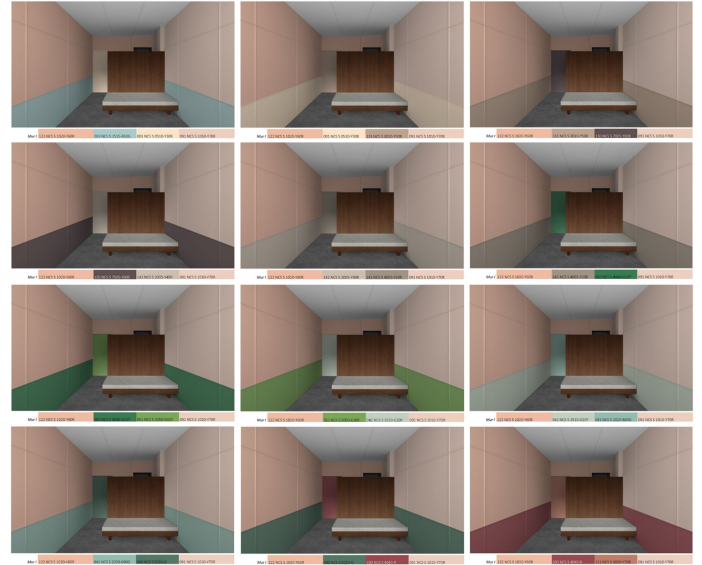
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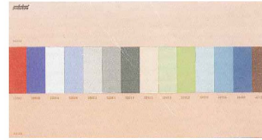
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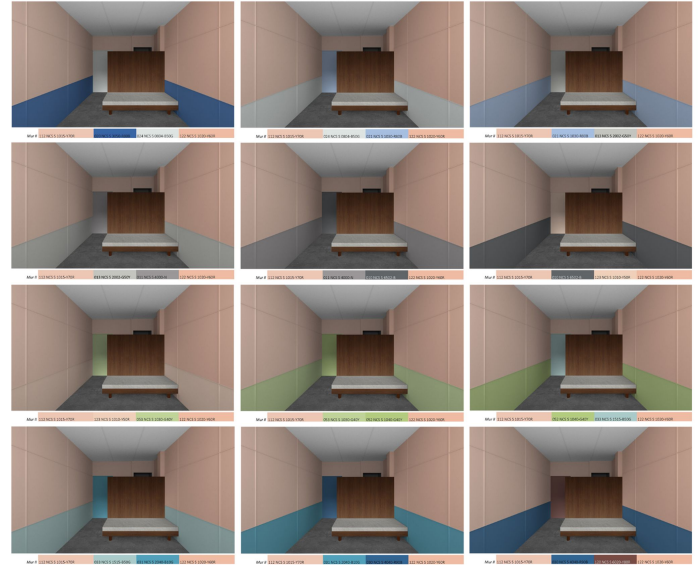
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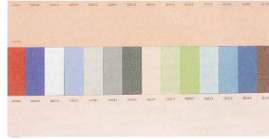


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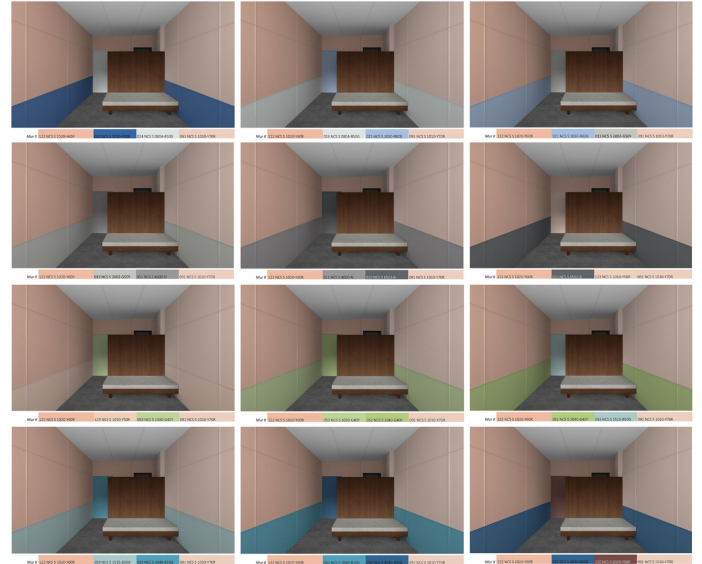




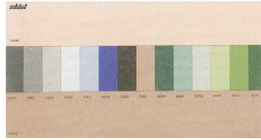
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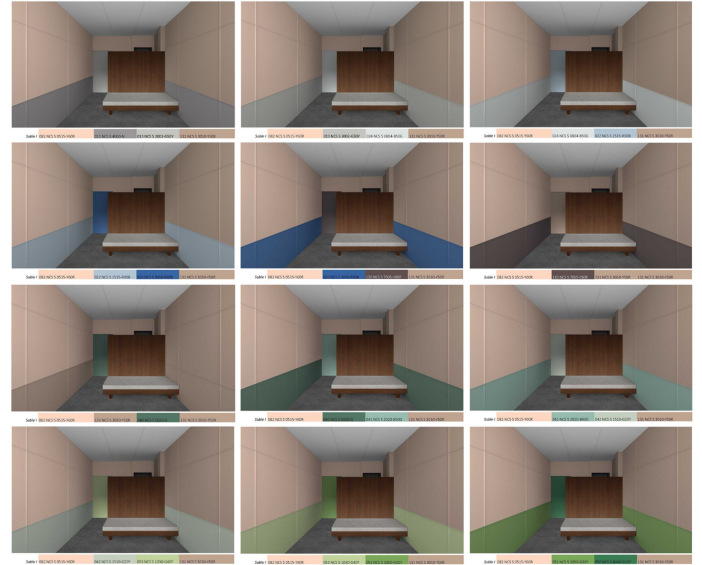
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Clavier Sable I

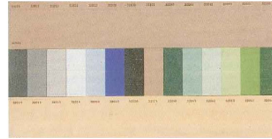


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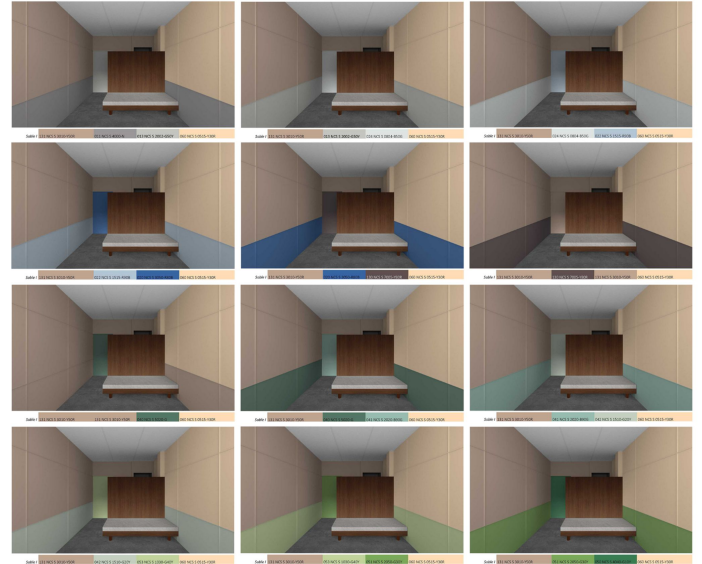




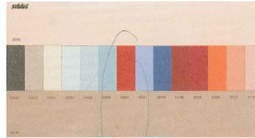
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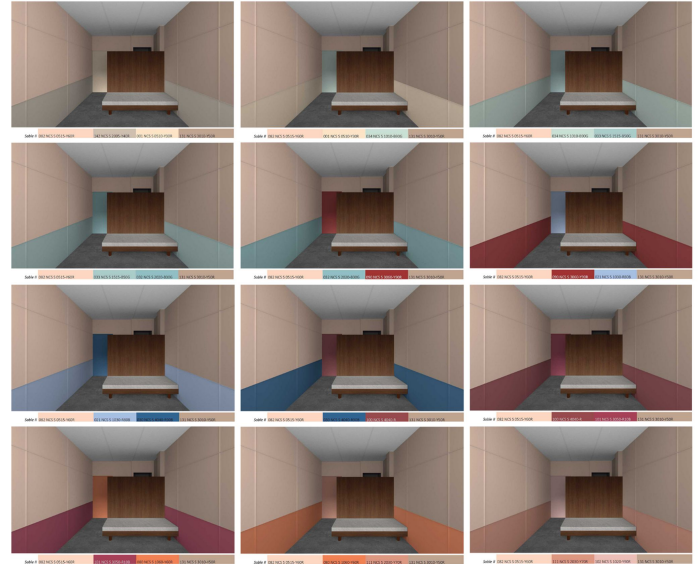
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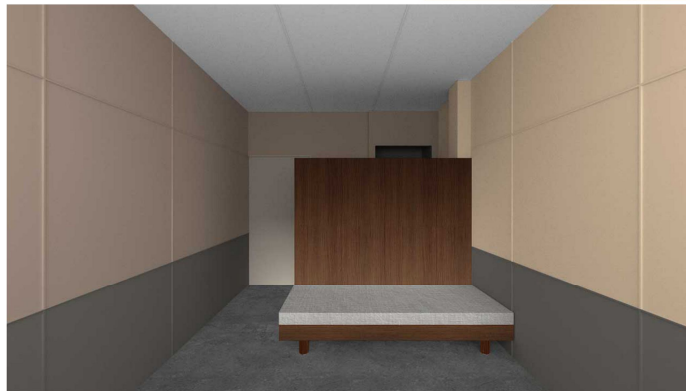
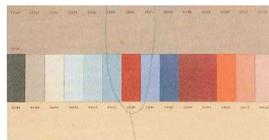
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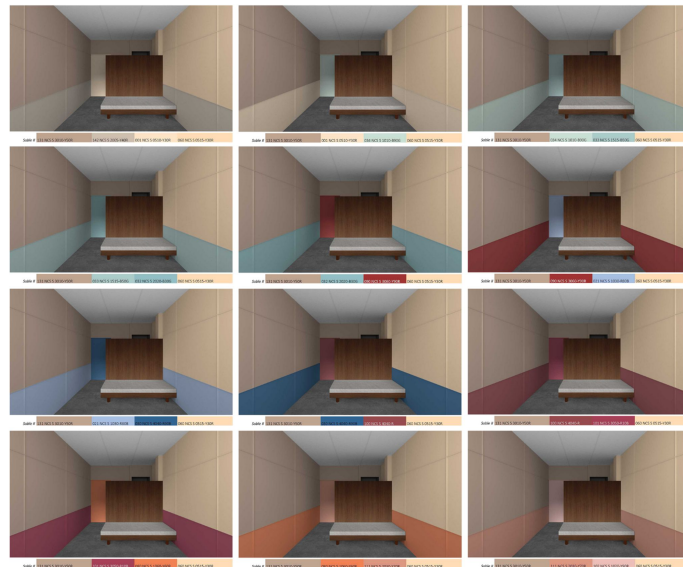
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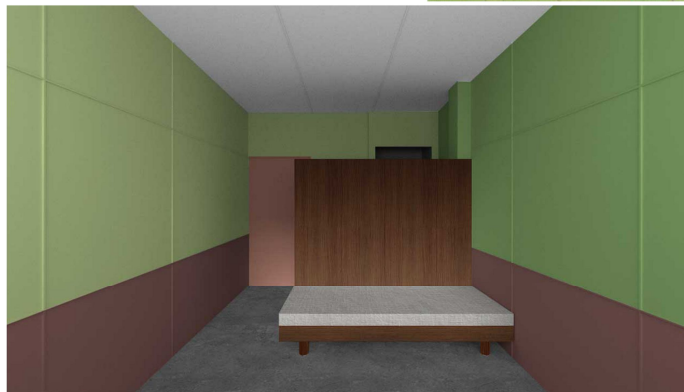
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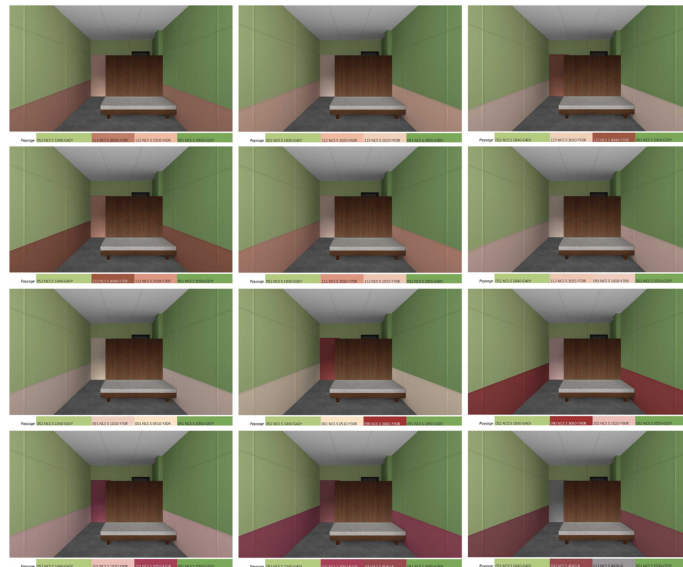
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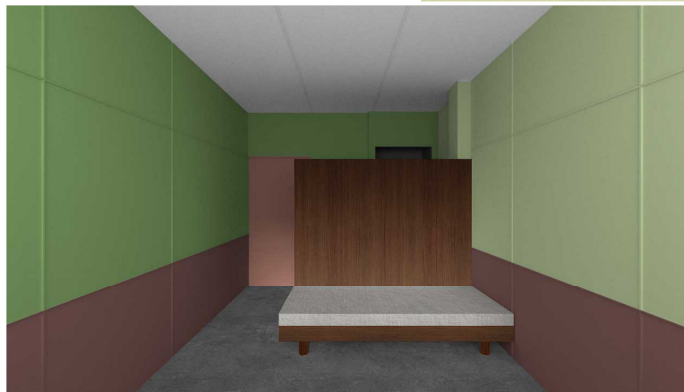
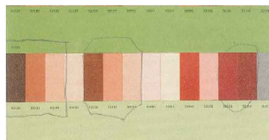
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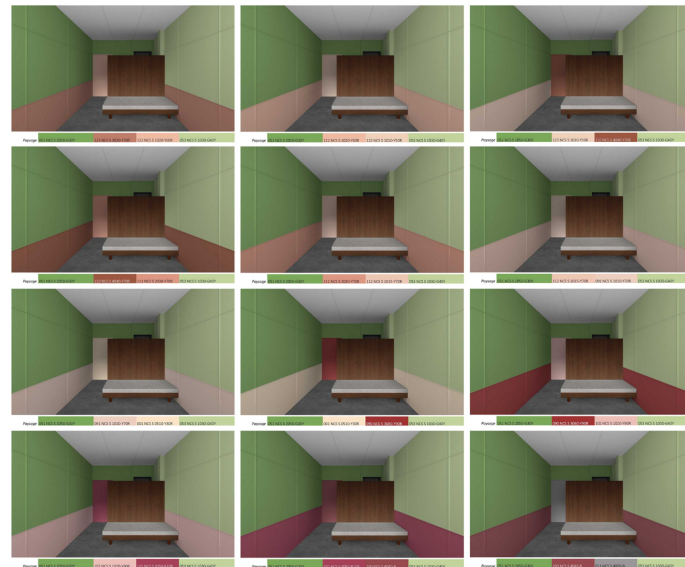
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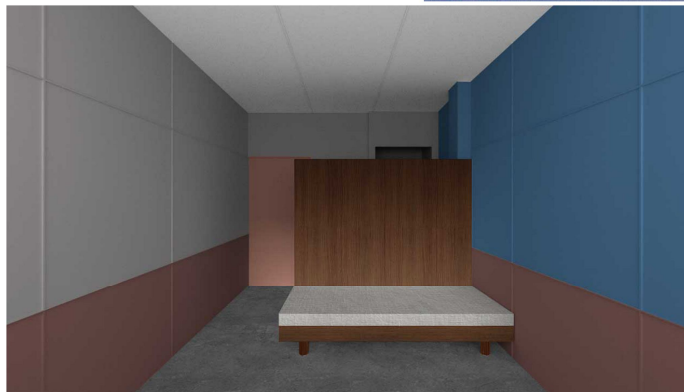
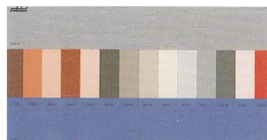
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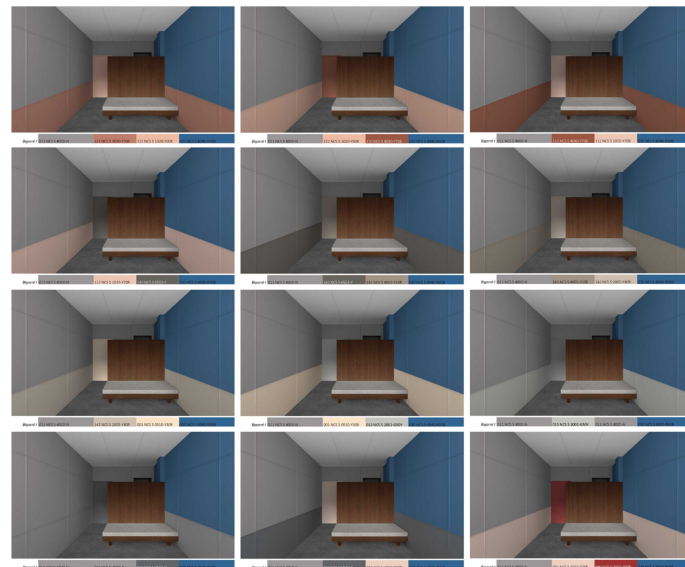
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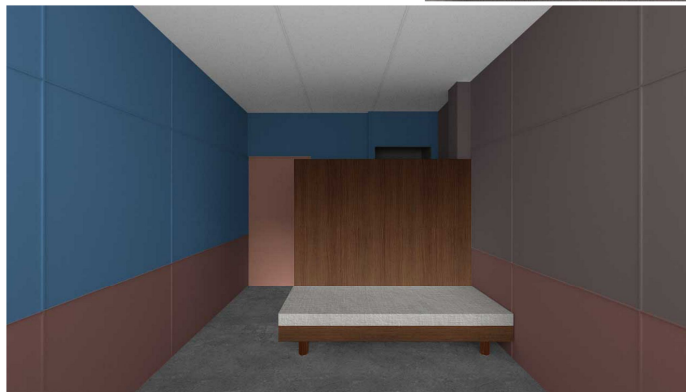
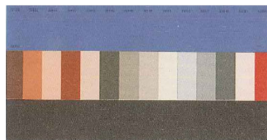
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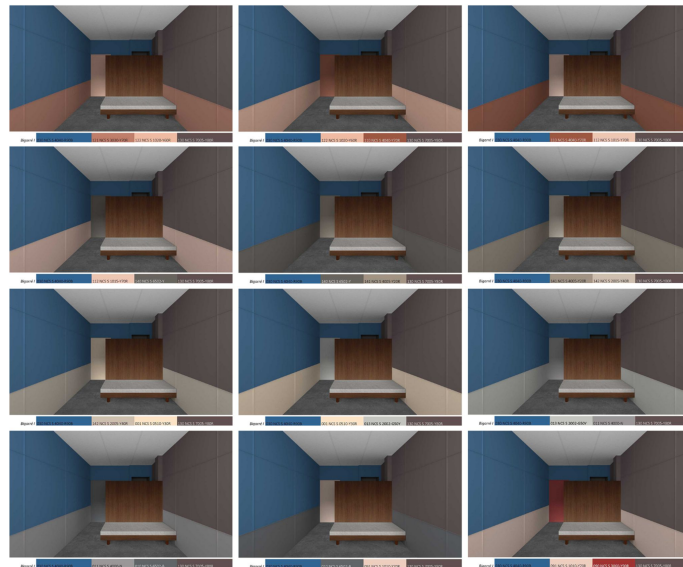
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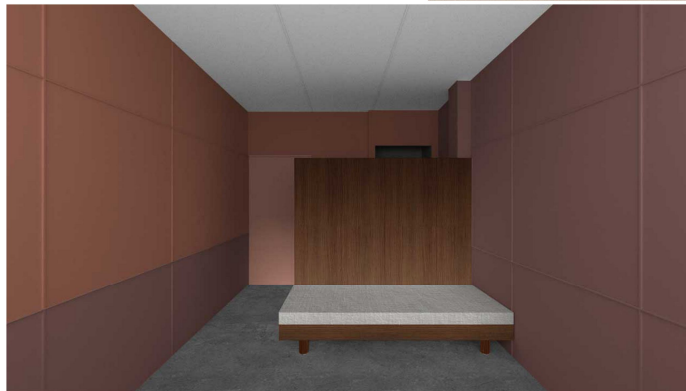
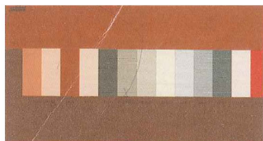


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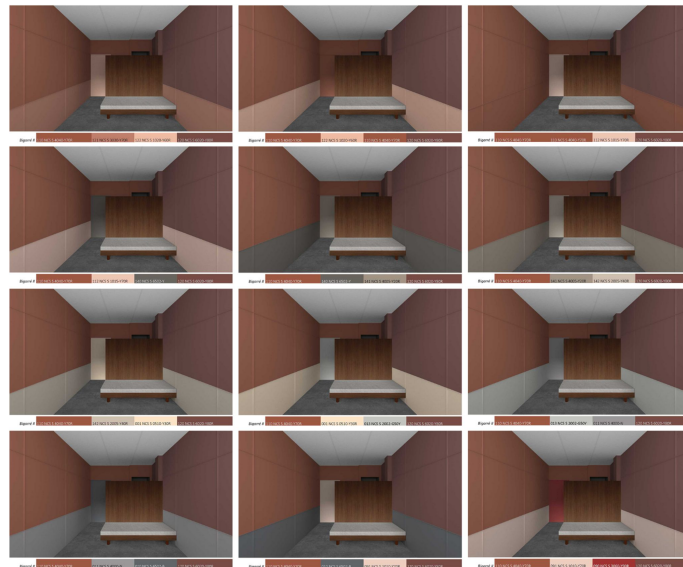




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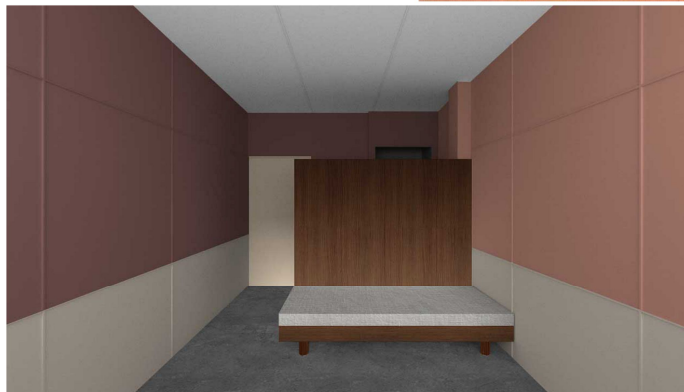
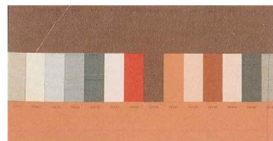


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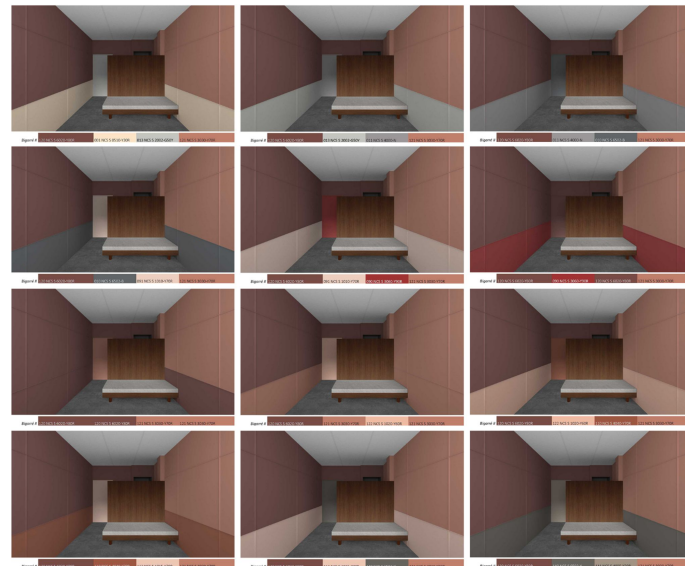




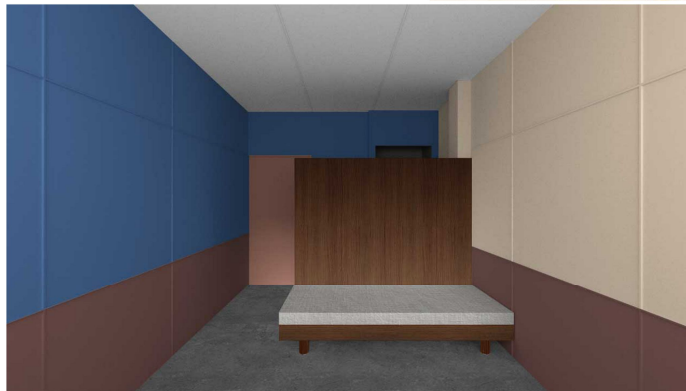
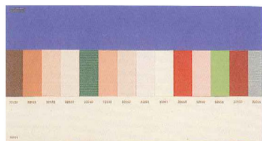
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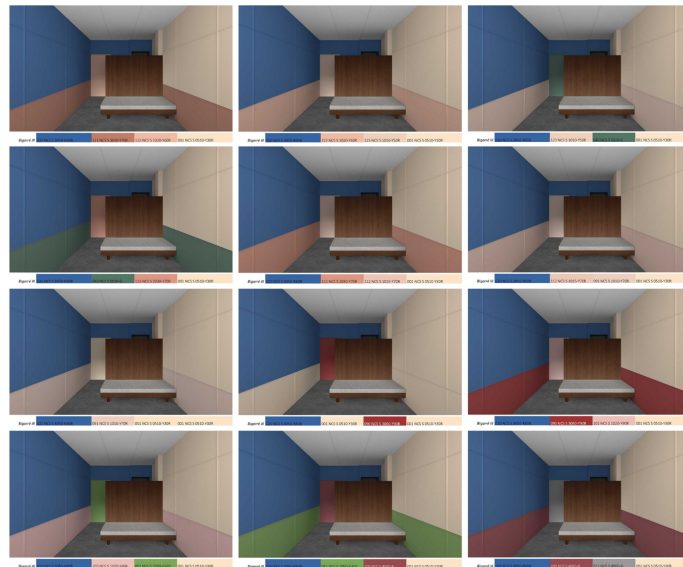
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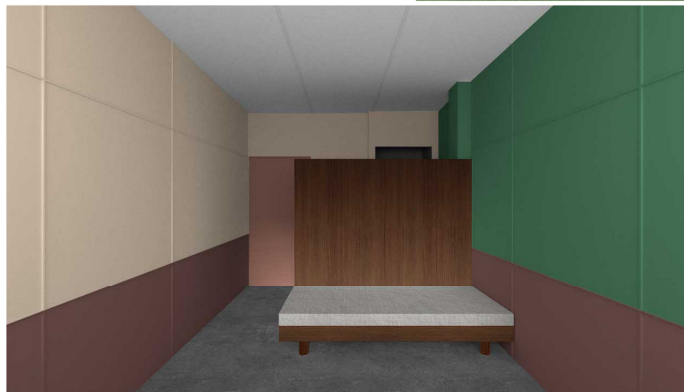
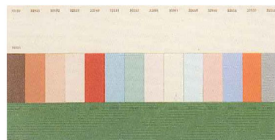
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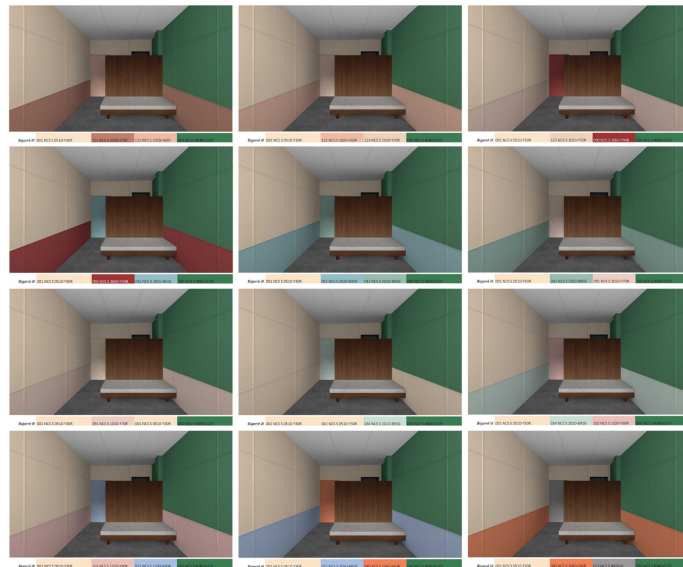
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Clavier Bigarré III



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Assessing color preferences Le Corbusier Salubra 1931

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## Assessing color preferences in Le Corbusier's 1931 Salubra Keyboards A cross-cultural analysis

About the project Serra et al. study ColorArch App Scholars Contact

Within the framework of this project, a psychophysical experiment is developed to assess the color preferences for four-colors combinations of the Salubra 1931 color chart developed by Le Corbusier. A total of 312 combinations is presented in a virtual room of Le Corbusier's project "The Suisse pavillon" to be assessed using a 7-category scale ranging from "Dislike extremely" to "Like extremely".

**TO START THE EXPERIMENT PLEASE CLICK ON THE BUTTON BELOW**

**START THE PSYCHOPHYSICAL EXPERIMENT**

This projects, coordinated by the [Instituto Universitario de Restauración del Patrimonio](#) of the Polytechnic University of Valencia in Spain, aims to study color preferences in the 12 keyboards of the Salubra 1931 of Le Corbusier within a cross-cultural analysis.

UNIVERSITAT POLITÈCNICA DE VALÈNCIA | IRP INSTITUTO UNIVERSITARIO DE RESTAURACIÓN DEL PATRIMONIO | UNIVERSITE Abdelhamid El Mehrez ALGERIE | İSTANBUL AYYANSARAY ÜNİVERSİTESİ

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# Assessing color preferences in Le Corbusier's 1931 Salubra Keyboards A cross-cultural analysis

About the project Serrà et al. study ColorArch App Scholars Contact

## Scholars

**HEAD OF THE PROJECT**

**Juan Serra Lluah**, Polytechnic University of Valencia, Spain  
He is a Titular Professor and Permanent Researcher at the Polytechnic University of Valencia, Spain. He received a Ph.D. in architecture with European mention (2010) and special award (2012) from the Polytechnic University of Valencia (UPV) and has been teaching the Department of Architectural Graphic Expression in the UPV since 2006. He is a member of the Color Research Group of the Instituto de Restauración del Patrimonio at the UPV. His preferred field of research is color in modern and contemporary architecture. He is currently the main researcher in a project about color strategies for the visual integration of architectures with visual impact on the landscape. Email: juanserra@ega.upv.es

**MEMBERS**

**Meria Olibert**, Polytechnic University of Valencia, Spain  
She is a Master student at the Department of the Architectural Graphic Expression in the Polytechnic University of Valencia. She has been working on the topic of the Salubra 1931 of Le Corbusier in her project, as she has provided several results about it. Her main research interest is the history of modern architecture in Europe. Email: margian@xnetmail.com

**Yasmine Gouach**, University Abouhamriz Ibn Badis of Mostaganem, Algeria  
He is a state architect and Assistant Professor in the Department of Civil Engineering and Architecture, University of Mostaganem (UMAG), Algeria. His Ph.D. thesis was dedicated to the investigation of the urban topography in historic centers in Algeria. His current research interests focus on the study of the urban landscape of the region of M'zab Valley in Algeria, as well as the restoration of the architectural heritage. Email: yasmine.gouach@univ-mosta.dz

**Elena Manav**, Istanbul Avcansaray University, Turkey  
She was educated as an Interior Architect, with an MPA degree in interior design, and a Ph.D. degree in architectural design science. Her research areas include artificial lighting system design, space perception, light and color, light health, lighting quality, and user comfort - design parameters. Now she is the Dean of Faculty of Art, Design, and Architecture in Istanbul Avcansaray University, Turkey. Email: tsunmanev@avcansaray.edu.tr

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**About the project**

This projects, coordinated by the Institute Universitario de Restauración del Patrimonio of the Polytechnic University of Valencia in Spain, aims to study color preferences in the 12 keyboards of the Salubra 1931 of Le Corbusier within a cross-cultural analysis.

## Personal Information

**\*Obligatorio**

Where are you from? \*

Spain

Algeria

Turkey

Otro: \_\_\_\_\_

Do you live in the same country of your origin? \*

Yes

No

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### Color preference for interior design

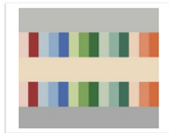
You will be asked to assess your color preference for a bedroom from the Swiss Pavilion (Le Corbusier, 1931-1933) with 26 variations, following Le Corbusier's Salubra Color Keyboards. Please note that the scale of assesemet is set as following:

- 1 Dislike extremely
- 2 Dislike moderately
- 3 Dislike slightly
- 4 Neither Like nor Dislike
- 5 Like slightly
- 6 Like moderately
- 7 Like extremely

Select the color keyboard you prefer \*



Paysage



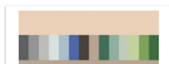
Velour II



Ciel



Bigarré I



### Sable II

I love this colour combination...

199



Salub P 030 NCS S 300G-Y50R 024 NCS S 400G-B00G 049 NCS S 4115-B02G 010 NCS S 0515-Y30R

1 2 3 4 5 6 7

Absolutely disagree



Absolutely agree

205



## 5.CONCLUSIONS

As conclusion of this TFG project supervised by Juan Serra Lluh and Yacine Gouaich, we have done an academic research about the color preferences in the Salubra 1931 of le Corbusier, in order to study the use of color in le Corbusier's architecture, the harmony that exist in the colors combination, as well as the color preferences on the basis of the Salubra conceptions.

Through the 19th and early 20th centuries color became an explicit issue of debate, inspired by the close interaction among the artistic and architectural avant-gardes. The modern color arrives with scientific theories of color perception and the remarkable development of techniques for producing new colors and colorful materials. Le Corbusier is one of the architects who puts value on color and encourages us to use it, but always under very specific conditions. That is the reason why, in 1931, the Swiss Salubra Wallpaper Company, commissioned him to make a first color chart collection for architecture which is completed in 1959 with a second version. The first Salubra collection of colored papers has 12 different color charts named claviers, and provides an exact criterion to choose them, in groups up to four colors. On 1931, the time at which the first Salubra collection appeared, Le Corbusier writes the text 'polychromie architecturale' where he pretends to address the dilemma of wallpaper selection and dedicates a section to dealing with the relationship between color and space to which he titled 'color modifies space' and mentions the Swiss pavilion.

We have carried out an analysis in a 3D virtual render of a room in le Corbusier's project "the Swiss pavilion" which is located in Paris, France, where we have generated 312 colors combinations upon the basis that le Corbusier has set in his text/manuscript "*polychromie architecturale*" by using the colors notations provided by Juan Serra's research (Serra et al. 2013) through the NCS color system. We have found that the color combinations of the Salubra 1931 give an importance sense to the architectural space, and they could be really considered as "architectonic colors", as it has been mentioned in Jan De Heer book and by le Corbusier as well. Additionally, we have found that there a lot of similarities in the combinations as it is so difficult to distinguish the used keyboard or the used colors in the room. Nevertheless, the Salubra 1931 give a wide variety of color combinations and can be a relevant example to study color preferences in architecture.

Finally, we believe that this work, of the study of the color combinations in the 1931 Salubra Keyboards, can open many perspectives for future academic/Scientifics researches in the field of color in architecture, as well as in the study of le Corbusier's architecture. For a future step of a study, an online web page has been created ([www.lecorsdsjhs.es](http://www.lecorsdsjhs.es)) to asses scientifically, and in a

detailed methodology the preferences of different subjects on the basis of the background culture, age, sex...etc.

## 6. BIBLIOGRAPHY AND SOURCES

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