EFFECTS OF COLOR IN INTERIOR DESIGN

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Summary: *Interior design is a complex process which includes numerous steps from the concept development to the design realization. Numerous factors affect the design of interior architecture of a space. One of the basic quality factors of a realized interior design is color.*
Complex nature of colors and their impact on the art, culture, psychology and religion has been often studied. Color is observed as a fundamental quality of our visual perception. There are numerous developed theories and assumptions related to the esthetic comfort offered by colors, and to their effect on human psyche.
The paper addresses the importance of colors in the interior design. This includes housing buildings, but also public buildings such as administrative, hospital, educational institutions. The importance of usage of specific colors in day and night zones of housing areas is analyzed. The experiments conducted in this field, showing the wide range of effects in various aspects of human life are considered.
Based on the analysis of the conducted experiments, conclusions are drawn about the implementation of colors in the public areas interior. Their effects on productivity and disposition of employees, recovery of patients in hospitals and efficiency of student work in schools have been shown.
The goal of the paper is analyzing effects of colors used in an interior on the users of the corresponding area.

Keywords: color, interior design, effects, housing buildings, public buildings

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1. INTRODUCTION

One of the essential roles of architecture is to provide built environments that sustain the occupants' psychological well-being. This role is made even more important because, in modern society, more than seventy percent of a person's lifespan is spent indoors [1].Interior design represents a considerably important factor which affects the users of the space, both in functional and esthetic and psychological terms.
Colors are an integral part of the world we live in and their impact on the human perception of the environment is irrefutable. Also, they are one of the most important elements of an interior, so they represent a key factor in formation of a suitable space for living and working. Numerous researches proved that colors have an intensive psychological and physiological effect on people, for which reason it is important to know how different colors affect the space users. It is similar to the way how cheerful a person feels when it is sunny; and also how unhappy a person feels on a rainy day. Color has the energy to influence both emotions and cognitive processes [2]. Experience, memories, cultural differences influence the color perception, i.e. the same color can differently affect different people.
When designing an interior space, it is necessary to have experience in working with colors. An architect or interior designer must understand the impact of colors, psychological effects caused by certain colors in people, and so must know where it can be implemented to obtain a combination appropriate for each situation. Combining colors and using them in an interior can result in a positive or negative impact on a viewer. A space can exude comfort and serenity, while on the other hand, colors can cause a feeling of annoyance and discomfort. They are a very powerful tool in the interior design, so they can create various illusions in space; a small room may appear larger or smaller, if an inappropriate choice of color is made. When architecture itself does not permit changes and flexibility, one of most important solutions are colors.
Due to the previous assertions, the paper specially addressed effects of color on the users of specific spaces. The effect of color choice is discussed, both within the housing and within public spaces. The psychological effects of various designs of office, hospital and classroom interiors are discussed separately.

2. TYPES OF COLORS

Color can be defined as "different sensations on the eye as a result of the way objects reflect or emit light"[3]. In 17th century, the famous mathematician and physicist Sir Isaac Newton conducted a number of experiments to prove that a rainbow consists of all the existing colors. He darkened the room, letting the light only through a small hole and placed a prism in front of it. He succeeded in reflecting all seven colors on a white background and he called them the Visible Spectrum. These colors are; red, orange, yellow, green, blue, indigo and violet. The color wheel or color circle is the basic tool for combining colors, figure 1. The first circular color diagram was designed by Sir Isaac Newton in 1666. The most common version is a wheel of 12 colors based on the RYB (or artistic) color model.

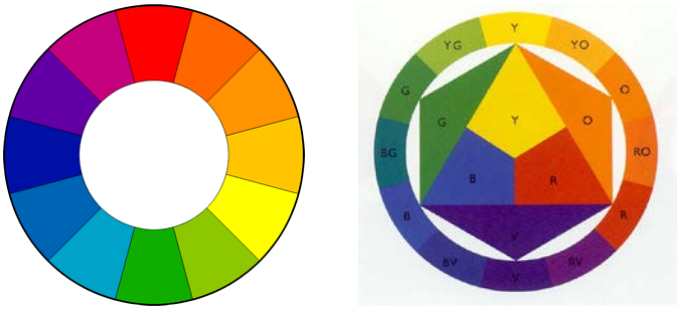

Figure 1. Different types of color wheels.[3]

In nature, there are three primary colors: red, yellow and blue. Secondary colors are formed by mixing these three. For example, the combination of blue and yellow results in green, the combination of red and yellow results in orange and the combination of blue and red results in purple. By moving through the color wheel, harmony between neighboring colors can be seen. The colors that are next to each other are called harmonious colors. Colors in a circle facing each other are called complementary or opposite colors. Moreover, the color wheel is divided into warm and cool colors, figure 2.

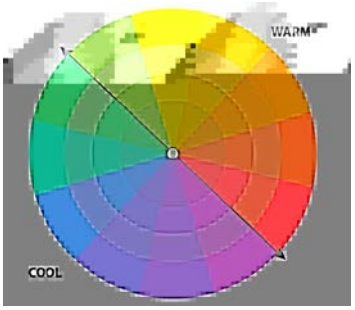

Figure 2. Warm and cool colors spectrum[4]

Out of the seven hues that make up our visible range of color, red, orange, yellow, and some shades of green are considered to be the warm colors. Warm colors are defined as energetic and bold, so they can cause both positive and negative effects. By using warm colors, something can be accentuated, but too much of them, and a space can become congested. Warm colors stimulate the nervous system, so under their influence, the hearth rhythm and blood pressure may be increased, as well as the breathing.
The green, blue, indigo, and violet hues from our visible range of color are considered to be the cool colors. They have an opposite effect from the warm colors. They also influence the nervous system, by reducing pulse, blood pressure and breathing speed. In certain hospitals, there were experiments with the so called blue rooms which have a calming effect. White, black and grey are considered to be neutral colors.

3. PSYCHOLOGICAL EFFECTS OF COLORS

Colors directly affect the mood of a man, and therefore play an important part of his life. Man is greatly a visual creature. He gets about 87% of all sensory information through the world of colors. It has been proven that a person reacts differently to certain colors and that colors can cause different emotional states in humans. Colors have a powerful impact on people and to a great extent colors directly affect their habits and life in general. Each man has his own range of favorite colors that reflect his personality.[5]

Psychologists concluded that colors can be related to certain emotions in people. Feelings are an important element when it comes to design of living and working spaces. When designing interiors it is very important to know what effects and emotions are caused by certain colors. In the text are listed some of the primary colors used in designing, and their relation to feelings and symbolism is explained.

Red is the most vibrant, compelling color in spectrum. It expresses passion, love, warmth, excitement, power, energy etc. Red color attracts immediate attention and brings objects or images to foreground, because of its powerful effect on automatic nervous system. It is the strongest among warm colors therefore can change a space into looking compact and stimulating.

Blue is the color of harmony and peace, but it can be recognized as cold, unemotional and unfriendly. It has been a symbol of faith, hope and loyalty since ancient times. In physiological terms, it impacts on calming the central nervous system. As mentioned earlier, it reduces the pulse and blood pressure, but increases concentration.

Yellow is associated with joy, optimism and warmth. It is considered the most joyful color in the visible spectrum. Yellow encourages concentration and alertness. Moreover, it has a beneficial impact on the nervous system, stimulates blood pressure, the heart rate and breathing, triggers fear.

Orange is a stimulating color which has the energy of red and cheerful qualities of yellow. It is associated with the sun and refreshing fruits. Orange improves appetite, stimulates the heart and is good for the treatment for depression.

Green is the color of nature, restful and refreshing. It has a great healing power which is one of the reasons why it is dominant color in hospitals interiors. Green light reduces pressure, expands capillaries, stimulates the endocrine glands and relieves insomnia. Pale green is the most relaxing and calming color in the spectrum.

Purple is often characterized as a mysterious color. This mixture of blue and red is believed to be the color of sensitivity and artistic nature. Violet light waves, impact the brain, purify and have a refreshing and disinfectant effect. It also regulates the metabolism and suppresses hunger. Indigo light waves fight against high fever and skin diseases.

Black and white. Black is the mixture of all colors totally absorbed. It symbolizes power, mystery and death. This color is unfriendly and unapproachable, therefore, it can cause abasements and mood swings and create an adverse environment. White, on the other hand, symbolizes innocence, purity and truth. It is clean, hygienic and sterile and creates soothing environment. White contains an equal balance of all the colors of the spectrum, representing both the positive and negative aspects of all the colors.

It is very important to understand the colors and their relation to certain emotions and meaning. In addition to the mentioned psychological factors, cultural diversity plays

and important role. All the colors have a certain symbolism, and they have different meanings in different cultures. All this has to be specially taken into consideration when using colors in the interior architecture design. In particular, the usage of colors in shaping of housing and non-housing spaces must be differentiated.

4.USE OF COLOR IN RESIDENTIAL SPACES

Housing spaces play an important role in the everyday life of a person. The way space we live in is designed has a definite impact on an individual. In addition to the appropriate functional solution and choice of furniture, the colors implemented in the interior design may change the overall impression. Also, the purpose of a space may define the choice of suitable colors. Thus, usage of certain colors should be adapted to the day and night zones of a housing unit.

There are numerous factors affecting the choice of colors in the housing space interior. The used color patterns may depend on the climate. For instance, usage of patterns dominated by the warm, cool or neutral hues can depend on the climate, orientation and degree of activities. So, warm colors are more acceptable in cooler climates, while cool tones are more used in the hot climate areas. Orientation of rooms also needs to be taken into account; for instance, if a room is facing north it is recommended to use warm colors, while for a south-facing room, it is recommended to use cool colors. As previously mentioned, colors affect mood of people and activities performed. Warm colors stimulate excitement and inspire people to perform activities, while cool colors cause calm and pensiveness.

Red, as one of the warmest colors is very stimulating, but can cause irritating and disturbing sensations. For that reason this color is not suitable for bedrooms or rooms planned for relaxation. On the other hand, red color can be used in the kitchen and dining room design, as it is known that this color stimulates appetite. Vibrant hues of red must be carefully fitted and used as a detail in the housing space interior. Yellow color stimulates optimism and a positive attitude, however it can become straining. As in the case of the red color, the yellow color should be used carefully, in lighter hues. Orange is to be treated in the same way. These colors may visually expand space, and can be used as details in all rooms of an apartment (figure 3 a). These colors must not be used for painting entire rooms, because it can be too intensive for the users.

Blue has many connotations and meanings, but it primarily stimulates the feeling of clarity, order and calmness. This color is particularly useful for a study, but it is a good choice for the bedroom because it stimulates sensation of peace and quiet. (figure 3b). The hues of blue must be carefully used, since the lighter tones have a calming effect, while the darker tones may cause a depressing feeling. Green color has similar effects, but it is also strongly related to nature, so its calming effect is stronger. (figure 3b). On the other hand, blue and green can cause negative feelings so they require caution.

Figure 3 a. Usage of red color in the kitchen and yellow in the living room.[6,7]
Figure 3 b. Usage of blue and green colors in the bedroom and study interiors [8,9]

Neutral colors are not remarkable and have no intense psychological effect, however, this makes them ideal for usage in rooms of varied purposes. White, beige and gray hues can be used both in bedroom and living room, kitchen and bathroom. They are very flexible and adaptable. Black has a different effect, so it is good for bold and dramatic interiors. It can provide an effect of refinement and elegance.
Of course, most of the rooms are not designed in one color only. The way in which the colors are juxtaposed is very significant, so the appropriate usage can produce considerable psychological and emotional effects. Also, when designing a housing space, subjective factors of the users of the space are important, too.

5.USE OF COLOR IN NON-RESIDENTIAL SPACES

Although the focus of the interest of interior design is often personal, it certainly needs not to be limited to the personal home environment. Life style today dictates that people spend many hours in working situations, shopping and they also spend time eating out, traveling and staying in hotels. The nonresidential environment should be as well planned as the home environment.[3] The impact of colors in the interior of public spaces is discussed in detail, this meaning offices, hospitals and schools.
An office interior design depends on the nature of the job. So, a lawyer's office interior design is different from an IT company office. One of the main goals is to achieve a creative and effective working ambient which stimulates the working productivity of the employees, and which is comfortable at the same time. It is very important to know how colors impact the health and productivity of the employees. It has been proven that the

working space design affects job performance and communication. Some of the experiments conducted are singled out.

A series of experimental studies has been conducted in order to better understand the effects of colors on the space users. They were conducted during the last 20 years in a controlled environment of an indoor office space so that the effects of colors on the employees' organisms, productivity and disposition could be precisely determined.

The first in the series of experiments is focused on the performance of typing texts depending on the color of the office in which it is done – red or blue, figure 4,[10]. Eighteen women and eighteen men, older than 18 years are divided into four groups. The first group remains in the red office during the entire experiment, the second remains in the blue office during the entire experiment, the third starts in the red room and ends in the blue room, while the last starts in the blue room and ends in the red room. All the walls in both offices are fully colored in the appropriate color, it is, red or blue. The task comprised a text to retype, as well as a questionnaire to be filled in after typing by each participant. The highest number of typing errors was made by the group changing the offices, i.e. the one going from the blue into the red office. From the questionnaire, it could be concluded that he red office was related to anxiety, and blue to depression. The participants who changed offices, were increasingly excited.

Figure 4. Blue and red office [10]

Another important experiment tested the impact of main colors, Munsell Color Circle (green, blue, purple, red, yellow, and orange) and three neutral colors (white, gray, and beige) [10]. Also, the effect of combination of certain colors was observed. The subjects were the psychology students from the University of Texas, Austin, 334 females and 341 male of average age of 18.89 years. All 9 offices were equipped with the same furniture and illumination, of the same size but of different colors. All the subject filled in three different questionnaires on whose basis the level of concentration, and the effect of colors on emotions and productivity were assessed later on. It was concluded that the subjects in the light color rooms made more errors than the subjects from the darker rooms. The male subjects stated that in the offices with more color saturation they felt more depressions, confusion and anger, while females felt this in the rooms having lower saturation colors. In general, warm colors were more stimulating than the cool ones. The subjects liked the least working in orange and purple offices, while there were most comfortable in white and beige offices. Even though white color was the most favored among the subjects, they made the most errors during the work in it.

Based on these studies, the findings suggested that color scheme alone may impact occupants' mood. However, no link was found between the worker mood and worker

performance. Positive mood characteristics did not lead to higher productivity, contrary to the popular assumption. This suggested that color may have differential impacts on mood and performance respectively. The difference in perception and preference between females and males was also reflected.

The next area which was studied is the effect of colors used in the hospital interior. The hospital design must reflect a wide spectrum of its users, from the patients, visitors to the employees. For patients and visitors, hospitals are stressful environments. The study conducted in the United Kingdom shows an advancement in the recovery of the patients who stayed in refurbished rooms, as opposed to those who stayed in the old rooms [11]. Colors and illumination in hospitals may have a great impact on the patients' disposition. And for that reason the choice of decoration, art works, architectural element design are very important for relieving stress of the environment. An adequate design of patient rooms depends on the nature of illness and age of a patient. For instance, the older patients and those with weak eyesight prefer calming and light colors of cool hues, such as blue. Confined spaces and vibrant colors may cause negative effect for the persons with mental problems. On the basis of the research, it was concluded that 45% of the patients with mental problems especially dislike orange and red colors. [11] Usage of vibrant colors to refresh a space and make it "positive" does not always have a good effect on the patients, and it may be too aggressive for them. Very young people, staying in hospitals have special requirements regarding the color patter. For children, hospital stay can be especially stressful and boring, so in this case, usage of interesting forms and color combinations is particularly significant.

The level of stress and rate of recovery of cardiovascular patients depending on the dominant colors in the room interior were studied within an experiment of the University of Florida [12]. The recovery of 39 patients was studied based on several factors, of the length of stay, perception of pain and stress levels. The subjects ranged between 26 and 89 years of age. Ten double hospital rooms were painted in green, orange, purple and beige colors. Each of three studied aspects were tested also with the help of questionnaires filled in by each of the patients. After a detailed analysis of the obtained results, beige proved to be the most convenient colors, causing the least anxiety, while the green color was the most inappropriate. The head of the experiment proposed at the end of the test an idea for conducting similar research on a larger number of subjects in order to achieve globalized results. In years, a number of experiments were conducted with a goal of demonstrating psychological effects of colors, including hospitals, with a small focus on the patient recovery.

In the case of schools and faculties, whose rooms include various functions such as offices, cafes, laboratories, gyms; classrooms and amphitheaters have a special importance. The colors of classroom walls affect the behavior of students and their concentration. The research in two elementary schools in Istanbul was conducted to demonstrate the impact of classroom wall colors on the students [13]. The experiment included 78 children, aged from 8 to 9 years. A total of five colors was used for painting classroom walls: red, yellow, green, purple and blue. Testing student concentration lasted five weeks, whereby a new color was used each week, figure 5. In both cases, of the private and public school, the purple color proved to be the best, while the blue one is closely following. The red wall color exhibited the worst results. Therefore, this means that socio-culture and economic scale differences do not have an influence on

the classroom wall color and attention levels of students. This kind of research can considerably improve the quality of life of the people in the various aspects of everyday life.

Figure 5. Classrooms in 5 various colors, used in the experiment [13]

6.CONCLUSION

The color phenomenon has been studied for centuries. Even though there are numerous myths about the perception of colors and visual comfort, their impact on our mood and productivity is irrefutable. Colors play an important role in the world of design and architecture, they are related to the different uses of space and they have a great impact on human life. Persons dealing with design must know about various effects of colors. In the paper are presented some of the basic characteristics of colors and their importance in various cases. Symbolical and psychological meanings of color and their implementation in the interior are presented. In addition to the housing spaces, and implementation of adequate color combinations, public spaces are also discussed. Through a number of examples, that is, experiments, conclusions about positive and negative impacts of colors on the users of that space have been drawn. In addition to the psychological effects they cause, physiological changes in people as well as the changes in productivity are explained. All this is represented through three basic space uses: office space, hospital and school.

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УТИЦАЈ БОЈА У ДИЗАЈНУ ЕНТЕРИЈЕРА

Резиме: *Дизајн ентеријера представља сложен процес који обухвата бројне кораке од развоја концепта до извођења пројекта. На пројектовање унутрашње архитектуре једног простора утичу бројни фактори. Један од основних фактора квалитета изведеног пројекта ентеријера јесте боја.*
Комплексна природа боја и њен утицај на уметност, културу, психологију и религију је често проучавана. Боја се посматра као фундаментални квалитет наше визуелне перцепције. Развијене су бројне теорије и претпоставке везане за естетски комфор који пружа, као и утицај на људску психу.
У раду је обрађен значај боја у дизајну ентеријера. Обухваћени су стамбени објекти, али и објекти јавних намена попут административних зграда, болница, школских установа. Анализиран је значај употребе одређених боја у дневној и ноћној зони стамбеног простора. Сагледани су и експерименти спроведени у овој области,

којима је показан широк спектар утицаја на различите аспекте живота људи. На основу анализе спроведених експеримената изведени су закључци о примени боја у ентеријеру јавних простора. Показан је њихов утицај на продуктивност и расположење запошљених, на опоравак пацијената у болницама, као и на ефикасност рада ученика у школама. Циљ рада је анализирање ефеката боја примењених у ентеријеру на кориснике одговарајућег простора.

Кључне речи: *боја, дизајн ентеријера, утицаји, стамбени објекти, јавни објекти*