Architectural Environment and Emotions

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Abstract

The article deals with the problem of assessing the emotional potential of the architectural environment with its visual perception. To determine the emotional state of the perceiving subject, it is proposed to use the principle of correspondence of visual information and emotional reaction to it. It is proposed to use a distinctive informational model developed by the author to assess the informative nature of the architectural environment. Unlike probable and statistical model, it is based on the sensitivity of the human visual system to the perception of differences in the elements of the dimensional structure of the architectural environment. The formula for determining the amount of visually perceived information is given. The unit of information measurement is an eler (elementary differences). The method proposed for assessing the harmony of the dimensional structure - the basis for the comfort of visual perception and, as a consequence, the emotional potential of the architectural environment. Such a technique will simplify the psycho-physiological studies of visual perception of the human habitat and its design with predetermined (desired) emotional properties.

Keywords: emotion, visual information, architectural environment, distinctive information model.

What is the significance of human emotions in social development? In the process of communication, people form consciousness and conscience as the highest good record before themselves and society. The presence of consciousness enables a person to plan, think through his actions, conduct an internal dialogue with himself and consider various ways of his behaviour in his imagination. Being formed in the process of communication between people, consciousness is a necessary condition for their involvement in groups. The society forms from the participation of separate people into groups. Moreover, it is, above all, a system of connections between them. The highest achievements of human culture and science, art and technological progress are also connected with social experience as the most complex manifestations of a person's mental activity. Emotions play an important role in culture.

In his monograph "The Creating Brain" [1] P.V. Simonov divides emotions into positive and negative. One’s negative emotions (envy, hatred) engender wars, social cataclysms; positive ones generate inspiration, creativity, cooperation, constructive activities that determine the development of society. Positive emotions give a person psychological comfort. Therefore, he seeks to receive them again and again. To get positive emotions, a person listens to music, goes to the picture gallery, walks to the forest, to the mountains, where, unexpectedly, he gets beautiful landscapes, breathtaking air prospects, fantastic piles of rocks, fabulous chiaroscuro. Positive emotions for a person are a psychological drug. For positive emotions, he pays much money: for a symphony orchestra concert, for a trip to the Alps or the Maldives, for a trip to the Himalayas or the Amazonian forests. Moreover, everything is done for obtaining spiritual comfort, positive emotions, which are the result of the perception of sensory information from the surrounding world.

Information is known to be divided into pragmatic, semantic and syntactical (structural). The information theory of emotions, which was developed by P.V. Simonov [2], is based on the practical component of the information flow from the external environment. Another concept – activation, – by Lindsay-Hebb, relies on semantics. We will try to define the relationship between the structural (syntactic) information and the emotions it generates.

In reinforcement of our intentions, we cite a monograph from the staff of the Scientific Research Institute of Neurophysiology [3]: "The informational approach obviously has good prospects for studying the relationship between brain processes and the psyche. Indeed, if the information, which is in the aggregate of nervous processes and in the mental image, is equivalent, then it is the analysis of the informational content of physiological processes that will contribute to the study of the connection between cerebral and psychic phenomena" [3, p.10]. Such research was conducted for decades under the supervision of Academician P.V. Simonov. We do not doubt that such studies are significant for establishing this pattern. However, emotions cannot be described in words and expressed in quantitative form. How can we assess the "mental image" and what is meant by this phrase?

Apparently, we mean a psychological reaction to external stimuli in the form of emotional states – "surprise", "oppression", "fear", and others, but how to evaluate information coming from the external environment? If using the probability-statistical model, how to determine the probability of satisfying "needs"? Moreover, how to determine what needs are available to the perceiving subject at the time of perception?

As we see, the realisation of the idea of "studying the connection between brain and psychic phenomena" faces many uncertainties. The author of this article proposes to evaluate informational processes not in the brain structures, but on the "input" - the incoming structural information. At the "exit" you can record an emotional response to the stimuli of the external environment. Thus, the perceiving subject is regarded as a "black box". Emotional reactions of the perceiving subject psychologists can evaluate by frequency characteristics of cardiac contractions. When evaluating emotional responses, it is proposed to use the correspondence principle: each emotional response corresponds to the informational feature of the external environment. We accept this provision as a postulate because for healthy people the lack of correspondence is impossible. If there is no correspondence, the perceiving subject will lose its orientation in space. First of all, there is a visual perception of the architectural space.

The architectural medium consists of elements of different geometric modalities. They can be linear, rectangular, angular, curvilinear, volumetric-plastic and the most incredible irregular shape, as in a pile of construction debris. Moreover, the relationship of the dimensional structure of all geometric modules contains structural information, which corresponds to a sensory response to the perception of this data. Each link is the source of elementary information, which gives rise to a sensory response-sensation. The sum of omissions forms the emotion generated by the sum of elementary information.

Structural information, concluded concerning two elements of the dimensional structure, is determined using a distinctive information model [4, p. 225-231].

$$u = k \lg \frac{r_i}{r_j}, \quad (1)$$

where:

u – visual information regarding two elements of a dimensional architectural form;

r_i and r_j – are elements of the dimensional structure of the architectural medium, expressed in centimeters, meters (for linear and rectangular modality), degrees (for angular modality); when determining the informativeness of the elements of the curvilinear modality environment, the parts of the dimensional structure take the angles between the tangents to the curve of the curve at points that divide it into equal segments;

k – a factor that takes into account the differential sensitivity of the human visual system; with sensitivity, $C = \frac{1}{33}$ $k = 76{,}56$, [4].

$$U = \sum_{i}^{n} k \lg \frac{r_i}{r_j}. \quad (2)$$

Structural information, determined by the above formula, is measured in elementary differences (eler – the English transcription of Russian “элер” – “элементарное различие”), with a larger dimension being placed in the numerator, a smaller fraction in the denominator, in which case the information will have a positive value.

Structural information, enclosed in tonal relations of the architectural environment, can be determined by the different thresholds of visual distinction of the tonality, taking into account the tolerance of the relationship, i.e. those relationships that allow us to disregard subliminal differences. The same conditions for determining structural information will also apply to colour relationships.

It is necessary to make structural-level differentiation of its elements of the dimensional structure, to unify the computation of structural information, taking into account the variety of physical parameters of both individual parts and architectural space as a whole. We adopted the following classification of elements of the architectural space:

– urban level (level of the whole), including such elements of architectural space as the gaps between buildings, the width and depth of streets, areas, the overall size of buildings;

– the level of the parts of the whole, including such elements of the architectural environment as the cour d'honneur and avant-corps, porticos, large sections of buildings along the vertical;

– the level of elements of architectural form, including window openings, piers, intercolumniation, vertical inter-window spaces, cells of glass stained-glass windows;

– the level of details of the architectural form and space: above window hood molds, window frames, details of entablatures;

– microstructural level (tactile): elements of the texture of surfaces, grass lawns, leaves of crowns of bushes and trees.

The rules for calculating structural information are established by the researchers before the beginning of the experiment to identify an emotional response to the perception of

the architectural environment. It is necessary to take into account such qualities of information as its novelty. The fact is that a particular part of the information is in the memory of the subjects and the emotional reaction to it will differ from the perceived for the first time. In advance, assuming that the new information will evoke a stronger emotional response than the familiar, stored in the memory of the subjects.

It is necessary to dwell on one aspect of the perception of architectural space. It will be about the dynamism of the informational flow, which entails the dynamism of changing emotional responses. When the architectural space is perceived during the movement, the structural information of the architectural environment acquires the "flow" qualities of the informational flow: the angles of perception of the facades change, and the perspective angles of the horizontal lines change. Notwithstanding the law of constancy of perception, the dynamics of the informational flow is present. Some elements of the architectural environment in the process of "dynamic" perception disappear from the field of vision, some "swim" because of closer ones. However, the most critical moments of dynamic perception are the borderline moments of the transition from one space to another, from a close space to an open, wide. Here one can expect a surge of emotions, surprise, admiration and other positive emotions.

Moreover, conversely, when moving from an ample space to a close, there may be an emotion of discomfort, depression, even fear. Similar emotions are experienced by the passengers of the train when they enter the tunnel. When the train leaves the tunnel, a beautiful picture of the mountainous landscape opens suddenly with a breathtaking aerial perspective. There is an emotion of freedom, relaxation, joy. Of course, it is tough to assess the information content of a mountain landscape. However, to determine the dynamics of the informational flow, and, consequently, the dynamics of changing emotional states in the process of moving in the architectural environment is an entirely solvable task.

The examples above illustrate the "pulsating" environment that defines the "pulsation" of the emotional states of the people who perceive it. However, such qualities of the architectural environment are not always acceptable, when the physical parameters of space dramatically change because it can generate stressful emotional states, feelings of discomfort.

The comfort of perception is one of the manifestations of positive emotion. It is associated with minimal actions when perceiving a significant amount of structural information. P.V. Simonov in his monograph [1] noted that "Throughout their existence, people have repeatedly been convinced of the advantages of certain forms of organisation and their actions, and the things they create. The list of these forms includes the proportionality of the parts of the whole, the absence of unnecessary parts that do not work on the basic design, the coordination of the combined efforts, the rhythm of repetitive actions, and much, much more. And, further: "Aesthetic pleasure is a positive emotion associated with the satisfaction of a minimum of three needs: cognition, the economy of the force of weapons with knowledge, skills and abilities that lead to the achievement of the goal in the shortest and the right way" [1, p. 47].

The author dared, single out in the quote of the famous scientist the most vividly reflecting the means of achieving and the result of the manifestation of positive emotions: the proportionality of the parts of the whole and the saving of forces. It is the economy of forces, as a manifestation of the principle of the least action, that is achieved using the proportionality of the parts of the whole [4]. The proportionality of the architectural environment is achieved by the informational unity of the relations of all, or the majority, elements of its dimensional structure. Any proportionality based on the belonging of its elements to a proportional series of quantities, which is a geometric progression:

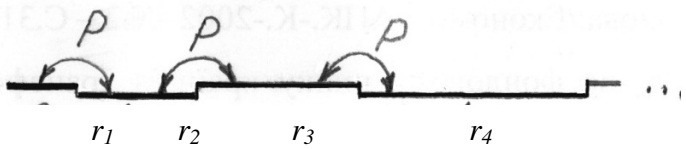

Fig. 1. Proportional series of quantities.

As can be seen from the figure $\frac{r_1}{r_2} = \frac{r_2}{r_3} = \frac{r_3}{r_4} = ...$

The mathematical dependence between any members of this series of elements looks like this:

$$\frac{r_i}{r_j} = p^s, \tag{3}$$

where:

r_i and r_j – are any members of a proportional series of quantities;

p – the basis of a proportional series of quantities is the ratio of the two neighbouring terms of the series;

s – is the integer of the natural number corresponding to the difference of the ordinal numbers of the terms of the proportional series, $s = j - i$.

If we substitute (3) in (1), we obtain:

$$u = k \lg p = sk \lg p. \tag{4}$$

In the last expression, k and p are *const* for any proportional series. Therefore – *const* for any proportional series of quantities and is its information module μ. If during the calculation of structural information, it turns out that the information is multiple μ, for example, ten eler, this is evidence of the membership of the dimensional structure elements entering into the relations, to a single system of proportionality.

Information has the properties of discreteness and disabilities. Suppose that the visual information U is divided into equal portions, and this took N "division" operations. If one part increases by ten times, the number of actions for the division will be reduced by a factor of 10. Thus, the visual system will spend ten times less effort (action) on the perception of visual information U. The fewer operations the optical system makes, the more comfortable the understanding of visual information will be. This is the principle of least effort.

The visual information enclosed concerning two neighbouring elements of the dimensional structure is called the information step of the relation (*U*). The magnitude of the information module relative to the information steps that it links characterises the information unity of this set of information steps. If we accept the maximum unity index for 1, it can be achieved only if the informational steps are equal, i.e. their informational module will be equivalent to the information steps, i.e., $u_i = u_j = \mu_{ij}$. The formula determines the index of proportionality Π_c:

$$\Pi_c = \frac{2\mu_{ij}}{u_i + u_j} = 1.0 . \quad (5)$$

In the same way, one can determine the index of proportionality of any pairwise taken neighbouring information steps of the architectural form or the environment as a whole.

The comfort of perception as a manifestation of positive emotions is the most characteristic in the field of art. "It is important not only to forget that feelings, emotions, experiences are not the goal of art, but the consequence of the perception by the listener, the reader, the viewer of the" message "about the world that the images of the artistic work bear to him as a result of the artist's knowledge of the" humanized "reality. True musicians do not express feelings in music, but make music into feelings - this amazing remark is true not only for musical creativity "[1, p. 28].

We will try to extrapolate this idea of P.V. Simonov into architecture, especially since "architecture is music that has frozen in stone" (Gogol).

The harmony of the architectural form and the architectural environment as a whole can be quantified if we consider it as a sensually perceived phenomenon from the general scientific sense of perception. It consists of the fact that any living system to ensure its vital activity tends to consume the maximum amount of information coming from the external environment, with the minimum costs already accrued for the assimilation of the incoming. It is quite logical, for development is the accumulation of information, and if the system spends more than it receives, it will not develop. Consequently, this growing sense of information processes in living nature reflects the principle of least action.

The principle of least action is considered to be the ultimate meaning of all physical laws in various sciences. Sensual perception obeys the laws of physics, as it is the result of physicochemical processes occurring in our nervous system under the influence of external stimuli. Therefore, knowing that the human body evaluates the information coming into it from the positions of least action, let us consider the problem of assessing the proportionality of the architectural form through the prism of this principle.

If we consider visually perceived information as a result of the interaction of data coming through the visual system with the information memory of a person, then we will judge the rationality of this communication by how many microprograms of our mind were used in the process of perception and how much information was accounted for by one microprogram.

As early as 1912, M.V. Bancroft gave the following interpretation of the principle of least action for biological systems: "The changes affecting the system (biological) are such that they tend to minimise the perturbation of the external order" [5, p. 12]. In other words, the information processes in the biological system proceed in such a way as to maximise the information of the outside world to perform a minimal amount of actions for its assimilation.

Since the information, according to our interpretation of A. Kolmogorov, is the "length of the perception algorithm", and the information modules are separate operations linking the neighbouring information steps, the efficiency of perception will be determined by the amount of information per one such operation. This value will reflect the magnitude of the action of the visual system and the information ordering of the architectural form, that is, its proportionality.

The number of information modules contained in two adjacent information steps is the modular capacity (E) of the sum of these information steps:

$$E = \frac{u_i + u_j}{\mu_{ij}}. \tag{6}$$

The modular capacity of a composition containing m pairs of information steps will be:

$$E_к = \sum_{2}^{m} \frac{u_i + u_j}{\mu_{ij}}. \tag{7}$$

The measure of the harmony of a composition containing m pairs of information steps will be:

$$M_{\varepsilon} = \frac{\sum_{2}^{m} (u_i + u_j)}{E_k}. \tag{8}$$

The measure of harmony characterises the strength of the information unity of the relations of the dimensional structure of the architectural composition. The stronger the information link between neighbouring information steps, the less the number of information modules will fit into their summary information. The more information will come from one information module, the higher the measure of harmony, the more comfortable the perception of the architectural form.

If we accept A. Kolmogorov's (1965) position that information is an expression of complexity, then in the last formula in the numerator we get complexity. Information unity of the architectural form is a consequence of its proportionality. Therefore, the total modular capacity in the denominator will characterise the degree of disorder in the architectural form.

Thus, the measure of harmony is a function of the complexity and orderliness of the architectural form and can be viewed as an informational interpretation of the aesthetic measure of Eysenck [6, p. 250-260].

Two squares with the same type of division are listed below to illustrate this message, but with different ratios of the elements of the dimensional structure (Fig. 2). Below them are

information fields that allow the reader to calculate the measure of the harmonicity of each square independently. In the centre of each cell the information step of the ratio of its sides is indicated, and near the arrows - the information step of the rate of the elements is pointed to by the arrows. We give the final result of the calculations.

The measure of the harmony of the square A is 6.16 eler; the square B is 8.2 eler. Most participants in the expert survey, who were asked about the comfort of visual perception of the squares, favoured the square of B.

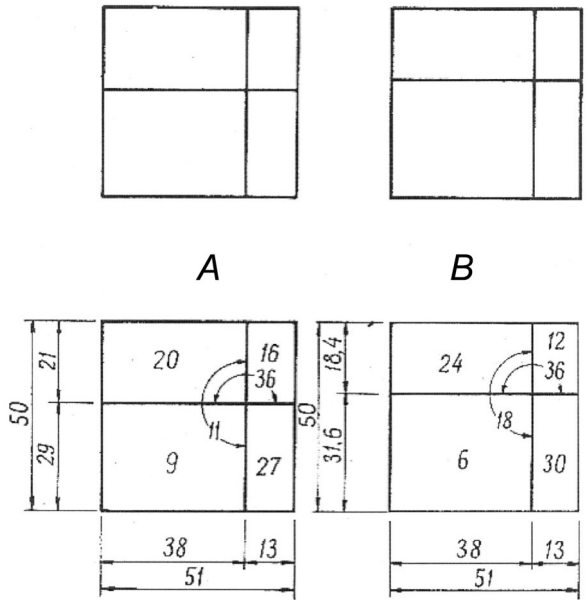

Fig. 2. Information fields of squares A and B

The comfort of perception is a positive emotion that is born with the understanding of visual information, which is created by the architectural environment. It is the most potent and inexhaustible source of emotion. It can not be eliminated from our lives. It cannot be discarded as a failed painting or turn off the TV if the unpleasant music is playing. The architectural environment surrounds us, generating both positive and negative emotions. In it we live, our future depends on what will be tomorrow.

An outstanding British politician of the 20th century, Winston Churchill once said: 'We shape our buildings; thereafter they shape us'. Harmonious architecture, generating positive emotions, forms a congenial personality, and harmonious individuals establish a peaceful society. Therefore, the problem raised here is of civilizational significance. Solving the task of formalising emotions depending on the informative nature of the architectural environment will allow us to design our environment in the future with pre-defined emotional characteristics.

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