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Sound in Architecture as an Abiotic Factor of Spatial Form

Irina Pershina
Belgorod Shukhov State Technological University
Belgorod, Russia
E-mail: Irina.Persina@mail.ru

***Abstract*—The general direction of the study of the psychoacoustic background of the architectural space is at the junction of several areas of scientific knowledge: the theory of architecture, general psychology, and psychophysiology. The connections between the human psyche and his subject-spatial environment are the object of research environmental and Gestalpsychology. At the same time, the author adheres to the ecological-psychological approach concerning the phenomenological aspect of the architectural space. The scientific problem of research is multidimensional and associated primarily with the formulation of a systematic study of the influence of geofactors on a person within the framework of architectural geonics, which implies the transdisciplinarity of research. And also with the formation of principles and models for constructing a geosynthesized specific space capable of positively influencing the psycho-emotional and physical state of a person; with the identification of structural properties of specificity. The combination of direct or indirect effects of the inorganic environment on living organisms leads to the concept of abiotic factors that can be a key component in creating a specific architectural environment.**

Keywords—architectural space; architectural geonks; geosynthesized architectural space; geo-directionality in architecture; geo-impact; sound

I. INTRODUCTION

Currently, the environmental theme continues its cultivation with a new direction in architecture — architectural geonics. Which the main subject of study is the formation of principles for constructing a geosynthesized space that can have a positive psycho-physiological effect. For a long time, research on the effects of space on human psychology was outside the general line of development of architectural science. The physical environment has always been considered as an object of influence and transformation. Also played the role of intrapsychological reason: the idea of the possibility of the influence of factors of the physical environment on people's behavior was not allowed as a vulgarly behaviorist.

The primary systematization of the concept of describing a specific architectural space in the categories of the system-structural approach is given in the paper “Development of Actual Problems of Geo-Directional Development in Architectural Geonics”, published in T. 2. Sat. scientific tr. RAACS, 2018. The hypothesis put forward in it consists in confirming the influence of geofactors on the formation of an architectural specific space. Geofactors are understood as a certain variety of natural abiotic phenomena. The interpretation of the concept of “space specificity” depends directly on the scientific approach used. There are several such approaches, differentiating them in disciplines that include the architectural space in the subject of their research. Using the methods of creating a morphology of spatial construction in indissoluble unity with such disciplines, one can single out the following factors of influence on human perception: a hydrogeological factor; the influence of geomagnetic fields; eniology as an energy-informational aspect of architecture; the influence of the phenomena of the cosmic order; the influence of the directional acoustic background on a person.

A person is oriented in the abiotic space through the information available to him in various forms of its assimilation. It can be sensations, rational knowledge, premonitions, and field conditions.

One of the means to achieve "specificity" is the use of acoustic features. But the acoustics are not “interior”, but continuously “living” in the natural environment, the so-called external acoustics externum loquentium (lat). The influence of acoustics on the creation of a psychological climate, the generation of positive emotions, creative mood and mental activity is well known. Different frequencies can have different effects on the state of the human body. By creating architectural artifacts that produce a sound background in the conditions of spontaneous air flow, a psychoacoustic background is created that forms the specificity of the space [1], [2].

II. EXAMPLES OF ARCHITECTURAL ARTIFACTS

In architectural practice there are precedents for the creation of acoustic space. This refers to the deposit of spaces created by means of “singing” small forms.

For example, it is shown in Wave Organ, San Francisco (“Fig. 1”). Authors Peter Richards, George Gonzales. Wave body consists of 25 pipes made of PVC and concrete, located at different heights on the dam. The combination of tides and waves pushes the air in the pipes, creating gurgling sounds.

Fig. 1. Wave Organ, San Francisco.

As shown in Sad sound, Seattle ("Fig. 2") by Douglas Hollis, it is a 12 steel towers, which are similar to the towers of cellular operators. The towers are organ pipes of different sizes, which emit low sounds when exposed to wind. Weathervanes, located at the tops of the towers, catch the wind and turn the pipes.

Singing tree ringing in Burnley, Lancashire is shown on "Fig. 3". (Arch. Mike Tonkin and Anna Liu). The tree consists of numerous pipes of different sizes. The construction of a three-meter height made of galvanized steel. The wind passes through tubes, at the ends of which special holes are made. Due to the fact that the wind direction changes and passes through different layers of tubes, the installation all the time makes new sounds. The facility includes 310 pipes. Pipes of the same diameter are designed so that they sound even when the wind seems to be gone. Unlike the soft string melody of the eolian harps of the past, the modern analogue of an unusual musical instrument makes cosmic low-frequency sounds.

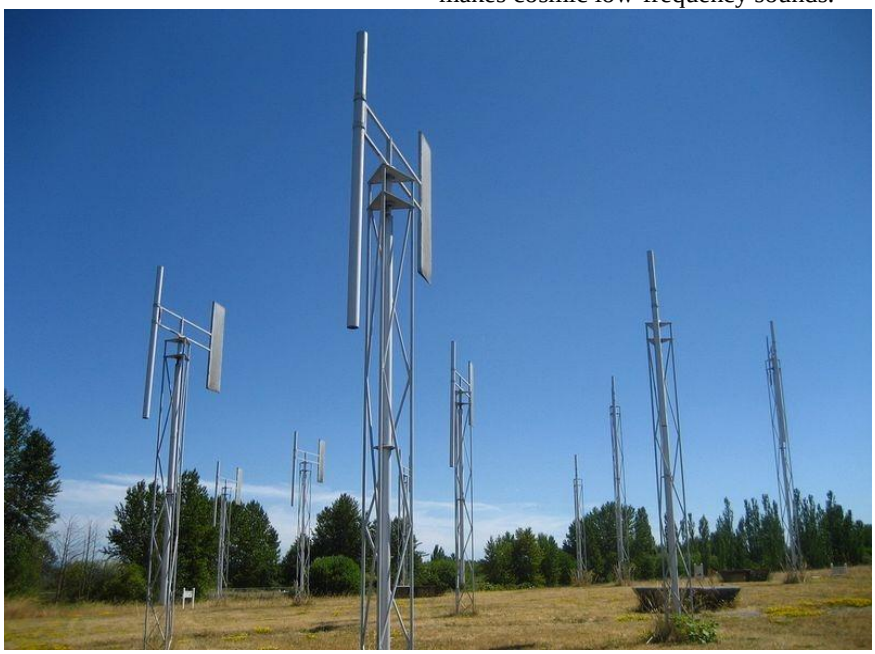

Fig. 2. Sad sound, Seattle.

Fig. 3. Singing tree ringing in Burnley, Lancashire.

As shown in Windorgel, Vlissingen, the Netherlands ("Fig. 4"), there are several vertical bamboo tubes with holes on the seashore along the entire length. They produce different sounds when the wind blows.

As shown in Bridge Chimecco, Aarhus, Denmark by Architect Mark Nixon ("Fig. 5"), the structure is constructed of anodized aluminum pipes with gold plating, ranging in length from 120 mm to 3750 mm. These pipes are attached to the lower side of the bridge, in order to create a melodic sound of the bridge from "nowhere", due to the wind and people walking along this bridge.

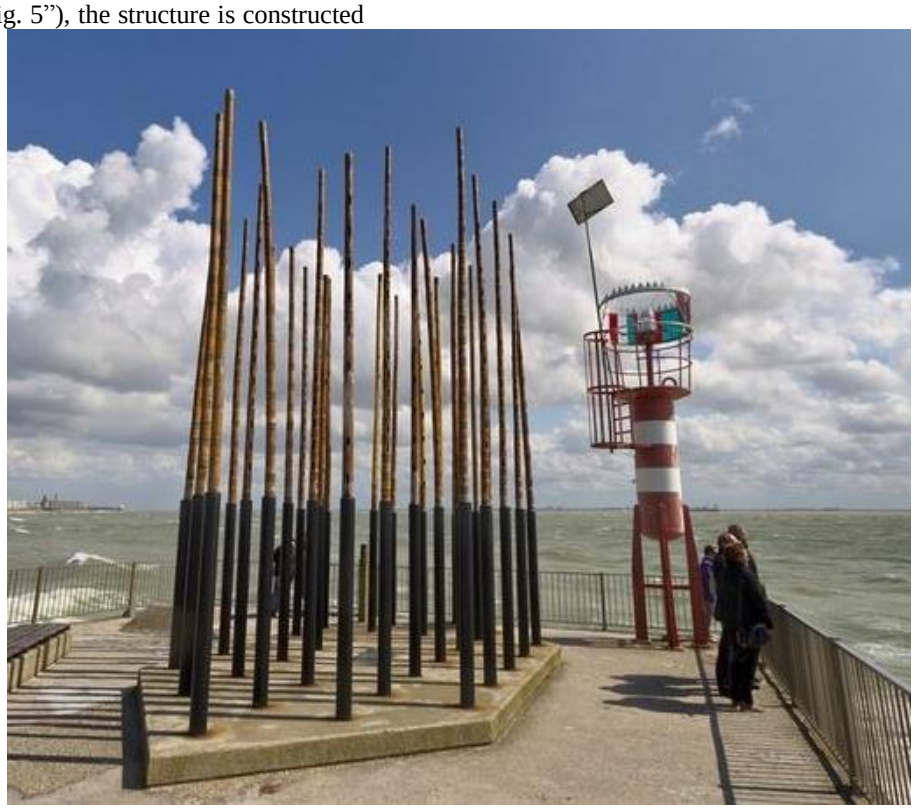

Fig. 4. Singing tree ringing in Burnley, Lancashire.

Fig. 5. Bridge Chimecco, Aarhus, Denmark.

Sea organ. Zadar. Croatia by Architect Nikola Bashich ("Fig. 6") is open to the public in 2005. Water and wind "enter" into the organ through the holes in the lower part of the steps, where they are sent to the resonating chambers. The sounds of these cameras come out through the holes along the high steps.

Tidal organ, Blackpool. The height of this body is 15 meters, it was built in 2002. On the quay, 8 pipes were fixed, which are connected to 18 organ pipes under the embankment. At high tide, water pushes air out of the pipes and causes the organ to sound.

Fig. 6. Sea organ, Zadar, Croatia.

Aeolian harp in architecture has been known since ancient times. Harps were performed in various techniques: from the resonator — a narrow wooden box with a hole inside which the strings are strung. The number of strings (usually from 4 to 12, sometimes 24 or 48) is arbitrary. Strings of the same length but different thickness and degree of tension are usually tuned in unison, for example, the "salt" of a small octave); when oscillating, they emit not only the basic tone, but also overtones, so that the total range of the aeolian harp is quite significant. The stronger the wind, the higher overtones can be heard. When the wind blows weakly, the aeolian harp is light and tender, sharp and loud at gusts. The tools were installed in such a way as to ensure the greatest possible wind access. Aeolian harps were usually placed on roofs and fronts of buildings (for example, in window openings), in park arbors (rotundas), grottoes, etc., and so that the wind blew from the side, parallel to the deck. Some aeolian harps were supplied with a special device to give the air flow the right direction (most beneficial for exciting the string).

III. The Medical Aspect of the Psychophysiological Influence of Sound, as a Factor Abiotic Space

The determination of the nature of the effects of certain acoustic ranges on human behavior and psyche, including the influence of non-optimal frequencies, is considered in the works by N. Kuralesina [3], A. Kuzmicheva and V. M. Ukhabova [4] and others.

The study takes into account bioresonance effects that can increase the stability of the regulatory mechanisms of physiological functions in the interaction of sensory vibratory wave stimuli with endogenous rhythms of the body with certain ratios of phase-frequency characteristics.

The overall assessment of the factors optimizing the effects of sounds is given in the author's works “On the transdisciplinary tandem of medicine and architectural geonics” [5] and “The medical aspect of architectural geonics - the effect of sounds on humans” [6]. Where results are shown demonstrate the ability of natural sounds to change the nature of the modulating effects on the physical and psycho-emotional state of the human body. In the process of interaction of sensory stimuli of oscillatory-wave nature with endogenous rhythms of the body, with certain ratios of phase-frequency characteristics, bioresonance interactions occur, which can increase the stability of the regulatory mechanisms of physiological functions.

The study of the neurological influence of sound indicates that the human brain responds to pure sounds in a very specific way. Positron tomography, which measures the level of glucose uptake at the cellular level, has shown that pure sounds and wordless music stimulate an increase in cellular activity in the right or non-dominant hemisphere. Some areas of our consciousness (such as a state of increased creative activity and genius) are most easily achieved through the activity of the non-dominant hemisphere. When stimulating the non-dominant hemisphere (for example, using pure sound), unusual states of consciousness often arise.

This is due to the fact that the non-dominant hemisphere includes the spatial and intuitive aspects of our consciousness. In such neurological states, our perception of reality (both internal and external) may be very different from our everyday perception. Our feelings can become aggravated, their perception becomes more alive and refined. Quite often, people experience the direct experience of their inner mental and emotional life through the direct perception of their mental motives (that is, deep-seated emotions, fantasies and archetypical conflicts and dramas). They can manifest as inner visions (dreamlike pictures) or even as inner dialogue.

IV. FORMULATION OF THE PROBLEM

As an acoustic material, it is proposed to use sounds resulting from the passage of air streams through strings or pipes, established as elements of the architectural structure [7]. The identification of the “necessary” frequencies will affect the volume-spatial formation of the structure: the geometric characteristics of the pipes, such as the length of the tube, the diameter of the internal cavity, the presence of the cut off ends of the tube; dependence on pipe material affecting sound reflectance; the effect of tube wall thickness; the use of methods for creating wind musical instruments to extract sound harmonic vibrations — all in the conditions of the spontaneity of the force and direction of the wind. As a result, pipes or strings, as the main translators of sound, will be able to synthesize only that range of sound frequencies, which has only a positive impact. In this case, the sounds will have some philharmonic complexity.

On this basis, it is possible to assert the legitimacy of creating an alternative to natural spontaneity, by calculating and selecting the above characteristics, when it is possible to control and direct the sound background.

V. CONCLUSION

So, based on the analysis of architectural prototypes, including the historical facts of the use of architectural small forms that contribute to the emergence of sounds, we can conclude about the deliberate use of acoustics as a means of creating a psychological climate. The scientifically based data of the biological significance of sounds of various frequencies and intensities can be used as a tool for physiological effects in the design of an architectural environment.

Designing the architectural space, taking into account the biological significance of the spectral characteristics of the acoustic factor, will make it possible to predict sustainable forms of spatial experiences. This helps the architect to predetermine intentionality as a distinction of mental and physical phenomena of “installation”. The definition of frequency boundaries will allow you to simulate the sound load in order to identify favorable effects on the consumer of the geospecific environment. The results of acoustic data will allow the authors to continue the experimental work on the architectural design of small forms that produce acoustic space. Intermediate results of this work have been published and made public.

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