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LED-TECHNOLOGIES AS A MEANS OF POST-INDUSTRIAL ILLUMINATION DESIGN

Koval L. LED-technologies as a Means of Post-Industrial Illumination Design of Object Spatial Environment. *Basic peculiarities of LED-technologies as a means of post-industrial design of objective spatial environment are under consideration in the article. It has been stated that all the characteristics typical of modern post-industrial design, are immanent of LED-technologies. In illumination design dynamic LED-illumination is a bright exponent of time changes. With its introduction into the project-graphic design the factor of time has become a fully-featured compositional means. Post-industrial 'continuity' of illumination is secured by LED-technologies in tuning of artificial illumination according to natural cycles, as well as certain 'unpredictability' is provided due to interaction of LED-illumination with a user. With the help of LED-technologies 'probable' conceptualization of post-industrial society is implemented thanks to a set of scenarios and limitations in the framework of which a user can enjoy the freedom of choice, while 'system' conceptualization is maintained owing to programming of illumination as of a single system with general control.*

Keywords: *post-industrial design, LED-technologies, object and spatial environment, illumination design, information-oriented society*

Коваль Л. М. LED-технології як засіб постіндустріального дизайну освітлення предметно-просторового середовища. *У статті досліджуються основні особливості LED-технологій, які характеризують їх як засіб постіндустріального дизайну освітлення предметно-просторового середовища. Визначено, що основні риси, притаманні сучасному постіндустріальному дизайну, стосуються і ознак LED-технологій. У світловому дизайні яскравим виразником змін у часі є динамічне LED-освітлення. Із його введенням в проектно-образне рішення інтер'єру фактор часу стає повноцінним композиційним засобом. Постіндустріальна «безперервність» світу забезпечується за допомогою LED-технологій налаштуванням штучного освітлення відповідно до природних циклів, а певна «непередбачуваність» завдяки інтерактивному взаємозв'язку LED-освітлення з користувачем. За допомогою LED-технологій «ймовірнісні» уявлення постіндустріального суспільства реалізуються завдяки набору сценаріїв і обмежувачів, у рамках яких користувач вільний у своєму виборі, «системні» — завдяки програмуванню освітлення як єдиної системи із загальним керуванням.*

Ключові слова: *постіндустріальний дизайн, LED-технології, предметно-просторове середовище, освітлення, світловий дизайн, інформаційне суспільство.*

Коваль Л. М. LED-технологии как средство постиндустриального дизайна освещения предметно-пространственной среды. *В статье исследуются основные особенности LED-технологий, которые характеризуют их как средство постиндустриального дизайна освещения предметно-пространственной среды. Определено, что основные черты современного постиндустриального дизайна характерны и для особенностей применения LED-технологий. В световом дизайне ярким примером изменений во времени является динамическое LED-освещение. При его использовании в проектно-образном решении интерьера, фактор времени становится полноценным композиционным средством. Постиндустриальная «непрерывность» мира создается с помощью LED-технологий настройкой искусственного освещения в соответствии с природными циклами, а некоторая «непредсказуемость» — интерактивным взаимодействием LED-освещения с пользователем. С помощью LED-технологий «вероятностные» представления постиндустриального общества реализуются благодаря набору сценариев и ограничителей, в рамках которых пользователь свободен в своем выборе, «системные» — благодаря программированию освещения как единой системы с общим управлением.*

Ключевые слова: *постиндустриальный дизайн, LED-технологии, предметно-пространственная среда, освещение, световой дизайн, информационное общество.*

Background. In the last third of the XX century design has turned into the global phenomenon of the post-industrial society, which embraced new spheres of project practice, even those that do not have direct connection with project-graphic methods [17: 12]. Year by year the increase of the culturological influence of design on the society is becoming more noticeable. Moreover, the circle of specialization within the branch itself is becoming wider. M. I. Schepetkov, a well-known Russian expert in projecting of urban architectural illumination, stated in his paper, presented at the International conference 'Robust Architecture: the Present and the Past' (Moscow, 17–18 November, 2011) [20: 137], that during the last two decades an increased interest of the global society to illumination design of a city as well as of an interior (design of illumination of the object and spatial environment) has been observed. In his opinion, visual comfort, visual ecology and aesthetic (graphic) value of designed environment depend on the quantity and quality of illumination (especially of artificial illumination which is manually controlled) both in the environment under design and on surfaces of the material objects.

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Рецензент статті: Трегуб Н. Є., кандидат архітектури, професор, завідувач кафедри «Дизайн меблів», Харківська державна академія дизайну і мистецтв, Член Національної спілки архітекторів і Національної спілки художників України

development' that was held in the framework of the International Illuminating Forum 'LEDLIGHT'2013' (Kharkiv, 15–16 May, 2013) was devoted to a wide circle of problems connected with the development of modern illumination technologies, e. g. elaborating alternative energy sources, the use of photodiode illuminators, the theory and practice of light measurements. Special attention was given to the impact of illumination on a human-being, as well as to the development of architectural and aesthetic illumination [18]. Traditional illumination methods tend to change with the emergence of new illuminators. That is why the employment of LED-illuminators in the interior transforms the approach to the design of objective spatial environment. LED-technologies belong to the modern nanotechnologies, so it is appropriate to investigate them in the context of the general tendencies of post-industrial design.

Recent research and publications on the topic. Design as a phenomenon of post-industrial (informational) culture is analysed in the monograph by V. V. Chizhikov [19]. The peculiarities of post-industrial design are viewed by S. M. Mikhailov [10; 11]. In the framework of general history and theory of design this problem is outlined in the works by A. N. Lavrentiev [7], I. O. Rozenson [16], V. F. Runge [17], V. O. Timokhin, N. M. Shebek, T. V. Malik [13].

Aesthetic and practical aspects of interior illumination were analysed in the 1960–1980s in the works of such well-known authors as M. M. Gusev, V. G. Makarevich [4], O. S. Schipanov [21], G. B. Bukhman, L. A. Voronets [2]. At present that is characterized by active practical introduction of illuminating LED-technologies reconsideration and updating of the traditional scholarly ideas is necessary. In modern textbooks written by O. I. Lisna [8], L. O. Griffen, S. V. Chirchik [3] the problem of shaping of light and colour environment is viewed mainly from the point of illumination engineering. The work of L. Martin [9] is devoted to the peculiarities of light and colour design of home interior. D. G. Ismagilov and O. P. Drevaliova [6] give a detailed view of theatrical illumination, some methods of which can be used to achieve 'theatrical' illumination effect. In Zurich Colour-Light Centre (FLZ) of Zurich University of the Arts and the Institute of Design and Technologies they investigate the interaction of colourful LED-illumination with different types of surface [22]. Besides, a separate research groups is working on a wider application of colour-light theory for practical tasks solutions [14].

All the mentioned above publications are connected with some parts of the present research paper: e. g. they analyze post-industrial design as irrelative to illumination design; works devoted to interior illumination do not take into account LED-technologies and their peculiarities; researches on LED-light do not aim at characterizing it from the point of view of post-industrial (informational) culture. It is worth mentioning, that illumination design of object and spatial environment by means of LED-technologies has never been analyzed in the context of post-industrial tendencies. Such research seems to be very actual nowadays.

The objective of the article is to define and to analyze main peculiarities of LED-technologies that characterize them as a means of post-industrial design of illumination of object and spatial environment.

Research statement. Every branch of knowledge defines modern society using different terms. Design prefers the term 'post-industrialism' (post-industrial society). It is partially connected with the professional term 'industrial design', which occurred during the industrial revolution of the XVII–XIX centuries [10: 12]. In the late XX century scientific and technical progress and the development of information technologies considerably broadened intellectual horizons of a human and marked the transition to 'post-industrial' or 'informational' society. Its basis is knowledge-consumptive, resource-saving and informational technologies. In the post-industrial society all the basic characteristics of the industrial society are up to rethinking: economic growth is not the main aim of the social development; emphasis is transferred to social and humanitarian problems centered on a human as a personality and an individual. On such condition design strives at meeting individual needs of a customer. Taking into account the present-day humanistic trends of design, S. M. Mikhailov compares this situation to a kind of 'new Renaissance'. Eco-friendly approach to the environment, as well as humanization of man-made world, is put on the first position, the process of ecologization of social and economic development is on. A new type of human-nature interaction is being formed, it implies a human to be a natural element in the system 'human — society-nature' [10: 93].

V. V. Chizhikov also defines 'post-modern' design as a phenomenon of post-industrial (informational) epoch and of those major transformations in the system of culture, that were caused by extensive development of IT and mass media that have become a loudspeaker of mass culture [19: 257–258]. The scholar identifies modernism as univariance of the world development, while post-modernism is qualified by him as multivariance of its development [19: 263].

While analyzing design in post-industrial society S. M. Mikhailov [10: 63] mentions that modern informational and technical opportunities, the specifics of social and economic development, the change of axiological orientations as well as of aesthetic ideals have caused substantial changes of the idea of the comfort of the environment. Apart from the traditional functional and practical, physiological and ergonomic aspects the role of aesthetic, psycho-emotional and socio-cultural aspects has been increasing. In condition of the IT society design gets a brand new consumer having higher spiritual and functional-practical demands that become an inseparable element of the idea of the comfort of object and spatial environment.

A. N. Lavrentiev [7: 290–292] states that the design of the third millennium is founded on the artistic creativity, on modern art experience and on the development of emotional and imaginative element. With the use of modern technologies the volume and weight of things disappear, leaving only useful effects. Design influences

human manners and behavior, that is why designer often tend to combine the material and the virtual.

According to S. M. Mikhailov [10: 93–94], the specific features of post-industrial design are the following:

- Miniaturization of design objects (the shape of an object is subject to ergonomics;
- Virtual design (the shape of an object loses its substantiality);
- Artificial intelligence of objects (the shape of an object follows human emotions);
- Interactivity (chameleonic shape of an object).

The mentioned above features of post-industrial design fully correspond to the main characteristics of LED-technologies, which are the following:

Standard sizes of LED-illuminators that averagely are 1-10 mm turn them into a light dot thus securing such feature as miniaturization;

LED-technologies enable broadcasting of any graphic or video information, as LED-illuminators can transform a surface into a solid screen (on condition of a certain assembling), which is a direct feature of transforming a material form into a material-virtual one;

The use of various sending units that react to a user, to changes in the environment as well as preliminary programming of certain light effects, create the sense of 'artificial intelligence' of illumination environment;

Certain 'dialogue' between the user and the illumination environment which is capable of reacting even to changes in his/her psycho-emotional state provides interactive connection between objective and spatial environment and the user (the ability of the system to respond to a user's queries in a real time mode).

I. O. Rozenson considers that [16] the new rationality neglects the concept of 'living arrangement', that is why it does not have tendencies of the total design. It is connected with the idea of space as of the objective and spatial environment, where special stets are presented as both separate figures and separate connections. Changing in their correlation, they alter the environment as some inseparable total. V. O. Timokhin, V. O. Shebek, T. V. Malik and others [13: 68] outline the perspectives for further development of the ideas and methods of the total design in the field of the design of architectural environment as following:

- absolute mechanization, automation and computerization of the global environment;
- removal of the difference between exterior and interior environment;
- disappearing of local architectural traditions and the formation of new aesthetic doctrine of modern architecture;
- extinctions of the borders between architecture and industrial design;
- versatility of design methods.

I. O. Rozenson accentuates [16: 92] that any changes are possible only in *time*, so space which is defined as environment most accurately connects these two notions. In the post-industrial society there is a transition to the idea of the world as *continuous and vaguely predictable* which provokes the development of probabilistic and system images. This interpretation of changes in the modern post-industrial worldview can be used to illustrate the connection of the modern LED-technologies with the post-industrial illumination design of object and spatial environment.

So, any changes can happen only in the course of time. A bright example of this phenomenon in the light design is *the dynamic LED-illumination*. Its use in the project of an interior design makes the time factor a full compositional element. Отже, будь-які зміни можуть відбуватися лише в часі. This circumstance makes the design of artificial illumination close to light and colour direction. Variability of colour solution of both decorative and functional illumination becomes usual and gives certain freedom of choice to the user and a powerful compositional tool to the designer. LED-technologies allow the designer to implement not only complicated illumination designs in an interior, but also to create different variants of illumination arrangement, creating dynamic light environment by means of programmed control over the light. Dynamic illumination can be implemented by means of different visual methods, but all of them are united by one additional compositional tool — the time.

As R. Arnheim points out, the difference between spatial and time arts lies in placing emphases. One type of artistic presentation defines action via existence, while the other one defines existence via action. It means that they interpret existence in its two aspects — dynamic and static [1: 347–350]. Colour and light dynamics of an interior has its own specific that implies that elements of the environment keep their shape and location stable, and it is the illumination that changes in the course of time thus altering the user's perception of the environment.

The worldview of post-industrial (informational) society develops the vision of the world as *continuous and vaguely predictable*. Thanks to LED-technologies the 'continuity' of the world is secured by *tuning of artificial illumination according to natural cycles*, as well as certain 'unpredictability' is provided due to *interaction of LED-illumination with a user*.

Natural light which cyclically changes during the day includes morning light, bright afternoon light and evening twilight. Depending on the weather and season natural illumination can be soft and diffused, or harsh and lucid. Maximal approach of the LED-illumination to natural one, as well as the imitation of natural light cycles by means of artificial illumination brings artificial light to a new level of comfort and perception. Such illumination helps to save energy, to increase the performance of users, improves hygienic characteristics of the environment. Technologically the imitation of natural light is provided by smooth changes of brightness and colour temperature of the 'white' light. Combining photodiods of warm (2600 K) and cold (5600 K) spectrum in one illuminator, it is possible to provide a wide range of the shades of white: warm, neutral, cold, daylight. The main achievement of this technology is the possibility to control colour temperature and smooth control over the colour brightness (at a fixed colour

temperature). The adaptation and tuning of such illumination is either automatic or can be maintained directly by the user choosing a certain program out of a number of the given ones. Such illumination is especially appropriate in the rooms with lack of daylight. LED-light of this type helps to bring the work of the biological clock of a user into balance, improves user's health, and brings natural dynamics to the room.

The scientific experiment which was held during 2007–2008 in schools in Hamburg, Germany by Philips Company, demonstrated that dynamic illumination of schools that is tuned automatically, in accordance with the intensity of the daylight as well as with the natural rhythms of a child's organism, increases students' attention concentration, forms positive attitude towards studies and improves students' health. [15].

Imitation of daylight by means of LED-technologies provides functional illumination that meets all the ecological hygienic standards, compensates lack of natural light, increases productivity and efficiency. Moreover, a light-colour environment is created that highlight the connection with the outer space and evokes aesthetic and emotional impressions that are close to those inspired by the interaction with sunlight.

Interconnection of LED-illumination and the user is often provided due to its interactivity which is an ability to have a sort of a dialogue with a human. Tin the modern post-industrial society this feature has gradually become an essential element of a comfortable object or object and spatial environment. The notion of interactivity came to the sphere of design owing to its interaction with IT and mass-media. Thanks to this the emergence of 'alive' things that react to human behavior, taking into account changes in his/her emotional state, has become possible.

S. M. Mikhailov [11] considers that interactivity has become the main characteristics of post-industrial design and has brought new objects for design activity and dramatically changed the already existing traditions. The introduction of the so-called 'smart house' has become a certain climax in the development of interactive design, when not a separate thing becomes intelligent, but the whole object and spatial environment — a complex of interdependent robotic objects that create 'intelligent and spatial environment'. LED-technologies provide complex interactive control over illumination which can be performed both by the used, in accordance with his/her subjective feelings, and automatically — with the help of various sensors that react to the parameters of the inner environment and tune the illumination system according to them.

In the condition of interactivity the shape of an object gradually loses its traditional definitude and predictability, turning into more flexible and spontaneous 'chameleon shape', able to change reacting to outer factors or to a human. In design shape formation turns into the construction of a range of interdependent levels of 'human covers' that penetrate into one another and provide comfortable conditions for different functional processes of life activity. S. M. Mikhailov [10: 86] defines several levels, such as: 'biomechanical level' (a diffusive contact of a human and of a thing with mutual penetration), 'the level of the long-lasting tactile contact', 'the level or sensor contact and motility', 'the level of eye-contact'. The total of these covers and levels makes a hierarchic 'ergocentric' model of object forming, in the centre of which there is a system 'a human — an object'. The specific feature of object forming on the tactile contact level is the demonstrated individual direction of objects that often belong to the 'personal possessions' category. To make tactile contact between the user and a light object safe, it has to meet some necessary requirements to LED-illuminators.

Probabilistic and *system* ideas have developed in the post-industrial society. With the help of LED-technologies probabilistic ideas are implemented though *a set of scenarios and limits within which a user is free in his/her choice*. System ideas are implemented thanks to *programming illumination as a united system with general control*.

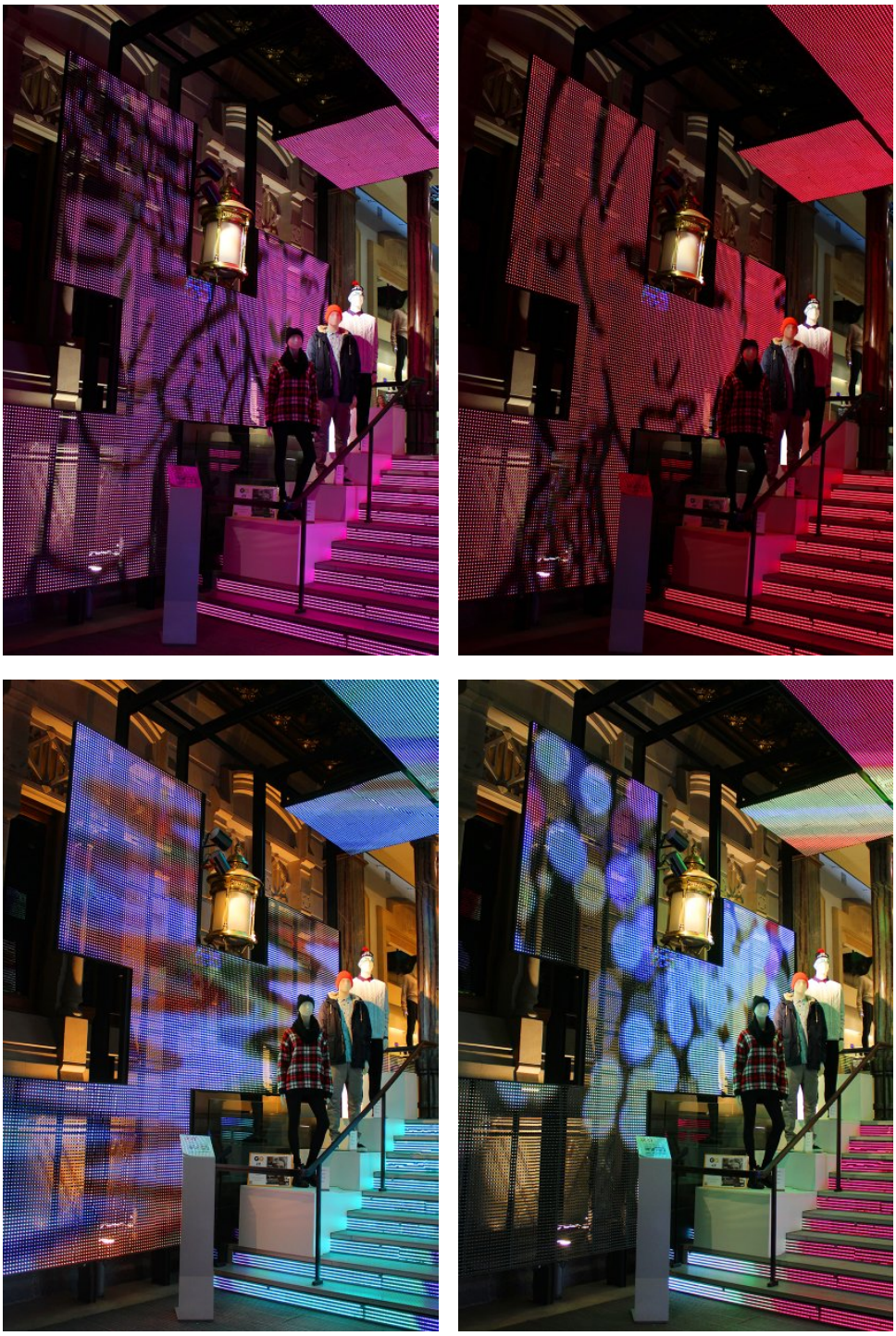
D. A. Norman [12: 284] gives nice examples to illustrate the important role of the set of scenarios and limits, within which a user is free to choose. He thinks, that the design has to:

- prompt possible actions for this very moment (the use of limits);
- correspond to the principle of visualization, including the conceptual system model, possible actions and their results;
- enable the estimation of the current state of the system;
- express natural correspondence between intentions and necessary actions, between actions and their results, between the visual and real system state.

The use of scenario modeling during the design of light-colour environment provides meeting all these requirements. Talking about urban environment, S. M. Mikhailov calls this process 'the completion of a scenario map' [10]. In the scholar's opinion the development of the scenario happens due to the movement of the subject in the environment. For this scenario modeling a certain environment spot does not have to change at a certain period of time, as urban environment is broader that the interior. To perceive any changes in urban environment it is enough to move inside it. In case of an interior certain environment may alter together with a human moving inside it. The user perceives the interior from different points and sides, and the environment, in its turn, can 'respond' to a human's actions and interact with him/her.

Scenario modeling is a verbal-graphic form of unveiling the design system, which determines its future state, logical consequence of construction, disclosure of some separate situations (setups). Such researchers as A. V. Efimov, M. V. Lazareva, V. T. Shimko [5: 61–62] offer a complex of special activities that implement illumination scenario: arrangement of illuminators and supervision points, corresponding distribution of brightness levels within the interior, elaboration of different variants of functional and emotional illumination of different interior zones. The authors also state the tasks which they solve with the help of the illumination scenario:

- arrangement and supervision of illuminators that are technologically essential for this of that activity (operational lamps, scenery projectors, highlighting of surfaces or exhibits, general illumination of the interior);
- visual zoning of the interior (separating of highlighted zones and dotty light emphases, luminance difference, light screens);
- creation of image and atmosphere (the use of directed, local, colourful illumination and light patterns to create certain mood or associations among the visitors of the interior);
- the use of illumination systems as of information means (highlighting signs and charts, marking exits, compositional 'magnets' and movement directions in communicational interiors with intense light, highlighting the floor etc.);
- the use of replaceable light modules and multifunctional illumination systems for implementation of various temporal scenarios and actions, that suggests
- program supervision of illuminators in safety system complexes;
- correction of defects of spatial-compositional design by means of illumination design.



Picture 1. Entrance to the 'H & M' shop, Barcelona, Spain (photo is taken by the author)

The fact that LEB-illuminators tend to create a light cover for any object or environment and to integrate or to merge with the object and spatial environment promotes programming illumination as a single system with general control. Turning into the 'skin' of filler structures, illumination acquires absolute flexibility. The main advantage of combining light with objects is mobility that is revealed in its brightest with energetic in-feed with the help of solar panels. Mixed LED-illumination set in the shape-environment becomes an inseparable part of the whole system of the object and spatial environment. With the help of switching the programs of the scenario this illumination is able to immediately highlight as well as totally ruin the shape of space. LED-illumination is usually designed so, that supervision of compositional elements of light-colour environment could be performed with the help of the general control system. This enables maximal compositional correlation of the whole system. For example, *picture 1* shows some variants of light dynamics changes that occur simultaneously in all illumination elements of the general composition: on the stairs, on the light panels of the wall, on the light panels of the ceiling.

Conclusion. To sum up, it is worth mentioning that main features that are typical of the modern post-industrial design can be applied as main characteristics of LED-technologies. Any changes are possible only in the course of time. The brightest illustration for this phenomenon is the dynamic LED-illumination. The use of it enables the factor of time to become a full compositional means. The worldview of post-industrial (informational) society has shifted to the idea of the continuous and vaguely predictable world. The 'continuity' of the world is secured by the tuning of artificial illumination correspondingly to natural cycles, and certain 'unpredictability' is maintained by interactive connection of LED-illumination and the user. The worldview of the post-industrial society develops probabilistic and system ideas. With the help of LED-technologies 'probabilistic' ideas are implemented though a set of scenarios and limits, while system ideas are implemented owing to programming of illumination as of a single system with general control.

So, the emergence of LED-illuminators marked the transition to informational light-colour environment that has its own formation peculiarities. The total of technological methods of LED-illumination has to comply to the general solution and correspond to the main rules of composition. Unsupervised use of modern technologies disables the achievement of compositional harmony. Abuse of light effects in certain cases can not only ruin the totality of a design image, but also bring imbalance into the feeling and emotions of the user.

Further research can be focused on the detailed analysis of the means of light-colour forming in illumination design of object and spatial environment by means of LED-technologies.

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