Traditions and innovations in lighting of libraries

L V Karaseva
Don State Technical University, Gagarin square, Rostov-on-Don, 344000, Russia

E-mail: klarissav@yandex.ru

Abstract. The libraries lighting systems development was shown with the changes of their functions when the new architectural directions appeared and the light role in the space formation was rethought. The main factors influencing the comfortable luminous environment creation - maximum natural light use, protection from insolation, color and texture of finishing materials - were considered on the examples of the well-known libraries. Special attention is paid to the Don state public library interior lighting theme in Rostov-on-Don.

Introduction
Luminous environment is an important component of the artificial environment created in buildings. Light in the interior performs many functions: it illuminates the room, is useful for health, creates a certain mood, provides security, is a source of information and sometimes plays the role of a guide. When designing the lighting of libraries, it should be taken into account the specifics of their rooms, the peculiarities of visual work, as well as the necessity to protect paper media (especially archival documents and ancient books) from the damaging effect of light.

The lighting system choice determines not only the visual work conditions, but also the architectural and art appearance of the interior. This paper deals with the evolution of library lighting and the gradual change in attitude to the role of light in the interior – from utilitarian to formative one. Innovations in lighting of libraries are associated not only with the emergence of new lighting devices and finishing materials, but also with the new status of the library and the search for new architectural and design solutions.

Evolution in library lighting

The library interiors natural lighting of in the pre-electric period. The first libraries were created as rooms and institutions for storing documents and books available for use by a very limited number of people. In medieval Europe, the library has new functions associated with the emergence of educational institutions - universities. In the 18th century, there was a turn from the storage tradition to an educational one, books became accessible and open to the public.

The best architects were attracted to the design of the new library buildings and for their construction a place in the heart of the city has been chosen. The library building was to become a symbol of the repository of knowledge, cultural revival and civic identity.

Most of the libraries were distinguished not only by the magnificent interior, but also by the thoughtful natural lighting. In the pre-electric epoch, the architects tried to ensure maximum flow of daylight into the library premises. For this purpose, they set up large windows of various shapes in the upper part of the walls and a partially or fully glazed ceiling. The choice of finishing materials with high reflectivity also increased the illumination of the room surfaces.
French architect Henri Labrouste, who was the first to start using widely iron frame in his constructions, is known primarily for the Parisian libraries he designed. In the National Library (1862–1868), Labrouste rationally divided the reading room and the book depository, which were previously located in the same room. In the reading room, nine domes rest on tall slender columns as shown in Fig.1. Spherical vaults were performed by Labrouste of thin faience tiles; in the center of each vault there is a round hole [1]. This technique ensures uniform illumination of all tables in the reading room. White faience, filling the metal frame, perfectly reflects the daylight and enhances the feeling of lightness.

![Figure 1. Reading Room of the National Library of France (architect H. Labrouste)](image)

Light openings in the roofing, and then completely glazed roofs illuminate the interiors of many famous libraries of XIX - early XX centuries. The famous British Museum Reading Room, covered by a dome, with 42 meters in diameter, was erected in 1856-1857 by Sydney Smirke and was lit through a hole in the dome and many windows around the perimeter. One of the most beautiful libraries in North America is the George Peabody Library, located in Baltimore, USA (architect Edmund G. Lind, 1878). The six-tiered atrium with columns and wrought balustrades is filled with light.

The Domed Reading Room of the Victoria Library in Melbourne, Australia, built in 1913, is covered with the biggest dome in the world at that time. Daylight streams passing through the glazed openings in the dome and round windows around its perimeter and the light reflected from the white walls, create a calm and solemn atmosphere.

**XX century. From lighting of libraries to light architecture.** From the outset, the 20th century is characterized by the cities’ growth, intensive post-war construction and the rapid technology development. In the last quarter of the XIX century electric light sources – incandescent lamps - were created. And in the 30s of the 20th century economical fluorescent lamps appeared. The development of artificial light sources and lighting fixtures gave the new opportunities for the interiors’ luminous environment formation.

The use of new construction technologies and materials, as well as the search for modern forms and buildings esthetics have led to the new directions’ emergence in architecture.

The theme of light, natural lighting is noticed in all the works of Alvar Aalto, the famous Finnish architect. Aalto implemented his concept of humane architecture in the projects of buildings of cultural purpose [2].

In the library in Vyborg (1927 – 1935) the young architect embodies his ideas for the creation of a comfortable luminous environment, favorable for reading and intellectual activities. He comes up with funnel-shaped skylights in the ceiling that do not allow direct sunlight. The depth of the cones is such that only reflected light enters the room, creating soft, shadow less lighting. The light reflected from the light surfaces of the walls and the ceiling also participates in the interior illumination. Aalto preferred natural materials and a color palette typical of Finnish architecture. The white stucco, concrete, and glass of the facade create a pleasant contrast with the wood finishes of the interiors.
Light is multifunctional in Aalto architecture. Using different types of openings, deliberately creating uneven natural illumination, the architect divides a single space into zones, controls visual perception, sets the orientation and creates light dynamics of the interior.

In the early works of Aalto, the light openings and the shape of the room are autonomous, independent of each other. Conical skylights can be replaced with spot lamps, the perception of the shape of the reading room will not change. Later, the architect uses roof lanterns of various shapes and creates real daylight “traps”. The curved plane of these roof lanterns, reflecting the light, becomes essentially the ceiling. The form catches and distributes light. A variety of devices of natural lighting are used in the regional library of Lapland, Rovaniemi, (1965) and the library of the Polytechnic Institute in Otaniemi (1970). In these projects, the architect managed to achieve full unity of light, form and space.

In 1967 in Zelenograd, a new experimental satellite town of Moscow, construction of the educational complex of the Moscow Institute of electronic technology (MIET) began. The authors of the project were architects F. Novikov and G. Saevich [3]. At that time, it was a completely innovative project, representing a sample of the best architecture of the 60s for the USSR.

Architects widely use various techniques of top natural lighting as presented below (see Figure 2). The inner space of the main building is organized around the library cube inserted into the hall. Above the central part of the library there is an inverted pyramid, diffusely reflecting light. The ceiling above the readers places consists of pyramidal caissons formed using the basic structure of the overlap. Their tops are overlapped by skylights. Direct solar rays don't fall into the reading room, and diffusely reflect from the light sloping sides of the caissons. Such a luminous ceiling creates a quiet comfortable lighting in the library.

![Figure 2. Section of the main building MIET](image)

Natural light plays a key role in the creativity of the famous American architect Louis Kahn. According to his ideas, space is formed by the light that penetrates it. The choice of the type of light that necessary for space determines the choice of constructive solution [4].

Kahn designed the library in Exeter, USA (1971), one of his landmark works. The building plan is divided into nine equal squares. In the center there is an illuminated hall, in the concrete walls of which round holes of large diameter are made. Through these openings visitors can see several floors of the library. Two massive concrete cross beams above the hall diffuse the light entering from the clerestory.

In the brick building interior, Kahn uses mostly concrete. Shelving, furniture, some enclosures are made of metal, leather, wood. When the solar rays enter the interior, interesting light contrasts of these materials with concrete appear. The interaction of natural light, space, structures creates a favorable luminous environment.

**XXI Century. Luminous environment of new libraries.** In the 90-ies of the twentieth century the digital technology wide distribution epoch began. The libraries faced the problem of reducing interest in them as a book storage, a special place for reading and working. To return the attention of the society, the modern library had to fit into the new reality, meet the needs and demands of people.

New information technologies have been introduced everywhere. Along with the traditional places for reading, there are zones for working with computers. But the changes affected not only the expansion of the resource base. The library becomes a community and cultural center, where various
events are held, such as exhibitions, presentations, conferences, lectures, trainings, meetings, courses, flash mobs.

Currently, library innovations are concentrated to a greater extent in the field of architecture and design. Libraries around the world have become a fashionable and status object [5]. According to the projects of famous architects, amazing buildings, in which modern views on the social space of the library reflected, were built. Below some vivid examples in which light plays a crucial role are considered.

The central library in Seattle (USA) was opened in 2004. Architect Rem Koolhaas has designed a building of unusual shape in the style of deconstruction, asymmetrical facades which faced with a powerful diamond-shaped steel lattice, glass filled. For half the walls of the building triple glass is used - with a metal grid between the two outer layers. In that way the problem was solved to reduce the solar heat entering the building through the sunlit facades. The internal space of the library is flooded with light, through the complete glazing a panorama of the city opens.

Zaha Hadid created in Vienna (2010-2013) a completely futuristic library building at the University of Economics and Business. The freely designed interior resembles the interior of a spaceship. Atrium, library halls, zones for individual occupations and for communication are connected by curved bridges, inclined passages, galleries. A lot of glass, plastic are used in the interior, white color dominates. Natural light coming through the roof and windows, reflected from white surfaces, harmoniously combines with the original lighting devices.

The mega-library "The Eye of Binhai" (MVRDV, Netherlands, in collaboration with TUPDI, China, 2017) of the Chinese city Tianjin impresses with its unique innovative design. In the center of the library atrium there is a huge sphere, illuminated through a hole in the dome of the building. The surface of the ball reflecting light, mirror floor, white curved bookshelves by floor-to-ceiling (with real books and their printed images) and hidden illumination fill the space of the library a calm soft light.

Worldwide, an active search for a new look of library buildings is observed. Not all projects are distinguished by such radically new solutions that were discussed above. One of the directions of the search is "the actualization of cultural traditions" [5]. The classic style still prevails in the interiors and architecture of most current library buildings, including Russian ones.

**Interior lighting of the Don State Public Library in Rostov-on-Don.** DSPL is the central library of the Rostov region, information, community and cultural center. Founded in 1886, the library is now housed in a building on the Pushkinskaya street, the most beautiful and green street in Rostov-on-Don.

The history of the erection of the new library building is quite dramatic. The construction of the library complex, designed by architect Jan Zanis, began in 1974 and lasted for whole 20 years. During this period, some ideas and details of the project were violated, for example, the facing of the building was made not of light marble, but of less expensive tuff and natural stone. In 1994 the library moved to a new building.

The library complex consists of two buildings. The 13-storey (including underground floors) monolithic concrete book storage is almost devoid of decor, reading rooms and other library premises are located in three-storey blocks, made in the similar style. The monumental image of the building, corresponding to the style of the 70s, successfully blended into the environment and reflects the idea of the temple of knowledge, as the architect intended.

Behind the restrained laconic appearance of the building a diverse interior hides. Lighting plays a significant role in creating the architectural and artistic image of the block of reading rooms. The choice of lighting systems and finishing materials corresponded to the idea of architect Zanis to create a light image of the library as a place to get knowledge, reading, reflection, communication with like-minded people.

A variety of finishing materials: brown tuff, gray basalt, white marble and granite, wood, various types of plasters, warm light coloration were used in the library interior. Choosing materials, light apertures, lighting devices, the architect successfully zoned the library space.

Entering the library, you find yourself in a relatively dark zone of the lobby. The walls are finished with tuff, having a small reflection coefficient (measured value is 0.2), the floor is also dark. Behind
the columns of the lobby, an illuminated space can be seen as shown below (see Figure 3). So the light becomes a kind of guide for visitors when moving from the lobby to the center of the building.

![Figure 3. Lobby of the Don Public Library](image1)

On the Figure 4 the central place in the composition of the library is shown. It is an atrium in which the winter garden, a cozy area for relaxation, reading and chamber communication is located. The abundance of greenery, pools, fountains create a comfortable environment and attract visitors.

![Figure 4. Atrium in DSPL](image2)

Natural light enters the atrium space through the original light-transparent ceiling as shown on the Figure 5. It consists of 60 caissons, the tops of which are covered with roof lanterns of gable shapes. Such a construction, letting daylight through, protects the library’s premises from insolation, which is undesirable for books and comfortable visual work. Sunlight passes through the lattice of the luminous ceiling partly, creates a play of light and shade on the white enclosures of the atrium, but does not get deep into the premises.

Various techniques of artificial lighting are used to illuminate the premises of the library. In some halls, the daylight effect is created by means of a caisson ceiling, repeating the geometry of the atrium roof (see Figure 5). Around the perimeter of the caissons frames are installed, behind which the lamps are hidden. In the recess of each caisson there is a square luminaire with frosted glass. Direct and reflected light streams emitted by these “artificial lanterns of top lighting” create sufficient illumination on the working surfaces (415 – 450 Lux at a norm of 400 Lux).
Figure 5. Fragment of the ceiling in the Don Public Library

Since 2017, only LED lamps have been used for artificial lighting of the library premises. The total number of such lamps is 7456; the average power is 29-33 watts.

Two 100-watt linear LED luminaires are installed above each cell of the light-transparent ceiling. They illuminate the atrium space in the evening or even at night, during the popular event "Night in the Library".

The lighting project of the Don library was an inalienable part of the architectural project. Ya.S. Zanis in collaboration with lighting engineers managed not only to create a comfortable luminous environment, but also to realize the architectural and artistic design. The light leads visitors from the dark entrance area to the illuminated atrium and up the white stairs to knowledge, spiritual growth. At the same time, a green oasis in the atrium and the use of natural materials create a feeling of comfort, a warm atmosphere.

Summary
In the library buildings design the lighting issues play a very important role. The key role has always been played by natural light, which in many libraries, from the oldest to the most modern, came from above through the light-transparent ceiling. Top lighting creates uniform high illumination for visual work. In the twentieth century, the light began to exert a certain form-making influence on the architecture of buildings.

Nowadays, when creating an attractive, sometimes unusual, library design, new sources of light and lighting devices are actively used: economical, dynamic, with good color reproduction. For example, hollow tubular light guides are widely used to illuminate buildings, including libraries, creating a high-tech style preferred by the younger generation.

Lighting techniques of the library buildings can be very diverse, corresponding to the architectural solution and design, innovative or classical. In any case, the formed luminous environment should be favorable for reading, reflection, education, knowledge of the world. These are the traditions of library lighting.

References
[1] Ern I V 1972 Chapter III. Architecture of France, in: General history of architecture (Publishing house of literature on construction, Moscow) 10.
[2] Information on http://www.forma.spb.ru/magazine/articles/d_006/main.shtml
[3] Information on https://www.netall.ru/realty/articles/1037312.html
[4] Information on https://www.architime.ru/specarch/louis_kahn/exeter_library.htm#6.jpg
[5] Information on http://www.library.ru/1/kb/articles/article.php?a_uid=332