Niğde Ömer Halisdemir Üniversitesi Güzel Sanatlar Fakültesi
STAR
JOURNAL OF ART AND DESIGN RESEARCHES
SANAT VE TASARIM ARAŞTIRMALARI DERGİSİ

DAYLIGHT IN LIBRARY DESIGN AND NATURAL LIGHT DISTRIBUTION: OSTIM TECHNICAL UNIVERSITY LIBRARY

KÜTÜPHANE MEKANI TASARIMINDA GÜN IŞIĞI VE DOĞAL IŞIK DAĞILIMI: OSTİM TEKNİK ÜNİVERSİTESİ KÜTÜPHANESİ ÖRNEĞİ

Tuğçe ÇELİK[1], Nurgül İNAN[2]

Gönderim Tarihi: 13.01.2023
Araştırma Makalesi
Kabul Tarihi: 02.06.2023

Abstract

Natural light is the healthiest light physically and spiritually and should be used with maximum efficiency in the space. The library structures, which serve users with different characteristics, continue to function as culture and information centers and have been an indispensable part of information societies from the past to the present with their contributions to social and economic development. In this study, the illuminance levels of natural light were analyzed in the library space of Ostim Technical University, which is a university library, and space-light discussions were made on the visual outputs. The method of the study consists of several stages. First, the library space was modeled in the computer environment and natural light distribution analyzes were made in the Velux Daylight Visualizer program in line with the determined parameters. The outputs were examined according to the standards researched within the scope of the study. The aim of this study is to examine the brightness levels provided by natural light in the library spaces through the library selected as an example and to reveal its undeniable role in shaping the space together with the spatial setup.

Keywords: *Space-Light, Natural Light Distribution, Library Design, Lighting, Architectural Design*

Öz

Doğal ışık, fiziksel ve ruhsal olarak en sağlıklı ışıktır ve mekanda maksimum verimle kullanılmalıdır. Değişik özellikteki kullanıcılara hizmet eden kütüphane yapıları, kültür ve bilgi merkezi olarak işlevlerini sürdürmekte olup sosyal ve ekonomik gelişmeye yaptığı katkılarla geçmişten günümüze, bilgi toplumlarının vazgeçilmez bir parçası olmuştur. Bu çalışmada Ostim Teknik Üniversitesi kütüphane mekanında doğal ışığın aydınlık seviyeleri analizleri yapılmış ve görsel çıktıları üzerinden mekan-ışık tartışmaları yapılmıştır. Çalışmanın yöntemi birkaç aşamadan oluşmaktadır. İlk olarak kütüphane mekanı bilgisayar ortamında modellenmiş ve belirlenen parametreler doğrultusunda Velux Daylight Visualizer programında doğal ışık dağılım analizleri yapılmıştır. Alınan çıktılar, çalışma kapsamında araştırılan standartlara göre irdelenmiştir. Bu çalışmanın amacı, örnek seçilen kütüphane üzerinden kütüphane mekanlarında doğal ışığın sağladığı aydınlık seviyelerini irdelemek ve mekansal kurguyla birlikte mekanı biçimlendirmedeki yadsınamaz rolünü ortaya koymaktır.

Anahtar Sözcükler: *Mekan-Işık, Doğal Işık Dağılımı, Kütüphane Tasarımı, Aydınlatma, Mimari Tasarım*

[1] Sorumlu Yazar: Doktor Öğretim Üyesi, Tuğçe Çelik, Ostim Teknik Üniversitesi, tugce.celik@ostimteknik.edu.tr, ORCID ID: 0000-0002-2953-6373.

[2] Doktor Öğretim Üyesi, Nurgül İnan, Ostim Teknik Üniversitesi, nurgul.inan@ostimteknik.edu.tr, ORCID ID: 0000-0003-3006-9271.

- **Alıntılama:** Çelik, T. ve İnan, N. (2023). Daylight In Library Design And Natural Light Distribution: Ostim Technical Unıversıty Library. Sanat ve Tasarım Araştırmaları Dergisi, 4(6), 70-89.
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Introduction

The most basic element that creates the essence of architecture and creates an architectural product is space. Although architectural space is handled in different ways by various approaches, it can be defined as a limited space that creates living spaces to meet needs in the most general sense. The boundaries that define the space may not always surround the space as a completely closed volume. However, boundaries can be precise and physical to impede movement, or they can be perceptual such that they are unclear and only detectable by other senses. In the context of visual perception, light creates the space by making it visible. The user creates meaning in his/her mind with the intensity, distribution and arrival of natural light in the space and perceives the form, geometry, structure of the architectural space, and therefore the whole space. This whole also creates an aesthetic judgment of architecture in the minds of the users.

Meiss (1991) directly associates architecture with light with the definition that “Architecture is the art of placing and controlling light sources” (Meiss, 1991: 191). L. Kahn (1968), on the other hand, discusses the space-light relations by interpreting architecture in his works as "a beginning that exists between silence and light" (Kahn, 1968: 135). According to Gür (1996), a sufficient amount of light (illumination) ensures that objects are easily noticed and the environment gains a safe and pleasant feature. Insufficient lighting causes accidents and reduced work efficiency (Gür, 1996: 53-68).

Libraries are needed as a result of social life and need to serve scientific, social and cultural development. In parallel with the development of civilization, libraries have become the most important institutional structures in terms of access to information.

Lighting and visual comfort have a very important place in ensuring the performance expected from libraries. In these buildings, natural light distribution directly affects user performance. This performance can be increased with a correct and sufficient lighting design. Therefore, it is important that natural lighting and light distribution are correct and sufficient illumination level is provided in the interior design of libraries.

The geographical location of the building, the direction and dimensions of the windows determine the performance of the natural light taken in indoors. In order to provide the desired comfort in terms of light distribution, the color, texture of the building elements, the positioning of the functions according to the windows and the placement of the furniture are taken into consideration. Therefore, the need for lighting also determines the spatial formation and organization of the space.

The aim of this study is to reveal how the desired performance is affected in accordance with these criteria over an existing library space. In this direction, an evaluation of the Ankara Ostim Technical University library in terms of lighting and visual comfort was made in line with the current conditions and layout. In the study, especially natural lighting performance was analyzed and artificial lighting performance was excluded. It is expected that the positive or negative conditions obtained will lead to other library designs.

Natural Light And Lighting

Lighting is defined by the International Commission on Illumination (CIE = Commission Internationale de I'Eclairage) as "applying light to ensure that the environment and objects are properly seen" (Ünver, 2002: 213). M. Leland Roth, in his book titled “The Story of Architecture”, explains light and its effect on people: “Our primary receptors are our eyes in our sense of the environment, and therefore the light that illuminates the environment has an important place in the cognition we receive. The perception of tissues depends on the quality of the light falling on the structure. Moreover, light creates strong psychological responses." (Roth, 2000: 112). These explanations reveal that the image obtained with the lighting should be suitable for a certain purpose and a request, and that it is necessary to look at the subject from an artistic and architectural point of view as well as from a technical point of view (Özkum, 2011: 94).

The effect of light entering space on human perception has been used by architects since ancient times. The behavioral principles of natural light have guided architectural design throughout history. Due to the need for light during daily activities and the benefits of sunlight to the human body and psychology, natural light has always been an important data in architectural space design (Taşpınar, 1977: 15). Daylight, with its dynamic structure, both contributes to the space aesthetically and creates different effects in the space at different times of the day. With the design decisions taken, daylight can be added to the interior as an aesthetic value, apart from its feature of making the architectural space visible. Light participates in the structural and formal formation as a perceptually separate design element. Thus, it takes its place in the fictional integrity again. However, the most important functional advantage of natural lighting is that it enables us to see and perceive volumes, objects, colors and textures in their most realistic and natural state (Özkum, 2011: 95).

The sun, the source of natural lighting, is the oldest known primary energy source. Almost all energy sources are derived directly or indirectly from solar energy. It is clean, renewable and abundantly available all over the world. In today's design concept, the use of renewable energy sources has gained great importance within the scope of ecological and sustainable design. As the most important renewable energy source, the sun is considered as an important input from the beginning of the design phase. In this context, one of the purposes of using solar energy in buildings is natural lighting. Natural lighting is the provision of qualified daylight and necessary and sufficient illumination within the space in order to provide visual comfort conditions. However, solar energy is intermittent and variable. There are daily and seasonal variations (Berktan, 2006: 24-25).

According to Arpacıoğlu, “Daylight is not a new concept in design. Daylight is an important spatial design input that increases the spatial quality and enables people to integrate with nature." (Arpacıoğlu, 2010: 8-18). A design that provides effective use of daylight depends on the decisions to be taken at the scale of building, volume, building element and material, starting from the settlement scale (Erlalelitepe et al., 2011: 40). While making these decisions, the size, direction and position of the windows, the depth and shape of the space, and the color of the interior surfaces are important criteria (Lam, 1999: 113-124).

Developments in building and construction technologies have allowed the construction of larger and more complex buildings. In this type of buildings, artificial lighting is used because natural light cannot be accessed in every space. However, natural light is always an important design criterion because of its positive physical and psychological effect on people and because it is a renewable energy source within the scope of sustainable architecture.

The direction, dimensions and positions of windows, which are the most important building elements that allow sunlight to enter the interior, are the most important criteria in lighting design (Avcı, 2010: 23-26). The lighting levels provided by window types with different sizes and positions will be different from each other. Figure 1 shows the different window types and Figure 2 shows the light distribution they provide.

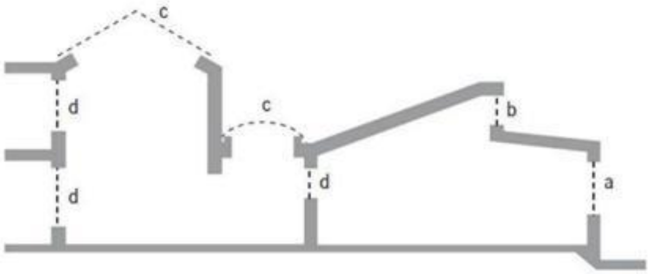


Figure 1. Different Window Types.

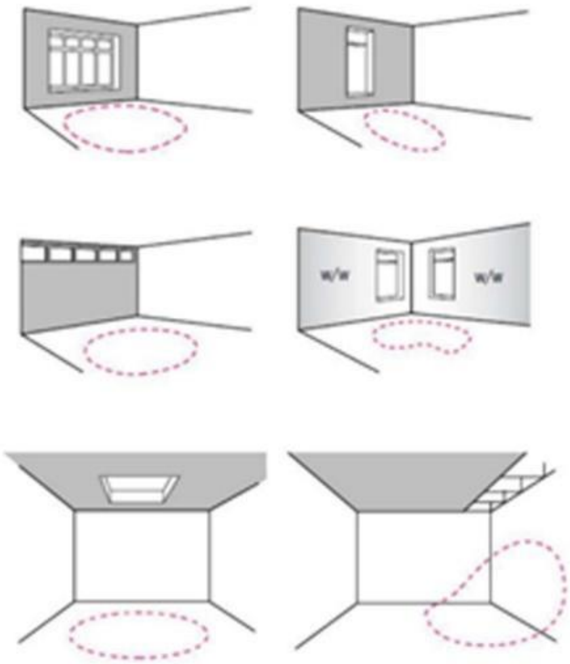


Figure 2. Light Distribution Provided by Different Window Types.

Different buildings have different lighting needs according to their usage characteristics. Different conditions of natural light, which has a variable structure, are used according to the needs of all types of buildings such as residences, hospitals, libraries, cultural buildings, station buildings, offices, and educational buildings. These needs determine the window types and the way the daylight is taken into the space in the design of the buildings.

Material and Method

In this study, it was desired to evaluate the relationship between providing the daylight needed in the library spaces with the size, placement and window types of the space. As a method, space-light analyzes were made with the help of a computer program on a 3D (three-dimensional) model of a selected study area. As a result, an evaluation has been made on how much the existing space setup meets the needs. The method of the study is shown in Figure 3.

Figure 3. Methodology of study.

In the study, the library of Ostim Technical University (Table 1) was chosen as a sample place. The library space is a place within the university building. The examination made in the study was made for the open reading section, which is the library space of the university, and the three group study rooms in it. Relief measurements of the selected space were taken and the plan (Figure 4) and sections were drawn in the AutoCAD Architecture program. According to these drawings, a 3D model of the space was created in the AutoCAD Architecture program (Figure 5). During the modeling phase, building elements in different materials such as the floor, walls, columns, glass curtain walls were created in different layers. The aim here is to provide an easy way to assign a different material to each building element in the Velux Daylight Visualizer program used in the next step.

Table 1

Examined space and properties.

Location	**Volume**	**Windows**
Ankara, Ostim	25,30x 24m	Glass curtain wall
39º58’08”N 32º44’37”E	2428,8m^3	24,20x4 m
	Materials	
	Floor: carpet, reflectance:0.350	
	Wall: brick coating, reflectance:0.208 + acoustic fabric coating, reflectance:0.350	
	Ceiling: acoustic fabric coating, reflectance:0.350	

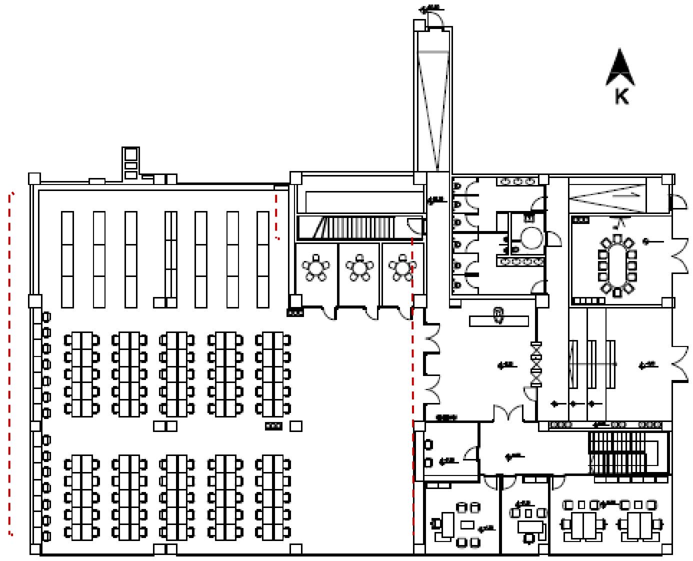


Figure 4. Library plan, AutoCAD Architecture.

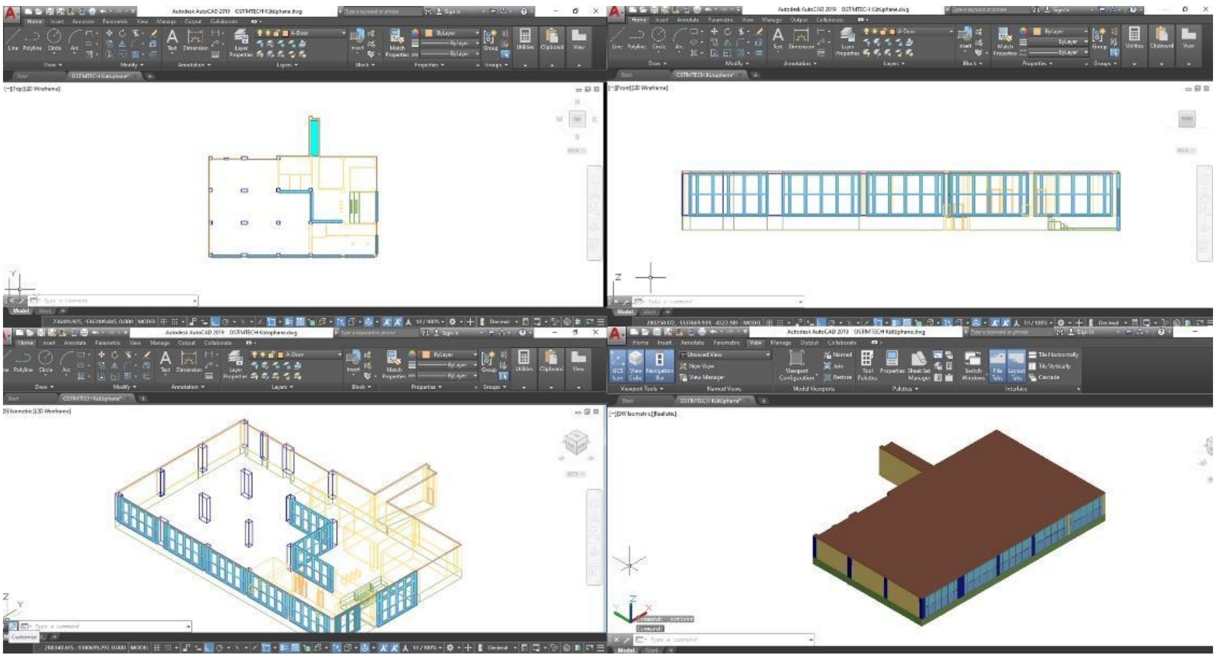


Figure 5. 3D model of the library, AutoCAD Architecture.

In the "Velux Daylight Visualizer" program, which shows the light distributions in the space and gives the luminance values, the 3D model of the selected space in the study was imported. Velux Daylight Visualizer is a program based on natural lighting and design, allowing 3D modeling of the space/structure, openings such as skylights, horizontal windows, which can be designed, giving the values of luminance and daylight factor and presenting these values as visual output. The Velux Daylight Visualizer program, which works for all relevant designers, also allows the material information of building components such as walls, floors, roofs, doors, windows to be entered. At the same time, the location and orientation information of the building can be selected from the library of the program. In this study, some parameters such as the coordinates and orientation of the building where the space is located, the materials of the components of the space, the placement and size of the windows, which are the openings in the space, and the dates on which the natural light distribution printouts will be taken were determined (Figure 6). In addition to the light distributions of the sample space of this study which is the library of Ostim Technical University to be taken throughout the year, these dates are also chosen as solstices: March 21 equinox, June 21 summer solstice, September 23 equinox and December 21 winter solstice (Çelik, Karamağaralı, 2019: 527).

BUILDING

Coordinates
Direction
Interior Materials

OPENINGS

Form of Windows
Location of Windows
Dimensions of Windows

DATE

March 21 - equinox
June 21 - summer solstice
September 23 - equinox
December 21 - winter solstice

Figure 6. Parameters used in the study.

When the model of the library space, made according to the real dimensions, is imported into the Velux Daylight Visualizer program, the first step is to set the scale correctly (Figure 7). Material has been assigned to the building elements of the library space whose scale is equal to the model. There is carpet flooring on the floor, brick coating on the walls, acoustic fabric coating on the columns and ceiling, and glass and steel material assignments were made on the curtain wall (Figure 7). The reflectance values of the building materials in the space were entered in the Velux program and presented in Table1. After processing the coordinates and orientation of the model, Ankara and the north direction, which are available in the program's library, cameras were placed to obtain visual outputs of natural light distributions both annually and on selected dates (Figure 8).

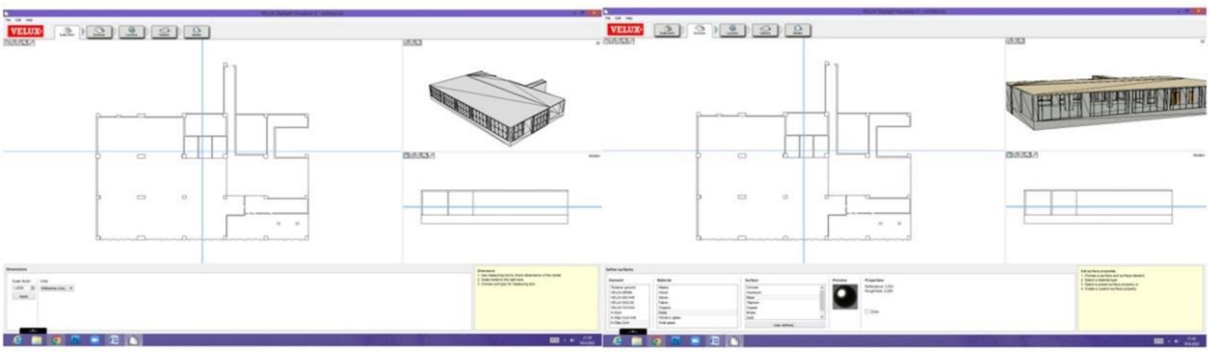


Figure 7. Scaling and material assignment in Velux Daylight Visualizer.

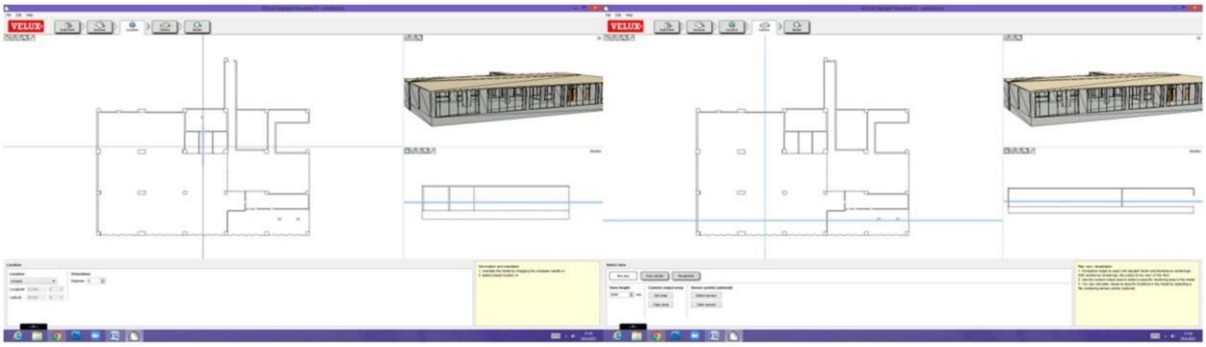


Figure 8. Coordinate and orientation, camera placement in Velux Daylight Visualizer.

The program gives the plan and section camera ready, and allows to place the camera from the desired point and angle for the interior perspective. The locations and viewpoints of the cameras can be changed. Visual outputs are taken from the point of view of these cameras, which depends on user preference. In this study, the plan, section and perspective selected from the interior space were taken for the visual outputs of the natural light distribution of the Ostim Technical University library space. The camera plane of the evaluation made for the planned plane is the working plane at a height of 85 cm from the ground, as seen in Figure 8. The reason for this choice is that the visual actions are performed on a horizontal plane, approximately 75-80 cm above the floor, on the table, since the examined space is the library. The cross-section camera cuts through the reading room and sees the floor, wall and ceiling tiles entering the reading room section. In this direction, in addition to the existing plan and section cameras, a camera placed at a height of 85 cm from the ground has been placed in the plan perspective and at a selected point from the interior (Figure 9). Annual light distribution visual outputs were obtained from each camera separately according to the luminance values of the average of months presented by the program. In addition illumination levels and distribution, and their visual outputs were obtained for the dates selected as the working parameters for the section and interior perspectives, 21 March – equinox, 21 June – summer solstice, 23 September – equinox and 21 December – winter solstice. Then, the light distribution given by the visual outputs of the camera placed in the interior perspective and the luminance values in the interior space were reached.

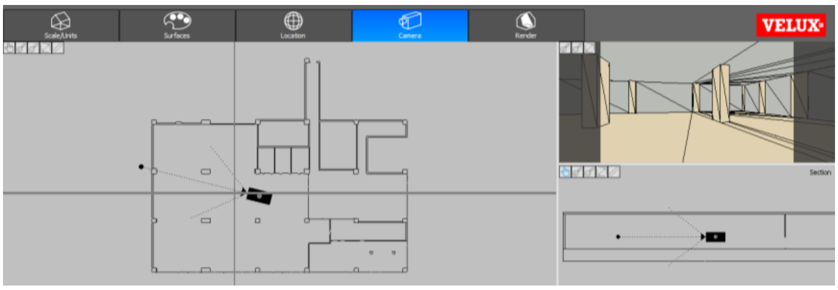


Figure 9. Camera placement, selected angle for perspective in Velux Daylight Visualizer.

The representations of the graphics are in two different formats, false color and ISO contour. False color refers to a group of color rendering methods used to display images recorded in the visible or invisible parts of the electromagnetic spectrum in color. ISO contour, on the other hand, draws the contours of the changes in the plan of the varying percentages of daylight factors.

First of all, the "illumination level" analyzes in the space were made. The illuminance level can be briefly defined as the amount of luminous flux per unit area. Luminous flux is a quantity derived from the radiant flux, Φe, by evaluating the radiation according to its action upon the CIE standard photometric observer (Url-1). Luminous flux is the total amount of light emitted from a light source. The symbol for the illuminance level is E, the unit is lux, the symbol for the unit is “Lx” (Ganslandt, Hoffmann, 1992: 42). At this stage, first of all, annual graphics showing the average illuminance value of each month were obtained separately as False color and ISO contour display. These graphs are taken for the plan (horizontal) (Figure 10, Figure 11) and section (vertical) (Figure 12, Figure 13). In addition, the illuminance levels in the interior viewed from the camera placed in perspective were also obtained (Figure 14, Figure 15).

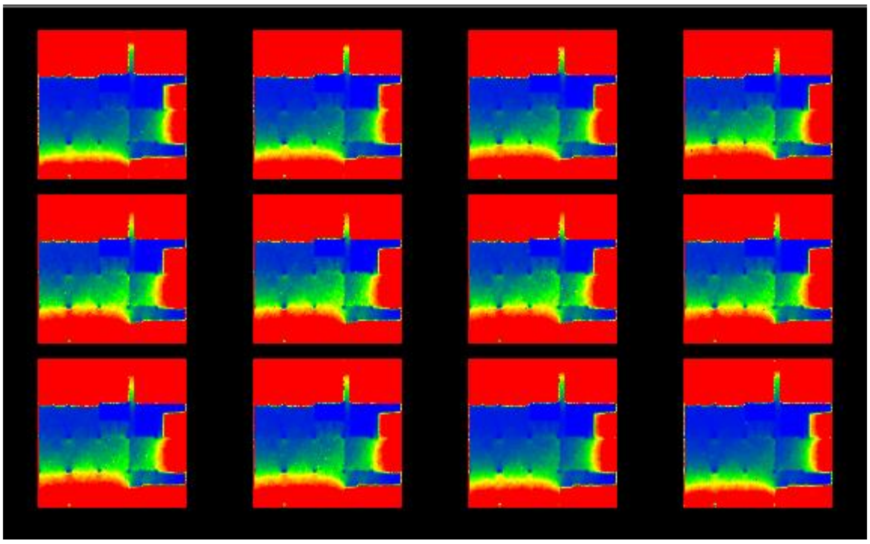


Figure 10. Visual output of annual illuminance values on plan (horizontal), False color display (on the floor of library space).

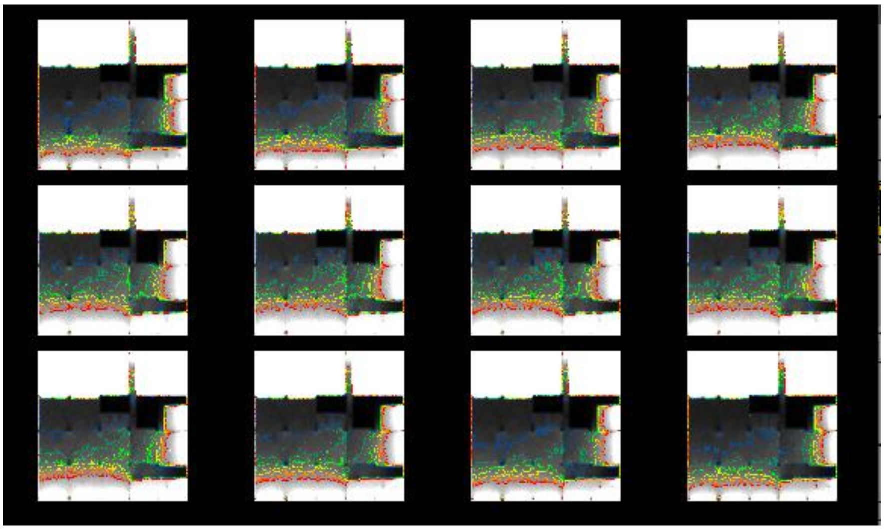


Figure 11. Visual output of annual illuminance values on plan (horizontal), ISO contour display (on the floor of library space).

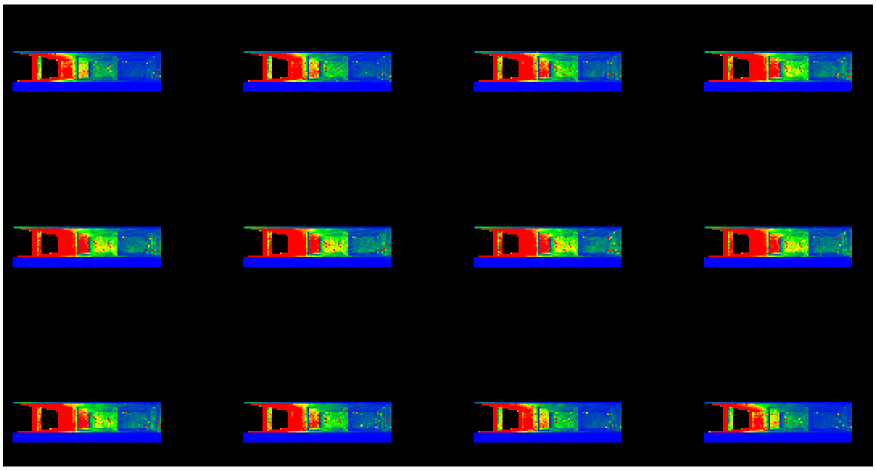


Figure 12. Visual output of annual illuminance values in cross-section (vertical), False color display (on the wall in the library area).

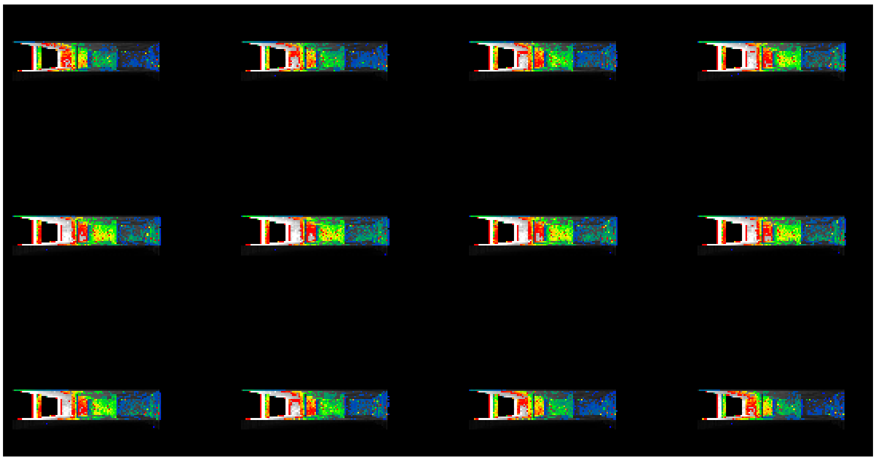


Figure 13. Visual output of annual illuminance values in cross-section (vertical), ISO contour display (on the wall in the library area).

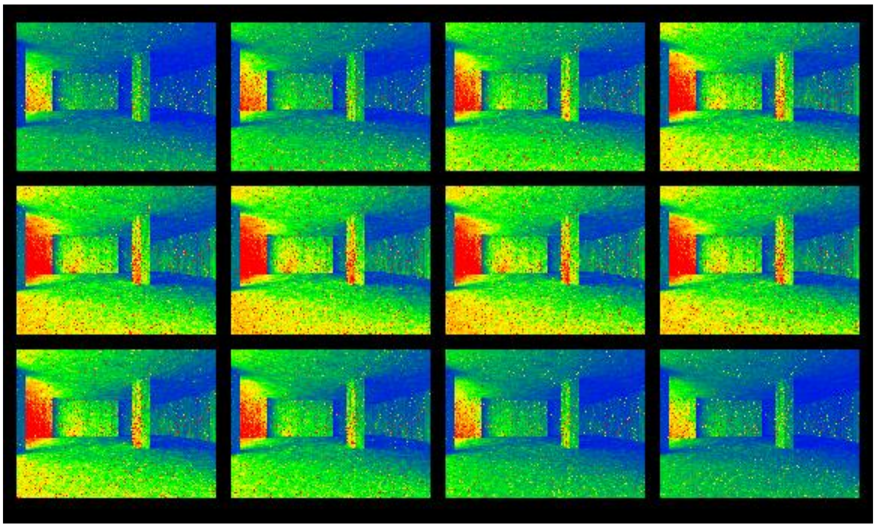


Figure 14. Visual output of annual illuminance values for indoor perspective, False color display (all surfaces in perspective).

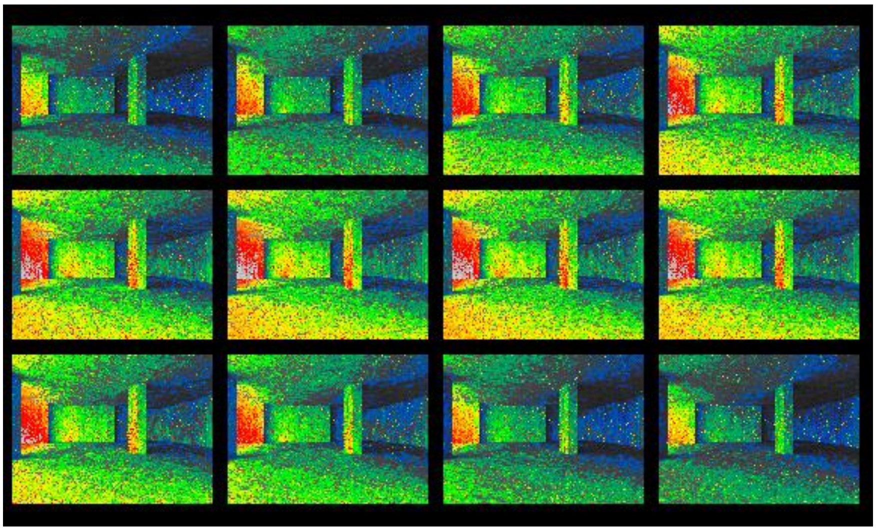
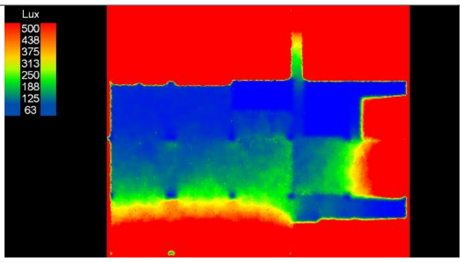
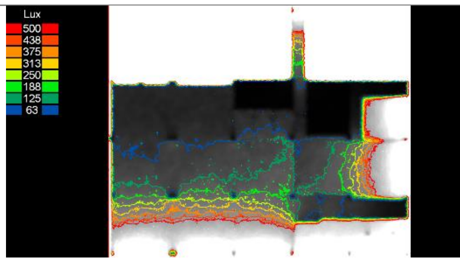
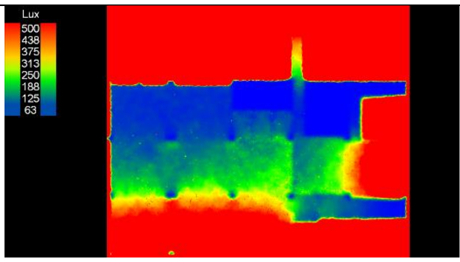
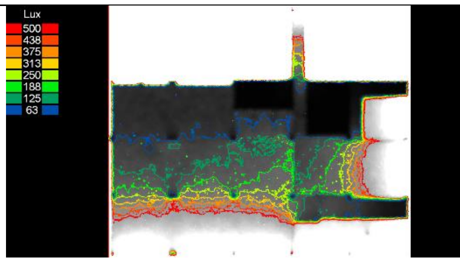


Figure 15. Visual output of annual illuminance values for indoor perspective, ISO contour display (all surfaces in perspective).

More detailed analyzes were made for the solstice and equinox dates, which are the study parameters. The illuminance values in the plan (horizontal) (Table 2), section (vertical) (Table 3) and indoor perspective for the days of March 21 – equinox, June 21 – summer solstice, September 23 – equinox and December 21 – winter solstice were calculated in the program and graphic visual outputs were obtained. In addition, the numerical values of the indoor illuminance level (Figure 16, Figure 17, Figure 18, Figure 19) as well as the outdoor luminance level on the days selected for the province of Ankara were also taken from the program Velux. All of this information is shown in Table 4.

Table 2

Illumination levels distribution outputs in the plan (horizontal) for the selected days. (on the floor of library space)

	Graphic (False Color Display)	**Graphic (ISO Contour Display)**
March 21 – equinox		
June 21 – summer solstice		

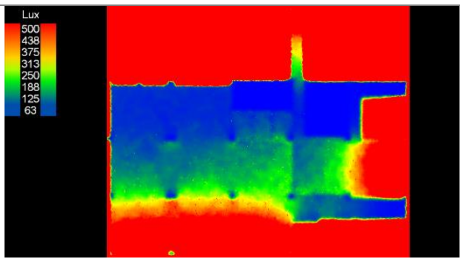
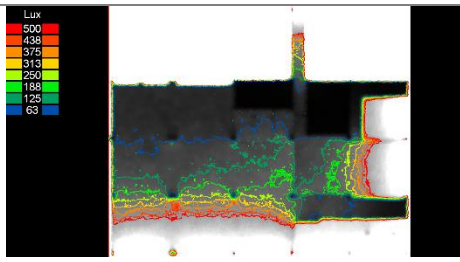
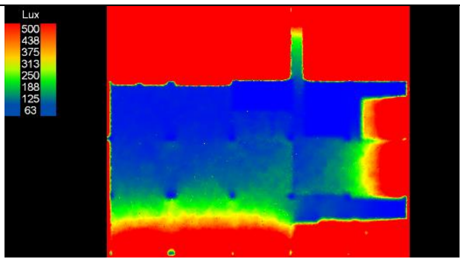
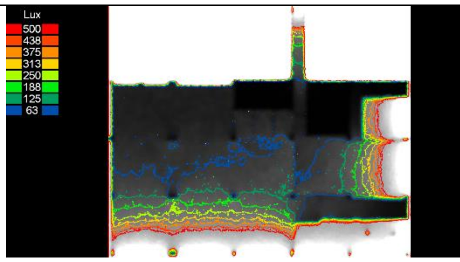
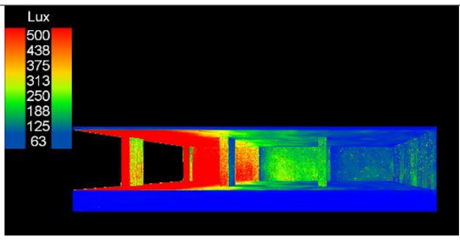
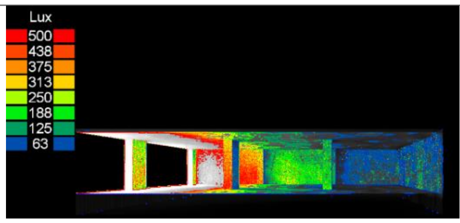
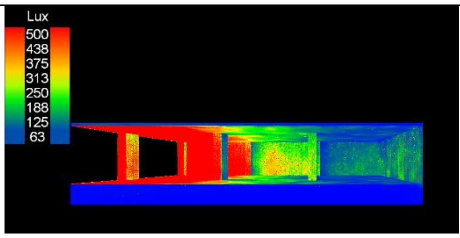
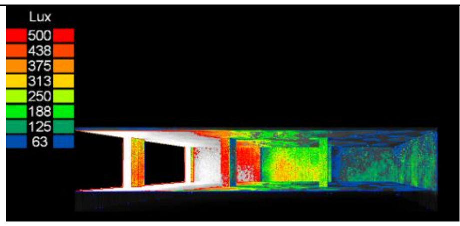
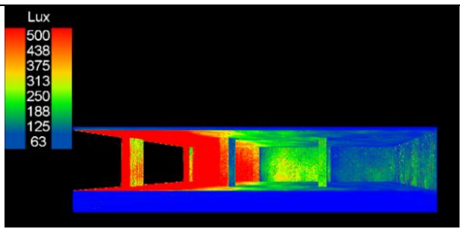
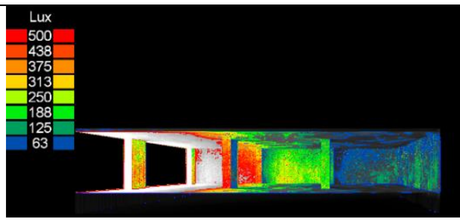
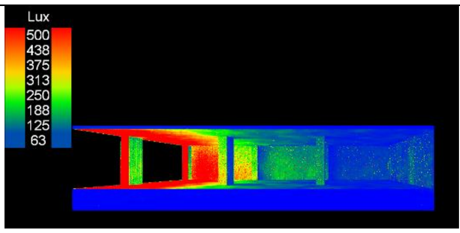
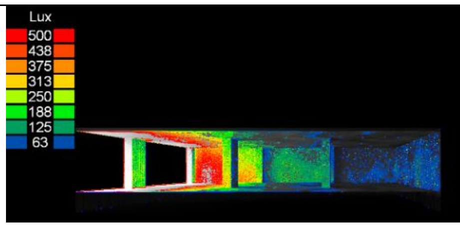
September 23 – equinox		
December 21 – winter solstice		

Table 3

Illuminance levels distribution outputs in the section (vertical) for selected days. (on the wall in the library area)

	Graphic (False Color Display)	**Graphic (ISO Contour Display)**
March 21 – equinox		
June 21 – summer solstice		
September 23 – equinox		
December 21 – winter solstice		

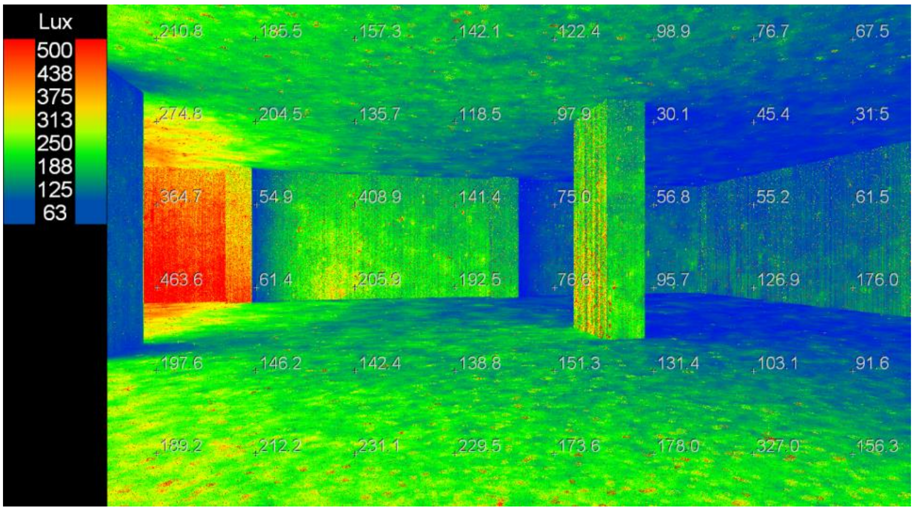


Figure 16. Numerical values of illuminance level indoors on March 21 (open study hall).

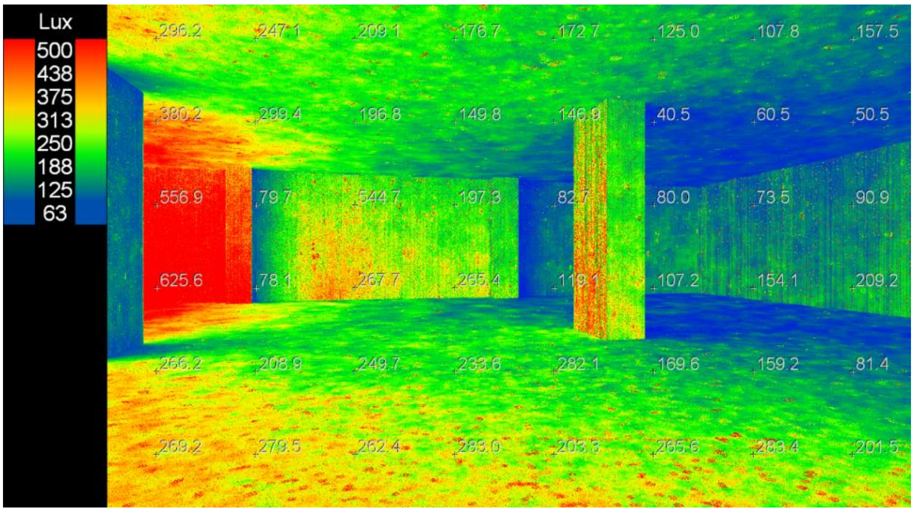


Figure 17. Numerical values of illuminance level indoors on June 21 (open study hall).

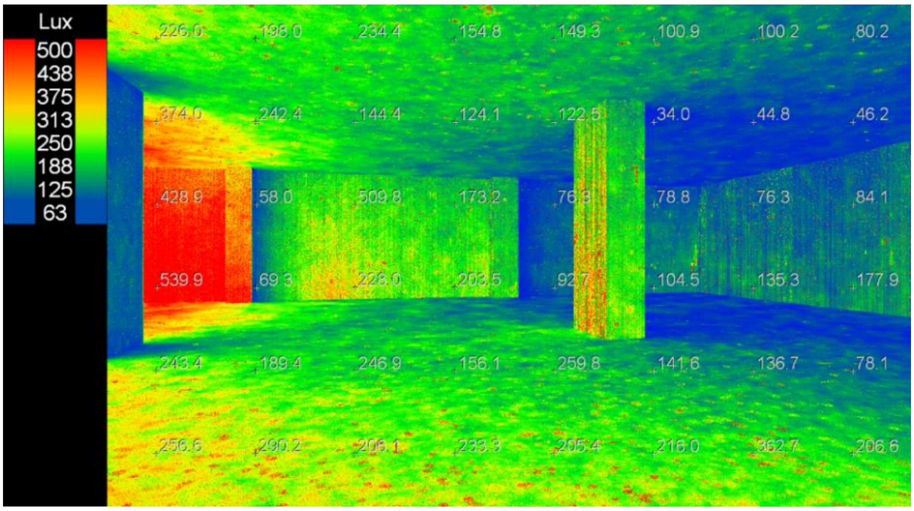


Figure 18. Numerical values of illuminance level indoors on September 23 (open study hall).

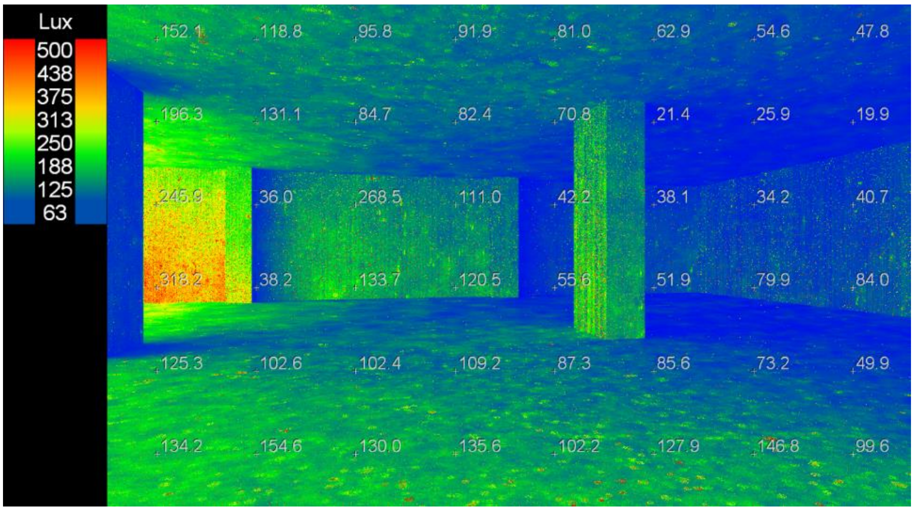
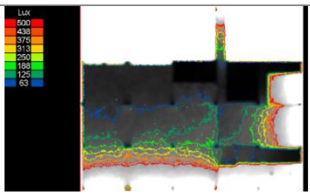
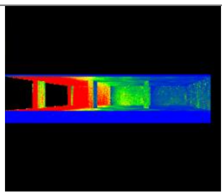
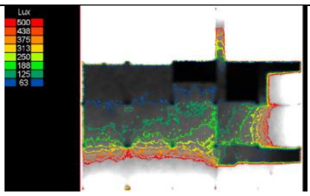
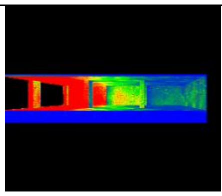
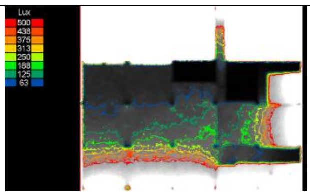
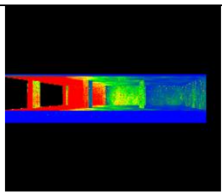
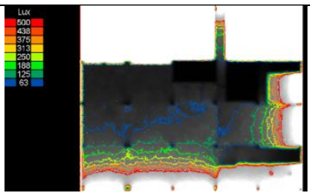
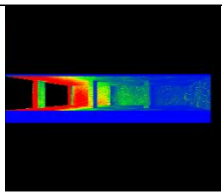


Figure 19. Numerical values of illuminance level indoors on December 21 (open study hall).

Table 4

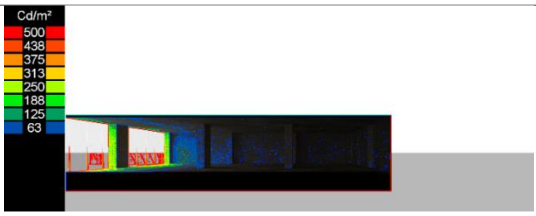
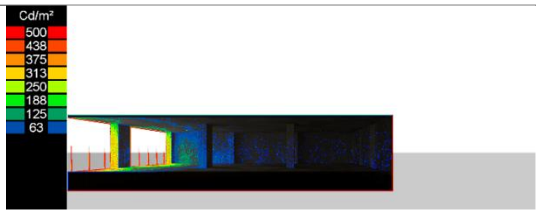
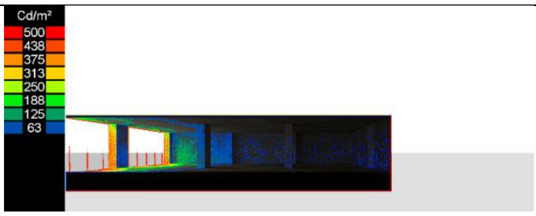
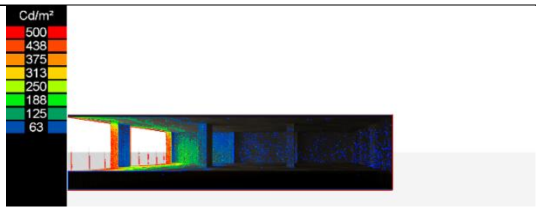
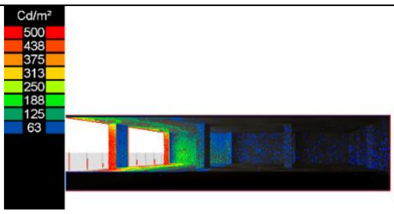
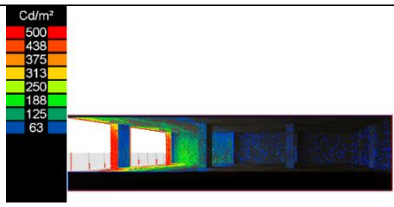
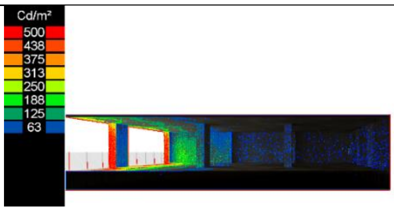
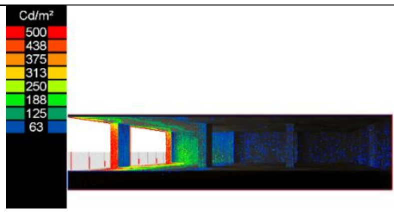
Indoor illuminance levels for selected days. (open study hall)

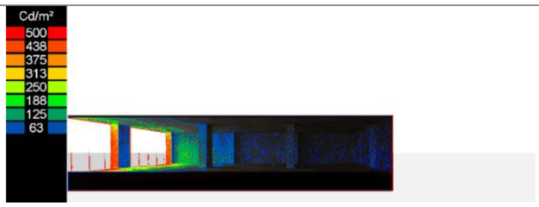
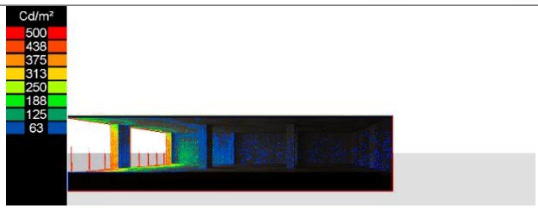
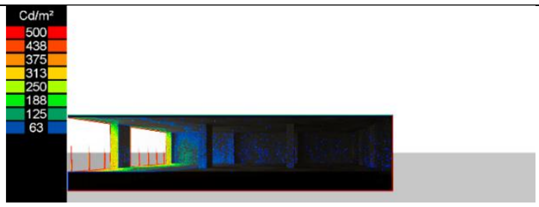
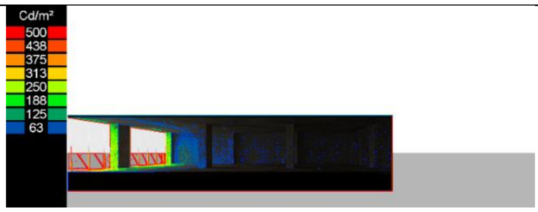
	Outdoor illuminance level (Lx)	**Plan (horizontal)**	**Section (vertical)**	**Indoor max illuminance level (Lx)**	**Indoor min illuminance level (Lx)**
March 21 – equinox	15.247,7			+463,6	+30,1
June 21 – summer solstice	20.446,7			+625,6	+40,5
September 23 – equinox	17.727,2			+539,9	+34,0
December 21 – winter solstice	10.084,8			+318,2	+21,4

Luminance is the density of luminous intensity with respect to a projected area in a specified direction at a specified point on a real or imaginary surface. In a practical sense, the definition of luminance can be thought of as dividing a real or imaginary surface into an infinite number of infinitesimally small surfaces which can be considered as point sources, each of which has a specific luminous intensity, Iv, in the specified direction. The luminance of the surface is then the integral of these luminance elements over the whole surface (Url-2). Luminance is also defined as the ratio of the luminous intensity (cd) incident on a surface to the area of the projection of this surface (m²). Its symbol is L and its unit is cd/m2. Visual comfort improves as the luminance level increases. However, at very high luminance levels, visual comfort begins to decrease due to glare (Ganslandt, Hoffmann, 1992: 42). In order to test the visual comfort in the library space, the luminance distributions in the space were also analyzed. In order to see the luminance distribution of the light entering the space through the glass curtain wall, analyzes were made on the cross section (Table 5) and perspective (Figure 20).

Table 5

Annual luminance distribution in the library interior, cross section. (open study hall)

SECTION (ISO Contour Display)	SECTION (ISO Contour Display)
	
January	February
	
March	April
	
May	June
	
July	August

	
September	October
	
November	December

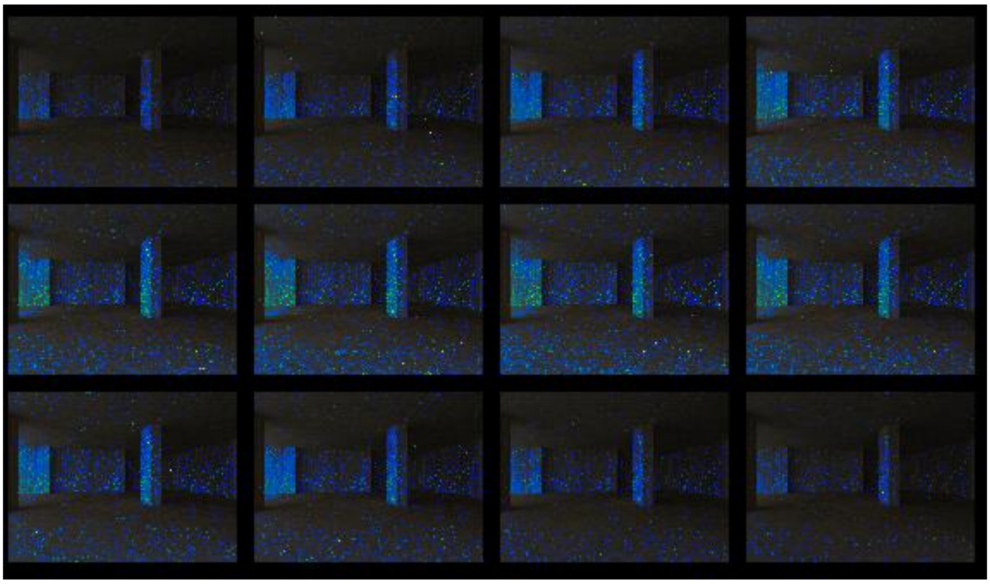


Figure 20. Annual luminance distribution in the library interior, interior perspective (open study hall).

Findings

When the interior of the Ostim Technical University library is examined, it is seen that daylight is considered and handled as an important element in terms of lighting. The library space is positioned on the south of the building in such a way that it can benefit from maximum daylight with its wide windows from floor to ceiling. There are no window openings on the west, thus preventing harsh sunlight from the west from entering the space.

The reading and study sections are located close to the windows facing the south façade in order to benefit from the daylight in the most efficient way. Shelves with books and magazines are positioned away from windows to avoid exposure to the harmful effects of daylight. At the same time, since these shelves are placed perpendicular to the windows, daylight can be used to illuminate the corridors between the shelves. In this way, sufficient natural lighting is provided for those who choose books, and the books and magazines on the shelves are prevented from being damaged by sunlight.

As seen in Figure 21, when the library plan and the daylight distribution graph that was analyzed for June are matched, the amount of daylight is sufficient in the reading-study sections located close to the windows in order to get the maximum benefit from daylight. Because the illuminance values of the floor with the camera placed at a height of 85cm from the floor will also be valid for the working plane at a height of 75-80 cm from the floor. However, there is a possibility of glare for the first row tables right next to the window. Glare is a condition of vision in which there is discomfort or a reduction in the ability to see details or objects, caused by an unsuitable distribution or range of luminance, or by extreme luminance contrasts (Url-3).

Glare is defined as the high cd/m² value defined as luminance or the perception of the radiation emitted from the light source as directly disturbing to the eye (Özden, 2009: 6). For this, it is recommended to control the sun and glare in the space. According to the research conducted and published by Edward T. Dean in 2005 within the scope of the project called Library Designs, solar control, glare control, variation control and contrast control should be done in library spaces. Glare that may occur in the library of Ostim Technical University can also be prevented with sunshades and the harsh effect of daylight can be broken.

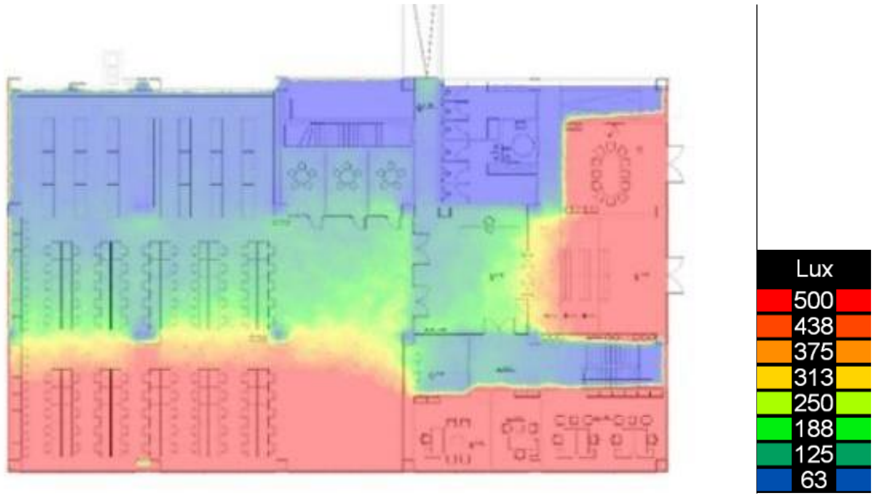


Figure 21. Matching the library plan with the June distribution chart (with illuminance levels value curves).

When the illuminance levels of the Ostim Technical University library are examined in line with the analyzes made, it is seen that the luminance levels decrease in the autumn-winter months, while it is brighter in spring-summer as a result of its location in the northern hemisphere. As the first places where daylight touches the space, the fronts of the windows have the highest level of illumination, while the level of illumination decreases when you go inside. In order to examine the suitability of daylight values in the space, it was compared with the standards on this subject. Today, whether a place is illuminated at values suitable for its function is accepted as an important element in terms of the health and performance of the users of that space. For this reason, many different domestic and foreign institutions are conducting research on this subject. As a result of these studies, standards related to lighting have been established.

Today, TS EN 17037 "daylight in buildings" standard is used in our country. In addition, the calculation of daylight intake in spaces and its evaluation according to TS EN 17037 daylight standards in buildings are included (Table 6).

Table 6

Conditions for providing minimum daylight in accordance with TS EN 17037 Daylight Standards in Buildings (TS EN 17037+A1, 2022)

Suggestion Level	Daylight Aperture Type	Luminous Level
Minimum Recommendation	Facade Opening	300 lx: Volume×0.5 100lx :Volume×0.95
Medium Recommendation	Facade Opening	500 lx: Volume×0.5 300lx :Volume×0.95
High Recommendation	Facade Opening	750 lx: Volume×0.5 500lx :Volume×0.95

According to the criteria of daylight illumination in the TS EN 17037 standard, it is necessary to provide daylight illumination and to establish a visual connection with the external environment. Visual connection is established with the external environment in the library space where the examination is made. Again, according to the standard, as given in Table 6, it is said that 50% of the volume should be illuminated with ≥300lx and 95% with ≥100lx, according to the minimum recommendations. In this example, this recommendation is provided according to the volume and its values examined in Figure 22.

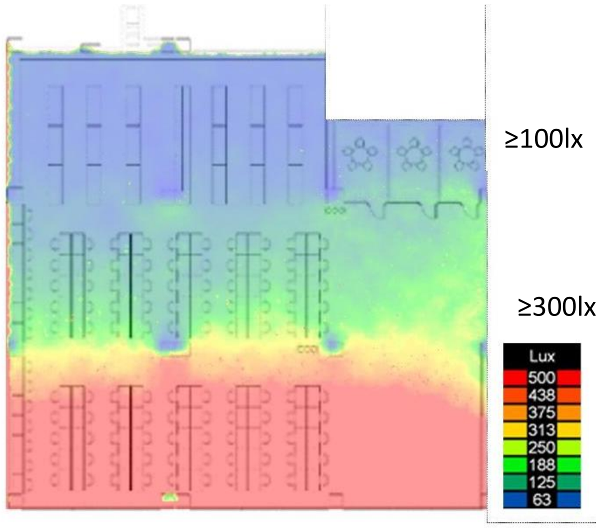


Figure 22. Example showing that 50% of the examined volume is illuminated with ≥300lx and 95% with ≥100lx.

Conclusion and Suggestions

After the information age, the development of societies is measured by the knowledge and technology produced. Library spaces, where information production, research and learning take place, are important for users with their spatial structures as well as the richness of their resources. In this context, libraries should be designed considering all the physical and psychological needs of users and employees. Beyond avoiding the factors that negatively affect the performance of the users, the necessary design decisions should be taken and implemented for maximum performance.

One of the most important elements affecting the design of library spaces is natural lighting. It is a necessity for the designer to make maximum use of daylight due to the lack of an artificial light source that meets the characteristics of daylight, which is the healthiest light source physically and psychologically, as well as increasing energy costs and ensuring sustainability.

In this study, the natural light distribution of the Ostim Technical University library, which is an existing library space, was examined in line with the determined working parameters. These parameters are the coordinates and orientation of the building, the building materials used in the interior and the shape, size and location of the openings that let daylight into the space. When daylight distributions and interior design are compared, it is seen that the distribution of daylight in the space affects the spatial setup. Circulation, group study rooms, shelves where resources are stored and work desks that require attention should be placed according to the distribution of daylight, as they need different luminous values. When sufficient natural lighting is provided, artificial lighting will not be needed or will be used at a minimum level. Thus, energy consumption will also decrease. At the same time, maximum benefit will be obtained from the physical and psychological positive effects of natural light for users.

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VELUX Daylight Visualizer 3

İnternet Kaynakları

Url-1: https://cie.co.at/eilvterm/17-21-039 (Date of access: 15.03.2023).
Url-2: https://cie.co.at/eilvterm/17-21-050 (Date of access: 15.03.2023).
Url-3: https://cie.co.at/eilvterm/17-22-098 (Date of access: 15.03.2023).

Görsel Kaynaklar

Figure 1. Loe, D., Watson, N., Rowlands, E., Mansfiels, K., Venning, B., Baker, J., (1999). Lighting Design For Schools, Building Bulletin 90, Department for Educationand Employment, London, pp.9.
Figure 2. Loe, D., Watson, N., Rowlands, E., Mansfiels, K., Venning, B., Baker, J., (1999). Lighting Design For Schools, Building Bulletin 90, Department for Educationand Employment, London, pp.10.
Figure 3. Methodology of study (Sorumlu yazar arşivinden, 2022).
Figure 4. Library plan, AutoCAD Architecture (Sorumlu yazar arşivinden, 2022).
Figure 5. 3D model of the library, AutoCAD Architecture (Sorumlu yazar arşivinden, 2022).
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Figure 13. Visual output of annual illuminance values in cross-section, ISO contour display (Sorumlu yazar arşivinden, 2022).
Figure 14. Visual output of annual illuminance values for indoor perspective, False color display (Sorumlu yazar arşivinden, 2022).
Figure 15. Visual output of annual illuminance values for indoor perspective, ISO contour display (Sorumlu yazar arşivinden, 2022).
Figure 16. Numerical values of illuminance level indoors on March 21 (Sorumlu yazar arşivinden, 2022).
Figure 17. Numerical values of illuminance level indoors on June 21 (Sorumlu yazar arşivinden, 2022).
Figure 18. Numerical values of illuminance level indoors on September 23 (Sorumlu yazar arşivinden, 2022).
Figure 19. Numerical values of illuminance level indoors on December 21 (Sorumlu yazar arşivinden, 2022).
Figure 20. Annual luminance distribution in the library interior, interior perspective (Sorumlu yazar arşivinden, 2022).
Figure 21. Matching the library plan with the June distribution chart (Sorumlu yazar arşivinden, 2022).
Figure 22. Example showing that 50% of the examined volume is illuminated with ≥300lx and 95% with ≥100lx (Sorumlu yazar arşivinden, 2022).