Aesthetics of Day Lighting in Buildings Case study: Presidential Building at Jordan University-Amman, Jordan

Omar Amireh, Hadeel Sarhan, Bahija Al-Natsheh, Rawan Nofal

Department of Architecture, Faculty of Engineering, Jordan University
omaamir@yahoo.com

Abstract: This paper investigates the daylight aesthetics in the architectural space by studying the effects of daylight quality on the architectural space dynamics. The observation recorded photographically the daylight effects in the atrium of the presidential building of the Jordan University as an architectural space depend the day lighting design. Classified photos reveal the visual daylight aspects on the dynamics of architectural space. Daylight measurements show the dynamic variances of daylight at the different points in the atrium and proof that available daylight is appropriate for the atrium functions and even exceed the required quantities. The study concludes that daylight can improve the quality of the space through a comprehensive lighting design to provide the required daylight quantities while the aspects of daylight boosting the aesthetics of architectural space.
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1. Introduction

"A building speaks through the silence of perception orchestrated by light." Steven Holl (Descottes and Ramos, 2011).

Light seems to be a very changeable pattern in our built environment. Being an immaterial building stone, light takes a liquid shape in our design-vocabulary. It consists of an invisible material – photons – and therefore it takes no specific form in itself but it is only articulated through the meeting with form (Volf, 2010).

The latitude of a given location affects the length and intensity of daylight hours throughout the year, while local changes in climate affect its hourly strength and variability. Surrounding site conditions can amplify or diminish the sun's ability to penetrate an interior space and it is often difficult to predict how these conditions will change over time (Rockcastle and Andersen, 2015).

In addition, daylight presents a dynamic changeable factor that seems to be very effective in any building design. Many designers agree that daylight is an essential factor in user's cognitive experience of any interactive space. The perceptual qualities, such as brightness, contrast, and temporal variability influences our experience of the physical space, while illumination of daylight infuses our imaginability of any static interior spaces with shifting compositions of light and shadow.

Architects appreciate daylight systems due to several reasons. Day lighting is becoming more and more a key component of any green building design (Guzowski, 1999). The high quality direct light provides through roof openings and mainly skylights provide an aesthetically pleasing dynamics to any static space. Although daylight mainly exist simply by adding windows or skylights to a wall or a roof, yet it entails finding a proper design that controls heat gain, heat loss, glare, and the changing position of the daylight illumination. Created a new aesthetic of openness, the Crystal Palace by Joseph Paxton is one of the earliest examples of new architecture of glass and light. A great achievement of the 20th century architecture inspired and gave architects, in different regions and different time, a different attitude toward daylight (Volf, 2010).

Other architects of the modern movement were mature and skillfully enough to handle light and shade. They reinterpret their original definition and understanding of architecture by manipulating light, openings and space. They masterly, correctly, and magnificently brought masses and light together in a play of shade, shadows and surfaces. Their architecture responds to the unique light conditions prevailing in each country. They used clerestories, baffled skylights, and screen windows as major design elements. Like many, Aalto was able by manipulating all sides and positions of the architectural elements and facades, to control and to redistribute daylight in internal spaces whether in the long days of summer or during the very short days of winter (DeKay and Brown, 2014).

Louis Khan in his famous theory of Silence and Light rejects any space that has no natural light because "the moods which are created by the time of day and seasons of the year are constantly helping you in evoking that which a space can be if it has natural

light and can't be if it doesn't (Khan and Lobell, 2008).

2. Daylight aesthetics in architectural spaces

"By observing how light behaves, we can work with it to reveal architecture" (Millet, 1996).

Aesthetics is a study of the interaction of our senses and our emotions, in short, our taste. A study of our most important sense is the vision (Volf, 2010). The influence of the daylight on our vision is of great importance to a deeper understanding of the art and architecture aesthetics.

Daylight is the illumination of a building interior with sunlight or sky light; it is known to affect the visual performance, lighting quality, health, human performance, and energy efficiency.

Previous Studies had investigated the quality of daylight in architectural spaces. Daylight dynamics and Luminance diversity of shadow patterns, reflections and brightness ratio differences were investigated in the atrium of City Mall- Amman, Jordan (Hourani and Hammad, 2012). Another study of the daylight variable effects on the space virtual morphologies compared and analyzed the skylight in three different architectural spaces (Rockcastle and Andersen, 2015).

The interaction between the daylight and the elements of architectural space produces the animated daylight aspects revealing the dynamics of the architectural space (Hourani and Hammad, 2012).

3. Procedure and tools

Site observation and daylight measurements, were used as a methodology to investigate the daylight impacts whether quality and quantity variances within a dynamic space. The selected JU presidential offices and as usual in administrative buildings characterized as a monumental architecture with an atrium subtracted from all its upper four floors. The atrium while adding a sense of place to the main entrance hall of the building, it provided all overlooking levels and inner surfaces with an aesthetic daylight dynamic pattern that can be perceived and projected at any sunny day, shown in figure 1. The morphological characteristics of the above space and its congruent with the daylight potentials make the atrium one of few cases in Jordan where the daylight effects, manipulate, generate and endow the space with the dynamic aesthetics whether physical or virtual. Using photography to record the scene in the atrium, is classified on different views to prove that natural light besides being a source of lighting, it impart the atrium with a spirit of aesthetic and dynamics volume. Quantifying daylight in the atrium would help to investigate it's correspond with the design manuals used to measure the space illuminance.

3.1. Observation

Observing the impact of daylight on the atrium of the Presidential building at JU, rely on variety of modes of photography used to investigate the quality of daylight. Initial observation of sun shadow and shades noticed in one of the sunny days, 20-4-2015, from, 8am to 4 pm, covering all working hours and every 10 minutes. Further readings and observations recorded the visual daylight aspects and dynamic diversity of the atrium in other working days on 13 April, 10 March and 22 February 2015, at different levels and locations in the atrium.

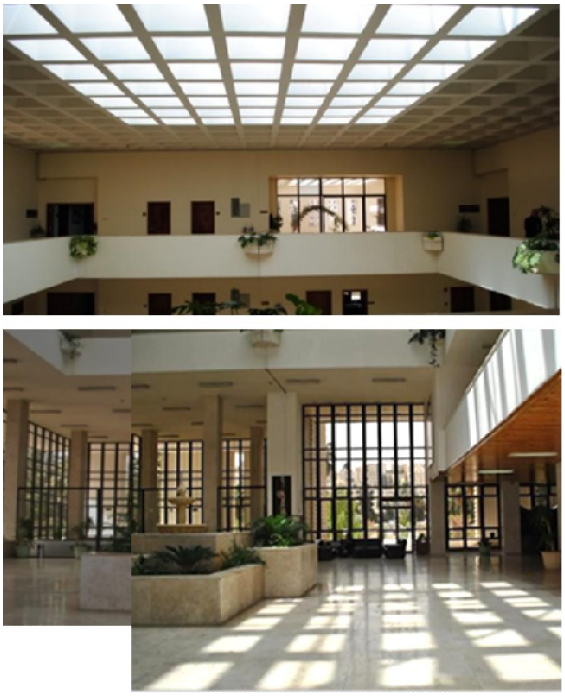

Figure 1. JU Presidential Building Atrium.

3.2. Daylight measurements

Digital lux-meter used to make a daylight table measuring illuminance at the main atrium of the Presidential Building at a grid of points, every 1.75 m with 1m above the floor level. Recording process of daylight readings done on the 23 April 2015 from 11:30 am to 12:30 pm. Furthermore, hence to support the measurements outcomes the study measured the external illuminance just next to the main entrance façade at 1m above floor level.

In order to get a full image of the light sources in the atrium, other architectural elements located and analyzed, to determine the effect of the daylight impacts on any particular space in the atrium, and to reach all aspects of the dynamic light diversity according to the investigation tools adopted in the illumination strategy.

4. Results and discussion

In taking the Presidential Building of University of Jordan, as a case, the study will easily adopt the daylight illumination strategy in which it will investigate the impact of daylight quality variances on the dynamics of architectural space. Here a huge, but well-articulated well-proportioned atrium, characterized with a clear 3d spacious open space. The main entrance of the four floors open lobby gave the administrative building and its users a monumental image hence impart a sense of prestige. The huge volume of the atrium with the grid-patterned sky light defined the floor directions and distribution at the same time accentuated the hierarchical conception of the official formality of the building. In addition, the area of the atrium about 352 m2 and its height about 17 m serving four floors prove to serve best with the illumination study strategy.

The atrium receives indirect and direct daylight from the waffle-grid skylight-openings from the roof and from several wide and high openings on the east-south and south-west sides of the lobby. Therefore, the illumination value varies from one position of the floor or the four sides of the atrium.

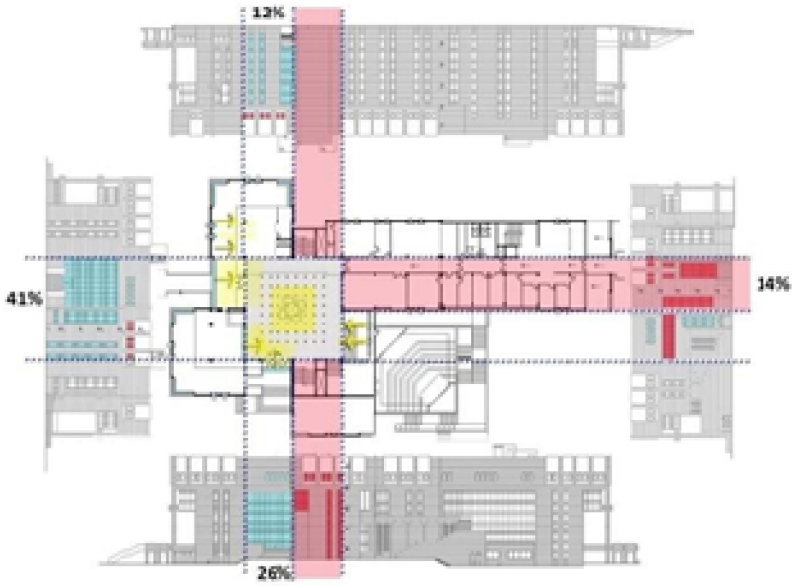

Figure 2. Daylight sources via architectural elements analysis

Daylight sources coming from the various surfaces, sides and elements of the atrium were located, and the area percentage of the glass openings in every elevation was calculated. All openings in the four elevations classified into two groups. The first group is openings colored with red, which does not affect the illumination value of the atrium and not calculated with the percentage of glass as a void. The second is the void percentage consists of the opening with the blue color which allow daylight to reach the various parts of the atrium and these values are 41%, 12%,14%, 26% as shown in figure 2. From the observed photos classified to clarify, the movement of shade and shadows on the walls of the atrium, we can clearly see the contrast made by the daylight in the atrium, see figure 3.

4.1. Dynamic diversity

The recorded photos classified according to the visual aspects of the atrium, and taken on an hour and half intervals during one day and on a yearly base, prove that daylight enhances the apparent variety of the atrium space. Further, it highlights its dynamic visual depth, accentuates the diversity of the used colors, and evaluate the visual appearance of the decorative architectural surfaces and layers (Parpairi, 2004).

4.1.1. Shadows dynamic symphony

Casted Shadows in the atrium appeared in several ways:

1. Shadow movement during the day

The perceptual movements of the shadow observed through time and space and later captured by photos in order to record the harmoniums pattern and rhythmic movement path created during the day. Photo of the same view repeated from the same point every 10 minutes in a sunny working day from 8 am to 4 pm, intended to register the changing shadow path and its impact on the dynamic space. In addition, the atrium scenes responded to the shadow movements as it emphasized the elements and the layers of the space by composing a decorative dynamic pattern.

2. Shadows on levels

Taking several views from the same level and from the same floor overlooking the various sides and surfaces of the atrium, presented the users with diversity and vivid scenes see figure 4. Accordingly, the sun path defined the space into impacted articulated openness, granting the employees wellbeing, pleasure (Edwards and Torcellini, 2002) and allow them a place to meet in their break time.

3. Broken Shadows

Observing the effect of the shadow on some of the features or elements lying on the shadow path, such as plants, tile, stairs and water fountain, while adding value appearance to the features themselves it integrate all with the atrium morphology, see figure 5.

Both daylights and shadows coming and created by the skylight and the sides openings activated an image-ability scenario of a daylong symphony with multiple distinct sections of movements of several scenes articulated on all six sides of the atrium.

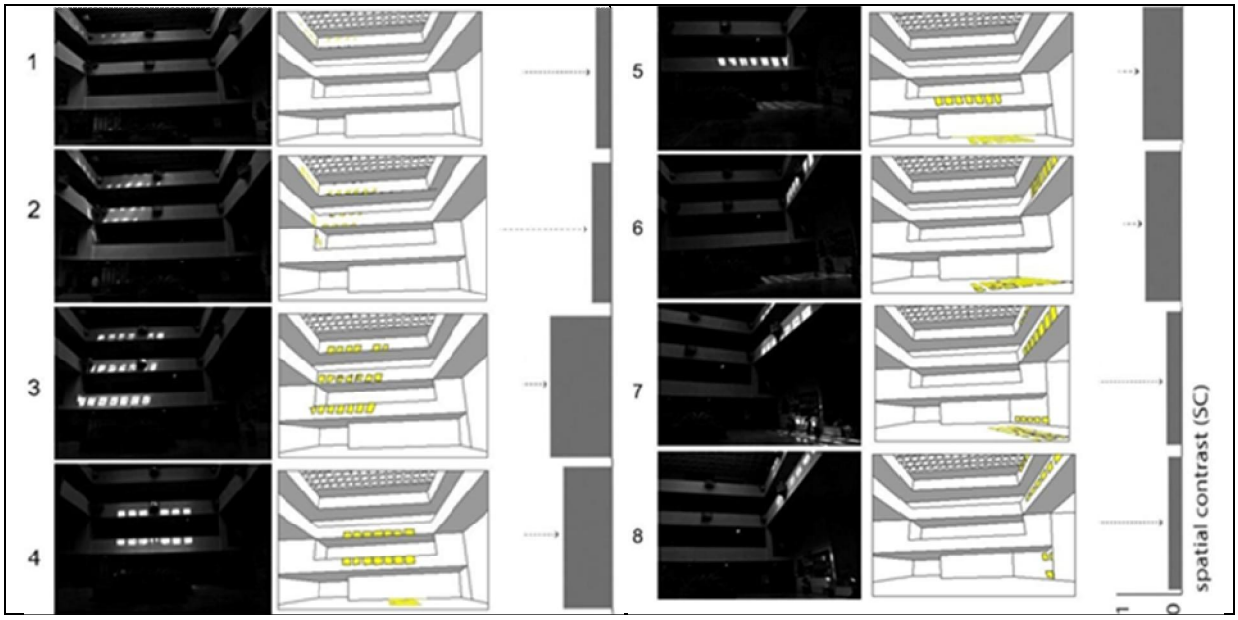

Figure 3. Atrium spatial visual contrast effects, shade and shadows movement (Volf, 2010)

Figure 4. Variety of Shadows' scene observed from the same level.

Figure 5. Broken Rhythm of Shadow.

4.1.2. Reflection

Daylight created a dynamic reflection on all surfaces of the atrium's tiles, ceiling, paintings and glass doors, see figure 6. Spectacular reflections extended the atrium scenes depth (Michel, 1996), accentuated the tone intensity of the colors hue, and emphasized the luminance value and brightness ratio

of various reflections in the atrium. Besides that, daylight visual aspects imparted sense of dynamic variety and diversity of the architectural space.

4.1.3. Luminance Brightness Ratio Differences

Variation of brightness refers to variances of daylight contrast between shadow and light areas within a dynamic rhythm of shadow. It is seen as a woven fabric of porcelain, aluminum, wood and leather with light, see figure 7.

Figure 6. Dynamic reflections in the atrium of the presidential building.

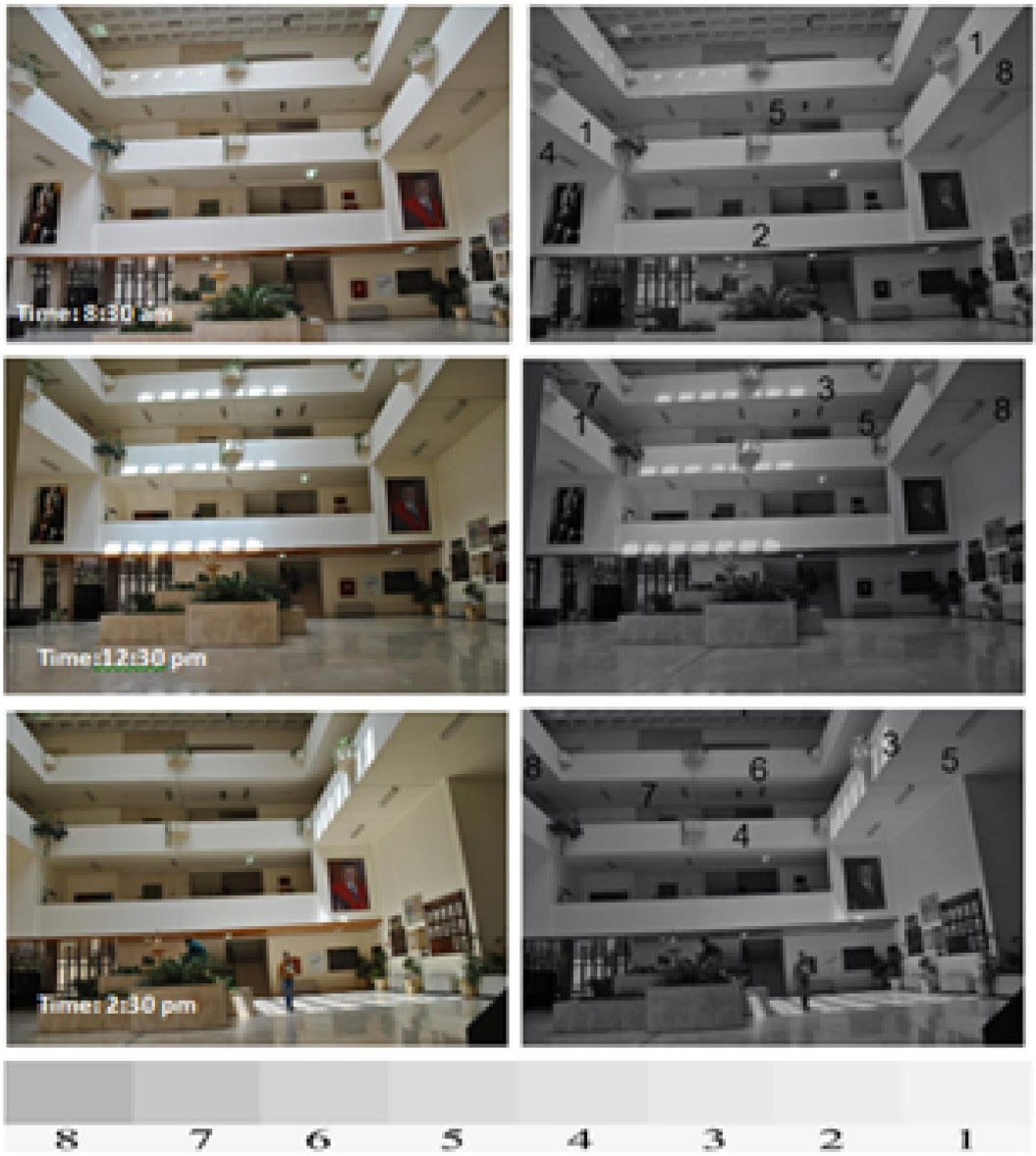

Figure 7. The Luminance brightness ratio differences in the atrium during daytime.

4.1.4. Visual connection

The atrium of the presidential building at JU characterized with a number of wide and high glass openings and 49 grid skylight openings. All openings provide the atrium with clear connectivity whether with the spacious landscape around the building or the open spaces above or in front of the building, see figure 8.

1. The skylight modeled to represent highly contrasted and variable interior daylight environment with an open roof structure that casts dynamic and articulated patterns of light and shadow down onto the walls and floor. It generates a high degree of spatial contrast throughout the year. The highlighted roof structure is the least effective architectural source of beauty in the design, yet with the skylight, it became the most effective dynamic source of conceptual aesthetics with clear traces on both the floor and the walls.

2. The semi-curtain Glazed wall represents more traditional side- daylight strategy with a clerestory window above and louvered screen below which creates varied effects across the year depending on the time of day and position of the sun. That arrangement show high spatial contrast between October and March, with low-to- moderate levels throughout the summer months of the year and the accumulation of contrast on the walls and floor close to the exterior glazed wall.

Figure 8. Visual connection and outdoor views at the atrium.

4.2. Daylight measurements results and discussion

The illumination of daylight in the atrium measured and plotted as contour lines as shown in figure 9. The illumination average in the atrium is 952 lux, which is sufficient for the atrium activities, compared with the recommended illumination of 400 lux according to the light design tables. In addition, circulation areas and public zones in office buildings need 400 lux of daylight illumination, and the average illumination value in the atrium in our case study is 952 lux, which is more than enough, compared with the used lighting design table's values. Giving that the external illumination measurement is 15,000 lux. Although the skylight openings, location, sizes, and shapes are of a regular pattern, yet its measured illumination varies as shown in the atrium 3D dynamic view, figure 10.

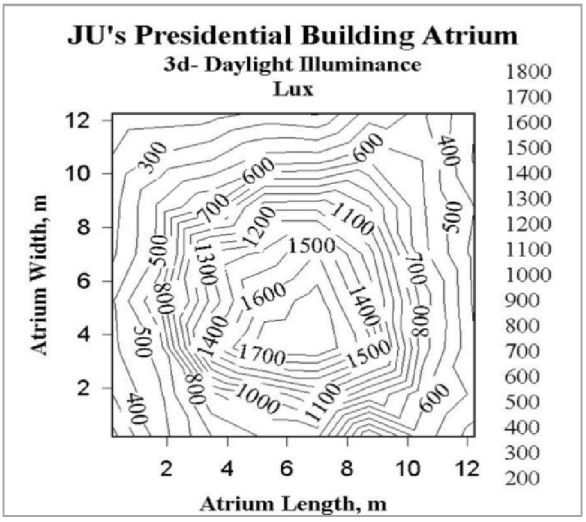

Figure 9. Measured daylight illumination contour lines, the Presidential Building atrium.

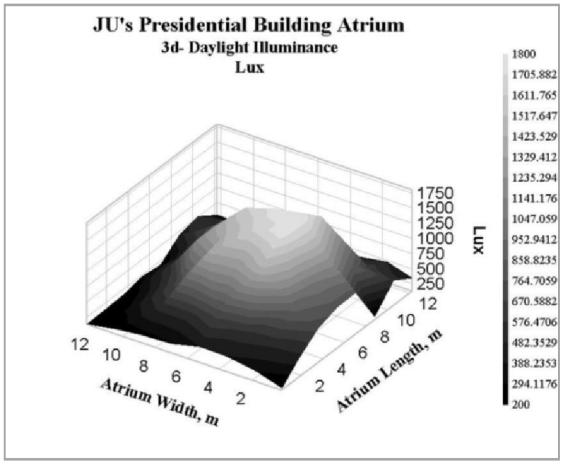

Figure 10. 3-dimensional view of dynamic daylight illumination, the Presidential Building atrium.

5. Conclusion

The study concludes that giving daylights the chance to encroach onto the inner spaces would activate the architectural hidden-dynamic dimensions and would reveal its spatial design quality. The study

also proves that daylight quality is an effective design element in; enhancing the esthetical and the psychological aspects of the architectural space; enriching its variables and its experience of diversity; generating interest in its elements and pleasure in their use; elaborating its inner structural morphologies, way finding and sense of place. The effects of daylight quality on the dynamics of the architectural space can be tuned into daylight design quantities, which can be used in the design process and requirements.

The study recommends the following:

1. Daylight quality is one of the effective design elements that enhances esthetical and psychological aspects of the architectural space and enriches users' experience of pleasure, diversity and interest.

2. The dynamics of the architectural space can be fully activated by day lighting quality aspects.

3. Giving daylight qualities needed attentions and importance in every design process would enhances users feeling of architectural sense of the place.

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Corresponding Author:
Dr. Omar Amireh
Department of Architecture
Faculty of Engineering, Jordan University
Amman 11942, Jordan
Telephone: + 962 7 9033 4959
E-mail: omaamir@yahoo.com

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