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The importance of lighting to the experience of architecture

- the lighting approach in architectural competitions

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“Architecture is the skillful, accurate and magnificent plays of volumes seen in light.” - Le Corbusier

1. Introduction

The perception of space is directly connected to the way light integrates with it. What we see, what we experience and how we interpret the elements is affected by how light interacts with us and with the environment. Regarding architecture, in whatever dimension it can be analyzed, either as space, as material or as color, it is essentially dependant on the lighting situation that involves both the object and the observer.

The dynamic daylight and the controlled artificial lighting are able to affect not only distinct physical measurable conditions in a space, but also to instigate and provoke different visual experiences and moods. Due to the light, it is possible to perceive different atmospheres in the same physical environment. Light constitutes an element of fundamental relevance for the design of spaces and therefore it plays a significant role in the discussion of quality in architecture.

In architectural competitions, light has often been a mentioned term in the jury’s comments; even if it has not been a criterion of the program. Generally in form of daylight, the generous use of both sunlight and skylight in the spaces is considered positive; adding tremendous value to the architectural object. Furthermore, the importance of a well designed daylighting today is not only because of the improvement it gives to the space or its benefits to our health and well-being, but also because of the ecological issues which are in debate today, since it means less energy consumption for the artificial lighting.

1.1 Purpose

The aim of this paper is to highlight the importance of light in all dimensions, both daylight and artificial light, in relation to architecture and to insert this debate in the field of architectural competitions. My goal is to discuss the following questions:

- How does light affect the perception of the space? What difference does it make to the architecture?
- How is light analyzed in competitions where only graphic material is submitted?
- Do the new 3d models express the real lighting situation, or is the tool used for another purpose?
- Is it important to have a criterion of daylighting studies?
- How conscious of the daylight situation in the site is the international jury?
- Should the artificial lighting design also be incorporated in the program?
- For the existing competitors’ buildings, is the jury’s visit done under similar lighting conditions?

1.2 Method

In order to get the overview of the theory of light and architectural lighting, a literature study was made.

Regarding the investigation of the light terminology in the jury comments, a research was done of Swedish magazines and internet sites about recent architectural competitions.

2. Light – physical and visual

In the theory of light, it is common to find an explanation of what light is by considering it as energy or visible radiation. Our vision is then the perception determined by this radiation. However, the definition of our visual system by physiology and psychology goes to advanced image processing and psychological outcomes.

When dealing with lighting analysis, many specialists consider light quality to be only physical aspects and run their principles by making measurements. They often rely their ideas based on a numeric and scaled light level, discussed in number of lux, which can be compared and detected by instruments. However, if we study deeper our relation to light, we will understand that light comprises a more complex field. Energy that can be measured it is not so reliable and comparative to our senses.

According to Anders Liljefors's lighting fundamentals, physical and visual terms are running parallel. The combination between the physical and the visual worlds is served by the stimulus of vision, the optic radiation from 400 to 700 nm wavelength. The vision is primarily concerned with lighting quality, with the information that is received from the objects in the environment (Liljefors, 1999).

2.1 The vision

In our vision, the receptors in the retina transform the electromagnetic energy into bioelectric nerve impulses. The signals we receive are just radiant differences that are the contrasts of brightness and color. The contrasts can have sharp, diffuse or gradient border. The visual process is a combination of two systems: the optical and the interpretation system. The last system has a process that starts on the retina, where our interpretation of light begins.

The receptors, rods and cones, are connected to the visual nerves by nerve layers. The rods are responsible for distinguishing contrast (difference in brightness), while the cones perceive the spectrum distribution (colors), if there is enough radiant energy on the retina. The different wavelengths are registered by three types of cones: S, M and L; that stands for short, medium and long (Liljefors, 1999).

We adapt to different situations and light conditions. Using the night vision, we are able to see by very low amount of radiation thanks to the rods that give us some information about the environment. As soon as radiant stimulus appears with enough intensity, the cones are prepared to work.

The aging plays an important role to our vision. The lenses get more yellowish and rigid. Adaptation gets slower through the years which also raises the sensitivity to glare; because receptors exposed to glare need more time to recover before functioning normally again.

The basic visual functions that collaborate to each other are: retinal vision (spatial information, with approximately 170 degrees) and foveal vision (information and details). The earlier names for these visual functions were peripheral and central, respectively (Liljefors, 1999).

It takes time before we develop completely our vision and the ability for interpretation. According to Mr. Liljefors, only at the age of twelve are we able to manage a situation of sudden fear, e.g. on a bicycle in traffic. Training how to see is another way to develop the visual condition. If a person works with colors, he/she will get more ability in distinguishing color than another that does not.

2.2 Seeing – visual terms

When we see, we distinguish impressions of space, form, surface/texture, color and light. However, in order to really see the minimal aspects of the environment, it is necessary to have attention and concentration. It is important to develop the ability to observe the visual terms in the space, thinking how they occur and are described.

In the first level of visual terms, there are three factors that can be distinguished: spatiality, atmosphere and visibility.

The consideration of spatiality is the possibility to define the physical room: volume, distance, proportions and orientation. Depending on the light in a space we can perceive its volume as huge, as small, open and crowded. The perceived extension can also change a lot from an airy to a cramped space. Even the orientation is influenced by lighting; because how you find your way in the space can be well determined by the light present there

The atmosphere consists the general character, related to the psychological mood that light creates. Many times people experience the space as boring, private, public, cheerful etc. only because of lighting influences.

At last, the visibility is connected only to work demands, to the possibility to see things during the task: form, surface/texture, color and light.

When analyzing or designing, it is fundamental to work on ratios regarding these three aspects (spatiality, atmosphere and visibility) in relation to the function of the space. For instance, a church has atmosphere about 50% of the whole, 30% for the space and 20% for visibility. On the other hand, a classroom requires 50% for visibility.

The second level is the description of the light in space. In his theory, Mr. Liljefors presents a list of seven basic terms for description of the light in the space by the visual experience:

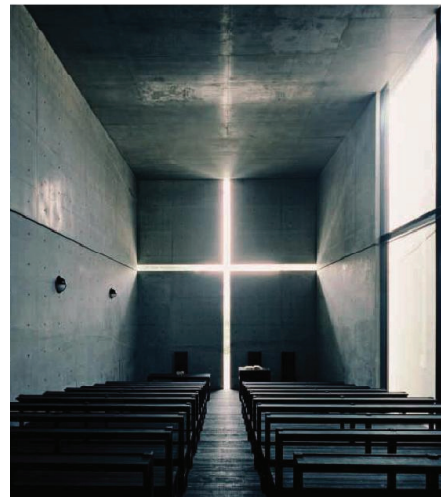
- level of lightness
- spatial distribution of brightness
- shadows
- reflections

- glare
- color of light
- colors

Using these terms, it is effective to describe and understand the effects of lighting in a space and to make a reliable classification.

Shadows, for example, play an important role to our observation. They can be soft or strong; they can present sharp or diffused borders. Good shadows are pleasant to see, but bad shadows can destroy the ambience.

The colors of the materials are also responsible to change the atmosphere. This issue should be designed from the beginning and not after the whole architectural process. Below, it is possible to see an example of how the Japanese architect Tadao Ando plans color, affecting positively the space he designs and also how the level of brightness is thought for his conceptual chapel work.



Pehr Sällström points out the importance of not treating lighting planning and color planning of an ambience separately. For the experience of an environment, both aesthetically and emotionally, color and light play together intimately. The way we perceive lighting conditions depend (among other things) on the coloring and even more so the way the color materials behave depend on how they are lighted, since the light affects not only not only the color tone or nuance, but also the character of the material and the sharpness of the boundaries and most importantly if the color scale seems natural and well balanced or not (Sällström, 1980).

The materials inside a room have reflective characteristics, reflectance. The reflections of light can make the difference in the visualization and even influence the lighting in the room.

A good lighting is dependent on the function. If the contrast is clear (strong), our interpretation will be easier and less activity for the brain will be required. In order to interpret a space, it is not necessary (nor right) to increase the lighting or uniform illumination. The difference of brightness, between lit and shadowed surfaces, contributes to our understanding of spatiality. Moreover, the spatial distribution of light is also extremely important for the spatiality, but also to orientation and the atmosphere.

In Mr. Liljefors book, he lists some overall demands for good lighting:

- stimulating surroundings
- adequate visibility of detail information
- opportunity of individual adjustment
- daylighting as far as possible
- attention to running costs and energy

3. Lighting in Swedish Architectural Competitions

Competitions in general do not consider artificial lighting as an established criterion. Even the designing with daylight is not often mentioned in the list of considerations. Some countries, such as Denmark, have a certain level of daylight factor as code or standard for commercial and residential buildings. Daylight factor is defined as the ratio of the indoor illuminance at point to the outdoor horizontal illuminance, under an overcast CIE reference sky (thedaylightsite.com). However, even if daylight factor standard can represent an improvement as a recommendation for the daylight design, it can be inappropriate if it turns to a general law, since it alone does not give a proper evaluation of the annual daylight level in a building. As a result, it would underestimate existing buildings that don't fulfill the standard.

Architectural competitions in Sweden commonly do not have explicit daylight recommendations in the program; but reading the comments from the jury about the projects, it is very clear to notice that the presence of light represents a very important factor in their evaluation. In many texts, it is possible to identify comments that are related to light. Often light is contributing to a positive result of their judgment; and if there is lack of light in the building this will decrease the value of the proposal.

However, in competitions to which graphic material is submitted, such as drawings and 3D models; it can be doubtful to analyze this aspect, since it is complex to understand the reality of the light conditions. It is necessary to have in the jury people that are trained and have experience in the subject.

3.1 Jury Comments

In the following section, some examples from Swedish architectural competitions starting from the year 2000 will be shown. The main interest in these samples is how the jury used the word "light" in various contexts; both positively and negatively; sometimes as a decisive commentary for selecting or neglecting.

Nr. 3, 2000

Flemingsbergs University Library

Förslag: Undantag – regel – C. Malmströms Arkitektkontor AB, Göteborg (winner)

"...sin öppna kvadratiska form som genomskärs av en lätt diagonalt ställd ljusgård".

"...men den våningshöga glasningen kan ge problem med solinstrålning". (p.5)

Nr. 4, 2000

Single family housing competition, Linköping

Förslag: Core – Erséus Frenning & Sjögren Arkitekter AB, Göteborg (winner)

"Den bygger på en kvadratisk planform och en centralt placerad trappa i ljusaxel som löper genom husets båda plan" (p.4).

Förslag: Bruno – Q.P.G Arkitektur AB, Göteborg

"Man kan också fråga sig hur ljusföringen hanteras i huset om familjen växer och väggar måste adderas" (p.8).

Förslag: Ludwig – Vera Arkitekter AB, Stockholm

"Juryn ifrågasätter dock (...) konsekvensen av fönstersättningen i övre plan vilken ger en mörk hall och ingen möjlighet till kontakt med egna inre gården" (p.8)

Nr. 7, 2000

Office buildings, Solna

Förslag: H3– Scheiwiller Svensson Arkitektkontor AB, Stockholm (recommended)

"...uppdelningarna ger alla ljusa och attraktiva lokaler" (p.4).

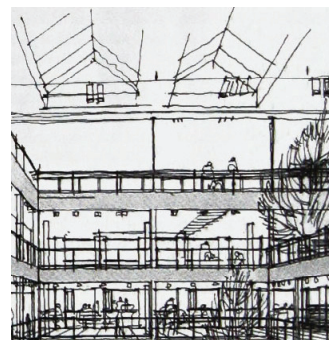
"...ljusöppningar i tak över ljusgårdar är utformade som sågtandade glaslanterniner" (p.5).

Förslag: Konvex – Tengbom Arkitekter, Stockholm

"Den redovisade uppdelningen är inte tillfredsställande vad gäller ljusinfall eller entréförhållanden" (p.7).

Förslag: www.crescendo.com - Gullström och Westerberg Arkitektkontor AB, Stockholm

"Juryn kritiserar (istället) främst förslagets kontorslösningar med stora mörka planer. Ljuscynders vid trapphuset kan möjligen skapa ett effektivt ljus lokalt, men ger inget tillskott till arbetsplatserna" (p.8).



Nr. 5, 2001

Expansion and renovation of the Växjö Library

Förslag: 21711 – Arkitekterne M.A.A Schmidt, Hammer & lassen K/S, Århus, Denmark (winner)

"...vars allmänt tillgängliga utrymmen i huvudsak får ljus via den cirkulära öppningen i bjälklaget" (p.4).

Förslag: 1-2-3 - Erséus Frenning & Sjögren Arkitekter AB, Stockholm

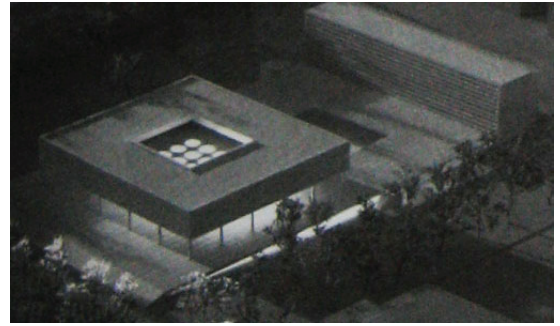
"Smala slitsar med lanternintak i mellanrummen är tänkta att göra de olika delarna klart urskiljbara men är troligen för underordnade för att få önskad effekt" (p.8).

Förslag: Konsten att se – Wingårdh Arkitektkontor AB, Göteborg

"Ett stort glastak (...) utgör ett nytt, självständigt element. Av detta tak är föga framträdande från den närmaste omgivningen; under den mörka delen av dygnet skymtar det dock som en utbredd ljusvolym ovanpå anläggningen, en lysmask i jätteformat" (p.8).

Förslag: 89416 – Henning Larsens Tegnestue, Köpenhamn

"Plattan lyfter några decimeter över marken och släpper in ljus till ett utvidgat arkiv"(p.9).



Nr. 7, 2001

Student's union building and main entrance, University of Stockholm

Förslag: EQ - Erséus Frenning & Sjögren Arkitekter AB, Göteborg (recommended)

"...måste förslagsställaren dock visa antingen en övertygande lösning med salen i källarplanet eller uppflyttad till det nedre entréplanet. Det sistnämnda läget skulle möjliggöra dagsljusbelysning" (p.7).

Förslag: Ba nan - Wingårdh Arkitektkontor AB, Göteborg

"Men högre byggnadshöjden har stråket blivit till en korridor som dessutom ofta kommer att ligga i skugga och med sin trattform riskerar att bli extremt vindutsatt" (p.15).

"Både restaurang/kök och Stora salen har fått mer centrala och dagsljusbelysta placeringar i huset" (p.15).

Förslag: Frank & Ernest – Arkitekt Magasinet AB, Stockholm

"...för dess smala, långsträckt relativt slutna glasburna byggnadskropp med en intressant introvert ljusföring" (p.16).



Nr. 1, 2002

The New College of Music in Örebro

Förslag: Campus off Broadway – Husplan Arkitekter Örebro AB

"Denna inre gata, som förutsätt myllra av liv och aktiviteter har dubbel våningshöjd och får ljus genom en mängd små taklanterniner".

"Lokalerna är mestadels ljusa, men ett antal övningsrum saknar helt dagsljus" (page 7).

Förslag: Inside Out – White Arkitekter AB

"...får den genomgående entréhallen kontakt med dagsljuset och skogsbacken" (p.8).

Förslag: Scala - Semrén och Månsson Arkitektkontor AB, Göteborg

"Hallen får också ljus genom taklanterniner" (p.9).

Förslag: Steinway – Nyréns Arkitektkontor AB, Stockholm

"...med en betydande andel av övningsrummen placerade i byggnadens kärna med enbart överljus från taklanterniner" (p.10).

Nr. 2, 2002

Concrete's possibilities, Sollentuna centrum

Förslag: Olle – Bjurström & Brodin Arkitekter Ab, Stockholm

"Torget är bearbetat med en trappa som differentierande element, i ett soligt läge som dessutom ger överblick" (p.2).

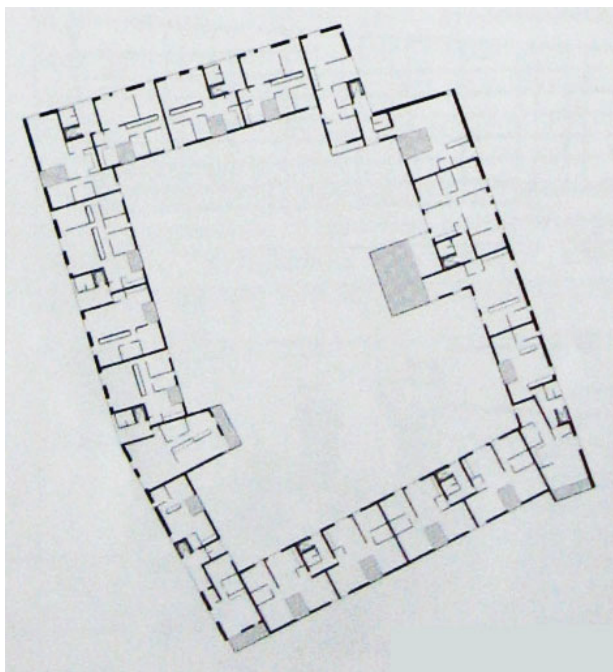
"Lägenheterna rymmer goda möjligheter och har liksom gården goda dagsljusförhållanden" (p.3).

Förslag: Miss Universum – Kod Arkitekter, Stockholm

"Lägenheterna (...) har vissa brister, t ex vad gäller dagsljus och möblerbarhet" (p.5)

Förslag: Meander – White Arkitekter AB, Stockholm

"Principen följer logiskt buller- och ljusförhållanden" (p.6)



Förslag: Om att odla sin trädgård – Ulrica Ericsson, Stockholm

"...de smala huskropparna medför goda dagsljusförhållanden såväl inomhus som utomhus" (p.9).

Förslag: Spjärn – Jörgen Pehrson Arkitektkontor AB, Stockholm

"Föreslagna fasadelement och solavskärmningar av betong är intressanta" (p.10).

Nr. 3, 2002

A multi activity building adjoining Huddinge University Hospital

Förslag: Lekande lätt – Planeringsbyrån Molino AB, Helsingfors (winner)

"Även andra detaljer i planerna behöver bearbetas liksom möjligheten att erbjuda föreläsningssalen dagsljus" (p.3).

Förslag: Fågel Blå – Bjurström & Brodin Arkitekter AB, Stockholm

"Maximal ljus- och markkontakt har eftersträvats i huvudplanet där barnen vistas..." (p.4)

Förslag: Maja Piraya – Merom Kirchmeier Arkitekter AB, Stockholm

"Väl inne möter besökaren en stor hall med dagsljus i fonden. En kvalité som förslaget nära nog är ensamt om".

"Vidare innebär den runda formen att ett flertal rum inte har fasadläge, utan endast får sekundärljus." (p.6).



Förslag: Uppsala Kristallen – Henning Larsens
Tegnestue, Köpenhamn (winner)

"En av ljus genomflödad öppen foajé skär genom hela byggnaden uppifrån och ned och binder samman husets alla funktioner... Genom sin orientering låter den också solens gång avteckna sig nere på Vaksala torg under sena eftermiddagar" (p.3).

Förslag: Mono – Vera Arkitekter AB, Stockholm

"...men juryn ställer sig tveksam till såväl dagsljusföring som kontakten med utomhusauditoriet" (p.4)

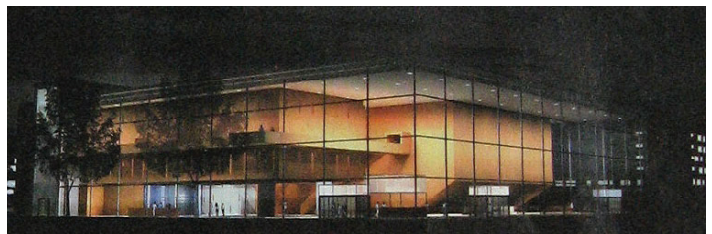
Förslag: May – Roger Spetz Arkitekter, Stockholm

"Detta förhållningssätt har givit en mjukt skulpturalt formad byggnad med poetiska rumsekvenser och vackert dagsljus" (p.9)

Förslag: Rymd – Archus Arosia Arkitekter AB,
Västerås

"Den breddade Vaksalagatan kommer i kombination med den låga bybyggelsen längs gatans västra sida att borga för fina ljusförhållanden i foajén under eftermiddagar och kvällar"

"De ensartade glasfasaderna ger byggnaden ett väl anonymt uttryck och kommer dagtid att framstå som mörka och slutna istället för transparenta och inbjudande" (p.11)



3.2 Three-dimensional models

Graphic 3D models are very common in the architectural field today. This representation aims to make a better visualization of the inexistent object. The results sometimes are very interesting and important for the understanding of the space. Nowadays, light is also usually integrated to the representation of these models, in order to express a night view composition. The lit model can be a very useful tool to represent how the building and the space are perceived at dark time. When it is aesthetically well done, the graphic result contributes to the general appeal and adds value to the representation of the architecture.

However, the real lighting design is most of the time not integrated with the process; and furthermore the graphical tool (rendering program) has its limitations and incompatibilities with the lighting in the real world. As a result, the representation can not correspond to the reality. Because of this, it is important to understand these images for what they are and not be visually deluded by them.

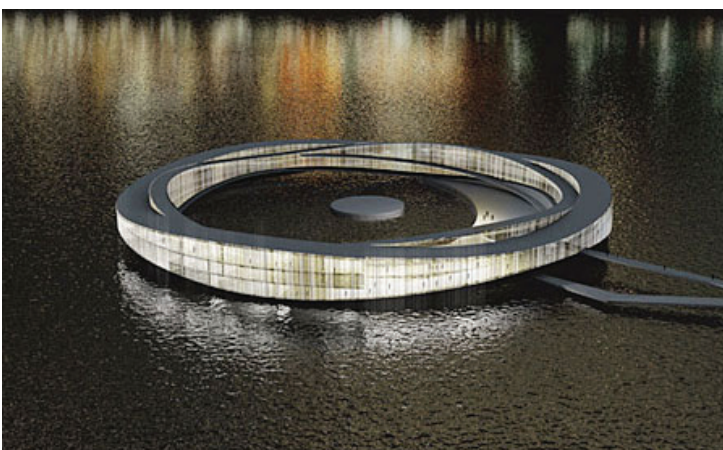
Below, it is possible to see examples of recently made 3D models for relevant projects in Stockholm, using light as a enhancer for the night composition.



Stockholm Library – winner proposal
Delphinium
Heike Hanada



Slussen – Big Architects



Stockholms Kallbadhus – Thomas Sandell

4.0 Discussion and conclusion

Light is a fundamental element to architecture; it interacts with the space, affecting the way we perceive it. The way lighting acts can change the spatiality, the atmosphere and the visibility. The lit environment deals with brightness, shadows, lighting distribution, color and many other aspects that influence our visual experience and plays with our mood.

In my review of architectural competitions, it became obvious that daylight should play a crucial role in the way the jury analyzes the proposals. However, it was shown that lighting analysis is not yet a standard criterion. When discussing lighting, the members comment the presence or absence of daylight, but do not go deeper in the lighting situation. Important issues such as shadowing, reflection and color are not discussed. In my opinion, due to the fact that light is so important for countries like Sweden, combined with the need for urgent environmental friendly design; daylight analysis should be a part of every architectural proposal. In some cases, it could be interesting to incorporate the basis of the artificial lighting design in the submission of proposals.

For the competitions of existing buildings, the lighting situation should also be considered since it affects the ambience and the jury experience. It could be reasonable to have the visit done under the same condition of light. It is also desirable that in international competitions the jury members are aware of the local daylight system, so that the annual range is considered.

When it comes to 3D models, the night time images should be understood as a special effect that often does not correspond to the real situation, even more if the lighting design is not previously done.

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