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"Lost Shadows"

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To the Graduate Council:

I am submitting herewith a thesis written by Julle Oksanen entitled ""Lost Shadows"." I have examined the final electronic copy of this thesis for form and content and recommend that it be accepted in partial fulfillment of the requirements for the degree of Master of Science in Landscape Architecture, with a major in Landscape Architecture.

Ken McCown, Major Professor

We have read this thesis and recommend its acceptance:

Scott Wall, David Matthews

Accepted for the Council:
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Vice Provost and Dean of the Graduate School

(Original signatures are on file with official student records.)

“Lost Shadows”

A Thesis Presented for
The Master of Science Degree
The University of Tennessee, Knoxville

Julle Oksanen
December 2012

DEDICATION

To my wife

Leila Oksanen

My children

Olli Oksanen

Pauliina Oksanen

Karoliina Oksanen

Petteri Oksanen

My parents

Linda and Eero Oksanen

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Julle Oksanen

ABSTRACT

There are thousands of pages of technical argumentation on lighting. We could say that there is already a legacy of technical lighting. It is the result of the activity of technically oriented people. In the 1900, CIE was founded to research oil socks and their properties. Standardization got a huge boost in 1931 when CIE introduced international trichromatic colorimetry system, known as “CIE System”. Engineers became active in illumination engineering societies. Sadly, the more visual skills of the lighting designer started to ebb. The lighting design work shifted from the hands of visually oriented people to the hands of technically oriented people. Engineers have done a good job as far as the quantity and distribution of light, but lighting design is at the same time unbalanced and skewed. Because of this, projects also look technical and often suffer from lack of visual beauty.

It is good to look at and study lighting with open eyes, and to not judge earlier activities, solutions, norms or recommendations. It is also good to carefully study existing solutions and their connection to technical lighting recommendations. It opens doors for better architectural lighting design solutions. Recommendations are really only recommendations, not solutions for lighting design projects. They are only one tool, which must be used very carefully. Projects late in this thesis work are good examples to help to understand recommendations and put them in the right perspective as a helping tool.

This thesis work is focusing on finding back the tools for beautiful architectural lighting solutions. It is not easy task after decades in darkness and under the influence of strong technical lighting eras.

Thesis is divided in 2 parts. Part 1 is the core of my Thesis in nutshell and Part 2 has more detailed information for readers who want to learn more on architectural lighting design.

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PART 1

I) THEORY & METHOD OF LANDSCAPE LIGHTING DESIGN

In this document, I propose a theory of lighting design that integrates engineering and standardization principles with principles of perception and composition to create aesthetic and functional landscape lighting design aptly tailored to its site and context. This theory of landscape lighting design has four "Design elements": 1) Perception psychology, 2) Physiology, 3) Composition, 4) Appropriate use of technique and technology.

In 1931, CIE (Commission Internationale de L' eclairage / International Commission on Illumination), introduced the international trichromatic colorimetry system, known as the "CIE System." This introduction created a standardized lighting design method, and engineers became active in illumination engineering societies and as practitioners of lighting design. Gradually, theories changed from the visual skills of the lighting designer to the standardized lighting offered by the new engineering-based standards. Lighting design work shifted from visually oriented people to technically oriented people. Engineers focus upon and provide quantity of light, norms and lighting recommendations and even distribution of light. Engineered projects result in a technical look and often suffer from lack of visual beauty.

Figure 1: Lighting engineering (Julle Oksanen)

These projects are often derived from standards and codes books with little attention paid to unique site qualities (e.g. IESNA Handbook in USA). Many of these projects have resulted in too much light, light pollution, light is in wrong place, garish contrasts, and often have a loss of shadows.

The theory of lighting design I propose will address these contemporary lighting problems, ground lighting design theory in four critical dimensions or 'elements', and provide opportunities for aesthetics based upon individual sites and their contexts. First, I will describe the four critical elements a lighting designer should focus upon to create an effective landscape lighting design.

PERCEPTION PSYCHOLOGY.

> "Perception psychology is a psychology mental process by which intellectual, sensory and emotional data are organized logically or meaningfully in observer's head. It serves as a basis for

understanding, learning, and knowing or for motivating a particular action or reaction" [1]. "Perception psychology in landscape lighting design is based on Richard Kelly's lighting ideas. Richard Kelly (1919-1977) was a pioneer of qualitative lighting design who borrowed existing ideas from perception psychology and theatrical lighting and combined them into a uniform concept for lighting design. Kelly broke away from the rigid constraints of using uniform illuminance as the central criterium of lighting design. He replaced the question of lighting quantity with the question of individual qualities of light. These were designed according to a series of lighting functions, which were in turn geared towards the perceiving observer. Three of these functions are critical to perception psychology for landscape lighting design: "Ambient Luminescence", "Focal Glow" and "Play of Brilliants." [2]

Figure 2. Richard Kelly. (Richard Kelly's archives).

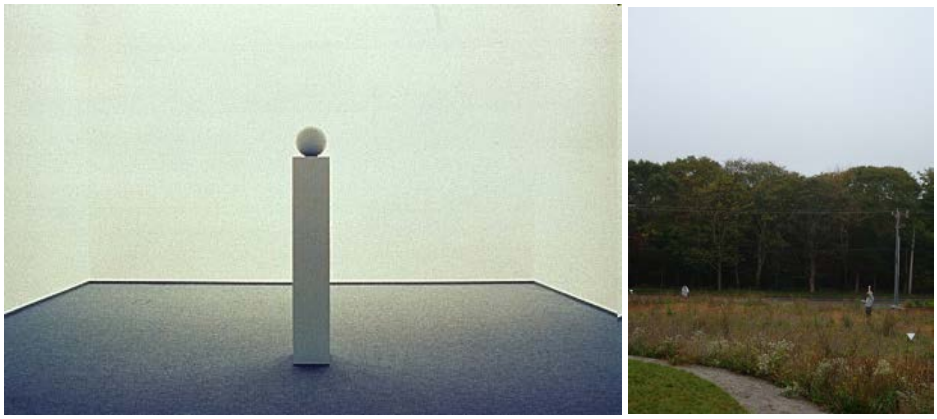


Figure 3-4. Ambient Luminescence, theorical display (ERCO) & case study (Julle Oksanen)

Ambient Luminescence

> "Kelly called the first and foundational form of light "ambient luminescence". This is the element of light that provides general illumination of the surroundings; it ensures that the surrounding space, its objects and the people there are visible. This form of lighting facilitates general orientation and activity. Its universal and uniform orientation means that it largely follows along the same lines as quantitative lighting design, except that ambient luminescence is not the final objective but just the foundation for a more comprehensive lighting design. The aim is not to produce blanket

illumination, or "one size fits all" lighting at the supposed optimum illuminance level, but to have differentiated lighting that builds on the base layer of the ambient light." [2]

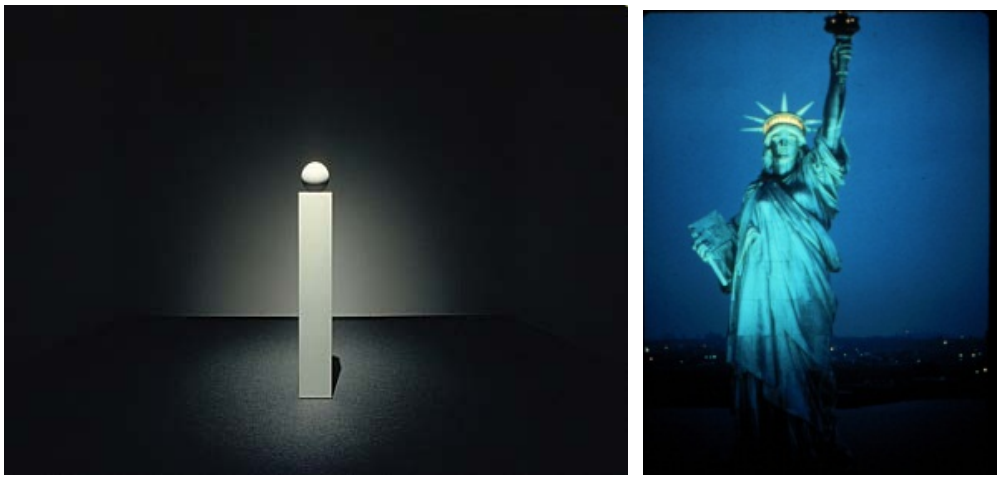


Figure 5-6. Focal Glow, theorical display (ERCO) & case study (Statue of Freedom, lighting design and photo: Howard M. Brandston Lighting Design).

B. Focal Glow

"To arrive at a differentiation, Kelly came up with a second form of light, which he referred to as "focal glow". This is where light is first given the express task of actively helping to convey information. The fact that brightly lit areas automatically draw our attention now comes into consideration. By using a suitable brightness distribution it is possible to order the wealth of information contained in an environment. Areas containing essential information can be emphasised by accented lighting, whereas secondary or distracting information can be toned down by applying a lower lighting level. This facilitates a fast and accurate flow of information, whereby the visual environment is easily recognised in terms of its structures and the significance of the objects it contains. This applies just as equally to orientation within the space (e.g. the ability to distinguish quickly between a main entrance and a side door) as for emphasising certain objects, such as when presenting goods for sale or when highlighting the most valuable sculpture in a collection". [2]

Figure 7-8. Play of Brilliants, theorical display (ERCO) & case study (Gateshead Millennium Bridge. Lighting design Speirs + Major, photo Graham Peacock).

C. Play of Brilliants

”The third form of light, "play of brilliants", results from the insight that light not only draws our attention to information, but can also represent information in and of itself. This applies above all to the specular effects that point light sources can produce on reflective or refractive materials. Furthermore, the light source itself can be brilliant. This "play of brilliants" can add life and ambiance, especially to prestigious venues. What was traditionally produced by chandeliers and candlelight can now be achieved in a modern lighting design by the targeted use of light sculptures or by creating brilliant effects on illuminated materials”. [2]

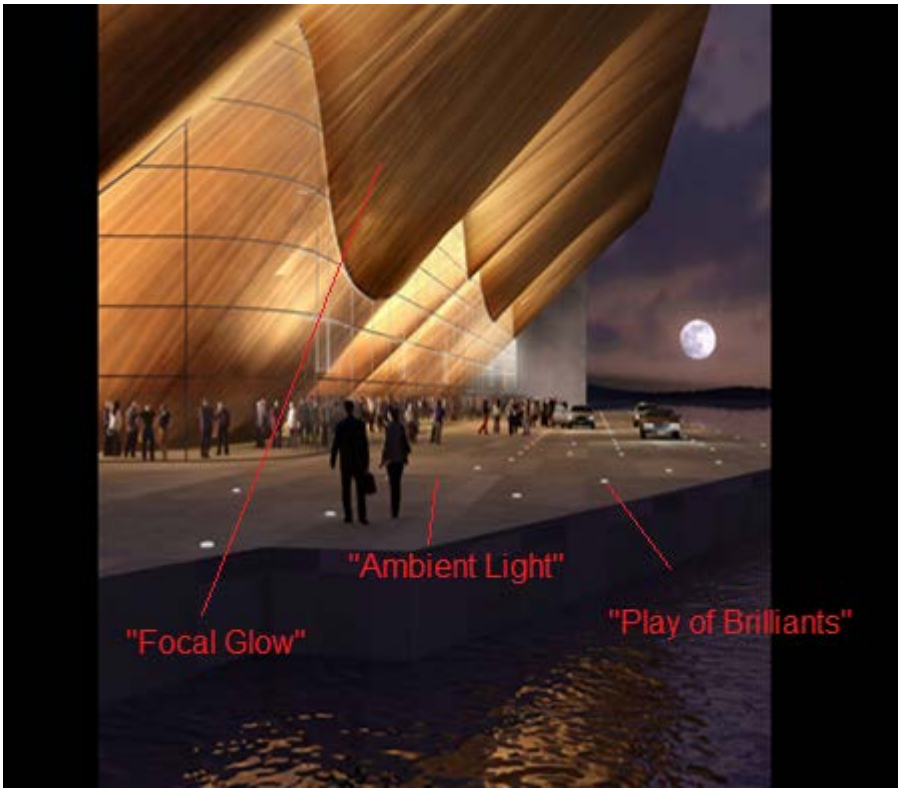


Figure 9. “KILDEN”. Architect and CAD manipulation: ALA Architects Ltd

A good landscape lighting design project to demonstrate these three principles of Richard Kelly is ”Kilden,” the Concert and Theatre hall in Norway. It is designed by ALA-architects and has a lighting concept by Julle Oksanen Lighting Design Ltd.

Application of Richard Kelly’s lighting theory:

”Ambient Light” = The glowing facade produces horizontal light on the ground. The horizontal light meets the minimum engineering and code standards for levels of light necessary for things like safe movement. Minimum values are acceptable due to other fixed lighting in the area, and ’live lights’ coming from cars for example, will provide more light to raise the lighting levels. In other words, if maximum lighting was provided, additional ’live lights’ would raise lighting levels far beyond the amount necessary, creating light pollution.

One of the most important thing is to avoid Glare, which is the worst enemy of light. As a rule of a thumb: Contrasts are strong and there is no veil on the retina if the maximum brightness of the light distribution surface in all views is the moon brightness. (Moon luminance is approx. 3000 cd/m2).

”Focal Glow” = In-ground luminaires differentiate the facade of the building by create a glowing wooden surface. Because of its figural and attractive nature, the wooden and curving facade was selected as a ”Focal Glow” element of the landscape lighting. It is a glowing landmark on the area and by switching on and off different underground luminaires it can be used as an information wall As an example of information; more light is focused upon the entrance of the theatre when there is a performance.

”Play of Brilliance” = In-ground luminaires (stars on the ground). Landscape lighting solution was based on underground luminaires as ”Stars on the ground”. This exciting solution removes ugly and disturbing technical lighting poles and glary floodlights.

Citations:

1. Wikipedia
2. Julle Oksanen Lighting Design Ltd archives (collected information).

PHYSIOLOGY

> “With our senses we are able to detect certain stimuli in our surroundings. But most go unnoticed due to our limited visual range on the electromagnetic spectrum. Our eyes only perceive wavelengths between 380 – 780 nm. So the “picture” our brains make of our surroundings remains limited – and the world we experience with our senses is not identical with the physical world. Visual perception is a process driven by sensation with its outcome dependent on judgements based on the perceiver's situational experiences. Seeing is an intellectual exercise strongly influenced by perceptions and cultural experiences. It may be expressed in several ways, among them, verbally and pictorially.”[3]

The study of the physiology of perception is important because it allows us to understand how color and levels of light lead us to perceive our environments as legible and safe. In the 1980s, anthropologist E.T.Hall and architects Jan Caminada and Ing. Wout van Bommel conducted a research study of how people behave in the dark and found two important elements relevant to lighting designers:

a) The mandatory recognition distance between people approaching each other in the dark is 3.5 meters (approx. 12 feet). There should be enough light in public space to enable people to see each other at this recommended distance.

b) To meet this recommendation, the illumination value should be .8 lux or approximately .08 footcandles.

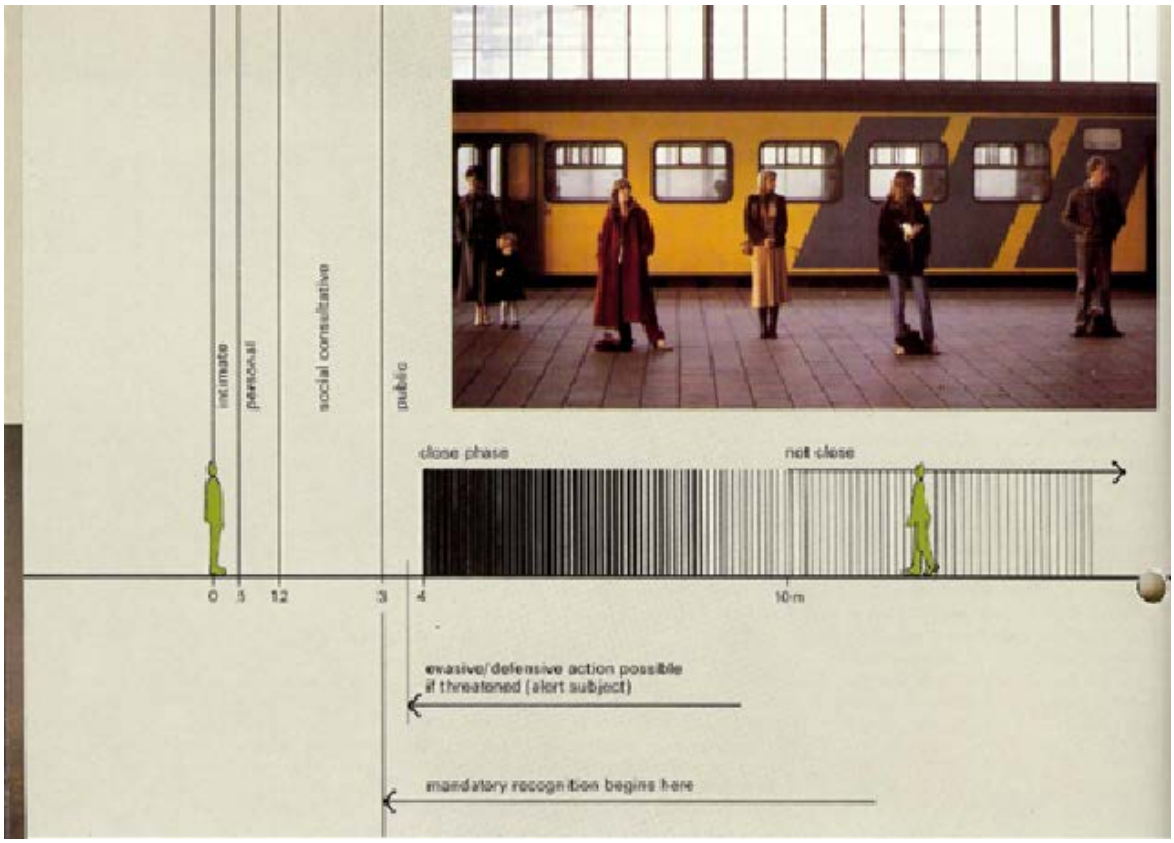


Figure 10: Personal zoning according to research. (Philips ILR 1980 /3)

COMPOSITION (LIGHTING COMPOSE)

Shadow is the best friend of light. Inviting and beautiful landscape views have shadow and light in harmony. Lighting designers compose with light and shadow. Landscape lighting composition should use ambient landscape lighting standards set by codes as the foundation and structure for the play of light and shadow. For example, it is important to focus light from roadlighting luminaires on the road surface in order to be able to compose nice contrast and shadows.

An example of variation of light and shadow can be shown through drawing sections that describe light levels and how they fit a particular landscape. Four compositions shown in this section include different elements which form a gradation of illluminance and shadow including: pedestrian walkways having ambient light, building and trees as focal point through focal glow, a sculptural element or in this case a ship has a play of brilliance. In these case studies, note the sides of boats having a play of briliance and focal glow, the windows of big cruise ships with a play of brilliance.

Practical example of Light Compose, Mariehamn harbour in Finland:

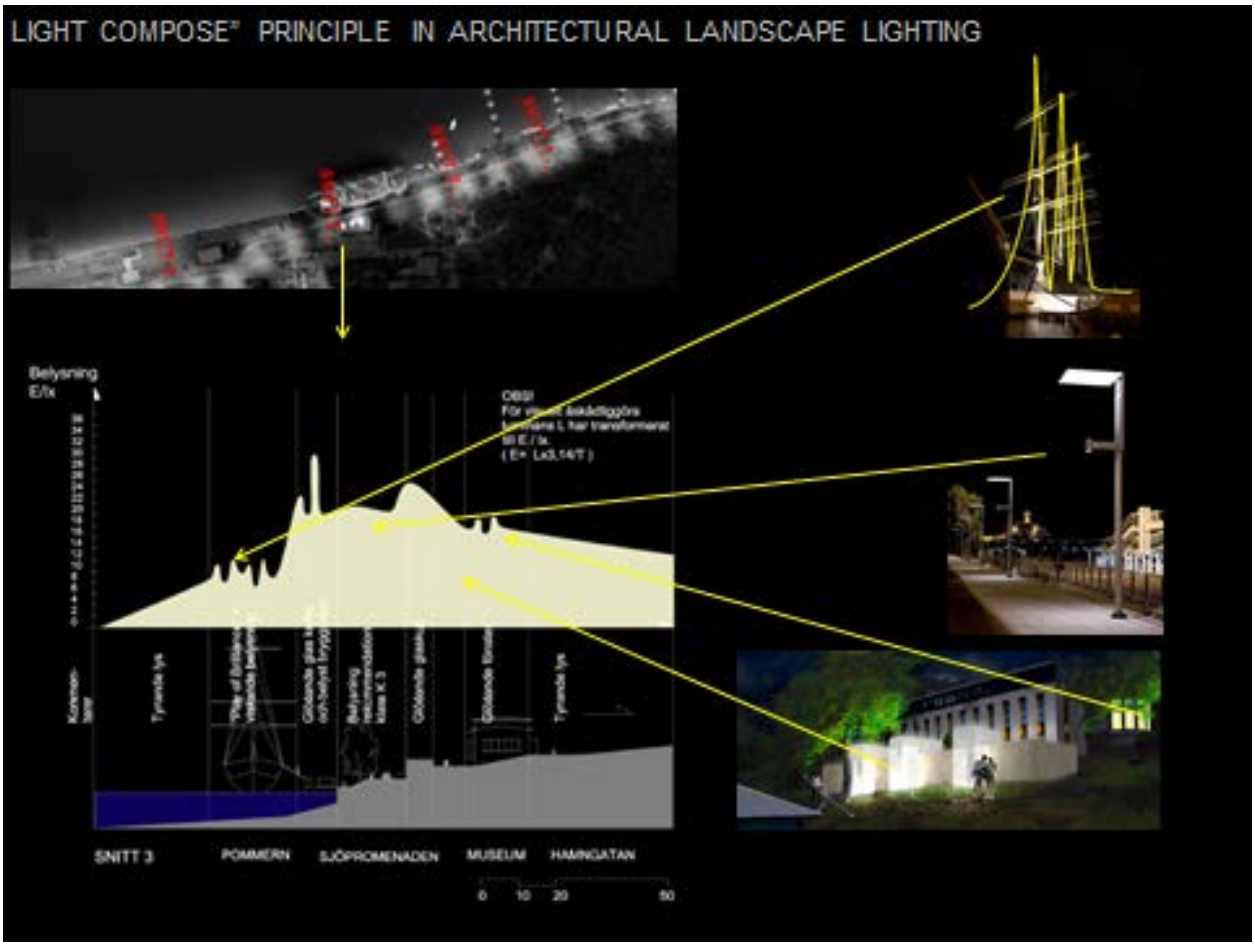


Figure 11. Lighting section and compose explanation. (Julle Oksanen Lighting design Ltd).

Play between shadow and light in this example section from left to right are: 150 foot high masts of sailing boat Pommern; a pedestrian walkway illuminated with the Brando light fixture gives basic low lighting ”tone” over all area; the glass cubes of new musem building and finally the side windows of the museum building.

Lighting composition is shown by the horizontal illumination values drawn on the section. It is not scientifically exact, but designed, measured and calculated as near reality as possible. In order to be able to create effective lighting compositions, it is important to go to site and analyze it during dark hours. Take cameras, notepads and pencils to document observations of the space in different viewing points and – sections.

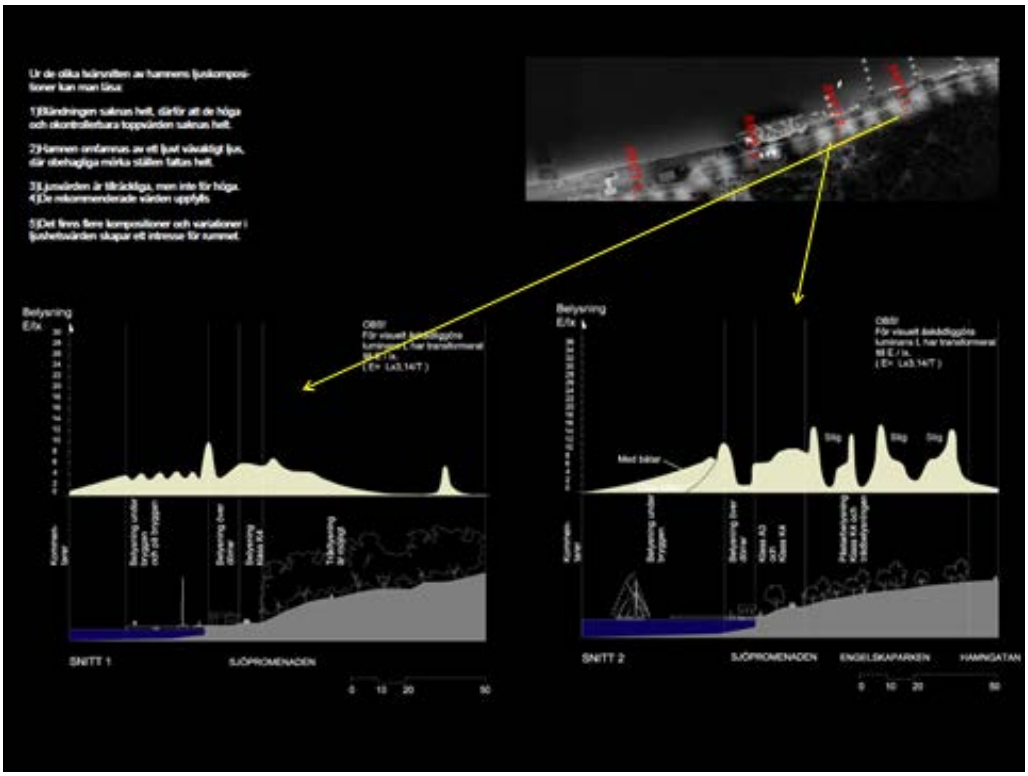


Figure 12: Compose for sections 1 and 2 (Julle Oksanen Lighting Design Ltd)

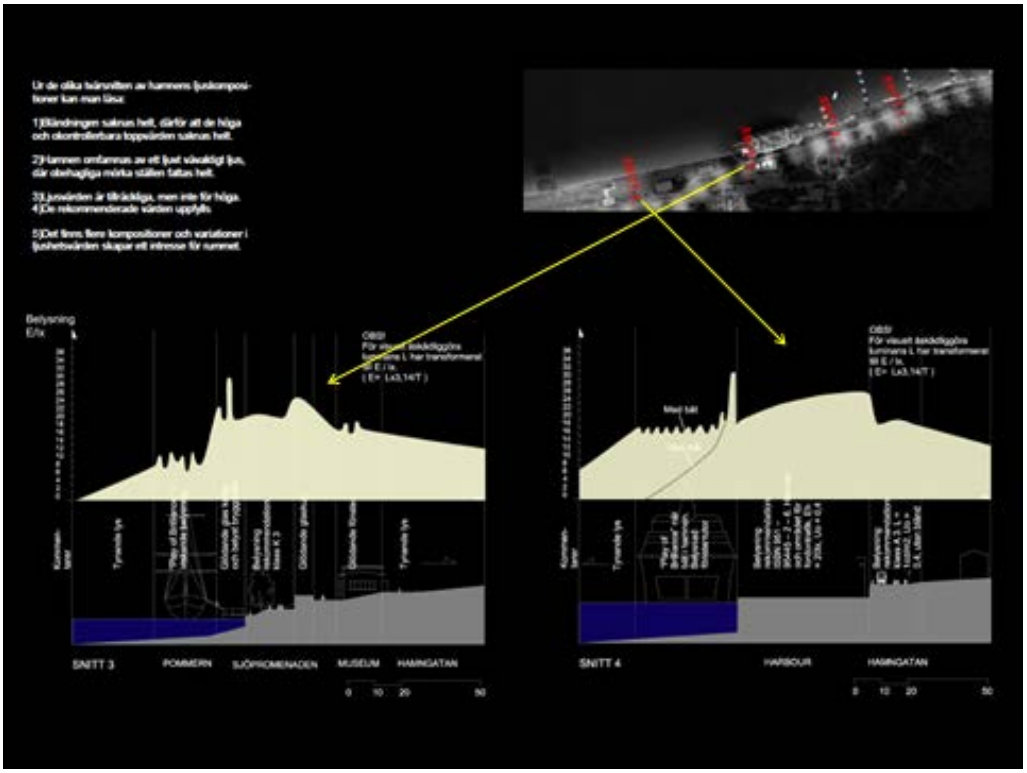


Figure 13: Compose for sections 3 and 4 (Julle Oksanen Lighting Design Ltd).

TECHNICALITY (LIGHTING ENGINEERING).

There are thousands of pages of technical argumentation on lighting; there is already a legacy of technical lighting. It is the result of the activity of technically oriented people. In the 1900, CIE was founded to research oil socks and their properties. Standardization got a huge boost in 1931 when CIE introduced international trichromatic colorimetry system, known as “CIE System”. Engineers became active in illumination engineering societies. Engineers focus upon the quantity and distribution of light. Because of this, projects look technical and often suffer from lack of visual beauty. Lighting engineering ought to help to find right ”Hard Ware” for a good visual landscape lighting design solution, not to be in main role of landscape lighting design as it is now. There is also a hiearchy in lighting engineering: CIE is makeing basic research on lighting in 6 divisions and hundreds of technical committees (TC). CIE sends research results to all Illumination Engineering Societies in all over the world (In USA IESNA, Illuminating Engineering Society of America). National IES add results on national lighting recommendations. Practising electricity engineers use those recommendations as a quidance in ambient light design/ solutions.

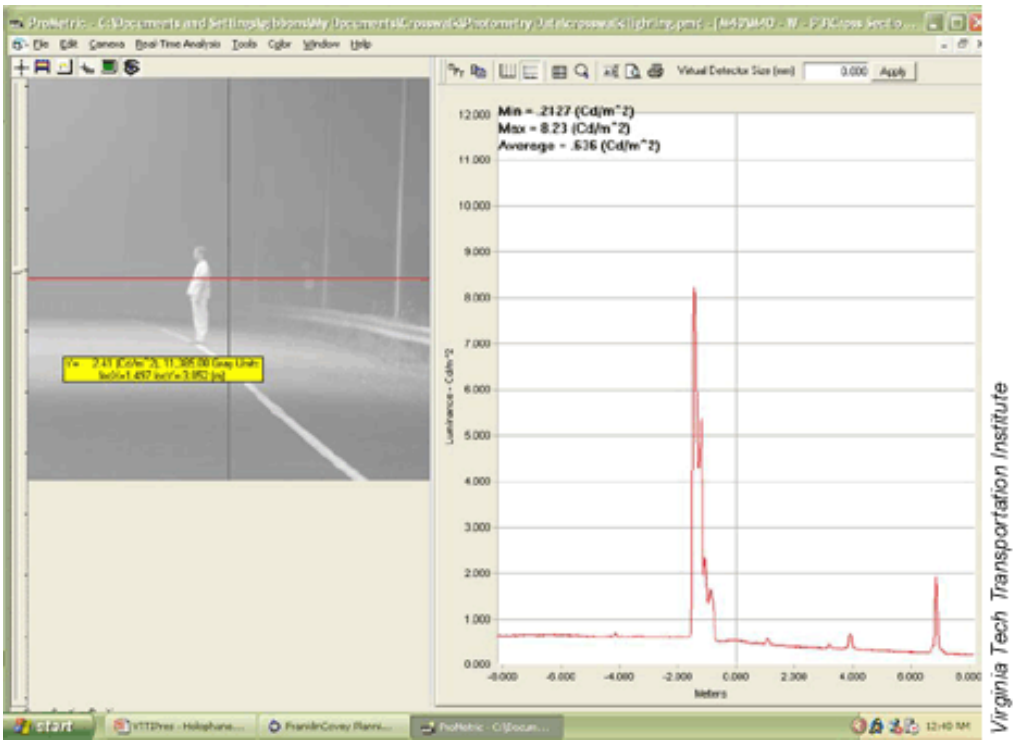


Figure 14. Lighting research (Virginia Tech Transportation Institute).

Engineers primarily focus upon lighting research, norms and standards. There are few tools or theories for architectural lighting design. The image above reflects a typical activity in lighting engineering. This screen shot of a pedestrian crossing a street, and the corresponding luminance readout, were both produced by CCD camera processing software used in visibility improvement research. This is an image of Virginia Tech Transportation Institute research on road lighting.

What lighting engineering ought to do?

They ought to help to find right ”Hard Ware” for a good visual landscape lighting design solution, not to be in main role of landscape lighting design as it is now. There is also a hiearchy in lighting engineering: CIE is makeing basic research on lighting in 6 divisions and hundreds of technical

committees (TC). CIE sends research results to all Illumination Engineering Societies in all over the world (In USA IESNA, Illuminating Engineering Society of America). National IES add results on national lighting recommendations. Practising electricity engineers ought to propose those recommendations as a quidance in ambient light design/ solutions. After getting that information/proposal from engineer, professional lighting designer then add those to his/her lighting compose.

Citations:

1. Wikipedia
2. Julle Oksanen Lighting Design Ltd archives (collected information).
3. Applied and modified citation of Sciense Center Spectrum / seeing and perception abstract

II) TYPICAL AND RECOGNIZED ELEMENTS ON BAD LIGHTING SOLUTIONS

Light on the hands of the professional lighting designer is equal to clay on the hands of the ceramist. Design is an attitude. It is same if you deing a spoon, a house, a car or lighting. Bad solutions done by unprofessional people can bee recognized from several elements like: 1) Lot of Light Pollution, 2) Too much light, no shadows (Shadow is the best friend of light), 3) Wrong fixtures (Glare is the worst enemy of light), 4) Poor lighting recommendations.

LIGHT POLLUTION

Light pollution is a pollution of the evening as it is perceived through light. The impacts of light pollution range from poor legibility, to visual fatigue to a loss of the ability to see the dark sky and stars at night. These impacts range from aesthetic to functional – including safety. There are four different types of light pollution, over-illumination, light trespass, glare and skyglow. I will describe and define each one of these terms:

Figure 15. Facade lighting (www.darksky.org).

Over Illumination.

Over-illumination is the excessive use of light. Engineering standards and recommendations can often tend towards over-illuminating levels, for example, in façade lighting. This façade is glowing so much that the adjacent building is colored yellow from the reflected light.

Figure 16. Museum in Fiskars. Lighting design Julle Oksanen & Vesa Honkonen (Julle Oksanen)

In contrast to glow from facades, techniques in appropriate vertical illuminance can reduce glow and minimize light pollution. The Vertical illuminance value on these walls of museum in Fiskars is 24 lux compared to typical lighting recommendations which establish a value between100 to 200 lux. Note that the building is legible, but unlike the first example, there is not a glare, or light falling on adjacent buildings. Even the trees that grow close to the building do not show reflected light from the building in this view.

Figure 17. Library in Fiskars. Lighting design Julle Oksanen & Vesa Honkonen (Julle Oksanen).

This shows another example of controlled vertical illuminance to reduce glow. In this example the

Vertical illuminance value on these walls is 21 lux. Normal recommendations for this situation establish 35 lux as a minimum value.

Figure 18. An example of light trespass (www.darksky.org).

Light Trespass

In relation to glowing light from unintended sources, is the trespass of light meant for other sources. According to IDA: “A common light trespass problem occurs when a strong light enters the window of one's home from the outside.” This common example is one frequently experienced, where light intended for another use affects one for which it is not intended.

Figure 19. Glare (www.darksky.org).

Glare

Glare may be considered an extreme example of light pollution. It commonly affects our ability to perceive things at night, and can reduce legibility. Glare can be categorized into two types:

Disability glare describes effects such as being blinded by oncoming car lights, light scattering in fog or in the eye that reduces contrast.

Discomfort glare does not typically cause a dangerous situation in itself, though it is annoying and irritating at best. It can potentially cause fatigue if experienced over extended periods.

Figure 20. Lights in Las Vegas may be an example of light clutter at the scale of the city. (www.darksky.org).

Light Clutter.

According to IDA, "Light clutter refers to excessive groupings of lights. Groupings of lights may generate confusion, distract from obstacles (including those that they may be intended to illuminate), and potentially cause accidents." Light clutter therefore affects legibility and can impact safety due to the lack of differentiation of lighting.

Figure 21. Skyglow in big city (www.darksky.org).

Skyglow.

Skyglow is the glow effect that can be seen above populated areas. It is the accumulation of all the area light being reflected from the lighting targets and escaping into the sky. Much of this escaping light is the result of badly designed or engineered light in the area, or light that is inappropriately directed. Skyglow is particularly problematic for amateur astronomers, whose ability to observe the night sky from their property is likely to be inhibited by any stray light from nearby. Most major optical astronomical observatories are surrounded by zones of strictly enforced restrictions on light emissions. Skyglow is made considerably worse when clouds are present. It is important in the context of ecological light pollution. Since cloudy nights can be up to ten times brighter than clear nights, any organisms that are affected by sky glow (e.g. zooplankton and fish that visually prey on them) are much more likely to have their ordinary behavior disturbed on cloudy nights.

TOO MUCH LIGHT & LOST SHADOWS

Figure 22. Empty street, overlit and lacking shadow (Julle Oksanen).

The above image shows too much light on an empty street. This is a common situation that is a result

of an engineering approach to landscape lighting. Note the lack of shadows on the surrounding areas – the light bleaches not only the subject of the light, but the surrounding areas as well. In addition to the physiological, functional and aesthetic effects, there is also a negative environmental effect having to do with energy consumption. According to The NOAA ESRL Carbon Cycle Greenhouse Gases group night lighting consumes 20% of the energy we use. Reducing the light levels in common situations as seen above could reduce the energy we use on lighting and help to reduce all of the ancillary effects of that energy use. Sustainable lighting solutions are critical to help deal with issues such as climate change. There are several technical tools that can help with efficiency including motion sensors and smart grids in addition to high-efficiency bulb types.

WRONG FIXTURES

Poor design, or poor choice of use of light fixtures is a significant cause of light pollution. It is the fixtures that create light clutter, glare, skyglow and the other effects mentioned above. It is critical to understand light pollution from the aspect of the light fixture. Below I offer one example from one of the most ubiquitous lighting fixtures in use in the landscape.

Figure 23. Typical landscape lighting luminaire in USA (Julle Oksanen).

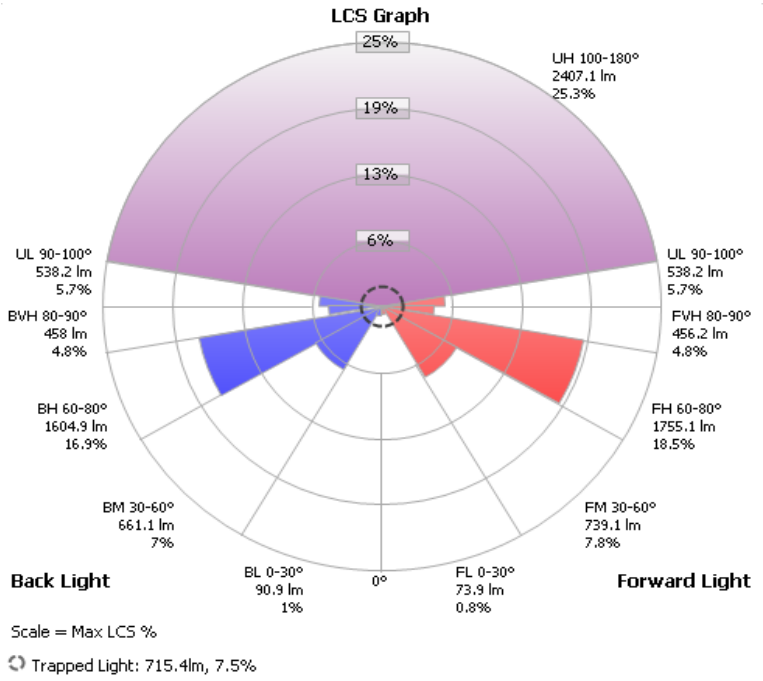


Figure 24. Light distribution curve of figure 23 luminaire (Holophane lighting prochure)

This luminaire type is one type of the a most used landscape lighting luminaire range in the United States. Typically it is used in parks, pedestrian walkways, streets e.t.c. In this fixture, over 40% of light output goes to the sky. You can see this in the diagram, the part of light that goes over 90 degrees of horizontal line. The light distribution curve indicates lighth trespass which causes light pollution. This luminaire type is not sustainable, especially when used on open plazas as the U.L.O.R (Upwards Light Output Ratio) is over 40 %. By new sustainable lighting recommendations in Europe, this luminaire could not be used.

LIGHTING RECOMMENDATIONS

Technical lighting recommendations led us to the problems noted above. There is room to reconsider and refine how we establish codes for lighting, how we design and use fixtures, and most importantly construct theories for lighting design. More details relating to issues with lighting recommendations lie within part two of this thesis.

Ultimately, lighting recommendations should amount to a place-based solution that addresses function and aesthetics as the related to the spaces of the landscape. According to lighting designer and professor Howard Brandston, New York, New York:

Figure 25. Statue of Liberty, New York, New York, USA (Howard M. Brandston Lighting Design).

"…A lighting designer is what the term says he is – *a designer* whose field of specialization is light, … The good lighting designer does not think in terms of equipment, wattage or illumination level. He thinks in terms of space"

Next, I will take the principles of light pollution bad solutions and demonstrate them through a case study to show their impact on one space.

III) SUMMARY AND EXAMPLE OF BAD SOLUTION

It is educational to study and evaluate a typical bad lighting solution with earlier introduced theories: Perception Psychology, Visual Physiology, Lighting Compose/ Composition and Lighting Technicality. Evaluation of bad lighting solutions (Light Pollution, Too Much Light, Wrong Fixtures and Recommendations) also brings out the 'levels' of the different problems. This case study is The Market Square in Knoxville, Tennessee. This case study represents a typical engineered lighting design solution for landscape space, in one of the most important spaces in the city.

Figure 26.Market Square in Knoxville, Tennessee, USA is a typical example of incorrect luminaire types, poor architectural lighting design and a misguided technical lighting solution.(Julle Oksanen)

ANALYSIS:

ANALYSIS 1: ”SPACE AND RICHARD KELLY’S LIGHTING FUNCTIONS”

Figure 27 – 28 – 29 Lighting functions (ERCO)

In good lighting solution Ambient Light, Focal Glow and Play of Brilliance can be found in harmonious combination. In landscape lighting project you can recognise easily the difference between engineering approach and architectural approaching. Lighting functions can be found in architectural landscape lighting solution.

Figure 30 Market Square, Knoxville, TN, USA (Julle Oksanen)

Ambient Light

Horizontal light on the groundplane fullfils recommendations, though most of the light falls upon the wrong surfaces. Facades ought to glow humbly in original colors due to the right lamp selection. There ought to be vertical values of light down to the square for mandatory recognition purposes without having the ground of square have too much light creating glare and glow.

Focal Glow

Focal glow is missing. There are certain elements of focal glow, but these are unplanned and haphazard. Often areas of focal glow are places of advertisment, not areas for legibility or hierarchy or the civic presence of illuminating a shared monument. There are good elements existing to implement focal glow. There are the beautiful facades of thehistorical buildings, and statues, the stage, and color light for the dominating facades of the TVA buildings.

Play of Brilliance

Any design play of brilliance is missing. There is little in the way of this third order of light in this lighing hierarchy. However, elements such as the leaves of large trees could provide areas for the play of brilliance. Selection of different fixtures like in-ground luminaires could be used for orientation and legiibility or aesthetics. Restaurants could use luminaires or candles on their outdoor tables, or stage lighting to produce the play of brilliance and add depth and interest to the space. This is an

imporatant feature for the Square due to its size and limited material palette. The play of brilliance could add interest and break down the scale of the square at night.

ANALYSIS 2: ”RELAXED MOVEMENT AND APPROACHING IN A DARK ENVIRONMENT”

The existing lighting solution creates a sense of safety and demostrates legible areas for movement, but the glare values varied and were too high. According to lighting designer Howard Brandston: ”A solution is comfortable if the luminance of light distribution surface is less than the moon luminance (3000 cd/m^2). Market Square is unpleasant and, in many locations, the measured value was even 30000 cd/m^2 (10 times higher than moon luminance).

In the Square, recognizion distance is long, but the landscape lighting solution is still bad. This is also due to the color of light. The color is yellow from high pressure sodium lamps developed from an era of high energy costs. Ironically, these luminaires developed from the oil crisis leave a lot of trespass light, glare, and eliminate shadows and legibility due to the differentiation of light into legilble light and shadow.

ANALYSIS 3: ”LIGHTING COMPOSITION”, THE RELATIONSHIP BETWEEN LIGHT & SHADOW ON ARCHITECTURAL SECTIONS.

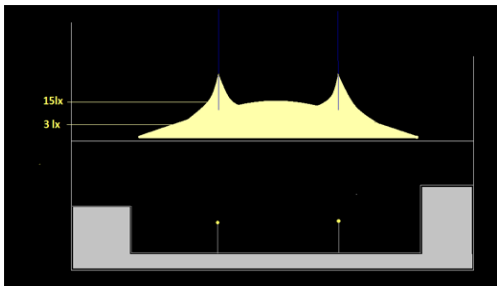
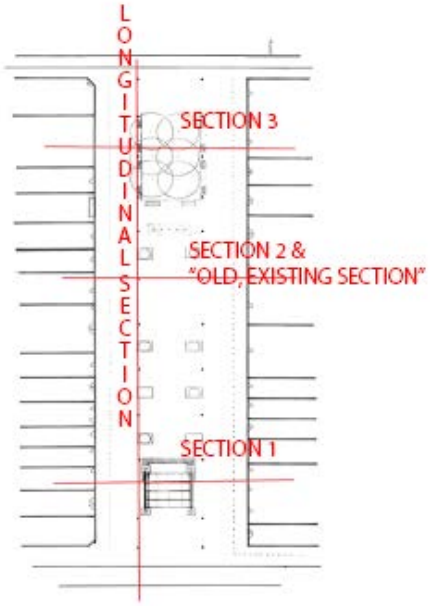
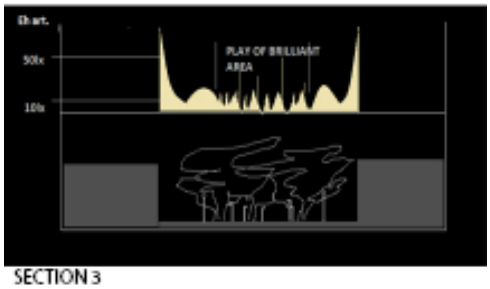


Figure 31. Lighting composition of market Square – a sectional analysis. (Computer image Julle Oksanen).

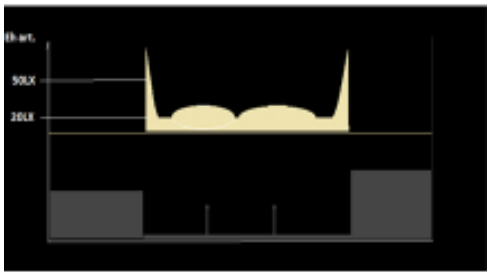
The lighting composition of Market Square is poor. The overall effect as seen in the section analysis in Figure 31 of light and shadow is a ‘Batman hat.’ This section shows too much light exists in the

square and the building façades are dark. The light posts are in two rows and are the variety noted earlier in the technical analysis above. The lighting composition does not respond to the facades, nor the unique elements of the square; it is a 'one size fits all' solution through rows of lights. Below I offer an example of a place-based solution driven from a site analysis and the theories of the integration of ambient light, focal glow, and the play of brilliants.





SECTION 3



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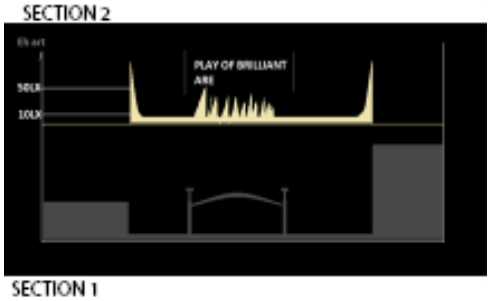
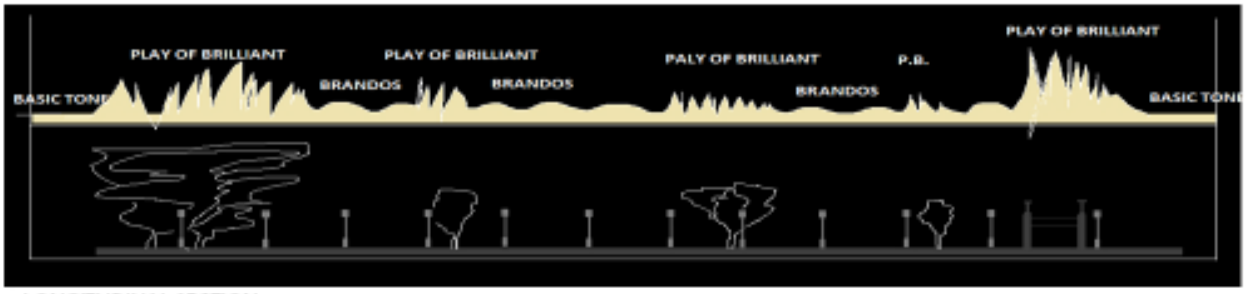


SECTION 1



LONGITUDINAL SECTION

Figures 32 – 36. New compose of Market Square. (Julle Oksanen).

IV) GOOD LANDSCAPE LIGHTING SOLUTION / LIGHTING THE LADY

Professor, Lighting designer Howard Brandston, New York, New York, USA

Next I will provide an existing example of the use of the theory of lighting design based upon ambient light, focal glow, and the play of brilliants. Whereas Market Square was a proposal, Howard Brandston's lighting design for the Statue of Liberty shows how the three-part theory can be integrated with a method of site and context analysis to create a strong lighting design concept. Landscape is important in our civic lives, and much of our experience of civic places and monuments occur at night. The Statue of Liberty is a good example of how lighting design can enhance civic places and create shared memories and iconic images and experiences of our share heritage.

Figure 37. Statue of Liberty, New York, New York, USA (Howard M. Brandston Lighting Design).

"I pondered the challenge of how to illuminate this icon, so I took a boat out into the harbor and observed her from various distances and at every angle. I observed her at dawn, noon, dusk and in the darkness of night. At some point of the process, I walked to the end of the Battery Park Promenade, sat on a stone wall, and it came to me: She looked best in the light of dawn. I took out my little notepad and wrote: "Needed: one light source with spectral power distribution to mimic the morning sun, one to mimic the morning sky and a new light fixture to project light from a great distance – this will make a lady with green skin look good."

Figure 38-39. Statue of Liberty, New York, New York, USA (Howard M. Brandston Lighting Design).

ARCHITECTURAL LIGHTING DESIGN ANALYSIS:

The composition of lighting in this design is outstanding. Light & Shadow have a beautiful balance in addition to the composition working from every viewpoint of the Statue of Liberty. This is remarkable given the variety of vantage points that include the harbor and surrounding sites of New York City, New Jersey and Staten Island. Also there are great views from ships and airplanes flying into JFK, La Guardia and Newark International.

The lighting composition demonstrates features of Richard Kelly's design theory. Ambient light exists from the sun rise and sky. The lighting of the statue provides the focal glow with balanced light and shadow. The surrounding lights of the metropolitan region give a play of brilliance.

The technical solutions for this scheme should be noted. General Electric created a new metal halide lamp version for this project according to Howard Brandston's requests. This shows the importance of collaboration between technical suppliers, engineers and lighting designers. Luminaires with special optics were designed and manufactured to provide the precision control of light at this scale. These luminaires allow the color solution to imitate dawn light conditions, remarkable given that the

Statue has green ‘skin’!

The Statue of Liberty is a special object with a civic significance and symbolism. A gentle and gradated light enhances the symbol, but also imbues it with an almost ethereal presence. The light is the softest at the base, allowing the Statue to mysteriously arise from her place on dark waters. The increasing in intensity of light draws the gaze upwards to the pinnacle, creating softly glowing brightness at the crown and the torch. This gradation makes the Statue present, and enhances the top of the structure, providing an iconic and memorable image.

V) SUMMARY OF GOOD LANDSCAPE LIGHTING DESIGN METHOD

For this lighting design theory to be effective, it is critical to structure a place-based method to achieve quality results. As noted in the example of the Statue of Liberty, each project may be considered unique and special, and several visits and analytical approaches tailored to the site are necessary. A good landscape lighting design method includes:

a) Site analysis

The lighting designer has to go to site and observe surroundings to understand what areas should be enhanced through focal glow, what ambient lighting is necessary, and where the play of brilliance may occur. A map of the site as it exists and the plan of the new landscape design (if there is one) and camera are important tools to document and locate site conditions of interest. The site must be analyzed in all directions on foot focusing on popular viewing directions. There may need to be several site visits to understand the spirit of the place, how to enhance or create it, and execute the details to create a cohesive and legible lighting composition.

b) Sketching

A sketchbook is essential to document ideas. It is important to write clearly, as it is often the case notes may represent ‘the moment’, but not be understandable when revisiting the sketchbook. The sketchbook is also important in the design process; it should be available when creating ideas back in the office.

c) Lighting design concept

The lighting design concept is the most important part of the project. The lighting design concept consists of how to capture the spirit of the site through personal connections and then to relate this spirit to the design team and necessary requirements for a functional space and place. Concepts can be created in minutes or sometimes take a year, depending upon the quality of analysis, the chemistry of the design team, and the amount of time to work on the project. More information about concept is located in Part 2 of this thesis document.

d) Lighting design master plan

The master Plan is a strategic method of documenting and figuring out the concept and communicating it to collaborators. With the plan, lighting designers have to find lighting ‘hardware’ and ‘software’ solutions to fulfill the concept design practically. Activities during master planning include; luminaire selection, lamp selection, preliminary checking of construction solutions, lighting calculations, and computer modeling.

If the right solutions cannot be found, the concept needs to change. It is important to understand a concept is a theory, but if it cannot work in a situation, the theory must change. This demonstrates how theoretical concepts, when applied to a specific lighting design, create a pragmatic truth. Experience with real projects matures a lighting designer's capabilities and understanding of what can be done and what cannot be done. More information about pragmatic truth, master planning and the activities that occur within this phase is located in Part 2 of this thesis document.

e) Physiology, Function and Luminaire Selection

The selection process of right kind of luminaires is important to meet the necessary functions of the lighting design. Luminaire selection influences all aspects of the lighting design including; light composition, glare, and recognition distance. It is critical to understand this role and impact of luminaires from the beginning of the conceptual phase. Though fundamentally important, the luminaire selection is not the primary thing in the design process, it still comes after concept and composition done in the master planning phase.

f) Lighting composition

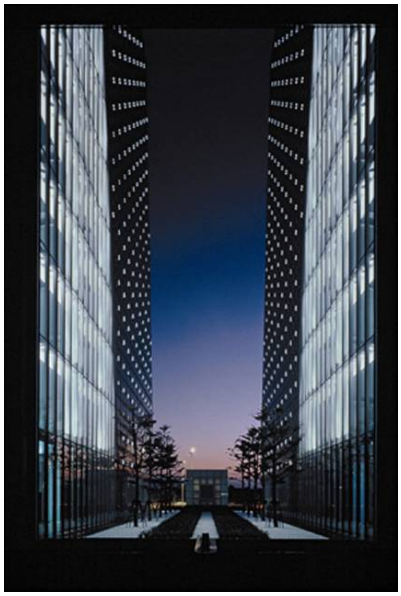
Once the luminaires have been selected, the composition needs to be re-evaluated. There are many ways to evaluate a lighting design. One way is to make a preliminary composition on photos taken in the sketchbook and analysis phase. One can explore with reasonable precision the play of brilliance, fogal glow and ambient light through modeling in photos and the computer. If resources are scarce, evaluation can be done on, or through drawing and and sketches.

g) Maintaining the right technical tools

The designer must remember that engineering serves design. Exact technical tools serve lighting design for function and composition. Luminaires, dimming systems, color changes, fixtures and energy supply types like solar, are good to add in detail design phase.

h) **Right kind of collaboration**

The lighting design process is collaborative between many professions and people. A team united in idea by concept, working in harmony, is essential for a lighting design concept to reach its potential. Proper working methods and tools are necessary to help communicate the lighting design concept to get everyone involved and understanding how to implement the design..



M39/40 Office Building

The Thomas Jefferson Memorial 2001 Relighting

Jefferson National Expansion Memorial Gateway Arch & Lighting Master Strategy for North Vancouver

VI) SUMMARY: MASTERS' VOICES & THEIR MASTERLY WORKS

Hopefully I have been able to prove necessary elements for good Architectural Landscape Lighting Design. As a practicing lighting designer, I know that they are not generally wellknown in any "design field". More "strenghtening" information can be found on PART 2,

which has more detailed information for successful Architectural Landscape Lighting Designs. Let's follow Master's Voices:

"…A lighting designer is what the term says he is – *a designer* whose field of specialization is light, … The good lighting designer does not think in terms of equipment, wattage or illumination level. He thinks in terms of space"

Howard Brandston

"Architecture is the masterly, correct and magnificent play of volumes brought together in light…I compose with light…Light is the key to well being."

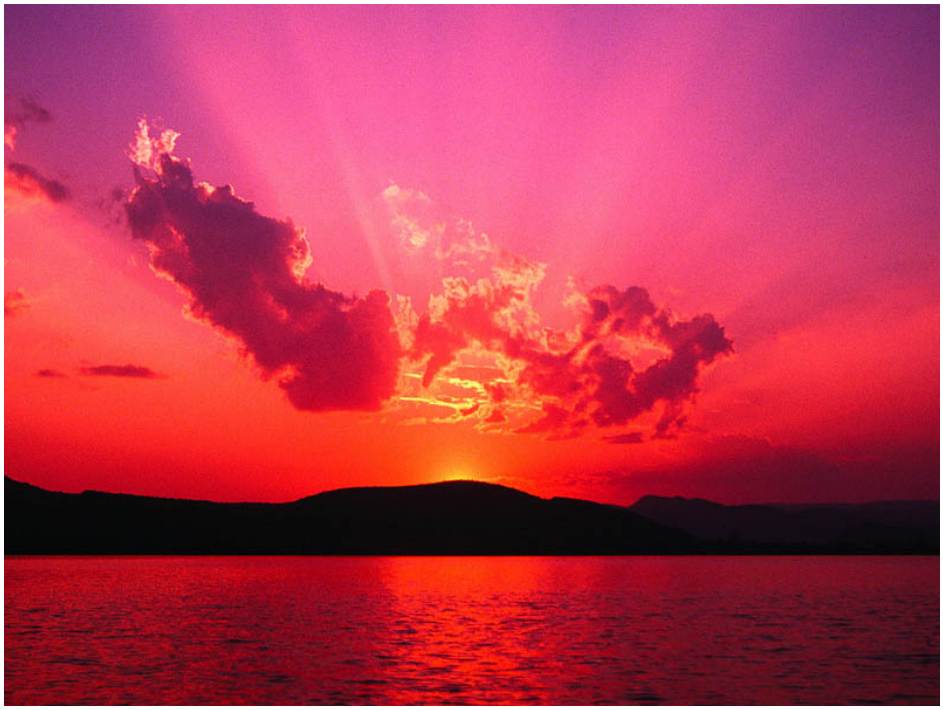
Le Corbusier

“ More and more, it seems to me, light is the beautifier of the building…Lighting may be made part of the building itself.”

Frank Lloyd Wright

“You can say that the light, the giver of all presences, is the maker of a material, and the material is made to cast a shadow, and the shadow belongs to the light…”

Louis Kahn, *Silence and Light*



“ In the beginning God created the heaven and the earth. … And God said Let there be light: and there was light. And God saw that the light was good.”

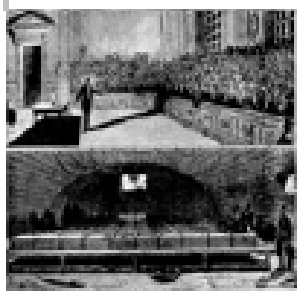
Genesis 1:1-4

PART 2

CHAPTER 1 “HISTORY OF LOST SHADOWS”

As seen on ”Chart of lighting features 1810 – 1962” (on next page), the whole lighting world has been in fermentation during it’s over 200 years history. Especially lighting design has been under different kinds of pressure in different decades. Mature yourself to study this thesis work by looking first carefully this history chapter. Collection of remarkable activities during different Eras, like: - Electricity founding era – Experimental era – Lighting design starting era – Lost shadow era – One man show era and reawakening era- gives you a good starting point for understanding the big picture. Isn’t that the main goal for studying history also generally and basic element when making decisions for future?

1810 — ELECTRICITY LIGHTING FOUNDING ERA



ELECTRICITY LIGHT

The First Experiments With The Electric Light
Electric lighting dates back, as well known;
to the celebrated experiment of Sir Humphry Davy,
which took place in 1809 or 1810, but the date of
which is often given as 1813. There exist however,
some indications that experiments on the production
of the electric spark between carbons had been performed
before the above named date.

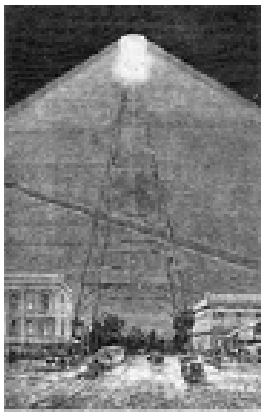
NATURAL SHADOWS AND HUMANISM

Right up until the 18th century people only had two
light sources at their disposal: natural daylight and the
flame - the latter being the only artificial light source
since the Stone Age. These two types of lighting
dictated the patterns of life and architecture down
through the ages, but a new epoch was ushered in with
the invention of gas lighting and then electric lighting.

1885 EXPERIMANTAL ERA 1913 LIGHTING DESIGN 1931 LOOSING SHADOW ERA
1900-3 STARTING ERA

The first steps towards the formation of an international body concerned with light measurement were taken at the International Gas Congress held during the Paris Exhibition of 1900. 400 gas engineers gathered in the Palais des Congre's at the exhibition, under chairmanship of Prof. T.Vault, the president of the Socie'te' Technique de l'Industrie du Gas de France. The result of this meeting was "The Photometry of Incandescent Gas Mantles". 1903 CIP, the precursor of CIE found in 1903.

CIE founded in Berlin to study photometric properties of first gas lighting and expanding later on for other light sources. (coil- and incandecsent lamps).



QUANTITAVIE LIGHTING DESIGN

The American Electric Light Tower (San José 1885)
With the advent of electrical lighting, obtaining illuminance levels similar to those of daylight became a question of how much technical effort one was prepared to invest. At the end of the 19th century, one attempt at providing street lighting was to mount floodlights on lighting towers. Glare and harsh shadow caused more problems than advantages and so this form of outdoor lighting was soon abandoned.

ERA OF LOOSING SHADOWS

In the beginning CIE was founded to research oil socks and their properties. Standardization got a huge boost when CIE 1931 Session established an international system for trichromatic colorimetry, the now generally accepted and known as "CIE System".
Engineers became active in illumination engineering societies.
Sadly, the more visual skills of the lighting designer started to ebb.
The lighting design work shifted from the hands of visually oriented people to the hands of technically oriented people.
Engineers have done a good job as far as the quantity and distribution of light, but lighting design is at the same time unbalanced and skewed.
Because of this, projects also look technical and often suffer from lack of visual beauty.

1955 "ONE MAN SHOW" ERA — 1969 REAWAKENING ERA FOUNDING SHADOWS AGAIN

Richard Kelly (1919-1977) was a pioneer of qualitative lighting design who borrowed existing ideas from perception psychology and theatrical lighting and combined them into a uniform concept. Kelly broke away from the rigid constraints of using uniform illuminance as the central criterium of the lighting design. He replaced the question of lighting quantity with the question of individual qualities of light. These were designed according to a series of lighting functions, which were in turn geared towards the perceiving observer. In the 1950s Kelly made a distinction here between three basic functions: ambient luminescence, focal glow and play of brilliants.

Ambiant Light Focal Glow Play of Brilliants

Founded in 1969 and based in Chicago, Illinois, USA, the International Association of Lighting Designers (IALD) is an internationally recognized organization dedicated solely to the concerns of independent, professional lighting designers. The IALD strives to set the global standard for lighting design excellence by promoting the advancement and recognition of professional lighting designers. Value Lighting designers are a tremendous resource of innovative, practical and economically viable lighting solutions. They understand the role of lighting in architectural and interior design and utilize their extensive experience and knowledge of lighting equipment and systems to enhance and strengthen design.

CHAPTER 2 "HISTORY OF LOST LIGHT"

Defining Light Pollution and its influence on Lighting Design became a populistic tool both for researchers (research money) and astronomically orientated people late 1980's. Everybody can be a member of over 10 international organizations focusing only on light pollution. These organizations are somehow also compiting among themselves who is leading the studies. Good thing is that summa summarum we now know all types of light pollution. General hypersensitivenes among these organizations have lead to exaggerated conclusions. Foreaxample very important lighting design element of Richard Kelly's lighting function, "Play of Brillliant", which is chandelier, stars e.t.c, have got a shape of "Glare" because engineering type of treatment. Just to mention. Strong start to this light pollution debade came from unaccepted quarter, luminaire manufacturer, whose commercial sentence was "Who stole the milkway". There are also contradictions like IDA refers that light penetrating to rooms from street lighting is disturbing. According to Antrophology E.T Hall and Philips International studies, that is not a problem, sometimes even opposite off. Maybe most interesting issue is that IDA, the leading association of light polution admit that tresspass light don't disturb professional astronomers at all. Maybe this is the reason that light pollution associations have started to study different light pollution types than tresspass lighting just to keep their organizational wheels rolling. The co-operation with more professional organizations, like CIE and IESNA, has led to positive sustainability proposals which have became as sustainable design recommendations after professional studies and treatment. (e.g. LEED, CIE tresspass light classification e.t.c.).

Figure 1. The Natural Night: A Disappearing Resource? (photo: www.darksky.org)

The awareness of lost light, equal to light pollution, has a remarkable role in the lighting world because the amount of lighting used outside during the night has increased in level during the late 90's. Early 2000 marked the emergence of a saturation point for the acceptance level of activity and prompted action. Light pollution also became a popular media item. In the early 2000s, calls for a reduction in light pollution in the news media became common. Those calls were often accompanied by overexposed images of lighting installations on foggy nights when light becomes visible by hitting small water particles of fog. Typical grievances were, and still are, that our children or subsequent generations will never see stars anymore. Many articles written in popular newspapers usually conclude with a demand for authorities to do something. The problem facing authorities is twofold: how to identify the balance between useful lighting and light pollution and how to quantify lighting objectively to see if this balance is being met. There are many outdoor lighting elements which constitute light pollution. For example, the business owner's commercial necessity (light advertisements, façade lighting, overloaded security lighting on outdoor sales like cars, etc), or the private citizen's lighting solutions (wrongly aimed garden lights, building façade, etc). People and car owners prefer their streets to be lit at night for a feeling of security that the lighting provides. Also many roads are lit at night to enhance travel safety. Building and landscape lighting methods used to create an attractive and safe environment at night. If strong street lighting is the default lighting method and environmental elements such as buildings are in the dark, the lighting only serves to alienate a person from his own living environment. It easily creates fear and tension. Determining what the balance should be for outdoor lighting is up to each individual community and / or administrative body to decide based upon their community values. Agreeing upon a common

framework in which to quantify outdoor lighting is a task that should be done by all. The debate will continue forever, but finally strong institutions like IDA (International Dark-Sky Association) and CIE (The Commission Internationale de l'Eclairage) have introduced recommendations which will limit light pollutions. Those recommendations are introduced later on in this chapter with examples.

There are several active professional organizations that are currently addressing light pollution problems. Institutions include: IDA, CIELOBUIO (Coordinamento per la protezione del cielo notturno, Italia), Light Pollution Abatement Program (Canada), CIE, ISTIL (Light Pollution Science and Technology Institute, Italy), CELFOSC (Catalunya – Spain), ANPCN (Association Nationale pour la Protection du Ciel Nocture, France), CfDS (The British Astronomical Association's Campaign for Dark Skies), ILPAC (Irish Light Pollution Awarness Campaign, Ireland), The European Greenlight Programme, ILE (The Institution of Lighting Engineers, UK and Ireland), and the German dark sky initiative (Germany). The number of these organizations reflects both general concern about light pollution all over the world and also a lack of international co-operation capability.

TYPES OF LIGHT POLLUTION

The push to abate light pollution came from an unexpected quarter. International luminaire manufacturer Iguzzini (Main office in Recanati, Italy) began promoting their products with a slogan : "Who Stole the Milkway?" ("Chi ha Rubato La Via Lattea"). Hypocritically, when they launched their slogan, they were promoting many outdoor luminaire products that project light to the sky.

Ironically, IDA, which is an overarching organization in light pollution, admits that trespass light is a problem only for amateur astronomers, not professional astronomers. Without the help of sustainable lighting design arguments from CIE, we possibly wouldn't have what limiting recommendations we currently have in 2012. Perhaps the best argument for limiting light pollution is that there is no specific reason or benefit to sending light beams into space and needlessly consuming the energy required to do so. Past generations have enjoyed stars and nature. Future generations are looking at their computer screens instead of enjoying stars.

Limiting light pollution is an important part of functional lighting solutions. Hopefully, the aforementioned organizations create new lighting recommendations for general over-illumination.

Active research work conducted by these international light pollution research organizations has led to a carefully constructed outline of 4 different types of light pollution.

LIGHT TRESPASS

According to IDA, "a common light trespass problem occurs when a strong light enters the window of one's home from the outside, causing problems such as sleep deprivation or the blocking of an evening view".1 A study conducted by Philips Lighting and the anthropology research of E.T.Hall produced contradictory results on the topic of light trespass. Philips studied 20 houses, mainly in residential estates in different locations. Lighting was measured behind the glass of the bedroom window and behind the closed curtains in the same bedroom. The residents were asked to give an opinion as to the disturbance caused, if any. "Actual quantifiable light measurements are not as important as the qualified results of the surveyed homeowners: the majority of those questioned had no problem with light penetration in their bedrooms. They maintained that the light penetration made circulation possible at least in the bedroom and in some parts of the house and considered that to be positive. The few respondents who closed the curtains did so to keep out the light and were troubled by the high luminance ("brightness") of the lamp in a nearby road. Those who were not troubled lived in the street lighted by present day residential luminaires (mainly post top mounted, diffusing, spheres, cones e.t.c.)." 2 As a result of this research, CIE and Illumination Engineering Societies have added recommendations for lighting values of street luminaires.

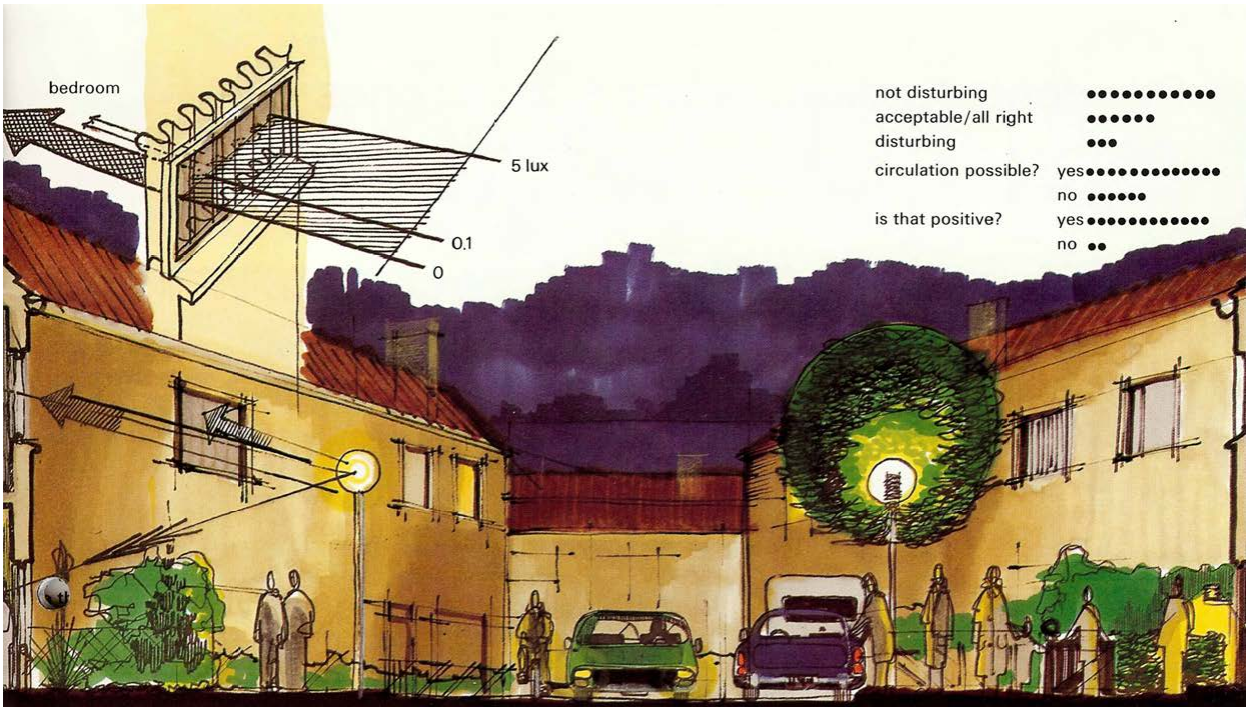


Figure 2. Study of disturbing light. Photo: Philips International Lighting review (ILR 1980 / 3)

A number of cities in the U.S. have developed standards for outdoor lighting to protect the rights of their citizens against light trespass. To assist them, IDA has developed a set of model lighting ordinances. The Dark-Sky Association also began introducing recommendations to reduce the amount of light going into the sky, which reduces the visibility of stars. This is any light which is emitted more than 90° above nadir.

Figure 3. An example of light trespass. Photo: www.darksky.org.

By limiting light at this 90° mark, they have also reduced the light output in the 80–90° range which creates most of the light trespass issues. Because of the fact that IDA is not strong enough alone, they have co-operated and /or at least shared their opinions with USGBC and CIE in very successful way. The US Green Building Council (USGBC) has incorporated a credit for reducing the amount of light trespass and sky glow into their environmentally friendly building standard, LEED. CIE has launched U.L.O.R, Upwards Lighting Output Ratio, for lighting installations which has direct influence on luminaire manufacturers products used in outdoor lighting.

In 2003 CIE announced “Classification of Disturbing Light / CIE 150 / 2003”. After a national recommendation launching campaign in different countries, this recommendation has been released and is being used in many parts of the world.

Table 1. Classification of disturbing light

Table. CLASSIFICATION OF DISTURBING LIGHT / CIE 150:2003

Class	E1	E2	E3	E4
Environment	Nature like	Countryside	Suburb area	Town city
Lighting environment	dark	Little envir. lighting	Average envir. lighting	Strong envir. lighting
ULOR % Max. To sky	0%	5%	15%	25%

Project environments are divided for 4 classes according to activity and ambient lighting conditions.

Table. LIGHT TRAFFIC CLASSES / SFS - EN 13201 - 2

Classification	Horizontal illumination	
	E_m lx, min	E_{min} lx, min
K1	15	5
K2	10	3
K3	7,5	1,5
K4	5	1
K5	3	0,6
K6	2	0,6

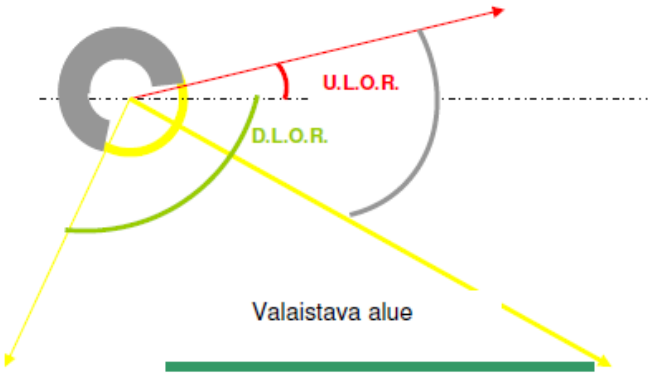


Figure 4.
U.L.O.R = Upwards Lighting Output Ratio = ULR % on the table above
D.L.O.R. = Downwards Lighting Output ratio. (All light under 90 degrees horizontal). Photo: SVS recommendation 2011.

CHAPTER 4

PERSONAL ANALYSIS OF GOOD LANDSCAPE LIGHTING SOLUTIONS

TELENOR HEADQUARTER / OSLO, NORWAY

Figure 60. Telenor headquarter. Photo Jan Draplos)

Ambient light flows down from hundreds of windows to the ground surface. The focal glow is the deep glowing light shining behind the double steel glass façade creating whispering lights.

Carefully designed horizontal illuminance values on the plaza do not fulfill any technical lighting design recommendations. The light from the glowing windows, located behind the vertical large steel and glass façade forms great semicylindrical illuminance values on the plaza. Recognition of an approaching person's face is easily 5m and the large facades are like large whispering illuminators. 'Shadow is the best friend of light' is the main argument and led the lighting designers through whole lighting design process. We found and designed the Lost Shadow. If it is anywhere, it is here.

"KUMU", NATIONAL MUSEUM IN TALLINN, ESTONIA

Figure 61. National museum in Tallinn, KUMU. Photo Jussi Tiainen.

The ambient light flows down from hundreds of windows on the ground surface. The focal glow emanates from windows over the slope (skylights of graphic galleries) and the vertical windows on main facade.

The play of brilliance comes from the orientation of the lights leading up to the entrance of the museum.

A harmonious general impression is created because no technical post top luminaires or masts were used. The whispering lights almost whisper, "Welcome brothers and sisters, welcome in.."

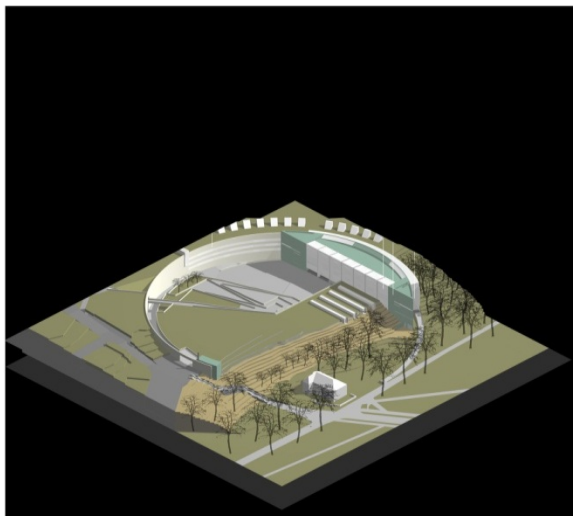


Figure 622. Airview of Kumu. Manipulation Pekka Vapaavuori

NELSON- ATKINS MUSEUM, KANSAS CITY, USA

Figure 63. Nelson- Atkins museun. Photo: Julle Oksanen

The ambient light flows out from backlit glass facades on the ground surface.

The focal glow is achieved by using cubic glowing museum elements.

The magic of three is here, Oscar Niemeyer stated, “if you can draw a naked woman using 3 lines, it must be good”. In this project architect Steven Holl’s three elements are: Glass, Grass and Light.

GRAND CENTRAL STATION / NEW YORK CITY, USA

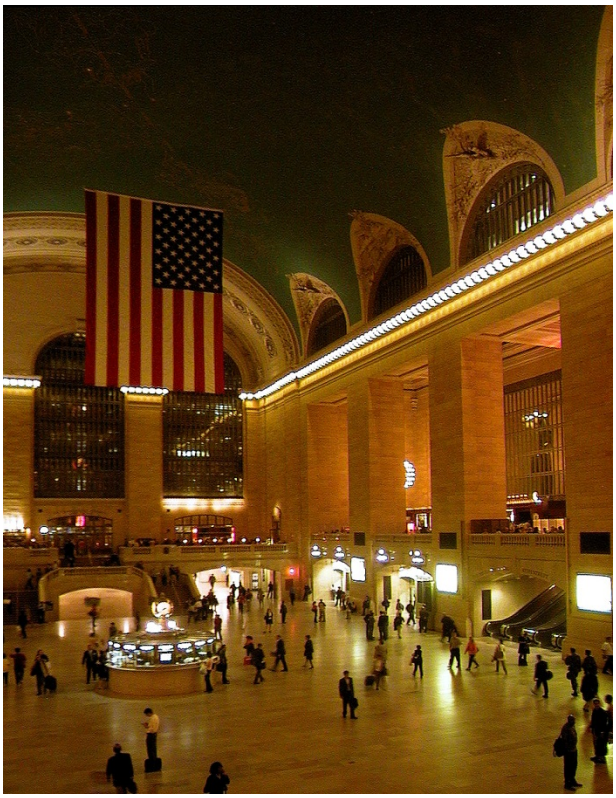


Figure 64. Grand Central Station. Photo Julle Oksanen

The ambient light was achieved with silently whispering lights on plaza area.

The focal glow was achieved with lights glowing on entrances of the platforms.

The play of brilliance was achieved with a row of incandescent lamps on the upper edges and chandeliers.

The lighting level is Ehav = 15lx, which is 8 % of recommended Eh = 200 lx. The space is like an enormous shadow which has some lights flickering here and there, yet still you can recognize an approaching person from a 10 meter distance. The lighting composition is perfect and designed by lighting designer Charles Stone (FMS Ltd, New York New York). You can almost hear the basic silent sounds of a violin and the sharp footsteps of a traveler. All senses are tuned for sensitive levels. This is a masterpiece space of the lighting renovation project from late 1990's.

POMMERN, WORLD'S LARGEST 4- MAST PARK, MARIEHAMN, FINLAND

Figure 65. Pommern (photo: Julle Oksanen)

Shadow is the best friend of light.

CHAPTER 5

"POETICAL LIGHT & SHADOW"

The fact is that we have globally much too much light in all over in our illuminated landscape areas and also indoors. We have to remember that "The Shadow is The Best Friend of Light" (author) and that shadow has born from light (Howard Brandston). Life&Death / Salt & Sugar / Love & Hate / War & Peace/ Light & Shadow. They are pairs of life and we desperately need them. Look old movies like " Citicen Cane" or " Casablanca" or Charlie Chaplin's "Hitler" or "Harry Lime The 3rd Man". Masterly used shadows and light with dramatic music. Beatifully applied light & shadow in lighting project is an example in Chapter 2, "Lost Light". Grand Central Station has average illumination value of Eav = 15 lx. International lighting recommendations is Eav = 200 lx. Energy saving is 92% and solution is beautiful. People in all over the world come to enjoy great Genius Loci of the station. Lighting designers have to think space 3 dimensionally with right relation of shadow and light. Two Masters of shadow and light will share their thoughts. Professor, Architect Juhani Pallasmaa and Professor, Lighting designer Howard Brandston whose voices I hope you remember forever. (Lighting) World needs more skillful thinkers and -architectural (lighting) designers like them. I am not sure if these things can be thaught, but we have to do something quite radical. We have to find "Lost Shadow" again. Best path to find lost shadow is to add lighting design as a solid part of the design education programs in architect schools. Now it would be a perfect time when sustainable-, but inefficient light source, LED has been "selected" as a light source for tomorrow. At the moment there are 19 Universities in worldwide which offer Master Degree in Lighting Design. We have to thank IALD (International Lighting Designer's Association) of the persistant and pioneer work which they have done for lighting education. See: *www.iald.org*

World-famous philosopher, Professor and Architect Juhani Pallasmaa has masterly expressed his personal and poetical relation to light and shadow:

(Citation: Part of Professor Juhani Pallasmaa's lecture**: "THE TOUCH OF LIGHT – materiality and tactility of light"**, given at Cooper Union School of Architecture, New York City, 5 April, 2011.):

"LIGHT AND SHADOW by JUHANI PALLASMAA

Light and its accompanying shadow give volumes, spaces and surfaces their character and expressive power, and they reveal shapes, weight, hardness, texture, moistness, smoothness, and temperature of materials. The interplay of light and shadow also connects architectural spaces with the dynamics of the physical and natural worlds, seasons, and the hours of the day. "What is there more mysterious than clarity? … What more capricious than the way in which light and shade are distributed over hours and over men?", Paul Valéry asks.[7] Natural light brings life into architecture and connects the material world with cosmic dimensions. Light is the cosmic breathing of space and the universe.

Light has its own atmospheres, ambiances and expressions; it is surely the most subtle and emotive of the means of architectural expression. No other medium of architecture – spatial configuration, form, geometry, proportion, color or detail – can express equally deep and subtle extremes of emotion, ranging from melancholy to joy, grief to ecstasy, sorrow to bliss. The occasional and happy mixing of the cool light of the northern half of the sky and the warm light of the southern sky in a single space can give rise to an experience of ecstatic happiness. As a young architect, I understood light merely as a quantitative phenomenon, but I have learned to understand that, in fact, it expresses the most subtle, metaphysical and emotive qualities. Nowadays, I try to bring natural light into the darkest areas of my buildings, where it is experienced as a special gift and sign of the architect's generosity.

Light and shadow articulate space into sub-spaces and places, and their interplay gives space its rhythm, sense of scale, and intimacy. As Brancusi said, “Art must give suddenly. All at once, the schock of life, the sensation of breathing”[8]; in architecture this sensation of breathing is mediated by light. Light directs movement and attention creating hierarchies and points of importance and foci. The paintings of Rembrandt and Caravaggio demonstrate the power of light for defining hierarchy and a point of dominance.

Figure 36. Rembrandt - Meditation

Figure 67. Caravaggio: "O chamado”

In these paintings, human figures and objects are wrapped in a soothing embrace of soft light and merciful shadow. In the paintings of Georges de la Tour (1593-1652) and Louis Le Nain (c. 1603-1648) the light of a single candle suffices to create an intimate enclosing space and a forceful sense of focus. Due to its fluttering character, candle light is especially tactile; it seems to finger objects and surfaces like

a gentle massage. Candle light creates an entire universe of intimacy. No wonder Gaston Bachelard wrote an entire book on the light of the candle.[9]

Figure 68. Georges de la Tour - Payment of Taxes

Figure 69. Louis le Nain - La tour

Ten days ago I experienced one of the most beautiful works of art I have ever seen. This was Johannes Vermeer's *Woman Holding a Balance* (c. 1664) in the Alte Pinakothek in Munich. I had seen the painting perhaps twenty years earlier at the Natural Gallery of Art in Washington, D.C., but it did not hit my soul quite as forcefully and nobly as it did now. The light enters behind the curtain from the upper corner, embraces the room very gently, lights the white parts of the woman's dress into a sacred glow, and picks up the objects and pearls on the table like one would pick berries on a meadow. This is not only light for the eyes; this soothing light penetrates directly into one's heart. ".

Figure 70. Johannes Vermeer's Woman Holding a Balance

SOURCES

7. Paul Valéry, "Euphalinos, or the Architect", *Dialogues*, Pantheon Books, New York, 1956, p. 107.
8. As quoted in Eric Shanes, *Constantin Brancusi*, Abbeville Press, New York, 1989, p. 57.
9. Gaston Bachelard, *The Flame of a Candle*, The Dallas Institute Publications, Dallas, Texas, 1984.

"SHADES OF LIGHT" by HOWARD BRANDSTON

An other World-famous philosopher, Professor and Lighting Designer Howard Brandston, has also masterly wrote about light & shadow in his book "LEARNING TO SEE: A Matter of light".

"LIGHT IS TIME'S SWIFTEST TRAVELER. Light allows us to see not only through our senses, but through our soul. It is a word that evokes a wide range of feelings within different people. To a philosopher, light is a metaphor for knowledge; to the scientist, it is a fundamental component of his or her work; and to the scenic artist, it is a tool to manipulate emotions. It has been defined by Maxwell and painted by Caravaggio. To the rest of us, who are sighted, it is the primary medium through which acquire information. Light is energy – it is matter by which all life is measured.

A solitary, universal language unto itself, light is a link through all humanity, encompassing the entire spectrum of needs and emotions. It defines cultures and reveals architecture. It creates shadows and is born of shadow. Light has the power to uplift, soothe, enhance visibility and discrimination and generate a sence of comfort or even discomfort at times. Light can be harnessed to inspire, befriend, create a sence of community.".[1]

"Light, like music, fills, reveals and creates space" – Howard Brandston.[1]

THE STATUE OF LIBERTY AND POETICAL LIGHT

Great example of Howard Brandston's skills to apply his poetical theories and - touch on lighting, is one of his greatest and challenging project: Lighting design of the Statue of Liberty in New York City, " LIGHTING THE LADY".

"**IN REVIEW, LIGHT IS THE PATH** to what it is you wish to see. Light is a pure form of energy that is neutral to all matter it touches no matter what the context. It is an essential natural energy that is produced in many ways. Lighting is the application of light to compose space. It is a malleable medium that manipulates the senses to reinforce the context and mood of spaces. Lighting is an art unto itself, supported and enhanced by science." [2]

"Lighting the Lady is a perfect illustration of these concepts.

Figure 71. Statue of Liberty. Photo Howard M. Brandston

Figure 72. Statue of Liberty. Photo Howard M. Brandston

“I pondered the challenge of how to illuminate this icon, so I took a boat out into the harbor and observed her from various distances and at every angle. I observed her at dawn, noon, dusk and in the darkness of night. At some point of the process, I walked to the end of the Battery Park Promenade, sat on a stone wall, and it came to me: She looked best in the light of dawn. I took out my little notepad and wrote: “Needed: one light source with spectral power distribution to mimic the morning sun, one to mimic the morning sky and a new light fixture to project light from a great distance – this will make a lady with green skin look good.”” [3]

The fact is that we have globally much too much light in all over in our illuminated landscape areas and also indoors. Examples have been shown e.g. in Chapter 2, “Lost Light”. Grand Central Station has average illumination value of Eav = 15 lx. International lighting recommendations is Eav = 200 lx. Energy saving is 92% and solution is beautiful. People in all over the world come to enjoy great Genius Loci of the station.

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SOURCES

1. Howard Brandston, “LEARNING TO SEE: A Matter of Light”, p. 19
2. Howard Brandston, “LEARNING TO SEE: A Matter of Light”, p. 89
3. Howard Brandston, “LEARNING TO SEE: A Matter of Light”, p. 91.

Chapter 6

LIGHTING DESIGNER'S TOOLBAR

This chapter introduces some important tools to find the balance between light & shadow. Tools are always introduced with examples (authors "own" projects). These are authors tools, but every person and/or team can use and create their own tools. I started to collect tools 20 years ago and happily project goes on and new tools appear almost annually. Latest one is Poetry added in real projects. Either poetical approach, or often pure poem.

Poetry & Concept

Master Plan

Lighting design processes

New Technology

Computers

Light & Space & Architecture

Daylight

Teamwork

Lighting recommendations

Client

Scale Models

Lighting calculations

Figure 73. Lighting designer's toolbar

Concept

is the most important design element and tool in your lighting design project.

Concept consists of Big unknown + personal semiotic connections + Ideas + collected creativeness of designer/design team.

Concept can be created in minutes or it can take a year, depending on how much creativeness is accumulated into the designer's or design team's brain and how it can be "pulled out" together to serve the design task in real life .

The lighting designer collects an idea library into his/her brain while practicing his/her profession. When a project starts, the designer or the team members pull out different kinds of ideas, which are evaluated and the best one is selected to become the concept. Lighting design concept brainstorming can be done alone or in team.

When the concept is ready, it is introduced to the right representative of the client (A creative person who understands design). Normally after this presentation the real design work starts with the "Master Plan"- design phase.

Figure 74. Concept example 1. Amphitheater in Ankara, Turkey. Photo Julle Oksanen

Amphitheater is located on the slope of a dark hill in Ankara. People approach the area by cars. They drive towards the amphi theatre guided by car head lamps . The turning car head lamps create an interesting light phenomenon. No specific street or area lighting is needed at all. General lighting is the falling, humble white veil of light which runs out from huge openings of the theater structure.

From their parking places people start to walk on rows like hundreds of ants towardsthe main stairs and entrance of the building. Expectations are high and slowly art starts to fill their minds.

Cars in the carpark start to sleep together on the embrance of darkness. You almost can hear their whispering together when their engines cool down.

When people have passed the stairs they have their historical moment to be as a Gladiator for a couple of minutes. They have to walk bravely through an approximately 20 meter high and 4 meter wide stone corridor under the light which falls down from canvas and open ceiling.

After they have come inside the amphitheater, they orientate themselves under mystic indirect light. The huge size of amphitheater influences your emotions very strongly. People find their places and sit down to await the performance and observe the happenings inside. You almost can touch the exciting atmosphere. Ants are in the nest.

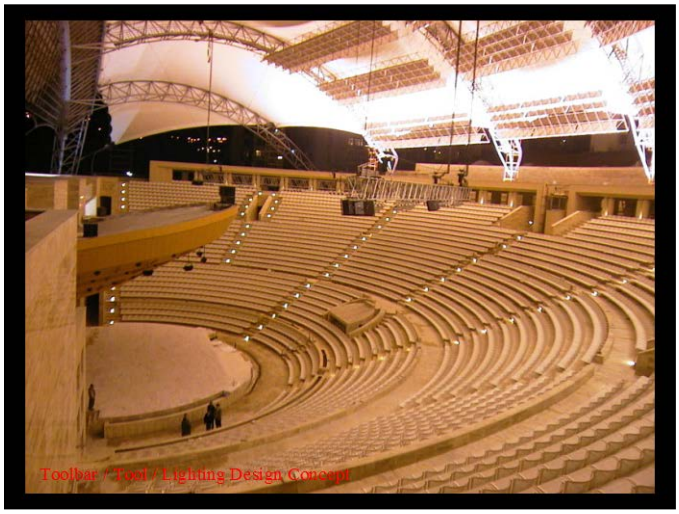


Figure 75. Inside view of Amphitheater. Photo Julle Oksanen

The brightness of the canvas is very peaceful and the maximum luminance value is 170 cd/m2. Luminaires are hidden to avoid any glare or disturbing visible elements. Horisontally installed acoustic elements which are located in the ceiling create beautiful shadows onto the canvas. Shadow is the best friend of light. After having all inside, Ehor illuminance values fall down step by step. Switched values are 60lx - 40lx - 20lx – 0lx. Before 0 lx (?) stage lighting goes on and fulfills the atmosphere of the space.

Let the show begin.

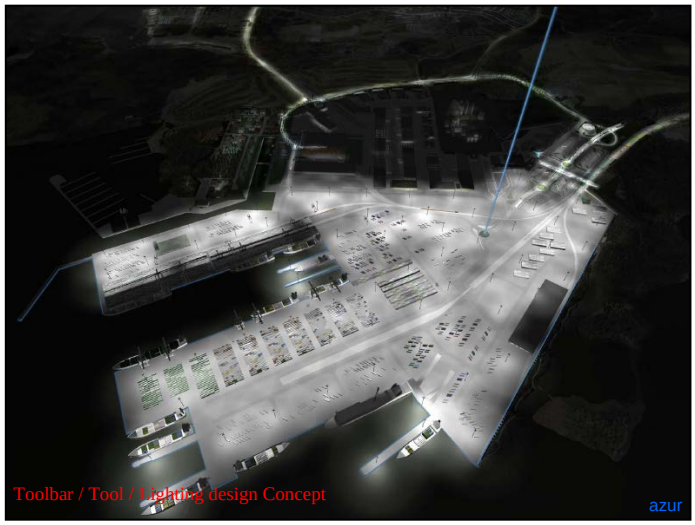


Figure 76. Concept example 2. Vuosaari- harbour in Helsinki, Finland. Maipulation APRT Architects

This huge project needs a clear, simple and equally large concept, no details.

The lighting design concept consists of 3 lighting elements:

1) 100 million lumens of white light falls down from 45m (150 ft) high masts without any glare, embracing the area on its humble veil. Ambient light.

2) Blue light line follows the edge of the platforms. Some kind of mystical semiotic connection on sea, sky, life, freedom.
3) Blue Christmas- celebration light runs up to 100 km (300,000 ft ???) height giving mystical phenomena which follow different weather conditions (Fog, snow rain, rain, clear sky, cloudy sky e.t.c.).

That is all.

Figure 77. Harbour scaling. Photo APRT Architects

Blue light creates style to the harbour with its reflections from surface of sea. Huge sea vessels float in and their huge white sides start to change and take on a glowing blue color as a welcome to our harbour.

Also, the huge masts are painted blue to strenghten the emotional feelings and connection to sea. Cranes are also proposed to be painted blue.

Figure 78. Christmas lights at harbour. Photo APRT Architects

As seen from the seaside, there is no glare . All glare is eliminated over the distance of 400m (1,300 ft) from the edges of harbour platforms. We gave the name AZUR for this concept. Let sea vessels float in..

Figure 79. Concept example 3. Stockmann shopping mall. Photo Julle Oksanen

Stockmann is a very healthy and profitable company with sales of approximately 2000 million USD. They sell expensive products and the company profile is, in brief, high quality.

Their biggest shopping mall, located in Helsinki city center, has 7 floors and 880 000 square feet of sales area.

The main building is designed by the famous architect Sigurd Frosterus.

In this main shopping mall Stockmann started a huge renovation project which also includes new lighting. Renovation takes years and millions of Euros.

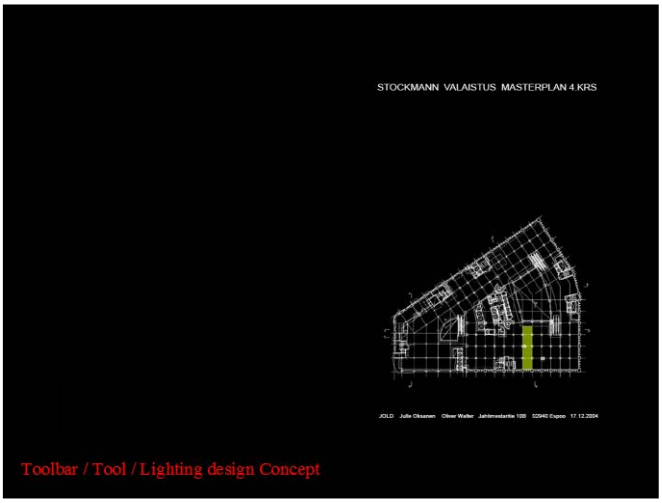


Figure 80. Stockmann Plan. Photo Julle Oksanen

We are focusing on the concept of lighting renovation of 4th floor, which also was a testing floor for the concept.

Specifically now we are focusing on the area which is marked on green color on the recessed ceiling plan. It is a 30m (100 ft) long and 6m (20 ft) wide area.

After Concept design phase we designed the Master plan phase which also included a test area in scale of1:1.

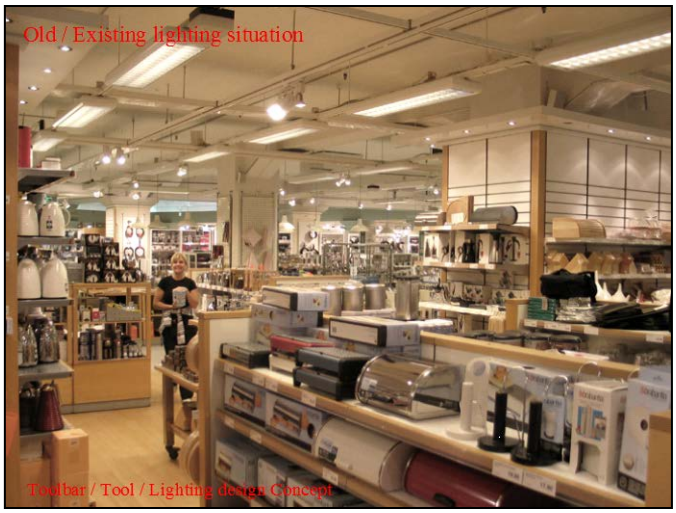


Figure 81. Existing lighting before renovation. Photo Julle Oksanen

All kinds of luminaires were located here and there integrated into the general mess of architecture.

It was the result of making smaller and bigger changes over a time period of tens of years and without any logical renovation plan. Nobody couldn't handle it anymore as a whole.

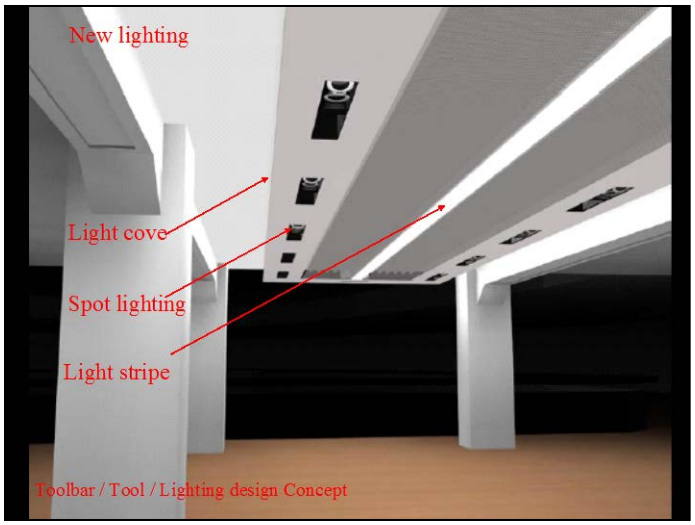


Figure 82. Lighting design concept. Manipulation Julle Oksanen Lighting Design Ltd

Design is good if you can cover your idea with 3 main elements. We wanted to create peaceful recessed light ceiling which reflects quality, leads people to concentrate on selecting products and hides all technical elements behind its peaceful face.

In this lighting solution we used 3 lighting elements as follows:

1) Light cove shoots light onto the ceiling structure. That opens the space visually. This was important, because the space is huge and we recessed the ceiling 0,6m (2 ft). Rows of fluoresent lamps were hidden so that nobody could see the bright surfaces of the lamps. They are also dimmable.
2) A light stripe in the middle. Its main task was to give character to the space. The second task was to give a humble general lighting level. Dimmable.
3) Spot lights from black holes. The rhythm of lamps ought to respect the structure of the building and at the same time fullfill all areas where spot beams were needed. We also wanted to integrate electric plugs, electronics, loudspeakers e.t.c. into the black boxes.

Figure 83. New lighting in Stockmann. Photo Julle Oksanen

Lighting Design is a constantly changing process and in normal cases the final result always have some small changes compared to the Concept and Master Plan design solutions. Changes depend on how many other professionals are included in the process. In this project we co-operated with:

- Project architect
- Electric designer (wiring)
- HVAC designer (air condition system)
- Water pipe designer (Sprinkler system)
- Electronic designer (Internet- computizing e.t.c. systems).
- Constructional designer (Construction systems)
- The Purchasing director of the client
- Employees of sales departments (Different recommendations and needs).
- Director of Stockmann (Financing)
- Luminaire manufacturer.
- Lamp manufacturers.

Everybody in this team had their own demands and needs which didn't always match together with other team members' needs. That's why the result normally, as also in this case, is a compromise.

We, as lighting designers, were happy to lead the whole team through the design process and we managed to get everybody to want the best possible result. Consequently there were minimal changes compared to the Master Plan design and the Concept was exactly followed.

The concept was to use 3 elements – Indirect light – Light stripe – Spot lighting to create harmony to the shopping mall.

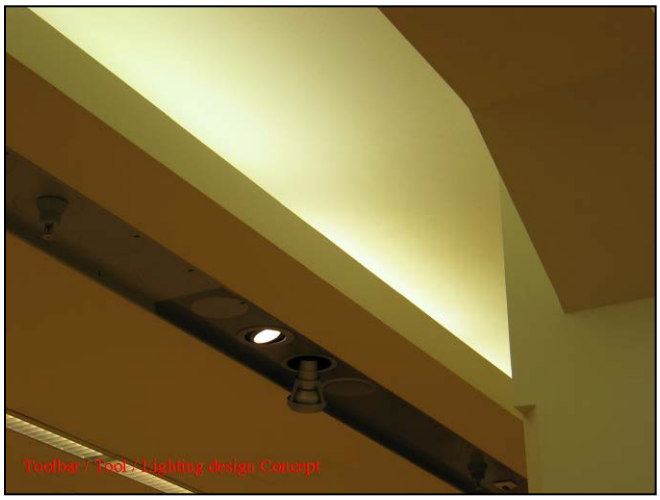


Figure 84. Feel the harmony from this photo. Photo Julle Oksanen

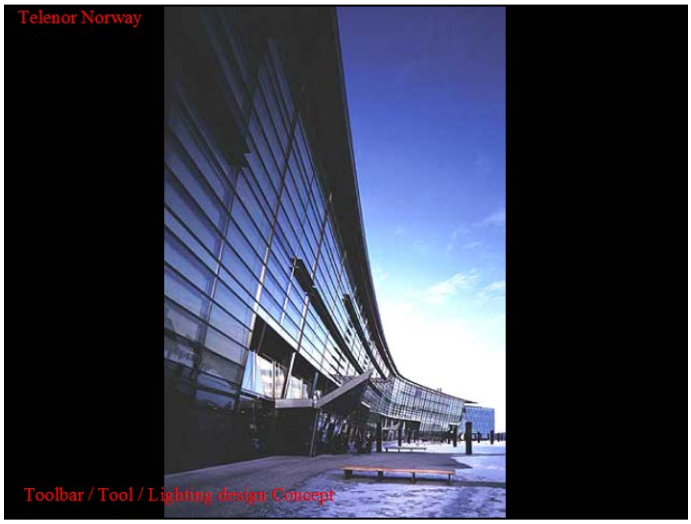


Figure 85. Concept example 4. Telenor- building in Oslo, Norway. Photo Telenor

Telenor is one of the fastest growing providers of mobile communications services worldwide and also the largest provider of TV services in the Nordic region.

Revenues 2006: NOK 91.1 billion

Workforce: 33 500 man-years

Listed on the Oslo Stock Exchange and headquarted in Norway.

We are now looking for the Lighting Design Concept of their new headquarter, which is located in Oslo, Norway.

The building has a lot of glass as a construction material and we are now focusing on mainly those glass areas and the Plaza, which was our design task.

Figure 86. Telenor aerial view. Photo Telenor

This office building is located near a beautiful fjord and in a natural setting. To us, as lighting designers, Norwegians are people of nature. When we started to create the concept, we had in our brains an image of Norwegians wandering on their huge hills and fjords with their famous Norwegian made pullovers and rucksacks on.

But we also kept in our minds that Norway is also very wealthy with a lot of oil, great educational possibilities and is a modern nation; of which this Telenor building is a good example. This is somehow an odd combination for the lighting design concept design phase-wise. 7000 employees approach this modern and high technology building every day. They approach the main entrances through the huge plaza which is approximately the size of 4 full size soccer fields.

They enter the building by using 8 main entrances which are located in the oval glass edges of the two building blocks.

Through the entryway they arrive at an indoor entrance which is mainly made of glass, steel and stone. After this they travel to their own office desk by using stairs or elevators.

This is an architectural section of the office entrance hall block. It is located between offiice blocks and is mainly made of glass. A cafe is located on the hall.

Our concept was to create a place for employees where they could have a clear and visible connection to nature. There is a person in the cafe who is looking for the stars and moon in the Nordic sky.

Glass acts like a mirror. The reflection factor of normal ”float” glass is something like 20 %. The hall block was full of turning glass elements at different angles both vertically and horizontally. So we made a decision to use ”Functional lighting concept”, which meant that we wanted to minimize reflections from the glass surfaces. These entrance halls were, as a matter of fact, ”Light traps” during dark periods. We used large surfaces and placed luminaires so that reflections were avoided or at least minimized.

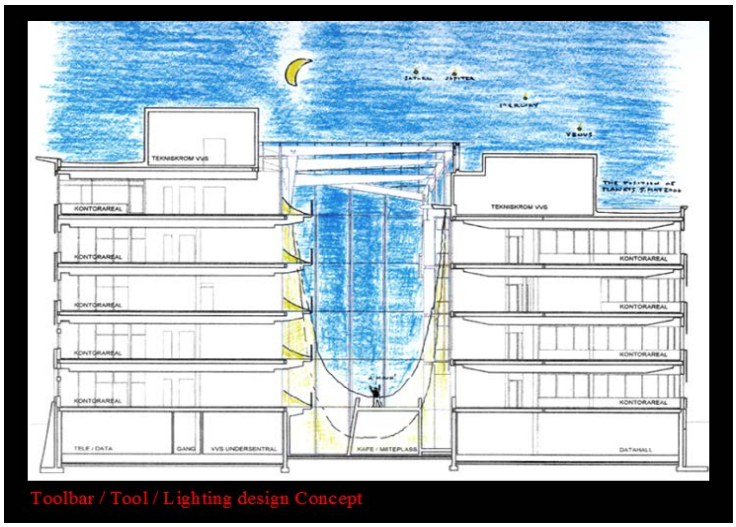


Figure 87. Telenor lighting design concept. Photo Vesa Honkonen & Julle Oksanen

It would have been easy to integrate downlights on the beams which were located on the roofing area. We did not want to illuminate only air, which is an invisible material. We also estimated that there would have been hundreds of reflected light sources as result of this common solution.

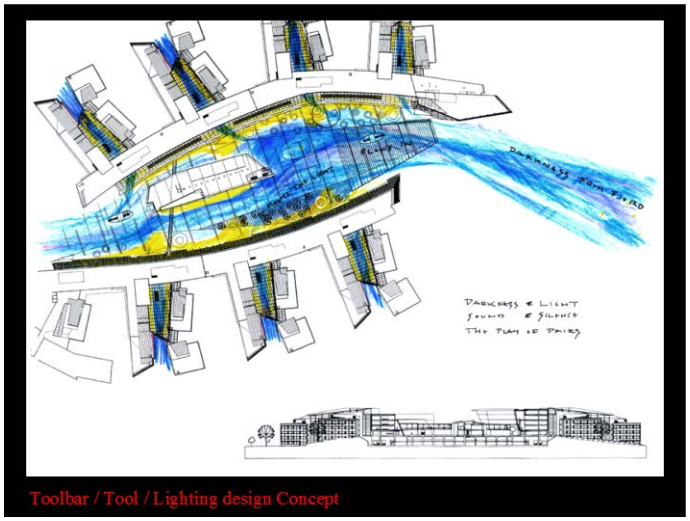


Figure 88. Telenor lighting design concept. Photo Vesa Honkonen & Julle Oksanen

- Love & Hate
- Sound & Silence
- Black & White
- Light & Dark,

Those are the pairs of life. Without pairs life would be boring and dull. Shadow is the best friend of light. We desparatly wanted to use this philosophy on that plaza.

We wanted to bring darkness from the fjord to the Telenor plaza. From the plaza darkness runs through the entrance halls back to nature. This somehow a very Norweigian style.

This concept ment to us immediately that we did not want to install any luminaires on the plaza. The huge glass openings of the boulevards of the building blocks were our large illuminators. Also the education center, which is located on the plaza, had glowing walls.

This concept was very strong and meant that we had to be able to influence and use the office lighting, which created those illuminators of ours.

Figure 89. Lighting designer's toolbar

Master Plan

is a tool which is located in a very strategic place in lighting design process as a whole. With this tool lighting designers have to find lighting "Hardware" and "Software" solutions to fulfill the concept design on a practical level. If the right solutions can't be found, it is possible that you will have to change the concept. In some cases it is also possible that you even have to create a new concept.

Accumulating working experience in the real world and in real projects imatures a lighting designer's perception and understanding of what can be done and what can't be done.

Sometimes even a great concept can stay on the level of dreams and the lighting designer gives up hope and is not sustained enough to try to find a right solution. Don't give up hope. It can be possible that small change in concept can save the high quality result of your design. (Compare Stockmann shopping mall Master Plan and the result). A little change in design doesn't necessarily mean that a big and great idea / concept is broken forever.

The master Plan phase consists of luminaire selection, lamp selection, preliminary checking of construction solutions, lighting calculations, computer images, etc.

The Master Plan phase excludes detailed design elements like working drawings, construction detailing and luminaire integration into structural elements. . It is a good time to clarify what is in the offer in order to be able to avoid unclear situations later about what is included in the work and what is not.

Figure 90. Master Plan example 1) Telenor Headquarter in Oslo Norway

In order to give you a flavor of design process as a whole, we are focusing now on the Master Plan design for Telenor Headquarter in Oslo Norway.

In the Master Plan phase you have to have a deeper understanding of the building itself and it's purpose. Then you can "quide" the lighting design process in the right direction in the Master Plan design phase.

Things which are good to know:

- How people use the building during workdays (Approaching the building, moving in buildings, floors, café's, offices, other activities, e.t.c.)
- How building is used during the night time
- Materials of the building
- Special needs of different activities
- Who are co-operators and what are their needs
- National lighting design recommendations and their application "style" and code requirements
- How to introduce Master Plan designs and to whom

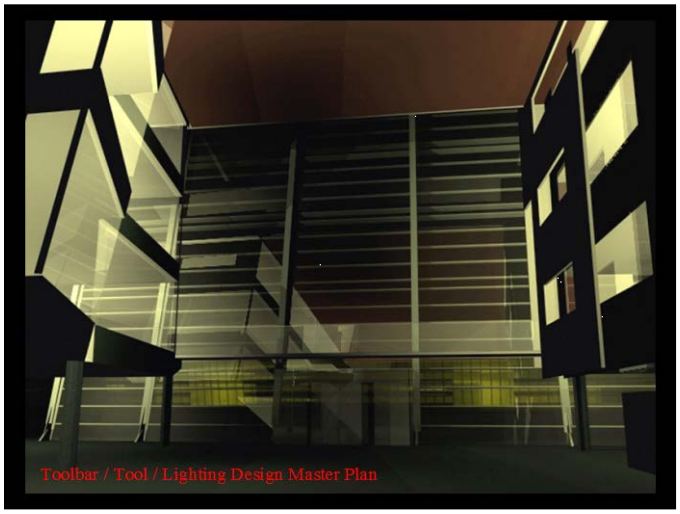


Figure 91. Lighting design Master Plan. Photo Erkki Rousku

Master Plan phase starts with analysis. In existing buildings you have to analyze the existing situation in order to be able to compare it to your new design

proposal. New advantages and solutions are great to introduce to the customer by comparing them to existing and “old ones”.

In new buildings you normally have to use more creativeness in three dimensional thinking, because you have to imagine yourself in the building / space to find your ideas and proposals in the right way. In good lighting design three dimensional thinking is a great way to a successful result.

In the Telenor building we closed our eyes and thought how would it be to stand in the middle of the atrium and look around. We understood that we have to analyze glass atriums with a computer and we found out that glass atriums are “Light traps” during night time.

There are lots of reflections from different surfaces. This fact led us to create a lighting solution that minimizes the mirror effects of light distribution surfaces, or luminaires, from hundreds of glass elements. More problems are also caused by the different angles of the huge glass elements, both horizontally and vertically. We also analyzed whether it would be possible to see out of the building during night time and dark periods.

We used Hopkinson’s diagram which compares different brightness of objects with the brightness of different ambient conditions. The result is “Earned viewing points”.

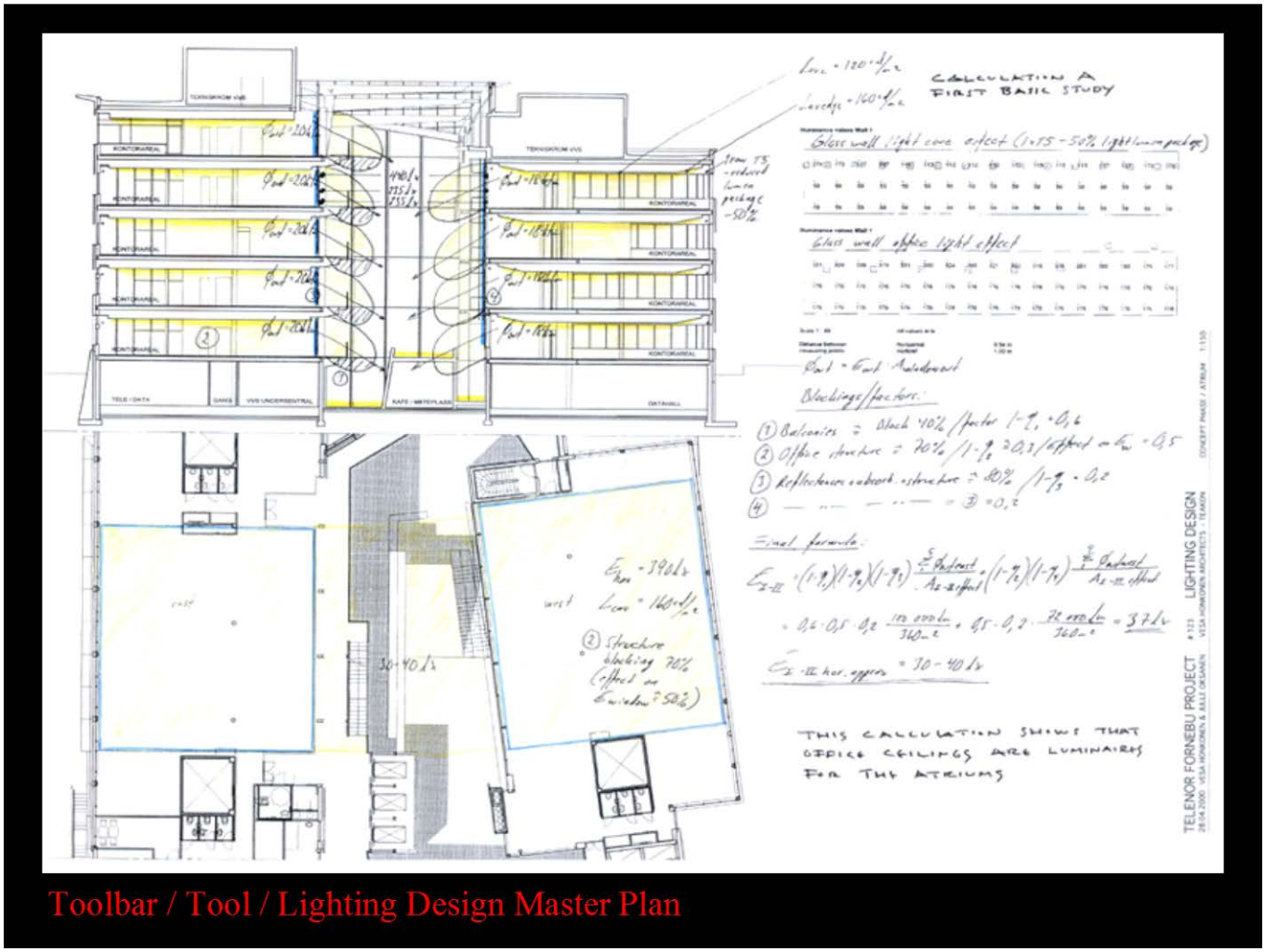


Figure 92. Lighting design Master Plan. Photo Vesa Honkonen & Julle Oksanen

Office blocks are located on both sides of the glass atrium. After analysis we started to figure out how much light actually runs from all those office areas to our design area – the glass atrium.

We contacted the electric designer, who, together with luminaire manufacturers took care of lighting in office areas. We asked what was the lighting procedure in offices. According to that information we made lighting calculations for the office areas. We were interested in only the vertical illuminance values on windows which were located on both sides of the glass atrium.

With the basic formula: E = O/A, in words: Illuminance value on window areas E is equal to Lumen package of window areas O divided by illuminated window areas A. From this formula we solved the value of Lumen package O on window areas.

Then again the basic formula E = k x O/A was used in a creative way: Now E was the illuminance value on floor surface of the glass atrium, O was the lumen package which runs from the windows to the floor of the atrium and A is the atrium floor area. Of course we had to use additional factors (marked k on formula) which had effects on the result. K is the product of: Penetration factor of window glass, construction elements (balconies), direction of outflowing light from windows, reflections from surfaces and the approximated and “corrected” room factor of atrium.

With these Master Plan calculations we went to the customer and told them that these office designers had done our work. We only need to send the bill. We had made our analysis calculations conservatively to be on the “Sure side” and the result was 40 lx (4 fc). In reality we told them that it will be more nearly 100lx(10 fc) than 50lx (5 fc). Of course we wanted to create contrasts and functional lighting instead of only “Dull 40lx (4 fc)”. So we said that we have to design for more light but take these values into consideration too.

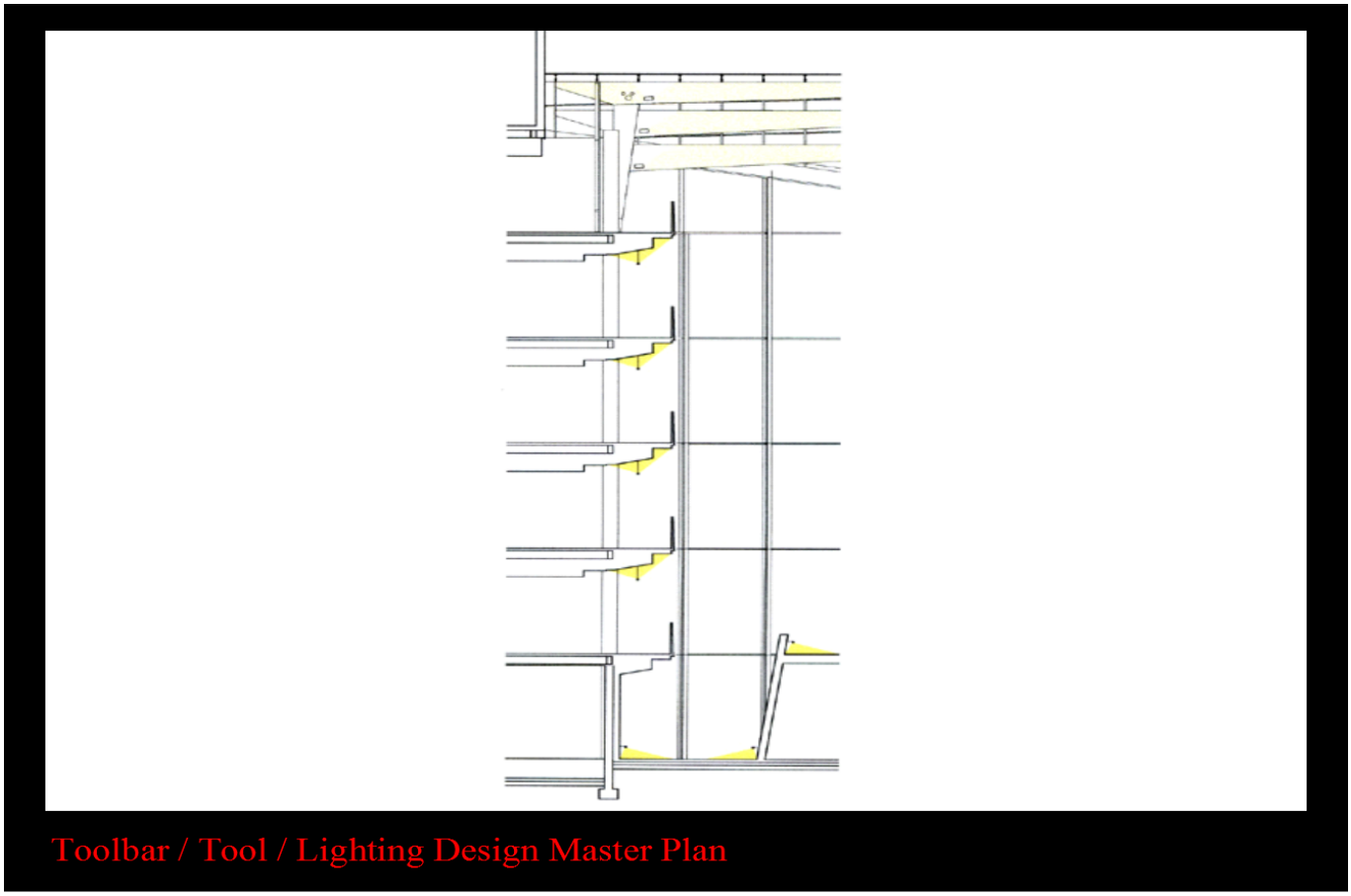


Figure 93. Lighting design Master Plan. Photo Vesa Honkonen & Julle Oksanen

In order to be able to avoid reflections of light distribution surfaces of luminaires, we had to create a new way to illuminate the glass atriums functionally. We could not accept downlight luminaires, because they would have caused oval reflections (round shape holes of luminaires seen from different angles and levels.). We could not accept luminaires on the wall surfaces at all (huge reflections), nor wall washers (because of glass walls and difficult tracking systems).

“Normal” fluorescent luminaires were, of course, out of the question because of the earlier reasons.

We created a new kind of functional lighting solution. We designed long indirect fluorescent lighting rows with continuous light. Providing light functionally where it is needed and at the same time minimizing reflections.

We could not find fluorescent luminaires with continuous indirect light, with the style, dimensions and invisible pendant and hanging systems,so we designed them ourselves. Telenor building had 8 km (26,000 ft) of luminaires in rows, bothindirect and direct versions.

Later on this lighting system matured as a standard luminaire range for standard production for the manufacturer.

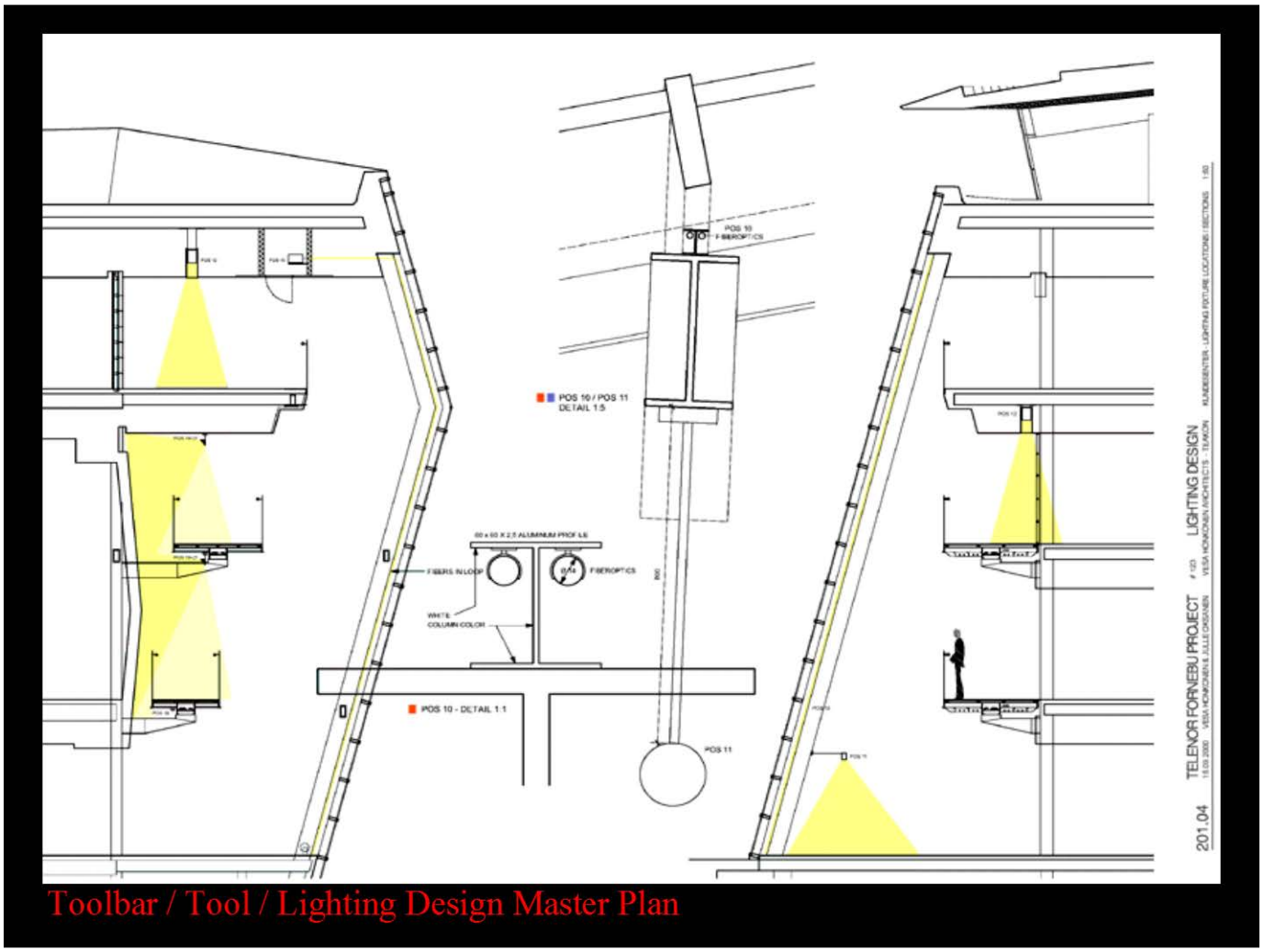


Figure 94. Lighting design Master Plan. Photo Vesa Honkonen & Julle Oksanen

When a project is very large and complicated, you have to be able to create all kinds of innovative Hardware solutions to fulfill your concept.

We also had some other solutions in addition to the fluorescent light row. Just to mention a few examples, we used:

- “Black hole”- luminaire solution
- “Hidden lateral fiber optic”- solution” for facade
- “Fiber optics pylon”- solution
- “Wall washing”- solution

- “Deep down light for orientation”- solution

Remember that this is Master Plan, no details yet. It is same in real life projects. In this phase you only have to show innovative solutions to your client and introduce how they “follow” your concept. Representatives of the client, like the architect, interior architect, electrici designer, etc. want to see that it can be done. The reason for the interest of other designers is that your solutions also can have a huge influence on their solutions. Co-operation is the key.

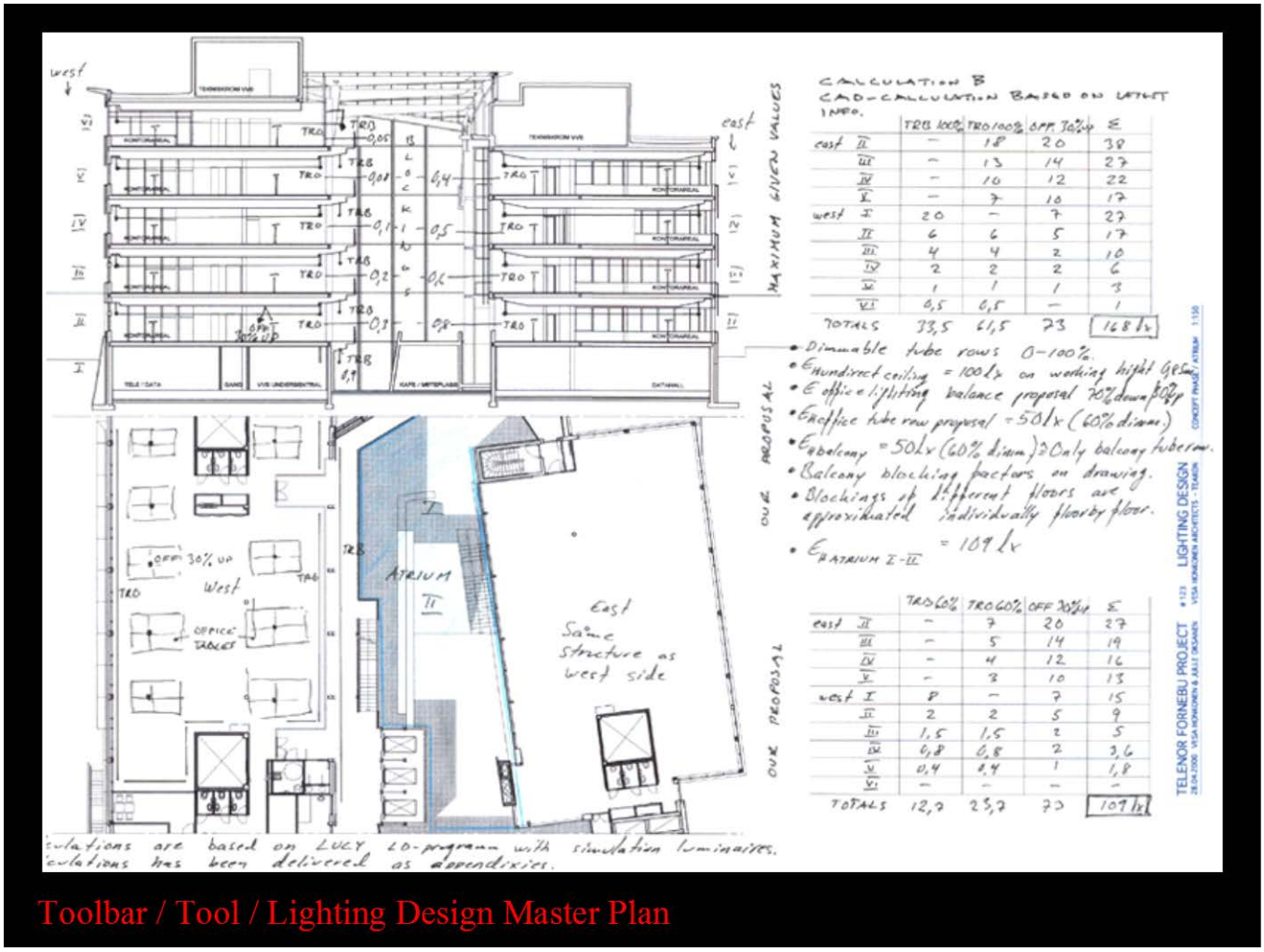


Figure 95. Lighting design Master Plan. Photo Vesa Honkonen & Julle Oksanen

After all approvals from client side and matured Master Plan ideas, we had to start to make real life calculations and plan how to use light as a whole.

Final calculations took care of all areas, like:

- Offices
- Atrium floors
- Café area
- Walking areas
- Areas in front of elevations

- Entrance area
- Stairs
- Balconies

We used the simple and free Dialux lighting calculation program. That program didn't include light distribution values for our new luminaire. That's why we had to do simulation calculations by choosing a standard luminaire from the program. After that selection, we manipulated light distribution values to model to our new luminaire. Based on these results we proposed the way how to use all lighting. We also had to take into consideration that these values also had influence on lighting values on the Plaza, not only for atrium areas.

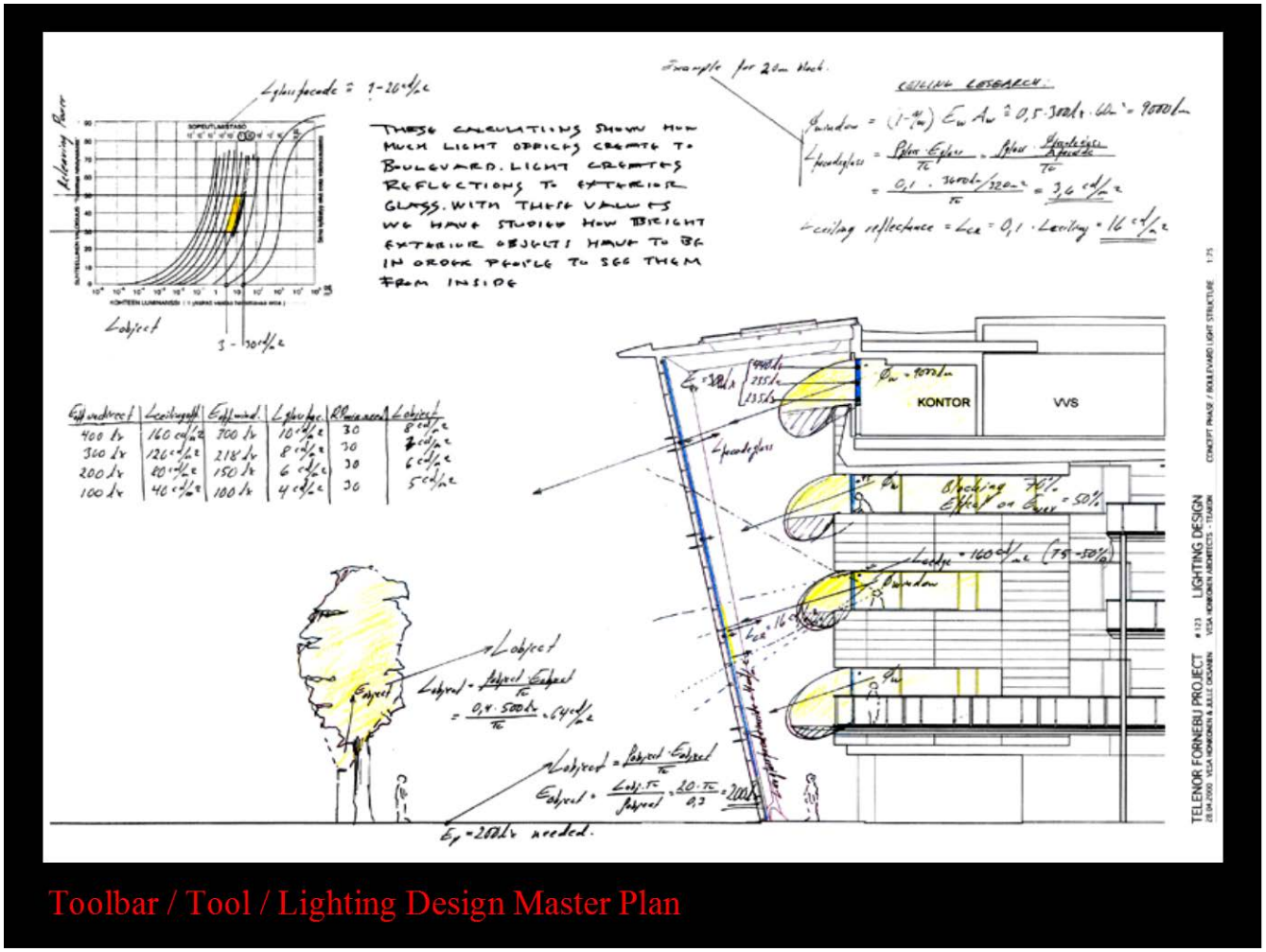


Figure 96. Lighting design Master Plan. Photo Vesa Honkonen & Julle Oksanen

The director of Telenor asked us whether his employees could see out of the building during dark periods. That was a huge challenge for us as designers. We had to use Hopkinson's diagram *(reference?)* as follows:

1) Mr. Svensson is looking out from his office window. He tries to look outside and enjoy the view.
2) There are 2 windows = mirrors between him and Plaza.

3) Let's assume first that Mr. Svensson has only outer glass elements (Façade glasses) and his own window is just a hole (equal to his office window being open).
4) What he sees is ambient light in Hopkinson's diagram (punch of curves). Value of that ambient luminance is reflections of interior values from façade glasses. Those values are between 1 – 20 cd/m2.
5) In order to "earn" 40 viewing points from left side of the diagram (Officially said Relieving Power) an object must have a luminance value of approx. 20 cd/m2. (Horizontal values on diagram). That means E-value of approximately 200 lx (20 fc) on objects like a tree for example. This is not possible within reasonable limits.
6) Summa summarum: Mr. Svenson can see out if Telenor will purchase extra glass which has reflection factor of 2% (Very expensive glass material and normally used in control rooms). Otherwise Mr. Svenson can only see lot of reflections like his own face, wall bricks, structural elements and outside something. Big mess.
7) Telenor desided to use normal float.

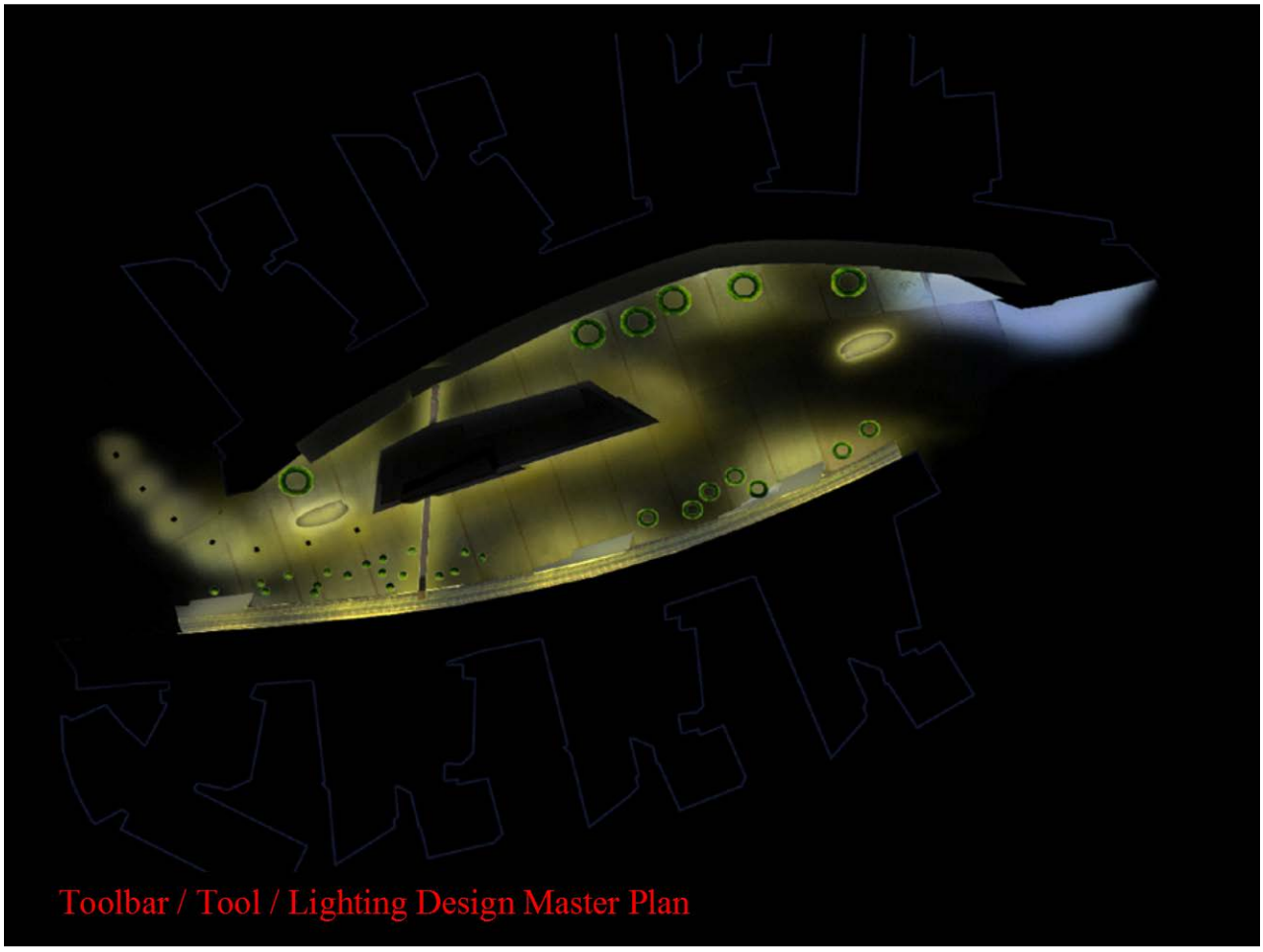


Figure 97. Lighting design Master Plan (Plaza). Photo Oliver Walter

This image was made for client's directors and decision makers who normally don't understand lighting "language". It is a very sensitive action matter, in fact, how you introduce project concepts and designs for these people. It is very important that you don't give them impression that they are "dummies" in lighting, but rather they are bosses. Visual images help them to understand your goals and it is also easier for you in this way.

Plaza luminaires are those huge glass sides of both buildings. Hundreds of meters long and tens of meters high glowing luminaires give soft general light to Plaza. Beautiful vertical values.

The eight entrances had their own inviting lights. Entrance canopies were illuminated by underground luminaires. The Education Center in the middle part of the Plaza was also a huge glowing luminaire with light bridges to buildings. Also underground luminaires with assymmetrical light distribution were used. The head/end part of the building, the nearest part to fjord, was so called “PR part”. It has a bluish glowing façade lighting with lateral fiber optics. The parking area was located under the Plaza. Two oval holes are approaching areas from parking place to the Plaza and also buildings themselves. Seven small dots on the left side were indirect luminaires leading from outdoor parking place to buildins. The greenish round shaped elements on the Plaza are illuminated plant areas. They look small on this image but their diameter was many meters in each.

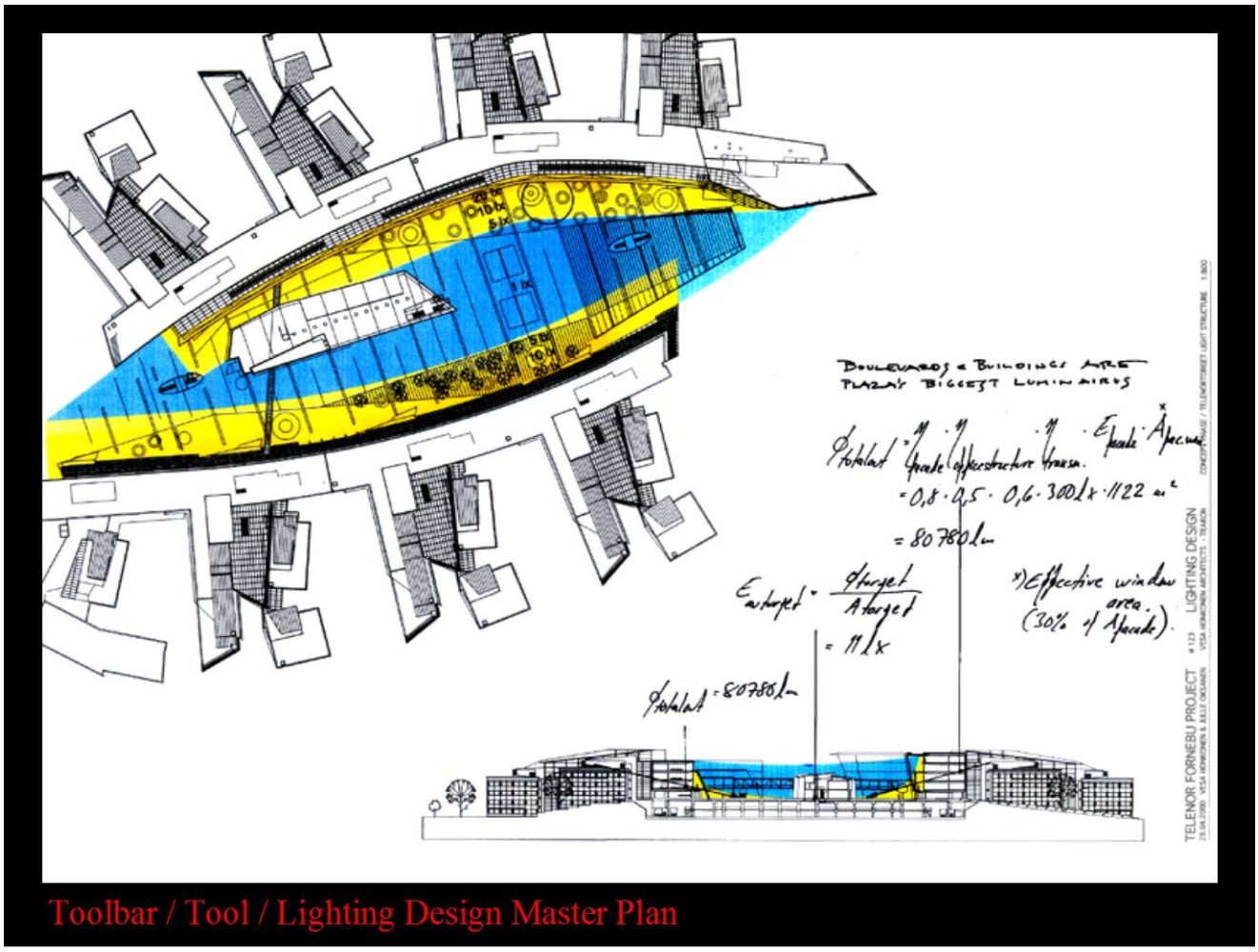


Figure 98. Lighting design Master Plan. Photo Vesa Honkonen & Julle Oksanen

The master Plan calculation for the Plaza was very interesting. Again we used the basic applied lumen method to calculate illuminance values on the Plaza.

In words the formula is as follows:

We

- Calculated the lumen package on the glass surfaces of both building blocks according to earlier calculations for offices.
- This value was divided by the A, area of whole Plaza. (E=O/A).
- This value was multiplied by summa factor, which is formed of: k_{glass} = Glass penetration factor, $k_{structure}$ = structural elements which are rejecting light coming out of the buildin to Plaza (Like steel pylons, framing elements of glass e.t.c.), $k_{directional}$ = Factor which takes care how big part of light approaches the surface of Plaza.
- $E_{averageplaza}$ = 11 lx (1.1 fc). This meant that of course light mostly felt down on Plaza near the facades fading beautifully near the center line. Vertical light is beautiful, because light don't disappear anywhere, it is just running on the air vertically to other side flowing partly into the other building through window areas and partly reflecting back to Plaza and other building again.

Result:

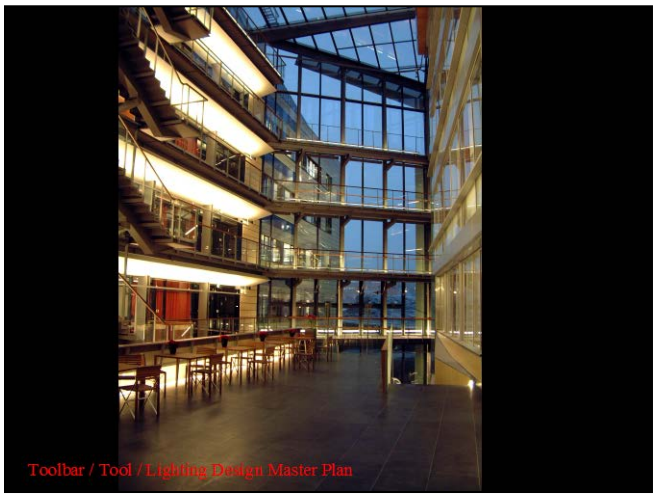


Figure 99. The result of Telenor lighting design. Photo Jan Drablos

Minimized reflections from windows allow people to see stars and other space elements in Northern sky. We were happy and relaxed to achieve our concept and goal.

Indirect luminaire rows above the balcony gives nice contrast in space and soft horizontal light on the floor level.

A nice contrast for café visitors is given by a light row located very low on the left side of the the image. The height of this row, which is located on the small edge element of the café, is approx. 2 feet. Light distribution surface is towards the floor, but it is aim-able if needed.
Somehow a cosy feeling is created in the office environment.

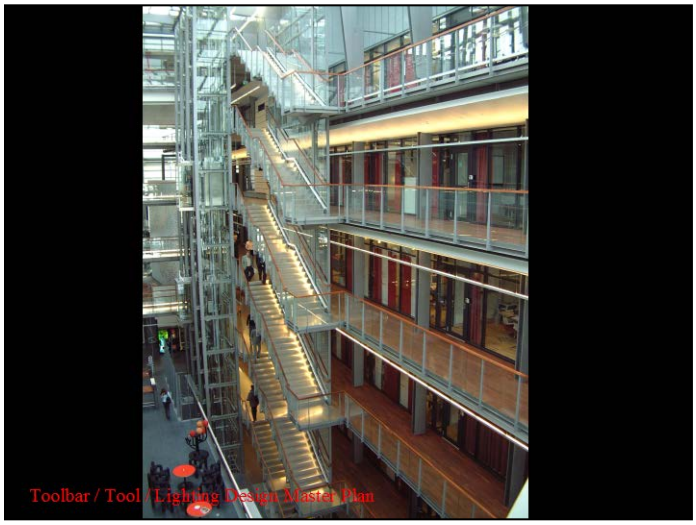


Figure 100. The result of Telenor lighting design. Photo Jan Drablos

Light rows again installed approx. 1 foot above the stair surface.

Lines follow the angle of stairs and the light distribution surface is aimed towards the stair levels.

This solution for the stairs looks and sounds somehow easy now when the project is ready, but caused quite a lot of headache in the real design phase. One of the reasons possibly was that nobody else had ever used this kind of method to illuminate stairs.

Also the importance of continuous light on the balcony can be felt on the right side of this image.

“Light tube” rows also provide anonymous and functional elements in the space. They don’t fight against any architecture and they still fulfill their task as luminaires.

Contrast and continuous row of light and “tube” somehow also gives carriage to the space.

Figure 101. The result of Telenor lighting design. Photo Jan Drablos

Nice illuminance values, which also fullfil lighting recommendations in Norway together with great contrasts is an interesting combination.

Shadow is the best friend of light.

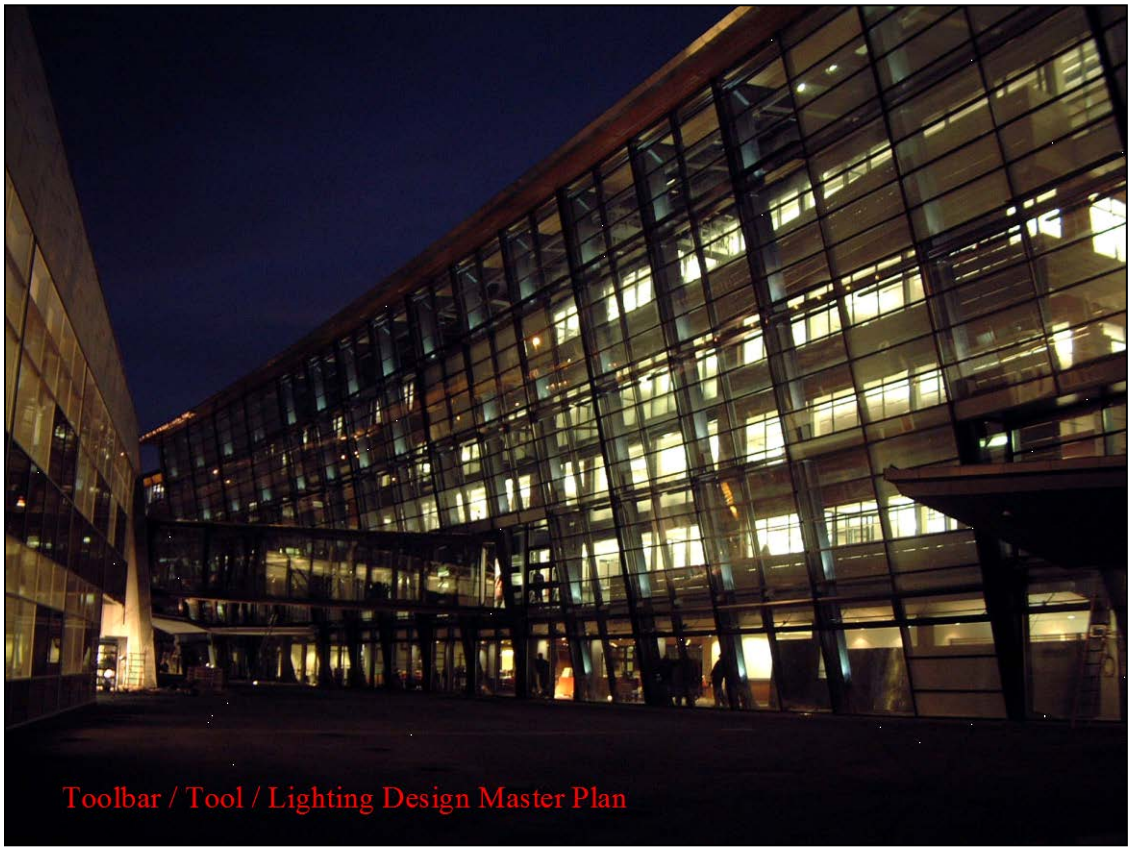


Figure 102. The result of Telenor lighting design. Photo Jan Drablos

Plaza seen from other direction. Plaza is cosy and yet huge, which is interesting combination.

Vertical illuminance values are beautiful and allow you to recognize approaching persons faces and attitude with reasonable distance. It is an important factor in dark environments. According to anthropologists E.T. Hall's and Wout van Bommel's research, the semicylindrical illuminance value on height 1,5m (5 ft) must be E_{scmin} = 0.8 lx (0.08 fc). At this value an observer can recognize the faces of approaching persons from the mandatory recognizion distance of 3.5 meters (12 ft).

Lighting values are humble, but you are surrounded with illuminated walls. You feel safe. Also contrasts of moving people, even at a distance, makes you feel cosy.

Figure 103. Lighting designer's toolbar

Lighting Design Process

Some great masters of light have created unique lighting design processes to give character and “Back bone” for their lighting design.

I have manipulated and striked up Richard Kelly’s famous lighting design process to serve “Theory of The Pragmatic Truth”. My philosophy is that Theories are truth only if they serve and can be applied to real-life-design. Theory which serves theory is just an action, which serves itself, is a way to get research money and is not matured to serve real life yet. Maybe later.

Often, specially in building projects, everybody announce themselves as lighting specialists. The use of lighting design process gives great possibility to improve the position of lighting designer to equal level as other professionals and specialists in the project.

I have used lighting design processes in projects where they can be applied naturally. Sometimes processes just don’t fit in and then you have to use and follow your design instincts which are reflections of “Big unknown” in your brains. Be strong and humble in front of your design tasks.

These 4 examples reflect bad and unprofessional lighting design. It is quite clear that no lighting design process have been used in these cases. When you use e.g. Richard kelly’s ”Ambient Light”, ”Focal Glow” and ”Play of Brilliance” – process you have to think carefully all elements of the space and into which category illuminated elements belong to. It leads to more carefull thinking and - design somehow ”automaticly” and accidental architectural lighting solutions are more rare.

Left up

Horizontal illuminance values are great and all light technical recommendations can be fulfilled, but designer have not understood that perspectively, from this observer position, the space looks like it has a light ceiling.

Left down

Uncontrolled indirect lighting solution. Space looks unnatural because there are no shadows and there is too much light in wrong place, ceiling.

Right up

Lot of horizontal light on floor surface, but vertical surfaces have no light at all. Conflict between interior design and lighting design is ready.

Right down

No comments.

These kind of mistakes can be avoided by using lighting design processes. If lighting designer has skills in 3- dimensional thinking, the combination for successful lighting result is good.

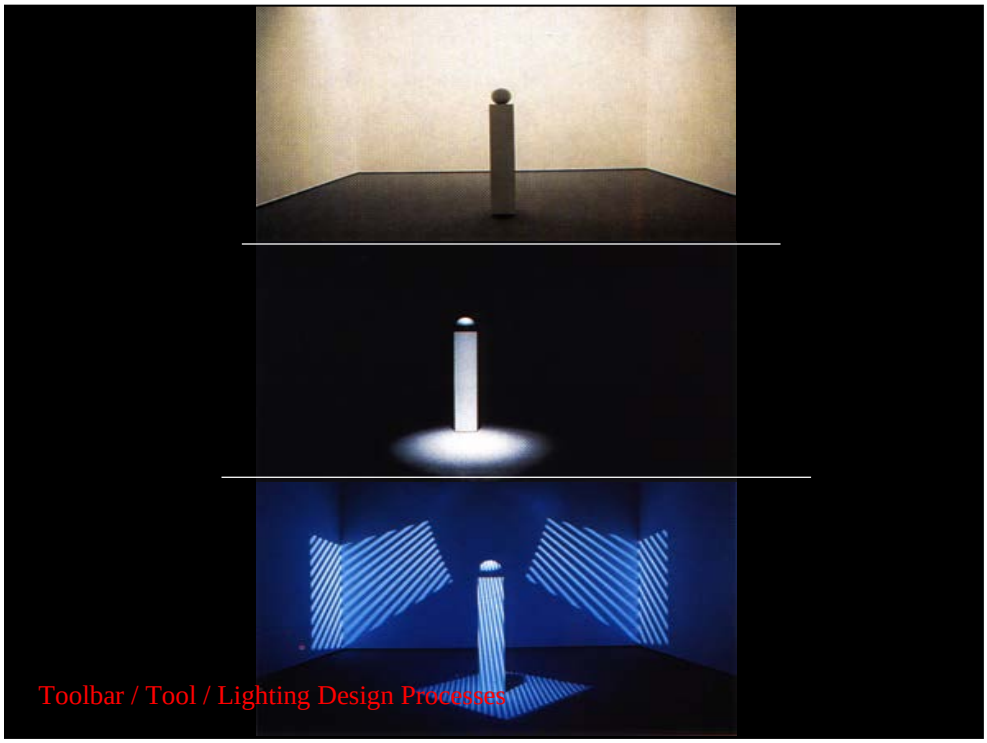


Figure 104. Richard Kelly created lighting design process of "Ambient Light", "Focal Glow" and "Play of Brilliance". Photos ERCO

I personally use these lighting design elements in personal way according to his philosophy of "The Theory of Pragmatic Truth".

"Ambient Light" (top image) in my design works mean areas where recommendations must be used to manage from certain task. In international projects it is important to check local difference between recommendations, norms and law.

"Focal Glow" (image in the middle) is lighting for architecturally important elements in the space. It is important to discuss about the space with architect, because she/he has created it and has hopes and dreams on lighting. Of course lighting designer must propose his/her ideas from his /her idea- library.

"Play of Brilliance" is meant for dull places where light can give richness itself. If space has natural interest and soul in it, this lighting elements is not useful. It is good to remember that less is more and shadow is the best friend for light.

Practical example of use of Richard Kelly's lighting design process in real project is the cathedral in Neubrandenburgh which was renovated as a concert hall. I used process as follows:
"Ambient Light"

- Cloak room. You leave your clothes there and service person must read the number of your ticket and you must pay and see money
- Seating area. You must be able to read manuscripts and programs
- Notepads. Orchestra have to read small notes without extra effort
- Stairs. In Germany Eh on stairs must be over 100lx

Figure 105. Cathedral in Neubrandenburgh. Photo Erkki Rousku

"Focal Glow"

- Acoustic light ceiling
- Organs
- Arches on edges

"Play of Brilliance". Not used at all.

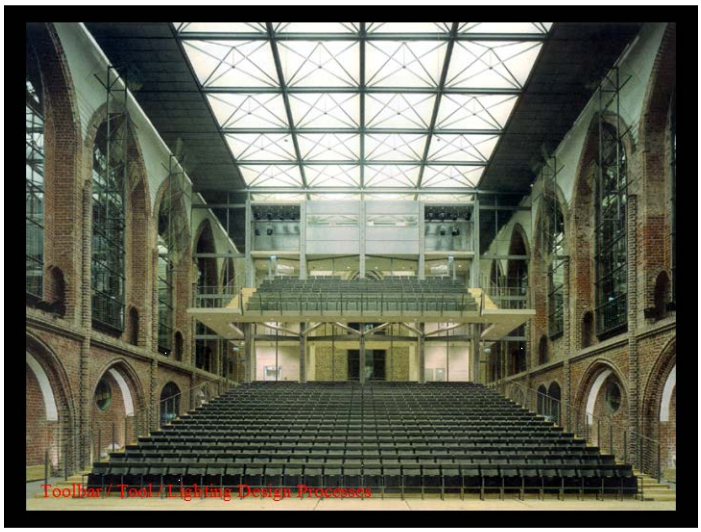


Figure 106. Cathedral in Neubrandenburgh. Photo Pekka Salminen

Lighting was designed to be used in creative way. Different kinds of combinations between stage lighting, acoustic light ceiling and illumination of arches was designed to be used. Values can be preset into the control unit.

Lighting control units are located in the music control room.Acoustic light ceiling is dimmable from 0 – 100%. Ehmax = 200lx. (Value for cleaning).

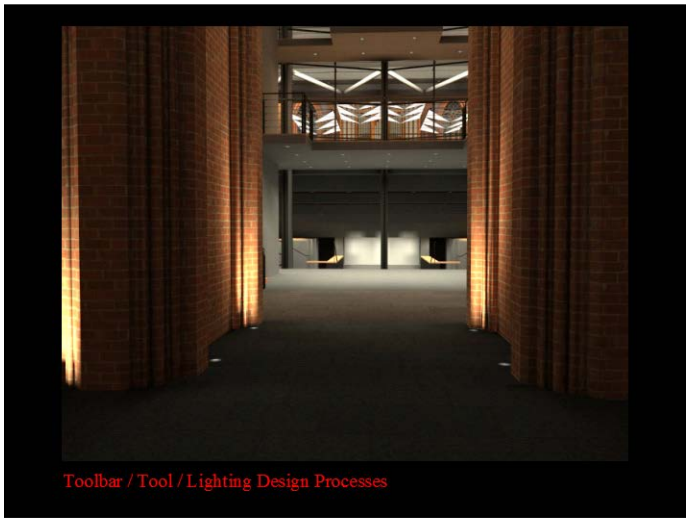


Figure 107. Cathedral in Neubrandenburgh. Photo Erkki Rousku

Asymmetric under ground luminaires were used to wash beautiful brick walls so that light and shadow, as a pair, are supporting the rhythm of architecture. This is some kind of combination of “Focal Glow” and “Play of Brilliance”.

German electricity designer wanted to have 100lx on the floor surface of approaching hall. I as a lighting designer wanted to illuminate walls as a reminder of old times, when also this cathedral had fire torches on it’s brick walls. I told to everybody that reflected light (approximation was 5 – 10lx) on the floor surface is enough. After long dispute, test was made on real site. Everybody loved simulation of torches which was the final solution. Matter in fact this was not only a dispute between electricity designer and lighting designer, this was also a dispute between “Ambient Light” and “Focal Glow”. Dispute of a lighting solution for historically important approaching hall of hundreds of years old cathedral. Using brains is not prohibited when applying recommendations in real life and real project.

In this project I didn’t use lighting design process at all. Design was done following the big unknown and intuition. Reason for this was that somehow lighting design process could not be applied to this project in natural way. It is important that design process can be applied as a natural part of design. It can not be forced to serve design.

Figure 108. “KILDEN”. Photo ALA Architects

This image is here because it is a great example of those elements of Richard Kelly’s design process in very clear way. Extra plus is that all those elements are in great symbiosis.

“Ambient Light”, which is light for walking and driving safely, is produced by one huge reflection of huge wooden façade, which is clearly part of “Focal Glow”. And that focal glow is produced by using “Play of Brilliance”, which is all those under ground luminaires. What a great combination and example. As an extra point for this all is the moon. It creates a small part of ambient light with it’s glow and at the same time it is natural representative of Focal Glow.

Figure 109. Lighting designer's toolbar

New Technology

Change is only constant in new technology and matter in fact also life generally. It is good to remember that there are thousands of different kinds of light sources (lamps) and different kinds of luminaires. They all have been new sometimes and designed often to fulfill certain task.

It is also important to understand that there are no bad products, there are only bad solutions. Manufacturers launch their new products on market with big money and put their effort and emphasis on good characteristics of the product. But as a lighting professional it is wise to study new products very carefully before using them in projects. Good example is LED as a light source since now (2009). There is a common understanding that LED are very energy friendly and - saving products. But in real life LED light efficiency, measured in lm/W- value (50 – 60 lm/W in the luminaire), is more near lamps than High Intensity Discharge lamps like Metal Halide lamps (100 lm/W in the luminaire). But LED prime time as efficient energy saver and light producer will possibly come later, maybe after 10 – 15 years. Other example is a Sulfur lamp, which was launched in 90´s as biggest innovation after incandescent lamp. It is not existing anymore at all.

Be creative and strong. Use your imagination and new lighting technology in creative way without loosing hope for old ones.

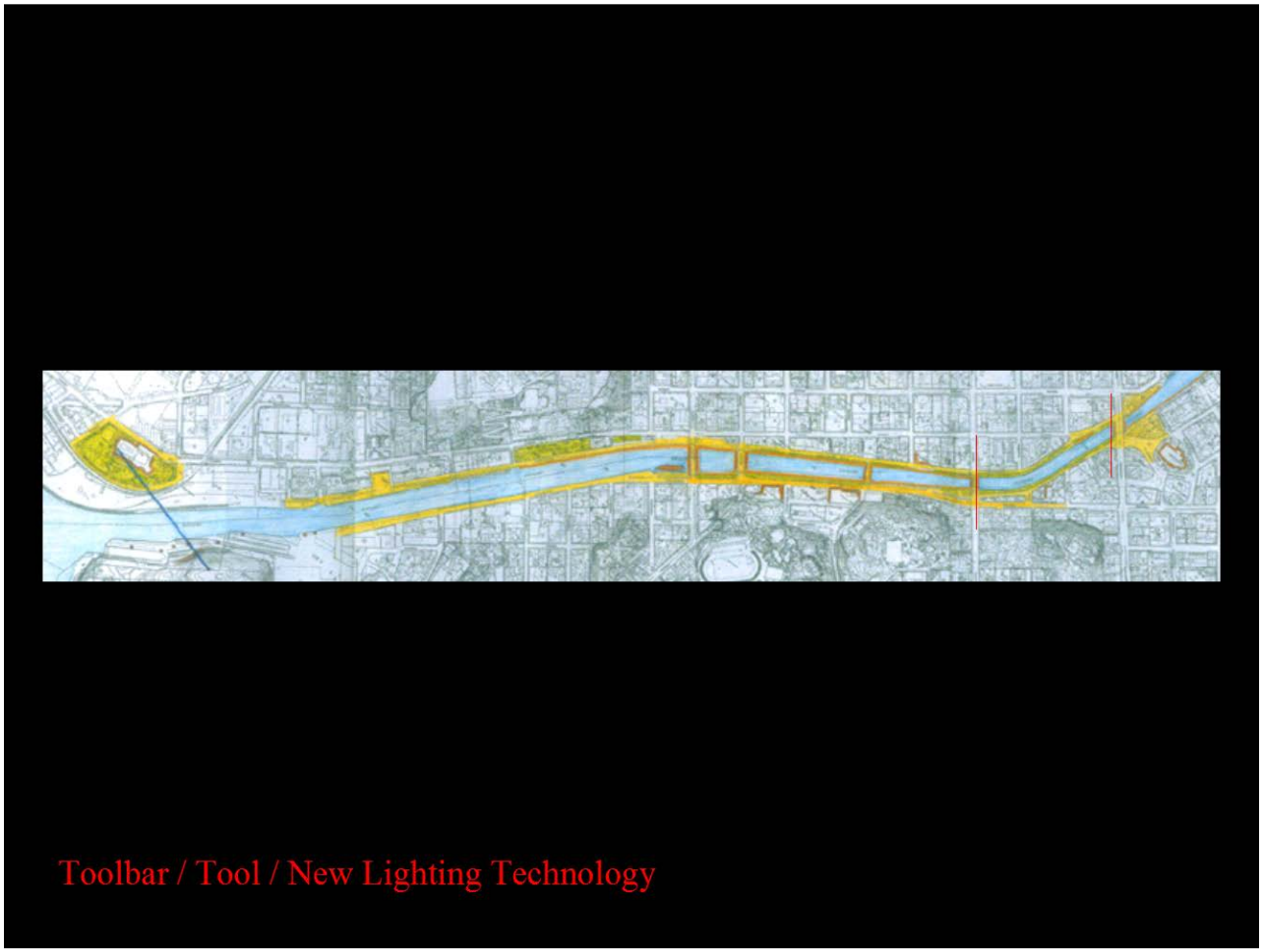


Figure 110. Aura river project. Photo Vesa Honkonen & Julle Oksanen

First example of using New Technology as a tool is Aura- river project in Turku Finland. Our assignment was to create new lighting to that area. 3 miles of river and river bank, beautiful parks with old lime trees and oaks, streets around the river, romantic pedestrian walkways, old and new bridges and building facades.

Just to mention interesting things of this project how it started:

Architect from Town Planning Office of Turku Town contacted me and asked am I ready to make lighting design for this area. I asked what is their estimation of total costs. They estimated 75.000 USD. I said that total costs will be approx. 1,2 million USD. I proposed that they order perfect Lighting Design Master Plan for whole area and build it up annually according to annual budget possibilities.

We are now focusing only between two red lines which are marked on the drawing. There are 100 hundred old lime trees located in both sides of Aura- river, 50 pcs on each side. We wanted to illuminate those trees.

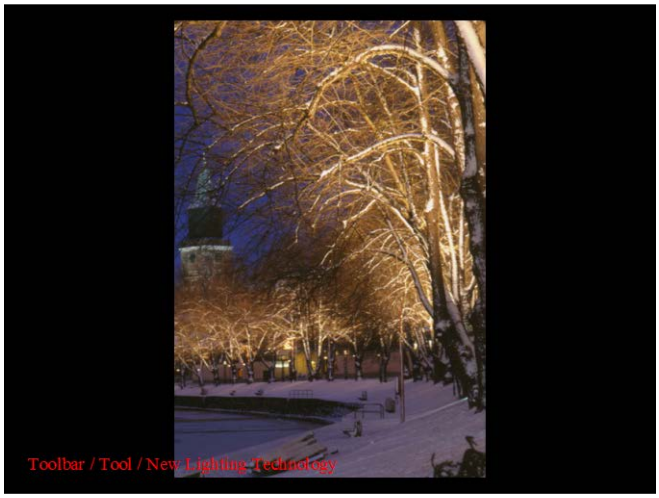


Figure 111. Illuminating trees. Photo Julle Oksanen

We started to study how to illuminate the tree. Because tree is a living organism, we contacted different kinds of tree- specialists like gardeners of Turku Town Planning office and plant scientists.

We didn't know if trees have to sleep during night or can you "fool" or disturb their lifecycle with electric lighting. New questions rose up during our research process all the time. Questions like: How trees react when electric lighting is artificially creating longer day-period than natural cycle, what happens when light suddenly comes during night time from other direction than daytime, how leaves react on that change of approaching light direction, are leaves more sensitive on light which arrives from under than from up. e.t.c.

We also wanted to know how luminaires can be installed so that roots are not suffering. What kinds of roots limes have? If we hurt roots will lime tree die e.t.c.

Summa summarum: No suffering with our lighting solutions and normal pole foundation could be used. Lucky we. We could continue the project after these studies.

Figure 112. Underground luminaire. Photo Philips

One way to illuminate tree is to use so called underground luminaires. We had 100 pcs of big lime trees. Each of them would need 3 pcs of these under ground luminaires. If you look the river view from bridges which are located on both ends of illuminated lime tree rows, you have 300 pcs of light beams running into your eye bottoms which form together veiling luminance.You could simulate situation by looking the view through the old time veil type baby vipers. Contrasts are disappearing.

These kind of luminaires also have a hot light distribution surface. Depending on manufacturer and model, temperatures of front glass surfaces are between 130 – 300 degrees of Fahrenheit. Leaves are dropping on those hot surfaces and dry there. Possibly some fires could happen.

These kind of luminaires also become dirty on such a natural environment. Animal and people waste, grass, sand, dust e.t.c.

We didn't like this solution, so we skipped it.

Other "normal" way to illuminate a tree is to use floodlights. Big tree needs a big luminaire. 100 trees need 100 big luminaires. Big luminaire also needs big or at least thick poles and louvres to avoid glare e.t.c.

We didn't want to bring these big lighting elements on this historically important area to spoil the view.

We suddenly found out that we had a very peculiar problem in front of us. At the same time we felt that it was a new and inspiring challenge for us to solve this odd problem.

We continued the project very carefully. First we thought that we have to study "How many gallons of light" we have to shoot into the branches to get a beautiful view and how to shoot it.

Figure 113. Floodlight luminaire. Photo Philips

We proposed a demonstration to our client. Customer told us that they don't have a lot of money for this purpose. So we told them to manufacture simple wooden structures for luminaires in local prison or professional school.

We also proposed them to buy cheap chinese halogen luminaires from local hardware store. Every structure should have 4 pcs of 500W halogen lamps.

Representatives of local power plant were not happy, because our solution took so much energy. We told them that they ought to be happy, because they sell electricity and secondly this is temporary study and thirdly it was a celebration lighting for Finnish 80th independence day.

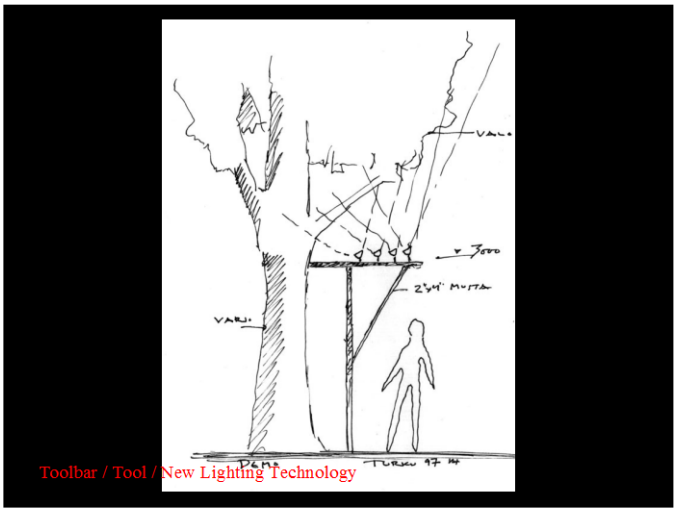


Figure 114. Sketch of tree illumination. Photo Vesa Honkonen

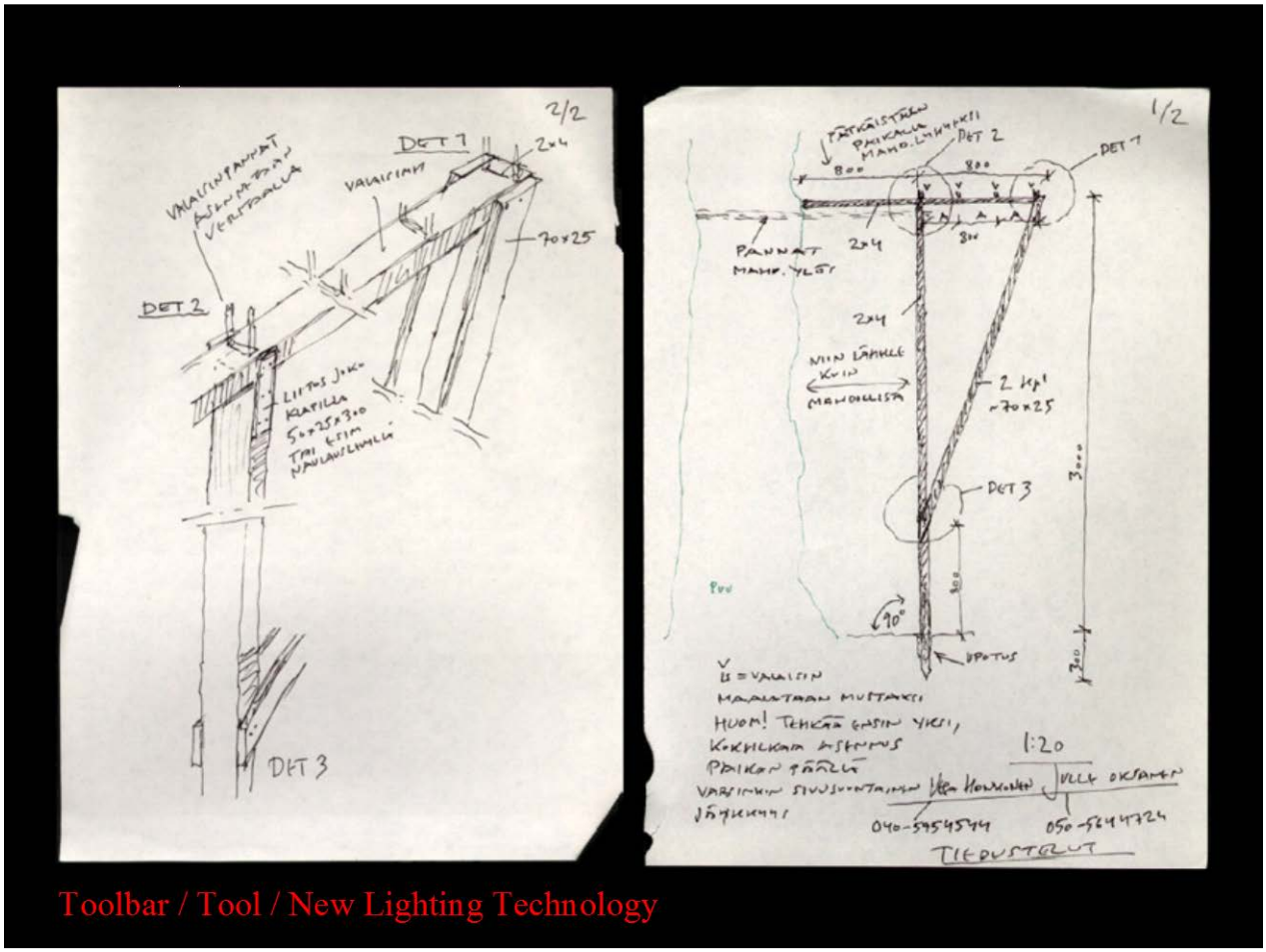


Figure 115. Authentic drawings for installers. Photo Vesa Honkonen

Here are our authentic drawings for installers to make black wooden construction and how to install it.

Everybody was very excited after we had introduced the project to everyone (Town Planning office, Power Plant, Prison director, electricians, comnstructional installers e.t.c.). It is important to tell and give information what is going on to everyone who is somehow involved in project. It gives motivation to be part of the team and later on everybody can proudly tell to their family members and friends: “We did it”

Figure 116. The result of Aura river's tree illumination. Photo Turku City

Architects in Turku Town Planning Office asked us could it be possible to have different lighting situations, like celebration lighting and normal every day lighting. We told them that nature takes care of changes. In Finland we have 4 strong and beautiful seasons. During autumn leaves turn red and yellowish, during winter white branches look mystical, during summer no electric lights are needed at all. During spring it will be great to see how green leaves brings us summer. We also told them that there are times, like rainy days, when trees look humble and lighting effects are zero.

We can see from this image that camera eye have catched up all details from branches and view is great without glare. No light distribution surfaces can be seen from 3m high luminaire constructions.

Only problem of course was that whole lighting installation took 200 kW as total power and thick wires were needed. But we all knew that based on this demonstration new luminaire was born to the market.

We had to remind people that this was a test how much light is needed and according to that information we would use New Technology to produce same amount of light.

After demonstration we knew that we have to produce approx. 30000 lumens / 1 lime tree in order to get beautiful phenomenon, equal to our demonstration.

We selected 2 pcs of 150W Cheramic Metal Halide lamps per one lamp chamber. Total lumen package is exactly 30000lm / luminaire, which was great. Other reasons for this new lamp selection were:

- Cheramic discharge tube keeps color of light stable trough the whole life time of the lamp.

- Color rendering index is great, Ra = 88.
- We can choose warmer or cooler color temperatures.
- Lifetime is 12000 hours, which means group change of lamps after 3 years use connected in power plants electricity net..

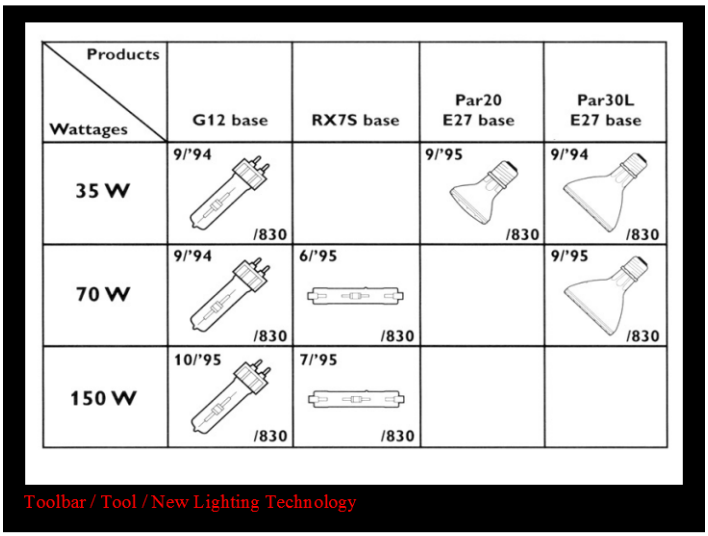


Figure 117. Metal halide lamps. Photo Philips

Figure 118. Luminaire "Tree". Photo Jussi Tiainen

One of the most important design- criteria was that this lamp is very small and allows beautiful design. Also lamp chamber can be relatively small because of 300W total power, no extra cooling elements needed.

This is a result of final solution. Simple 3m high black luminaire. Pole 76mm / 60mm, small lamp chamber and extra cover glass. Ignitors are located on the top of the pole and ballasts lower part of the pole. After producing first sample as hand craft work, we took the luminaire on site and put it on. Old couple had their nightwalk and they stop infront of us, just couple of feet from luminaire. Old man looked up and asked us where this beautiful lighting phenomenon comes from. We shaked his hand and told that his comment was best comment for us in years. We had a dream to design anonymous tree lighting producer and according to his comment we succeeded well. Luminaire is now a standard Philips product called "Tree".

Figure 119. The result of Aura river project. Photo Jussi Tiainen

This lighting solution has given a lot of joy to citizens of Turku and we are famous people there.

We have also wan lighting design award with this project and also award of creative persons in Turku Town.

This tree lighting project is only one part of our large Master Plan Design of Aura river project. Every year something new appears according to our big design. Project lasts approximately 10 years.

This project is a great example how creative lighting design can be done. There is a lot of places where new lighting technology can be in a key role when doing something new like products, solutions e.t.c.

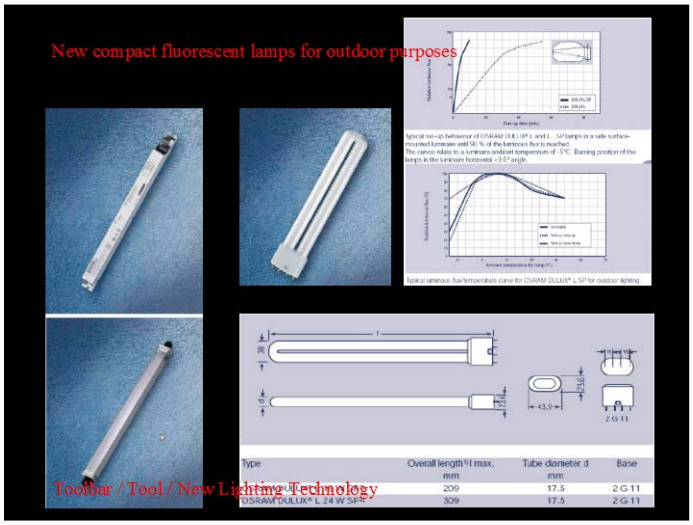


Figure 120. CFL for Plane luminaire. Photo Osram

Second example of New Technology as a tool differs from first one. In this case we didn't try to solve how to illuminate something (like tree in earlier example). We found out that now we have an opportunity to

design a new street lighting luminaire as a modern anonymous substitute for old fashion street lighting luminaires.

We found out that this new design- project was possible, because Osram had created a compact fluorescent lamp for outdoor purposes. The problem in “normal” compact fluorescent lamps in cold environment has always been big lumen depreciation as a function of ambient temperature. Reason for this is a sharp and strong angles in glass tubes on the head of the lamp. Osram created smooth curve instead of sharp corner and got lamp which is suitable for outdoor purposes. Also this lamp looses light in cold ambient circumstances, but lamps are located in lamp chamber which heats up to keep lumen output quite stable and in good level. Lamp works with electronic ballast which can be located inside IP 64 tube, which is made of acrylic.

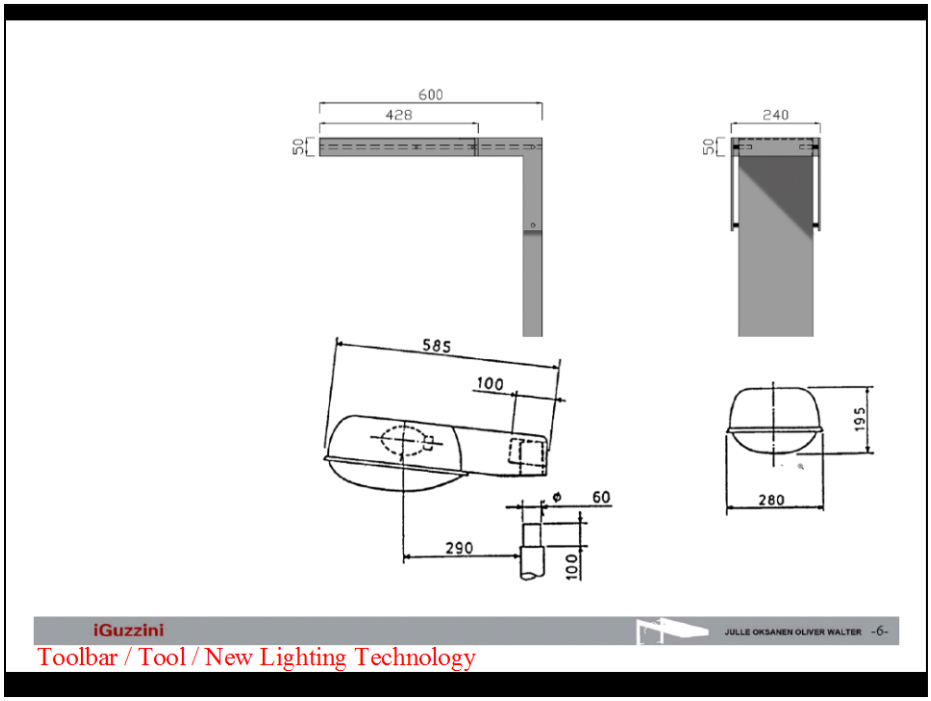


Figure 121. Plane luminaire. Photo Julle Oksanen Lighting Design Ltd

Plane luminaire (upper images) is a substitute for old fashion luminaires (lower images), which normally are made for mercury lamps (white light) or high pressure sodium lamps (yellow light).

Scale in both types are same so that you can compare your feelings with them. To me Plane reflects anonymous design, which is not fighting against any architecture. It fulfills its task as a light producer and lives its own life.

Old version is reflecting old times and somehow specially old 60´s when The Beatles was on the top. Somehow I feel that I could almost take this “Old and fat boy” (old luminaire type) on my lap, hug it and listen at the same time The Beatles singing “All you need is love”.

In that “new type” case, I couldn’t take it on my lap, because somehow it is more independent and made for survive alone and only produce its light to environment. To me it is a sharp and handsome, independent element.

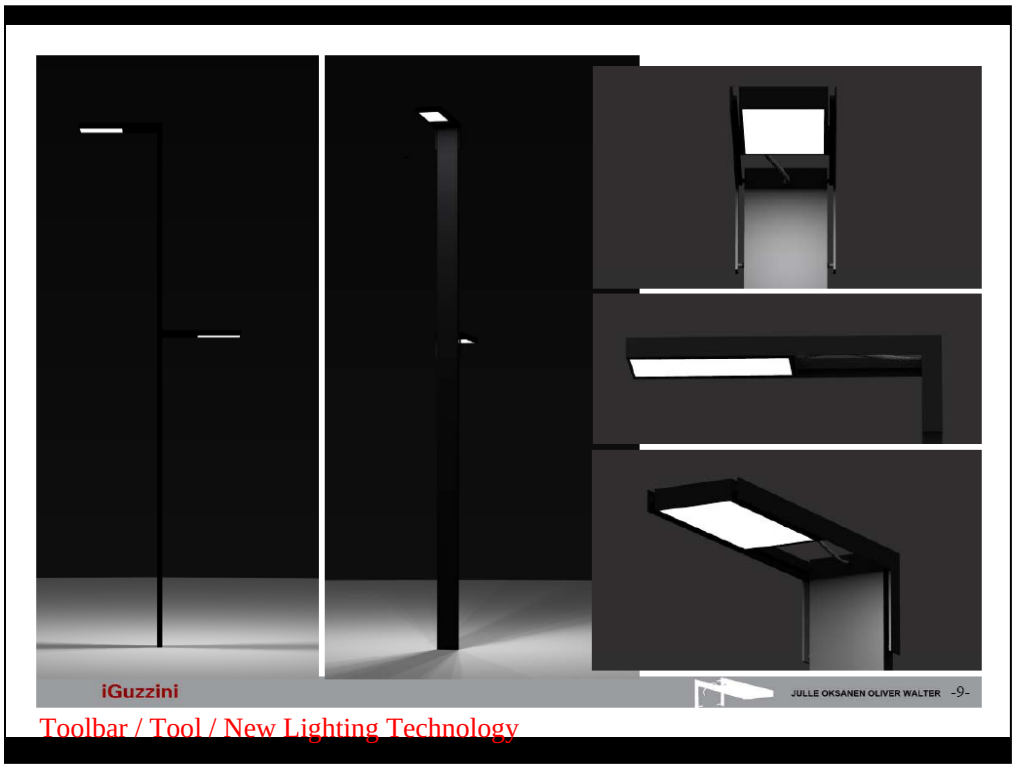


Figure 122. Plane luminaire. Photo Julle Oksanen Lighting Design Ltd

My goal in the begining of the design process was to create as thin luminaire as possible. I took wine and kept that new lamp in my hands and started to sketch it. “Original Plane” was proposed to made from steel and sand plasted glass.

I wanted to use human scale. That’s why hight proposal was 5m. Other version is 5m for car traffic and 3m for pedestrian.

We made our own wooden Mock´ Up luminaire to check out how it looks and produces light. Light measurements showed that it just had great values and if it is used on 15 feet wide small road (our testing road), spacing distance between 2 luminaires can be approx 65 - 75 feet, depending which country we are talking about and which recommendations are valid.

Figure 123. Eco-Plane luminaire. Photo Julle Oksanen Lighting Design Ltd

We also wanted to create “Ecological version” of it. We contacted wooden pole manufacturer.

Process work so, that when this wooden manufacturer gets order, they go to forest and hug straight Finnish pine trees as many as is needed. They take off park and thrill the heart part away. The heart part don’t shrink when pine tree is drying and because of that the cover/outer part of pine would burst broken. After drying exactly certain days for certain humidity, manufacturer sinks the poles into Norwegian boat oil. It must happen in exactly the right humidity of the pole. If you sink poles more wet, oil don’t go inside wood at all. If you sink poles into oil too dry, wood sucks oil only 0,1 inch deep.

After the pole have been used, you can burn it in your fireplace or use it in some other ecological way. Also luminaire parts can be used again (steel and glass).

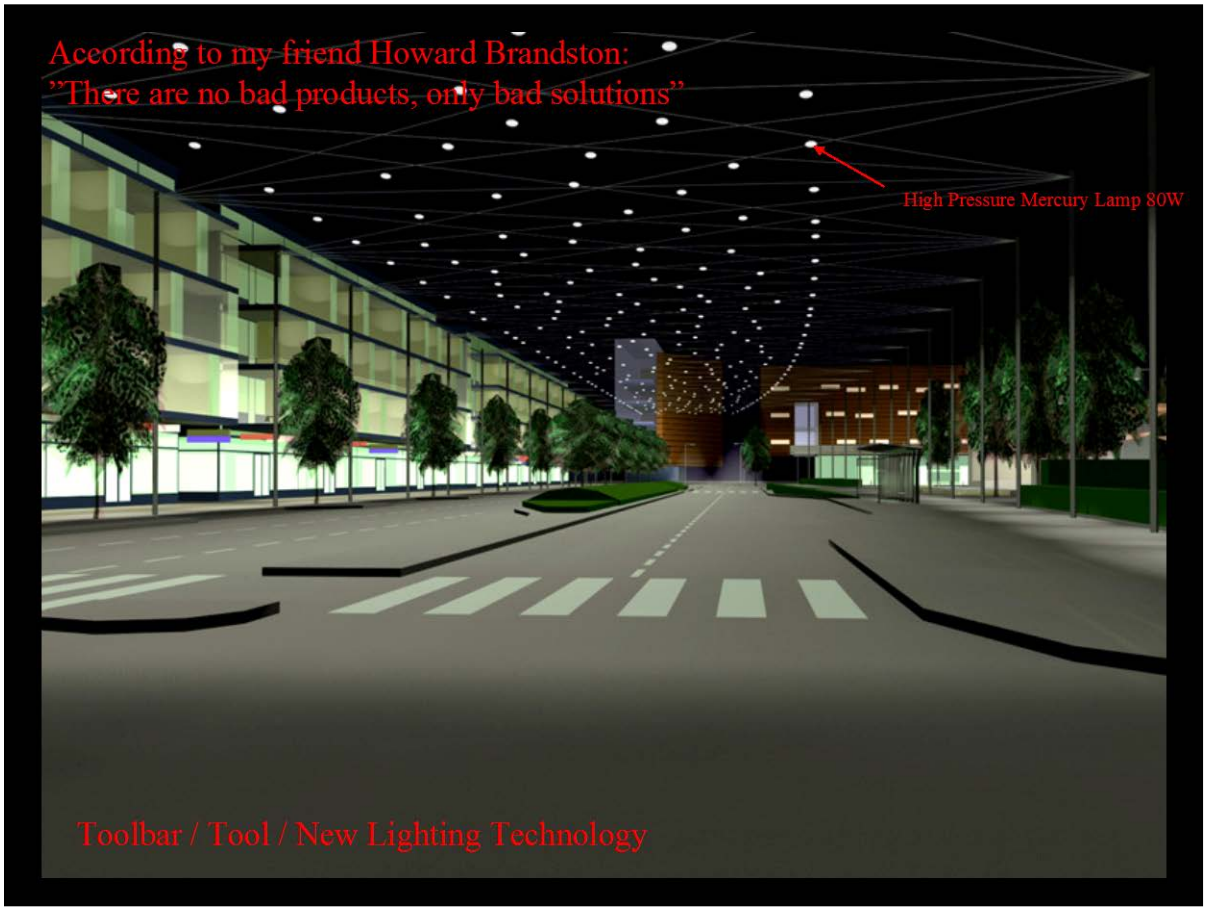


Figure 124. Raisio computer manipulation. Photo Oliver Walter

What comes on New Lighting Technology as a tool for lighting design, it is also very important to remember the words of one of the most famous lighting designer in the world, Howard Brandston, New York, NYC:

"There are no bad products, only bad solutions"

One exciting example of this fact is our early project "Raisio Light Plaza", where we had problems to find lamp which produces humble cool light. We found Mercury lamp of 80W. That was unefficient enough to create the atmosphere which we wanted (See image).

When we sent our custom made luminaire drawings to German manufacturer, they sent us a message "Why do you use so old fashioned lamps, don't you have new ones there in Finland"??? They sent back drawings where they had used very efficient Cheramic Metal Halide lamps in our custom made luminaire. We sent them a message: "We can't use these lamps, because they produce too much and too warm light". We had to go to Germany to clear up the situation. Afterwards they managed to do luminaire which was right one for our purpose.

Often, when new products come out in lighting world, like LED, Sulphur lamp, e.t.c., we use to exaggerate it and hope that it does something amazing and extraordinary. Exactly that also happened with computers in lighting world. This phenomenon somehow belongs to normal human behaviour.

Computers

Today, when every lighting designer has a computer, it has "come down" to serve every day lighting design as only one tool among all other tools, nothing else.

It is very important to bear in our minds that for a lighting designer, nothing is more important than what runs from your head to your hand and pencil.

Somehow it is also sad, that only the final result is what counts on the end and is important. When project is ready and people use the space, nobody knows what tools lighting designer has used, or even who has designed that lighting. They only see the result of lighting designers lighting design work.There are many different ways to use computer in lighting design. Here we have some examples.

Figure 125. Public building project. Photo APRT Architects

In public building projects architect offices normally use databank, where sub designers can pick up architectural drawings and design their own layers on it. Modern buildings are very complicated and have lot of layers where lighting designer's layer can be one of them. This is typical when electricity designer does lighting design work.

In more demanding lighting design projects where special know how and creativeness is needed, special report is a must. This report include normally: Concepts, Master Plans and some Detailed Design elements. It is an independent lighting design report from which all other designers, like: electricity designer, interior designer, landscape architect, architect and final customer can pick up information to their own purposes. In normal case for example electricity designer takes elements from my report to his/hers electricity plans and makes at the same time detailed working drawings.

It is important that lighting designer supervise electricity designer very carefully in order to avoid conflicts later on when design goes forward and for example constructional drawings are under the work. This is important to add also lighting design offer. I for example write to offer what is included and what is excluded to offer.

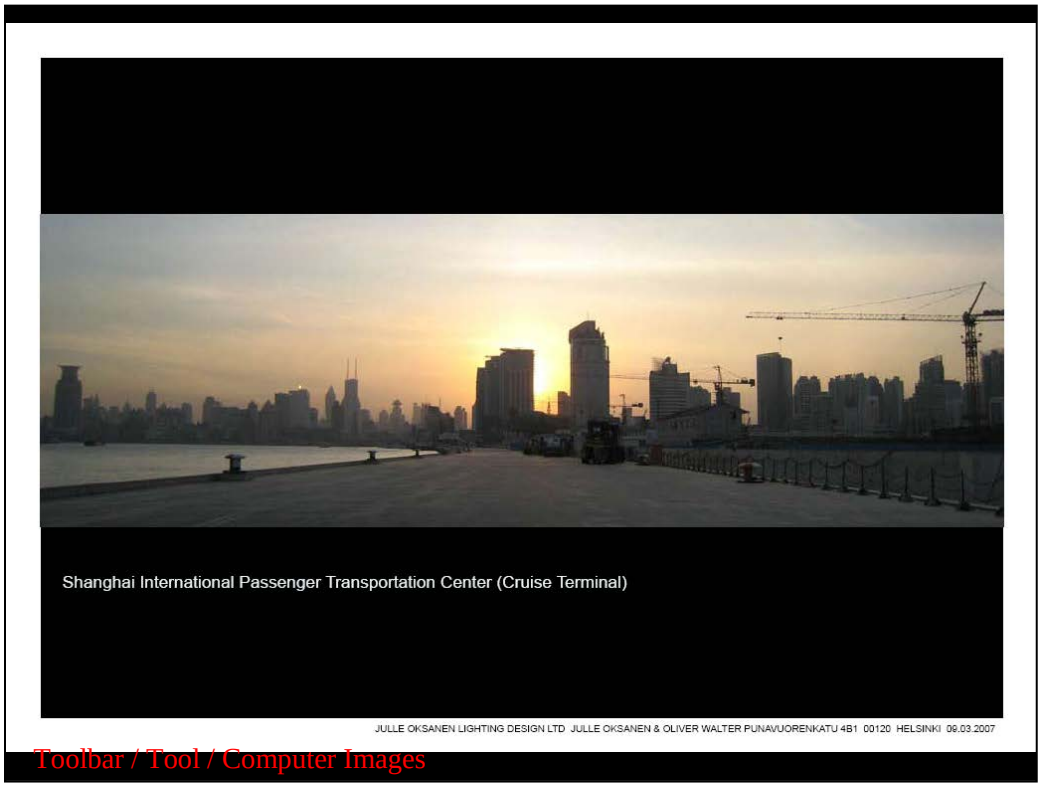


Figure 126. Shanghai harbour. Photo Julle Oksanen Lighting Design Ltd

One example how I and my team use computer is a concept image. Old saying “One image tells more than 100 words” is still valid also in real life. In good team work lighting designer sends report to architect, other sub consults and final client. Today it is super easy compared to 10 – 15 years ago. You just create a pdf- format of your report and send it to everybody by e-mail.

It is also always good to add written words to support conceptual image, because peoples’ visual world differs from each others and there is always some kind of possibility to misunderstandings.

Typical example of computer as a tool for conceptual image is this Harbour- project.

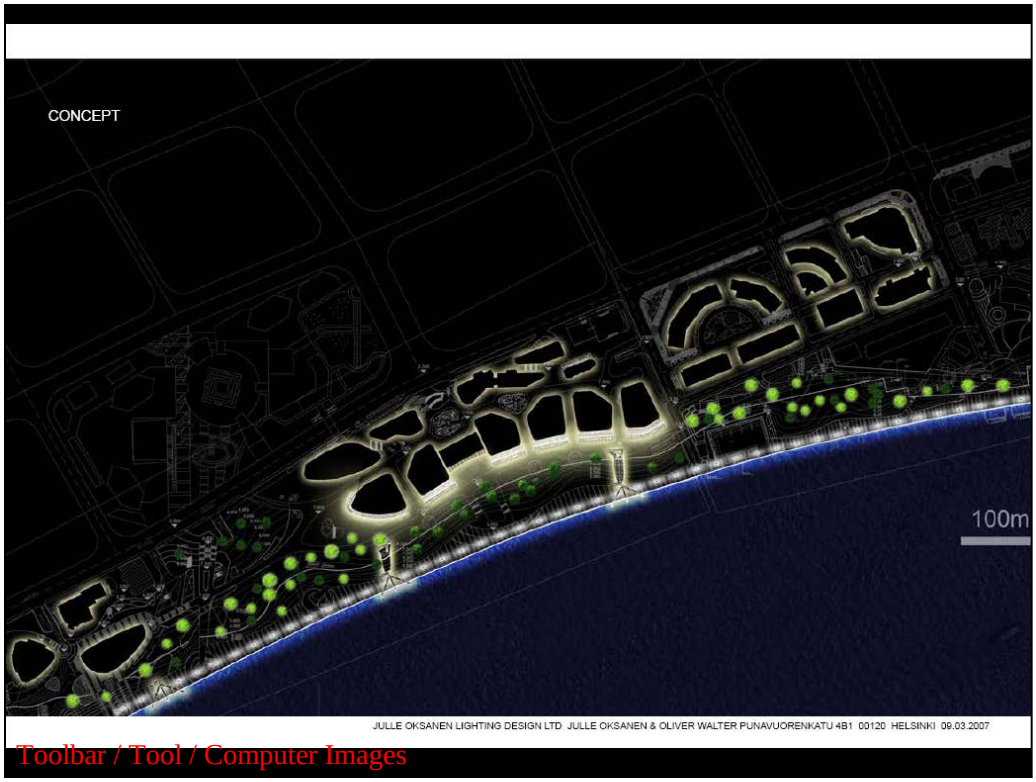


Figure 127. Shanghai harbour lighting project. Photo Julle Oksanen Lighting Design Ltd

This town has much too bright and glary city center. Our concept was to create peaceful and style harbour area. From seaside it ought to be like a post card image.

You can “read” from this concept image that blue light line is following the edge of the pier creating clear, clean and exciting semiotic connection to sea. Part of “Play of Brilliance” type of lighting.

“Ambient Light”- part, which represents general lighting, is produced by using indirect – direct- luminaire. Light is white light. No glare at all. Indirect component from big reflectors gives veil of white light which takes whole area on it’s embrance. Direct down light- part gives sharp and strong light beam under the luminaire. Contrast.

Some beautiful and exotic plants are illuminated as part of “Focal Glow”.

Huge facades of buildings are glowing and giving depth for the space. “Whispering Light”.

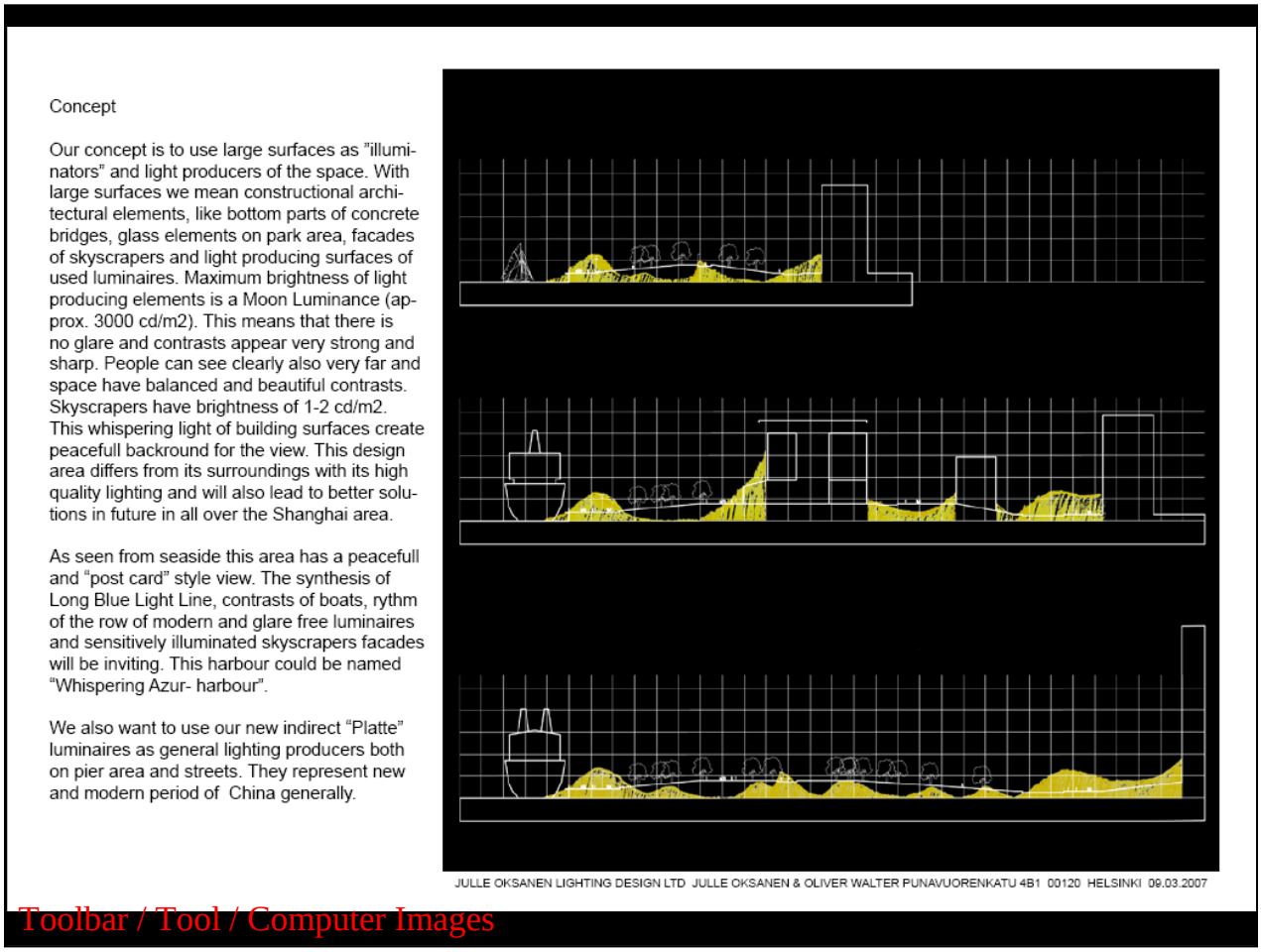


Figure 128. Lighting design concept. Photo Julle Oksanen Lighting design Ltd

In order to be able to strengthen the concept and also conceptual image, it is good to write some more detailed information. This always gives a professional flavor on it.

Computer can also be used to create "Illumination sections". These drawings show the rhythm of light on architectural sections. Also non professional people who might study the report (like owners and final client), can easier understand the behavior of light on your design. Although light philosophically is invisible.

Lighting section represents the compose of light. You can visualize your compose with computer. It is also good to put some words on the text to support compose, which in best cases reflect life which is formulating from elements like: Maximum brightness, shadow is the best friend of light. Jing & Jang, Love & Hate, Sound & Pause, Light & Shadow.

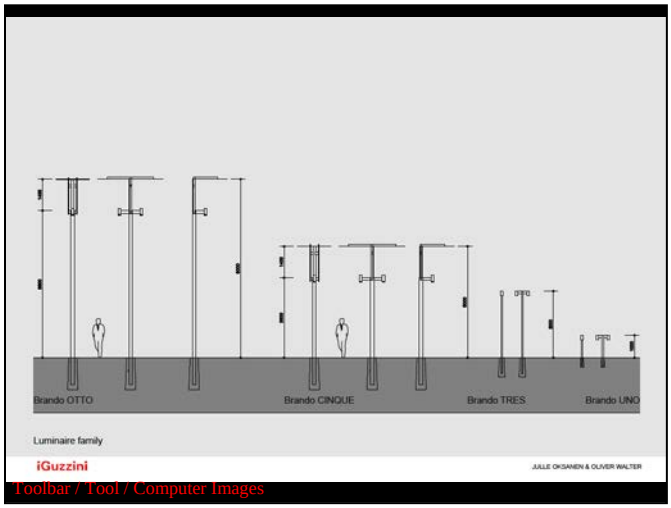


Figure 129. Brando luminaire types. Photo Julle Oksanen Lighting Design Ltd

Although it is more or less clear matter, it is good to mention that computer as a tool can also be used for luminaire design purposes.

It is important to mention in this context that real luminaire design work happens in the brains of luminaire designer. It is fantastic to have all those very personal and creative moments by listening peaceful classical music, drinking red wine and sketching things which run from your head to your hand. Ideas are flying, no hurry to nowhere, lot of time to enjoy and draw maybe even hundreds of sketches on the sketch- paper by thick pencil. Real Design Happiness. Finally, sometimes even years later, computer images and more detailed computer drawings can be made to finalize luminaire design. Surprisingly from first sketches to final product it takes often years of time. Luminaire design needs very persistant attitude.

Figure 130. Brando manipulations. Photos Oliver Walter

Very popular use of computer as a tool is image manipulation. There are many programs available for this purpose. There is no reason to tell any names or brands of these programs, because they probably are old when this book will be established. New computer manipulation programs appear annually. Those programs can be bought or they are free from internet. At this very big moment, most of best programs are free.

These computer manipulation examples are from Oksanen – Walter luminaire design report, where designed luminaires are located hypothetically on the yard of Louvre in Paris and park in Lisbon. Somehow it is also little scary that everybody can be "Leonardo Da Vinci" by drawing a straight line with the computer and push the "Leonardo Da Vinci"- button. Program turns the line as Leonardo Da Vinci would have been drawn it. Something is wrong in this context.

I think that for a project, it is more important to have a person with experience of life, soul and spirit than a young person with marvelous computer skills but without any soul or spirit.

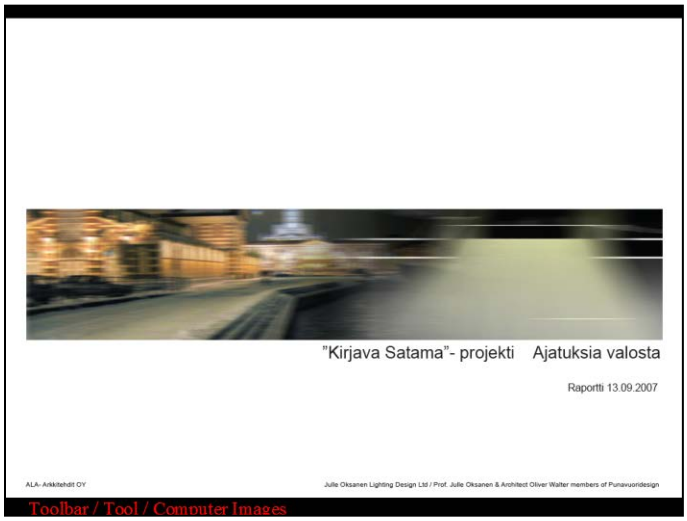


Figure 131. "Checkered Harbour of Helsinki". Photo Julle Oksanen Lighting Design Ltd

Computer can also be used to change attitude. This is the first page of the report “Checkered Harbour of Helsinki”. Page is blurred. Reason for this was that I knew that there will be many persons on the design team, who have no idea about design aspects and 3- dimensional thinking. According to my experience, these people often have problems to understand what is going on at the concept of the project. In project meetings they often have to draw/pull themselves on the defensive and project itself is suffering of misunderstandings. It is not their fault and visually skillful people ought to try to help them in all possible ways.

This blurring of the first report page strikes these people to the better attitude, before any conceptual explanations. They see that something exciting will come out now and things possibly are more or less blurry and negotiable. It is not so scary anymore. Exact image reflects exact opinion, blurry and exciting image gives room to everybody to use their brains personally. It seems to have semiotic help also in real life.

This is very odd reason to use computer as a tool, but can be done very quickly.

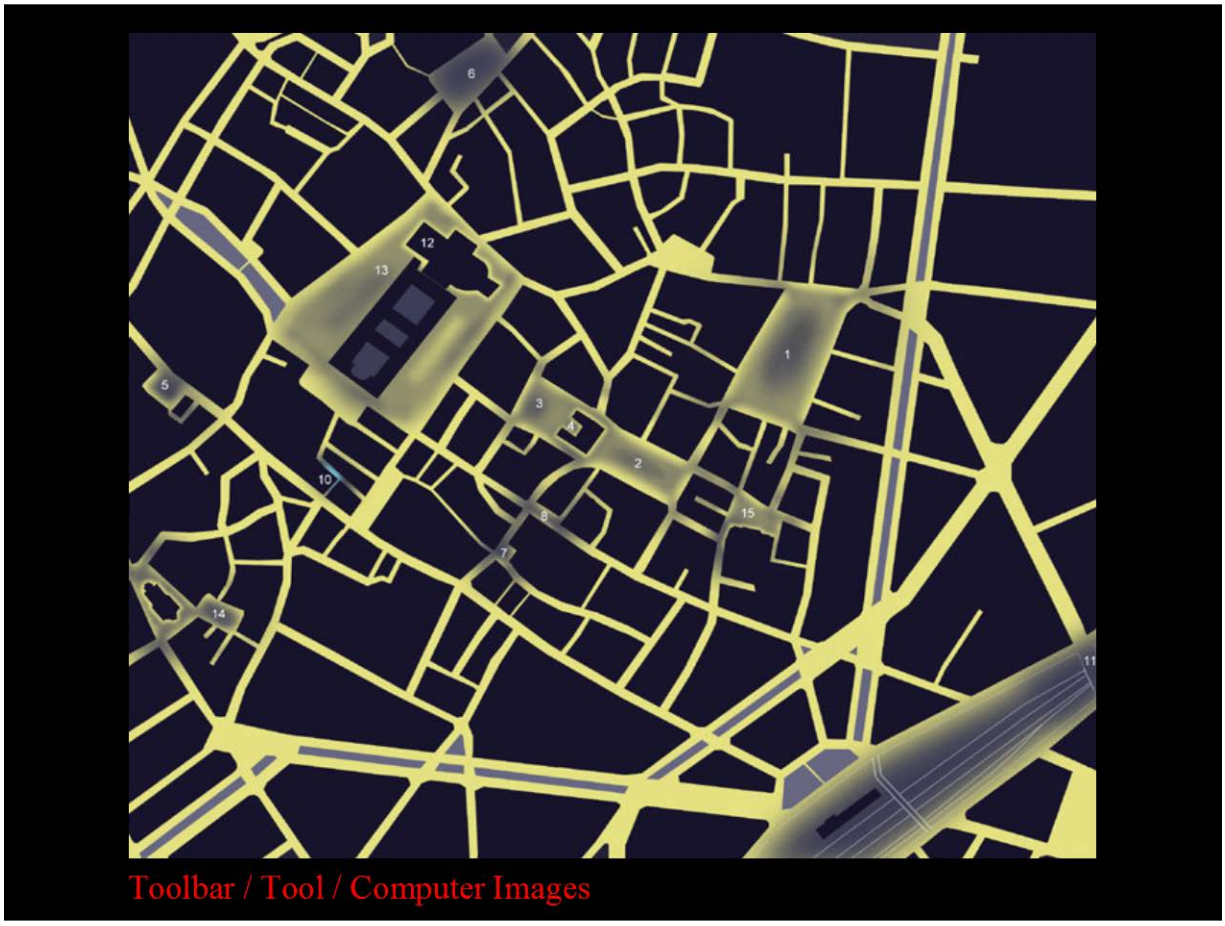


Figure 132. Arras city centrum manipulation. Photo Mari Koskinen

Manipulated computer image can also be a “silent story teller” as in this old international lighting design competition image from 90’s. It is a very old and beautiful city of Arras in France, where only streets and plazas are left on screen and all other city elements are cleaned away.

The “story” here in this specific image is to tell judges of the jury that shadow is the best friend of light and located in very carefully designed locations in this competition work. When you approach the plaza along small, beautiful and old road, you first walk on illuminated part of the road and some seconds before you enter the plaza, darkness falls down and opens the view beautifully and poetically.

Other story is also “hidden” into this image and our team knew that judges would recognize it: The facades which enclose the plazas are illuminated and plaza itself is “sleeping” in darkness. Vertical values of surroundings are great and that is why you feel safe also in the middle of plaza. In “typical” case there would be tall poles in the middle of plazas equipped with glary and powerful floodlights causing glare and eating the happiness of observers and people who spend their time in city center.

This old cathedral was also one of the objects in this lighting design competition. We took a digital photo with digital camera during one of our visits in Arras.

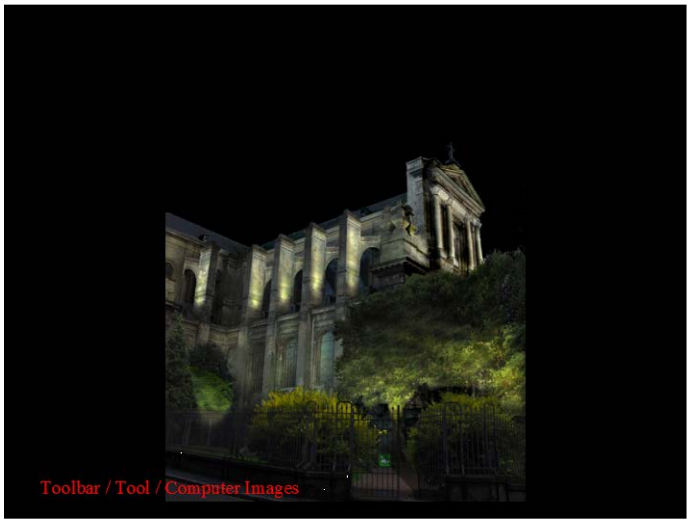


Figure 133. Old cathedral. Photo Oliver Walter

Daylight image was manipulated with computer as an attractive night view. This is often also very dangerous action in hands of the team which is not experienced lighting and its realities. It is very easy to "overload" image with dreams and not possible elements, such as dreamy and mystical sky, colorful surfaces which can not be done, shadows in wrong places if any, or what ever over artistic comes to designers mind..

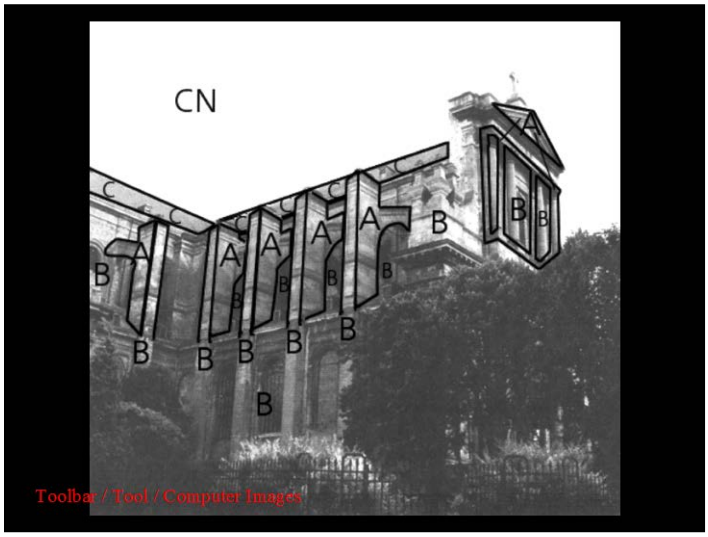


Figure 134. Computer generated sketch of cathedral. Photo Oliver Walter

It is always good to at least try to imitate what will happen in reality. Hopkinson's diagram of relieving power and relations of ambient and object luminance is very useful tool to determine what really happens with contrasts on view of observer.When you use Hopkinson's diagram you just determine different brightness of different surfaces like in this image.

Dark night sky luminance CN can be measured in City of Arras with luminance meter.

Vertical columns are marked as A in image. We3 wanted to put some style emphasis on them compared to brightness B and C.

B and C are representatives of their own and wanted brightness.

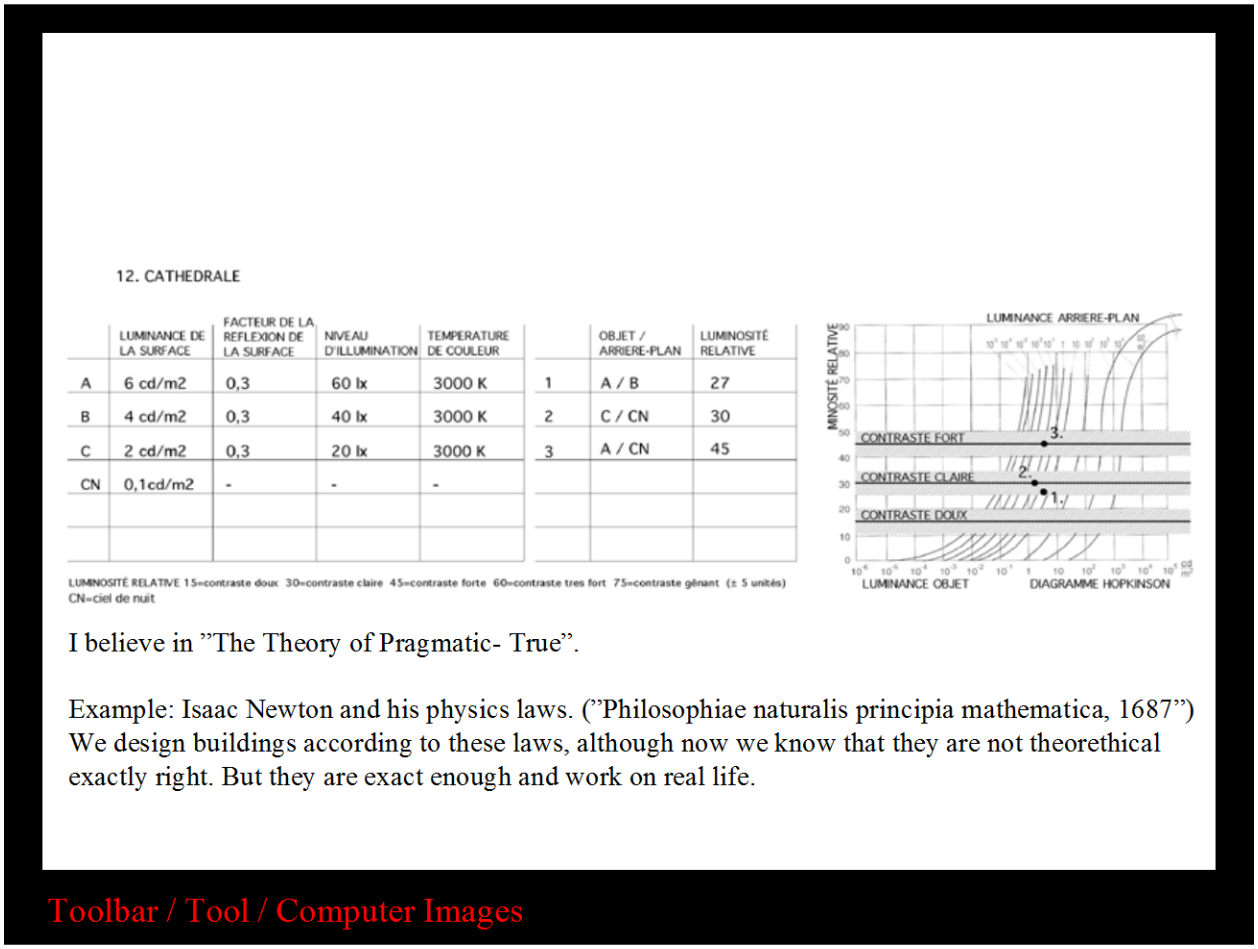


Figure 135. The Theory of Pragmatic- True and contrast.

I believe in "The Theory of Pragmatic True". Theory is true only after it has a successful application. If theory has been used successfully in real life, it even can be inaccurate. Maybe best example of this is Isaac Newton and his physics laws. We design and build sky scrapers and very complicated structural elements today according to his laws, although we know that they are not exactly right but work in real life.

Hopkinson's diagram is a subjective diagram according to his own visual findings. He treated them mathematically and proved that two different objects in grey scale create different kind of "Revealing Power". Revealing power can be "translated" in practical project as "Earned Viewing Points". Values of 10-20 means architecturally style and Humble surface compared to other surface which have same luminance as ambient. Value of 25-35 means clear contrast and values over 50 means strong contrasts.

Different surfaces have different reflection factors which can be measured with reflection factor chart. After that luminance value can be changed to illuminance value with basic formula: Eobject = 3,14 x Lobject/Reflection factor.

After this right luminaires can be selected by calculating illuminance values on surfaces with lighting calculation programs or using diagrams from catalogue of selected manufacturer.

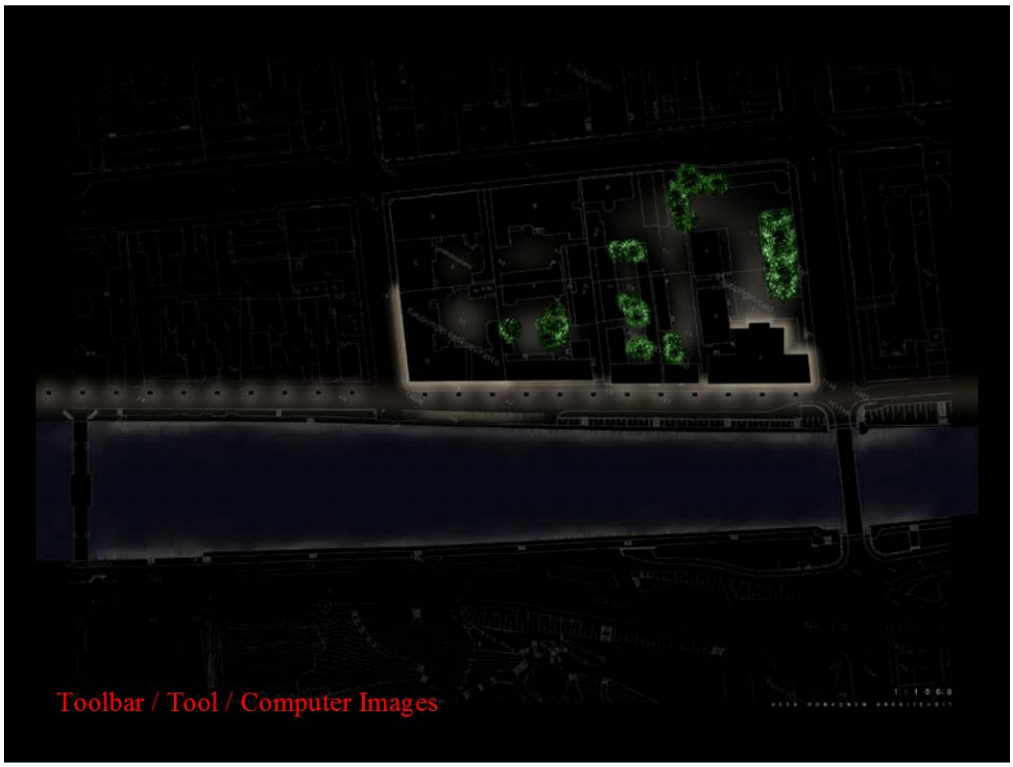


Figure 136. Turku Aura river 2D image. Photo Mikolaj Smolenski

Lighting designer is daily dealing with “lighting language” which includes words like: Illuminances, luminances, brightnesses, observer positions, glare values, reflection values, uniformity values, color temperatures, color rendering indexies, revealing powers, veiling luminances, Daylight values, norms and recommendations, e.t.c.e.t.c.

Lighting designer is often working and co-operating with people who don’t understand his/her “lighting language”. Then computer again comes and helps designer to scream out his message.

Image above is an example from Aura River- project in Turku Finland, where our team introduced lighting design proposal for politicians. This manipulated image tells about façade lighting, humble indirect road lighting, illumination of river bank and trees in the back yard. Lighting designer can of course in certain limits also give some professional comments in order to give credibility to his design.

Figure 137. Turku Aura river 3D image. Photo Mikolaj Smolenski

This computer manipulation is from same project and spot as earlier image just observer position is changed to support 3- dimensionality.

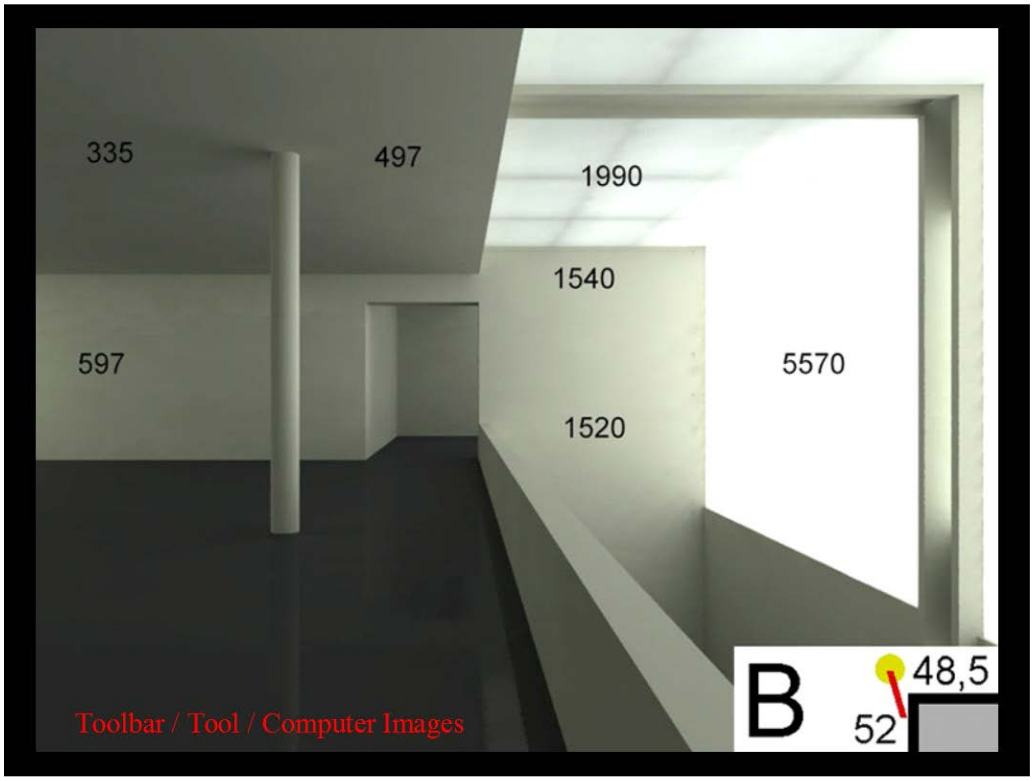


Figure 138. KUMU -museum 3D image. Photo Markku Norvasuo

There are also very scientific programs which support more research, but can also give great computer manipulation images at the same time. This example is from KUMU, museum in Estonia.

Different kinds of glass materials and glass packages where designed and important scientific criterias were:

1) Annual exposure times and pigments fading.
2) Illuminance values on vertical walls.
3) Luminance values of huge glass surfaces during different Daylight situations.
4) Museum lighting and protection against radiation damages.
5) Shading strategy of openings.
6) Art and architecture
7) Mix of electricity lighting and daylight.
8) Glass packages and glass selections.

Figure 139. Lighting designer's toolbar

Light, Culture, Space and Architecture

Although light, space, culture and architecture are all very large entities themselves, their influence in lighting design as a process have semiotic and at the same time, quite clear and recognized connection as a whole.

Maybe this is also the reason why this "combined tool" in this toolbar is oddest tool to handle, but must be mentioned. This tool really have roots in all over the lighting design process, it is a real spider net- tool.

In every project this tool is existing but always having it's emphasis on different elements. Sometimes light technical aspects have important role, sometimes cultural things are very important. Architecture is always there with full power, e.t.c. Next pages clarify the elements which have effect on the use of this tool.

But as some kind of summa summarum of this tool in this context as it is set forth is, that lighting designer have to recognize these elements as tools and use them on his/her own way and according to his/her understanding.

Figure 140. Understanding of light. Photo Oksanen

Extraterrestrial light effects on our life and makes it possible. Sun is a source of life. Environment- and energy saving are playing important roles in our common future surviving strategy. That is why Extraterrestrial light / Daylight will have more and more important role both in architecture and architectural lighting.

In lighting design world it is very common that instead of Extraterrestrial light we use to say Daylight. We'll study this matter also more carefully in the context of the tool: "Extraterrestrial Light" on coming pages.

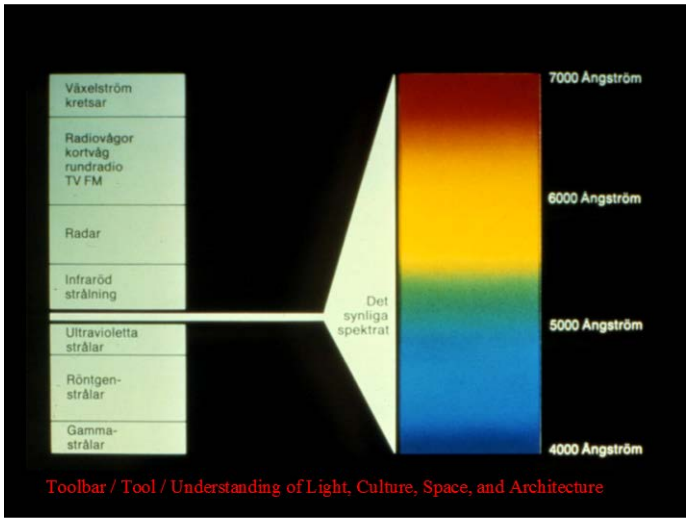


Figure 141. Visual spectrum. Photo Philips

What comes on electric lighting, lighting research centers and engineering departments of universities in all over the world have studied eye, seeing process, lamps and luminaires.

CIE, International Commission on Illumination (Founded in 1931), with it's 7 Divisions and hundreds of Technical Committees are studying and preparing application proposals for these basic studies of light and seeing. CIE is sending results to Illuminating Engineer Societies, which are located in every country.

Based on this information IESNA (Illuminating Engineering Society of North America) and equal societies in all over the world are writing lighting recommendations and – handbooks, which are in common use among designers in every country.

We are not concentrating on these light technical elements so deeply here in this book, though we have later on special tool for “Lighting Recommendations”. There we are looking recommendations with the eyes of visual lighting designer and couple of examples.

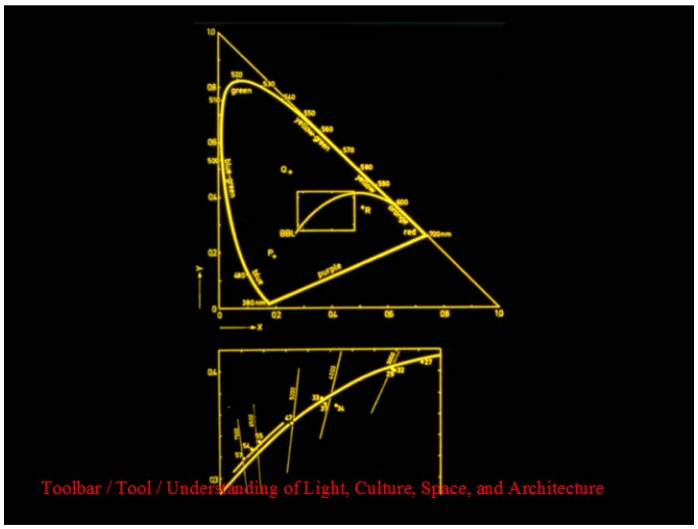


Figure 142. Black bocus line. Photo Philips

It is good to mention that it is very valuable to take part and work in these voluntary organizations (CIE, IESNA, IALD e.t.c.). They also often have “Student wings” with cheaper membership payments.

Electricity lamps have many standardized characteristics like: color temperature, color rendering, lumen package, luminance, lifetime, e.t.c. There are tens of thousands of written pages about this information in libraries of technical universities, lighting research centers, illuminatin engineering societies and CIE main library in Austria. Information is free of charge or costs some dollars to cover basic costs only. It was interesting to see lighting designers and architects visiting in library of Lighting Research Center (LRC) in Troy New York when solving some details in their design tasks. That is also interesting “service” from research centers.

Figure 143. Metal Halide Lamp. Photo Philips

Lamp is a light source and hearth of electricity lighting. There are thousands of different kinds and shapes of light sources serving the world. Lamps for indoor lighting purposes, outdoor lighting purposes, chemical processes, industrial use, tanning, traffic quidance, transportation, movies, water elements, sports, scientific purposes, e.t.c….the list is endless….

There are thousands of highly educated researchers working daily around the lamp technology. Electricity lamps are very complicated products. Their functional properties have been standardized in order to avoid general chaos in electricity lighting world. Just to mention in this context: There are some new light sources,which properties are not standardized because of rapid development of the product and commercial competition. Example: The measurement of light producing properties of LED. Manufacturers measure LED's with high current impuls to get huge lm/W- value (even 130 lm/W informed in 2008). In reality, when "driving" LED inside the luminaire with "normal" current , the lm/W- value is 50-60 lm/W. You can go and study more about these very interesting products and their properties from manufacturers' homepages and catalogues.

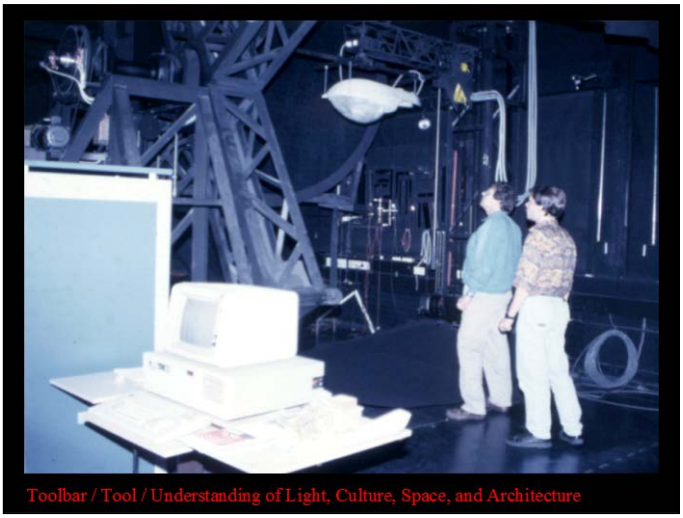


Figure 144. Luminaire measurement tool. Photo Julle Oksanen

Lamp is producing certain "amount" of light, like volume. Luminaire has optical systems, which delivers that "volume" of light to wanted directions with wanted power. Volume of light which lamp has produced, lumen package, has now directions and dimensions.

These directions and dimensions can be measured with a special measurement tool. Huge, half spherical honeycomb surfaced measurement element (in photo) is going around the luminaire which is located in the "air". Each light beam goes inside into the half spherical equipment, which has measurement "eye" inside it. "Eye" element sends each beam value to the computer (On the desk in photo). When luminaire have been measured, the light distribution curve can be drawn according to these values. (See light distribution curves in manufacturers catalogues). Each luminaire has 3240 pcs of sigle light beam information (candlepower) if all light comes down from horizontal level. (360 deg./5deg times 90 deg. / 2 deg. = 3240). Modern measurement tools have mirror- system instead of honeycomb half spherical element. (Less space and more exact result).

All manufacturers have these lighting distribution curves in digital form. Light distribution information (As often also calculation programs) can be loaded from manufacturers homepages to individual computers to serve lighting design.

Figure 145. Finnish tango orchestra. Photo Old archieves

There is always a certain capacity/volume of different semiotic connections of art, design and culture, which is loaded into the lighting design team. This volume is very important for successful result in architectural lighting design project.

Early 30's or so, there was a group of real lighting designers who had a lot, lot of artistic design capacity in their brains to bring success on their lighting design projects. They served architects as their "partners". These real professionals just disappeared or faded away on the result of standardization of lamps and luminaires, which brought engineers strongly involved in lighting. Many university started to measure lamps and luminaires in their engineering departments. At the same time was founded CIE, IES and other "strong" associations which all supported the conquest of lighting design strongly under their technical wings.

At the moment art is balancing strongly again lighting design processes and more and more beautiful lighting solutions can be seen in all over the world. There is no legacy in architectural lighting design yet, but soon will be.

Figure 146. Finnish tango and midsummer festival. Photo Old archieves

To give a flavor of cultural difference I give an example of one old lecture which I gave at Lightfair in Las Vegas together with my old colleague.

Finnish summer is very short and that is why finns want to get all out of it. Summer lasts mainly 3 months, but July is warm enough to be able to swim in lakes and air has matured warm and kind.

Specially Midnight summer festival is very important national happening. During that festival everybody is singing, drinking and dancing mainly tango all over the country, outside on open air dance floors and pavilions. People go to swim naked or all clothes on, drunken and happy. There are tens of killings by knives and drowns during that festival too.

Figure 147. Finnish Midnight summer festival. Photo Old archieves

We showed this photo during our lecture at Lightfair, put finnish tango on from CD player and what happened: Everybody started to laugh loud.

We told that audience was hurting our feelings, because of cultural diffrerence. Finnish tango is very important to all finns and it is not easy to understand with american brains.

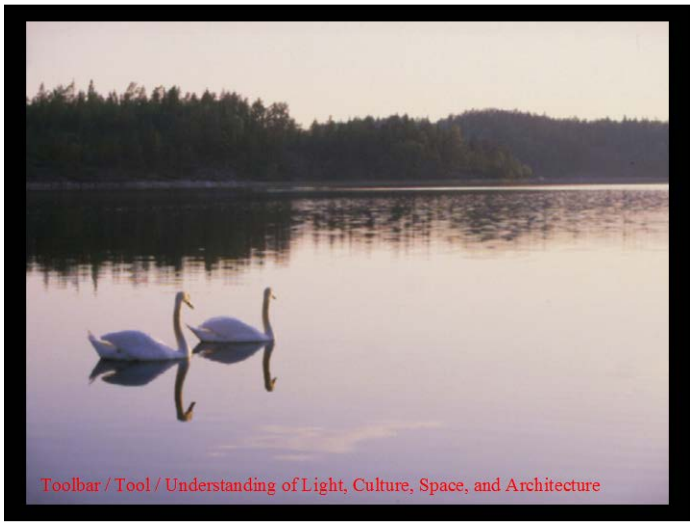


Figure 148. Finnish lake. Photo Vesa Honkonen

That was a great and pragmatic demonstration of cultural difference.

What comes on space, design is always an attitude. It is same if you design spoon, car, building, city center or space ship, it is always an attitude.

Anyhow it is different to design lighting project here……..

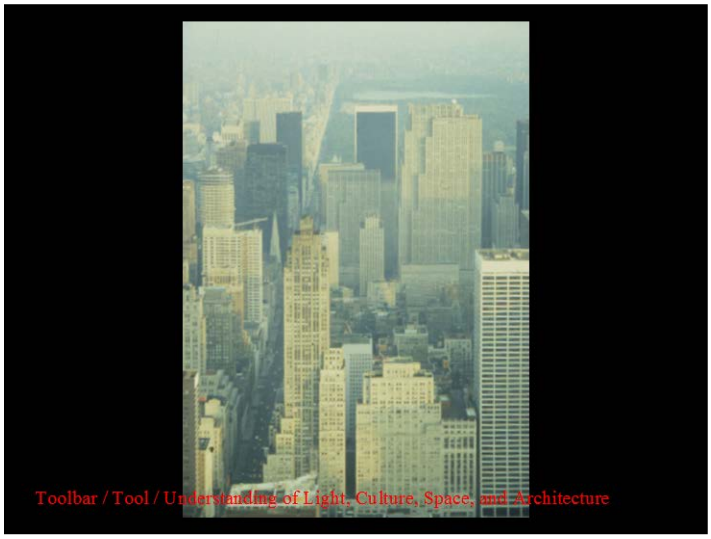


Figure 149. New York skycraper. Photo Julle Oksanen

….than here.

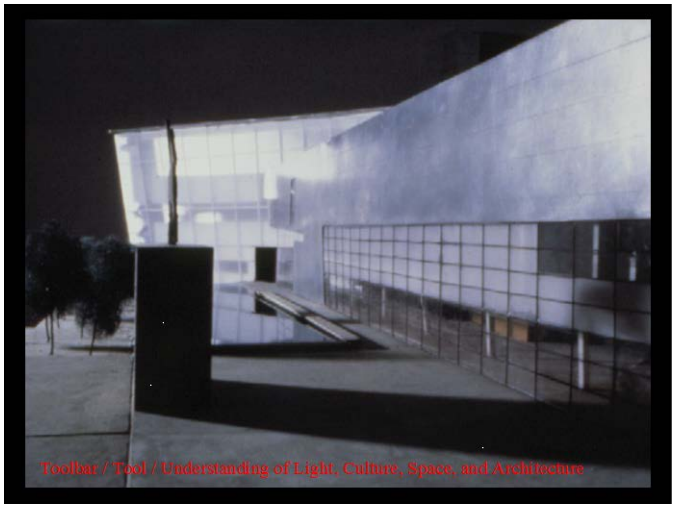


Figure 150. Model of Kiasma. Photo Steven Holl Architects

Other cultural orientated example is Kiasma, The Museum of Contemporary Art in Helsinki.

Architect Steven Holl from New York City, USA, designed KIASMA. During the design process he wanted to change the location of the statue of Marshall Mannerheim some meters. Mannerheim was a finnish war hero and leader of the country during second world war.

Old finnish combatants, who still are alive, sent letter to Seven Holl that they will come and shoot him with their old rifles if he touches the statue of their war hero.

Steven Holl wrote to finnish main newspaper that he apologize his proposal and that he will not touch the statue. Internationally well known architect Steven Holl studies always very carefully the local conditions, history, context e.t.c. in his projects before design.

Figure 151. Old and new in harmony. Photo Julle Oksanen

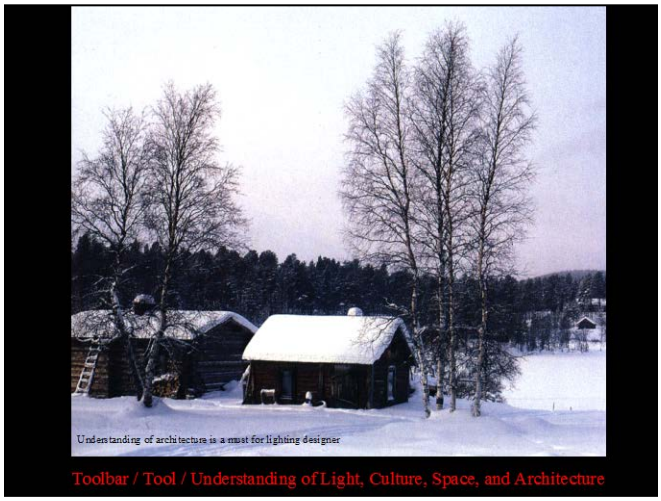


Figure 152. Typical finnish farmhouse. Photo Julle Oksanen

Lighting designer don't have to be architect, but he/she has to understand architecture.

I was once asked to do lighting design for this building and it's environment. I said that only light which is suitable for this context is light which runs out of the openings (windows) and light of oil lamp which is used when you have to visit toilet, smoke sauna or wood shed which all are located outside the main log cabin.

This kind of natural environment is somehow supporting the philosophy that buildings ought to sleep during night time. No electricity, only natural fire and flickering oil lamps.

EXTRATERRESTRIAL LIGHTING

In this context words "Extraterrestrial Lighting" has a wider concept compared to more familiar known word as "Daylight".

One of the reasons for this action is that this new attitude gives more space in our minds for more creative lighting design with natural light and also somehow “pulls” us out from exact and engineering orientated attitude.

I am not sure which one is “better” or “right” way to treat natural light, but anyhow I give argumetation for “Extraterrestrial Lighting” as a useful tool in pragmatic lighting design work.

Scientists use word “Daylight” in their research work and efforts in the process of trying to control natural light in building projects and even on the process to trying to standardize it.

Creative lighting designer have to look after his/her pragmatic, natural lighting design- projects. Then thinking natural light as “Extraterrestrial Lighting” supports more project by project basis design possibilities. After this “extraterrestrial” part we’ll continue as Daylight- part, where you also have an opportunity to **learn how to earn LEED credits on Daylighting.**

Nicolaus Copernicus (1473 – 1543), was the first person who formulated scientifically so called “Heliocentric cosmology” instead of earlier understanding of earth, planets and sun.

His new way of thinking and treating space displaced the thinking of the earth from the center of the universe. He wrote a book called “On the Revolutions of the Celestial Spheres” which was a real starting point of modern astronomy.

There were many people and scientists before Copernicus who demonstrated movements of celestial bodies even centuries before Copernicus, but he managed to start and make a landmark of the history of modern science, that is well known as the “Copernican Revolution”.

Figure 153. Understanding of extraterrestial lighting some years ago. Photo Old archieves

Figure 154. Our galaxy. Photo NASA

This is our galaxy. It is called The Milky Way. It is possible that it is not only our home, but also for example home for E.T and other aliens too. We try to study that too. All stars and planets that we see with bare eyes from earth belong to the earth's galaxy, the Milky Way.

Galaxies are a massive entity of hundreds of millions of stars, which all are gravitationally integrated to each others. They are orbiting about a common center.

Galaxies are generally not isolated in space but are often members of small or moderate sized groups, which in turn form large clusters of many galaxies. In our so called “Local Group”, we are among with about 20 others. Our galaxy and our neighbor galaxy called Andromeda, are the two largest members, having at least a million million stars.

The largest galaxy which we know at the moment has about 13 times as many stars as the Milky Way. “Extraterrestrial Light” instead of “Daylight” comes from the fact that when night falls on our county, the sun is shining on an other side of the globe. So there is philosophically Daylight in 24 hours.

Figure 155. Light in Cathedral. Photo Julle Oksanen

Light is the fourth dimension of architecture and creates all architecture with it's magical touch. Without light there is no architecture for us. Simple test:

Close your eyes and see architecture without light.

It is important to understand that light itself is not visible element or material, but radiation which appears to live only after it touches the solid surface.

Recognizing this fact also helps us to understand extraterrestrial light and it's behaviour.

Other important perception of light behaviour is that it is not disappearing nowhere. It is always reflected from surfaces to other surfaces making them visible and changing finally to warmth. This is important perception for a lighting design and needs maturing and skills from lighting designer to utilize it in real life.

This interesting element causes lot of accidental architectural lighting phenomenon in real projects which is OK when it happens "inside" a good and carefully designed lighting concept and master plan. It is always exciting to see the final result of lighting project.

Figure 156. Unvisible façade of building. Photo Vesa Honkonen

Extraterrestrial light is always coming inside the building through openings which are covered normally with glass. We call them windows. One of the newest invention was made by young man, who designed light penetrating concrete.

I have asked from many architects why they use glass as façade material. 90% of architects told that the reason was the lightness of glass as visual material.

This is an easterfacade of the building in Finland, it really looks light and unvisible.

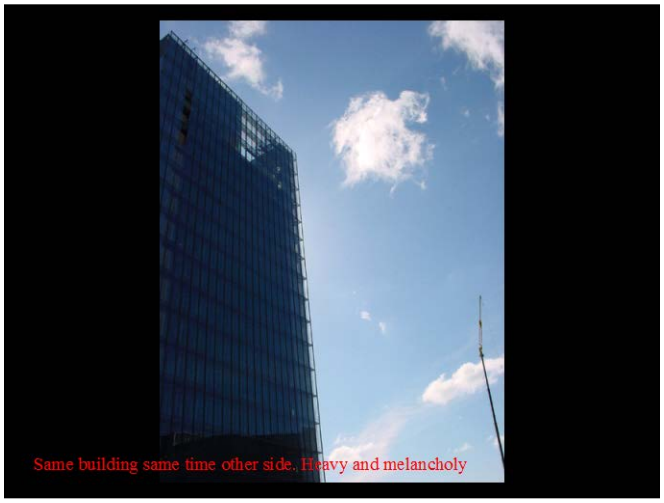


Figure 157. Visible facade of building. Photo vesa Honkonen

This is a west side façade of the same building at the same moment as earlier, east side façade. This part of the building looks very heavy at the same moment when other side looks almost invisible.

Very popular is to use double façade where glass is the outer material. I don't exactly understand its advantages.

Maybe the real answer to that earlier question of "Why glass as building material" is, that architects keep glass as a modern material of our decade or very fashionable building material of today.

Figure 158. Glass building in Helsinki. Photo Vesa Honkonen

This building somehow looks very melancholy and sad giant, doesn't it?

4 Different Lighting Design Examples:

1) Telenor- building / Helping building with extraterrestrial light
2) Cathedral / Creating extraterrestrial light
3) Airport / Continuing extraterrestrial light
4) Museum / Tried to be perfect and take care of everything

1) Telenor,office building

Telenor- building / Helping building with extraterrestrial light
"Light trap" during night times and no problems
on daylighting.
Task: "Design space avoiding glare and open views out"

2) Marienkirche, concert hall

Cathedral / Creating extraterrestrial light with electric lighting solution. (Concerts after 0700pm normally).
Task: "Design daylight simulation"

3) Helsinki-Vantaa Airport, EU terminal

Airport EU- terminal / Continuing extraterrestrial light.
Task: "Design light-mix".

4) Kumu,museum

Museum / Tried to be perfect and take care of everything
Task: "Pigments and architecture"

hope that my own 4 lighting design project examples give strength to you to treat every “Extraterrestrial Lighting Design project” as an individual challenge.

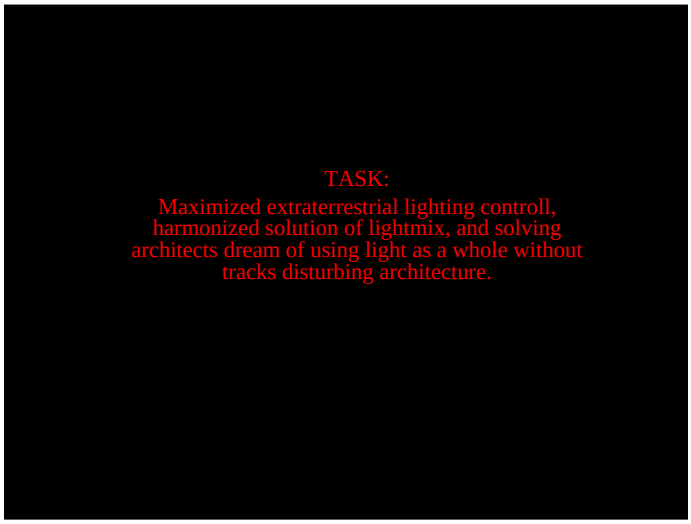
It is somehow wrong to try to force all different projects to same lighting design- mold. Materials, goals of building, use of building, structure of building and ecological goals differ. When we here add the fact that also natural light during daytime changes constantly, we only can ask what is the reason why trying to force to use extraterrestrial light in the same way.

4 different kind of buildings and 4 different kind of structures of lighting design task.

1) Huge office building in Norway
2) Concert hall in Germany
3) Airport in Finland
4) Museum in Estonia

Figure 159. Design sheet for KUMU. Photo Julle Oksanen lighting report

Let’s study more carefully only one case study of these four examples, KUMU, museum in Estonia.



Task was quite clear and simple, but design work was very complicated and needed lot of professional skills.

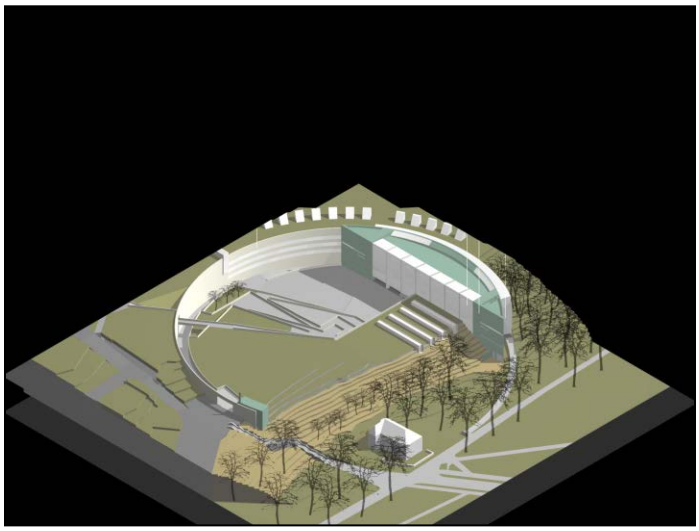


Figure 160. KUMU 3D image. Photo Pekka Vapaavuori

KUMU is located in the beautiful Kadriorg park near the Baltic sea in capital of Estonia, Tallinn. Building is partly embedded into the ground.

Because of it's interesting shape, during the design phase we called it as Circulos and when it was ready, it got his own name KUMU.

Dimensions are really huge. The length of glass front (White blocks on this computer manipulation photo) wall was about 75m and hight about 25m.

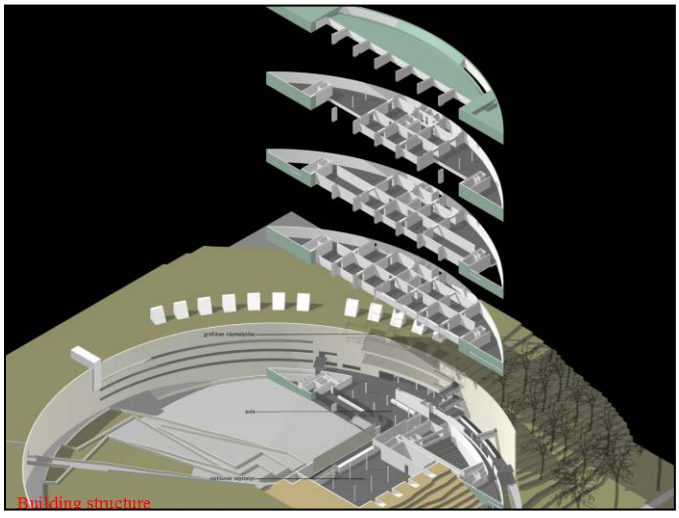
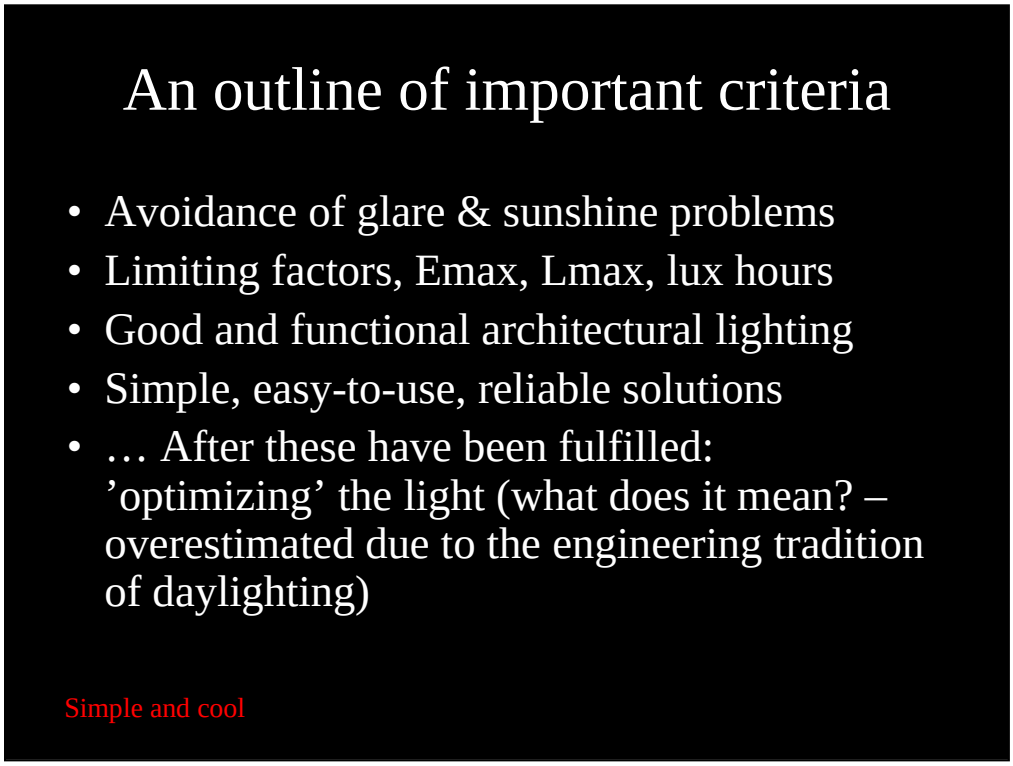


Figure 161. Design view of KUMU. Photo Pekka Vapaavuori

The structure of the building is exciting: You approach it from the sharp end of the building, first floor has foyer, secondary service areas and exhibition area for changing exhibitions. White, triangle blocks on the

edge of building are glass openings for graphic arts. Other floors have exhibition rooms for oil paintings and permanent exhibitions.



Building has many large openings (windows) and that means that pigments fading and yellowish phenomenon will cause extra problems and needs quite exact treatment. Expert of Radiance lighting design program from Technical Research Centre of Finland was hired to make needed calculations.

Radiance is a scientific program to calculate lighting values on the surfaces of the building, helps glass material- and shading system selection. Program is very complicated to use and needs constant use to keep designer “fresh” and ready.

Before starting any computer calculations, concept for lighting design had to be created. Just simple and nice outline of important criteria for lighting was created as a concept. Later on we created design process chart which helped us as designers to meet all different demands to achieve a successful result.

(Like different designers’ demands: architect, builder, owner,electricity designer, e.t.c.).

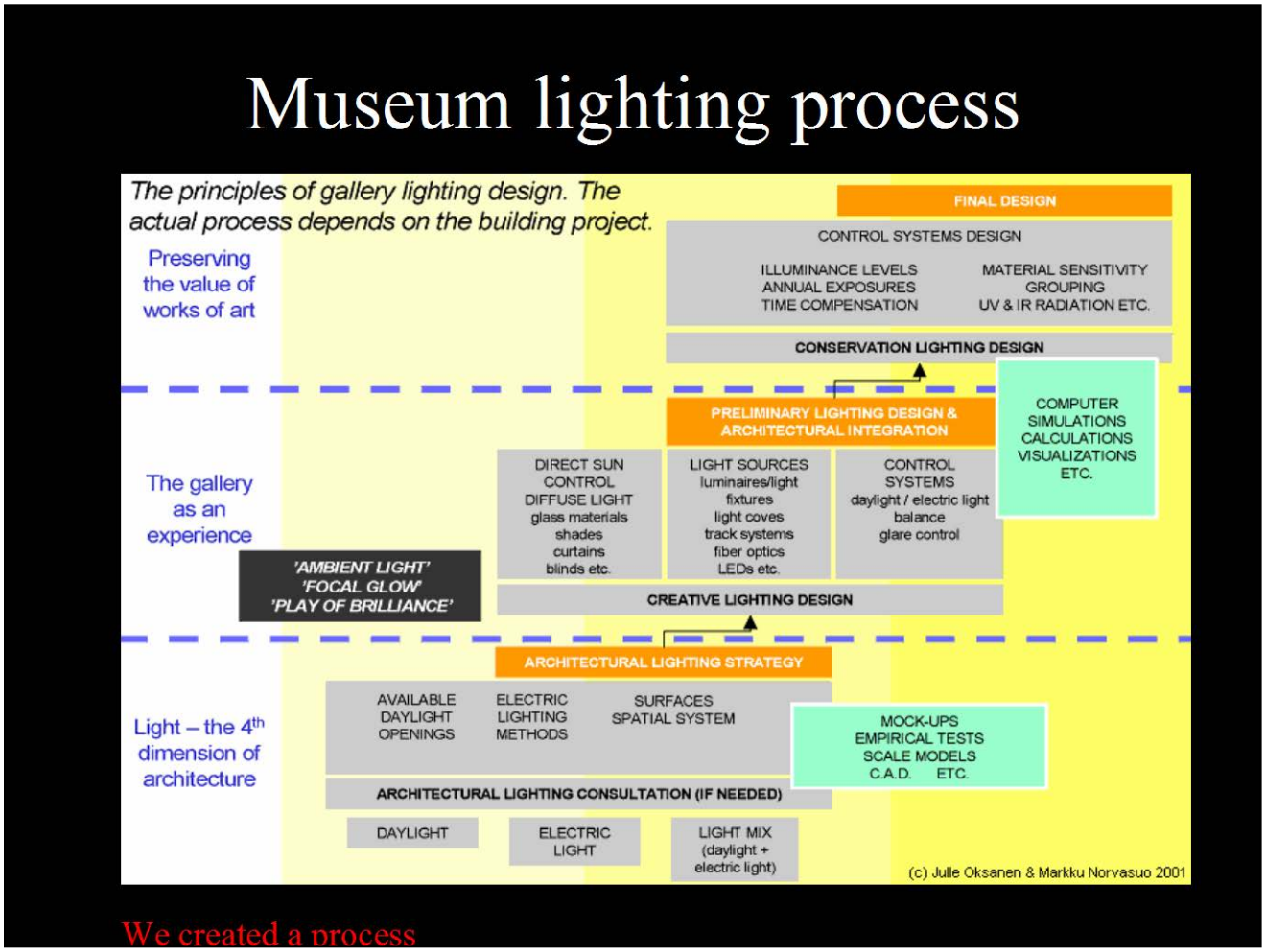


Figure 162. Museum lighting process. Photo Julle Oksane & Markku Norvasuo

I created this kind of Museum Lighting Design Process Chart already for designers and partners in Kiasma, museum of contemporary art in Helsinki on 90's to show them the lighting design process. It helped people to understand the whole process and helps co-operators to understand the complexity of carefully done lighting design.

This kind of process chart can also be used for different kinds of projects like Opera houses, office buildings, outdoor lighting projects, e.t.c. It helps decision makers and co-operators to understand the whole process. It is valuable thing because light also must be integrated to other designs like architecture, HVAC, electricity e.t.c. both timing wise and also design wise.

Once one american architect told to me that "We are married together during the whole building design process".

Some available means

- Openings of building envelope (windows)
- Sun shading
- Properties of glass
- Light reflecting (diffusing etc.) surfaces
- Material appearance (transparency, translucency)

Means

Some available means were needed to start study calculations with computer.

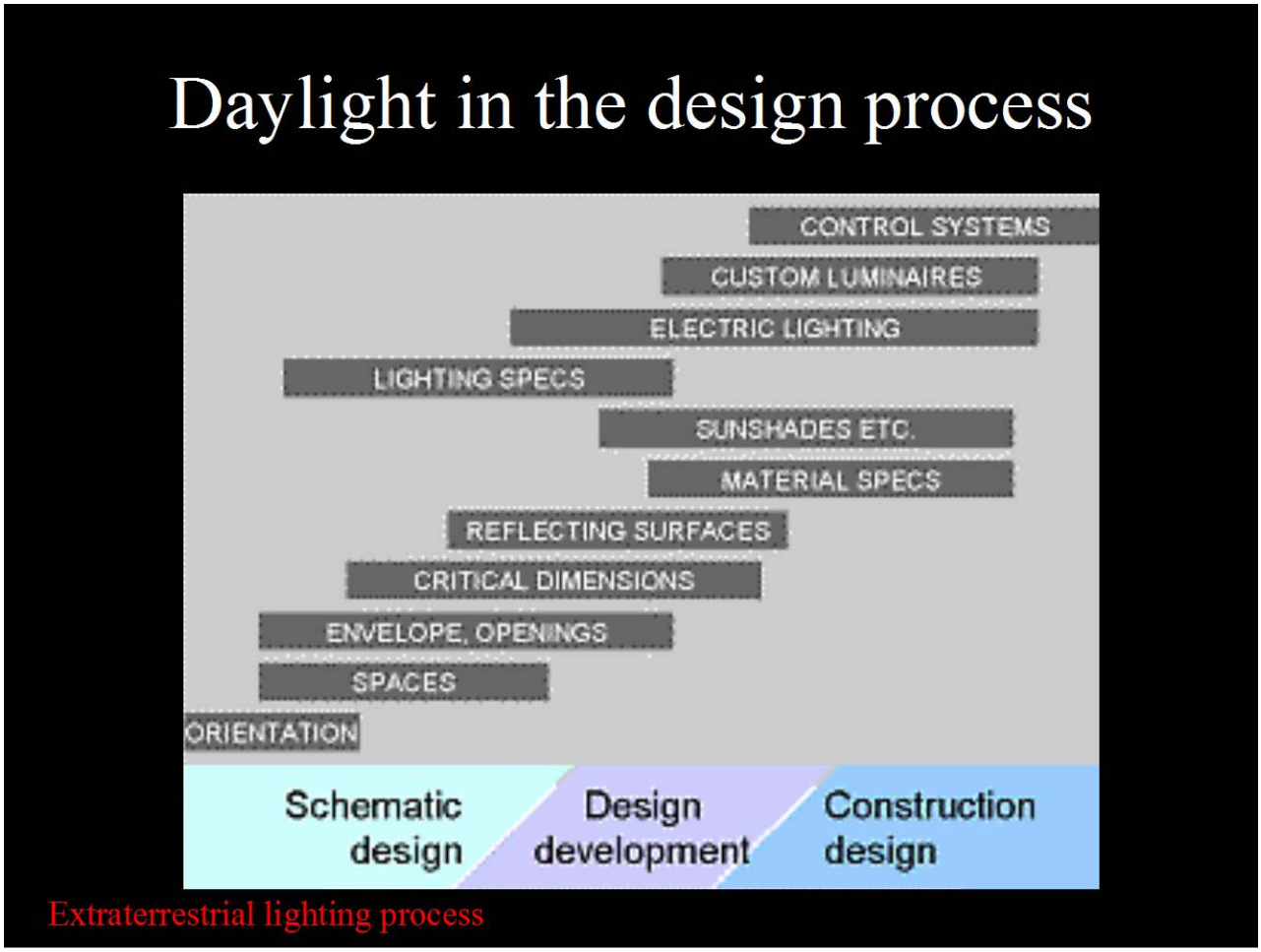


Figure 163. Daylight in the design process. Photo Markku Norvasuo

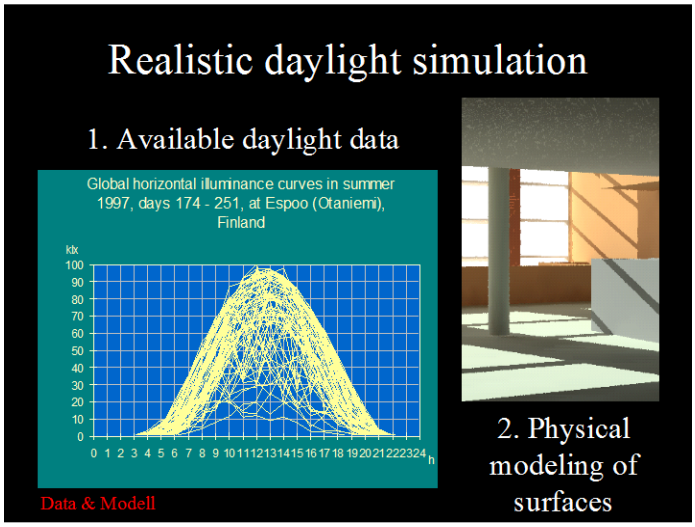


Figure 164. Realistic daylight simulation. Photo Markku Norvasuo

Timing is also one important criteria in Daylight design process. During design process architect and daylight designer have to communicate all the time. In this project for example daylight calculations took months. You have to first check the position of building and how spaces react especially for direct sun if any. What kind of openings are and what are their locations. Material properties and surfaces are important criteria. Electric lighting must be designed also together with daylight as a light mix for galleries. Shading systems must be compared and shading philosophy is also important. Light control system must be designed, where to operate and how and why…..e.t.c. All those elements have their own timing in the process.

Realistic daylight simulation can be achieved as exact as possible when using available daylight data and physical model. Of course the daylight/extraterrestrial light changes constantly and all measurements are already history and don't come back anymore.

In KUMU project we used 5 years of Tallinn annual daylight figures and we summarized them in exel program to get average annual values per year.

Available daylight data is free of charge information from Berkley university.

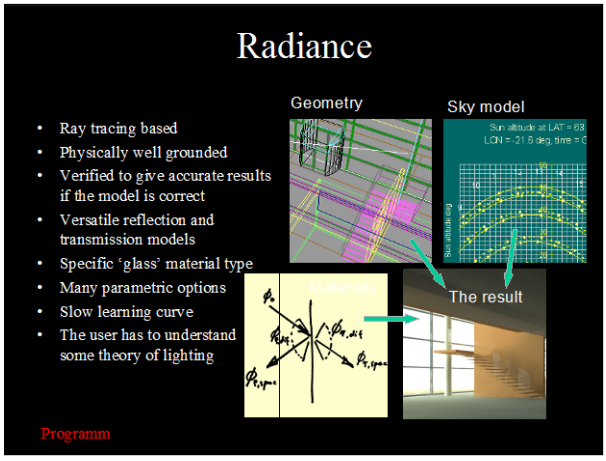


Figure 165. Radiance illustrations. Photo Markku Norvasuo

Some information of the program. Program works on Ray tracing system and is well grounded. Matter in fact though Radiance is the best scientific program at least in this kind of project, it still is only a program, not designer.

Good example of this fact that Radiance is only a program not a designer is, when once in one gallery design project a person called me and told in panic: “Julle, we are in big trouble.

All walls of these galleries will look completely yellow, because of fluorescent lamps in all light coves has color temperature of 4000 Kelvin and huge windows, which penetrate daylight, causes this yellowish visual trick”. I told that it is not true, but he told that all walls will be yellow, because Radiance program gives exactly right visual images. I told to him to take it easy and go to see galleries in Museum of Contemporary Art in Helsinki, Kiasma. Most of the galleries also has huge windows and thousands of 4000 Kelvin fluorescent lamps in all coves, and it looks just great. White light.

Images which later on was shown to customer had to be manipulated to give right impression of reality. It is question of designer, computer, program which is used, screen type, color balance of computer, printer type, Calibrations of computer, screen and printer, .e.t.c.e.t.c. It is important to understand that designer is finally responsible of the result.

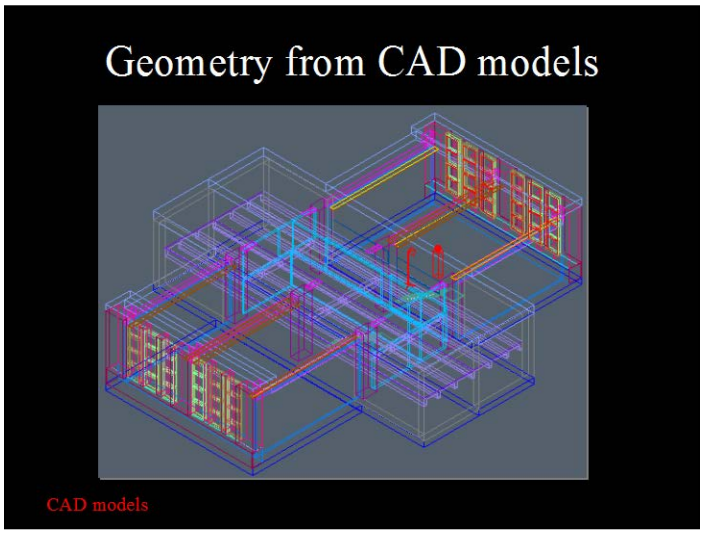


Figure 166. Geometry from CAD models. Photo markku norvasuo

Architect office normally gives the CAD models to radiance designer who integrates those into the Radiance calculation program process.

Nowadays also so called databanks are in general use.

Designers, which normally are sub consults for architect (like lighting designer, electricity designer, HVAC designer, interior designer, landscape designer, e.t.c.), go to take drawings from databank of architect office, integrates his/her own layer on drawings and send it back to databank.

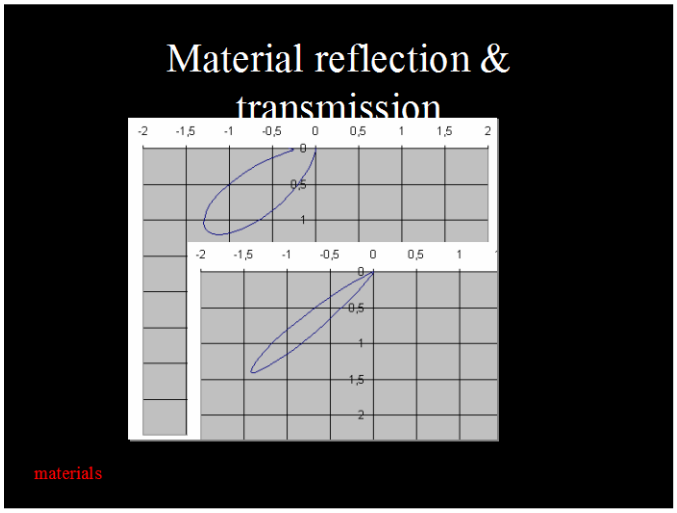


Figure 167. Material reflection & transmission. Photo Markku Norvasuo

Material information is also important information to add to Radiance lighting calculation process.

If you want to have very exact result of your lighting design project, glass materials which you want to use are good to measure in research centers or university laboratories (Like penetration factor, light absorbing factor, light scattering level of glass, reflection factor, e.t.c.e.t.c.

Of course it is good to think carefully how exact information is relevant, because laboratory measurements are also relatively expensive and time consuming. Things which also influence on this exactness level are:

- Daylight situation anyhow changes constantly and is not controllable
- Maximizing annual exposure time in real life can be done just when museum and galleries are in use. Balancing needs constant measurement
- Accepted tolerance on design phase (How relevant is to get Ev = 200lx or Ev = 196lx in design phase from certain and selected light mix values)

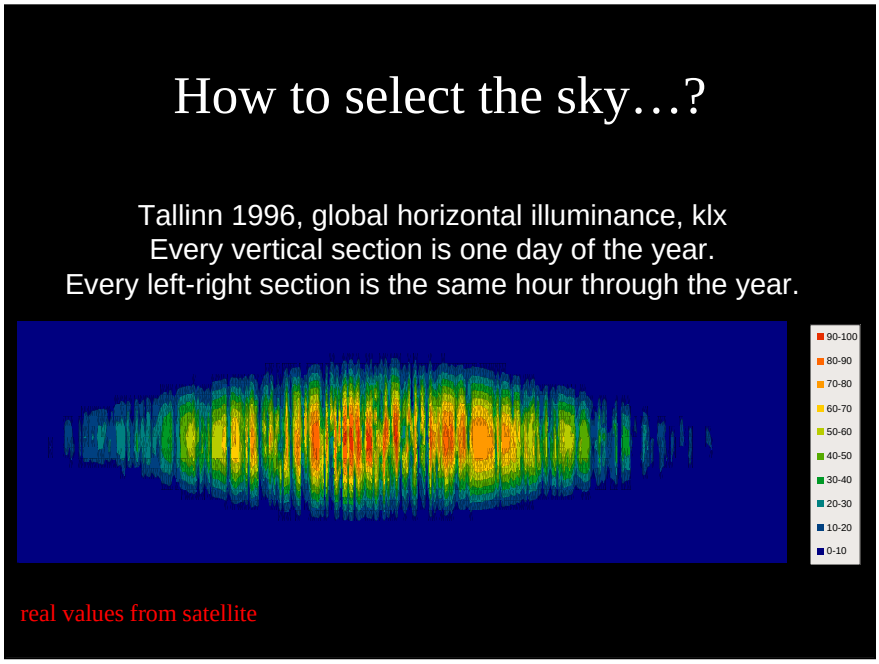


Figure 168. Daylight values from satellite. Photo Markku Norvasuo

We can have real horizontal illuminance values from satellite. These are real values in Tallinn in 1996.

In KUMU project 5 different years were collected together and calculated as average in exel program. Those values were added to Radiance calculation process.

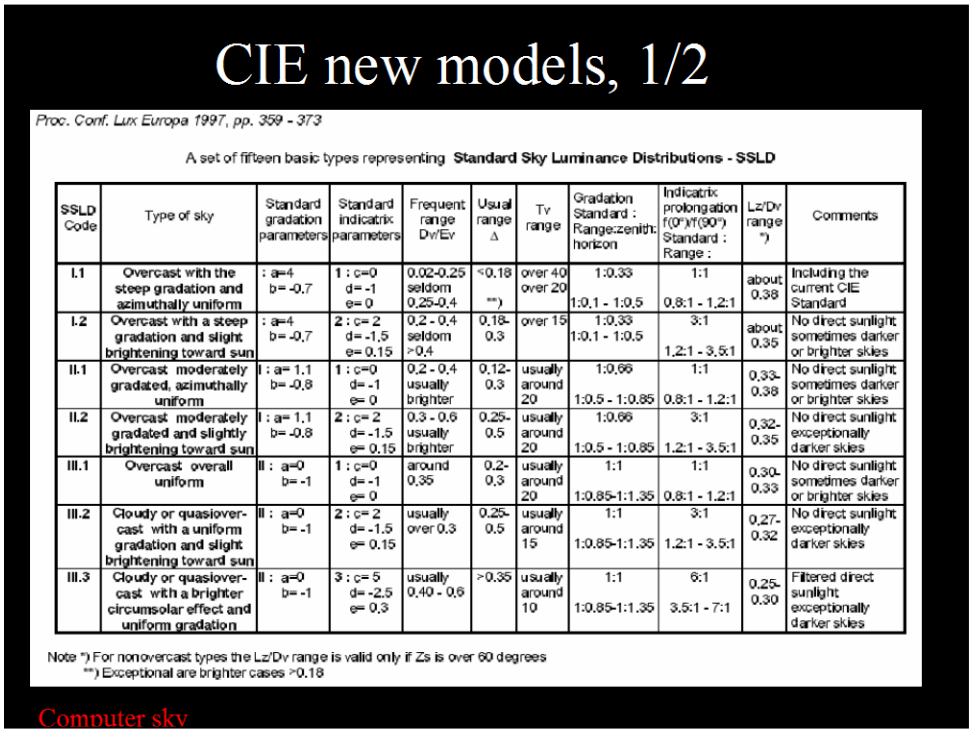


Figure 169. CIE models

CIE has created new sky models for daylight calculation purposes. There is a set of fifteen different kind of basic types representing Standard Sky Luminance Distribution – SSLD. Every SSLD code consists different type of sky (One example: “Cloudy or quasiovercast with a uniform graduation and slight brightening towards sun”). These sky types have all technical elements / codes which are needed in computizing sky.

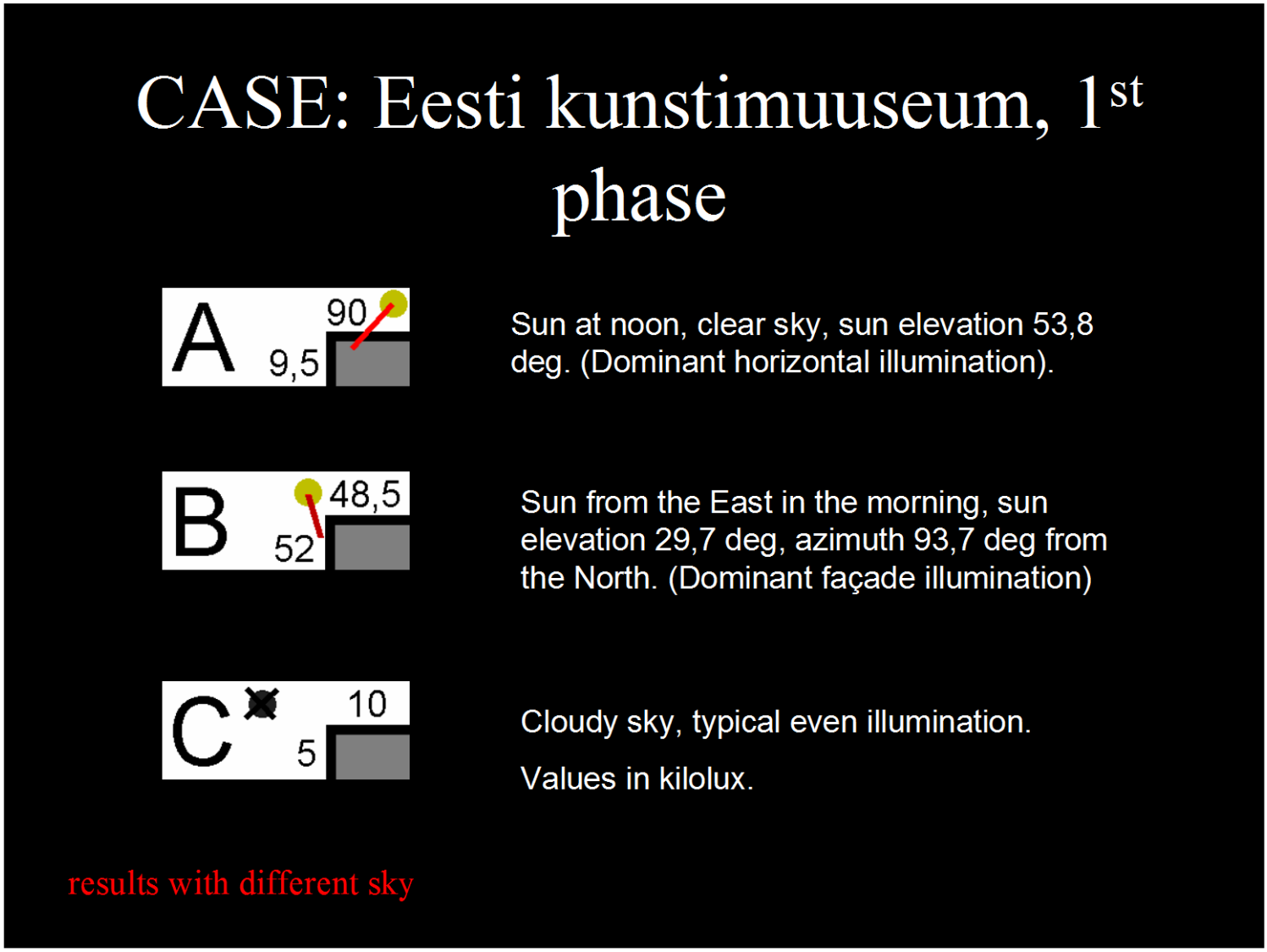


Figure 170. Daylight concept in KUMU project.

In KUMU- project huge openings became as a leading task for lighting design. Big window areas had to block all UV radiation under 400nm and block infrared radiation too. Still these huge windows should look like natural glass. One of the problem was, that windows in certain galleries were really almost like a glass walls, which means that lot of UV radiation penetrates through window area. If we block too much light the risk that window looks “dirty” and not as glass anymore is high. We had to make first phase testing calculation by thinking in our brains what kind of glass package could be right one. We took 3

different sky examples to pull out design direction and glass selection. First phase calculations took couple of months daily calculation.

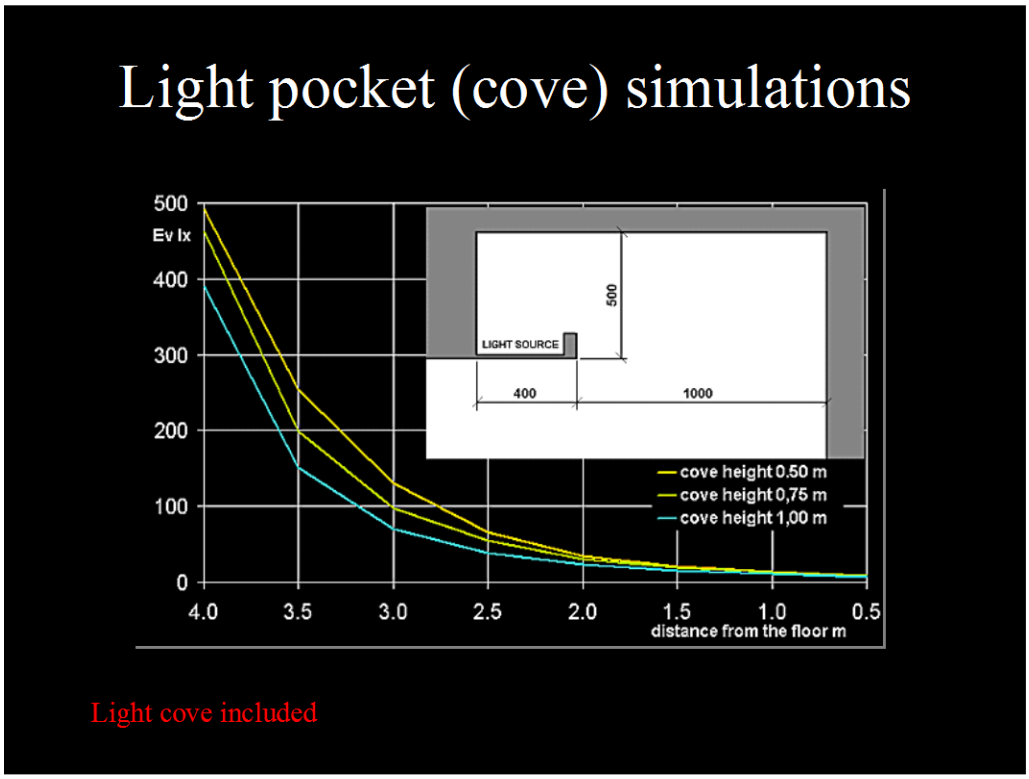


Figure 171. Light cove simulations. Photo Markku Norvasuo

Light coves were also used and added to these calculations. Light cove did not have very great geometry when task was to illuminate 4 m high wall evenly. I asked more room inside the cove, but architect did not want to give it. So I told to architect that result is not perfect, but only good.

Radiance program can also take light coves to same calculation as daylight openings, but lamps must be treated as a “Light plate”. Into that light plate you only have to include right lumen package which simulates equal lumen package as fluorescent lamps in the real cove have.

The curves show how much vertical illuminance value drops when measuring points comes lower and lower. Though Evertical drops so dramatically in figures, in reality eye works logarithmicly and changing of E- values are difficult to recognized with eyes on white huge wall.

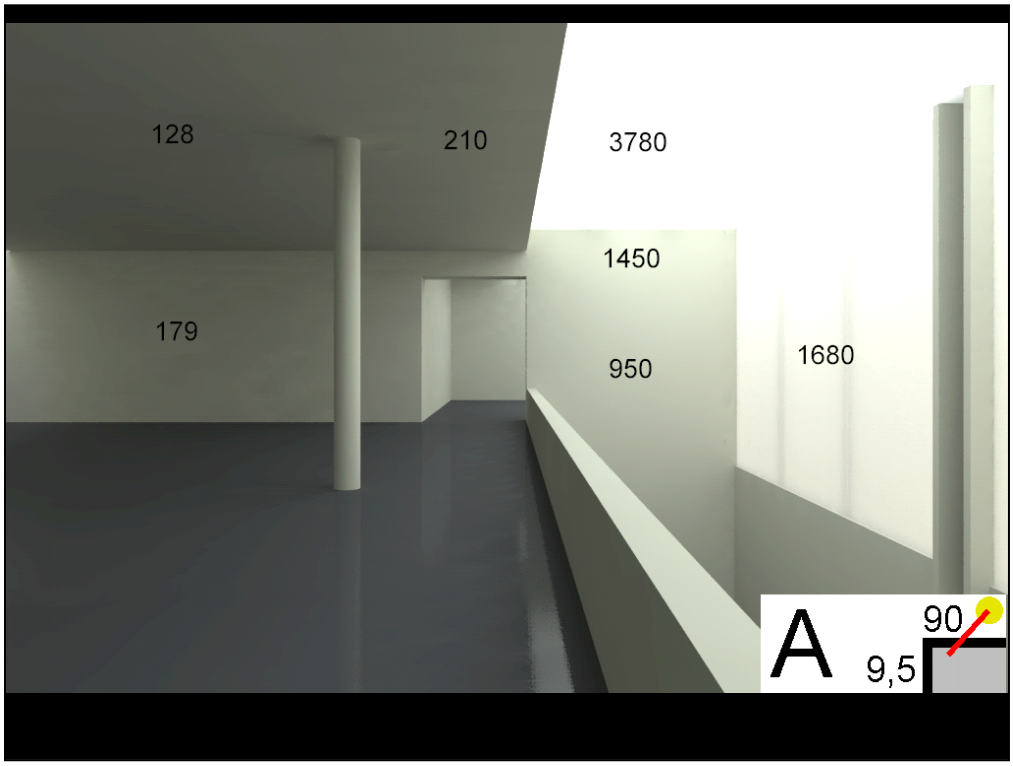


Figure 172. Gallery lighting case A. Photo Markku Norvasuo

This is one of main galleries and lighting situation A.

A has:

- Sun at noon
- Clear sky
- Sun elevation 53,8 degrees.
- Situation is dominant moment for Horizontal illumination.

Values on the glass- and wall surfaces are luminances L. Luminance values are important for glass surfaces to judge it.

Illuminance value is important for art wall to calculate annual exposure times and maximum Evertical values on oil paintings. When using so called “Painter’s white” matt paint on walls, reflection factor is 0,7. With this factor we can calculate what is Evert value on the wall. E vertwall = 3,14 x 179 / 0,7 = 802 lx. Much too much. Evert ought to be less than 200 lx, other wise we have to make time compensation for Annual exposure time from formula Annual exposure time = Evert x Annual use. Maximum Annual exposure time for oil paintings is 650000 lxh (lux hours).

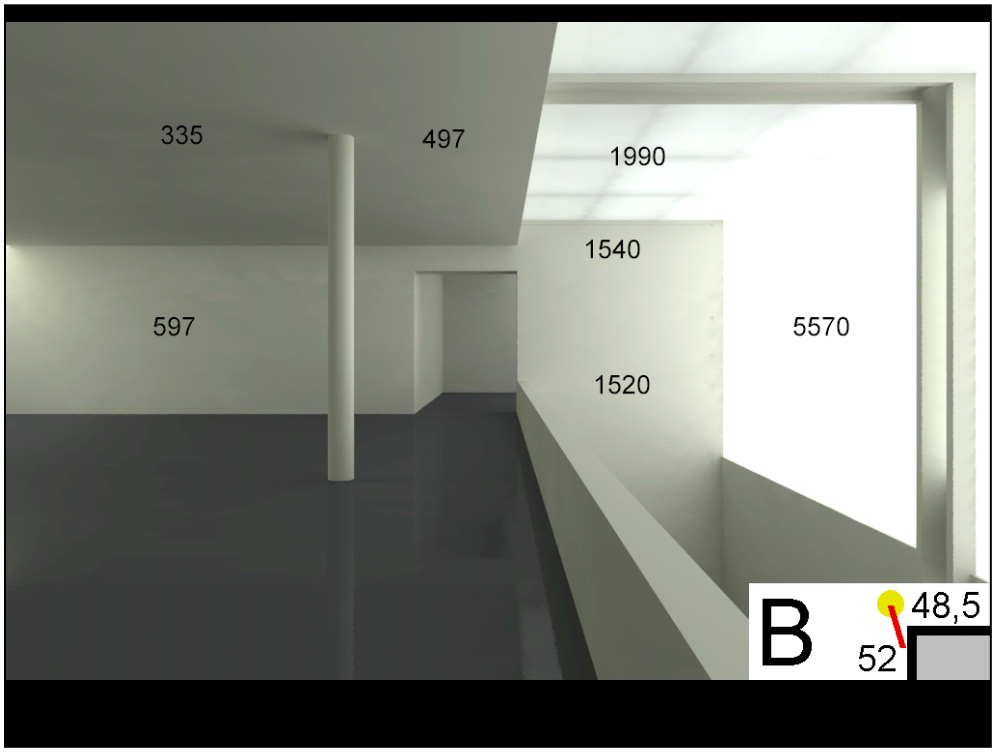


Figure 173. Gallery lighting case B. Photo Markku Norvasuo

This is same gallery as in case A, but lighting situation is B.

B has:

- Sun from East in the morning.
- Sun elevation 29,7 degrees.
- Azimuth 93,7 degrees from North.
- Situation is dominant moment for Facade illumination.

Values on the glass- and wall surfaces are luminances L. Luminance values are important for glass surfaces to judge it. Over 5000 cd/m2 on big surface hurt eyes. Illuminance value on the oilpaint is Evertwall = 3,14 x 597/0,7 = 2677 lx. Value is already dangerous for pigments which are located in dispersion material of painting. Time compensation don't help anymore and is not proposed to use. We have to change glass materials OR use shades / curtains.

Calculation example of annual exposure time:

IF this would be situation all the time (theoretically only), gallery could be used annually open only 650000lxh / 2677lx = 242hours. IF gallery would be open 10 hours / day it means that gallery could be open 242h/10h/day = 24 days / year ONLY.

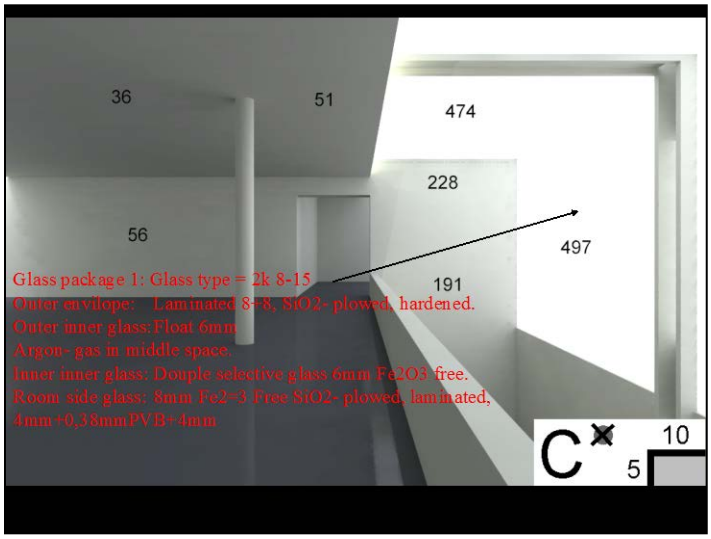


Figure 174. Gallery lighting case C. Photo Markku Norvasuo

This is same gallery as in case A and B, but lighting situation is C.

C has:

- Cloudy sky.
- Typical even illumination.
- Situation is dominant moment for glass package design as seen as clear glass.

Values on the glass- and wall surfaces are luminances L. Luminance values are important for glass surfaces to judge it. 497 cd/m2 on big surface is beautiful and piecefull value. Illuminance value on the oilpaint is Evertwall = 3,14 x 56 /0,7 = 251 lx. Both values are just great. Values can not be less, because other wise glass surface starts to look “dirty” and artificial plastic or so.

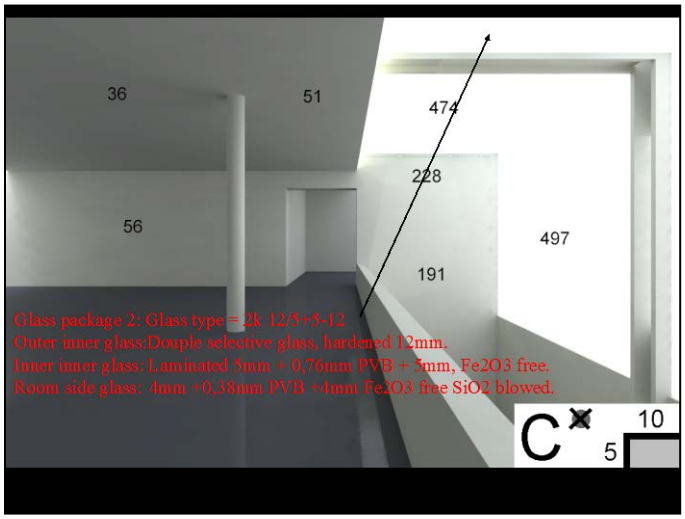


Figure 175. Gallery lighting case C. Photo Markku Norvasuo

Based on this information we found out, that we selected right kind of glass package values for further lighting design. We also understood that some kind of shading system must be designed. In this case

only glass could not take care of everything. (Pigments fading and visually interesting gallery). Electric lighting didn't influence on this decision.

Upper glass materials had to be different kind of glass than front glass wall.

I also had to use a glass specialist to determine exact glass packages in different openings.

Glass had so many tasks to do that real glass consult had to be used.

Because lighting design was in my responsibility, I finally had to pay his fee.

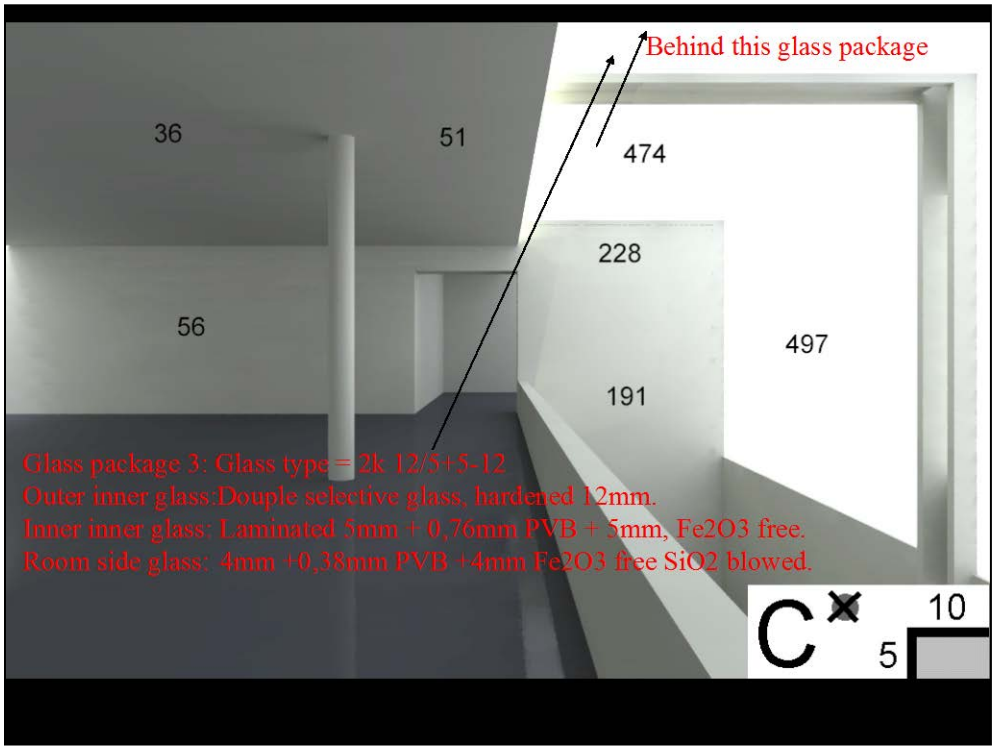


Figure 176. Gallery lighting case C. Photo Markku Norvasuo

More different kind of glass behind first layers.

Figure 177. Gallery lighting conclusion. Photo Markku Norvasuo

This museum glass packages and shading solution fullfills:

- All recommendations of CIE, Div. 3, TC 3.22 “Museum Lighting and Protection Against Radiation Damages”
- Architect dreams.
- Lighting Designers own demands of his work.

Figure 178. KUMU seen from the entrance. Exciting approaching from sharp corner of the building is quite unique idea from architect. Photo Jussi Tiainen

Figure 179. KUMU. Photo Jussi Tiainen

Sometimes it is difficult to understand the real size of the building. The reason for this is that eyes only can see as a camera lens, transfer the image to our brains and brains finally form the final image into our head and mind with so called ”Viewing hint”.

Practical and interesting example of viewing hint is the moon. If you look it on the beach or in the sea it looks huge. The reason for this is that there is no viewing hint at all where to compare it. If you look the moon behind the forest it looks smaller because trees are observers viewing hint and helps brains to put moon to right relation with them.

You loose the control of size when you have no ”viewing hint”. This image betrays the real size of KUMU, because our viewing hints are people who walk on pavement. Brains understand the distance to people and form the relation between them and building. Different kind of viewing hint is the curving line of the roof seeing towards sky. We understand that radius is huge.

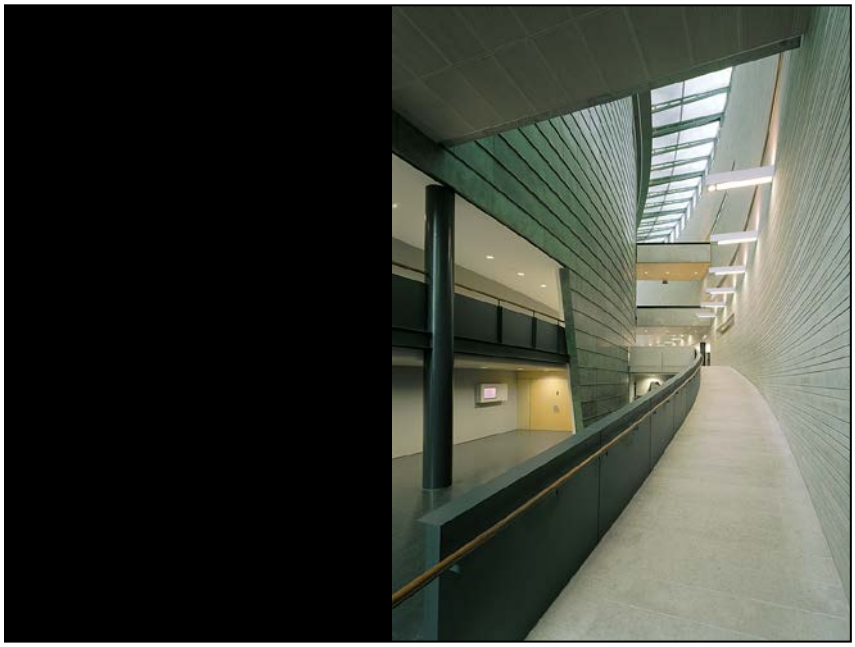


Figure 180. KUMU. Entrance. Photo Jussi Tiainen

Good selection of genuine materials, beautiful colors and peacefully curving surfaces gives harmony to visitors' minds.

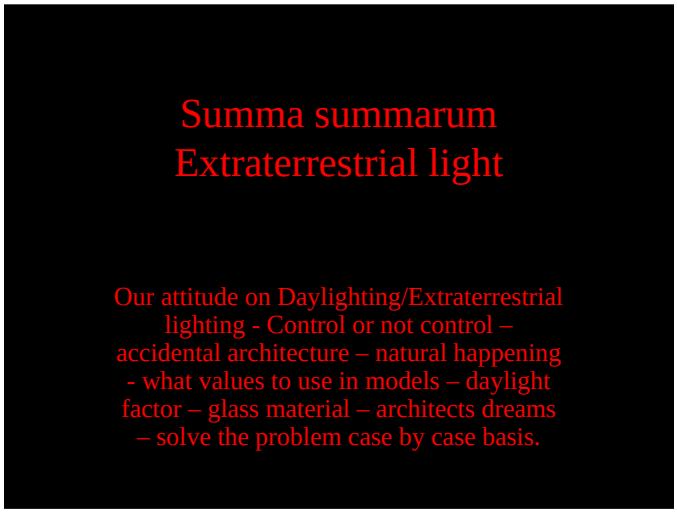
Figure 181. KUMU. The big gallery. Photo Jussi Tiainen

Photo of the big gallery. White matt walls and sand plasted windows reflect light on to the whole space. Deeper (right side of the photo) in gallery room light is fading which is natural and accepted phenomenon. Coves on the right side of the gallery room are not on yet and it is also good to think what light mixes(daylight + electricity light) are pre set in light controlling units which operate gallery rooms.

Figure 182. KUMU gallery. Photo Jussi Tiainen

Also totally even brightnesses on the vertical surfaces can be achieved, but in an other hand it is also good to think is it better than natural fading caused by geometry of the space. In this fading case we also save pigments on oil paintings, which is always good for art. After controlling and measuring annual lxh-values on selected oil paintings, decision of pre set values of light mix can be done based on relevant information.

One of the many goals in the galleries of KUMU was to manage only with big windows and light coves. Use of visual electric luminaires was avoided. But of course statues need spot luminaires equipped often with sculptor lence. Gallery spot lighting was designed by using recessed adapters so, that also adapter holes in the ceiling with installing grid of 2m x 2m were covered with white plastic covers when spot luminaire was not in use. When luminaire was used, the plastic cover could have been taken away and luminaire could have been installed to adapter in normal way. After use of spot lighting, luminaire was planned to take away into “Luminaire gallery” and plastic cover installed again on the adapter hole.Sometimes reality is odd and people use their power as descision makers in very odd situations. Other people than I anyhow made the descision that two adapters per gallery would be enough. I fought hard with my installing grid of 2m x 2m, because adapters also were very cheap, just few dollars each. Finally two adapters per gallery were installed. You can compare those 2 spot luminaires in adapter and track, which they had to install afterwards. Sad.



It is important to try to understand the whole picture in Extraterrestrial lighting project. Often the final solution is a compromise. Carefully and professionally done, the museum lighting design as a design process is the most oddest and complex task for lighting designer. There are so many different kind of changing elements starting from constantly changing extraterrestrial light up to the whole process.

Also office buildings have different kind of concepts in lighting. Sometimes utilizing of extraterrestrial light most important thing, in other case it is possible that more important concept is to avoid “Light trap” phenomenon during dark times and need more focusing.

Opera and art buildings often need artificial daylight simulation, because buildings are “empty” during daytime and performances start late night.

Airport is in full use 24 hours per day, which means that extraterrestrial light is needed all the time using both Daylight and electricity light (Like in our example Helsinki-Vantaa airport).

Old saying: “Change is only constant in the world” suits here well.

“GREEN DESIGN – SUSTAINABLE DAYLIGHTING DESIGN”

LEED and Daylighting

Overview of the LEED credits for Daylighting (IEQ 8.1) and Views (IEQ 8.2)

The United States Green Building Council (USGBC) publishes a set of building sustainability rating systems called Leadership in Energy and Environmental Design (LEED). LEED is a trademark of the USGBC. The applicable rating system for building design using daylighting is LEED Version 3 for New Construction (NC), Schools and Core and Shell (C&S). The LEED rating systems and other information are available on the USGBC website www.usgbc.org .

Building sustainability is widely accepted as a positive goal. Owners are willing and even eager to have LEED Rated buildings, but it is important to keep the cost of achieving a Rated building as low as

possible. The LEED rating systems are intended to guide and measure the sustainability of a building from pre-design all the way through operations.

For this purpose, simplicity and ease of use is important. Hence most of the credits are clearly defined and explicit, leaving little to the designers' imagination. Daylighting is one of those.

The "LEED Reference Guide for Green Building Design and Construction, 2009 Edition, US Green Building Council, Washington, DC" defines daylighting as the "controlled admission of natural light into a space, used to reduce or eliminate the use of electric light".

BUT

In order to be able to keep daylight design in reasonable balance between "Architectural" and "Technical" elements, it is important to have a look at both. This course is focusing more on "Technical" oriented elements because of the nature of LEED point collection and daylight harvesting to minimize the building's Carbon Footprint.

So, as a matter of fact, there are two common ways or reasons to utilize daylight in buildings:

Reason 1 (Architectural approach for daylighting):

To reflect the daylight off of carefully located and shaped surfaces so as to create a visually dramatic or pleasant scene in the indoor space to serve architectural philosophies.

Let's study 6 great examples of this kind of use of daylight which have been designed by real Masters of daylight. Examples show the timeless skills of mankind to capture daylight for its use.

- Abu Simbel
- Pantheon
- Ronchamp Chapel
- Kimbell Art Museum
- Chappel in St. Ignatius
- Mount Angel Abbey Library

Abu- Simbel, Egypt

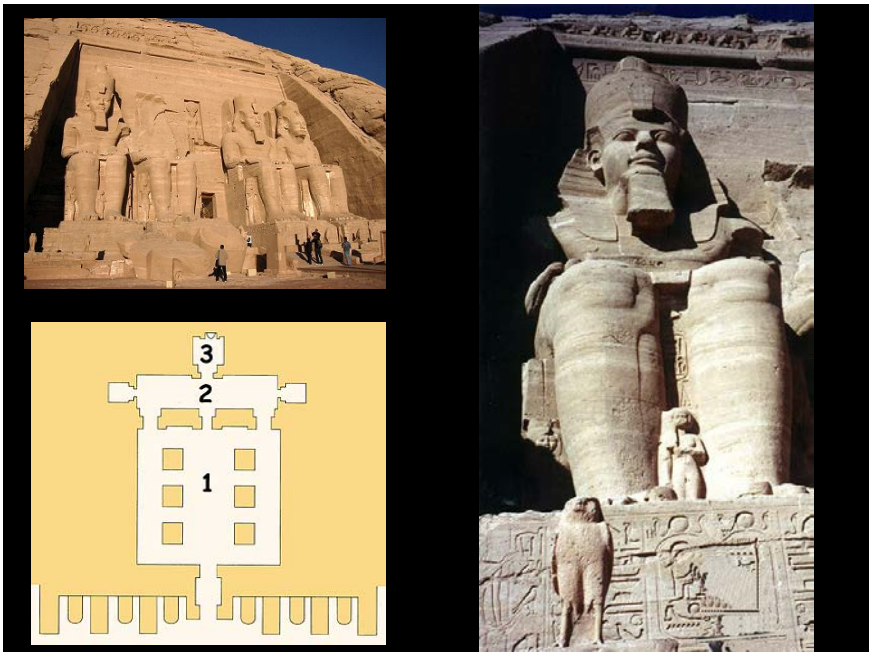


Figure 183. Solar phenomena of Abu- Simbel, Egypt, Sacred Light. Photo Wikipedia 2011

It is believed that the axis of the temple was positioned by the ancient Egyptian architects in such a way that on October 21 and February 21 (61 days before and 61 days after the Winter Solstice), the rays of the sun would penetrate the sanctuary and illuminate the sculptures on the back wall, except for the statue of Ptah, the god connected with the Underworld, who always remained in the dark.[5][6]

These dates are allegedly the king's birthday and coronation day respectively, but there is no evidence to support this, though it is quite logical to assume that these dates had some relation to a great event, such as the jubilee celebrating the thirtieth anniversary of the pharaoh's rule.

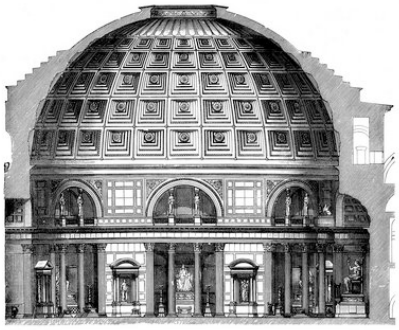
In fact, according to calculations made on the basis of the heliacal rising of the star Sirius (Sothis) and inscriptions found by archaeologists, this date must have been October 22. This image of the king was enhanced and revitalized by the energy of the solar star, and the deified Ramesses Great could take his place next to Amun Ra and Ra-Horakhty.[5]

Due to the displacement of the temple and/or the accumulated drift of the Tropic of Cancer during the past 3,280 years, it is widely believed that each of these two events has moved one day closer to the Solstice, so they would be occurring on October 22 and February 20 (60 days before and 60 days after the Solstice, respectively).

The NOAA Solar Position Calculator [7] may be used to verify the declination of the Sun for any location on Earth, at any particular date and time. For the latitude of Abu Simbel 22°20′13″N 31°37′32″E / 22.33694°N 31.62556°E, the calculator will yield values close to -11º for both Oct 22 and Feb 20.

This is a real masterpiece of daylight without computer or LEED point earning possibility. More: http://en.wikipedia.org/wiki/Abu_Simbel_temples

Pantheon, Rome, Italy



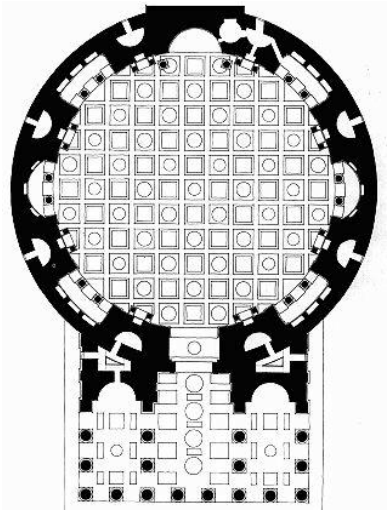


Figure 184. Pantheon. Photo Wikipedia 2011

Figure 185. Pantheon. Photo Julle Oksanen

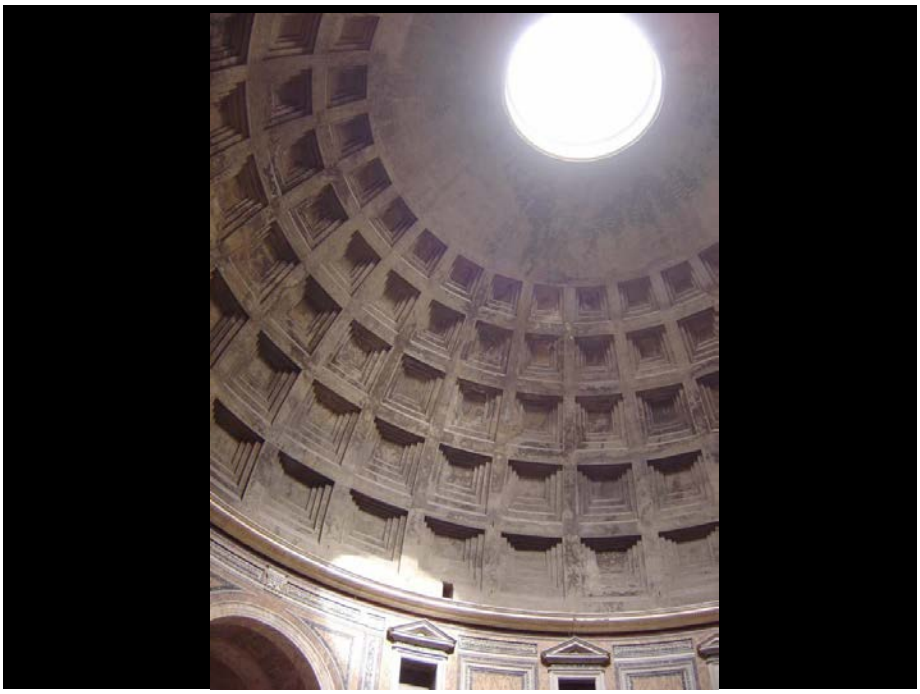


Figure 186. Photo Julle Oksanen

The interior of the dome was possibly intended to symbolize the arched vault of the heavens.[30] The oculus at the dome's apex and the entry door are the only sources of light in the interior. Throughout the day, the light from the oculus moves around this space in a sort of reverse sundial effect.[34] The oculus also serves as a cooling and ventilation method. During storms, a drainage system below the floor handles the rain that falls through the oculus. More: http://en.wikipedia.org/wiki/Pantheon,_Rome

Ronchamp Chapel, France

Figure 187. Ronchamp Chapel, France, Architect Le Corbusier. Photo Wikipedia 2011

In the interior, the spaces left between the wall and roof, as well as asymmetric light from the wall openings, serve to further reinforce the sacral nature of the space and buttress the relationship of the building with its surroundings. More: http://en.wikipedia.org/wiki/Ronchamp

Kimbell Art Museum, Texas USA

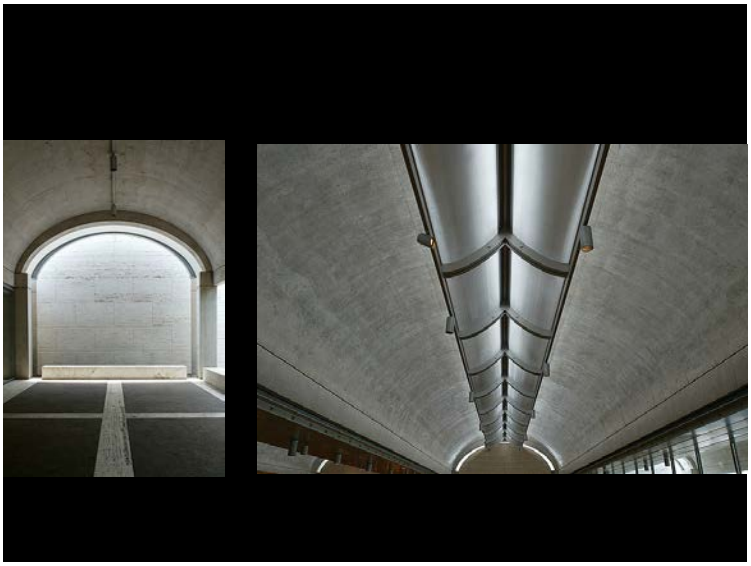


Figure 188. Kimbell Art Museum, Texas USA, Architect Louis Kahn. Photo Julle Oksanen

David Brownlee and David DeLong, authors of *Louis I. Kahn: In The Realm of Architecture*, declare that "in Fort Worth, Kahn created a skylight system without peer in the history of architecture."[13]:132 Robert McCarter, author of *Louis I. Kahn*, says the entry gallery is "one of the most beautiful spaces ever built," with its "astonishing, ethereal, silver-colored light."[5]:355 Carter Wiseman, author of *Louis I. Kahn: Beyond*

Time and Style, said that "the light in the Kimbell gallery assumed an almost ethereal quality, and has been the distinguishing factor in its fame ever since."[4]:222

Creating a natural lighting system that has evoked such acclaim was challenging, and Kahn's office and the lighting designer Richard Kelly investigated over 100 approaches in their search for the proper skylight system. The goal was to illuminate the galleries with indirect natural light while excluding all direct sunlight, which would damage the artwork.[12]:184 Marshall Meyers, Kahn's project architect, worked with several experts to determine that a reflecting screen made of perforated anodized aluminum with a specific curve could be used to distribute natural light evenly across the cycloid curve of the ceiling. His team used a computer to determine the exact shape of the reflector's curve, making it one of the first architectural elements ever to be designed with computer technology.[12]:209[4]:221

In areas without art, such as the entry hall, cafeteria and library, the entire reflector is perforated, making it possible for people standing beneath to glimpse passing clouds. In the gallery spaces, the central part of the reflector, which is directly beneath the sun, is solid, while the remainder is perforated.[5]:353 The concrete surfaces of the ceiling were given a high finish to further assist the reflection of the light.[4]:221 The end result is that the strong Texas sun enters a narrow slot at the top of each vault and is evenly reflected from a curved screen across the entire arc of the polished concrete ceiling, ensuring a beautiful distribution of natural light that had never before been achieved. More: http://en.wikipedia.org/wiki/Kimbell_Art_Museum

Chappel of St. Ignatius, Seattle

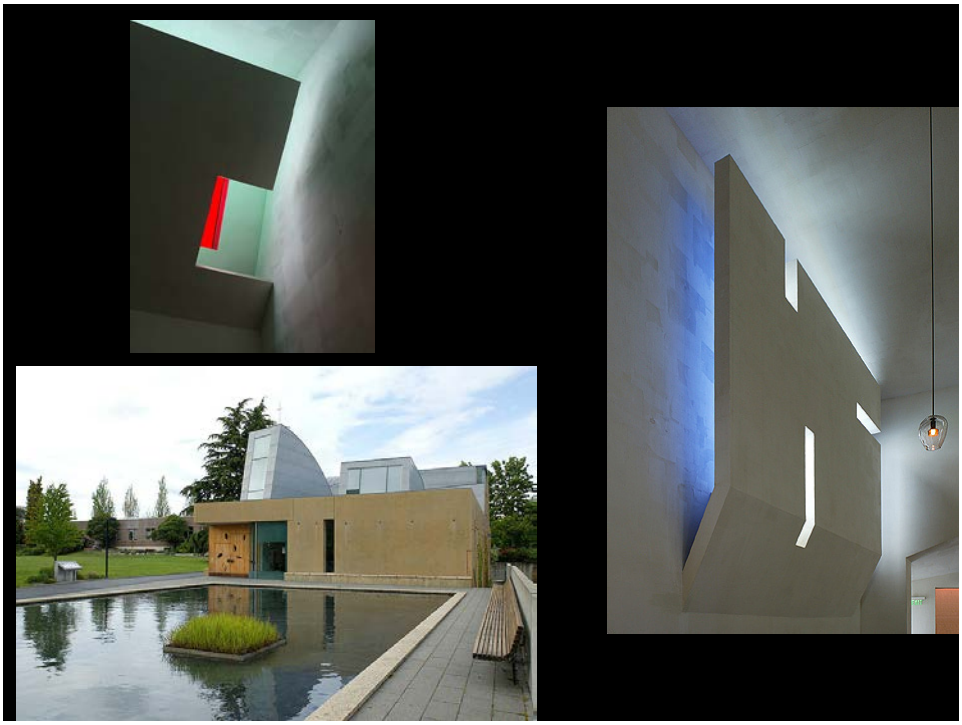


Figure 189. Chappel of St. Ignatius, Seattle, Architect Steven Holl. Photo Julle Oksanen

Seven bottles of light in a stone box; the metaphor of light is shaped in different volumes emerging from the roof whose irregularities aim at different qualities of light: East facing, South facing, West and North

facing, all gathered together for one united ceremony. Each of the light volumes corresponds to a part of the program of Jesuit Catholic worship. The south-facing light corresponds to the procession, a fundamental part of the mass. The city-facing north light corresponds to the Chapel of the Blessed Sacrament and to the mission of outreach to the community. The main worship space has a volume of east and west light. At night, which is the particular time of gatherings for mass in this university chapel, the light volumes are like beacons shining in all directions out across the campus. More: http://www.stevenholl.com/project-detail.php?id=40

Mount Angel Abbey, Library in Oregon

Figure 190. Mount Angel Abbey, Library in Oregon, Architect Alvar Aalto. Photo Wendy Fujinaka

The Mount Angel Library is one of Aalto's few designs in the United States. However, his same consideration in the surrounding nature and incoming daylight still remains strong. The clerestory that he employed in this design allows for the building do receive as much light during the cold winter months while saving itself from the heat during the summer months. This method, seen mainly throughout the second half of his career, is yet another technique of bringing in diffused light which is better for reading and studious environments. Since the library is a large, 3 story building, Aalto designed for a double height space on the first floor which allowed light to trickle down to the darker floors. He also used horizonal windows with louvres to provide sufficient light to those areas farther away from the clerestories. More: http://www.uh.edu/honors/_documents/Posters-UR-Day-2010/poster-pdfs-o-r/Ostaszewski-Natasha.pdf

Reason 2 (Energy saving and minimizing CO2- Footprint & View):

To provide adequate natural light for visual tasks and minimize the need for electric lighting, thus saving energy. **It is this second reason that the LEED credit is directed toward.** If visual tasks can be efficiently performed without consuming electricity and producing the attendant pollution and carbon dioxide emissions the building is more sustainable. Further benefits are produced and are credited in the Energy and Atmosphere and elsewhere in the Indoor Air Quality sections of the LEED credits.

Figure 191. Telenor office building. Photo Jan Draplos

This Telenor- office building in Norway has glass walls which very efficiently minimize the need of electric light during daytimes on working areas.

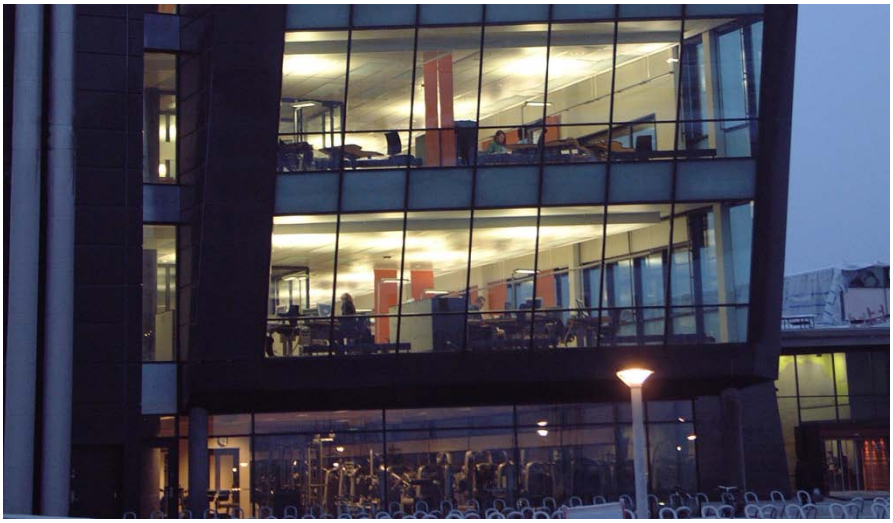


Figure 192. Telenor office building. Photo Jan Draplos

Another strong benefit resulting from the use of windows to admit daylighting is that it allows the occupants to have a view to the outdoors.

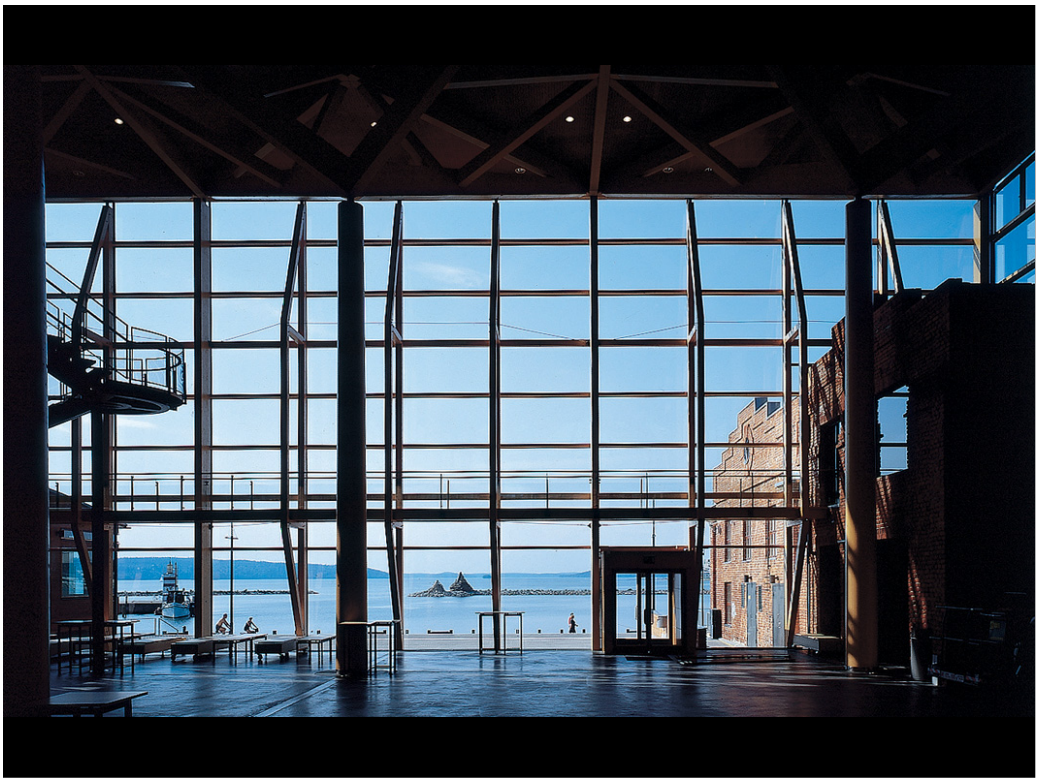


Figure 193. Sibelius building in Lahti, Finland. Photo Hannu Tikka

All of us are aware of the need to see the passing of the day, even if we must be confined indoors by work. We are happier and more productive when we are connected with the natural world, even if it's only

through a glass surface. On the other hand, windows and skylights are more expensive than typical opaque construction and they allow much more heat to flow in or out per unit of area. One would not design-in windows unless their benefits outweighed these penalties.

LEED NC, C & S and Schools 2009

IEQ Credit 8.1 – Daylight and Views - Daylight

The LEED credit for daylighting (IEQ Credit 8.1) provides 1 credit for achieving daylighting in 75% of the regularly occupied spaces (NC and CS) or 75% of the classrooms (Schools). In Schools, an additional point can be earned by daylighting 90% of the classrooms and another by achieving daylighting in 75% of all regularly occupied spaces. The LEED credit for views (IEQ Credit 8.2) provides 1 credit for a direct line of sight to the outdoors from 90% of all regularly occupied spaces.

Four optional methods of demonstrating daylighting are allowed.

Option 1 is to simulate the daylighting in each space using a computer. The simulation has to show that 75% of the area will have between 25 and 500 footcandles at 9:00 am and 3:00 pm on September 21, the Fall Equinox.

Figure 194. Lux meater. Photo Richard Kelso

Example calculation of Option 1: Shopping Mall in Finland (designed by Arkkitehtityohuone ArttopaloRossiTikka Oy/ Architect Hannu Tikka).

Introduction photos of the project:


ANTILA
APBT


APBT

Simplified computer model for Option 1 calculation. Blue elements on the roof area and on walls that are seen on model below are glass packages with Visible Light Transmittance (VLT) of 0.72. The architect wanted to create special toplights- not only huge glass elements shooting light in all over. The only fully glass toplight is on left side of the model

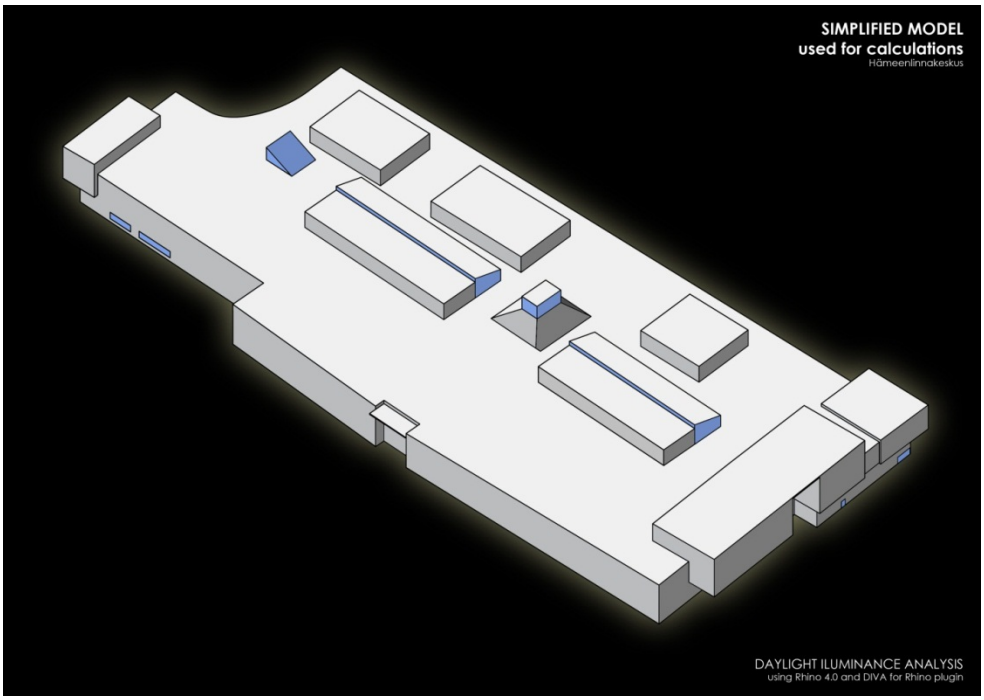


Figure 195. Model of a shopping mall. Photo Tony Osterlund

Calculation program:

There are many computer programs which are available for daylight analyses to check if the project can earn LEED points under option 1. Some available programs are:

- Autodesk Ecotect Analysis

More: http://usa.autodesk.com/adsk/servlet/pc/index?id=12602821&siteID=123112

- Autodesk 3ds Max Design

More: http://usa.autodesk.com/adsk/servlet/pc/index?id=13567410&siteID=123112

- McNeel Rhinoceros 4.0 + DIVA for Rhino plugin

More: http://www.rhino3d.com/resources/display.asp?language=&listing=4784

In our shopping Mall project example we checked LEED points with **McNeel Rhinoceros 4.0 + DIVA for Rhino plugin** program.

Calculation results:

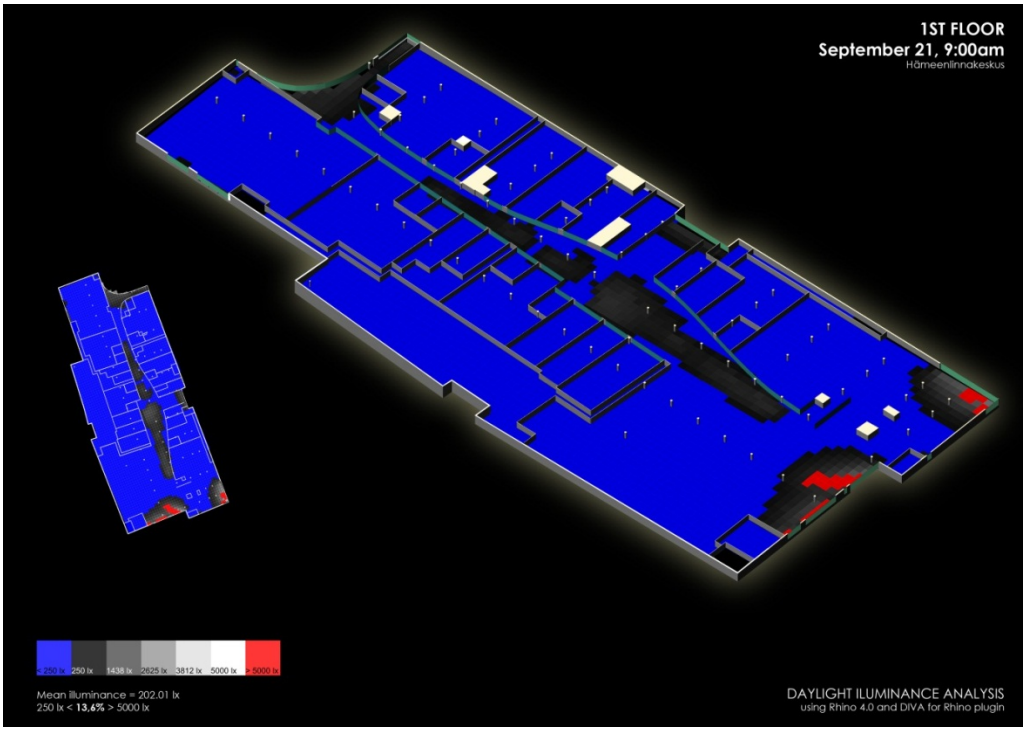
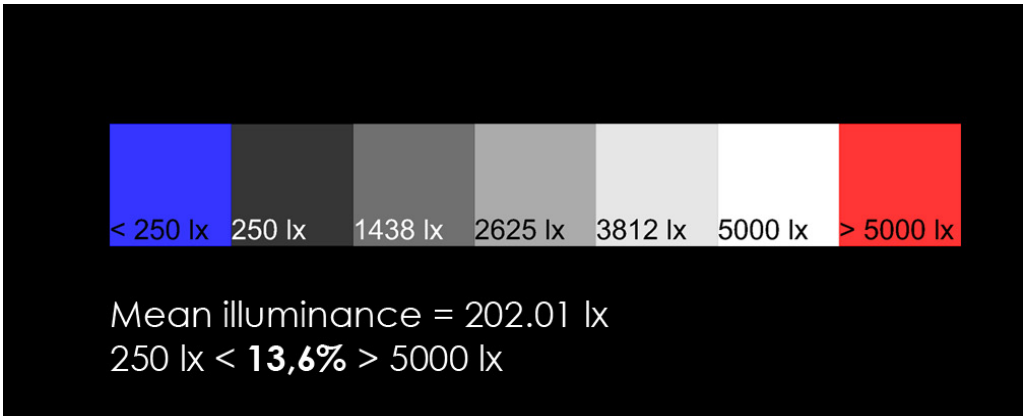
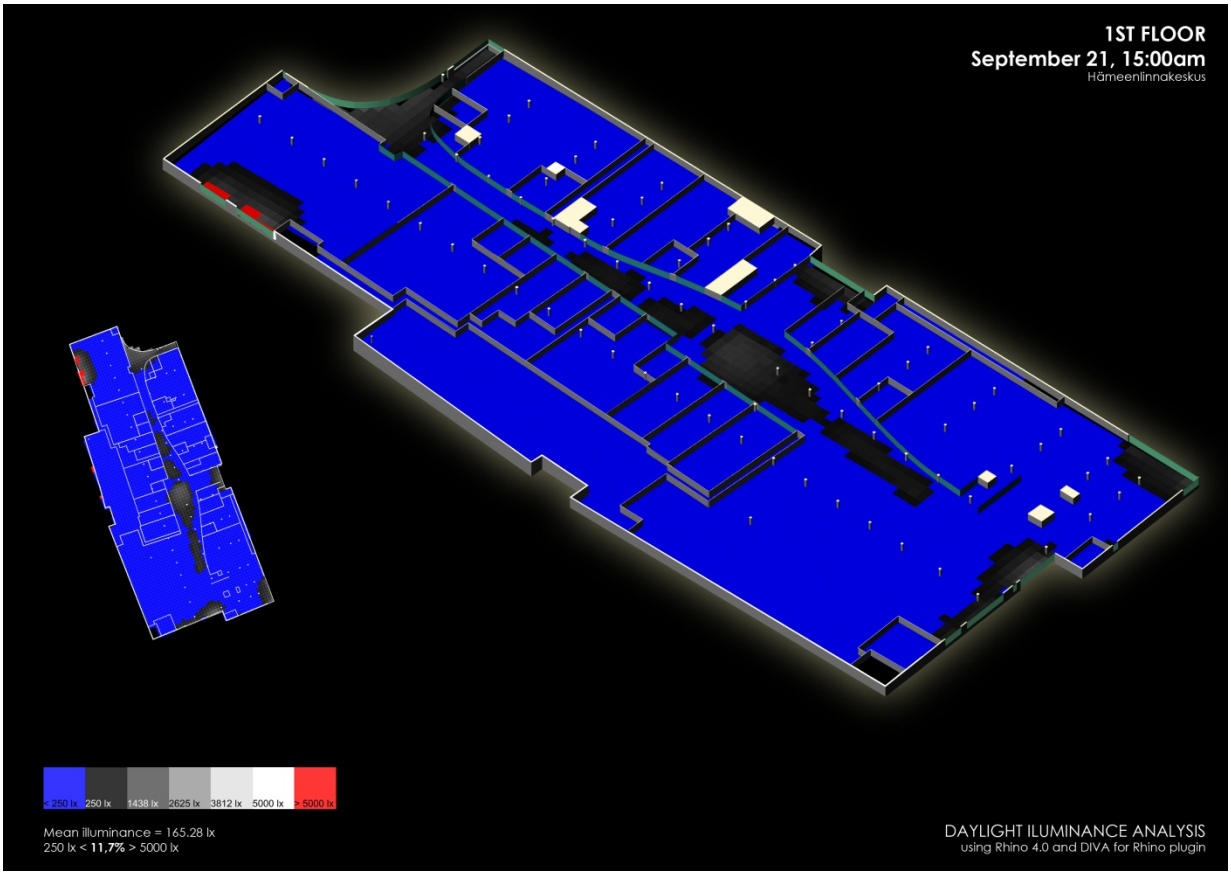
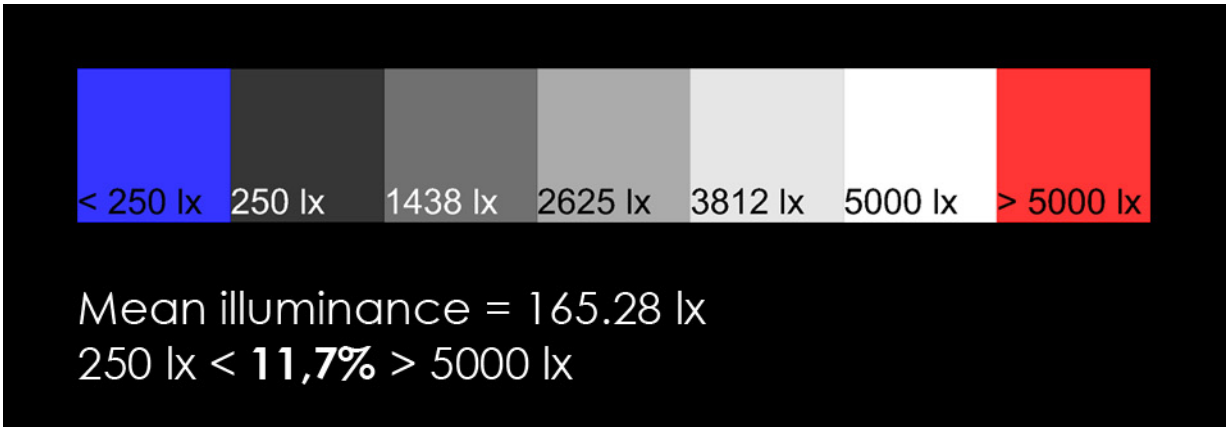
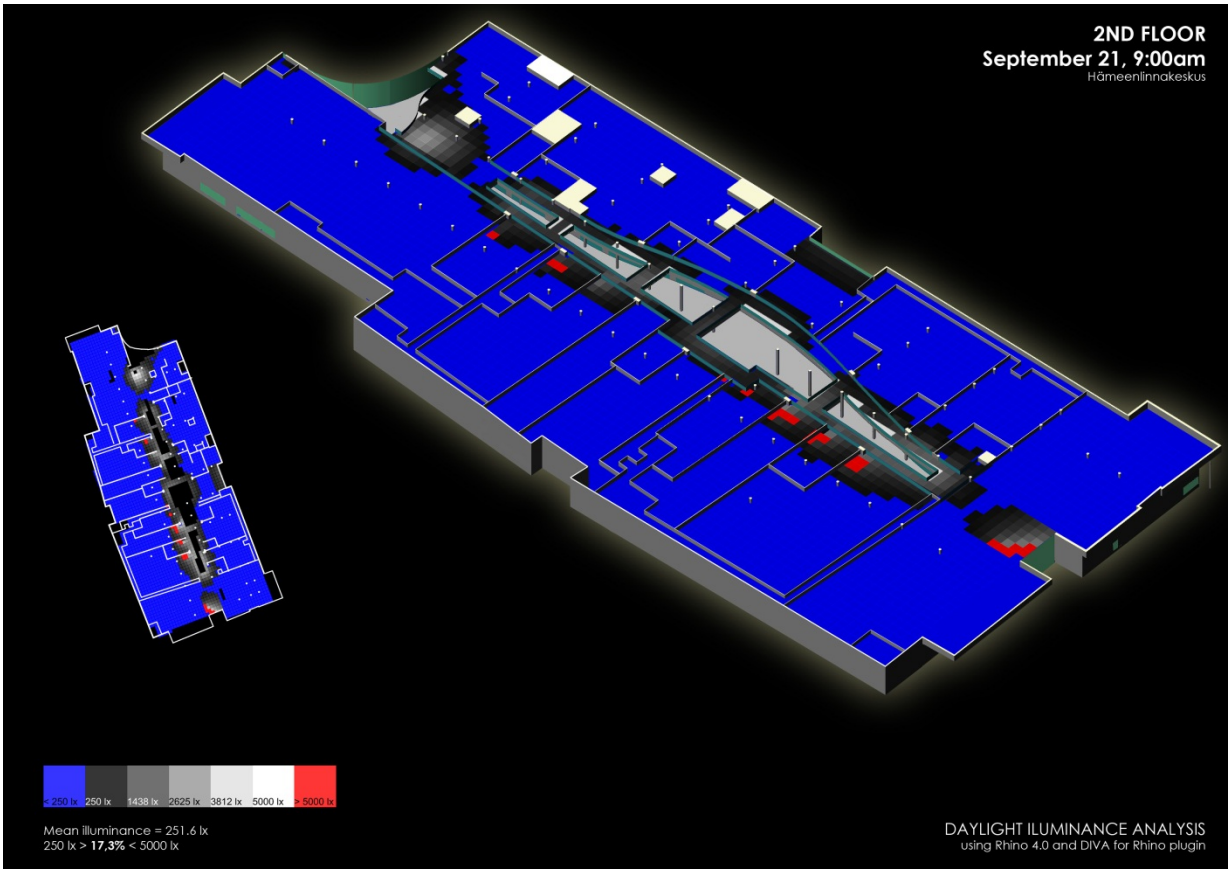


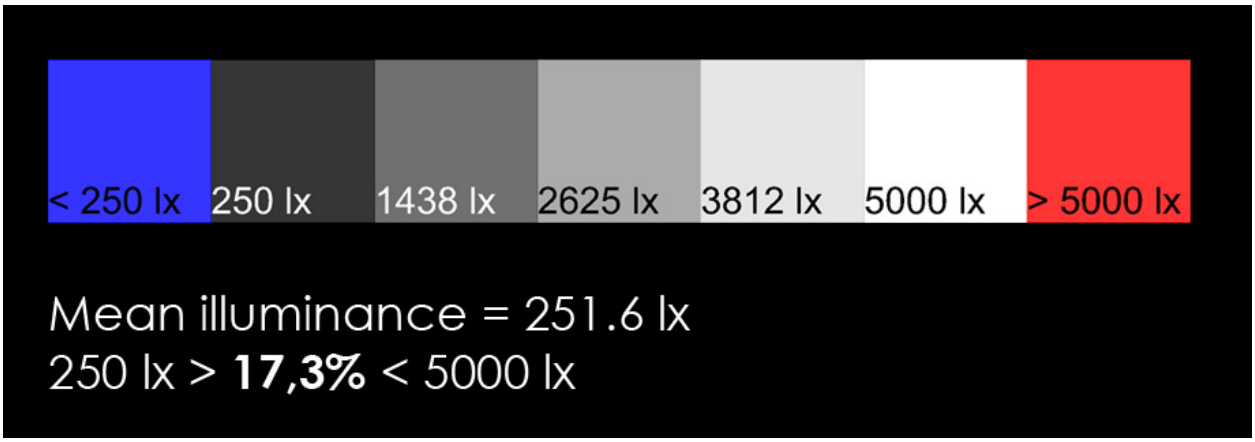
Figure 196. Calculation results. Photos Tony Osterlund

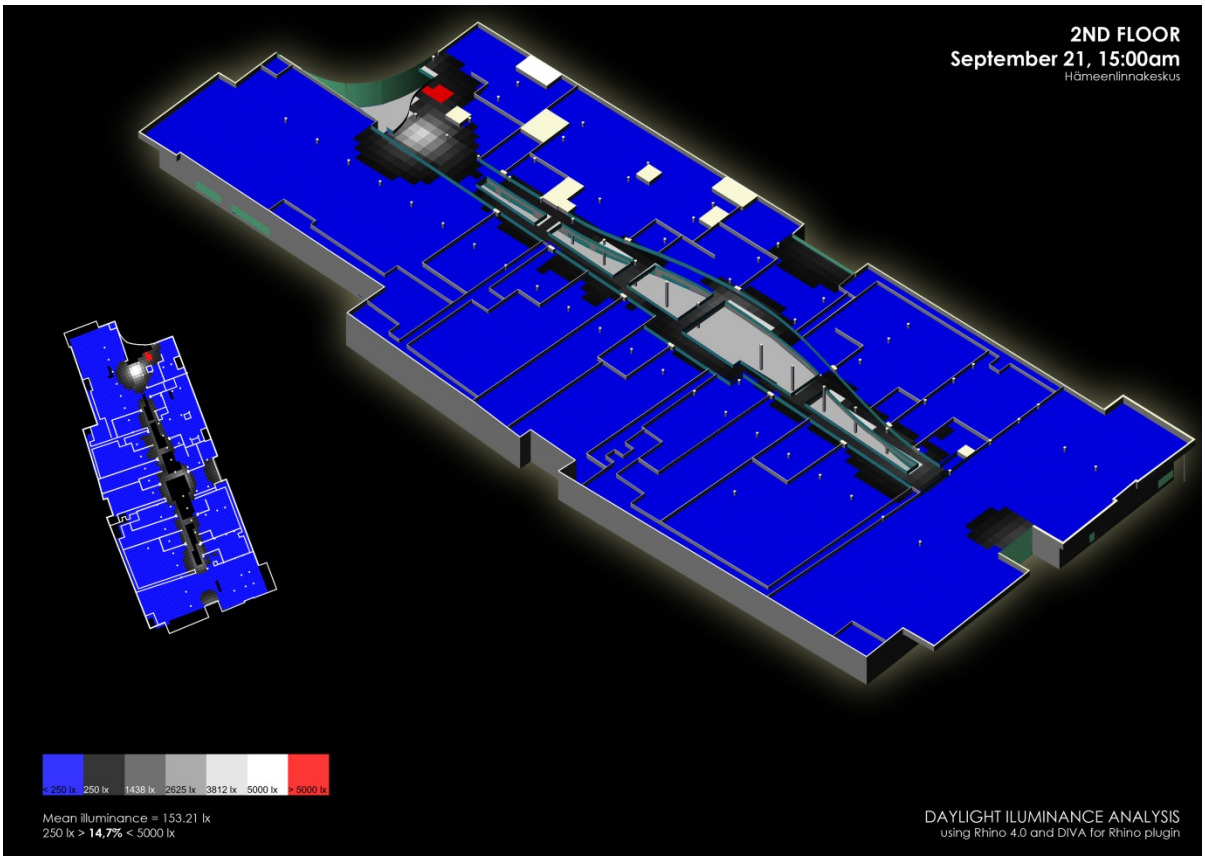

< 250 lx
250 lx
1438 lx
2625 lx
3812 lx
5000 lx
> 5000 lx
Mean illuminance = 202.01 lx
250 lx < 13,6% > 5000 lx

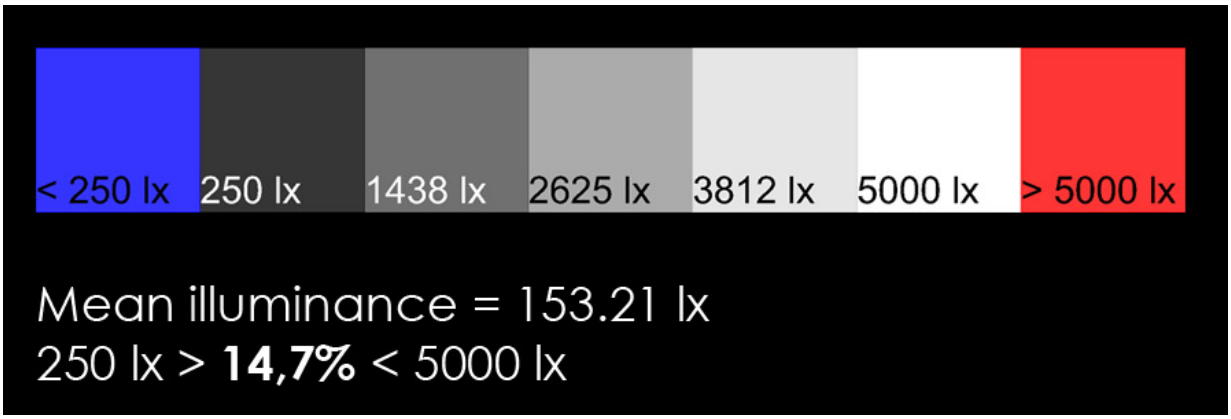

1ST FLOOR
September 21, 15:00am
Hämeenlinnakeskus
< 250 lx
250 lx
1438 lx
2625 lx
3812 lx
5000 lx
> 5000 lx
Mean illuminance = 165.28 lx
250 lx < 11,7% > 5000 lx
DAYLIGHT ILUMINANCE ANALYSIS
using Rhino 4.0 and DIVA for Rhino plugin


< 250 lx
250 lx
1438 lx
2625 lx
3812 lx
5000 lx
> 5000 lx
Mean illuminance = 165.28 lx
250 lx < 11,7% > 5000 lx


2ND FLOOR
September 21, 9:00am
Hämeenlinnakeskus
Mean illuminance = 251.6 lx
250 lx > 17,3% < 5000 lx
DAYLIGHT ILUMINANCE ANALYSIS
using Rhino 4.0 and DIVA for Rhino plugin


< 250 lx
250 lx
1438 lx
2625 lx
3812 lx
5000 lx
> 5000 lx
Mean illuminance = 251.6 lx
250 lx > **17,3%** < 5000 lx


2ND FLOOR
September 21, 15:00am
Hämeenlinnakeskus
< 250 lx
250 lx
1438 lx
2625 lx
3812 lx
5000 lx
> 5000 lx
Mean illuminance = 153.21 lx
250 lx > **14,7%** < 5000 lx
DAYLIGHT ILUMINANCE ANALYSIS
using Rhino 4.0 and DIVA for Rhino plugin



Evaluation of calculation results:

September 21st at 9:00 am 1st Floor 250lx > **13,6%** < 5000lx (ought to be min. 75%)

September 21st at 3:00 pm 1st Floor 250lx > **11,7%** < 5000lx (ought to be min. 75%)

September 21st at 9:00 am 2nd Floor 250lx > **17,3%** < 5000lx (ought to be min. 75%)

September 21st at 3:00 pm 1st Floor 250lx > **14,7%** < 5000lx (ought to be min. 75%)

LEED Credit for Daylighting is not achieved in this project. Big Skylights are not "powerfull" enough to serve deeper parts of the floors (sales areas). Daylight is fading surprisingly fast when going deeper towards the outer walls of the building in both floors.

If the architect wants to earn 1 LEED Credit for Daylighting, he ought to add more windows on walls around the building. In this project, which is a shopping mall, there is a lot of resistance for windows from customer's side. Mall area is delivered for smaller shops which all want to maximize sales and money income. More windows on walls mean fewer racks and fewer shelves and this means fewer sales.

Option 2 is a prescriptive method that is assumed to produce the same results.

Prescriptive Option Calculations

Sidelighting

Daylighting is a complex mixture of art and science that is difficult to evaluate so, for practical reasons, the LEED daylighting credit requirements have included a relatively simple method of establishing compliance. **For sidelighting**, the formula has only three parameters: floor area, window area and glazing visible transmittance (VLT).

Figure 197. Glass materials for sidelighting. Photo Richard Kelso

The formula is

$0.150 < VLT \times WFR < 0.180$

where WFR is the dimensionless ratio of window area to floor area. The window area is defined as the area between the work plane (standard desktop height is 30 inches above the floor) and the window head; subject to the limitations shown here.

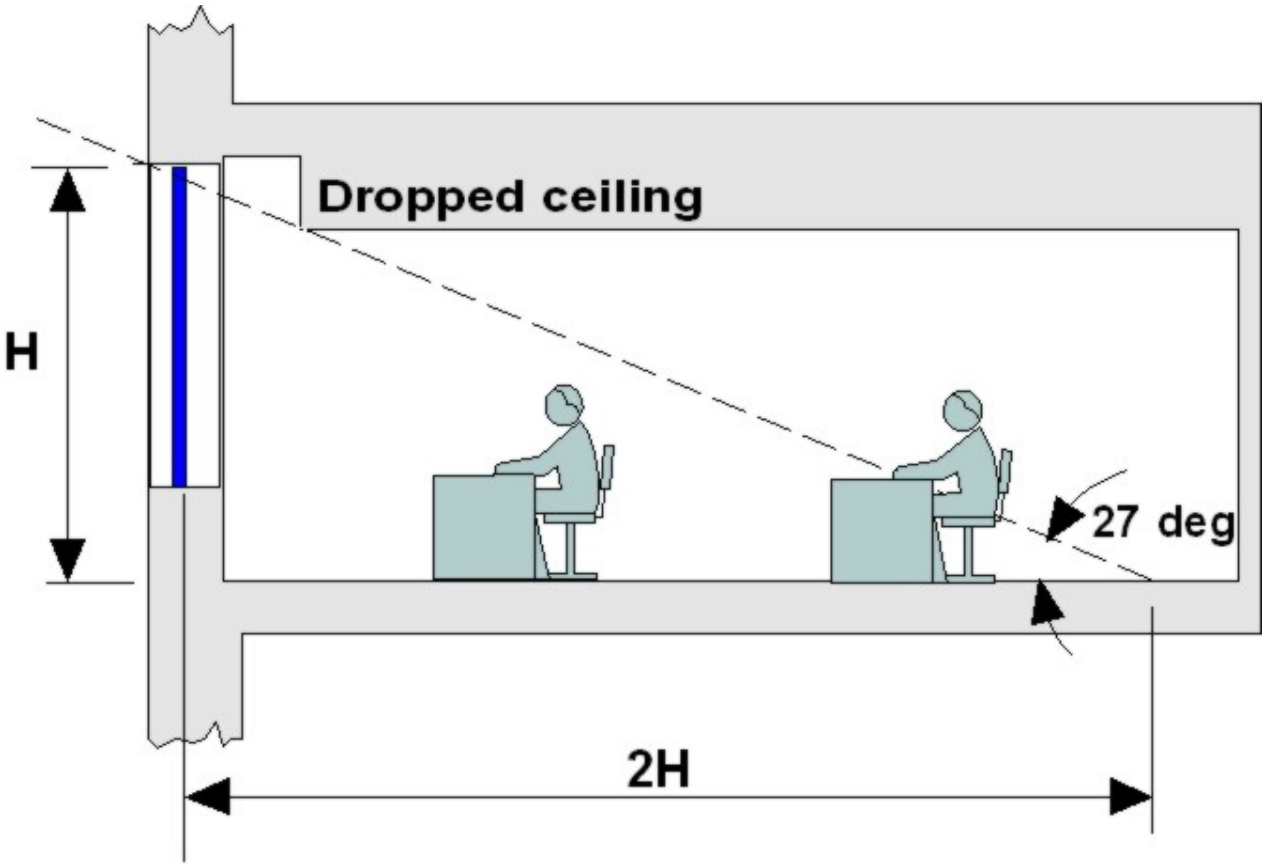


Figure 198. Sidelighting model. Photo Richard Kelso

For example, a 120 square foot office with the double tinted glass mentioned above (VLT = 0.46) would have to have a window area between 39 and 47 square feet to comply.

Check up calculation (VLT x WFR < 0,18):

$0{,}46 \times A_{window} / 120 \text{ square foot} < 0.18$

$A_{window} = 0.18 \times 120 \text{ square foot} / 0.46$

$A_{window} = 47 \text{ square foot.}$

This works.

Example calculation of Option 2/ Sidelighting: Shopping Mall in Finland (designed by Arkkitehtityohuone ArttopaloRossiTikka Oy/ Architect Hannu Tikka).

Window area calculation is performed in Rhino 4.0 and using custom tools.

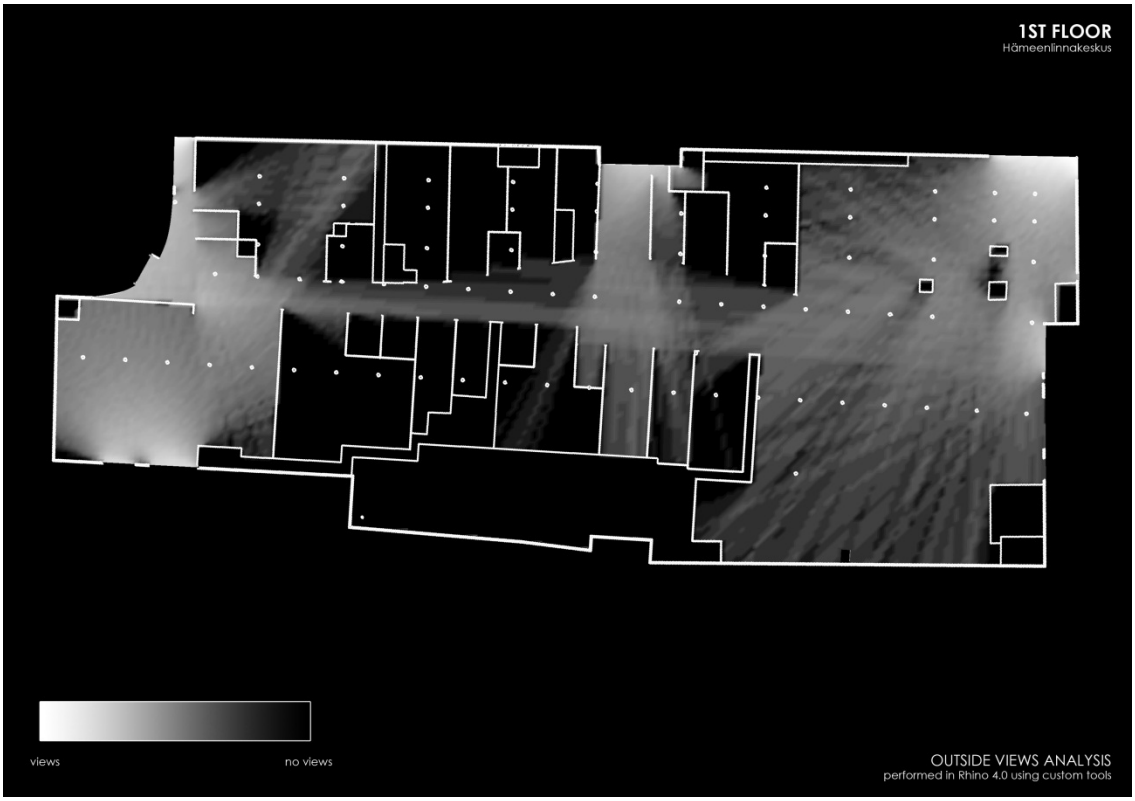


Figure 199. View analyses with computer. Photo Tony Osterlund

Calculation for OPTION 2 Sidelighting :

0.150 < VLT x W/F < 0.180

VLT = 0.72

W = 15,425 ft^2 (1433m^2) (over 2.8 ft (850mm) high glass surfaces)

F = 136,088 ft^2 (12643m^2) + 145,119 ft^2 (13482 m^2) = 145,256 ft^2 (26125m^2)

W/F = 0.055

VLT x W/F = 0.72 x 0.055 = 0.0396, which doesn't fullfill the option requirement. The result is the following calculation of option 1.

Prescriptive Option Calculations

Toplighting

For toplighting, the prescriptive option is a little more complicated. The area of the skylights themselves must fall between 3% and 6% of the roof area and the distance between them must not exceed 1.4 times the ceiling height. The glazing material must have a VLT of 0.5 or higher. If the skylights are to have diffusers, they must have measured haze value greater than 90% according to ASTM D1003. Direct line of sight to the diffuser should be avoided.

The daylit area is counted as the area directly under the skylight plus, in each direction, the lesser of 0.7 times the ceiling height or ½ the distance to the next skylight or the distance to any permanent partition that is farther than 0.7 times the height between the top of the partition and the ceiling. See figure

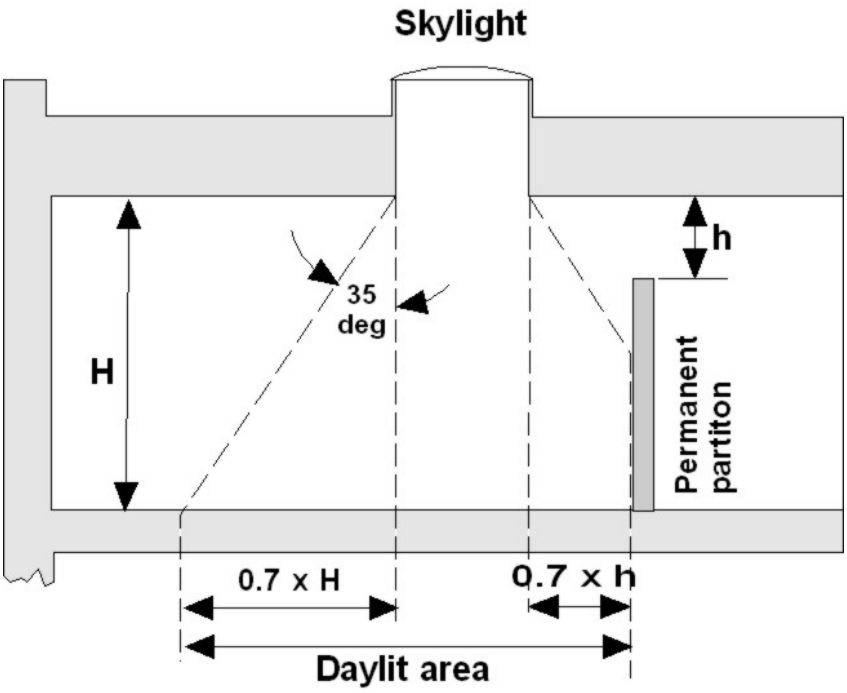


Figure 200. Toplighting. Photo Richard Kelso

Example calculation of Option 2/ Toplighting:

Helsinki – Vantaa Airport designed by Pekka Salminen Architects. (More details later on this course). Terminal triangle Skylights.

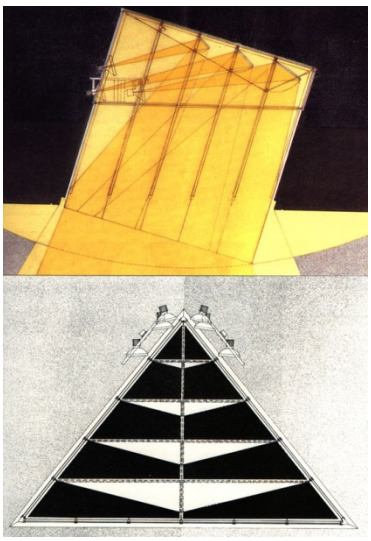


Figure 201. Lightprisms penetrated through the roof and ceiling. Photo Pekka Salminen Architects

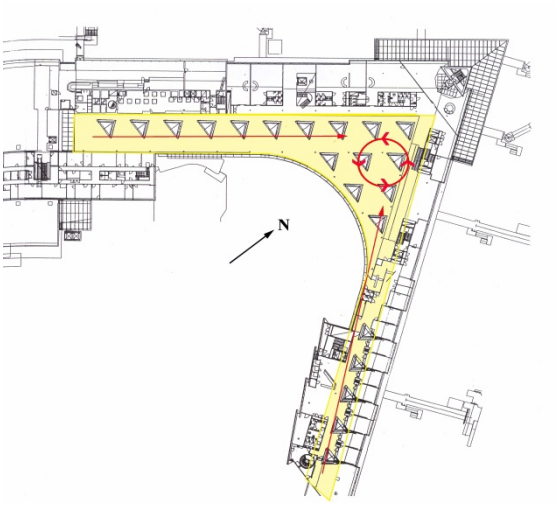


Figure 202. Lightprisms locations. Photo Pekka Salminen Architects

Figure 203. Indoor view. Photo Pekka Salminen Architects

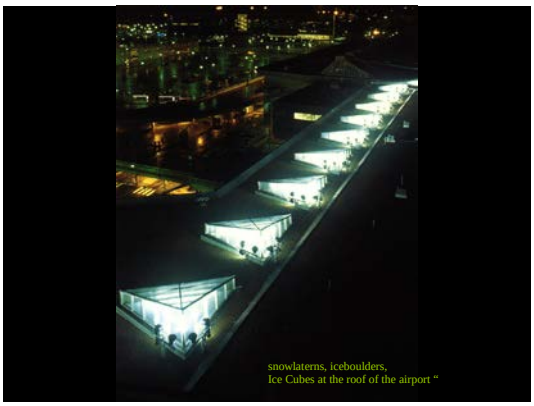


Figure 204. Outdoor view. Photo Pekka Salminen Architects

Calculations:

- The area of the skylights themselves must fall between 3% and 6% of the roof area. It is 20%, which is more than 6%, so OK.

- The distance between skylights must not exceed 1.4 times the ceiling height. Height of the transit hall is 21 feet and distance between prisms is 27 feet. Distance could be 1.4 x 21 feet = 29 feet > 27 feet. So, ok.
- The glazing material must have a VLT of 0.5 or higher. VLT of the glazing material used is 0.75. So, ok.

1 LEED Credit earned.

Option 3 is to construct the building and then measure the illuminance on the workplane on a ten foot square grid in each room.

(Definition – Illuminance is the density of the luminous flux incident on a surface. It is measured in footcandles (lumens per square foot) in the U.S. or lux (lumens per square meter) elsewhere. It is measured with a light meter held parallel to the surface (horizontal, in this case) and looking away from the surface.).

Demonstrate through records of indoor light measurements that a minimum daylight illumination level of 25 fc has been achieved in at least 75% of all regularly occupied areas. Measurements must be taken on a 10-foot grid for all occupied spaces and recorded on building floor plans.

Only the square footage associated with the portions of rooms or spaces meeting the minimum illumination requirements may be counted in the calculations.

For all projects pursuing this option, provide daylight redirection and/or glare control devices to avoid highcontrast situations that could impede visual tasks. Exceptions for areas where tasks would be hindered by daylight will be considered on their merits.

This option 3 is also one possibility, but too often, if not always, gives result maybe too late as lighting- and architectural design point of view. What is done is done and changes often are not possible anymore. That is why we'll take our calculation / measurement example of predicting values of daylight by using physical model, daylight factor and measured values on september 21st 9am and 3pm which can be found from different information sources. After this study it is easy to change architecture and light elements (openings, e.t.c.) to serve goal to earn 1 LEED credit with option 3. Later on, after the building is ready, you can go and measure how professional work you had done.

Potential Technologies & Strategies to earn this LEED point:

Design the building to maximize interior daylighting. Strategies to consider include building orientation, shallow floor plates, increased building perimeter, exterior and interior permanent shading devices, high-performance glazing, and high-ceiling reflectance values; ly, additionally, automatic photocell-based controls can help to reduce energy use. **Predict daylight factors via manual calculations or model daylighting strategies with a physical or computer model to assess footcandle levels and daylight factors achieved.**

About Daylight Factor, DF

A useful tool for daylight design is the Daylight Factor (DF). It is defined as the ratio of illuminance on a desktop at a given location in a room to the illuminance on a horizontal plane outdoors at the same time. This ratio is surprisingly constant for the wide range of outdoor illuminance. It can be used to predict the distribution of the available daylight with an interior space. For example, next figure shows a section through a space with single sidelighting. The space is nondimensionalized by using the window height H as the unit of room depth measure. This hypothetical case is typical of measured and calculated results.

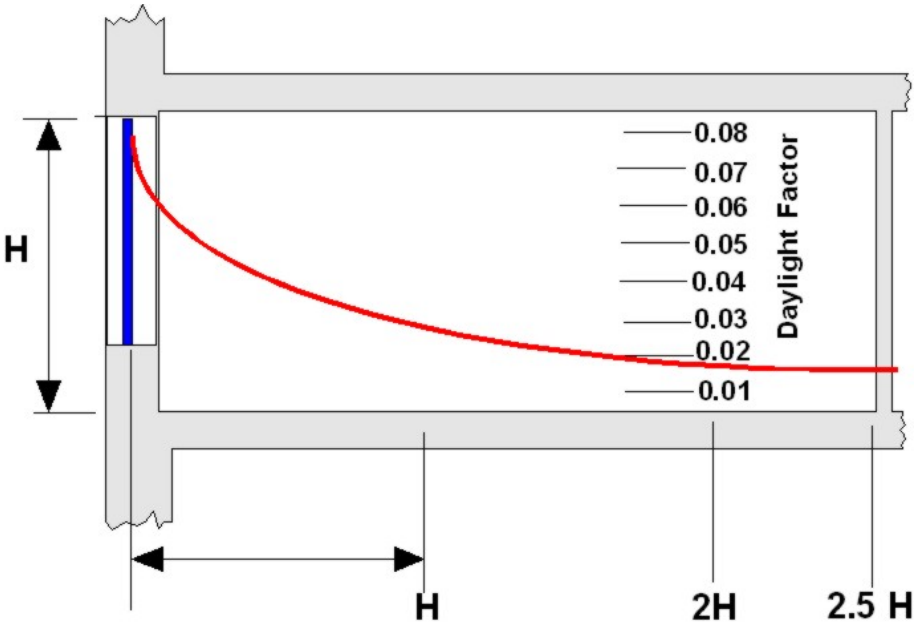


Figure 205. Daylight zones. Photo Richard Kelso

The reason to show this curve is that you can split the room (specifically at schools) for different daylight zones. For example if you have 3 rows of luminaires running in parallel to wondow directions, you could dim all 3 rows differently with electric lighting controlling system (row near window 30% of lumen output on, middle row 50% of lumen output on and deepest row 100% of lumen output on). Controlling system include also daylight sensor, so depending on daylight value all rows dim in right relation.

The other reason why this curve is also often shown is that it gives a flavour how surprisingly fast daylight value fades when going deeper the room.

Example of Option 3: LEED Credit study of Helsinki Vantaa Airport with DF and physical model.

Figure 206. Helsinki - Vantaa airport. Photo Finavia

Pekka Salminen Architects Ltd designed Helsinki-Vantaa Airport new terminal in 90's. Airport have earned a lot of international Awards for it's great functionalism, quality and beauty. We are focusing on the yellow lighting design area on the plan. There are many 5000 lb. lightprisms located on the roof.

Glassprisms penetrate through the ceiling and change the new terminal (yellow area on plan) to an eternal Daylight area. During daytime lightprisms act as huge daylight producers and during dark periods floodlights, which are located on the roof area, cast light on the terminal surfaces via aluminium wings. In this course we are focusing on daylight only. (Electric light part was treated in the other Red Vector-course “Green design: Sustainable Lighting Design”).

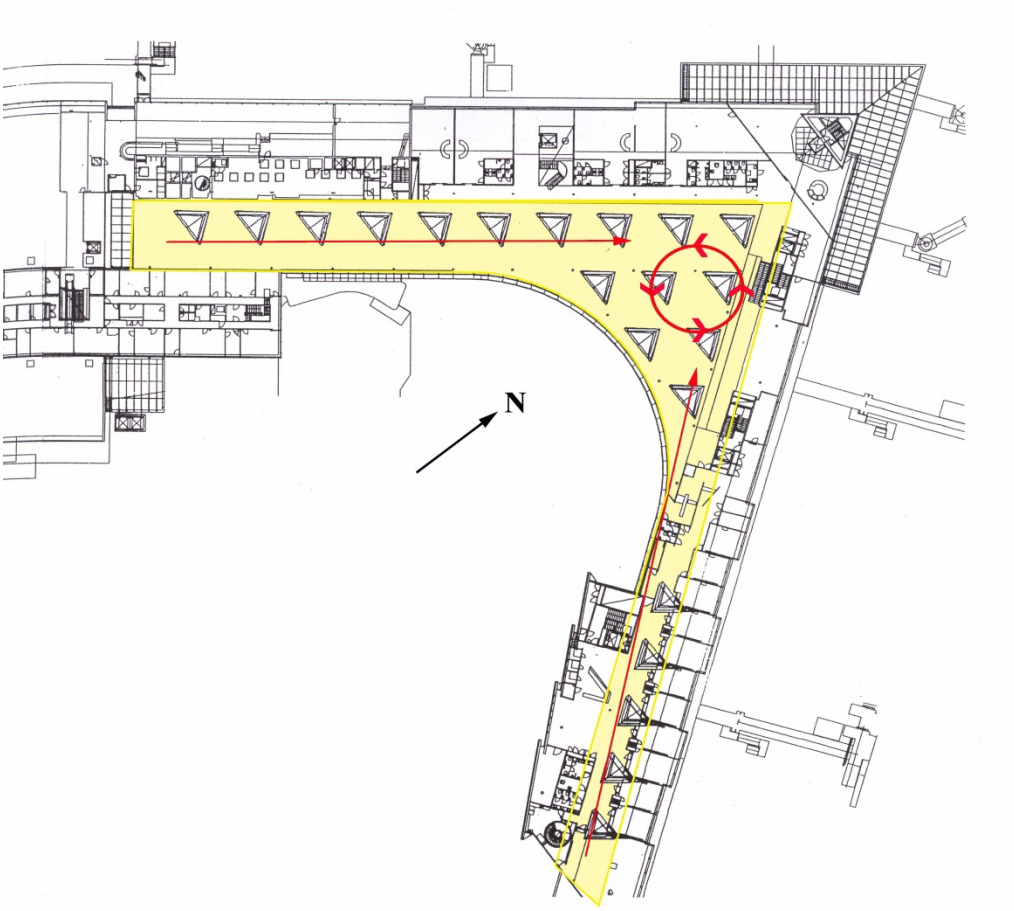


Figure 207. Photo Pekka Salminen Architects

Some simple facts to open the project:

- Helsinki Vantaa Airport 60°10’N
- Terminal 2 – International terminal, European gateway between East and West
- Architectural concept uses triangular shape of site as theme
- Lighting concept is everlasting light from glowing ice boulders
- Finnish design “functional, natural and austere, with a purity of form and material”

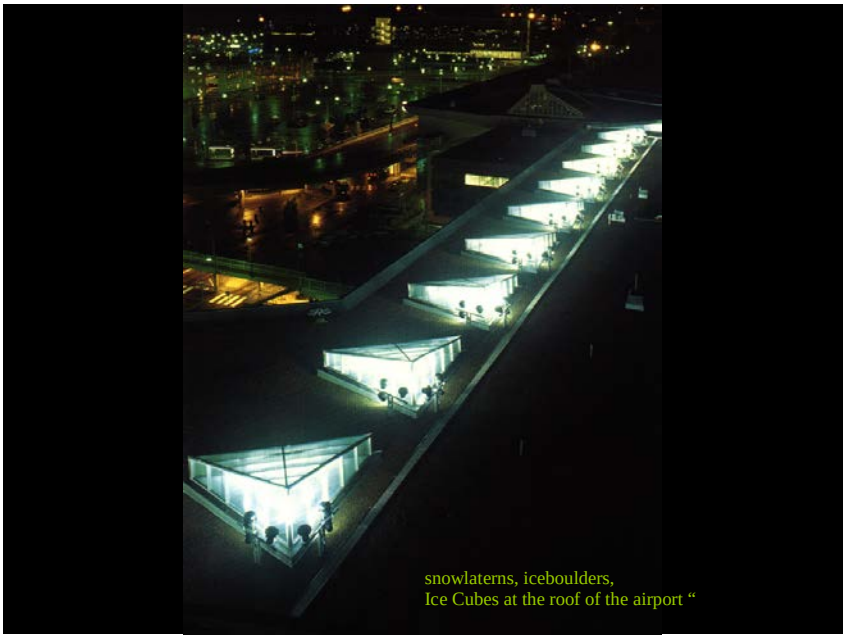


Figure 208. Lightprisms on the roof. Photo Pekka Salminen Architects

View from air traffic control room to “west wing” roof. Glass elements penetrate through the roof down to interior part of the airport hall

Figure 209. Lightprisms inside the terminal. Photo pekka Salminen Architects

View inside the airport hall. Glassprisms bring both daylight and electric light inside the west wing corridor. Everlasting cool light refreshes travellers with its approx. 5000 kelvin light days and nights.

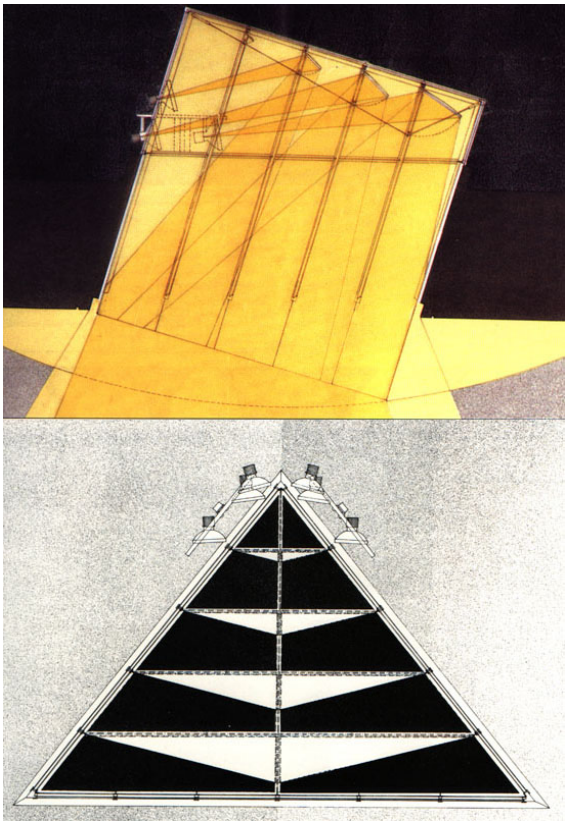
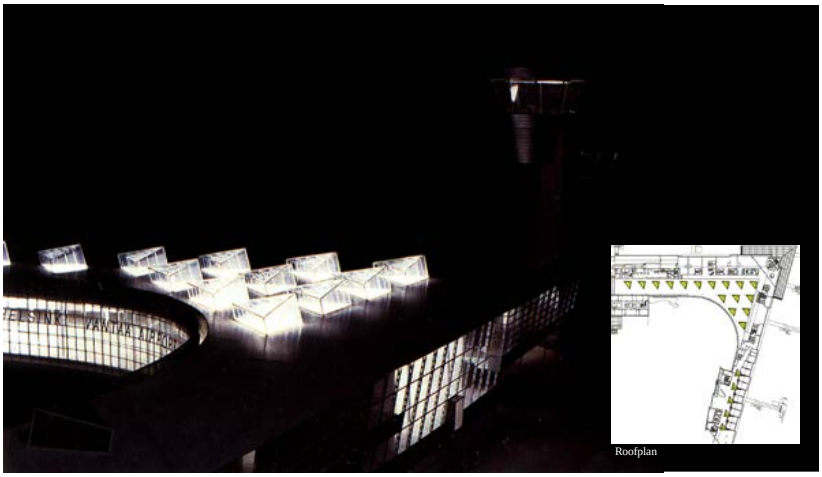


Figure 210. Lightprism as a luminaire. Photo Pekka Salminen Architects

We treated those 5000 lb glass lightprisms as huge luminaires. Light sources were daylight and metalhalide floodlights.

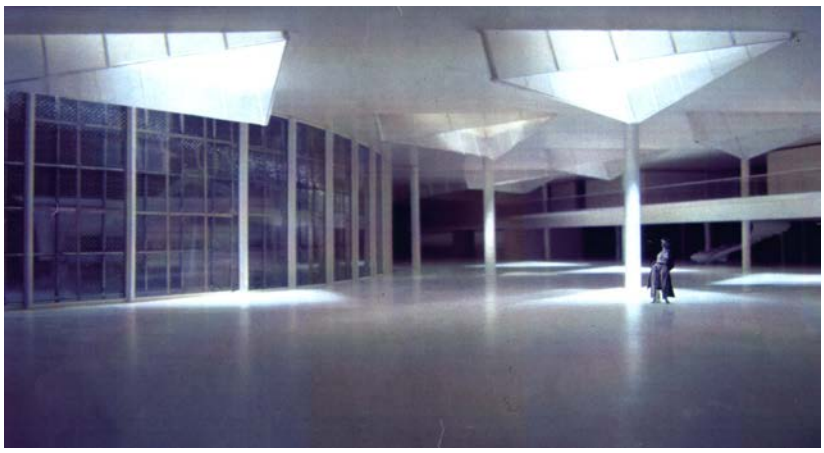
Figure 211. Lightprism during the day. Photo Julle Oksanen



Location of light cubes and scale-model 1:50
Philosophy outside: Shining icy elements,
glowing ice-cubes in nordic night

Figure 212. Airport model 1:50. Photo Pekka Salminen Architects

Models and mock up's are needed when calculating Daylight factor (DF). The scale of the model is not very important. The size of it is good to design so, that it is easy to handle inside an artificial sky room. This model is a perfect model to calculate and measure DF. View outside the airport model.



Scale-model 1:50 inside gateway-area
Examining the shape of the light in the gateway hall

Figure 213. Camera view from inside the airport model. Lady in the middle of the photo is 2 inches high and is taken from fashion magazine and glued on cardboard. Photo Pekka Salminen Architects

Good to know before DF measurement:

Sky Types

Whenever we take a look at the sky, its appearance has changed. Wheather it's clouds drifting across, the sun making its way from the East to the West, or the blue colour changing into a glowing red-- the sky has many faces.

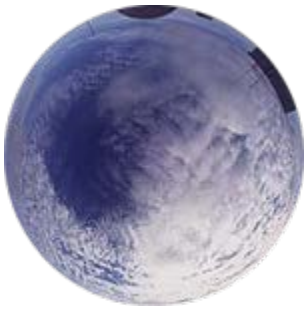
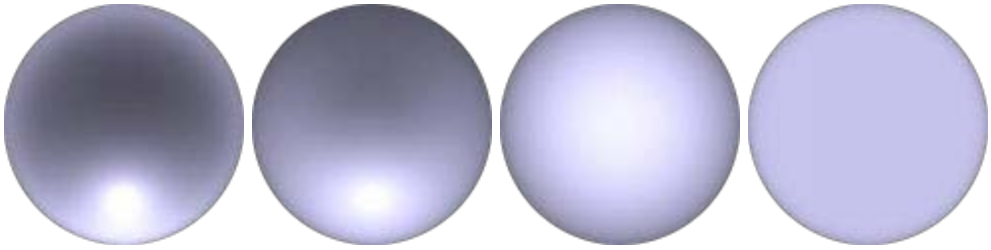


Figure 4. Sky over Trondheim. Photo Lighting lab of University of Trondheim

While all those effects are very interesting, they also make it difficult to create an accurate description or even a mathematical model of the sky. Architects and engineers, however, need to be able to model the sky so they can plan the daylight performance of buildings accurately.

The CIE has made succesful attempts to create such model skies that are a very valuable tool for everybody dealing with daylight.

Table 2. Sky models



Clear sky | Intermediate sky | Overcast sky | Uniform sky

Clear sky

The luminance of the standard CIE clear sky varies over both, altitude and azimuth. It is brightest around the sun and dimmest opposite it. The brightness of the horizon lies inbetween those two extrems.

Intermediate sky

The standard CIE intermediate sky is a somewhat hazy variant of the clear sky. The sun is not as bright as with the clear sky and the brightness changes are not as drastic.

Overcast sky

The luminance of the standard CIE overcast sky changes with altitude. It is three times as bright in the zenith as it is near the horizon. The overcast sky is used when measuring daylight factors. It can be modelled under an **artificial sky**.

Uniform sky

The standard uniform sky is characterised by a uniform luminance that does not change with altitude or azimuth. It is a remnant from the days when calculations were done by hand or with tables. Today, it is still used for Rights of Light cases.

Figure 5. Overcast Sky Simulator. Photo Pacific Energy Center

This is a Mirror Skybox in the Pacific Energy Center. It is also called the Overcast Sky Simulator, which is a tool for measuring daylight in physical models.

Figure 6. View inside the Mirror Skybox of the Pacific Energy Center.

Figure 7. Daylight study at PEC lab

Model is installed under the overcast sky in Pacific Energy Center.

Figure 9. Licon sensors. Photo PEC

Licon lx- sensors are located inside the model in relevant Grid. Measurements must be taken on a 10-foot grid for all occupied spaces and must be recorded on building floor plans - of course, you have to put sensors in relevant scale inside the model.

OBS!

Universities and research centers and even some luminaire manufacturers have Artificial Sky. If you don't have an opportunity to use any of existing Artificial Skies, you also can do equal measurements cheaper by bringing your physical model outside anywhere, under an overcast sky, and make

Figure 8. Overcast sky. Photo Julle Oksanen

same measurements there.

The Helsinki Vantaa Airport model has been measured in different universities as students' workshops both in USA and in London UK.

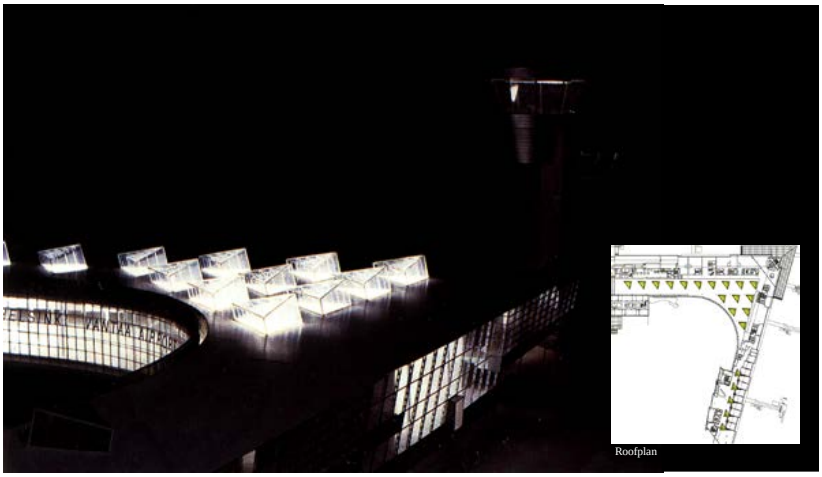


Figure 220. Helsinki vantaa airport model. Photo Pekka Salminen Architects

Average daylight factor of this airport terminal model was 4.1.

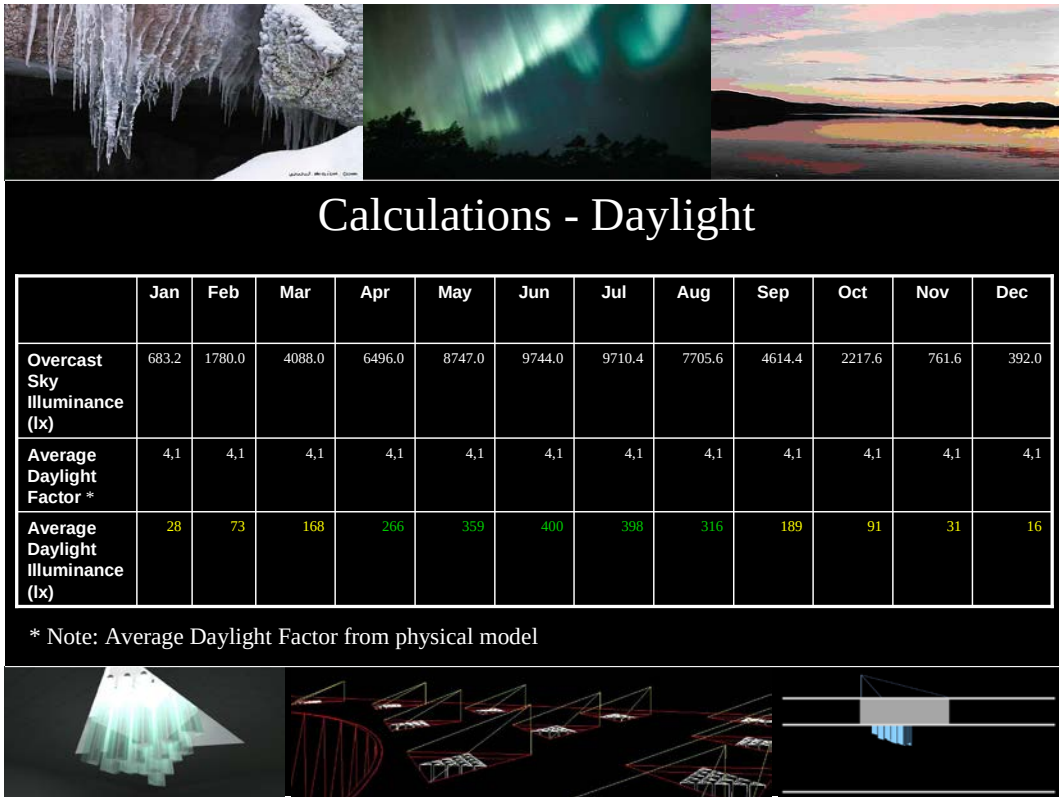


Figure 221. Students workshop at the Bartlett, University College, London. Photo UCL

Option 3

Demonstrate through records of indoor light measurements that a minimum daylight illumination level of 25 fc has been achieved in at least 75% of all regularly occupied areas. Measurements must be taken on a 10-foot grid for all occupied spaces and recorded on building floor plans.

Only the square footage associated with the portions of rooms or spaces meeting the minimum illumination requirements may be counted in the calculations.

For all projects pursuing this option, provide daylight redirection and/or glare control devices to avoid highcontrast situations that could impede visual tasks. Exceptions for areas where tasks would be hindered by daylight will be considered on their merits.

Relevant illuminance values for calculations September 21st 9 am & 3 pm can be found here: **http://www.energy-design-tools.aud.ucla.edu/**

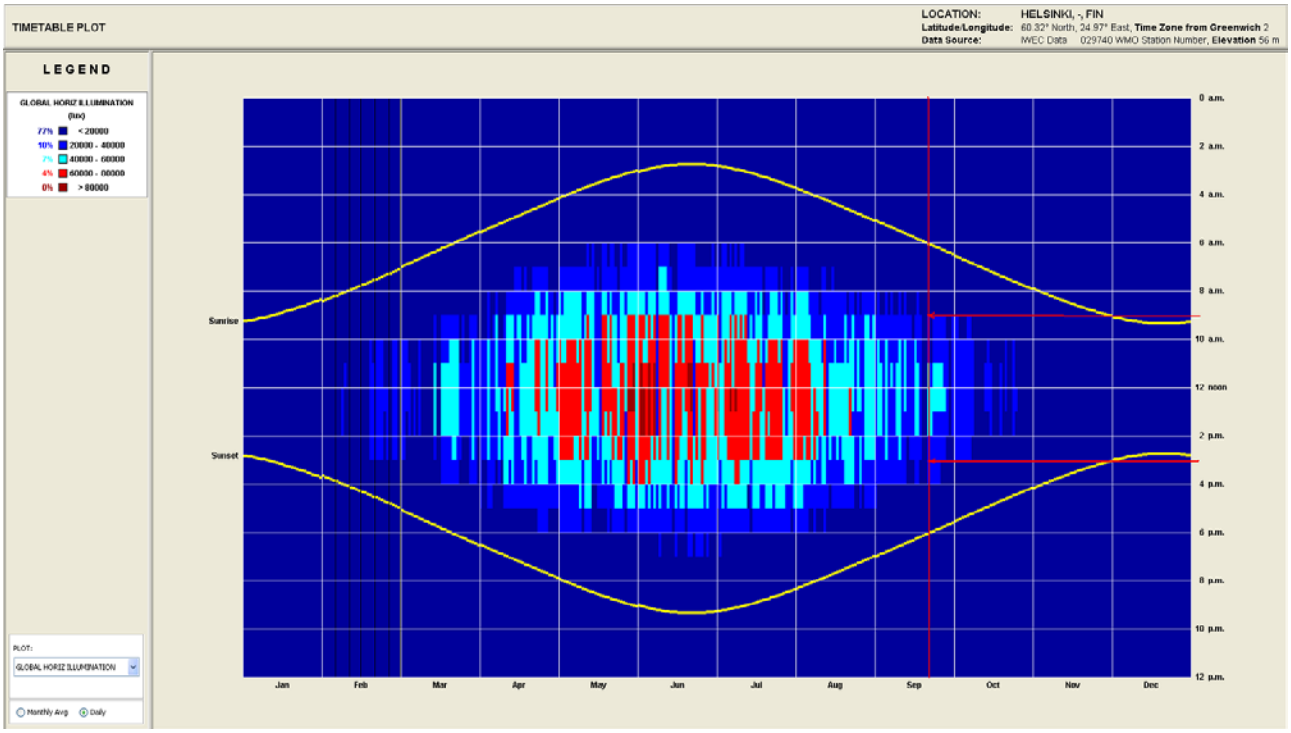


Figure 222. Annual daylight values in Helsinki. Photo UCLA

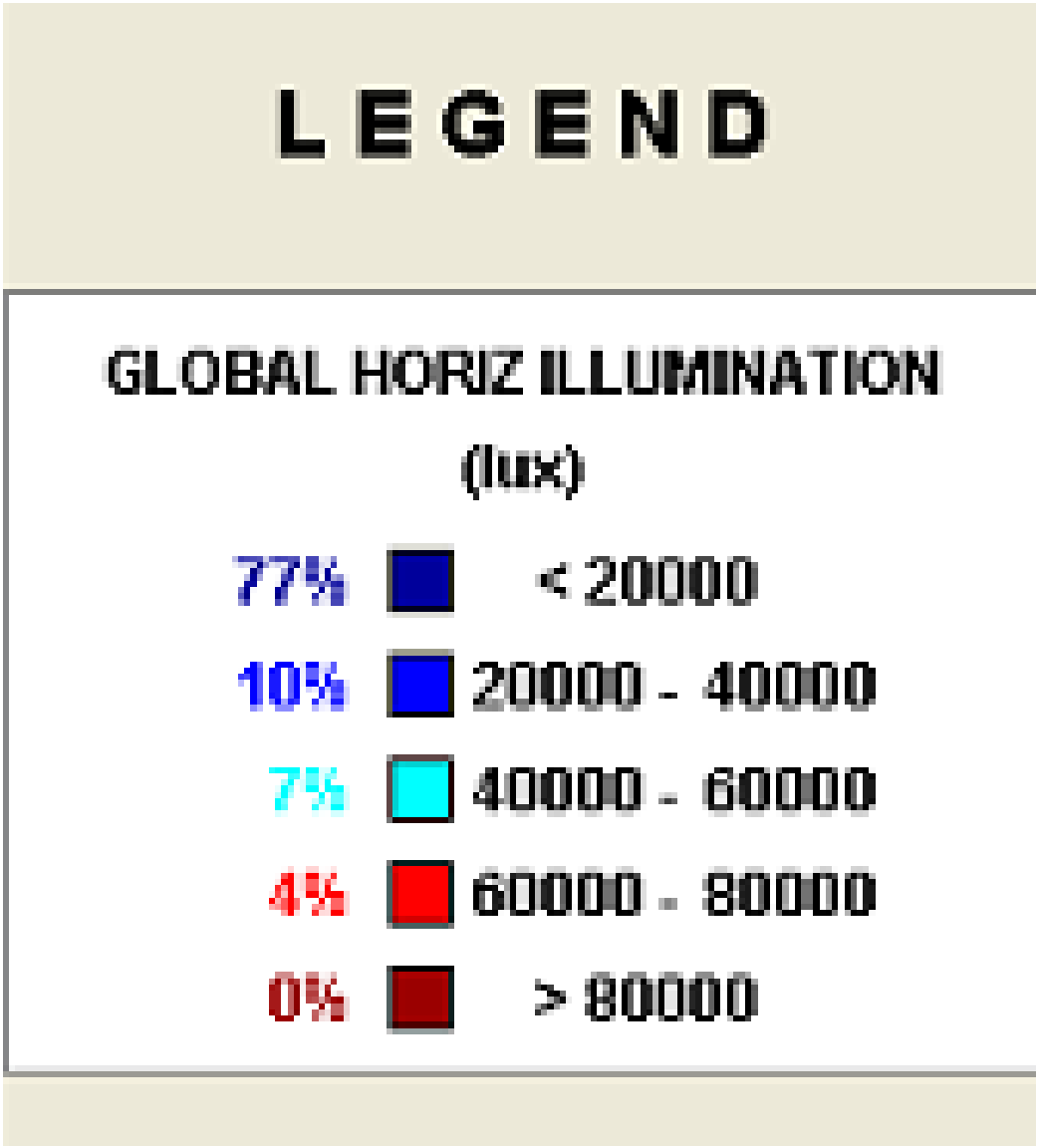


Figure 223. Daylight values. Photo UCLA

Note Note: 10 lux equals approximately 1 footcandle

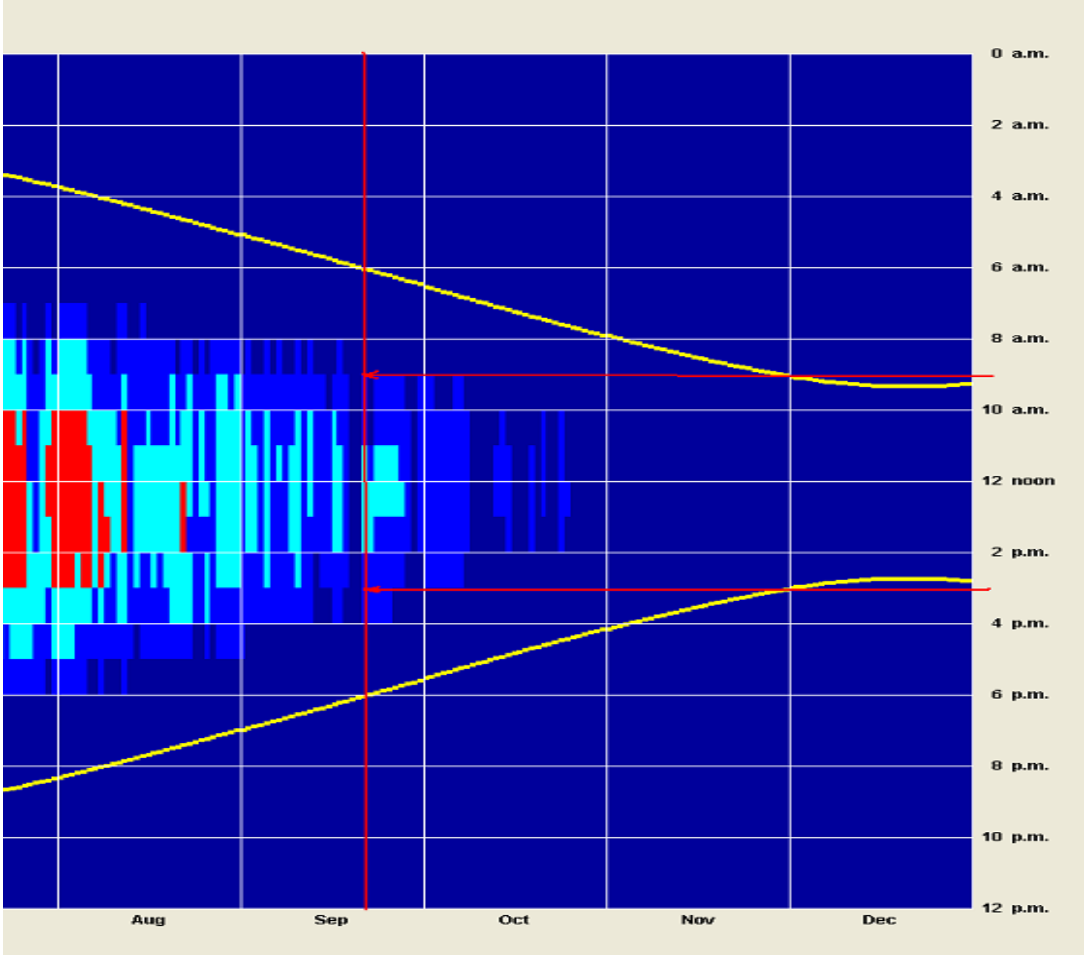


Figure 224. Daylight values September 21st at 9am and 3pm. Photo UCLA

Values can be find / determined**:** **http://www.energy-design-tools.aud.ucla.edu/**

Calculation:

September 21st 9am E_h = 20000 lx x 0,041 = 820 lx (82 fc)

September 21st 3pa E_h = 20000 lx x 0,041 = 820 lx (82 fc)

E_h- values on grid varied some, but all values exceeded E_h = 250 lx on September 21st at 9am and September 21st 3pm.

Figure 225. Helsinki - Vantaa airport. Photo Pekka Salminen Architects

1 LEED point is earned in this project according to this option 3 study.

On this project- latitude + 60 degrees,theoretical limits for minimum and maximum daylight values can be determined as follows:

- **Minimum** Clear Sky Illuminance value to earn 1 LEED credit on September 21st 9 am & 3 pm is 250 lx / 0.041 = **6097 lx(610 fc)**
- **Maximum** Clera Sky Illuminance value to earn 1 LEED credit on September 21st 9 am & 3 pm is 5000 lx / 0.041 = **121951 lx(12,200 fc)** (Not possible).

Because daylight varies all the time and exact figures do not exist, it is good to compare daylight values on September 21st at 9am and 3pm from different information sources.

Calculation above had values from the program: "Climate Consultant 5".

Other paths to check values are as follows:

Helsinki, Finland is at 60 deg 15' latitude. At 09:00 and 15:00h on 21 Sep, the sun altitude, **a** is approximately 20.5 deg.

Average total horizontal illuminance E_g derived from Chroscicki (Tregenza P R. Measured and calculated frequency distributions of daylight illuminance. Lighting Research & Technology, Vol 18, No 2 (1986) pp 71-74) from several European stations is given by an empirical equation:

E_g = (89100 sin **a**)/(1+0.2 cosec **a**)

For Helsinki therefore E_g = 31203.48/1.571 = **19 862 lx (1986 fc)**

Krochmann (Krochmann J and Seidl M. Quantitative data on daylighting for illuminating engineering. Lighting Research & Technology, Vol 6, No 3 (1974) pp 165-171) provides a graph.

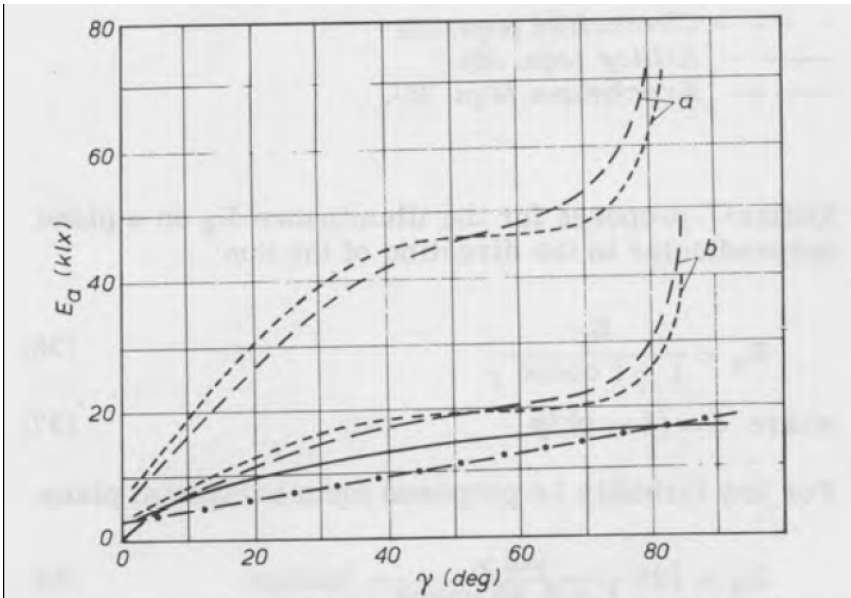


Fig. 11. Illuminance on a horizontal plane from clear sky.

— — *Dogniaux, Kittler*
– – – *Dogniaux, Gusev*
——— *Krochmann (eqn. 32)*
—. — *Chroscicki (eqn. 33)*
a $T = 7.0$
b $T = 3.0$.

Figure 226. Photo Krochmann & Seidl

suggesting the illuminance E_a on a horizontal plane from the clear sky based on the work of Dogniaux, Kittler and Gusev for two values of turbidity of the sky, T = 7.0 and T= 3.0.

So by inspection,

for the altitude of the sun = 20.5 degrees with T=7.0, then E_a = **30 000 lx** (3000 fc)

for the altitude of the sun = 20.5 degrees with T=3.0, then E_a = **12 000 lx** (1200 fc)

I would imagine the turbidity of the sky in Helsinki is more like 3.0 than 7.0 so our calculations would not be far wrong if we estimate the horizontal illuminance from the clear sky in Helsinki on 21 Sep to be between **12 000 - 19 000 lx** (1200 – 1900 fc).

In first example calculation, where we took values from the “Climate Consultant 5”- program, E-value was 77% < 20000lx (2000 fc) and 10% > 20000 lx (2000 fc).

So we have done a good work and study.

As an extra study in this project to study a few more daylight values and the need for electric light controlling systems:

Design Sky

Design Sky values are derived from a statistical analysis of dynamic outdoor sky illuminance levels. They represent the horizontal illuminance value that is exceeded 85% of the time between the hours of 9 am and 5 pm throughout the working year. **Thus they also represent a worst-case scenario that you can design to and be sure your building will meet the desired light levels at least 85% of the time.** Design sky values vary from around **12-15,000 lux** (1200 – 1500 fc) at the equator down to around **3-4000 lux** (3000 – 4000 fc) at a latitude of ±60°, as shown here:

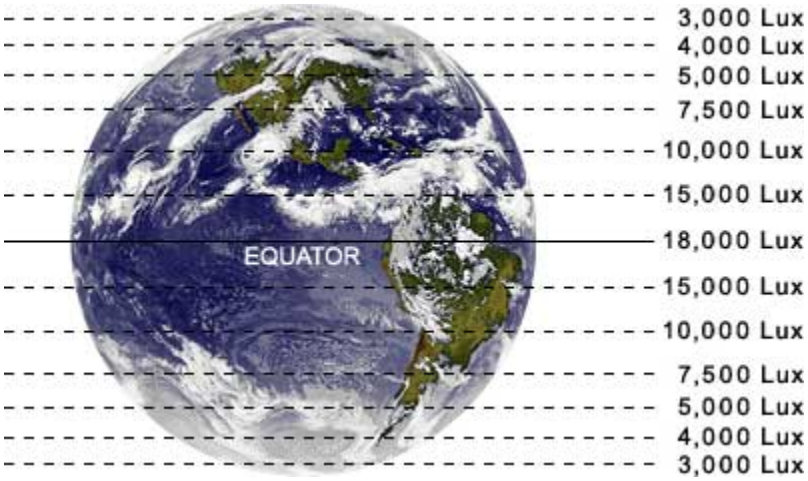


Figure 227. Design Sky Illuminance values as a function of latitude

In our project we can now multiply this average +60 latitude value of 4000 lx (400 fc) with our DF, which is 4.1. The result is 4.1/100 x 4000lx = **164 lx (16.4 fc), which represents the worst daylight- value between timeperiod of 9am – 5pm.**

We can predict that this Lightprism solution is a great daylight producer and if the project would be space which were used only between 9am and 5pm, electric light would not be needed at all. But an airport never sleeps and electric light is also needed. Naturally a lighting control system is needed. This is a great project- a solution to harvesting energy savings and minimizing the CO_2footprint.

Option 4 permits a combination of the other 3 methods.

For views, it must be demonstrated that vision glazing between 30 inches and 90 inches above the floor is within direct sightlines in both plan and section from all regularly occupied spaces. For both credits, the 75% or 90% compliance is calculated by dividing the area of the floor that meets the criteria above by the total floor area of all the regularly occupied spaces.

Sight to perimeter vision glazing. For multi-occupant spaces, the actual square footage with a direct line of sight to perimeter vision glazing is counted.

IEQ Credit 8.2 – Daylight and Views - Views

In addition to credits for daylighting, LEED offers credits if building occupants are given the opportunity to see outdoors. A view to the outdoors gives people a way of connecting to the cycle of the day and a relationship to nature that helps offset the pressurized high tech environment found inside most buildings. The author experienced working in a windowless building during his college co-op terms and found it to be depressing and disorienting. During the winter, entering before dawn and departing after sunset was especially hard. The Reference Guide states that, in offices with sufficient daylight and views, occupant productivity and comfort are increased.

The LEED Credit for views earns 1 point for providing direct line-of-sight to the outdoors from 90% of all regularly occupied spaces. This line-of-sight must be through vision glazing between 30 and 90 inches above the finished floor. This view to the outdoors can be through glazed partitions. For private offices, the entire office area can be counted if 75% or more of the floor area has a view.

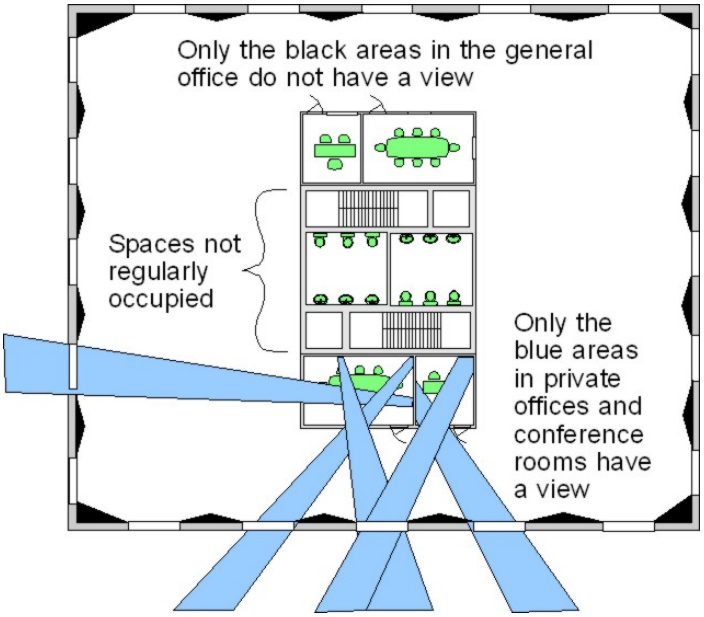


Figure 228. Study without computer

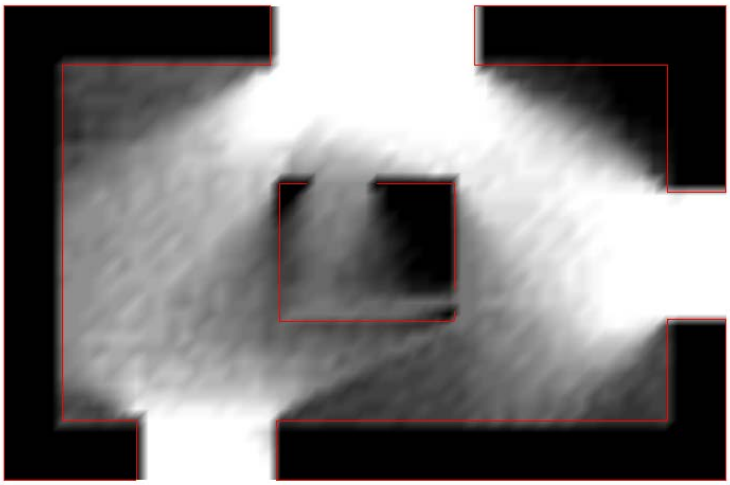


Figure 229. Study with computer (White = direct line-of-sight to outdoors). Photo Tony Osterlund

For classrooms, the area with a direct line-of-sight to the outdoors is counted. If 90% of the floor area meets these criteria, the Credit is earned. For Core and Shell projects, a feasible tenant layout must be provided.

The line-of-sight vision is measured in both horizontal and vertical planes. In the vertical plane (Fig 230), it is usually taken at the eye level of a seated adult which is considered to be 42 inches above the floor. For schools it is lower, since younger students are shorter and have lower seats. For other uses the level may also be different.

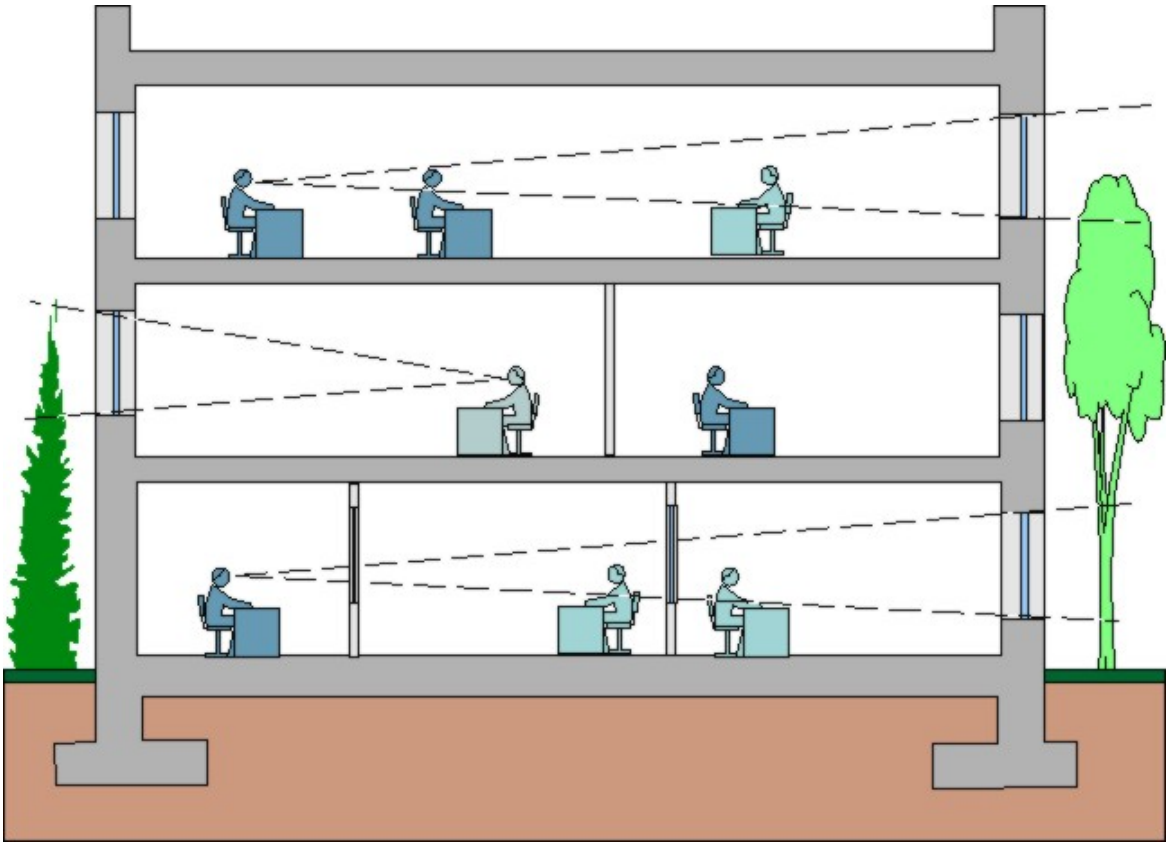


Figure 230. Lines of sight

Architectural and Environmental Issues

The discussion under Daylighting above is also applicable to the Views credit. The Reference Guide encourages designers to place private offices in the core areas of the building and large open plan areas such as classrooms on the perimeter. This provides the greatest amount of views to the exterior for the most occupants.

Example calculation of Daylight and Views- Views: Shopping Mall in Finland

(designed by Arkkitehtityohuone ArttopaloRossiTikka Oy/ Architect Hannu Tikka).

The main entrance has large glass walls. It opens the shopping mall for customers and looks attractive and inviting.

Figure 231. Shopping mall in Finland. Photo APRT Architects

Figure 232. Shopping mall in Finland. Photo APRT Architects

Other walls don't have large window areas because it means fewer sales areas inside the shops which are located inside the shopping mall.

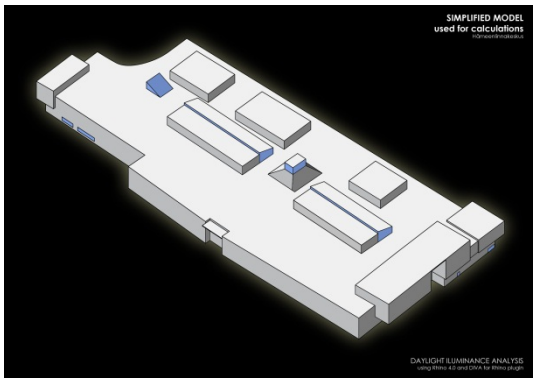


Figure 233. Skylights (blue). Photo Tony Osterlund

4 large skylights don't give a view area.

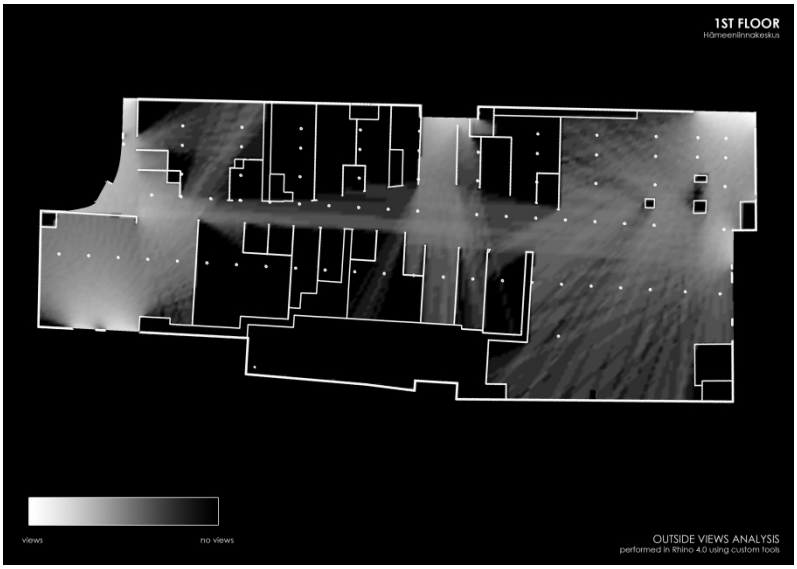


Figure 234. Calculation for Outside Views. Photo Tony Osterlund

Calculation for Outside Views Analysis is performed in Rhino 4.0 and using custom tools.

Less than 75% of the total area has a view. No View Credit earned here.

Architectural and Environmental Effects

To effectively use natural light, the designer must balance several potentially conflicting issues. In the first place, enough light must be provided but not too much. With overhead electric lighting, the sources can be uniformly distributed in a space. Toplighting (from over head through skylights or clerestories) can approach this uniformity, but sidelighting cannot. Toplighting, however, does not provide views and is mostly applicable to spaces with a roof directly overhead.

Note that the LEED Rating System and the Reference Guide use the term skylight, which is generally used to describe horizontal glazed openings in the roof, to include clerestories and monitors, which are roof openings with vertical glazing and a partial opaque roof.

Figure 235. Clerestory labeled a skylight. Photo Richard Kelso

Sidelighting provides a lot of light near the windows and progressively less light further into the space while toplighting can be more uniformly distributed. Toplighting, however, admits the most light during summer months when overheating is the problem and the least light in the winter when heat is usually desirable.

Some samples of different kinds of architectural arguments and styles in skylights and clerestories:

Figure 236. Konxville airport. Photo Richard Kelso

Soft and nice daylight. Skylights also follow the architectural rhythm of the space.

Figure 237. Helsinki - Vantaa airport. Photo Pekka Salminen Architects

Architect Pekka Salminen designed skylight-clerestories at Helsinki-Vantaa airport. They simulate and represent the Nordic spirit and Finland. Important snowlanterns and ice boulders in the Nordic environment produce eternal daylight inside the building.

Figure 238. Nelson Atkins Museum. Photo Julle Oksanen

Figure 239. Nelson- Atkins Museum. Photo Julle Oksanen

Architect Steven Holl has designed the Nelson- Atkins Museum of Art in Kansas City. This building is made with mainly glass without getting the LEED credit for Views.

Figure 240. New German Parliament house in Berlin. Photo ERCO

Architect, Sir Norman Foster. The Reichtag, the New German Parliament house in Berlin. Glare is not a problem if the whole space or building is made of visible glass. In this kind of case our eyes don't have to react to fast luminance changes. No adaptation zones and timing is needed. Our eyes' adaptation ability is great. A good example is that during dark periods the illuminance values are between levels of 10 fc–50 fc (e.g. in offices) and still our eyes can handle perfectly even 10,000 fc (100000 lx) values in the outdoors during daytime.

Glass as building material

The LEED requirement is that the illuminance be between 25 footcandles and 500 footcandles.

Figure 241. LX- meter. Photo Richard Kelso

The Illuminating Engineering Society of North America (IESNA), the Chartered Institute of Building Service Engineers (CIBSE) and the Commission Internationale de l'Eclairage (CIE) have all developed recommendations for illuminance levels that are too complex to include here. However, 25 footcandles is

considered adequate for general room illuminance and for visual tasks of large size and high contrast. 500 footcandles is suitable for detailed visual tasks of small size and is an illuminance level that might be found outdoors on an overcast day.

A major problem designers must avoid is glare. (Definition – Glare is the presence of a bright light or reflection in the field of view that causes discomfort or interferes with performing a visual task).

Areas near windows have potential for glare problems. For example, as this is being written, the author is sitting in his office looking out of a north-facing window. Thirty feet away, a building extension houses a stairwell with south-facing windows and the sun, high in the southern sky, is reflecting off the glass into his eyes.

Figure 242. Glare. Photo Richard Kelso

In most cases, the illuminance on the floor or a horizontal workplane near a window on a sunny day can be 1000 footcandles or more. For these reasons the LEED requirements include upper limits for illuminance and warnings about glare.

Daylight is by definition only available in the daytime, and even then is highly variable. Human eyes can adapt to these varying levels but there will inevitably be times when daylight is insufficient for visual task needs. Electric supplementary lighting with controls to dim or turn it off will be required. Occupant-operated controls such as curtains or blinds are highly recommended.

Glass for windows or skylights is another consideration. Three performance measures are necessary to evaluate and select the glass. One is the convective/conductive heat transfer coefficient U_0 measured in Btu/hr-sf-^{0}F. It is the reciprocal of the overall thermal resistance R_t. It measures the rate of heat flow from warm inside air to cold outside air in winter and the reverse in summer and is independent of the radiant heat transfer. Single 1/8 inch glass has $U_0 = 1.13$ and triple glazing has a U_0 as low as 0.27 - the lower the better, of course.

The second performance measure is the visible light transmittance, VLT. It is the dimensionless ratio of the visible light that passes through the glass to the incident light on the outer surface. Single 1/8 inch clear glass has a VLT of about 0.90 and double tinted glass can have VLT in the 0.46 range. In this case, higher is generally better.

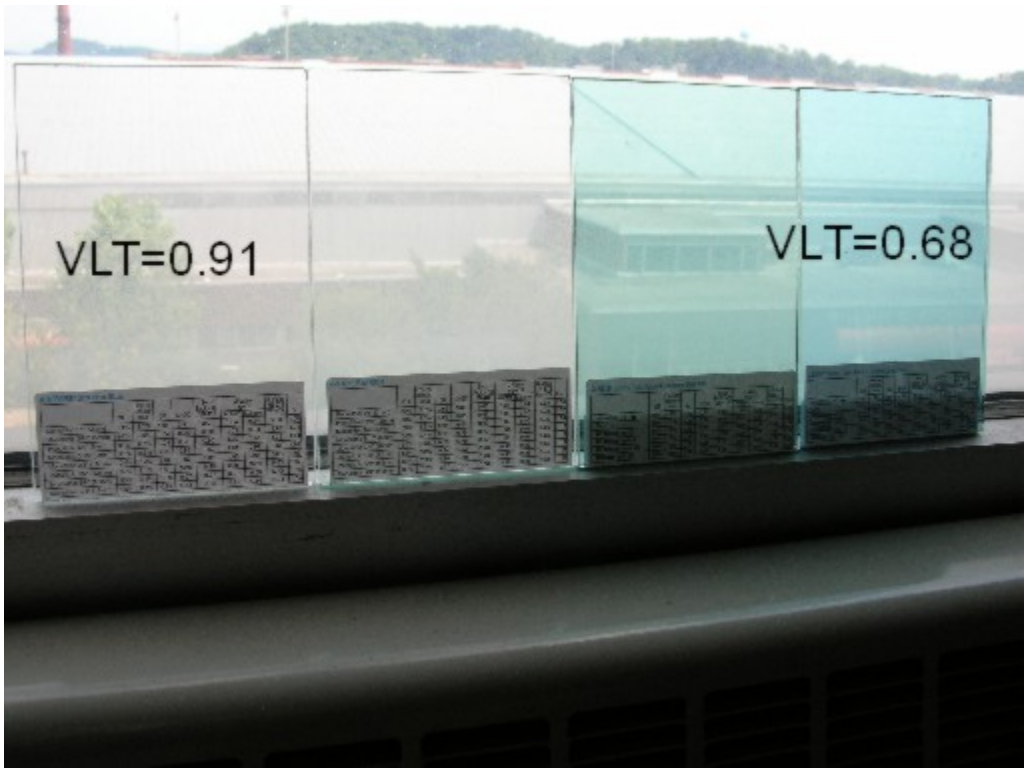


Figure 243. Glass samles. Photo Richard Kelso

The third measure is the transmission of radiant heat. The common measurement parameter is the Solar Heat Gain Coefficient (SHGC) which is the dimensionless ratio of total solar heat admitted through the glass to the incident solar heat. Single 1/8 inch clear glass has a SHGC of about 0.86 and triple glazing with low-e coatings can be as low as 0.26, and lower is better. An ideal glass would have a low U_0, a high VLT and a low SHGC. Such a glazing system almost always costs more than glass with lower performance, so the designer must do a cost-benefit analysis to select the proper combination and size. Window manufacturers have formed an industry rating organization called the National Fenestration Rating Council (NFRC) whose website www.nfrc.org gives measured performance data for their products.

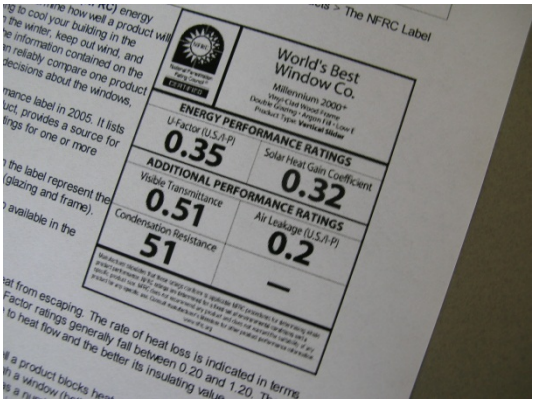


Figure 244. Glass performance data. Photo Richard Kelso

Glass manufacturers also have developed new helping tools for window selection process. Pilkington USA has created “calculators” like:

1) Sun Management Calculator: http://www.pilkingtoncalculators.com/smc.php
2) Thermall Stress calculator: http://www.pilkingtoncalculators.com/tsc.php
3) The Pilkington Sun Angle Calculator http://www.pilkington.com/the+americas/usa/english/building+products/tools+and+calculators/sun+angle+calculator.htm
4) ASTM E1300 Wind Load Calculator http://www.pilkington.com/the+americas/usa/english/building+products/tools+and+calculators/wind+load+calculator.htm

Example of glass selection process:

When you make a glass selection, you have to be very careful and very sharply understand what you are doing.

This example is a Stockmann shopping mall skylight glass design and selection process. The shopping mall is located in the center point of Helsinki, Finland. The skylight was designed for natural daylight, but during the years Stockmann had raised the building with many floors to increase their business. Our task was then to create daylight simulation through that skylight. We won’t go too far in details, but just focus on the “main” thing, the glass selection process.

Figure 245. Stockmann shopping mall in Helsinki, Finland. Photo Julle Oksanen

Figure 246. Stockmann shopping mall in Helsinki, Finland. Photo Julle Oksanen

The Stockmann shopping mall has 7 floors and approximately 880.000 square feet of sales area.

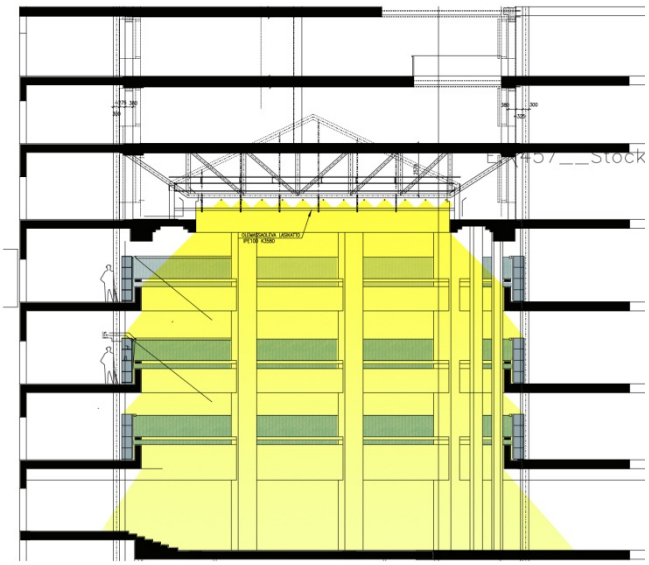


Figure 247. Section of skylight simulation. Photo Julle Oksanen Lighting Design Ltd

Figure 248. Lamp luminaires integrated in the glass panels. Photo Julle Oksanen

During the years the old and beautiful skylight was changed to a “glary ceiling” with industrial metal halide lamp luminaires integrated in the glass panels.

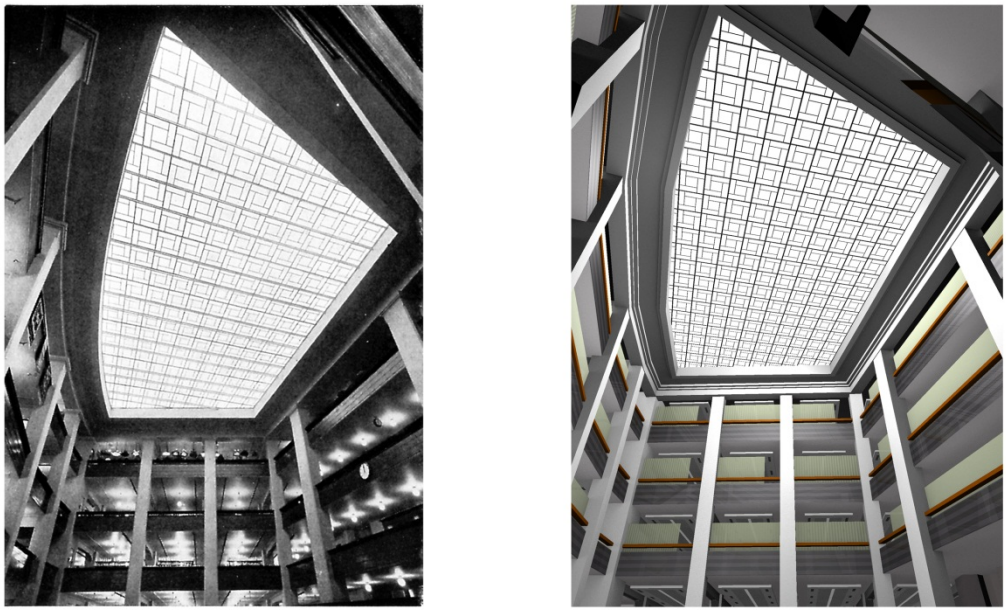


Figure 249. Old skylight (left) and computer generated model (right). Photo Julle Oksanen Lightingdesign Ltd

We wanted to change back to architect Frosterus's beautiful skylight. On the left side on the image is the old skylight and on the right side is our computer manipulated model.

Our lighting design worklist was shortly, but sharply as follows:

1) Successful daylight simulation

2) Right light sources = lamps.

3) Right color temperature and color rendering index.

4) Luminance of skylight. (How bright the surface appears to us)

5) Right glass material selection.

6) Produced E_{hor} on the ground floor (see the section).

7) Heat that light sources produce inside the "lamp chamber" (see lamp chamber)

8) Reasonable price.

9) Maintenance free.

10) Solve conflicts between 1-9 and find greatest compromise.

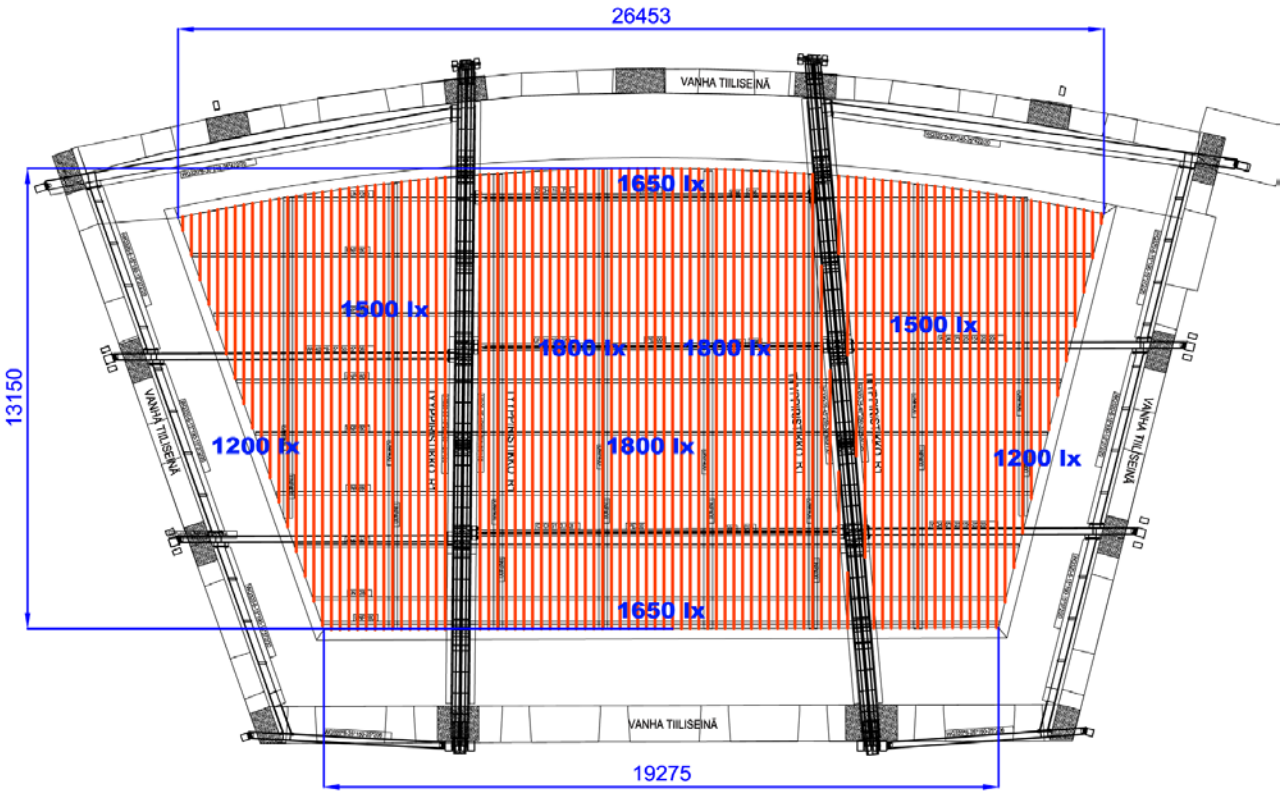


Figure 250. Calculation results without glass = skylight is open. Photo Julle Oksanen Lighting Design

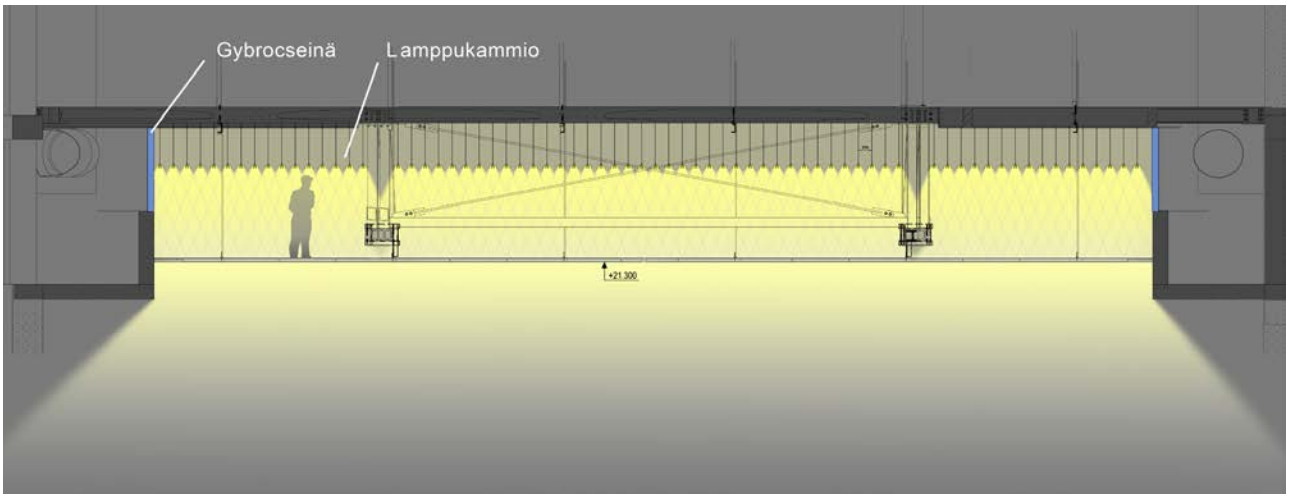


Figure 251. Lamp chamber. Photo Julle Oksanen Lighting Design Ltd

Lamp chamber. We closed the skylight and created a **lamp chamber**. See the person standing inside.

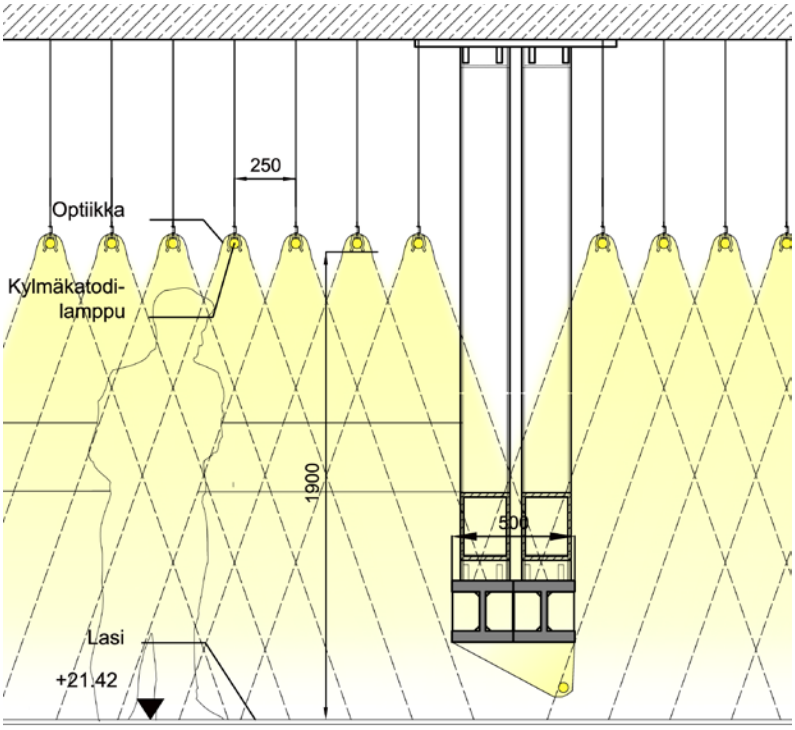


Figure 252. Detail. Photo Julle Oksanen Lighting Design Ltd

Figure 253. Our computer manipulation inside the lamp chamber. Photo Oliver Walter

Figure 254. Glass demonstration. Photo Julle Oksanen

Figure 255. Empirical tests for preliminary glass material selection. Photo Julle Oksanen

The glass selection process was quite complicated. We purchased samples from manufacturers and tested light scattering, absorbtion, penetration, VLT values, visual effects (If you can see lamp projections through the glass, skylight simulation effect is lost), luminance of the glass surface, produced heat, e.t.c.

The biggest problem of the glass selection process was that we didn't know how the glass would react in our case. Also, features of glass are not simple and it often requires a professional glass expert to solve glass problems. We contacted the manufacturer and asked what is the right glass for our purpose. The

glass expert told us that the glass must be strong enough to carry a person who weighs 220 lb (100kg) who steps on the middle point of the largest glass panel and his foot size is European size 30 (children's size). We knew the light values that we wanted and together we found the right glass for that project.

Figure 256. Final result. Photo Voitto Niemelä

Site, light and building

Other factors that designers must consider include such building elements as the number of stories which will affect whether top- or side-lighting can be used. The orientation of the building is of major importance. Frequently designers find that daylighted buildings that are elongated on the east-west axis and shortened on the north-south axis, having smaller window areas on the critical west side, are more energy-efficient. Interior finish material light reflectances are important in daylighting. To reflect more light into the deeper parts of rooms, light surfaces are essential.

Up until the 1950's, when daylight was the preferred light source for commercial, institutional and industrial buildings, most building plans were for single or double loaded corridors with rooms perhaps twenty five feet deep. If more space was required the buildings formed an L, a U or E, or had a central courtyard to admit light to all spaces.

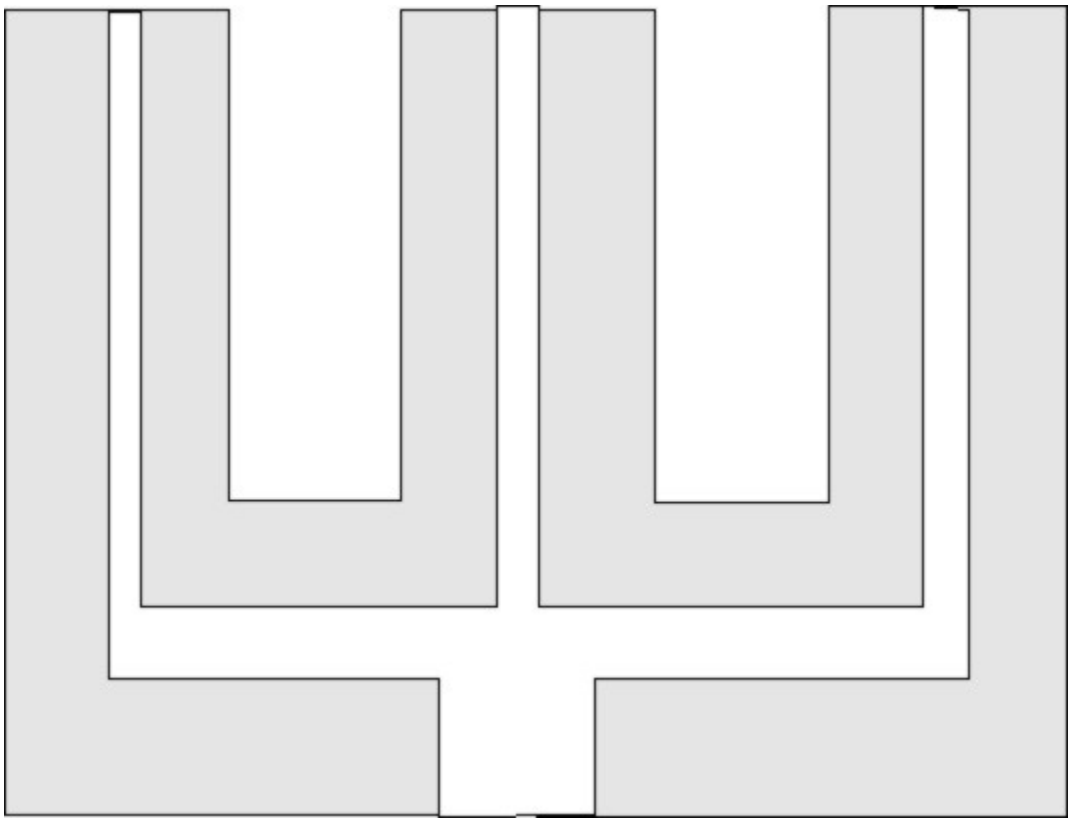


Figure 257. Building with central courtyard. Photo Richard Kelso

These plans are still viable for the same reasons, but now buildings with atria have assumed a prominent role.

Figure 258. Building with and atrium. Photo Julle Oksanen

An atrium offers an opportunity to introduce daylight from the top or sides deep into the interior of a building and yet have the added interior space that a courtyard lacks and even have a smaller enclosed surface area. Rooms that open into the atrium can receive some daylight and those that open both into the atrium and the exterior can have light from both sides.

Daylight control elements

Daylighting control elements that designers may consider include fixed devices such as overhangs or fins. Overhangs above the windows work especially well on the south side of a building

Figure 259. Photo Richard Kelso

and also to some degree on the east and west. However, the early morning and late afternoon sun is so low that overhangs must be excessively long to completely shade east and west-facing windows. Vertical fins on the south side of windows can help in this case

Figure 260. Photo Richard Kelso

External devices such as screens.

Figure 261. Photo Richard Kelso

or perhaps tall trees can provide excellent shade.

Figure 262. Photo Richard Kelso

A light shelf may be preferable to an overhang.

Figure 263 Photo Richard Kelso

It is a fixed horizontal plane similar to an overhang, but located some distance below the top of a window with glazing above it. Its top surface acts to reflect light deeper into a space while the light shelf reduces illuminance near the window like an overhang. It may be entirely outside, partially in and partially out, or completely inside the window. Model testing or simulation can help determine which is best.

Adjustable shading devices to be considered include drapes, curtains, roller shades and blinds. Inside-the-glass shading is less effective than external shading, but can be effective and has the benefit of less maintenance and also occupant control. Heat gain effectiveness of these shades can be measured by their SHGC, which manufacturers can provide or which can be obtained from industry literature such as the American Society of Heating, Refrigerating and Air-conditioning Engineers (ASHRAE) Handbook of Fundamentals (www.ashrae.org).

For daylighting to improve the building's energy efficiency, electric lights must be dimmed or turned off when daylight is sufficient. Studies have shown that people are unreliable controllers – they tend to forget to adjust the lights or even to dial the level up to match the daylight luminance as it increases. Light sensors are more reliable and can switch rows of lights or dim lights in response to daylight availability.

Daylight controll structure design with Models

Daylight, especially sun light control design can be done with two different research methods. You either can use an existing **Heliodon** or you can use a **SunPegChart and camera stand (or equal rack)**. Universities and research centers in all over the world have Heliodons which you normally can use free of charge or just small compensation to cover costs of Heliodon. Some research centers and Universities also can prepare a reseacrch report of your model if you like. Polite help is also offered to use a Heliodon. You also can buy a report of the study of your model.

If you have not an opprtunity to use any existing heliodons, you can study the influence of the sun on your building in different sun positions in any location on earth regardless of your own positioning with a Sun Peg Chart and camera stand and the sun, of course.

In both cases the important thing is that the beam of light is SOLID. In the Sun Peg Chart case it is obvious because you use the real sun. In Heliodon cases the light source ought to supply light beams as straight on the model as possible. Then sun simulation is OK. IF light is not solid, the result will be wrong and the sun shading structures of your model don't work in the real building.

Why solid light?

Figure 264. The sun and earth. Photo NASA

In this image sun and earth are in right scale. The average distance between the sun and the earth is approx. 93 million miles. Because of earth's elliptical orbit around the sun, the distance changes over the course of a year. The distance between the sun and the earth in this image is approximately 300 miles. In reality, the distance between the sun and the earth is 93 million miles. This distance, drawn on same picture in scale, means that earth would be located in approximately 37 feet to right of that sun surface.

This is the reason why light beams of the sun are in a solid angle on the surface of the earth.

Heliodon method

Pacific Energy Center Heliodon:

The heliodon is a tool for identifying opportunities for energy savings and occupant comfort through more solar-responsive architecture. Read the function here:

www.pge.com/pec/heliodon

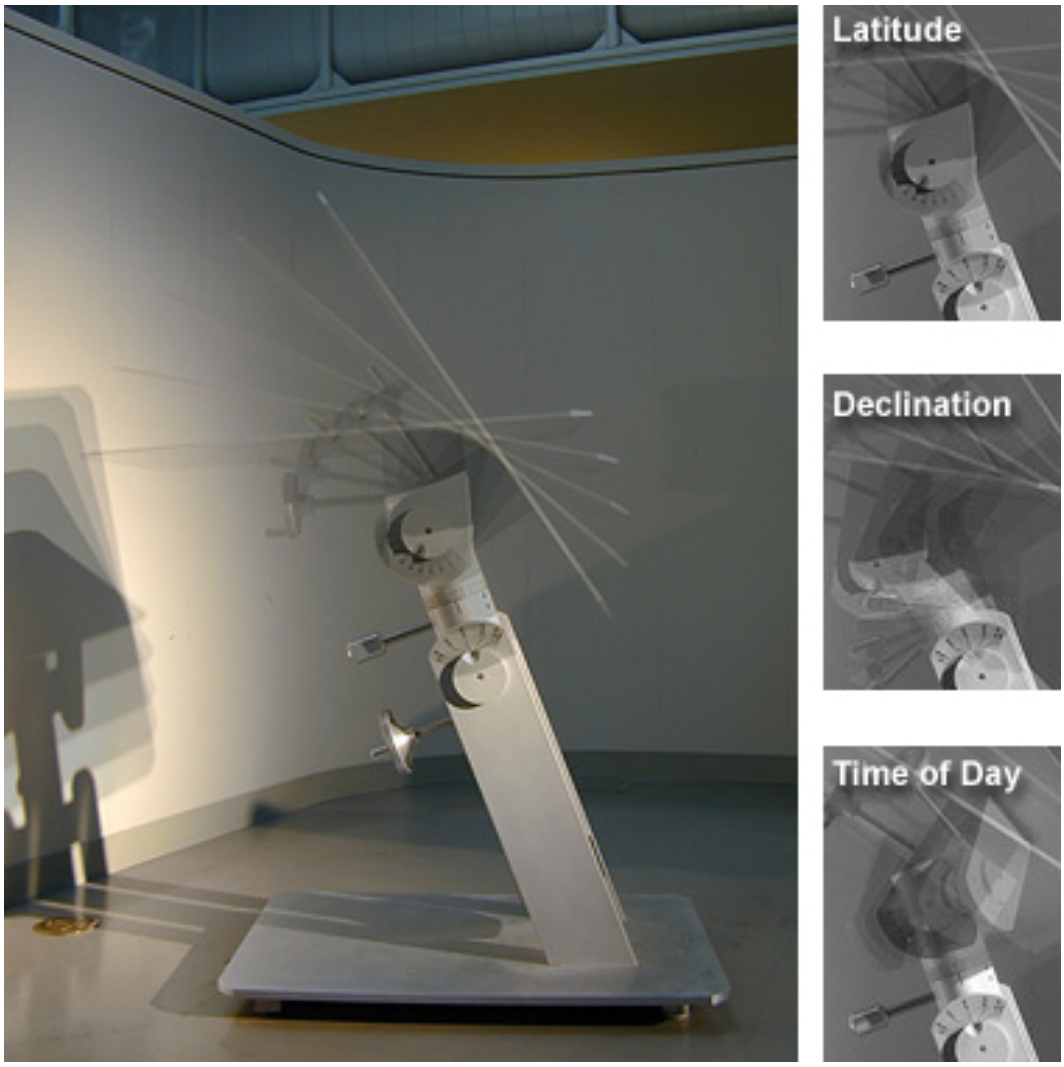


Figure 265. Heliodon. Photo PEC

You install your model on the heliodon table. Latitude, declination and time of the day can be determined for the table.

Figure 266. Heliodon in use. Photo PEC

Sun effect research of the model is under the way. The next photos give a flavour of the demonstration possibilities and advantages when studying the sun penetrating into the model.

Figure 267. December 21st – 9AM

Figure 268. December 21st – 10AM

Figure 269. December 21st – 11PM

Figure 270. December 21st – 12PM

Figure 271. December 21st – 1PM

Figure 272. December 21st – 2PM

Figure 273. December 21st – 3PM

After testing your model you can change the shading structures and see the effects and differences. Remember that you can study the behaviour of direct sun light, not any lighting values for your real building.

Sun Peg Chart- method

A Sun Peg Chart is a very handy tool to study and evaluate the effects and extent of sun penetration into the building, building site conditions and especially to study different shading system devices with “Hands on” method.

The working procedure to study sun effects and shading device with your model:

1) Select the Sun Peg Chart with a latitude closest to your site.

(Sundials are drawn by using azimuth and altitude sun angles for certain latitudes and a peg position which is located on the cross marked under the June line. If you draw your own Sun Peg Chart, select the length of the peg so that all lines can be drawn on paper. Sun positions in USA can be found here:

http://www.usno.navy.mil/USNO/astronomical-applications/data-services/alt-az-us

Examples:

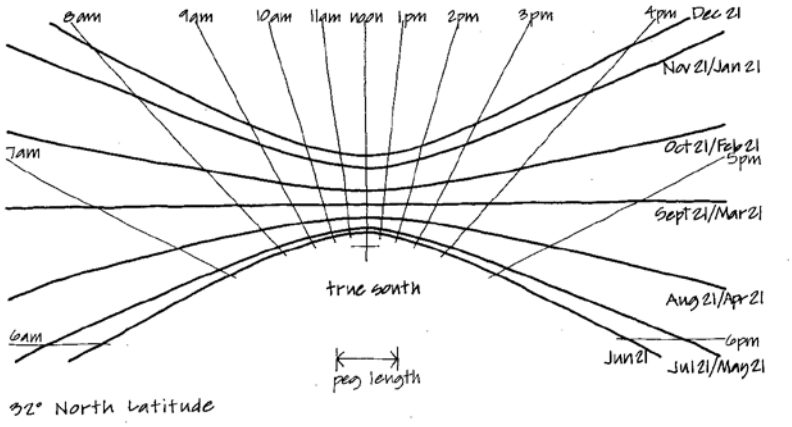


Figure 274. Sundials drawn by Prof. Virginia Cartwright

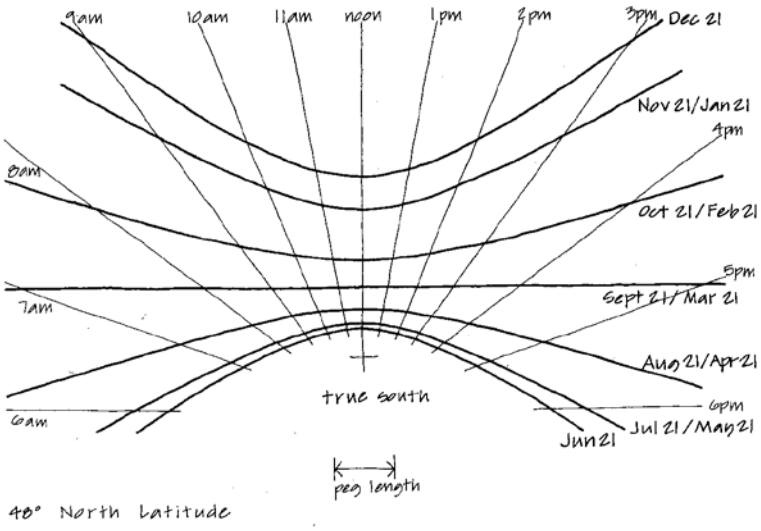


Figure 275. Sundials drawn by Prof. Virginia Cartwright

2) Mount that Sun Peg Chart on your model with north on the sundial corresponding to north of the model

Be sure that the Sun Peg Chart is on horizontal plane on your model, not on a sloping surface. On a sloping surface Sun Peg Chart looses the right proportion and direction with sun and peg and gives wrong information

3) Mount a peg at the cross marker

You can glue a wooden peg (size is given = marked as peg length). Be sure that the peg is standing straight.

4) Now you can tilt the model in the sun and make the end of the peg's shadow fall on different intersections of the Sun Peg Chart

You can put the model on the top of the camera stand and lock it in study position. You can all kinds of research like:

- Study different kinds of shadings systems inside the model
- Study different kinds of shading systems outside the model.
- Study sun penetration into the building.

(Remember that you don't get the right illuminance or luminance values for Daylighting by measuring inside the model. For that purpose you can use computer or DF calculation as shown earlier on this thesis).

Example of Sun Peg Chart Method: Helsinki- Vantaa Airport.

Task: Study sun penetration through the Lightprisms inside the gateway.

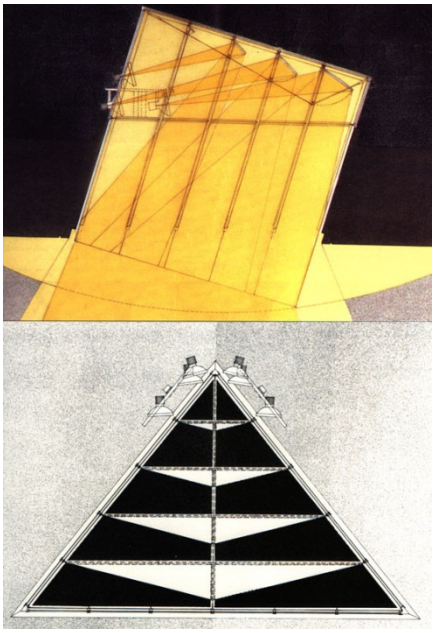


Figure 276. Helsinki- Vantaa airport Lightprisms. Photo Pekka Salminen Architects

Lighting Prism Model

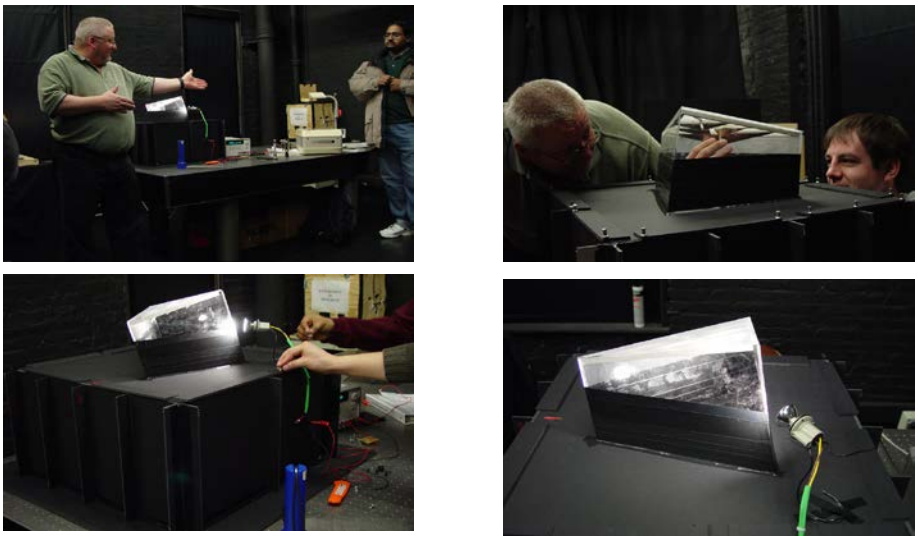


Figure 277. Light prism model at Rensselaer Polytechnic Institute's LRC. Photo Julle Oksanen

Figure 278. Light prism model measurement. Photo julle Oksanen

- Daylighting was observed at different times of the year
- Sun peg chart gave accurate sun angles for 56 degrees latitude (nearest found).
- Phenomenom was interpolated to 60 degrees latitude.

Figure 279. June in Finland at noon

December in Finland at noon

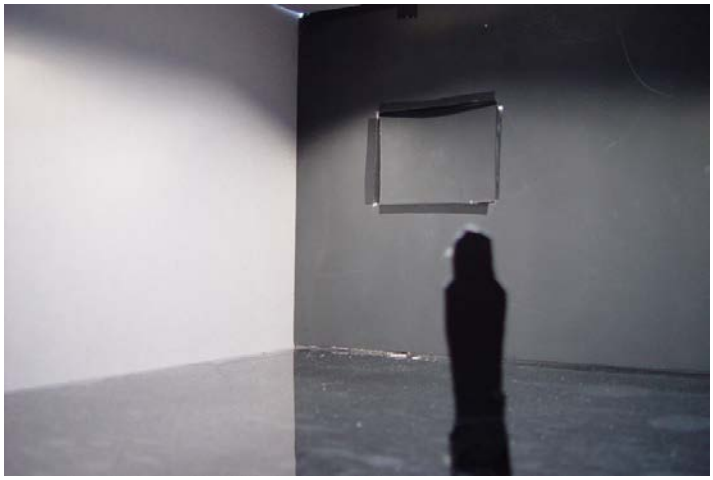


Figure 280. December in Finland at noon

Sun Path Diagram and shadow studies

The Sun Peg Chart method is a great working procedure to study sun effects and design of shading device structures with a simple model. But sometimes the project location can make the Sun Peg Chart study useless and you have lost time and money for nothing. The site can have lot of shadowing elements like other buildings, trees or other mechanical structures which capture sun light before it enters into your building under the work. A Sun Path Diagram is a great tool to study these shadowing site elements before a Sun Peg Chart study.

Figure 281. Skyscrapers in Manhattan. Photo Julle Oksanen

Sun, Wind and Light, G.Z. Brown & V. Cartwright:

"The times of the day and the year in which the sun will be available within a particular site can be determined by drawing the existing objects on the site on a sun path diagram"

Sun path diagrams show the path of the sun in the sky dome as projected on to a horizontal surface. (Libbey – Owens – Ford, "Sun angle calculator"; Olgyay, p.35; Parkard, p.80).

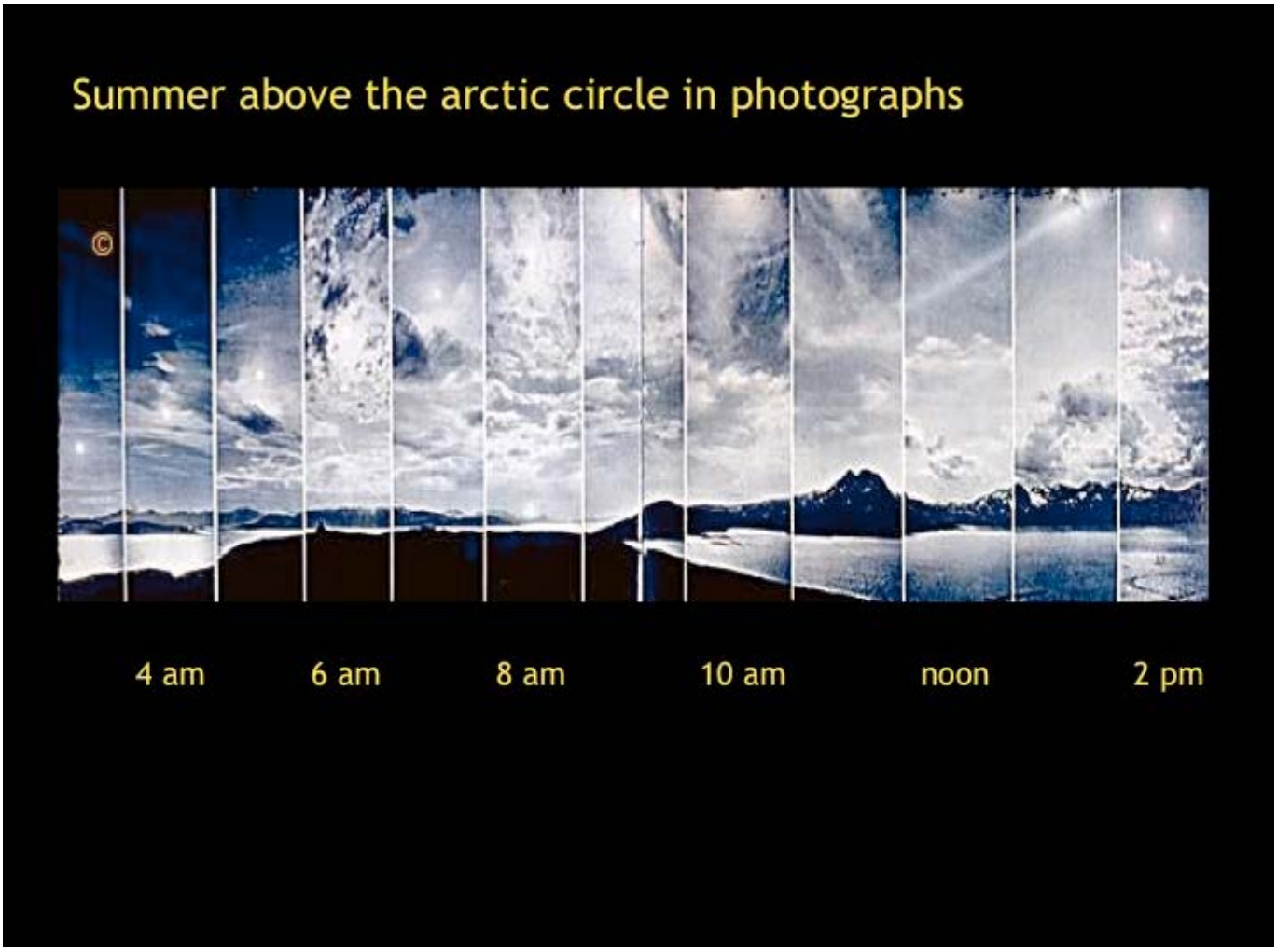


Figure 282. Summer above the arctic circle in photographs

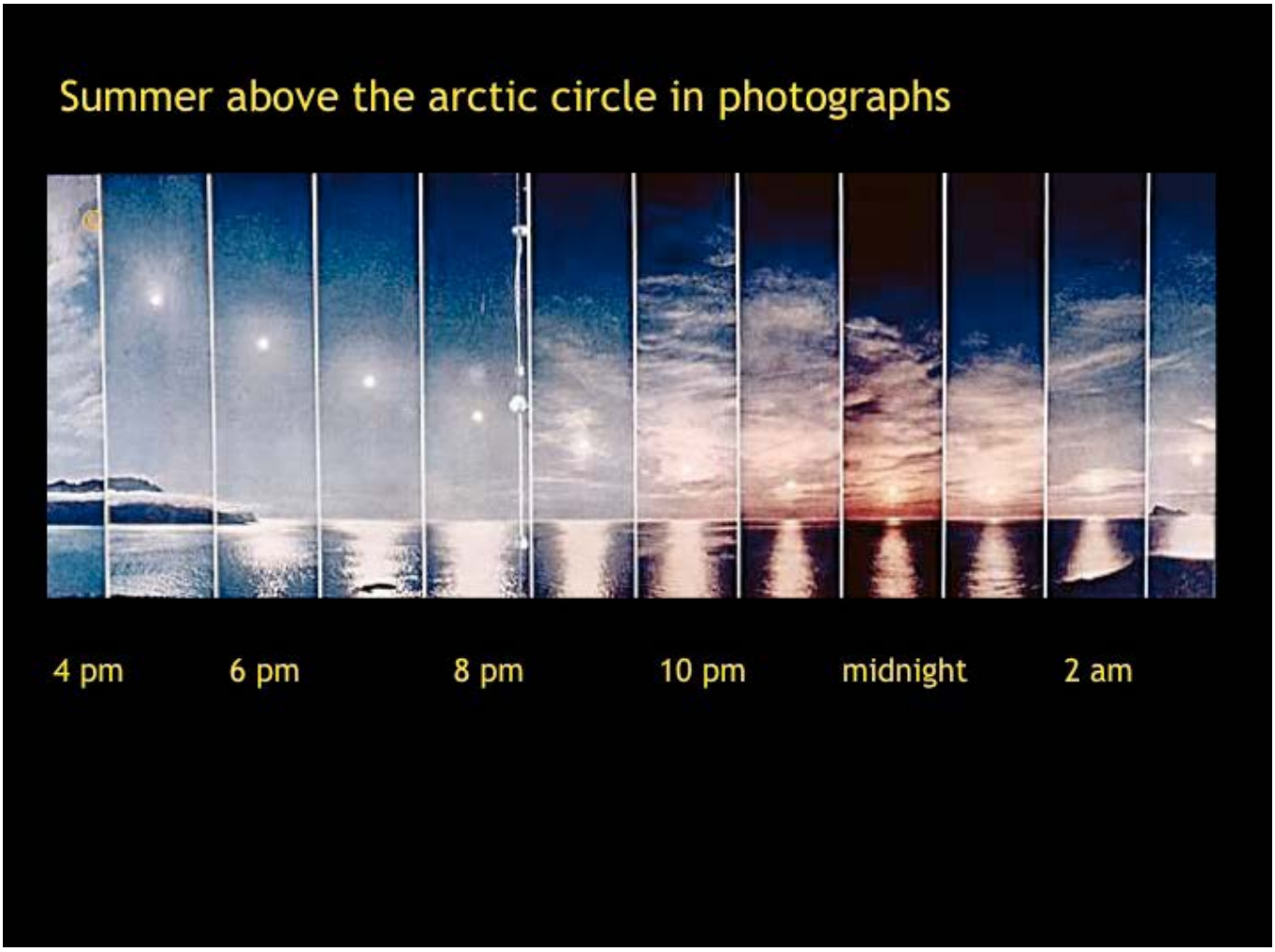


Figure 283. Summer above the arctic circle in photographs

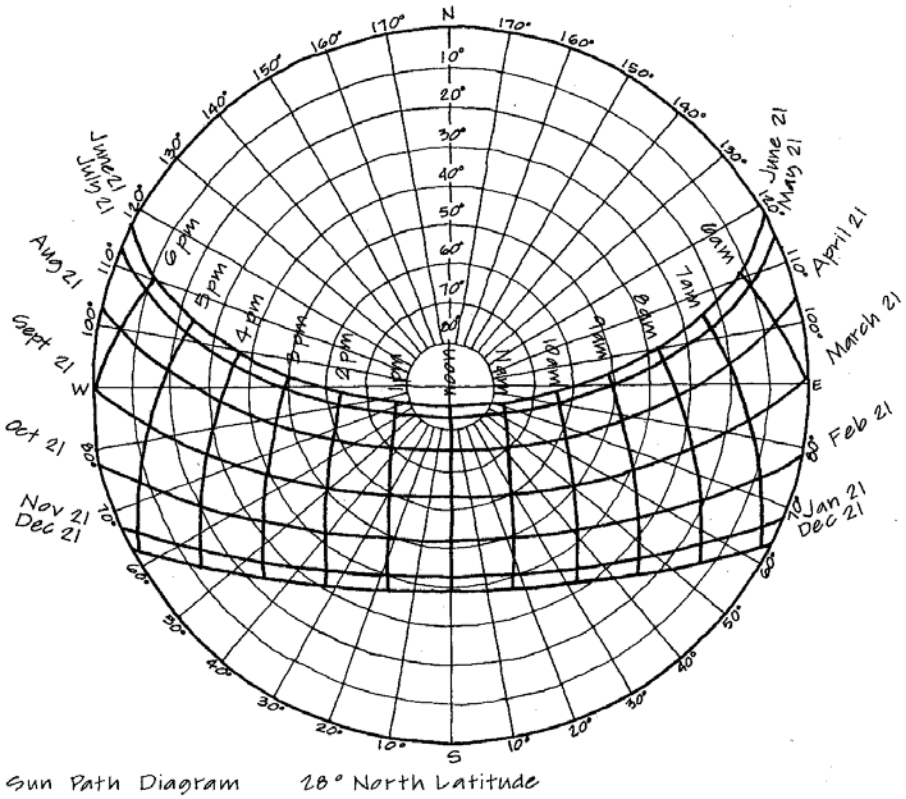


Figure 284. Sun Path Diagram drawn by Prof. Virginia Cartwright

If you want to study more closely how to read a Sun Path Diagram, go here:

http://www.gaisma.com/en/info/help.html

A great example of the use of Sun path Diagram is from the book “Sun, Wind and Light”:

“The same diagram of altitudes and azimuths may also be used to describe the position and size of objects from a particualr viewpoint on a site. Trees, buildings and hills can be described in terms of altitude and azimuth from that viewpoint. By plotting them on the sun path diagram, one can tell when they will obstruct the sun and therefore shade the reference point on the site.

The altitude and azimuth of site objects can be measured on the site using a compass and an altitude finder such as a transit or adjustable triangle, or they can be determined geometrically from a site map thatn shows the location and height of objects.

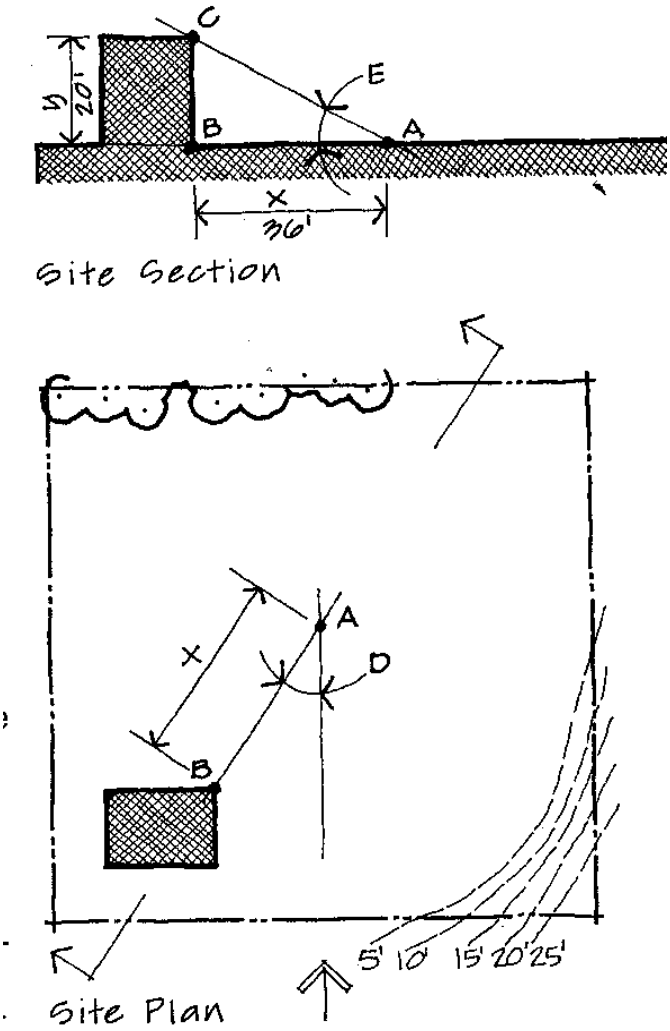


Figure 285. Site plan. Photo Prof. Virginia Cartwright

The example establishes a point A on the site plan, to evaluate for solar access. To determine the potential obstruction of the existing building, draw a line from point A to the corner of the building, point B. Measure the azimuth angle between that line and a due south line. Measure the distance x from point A to point B and the height y of the building. The altitude of point C, which is directly above B on the edge of the building, can be determined by the formula:

tan E = y/x.

If the building height, y, is 20´ and the distance from point A to B, x, is 36', the altitude of point C in 29 degrees. The altitude of point b in 0 degrees, because it lies in the horizontal plane of the reference point A. The azimuth for both points B and C is 34' west of south.

You can now plot points B and C on the sun path diagram. The line connecting them represents the building edge on the diagram. Plotn enough significant points for each object on site so that those objects can be represented on the sun path diagram. The places where the objects on the diagram cover the sun path show the times when point A will be in shade.

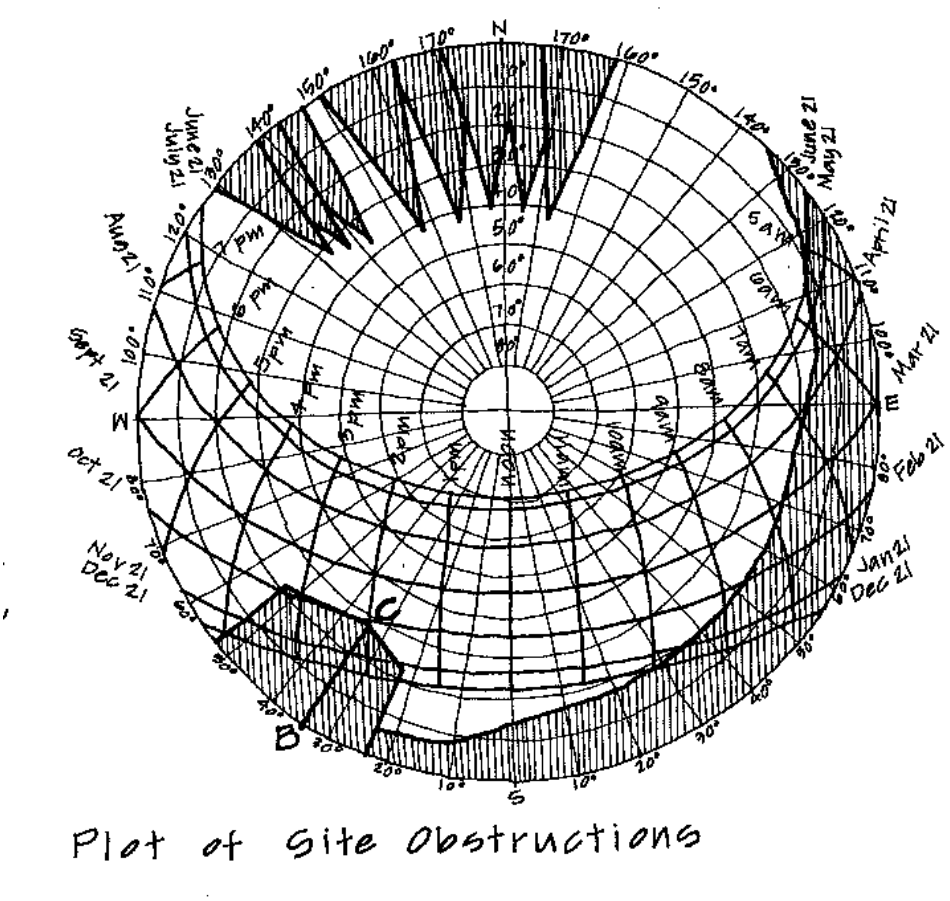


Figure 286. Plot of Site Obstructions. Photo Prof. Virginia Cartwright

In the example, the building will shade point A from about 1:30 PM to 4 PM between Nov. 21 and Jan 21 and 2 PM to 3 or 3:30 PM between Oct. 21 and Nov. 21 and between Jan 21 and Feb. 21. The ridge line will shade point A for some time in the morning throughout the year.

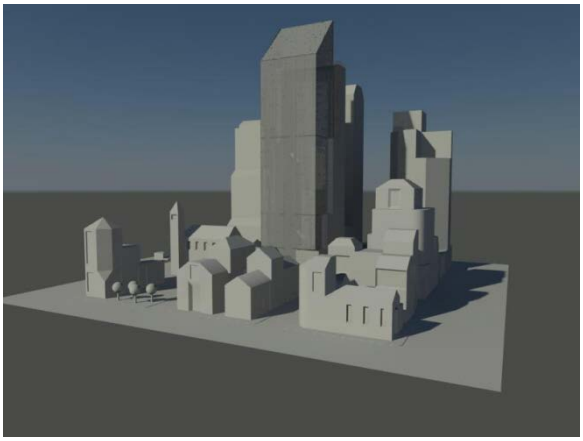
If you want to study more about sunpath diagram, fisheye method e.t.c. see here:

http://www.ced.berkeley.edu/~crisc/Arch140_10/Documents_old/Lectures/04_Horizon%20Shading_ccb_2010_BW.pdf

Shadow and shading design with computer

Shadow studies by using brains, paper, pencil and a sun path diagram is a time consuming process, but educational and fun. There are many computer programs which will working either alone or which are integrated in architectural design programs. Very impressive and educational tutorials are also often included in these programs.

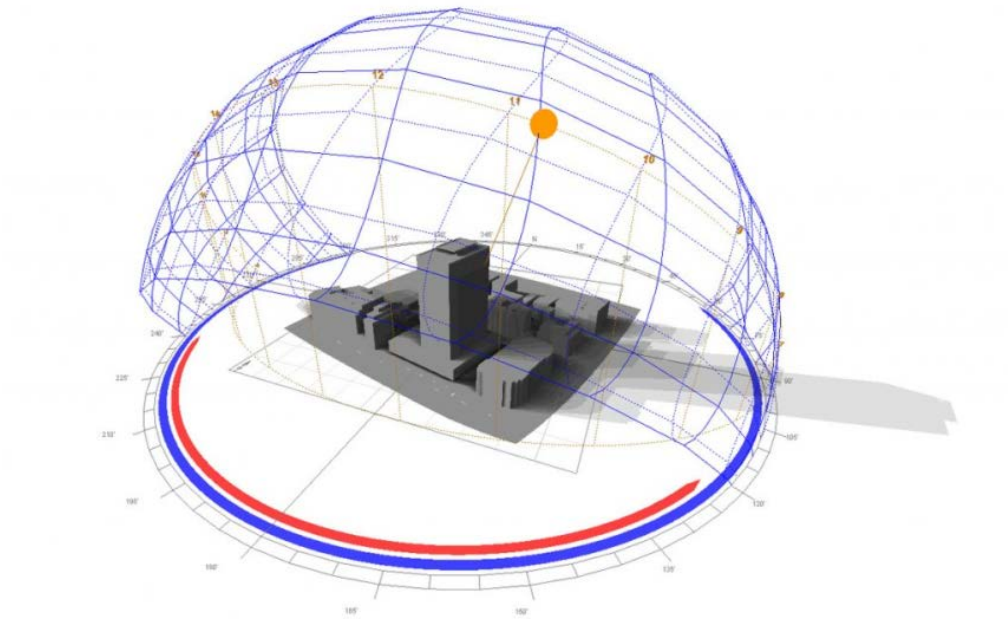
Some shadow study programs and addresses:



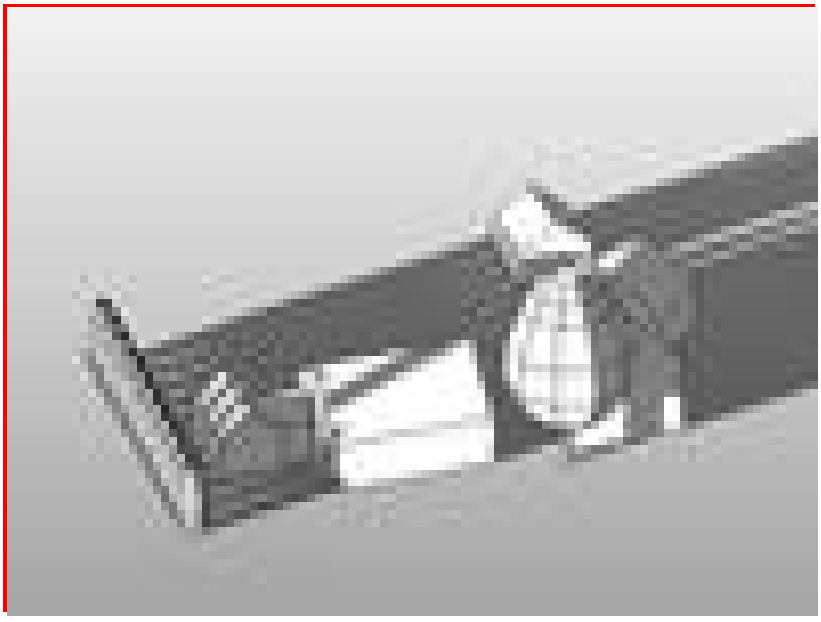
http://download.autodesk.com/us/3dsmaxdesign/2011/help/index.html?url=./files/WS73099cc142f48755-385a98b012180d20f1926.htm,topicNumber=d0e19288

http://www.pfbreton.com/2009/11/sun-study-assistant-for-3ds-max/

http://docs.autodesk.com/REVIT/2010/ENU/Revit%20Architecture%202010%20Users%20Guide/RAC/index.html?url=WS1a9193826455f5ff9110c710853413911d-287e.htm,topicNumber=d0e105335



http://design.epfl.ch/piraeus/2-day-to-day/3-process/shadow-study-qualitative-research



http://vimeo.com/5629642

Teamwork

Figure 287. Lighting designer's toolbar

is one of the most important tools in lighting design process. It is also a tool which have to be used in every project.

Teamwork is also most demanding tool in the toolbar. Maybe it has something to do with the fact that designers have to be little selfish too in his/her work. Healthy selfishness also feeds "design- personality", which is supporting self confidence in healthy way too. It helps to be stronger and stronger designer.

It is difficult to share credit during design process or when the project is done. We are human being. It is so easy to say: "This is my design". It is much, much more difficult to say: "We designed this".

I have not met a person, who could handle all tools of the toolbar him/her self alone. That fact also supports "We designed this"- philosophy.

Remember to be strong enough to share credits. The prize comes later on. Of course different thing is if people who really don't earn any credit, take or demand it.

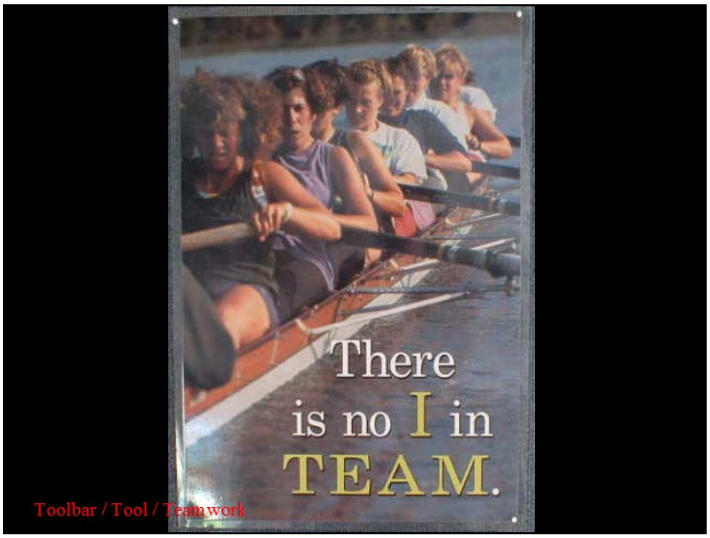


Figure 288. Photo Book cover

This is sometimes a big “Designer- dílemma”:

I love me and my design and there is no I in the team.

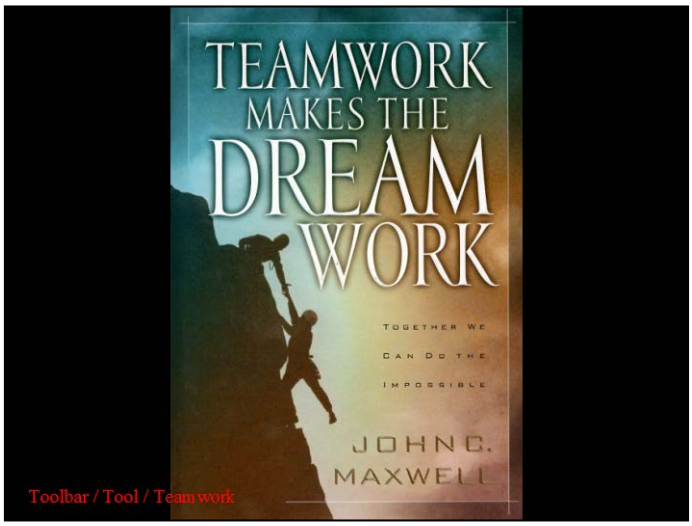


Figure 289. Photo Book cover

Other dilemma is also the fact that we, as human beings, we are gregarious animals who need leaders. If we simply apply this fact to design world, it means that design team ought to have independent members with their independent design tasks for each and a good boss. Team then will share “team- credits” after project is ready. Leader task is to share design tasks according to skills of team members.

Often in real life we can read from newspapers and magazines that this and this designer with his/her team has done this and this project. So, also in “normal” life design is personilized to one person, who normally is the owner of the office. That is right and this could also be called “Opposite sharing” from design team point of view/side. It brings more work for company and people who work in the famous company share his/her own part of the credit later on when applying work from other design companies. And they also can be proud and get credit when they have an opportunity to work in this succesful company.

Not easy tool at all.

Figure 290. Lighting designer's toolbar

Lighting Recommendations

There are thousands of pages of technical argumentation on lighting. We could say that there is already a legacy in technical light. It is the result of activity of technically orientated people.

In 30's, founding CIE to research oil socks and their properties, standardization got a huge speed.

Engineers became active on Illumination Engineer Societies and sadly also more visual skills needing lighting design started to slide from visual people more and more on hands of light technical people. Engineers have done good work, but lighting design is at the same time unbalanced and twisted wrongly. Based on this, projects also look technical and often suffer from lack of visual beauty.

It is good to look and study light with open eyes and not judging any earlier activities or solutions or norms or recommendations.

It is also good to study carefully existing solutions and their connection on technical lighting recommendations. It opens doors for better architectural lighting design solutions. Recommendations are really only recommendations, not a solutions for lighting design projects. It is only one tool, which must be used very carefully. Examples later on are good examples to help to understand recommendations and put them in right light as a helping tool.

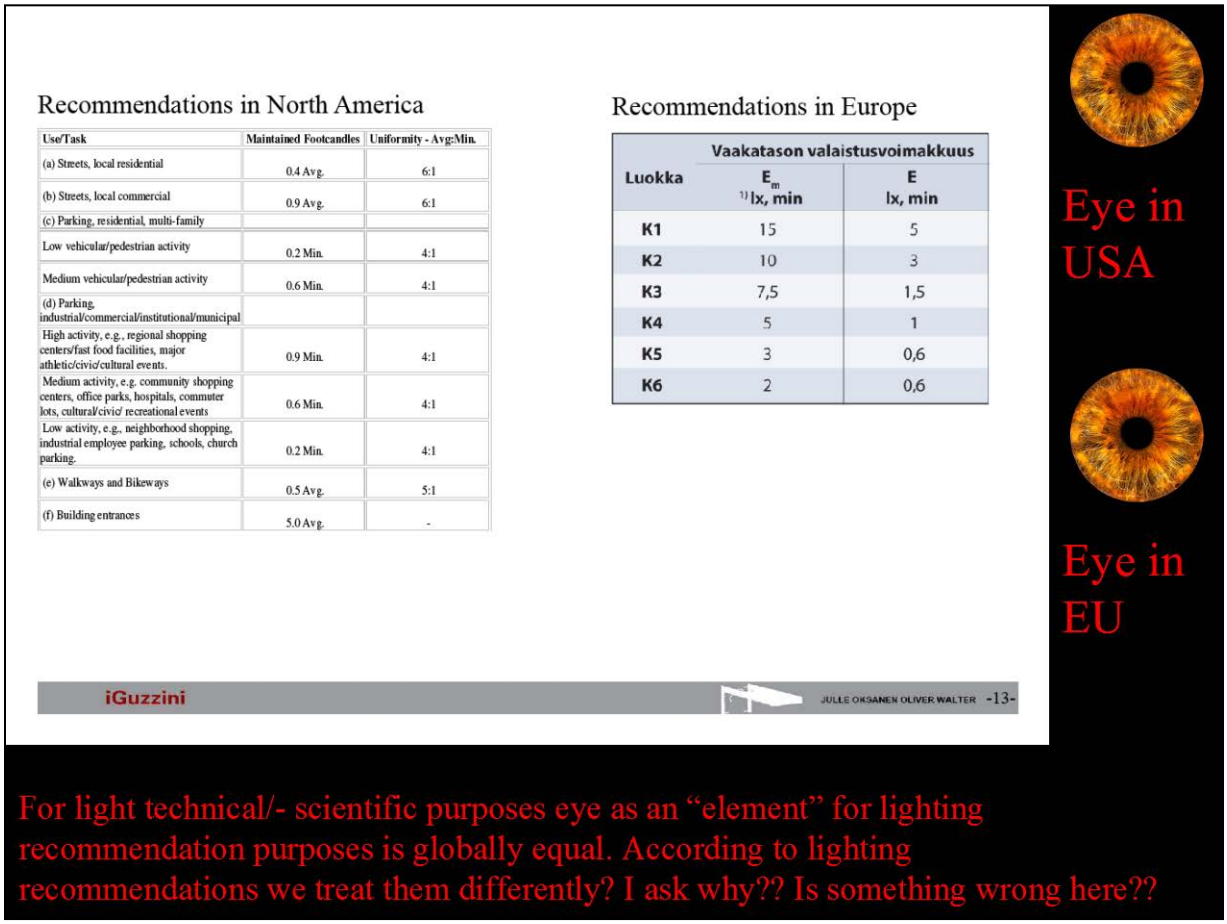


Figure 291. Photo Julle Oksanen

When comparing recommendations in for example in North America and European area, we can easily find that they differ quite a lot. There are also differences between countries inside European area.

I think that something is wrong with these recommendations if one country in Europe has 3 times higher values in road lighting recommendations than e.g. in North America.

Why these carefully researched recommendations differ so much when our eyes are more or less same on the globe? Answer is simple: Politics.

Reason for telling this in this context is that we have to really look carefully how to use recommendations in lighting design project.

I have worked in CIE for over 10 years in Division 3, Technical Committee 3.22 "Museum Lighting And Protection Against Radiation Damages". I have made also other research projects between 80's – 00's.

Problem is that there are no architectural lighting design recommendations existing and balancing technical lighting recommendations. At least not yet.

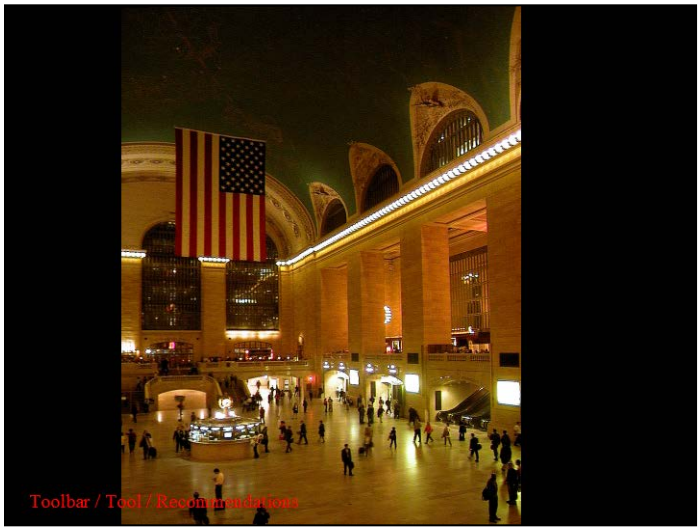


Figure 292. Grand Central Station in New York City. Photo julle Oksanen

First practical example of Lighting Recommendations is Grand Central Station in New York City. Lighting is renovated and horizontal illumination value, Ehor, is 15 lx (150 fc) on the floor of station main lobby. Lighting recommendations almost in every country say that Ehor ought to be 200 lx. (2000 fc).

So, Grand Central Station has only 8 % of recommended horizontal illumination value. Sounds absolutely odd, doesn't it??

Dilemma here is that this station is so beautiful, that people in all over the world come to see it. It is so beautiful that we don't have to explain even anything. Photos tell the whole story. And the legacy is again constructed with one beautiful project in the quite center point of civilization "NYC".

Maybe the biggest dilemma is that everybody is talking at the moment about energy saving lighting solutions. It is difficult to find bigger, easier and more simple target for energy saving than good lighting design.

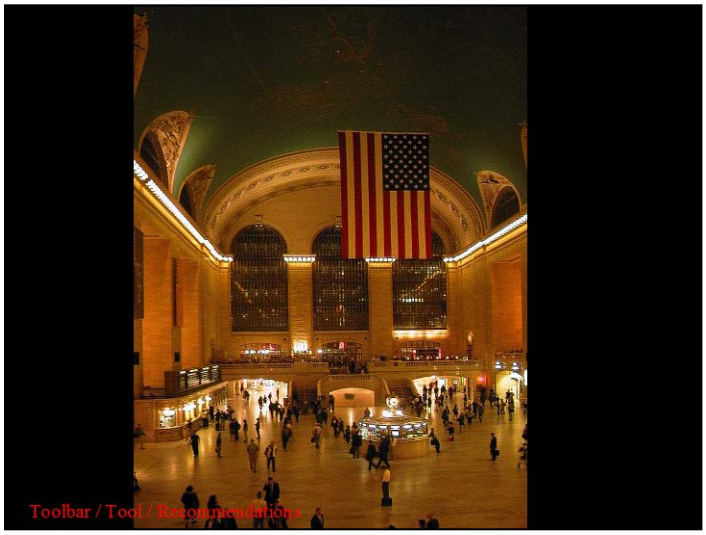


Figure 293. Grand Central Station in New York City. Photo Julle Oksanen

Hard to do it better.

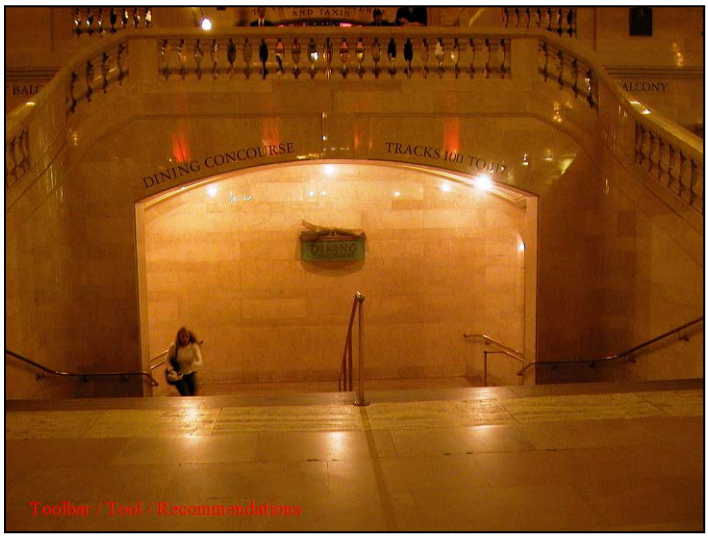


Figure 294. Grand Central Station in New York City. Photo Julle Oksanen

Functional lighting. Light is there where it is needed. In this case quiding the way to terminal tracks.

Maybe it is not relevant to tell this kind of story in this context, but because it is so important in lighting wise, here it is:

Big slaughterhouses have thoroughfares for pigs. Big sow might weight hundreds of kilos and they are hard to quide to right thoroughfares. The solutions was found in lighting. There is one bright PAR lamp on the end of thoroughfare. All pigs and sows walk automatically towards to that light and personnel don't have to help them at all. Functional lighting.

Figure 295. Helsinki - Vantaa airport. Photo Pekka Salminen Architects

Other example of recommendations and stations.

Helsinki – Vantaa airport has Ehor = 200 lx on the floor of the EU terminal, Terminal 2.

The lighting design concept for this terminal was, that terminal was a terminal for “Eternal Extraterrestrial Lighting”. Huge, almost 5000 Lbs per each, glass boulders drop through the roof down to ceiling bringing natural light during Daytime. When darkness arrive, 6 pcs of 400W Metal Halide Lamp luminaires per each iceboulder, located outside on the roof of airport, illuminate these independent ice cubes. Very carefully designed light beams, which penetrate glass walls of ice cubes, are touching 6 pcs of independent light wings inside the glass boulders. Those independent wigns reflect light down to EU terminal.

Horizontal illuminance value of 200 lx was good here, because of materials: Glass, stone, steel and light. Lot of play of brilliance (reflections from glass and steel surfaces, ice boulders in ceiling) was also created inside the terminal to achieve eternal daylight phenomenon also with so humble electric lighting values compared to thousands of lx of daylight.

Figure 296. Lighting designer's toolbar

CLIENT

It is somehow impolite to say that Client is also a tool for a lighting designer, but in design wise it is true.

If you can not handle your client, you can lose the whole project. If personal chemistries between client and lighting designer work, it helps a lot.

It also is also important to clarify everything to customer already in the beginning.

Things like:

- Is client's budget and expectations in right balance
- Is there enough time for design
- Lighting design process, how it goes. (Like Museum process earlier)
- Content of lighting design (Concept, Master Plan, Detailed Designs,e.t.c.)
- What is not included to design
- The results (Report, paper copies, CD, stick e.t.c.)
- Offer
- Payments
- E.t.c.e.t.c.

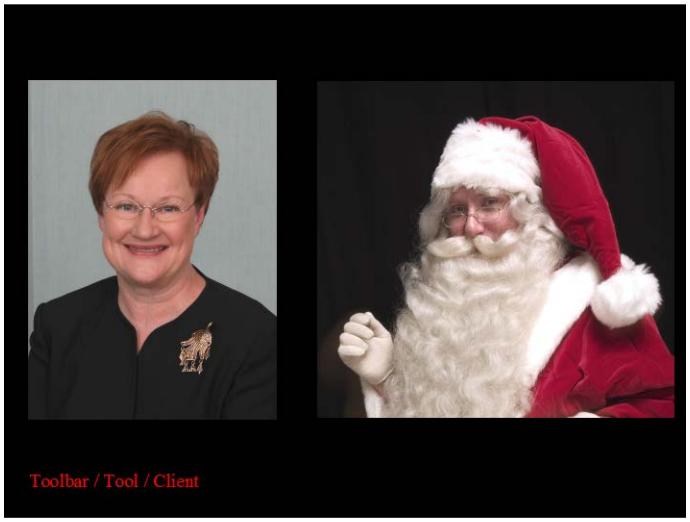


Figure 297. President Tarja Halonen (left) and Santa Claus (right)

President of Finland, Tarja Halonen, on left and Santa Claus on right. I have been happy to have both of them among my customers.

Client can be a person or a group of persons. If it is a group of people, it helps a lot if lighting designer can clarify everybody's task on the team and to whom he/she ought to send and what. (Like to whom to send conceptual design idea and to whom to send Master Plan, e.t.c.)

The written agreement- process (Inquiry – offer – order-.payments) is always a mark of professional touch on design. It gives character for whole design, when everything is perfectly clear.

Figure 298. Lighting designer's toolbar

Scale Models

or Mock' Up's are great in many ways. Computer manipulations are great, but there are cases that nothing can beat scale model.

The secret of scale models lay in the fact that computer manipulations can be seen from 2- dimensionally from flat screen, but real scale models are real 3- dimensional mind feeding monsters. Best scale models are part models in scale 1:2 and/or when you can put your head inside the model / space.

There are many good reasons for real scale models like:

- Commercial purposes
- Comparison purposes (e.g. comparison different ways to illuminate space)
- Spirit purposes (If you e.g. see model every morning when you arrive office).
- Research purposes (e.g. behaviour of daylight or measuring values in reality).

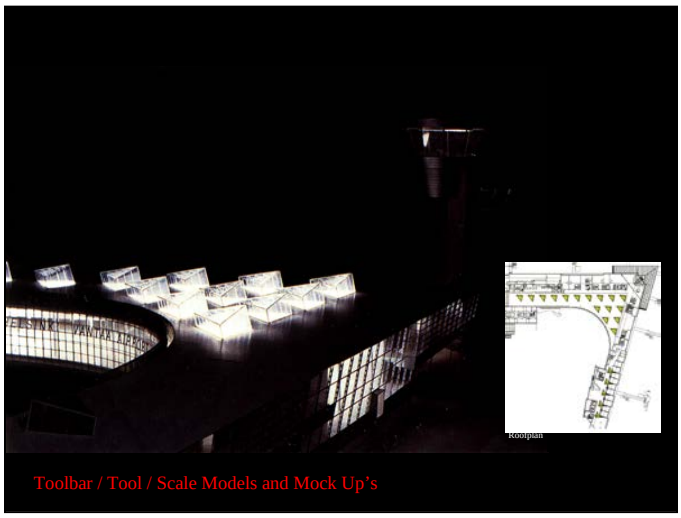


Figure 299. Airport model. Photo Pekka Salminen Architects

First example is Helsinki- Vantaa Airport Terminal 2. This scale model is 1:50 Mock'Up, which was build for mainly commercial purposes. Scale model was located in airport area, before it was build.

Also some preliminary electric lighting tests was done to get flavour of the night view both inside and outside of terminal.

Huge, almost 5000 Lbs glass boulders, which drop trough the roof down to ceiling, are glowing Ice Boulders in Northern Night.

Figure 300. Inside view of airport terminal model. Photo Pekka Salminen Architects

This is a view from inside the airport terminal when electric lighting is on.

Every Ice Boulder / Light Prism has 6 pcs of 400W Metal Halide Lamps outside the the boulder on the roof. Light beams run trough the glass walls of prisms, arriving to adjustable aluminium wings, which are located inside the light prisms. Each light prism has 6 pcs of light wings. They reflect light onto the terminal floor.

Lighting values were calculated mathematically and the shape of light was studied with this scale model of 1:50 and scale model of 1:10 of light prism itself with adjustable aluminium wings and halogen lamps.

Figure 301. Scale Model Museum of Contemporary Art. Photo Steven Holl Architects

Other example is Scale Model of Museum of Contemporary Art in Helsinki. This is a model in architect Steven Holl's office in New York City.

It must be exciting to come to office every morning and enjoy the Mock' Up before morning coffee.

It is also easier to see quickly all elements of the building and easy to talk about design things around it with design kolleagues or customers.

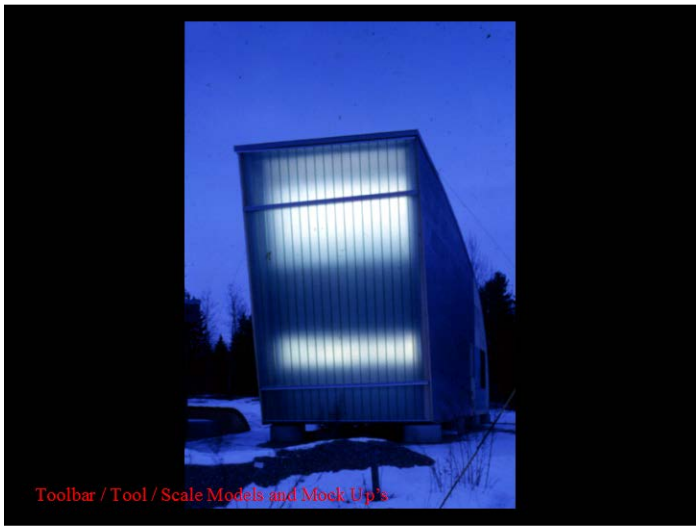


Figure 302. KIASMA Mock' Up 1:2 built from floors 4 and 5. Photo Timo Kiukkola

Also 1:2 size Mock' Up was built from floors 4 and 5 of Kiasma to study lighting and materials.

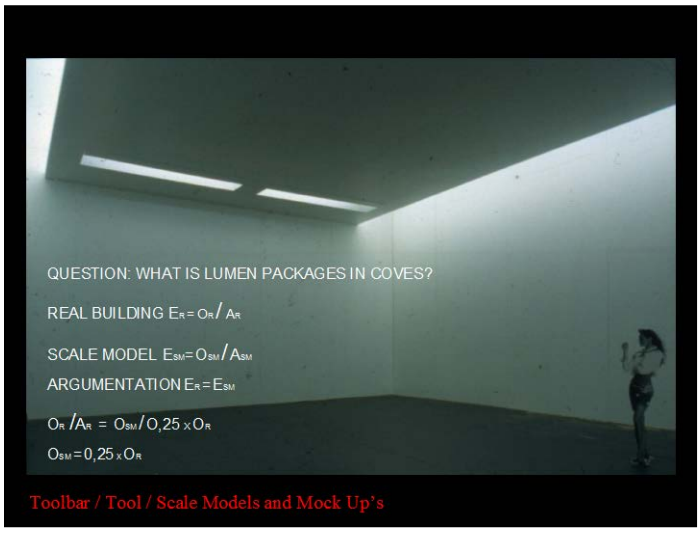


Figure 303. KIASMA Mock Up 1:2 interiors. Photo Timo Kiukkola

It is a tricky thing to study electric lighting values even with scale model of size 1:2. Not easy at all. I called many top architects and lighting experts in the world by asking what was their experience on right lighting values inside the scale model when trying to get real phenomenon of real size.

There was one common argument from all comments: To maximize electric lighting simulation in scale model, surfaces need to have equal Illuminance values as real size space. In this case of size of 1:2, into coves for example you have to put fluorescent lamps which give 25% of lumen package of real light cove in real size space. This comes from the fact that we speak about areas A which means length x width is equal to m2. So, illuminance value of scale model = illuminance value of real space. In both cases lumen package divided by area A. Scale model area A is 25% of real space area A. So lumen package of scale model cove must be 25 % of real space cove value to get same Illuminance value on the wall. Of course reflection factors of scale model surfaces take care that also whole space in scale model has 25% of lumen package of real space.

Nobody knows what values would be exactly right for scale model, because there are no research of light, space, eye size and space formitting in brains according to these elements. But as told earlier, the theory of Pragmatic Truth works also here with equal E's.

Figure 304. KIASMA gallery. Photo Timo Kiukkola

Figure 305. Lighting designer's toolbar

Lighting calculation

is also only a tool, not a solution itself either lighting design. There are projects where calculation is important role and sometimes it is not needed at all.

There are so many calculation programs that it is not even relevant to start to make any kind of list of those in this context. Maybe one example, what is good to know:

Years ago all european manufacturers had their own lighting design programs for their own luminaires. It caused lot of problems and work for people who made lighting calculations. Manufacturers put their efforts together and hired some scientists to create a common calculation program to all luminaire manufacturers. The program is called DiaLUX and it is free to everybody. Both Dialux program and light distribution information can be loaded from most of the manufacturers home pages free of charge.

Hand calculation is also very handy and quick way to check lighting values. Specially applied lumen method is useful.

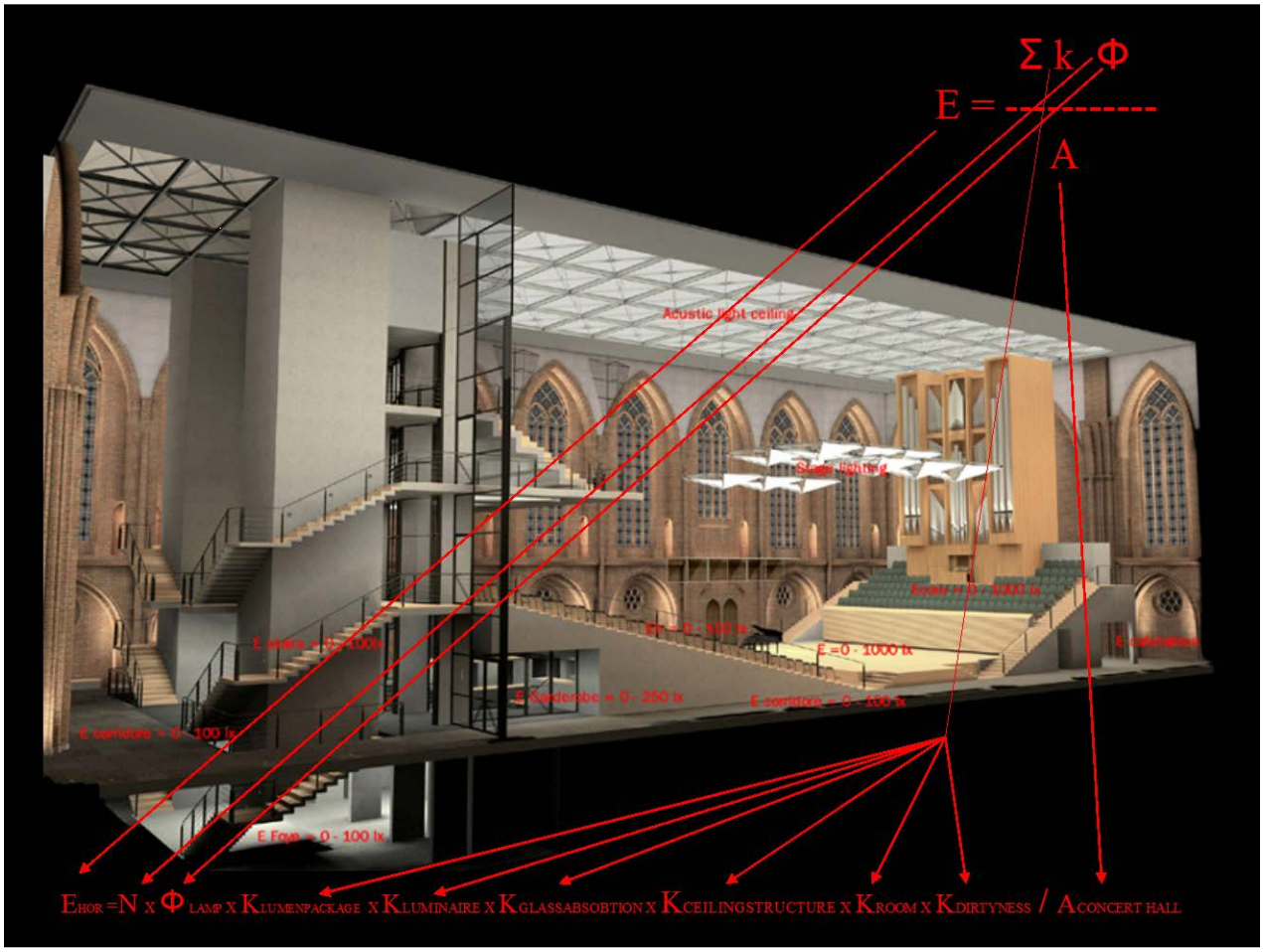


Figure 306 Calculation of acoustic light ceiling in Neubrandenburg Concert Hall in Germany. Photo Erkki Rousku

Example of hand calculation and Applied Lumen Method is calculation of acoustic light ceiling in Neubrandenburg Concert Hall in Germany. With Applied Lumen Method the amount of lamps were calculated based on information as follows:

- Wanted visual experience
- Wanted different lighting situations for different performances and moments
- Wanted E hor on concert hall at hight of 2m
- New lumen package of each used lamps
- Lumen depreciation factor
- Light Output Ratio of uced luminaires (LOR)
- Dirtiness factor
- Glass absorbation factor / light penetrating factor
- Structural factor of light loss on ceiling structures (Designers estimation)
- Room factor of concert hall
- Floor area of concert hall

Calculation: You just multiply wanted Ehor- value with floorarea Afloor and divice these with with all other known values. So you get the amount of lamps (N in formula) and also luminaires which is needed. There are some estimations, but they are easy to find and it is always allowed to use head and think.

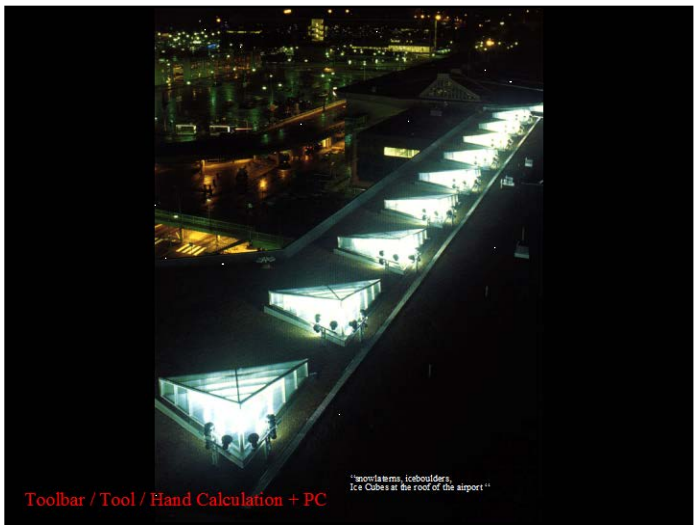


Figure 307. Light Prisms of Helsinki- Vantaa airport. Photo Pekka Salminen Architects

Example of common use of hand calculation and lighting design calculation program is Light Prisms of Helsinki- Vantaa airport.

Light Prisms work as follows:

Light prisms (Weight of 5000 Lbs/ each) penetrate roof and ceiling of airport terminal and give extraterrestrial light into the terminal during day.

When extraterrestrial light is gone, daylight shines on the other side of the globe and darkness is embrasing environment, electric lighting is switched on. 122 pcs of 400W Metal Halide Lamp luminaires are ”shooting” light quite exactly onto the aluminium light wings trough the glass walls of Light Prisms. From light wings light continues its way down to the terminal 2 indide space simulating extraterrestrial lighting.

Terminal is the place of eternal light.

Computers were used to calculating lighting values from luminaires onto the light wings. From light wings to terminal floor level, hand calculation and own made formula were used.

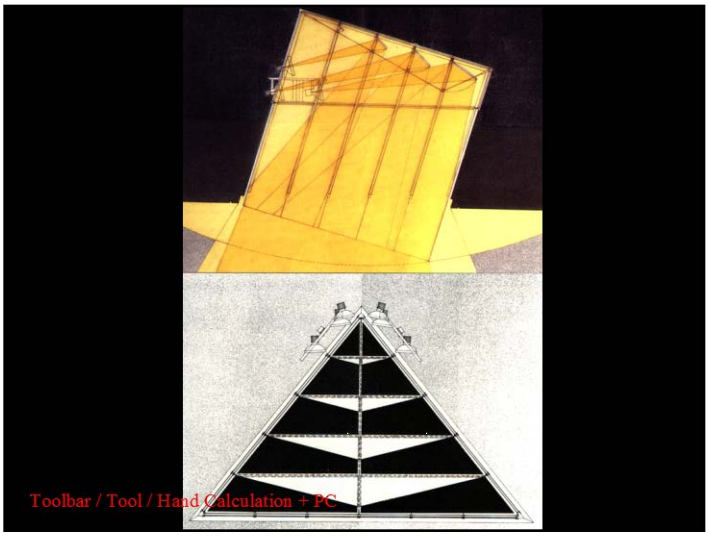


Figure 308. Helsini-Vantaa Light Prism. Photo Pekka Salminen Architects

This is Helsini-Vantaa Light Prism. It is and independent ”Glowing Ice Boulders in Nordic Night”. It is made of glass, aluminium wings and Nordic spirit.

Mathematically I treated it as a huge luminaire.

The triangle, which was a motive of whole Terminal 2, was selected also as a shape of the wings. The size of wings were designed and selected according to 2 elements:

1) Free run of extraterrestrial light during day time
2) Needs of electric light. 6 biggest wings were selected as light producers and all of them had their own luminaires, which were located on the roof

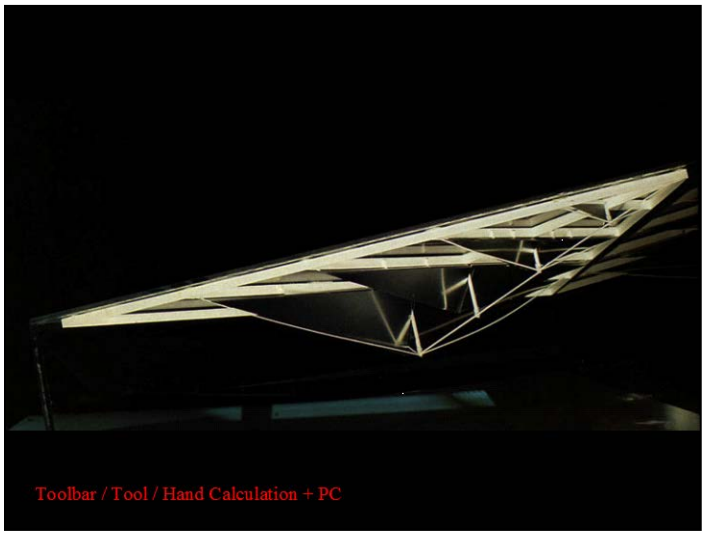


Figure 309. Scale model of light wings in one Light Prism in scale 1:10. Photo Pekka Salminen Architects

This is scale model of light wings in one Light Prism in scale 1:10.

All 6 light wings were adjustable in vertical and horizontal directions by designing special one place fastening joint for each wing. This was needed, because calculations only give the theoretical calculation result. With this special fastening joint we could maximize light output ratio (LOR) of wings as they were treated philosophically as aluminium luminaires.

During testing one demonstration wing and one luminaire in lab, no light was reflected from very efficient Miro aluminium reflector on the testing surface (white huge wall), which simulated termminal floor. When turning aluminium wing just some degrees as convex shape (R = 6m), wing collected all light to the wall.

That was a great and pragmatic evidence of the fact that it is always good to make demonstration.

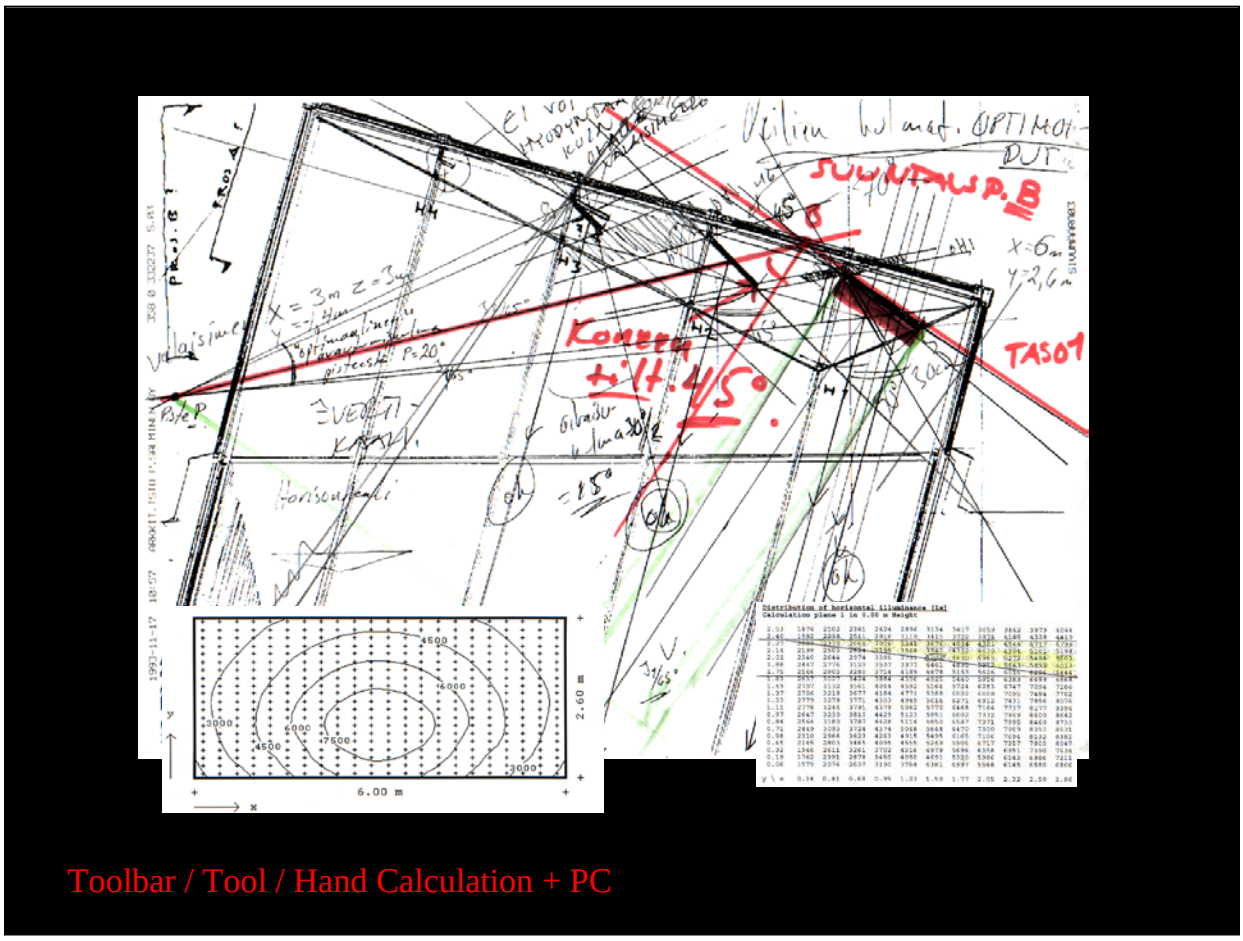


Figure 310. Computer calculation for the biggest wing. Photo Julle Oksanen

Computer calculation for the biggest wing. Illuminance value on the wing surface was important information and also basic study for selection process of right luminaire for this special purpose.

Later on we change all E-values of all wing surfaces for lumen packages by basic Lumen Method formula E = O/A → O = EA, where O is a lumen package which falls on the wing, E is calculated illuminance value on the wing surface and A is wing area.

Of course this lumen package runs forward from the wing according to reflection factor of the wing material.

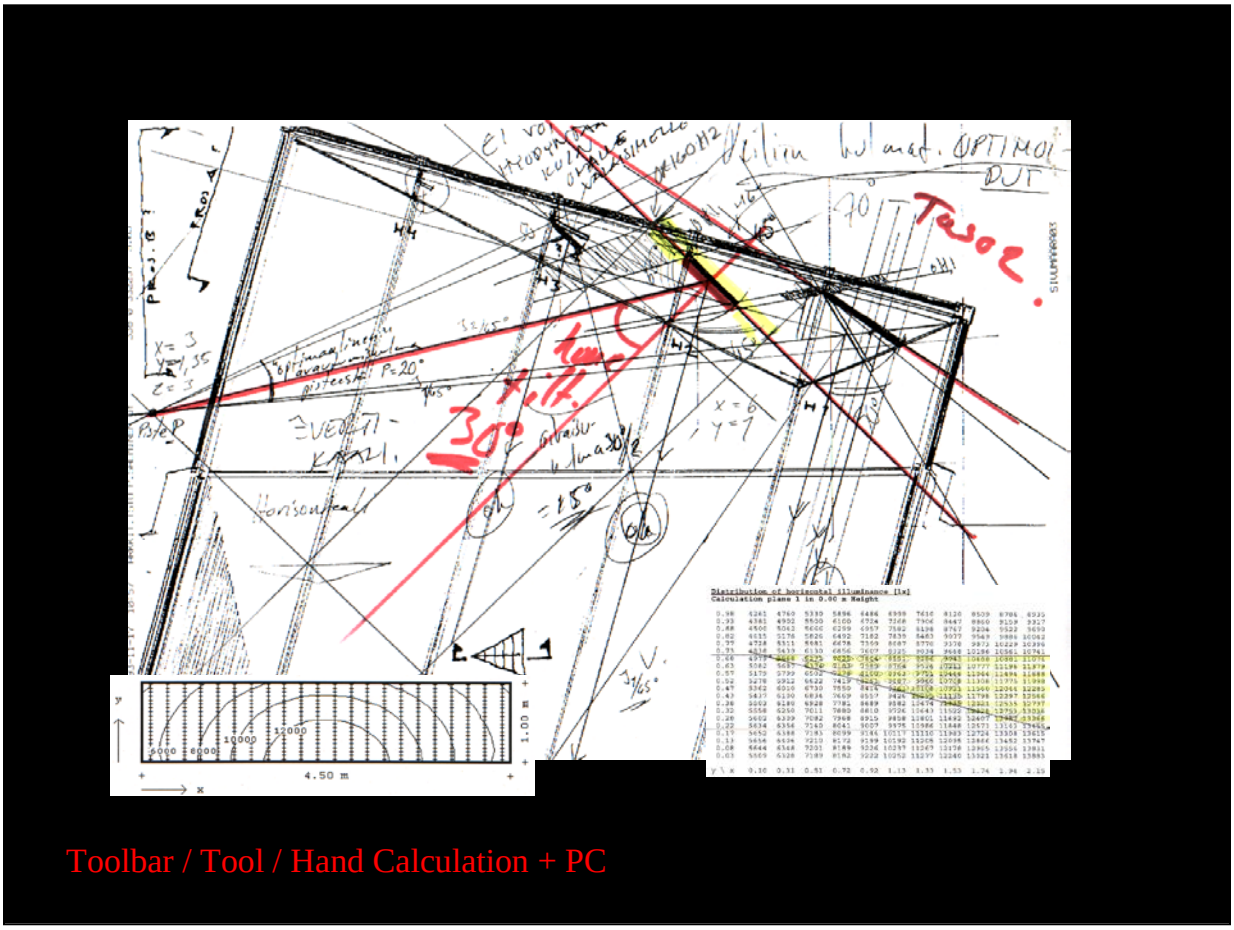


Figure 311. Middle wing. Photo Julle Oksanen

All 6 wings were calculated carefully. This is middle wing.

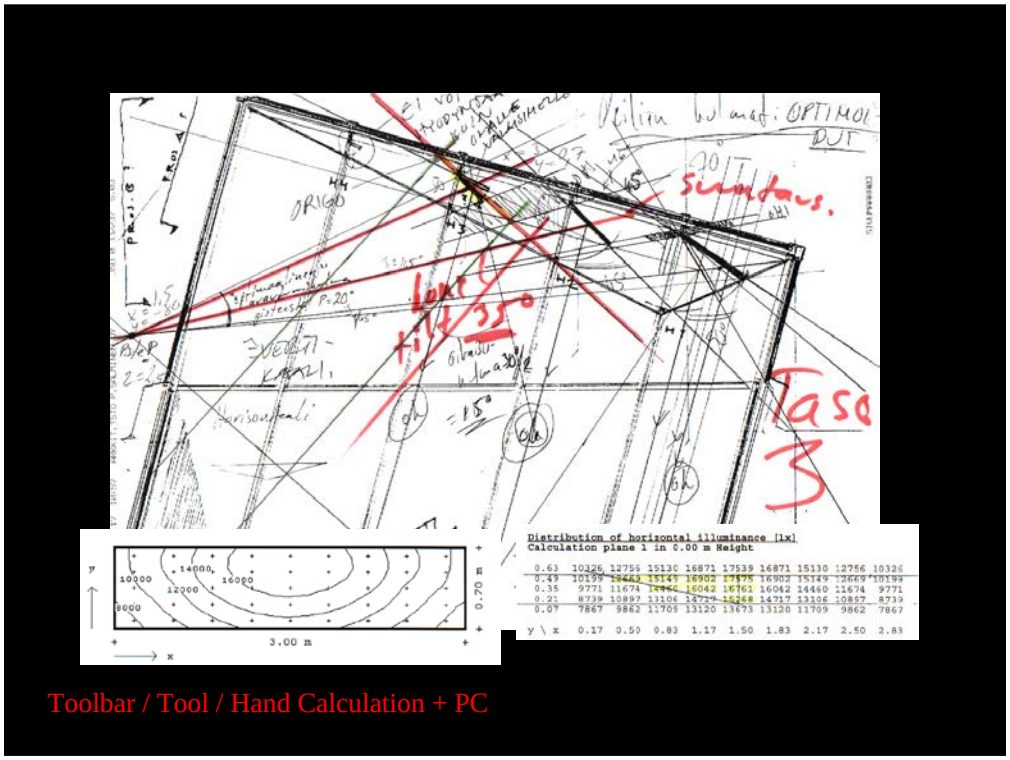


Figure 312. Smallest wing. Photo Julle Oksanen

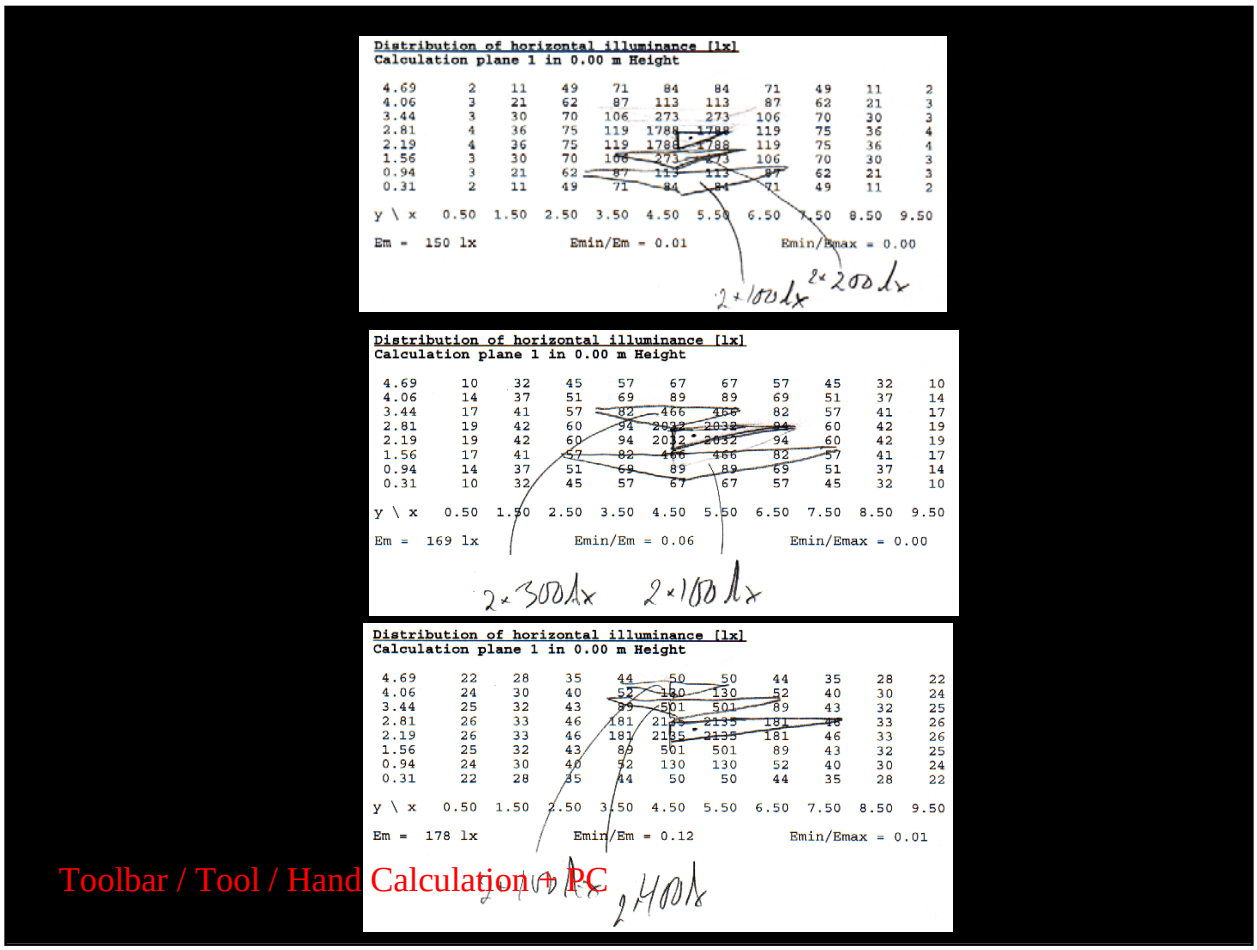


Figure 313. Wing calculus. Photo Julle Oksanen

All luminaires give also light for other wings too. This is quite big amount and is important to calculate and add on to the created formula.

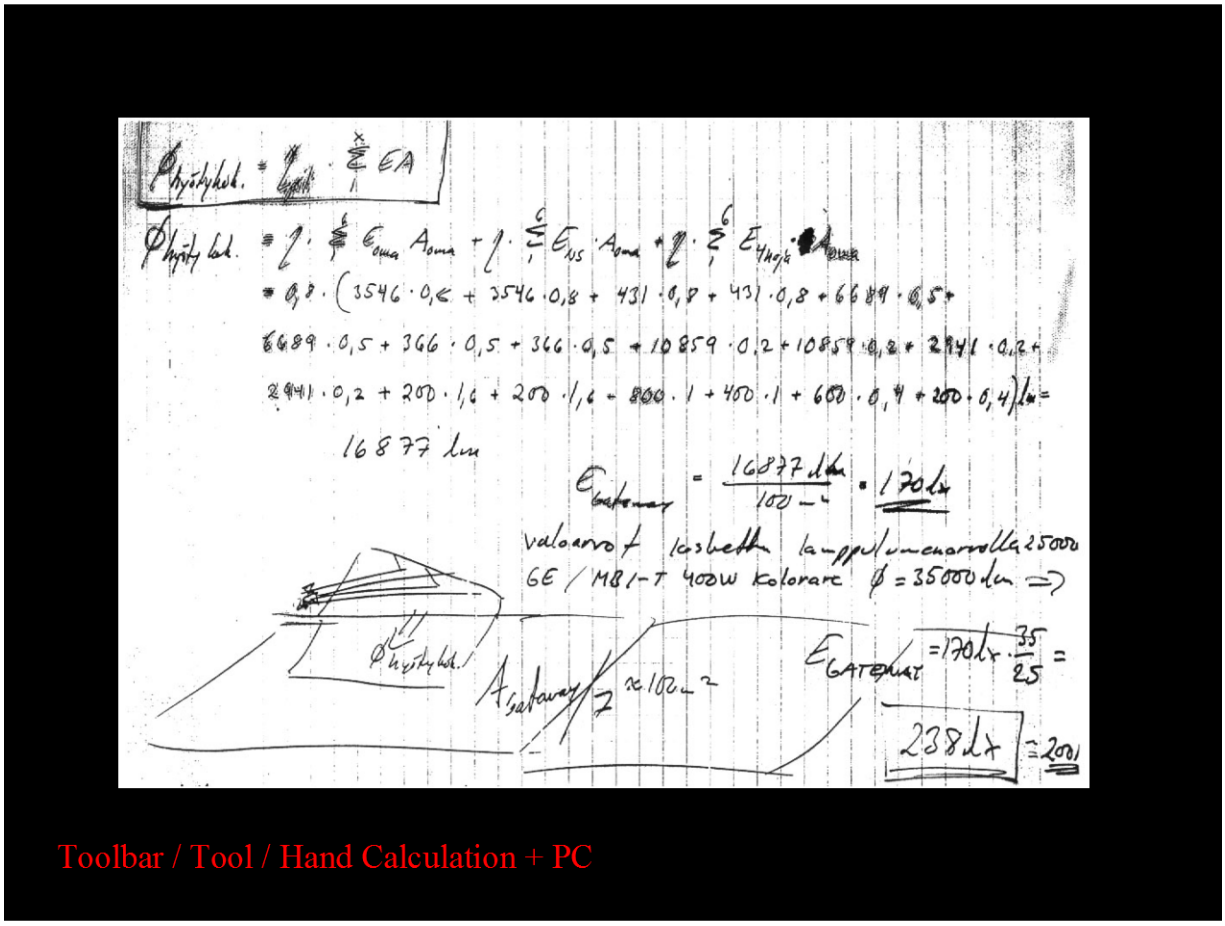


Figure 314. Final authentic formula. Photo Julle Oksanen

This authentic calculation formula from real life was created to check out are Light Prisms as wise solution as thought as eternal light producers.

Based on this information the project could continue to more detailed lighting design. New and final calculations needed some checking like:

- Reflections from the luminaires to airport area and air space (Sensitive and “dangerous” location without good control).
- Final absorbations of glass packages
- Air pollution factor
- Lost light between wings and terminal floor
- Effect of sand plasted Light Prism surfaces (roof and back side) on calculation result.
- Final selection of wing aluminium (Miro)

Figure 315. Helsinki - Vantaa airport Terminal 2. Photo Pekka Salminen

Helsinki-Vantaa airpoort Terminal 2, EU- Terminal. Designed value and measured value had only 5lx difference. Ehor = 200lx was the goal. Final lighting calculations gave value of Eh = 245 lx and measured values in reality gave Eh = 240 lx.

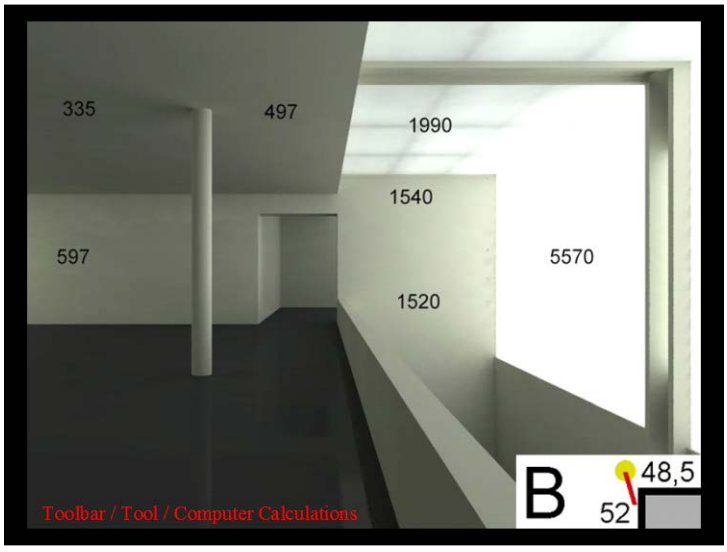


Figure 316. Radiance program calculus. Photo Markku Norvasuo

Radiance program is an example of “pure” computer calculation.

Figure 317. Fiskars old mill area, located in Fiskars Finland. Photo Julle Oksanen

It is also possible to use mathematics in creative way. One good example of that is the use of illuminance sections in lighting design process.

This case- study is from Fiskars old mill area, located in Fiskars Finland.

Fiskars old mill area is 350 years old environment, which was founded to manufacture plows, axes, knives and other iron tools for mainly agriculture purposes. It was also the original birth place of Fiskars, huge international enterprise.

Fiskars wanted to have Christmas lighting and fireworks for its 350 years anniversary celebration. Lighting designers proposed that instead of 3 minutes lasting and 1 million USD costing fireworks, Fiskars can get better lighting for whole area with a same amount of money.

Existing lighting was so bad, that designers told that they can take a project with one condition: Old lighting must be destroyed and they start from complete darkness.

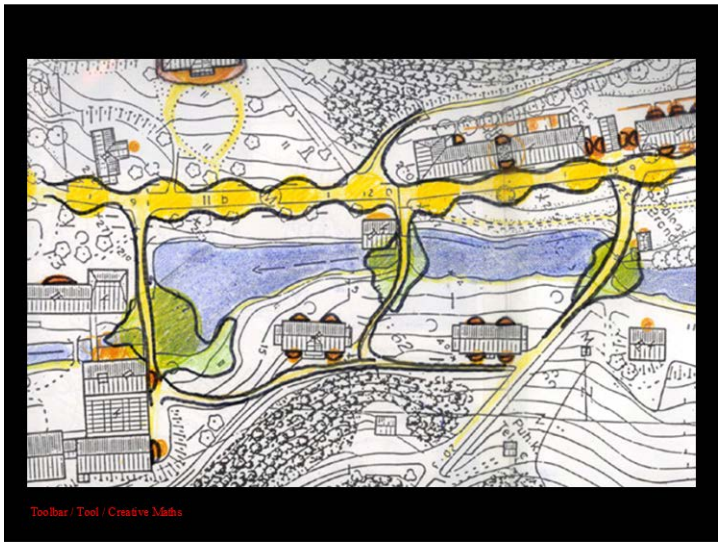


Figure 318. Lighting functions. Photo Vesa Honkonen

There were three clear elements which rose up to a leading position when thinking functionalism and arguments for a lighting design concept. They were:

- Movement (road trough the mill area)
- Nature (Trees and river)
- Buildings (Old buildings for directors and also workers)

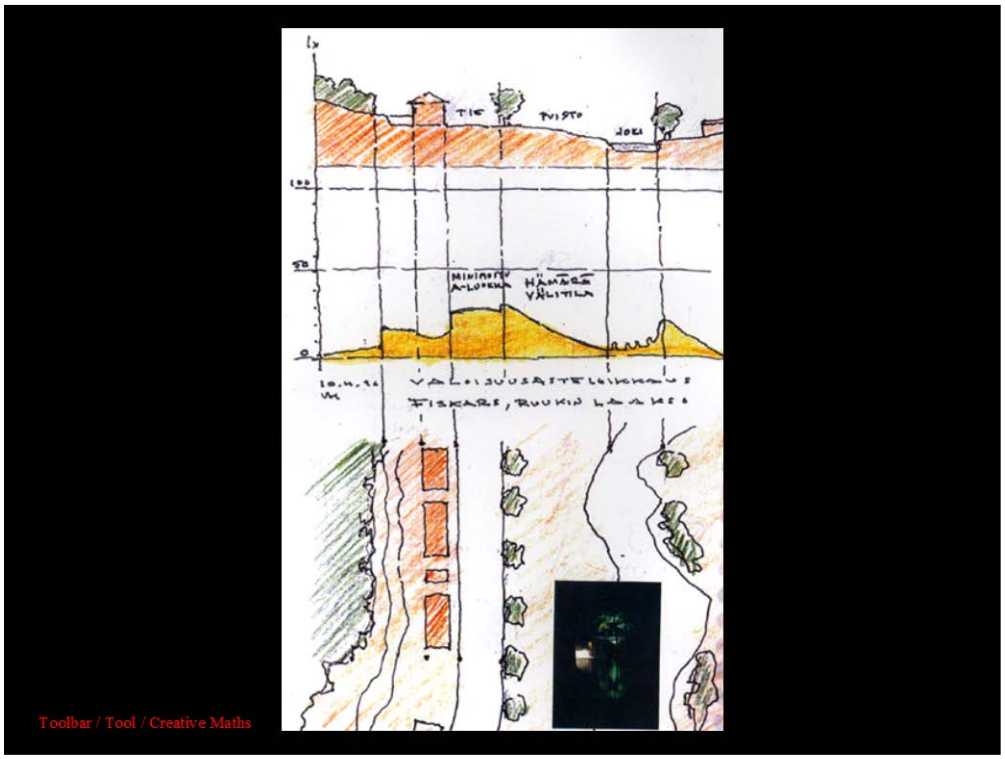


Figure 319. Lighting compose. Photo Vesa Honkonen

Architectural section was cut trough the area and Illuminance section was created. A compose for light. It is like a musical compose, but instead of notes there is illuminance value.

Existing lighting solution was just 10m high poles with 250W High Pressure Sodium lamp luminaires in 2m long arms. Yellow light was all over the place. Compose for that was just one line trough whole area. Very boaring and comparable to one long sound. Not very excited.

In music the pause is at least as important than a note/sound. During the pause listener is waiting what happens next and enjoys the compose after hearing sounds after pauses and in different volume and force. It is same in illuminance section. There are different illuminance values which are equal to notes and dark places, which are equal to pauses.

Contrast, the power of light and life. Equal to Love & Hate, Life & Death, Rich & Poor, Jing & Jang, Light & Dark….Pairs of rich life.

Old and yellow light ran trough the whole place. This photo from old case happens to give an impression of quite nice area, but it is a trick which camera does. In reality the place was really awful.

In normal street lighting luminaire cases only approx. 30% of lumenpackage of the used lamp falls on the road surface. Rest of light, 70 % of lumen package of the lamp, disappear for LOR -> heat, into the bushes, on the wall surfaces of the buildings near the road and in all over the nature.

Uniformity of light was really boring and lighting levels were high like L = 1,5 – 2,0 cd/m2. Of course it was quite safety to drive, but that simply is not enough for this kind of historical area.

Figure 320. Fiskars old street lighting. Photo Vesa Honkonen

Figure 321. Fiskars new street lighting. Photo Jussi Tiainen

New lighting. From illuminance section you can see how exactly light was designed to run on the road surface in road area. That ment that custom made optical system had to be used. This “wet” image shows how sharp light falls down on road surface from custom made optics. Light don’t go in all over to spoil lighting compose of whole area.

Special POT optics were used and lamp was pushed deep into the lamp chamber. White light was used (Cheramic Metal Halide Lamps) instead of yellow High Pressure Sodium. Also color rendering increased from 20 up to 80. Color temperature was still warm and inviting 3000 Kelvins.

Uniformity was suffering, but that was designed. Speed limit was succeeded to drop down from 70 km/h down to 40 km/h.

Glare value was of course fantastic low. No glare at all. Old G- value was over 8 and under 9.

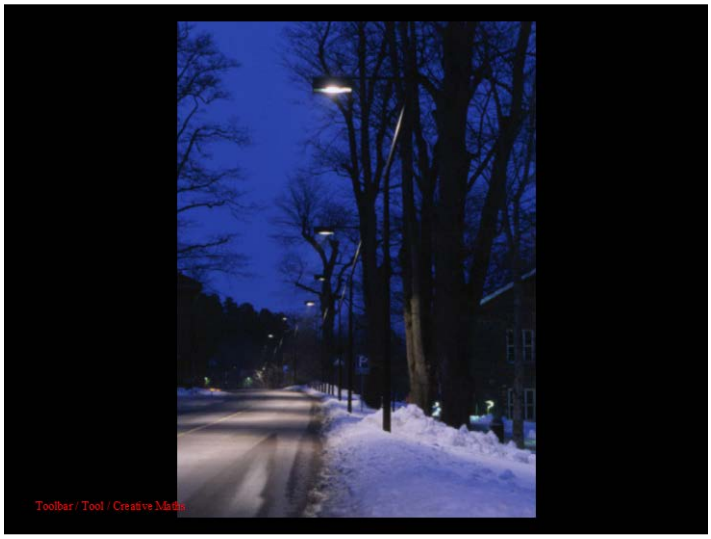


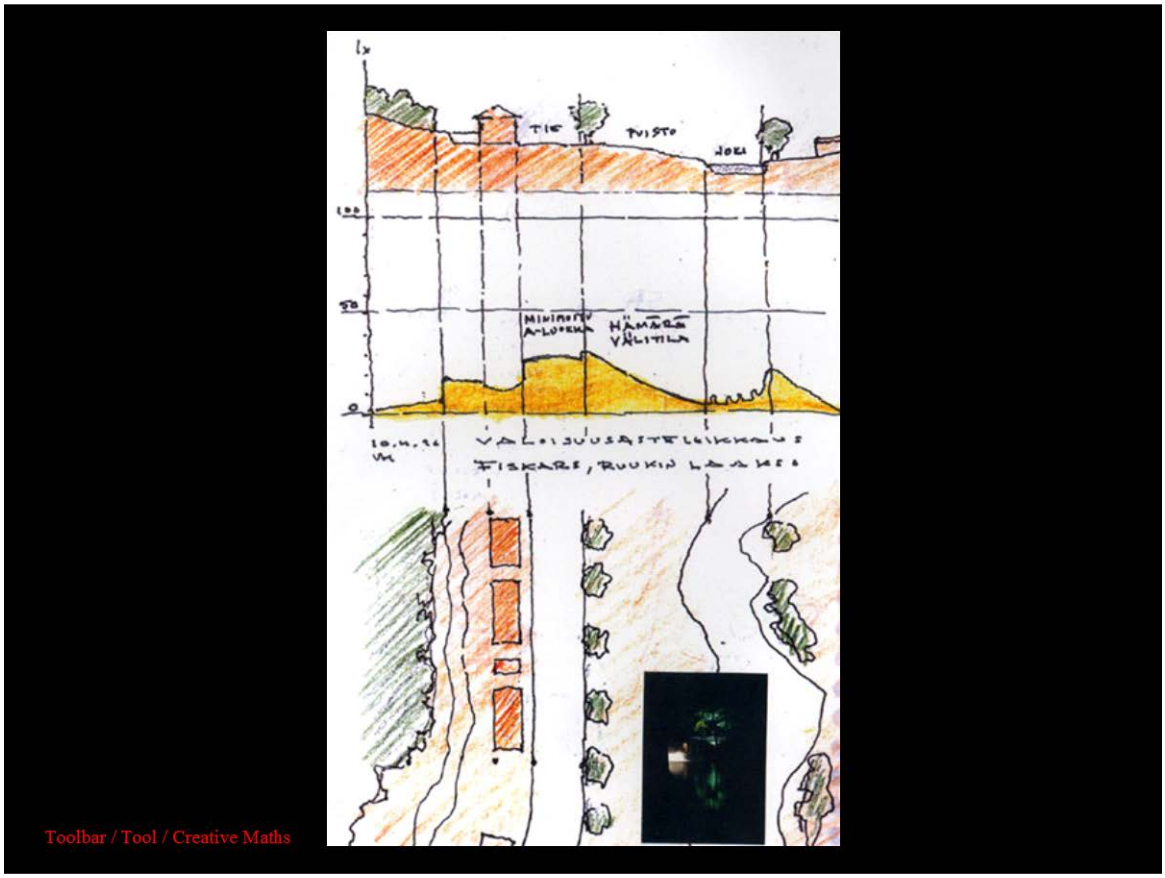
Figure 322. Fiskars street lighting in winter. Photo Jussi Tiainen

Visually luminaire was designed to give flavour of Fiskars. Almost like an ax, but not in naive way. Anyhow narsistic person, who illuminated himself.

Contrast on the road surface was simulating old oil lamp solution, which also gave a hint of history of Fiskars.

If you stand on the road in the middle of clear night and strike up your imagination to maximum power, you almost can hear the voices of hooves of horses slowly drawing away.

Historical touch.



Look the compose and river lighting. Can you feel the quick notes and pauses of Figaro and equality on classical music:

Fiiigaro, Fiigaro, Figaro, Figarooooo……..then sliding down to right side into the forest….

Figure 323. Fiskars. Photo Vesa Honkonen

It looks like this when it is made of light.

Figure 324. Fiskars. Photo vesa Honkonen

More enjoyable Fiigarooo..

People walk near this bond and specially during autumn, it looks fantastic. Reflections from water surface of the bond reflect mystery of life and darkness. Excitement of life and optical illusion is clear.

After some warm red wines, served in restaurant on the right side of the image, walking on the bridge on the bond, you could almost feel, see and hear goblins and trolls having party in darkness, between illuminated trees….You desperately want to go to have night swim into the bond, but of course under water it is possible to…

Vita

Professor Julle Oksanen

Julle is a Professor, Lighting Designer, Luminaire Designer, Examiner and Author. Activities are covering USA, UK, Asia and European area. Julle found "Light & Space Academy, The Finnish Mobile University" together with Professor Hannu Tikka. They have taught in USA, China, Russia, Poland, Japan, Singapore and UK.

Julle is a principal of Julle Oksanen Lighting Design Ltd projects in all over the world like: Opera Houses, Cathedral, concert hall, museums, office headquarter, shopping mall, harbours and parks.

Before design he was active in lighting research. Julle has awarded in over 20 design competitions as a lighting designer and he also have designed luminaires for manufacturers like iGuzzini , Louis Poulsen, Philips, Se'elux and Fagerhult.

Julle is author for more than 30 books, booklets and articles in international publications. Julle has also written CEU- credited, Green Design, Lighting design Courses to Red Vector in USA, authorized by The University of Tennessee. New book is under the work.