Architecture, home & daylight

The openings affection on the quality of a space

FREDRIKA VENNSTRÖM
The subject of daylight is extensive, for example it is relevant to fields of physics, medicine, biology, health, chemistry and environment. In our field of architecture it is relevant in terms of energy consumption, but also it is a fundamental key factor for everything we build and design. Even if we are not conscious about it and use the daylight as a factor in our design, it will affect everything we perceive; shape, color, surfaces, spaces etcetera. I'm well aware of the complexity of this subject, and to make it manageable and possible to reach a good result during the relatively short period for this thesis I have limited my work to look at the architectural key element thorough which we can provide a space with daylight, namely the opening and it's affection on the perception of a space. By this, I do not look at the window, with all its technical aspects, but limit the work to the visual experience of the space, and therefore the quality of light. The opening brings three aspects to take into consideration, namely daylight, sunlight, and view.

I focus on the opening in relation to the dwelling; it feels important and interesting to deal with this matter both due to the massive housing situation in Sweden as well as because the dwelling seems underrepresented when it comes to studies and research done on the subject of daylight. So far it has been dominated by education and workplaces, but today home and work gets more and more difficult to separate. Also I argue that we need to design dwellings not only for people going to school or to a daylit office during daylight hours. Today we can see a big interest in society about daylight in relation to the human, not least proven by the 2017's Nobel Prize for physiology.

As a consequence of this I have, parallel with my design process, distributed and collected a survey among architects, to maybe see a more validated tendency about the general knowledge about daylight and openings among architects. How the architects relate to daylight and is there any indications that there is a general idea of “the more daylight, the better?”

But what does an architect need to know about the matter today? - Well both regulations and Green Building Certification systems, which otherwise have brought the matter into the light, mostly focus on the quantity of light and is evaluated through the daylight factor. Because of this I have made a study with 22 rooms in scale 1:20, all of the very same volume and with the same daylight factor. From this study, I have been able to compare daylight maps and values to the perceived quality of the space by looking in to the model, here represented by photographs.

I have, by looking at existing buildings I perceive stand for a general condition of contemporary commercial residential architecture, also found a theory that the opening seems to be used in two ways. In the first way it is used as a design element, where the main function of the opening is to contribute to a peculiar and unique façade. In the second way the opening is used according to some kind of standard solution, it could be described as some kind of “non-design”, but often the openings help creating a balanced façade by being similar and repetitive. Both of these manners seems to be designed from outside and in and for this project, focusing on the perception of the interior space, it is interesting to see what happens with the façade if the openings design are using the human perception as main focus. Because of this I have as a third and last part of this investigation worked with an existing project, and used it as a case study, let the selected project represent and stand for a general condition, for what I perceive as, contemporary commercial residential architecture in domestic areas in Sweden. With this tool I have been able to evaluate the openings affection on the perceived quality of a space in relation to function, needs and a physical context. By setting up tenants use the space can direct a new design of the openings. Also this tool makes it possible to after changing the openings look at and evaluate the result on the affection on the exterior of the building.

With this thesis I will try to answer: How can the opening affect the perception of a space, what will the result be for the exterior of the building and if or how architects use the opening as a tool for their designs of commercial residential architecture of today?

This project is divided into 3 parts that should be understood as a whole, but read in order from 1 to 3 to fully understand the project and its contribution. At the beginning of each part there is a booklet explaining methodologies, defining words, describing findings and giving a deeper understanding of the project.

Please read the project as an investigation about how the openings affect the perception of a space, how it is used and how it could be used in contemporary, commercial residential architecture in domestic areas in Sweden.
1. THE MODEL

Summary of booklet no.1 - The Model

- The model is in scale 1:20 and represent a size of ceiling height of 2,5m, 6m deep and 4m wide.
- The size and scale are set to that, so I am not forced to use a very wide angle for the camera lens, since that creates a distortion of the image. The ceiling height is also chosen because it is a common ceiling height in Swedish apartments.
- The model is built in MDF, solid wood, cardboard, fabric and paint and is modifiable so that I can easily change the opening to study. My camera was set to fixed settings so that every image was comparable.
- Since I have been investigating the openings affection on the perceived quality of a space, and therefore the quality of light, I needed to consider what paint to use for the model. I made a number of tests both to find a nuance perceived as neutral and also to find an even surface without too much reflectance.
- To be able to compare the affection of the opening on the perceived quality of a space I need to compare the openings to some common factor. For this investigation the Swedish Building Code is a valid and functional factor to use. There are three ways to calculate the daylight factor. The first one is to calculate the Daylight Factor 1-dimensional, in one specific point in each space where people stay more than temporary. Because this is time consuming and difficult to calculate by hand there is a simplified method to control the needed glass area in a vertical wall to fulfill the Daylight Factor of 1%. This method is often mentioned as the glass-to-floor ratio. The third is to use a computer program. Even if the software is easy to approach it has been shown to generate quite different calculation results depending on the users' experience. I have used VELUX Daylight Visualizer for my calculations of the Daylight Factor.
- To be able to work more dynamic with the daylight and at the same time provide the tenants with a larger possibility to use a space in a flexible way in relation to need, one way is to separate these functions to at least two openings. The separation of the functions could be done at different levels depending on how much other qualities are taken into consideration. My study also show that the same space can be perceived in two ways and described by two words that is normally contradictions. For example, a space can be perceived as both calm and active. The reason for this is that the distribution and intensity of light is perceived as calm, at the same time as the view can be perceived as active. The quality of the daylight also depends on which direction the opening has, horizontal or vertical, and what function it has.
which is quite a deep space and the height of the opening is the main factor affecting how deep into the space daylight gets. Also this ceiling height was the same as for my Case Study.

The depth of the space is not only set in relation to common proportions, it is also a consequence of the method of using photography as a tool. The distance from the wall where the camera is placed and the wall with the openings needs to be long enough not forcing me to use a very wide angle for the camera lens, since that creates a distortion of the image. A focal length of 50 mm is usually considered as being closest to reality and the further from that value, the more distortion of the image. For this investigation I decided anything between 30-70mm would work just as fine to compare the different openings and if affection on the perception of a space, as long as it was set to the same focal length. If I would have thought that the focal length I decided to work with (30mm) did not work to represent the space in a reliable way I would have decided to try out a scale 1:10 for the model and thereby increased the distance between the lens and the object (the wall with the opening). In this way I would be able to set the lens at a longer focal length, giving less distortion of the photography.

After taking all the photographs and the images were transferred to the computer I opened the images in Adobe Photoshop to do some post-processing to see if I could help myself for the analysis by emphasize the distribution of light within a space. Quickly I found this to be confusing and disturbing for the evaluation of the space and therefore I decided to use the images as they were and only converted the file format from RAW to JPEG to compress the file size. Important to mention here is my background as a photographer which contain both studies at university-level, paid assignments and exhibitions.

The Paint

One aspect I had to consider for the model, since I have been investigating the openings affection on the perceived quality of a space, and therefore the quality of light, is what paint to use for the model. At first I just thought I would use “standard white wall paint”, this was before I realized such does not exist. I made a number of tests both to find a nuance perceived as neutral and also to find an even surface without too much reflectance. The reason for this was because I found it important to try to make the space as neutral as possible and not to affect the light in a way too far from how it would be perceived in someone’s home. This is really not possible, since the light itself affect how we perceive every little thing and every little thing will affect the light, more or less. However I had to make a decision and I decided to work with an even surface and with low reflectance since the structure of the wall (grains etc.) otherwise needed to be in scale
not to create distorted effects as a result.

The Daylight Factor

To be able to compare the affection of the opening on the perceived quality of a space I need to compare the openings to some common factor. For this investigation the Swedish Building Code is a valid and functional factor to use. In Sweden the way to evaluate the amount of daylight in a building is to calculate the Daylight Factor 1-dimensional, in one specific point in each space where people stay more than temporary.

The specific point is positioned:
- At the half depth of the room
- 1 meter from the darkest wall
- 800 millimeters above the floor

According to the Building Code the Daylight Factor needs to be 1% in this specific point. Simplified this means that the illuminance in the specific point should be 1% of the illuminance measured at a horizontal plane outside without any obstructions.

Glass-to-floor ratio

To calculate this by hand is time consuming and needs a lot of knowledge, therefore there is a simplified method to control the needed glass area in a vertical wall to fulfill the Daylight Factor of 1%. This method is often mentioned as the glass-to-floor ratio, which is valid as a standard for the Swedish Building Code. This method says that a room should have at least 10% vertical glazing, 0.8m above the floor, in relation to the floor area of the space. What makes this method problematic is that the limitations of the standard, like glass type, shape of the floor plan or surrounding obstacles often is forgotten or unknown. EN GENOMGÅNG AV SVANSKA DAGSLJUSKRÅV A third way to evaluate the Daylight Factor is to use the computer and a software to do the calculations. A common software for this is VELUX Daylight Visualizer which I, according me, believe is quite a simple software, which also is free to use. Through VELUX one can get the Daylight Factor calculated, render so called Daylight maps, but also render images of interior spaces based on illuminance or luminance. Even if the software is easy to approach it has been shown to generate quite different calculation results depending on the users' experience.

Velux

I have used VELUX Daylight Visualizer for my calculations of the Daylight Factor in the model. To be able to do this I built up the model in Google Sketchup after trying Autodesk Revit and Autodesks 3D Studio Max for the purpose. Finding it complicated and time-consuming to work with these last mentioned software made the choice easy. After adjusting the opening according to the physical model I could import the model into VELUX Daylight Visualizer. I had to design and redesign each opening several times for them to fulfill the required daylight factor of 1% according to the Swedish Regulations. After a while I learnt how I could change the opening to meet the demands after looking at the first daylight map for each opening. Still at this point of the investigation I had no evidence for my idea of how each opening would affect my perception of the space.

It took me some time to understand the different parameters in the software and how to adjust them. The idea is to select interior materials so as they can represent realistic materials in relation to daylight. The light

5 Boverket, Boverkets Byggregler - förskrifter och allmänna råd, BFS 2011:6
6 SBS-Standardiseringskommisjonen, Byggnadsutformning -Dagsljus - Föreskrift om kontroll av erforderlig fönnsterglasarea, SBS4201
7 SBS-Standardiseringskommisjonen, Byggnadsutformning -Dagsljus - Föreskrift om kontroll av erforderlig fönnsterglasarea, SBS4201
8 En genomgång av svenska dagsljuskråv
The perceived qualities I have evaluated are:
- Light distribution
- Contrast of light
- Contrast of view
- Light effects
- Intensity
- Safety
- View
- Dynamics
- Perceived Brightness

Result and analysis

During the work with the model I have learnt a lot. To be able to handle and use the perceived qualities of light I, thorough my analysis and to some extent literature I have been studying, found tools for how to affect each quality. Following I will describe these tools briefly.

Qualities, how I perceive them and how to affect them:

Light Distribution

**Definition:** How light is spread within a space

- **Direction of opening**
  A horizontal opening brings an even distribution of light within the space. A vertical opening of the same size and with the same sill height as the horizontal opening will bring light deeper into a space giving an uneven light distribution.

- **Position**
  The position of the opening is crucial to the light distribution both vertically and sideways. A high placed opening will bring light deeper into a space and distribute light more evenly in the space than an opening placed closer to a sidewall.

- **Angle of niche**
  The angle of the niche affects the distribution of daylight and should not be a forgotten tool. By looking at a few historical buildings there seems to be a relation between the handling of the niches and the perception of the space. Today the niches are thinner walls and therefore shallow niches, not affecting the perception of the space much. The niches are not as important as they were in the past for many reasons.

Glare/Contrast of light

**Definition:** The inconvenience appearing when light gets too intense so it appears dazzling or when the contrast of light is too high between two surfaces.

- **Direct sunlight**
  Direct sunlight brings sharp shadows, meaning a high contrast. Since I do not evaluate the sunlight, I still think it is an important quality to have in mind when evaluating a daylight situation in a real project.
- Reflected sunlight: Reflected light brings a gradient between light and dark.

- Skylight: The skylight is, even if it falls right through the window already reflected in the atmosphere, therefore the skylight brings a smooth gradient, with less contrast.

Glar/Contrast of view

Definition: The inconvenience appearing for example when being in a dark space, or a space with a dark window frame, often a space with the only opening facing north and the view outside is hit by the sun, creating a high contrast between the interior surfaces and the view itself.

- Orientation: The orientation of the room is crucial for daylight in general, since it affects the quantity of light, not looking at the Daylight Factor because of the CIE Overcast sky, but for any sky condition with less clouds it will make a significant difference. An opening facing north on a sunny day can make it difficult for the eye to focus and be able to switch between the very bright faces outside and the dark space inside, causing glare. Without making an investigation about the exact distance, this situation appears when the reflecting faces outside are far enough not to reflect extra light into the actual space where the observation is done. BILD FRÄN ISLAND. Also the function of the room is important to take into consideration here, this kind of situation will not occur if the viewpoint is close to the opening, with eye level within the area of the space being lit by the opening.

- Brightness of framing: The framing of the opening from the inside is highly important to take into consideration to avoid glare. A dark window frame and/or a dark wall will emphasize the contrast between the view and the interior space. This could be averted by choice of material/color but also by using multiple openings, this most efficient if the light can get into the space from more than one direction.

- Angle of niche: Again the niche can have an effect on the perceived quality of a space. By using an angled opening the contrast between the view and the interior space will get a smoother transition by letting the niche itself work as a lit frame around the view.

Light effects

Definition: Effect of light, with no purpose to increase light quantity or offering a view.

- Position: An opening with a position in the corner of a space will create a rakine light along the surface of the angled wall.

- Size: A narrow opening can in combination with a conscious choice of color create effects of light in the wall itself. A narrow opening placed close to a side wall can, only by reflected light, have a big impact of the perception of a space and its proportions.

- Mullions and raster: This will only be efficient in direct sunlight and the effect will appear both in the wall itself, but also on the other surfaces in the space.

Intensity

Definition: The intensity of light is affecting the perceived brightness in a space. The intense light is also a key factor to create dynamics within a space. The intensity could also be described as perceived luminance.

- Width of opening: A narrow opening can emphasize the perceived intensity of light, since the direct light is mixed with reflections between two surfaces.

- Position: The position is crucial to the perceived intensity of light. The closer to the floor, the more intense the light is perceived.

- Wall thickness: The wall thickness affect the intensity of the light since it creates the niche, a deep niche with a narrow opening will increase the perceived intensity of daylight compared to a shallow niche.

- Color: The choice of colors can emphasize the perceived intensity of daylight. A niche with a light color, framed by a dark interior wall will emphasize the perceived intensity of light, also the bright color will reflect more light than a dark color.

- Brightness in space: As for the color this has to do with contrast, a dark space can make emphasize the intensity of light.

Safety

Definition: The feeling of being safe in a space.

- View Out: When a view out is offered I perceive the space as safe since it helps to orientate and understand the position in relation to the surroundings. Also a view out offers an opportunity to follow actions and activities outside, giving control and making it possible to prepare for what to meet when leaving the space.

- View in: I believe view into a private space affect the perception of safety a lot in what way and to what extend is probably depending on if the relation to the observer on the outside.

- Sill Height: The sill height has a strong connection to the perception of safety, if it is low I perceive the space as open, making it less private and also affecting the perception of safety. On the other hand a very high position of the sill (above eye level) makes me perceive the space more like a basement which are probably related to earlier experiences.

- Guiding Light: The presence of daylight in a space help understanding of time and surroundings but also the dynamics of daylight within a space helps for navigation and understanding of a space. The understanding of a space is crucial for our perception of safety and comfort.  

Dynamics of Light

Definition: The perceived variation of light within a space.

- Position: The position of the opening will affect the dynamics of the daylight in multiple ways. The position will affect the intensity, being a key factor to create a dynamic perception of the space. It will also affect the distribution of daylight within the space.

- Multiple openings: Using more than one opening is an effective tool to use to make a space perceived as dynamic. Important is though to make sure that the different openings bring different qualities to the space.

Perceived Brightness

- Size: The size of the opening is affecting the perceived brightness by affecting how much light reaches a space, but also it can affect the perceived intensity of daylight, which is an important factor to affect the perceived brightness.

- Position: Again, by affecting the perceived intensity of light the position of the opening is important to the perception of brightness.

View

Definition: What we see from inside and out.
Direction
If the opening is horizontal or vertical it affecting my perception of the space a lot. A wide view brings a lot of knowledge about the surroundings but can be efficient in its way to direct our focus to a specific object.

Orientation
It is crucial to consider the orientation in relation to the surroundings when designing openings for a space.

Size
The size of the opening will control how much of the view outside is visible.

Silhouette
The sill height and position of the opening affect how much ground or sky being visible, and if there is possible to relate to the horizon. The issue of having (or not) a “horizontal view” probably over shadows the importance of the wide view.1

Angle of niche
The angle of the niche opens up the opening, providing view for a greater part of the space.

These qualities are affecting each other to various extents, making the analysis a bit confusing from time to time. Still I find this method as a good tool to evaluate and understand the openings affect on the perception of a space. To reach the result of finding these concrete tools to work with gives an understanding about how to affect a space and how it is perceived. These tools can always be used to try to understand why a space is perceived in a certain way, but also to how to create a space with a wish of a certain perception.

Use of the model as a tool
The model appeared to be a good tool to work with, both to understand daylight and how architecture can affect and change the perception of it. Since the model has the same dimensions and same materials in all images, it is clearly the opening on its own that affects the perception of the space a lot.

The construction of the model was sold and easy to work with, maybe I could have skipped making the ceiling adjustable, since I decided to go for a fixed ceiling height. On the other hand this made it possible for me to adjust and work with the same ceiling height as in the case study, using the height measurements of the openings straight off in the later part of the thesis. To work with a physical model made me feel I had more control, and could thereby also be more creative during my process. Also I could use the model to test openings for the case study in specifics. This work will be described in a later section of the thesis.

The use of photographs
To use photographs as representation for the space turned out to have pros and cons. Since I decided to work with a physical model it is the only way to actually compare and present the result. I think it is important to have a good knowledge about photography and how different settings affect the image, but also to be familiar with the camera equipment to get a good and reliable result of the study though. As I described earlier I had to choose between making the ceiling adjustable, both for settings and choice of equipment.

One difficult aspect of using photography and actual daylight for my analyzes was the time frame each day when there was enough light. The time of the year, October-December, when the photographs are taken, offers quite a short period of time each day to work with.

Choice of opening
Selecting what openings to analyze was, as described, an evolving process. I had some ideas at the beginning of some “standard opening” I wanted to test, to be able to compare them. The first ones I did all had one single opening, but during the process I realized it could be beneficial to separate the two functions of light and view into two openings instead.

As mentioned earlier research show that the most efficient opening to fulfill the need of a view is a vertical opening, since it is what we see that is important, not how much we see. At the same time the most efficient opening to fulfill the demands of the daylight factor is, according to my study, a horizontal opening placed 800mm above the floor. Comparing the two factors above we can see a contradiction in efficiency depending on what is seen as the most valuable factor, view or quantity in terms of the daylight factor. The opening supporting the fulfilling of the requirements for the daylight factor will, if only one large opening is used, be the selected option since that is the one being controlled in the regulations and a horizontal opening will both provide enough daylight and a view. One problem appearing if we always treat openings in this manner is that all spaces will be what I perceive, general and anonymous. The biggest issue in relation to function appears if the tenant needs to cover the opening, often because of glare or safety reasons. In this situation all qualities are taken away. To be able to work more dynamic with the daylight and at the same time provide the tenants with a larger possibility to use a space in a flexible way in relation to need, one way to separate these functions to at least two openings. The separation of the functions could be done at different stages of day, and therefore on a horizontal opening the qualities are taken into consideration. It can be the same opening, divided into smaller areas, preferable horizontally, or two or more openings.

In relation to today’s commercial housing architecture this might seem strange, but the function will be explained further in the following paragraph.

By providing a space with two openings it makes it possible to limit the view, but keeping the connection to the surroundings by letting daylight in, letting the light itself work as a carrier of information. At the same time the opposite situation can be created. With a smaller opening providing a view, the light can be removed if needed without losing the connection to the surroundings. Why this also works if one opening is divided in two horizontal parts is because it is the height of the opening that affect how deep in to the room the daylight reaches. Dividing an opening in a kitchen with a horizontal mullion, makes it possible to keep the view when sitting at the table, but shutting the sun out, preventing the persons sitting at the table from being dazzled, since the sun will only hit the table surface closest to the exterior wall.

The horizontal division gives the possibility to restrict insight, while the daylight can still be spread evenly in the room. The favor of the horizontal opening is only true if the use of the space is in favor of an even lighting situation.

The key factor for changing the distribution of light within a space is to change the direction of the opening together with the position. A horizontal opening brings a more even distribution of the light then a vertical opening does. The horizontal opening will spread the light wider while a vertical opening will spread the light deeper into the space (having the same size and sill height). The illuminance of the skylight is highest close to the opening, therefore the space will be perceived as brighter with the horizontal opening, providing more daylight close to the outer wall than the vertical one, which distribute the light deeper into the space but offer less light perceived as intense.

Different perceptions
The perception of the qualities of the openings will be affected by how tall the observer is. For example a child and an adult will probably perceive the spaces differently due to their relation to the sill height of the opening.

The same space can be perceived in two ways and described by two words that is normally contradictions. For example a space can be perceived as both calm and active. The reason for this is that the distribution and intensity of light is perceived as calm, at the same time as the view can be perceived as active. In the photographs for my analyzes the view is a bit blurred because of the chosen aperture, but here an evenly grey sky and silhouettes of buildings and trees made a big difference for the perceived activity of the view.

Light qualities
The perceived intensity of light is mainly related to the sill height of the opening. The closer the opening is placed to the floor, the more intense the light gets. Since the light is falling from above it will, if the opening has a high sill (and a high position) fall deep into the space and be spread and reflected there within. Direct light is more intense than indirect light; here the skylight is considered being the direct light compared to light being reflected by materials of the building. The sill itself will reflect some of the light, if it is not visible for the eye, being above eye level, the first visible light will be a reflected light visible in the ceiling or the top of the niche, and therefore be perceived as less intense.

Also the brightness of the room and therefore the size of the opening is crucial for the perceived intensity of light. The brighter contrast between the lit area and the rest of the space, the more intense the light is perceived. The intensity of light is the next step affecting the perceived brightness within the space.

Direction of the opening
A wide opening providing a lot of information about the surroundings makes me perceive the space as safe and calm since I can follow activities outside. This could be seen as a contradiction to what Szybinska12 concludes saying that the quality of the view is more important than the scope of it. My analysis of this is that the perception might be related to what context the building is situated in, and how comfortable the observer is in the neighborhood.

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For a narrow opening to contribute to quality to a space, especially considering a vertical opening, the position needs to be well evaluated in relation to sightlines and/or the use of the space. A so called ribbon window, a horizontal opening reaching from one corner to the other gives an even distribution of light in the space. Also it gives a large possibility for the tenant to use the space as needed and desired by the use of curtains. In this way the tenant can decide what part of the room should be lit, on the other hand all openings will have the same sill height, which through my studies are important in relation to activity. Analyzing the ribbon window I also find it interesting that even if the light is evenly distributed horizontally, one can, by using quite a narrow opening vertically, make the light distribution somewhat dynamic vertically.

The function of the opening
To create a lighting of a space being perceived as dynamic one can use intensity and distribution as key factors in the designing process.

My investigation through analyzing the spaces of the model I have found the opening to be able to affect the perceived height of a space. This seemed to depend on a combination of different factors. The size, proportions and maybe especially the height of the top of the opening affect the proportions of the wall being perforated. The contrast of the view also seems important since a great contrast makes it difficult for the eye to perceive details in the dark areas like where the ceiling meets the wall. Watching TV is suitable for a lot of openings, it is preferable to have a space with possibility to get some light in, but with no or little risk of reflections from sun, which are completely depending on the orientation of the room. Also a very intense light in some part of the can be perceived as annoying for the eye that during the activity is supposed to focus on the screen.

The position of small openings with the function of providing a view needs to be very well considered in relation to sightlines and/or how the space is used to bring any extra quality to the space. If the opening is small vertically the view will only be offered to people with a certain length which can be important to have in mind.

I also want to point out that not even the perception of the amount of light in the room is truly correlated to the daylight factor. I believe the reason for this mainly is about one of the qualities I'm looking at, namely the distribution of light, combined with the fact that the daylight factor only shows amount and distribution of light on one specific height, it is in no means 3D. The table also shows that the daylight factor itself differs depending on calculation method. Beyond the distribution of light within the space I also look at GLARE, CONTRAST and VIEW which are important qualities of the opening, strongly effecting the perception of the room through comfort, character and safety.

References

Boverket, Boverkets Byggregler-förskrifter och allmänna råd, BFS 2011:6


SBS - Standardiseringskommissionen, Byggnadsutformning - Dagsljug - Förenklad metod för kontroll av erforderlig fönsterglasarea, 5914301


Fridell, Kranth Forsikre och Praktiker om Färg Ljus Rum: Stockholm: Formas; 2006
## Analyzed Qualities of the Openings

- with actions affecting named quality

**Definitions and explanations can be found in booklet no. 1 MODEL**

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<td>Width of opening</td>
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<tr>
<td>Position</td>
<td>Wall thickness</td>
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<tr>
<td>Color</td>
<td>Brightness within space</td>
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<tr>
<td>OPENING SIZE mm (hxw)</td>
<td>SILL HEIGHT mm</td>
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<td>1 650x4000</td>
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<td>2500 850</td>
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<td>22 2500x700 1200x1000</td>
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</table>

* Does not truly fulfill the criteria for use of the swedish standard: "Building design - Daylighting - Simplified method for checking required window glass area". Some of these openings are horizontal and some are eccentrically placed on one side of the wall. There are not mentioned in the standard how far from the corner the opening should be calculated, as it does for the sillheight, therefore I decided to count those openings since I still think the numbers are interesting.
Perception of the space: Bright, Even, Intense, Soft, Open, Comfortable

Daylight Factor
(Point Measurement)

Ceiling Height: 2500mm
Opening Size: 650mm x 4000mm
Opening Height: (lower edge) 0mm

Comment:
This opening brings an intense light, this since the skylight passing through the opening immediately hits the bright surface of the floor.
The reflected light is also lighting up the interior of the outer wall, but also framing the space by lighting up the side walls and the ceiling with a soft but still dynamic light, due to the gradients appearing on each surface. Again I believe this horizontal opening brings a lot of dynamics in the light, both in vertical distribution but also in intensity. Here I can see myself lying on my back, following the changes of light in the ceiling, depending on time and shifting weather outside.

My suggested activity: Resting, Sleeping, Watching TV

Perception of the space: Bright, Active, Comfortable, Open, Intense

Daylight Factor
(Point Measurement)

Ceiling Height: 2500mm
Opening Size: 500mm x 4000mm
Opening Height: (lower edge) 800mm

Comment:
The height of this opening gives a possibility for a sitting or a short person to overlook the space outside. The sill height in combination with the height of the opening itself makes me perceive the distribution of light within the space somewhat dynamic even if the opening is wide and therefore usually is considered to distribute the light evenly. The ribbon window opens up the space from one corner to the other and makes me therefore perceive the space as open and public.

My suggested activity: Reading, Eating, Resting
Perception of the space: Dark, Calm, Active, Safe, Comfortable, Risk of Glare

My suggested activity: Cooking, Sleeping, Reading, Watching TV

Comment: A wide opening with a sill height suiting for an adult person standing up will bring an even distribution of light within the space and bring a lot of information about the surroundings, making me perceive the space as safe since it offers a possibility to follow activities outside the building.

Daylight Factor (Point Measurement)

Ceiling Height: 2500mm
Opening Size: 450mmx4000mm
Opening Height: (lower edge) 1300mm

Perception of the space: Dark, Gloomy, Dull, Calm, Safe

My suggested activity: Sleeping, Watching TV

Comment: The narrow opening along the ceiling gives a light evenly distributed deep into the space. There are no risk someone can look in, making me perceive the space as private and safe, but on the other hand it does not offer the observer any possibility to see what is going on outside except from changes in whether and time.

Daylight Factor (Point Measurement)

Ceiling Height: 2500mm
Opening Size: 440mmx4000mm
Opening Height: (lower edge) 2060mm
Perception of the space: Bright, Intense, Dynamic, Soft, Balanced, Unsafe, Public, Closed

Comment:
Depending on how high above ground the floor level of the space is I perceive that this opening, due to its size and position in the center of the wall, directly adjacent to the floor, makes the space feel unsafe. There are almost no areas in the space the user can stand or sit without being seen from the outside. The low opening offers an intense, reflected light lighting up the interior wall and the ceiling, emphasizing the space and its proportions at the same time as it makes me perceive the space as bright. Placing a dining table by this opening would offer all seats a view, even if the quality of the view can differ.

My suggested activity: Hanging out

Daylight Factor
(Point Measurement)
Ceiling height: 2500mm
Opening Size: 1100mm x 1700mm
Opening Height: (lower edge) 0mm

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Perception of the space: Even, Bright, Safe, Comfortable

Comment:
An opening being placed in the center of the wall, copying or nearly copying the proportions of the wall makes me perceive the entire wall as a frame for the view. This also makes me perceive the space as well-balanced and calm. On the other hand it brings a very even distribution of the qualities of the space, both regard the light and view. This makes the space suited for activities that are in favor of equability. Placing a dining table by this opening would offer all seats a view, even if the quality of the view can differ. This is an example of an opening making it difficult restricting the light while keeping the view and vice versa.

My suggested activity: Reading, Resting, Sleeping, Eating, Cooking, Hanging out

Daylight Factor
(Point Measurement)
Ceiling Height: 2500mm
Opening Size: 900mm x 1700mm
Opening Height: (lower edge) 800mm
Perception of the space: Dark, Soft, Gloomy, Safe, Uncomfortable, High, Open, Risk of Glare

My suggested activity: Resting, Sleeping, Watching TV

Comment: The sill height of this opening is too high to let anyone see anything but sky, still the opening is large enough to let someone through. The size of the opening is big enough to bring both daylight and a view, but does not give the only thing being visible is the sky. The size and proportions of the opening makes me perceive the space as open, but the position makes it hard to use and control the openness. Also I perceive the space as dull and gloomy, maybe because of the lack of dynamics in light. Looking at the surfaces of the space they all look very similar.

Daylight Factor
(Point Measurement)
Ceiling Height: 2500mm
Opening Size: 900mmx1700mm
Opening Height: (lower edge) 1600mm

----

Perception of the space: Dark, Dynamic, Soft, Safe, Risk of Glare

My suggested activity: Reading, Resting, Sleeping, Eating, Cooking, Hanging out

Comment: This opening divides the space into two areas, offering different qualities in different parts of the space. I perceive the opening as well-proportioned in relation to the wall it is perforating and are framing the view in a nice way. I see a risk for the view to be perceived as dazzling depending on how the niche of the opening is treated. It would be in favor of an angle, making a smooth transition for the eye between the interior of the outer wall and the view outside. The reflections from the raking light along the right wall are also helping to provide glare of the view.

Daylight Factor
(Point Measurement)
Ceiling Height: 2500mm
Opening Size: 1100mmx1800mm
Opening Height: (lower edge) 800mm
Perception of the space: Soft, Dynamic, Open

Comment:
The position directly adjacent to the floor brings an intense light at the bottom of the opening. The light is reflected to the interior of the outer wall and to some extent also onto the sidewalls and the ceiling, helping the view appear less dazzling.
The position in the center of the wall in combination with the lack of a sill the possibilities for how to use the space are limited. The position and proportions of the opening is similar to a door, but far too low, making me perceive the space and the opening itself as disproportionate.

My suggested activity:
Hanging Out

Daylight Factor
(Point Measurement)

Ceiling Height:
2500mm

Opening Size:
1600mm x 1100mm

Opening Height:
(lower edge) 0mm

---

Perception of the space: Dynamic, Low, Comfortable, Risk of Glare, Safe

Comment:
This opening brings an intense light in a small part of the space, creating a dynamic light, both in terms of intensity and distribution. The opening offers different qualities in different parts of the space, making it suitable for multiple functions at the same time, like for example a child’s room.

My suggested activity:
Reading, Resting, Sleeping, Hanging out

Daylight Factor
(Point Measurement)

Ceiling Height:
2500mm

Opening Size:
1700mm x 1250mm

Opening Height:
(lower edge) 1300mm
Perception of the space:
- Dark, Dull, High, Soft, Calm, Comfortable, Safe

My suggested activity:
- Reading, Resting, Sleeping, Hanging out, Cooking, Watching TV

Comment:
This opening divides the space into zones with different light qualities making it suitable for multiple functions at the same time. It has a dynamic light in terms of distribution and perceived quantity, but has quite low intensity and contrast, making me perceive the light as soft. The opening also brings the light deep into the space. The position of the opening makes it possible to avoid looks from the outside and use a part of the space privately.

Daylight Factor (Point Measurement)
- Ceiling Height: 2500mm
- Opening Size: 1650mm x 1250mm
- Opening Height (lower edge): 850mm

Daylight Factor (Point Measurement)
- Ceiling Height: 2500mm
- Opening Size: 1400mm x 1050mm
- Opening Height (lower edge): 900mm

Perception of the space:
- Dark, Dull, Gloomy, High, Safe, Risk of glare, Anonymous

My suggested activity:
- Reading, Resting, Sleeping, Eating, Hanging out

Comment:
This opening provides daylight and view for the space, but not much else. The corners are dark and I would say that this opening does not help much for the understanding of the space. In relation to the other openings in study I perceive this space as dull and anonymous.
Dark, Gloomy, Dynamic, Comfortable, Risk of Glare

My suggested activity: Reading, Resting, Sleeping

Comment:
Using two openings with very different qualities offers a possibility to limit the view but still keep the connection to the surroundings by getting information from the daylight. The vertical opening prevents any risk of being seen from the outside, if the user of the space does not literally stand inside the opening itself. Therefore I perceive this space in a way suitable for a bedroom or some other space where the user can be in need of privacy.

Daylight Factor (Point Measurement)

Ceiling Height: 2500mm
Opening Size: 2500mm x 900mm
Opening Height: (lower edge) 800mm

Daylight Factor (Point Measurement)

Ceiling Height: 2500mm
Opening Size: 475mm x 4000mm
Opening Height: (lower edge) 2025mm

Dark, Gloomy, Soft, Safe, Comfortable, Risk of Glare

My suggested activity: Resting, Sleeping, Watching TV

Comment:
The idea here was to restrain views from above if the space is placed on a low level facing a street with a building on the other side or if it is oriented towards a courtyard. Between the two openings there is a reflector which I hoped would reflect the light to spread it up to the ceiling to get it deep into the space and at the same time prevent view in. The effect I was looking for did not appear, maybe it would work more efficiently with sunlight. I perceive the size and proportion of the vertical opening as good for providing a limited, but functioning view.

Daylight Factor (Point Measurement)

Ceiling Height: 2500mm
Opening Size: 1300mm x 950mm
Opening Height: (lower edge) 1100mm

Daylight Factor (Point Measurement)

Ceiling Height: 2500mm
Opening Size: 1150mm x 500mm
Opening Height: (lower edge) 800mm
Perception of the space:
Bright, Even, Intense, Soft, Open, Comfortable

My suggested activity:
Resting, Sleeping, Watching TV

Daylight Factor
(Point Measurement)

Ceiling height:
2500mm

Opening Size:
570mmx4000mm 800mmx500mm

Opening Height:
(lower edge) 1300mm 0mm

Comment:
These openings bring basically the same qualities as the one with the room-wide opening along the floor, but with the small opening providing a glimpse of a view as an addition. The added opening does nothing for the actual quantity of light. For such a small opening to contribute to any extra quality of the space its position needs to be very well evaluated in relation to sightlines and/or use of the space.

Again, I judge the position of the small opening very sensitive and I believe it needs to be consciously decided in relation to sightlines, quality of view and use of the space. Its position is crucial for it to offer the desired quality.

The horizontal opening in the ceiling is bringing a lot of light into the area close to the outer wall, but is not offering any direct skylight deeper into the space. I perceive the brightness to be unbalanced in relation to the small opening providing a view. The opening in the ceiling could be smaller in favor for the other opening to be larger.
Perception of the space:
Dark, Gloomy, Dull, Calm, Uncomfortable, Risk of Glare

My suggested activity:
Sleeping, Watching TV

Comment:
A narrow opening like this, with a high sill, is supposed to provide a view that gives very little information about the surroundings, but opens up for curious eyes to look in. When the opening is as small as this the position is crucial to bring the supported quality to the space. With this position, it only gives extra information about the surroundings if the observer is tall and standing up, otherwise it will bring the same information as the horizontal opening along the ceiling.

Daylight Factor (Point Measurement)

Ceiling Height: 2500mm

Opening Size: 400mm x 4000mm
800mm x 500mm

Opening Height (lower edge): 2100mm
1100mm

Perception of the space:
Dark, Intense, Soft, Safe, Comfortable

My suggested activity:
Nesting, Sleeping, Watching TV

Comment:
With this opening, I wanted to see if it was possible to keep the light effect from the wide opening directly adjacent to the floor but raise the perception of safety by limiting the possibility to look in to the space from outside. I feel that the result is close to the desired effect, with a smooth but intense light, bringing information from the daylight to the ceiling, but with the screening that prevents curious glimpses from outside.

Daylight Factor (Point Measurement)

Ceiling Height: 2500mm

Opening Size: 800mm x 500mm
950mm x 4000mm

Opening Height (lower edge): 1100mm
0mm
Perception of the space: Dynamic, Dark, Soft, Safe, balanced, Comfortable

Comment:
I perceive this space as balanced and very comfortable. The side openings bring a soft gradient from the raking light along the outer wall and are designed in a way not to provide view from any part of the space but close to the outer wall, an effect working in the opposite way as well. With this design I do not perceive the space as dull and gloomy, even if it has the vertical, centered opening in another analyze perceived as just that. I believe this is thanks to the dynamic light brought by the side openings.

My suggested activity: Resting, Sleeping, Watching TV, Hanging out

Daylight Factor (Point Measurement)
Ceiling Height: 2500mm
Opening Size: 1200mmx1000mm 2500mmx1000mm 2500mmx400mm
Opening Height: (lower edge) 800mm

Daylight Factor (Point Measurement)
Ceiling Height: 2500mm
Opening Size: 800mmx4000mm 1000mmx600mm
Opening Height: (lower edge) 2500mm

Perception of the space: Bright, Intense, Even, Soft, Safe, Comfortable

Comment:
This design has a 800mm high sill and are met by a tilted wall reaching up to a skylight. The vertical part of the wall simplifies the use and furnishing of the space. I would say that this opening works well for activities performed at a table, desk or a counter placed close to or along the outer wall, which would reduce the use of artificial lighting. The light is evenly distributed within the space but I perceive it as somewhat dynamic anyways thanks to the “broken” surface of the wall. The position of the vertical opening can be adjusted in relation to how the space might be used.

My suggested activity: Resting, Reading, Watching TV
Perception of the space:
Bright, Soft, Safe, Comfortable

My suggested activity:
Resting, Reading, Cooking, Sleeping, Watching TV

Comment:
This space has a tilted outer wall with a skylight at the top. The effect of the tilted wall is that the wall itself gets illuminated from above and is therefore perceived as bright at the same time as it gets a smooth gradient with the most intense light at the top, decreasing as it falls down the wall. The most intense light is, from this perspective, taken away since the outer wall overlaps the ceiling height and very little light reaches the space without being reflected on the outer wall or the surfaces of the opening itself. This is also the reason I perceive the space as rather dark.

Daylight Factor
(Point Measurement)
Ceiling Height: 2500mm
Opening Size: 650mmx4000mm 700mmx500mm
Opening Height: (lower edge) 2500mm 850mm

Bright, Intense, Dynamic, Soft, Safe, Comfortable

My suggested activity:
Resting, Reading, Sleeping

Comment:
The separation of light and view makes it possible to get information about the surroundings even when one of the functions is taken away. The outer wall is passing the corner a little bit and therefore I perceive the light as intense and due to the angle of the wall the light is bring in intensity rather rapidly. The idea of the opening was also to light up the interior of the wall to prevent glare of the view through the other opening. Looking at the sizes of the openings in this design it appears rather inefficient compared to the amount of daylight it provides, both due to the daylight factor and the perceived brightness.
2. THE SURVEY

Summary of booklet no. 2 - The Survey

What does architects think about daylight and how are they using their knowledge when they work on their projects? I found it interesting that during my whole architectural education there was a big gap in this subject when daylight is a fundamental factor for everything we see, and a lot of the things we perceive. There are some regulations but what does architects think about daylight and are they consider it during their design process?

To answer this, I made a survey about daylight and asked a couple of different questions to see what they think of daylight in different projects and situations. 77.8% of the respondents replied that they don’t put much time on the work with daylight.
What does an architect have to know?

After being a part of the architectural field for some years I have found myself in situations where I have seen tendencies to lack of knowledge about daylight among architects. To be able find out if there is any truth for this apprehension I must understand what an architect in Sweden must know about the subject of daylight. A reason for me to work with this subject for the thesis has been that I have missed Daylight as a subject during my own education, it has always been present due to its nature, but have never been discussed, analyzed or taught. I started my architectural education at Lund University in 2009, after three years I decided to have a break for a year when I was offered an internship at an architecture office, After the internship, which I continued, I started my education at the school of architecture at the Royal Institute of Technology. When I started in Lund we had a book as course literature which was recommended for us to use throughout the whole education. This book is called “Arkitektens Handbok” and is used by basically all of my fellow students. A quote from the back of the book is:


briefly saying that the book is a compilation of key information about architecture and building. Looking at the content of the book it goes through subjects geometry, acoustics, construction, insultation, measurements of sports courts etcetera. The word daylight is only found as a part of the word “dagligtstransmitter” meaning daylight transmission, which is briefly explained. Sunlight gets some attention when a tool to evaluate sunlight is explained, but not more than that. This was true until the 2017 year edition was released which have a chapter explaining the room and the objects that can be found within it, here the matter of light gets a section explaining the basics of light in six pages, with a brief paragraph explaining important basics about daylight and openings. During my education I cannot recall one single lecture or one single book being recommended on the subject of daylight. I find this interesting since it, as I have mentioned before a fundamental factor for everything we see, and a lot of the things we perceive.

Looking at what an architect must know about the subject of daylight and openings in relation to the perception of space to be able to work as an architect in Sweden today is based on two sources, namely the Swedish Regulations through the Boverket’s Building Regulations, and to some extent also the green building certification systems: LEED, BEEAM and Miljöbyggnad, becoming more and more usual to use.

Here is an excerpt from Boverket’s building regulations – mandatory provisions and general recommendations:

6.3.1 Light
6.3.1 General Buildings shall be designed to ensure satisfactory light conditions can be achieved without the risk of injury or human health hazards. The light conditions are adequate when sufficient light intensity and the correct brightness (luminance) is reached and when there is no glare interference and therefore the appropriate lighting intensity and luminance distribution are present. General recommendation Additional rules for windows and lighting are contained in Sections 3:1224, 3:1424, 3:22, 3:54, 3:53, 3:54, 6:253, 8:21, 8:23, 8:24 and 9:32. The Swedish Work Environment Authority issues regulations on light conditions in workplaces.

6.3.11 Definitions
Direct daylight Light through windows directly from outside. Direct sunlight Non-reflected sunlight in rooms. Indirect daylight Light from the outside which enters the room, other than through the window to the outside.

Boverket’s mandatory provisions and general recommendations, BBR Consolidated version (full text)

98 (165) Consolidated version (full text)
6.3.2 Light conditions

6.32 Lighting Lighting suitable for its intended use shall be arranged in all the spaces of the buildings. The requirement applies to the building as a whole. General recommendation SS-EN 12464-1 may be used in respect of lighting designing for indoor workplaces.

6.322 Daylight Rooms or separable parts of rooms where people are present other than occasionally shall be designed and oriented to ensure adequate access to direct daylight is possible, if this does not compromise the room’s intended use. However, in common spaces according to Section 3:227, access to indirect daylight is sufficient, (BFS 2016:6) General recommendation. For calculation of the area of the window glazing, a simplified method according to SS 91 42 01 can be used. The method applies for room sizes, window glazing, window placement and shielding angles according to standard. When used, a general figure for the window glazing area in the room should be at least 10% of the floor area. It entails a daylight factor of approximately 1% if the conditions of the standard are met. For rooms with other conditions than those specified in the standard, the window glazing area can be calculated for the daylight factor 1.0% according to the standard’s annex. (BFS 2014:3).

6.323 Sunlight At least one room or separable part of a room in dwellings, where people are present other than occasionally, shall have access to direct sunlight. However, student dwellings of not more than 35 m2 are not required to have access to direct sunlight. (BFS 2014:3).

6.33 Views
General recommendation At least one window in rooms or separable parts of a room where people are present other than occasionally should be situated to ensure the view provides the opportunity to follow the seasonal variations day and night. In dwellings, skylights should not be the only source of daylight in rooms, where people are present other than occasionally. However, in dwellings intended for one person with common spaces according to Section 3:227, view is not required in common spaces for everyday social contact, looking or meals. (BFS 2016:6).

Concluded one can say that the regulations mention a few more factors about the opening to handle than only the quantity of light. Also, the view and the risk of glare depending of light intensity and luminance are mentioned as important qualities. To be able to understand the full picture of the design of openings in apartments one also has to look at what tools the department for building permissions have to evaluate whether a project fulfills the regulations or not. As I mentioned in the chapter about the Model this is where the quantity of light gets extra important since the daylight factor, and in some cases daylight maps are their only tool to evaluate the openings. At the same time the daylight factor is rarely calculated in the process of building permissions, the common way of controlling the daylight situation within a building is to use the simplified method called glass to floor ratio. For the simplified method it is common that the restrictions of the method is forgotten and unknown. Making the calculations invalid. This proves that today’s methods put a great demand on the knowledge about light of the staff on the building department to be able to guarantee a satisfied daylight situation within a building if not least since it is proven, also through my own model investigation, that all of these tools bring very little information about the actual perception of a space.

The more daylight the better?

Since I heard an architect say “Well, you know, I wanted the apartments to be as good as possible so I put in as much windows as I possibly could.” I have been wondering if this is a common or even general thought among architects. To get an answer to this I have, as a part of this project being important to understand the treatment of daylight in commercial residential architecture, I have made and digitally distributed a survey among architects in Sweden. The digital distribution means I have not been able to control who the respondents more than by questions at the beginning to frame their background. To get an answer about the respondents attitude towards daylight its affection on the quantity respectively the perceived quality of a space I started by state “The more daylight the better”, letting the respondents give a value between 1-6 where 6 meant “totally agree” and 1 meant “don’t agree at all”.

The reason I have chosen to use a scale of 1-6 is to get a more nuanced picture, than if for example would have used a 2-option scale. The scale has an even amount of options to avoid to only receiving answers of the middle value.

1 Arkitektens handbok
2 BBR
3 En genomgång av svenska dagläskrav. 5.40.
The problem with this method is that it might not give me the best picture of what the respondents actually think and what they value for each question. To be able to get an even more nuanced picture and maybe be able to get closer to the truth about their attitude to the subject I also had to ask questions about how they work with daylight and how they value the importance of daylight in different situations.

I received 51 responses to the survey, out of which 39 was architects, students, teachers or researches within the field of architecture on a daily basis. 12 answers were from other people working with architecture in other ways, such as building engineers.

A problem with relatively few answers is that each answer affects the result quite a lot and therefore the tendencies are not statistically ensured but it still gives a clue about the attitude towards daylight and openings among Swedish architects.

I have decided to only focus on the responses from the group of architects, students, teachers and researchers within the field of architecture, hereafter named as architects, but I have used other related occupational groups as a control group to see if the answers differ a lot or not.

Result/ Analysis

My thesis for this part of the project has been that architects in Sweden tend to equal quality of light with quantity of light. Is there any truth in this and does/ how does architects in Sweden work with daylight as a tool in their designs?

Comparing the architects answers on “the more daylight the better”, where 58,1% answer 4-6 (6 meaning “totally agree”) with other answers as for “Only regarding the perception of a space, do you think there can be too much daylight in a space?” where 60% answer yes and 40% no.

If we further look at for what type of projects the responding architects perceive daylight as an important factor the answers are very similar. Everyone consider daylight as important for buildings related to health, care and education, but that daylight is of less or no importance for religious buildings. This could be an indicator of that the quality of daylight is seen as equal or very strong related to quantity of daylight. If the time spent in a religious building is seen as limited it would have no impact on health, but I would like to argue that the daylight in a religious building is of high importance. In religious buildings there is a desire to make the visitor perceive the space in a certain way, to put the visitor in a certain mood and to do this the perceived quality of daylight is one of the strongest tools to use.

Looking at the answers of how much focus the responding architects put on daylight during a project 77,8% answered 1-3, meaning they don’t put much time on the work with daylight at the same time that 71,4% answered that they feel like they don’t have enough time to put on the design of the daylight in their projects. This can indicate that they want to spend more time on daylight in their projects but that they don’t have the time to do it.

References

Survey regarding architects attitude on daylight

This survey is done as a part of a thesis project at the school of architecture at The Royal Institute of Technology in Stockholm. It aims for looking at tendencies about the treatment of attitude to daylight and architecture in general and housing architecture in specific.

All answers will be treated anonymous and the data will be published as a part of the thesis project.

You can not go back and change an answer or use the back arrow in your browser. If you do, you need to start over again.

The survey takes about 5-10 minutes to answer.

Thank you for your time.
Architect (buildings specifically)/ Student within the field of architecture/ Teacher/ Researcher/ Other:

Special interest/Specialized on the field of daylight

Woman/Man/Other

City: Stockholm Göteborg Malmö Other:: >90000 55000-90000 35000-55000 0-35000

Campus of architectural studies (more than one answer is allowed) Royal Institute of Technology/ Chalmers University of technology/ Lund University Umeå University/ Blekinge Institute of Technology Other (school, city, country, orientation, building, landscape):

Year of birth:

Masterdegree, Bachelordegree, No examination (years of architectural studies):

Examination within other field:

Year of completed/cancelled architectural studies:

1. To what extent do you agree with following claims?
   (1 meaning not at all and 6 meaning completely)
   The more daylight in a space, the better.
   1 2 3 4 5 6
   If I’d only consider the daylight situation in a room (within a dwelling), I’d choose as large window as possible.
   1 2 3 4 5 6

   During project meetings with other relevant actors like developer, consultant, municipal, constructor etc. I experience:
   Focus in discussions about the openings in the envelope is about energy consumption of the building
   1 2 3 4 5 6
   Focus in discussions is about the openings in the envelope is about the perception of the room
   1 2 3 4 5 6
   Focus in discussions is about the openings in the envelope is about daylight factor
   1 2 3 4 5 6

   1 2 3 4 5 6

2. How important do you consider the daylight management is in following projects?
   (1 is not important at all and 6 is very important)
   Housing 1 2 3 4 5 6
   Education 1 2 3 4 5 6
   Kindergarten 1 2 3 4 5 6
   Hospital 1 2 3 4 5 6
   Nursing home 1 2 3 4 5 6
   Workplace 1 2 3 4 5 6
   Public service (Libraries etc.) 1 2 3 4 5 6
   Religious building 1 2 3 4 5 6
3. The openings in the envelope in a housing project is, according to you, about:
   (1 is not at all and 6 is main purpose, more than one answer can have the same number)
<table>
<thead>
<tr>
<th>View in/out</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Daylight factor</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>Energy consumption</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>Security/Safety</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>Perception of the room</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>Decoration possibilities for inhabitant</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>Health</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>Other</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
</tr>
</tbody>
</table>

4. To what extent do you consider the focus on daylight is about:
   1 meaning not at all and 6 meaning entirely
   | Quantity (Reach a certain Daylight Factor) | 1 | 2 | 3 | 4 | 5 | 6 |
   | Energy consumption | 1 | 2 | 3 | 4 | 5 | 6 |

5. To what extent do you work with following criterias to affect the perception of a daylit space?
   1 meaning not at all and 6 meaning entirely
   | Brightness | 1 | 2 | 3 | 4 | 5 | 6 |
   | Contrast | 1 | 2 | 3 | 4 | 5 | 6 |
   | Light temperature | 1 | 2 | 3 | 4 | 5 | 6 |
   | Tint of light | 1 | 2 | 3 | 4 | 5 | 6 |
   | Light distribution | 1 | 2 | 3 | 4 | 5 | 6 |
   | Effects of light/shadow | 1 | 2 | 3 | 4 | 5 | 6 |
   | Dynamics | 1 | 2 | 3 | 4 | 5 | 6 |

6. When you work with the perforation of the envelope (of a housing project?), what’s your general focus?
   | Appearance of facade | 1 | 2 | 3 | 4 | 5 | 6 |
   | Perception of the room | 1 | 2 | 3 | 4 | 5 | 6 |
   | None of the options | 1 | 2 | 3 | 4 | 5 | 6 |

7. To what extent do you consider yourself to achieve what you’d like to in the question of daylight design in your projects
   1 meaning not at all and 6 meaning entirely
   | Not at all | 1 | 2 | 3 | 4 | 5 | 6 |
   | Completely | 1 | 2 | 3 | 4 | 5 | 6 |

8. How much focus do you as an architect, generally put on daylight in a project?
   1 meaning no focus and 6 main focus
   | No focus | 1 | 2 | 3 | 4 | 5 | 6 |
   | Main Focus | 1 | 2 | 3 | 4 | 5 | 6 |

9. Do you feel you have enough time to put on the design of the daylight in your projects?
   1 meaning not at all and 6 meaning completely enough
   | Not at all | 1 | 2 | 3 | 4 | 5 | 6 |
   | Completely enough | 1 | 2 | 3 | 4 | 5 | 6 |

10. Only regarding the perception of a space, do you think there can be too much daylight in a space?
   Yes/No
   Comment:
The more daylight the better

Only regarding the perception of a space, do you think there can be too much daylight in a space?

How much focus do you as an architect generally put on daylight in a project?

Do you feel you have enough time to put on the design of the daylight in your projects?

During project meetings with other relevant actors like developer, consultant, municipal, constructor etc. I experience:

Focus in discussions about the openings in the envelope is about energy consumption of the building.
Focus in discussions about the openings in the envelope is about energy consumption of the building.

Focus in discussions is about the perception of the room.

Focus in discussions is about the daylight factor.

Choice of window design is mostly default or limited due to contracts and procurements.

How important do you consider the daylight management is in following projects?

- Housing
  - 30.8%
  - 36.6%
  - 11.5%
  - 15.4%
  - 7.7%
  - 0%

- Education
  - 50%
  - 34.6%
  - 3.8%
  - 3.8%
  - 3.8%
  - 0%
  - 7.7%
  - 0%

- Kindergarten
  - 50%
  - 38.5%
  - 3.8%
  - 7.7%
  - 0%
  - 0%
The openings in the envelope in a housing project is, according to you, about:

- View in/out: 16%, 48%, 26%, 0%, 8%, 0%
- Daylight factor: 20%, 32%, 32%, 8%, 4%, 4%
- Energy consumption: 12%, 24%, 24%, 20%, 20%, 0%
- Security/Safety: 8%, 20%, 28%, 20%, 20%, 4%
- Perception of the room: 20%, 44%, 12%, 12%, 12%, 0%
- Decoration possibilities for inhabitants: 12%, 16%, 12%, 12%, 36%, 36%, 0%
- Health: 36%, 20%, 28%, 8%, 8%, 0%
- Other: 29%, 28%, 12%, 12%, 16%, 16%, 0%
How important do you consider the daylight management is in following projects?

Quantity (Reach a certain Daylight Factor):
- 20%
- 12%
- 20%
- 136%
- 12%
- 0%

Quality (How daylight effects the perception of a space):
- 16%
- 28%
- 20%
- 16%
- 16%
- 4%

Energy consumption:
- 0%
- 37.5%
- 33.3%
- 16.7%
- 4.2%
- 8.3%
3. THE CASE STUDY

Summary of booklet no. 3 - The Case Study

- I have used a typical commercial housing project in Uppsala, Sweden to investigate and to see how the openings affect the perception of the interior space and compare the difference between the appearances of the façade before and after.

- To work with the openings on a building in Uppsala and see how the openings affect on the perceived quality of daylight within the building I first needed to get some facts of how the daylight in the region works. The Nordic light is unique and only a few percent of the population on earth experience it. It is seen as exotic and the Nordic rhythm of the year has a great impact on life, affecting the circadian rhythm, sleep and alertness. The Nordic light has a long-lasting sunrise and sunset and has a relatively low sun angle. There is also a big difference between summer and winter. Uppsala is cloudy area with 49% of the year the sky is overcast to an extent of at least 75%

- I chose this building because it represents a typical Swedish building with a common factor of a certain size of developer such as Riksbyggeren who developed the building I chose. Åsken Södra is a block building and as I mentioned it offers several urban situations for me to investigate. The building has seven floorplans out of which six are used for housing and the ground floor is occupied for commercial purposes.

- In general, the building design does not seem to take the daylight much into consideration. Looking at the openings of the building one can see that the openings’ size and position seems to be chosen to try to fulfill the daylight factor from given conditions from the shape of the building except for some thoughts about the sun.

- To work with the openings, I chose to work with two different apartments, one two-room and one three-room apartment. These represent two typical Swedish apartments.

- By working with the openings I found them only to be a part of a chain of tools possible to use to affect the perception of the interior space. If one part of the chain doesn’t take daylight into consideration it will limit the possibility to work with the matter in the next step. This chain starts at a large scale, providing prerequisites for the medium scale which at the end creates conditions for the smallest scale.

- To be able to work with the openings to affect the perceived quality of a space, all the way, the perception of the space needs to be taken into consideration at all levels connected to the building industry. The city planning will set the basis for the shape of the building and the shape of the building will affect the layout of the apartments and will also affect the possibilities to place and design the opening and therefore affect the perceived quality of the interior space.
Choice of building

To use my model study and test it in relation to function I have used an existing project where I have changed the openings to affect the perception of the interior space. As a part of this I have compared the differences between the appearances of the façade before and after I have been doing the changes. This has worked as a tool to investigate and answer my question if a unique and/or balanced façade can be the result of designing a building from inside and out? The project I have used for my investigation is a typical commercial housing project in Uppsala in Sweden. Uppsala is a domestic area 70km north of Stockholm with about 157,000 inhabitants.¹

The Nordic Light Conditions

To understand the light conditions in Uppsala, which is a basis for the further work with the openings affect on the perceived quality of daylight within the building, there are a number of facts to know. Being born and raised in Sweden it is not always something being noticed but the Nordic light is unique, only a few percent of the population on earth experience it. The dominating latitude of the southern hemisphere is unpopulated and therefore the Nordic light is seen as exotic.² The Nordic rhythm of the year has a great impact on life, it affects the circadian rhythm, sleep and alertness, metabolism, body temperature, immune systems and the hormone production.³ After the electrolysis of light our dependence of the daylight has decreased in relation to the lifestyle of people living at this latitudes and what can do when. Even though the electrical light simplified the daily life a lot the presence of daylight has a strong impact on the population, both physical and psychological.⁴

The selected project is an ongoing project, close to its finish line. It is chosen through evaluation of visual materials on different developers homes pages, mainly of some floorplans and facade drawings. I selected ten properties from different developers which I looked at more closely and through contact with some of the architects I was able to get some material, including parts of the BIM-model of the finally selected project which helped me make the last decision. By getting hold of this material I could spend much more time on my actual investigations instead of producing a 3D-model on my own from printed material, of course it also gave me information about the actual building such as interior spaces, materials etc. The building responds well to esthetical- and structural principals I set up as criteria. This building type can be found all over Sweden and below are some of the examples I have been looking at, presented by name, developer and location.

₂ Skälinge, Malmö
₄ Österport 4, Västerås.
₅ Flyga, Järfälla.
₆ Victoriastrand, Skellefteå
₇ Åsikten Södra
₈ Österport 4, Västerås.
₉ Åsikten Södra
₉ https://rikbygggen.se/om-rikbygggen-–-hmtad-2019-01-05
The building I decided to work with does not only respond well to the criteria set up, but it also has an interesting location in the city, offering multiple situations to investigate. The building is situated in the corner of an area with block buildings, offering one side facing quite a narrow city street, it also has a courtyard and on the other side of the block it is facing an open area towards a boayard. As a last key for making the decision was that I, after being in contact with the architecture office working with Åkästen Södra, I was offered to get the digital material for the project, including the BIM-model made in Autodesk Revit, which was very generous. This gave me a lot of information about the building, such as materials and values. Also this made it possible for me to spend much more time on my actual investigations about the openings.

Analysis of the building

Åkästen Södra is a block building and as I mentioned it offers several urban situations for me to investigate. The building has seven floorplans out of which six are used for housing and the ground floor is occupied for commercial purposes.

By looking at one of the residential floorplans of the whole building one can see that the bedroom always faces the courtyard. I guess this has to do with privacy since there shouldn’t be any particular issues with noise in the area. Also the shape of the building witnesses about that other qualities than daylight has been directional in the design process. The open comera facing south shows an awareness about the sun and an endeavor of letting it pass between the facades but the rest of the shape of the building does not seem to take the daylight much into consideration. It has some extrusions and indentations towards the courtyard forming obstacles for both view and daylight, not least looking at the eastern corner of the courtyard. Analyzing the daylight map of the building witness about that a analysis of the shape of the building is correct. My theory about the reason for the existence of the extrusions is an aim to create a dynamic shape and to break down the scale of the massive block, but also to give a possibility to perceive privacy on the balconies and restrain view in some rooms.

Looking at the openings of the building one can see that the openings’ size and position seems to be chosen to try to fulfill the daylight factor from given conditions from the shape of the building, which is I wrote earlier do not seem to have taken daylight into consideration, except for some thoughts about the sun. This means that there are large openings in tricky and dark corners, close to obstructions or apartments with deep spaces. To point out about the size of the openings being related to the depth of the spaces are that these openings are not higher than others, just larger by width and by having a lower sill height and looking back and forth the daylights does not affect the daylight factor at all. The height of the daylights in the building are varying between 200mm-700mm with the majority of the openings set to 500mm or 700mm above the floor, my analysis of these measurements is that there has been an intention to affect the privacy and/or possible view in relation to use and furnishing.

One interesting and important part of this investigation is to see how the openings affect on the perception of the interior space can affect the expression of the façade. At the beginning of the process I tried to see the whole facade, but soon I realized that the buildings extrusions and indentations made it complicated to get a proper elevation since I only work with the interior of two specific apartments, generating four limited segments of the façade. Therefore I have chosen to only make elevations of those segments, plus for the mirrored apartment next to each of them. This is true except for the façade facing southeast towards the courtyard where the elevation only shows the façade of the actual apartment, due to the layout of the building.

Choice of apartments & tenants

To select apartments to look at I looked in to the numbers for the building:

<table>
<thead>
<tr>
<th>Floor</th>
<th>1 Room</th>
<th>2 Rooms</th>
<th>3 Rooms</th>
<th>4 Rooms</th>
<th>5 Rooms</th>
<th>6 Rooms</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>3</td>
<td>10</td>
<td>14</td>
<td>7</td>
<td>5</td>
<td>2</td>
<td>37</td>
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<td>11</td>
<td>11</td>
<td>11</td>
<td>8</td>
<td>6</td>
<td>46</td>
</tr>
<tr>
<td>4</td>
<td>5</td>
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<td>4</td>
<td>4</td>
<td>3</td>
<td>19</td>
</tr>
<tr>
<td>5</td>
<td>3</td>
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<td>3</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>11</td>
</tr>
</tbody>
</table>

I also compared the numbers for the building with the statistics for common sizes of dwellings in Sweden, where I found out the average apartment to be 68 square meters.10 With these numbers in mind I decided to look closer at two apartments, one two-room apartment and one three-room apartment. These can be seen both as representative for the dwelling (in apartment buildings) in Sweden but also for this specific building.

To be able to evaluate the existing floorplans and further work with the openings of the apartments I have decided to use example tenants to better understand and motivate my decisions. To choose these example tenants I have looked into the statistics of the Swedish household. In average there are 1,9 person living in each dwelling of an apartment building.11 Looking more closely at two room apartments and tree room apartments the numbers are 1 respectively 2,5 persons per dwelling.12 To be able to investigate the possibilities for the two-room apartment, without making it too specific, I chose a three shift labor for the single tenant.

For the three-room apartment I decided to set up a family with two adults and one child as example tenants. Using a family with a child as an example is something I find interesting since I have a theory that children having their own bedroom meet space differently than how older children and adults use a bedroom space in general. According to my theory a child uses the bedroom as a private space and use it more frequently during the day compared to its parents. To further understand the use of the spaces in each apartment, in relation to the openings and its perceived qualities I have set up an imagined schedule of a “normal day” for each of the tenants.

I chose to evaluate and work with two apartments placed on the fourth level, in the middle of the building. The two-room apartment located in the southeastern part of the building and the three room apartment located in the northwestern part. The first one has a situation with one side facing an open area towards southeast, with good conditions to achieve the demands on the daylight factor but that also is very exposed to the sun. This makes it important to take care of the openings in a way to give the tenant possibility to rest in the sunlit when needed, but giving the possibility to keep the connection to the surroundings. This part of the apartment contains of one single space, planned to be used for multiple functions, which are also important to have in mind when planning for and designing the openings. The other part of the apartment is facing the courtyard with a façade facing northwest. Towards the courtyard there is an extra obstacle for view and light in form of an extrusion on the building obstructing parts of the skylight and all but the outside reflected sunlight. In the original floorplan there is a balcony placed outside this room, which makes it even more troublesome to reach the daylight factor or to affect the light situation in the space. Another difficulty for this space is the conditions of perceived light quality, especially related to glare, where the gloomy interior space makes a big contrast compared to, at sometimes the sun lit courtyard, easily becoming too distinct. There is a high risk that this contrast will cause the eye a great effort and therefore making the space uncomfortable.

To be able to design the openings and affect its affection on the perception of the space in relation to function and desired quality I decided rearrange the layout for the apartments.

For the two-room apartment there are only minor changes done. The layout of the kitchen fittings is switched and the balcony towards the courtyard is taken away. The existing position of the different func-

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The three-room apartment has the same orientation in relation to north, but has a mirrored layout, here both bedrooms are facing southeast and are placed facing the courtyard. In similarity to the first apartment there is an extension on the outside of the building, looking from inside the apartment, to the right. The kitchen and living room have, similar to the first apartment, an open layout and is planned to be used for multiple activities. As a result, the living room is extended with an extra space to be used as a nursery and there the opening is set in an in relation to the position and size of the space.

None of the rooms reaches a daylight factor of 1% and the small bedroom is completely blocked from direct sunlight. In a three-room apartment I argue for both bedrooms to have good conditions to create a nice daylight situation including the possibility to reach the daylight factors that are included in a three-room apartment in Sweden in a situation where each apartment of a residential project, like interior renovations, changing colors and materials. Therefore I would like to mention four key factors which affect the perceived interior space of a building and needs to be remembered as just that. The building industry, as the architects, politicians and the developers need to be aware when working with:

- The plan of the city and how buildings relate to each other. The case study I have been working with is for a housing estate and the example tenants and their schedule set up for them. The main reason for the changed layout is that in the original plan the smallest bedroom, probably used as the child's room, is placed at the most difficult position both to get sunlight, but also for view and the possibility to get enough daylight in to the space according to the daylight factor. This, related to my theory about the use of daylight for a child's room. I have factored in position information and have calculated the opening in relation to the position of the courtyard to limit its affect on the possibility to provide both rooms facing the courtyard with daylight and view, this at the cost of losing some time of sunlight for some areas of the balcony. The kitchen and large bedroom have switched side of the building, this to get a neutral passage to the balcony but mainly to provide the kitchen with possible sunlight during daytime. This also provides the two common spaces, the kitchen and the living room, with possible sun effects during different parts of the day making it possible for all tenants to both experience the sun before and after lunch.

Software

For this part of the project I have mainly worked with Autodesk Revit, a BIM software commonly used for projects today. As I mentioned earlier in this report I was given and allowed to use the already existing file for the selected project, designed and projected in Autodesk Revit. Also I am already familiar with the software and an understanding of the modeling will be very useful in Asköne.

When I started the redesign of the open spaces I realized how complicated the work got and in how many steps I had to do everything for each opening I wanted to evaluate. By this work I found the software to set high demands on the knowledge of the user. To be able to work with angled niches in a smooth way for example, there is a need of a deep knowledge about how to build up a library of adjustable families [windows, doors, furniture etc. are called families in Revit]. Also this work appeared to be very time consuming. Using Google, Youtube, Autodesk's own forum and by calling friends with a lot of experience of the software, I have found that working with the software is very time consuming. Using the Sketchup model for the rendering production of the spaces I have, as for all daylight maps, used VELUX Daylight Visualizer. In Autodesk Revit I could not find a way to do renderings with a CIE overcast sky condition, therefore I imported the model from Google Sketchup to VELUX Daylight Visualizer instead. Using the Sketchup model for the rendering was because of two reasons, first the openings are better designed in detail, but also the model has no information not used for the project, making the file size tons smaller. In Sketchup it is both easier and faster to work with. One thing I also learned during the process is that to get a correct result for the renderings and daylight maps it is really important to simplify the surfaces and if using an Autodesk Revit file for other BIM-files it is important to make sure no windows have multiple glazing in the model before importing the file to VELUX Daylight Visualizer, the transmittance of the glass is instead set as a parameter inside VELUX Daylight Visualizer.

Result and analysis

This part of the project has brought knowledge about buildings in relation to daylight being outside the scope of the project, but also offer a good possibility to keep the space dark and cool during daytime. The architect cannot control the amount of sun light that will enter each apartment of a residential project, like interior renovations, changing colors and materials. Therefore I would like to mention four key factors which affect the perceived interior space of a building and needs to be remembered as just that. The building industry, as the architects, politicians and the developers need to be aware when working with:

- The plan of the city and how buildings relate to each other. The case study I have been working with is for a housing estate and the example tenants and their schedule set up for them. The main reason for the changed layout is that in the original plan the smallest bedroom, probably used as the child's

It is important to have the perception of the interior space in mind early in a project, no matter of projects scale; the sooner one is considered, the better possibilities to create spaces of a high perceived quality.

During this part of the project I also found that well considered openings, in relation to use, could make the project valuable also in terms of energy consumption. Even though it is not in the scope of the project to investigate, the different openings I have evaluated bring so much difference in perceived quality of the space that it is important to mention. Most of the light I have found it to be important to look closer into the question if well-considered openings could be related to energy consumption of a building, not only by getting free light where needed, but also because every opening in the envelope of a building would be there in its specific design because of a reason, meaning no glass area would be unnecessary.

The software used for design and projection of a project can be crucial for the result of the perceived quality of a space. This study shows that the perforation of the façade has a great impact on the perceived quality of a space but without Autodesk Revit for this project has shown that the software can constrain the design of the openings. The software have a high threshold of knowledge about how to build up a daylighting space, a well designed opening and one that is well suited for the location and the space.

It is important to have the perception of the interior space in mind early in a project, no matter of projects scale; the sooner one is considered, the better possibilities to create spaces of a high perceived quality.
One could argue, and I have also questioned myself during this work, if a more consciously positioning and design of the openings in relation to use could restrain the tenants in how they like to live their lives. Partly I believe this is another question, failing out of the scope of this thesis but on the other hand I think it is important that I briefly give my thoughts about it. I believe, after reading studies and reports on the subject, but also as a result of my work with this thesis, that the space always creates a frame for people’s lives. The “standard openings” that is common today, positioned in the middle of the wall also controls the possibilities of how a space can be used. By this I mean that well evaluated and considered openings do not restrain people’s freedom in their home more than the common opening design of today, but it can give a space a higher quality and a better function.

References


http://drift.portal.chalmers.se/northsouth-room.php Hämtad (2017-12-17)


https://riksbyggeri.se/om-riksbyggen. (Hämtad 2019-01-05)


Perspective from South

Rendering: Riksbyggen
MAP OF UPPSALA with well known landmarks in relation to Åsikten Södra
SCALE 1:20000

Train Station
Uppsala Castle
Uppsala Cathedral
Åsikten Södra, Case Study
Example Tenant
Domestic area, Uppsala, Sweden

Schedule of typical day

<table>
<thead>
<tr>
<th>Time</th>
<th>Day shift</th>
<th>Evening shift 17-02</th>
<th>Night shift 02-08</th>
</tr>
</thead>
<tbody>
<tr>
<td>06.00</td>
<td>Sleep</td>
<td>Sleep</td>
<td>Work</td>
</tr>
<tr>
<td>07.00</td>
<td>Wake up, Breakfast</td>
<td>Sleep</td>
<td>Work</td>
</tr>
<tr>
<td>08.00</td>
<td>Work</td>
<td>Sleep</td>
<td>Home, food</td>
</tr>
<tr>
<td>09.00</td>
<td>Work</td>
<td>Sleep</td>
<td>Rest/Sleep</td>
</tr>
<tr>
<td>10.00</td>
<td>Work</td>
<td>Wake up, Breakfast</td>
<td>Activity home or away</td>
</tr>
<tr>
<td>11.00</td>
<td>Work</td>
<td>Activity away or home</td>
<td>Activity home or away</td>
</tr>
<tr>
<td>12.00</td>
<td>Work</td>
<td>Activity away or home</td>
<td>Activity home or away</td>
</tr>
<tr>
<td>13.00</td>
<td>Work</td>
<td>Lunch</td>
<td>Lunch</td>
</tr>
<tr>
<td>14.00</td>
<td>Work</td>
<td>Activity away or home</td>
<td>Activity home or away</td>
</tr>
<tr>
<td>15.00</td>
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<tr>
<td>17.00</td>
<td>Work</td>
<td>Work</td>
<td>Activity home or away</td>
</tr>
<tr>
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<td>Work</td>
<td>Dinner</td>
</tr>
<tr>
<td>19.00</td>
<td>Activity away or home</td>
<td>Work</td>
<td>Rest</td>
</tr>
<tr>
<td>20.00</td>
<td>Activity away or home</td>
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<td>Sleep</td>
</tr>
<tr>
<td>21.00</td>
<td>Activity away or home</td>
<td>Work</td>
<td>Sleep</td>
</tr>
<tr>
<td>22.00</td>
<td>Activity home</td>
<td>Work</td>
<td>Sleep</td>
</tr>
<tr>
<td>23.00</td>
<td>Sleep</td>
<td>Work</td>
<td>Sleep</td>
</tr>
<tr>
<td>24.00</td>
<td>Sleep</td>
<td>Work</td>
<td>Sleep</td>
</tr>
<tr>
<td>01.00</td>
<td>Sleep</td>
<td>Work</td>
<td>Sleep</td>
</tr>
<tr>
<td>02.00</td>
<td>Sleep</td>
<td>Work</td>
<td>Work</td>
</tr>
<tr>
<td>03.00</td>
<td>Sleep</td>
<td>Home, quick food</td>
<td>Work</td>
</tr>
</tbody>
</table>

Use of spaces // Desired quality of light

- **Relaxation** (8h / day (mainly sleeping))
  - Soft
  - Calm
  - Warm
  - No direct sun
  - Little contrast
  - Soft gradient
  - Easy for eyes, no glare
  - If possible effects in cieling

- **Awake and protected** (0.5-2h / day)
  - Intense
  - Active
  - Help define kitchen/livingroom
  - View (active)
  - Limited view outside to inside
  - Mark corners with narrow openings (perception of intensifying light)
  - Contrast inside wall vs. view
  - Possibility for lit dining table
  - Light deep and high into the room
  - Reflector or changed direction in wall
  - Dynamic distribution
  - Enough sillheight to help feeling of safety

- **Protected** (1-2h / day)
  - Informative
  - Soft
  - Warm
  - No view
  - High position
  - Warm nuance on sill
  - Indirect light (from kitchen)

- **Focus/storage** (0-6h / day)
  - Even
  - Calm
  - Focused
  - No view
  - Reflected light
  - Horizontal opening

- **Welcoming and guiding** (0.5h / day)
  - Informative
  - Indirect light from surrounding rooms

- **Open and relaxed** (0-5h / day)
  - Calm
  - Help define kitchen/livingroom
  - Well connected to surrounding
  - Small risk of glare and reflections
  - Gradient with brightest from balcony towards darker entrance
  - Even distribution
  - Reflector or changed direction in wall
Comment:
I perceive the light in this space as even, both by distribution and intensity since all three openings are providing the space with similar qualities, although the space has several openings of slightly varying size and sill height. My analyze of why I perceive the space in this way is that the openings have similar positions in relation to the space, but are also following a pattern of being vertical, all with a different sill height, but none of them differ sufficiently (since the door are shadowed by the balcony) to affect the perceived quality of light. The sill height will affect the feeling of openness but does not affect much else.

The opening to the left in the image, in the kitchen area of the space, is 1200mm wide, 1500mm high and has a sill height of 700mm. The balcony door is 1000mm wide and 2200mm high and the opening to the right of the door is 1400mm wide and 1650mm high with a sill height of 500mm. The balcony the door leads to reaches past the kitchen window and limit the daylight coming in to the kitchen by the balcony above. This also affects the light penetrating the balcony door, where also the railing on the balcony has a considerable effect.
Use of space: Multifunctional; Kitchen; Livingroom

Perception of space:
- Calm
- Dark
- Gloomy
- Dull
- Closed
- Protected

Comment: From this angle I perceive this space as slightly more dynamic compared to the image above. This since the two openings visible in the image are providing the space with slightly different qualities of daylight. The window sill is 700 mm high, making the area under the opening being perceived as dark while the door, being glazed all way to the floor offers daylight direct adjacent the opening offer a light perceived as more intense. Still I perceive the space as gloomy, probably because of the balcony outside, being placed in such way it shades both openings. The sill height, but also the covered railing on the balcony makes me perceive the space as safe. This room is oriented towards the boatyard, meaning there are no view from other buildings.
Comment:
I perceive this space as very dark, the contrast between the dark interior space and the bright view is high and when sun hit the façade on the other side of the courtyard the glare can be really troublesome. This space does not only have a low daylight factor as the daylight map shows, I also perceive it to have a very low perceived brightness. I do not perceive that the low illuminance make the space calm, which I have found by my model investigation can be related in some cases. Due to the relatively large openings compared to the area of the space, I perceive it as open and the contrast of view activates the space.
NEW TWO ROOM APARTMENT
SCALE 1:50
DAYLIGHT ANALYZES
measurable values

New Design
Daylight Study
NEW TWO ROOM APARTMENT
Use of space: Unchanged

Desired perception of space:
• Dynamic
• Soft
• Protected
• Open

Perceived qualities to aim for:
• Dynamic distribution of light
• Dynamic intensity of light
• Light and views in relation to planned functions:
  Living room: Protected and calm, (avoid reflections on possible screen)
  Niche for reading/work/storage:
    View from seat
    Soft light helping the eye if reading, or if working on a screen.

Tools to affect perceived qualities:
• Position
  To affect the intensity and the possibility to create a dynamic distribution of daylight.
• Width
  The width of the opening will affect intensity and distribution of daylight.
• Sill height
  Related to furnishing and need of privacy.
• Horizontal mullion
  Offering a possibility to restrain the sunlight but keep the view or vice versa.
Use of space: Unchanged

Desired perception of space:
- Calm
- Bright
- Soft
- Active
- Open
- Protected

Perceived qualities to aim for:
- **Dynamic distribution of light**
- **Dynamic intensity of light**
- **High level of perceived brightness**
- **Light and views in relation to planned functions:**
  - **Kitchen:** Open, intense and bright, but avoid glare
    - Daylight for countertop
    - View from all seats at dining table

Tools to affect perceived qualities:
- **Intensity** Position and width of openings
- **Sill height** Related to furnishing and need of privacy
- **Horizontal mullion** Offering a possibility to restrain the sunlight but keep the view or vice versa
- **Position** The position of the opening in the corner opens up the space and brings a raking light providing space for the countertop.
- **Size** By raising the top of the opening the daylight is distributed deeper into the space.
Use of space:
Unchanged

Desired perception of space:
• Calm
• Cool
• Soft
• Protected

Perceived qualities to aim for:
• Perceived safety
• Low risk of glare
• Low intensity of light

Tools to affect perceived qualities:
• Brightness of framing
  A higher luminance of other objects framing the view will decrease the risk of glare
• Sill height
  Affect the perceived safety
• Angle of nices
  Makes the contrast between the luminance inside and outside lower by creating a smooth transition.
• Position
  The position of the large opening will provide daylight to the room without causing much view in.
Family: 2 parents & 1 child 10 years old
Work: Parent 1 gardener, generally working mon-fri 7-16. Parent 2 Entrepreneur, generally working in office mon-fri 8-17. Child school mon-fri 8-16
Sparetime: Family home, baking, gym

Example Tenant
Domestic area, Uppsala, Sweden

Schedule of typical day

<table>
<thead>
<tr>
<th>Time</th>
<th>Parent 1</th>
<th>Parent 2</th>
<th>Child</th>
</tr>
</thead>
<tbody>
<tr>
<td>06.00</td>
<td>Wake up, Breakfast</td>
<td>Wake up</td>
<td>Sleep</td>
</tr>
<tr>
<td>07.00</td>
<td>Work</td>
<td>Breakfast</td>
<td>Wake up, Breakfast</td>
</tr>
<tr>
<td>08.00</td>
<td>Work</td>
<td>Work</td>
<td>School</td>
</tr>
<tr>
<td>09.00</td>
<td>Work</td>
<td>Work</td>
<td>School</td>
</tr>
<tr>
<td>10.00</td>
<td>Work</td>
<td>Work</td>
<td>School</td>
</tr>
<tr>
<td>11.00</td>
<td>Work</td>
<td>Work</td>
<td>School</td>
</tr>
<tr>
<td>12.00</td>
<td>Work</td>
<td>Work</td>
<td>School</td>
</tr>
<tr>
<td>13.00</td>
<td>Work</td>
<td>Work</td>
<td>School</td>
</tr>
<tr>
<td>14.00</td>
<td>Work</td>
<td>Work</td>
<td>School</td>
</tr>
<tr>
<td>15.00</td>
<td>Work</td>
<td>Work</td>
<td>School</td>
</tr>
<tr>
<td>16.00</td>
<td>Work</td>
<td>Activity home or away</td>
<td>Activity home or away</td>
</tr>
<tr>
<td>17.00</td>
<td>Home, Cooking</td>
<td>Work</td>
<td>Activity home or away</td>
</tr>
<tr>
<td>18.00</td>
<td>Home, dinner</td>
<td>Home, dinner</td>
<td>Activity home or away</td>
</tr>
<tr>
<td>19.00</td>
<td>Activity home or away</td>
<td>Activity home or away</td>
<td>Activity home or away</td>
</tr>
<tr>
<td>20.00</td>
<td>Activity home or away</td>
<td>Activity home or away</td>
<td>Activity home</td>
</tr>
<tr>
<td>21.00</td>
<td>Activity home or away</td>
<td>Activity home or away</td>
<td>Sleep</td>
</tr>
<tr>
<td>22.00</td>
<td>Activity home or away</td>
<td>Activity home or away</td>
<td>Sleep</td>
</tr>
<tr>
<td>23.00</td>
<td>Sleep</td>
<td>Sleep</td>
<td>Sleep</td>
</tr>
<tr>
<td>01.00</td>
<td>Sleep</td>
<td>Sleep</td>
<td>Sleep</td>
</tr>
<tr>
<td>02.00</td>
<td>Sleep</td>
<td>Sleep</td>
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</tr>
<tr>
<td>03.00</td>
<td>Sleep</td>
<td>Sleep</td>
<td>Sleep</td>
</tr>
<tr>
<td>04.00</td>
<td>Sleep</td>
<td>Sleep</td>
<td>Sleep</td>
</tr>
<tr>
<td>05.00</td>
<td>Sleep</td>
<td>Sleep</td>
<td>Sleep</td>
</tr>
</tbody>
</table>

Use of spaces // Desired quality of light

- **Open and relaxed (1-5h/ Day)**
  - Calm
  - Well connected to surrounding
  - Small risk of glare and reflections
  - Gradient with brightest from balcony towards darker entrance, for possible TV-walls
  - Dynamic distribution

- **Activity and Relaxation (8-18h/ Day)**
  - Focused
  - Intense
  - Even
  - Calm
  - Gradient with brightest from balcony towards darker entrance
  - Even distribution
  - Reflector or changed direction in wall between kitchen and livingroom
  - Possibility to light without view
  - Reflected light
  - Horizontal opening

- **Relaxation (7-10h/ Day)**
  - Soft
  - Calm
  - Warm
  - No direct sun at evening
  - Little contrast
  - Soft gradient
  - Easy for eyes, no glare
  - If possible effects in cieling

- **Welcoming and guiding (0,5h/ Day)**
  - Informative
  - Indirect light from surrounding rooms

- **Awake and protected (1-3h/ Day)**
  - Active
  - Intense
  - Calm
  - Mark corners with narrow openings (perception of intensifying light)
  - Contrast inside wall vs. view
  - Possibility for lit dining table in morning
  - Light deep into the room
  - Enough sillheight to help feeling of safety
DAYLIGHT ANALYZES
measurable values

Original Design
Daylight Study

ORIGINAL THREE ROOM APARTMENT
Solar study
Summer Solstice
ORIGINAL THREE ROOM APARTMENT
Use of space:
Child’s room

Perception of space:
• Dark,
• Small
• Closed
• Gloomy
• Dull
• Risk of glare

Comment:
I perceive this space as small, dark and closed. When entering this room one is met by a view partly blocked by the extrusion of the building which I think emphasize the perception of the space as closed. The extrusion of the building is not only limiting the view, it also obstructs and affects the daylight and how it is perceived in the room. If the wall outside at some time were lit by the sun it could bring an extra quality to the space as a light effect appearing at some moments, now that is not possible.
Comment:
I perceive this space as small, dark and closed. When entering this room one is met by a view partly blocked by the extrusion of the building which I think emphasize the perception of the space as closed. The extrusion of the building is not only limiting the view, it also obstructs and affects the daylight and how it is perceived in the room. If the wall outside at some time were lit by the sun it could bring an extra quality to the space as a light effect appearing at some moments, now that is not possible. This space is if looking at its openings and the position very similar to the new kitchen, which has an even more difficult situation in relation to the morphology of the building, but still offers a completely different perception of the space.
Comment:
I perceive this space as rather closed, which surprises me a little bit due to the relatively large opening with the low sill height. To explain this I must look outside the opening where there is a balcony with quite a dense railing. To remember when placing a balcony is that if there is a balcony on one level, there will probably be another one above as well, this one will affect the interior space on the level beneath it. I also perceive the dark as gloomy and dull, I believe this is an effect of the centrally place opening, generating dark corners. Probably my own experience in life is also affecting the perception of the space as dull. To me it appears anonymous since I have experience this kind of spaces many times before.
Comment: For this space the building across the street affect the perception of the space, I find it rather closed. Even if the balcony is mainly placed outside the part of this space being thought of as a living room it affect the perception of this part of the space as well. By shading the balcony door it makes the dynamics of the space very even, making me perceive it as gloomy and dull.
DAYLIGHT ANALYZES measurable values

New Design
Perceived qualities to aim for:
- Light spread to hallway
- High level of perceived brightness.
- View from all seats at dining table.
- Safety

Tools to affect perceived qualities:
- Position of the openings direct adjacent to other surfaces increases the perceived intensity of the space.
- Sill height related to furnishing and need of privacy.
- Horizontal mullion offering a possibility to restrain the view but keep the daylight or vice versa.
- Size the top height of the opening helps distribute daylight deep into the space.
- Multiple openings offering possibility to create a dynamic distribution of light to bring contrast between bright and dark which will emphasize the perceived intensity of the bright areas.

Comment: The perception of this space is strongly affected by the extrusion on the exterior of the building.
Use of space:
Child’s room

Desired perception of space:
• Dynamic
• Protected
• Open
• Bright
• Flexible

Perceived qualities to aim for:
• Safety
• High level of brightness.
• Dynamic intensity of light, to fit for multiple activities
• Dynamic distribution of light, to fit for multiple activities

Tools to affect perceived qualities:
• Position Affect both distribution and intensity of the daylight. Also by placing the openings directly adjacent to one of the side walls, divides the narrow space into one open and one private corner.
• Sill height Related to furnishing and need of privacy in parts of the room and openness in other parts.
• Size The top height of the opening helps distribute daylight deep in to the space.
• Multiple openings Offer the tenant control over the space and the perceived quality of it.

Comment: To intensify the light more and raise the perceived brightness in this space the opening to the right could be extended to meet the floor, I decided to not do that based on the perceived safety of the space.
Use of space: Senior Bedroom

Desired perception of space:
• Calm
• Cool
• Soft
• Protected

Perceived qualities to aim for:
• Perceived safety
• Low risk of glare
• Low intensity of light

Tools to affect perceived qualities:
• Brightness of framing
  A higher luminance of other objects framing the view will decrease the risk of glare
• Sill height
  Affect the perceived safety
• Angle of nice
  Makes the contrast between the luminance inside and outside lower by creating a smooth transition.
• Position
  The position of the large opening will provide daylight to the room without causing much view in, this might be extra important on this side of the building since there is another residential building 24 meters away

Comment: If I would have had more time to customize and work with this project more than as a tool for investigation would have tried to alter the vertical opening so it completely would limit the possible view in.

NEW THREE ROOM APARTMENT
Use of space: Living room

Desired perception of space:
- Dynamic
- Soft
- Protected
- Open

Perceived qualities to aim for:
- Dynamic distribution of light
- Dynamic intensity of light
- Daylight reaching towards hallway and kitchen.
- Light and views in relation to planned functions:
  Livingroom: Protected and calm, (avoid reflections on possible screen)

Possible or armchair:
- View from seat
- Soft light helping the eye if reading, or if working on a screen.

Tools to affect perceived qualities:
- Position
  - Position to affect intensity and view.
    The opening to the left is placed outside the balcony, giving a slightly better possibility to illuminate the corner.

- Width
  - Affects the distribution of the daylight.

- Size
  - Letting the openings reach the ceiling distributes the daylight deep into the space.

- Sill height
  - Related to furnishing and need of privacy.

- Multiple openings
  - Offer possibility for a perception of a dynamic space, giving different qualities for different activities and purposes.
NEW THREE ROOM APARTMENT
SCALE 1:50
When starting the work with the case study I quickly decided to rearrange the layouts of the two apartments. This was made according to the schedules of the example tenants I set up to evaluate and work with the openings. The two room apartment only has minor changes but the three room apartment has been changed quite a lot. In a three room apartment I argue for both bedrooms to have good conditions to create a nice daylight situation, reach the daylight factor and have a view. The reason for this is that in a three room apartment there is possibly a greater need of privacy, since it is possible, as for my example tenants, for more people to share the common space such as kitchen and living room. Therefore there is a possible situation where more hours per day would be spent in the private bedroom.

After re-arranging the layout I realized it got more similarities to layouts from the 1940’s and 1950’s than the original open layouts in Åsikten Södra, being an example of the commercial residential architecture of today.

The floor plans to the right are a few examples of apartment layouts from the 1940’s and 1950’s to be compared to the floorplan of the apartments for my case study.
Nackahöjden, Nacka 1950-tal

Knoppen, Falun 1940-tal
Årsta, Stockholm
1940-tal

Årsta, Stockholm
1950-tal
Niches

The angle of the niche affects the distribution of daylight, the perceived openness of a space and helps prevent glare, it should not be a forgotten tool. By looking at a few historical buildings there seem to be a relation between the handling of the niches and the building year or type of construction. Old buildings with thick walls often have angled niches. Later the constructions got lighter, bringing thinner walls and therefore shallow niches, not affecting the perception of the space much. Today the niches gets deeper again due to thicker walls related to energy consumption, unfortunately the handling of the niches in many cases seems forgotten, and in recent buildings I often perceive the perforation of the outer wall as a hole in the wall, rather than an opening.

The images to the right are examples of what is described above, with information about location and year of construction.
Högbo
Falun
1910
Danholn
Falun
1974
Conclusion

When the simplified method for controlling the needed glass area for a space to fulfill the requirements not can be applied, the way of controlling the daylight factor is both time consuming and put a great demand on the knowledge for both architects and the staff on the municipal building department, which is the department permitting the building applications. As mentioned the restrictions of the simplified method often are forgotten or unknown, and therefore making this calculations invalid, this proves that this method is not enough to facilitate to control the quantity of daylight. To be able to guarantee a good daylight situation within a building there is a need of understanding both about light in general but maybe even more important about daylight. This not least since it is proven, also through my own model investigation, that the tools related to the daylight factor bring very little information about the actual perception of a space and the daylight within it. Still, the daylight factor is the only way for the building department to control whether a building fulfill the requirements or not, and it is the only thing architects must take into consideration when designing a building. The Swedish building code also briefly mention the need of a view and the problems with glare, but these are hard to control. I would like to argue that it is difficult, but it can also be inappropriate, to put up laws and regulations about quality since quality is something being perceived and are therefore individual. On the other hand it is important to make sure that the regulations makes it possible and encourage architects to work with light qualities and the developers to pay for them. It would be beneficial to find a way to formulate the Regulations in a way so it ensure that spaces have a quantity of daylight affecting long term health effects in a positive way, but without making the frame too narrow. The regulations need to be formulated in a way not to restrain the possibility to create spaces with a high level of perceived quality, by for example work with dynamic illumination of daylight. The way of calculating the daylight factor in one specific point makes it impossible to create different qualities of light within the same space. By reworking the regulations according to these thoughts would also move the responsibility of the perceived quality of a space to where I believe it belongs, namely to the architects. Following this thread it also puts a great demand on the schools of architecture to ensure that the architects have the basic knowledge about daylight and how to affect its qualities when they enter their careers.

To be able to work with the openings to affect the perceived quality of a space, all the way, the perception of the space needs to be taken into consideration at all levels connected to the building industry. The city planning will set the basis for the shape of the building and the shape of the building will affect the layout of the apartments and will also affect the possibilities to place and design the opening and therefor affect the perceived quality of the interior space. With complicated regulations, little knowledge given during the education and software making it difficult and time-consuming to work I can understand why the commercial residential buildings in Sweden have the kind of non-designed perforation of the façade. On the other hand it makes me glad to see that there is an ambition to work with daylight and openings to affect the perception of the interior space. Because, when it all is put together, daylight is a fundamental key factor for everything we see and therefore for a lot of the things we perceive.