Arkitektur- og designhøgskolen i Oslo
The Oslo School of Architecture and Design

DIPLOMA PROGRAM FALL 2018

Diploma candidate: **Joar Tjetland**

Institute: **Institute for architecture**

Main supervisor: **Marius Nygaard** Marius Nygaard

Second supervisor: -

External supervisor: Arnkell J. Petersen

Company cooperation: -

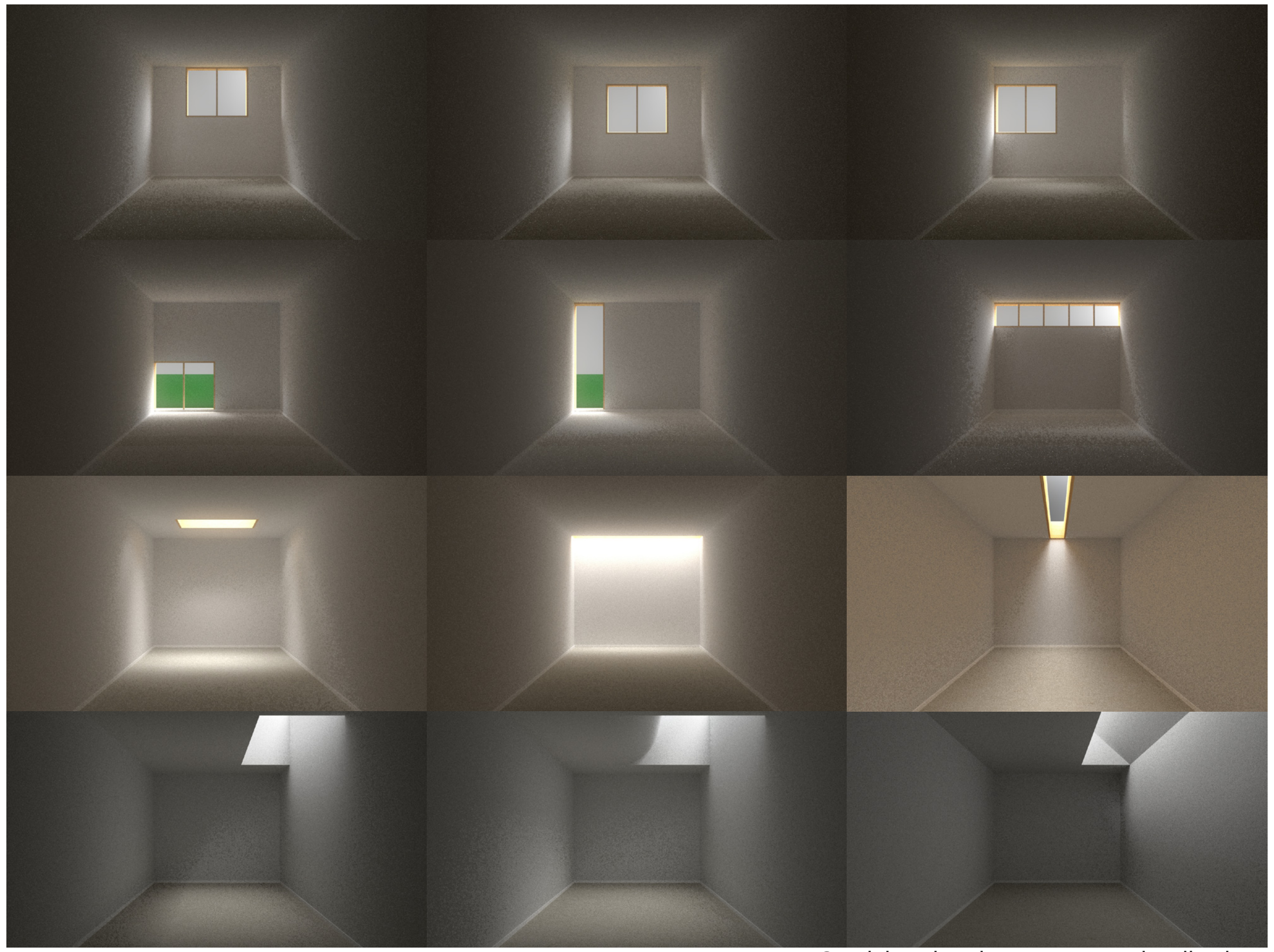
Title of project: Adaptability in daylight

Adapting to daylight -

A strategy for designing a multi purpose hall

Supervisor:
1. Marius Nygaard
2. Moritz Groba

Innholdsfortegnelse



Spatial explorations - my own vizualisations

Introduction

Light has fascinated me ever since I was made aware of it`s presence. To cite the american light artist James Turrell: "This world that we have around us is not a world that we see, but more a world that we create and make. This might seem as a bit of a surprise because we really feel, and are very much attached to the fact, that we are receiving these perceptions as opposed to creating them. But we do create the reality in which we live."[1]

Perception is an autonomous exercise we rarely consider while "operating" our vision. In the same way that we move the limbs of our body we rarely evaluate our environment into analyzing what it really is that we see. Why it looks the way it does. One of the most important factors that are very often missed is the light. There is essentially no space to perceive without light, and how space is rendered is crucial to how we perceive it. An architects choice of materials, colors, texture and importantly, initial daylight design, steer the final perception. As a reflection on how light has the power to change space one can consider the power that theatre lighting can have in completely changing the landscape of the stage and adapt to support different scenography. In my oppinion, the adaptation to daylight in architecture happens in the very early design process. Some architects are more aware of this than others. The adaptability of light is not an add on, it is a mindset in designing. In order for a building to be regarded as robust, valuable and worthy of care for future generations of users, daylighting design should be appropriated as a fundamental design approach. I simply believe that buildings that successfully utilize daylight as its main lightsource are the most preferred ones.

1 «James Turrell: 'Second Meeting'». YouTube video, 3:32. Lastet opp 17. mai 2013, https://youtu.be/_BuJpDXkMz8?t=3m32s (oppsøkt 26.02.2018).


Otaniemi university. - Alvar Aalto

Adaptability in daylight

”Adaptability in daylight” definition:
”The ability a building has to adapt and to modulate the available daylight outside, into the interior.”

A building should be able to adapt to the ever changing character of the sunlight by treating daylight as an integrated light source.

In the design of a building, the design process could be said to be of a reductive character. From a totally free situation, the program is gradually surrounded by ceiling and walls. A building wrapped with the correct filtering of light depending on its funciton. A daylit space normally utilize no more than 2-5% of the available daylight outside.

In relation to daylight, I would like to work with three parameters where I think that a building adapts in relation to daylight.

1. Design and placement/orientation of daylight openings.
2. The relation between constructive systems, materials and daylight openings.
3. The building outer shape, environment and orientation.

Research question
How can a multi purpose hall be designed and adapted to allow for the use of daylight as a the primary source of light?
The relation between daylight openings, construction and materials has a main focus.

Method and approach
By using modern and historic reference projects I can read principles and possibilities in the use of daylight in large spaces and multi purpose halls.
Historic references may be found with architects that has worked with daylight, such as Le Corbusier, Frank Lloyd Wright, Alvar Aalto, and Louis I. Kahn.
By using modern and historic references I can read principles, and hopefully, solutions for the use of daylight in larger spaces and multi purpose halls.
Historic references may be found with architects that has worked with daylight, suchas Le Corbusier, Frank Lloyd Wright, Alvar Aalto, and Louis I. Kahn. In many of their projects there are a focus on the relation between new possibilities of the time in regards to construction, technology, the site specific and daylight. Modern reference projects can be international and national multi purpose halls where daylight has been used as a central part of the architectural concept.

The main challenge of using daylight as a light source in multi purpose halls is direct sunlight that enters into the main hall. Direct sunlight can lead to unwanted light/shadow contrasts in the interior. The investigation around how daylight can be used in a large space will in a large degree be concerned with spatial studies of how daylight can enter in a way so that the light is glare free/indirect/filtered and give balanced and controlled light conditions.
If I find time it would be interesting for the project as a whole if the program is defined and investigated in relation to the the variation of the cyclus of the day, seasons and transition to electric light.

Model studies, hand scethces and digital models are tools in the work of understanding and experience space. Architecture models should be made in such a scale that they can be made out of solid materials and used for visual obervations. Models, in combination with digital and analogue sketches should drive the project into developing principles and architectural space.
Physical models must be simplified in terms of light transmission and optical systems.
Model studies are documented with photography. Pictures can be taken with the same exposure in order to be compare different situations.

Digital calculations of daylight factor, daylight autonomy and useful daylight illuminance will be a possible ways to evaluate solutions. From previous experience I know that calculations can be time consuming and that numbers often refer to thory that can be hard to verify in relation to spatial experience. Still, If I have time I would still like to document the final design.

Light modeling properties

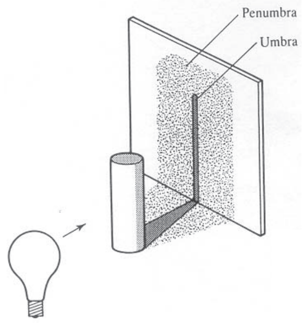
From still life studies and drawing, the modeling of light and shadow can be studied. Depeding on the properties of the light source, (the variations of being a surface or a point source), the shadows will be defined differently. In the light from a directional light source the shadows can be defined as highlight, half-tone, core shadow, cast shadow and reflected light.

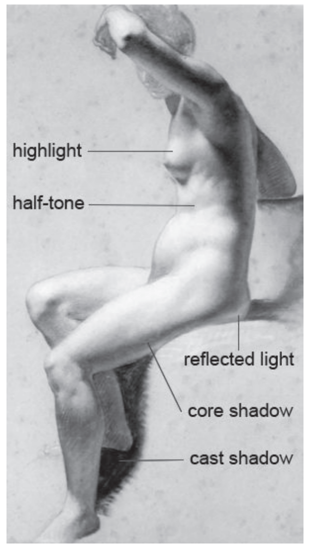
The modeling properties of light can be divided into three levels. High, medium and low level of modeling. High levels of modeling from a directional light source such as a spotlight or direct sunlight can give too large contrasts and can lead to glare. Low level of modeling from large light sources such as light emitting surfaces can give a lack of contrasts in fine details. It is a medium degree of modeling that is often most wanted to be able to read comfortable contrasts and simultaniously achieving a good lighting uniformity.[1]
An example of the variation between a high and a low level of modeling can be taken from the winter landscape in the mountains. Low level of modeling is a cloudy day when all contrasts are lacking and skiing is almost impossible, while a high level of modeling on a sunny day will render ski tracks and landscape in details with hard shadows.

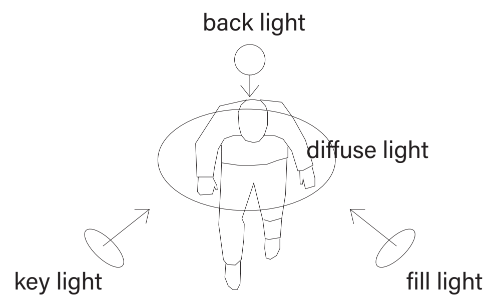
The ability light has to model a object determine how we read the shadows. In the example of the lighting of the sculpture there are used several directional light sources in combination with a diffuse light source. With different orientation and intensity they make out the final composition with a good level of modeling. The example of lighting the sculpture is a typical example from museum lighting where the representaion of the sculpture becomes especially important. The principles have similarities with a photo studio where light sources are used actively to model the subjects that are to be photographed.

Electric light has the property of allowing full control whereas daylight has a natural fluctuate property of variation in both intensity and spectrum.

1 Byggforsk 2018

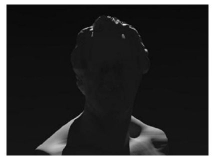







key light fill light fill+key only


diffuse light


back light


final composistion


1. Henging form- elements redicrect the light

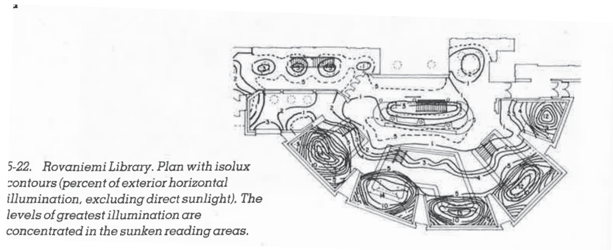
Alvar Aalto - and example of architectural light modeling

1. Form- elements that hang down under prismatic skylights distribute daylight vertically in the space and increase the cylindrical illuminaition whoch increase the three dimentionality of objects in the space. The form giving of both the space, ceiling and elements vary how the light is reflected.

2. The shape of the ceiling is no more than a poched hanging form. It has no load carrying function. Its function is connected with how the light is distributed in the space.

2.1 Observed from the circulation area the ceiling shields off the sightline from the big clerestory windows and the focus are oriented towards the books along the perifery wall thanks to the reflected light from the scoop shaped ceiling. The space is visually opened up and is preceived as bright and inviting.


2. Ceiling shape works as a reflector



2.3 Isolux curves show daylight distribution in the library
Moore: p. 44


2.1 Shielding from glare from clerestory windows

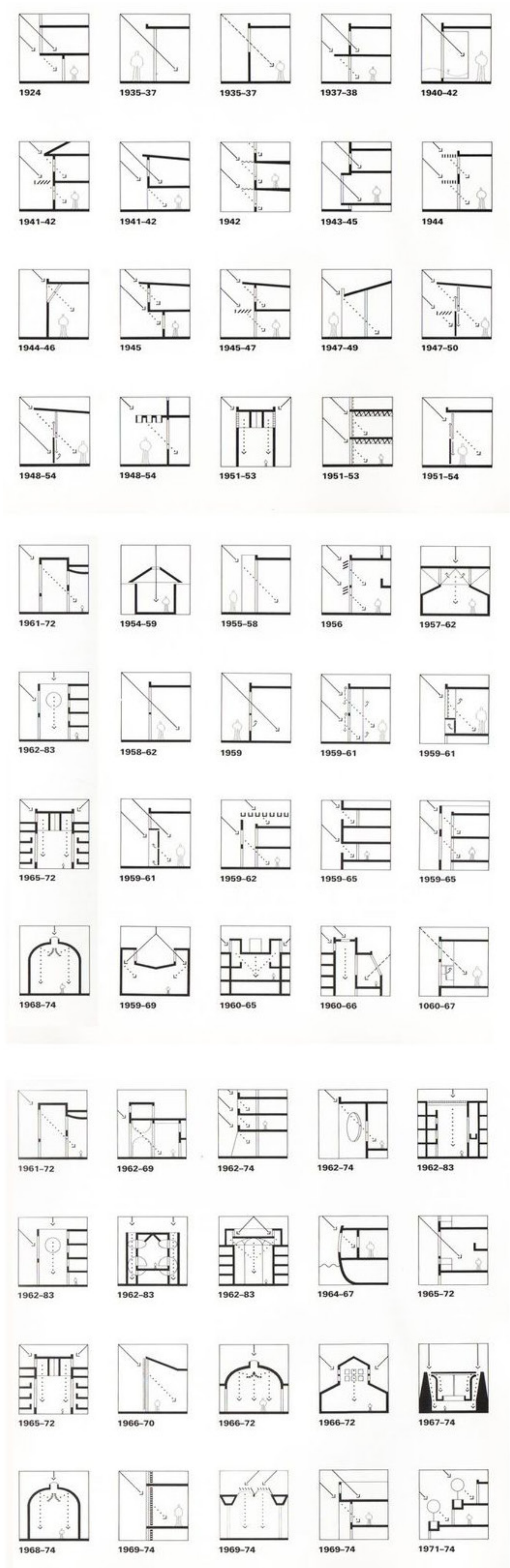
Passiv and active strategy
I think that daylight design can devided in a passive and an active strategy.

Passive
The design of the architecture can be used actively in the design process to redirect and reflect the daylight into the interior. Site specific conditions, design of building elements, ceiling height in relation to space depth, placement and modelling of daylight apertures are example of tools. As an example, many of Aalvar Aaltos works show an apparent design of both space and daylight openings are done with the same pen. For example the lecture hall at Otaniemy university where the daylight is a natural parts of the lecture hall spatial build up.

Active
Automatic outdoor shading systems, movable reflector systems, heliostats and elctromagnetic glass are examples of the technological sortiment for design of modern buildings.

Shutters, blinds and movable screens are also an active strategy, but the control is often more manual.

Load carrying construction and daylight
My idea is that the architecture should be based on a passive strategy to distrubute light into the interior in such a way that it becomes a part of the construction and the building DNA.
As an inspiration in regards of integrating daylight as a part of the architecture I would like to refer to Louis Kahn by showing an illustation from the book *"Louis I. Kahn : Licht und Raum = light and space / Urs Büttiker ; translation of German texts into English by David Bean."*. The illustration show a chonological and diagrammatic overview of his projects in relation to each projects daylight principle.



Diagrammatic and chronological overview of the works of Louis Kahn - from the book *Licht und Raum*

Example of projects with well integrated daylight strategies

Falkonergården

Pajol sport center

Landskrona

Turnhalle Haiming

Siobhan davies studios

Ullern high school

Rovaniemi library

The Museum of Modern Art, Aalborg

Christianhavns Sports Center

Seconday school with hall in Klaus

Overlys i hallen

Falkonergården

Location
Copenhagen, Denmark

Year completed
2015

Architect
Falko Arkitekter Aps

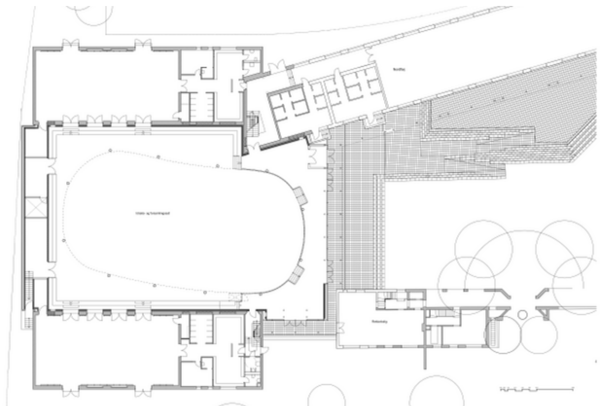
Authors
Tage Lyneborg (1946 Denmark); Carl Th. Lyneborg (1982 Denmark); Høgni T. Hansen (1971 Denmark)

Collaborators
Structural engineering: MOE A/S Acoustical: Gade & Mortensen A/S Technical architect: Halvorsen & Jensen

Program
Education/School

Total area - 1.200 m²
Size of hall surface - 975 m²
Usable floor area - 1.400
Number of seats - 1041
Free height - 10.5 m

Borrowed light fra tilstøtende aktivitetsrom



Plantegning

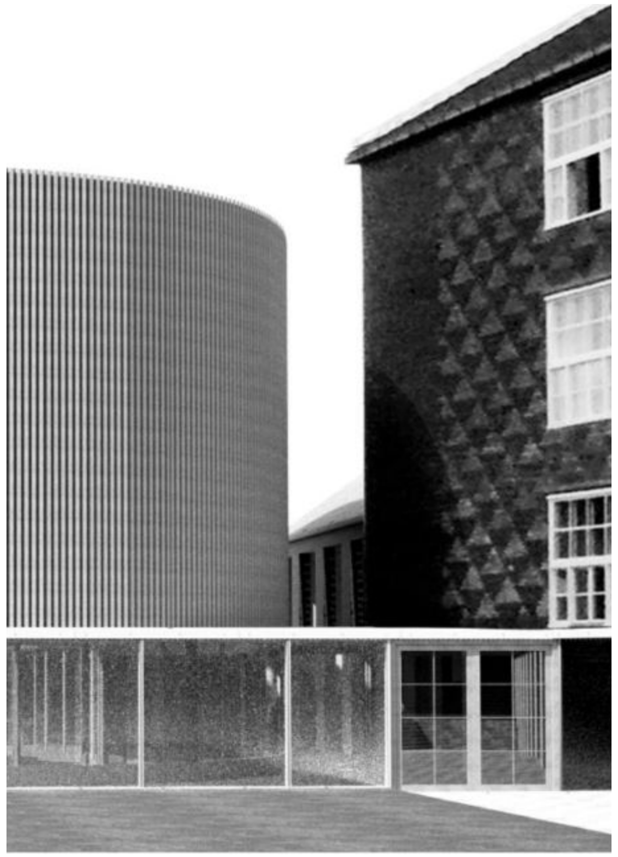
Snitt fra vest til øst

1. Design and orientation of daylight openings
Daylight enter through skylights with a considerable depth and give for the most parts of the day a indirect daylight into the hall space. Electric lighting fixtures are implemented in the skylight openings like a lamella. An open facade towards/through the entrance hall give a view out and brings indirect light into the hall. It also give a depth to the space in addition to information about the outside wather and time of the day. The hall also receive indirect daylight from adjacent acticity spaces. The skylights are placed evenly and relatively close together which give good light modeling and uniformity in the light. Skylights are an efficient way of bringing light into the interior as the glass area of a skylight is up to 6 times more efficient than the equivalent glass area orientated vertically on a wall. A glass area efficiency are dependent on the available and visible part of the sky component.

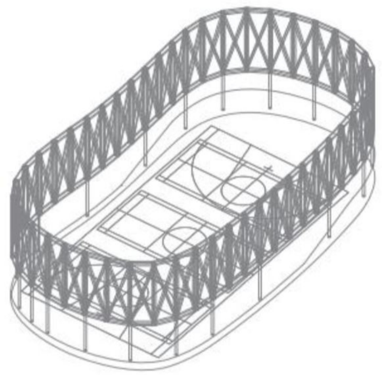
2. The relation between the constuctive system, material and daylight openings
As a load carrying principle the wall uses its height as a beam that is supported by columns placed with even distance around the hall. The ceiling is a two way beam construciton rotated 45°, where the daylight enter through every second opening.
The brightness of vertical surfaces are important to balance the contrast in the visual field. As the main picture on the previous page show, the curved end of the space is darker. The contrast could have been reduced by giving the end wall more light.

3. The buildings outer form, environment and orientation
The multi purpose hall is an addition to an existing school building. The hall is perceived as a separate volume with a skirt that binds it together with the existing building. The skylight form picks up the facade pattern on the existing brick building as a contextual reference to existing buildings. The entrance situation is orientated towards east and the morning sun. There are no outdoor obstructions.

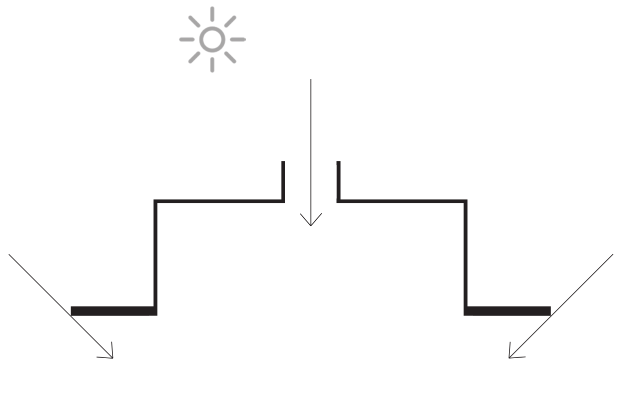
Picture references: http://miesarch.com/work/3118



The skylight shapes pick up existing facade pattern



Load carrying principle



Principle of entering daylight

Skylight from north facing clerestory windows

Pajol sport center

Location
Paris, France

Year completed
2012

Architect
Brisac Gonzalez

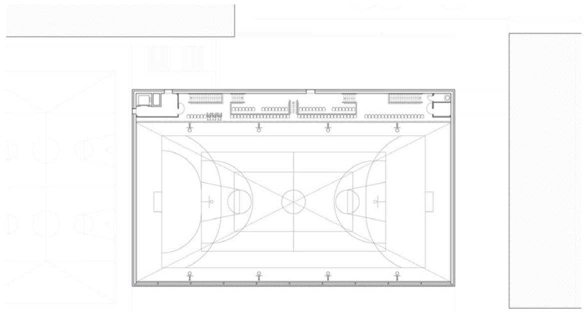
Program
47 x 24m sportshall, martial arts and fitness center on ground level

Total area
4060.0 sqm

Number of seatings
900

Free height - Assumed to be 9 m

Birds perspective - entrance



Plan drawing

Section

1. Design and orientation of daylight openings

The multi purpose hall utilize relfected light from north that enter through curved, sculptural clerestory windows. Light entering from the north works good seen from one direction, but lead to bigger contrasts in the opposite direction. Clerestory windows give a one sided direction of the light and the one short end of the space becomes darker.

2. The relation between the constuctive system, material and daylight openings

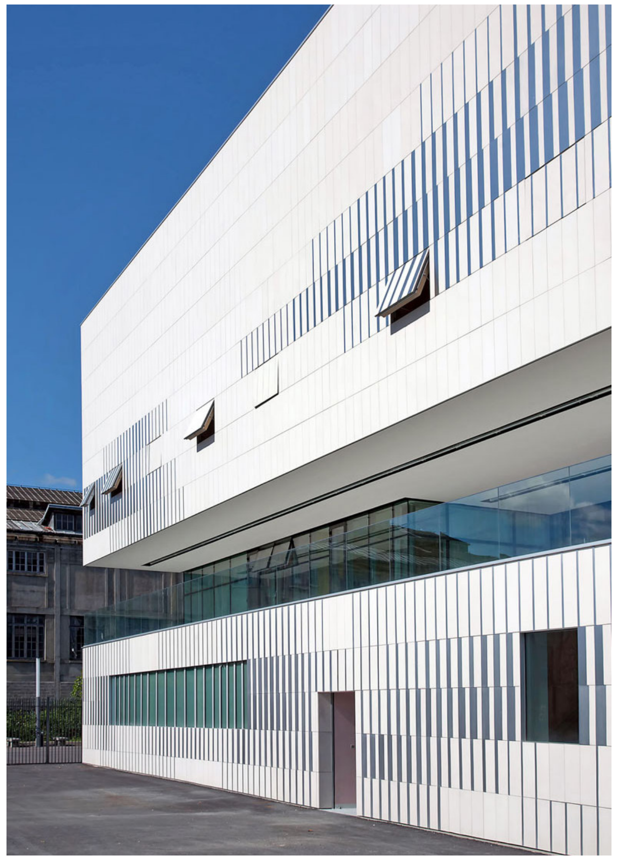
The load carrying principle is easy to read from the shape of the ceiling. The curved beam spans and works together with vertical steel posts. The lower beam is in tenision from horizontal forces from the curved beam and prevents it from sliding to the sides. Wood abosbs a lot of light, at the same time as it has a texture in the surface that diffuse the light in a nice way that give a warm tone to the interior. The back wall could have been treated with a brighter surface or be given a separate skylight.

3. The buildings outer form, environment and orientation

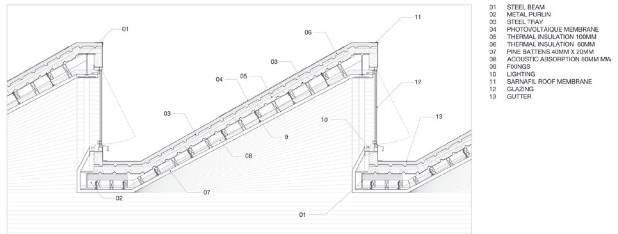
The building hosts a sport and activity program in a total of three floors. The building is oriented north-south. The longitudinal facade towards east is oriented towards a railway track. The entrance situation is directly into the 2nd floor from ground level in west. A glass band separate the hall volume from the lower base. The offset inwards works as a sunscreen.

Picture references: http://www.brisacgonzalez.com/pajol-sports-centre

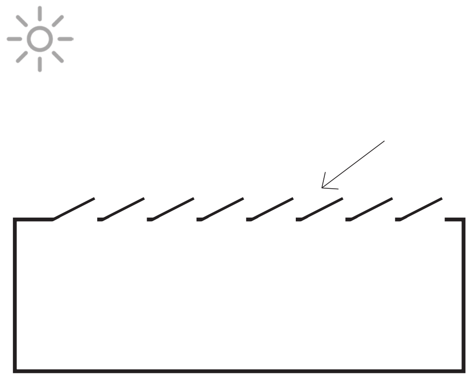
Relation in contrast - seen in both directions



Massing of volumes - public zone in the recessed glass band



Window detail



Principle of entering daylight


Sidelight from all four facades

Landskrona

Location
Landskrona, Sweden

Year completed
1965

Architect
Arne Jacobsen

Collaborators
-

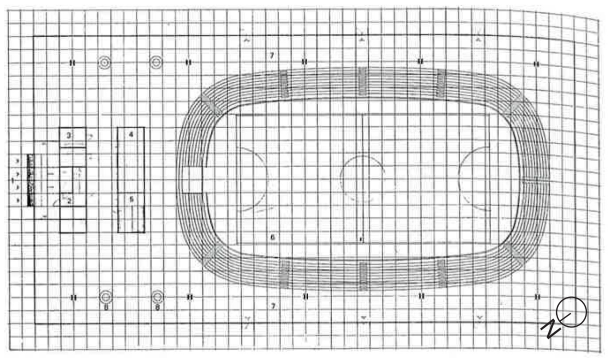
Program
Bordtennis, handboll, skolidrott, friidrott, tyngdlyftning, kampsporter och innebandy.

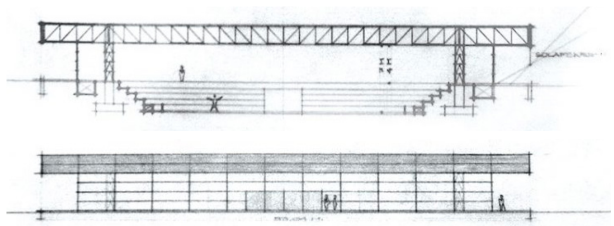
Total area
- m^2

Number of seatings
1100 seats
1000 standing

Free height - Assumed to be 7 m in center


View from outside at night


Plantegning


Cross section and elevation

1. Design and orientation of daylight openings
Daylight entering from four sides give a good light modeling, but will at the same time receive large perifery contrasts between ceiling and windows. The ceiling is glossy, and is in later refurbishments made matt white. The use of a spanning roof outside of the building in combination with the surrounding public area around the hall to screen of the sunlight are a very clear and legant move. (Although the low sun angles in Finland will enter). On all new photograps of the hall the curtains are closed. If there are issues concerned with heat gain/loss, visual disturbance og problems with low sun angles in winter is uncertain.

2. The relation between the constuctive system, material and daylight openings
The ceiling is a big two way beam construction, supported by 10 beams, 5 on each side. The walls are freed from carrying. The ceilling is glossy and reflects the outdoor inside.

3. The buildings outer form, environment and orientation
The building is a free standing structure and daylight is collected from the side of each facade. Big glass surfaces let light in from all four sides. Windows cover the whole walls. The transparency of the building is enhanced by that the sport hall is recessed under ground level. The ceiling is floating. The public enters on ground level with a overview of the hall where no walls meet the ceiling. The sport surface is lowered so that wardrobes and and storage is stored under ground in the short end of the hall.

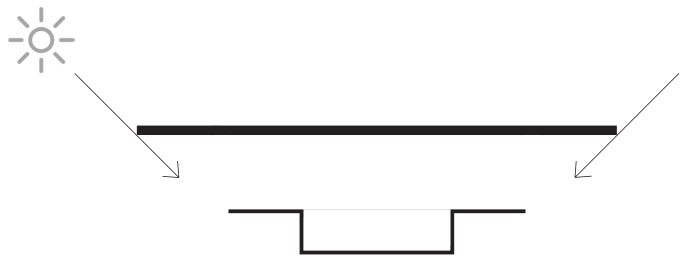
Picture references:
Foto: http://www.alamy.com/stock-photo-sports-hall-landskrona-1964-architect-arne-jacobsen-7889056.html

http://www.johannesreponen.com/journal/2016/3/30/landskrona-sports-hall-1965-in-sweden-designed-by-danish-architect-arne-jacobsen

Tegninger: http://hormaestudio.com/portfolio_page/arne-jacobsen/
http://architecturalmetabolism.blogspot.no/2013/04/blog-post_4296.html


Spanning roof screen from direct sunlight


Interior


Principle of entering daylight

Sidelight from two facades

Turnhalle Haiming

Location
Haiming, District Altötting, Upper Bavaria, Germany

Year completed
2013-2016

Architect
Almannai-Fischer

Collaborators
Rolf Enzel, Florian Fischer, Harald Fuchshuber, Benjamin Jaschke, Antonia Sivjakov

Program
2.5 size sports hall

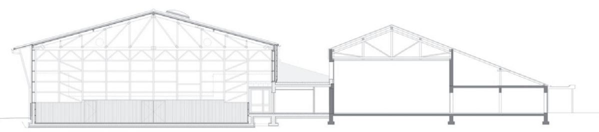
Total area
1800 m²

Number of seatings
ukjent

Free height - Assumed to be 7 m

View from outside

Plan drawing



Cross section

1. Design and orientation of daylight openings
The sports hall is a free standing building and daylight enter from the two longitudinal sides. Opaque windows stretches from floor to ceiling towards north west. The windows emitts a diffuse, indirect light that also give a brightness to the ”ceiling”. Windows on the oppostive wall is lower and limitied in area as they are placed on the south east wall. The windows are withdrawn behind the spectators area so that the direct sunlight is being screened off and reflected into the hall area.
Opaque skylights oriented south also give a brightness to the ceiling construction. Skylights also improve the uniformity of the illumination.

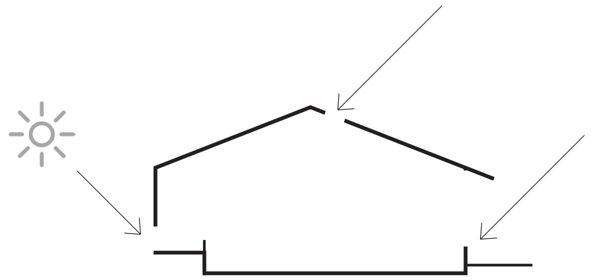
2. The relation between the constuctive system, material and daylight openings
The architect describe the building to be based on standardized building elements such as standard dimensions of wood, beams and nail plates that create a repetative pattern. The building is over dimensioned in the favour of visual repetition. White painted ceiling construction elements hide visual noise as the height, brightness and distance between them create a visual ceiling seen towards the longitudinal direction.
The choice of bright materials and a bright color palette helps the light reflect well inside the hall.

3. The buildings outer form, environment and orientation
The building utilize the indirect light from the north by placing service functions and the entrance in a wing on the south side og the hall. The ceiling span outside the building, especially towards north west. A triangulated construction between ceiling and the bottomn part of the facade screens the evening sun.
The hall is partly recessed in the ground and are surrounded by a solid, low wall with vertical wooden panels. Storage is hidden in the short ends of the hall.

Picture references:
http://almannai-fischer.de/turnhalle-haiming/

Diffuse glass

Interior from tribune



Principle of entering daylight

Borrowed light fra atrium

Ullern high school

Location
Ullern High School, Oslo

Year completed
2015

Architect
Dark

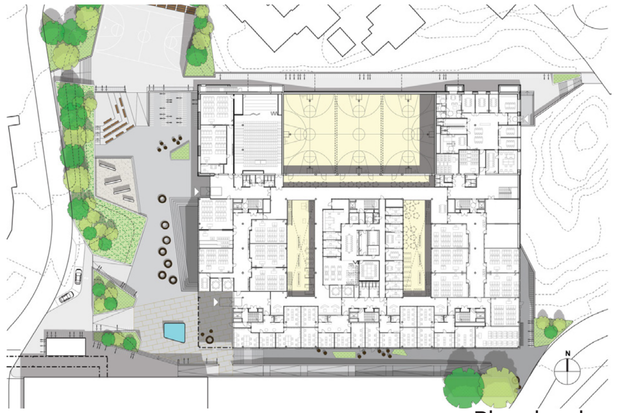
Program
Norwegian Radium Hospital and the Institute for Cancer Research, as well as Ullern High School

Total area
35.300 GFA, of which 13.300 m2 is High school

Number of seatings
900

Free height - Assumed to be 7 m

Telescope tribune



Plan drawing

1. Design and orientation of daylight openings
Daylight enter mainly from four skylights oriented in the cented axis. They are barely visible above the technical installations. The skylights help increase uniformity and modeling. There are two atriums that meet the hall in each corner. The atriums provide a borrowed light and a certain relation in intensity and variation thrughout the day.

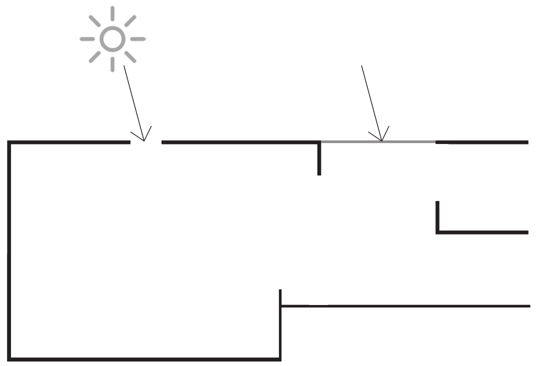
2. The relation between the constuctive system, material and daylight openings
Truss beams span between beam and wall and carry a outdoor area on the top. Auditoriums and technical installations are placed in the hall end. The beams and technical installations are exposed and create a visual noise in the ceiling. Especially when daylight enter the skylights. A bright colour palette is used and a matt flooring limits shiny glare spots.

3. The buildings outer form, environment and orientation
The hall is a part of a bigger building and is attached to a cantina, library and a larger office. The hall is placed in the northern part of the building where three office lamellas shadow the skylights. The hall can become a large living room for the whole buidling complex when is opens up towards the cantina and the library. Telescope tribunes can gather up to 900 people.

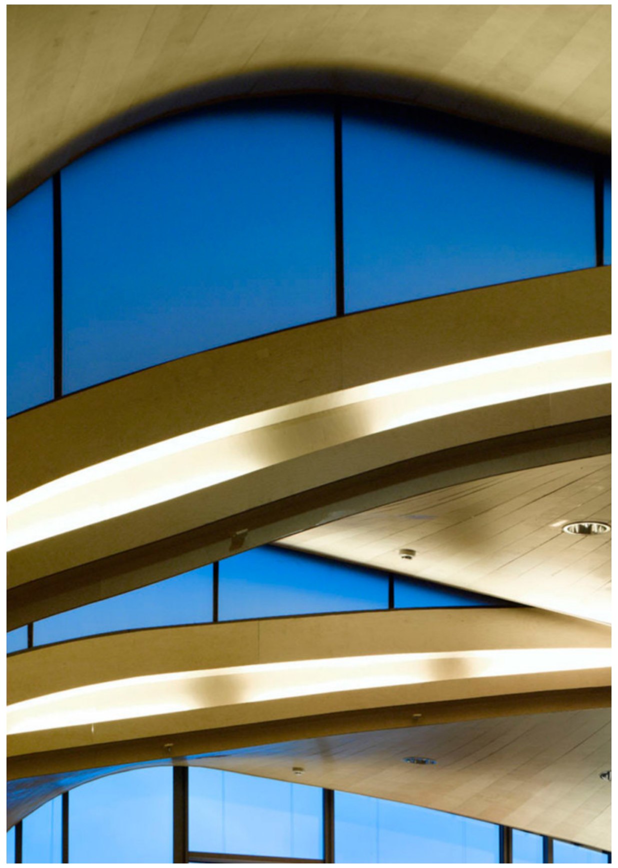
Picture references:
http://dark.no/projects/occi

Visual contact between communal space and multi purpose hall

Atrium with multi purpose hall in the end axis



Principle of entering daylight



Siobhan davies studios

Location
London, UK

Year completed
2005

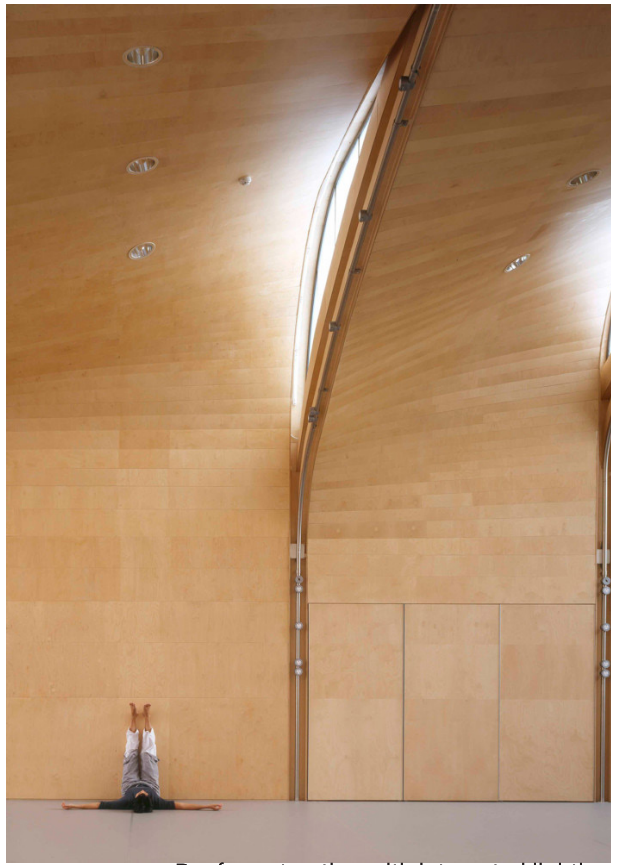
Architect
Sarah Wigglesworth Architects

Program
Dance studio, Utleie til bryllup, møter og kontor, private fester, foto location, film visning.

Total area
Roof studio - 16.5m x 12.0m

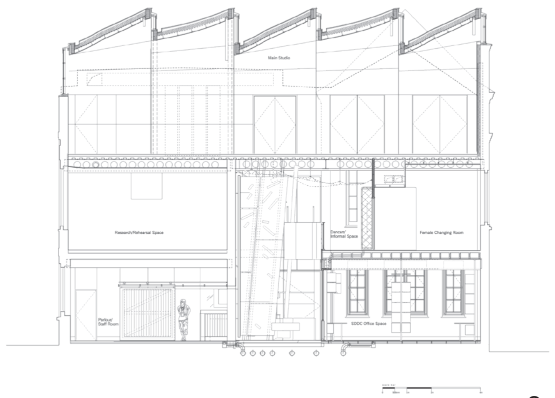
Number of seatings
-

Free height - Opp til 5.5m



Roof construction with integrated lighting

Private rental



Section

1. Design and orientation of daylight openings
Daylight enter mainly from clerestory windows integrated in the roof construction. They "see" both towards north east and south west. All windows can be screened off.

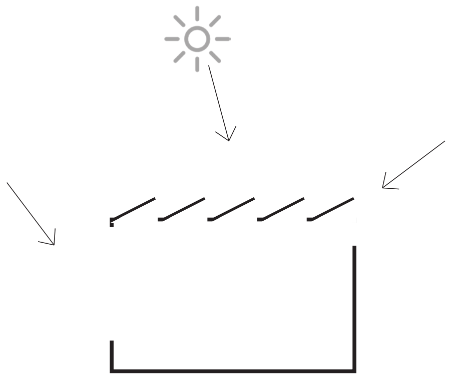
2. The relation between the constuctive system, material and daylight openings
Beams span in the transverse direction. The movement of the beam refer to a dancers movements. A bright color palette and a matt floor surface limits shiny glare in flooring.

3. The buildings outer form, environment and orientation
The dance hall is a part of a larger renovation project from early 19th century and are attached to support functions and another hall on the floor below. The hall is placed on top of the building and is oriented nortwest-southeast. When the hall is not used for dance, it is rented out for various private activities.

Picture references:
http://www.swarch.co.uk/

Daylight as a main light source

Dance hall seen from the outside



Principle of entering daylight

Borrowed light from atrium

Rovaniemi library

Location
Rovaniemi, Finland

Year completed
1965

Architect
Alvar Aalto

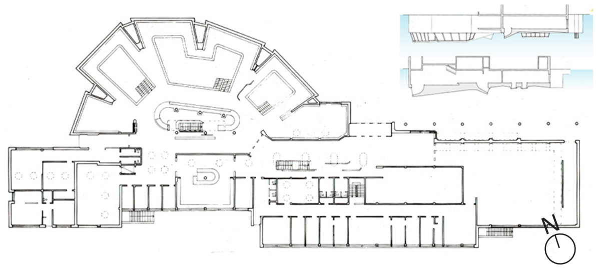
Program
Library

Total area
-

Number of seatings
-

Free height
-

Interior



Plan drawing

1. Design and orientation of daylight openings
Daylight enter through north facing clerestory windows. Daylight is reflected back onto the window wall and preserves the books from direct sunlight. The architectural language is used to distribute the light. In the common room the daylight enter from south, providing a more dynamic light. Light is reflected in a concious and natural way into the interior. It is almost as if the distribution of daylight is detached from the glass surface.

2. The relation between the constuctive system, material and daylight openings
The ceiling shape seems to be hanging on a load carrying system. The system has first and most the function of being a reflector for daylight. White painted surfaces, assumed to be gipsum, reflect light efficiently.

3. The buildings outer form, environment and orientation
The building is free standing and has got no outdoor obstructions. The entrance is oriented towards south and the books to the north. In each part of the fan shape there are placed a reading space.

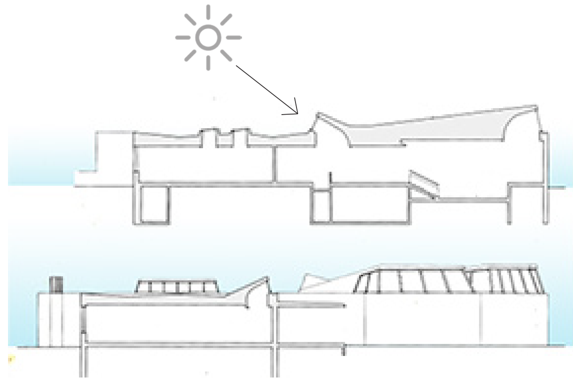
Picture references:
https://medium.com/iamacamera/rovaniemi-library-alvar-aalto-1966-ed17478d940a

https://encrypted-tbn0.gstatic.com/images?q=tbn:ANd9GcQpuGNdMdBsLfEpO-09rpjrkY9T9O0xi-oVHB97tzoN_1iBzq3X

https://i.pinimg.com/originals/73/46/5c/73465c30c350fdcc650bb57d39cfb9c5.jpg

Exterior photo - north facing clerestory windows

Interior - recessed reading space



Principle of entering daylight

Interior - every daylight opening has its purpose

Kunsten

Formerly the Museum of Modern Art, Aalborg

Location
Aalborg, Denmark

Year completed
1972- renovated 2011-2013

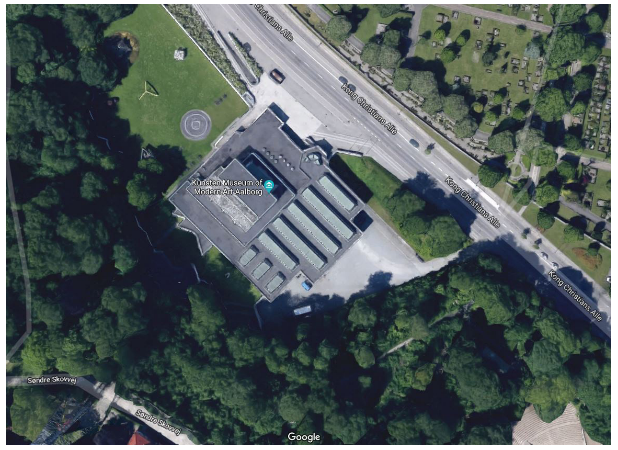
Architect
Alvar Aalto

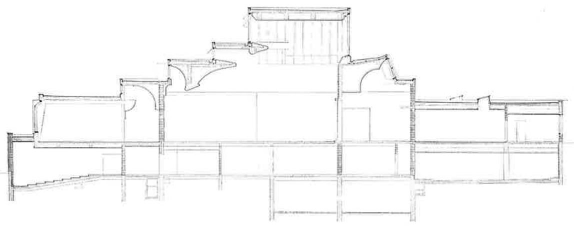
Program
Museum for modern art

Total area
6000 m² + 700 m² newbuilding

Number of seatings
-

Free height
-





Section - Pallasmaa & Sato 2007: 191

1. Design and orientation of daylight openings
Each daylight opening has its function and its connecting surface that are lit. Sculptural ceiling shapes work as reflectors that distribute light from skylights and clerestory windows into the interior. A concious strategy in the use of architecture as a tool for using daylight as a lightsource.
"In his project discription, Aalto argues that the quality of light is as important for an art museum as acoustics is for a concert hall. The main galleries are lit by two-sided, symmetrical, elongated clear-storey reflectors that prevent southern sunlight from entering the exhibition halls at an angle over 56 degrees (corresponding to Aalborg`s latitude), whereas the northern side permits light up to a 90 degree angle. The music room next to the main entrance is lit by prism-shaped skylights"[1]

Ceiling shapes reflect the light from clerestory windows, into the interior - Pallasmaa & Sato 2007: 191

2. The relation between the constuctive system, material and daylight openings
Construcion and ceiling shapes that reflect daylight is made out of white painted concrete.

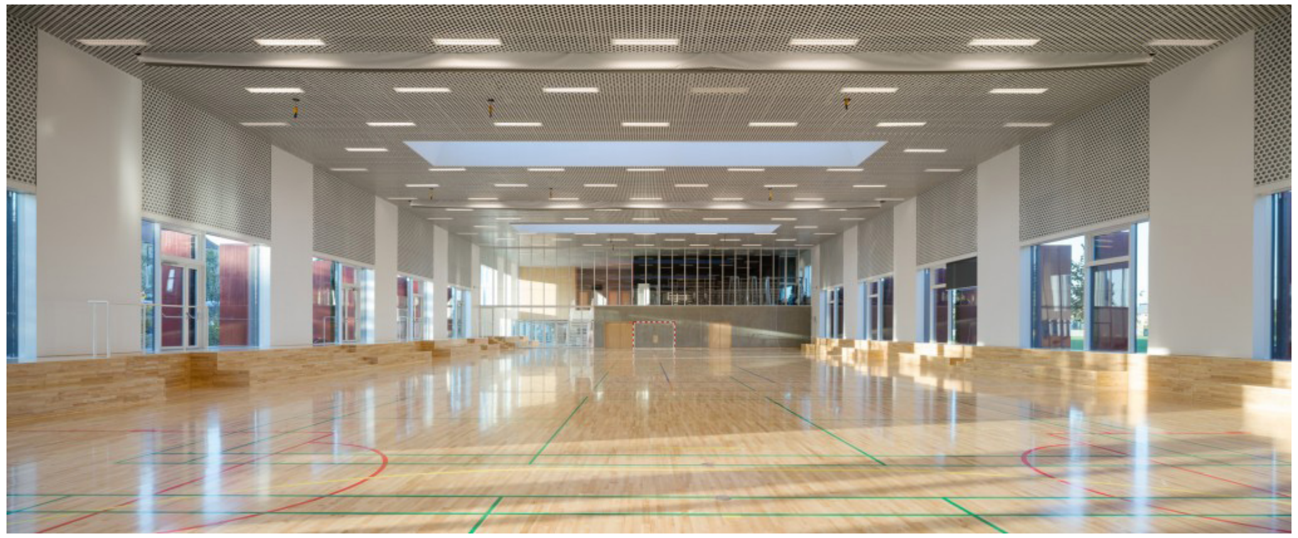
3. The buildings outer form, environment and orientation
The front of the buidling and the skylights are facing northeast and relate to the motor way that pass by. In the back of the building there is a small forest.

Picture references:
https://ssl.c.photoshelter.com/img-get2/I0000DbufQ8q7kSc/fit=1000x750/Kunsten-Soren-Jensen-2015-QJEL-20.jpg

http://denmark.dk/en/quick-facts/map-of-denmark/aalborg/kunsten/

https://www.cfmoller.com/p/-en/KUNST-EN-master-plan-for-restoration-and-revitalisation-i2825.html

1 Pallasmaa & Sato 2007: 190



Oriented towards the canal

Christianshavn Sports Centre

Location
Christianshavn, Copenhagen

Year completed
2013

Architect
Christensen & Co

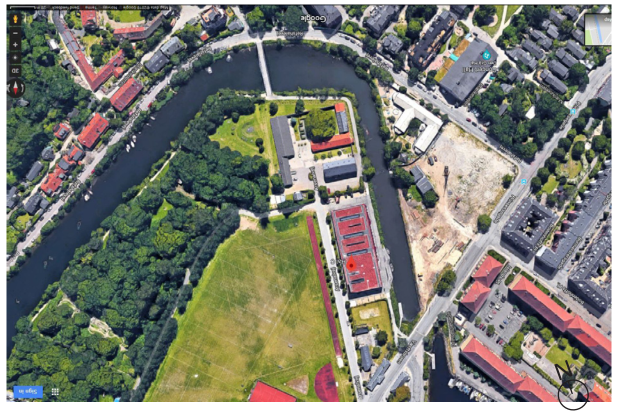
Program
Sports centre for Christianshavn Gymnasium, sports clubs, schools and community associations in the local area.

Total area
2450 m²

Number of seatings
-

Free height
-

Environment



Situation

1. Design and orientation of daylight openings
Daylight enters thorugh three wide skylight and from large windows on each side. Big vertical shutters can close off the vertical openings and shut out direct sunlight from entering the hall.

2. The relation between the constuctive system, material and daylight openings
In the general areas of the building, such as changing rooms, fitness area and meeting rooms there are used a variety of materials. The different program resemble stacked boxes featuring different finishes such as raw concrete, plywood and black-painted wood.
In the main hall features light materials and colors. The construction system can not be said to be articulated other than white painted sections on the side of the main hall, resembling load carrying walls.

3. The buildings outer form, environment and orientation
The buidling are oriented along a canal. Giving it an extra dimension in regards to being a social meeting place. Especially in the summer. The tribune seats is also a stair leading up and then down again to the outdoor environment. The building is oriented north-south.

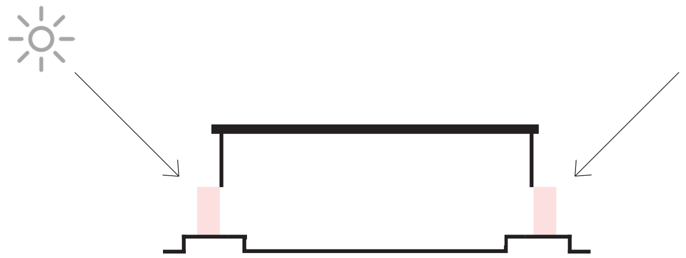
Bildereferanser:
https://www.mimoa.eu/projects/Denmark/Copenhagen/Sports%20Centre%20Christianshavn/

http://christensenco.dk/projects/christianshavn-sports-centre/

https://halc.kk.dk/sites/halc.kk.dk/files/styles/flexslider_full/public/uploaded-images/Haandbold.jpg?itok=t-u3v98V

Exterior show west oriented shutters

Interior



Principle of entering daylight

Direct sunlight enter the space

Secondary School with Hall

Location
Klaus, Austria

Year completed
2014

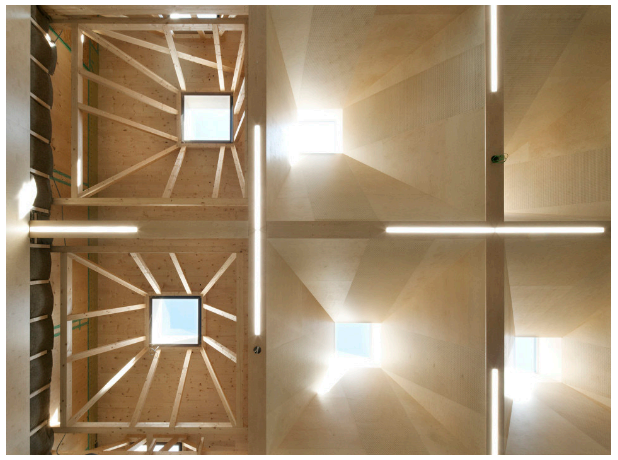
Architect
Dietrich | Untertrifaller

Program
Secondary School with sportshall

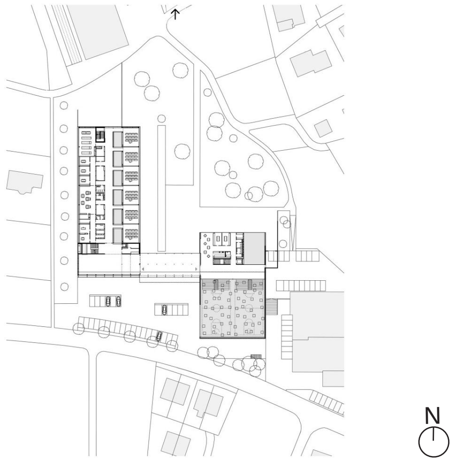
Total area
Multi purpose hall: 790 m^2
The whole project: 6,940 m^2

Number of seatings
Telescope tribune

Free height
7m



Skylight - interior



Situation

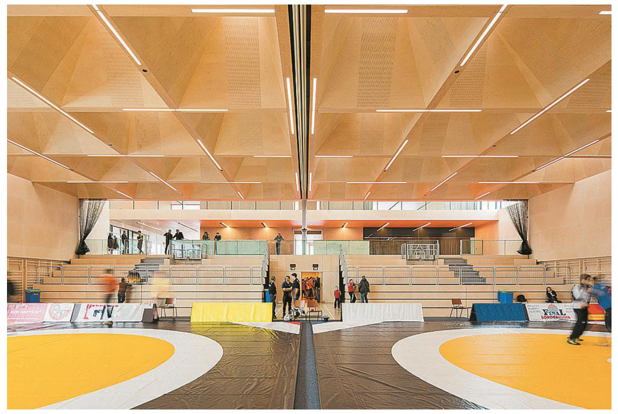
1. Design and orientation of daylight openings
The daylight enters the space from the skylights. All the skylights are oriented differently which lead to direct sunlight entering at different times of the day from different skylights. A vertical window in the west also give direct sunlight into the hall.

2. The relation between the constuctive system, material and daylight openings
The construction span in one direction and the skylights fill in the void. The angled inside of the skylights give a homogenous bright ceiling. The flush contact with the walls eliminates unwanted shadows on the walls.

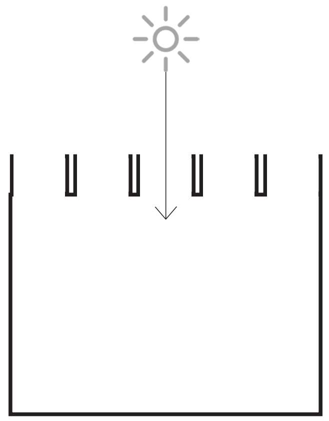
3. The buildings outer form, environment and orientation
The hall is lowered to be mostly under ground. The atrium is oriented in the halls northern part which reflects the entering sundlight. There are no outdoor obstructions.

Bildereferanser:
http://www.dietrich.untertrifaller.com/en/projekt/schule-und-sporthalle

Construcion site



Interior



Principle of entering daylight

The multi purpose hall

There is a strong need for multi purpose buildings in Oslo. In 2016 the city council of Oslo presented a budget to build 13 new sport halls during the next two years.[1] In 2017 the city council announced that they plan to spend 5 billion Norwegian kroner the next four years on sport facilities.[2]

To be able to make use of daylight as a light source a multi purpose hall need to adapt to the available daylight outside. In order to be useful and not prevent glare the amount must be between 3 and 5% of the available daylight of the exterior. Most multi purpose halls in Norway are built with little or no daylight in the main hall. I assume that this has to do with limited building costs, lack of knowledge in daylighting design and quite strong technical restraints on lighting levels, glare and uniformity. The Ministry of Culture has written a guideline for planning and building of "idrettshaller". On the matter of daylight it simply states the following:
"Innslipp av dagslys i idrettshaller er omdiskutert. I Norge har det vært vanlig å bygge idrettshaller helt uten vinduer i hallrommet. Dagslys er imidlertid positivt for arbeidsmiljøet i en hall, og i andre land kan man se eksempler på til dels store vindusflater i idrettshaller uten at dette tilsynelatende er problematisk for aktiviteter i hallen. Et godt alternativ kan være indirekte dagslys, det vil si at lys slippes inn via tilliggende rom eller annen avskjerming i bygget." [3]

In his work *Concepts and practice of architectural daylighting* Fuller Moore suggested three reasons why architects continue to depend on electric lighting for most of their commercial and institutional projects: "(1) recently, Illumination has been the sole domain of engineering specialists who do not consider daylighting to be cost -effective, (2) daylight is considered by most architects as an uncontrollable amenity (and thus unacceptable for task illumination), and (3) most architects do not understand the principles of daylight illumination sufficiently to introduce them early in the schematic design phase."[4]

1 Kirkebøen 2016
2 Kirkebøen 2017
3 Kulturdepartementet 2016: 58
4 Fuller Moore 1984: ix

Interior of a gym in The Netherlands, around 1900

Typology

As a typology the multi purpose hall grew out from a interest in sports as a leisure activity. The need for indoor facilities grew and from 1948 and on the building of multi purpose halls was financed on the basis of surplus of Norwegian gaming funds. From 1965-85 the gaming funds increased from 12 million NOK to 324 million NOK.[1]

A few years after the glulam beam was invented a standardized hall was developed. The standardized hall was adapted to the international size standard requirements for the different ball games. The entrepreneurs could deliver a standardized building set that was measured on technical parameters and price. The standardized hall was just in a few years widely spread across local communities. It was no longer subject of an architectural approach in terms of design of space. [2] Daylight was just a factor that made building on relatively small budgets more expensive and was not asked for by the local sport clubs.
Multi purpose halls has traditionally been placed as free standing building volumes in a geographic relation to sport facilities and or schools. As free standing buildings they have a potential of the use of daylight.

1 Ding 2017: 5
2 Lyngsgård 1990: 100

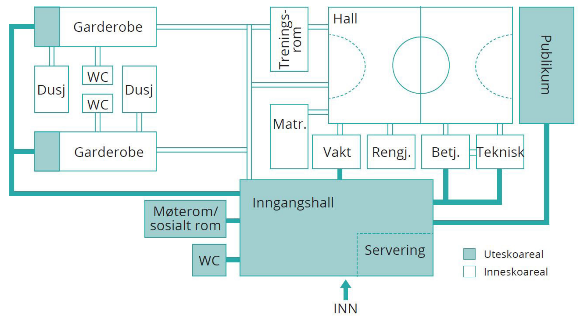
Program
In a multi purpose hall the term multi purspose is often associated with a variation over different team sports in the same hall. The multi purpose hall has with its big hall space also a property of hosting social and communal activities and support functions.

I wish to look at the normalhallen (the standardized sports hall - 25x45m) as a typology and adapt it to the site and the local needs for activities in Furuset.

The program are divided in three main themes: Sport, activities and happenings.

Area disposition:
Sport/activities/happenings: 1125 m²
Støttefunksjoner: 810 m²

Totalt: ca 2000 m²



Schematic ports hall program
Source: Kulturdepartementets veileder for idrettshaller

Sport:
- One handball field
- One bandy field
- Three basket ball training fields
- Three volley ball training fields
- Seven badminton fields
- Nine table tennis fields
- Gymnastics
- Martial arts

Activities:
- Play area
- Dance
- Gymnastics/parkour

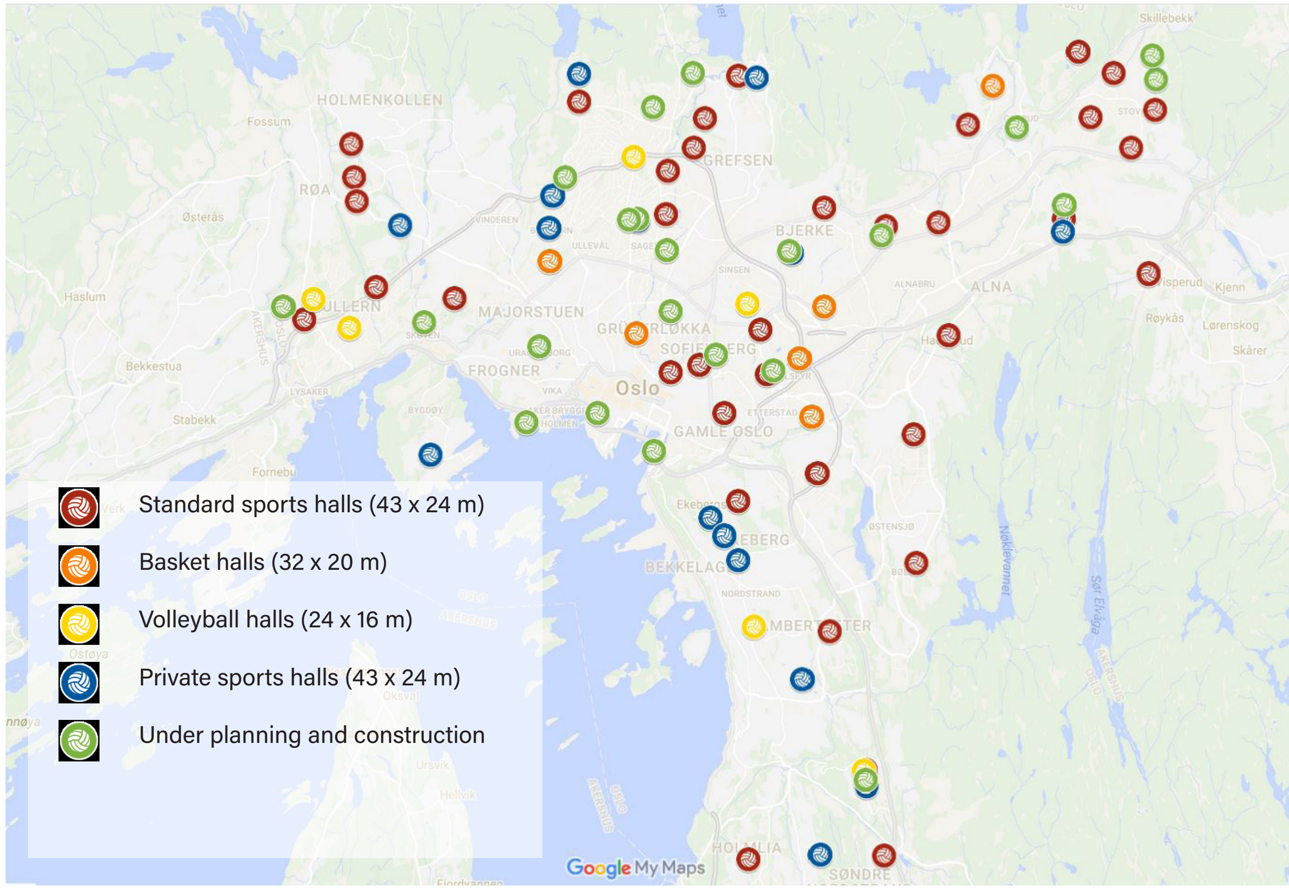
Happenings:
Congregation hall that can support the local community needs such as:
- Plays
- Congregations
- Local concerts
- Private rental
- Market/flee market

Support functions:

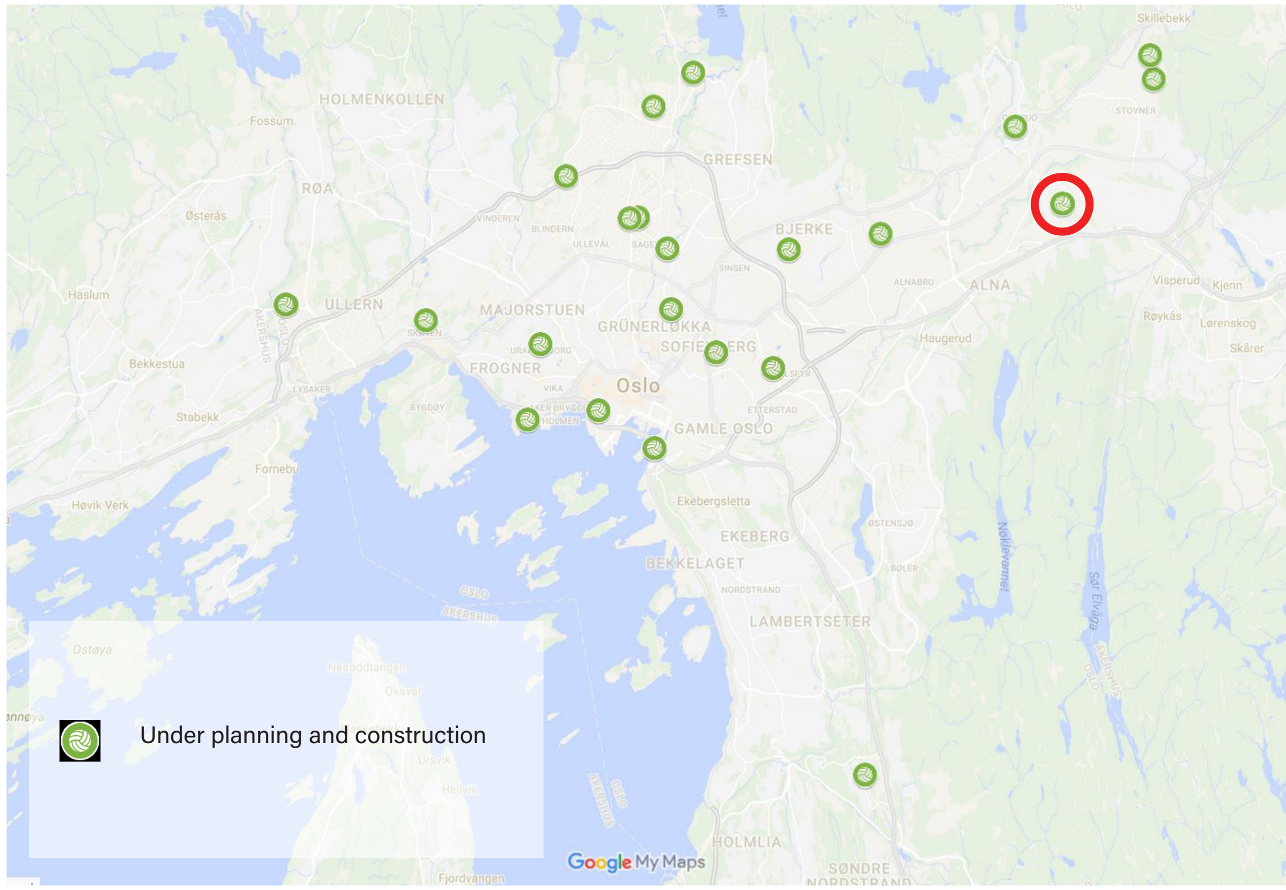
Storage -	200 m²
Wardrobes -	120 m²
Styrketrening/parkour -	300 m²
Meeting room facilities -	36 m²
Kitchen -	20 m²

Site regulated for a multipurpose hall

The decision on finding a site is based on idrettsforbundets overview of planned and existing sports facilities in the municipality of Oslo.



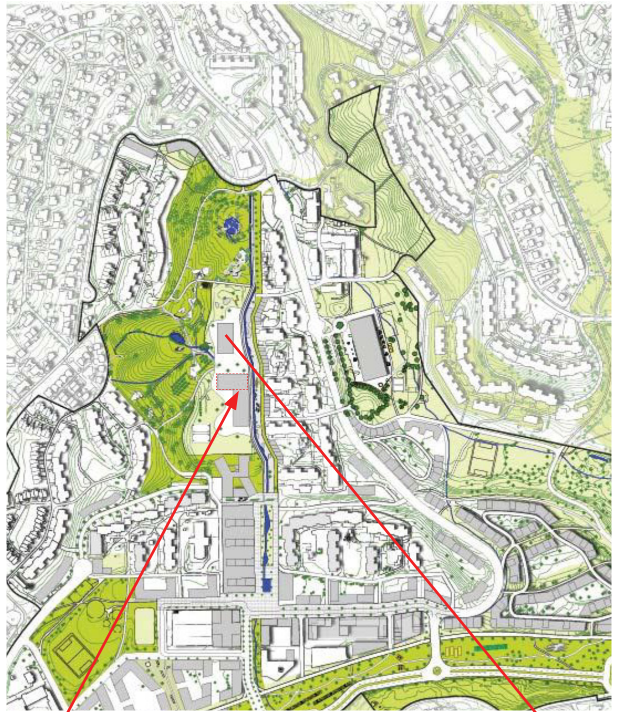
idrettsforbundet.no



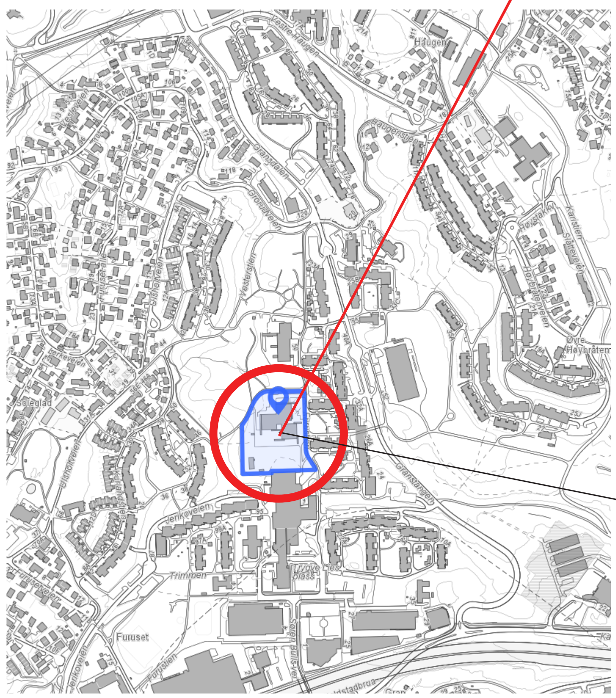
idrettsforbundet.no

Site regulated for a multipurpose hall

The site that is regulated for a new multi purpose hall in Furuset consists of two sites that are regulated according to the new regulation plan for Furuset (2014)
The regulation describes a new school Verdensparken skole, a kidnergarten and a multi purpose hall that should serve the school.

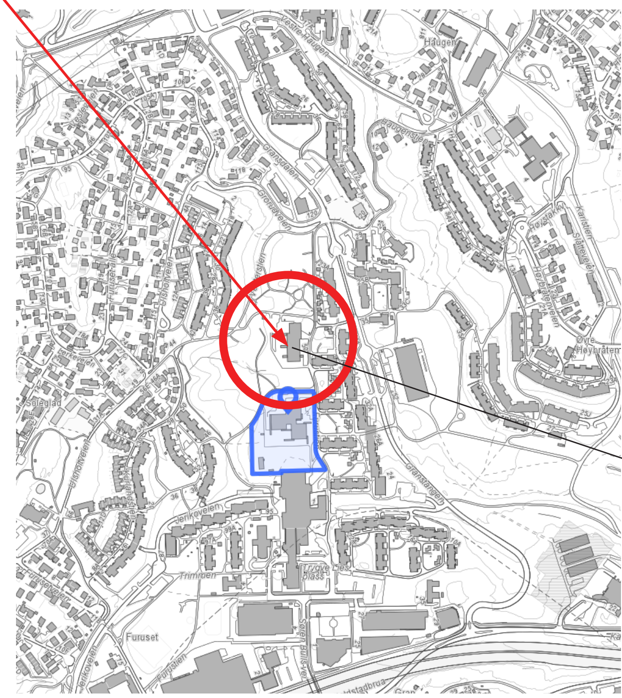


Regulation plan
Illustrasjon: Plan- og bygningsetaten



Site: The new verdensparken skole

Site: the old Gran skole

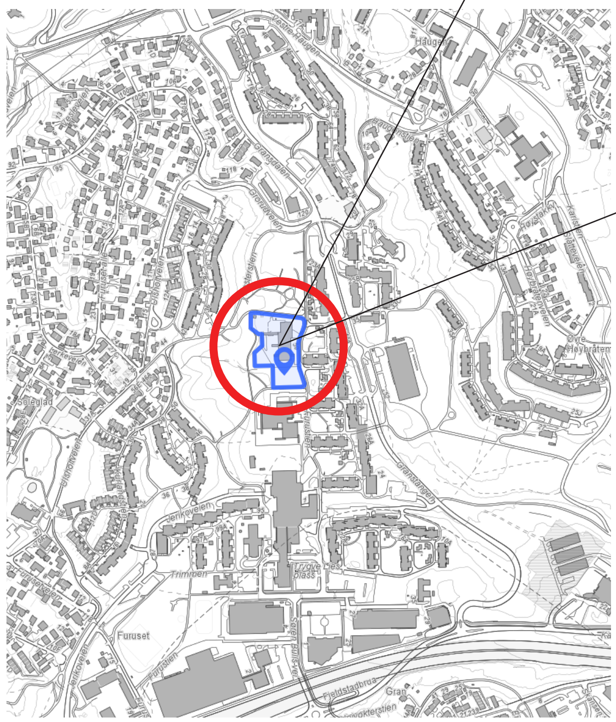


Tomt: the old Gran elementary school and kindergarten

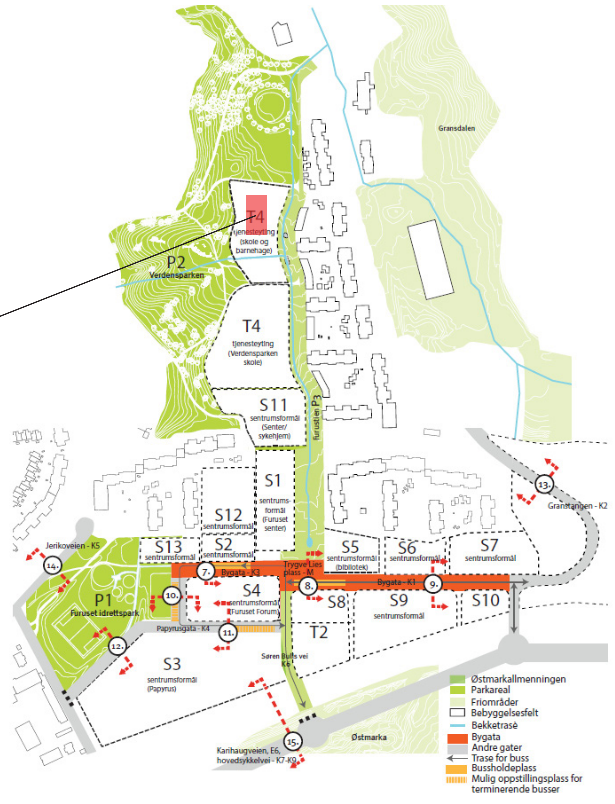
Chosen site - proposal

As I would like a multi functional hall to be a free standing building I propose that the multi functional hall will be given a prominent connection to Verdensparken at the end of the green/blue axis from Furuset center.

Regulation plan
Illustrasjon: Plan- og bygningsetaten

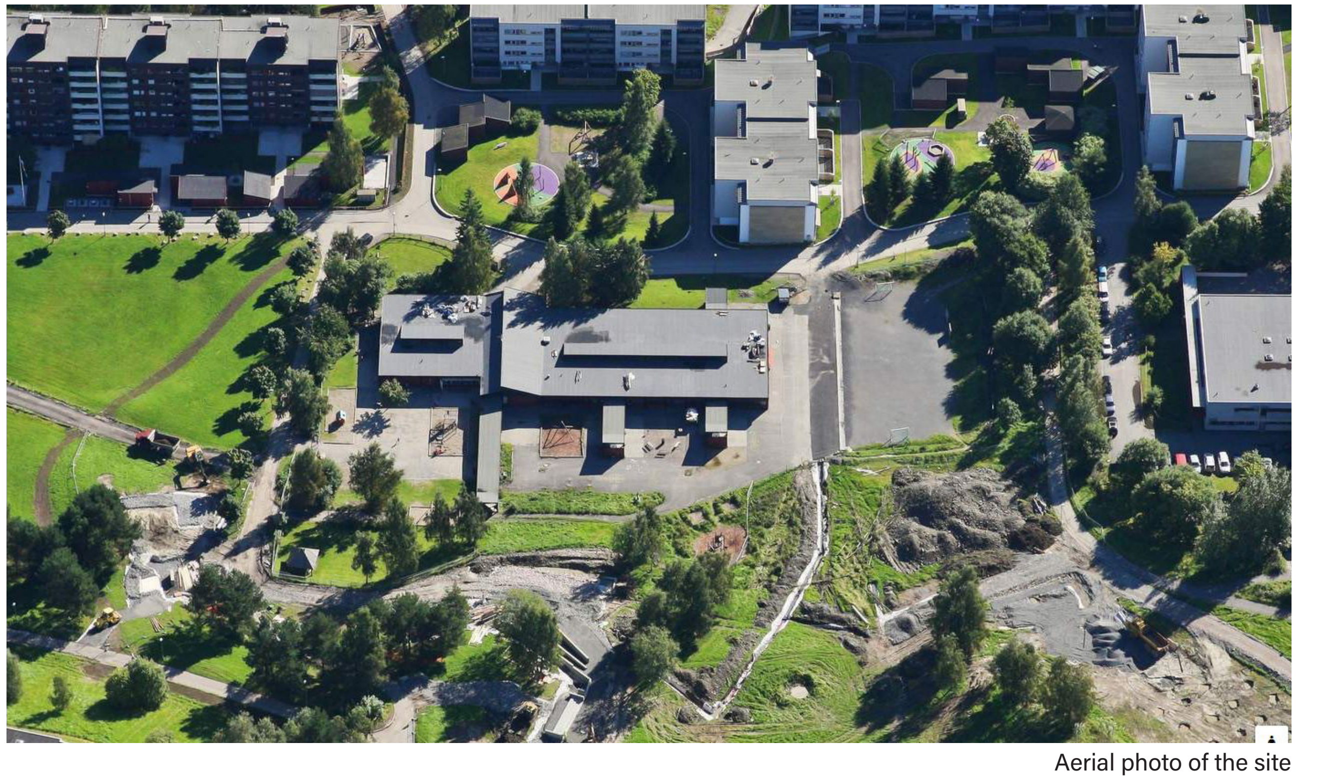


Site: Surrounded by verdensparken

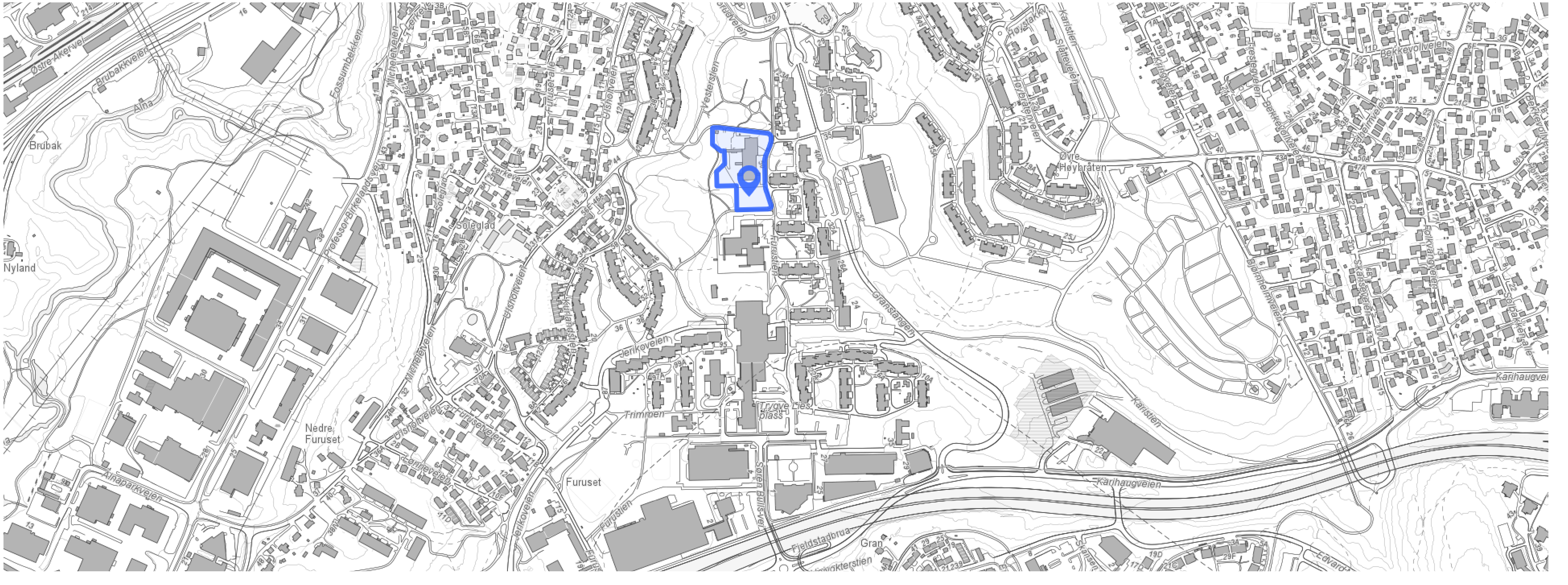


Regulation plan Furuset center
Illustration: Plan- og bygningsetaten

Aerial photo of the site



Aerial photo of the site



Submitted Materials

Model with situation context 1:1000

Situation Plan 1:1000

Ground Floor Plan 1:200

Plans 1:100

Sections 1:100

Elevations 1:100 / 1:200

Illustrations

Architectural Models 1:50 / 1:200 / 1:1000

Construction and Detail sections 1:25

Diagrams

Research Paper

Description / Book

Schedule Diploma Semester

SURVEY

August 1 2 3 4 5 6 7 8 9 10 11 12 **13 14 15 16 17** 18 19 **20 21 22 23 24** 25 26 **27 28 29 30 31**

Task: Understanding the urban and social context;
Mapping the site, drawing the existing site and its surroundings;
Case studies, understanding the organisation of successful multi purpose halls.

Product: Research report;
3D digital site model and DWG plans;
Summary of the new multi purpose hall program

CONCEPT

September 1 2 **3 4 5 6 7** 8 9 **10 11 12 13 14** 15 16 **17 18 19 20 21** 22 23 **24 25 26 27 28** 29 30

Task: Understanding modelling properties of daylight in a large multi functional hall;
Spatial experiments in physical model.

Product: Research report;
Spatial organisation research sketches;
Spatial modelling with daylight
Spatial organisation testing models.

SCHEMATIC DESIGN

October 1 2 3 4 5 6 7 **8 9 10 11 12** 13 14 **15 16 17 18 19** 20 21 **22 23 24 25 26** 27 28 **29 30 31**

Task: Understanding the programs;
Spatial experiments in physical model;
Research about the building construction materials.

Product: Strategies of space organisation of separate functions;
Diagrams of the spaces;
Physical models of the separate functions.

DEVELOPMENT

November 1 2 3 4 **5 6 7 8 9** 10 11 **12 13 14 15 16** 17 18 **19 20 21 22 23** 24 25 **26 27 28 29 30**

Task: Developing the final project;
Program.

Product: Strategies for the organisation of the whole spaces;
Physical spatial models;
DWG drawings for plans, sections and elevations.

PRODUCTION

December 1 2 **3 4 5 6 7** 8 9 **10 11 12 13 14** 15 16 **17 18 19 20 21** 22 23 24 25 26 27 28 29 30 31

Task: Finalize all the drawings and presentation model;

Submission of the final presentation.

January 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31

Final Reviews

LITTERATURLISTE

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Art 21.
«James Turrell: 'Second Meeting'». YouTube video, 3:32. Lastet opp 17. mai 2013, https://youtu.be/_BuJpDXkMz8?t=3m32s (oppsøkt 26.02.2018).

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Arkitektur krop rum Helle Bøcken Wikke, Karin Skousbøll - Wikke, Helle Bøcken
På edra platser Nils-Olof Zethrin - Zethrin, Nils-Olof
Louis I. Kahn : Licht und Raum = light and space / Urs Büttiker ; translation of German texts into English by David Bean
The design of lighting Peter Tregenza and David Loe
Daylighting : architecture and lighting design Peter Tregenza and Michael Wilson
Architectural lighting design Gary R. Steffy
Lighting design : principles, implementation, case studies Ulrike Brandi Licht ; [Authors: Christina Augustesen, Ulrike Brandi ; drawings: Andrea Saiko ; translation: Caroline Ahrens, Esther Mallach]
Perception and lighting as formgivers for architecture William M. C. Lam ; edited by Christopher Hugh Ripman
Sunlighting as formgiver for architecture William M. C. Lam - Lam, William M. C.
Made of light : the art of light and architecture Mark Major, Jonathan Speirs, Anthony Tischhauser - Major, M.

Figurliste:

Interior of a gym in The Netherlands, around 1900
link: https://en.wikipedia.org/wiki/Gym

APPENDIX

4.1

A historic context of light
In a historic perspective the focus on daylighting design has changed with the evolution of our society. The pendulum has swung from an experience based daylighting design during the pre-industrial age to an approach based on scientific principles at the turn of the 20th century. The focus on daylight as a free resource made the pendulum swing back again in the 1970`s with a renewed focus. On the swing back, the evolution of our modern society brought with it a new way of living that set different and more complex requirements for our built environment. But we are as biologically attached to the qualities of daylight now as we were then.

It is not possible to talk about daylighting in the aftermath of the industrial revolution without talking about artificial lighting. With the industrial revolution artificial lighting came in as a promising technology that in many ways overwhelmed the industry at the time. From once being inseparable from the building design, daylight was in many cases discarded in favour of the electric light source. Several attempts were made to design working-environments and schools with the absent of daylight. They failed.

Prior to the 1800s (with the exception of the Gothic church) the bearing exterior wall was the most widely used vertical construction system. Professor and architect Fuller Moore stresses that "the development of the structural frame and the availability of high strength steel members allowed the building to be solely supported by columns [...] The exterior wall was reduced to no more than a skin that would prevent rain and wind to enter."[1] Large glass openings gave greater access to daylight illumination, but they were at the same time accompanied by winter heat loss, over heating in the summer and potent for increased glare. The thermal buffer of previous massive building envelopes had disappeared. Mechanical heating and cooling systems were introduced and electric light sources replaced skylights, windows and clerestories as the primary sources of illumination. These were among the systems that allowed for a greater building depth. With new interventions such as the elevator, development in water pumps, central plumbing and waste treatment systems, building heights surpassed earlier times. The city could be densified to the point of restricting daylight to the street level.

1 Fuller Moore 1984: 13

Daylight and natural ventilation had previously dictated building depths with design rules such as floor height to room depth ratios. Now, technology had turned the page. Operable windows even became a disturbance, because if opened they would disturb the forced ventilation system. The electric light source was instant, safe, predictable and constant. But it did not address the human biological need for daylight. A view out is highly valued to set us in a relation to time and day, seasonal change and the outdoor context. Also the qualities of light such as its spectrum, daily and seasonal variations and intensity are qualities of daylight that cannot be replaced by electric light.

When sunlight was discovered as an disinfectant and bactericide by the end of the 19th century; light, air and health had a large impact on residential housing. The knowledge of light and health was still to be explored, and it was not until recent times that the link between light and our circadian rhythm was scientifically proved.

Nowadays, buildings are getting ever more compact and Europeans spend as much as 90% of their time indoors.[2] Technology has answered to problems such as heat loss and over heating with the use of energy. High-Tech inventions that control our indoor environment are almost taken for granted. The way high-tech inventions (such as blinds, airflow, temperature, electrical lights, doors etc.) control all indoor perceptual parameters undermine the importance of daylighting design in our buildings. – Or is it maybe the opportunity to control our environment that make daylighting design superfluous?

Electric lighting has now in many ways smelted into a symbiosis with daylight, filling out the dark corners in our interior. To successfully allow daylight into our indoor environments will be crucial for future use of buildings.

2 European commission 2003

Pre-Diploma report

Title: Adaptability in daylight

Kanditate: Joar Tjetland

Supervisor: Marius Nygaard