Theatre- and Experience House

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ABSTRACT

This project concerns the design of a new Theatre- and Experience House in Hjørring and takes its point of departure in a competition brief from February 2013 developed by Hjørring Municipality and Realdania.
With a focus on sustainable living, the aim is to design architecture which features theatre, music and cultural life and at the same time meets the energy frame of low-energy class 2020.

The project is developed through an iterative design process grounded in the Integrated Design Process, defined by Mary-Ann Knudstrup. The aim is to create a design that meets aesthetic, technical and functional needs and requirements.

TITLE PAGE

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Title: Theatre- and Experience House
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Technical supervisor: Rasmus Lund Jensen

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TABLE OF CONTENTS

PRESENTATION

OUTRO

INTRODUCTION

This project concerns the design of a sustainable Theatre- and Experience House located in the southern part of Hjørring city centre. The design deals with both theatre spaces and public spaces for different activities, spontaneous as planned, for both participants and curious onlookers, in short, a mix of experiences.

Hjørring, like other provincial towns, experiences that the desire for an active and diverse city life is challenged by an insufficient amount of citizens and visitors to the city centre. The Theatre- and Experience House, in that connection, is to generate experiences and activity and, in a larger perspective, support a positive development of the city.
With its location on the current bus station the house will lie as a central hub in the city traffic. Passing by is pedestrians from the nearby train station on their way to the city centre or schools in the city's eastern part. Also local car drivers and guests on their way to the resort areas on the coast comes by the house. From the trains, travellers can enjoy the sight of Vendsyssels new Theatre- and Experience House from a distance.

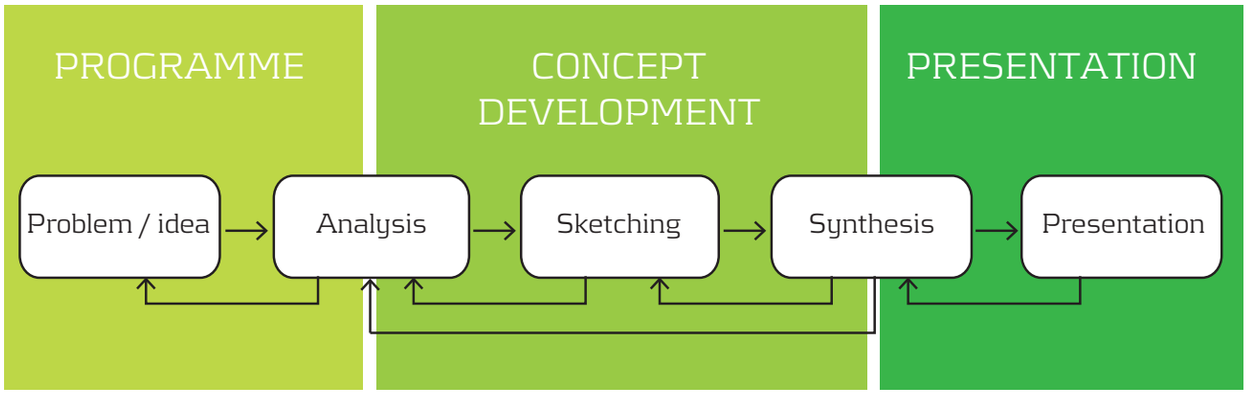
METHODOLOGY

The project is developed on the basis of the integrated design method, IDP, developed by Mary-Ann Knudstrup. This section describes how the iterative process is used to create a design that meets aesthetic, technical as well as functional needs and requirements.

The integrated design process, IDP, is characterized by embracing both engineering and architectural fields from an early stage in the process. During an integrated design process several aspects are considered in relation to each other. This project employes aspects of energy consumption, indoor climate, sustainability, function, theatre design, user, experience etc.

The integrated design process utilizes an iterative process throughout the development of the design. At Aalborg University the iterative process is implemented in a problem based learning environment, which has resulted in a specific process model defined by Mary-Ann Knudstrup; see the figure below [Knudstrup 2005]. The model illustrates five overall phases, between which, the iterative process circulates: Problem/idea, Analysis, Sketching, Synthesis and Presentation. The phases are configured linearly in the model, however the process should not be understood as a process, where one phase must be completed before the other phase can begin. Instead, the process is a continuous movement between phases. Like in the hermeneutic circle, knowledge is generated through repetitive circular movement.

This report is divided into three overall chapters: Programme, Concept development and Presentation which together represents the entire design process. Within each chapter different methods have been used which is illustrated in the figure below.



Phenonenological site analysis
Mapping
Document analysis
Interview
Collage
Microclimate
Sketching

Brianstorm
Case studies
Sketching
Volume studies
Analog modeling
Digital modeling
Revit drawing
Construction principles
Energy calculations
Indoor climate evaluations

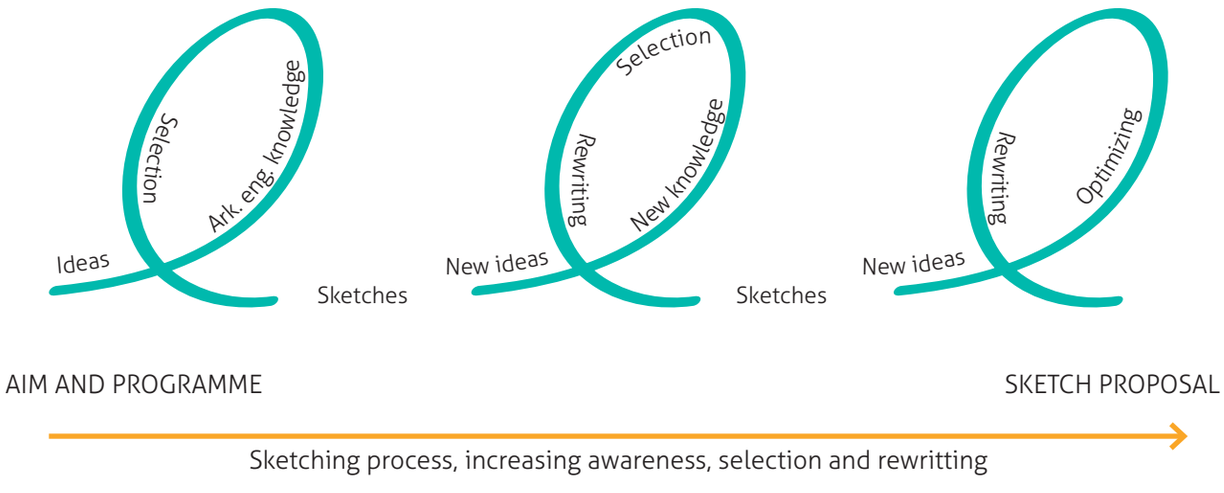
Energy calculations
Indoor climate simulations
Construction calculations
Revit drawing
3D-visualisations
Presentation modeling
Graphic presentation
Dokumentation

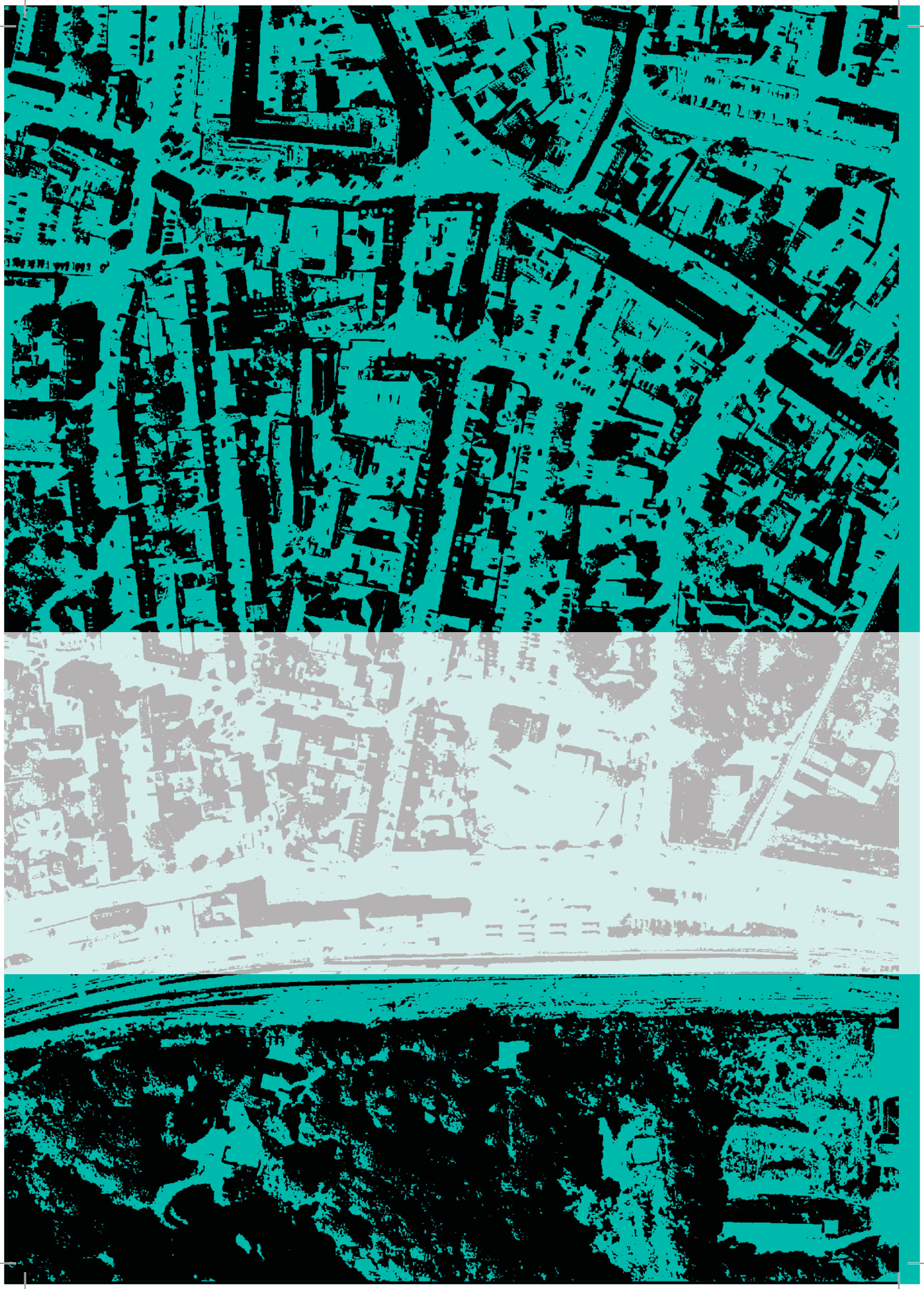
Especially in the sketching phase of the design, architectural ideas and technical principles are handled equally and linked together [Knudstrup 2005]. The following therefore, in more detail, describes this stage of the design.

In the sketching phase the many different aspects of the design are set in relation to each other and influence each other. In this phase, the integration of different knowledge generates new ideas and solutions. Thus, ongoing loops of new knowledge results in different sketching proposals. During the process different sketches are evaluated in relation to the vision of the project and design parameters. The figure below illustrates the sketching process [Knudstrup 2005].

The process starts with some initial ideas evolved during the development of the programme. In this project also brainstorms are used to generate ideas. First loop of sketching implements knowledge of both architecture and engineering and, after selection, results in a first group of sketches. New ideas occur in the process and they are brought into a second loop of sketching where new knowledge is taken into account. Again selection takes place and maybe one, at this point, also goes back and rewrites topics in the programme. The second group of sketches are optimized in a third loop of sketching.

In this report the chapter, Concept development, is divided into three overall concept loops which together illuminate the sketching process of the project.





PROGRAMME

The project programme describes the first two phases of the design process; Problem/idea and Analysis. On the basis of the competition brief an initial project idea is developed and different analyzes are carried out in order to clarify the project essence. In the end of each analysis some design parameters are drawn out.

During the process initial sketching has been done, however these sketches are not part of this chapter but is represented in the next chapter 'Concept development'.
The programme results in a problem statement and a project vision which together with the design parameters are used in the concept development.

COMPETITION BRIEF

The project takes its point of departure in a competition brief prepared by Hjørring Municipality and Realdania [Projektkonkurrence 2013]. This section illuminats wishes to the project as well as the project vision expressed in the brief.
Furthermore, a function diagram and a space programme clarifies demands in regards to functions and size of the new theatre house.

Wishes

The different wishes can be subdivided into three overall categories; wishes in regards to the user, the theatre and the city.

The new Theater- and Experience House should:

User
- be a gathering place for the local youth and the non-organized, interested in music, theater and culture, in as many hours of the day as possible.
- engage and inspire the citizens of Vendsyssel
- accommodate an attractive working environment for Vendsyssel Theatre

Theatre
- accommodate an innovative, intimate and unique theatre for Vendsyssel Theatre
- contain flexible theatre stages

City
- interact with its surroundings
- generate life and activity in the center of Hjørring
- be open and inviting as part of the city's public spaces.

Vision

> *The house is to enhance the development of Hjørring, and serve as a driver for cultural life in the Northern Jutland, and thus support the settlement, education and occupation [web 1]*

Function diagram

The function diagram on the next page shows the desired relationship between key functions in the Theatre - and Experience House. The colors denotes different levels of privacy.

The large stage called 'In-the-round' is the core of the house. This theatre space is to integrate the traditional stage tower height to the entire theatre space. The free volume above both auditorium and stage provide space for three-dimensional objects as part of the performance.
Furthermiore, three theatre seating typologies are to be integrated; Proscenium, amphi and in-the-round theatre. The seating typologies provide different experiences of the performance:

Proscenium Theater
The scenery is restricted on the stage and the audience views through the proscenium opening. Some of the stage area can be placed in front of the proscenium opening. The stage and the auditorium are separate but related volumes [Stronge 2010].

Amphitheater
The Greek amphitheatre wrapped its audience around a central stage, with a degree extended to 220. Typically the amphitheatres were semi-circular in form. The border between the auditorium and the stage is fluid [Strong 2010].

In-the-round theater
Theatre in-the-round was widespread in ancient Greece and Rome. This typology places the performance in the centre of the room with the audience surrounding the action and actors enter through the auditorium. The theatre in-the-round provides a strong sense of focus and brings the actor into the same space as the audience [Strong 2010].

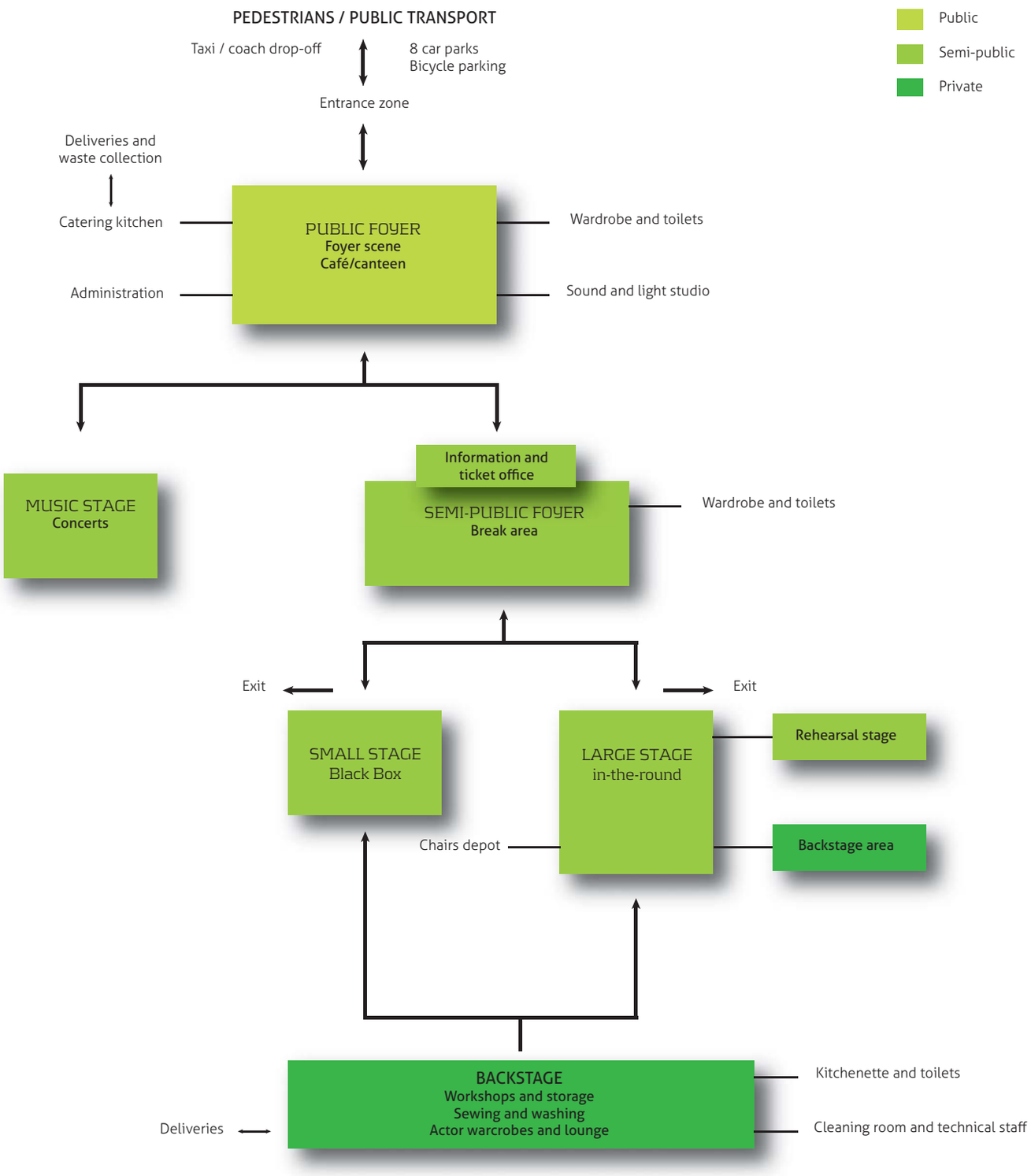


Fig. 1: Function diagram

	SPACE DIMENSION			INTERNAL LOAD	
	Area [m²]	Height [m]	Volume [m³]	Persons	Activity [Met]
Public interor					
Foyer	275	6	1650	350	1,2
Foyer scene	100	6	600	-	-
Café/canteen	125	3	375	35	1,2
Kitchen	100	3	300	5	1,6
Wardrobe	50	3	225	6	1,2
Toilets	25	3	75	-	-
Administration	120	3	360	11	1,2
Information and ticket office	25	3	75	2	1,2
Chairs depot	50	3	150	-	-
Scene area					
Large stage - 'In-the-round'	470	15	7050	250-350	1,2
Backstage area	150	9	1350	5	1,2
Small stage - 'Black Box'	200	6	1200	150	1,2
Rehearsal stage	150	6	900	10	1,2
Music stage	200	6	1200	150	1,2
Sound and light studio	20	3	60	-	-
Backstage					
Workshops	150	9	1350	10	1,6
Storage for scenery	180	9	1620	-	-
Sewing and washing	40	3	120	4	1,6
Storage for costumes , lamps and spot-lights	180	3	540	-	-
Actor wardrobes (6 x 15-30 m²), actor lounge and kitchenette	125	3	375	10	1,2
Actor toilets	25	3	75	-	-
Cleaning room	25	3	75	-	-
Technical staff	15	3	45	1	1,2

Space programme

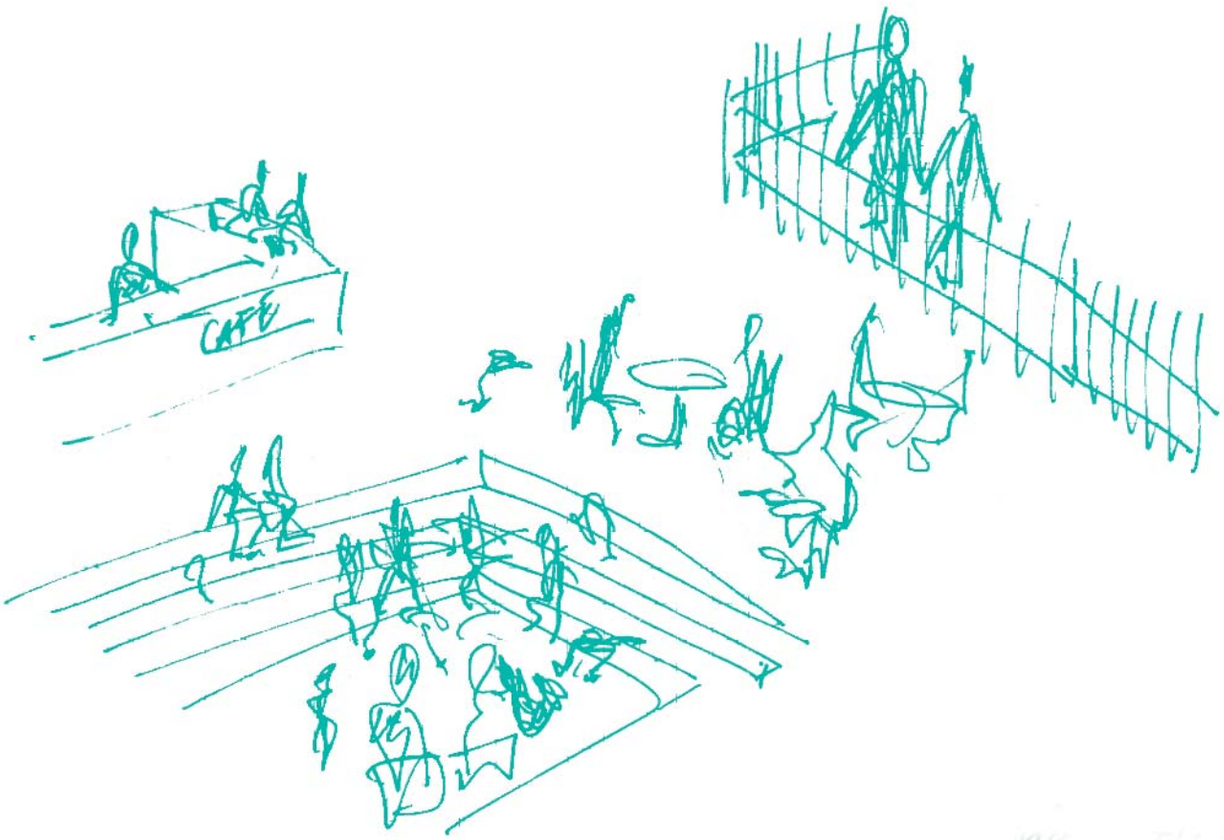
The space programme is separated in the overall categories: Space dimension, Internal load and Indoor climate. The space dimensions and internal load are values defined in the competition brief. Whereas values in regards to the indoor climate are developed goals for this project. The following is a description of each of the three categories.

The space dimensions illustrate the desired size of different functions in the house. All areas are net areas and leads to a total net area of approximately 2800 m². To this there is an approximately supplement of 50 % which is the relation between net- and gross area. Thus a gross-/net factor of 1,5.
The gross area includes walkways, staircases, lifts, walls, constructions, technique area etc. and should not exceed 4200 m².

The internal load express the internal load from people within each room. The load depends on the amount of people and their activity level which is determined from CR1752.

	INDOOR CLIMATE				
	Temp. summer [C]	Temp. winter [C]	Max. CO^2 level [ppm]	Daylight factor [%]	Reverberation time [sek]
Audience area					
Foyer	24,5 ± 1	22 ± 1	≤ 800	5	0,6
Foyer scene	-	-	-	-	-
Café/canteen	24,5 ± 1	22 ± 1	≤ 800	5	0,6
Kitchen	23 ± 1	19 ± 1,5	≤ 800	2	0,6
Wardrobe	24,5 ± 1	22 ± 1	≤ 800	-	-
Toilets	-	-	-	-	-
Administration	24,5 ± 1	22 ± 1	≤ 800	2	0,6
Information and ticket office	24,5 ± 1	22 ± 1	≤ 800	-	0,6
Chairs depot	-	-	-	-	-
Scene area					
Large stage - 'in-the-round'	24,5 ± 1	22 ± 1	≤ 800	-	0,9
Backstage	24,5 ± 1	22 ± 1	≤ 800	-	0,6
Small stage - 'black-box'	24,5 ± 1	22 ± 1	≤ 800	-	0,9
Rehearsal stage	24,5 ± 1	22 ± 1	≤ 800	-	0,9
Music stage	24,5 ± 1	22 ± 1	≤ 800	-	1,2
Sound and light studio	-	-	-	-	-
Backstage area					
Workshops	23 ± 1	19 ± 1,5	≤ 800	2	0,6
Storage for scenery	-	-	-	-	-
Sewing and washing	23 ± 1	19 ± 1,5	≤ 800	2	0,6
Storage for costumes, lamps and spotlights	-	-	-	-	-
Actor wardrobes, actor lounge and kitchenette	24,5 ± 1	22 ± 1	≤ 800	2	0,6
Actor toilets	-	-	-	-	-
Cleaning room	-	-	-	-	-
Technical staff	24,5 ± 1	22 ± 1	≤ 800	2	0,6

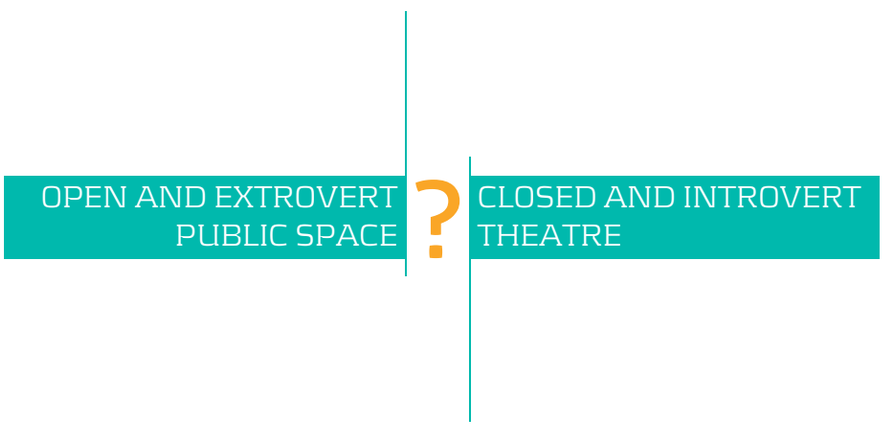
In regards to indoor climate, the project strives to fulfill category A which means that 15 % of people using the building will be dissatisfied with the indoor climate. In the table above overall goals in relation to the thermal [CR1752, p. 10], atmospheric [web 2], visual and acoustical comfort [web 3] are set up.


CAFE

INITIAL PROJECT IDEA

From the competion brief an inital project idea has evolved. The idea embraces the contrast between theatre and urban visions and sounds as follows:

> *Exploration of how urban life meets theatre in an active focal point*



EXPERIENCE HOUSE

The overall purpose of contemporary theatre is to entertain and provide experiences. People nowadays demand good and memorable experiences. Experiences that provide identity and quality of life. This section reflects on the term experience and, in this connection, the role of the framing architecture in which the experience is to evolve.

Contemporary theatre tradition is based on the development which began in Athens shortly after 500 B.C. However, at that time, the main purpose of the tragedy was to make people better citizens [Hannestad 1985]. A core service of today's theatre performances is entertainment.
In the society of today there is an increasing demand for experiences. In extension to this, the so called 'experience economy' is touted to be the business area with the main growth potential in the 21 century [Johansen 2006: 14]. Self-realization has for the young generation become a basic and required part of life and in that connection they, among other things, use experiences as a way to promote themselves. Traditions in relation to education and jobs have disappeared, and our main mission in life is to define ourselves as human beings. However, as a consequence of our growing need for self-realization and individualization there is also a growing wish for togetherness and shared experiences [Johansen 2006]. In that connection, a key potential of the theatre of today is not only to entertain but also to create a sense of experience and community.

The two American researchers Joseph Pine and James Gilmore subdivide the spectrum of experiences in four realms: entertainment, education, aesthetics and escapism [Pine and Gilmore 1999]. The richest experiences include aspects of all four realms. In the design of a Theatre- and Experience House it is obvious to study the different realms and how they can be used to enrich the experience space.

Pine and Gilmore consider two dimensions of how an experience can engage guests. The figure on the next page illustrates Pine and Gilmores model on experiences, which should be seen as a simplified picture of reality.
The first dimension concerns the level of participation and spans between passive and active participation. Passive guests do not influence the performance and are observers or listeners. Active participants personally affect the performance or the event that leads to the experience.
The second dimension concerns the environmental relationship that link guests with the event. This dimension spans between absorption and immersion. When the guest absorbs the experience, the experience is brought into the mind from a distance. Whereas immersion is about bringing the guest to be physically a part of the experience.
It is the coupling of the two dimensions that defines the four experience realms. The experience most people think of as entertainment, occurs when people passively absorb the experience. This is the oldest and most developed form of experience and today the most common. However, it can be preferable to mix this experience with the three other realms of the experience or even blurring the boundaries between realms, in order to enriching the experience [Pine and Gilmore 1999].

Hjørring Municipality in collaboration with Hausenberg and professor Jens Kvorning have made an brainstorm on the term experience and express three overall tracks for desired experiences in relation to the house [Hausenberg 2012]:

Activity track
Activities inside the house should be reflected or visible from outside and spaces in connection with the house should invite and support different activities.

Recreational track
Possibility for stay from where people can observe life and get something to eat and drink.

Aesthetic track
The architecture in itself should contribute with spatial experiences and art could be located both inside and outside the house.

The three experience tracks together, can be said to accommodate all four experience realms defined by Pine and Gilmore. The activity track supports the idea of designing spaces that makes it possible for the guest to actively absorb experiences or to be actively involved in the experiences. The recreational track supports the

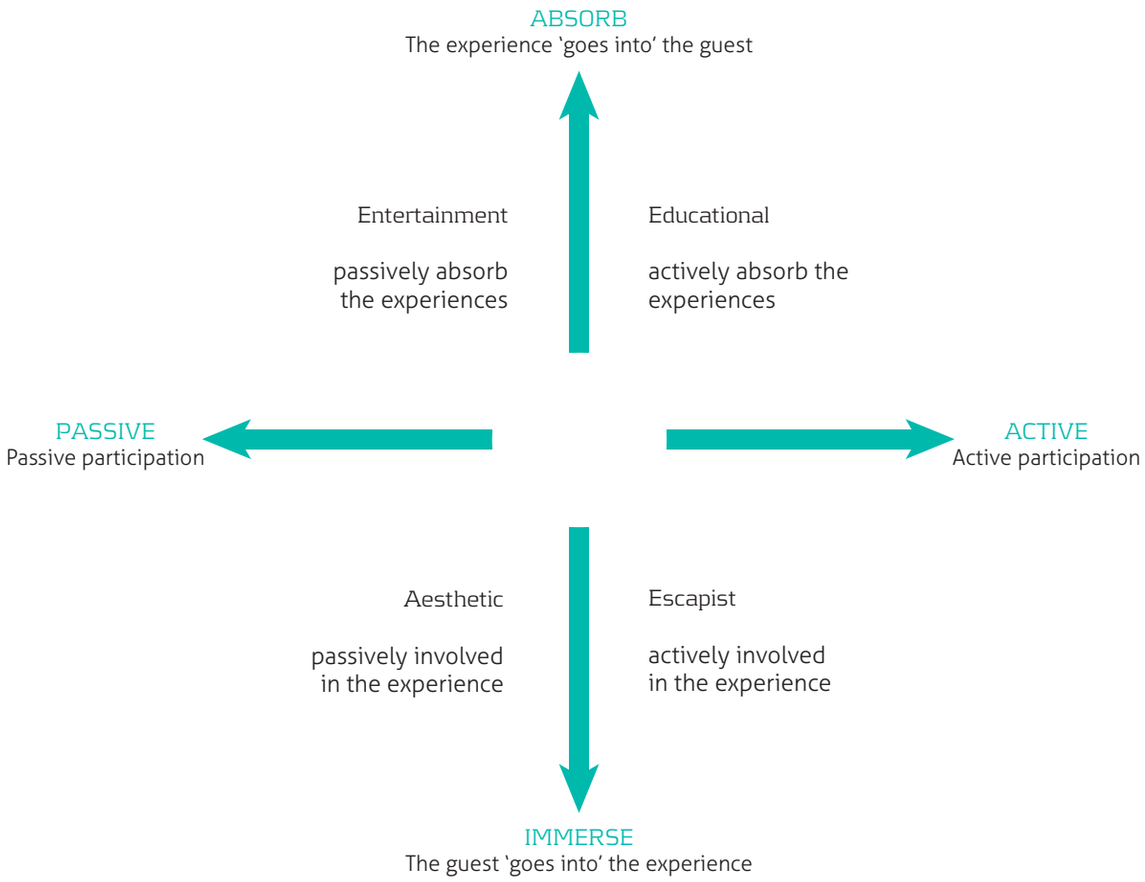


Fig. 2: Illustration of the four experience realms.

idea of creating spaces in which people passively absorb experiences. The aesthetic track supports the idea of creating spaces that foster passively involvement in the experience. The individuals are immersed in an environment but have little or no effect on it, leaving the environment, however not themselves, untouched [Pine and Gilmore 1999].

Thus, this project strives to explore spatial configurations in relation to all three experience tracks and implement and combine them in the design of a Theatre- and Experience House.

Design parameters

The design should:

- create a sense of experience and community
- reflect activities inside the house on the outside
- invite and support experiences where people are actively involved
- create possibility for stay
- create spatial experiences that involve people

URBAN SPACE

This section describes how the urban space is to be related to the Theatre- and Experience House. Different design options in regard to privacy versus openness as well as concepts on how to create urban comfort and value are described.

Brandscapes

In the last 15-20 years the city, in the Western world, has taken a new position due to changes in the society. The city has developed from an industrial – and commercial centre to a consumption – and leisure landscape in, what today is called, an experience society [Brandrup 2010]. The experience society denotes the collective orientation towards experiences as means to increase the individual well-being [Jantzen 2011]. Consequently, experiences and entertainment has become something that large as well as small cities use to brand their city and attract citizens [Brandrup 2010]. In relation to this trend, the new Theatre- and Experience House should be part of Hjørring's public spaces. A public space which is open and inviting and emphasizes cultural experiences.

Generating life

Life in cities is generated by the fundamental social behaviour of humans. People want to see people. The figure below shows different design options and their impact on the creation of see- and hear contact between people. The illustrations are used as an inspiration to how to create privacy as well as how to open up to the public. Dialogue and visual contact between different functions/people in the house and the nearby urban space, can contribute to a gradual transition between outside and inside. A transition which this project strives for in order to make the theatre part of the city's public spaces.

The scheme to the right illustrates 12 different qualities to the urban space which are defined by architect and urban planner Jan Gehl. The first and basic level of urban quality is to create protection against traffic, crime and unpleasant sensory stimuli such as weather conditions. To provide comfort, the urban space needs to contain elements which makes it possible to walk, stand, sit, see, talk, hear and utilize space. Approaches which brings a human scale into the space. Also the space should be considered in use both during day and evening and through the seasons to make it a natural element in the city. To create more value to the space opportunities to enjoy positive aspects of the climate should be provided.

People are people's greatest joy. Life generates life which is central to the development of this project [Gehl 2010].

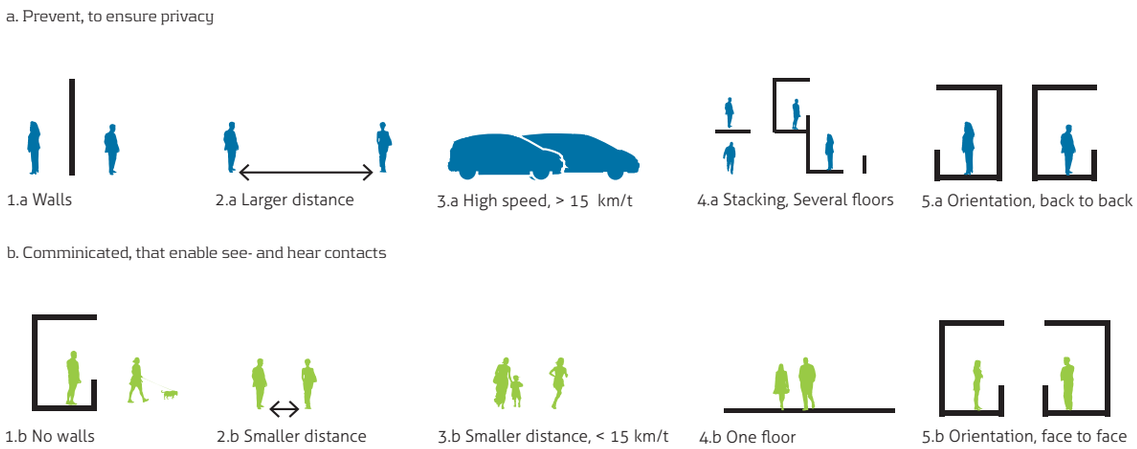


Fig. 3: Five ways to prevent or communicate see- and hear-contacts through the design.

PROTECTION	Protection against trafic and accidents *Experience of safety in relation to trafic*	Protection against crime and violence *Experience of safety* *Living spaces* *Functions that overlaps day/ night* *Well illuminated*	Protection against unpleasant sensory stimuli *Wind/draught* *Rain/snow* *Cold/warm* *Pollution* *Dust, glare and noise*
COMFORT	Opportunities to walk *Room for walking* *Respect for paths* *Interesting facades* *Access everyone* *Good surfaces*	Opportunities to stay or staying *Occupied zone/edge effect* *Bases to stand near* *Facades which invites to stay*	Opportunities to sit *Seating area with plenty of advantages* *Good places to sit* *Good interior* *Primary and secondary seating options*
	Opportunities to watch *Fair see-distance* *Free lines of visions* *Interessting views* *Illuminance day/night*	Opportunities to speak and listen *Low level of noise* *Conversation-friendly seating arrangements*	Opportunities to utilize and activities *Invite to physic activities, exercise, play and creativity* *Utilize day and night* *Utilize summer and winter*
AMENITY VALUE	Scale *Dimensioning buildings and spaces in a human scale related to sense, movments and behavior*	Opportunities to enjoy posivtive aspects of the climate *Sun/shadow* *Heat/cold* *Shelter/ brise*	Aesthetic qualities and positive sensations *Good design and details* *Beautiful views* *Good materials* *Vegitation, trees and water*

Fig. 4: 12 different qualities in the urban space.

Design parameters

The design should:

- be open and inviting as part of Hjørring's public spaces
- create a gradual transition and visual contact between outside and inside
- contain elements which makes it possible to walk, stand, sit, see, talk, hear and utilize space
- create opportunities to enjoy positive aspects of the climate

SUSTAINABILITY

The term sustainability has many meanings. This section defines sustainability in relation to this project.

If future generations are to experience quality of life, a sustainable approach towards use of the earth's natural resources is necessary. In Denmark, buildings are responsible for approximate 40 percent of the total CO2 emission, which makes architecture an important aspect of sustainable development.
Overall, sustainable architecture is about creating balance between human settlement and nature and hereby ensure future generations living conditions [web 4]. The time aspect of this statement is supported by the Brundtland Report which was published in 1987. The report defines sustainable development as:

> *The development that meets the needs of the present without compromising the ability of future generations to meet their own needs*
> *- Brundtland Report, 1987*

Furthermore, the report identifies three main aspects of sustainable development; Economical, environmental and social sustainability [web 5]. Thus, in a global scale, sustainable development includes economic growth, environmental protection and social equality. See figure 5.

Within an architectural scale, the aim of this project is to create a solution which is not only sustainable in terms of energy use but also in terms of human living. Sustainable aspects of this project are defined on the basis of the Brundland Report and sounds as follows:

Economic aspect
Creation of an energy optimized solution that reduce costs for future building operations.

Environmental aspect
Creation of a design which fulfils the energy frame of energy class 2020.

Social aspect
Creation of a physical environment that generates quality of life.

Indoor climate aspect
Approximately 90 percent of our life are spend indoor and therefore indoor climate is an important aspect of sustainable architecture [Brophy 2011].
This project strives to create a good thermal, visual, atmospheric and acoustic indoor climate which makes the building comfortable for people to live in. Goals in relation to the indoor climate are defined in the space programme on page 15.

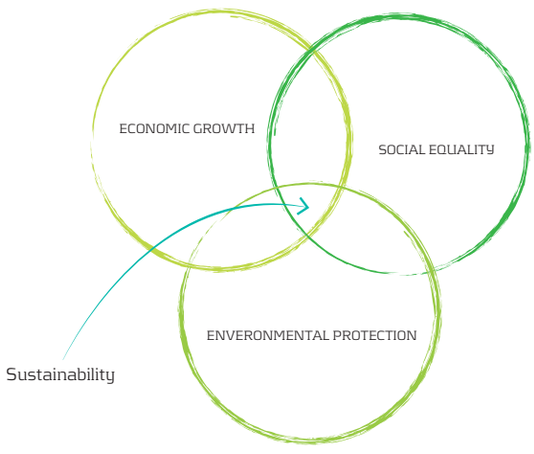


Fig 5: Three aspects of sustainable development identified in the Brundtland Report.

ENERGY STRATRGY

The following clarifies the energy challange and strategy of this project.

Energy challenge
This project strives to fulfil the energy frame of energy class 2020. To do this, the total demand for energy supply for heating, ventilation, cooling, domestic hot water and lighting pr. m² heated floor area should not exceed 25 kWh pr. year [web 6].

A theatre house sets high requirements to efficient heating and cooling in order to meet the audience demands for comfort and create good working conditions for the theatre staff. During a performance, stage equipments and lighting together with the large number of people generates excess heat. The excess heat is often wasted even though the building the rest of the time also need for heating [web 7].

Energy strategy
In order to fulfil the energy frame, an energy strategy is defined. The strategy is based on the method of the 'Kyoto Pyramid' as it highlights the importance of reducing the energy load before adding systems for energy supply.
The 'Kyoto Pyramid' is a strategy developed for the design of low energy buildings in Norway [Heiselberg 2007]. The design strategy is divided into three phases. See figure 6.

First step is to reduce the energy load by implementation of passive design solutions. In this relation, one needs to be aware of the microclimate which has a major impact of the final energy consumption of the building [Kjellerup 2011]. Also optimization of the building form is done at this stage.

The second step involves optimization of e.g. passive heating, passive cooling, daylighting and natural ventilation. Also at this stage, systems such as solar cells are to be applied [Heiselberg 2007].

If additional energy is needed, the least polluting fossil fuels should be used in an efficient way. The Theatre- and Experience House is to use district heating which is given an energy factor of 0,6 when calculating the total building energy consumption. For comparison electricity is given an energy factor of 1,8.
A theatre building is often in use in the evening and lighting is therefore an important aspect in relation to the energy consumption. In that connection LED lighting could be considered.

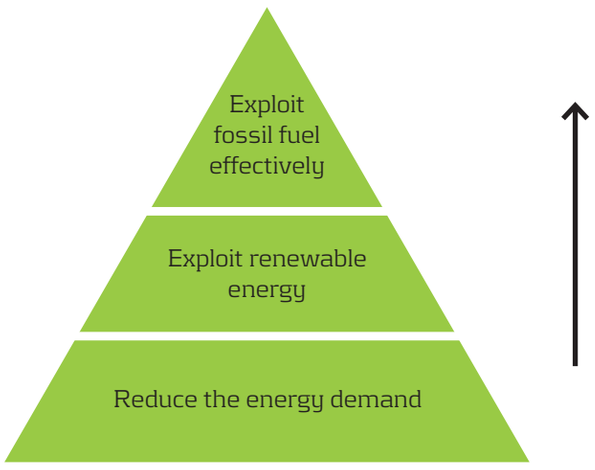
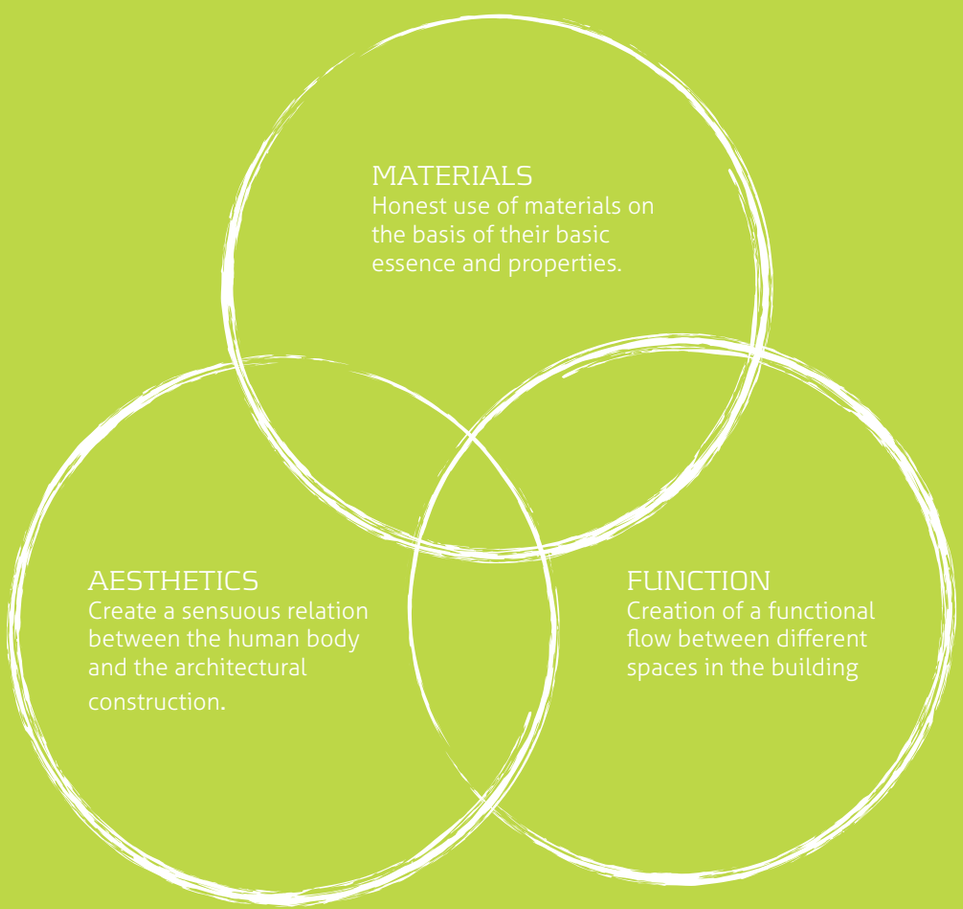


Fig. 6: Diagram showing the Kyoto Pyramid of how to minimize the energy demand for a building [Lehrskov 2011]


MATERIALS
Honest use of materials on the basis of their basic essence and properties.
AESTHETICS
Create a sensuous relation between the human body and the architectural construction.
FUNCTION
Creation of a functional flow between different spaces in the building

TECTONIC APPROACH

This section describes the term 'tectonic' and illuminates the tectonic approach within this project.

The term 'tectonic' is Greek in origin and is developed from the word 'tekton', indicating carpenter or builder. During time the term has evolved from this meaning to a more general notion referring to the making of buildings with an aesthetic idea. Or formulated by architect Kenneth Frampton; the art of constructing [Frampton 1995].
Within architecture Vitruvius was one of the first to interpret the term. He claims that architecture is created from a balanced relation between *firmitas* which refers to the field of materials, *utilitas* which covers the function of the building and *venustas* which includes aesthetic requirements [Kruft 1994: 24].

The following describes how this project employs all three fields of architecture defined by Vitruvius.

Materials
The aspect of materials is addressed by an honest use of materials on the basis of their basic essence and properties. In regards to sustainability, their properties in terms of heat capacity and patina are considered.

Function
A theatre requires functional connection between spaces. This project focuses on the creation of a functional flow between different spaces in the building.

Aesthetics
In his studies concerning the origins of construction, Gottfried Semper, focuses on the primitive conditions of architecture. He introduces four elements in which the primordial dwelling is divided: the *hearth*, the *roof*, the *enclosure* and the *mound* [Semper 1989].
In relation to the aesthetics of this project, his thoughts concerning the element of enclosure, is found interesting. Semper's historical studies bring him to believe that the most primitive technique used for enclosure is that of wickerwork. Even before the art of dressing the human body's nakedness is developed, he believes, that spinning, plaiting and waiving is used to furnish and define spatial enclosures [Semper 2004]. Later solid walls behind the light mat walls were more and more common. However, Semper claims that they are necessary for reasons that have nothing to do with the creation of space; they are needed for security and supporting of load. Semper finds our need for a soft wrapping of the body in the interior to be the essence of the wall [Semper 1989]. A wrapping that relates to the human senses.

On the basis of Semper's thoughts, the design is to create a sensuous relation between the human body and the architectural construction. Hereby the architecture becomes an experience in itself.

Design parameters

The design should:

- consider the basic essence and proporties of materials and their patina
- create a functional flow between different spaces in the building.
- create a sensuous relation between the human body and the architectural construction in order to be an experience in itself

USER

This section describes the different users of the theatre. In line with the competition brief the target group is the local youth and the non-organized.

The building has many different users who all contribute with life and energy. The users can be expressed by four overall groups:

1. Vendsyssel Theatre: the house becomes a workplace for actors; professionals, amateurs and upcoming talents, which together define Hjørring as a city of theatre. Organisation of the backstage area is therefore important. Also administrative and technical staff is part of the daily life at the theatre.

2. Theatre audience: People who buy a ticket to experience a performance. The audience represents a large number of people, which come to the house at specific times. In that connection flow and guidance of these users are important.

3. Music: today both rhythmical and classical platforms in Hjørring miss a permanent stage where they can practise their skills and talent [Hausenberg 2012].

4. Children and young people: the municipality wish for the house to be a meeting place for the younger generation after school [Hausenberg 2012].

Vendsyssel Theatre
The regional theatre 'Vendsyssel Teater' was founded in 1984 and employs 14 people. Vendsyssel Theatre has an ambition to reflect and be part of the local identity. The theatre produces about four screenplays during a year and has a large number of guest performances, evening events and educational facilities. Today, the theatre has a large and a small auditorium and backstage facilities.
Next to the theatre the 'Kulturhus' houses different types of creative schools such as music school, ballet and drama in which younger people can develop their talent [web 8].
Besides Vendsyssel Theatre the new design should embrace Hjørring citizens, especially the youth, and accommodate stages which are also to be used by creative schools in the area.

Design parameters

The design should:

- be a gathering place for the local youth and the non-organized, interested in music, theatre and culture


KULTUR
Samlede over

SERIAL VISION

The method, serial vision, by Gordon Cullen [Cullen 1996] is used as a phenomenological approach to illuminate the atmosphere at the site and the contrast between two streets near the site; Jernbanegade, 'the wild street' and Brinck Seidelens Gade, 'the nice street'.
The method fosters a registration of the visual experiences of the area, as it changes, while working through it according to specific routes. Thus, the area is sensed and experienced through our own bodies. Two different routes are followed which both can be seen on the map below. Pictures below are taken on the site, whereas pictures on the page to the right illustrate immediate perceptions and impressions along the two routes 'Jernbaegade' and 'Brinck Seidelins Gade and Metropol'.

Jernbanegade

1. View towards the train station seen from Springvandspladsen, the city centre.

2. View from Jernbanegade to the northern part of Mammutspladsen and the back of Brinck Seidelins Gade. Parkinglots dominate the area.

3. The old Court situated in the middle of the street and drawed back from the strict building path.

4. View towards the city centre from the old Court, where resturants dominate the urban landscape.

5. In this end of the street bars and discotheques, the night life of Hjørring, are dominant. In the background is the train station.

6. In the bottom of Jernbanegade is the train station and Banegårdspladsen. Here is the view towards east, youth center Zonen and Metropol. Heavy traffic.

Brinck Seidelins Gade and Metropol

1. Brinck Seidelins Gade seen from the bus station. A heavy wall divides the buildings and the parking area.

2. Buildings along 'the nice street' dated from the beginning of the 1900s. Detailed and ornamented.

3. Brinck Seidelins Gade seen from the northern part of the street.

4. Østergade which contains smaller shops with a broad range of items.

5. Between the shops, a hole opens up to the shopping centre Metropol which contains the public library.

6. Moving along Metropol, you end at Parallelvej and this is the view towards the site and train station.

VIEWS

The views show the site from different perspectives and capture the character of the place located in the centre of Hjørring.

The site seen from the south west corner, which gives a glimpse of the surrounding context of traffic and low rise building.

The site seen from above, which gives an interesting view of how the site is an extension to the dense-low building typology in the city centre.

MAPPING

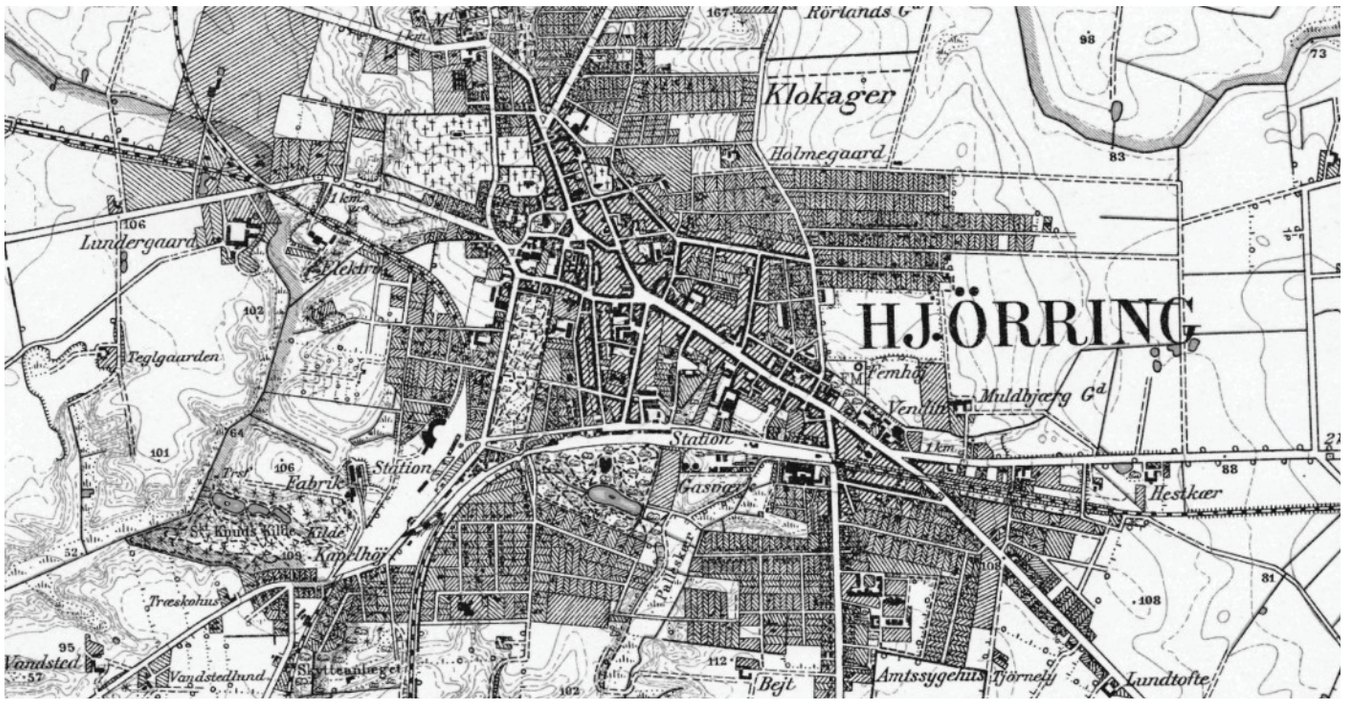
To understand the context in which the new Theatre- and Experience House are located analyzes of the historical development, microclimate, flow of people and functions are carried out.

Hjørring city

Hjørring is an old city from 1200s and has always been a gathering place for trade and entertainment in Vendsyssel. Historical traces characterize the city centre. From the Middle Ages three old churches are situated in a rather short radius with narrow streets and small squares in the near surroundings. Later, in the 1900s, the city was administrative head office of an 'amt'. In this period many large brick houses were built near the railway. Later the industry made its entry.

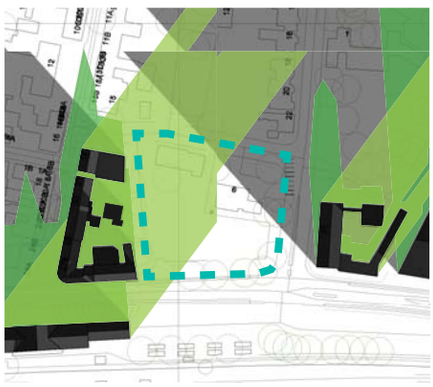
During the last few years, the industries have moved or closed and left large areas in the city centre empty. However, it gave an opportunity to 'refurnish' the city centre and create a coherent environment. Some of the larger institutions moved and gave space for larger areas for commercial, cultural and housing purpose.

During the last 20-30 years, the city has focused to brand them self as an educational and cultural city. Hjørring contains larger educational institutions as the seminar, healthcare school and a wide range of vocational education. Cultural facilities of the city imply Vendsyssel Teater, Vendelbohus and Vendsyssel Kunstmuseum. Hjørring Revyen was established in 1973 and still is one of the cultural events which Hjørring is known for in Denmark [Projektbeskrivelse 2010].



Sun path

Since there are no tall buildings in front of the plot to the south there are good opportunities to take advantage of solar radiation throughout the year. During summer the day length are 18 hours. Reverse is the wintertime with a day length of 6.5 hours [web 9].



Shadows

Shadows are studied in Revit. The illustrations show the movement of shadows on the plot during the day. To the left is the shortest day, 21st December, in the middle equinox 21st March and at last the longest day, 21st June.
The gray colour indicates shadows at 9.00 in the morning, the green at 12 o'clock and the lime green at 15 in the afternoon. Also, the June illustration contains shadows at 18 o'clock, since people stay out longer during the summer than winter.
As seen on the illustrations, shadows, only during winter, seem to have an influence on the possibility to take advantage of solar gain.

Flow

Primarily the access to the site is by bus, since the bus station today is located on the plot; both city and regional busses have their end here. From here, the passenger can walk to his destination. Each day many people come by the site on their way to work or school. With the many educational facilities and offices in central Hjørring, many people use the public transportation system and, in that connection, spend time waiting close to the site.

The new location of the bus station, just across the street and beside the train station, gives the best possible conditions to come to the theatre with public transportation [Rambøll 2012]. Arriving with the train from Frederikshavn to Hjørring, one will experience the building and, from that distance, the building and its function should be easy to perceive. There are many parking lots in the area, from which, it is possible to walk to the site. Most of these parking lots will be empty in the evening and could be used by guests of the theatre. However, it is a requirement that there must be eight parking spaces on the site to the staff at the theatre.

Heavy traffic runs close to the site on the south which will have an impact on the design of the building. Every day approximately 12000 cars drive by [Rambøll 2012].
The upcoming Theatre- and Experience House has a strong location near the city centre and public transportation system. In addition the site is located along the main traffic route trough the city and hereby is visible to many people every day.

0. The site **1.** Christiansgave, Park **2.** Vendsyssel Historic Museum **3.** Vendsyssel Theatre **4.** Music and Talent School **5.** Svanelund Restaurant **6.** New Elder Center, Svanelundsbakken **7.** Train station **8.** Future site of the bus station **9.** Sysseltinget, Music venue **10.** Springvandspladen , square **11.** P. Nørkjærs Plads, square **12.** Vendsyssel Artmuseum **13.** Amtmandstoften **14.** Metropol Shopping Centre and Library **15.** Shopping area

Green area Recreational area Culture institution

Functions

Towards north, we find the centre of the city with pedestrian zones as Strømgade and Østergade. Each zone has smaller shops with different items as cheese, wine and books. Behind the pedestrian zones, you find the art museum near P.Nørkjærs Plads.
To the east, educational and commercial areas are dominant. The city has educations as seminar, gymnasiums STX, HHX and HTX, technical college and many others. In this part of the city, you also find several leisure activities like badminton, football and swimming facilities. Nearby you find the new shopping centre Metropol that also contains the library of the city and SKAT Offices.
Towards south are some of the largest green areas of Hjørring, Svanelunden and Folkeparken, where public activities as Midsummer Day and outdoor concerts take place. Between the site and the green area is the railway, which contains two different connections. One of the connections is a state railway, from Frederikshavn and towards Aalborg and the rest of Denmark. The other is a direct link to Hirtshals in a closed railway.
To the west, you find Jernbanegade which is a street with restaurants, bars and discotheques, 'The Wild Street'. Here you also find the only Hotel in the centre of the city. Further west is the park Christiansgave, the cinema and the court.

Design parameters

The design should:

- be part of and support the connection between the public transport and the city centre
- Utilize its visible location to attract people.

FOCUS POINTS

This section picks up on the focus points of this project. The illustration below shows the eight most important aspects of this project and their priority in relation to each other.

As shown in the figure, sustainability, indoor climate and experience are the most important aspects of this project.
The aim is to create a solution which is not only sustainable in terms of energy use but also in terms of human living. In that connection, indoor climate is prioritized highly. The conviction is that it is of no use to design a low-energy building if the indoor climate is poor. The task is to create a good thermal, atmospheric, acoustic and visual indoor climate and at the same time fulfil the energy frame of energy class 2020. A good indoor climate and the generation of social activities and experiences are to bring quality to life.

The user and urban connection are weighted equally. The design is to create a functional flow between different spaces inside the building. Also the house is to be more than a theatre, it is to be a public space for Hjørring citizens to socialize and experience. There should be a dialog between the house and its context.

The design of the theatre stages are weighted lower than the design of connection between theatre and city.

In this project tectonics is a way to create a balanced relation between materials, function and aesthetics.

The design is to brand Hjørring as a culture- and experience centre and hereby bring life to the city.

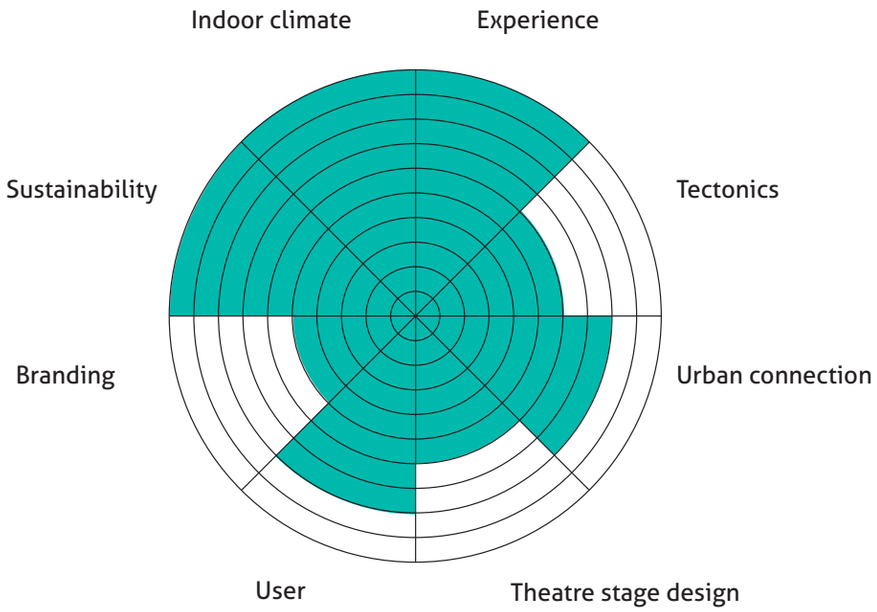


Fig. 7: Focus diagram

PROBLEM STATEMENT

This project explores the following problem:

> *How to design a sustainable Theatre- and Experience House that accommodate unique and intimate theatre spaces as well as public spaces that fosters social and cultural life in the centre of Hjørring?*

VISION

The project vision is developed on the basis of the competition brief and studies in the programme.

The vision is to create a unique Theatre- and Experience House that generates cultural life, experiences and social activity in the centre of Hjørring and hereby, in a larger perspective, supports a positive development of the city.
The theatre will be known for its experimental and spectacular theatre experiences and, in the local area, as a vibrant meeting space. The architecture relates to the human body and hereby, in itself, provides spatial and sensuous experiences.

The house is part of and supports the connection between public transport and the city centre and hereby becomes a natural part of Hjørring's public spaces. Activities inside and around the house relates to each other and invites people into the house. The house will be a gathering place for the local youth and the non-organized, interested in music, theatre and culture.
The design will set an example of how to develop sustainable spaces in which cultural life can evolve. The house will bring people together in an experience environment.


20G
STICKY

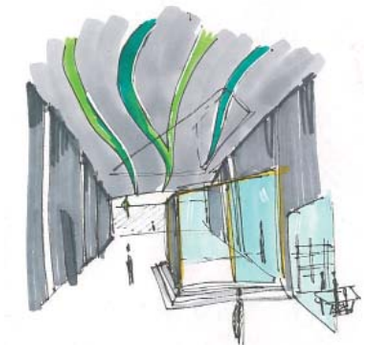
CONCEPT DEVELOPMENT

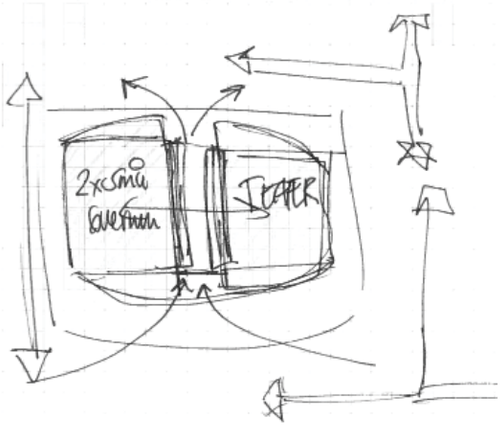
The design develops as sketching loops in which different knowledge are brought into the design. This chapter illuminates three loops of the sketching process and how they lead to the design solution. Each loop ends with a selection where the ideas are evaluated in relation to the vision of the project and design parameters.

CONCEPT LOOP I

INITIAL SKETCHING

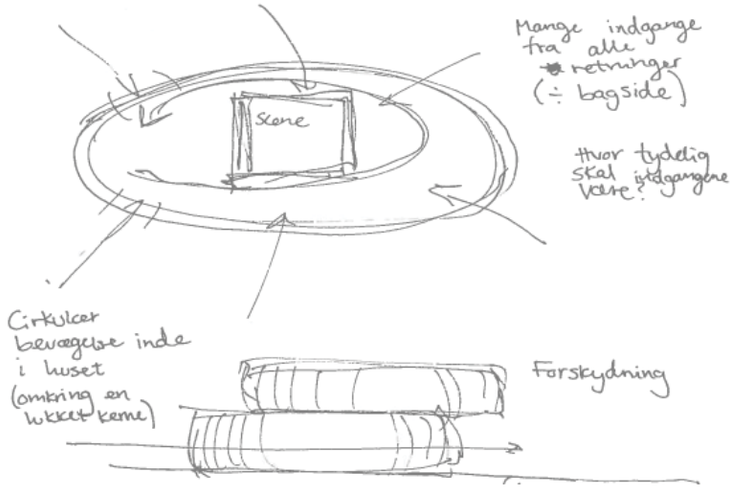
The first sketches started already during the programme phase. Sketching was done parallel to the analyzing and often was a tool to understand and transfer knowledge achieved to spatial ideas and concepts. From these sketches discussions about the project took place. At this stage, sketches individually represent different aspects of the design. In the following, sketches in relation to the creation of a connection to the city, connection between different levels of privacy as well as theatre design are illustrated.

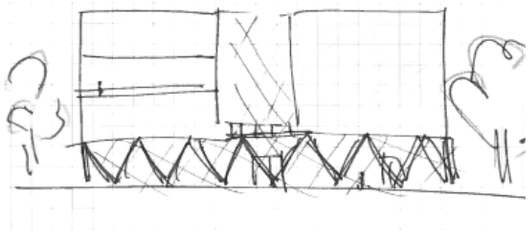




Connection to the city

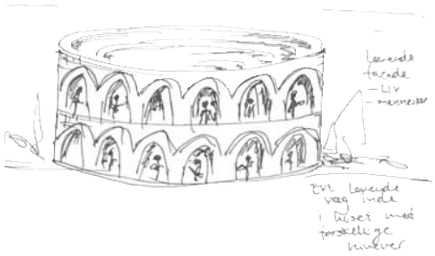
- Walkthrough
- Entrance from more directions
- No backside
- The large stage as the core of the building (in the centre)
- Open and inviting

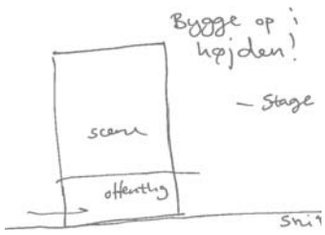


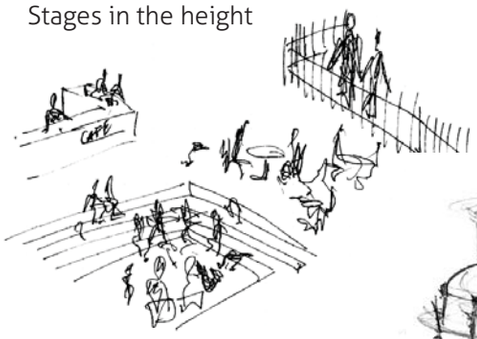


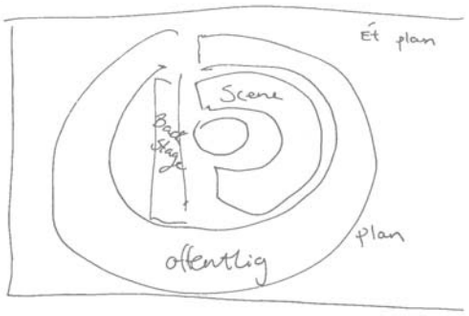
Connection between different levels of privacy

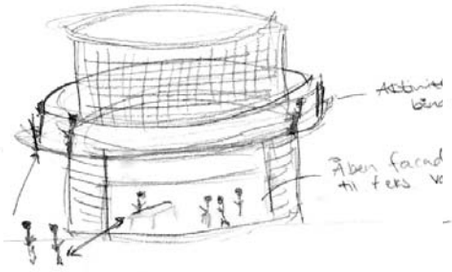
- Life in the facade
- Visual contact between different floors
- Inviting public area on the ground floor
- Stages in the height

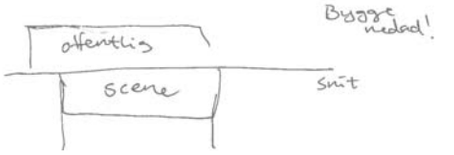






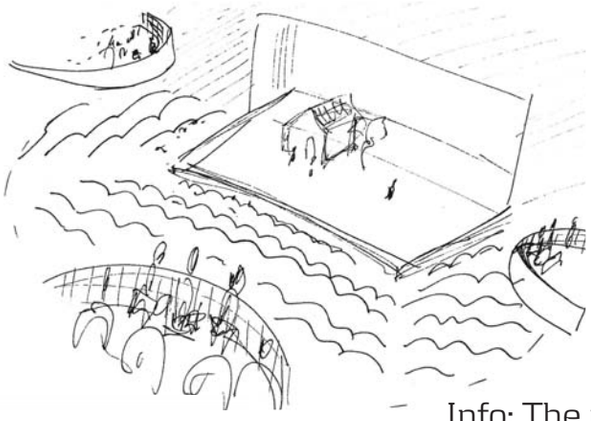


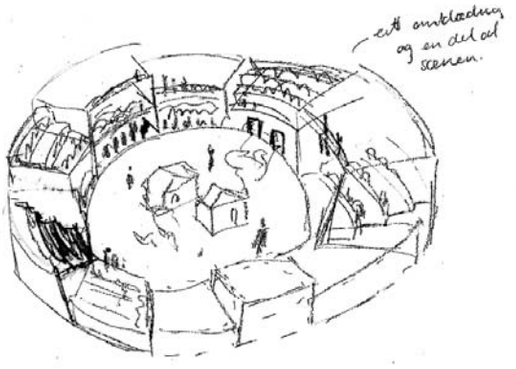


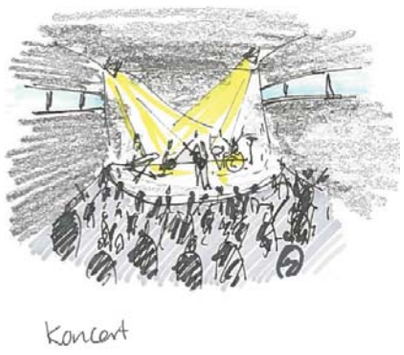


Theatre

- The main attraction of the house
- Different experiences







Info: The municipality

During the programme phase a meeting with the municipality clarified their wishes to the design. Talking with the client gave insight to the development of the competition brief and the thoughts behind. The meeting resulted in the following keywords in relation to the wishes to the house.

Keywords:

- Gathering place
- Inviting
- Living house
- Connect to the city life
- Draw attention like Utzon centre in Aalborg
- Landmark
- Maybe a connection to a water stream from 'Strømgade'
- Maybe include the Mammut parking space in the design

INSPIRATION: STUDY TRIP

A study trip to Copenhagen gave inspiration in relation to theatre design as well as the outdoor area. The following describes impressions achieved in regards to respectively 'Skuespilhuset', 'Superkilen' and 'Kvarterhuset'.

Skuespilhuset
A guided tour behind the scenes of 'Skuespilhuset' gave knowledge about the house and flow between backstage functions.
Also the use of materials, mainly brick, was interesting. The architects, Lundgaard & Tranberg, use the same brick inside and outside, which gives the building a coherent expression. Inside the large theatre stage displacement of the bricks are also used to create a good acoustical environment. The transparent foyer towards the seaside creates connection between inside and outside and gives the experience of being outside when sitting in the café.

COWI has developed an energy concept for the 'Skuespilhus' where so called thermo active constructions with pipes embedded in the concrete store energy and function as both heating and cooling system in an integrated system.
In winter, the excess heat from light and people is stored in the auditorium in the thermo active constructions and is released the next day. The heat in the ventilated air is transferred to liquid in the floor heating pipe system via a heat pump and used for heating of the administration, wardrobe and meeting areas on the third floor [web 10].
Because of the position of the house, close to water, seawater is used to cool down the system in the summer.
It is expected that the concept overall can save the 'Skuespilhus' for approximatly 40 percent of the energy consumption for heating, cooling and hot water [web 11].
The concept of utilizing excess heat from the theatre stages for heating of other rooms could be implemented in the design of the theatre house in Hjørring.

Superkilen
As a guideline, the pavement of pinkish rubber cuts through the area and leads you to your destination. Movement through the area becomes an experience because of different levels and activity objects in the area. The different activities are linked by the coherent coating. The space invites the neighbourhood to be part of the urban landscape.

Kvarterhuset
The facade of 'Kvarterhuset', located in Amager, contains smaller spaces where the guests can enjoy a cup of coffee or read a book. Hereby a transition zone between inside and outside is created. The spaces are placed on the edge between inside and outside and provide a living facade.

Ill. 'Skuespilhuset'. Left: the foyer with view towards the water. Right: The main material in the building; special made brick.

Ill. 'Superkilen'. Left: Different interior within the urban landscape. Right: Shared space between skaters, bicycles and pedestrians.

Ill. 'Kvarterhuset'. Left: The entrance and niches in the facade. Right: The auditorium.

ENERGY CONSIDERATIONS

Mixed used house

Different rooms in the house have different criteria in relation to e.g. light, privacy and ventilation because of their very different use. Below, criteria in relation to the café, In-the-round and Workshops are specified.

Cafe

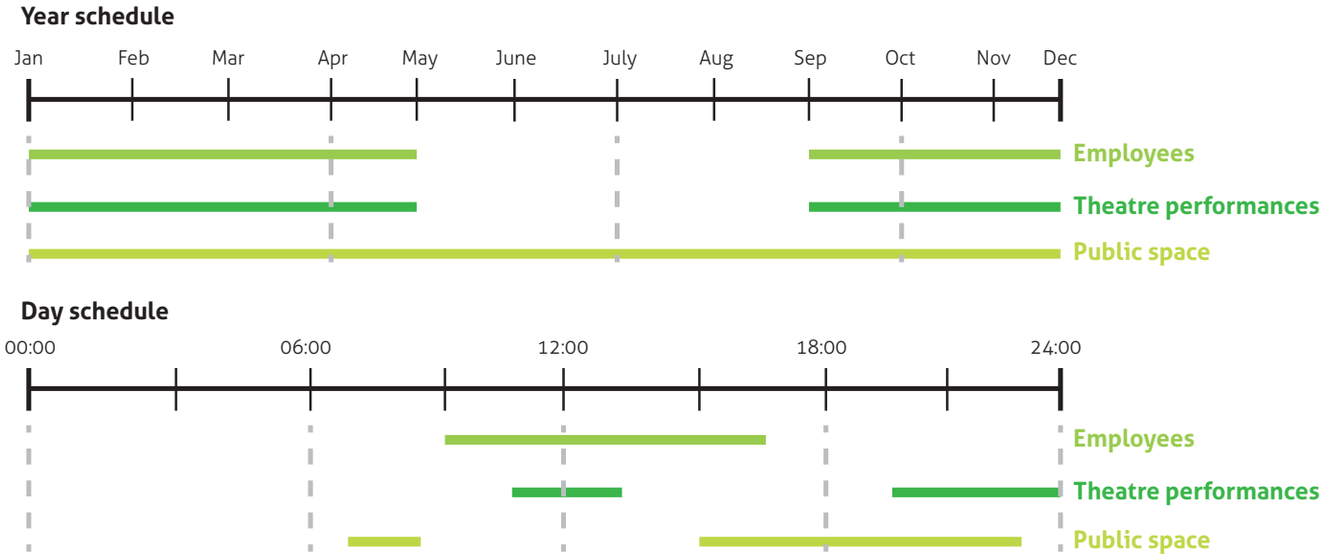
- Changing internal load. Most activity around eating time.
- Possibility for natural daylight (2 %)
- Transparency - possibility for view between inside and outside
- Possibility for solar heating
- Hybrid ventilation
- Public

In-the-round

- Large change in relation to the internal load. During shows there is around 250-350 people in the room
- Only artificial lighting
- No transparency
- Avoid solar heating
- Mechanical ventilation
- Semi-public

Workshops

- High activity level
- Possibility for natural daylight (2 %)
- Transparency - possibility for view between inside and outside
- Possibility for solar heating
- Hybrid ventilation
- Private

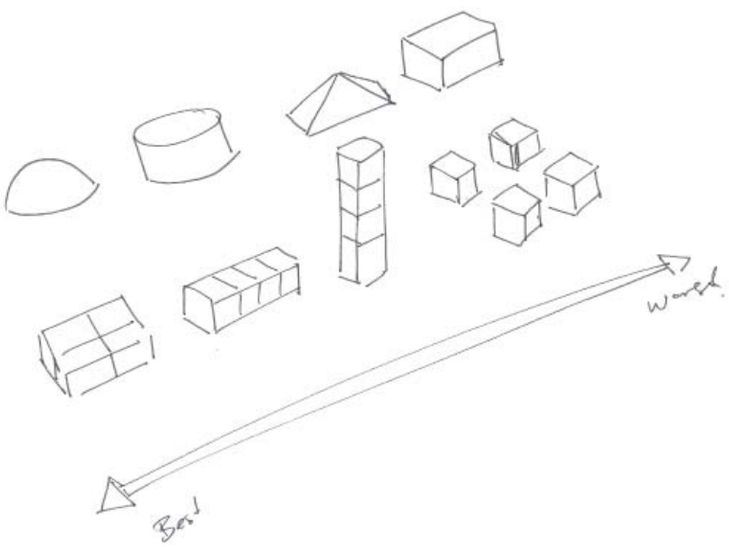


Use of the building during a year and a day

During a year the theatre stages are mainly in use from September to May, whereas the public area should be in use all year around.
During a day the theatre stages are primarily in use in the evening, when it is dark outside. Young people in the area will mainly be able to use the public space after school in the afternoon. Employees at the theatre use the building within normal working hours from approximately 08:00-16:00. Energy wise, this could be utilized. For example, waste heat from theatre stages, when large internal heat gain, could be beneficial for other rooms such as the foyer.

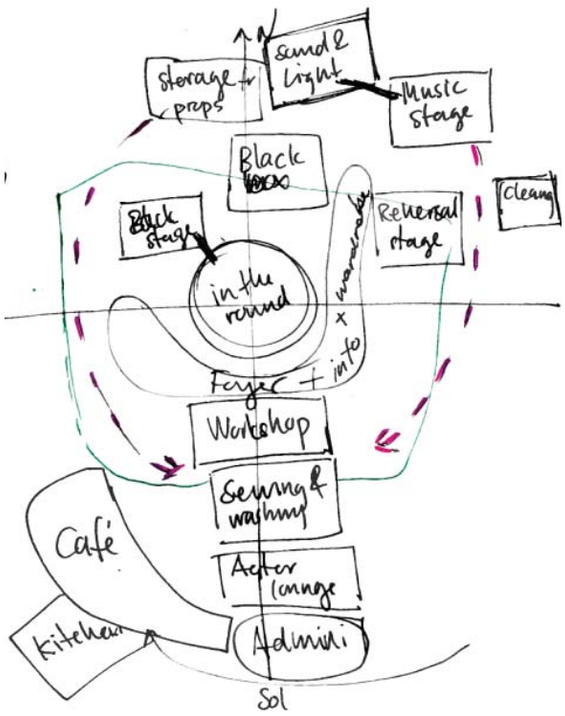
Building form

The building form impacts on the total energy consumption of the building. The more compact the building is, the less surface to the outside. However, to deep rooms will reduce the amount of daylight that comes into the building which requires more use of electrical light.



Microclimate

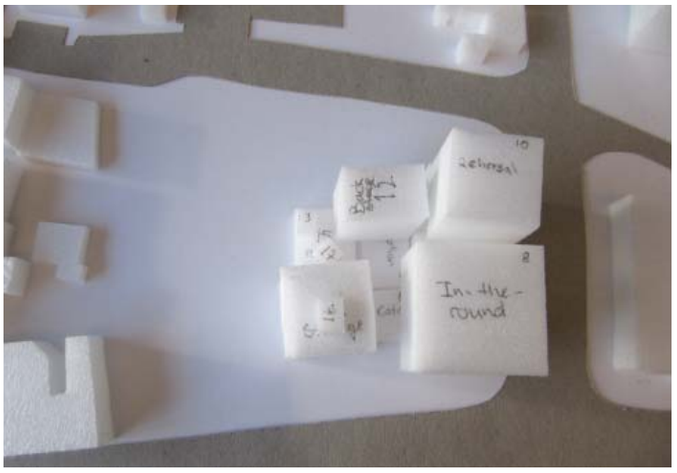
In terms of the microclimate, an evaluation of the placement of different rooms in relation to solar heating has been made.
The café has been placed to the southwest in order to be able to utilize solar heating in the afternoon when the cafe is estimated to be most in use. Towards south, working areas such as the administration, actor lounge and sewing and washing are placed in order to be able to utilize solar heating. All the stages and backstage areas are placed towards north in order to avoid solar heating.



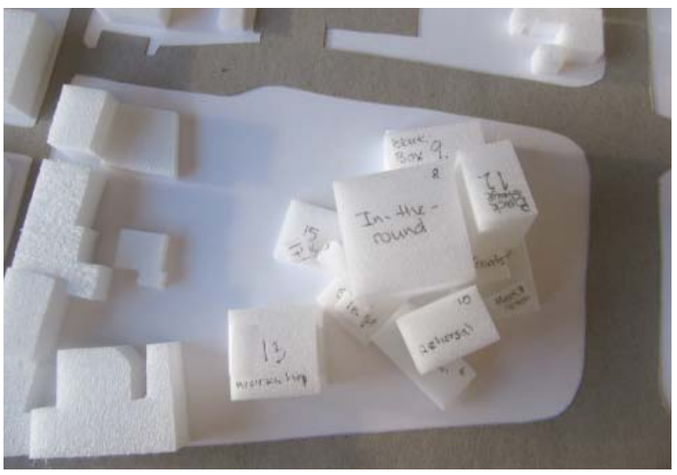
VOLUME STUDY

A volume study explores the placement of different rooms in relation to each other and, in an urban scale, how the building could be placed on the site. The study gave an understanding of the size of the different rooms in relation to each other and the size of the house on the site.

In relation to the placement of different rooms, aspects such as daylight and internal flow of people are discussed. In relation to the placement of the building on the site aspects such as visibility, size, sunlight, flow of people and shadows are discussed. The following illustrates different volume configurations.

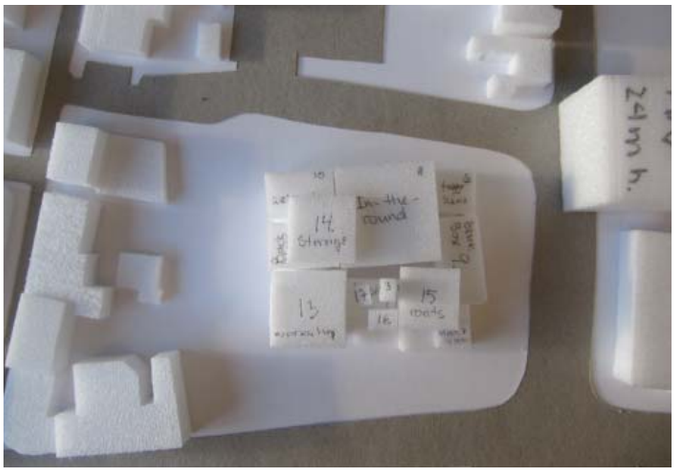


Placement of the building towards east. By placing the larger volumes in the corner, the building is visible from a far distance.



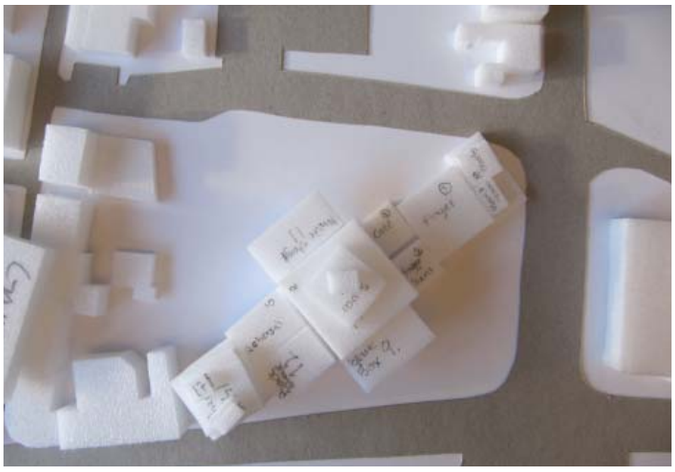
In-the-round placed in the centre of the building as the core of the house and source for heat recovery.

Walkthrough underneath the large theatre stage, In-the-round, and only one backside towards west. Working areas such as administration, sewing and washing and kitchen located to the east or west for good daylight conditions and to benefit from solar gain in respectively the morning and the afternoon.

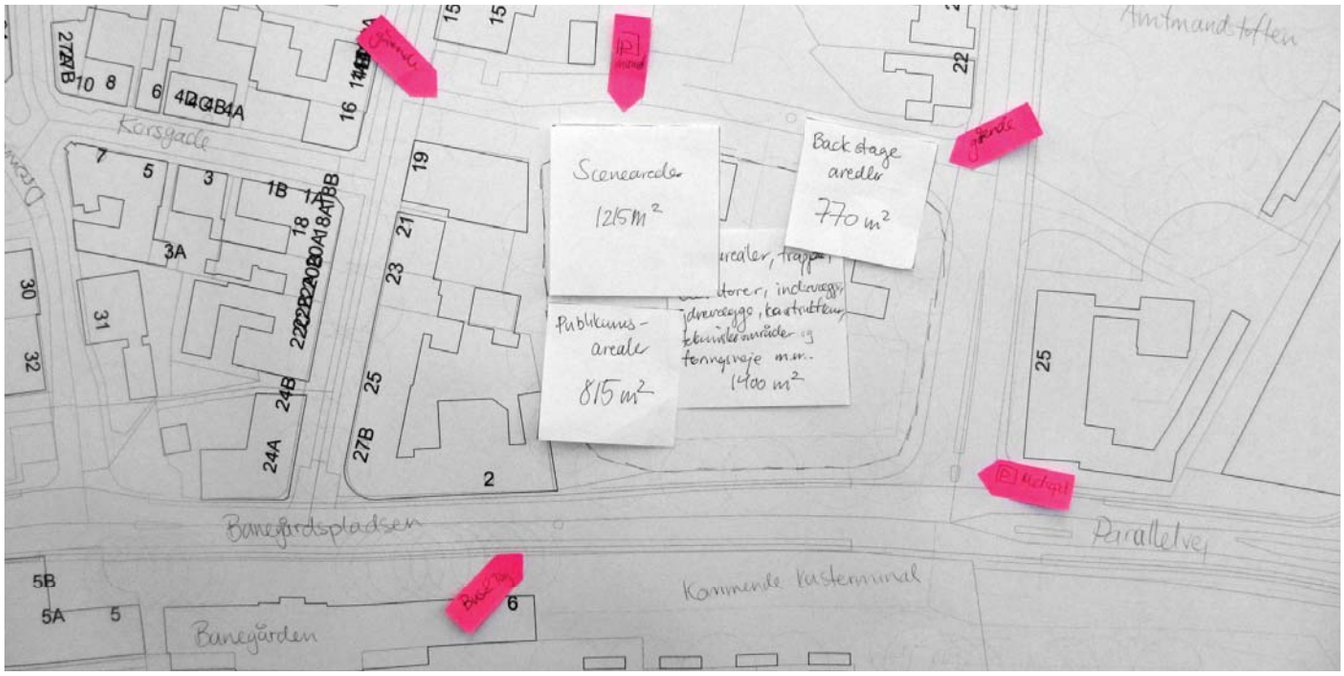


Creation of space between two building volumes. An urban street is created. Division of public and private areas.

The building divides the urban space and rooms inside the building become more private towards west.



URBAN SPACE



Flow of people near the site

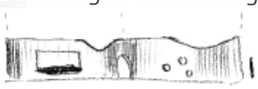
The building should invite people to use the house as part of their everyday life, a place where they can grab a cup of coffee on their way to work or a gathering place after school. People come to the site from many directions. In that connection, it could be an idea to make the building open and inviting from more directions at ground floor and hereby avoid a backside of the building. However, this openness could blur the direction of the house and people who do not know the house could find it difficult to read where to go into the building.

From the train station and future bus station, the site is visible and the design could be a link between the public transport and the city centre. Thus, the flow of people should be from the bus station, through the house and further up at 'Mammutpladsen' which will lead you to the city centre.

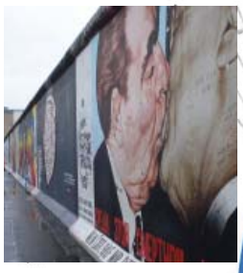
Involvement of 'Mammutpladsen'

The whole 'Mammutplads', which today is a parking area, could be part of the urban design and support the creation of a connection between public transport and city centre. The drawing on the page to the right with reference pictures and keywords illustrates thoughts about 'Mammutpladsen' as part of the urban design. The main idea is to remove the exiting parking lots and create two walls along the back yards which create possibility for different activities and green areas for stay.

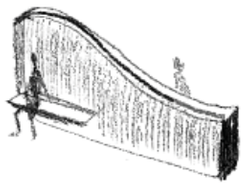
Possibility to look through the wall



Art on the wall



The wall as a bench



SELECTION - LOOP I

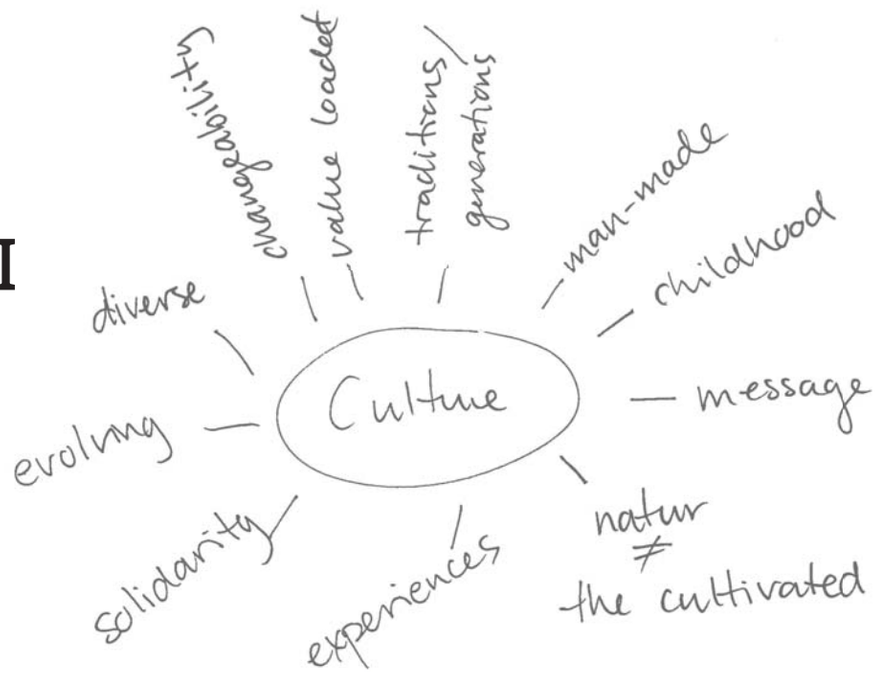
The meeting with the municipality illuminated that the 'Mammut' parking space could be included in the design. Therefore sketches in relation to the urban design within this loop focus on the 'Mammutplads' and how it could be a link between the Theatre House and the city centre. Sketching in relation to the urban space is in line with the design parameter of creating space that contains elements, which makes it possible to walk, stand, sit, see, talk, hear and utilize space. The 'Mammutplads' could support the creation of a connection between the building and the city centre. The design parameter, that the design should be part of and support the connection between the public transport and the city centre, is explored further in the later sketching process.

The study trip illuminated the possibility to use brick as an acoustical element inside the large theatre stage as well as the opportunity to use heat recovery as a strategy to utilize heat from the theatre stages to other rooms. Also the idea of a coherent coating as a way to link different activities is an aspect which is taken further in later sketching loop. The idea of reflecting activities inside the house on the outside could be addressed with the creation of a transparant and living facade which is explored in the next sketching loop.
The next sketching loop address the fact that the theatre functions mainly are in use in the evening and light from inside the house therefore could be an indicator of life and activity and hereby an element in the design.
In terms of energy, the compactness of the building form is an aspect which is taken further into the sketching process. Considerations in terms of solar gain are included in the placement of rooms in different plan solutions.

CONCEPT LOOP II

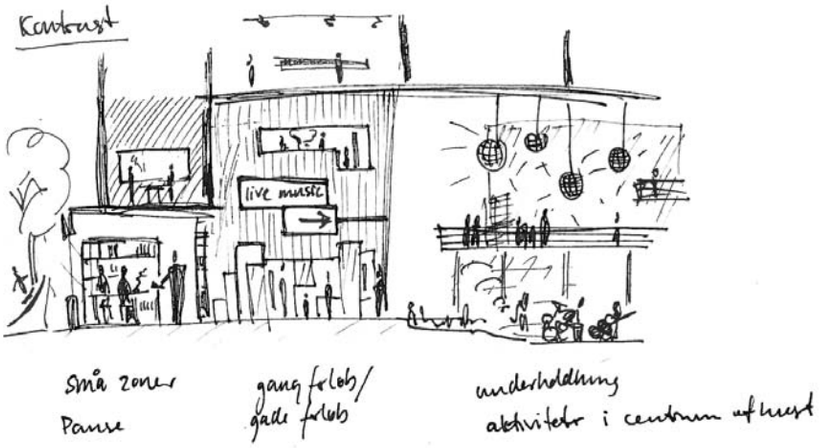
BRAINSTORM

To generate conceptual ideas a brainstorm on different notions in relation to the future theatre, defined in the programme, was performed. The following is a mapping of the idea development.




Source
Librent element
activities along the Source
levels/ terrain
waterfall
water = life/growth
life on the road
the sound of running water
source/origin
watersteam
movement
energy
human
in the movement
Creativity
no strings attached
innovation
create "something"
fantasy/ imagination
problem solutions
inspiring
Society Characterized
Surprising
Theatre
actors
acting
audience
"live"/ here and now
scenery
a story to tell
discussion
Business/ work
entertain- ment
Vendsyssel
small communities
Niels Hausgaard
"down on earth"
humor/mood
agriculture
windy
robust
water/land
country/nature
contrast

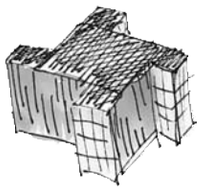
Words from the brainstorm were grouped in keywords and four overall concepts which each express values and qualities to the design. The following describes the four concepts in words, reference pictures and sketches.

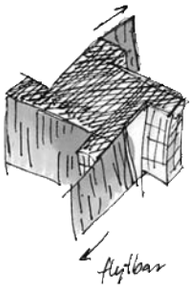


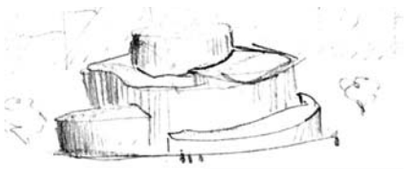
Contrast house
A house of contrasts. Normally a theatre is very closed and private. This project is to bring the public to the theatre and make it accessible. The contrast between openness and large closed volumes is explored.

Culture source, water
A dynamic facade that expresses energy inside the building on the outside. Energy inside are generated by the different activities. A water stream going from the city centre, through 'Mammutpladsen' and ends at the site and becomes part of the building design could support the link between the city centre and the site. Along the water source different cultural activities could be placed so that the water element becomes a source of culture within the city.

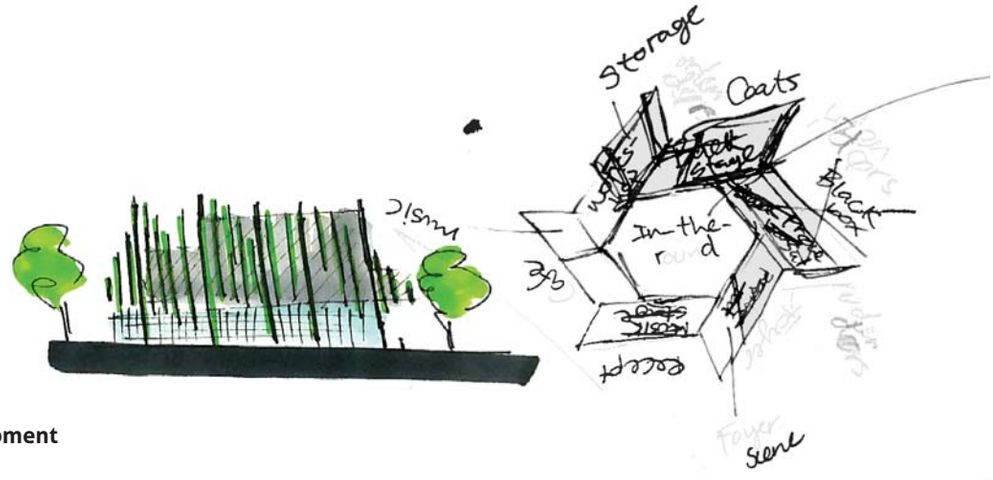
Chinese Box
Create view through the building so that the activities inside are visible from the outside and hereby attract people. Different levels of openness and privacy can be created by different transparency of materials. Also repetition of the same shape outwards can create different layers which graduate the transition between inside and outside.







North
Inspiration for the external shape takes its point of departure from the northern identity. Notions as the Northern Star, Northern Light and Northern arrow were explored. Connecting the house to the northern identity could create a link between the house and the local area, Vendsyssel, and hereby be a landmark for Hjørring.

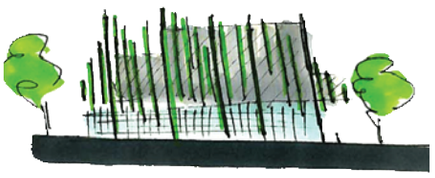


CONCEPTUAL IDEA

Relative to the vision of the project, the four concepts were merged to one conceptual idea. The following illustrates the essence of the concept idea.

Sensuous and experiential qualities:

- Variability
- Living the moment - timelessness
- Energy, movement, activity and experience
- Changing colour tones
- Light curtains
- Changing transparency
- Dialogue between inside and outside
- Northern identity

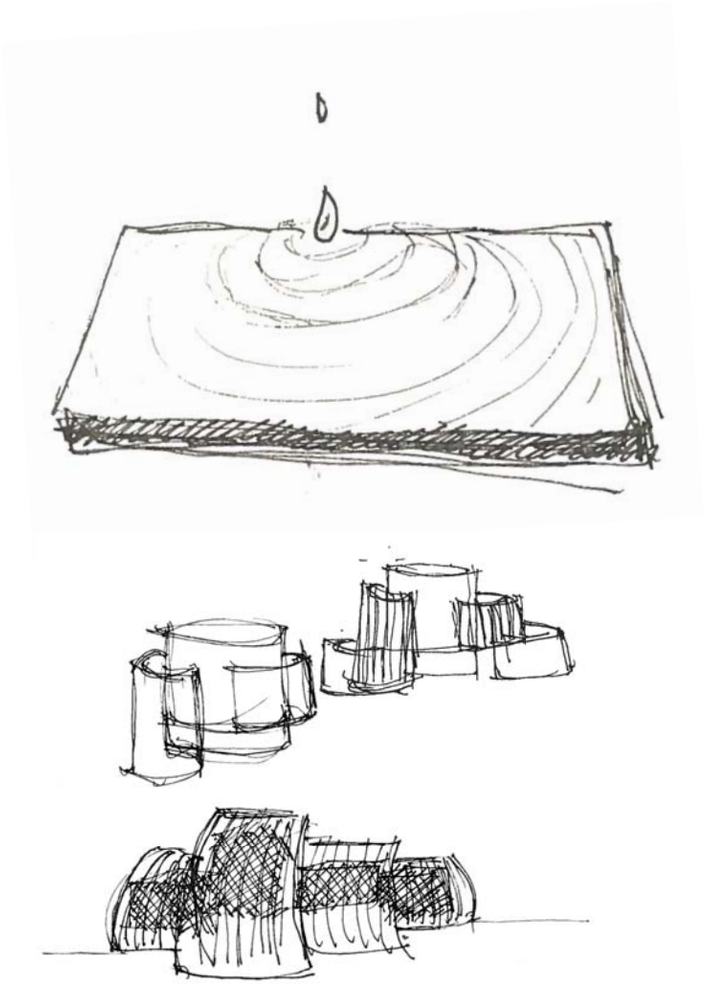


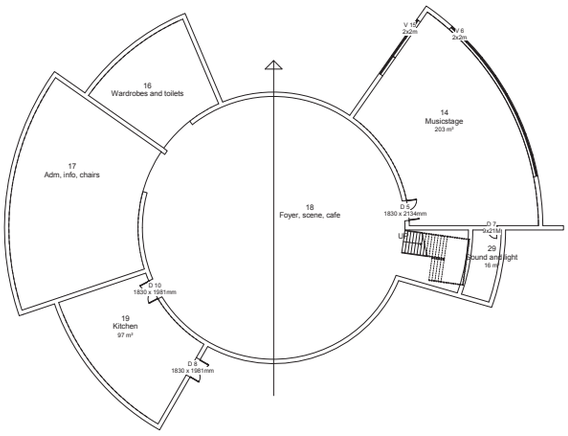
SHAPE: CIRCLE

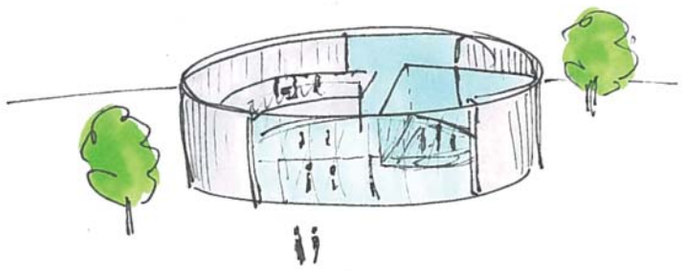
From the conceptual idea two different shapes were developed; the circle and the box. The circle design is described in the following.

Keywords

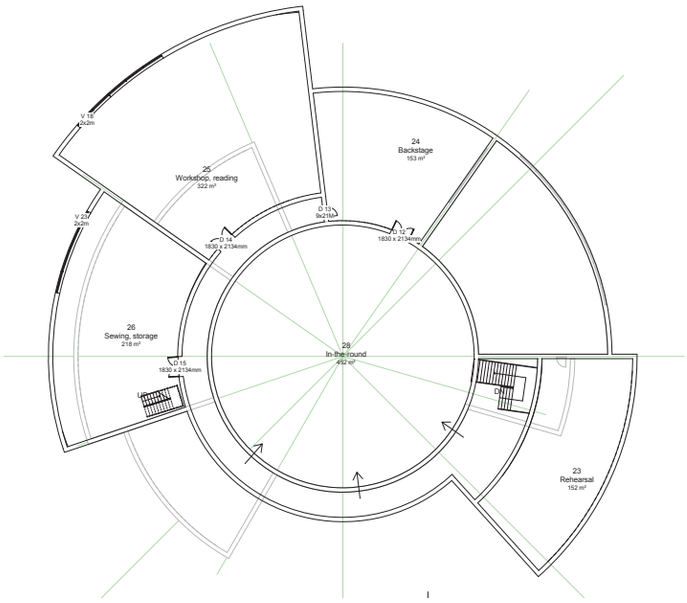
- Energy optimized shape (circle)
- In-the-round as the core of the building, massive – more transparent structures around
- Transparency. Possibility to sense activity in the building on the outside, dialog between inside and outside
- Variation in the facade to meet the human scale and relate to the low-building in the area
- The experience of the building will change over the day
- Walkthrough, connection between city and public transportation
- In-the-round shape can be sensed in the whole building



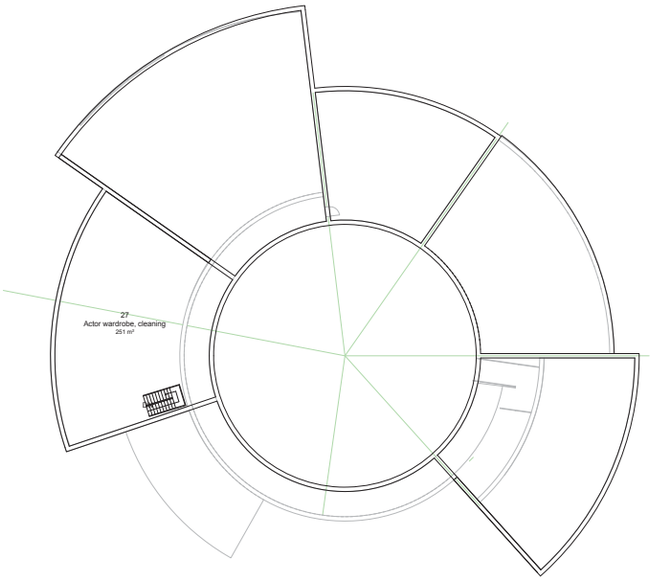




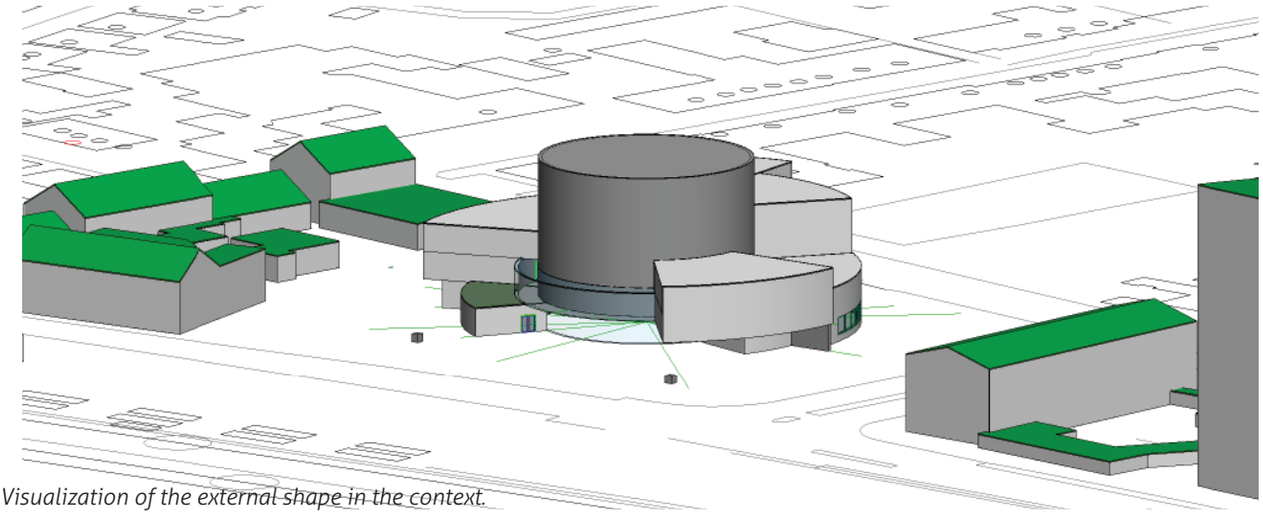
Ill. Ground floor 1:400: South- north axis through the building. Large public foyer at ground floor.



Ill. 1st. floor 1:400: The movement of people going into the large theatre stage becomes part of the facade.



Ill. 2nd. floor 1:400



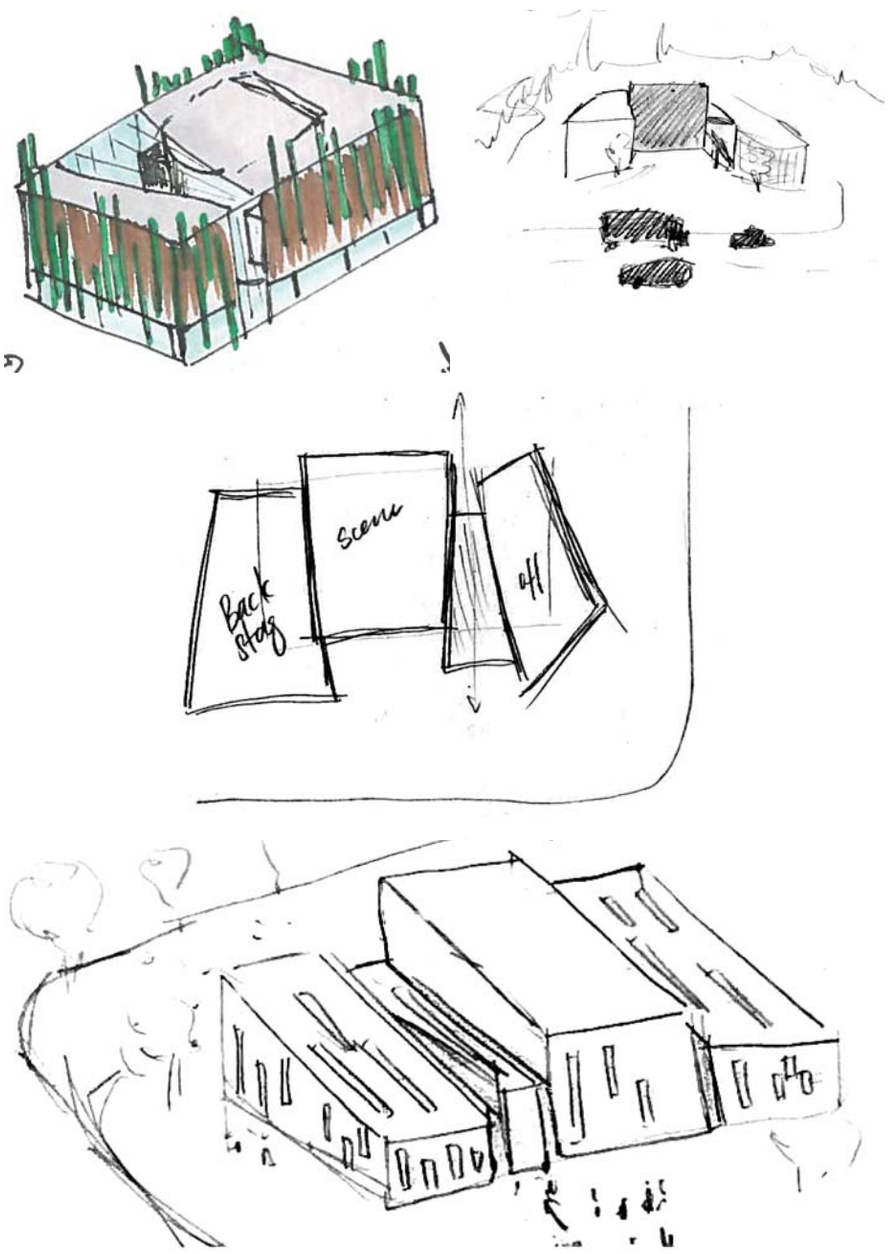
Ill. Visualization of the external shape in the context.

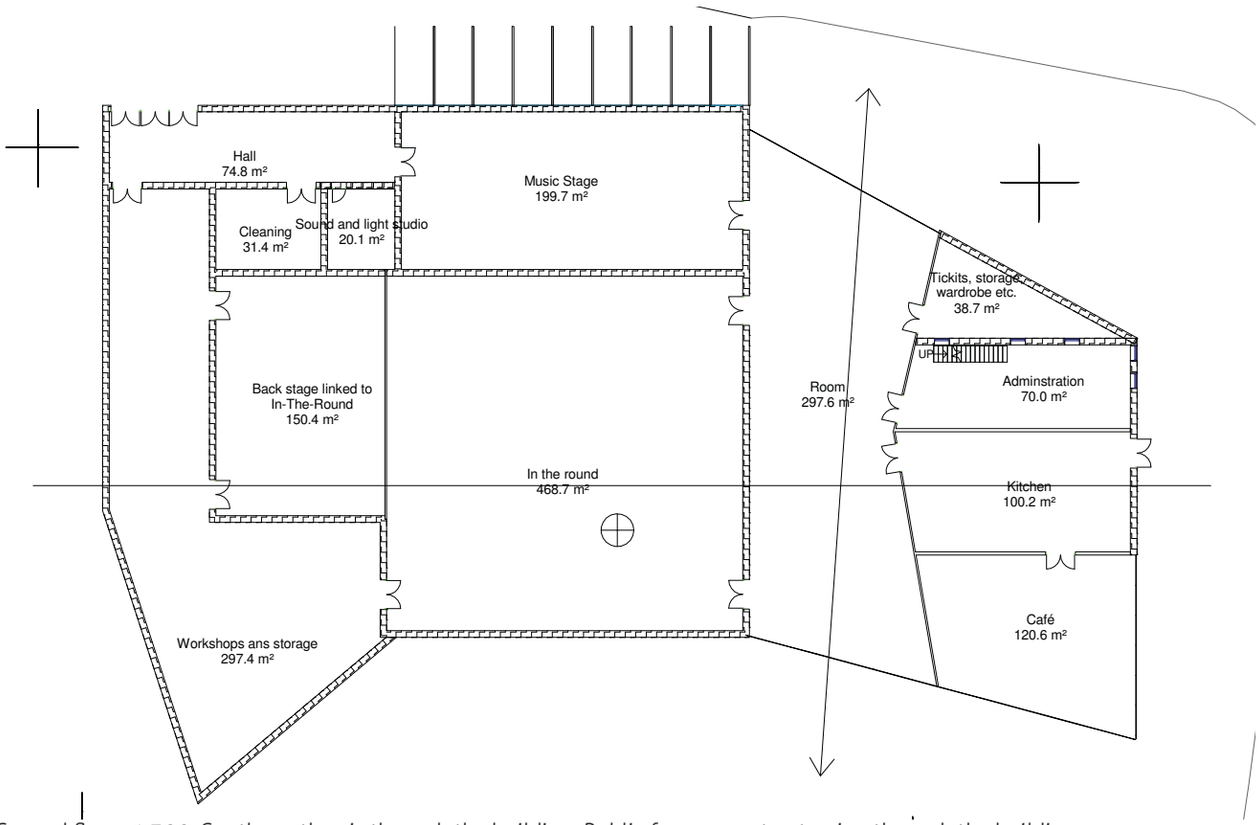
SHAPE: BOX

The box design is described in the following.

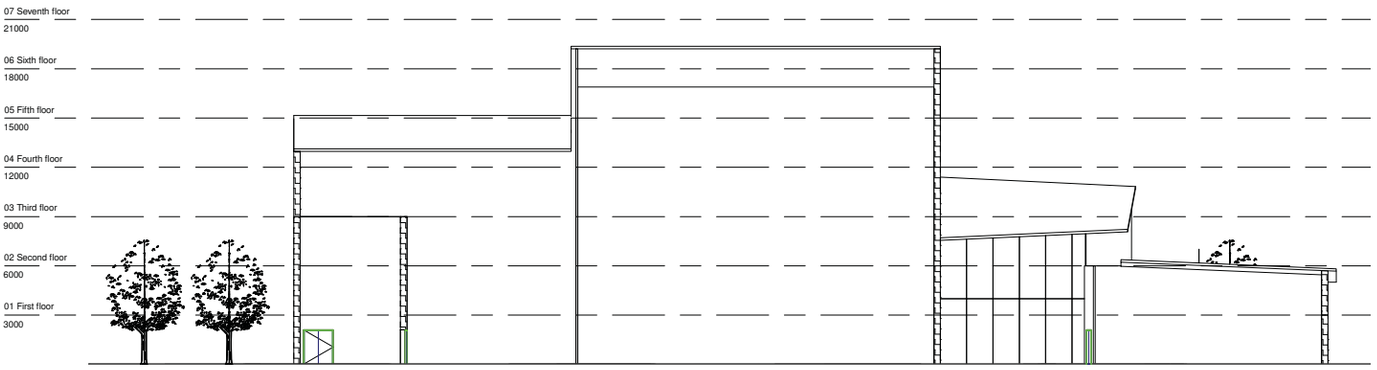
Keywords

- Human scale towards north versus the high level of traffic on the southern side
- Make it obvious where to walk through the building
- Arrange the functions according to the needs of sunlight
- Open up with transparency in the building e.g. the workshops, so that the public have a feeling that something is going on behind the walls
- The theatre core is the most important element in the building and is centrally placed, so it is easy to access for the guests and the staff behind the scenes.
- None of the building masses are elevated from the ground





Ill. Ground floor_1:300: South-north axis through the building. Public foyer as a street going through the building.



Ill. Section_1:300: East-West

Ill. Visualization of the external shape in the context.

FEEDBACK

At this stage of the design development, a second meeting with the municipality together with a midway critique at the university gave some feedback to the design. The feedback is listed below:

- The circular shape becomes very controlling in relation to the design. Something special is expected in the centre of the circle.
- The height of the building could be enhanced, so that the building would be a light tower, an icon, within the city. This way there will be a larger public outdoor area.
- Open up to as many functions as possible e.g. the workshops to create a building that gives life to the city.
- Locate some of the functions such as storage and techniques under ground level.
- Could the light element be used as an element of experience? Utilize the contrast between darkness and light.
- Could the facade change according to activity inside the building?
- Use of materials could link the house to the area.
- Could the café maybe be located on the roof of the building to be an attraction in it self? Hereby, the café brands the building.
- How should the large theatre stage, In-the-round, be experienced?

On the basis of the feedback, sketching in relation to the large stage, In-the-round, were carried out. See the page on the right. The discussion is how the round shape of the stage should be perceived from outside. Should it be visible from a distance or should the round shape be something that people first experience when entering the stage?
The 'funnel' shape occurred from an idea of reflecting the diagonal shape from the seats inside the stage on the outside. Also the sketches discuss how it should feel to go under and around In-the-round? An idea of having a large round shape, which it should be possible for people to perceive from more directions and be able to move around, occurred. The round shape as a contrast to the other square building volumes.

Also it was discussed if the café should be placed on the roof to be an attraction in it self and hereby attract life to the building. Placing the café on the roof it could be a possibility to have people going along the facade up to the café. However, due to the height of the building, it would be a long way for people to go to come to the café which contrary the goal of accessibility of the house. In the following pros and cons in relation to the placement of the café are listed.

Pros and cons

Café on the roof

Pros
- Vertical flow through the building
- Public attraction in Hjørring
- Unique views from the café
- Good sun conditions

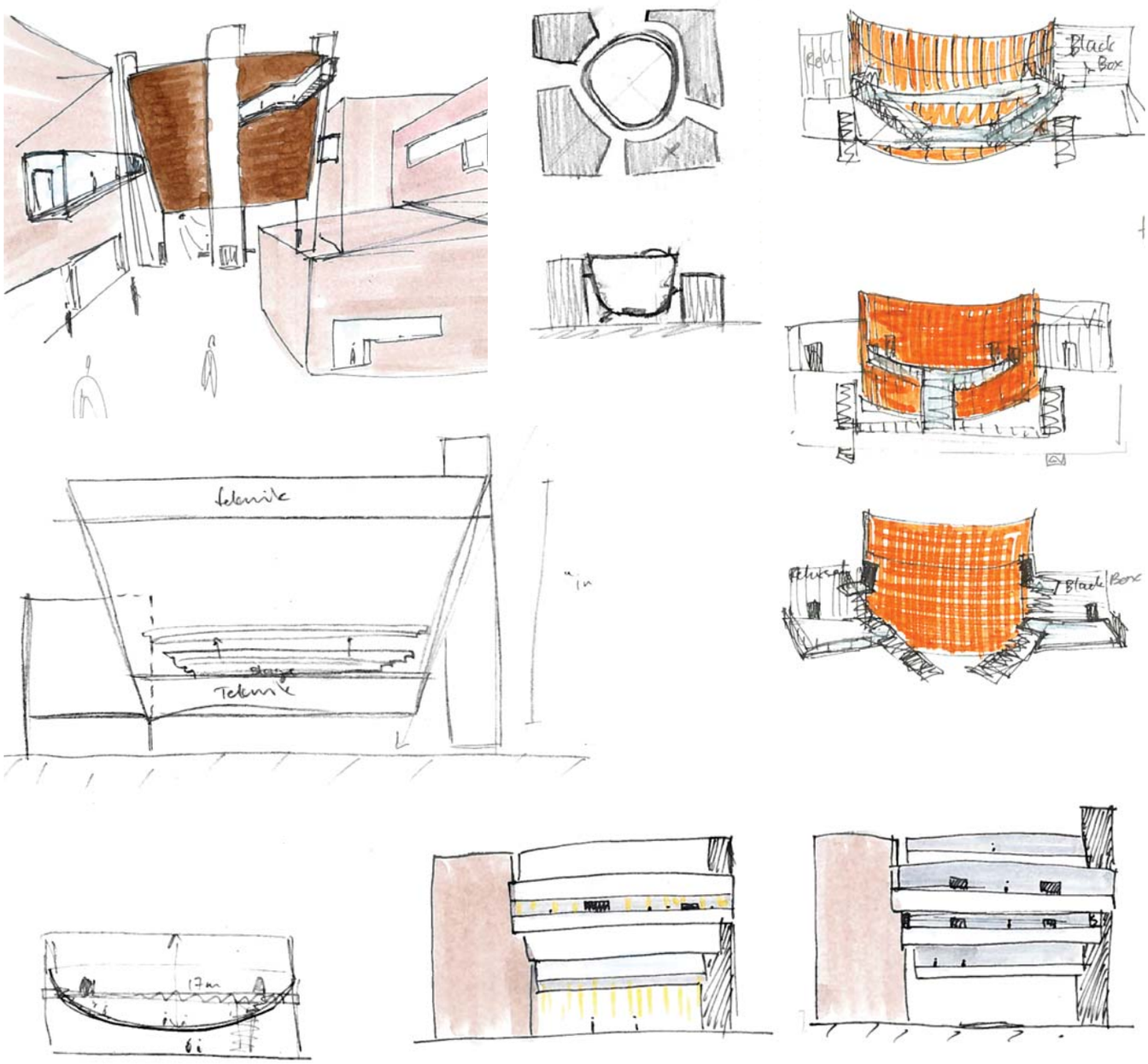
Cons
- More walking area
- Long way for people to go to come to the café
- Life from the café are taken away from the foyer area
- Product delivery

Café on the ground floor

Pros
- The café becomes part of the public flow of people
- Accessible
- A 'drop in' meeting place
- Generates life in the foyer
- Becomes part of the outdoor space at ground level

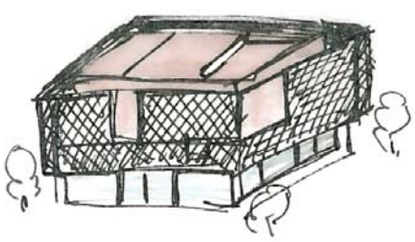
Cons
- The café should be placed to the southwest in order to benefit from solar gain.
- Near the traffic

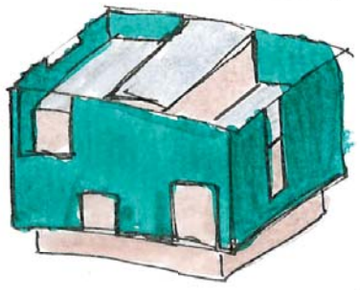
EXPERIENCE OF IN-THE-ROUND

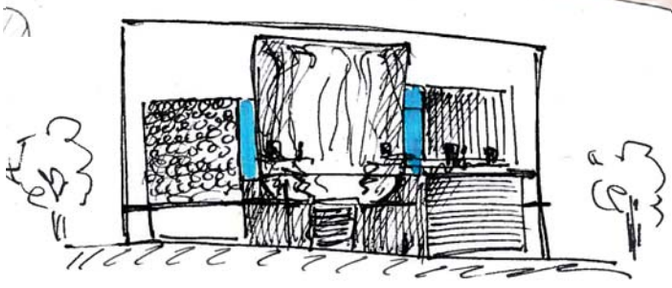


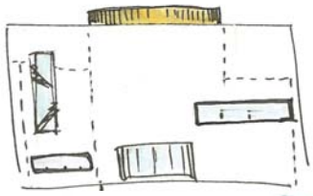
THE SCREEN

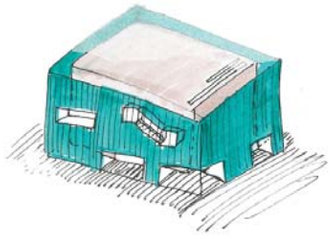
The screen is an idea of suiting up the external shape which otherwise consists of displaced building volumes. Also the screen is to provide shadow in the large foyer area, which is a very transparent area towards south and east.
The following shows the sketching in relation to the idea of a wrapping screen. Different levels of transparency of the screen are exploited. A transparent screen makes it possible from outside to perceive functions and life inside the house. Maybe the screen could be transparent in the evening, when the theatre functions are in use and the house lights up the city and more closed during the day when sun shading is necessary against south and east.

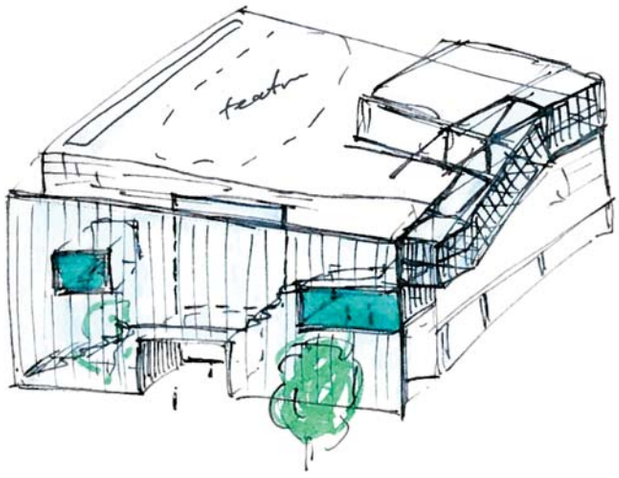












TECHNICAL ASPECTS

Month-average spreadsheet

To evaluate the required heating and cooling demand in relation to differnet types of window glass, experiments have been carried out in a month-average spreadsheet (see enclosed CD). The experimentations were done on a maximum volume with a gross area of 4200 m^2 and a height of 25m which are maximum values defined in the competition brief.

Different U-values and g-values of the windows in the building are evaluated.
Determination of the window area takes its point of departure from the following criteria defined for low-energy buildings [web 12]:

- Total window area should not exceed 30% of the gross area.
- 40% of the total window area should face south.
- The remaining 60% should be allocated to the east, west and north-facing windows.

	U-value	g-value	Heating kWh/m^2 year	Cooling kWh/m^2 year	Total energy performance
3-layer energy glass	0,9	0,48	31,2	1,2	32,3
Rationel window	1,13	0,63	32,8	2,5	35,3
Scan glass (DK cool lite SKN)	1,3	0,27	47,5	0,0	47,5

It can be seen that 'DK cool lite Scan glass' are economic preferable because they result in the lowest cooling demand. Also it was tried to use 3-layer energy glass to the north and west which resulted in a lower total energy performance of 40,7 kWh/m^2 year instead of the 47,5 kWh/m^2 year when only using Scan glass. Then the building use energy for heating from October to April.

Acoustics

In connection with building acoustics the spread of sound between rooms should comply sound insulation requirements defined in the competition brief [Projekt konkurrence 2013]. The sound insulation should be R'w ≥ 75 dB between stages, why it is preferable to avoid placing stages directly next to each other. Between the rehearsal stage and other stages, however, it is sufficient with a value of R'w ≥ 65 dB.

Solar cells

Solar cells should be placed straight to the south with an angle of 45 deg. in order to obtain the highest value of solar radiation [BPS 128]. Letting the wrapping screen go higher than the roof of the building, solar cells could be placed at the roof of the building without drawing attention.

SELECTION - LOOP II

The conceptual idea of a living facade, changing transparency, dialog between inside and outside and experience are taken further in the sketching process.

It is chosen to work more on the box shape which relates more to the context than the circle shape. Also the circle shape became to demanding in regards to placement of the different rooms of the house.
The idea of having a public axis through the building is explored further to meet the design parameter of creating a design which becomes part of and support the connection between the public transport and the city centre. Compactness is still a factor in order to lower the energy consumption of the building.

Furthermore, sketching is done in relation to the creation of a functional flow between different spaces in the building. In that connection thoughts about how the different functions are to be perceived by people in public areas are brought into the sketching process for the building to be an experience in itself.

It is chosen to place the café on ground floor to generate as much life as possible in connection with the public foyer. The shape and experience of the large theatre stage, In-the-round, are also an aspect of the further sketching process.
Also it is chosen to explore the idea of a wrapping screen in relation to the idea of creating a dialog between inside and outside and different levels of transparency of the building.

CONCEPT LOOP III

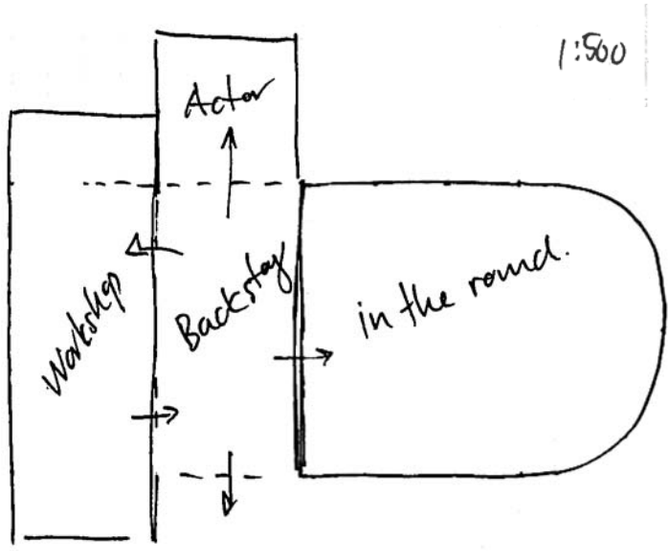
BACKSTAGE FLOW

Location of rooms in the backstage area.

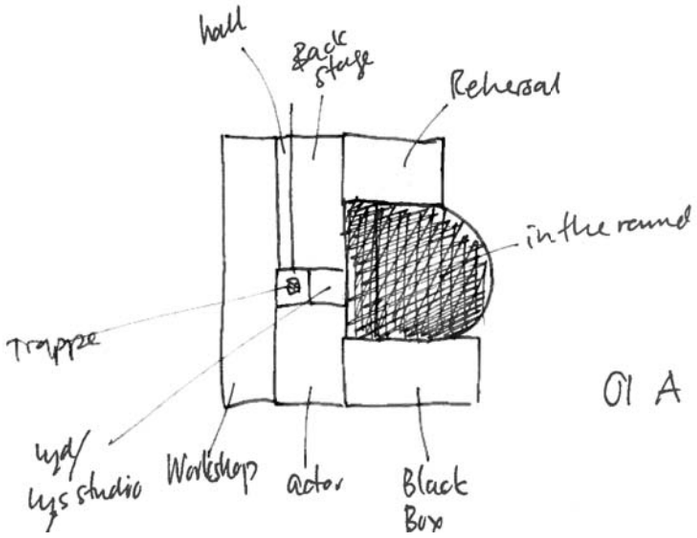
In a theatre there are specific requirements to how backstage functions should be located in relation to each other [Projektkonkurrence 2013]. Sketches and model work in relation to these requirements are illustrated in this section

Fire safety

Relative to fire safety there should be maximum 25 metres from any point in the house to a emergency exit which are thought into the design. Also it should be possible to divide the building into fire cells and fire sections.

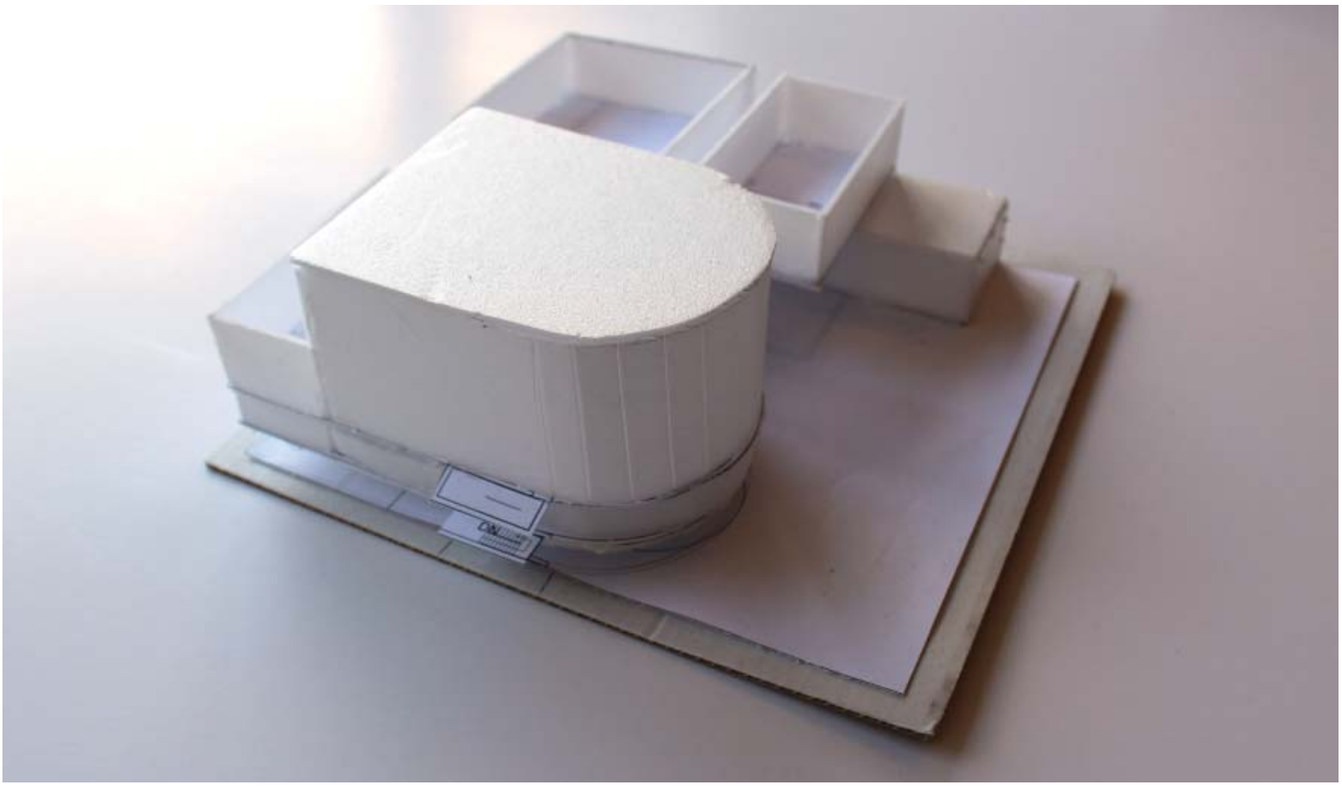


Ill. The actor area should be placed in close distance from the backstage area. However, the actor area can be placed on another floor than the backstage area.

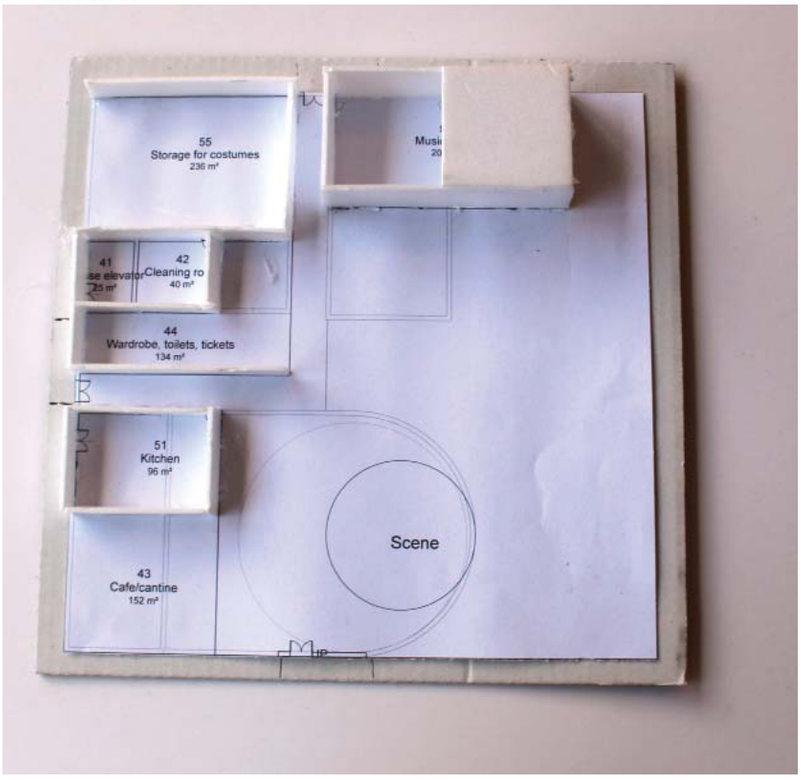


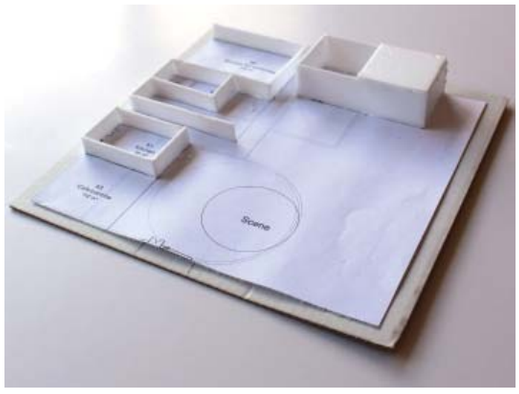
Ill. The workshop should be located in directly connection to the large theatre stage 'In-the-round', Black Box and the Rehearsal stage.

Model solution number one



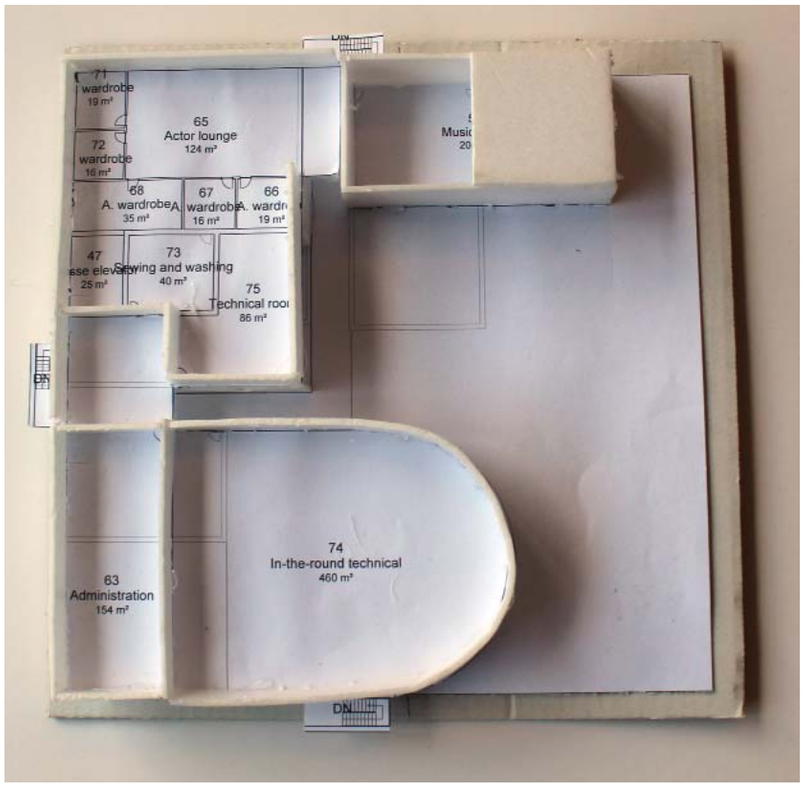
Ground floor

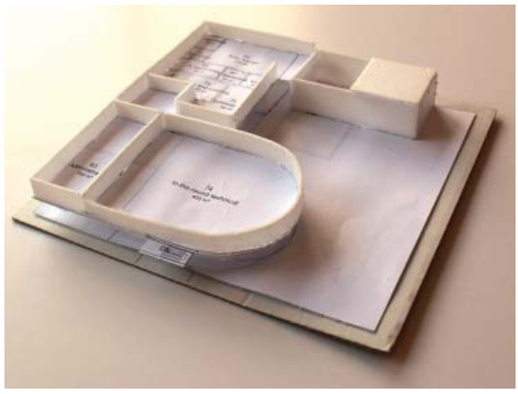




- Compact house with a square plan
- Large open foyer to the east
- Café located to the south west
- Foyer scene as a repo underneath the In-the-round
- Three emergency exits
- Storage area placed at the ground floor to create an opportunity to exhibit theatre costumes in the facade
- Loading elevator to the workshop on 2nd floor

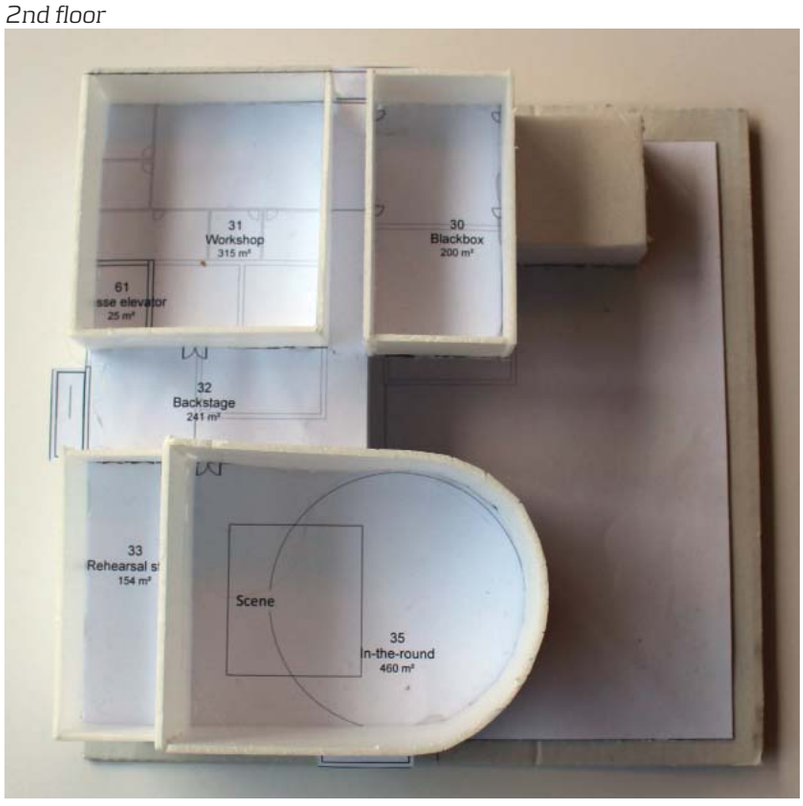
1st floor

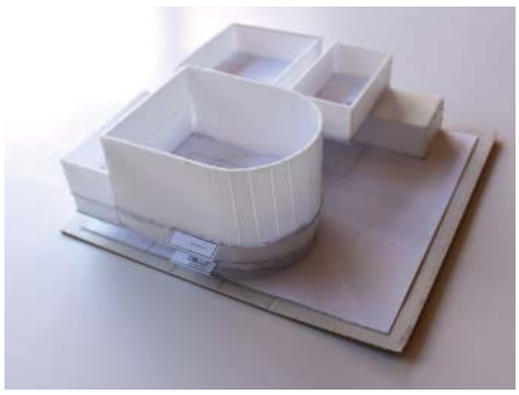




- Technical floor of the In-the-round located at 1st floor
- Administration to the south west to provide good day light conditions in the working area and opportunity to utilize solar gain
- Technical room placed central in the building
- Opportunity to perceive the round shape of In-the-round in the foyer

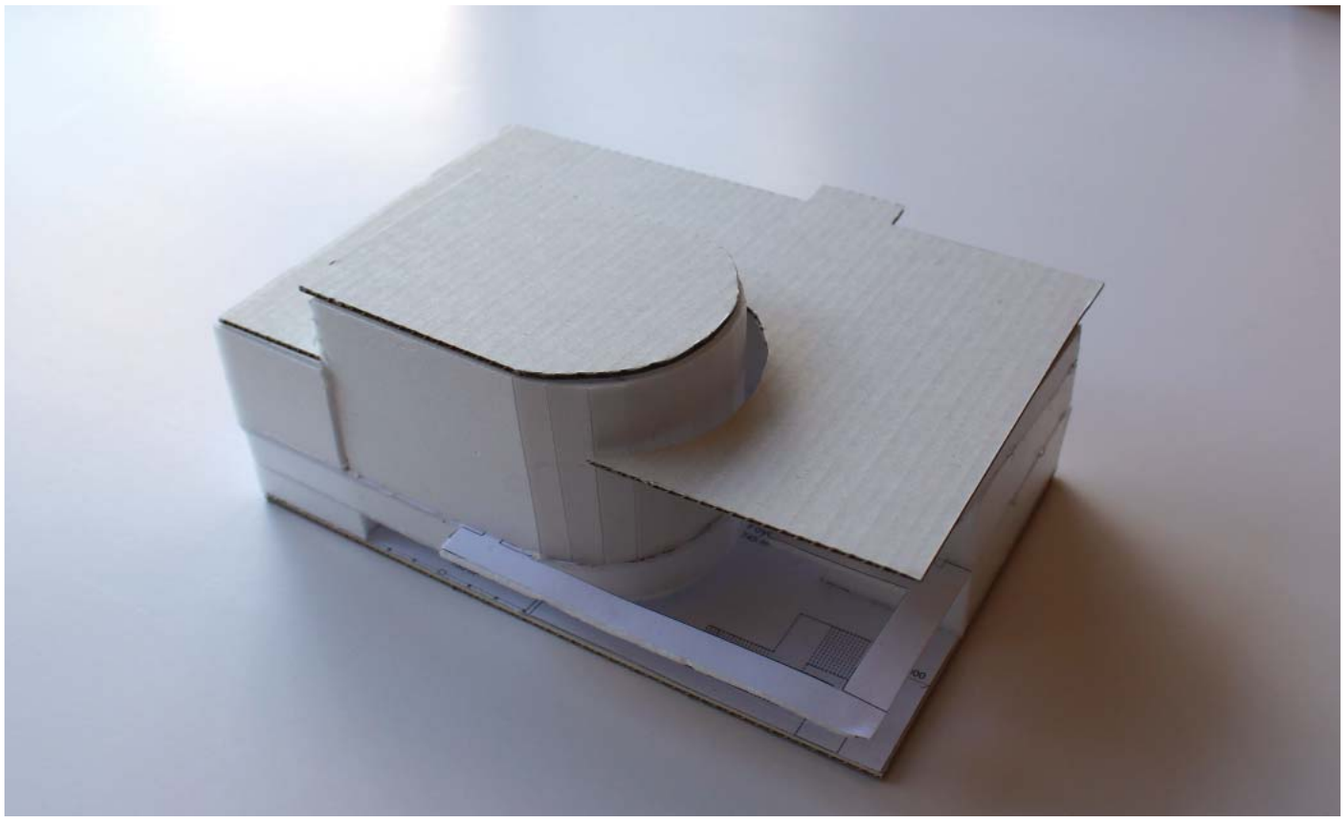
2nd floor



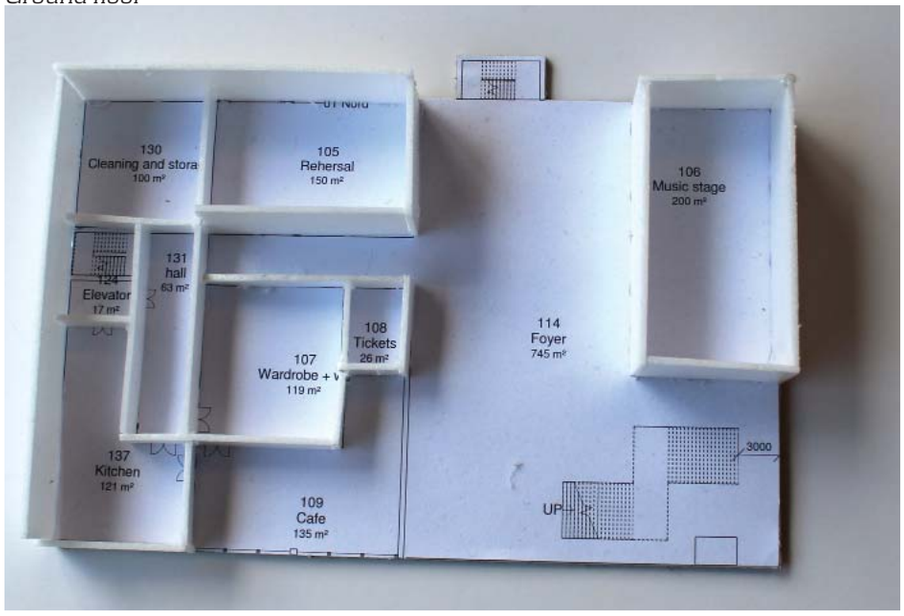


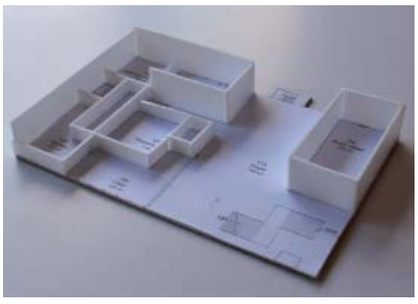
- Rehearsal stage located in extension of the In-the-round. Opportunity for flexible wall between rehearsal stage and In-the-round
- Opportunity for connection between the workshop and In-the-round, rehearsal stage and Black Box
- Break area on top of the music stage. From here the entrance to the Black Box are situated.
- Displaced boxes in contrast to the round shape

Model solution number two



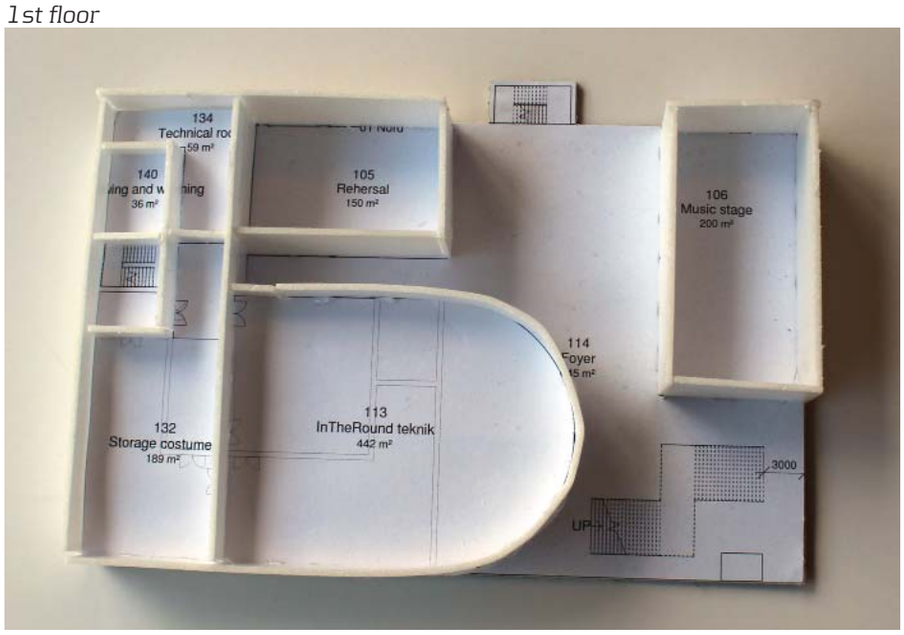
Ground floor

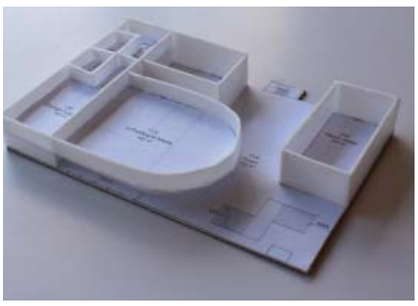




- Foyer as an axis through the building. South-north
- Café located to the south
- Kitchen located to the southeast for good day light conditions in the working space
- Rehearsal and music stage located at the ground floor for better accessibility

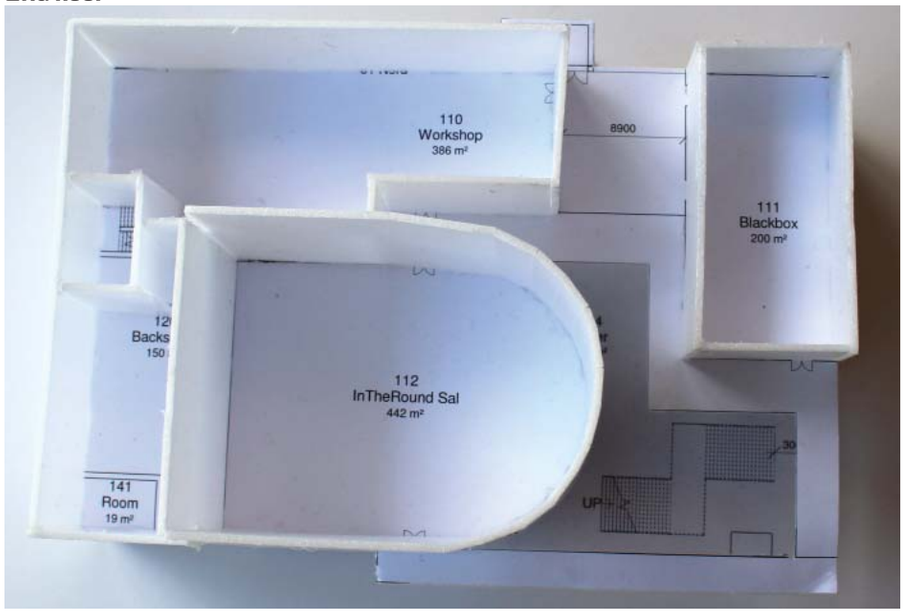
1st floor

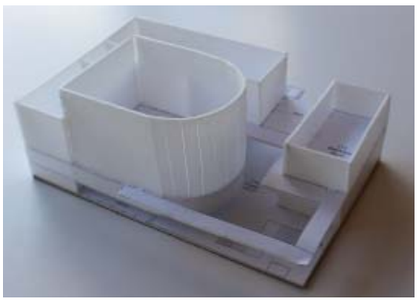




- Technical areas placed at 1st floor together with storage area

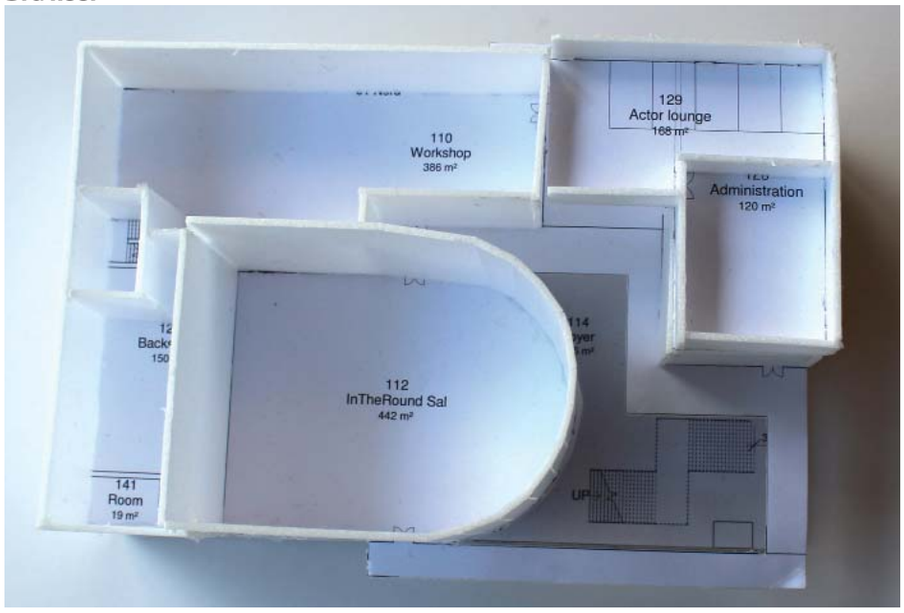
2nd floor

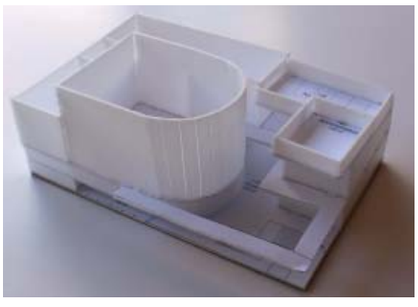




- Walkway placed along the facade to make the movement of people visible from outside
- Workshop in direct connection with In-the-round and Black Box
- No connection between workshop and rehearsal stage

3rd floor





- Actor area and administration to the northeast for day light

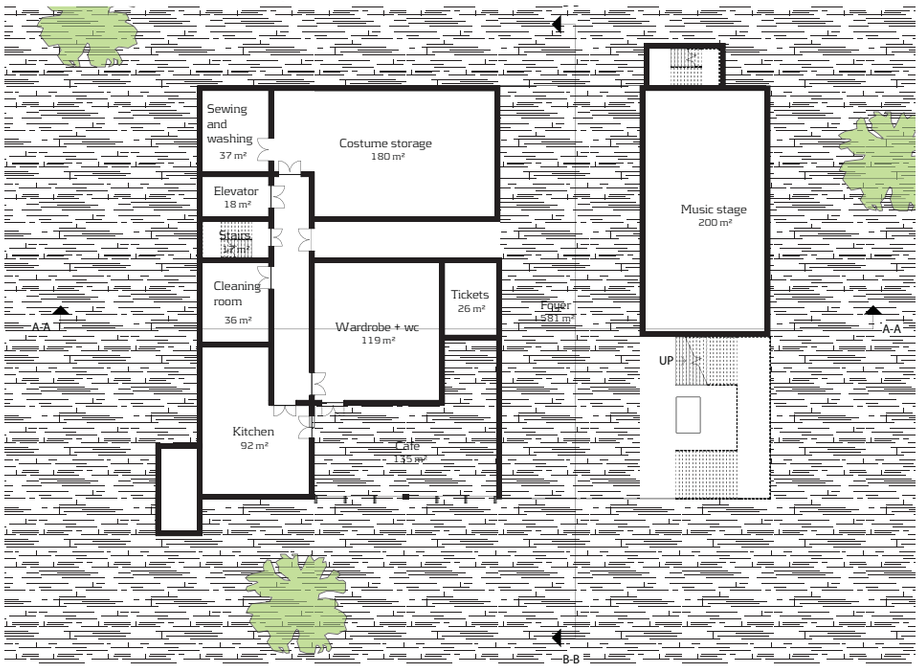
GROSS AREA OF MAX. 4200 M²

The two model solutions were discussed and from them a new solution was designed. However, the gross area of the new design was approximately 4800 m².
In the competition brief it is a demand that the gross area does not exceed 4200 m². Actions done to the design in order to meet this demand are like follows:

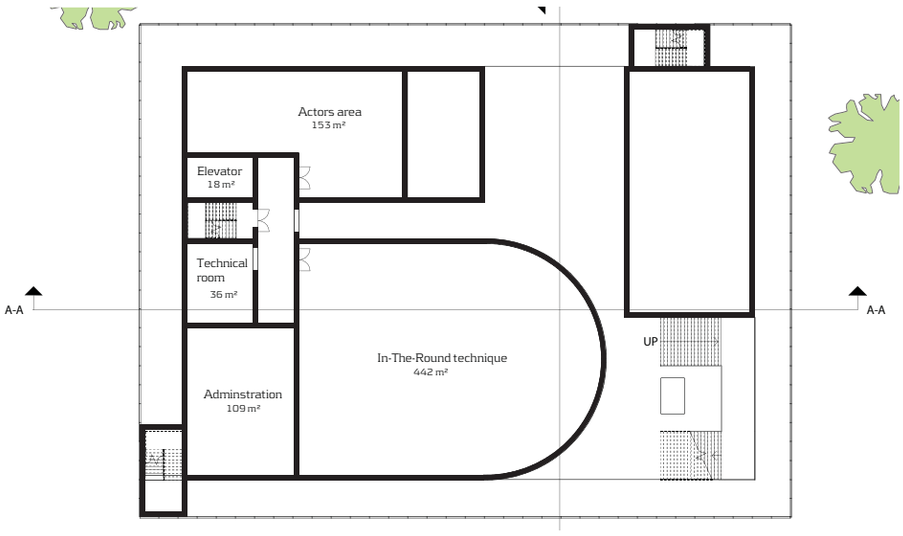
- Music stage is displaced three metres to the west so that it is not placed directly under Black Box. Hereby the foyer area is decreased and the music stage form walk area on the 2nd floor. This change also supports the experience of the two boxes, music stage and black box, as two different volumes
- Actor area was made smaller and double height in the costume storage is created
- Walk ways were changed from four metres to three

Plans and sections on the next two pages show the new design which has a gross area of approximately 4200 m².

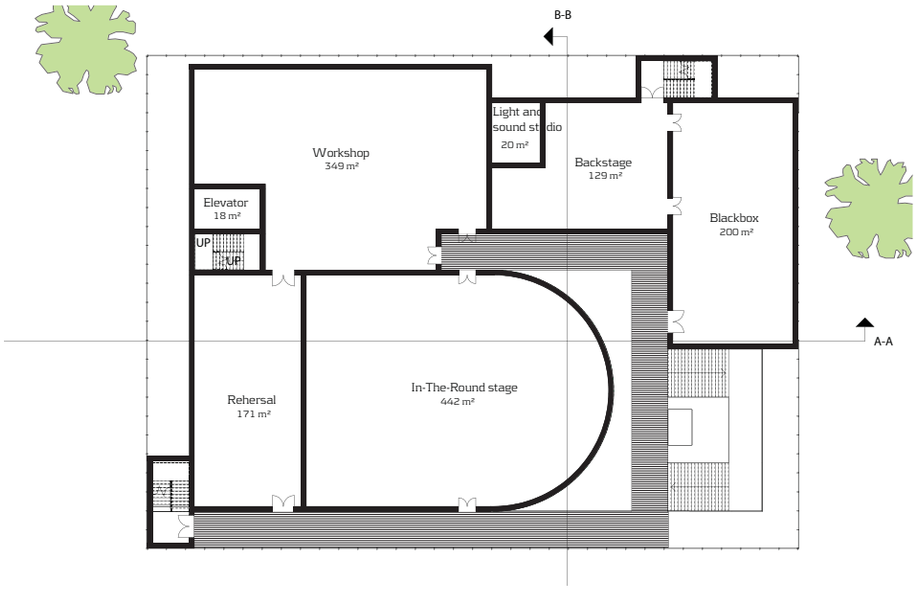
GROUND FLOOR, 1:600



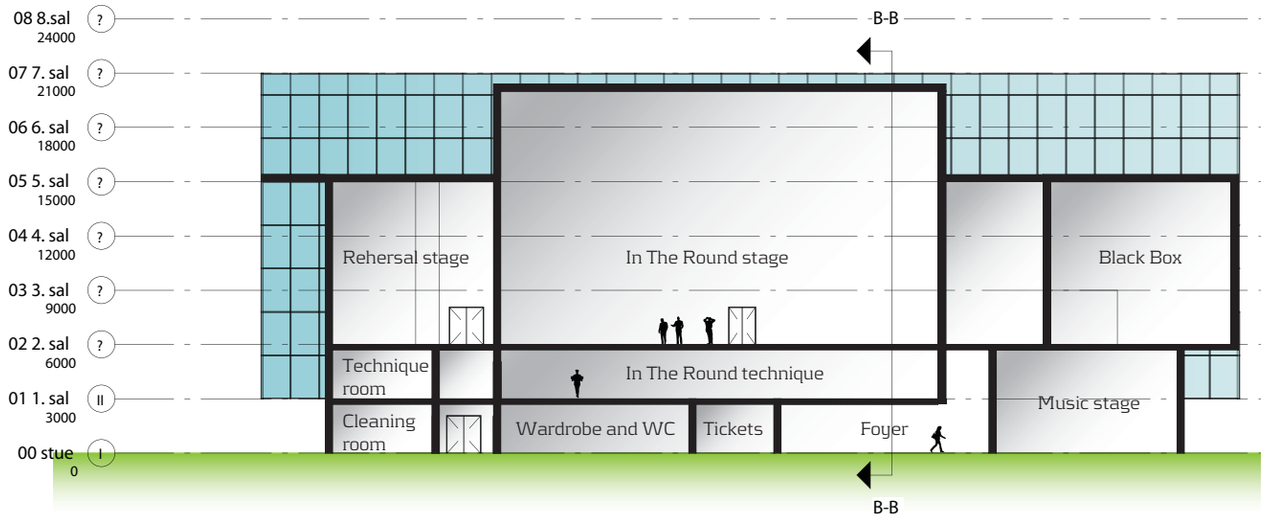
1ST FLOOR, 1:600

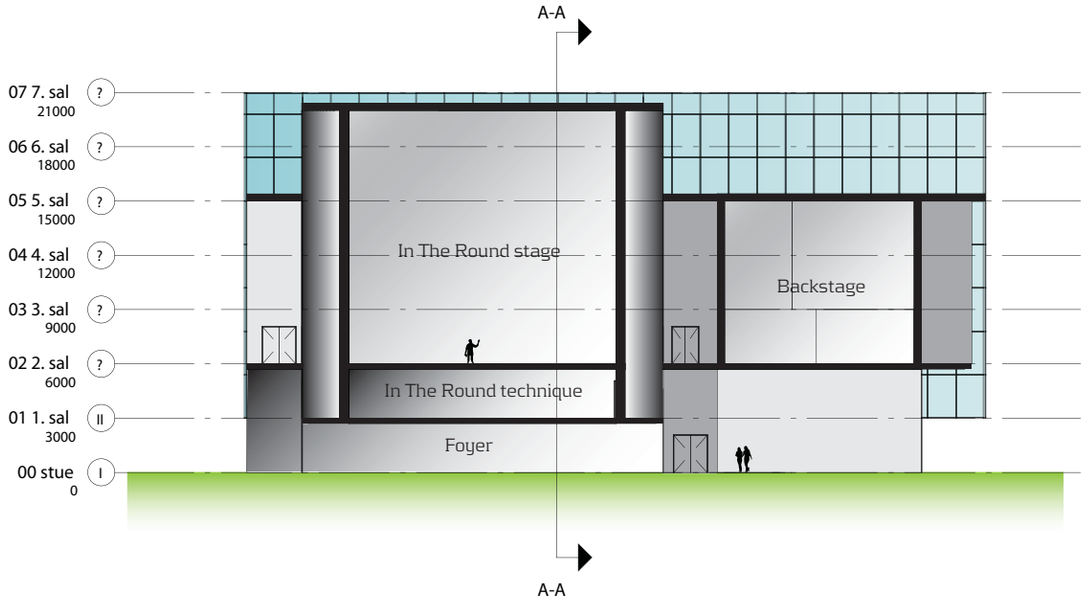


2ND FLOOR, 1:600

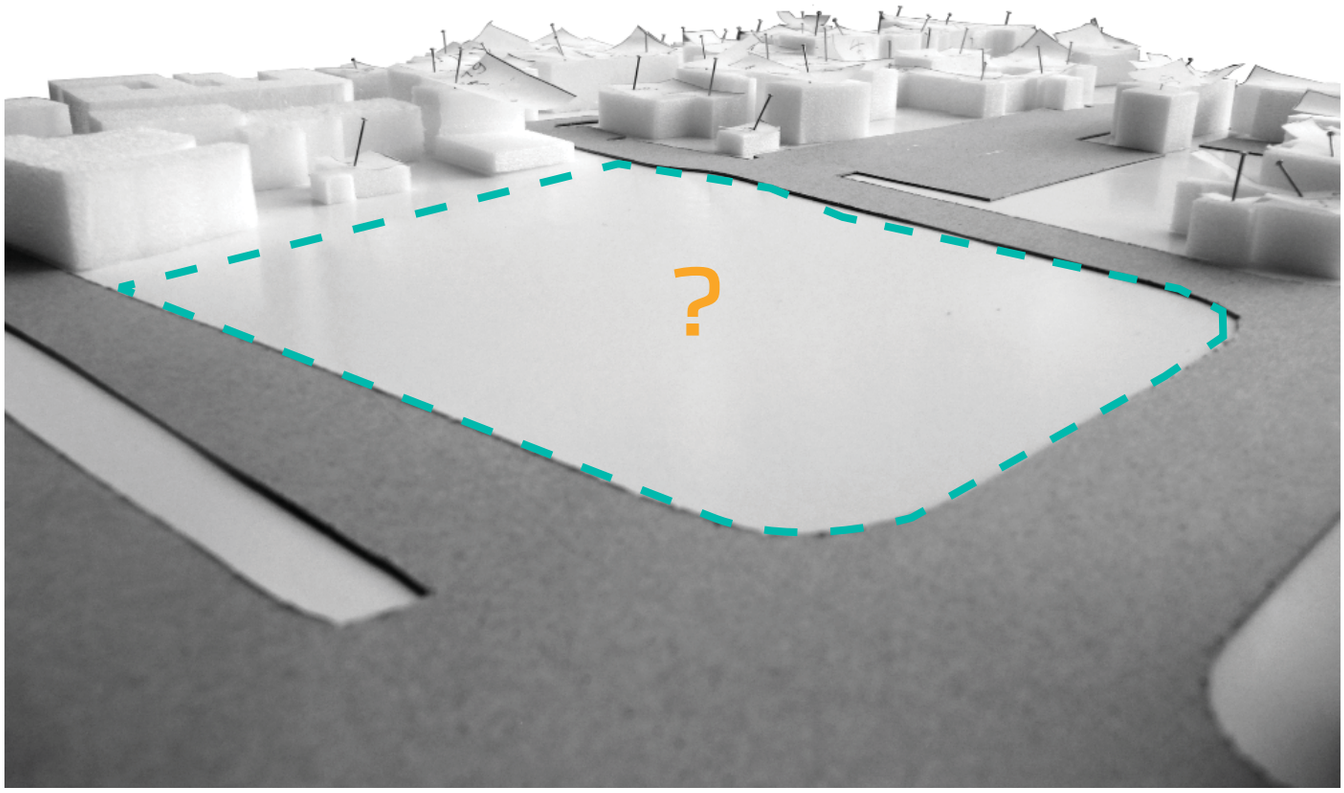


SECTIONS, 1:450





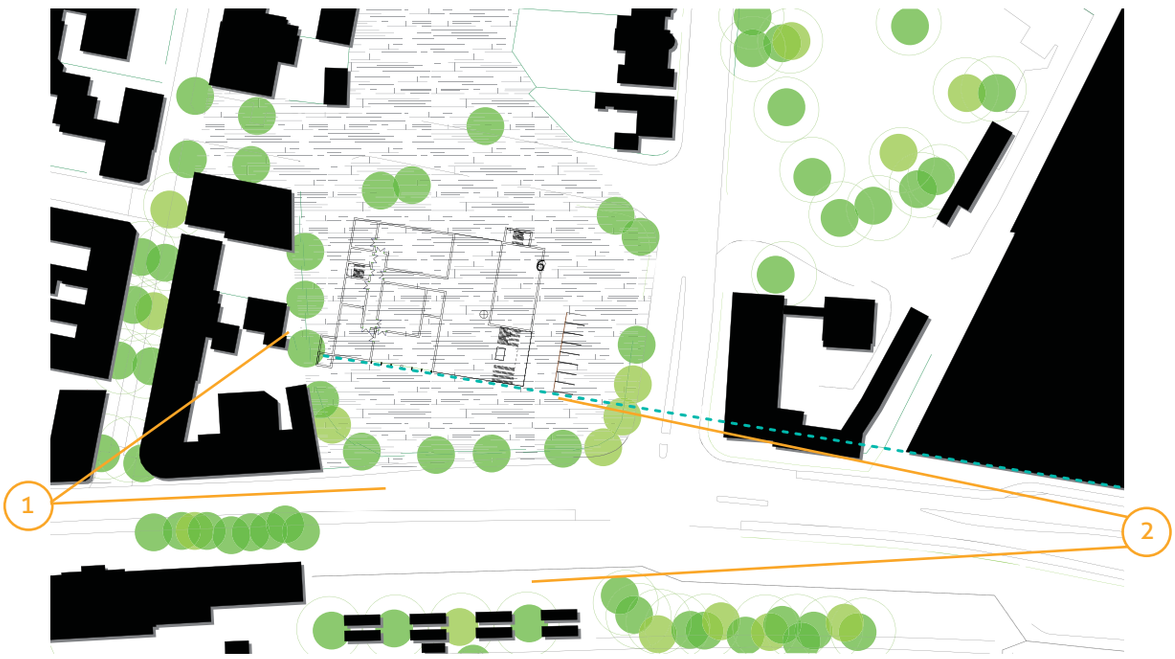
URBAN CONNECTION



The urban design is to support the connection between public transport and the city centre. Keywords and illustrations describe the urban design and how it creates this connection.

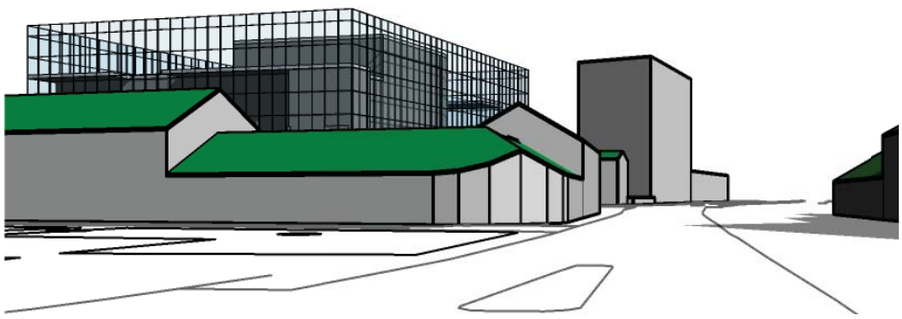
Keywords:

- Placement along an axis from Metropol
- Axis through the building that creates a connection between public transport and city centre (shopping street)
- Unique coating that runs through the foyer in the theatre
- Sculptures and art as part of the urban space
- Outdoor stage
- Mirroring in water
- Café located away from the traffic
- Parking to the east

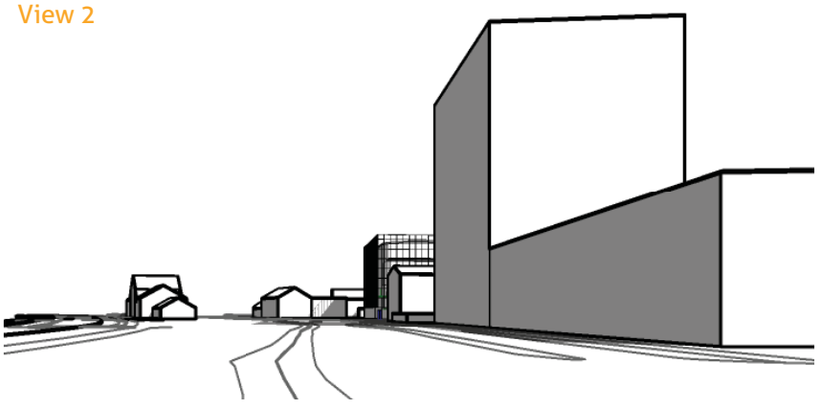


Ill. The theatre house is rotated to the east so the southern facade runs along with an axis from Metropol. More direct connection between train station and the 'Mammutplads'.

View 1



View 2



MATERIALS

The materials of the building should support the experience of different functions in the house. Thus different stages have there own expression, so that it is visible from a distance, that they are different rooms with different experiences inside. Other rooms in the house are of gray concrete, so the stages are in focus. Standing in the foyer or outside the building, it should be possible to experience volumes of different identity. The following describes materials in relation to different functions in the house.

In-the-round
The large theatre stage is the only volume of brick in the building. The brick brings textuality to the large volume and makes it stand out from the other volumes of concrete. Also brick is a very common material in the area and hereby the stage is linked to the city.
Inside the theatre stage, displacement of the bricks is beneficial in relation to the acoustics. Heavy walls of brick are also preferable in terms of air sound insulation.
Brick is a thermal mass material which stabilizes daytime temperatures inside the building.

Black Box
Black concrete is used for the Black Box so it, from a distance, can be perceived as a 'black box'. Inside the stage, the walls are of flexible black painted plywood plates.

Music stage
Like Black Box, the Music stage is of concrete. Only this is light gray concrete with an artistic waving pattern in the surface. Inside the stage flexible light plywood plates are used. Also a removable curtain is part of the one of the walls in order to be able to change the reverberation time inside the room, when used for e.g. conferences.

Backstage
Transparent glass embraces the backstage area which becomes a light spacing between massive concrete boxes. Here people can experience shadows of people and activity on the backstage area. People get a glimpse of the backstage activity which normally in a theatre a hidden away.

Foyer
Staircases in the foyer are structures of steel and concrete which seems light in relation to the large building volumes. This way the staircases become a structure that moves around and between massive volumes. The coating on the staircases is light wood as a warm contrast to the concrete and steel. The elevator in the foyer is also a steel structure with glass that makes it possible to perceive the vertical movement of people. Large facades of glass towards south and east create a visible connection between inside and outside. The coating in the foyer is tiles which are also used for the outdoor area.

The screen
The screen is a steel structure which is carried by the building. It is attached to the roof and building walls. In contrast to the massive concrete volumes the screen is to be perceived as a light and transparent structure.
Towards south and east the screen function as a climate shield with energy glass of 'Scan glass' with a high U-value and a low g-value to let as little as possible solar heating into the building and let the heat go out again. Also some of the glass towards south and east are semi-transparent to shade from the sun. In that connection, it was also discussed whether the steel structure in it self could have a certain width and hereby also become a shading element.
Towards north and west the screen is open in the bottom and the top and the glass are not energy glass. Here the screen is not the climate shield.
The screen starts at 1st floor and one and a half meter above the roof. The ground floor is moved three meters within the screen. Hereby a transition zone of three meters between inside and outside are created. In the top the In-the-round points approximately four and a half meters above the screen and contributes with giving the building a scale in relation to the surrounding buildings.

Pictures on the page to the right illustrate different materials of the design.

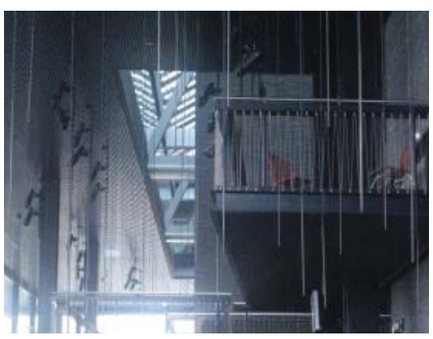
In-the-round

Blackbox

Music stage

Glass screen

Staircase and corridors in the foyer



Backstage

FEEDBACK

A third meeting with the municipality gave new feedback to the project. The feedback is listed below:

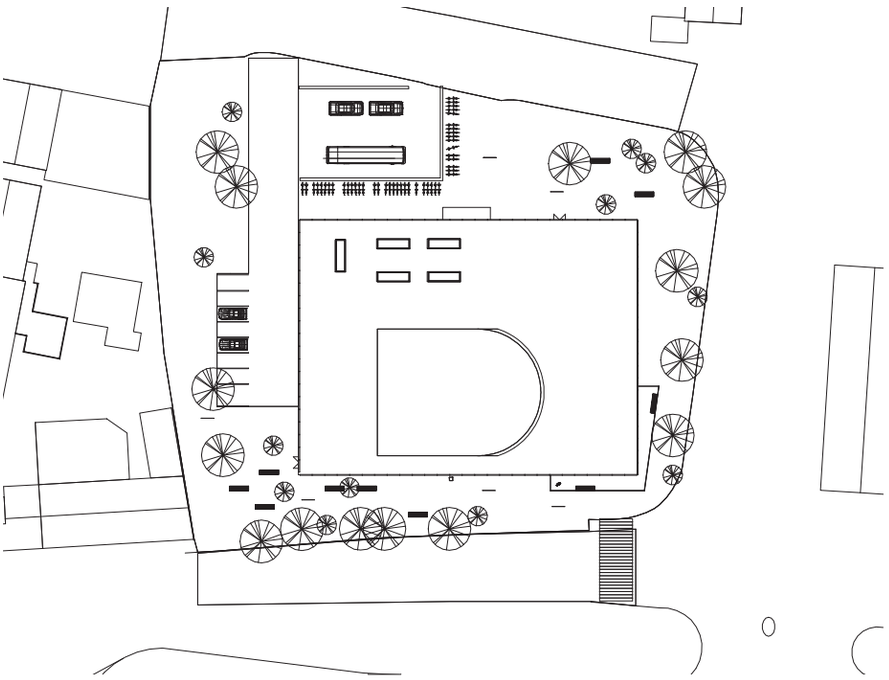
- Light and sound studio should be placed at ground floor.
- The interior of the foyer should be inviting and maybe split into smaller areas for stay.
- The location of the house on a line going from the Metropol to the site gives to much attention to Metropol which is not preferable. The building should expose it self and invite people to go through.
- Isn't the parking lots placed at a very attractive place of the site?
- The house could be located in the southeast corner to be oriented near the traffic junction between the bus station and the site and hereby invite people from the public transport through the building.

URBAN DESIGN

On the basis of the feedback, changes were done to the urban design. The drawing shows the new location on the site. The house is placed to the southeast so it is visible from 'Frederikshavnsvej'. The café is located approximately ten metres from the trafficked road. Ten metres are estimated to be an okay distance from the road in order to feel protected from the traffic but still be able to follow life on the road from the café. The estimation is done from a visit to cafés around Aalborg.
Orientation of the building is evaluated in relation to the energy consumption in Be10. See figure 8 on the page to the right.

Parking lots are moved to the west side of the building, where also a road for product deliveries are running. Parking for busses, taxis and bicycles are also located to the west. The west side of the building becomes the backside of the building. Trees and water are placed to the east as an extension to the buildings along 'Brinck Seidekins Gade'. The water goes close to the building where there are spaces for stay inside the building. Hereby the water becomes an element which is experienced from both outside and inside. In the evening the water reflects light from the building.

The same coating is running from the bus station, over the road, through the building and further up the 'Mamutplads' to create a coherent flow from the public transport to the city centre which goes through the building. On the road the coating slow down the traffic and traffic lights makes it possible for people to go from the bus station to the site in a wider area, defined by the coating, than the planed normal traffic junction. The house becomes a house of the city.



TECHNICAL ASPECTS

Overheating in the foyer

The foyer has large window areas towards south and east. Therefore overheating in the foyer is estimated in a 24h-average spreadsheet (see enclosed CD). The calculation is done on a simplified model of parts of the foyer. Thus the calculation concerns the southeast corner of the foyer (242 m^2) where the solar gain is highest.
Walls towards south and east are entirely of Scan glass with a U-value of 1,3 and g-value of 0,27. Walls towards north and west are calculated as heavy concrete walls to the outside. From the calculation it can be seen that the highest temperature occurs during July and is 26,5 degrees. It is one degree higher than the 25,5 degrees which this project strives for. Relative to the large window area, however, it is acceptable.

Orientation

Different orientations of the building are evaluated in Be10. See figure 8. It can be seen that the house, in terms of energy, should be placed straight south – north.

Rotation degrees	Energy perfomance kWh/m^2 year	Heat demand MWh
0	77,4	24,88
10	77,5	24,97
20	77,7	25,08
30	77,8	25,20
40	78,0	25,33
45	78,0	25,39
315	77,8	26,27
320	77,7	26,12
330	77,7	25,83
340	77,6	25,55
350	77,5	25,21

Fig. 8: Table showing the energy consumption and heating demand of the building in relation to different orientations of the building.

DAYLIGHT

To provide a good indoor climate daylight is a significant factor and the program VELUX Daylight Visualizer has been used to verify the design.
The rooms which need natural light are:

Administration

- It is important to provide good daylight conditions at the desks of the employees. The goal is to create a daylight factor of 2 %.
- Also the view to the outside is an important element to obtain a good indoor environment.

Workshop

- Skylights are a good way to get an equally distributed light in the rooms, since the employees spend a lot of time in the workshops and needs good light conditions, which is 5 % of the natural light coming into the room.
- Like in the administration, people in the workshop must have view to the surroundings to provide a good indoor environment.

Other rooms

- In relation to the actor lounge and make-up rooms the focus has been to provide views to the outside. The rooms are mostly in use in the evening why the opportunity for natural light has had a lower priority.
- Sewing and washing needs a view and good daylight conditions like in the administration.
- The kitchen must have a daylight factor at minimum 2 % and a view to the outside to meet the requirements for good indoor environment.

Challenges
The administration is located with external walls towards south and west. The southern wall has an overhang of three meters from the hallway. The room have the screen as an object which could take some of the daylight.

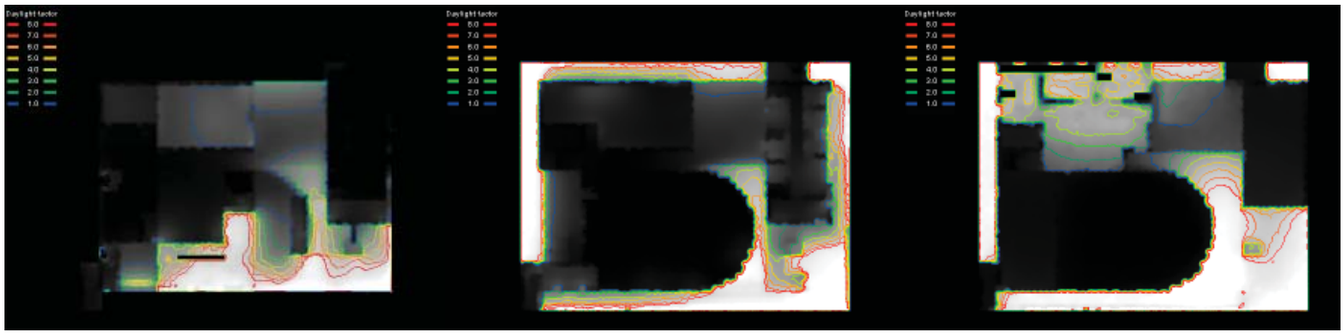
The workshop has skylights and smaller windows towards west and north to provide view and daylight at the working stations. The challenge is to provide evenly distributed light through a day, where skylight is a good solution. Like the administration, the screen is placed in front of the windows.

The actor area as well as sewing and washing have the Black Box on top, which creates an overhang of three meters. This makes it a challenge to get daylight into the rooms. Also these rooms have the screen on the outside.

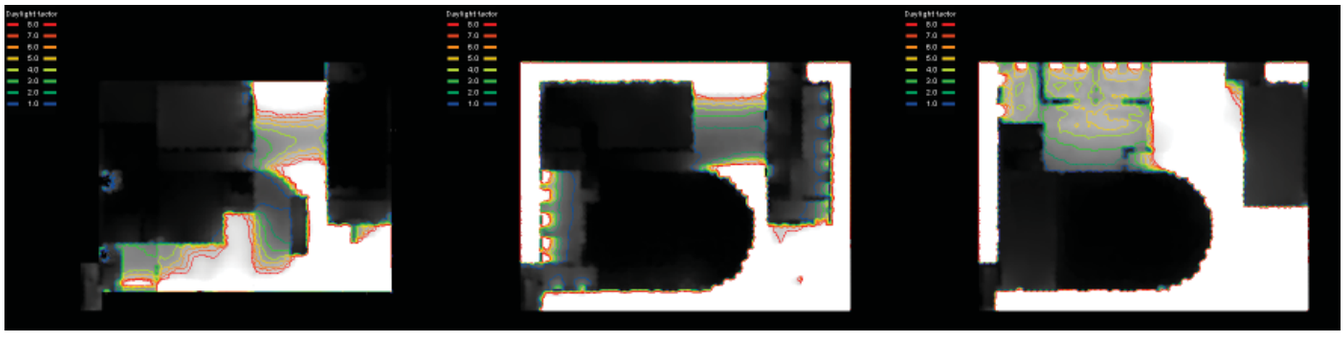
The kitchen is situated towards south and at ground floor, where there can be placed obstacles as trees, furnishes and people, to prevent the daylight to the room.

The process for creating the optimal daylight factor in these rooms is displayed at the opposite page.

Ill. The first illustration shows the ground floor, where it can be seen that the kitchen and café do not get enough daylight. The next picture shows the 1st floor, where it can be seen that there is not enough daylight in the administration. On the 2nd floor which can be seen on the last picture, the workshop has sufficient daylight. The window area must be increased in the other rooms.



Ill. A wider window is placed in the kitchen which gives more light into the room. However, the light is not distributed evenly. At the first floor the administration has a window which spans the entire room and a height at 1 meter. The daylight is more even, but the requirement of 2 % daylight in the room is not fulfilled. The same situation applies in the actor area.
The goal of a daylight factor of 5 % in the workshop is fulfilled and nothing further needs to be done.



Ill. By having a higher window in the kitchen, the daylight penetrates further into the room and the minimum at 2 % daylight is met.
In the administration, the wide window is replaced by higher and fewer windows. The result is, that the daylight penetrates deeper into the room and gives a better evenly distributed light. The same result replies to the actors' area, although they have an overhang of 3 meters.

OVERHEATING

The stage, In-the-round, has a high internal heat load under performances. Like in the 'Skuespilhus' the excess heat can be utilized for heating of other rooms of the house. The program, BSim, is used to verify overheating produced under a performance in the theatre stage as well as temperatures in the administration. The simulation models are included on the CD

In-the-round

The aim is to find out if the heat can be reused as heating in other rooms by the ventilation system. The season for the theatre spans from September to May, and the stage is not in use during the summer. The stage has full capacity, 350 people, in the evening from 20 to 23 o'clock and during the day the load of people varies. Therefore, it will be an option to reuse the heat to other room, which needs heating. In this example, it is the administration, which is going to have the heat.

Process
To create the room in BSim, a simplification of the shape needed to be done. The box shape has the same height and width as the 'right' one, but the length was adapted so the volume was intact.
When the stage is not in use, there are no overeating hours. By adding heating during the heating season, September to May, the result turned in another direction. The temperature should be maintained at 22ºC. The heating was changed from floor heating to radiator since it is easier to control the heat. When the heating system is placed in the flooring, it takes longer time to have a lower temperature, because the heat is storied in the thermal mass of the floor.
The ventilation of the room is mechanical as there are no windows in the room.
The internal load from equipment is estimated on the basis of a month-average spreadsheet. In the equipment is also the light.

Result
The simulation shows that the heat can be reused. One of the reasons is that there is enough heat to use and that the heat is generated in the evening where no other rooms are in use, so e.g. the administration can take benefit and reuse the heat.

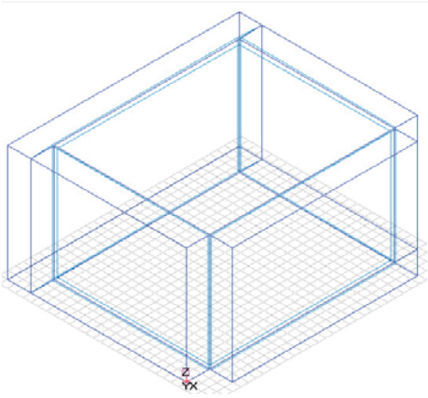
Administration

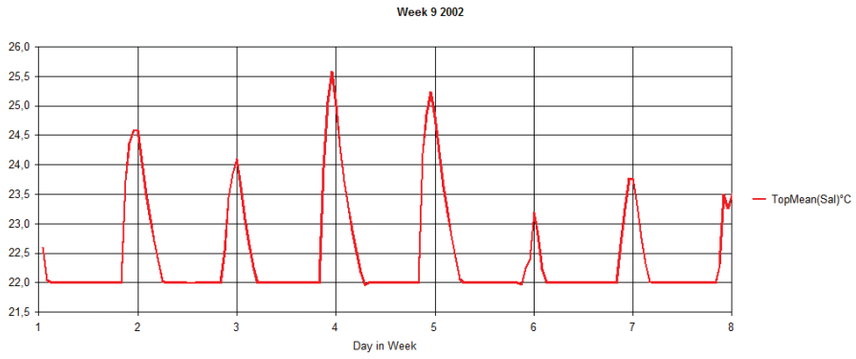
As described in the daylight factor section, there are some challenges for the administration to obtain daylight and as well heat from the sun. BSim is to make a general simulation to illustrate when heat is needed. The heat could come from excess heat produced in the stage, In-the-round. The simulation should meet the requirements with maximum 100 hours above 26 ºC and a limit of 25 hours above 27 ºC, which are the acceptable values from DS 474. The office is in use weekdays and between the hours 8 to 17.

Process
As In-the-round the shape needs to be simplified by having no inner wall in the desired area. This mean the administration is one room instead of smaller unites.
Even though the windows towards south have overhang, there is a need to use shutters and solar shading at the windows to protect from overheating during the summer period.

Result
The temperature should be maintained at 22ºC and it is success most of the time.

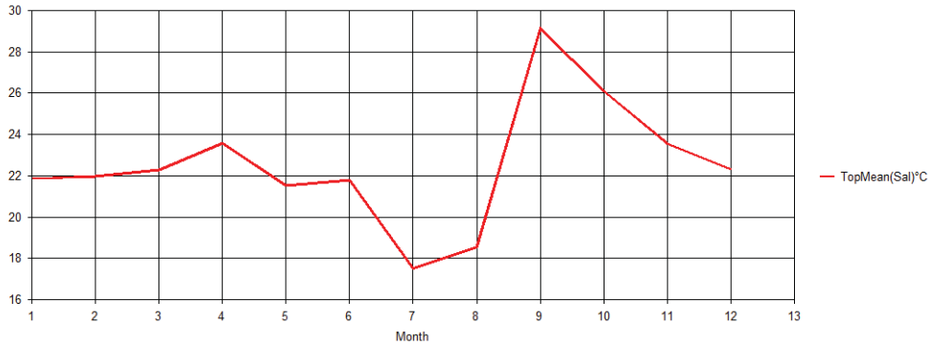
In-the-round:





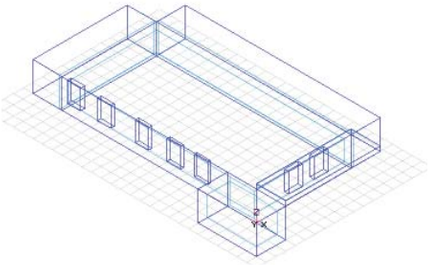
Ill. The graph displays a week in February where the temperature peaks when the 350 people have been in the room for three hours

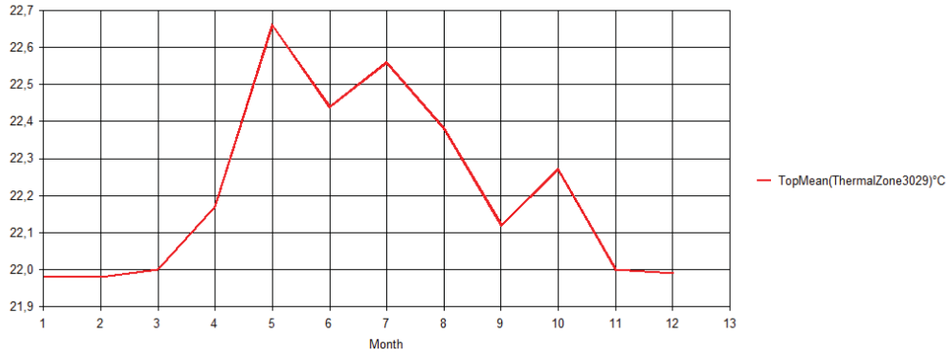
Temperatures
Hours>26°C = 1102
Hours>27°C = 832
Hours<20°C = 1484



Ill. The graph displays the temperature during a year and shows that it would be beneficial to use the heat during the heating season for other rooms.

Administration:





Temperatures
Hours>26°C = 29
Hours>27°C = 11
Hours<20°C = 4

Ill. The graph displays that the temperature are steady between 22 °C and 23 °C

ACOUSTIC APPROACH

In the development of the Theatre- and Experience House the acoustical strategy is to evaluate building acoustics and room acoustics.

Building acoustics

In connection with building acoustics the spread of sound between rooms should comply sound insulation requirements defined in the competition brief [Projekt konkurrence 2013]:

- The sound insulation should be R'w ≥ 75 dB between stages, however it is sufficient with a value of R'w ≥ 65 dB between rehearsal stage and other stages.
- The sound insulation should be R'w ≥ 50 dB between stages and the foyer.

In relation to step sound resistance the following requirements are set up in the competition brief [Projekt konkurrence 2013]:

- The Trinlyd-niveau should be L'n,w ≤ 58 dB in the large theatre stage and L'n,w ≤ 53 dB within the small stages.

Air sound insulation
By avoiding placing stages right next to each other it is avoided that it is necessary to use walls with a sound insulation of R'w ≥ 75.
The rehearsal stage and the large theatre stage, however, are adjacent to each other. Thus, the wall between the two stages is a heavy double brick wall (2 · 1/2 –stone) of 350 mm which provides a sound insulation of R'w = 60 dB [Teknisk Ståbi: table 2.29. 2011].
Walls of the other stages are all massive concrete walls of 250 mm which provide a sound insulation of R'w = 55 dB [Teknisk Ståbi: Table 2.28. 2011].

Step sound resistance
To fulfil requirements to the 'Trinlydsisolans', concrete deck of 270 mm with wooden floor on joists are used in the stages; Black Box, Rehearsal stage and In-the-round [web 13: 35].

Room acoustics

In connection with room acoustics the following describes the two stages In-the-round and Music stage. The competition brief sets out specific requirements to the reverberation time within these two rooms [Projekt konkurrence 2013]:

- Within the large theatre stage there should be an average reverberation at frequency range 500 Hz, 1000 Hz and 2000 Hz in the range of 0.7-0.9 seconds when empty.
- Within the Music stage there should be an average reverberation time at frequency range 125 Hz – 4000 Hz of 1,2 seconds with a maximum deviation of +/- 0,2 seconds.
- When the Music stage is used for conferences it is a requirement that the reverberation time can be adjusted to approximately 0,8 seconds at the frequencies 500 Hz – 2000 Hz.

Reverberation time
Tables on the page to the right show calculations of the reverberation time in the large theatre stage, In-the-round and the Music stage. The air sound-absorbing properties are not included in the calculation.

In-the-round
Dimensions:
Floor plan = 442 m2
Ceiling height = 15 m
Room volume= 442x15 = 6630 m3

Music stage
Dimensions:
Floor plan = 220 m2
Ceiling height = 6 m
Room volume = 220x6 = 1320 m3

Reverberation time - In-the-round (500 Hz-20000 Hz)

Surface	Area, S	Material description	500 H		1 kHz		2 kHz	
			α	α · S	α	α · S	α	α · S
Floor	442	Wooden floor on joints	0,10	44,20	0,07	30,94	0,06	26,52
Ceiling	442	50 mm wood concrete plates	0,35	154,70	0,45	198,90	0,65	287,30
Interior walls excl. doors	1205,16	Brick wall with displaced bricks	0,50	602,58	0,60	723,10	0,60	723,10
Doors	8,4	Solid wooden door	0,06	0,50	0,08	0,67	0,10	0,84
350 chairs	350	Thick padded chairs without people	0,38	133,00	0,39	136,50	0,40	140,00
Sum: α · S (m^2Sabine)				934,98		1090,11		1177,76
Reverberation time T(sec) per. 1/1 octave Ms = (0,16 · V)/A = (0,16 · 6630)/($\alpha_1 \cdot S_1$ + $\alpha_2 \cdot S_2$ +...$\alpha_n \cdot S_n$)				1,13		0,97		0,90

$T_{average}$ = 1,0 > 0,9 sec. at frequency range 500 Hz - 2000 Hz
The demand in the competion brief is almost fulfilled

Reverberation time - Music stage (125 Hz-4000 Hz)

Surface	Area, S	Material description	125 Hz		250 Hz		500 Hz		1 kHz		2 kHz		4 kHz	
			α	α · S	α	α · S	α	α · S	α	α · S	α	α · S	α	α · S
Floor	220	Wooden floor on joints	0,15	33,00	0,11	24,20	0,10	22,00	0,07	15,40	0,06	13,20	0,07	15,40
Ceiling	220	50 mm wood concrete plates	0,08	17,60	0,17	37,40	0,35	77,00	0,45	99,00	0,65	143,00	0,65	143,00
Interior walls excl. doors	372	Polished wooden battens	0,03	11,16	0,05	18,60	0,06	22,32	0,08	29,76	0,04	14,88	0,06	22,32
Doors	8,4	Solid wooden door	0,14	1,18	0,10	0,84	0,06	0,50	0,08	0,67	0,10	0,84	0,1	0,84
150 chairs	150	Chair with fabric on seat and back	0,10	15,00	0,30	45,00	0,30	45,00	0,30	45,00	0,35	52,50	0,35	52,50
Sum: α · S (m^2Sabine)				77,94		126,04		211,82		243,83		278,42		234,06
Reverberation time T(sec) per. 1/1 octave Ms = (0,16 · V)/A = (0,16 · 6630)/($\alpha_1 \cdot S_1$ + $\alpha_2 \cdot S_2$ +...$\alpha_n \cdot S_n$)				2,71		1,68		1,00		0,87		0,76		0,90

$T_{average}$ = 1,4 ≥1,2 ± 0,2 sec. at frequency range 125 Hz - 4000 Hz
The demand in the competion brief is fulfilled

Reverberation time - Music stage when used for conferences(500 Hz-20000 Hz)

Surface	Area, S	Material description	500 H		1 kHz		2 kHz	
			α	α · S	α	α · S	α	α · S
Floor	220	Wooden floor on joints	0,10	22,00	0,07	15,40	0,06	13,20
Ceiling	220	50 mm wood concrete plates	0,35	77,00	0,45	99,00	0,65	143,00
Interior walls excl. doors	372	Polished wooden battens	0,06	22,32	0,08	29,76	0,04	14,88
Doors	8,4	Solid wooden door	0,06	0,50	0,08	0,67	0,10	0,84
150 chairs	150	Chair with fabric on seat and back	0,30	45,00	0,30	45,00	0,35	52,50
Retractable sound absorbing curtains	90	Heavy curtains infront of wall	0,50	45,00	0,60	54,00	0,60	54,00
Sum: α · S (m^2Sabine)				211,82		243,83		278,42
Reverberation time T(sec) per. 1/1 octave Ms = (0,16 · V)/A = (0,16 · 6630)/($\alpha_1 \cdot S_1$ + $\alpha_2 \cdot S_2$ +...$\alpha_n \cdot S_n$)				1,00		0,87		0,76

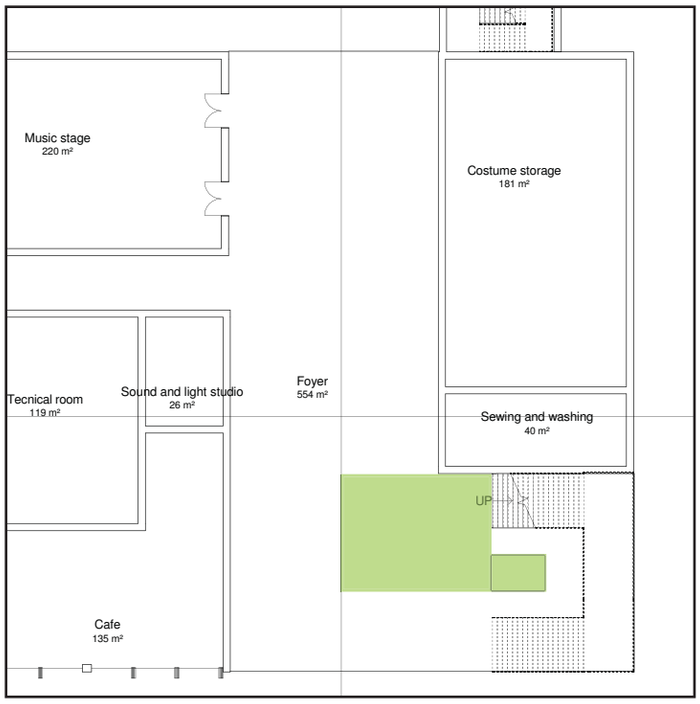
$T_{average}$ = 0,9 > 0,8 sec. at frequency range 500 Hz - 2000 Hz
The demand in the competion brief is almost fulfilled

PUBLIC FLOW

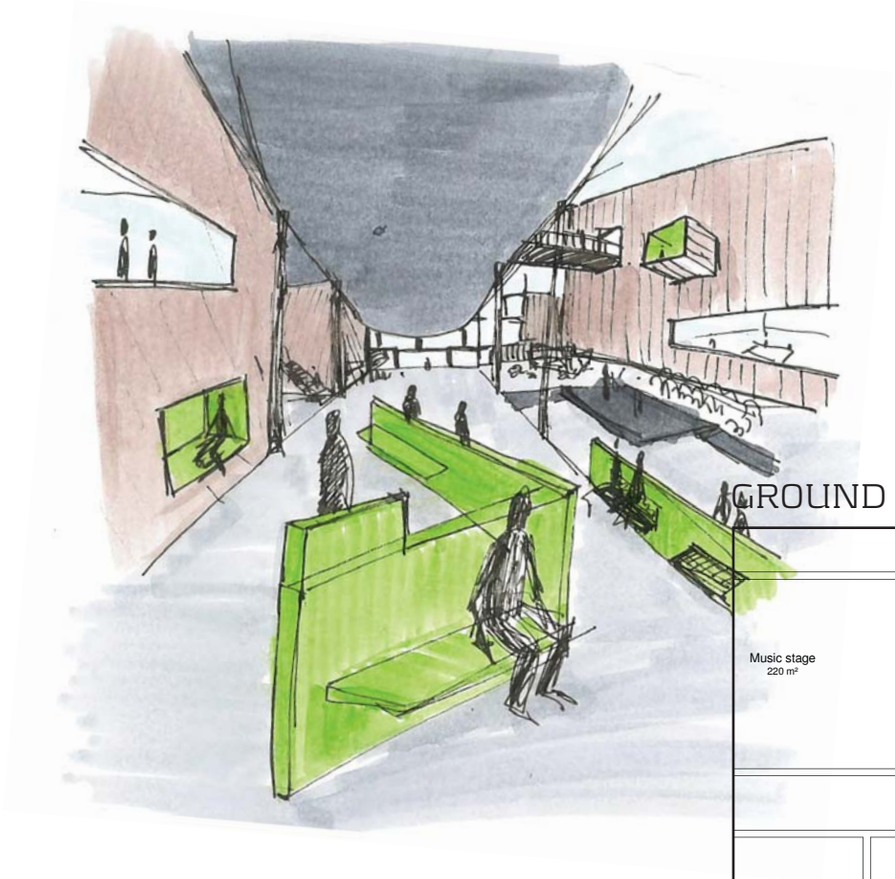
From the meeting with the municipality it was made clear, that the sound and light studio should be moved to the ground floor. The studio is moved to where the ticket office was placed.

The music stage is moved from underneath the Black Box towards east to underneath the workshop towards north. This is done in order to be able to create a clear division between people who have tickets to a theatre performance and the public areas in the building.
Where the Music stage where placed earlier storage for costumes and washing and sewing area are placed at ground level. On the first floor, the actor area is placed together with wardrobe and toilets.
A glass wall in the foyer divides the public area from the area where only people who are going in the theatre have access. The semi-private area for people with tickets are marked with a green colour on the plan drawings to the right.

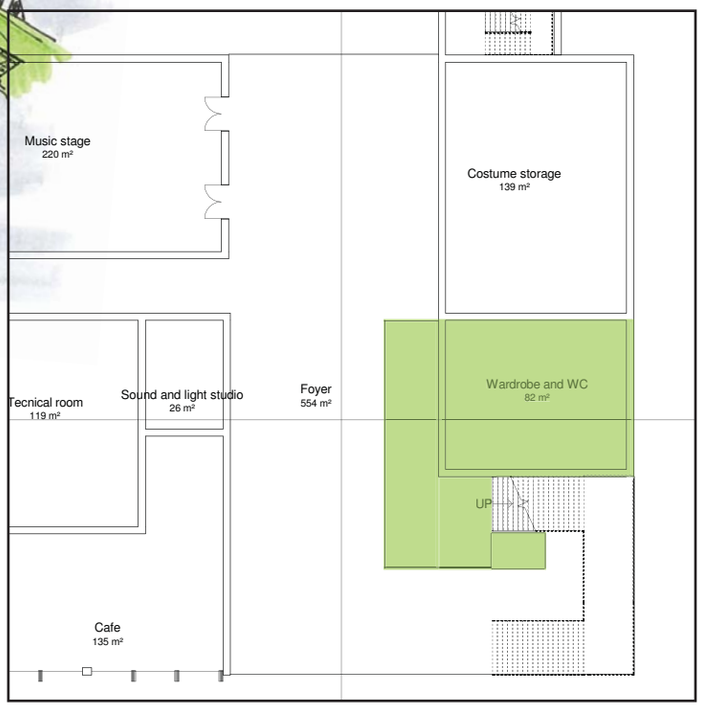
GROUND FLOOR, 1:400



1ST FLOOR, 1:400



GROUND FLOOR, 1:400



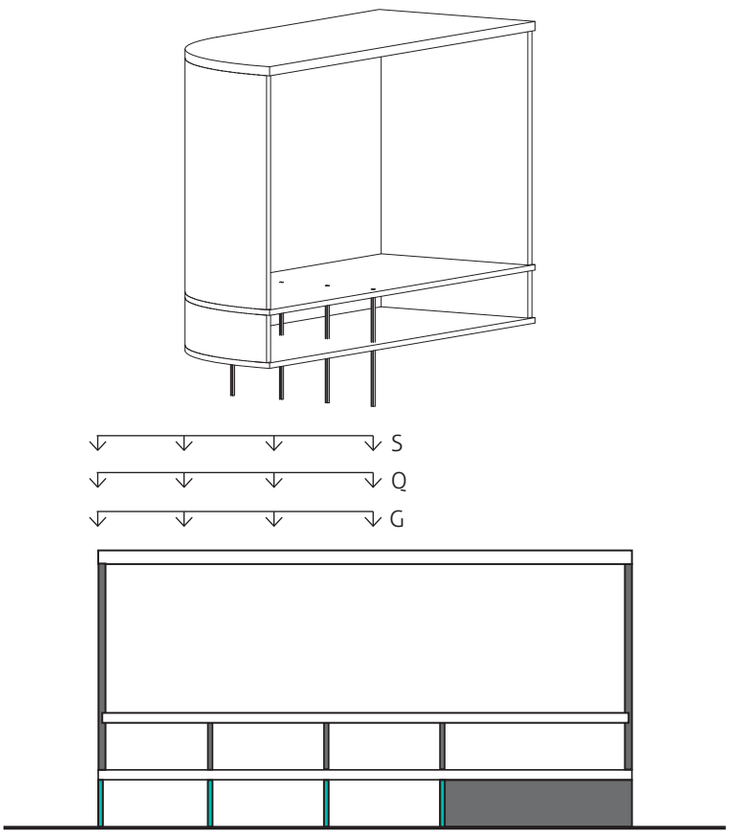
When the theatre performance is over, up to 350 people come out from the stage at the same time. In that connection, location of the wardrobe on the first floor could give some complications. People would have to wait in line on the staircase to pick up their coats. Therefore, the wardrobe and toilets are moved to the ground floor. To the right plan drawings show the new solution.

The elevator can be used by disabled and for staff from the café to arrange drinks and snacks on the break platform on 2nd floor

1ST FLOOR, 1:400

COLUMN IN THE CAFÉ

The large theatre stage is a large heavy volume which is carried by concrete walls of the technical room, sound and light studio and ticket office at ground floor. However, it is nessesary to have bearing columns in the wall between the café and the foyer.
The expression of the wall should be as transperant as posible to generate a visiual connection between life in the foyer and life in the café. To determine how many columns it is nessesary to have in the wall, a calculation is carried out in the following. It is estimated that the columns are to carry half of the load from the large theatre stage because, as mentioned earlier, also concrete walls carry some of the wheigt



Dimensioning of column under the large theatre stage, In-the-round

All references are from Teknisk Ståbi, TS, the 21.th edition.

First, the load combination is determined.

Live load, Q

$$Q = n \cdot A \cdot q_k$$

n, numbers of levels, which needs support = 2

A, area = 442m^2/2 = 147,33m^2

q_k =4,00kN/m^2 (TS p. 167, Cat. C2)

$$Q = 2 \cdot 147{,}33m^2 \cdot 4{,}00\ \frac{kN}{m^2} = \mathbf{1178,67}\boldsymbol{kN}$$

Snow load, S

$$S = \mu_i \cdot C_e \cdot C_t \cdot S_k$$

μ_i, is the shape factor of the roof = 0,80 ,which mean the roof pitch from 0 to 30 degrees

C_e, exposure factor =1,0

C_t, thermal factor =1,0

S_k, characteristic terrain value = 0,9 kN/m^2

$$S_1 = 0{,}80 \cdot 1{,}0 \cdot 1{,}0 \cdot 0{,}9\frac{kN}{m^2} = 0{,}72\frac{kN}{m^2}$$

$$S_2 = A \cdot S_1 = 147{,}33m^2 \cdot 0{,}72\frac{kN}{m^2} = \mathbf{106,08}\boldsymbol{kN}$$

Dead load, G

$$G = n \cdot A \cdot g_k$$

n, numbers of levels = 3

g_k, deadload, construction of the building = 3,89kN/m^2

$$G = 3 \cdot 147.33m^2 \cdot 3{,}89\frac{kN}{m^2} = \mathbf{1719.38}\boldsymbol{kN}$$

Load combination

It is assumed that the live load is greater than snow load

$$P_1 = 1.0 \cdot G + 1.5 \cdot Q + \psi \cdot S_2$$

Ψ-factor =0,6 (TS p. 166, table 4.6, Cat. C)

$$P_1 = 1{,}0 \cdot 1719{,}38kN + 1{,}5 \cdot 1178{,}67kN + 0{,}6 \cdot 106{,}06kN = \mathbf{3551{,}03kN}$$

Calculation of the needed amount of columns

The basis for the calculation can be found in Teknisk Ståbi, at page 292, example 6.6.

We know that the column must resist the load from the upper floors P = 3551,03 kN. A calculation shall demonstrate how much load one column can hold before deformation.

$$P_2 > P_1$$

The column has a height of 3000 mm from the ground floor to the floor of the technical room. The column is a HE-B profile and it has a width at 160mm and height 160mm which gives the column a section area of 5430mm^2.

The column is made of steel and steel has a characteristic yield stress at 365 MPa and a modulus of elasticity of 8,89 · 10^6 MPa. i_y is given 40,5mm. The values for the profile are given in TS p. 240.

Buckling at the y-axis:

$$\left(\frac{l_s}{i}\right)_{y,eq} = \left(\frac{l_s}{i}\right)_y = \frac{3000mm}{40{,}5mm} = 74.07$$

Buckling at the z-axis:

$$I_z = Iz + A \cdot 13,8^2 = 8{,}89 \cdot 10^6 mm^4 + 5430mm^2 \cdot 13{,}8^2 = 9{,}92 \cdot 10^6 mm^4$$

$$i_z = \sqrt{\frac{I_z}{A}} = \sqrt{\frac{9{,}92 \cdot 10^6 mm^4}{5{,}43 \cdot 10^3 mm^2}} = 42{,}75mm$$

$$\left(\frac{l_s}{i}\right)_z = \frac{3000mm}{42{,}75mm} = 70{,}17$$

$$\left(\frac{l_s}{i}\right)_{z,ep} = \sqrt{\left(\frac{l_s}{i}\right)_z^2} = \left(\frac{l_s}{i}\right)_z = 70{,}17$$

To find the deflection of the column we need to find the slenderness number λ, which tells how easy the material bends

$$\lambda = \frac{\frac{l_s}{i}}{93{,}9\varepsilon} = \frac{70{,}17}{93{,}9 \cdot 1{,}0} = 0{,}75$$

ψ needs to be found before the column reduction factor, which gives the indicating the relationship between the critical load capacity and the cross-section flow capacity [6.semeste 2011, Poul Henning Kierkegaard, 'Bygningskonstruktioner og Arkitektur, slides from his second lecture]

$$\varphi = \frac{1}{2} \cdot (1 + 1 \cdot (\lambda - 0{,}2) + \lambda^2) = \frac{1}{2} \cdot (1 + 1 \cdot (0{,}75 - 0{,}2) + 0{,}75^2) = 0{,}16$$

$$\chi = \frac{1}{\varphi + \sqrt{\varphi^2 + \lambda^2}} = \frac{1}{0{,}16 + \sqrt{0{,}16^2 + 0{,}75^2}} = 1{,}08$$

Now we can find out if the column can hold the load by calculating P_2. γ_{M1} is 1.2 (TS p. 228, Cat. C)

$$P_2 = \frac{\chi \cdot A \cdot f_{yd}}{\gamma_{M1}} = \frac{1{,}08 \cdot 5{,}43 \cdot 10^3 mm^2 \cdot 235 \cdot 10^{-3} MPa}{1{,}20} = 1146{,}30kN$$

The load P_1 is too much for one column. Therefore does the load need to be distributed to more columns and the needed amount of columns is

$$x = \frac{P_2}{P_1} = \frac{3551{,}03kN}{1146{,}30kN} = 3{,}01$$

The calculation shows that 3,01 columns are needed, however, we rounds up to four columns to be sure that the load from In-the-round and technical room can be lifted.

ENERGY CONSUMPTION

Defined in the programme, this project strives to fulfil the energy frame of low-energy class 2020. This is to be documented by a Be10 calculation of the total energy consumption of the building.

Be10 calculation

To fulfil energy frame of energy class 2020, the total demand for energy supply for heating, ventilation, cooling, domestic hot water and lighting pr. m² heated floor area should not exceed 25 kWh pr. year.
The energy consumption of the building is estimated in Be10. This section describes values used in the Be10 calculation.

The building

- Heat capacity, extra heavy: 160
- Service time, 08:00-23:00 seven days a week: 105 h/week
- Heat supply [Projektkonkurrence 2013]: District heating
- Contribution: Solar cells

External walls, roof and floors
Documentation of areas of external walls, roof and floors as well as lengths of foundations and joints around windows can be found at the enclosed CD.

- b-factor for ground slab, without floor heating: 0,70
- External walls of concrete, Expan sandwich element (450 mm): U-value = 0,15
- External walls of brick: U-value = 0,12

Windows and exterior doors
Documentation of window and door areas can be found at the enclosed CD.

- COOL-LITE SKN glass [web 14]: U = 1,3, g = 0,27
- Sun protection factor Fc, mechanically controlled shielding are used for skylights and windows towards south and east above 2nd floor: Fc = 0,4
- Windows at ground and 1st floor towards south and east are shadowed by overhang.

Ventilation
In relation to ventilation, the building is divided into five different ventilation zones according to service time and needed air change rate. In summer, hybrid ventilation is used within three of the ventilation zones. Otherwise, the house is ventilated by mechanical ventilation. Using ventilation for cooling of the building, however, resulted in a high energy consumption of the building. Despite the economic aspect, mechanical cooling therefore has been chosen. In the Be10 calculation values of the air change rate are therefore the calculated values in regards to the atmospheric indoor climate.
Documentation of the needed air change rate in the large theatre stage can be found in the appendix. Documentation of the needed air change rate in the other ventilation zones can be found at the enclosed CD.

Infiltration
- Outside service time: 0,06 x 0,5 = 0,03
- In service time: 0,04 + 0,06 · 0,5 = 0,07

Lighting
In relation to lighting, the building is divided into five different zones according to service time, the needed lighting level and control.

Result

As it can be seen on figure 9 on the page to the right, the Theatre- and Experience House has a total energy consumption of 78,6 kWh/m² year. Electricity represents the largest contribution to the need of energy. On this basis implementation of solar cells has been a strategy to lower the total energy consumption of the building. As it can be seen on figure 10 on the page to the right, implementation of 880 m² PV panels lowers the total energy consumption from 78,6 to 24, 7 kWh/m² year. Hereby the house fulfils the energy frame of energy class 2020.
On the next page an estimation of roof area for PV panels are carried out to determine if there is space for 880 m² PV panels.

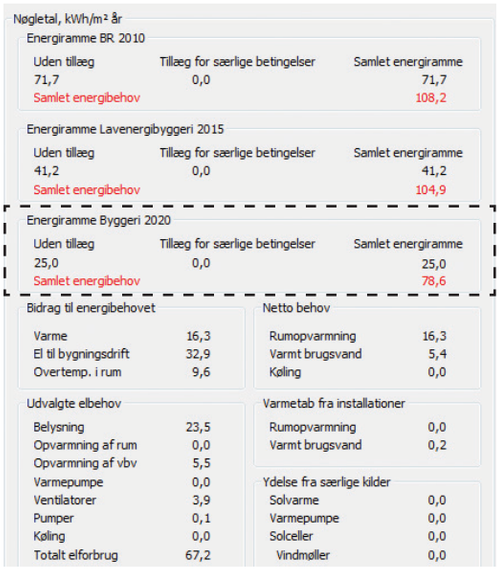


Fig. 9: Energy consumption of the house in relation to the energy frame of energy class 2020

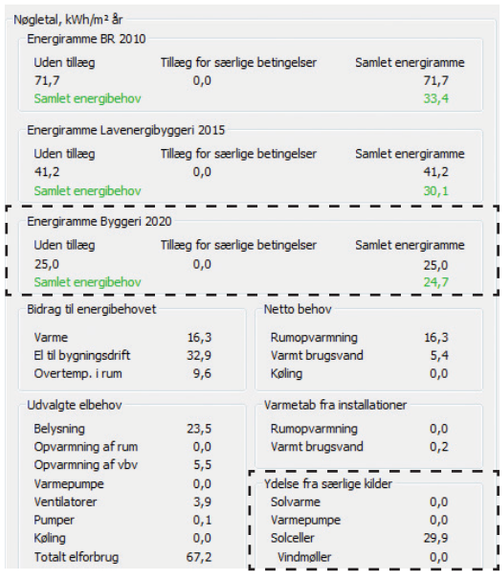


Fig. 10: Energy consumption of the house with solar cells

Estimation of area of photovoltaic panels on the roof

The needed area of PV panels is estimated in Be10. Values to the peak power (kWh/m²) and the system efficiency are chosen from tables in BPS 128. The photovoltaic panels are placed straight towards south and with an angle of 45 degrees. In the Be10 calculation it can be seen that it is necessary with 880 m² of PV panels to lower the total energy consumption of the building from 78,6 kWh/m² year to under 25 kWh/m² year.
Shadows from the glass screen along the edges of the roof are not taken into account.

The PV panels are placed on the roof of the building and should not shadow each other.
The length of the shadow on March 21 therefore is calculated. On this date the altitude angle is 34,10 deg (see enclosed CD).

On March 21 one PV panel takes up a total length of 2,2 m. See figure 11.
There are four areas on the roof which are not shadowed by the large theatre stage at noon. See figure 12. However, in the morning some panels at area 1 are shadowed. In the afternoon some panels at area 3 are shadowed. Panels placed at area 2 and 4 are not shadowed.
The following is an estimation of how large an area of PV panels it is possible to place at each of the four areas of the roof without shadowing each other.

Area 1
Roof area dimensions:
41m · 13m
Number of rows:
41m / 2,2m = 18 rows of PV panels
This makes a total area of panels:
(1,25m · 13m) · 18 = 292,5 m²

Area 2
Roof area dimensions:
19,2m · 20,3m
Number of rows:
19,2m / 2,2m = 8 rows of PV panels
This makes a total area of panels:
(1,25m · 20,3m) · 8 = 203 m²

Area 3
Roof area dimensions:
41m · 15m
Number of rows:
41m / 2,2m = 18 rows of PV panels
This makes a total area of panels:
(1,25m · 15m) · 18 = 337,5 m²

Area 4
Roof area dimensions:
8m · 20,3m
Number of rows:
8m / 2,2m = 4 rows of PV panels
This makes a total area of panels:
(1,25m · 20,3m) · 4 = 103 m²

Total area for PV panels:
292,5 m² + 203 m² + 337,5 m²
+ 103 m² = 936 m²

Needed area < area available
880 m² < 936 m² OK!

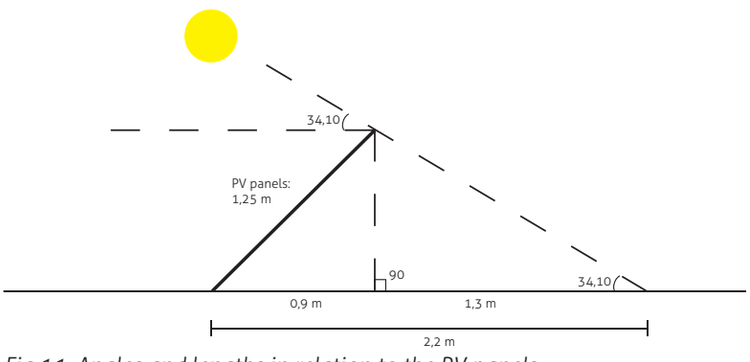


Fig 11: Angles and lengths in relation to the PV panels

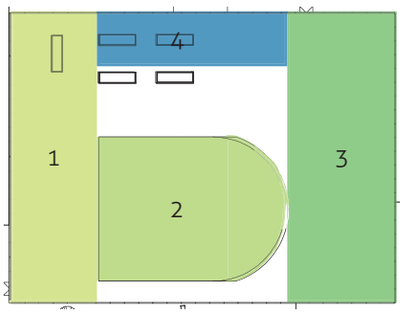


Fig 12: Areas on the roof for PV panels

CONCEPTUAL IDEA

Experience and transparency

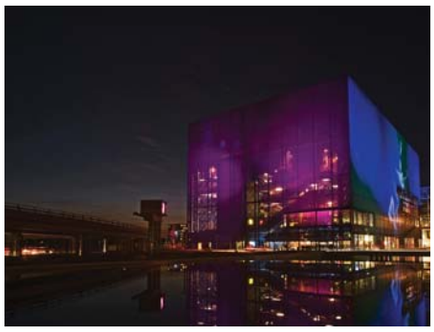
Sensuous and experiential qualities:

- Variability
- Living facade
- Energy, movement and activity
- Spatial experience
- Visual dialogue between inside and outside

Different identity of functions in the theatre

- Use of different materials

In the evening light changes the building expression and reflects life/ activity in the building



Different levels of privacy

- Transperancy

SELECTION - LOOP III

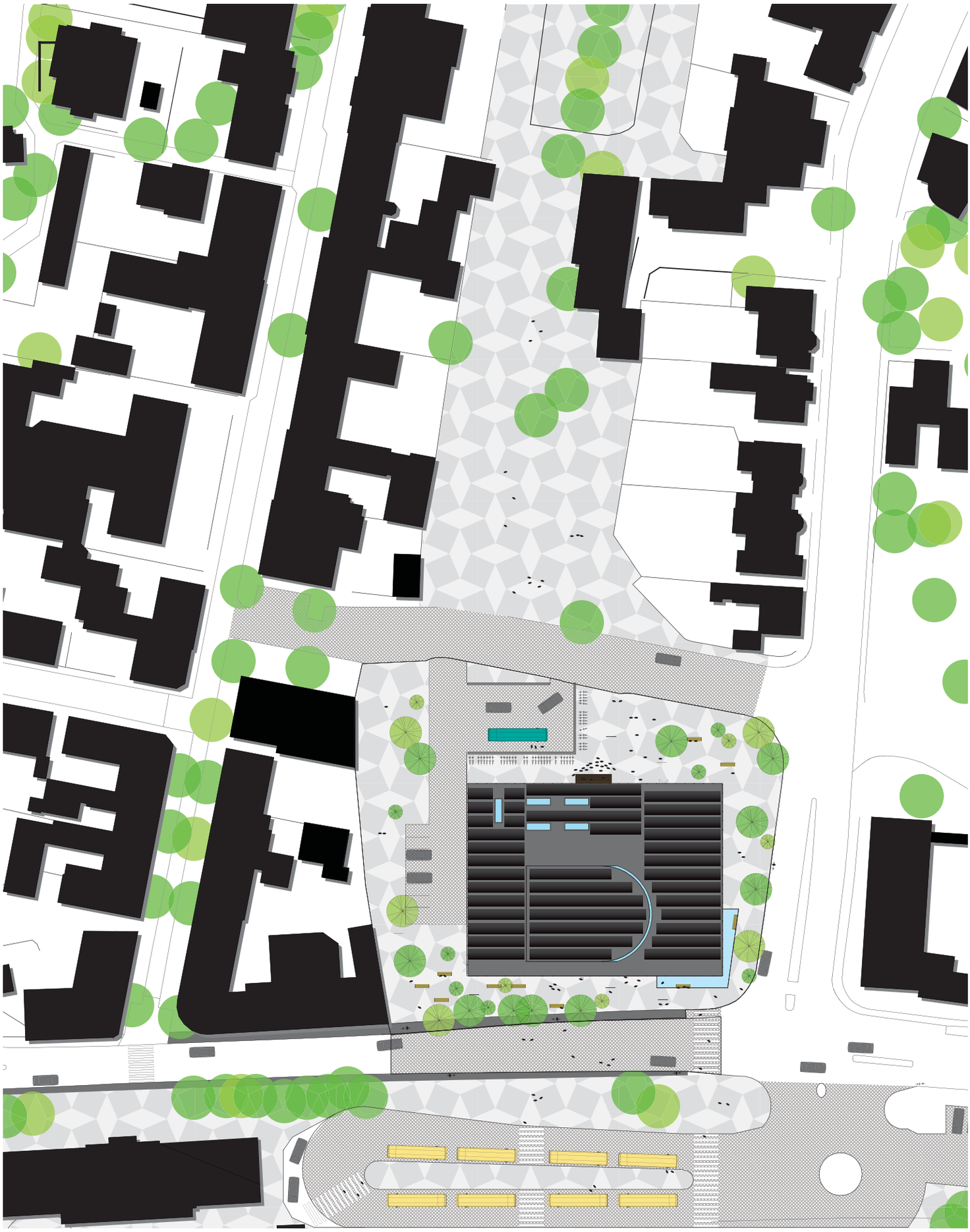
Sketching in relation to backstage and public flow of people in the building has resulted in a design solution which is presented in the next chapter.

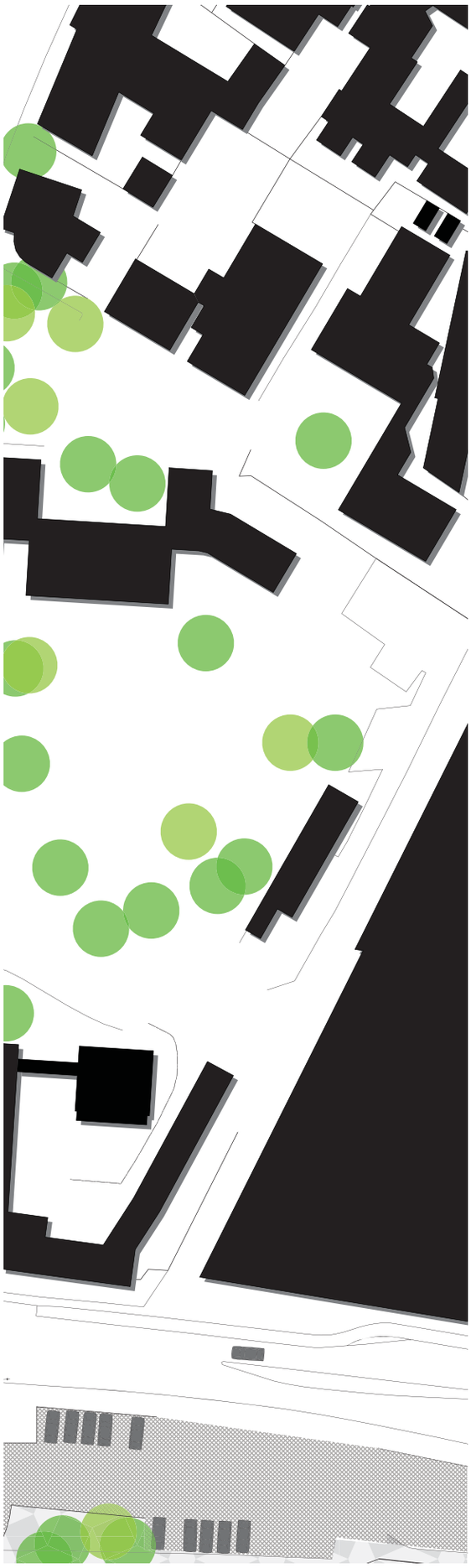
The urban design is to create a connection between the public transport and the city centre. This is pursued by creating a coherent coating from the public transport area, over the road and through the house. Also the transparency of the house creates a visible connection between the house and its surroundings and invites people to go through the theatre axis. Hereby the house becomes part of the public spaces in Hjørring and the urban flow of people from the public transport is lead across the site and through the building. Also the house becomes an obvious place to spend waiting time in connection with bus or train travel or as a central meeting place in Hjørring from where one can experience life outside as well as inside the house. The strategy is to generate as much life and social activity as possible in the building.
In the evening the transparent facades towards south and east makes the building light up towards 'Frederikshavsvej' and people moving inside the building will from outside be perceived as silhouettes.

The choice of materials supports the vision of creating a design that relates to the human body and hereby, in itself, provides spatial and sensuous experiences. The transparent screen of glass creates a visual dialogue between inside and outside. Normally a theatre is a closed building where typically only the interior of stages are experienced by the guests. The transparent screen, however, makes it possible for people in the city to experience the exterior of different stages as well as backstage functions and the flow between them. Use of different materials for different stages gives them their own identity and they become easy to perceive as different functions by the human eye. Heavy bricks for the large theatre stage, In-the-round, makes the stage seem as a large heavy volume in the space. It is located in a height of three metres and hereby becomes a volume which people can move around and experience from more directions. In the café the roof is also of brick. Here one sits underneath the theatre stage.

The following chapter presents the final design.

SITE PLAN, 1:1000





PRESENTATION

This chapter presents the final design of the new Theatre- and Experience House in Hjørring. The gross area of the building is 4024 m^2 and includes two theatre stages; In-the-round and Black Box as well as one Music stage and a rehearsal stage which can also be used for conferences or other purposes. Furthermore there are a public stage in the foyer area and an outside stage in connection with the house.

Facts

Total energy consumption:	24,7 kWh/m^2 year
Energy consumption without solar cells:	78,6 kWh/m^2 year
Energy frame for low-energy class 2020:	25 kWh/m^2 year

Gross area:	4024 m^2
Area of solar cells:	880 m^2

EXTERIOR: SOUTHEAST

EXTERIOR: NORTHEAST

Transparent and visible entrance zone seen from the 'Mammutplads'. From here, different identities of functions inside the building such as the Black Box, backstage and workshop can be perceived by people passing by. The screen frames the functions so they, as a whole, create Theatre-and Experience House, Hjørring.

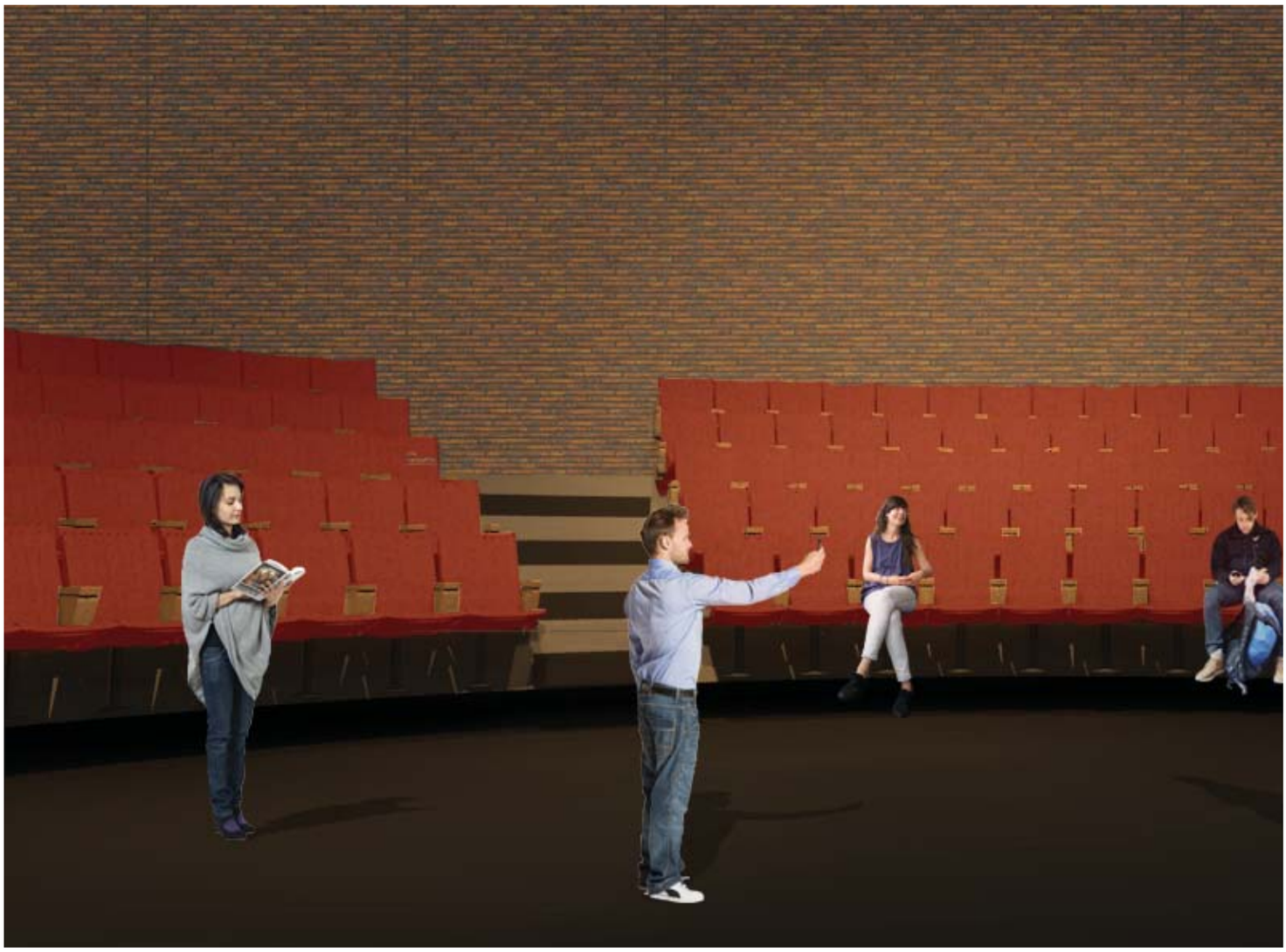
EXTERIOR: SOTHWEST

Café located in extension to the entrance zone on the south. The café serves the house as well as people passing by. Life in the cafe and foyer is part of the south facade and with its position to the road it becomes an attraction in the area. People waiting for the train can follow them arriving from the house.

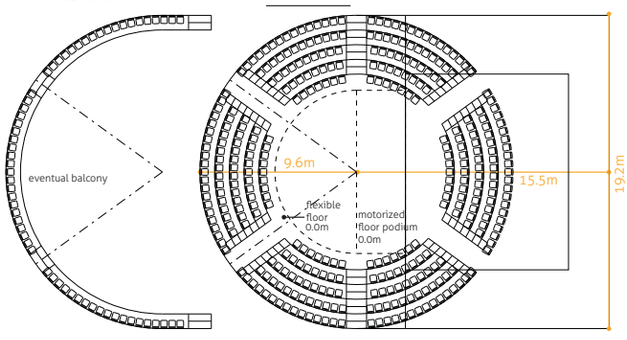
EXTERIOR: EVENING


METROPOL
METROPOL

INTERIOR: IN-THE-ROUND



"IN THE ROUND"



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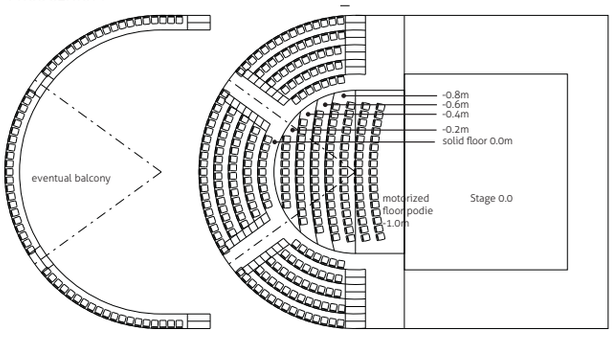
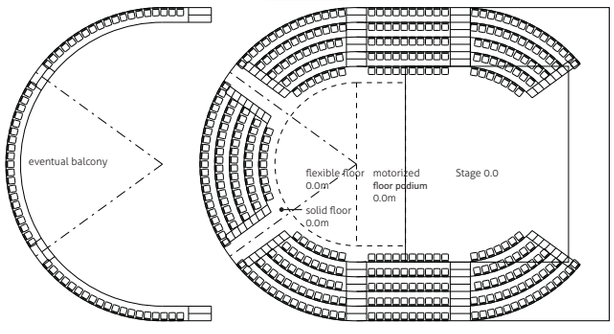
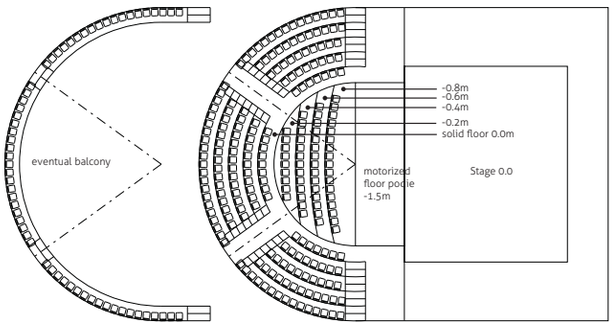
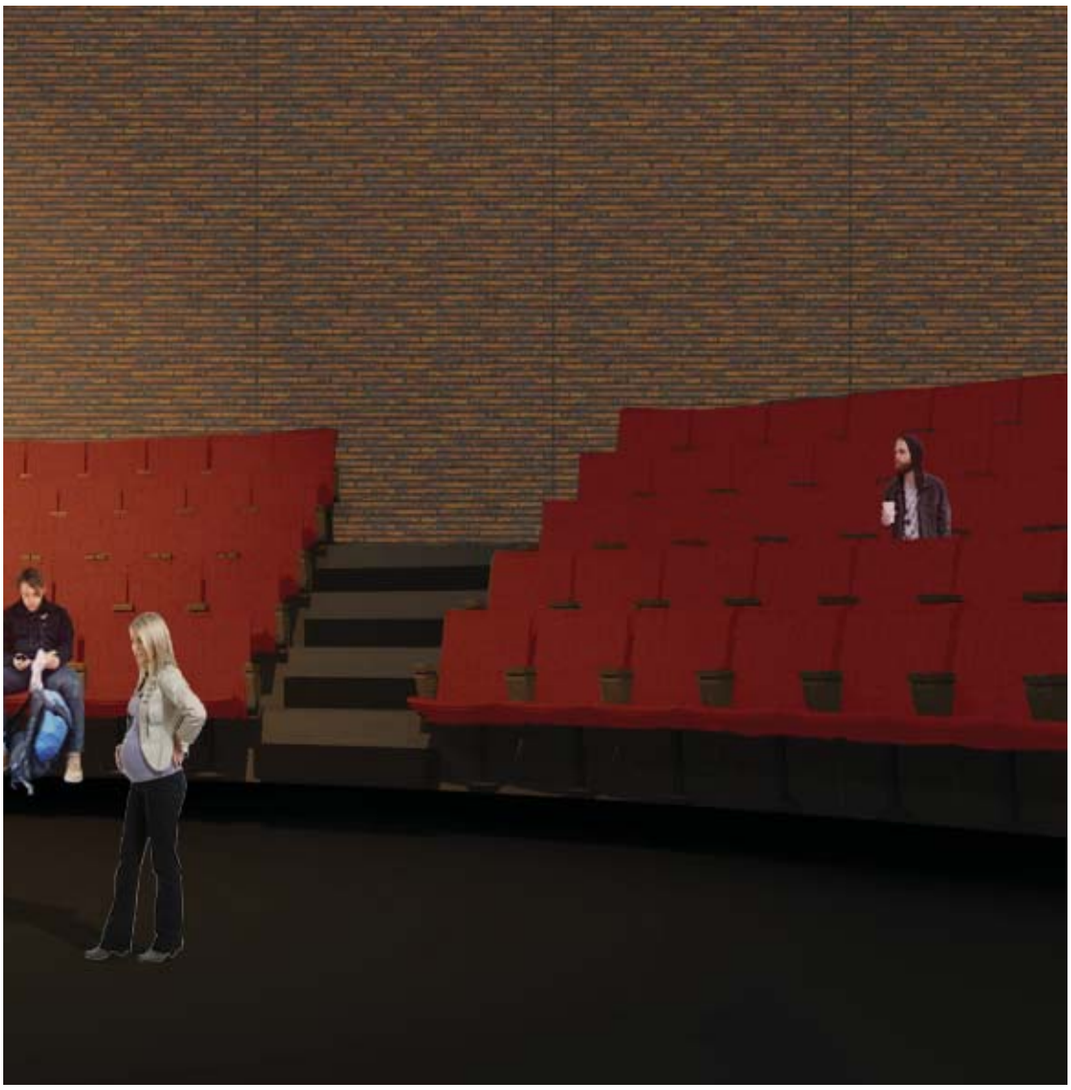


"HIPPODROME"



"PUBLIKUMSGRAV"





In-the-round is the core of the building and a space where feelings are in play. Within the intimate stage there are ample opportunity for both audience and actors to get unique experiences. The material, brick, goes again within the performance space which makes the frame recognizable. The stage is flexible and four different theatre configurations between audience and actors are possible.

INTERIOR: FOYER STAIRCASE

The staircase in the foyer is a central space in the house. It runs along the facade which, during the day, makes it possible for people to perceive the use of the building. Only people going in the theatre use the staircase and it hereby becomes a transparent transition zone between public and private. The staircase together with platforms on the 1st and 2nd floor is the break area from where people can enjoy the view over the city.

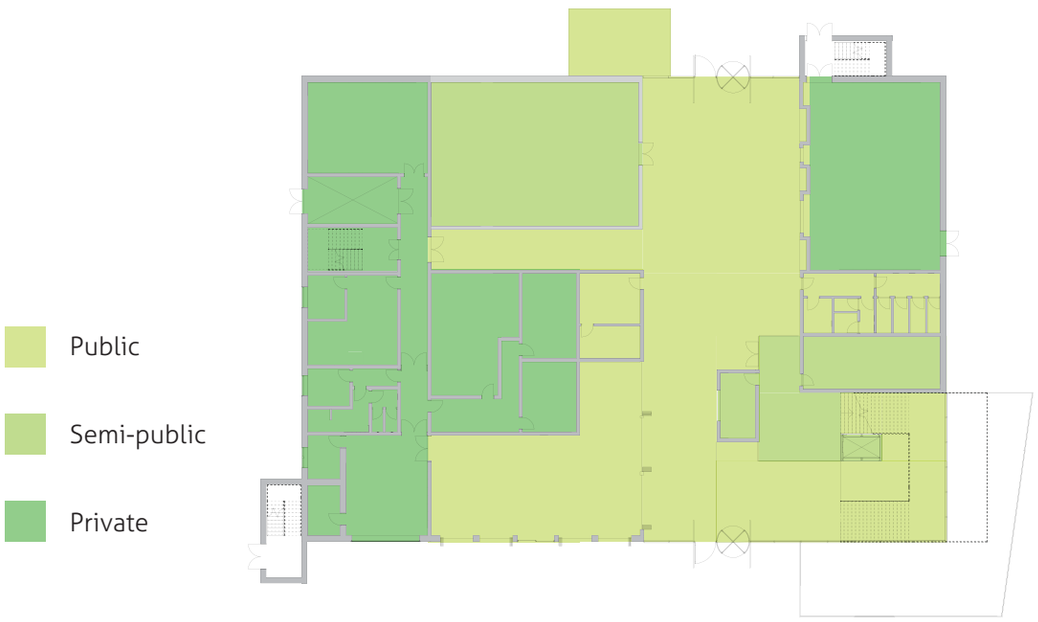
INTERIOR: FOYER STAGE


SÆSON
PROGRAM
2013/14
LEVENDE
BILLEDER
I OP TIL 4D


N
Costume storage
WC
Wardrobe
Foyer stage
Ticket office
Foyer
Outdoor stage
Sound and light studio
Café/canteen
Music stage
Technical room
Storage
Loading elevator
Cleaning room Technical staff
Kitchen

GROUND FLOOR, 1:250

At ground floor all the public spaces such as café, foyer and sound and light studio are located. It is here the public city life is to unfold with different activities during the day. Here it is also possible to meet and talk with the different users of the house such as e.g. actors who eat lunch in the café. Towards west more closed facilities such as storage, cleaning room and kitchen are located.




N
A-A
B-B
B-B
A-A
Actor area
Sewing
and
washing
In-the-round technique
Loading
elevator
Administration

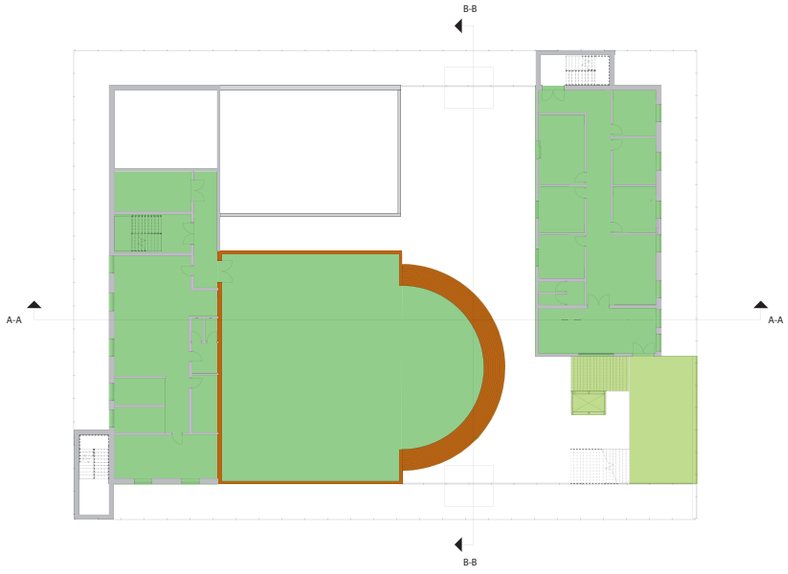
FIRST FLOOR, 1:250

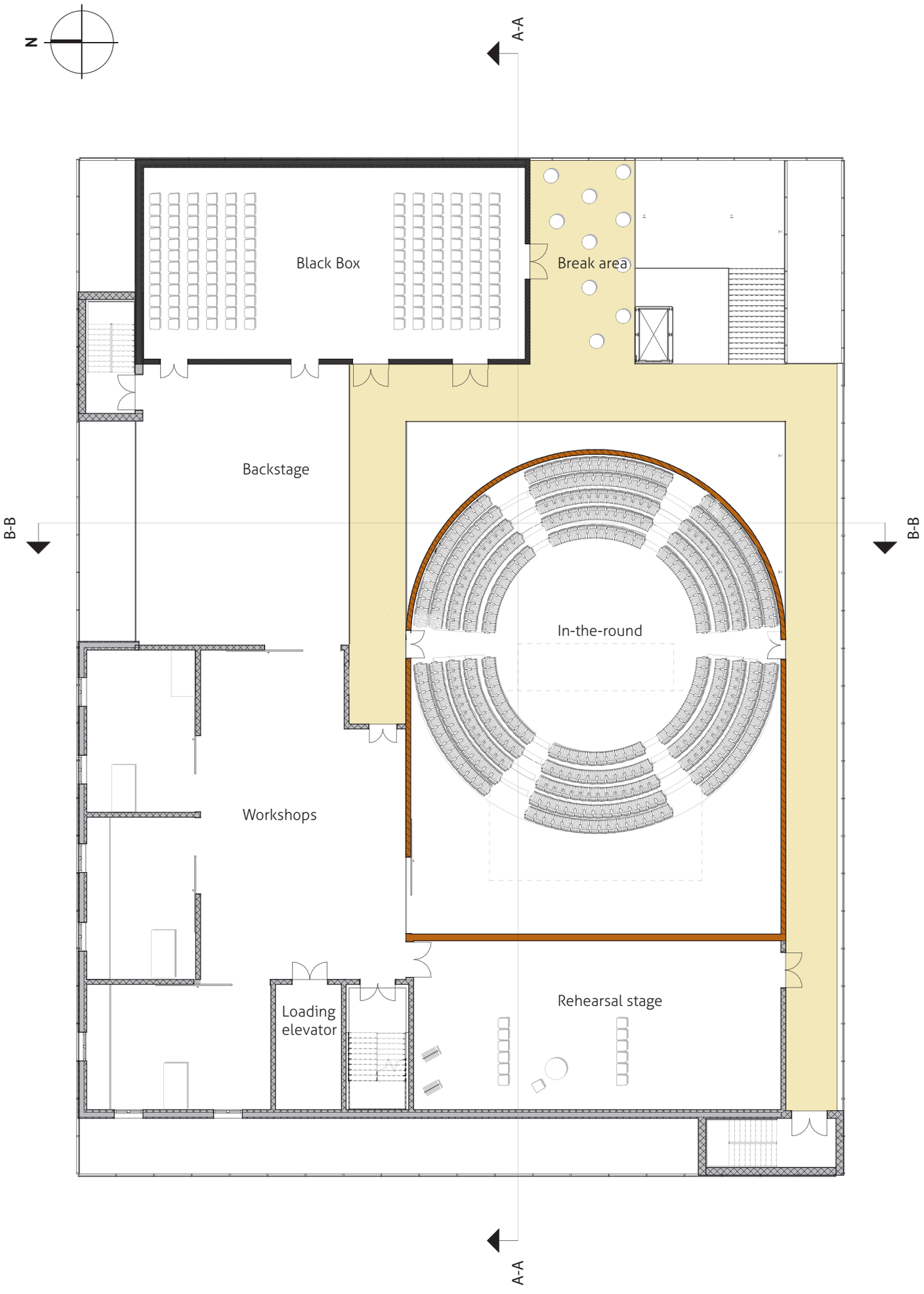
On the 1st floor spaces for the employees of the theatre are located such as the administration, actor area and the dressmaker area. The location on 1st floor makes them more private areas. At this level also the technical floor of In-the-round are located. Here it is also possible to store chairs.

Public

Semi-public

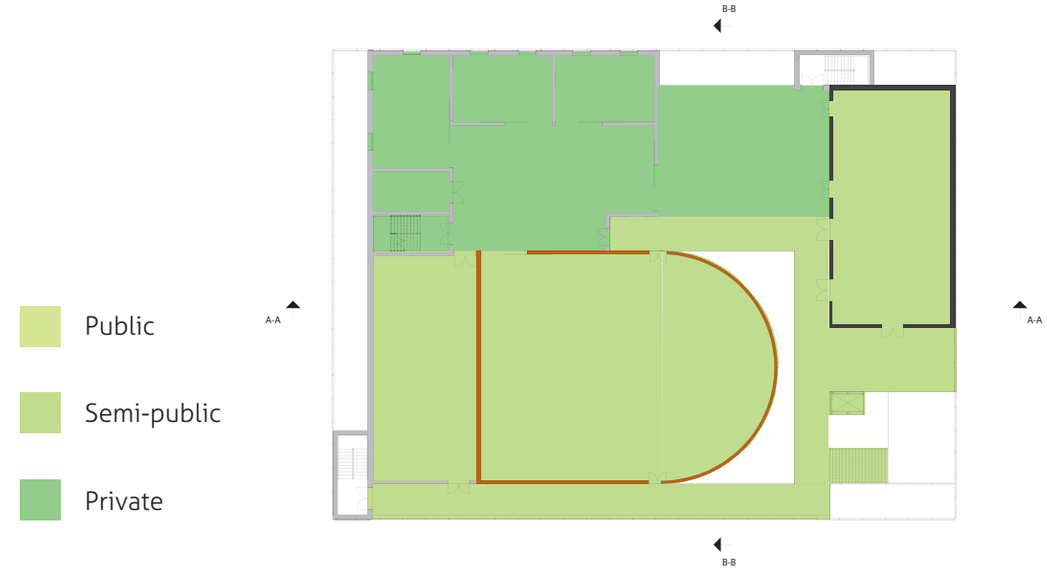
Private



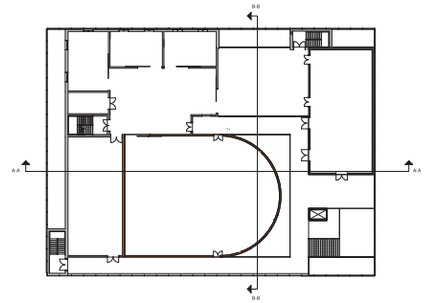

N
A-A
Black Box
Break area
Backstage
B-B
B-B
In-the-round
Workshops
Loading
elevator
Rehearsal stage
A-A

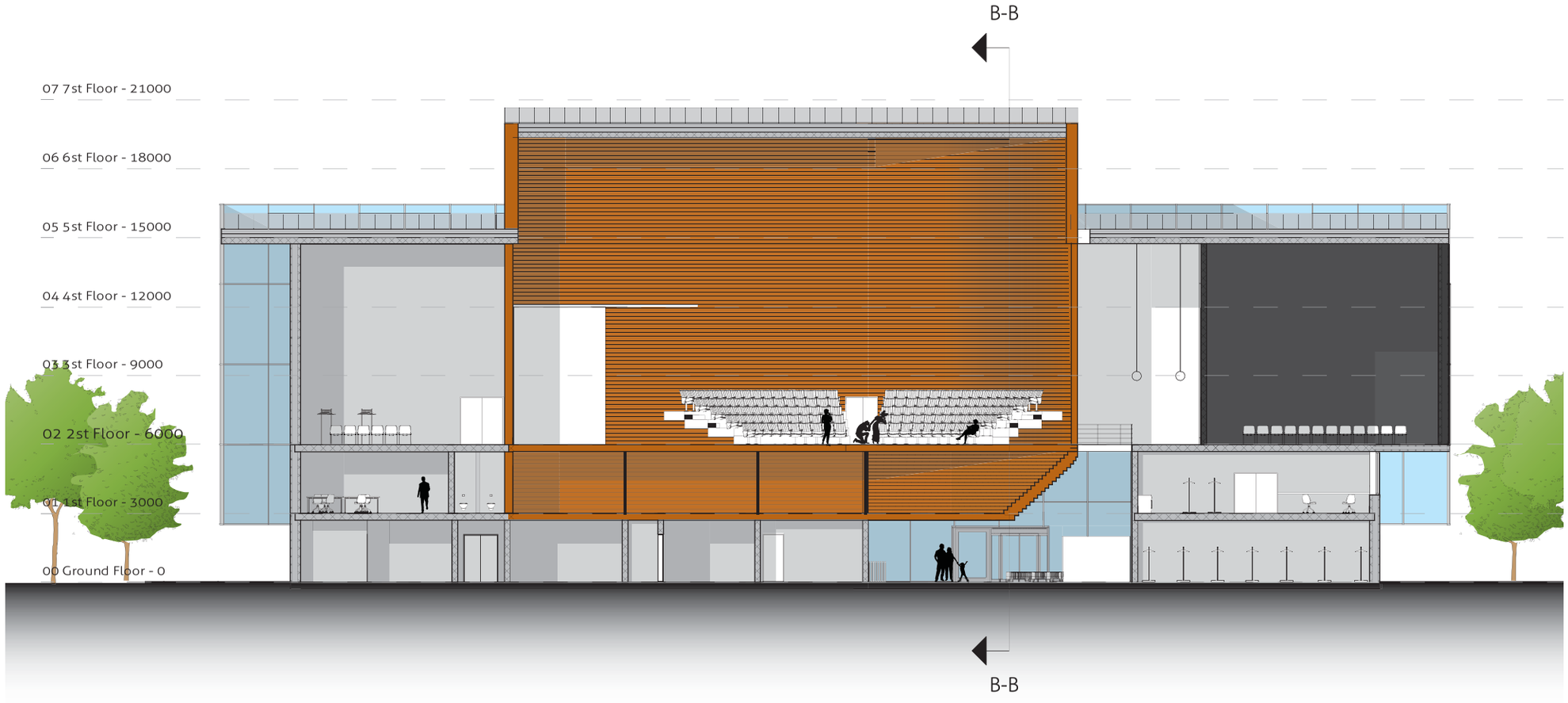
SECOND FLOOR, 1:250

On the 2nd floor all stages except from the music stage are placed. Only people buying a ticket goes to this area. Here the backstage area is semi-transparent for people to be able to perceive movement in the back-stage area. Walking on the staircase and break area on the 2nd floor makes it possible for people to experience the round shape of In-the-round from more directions. From the workshop there is direct connection to the three stages In-the-round, rehearsal stage and Black Box.

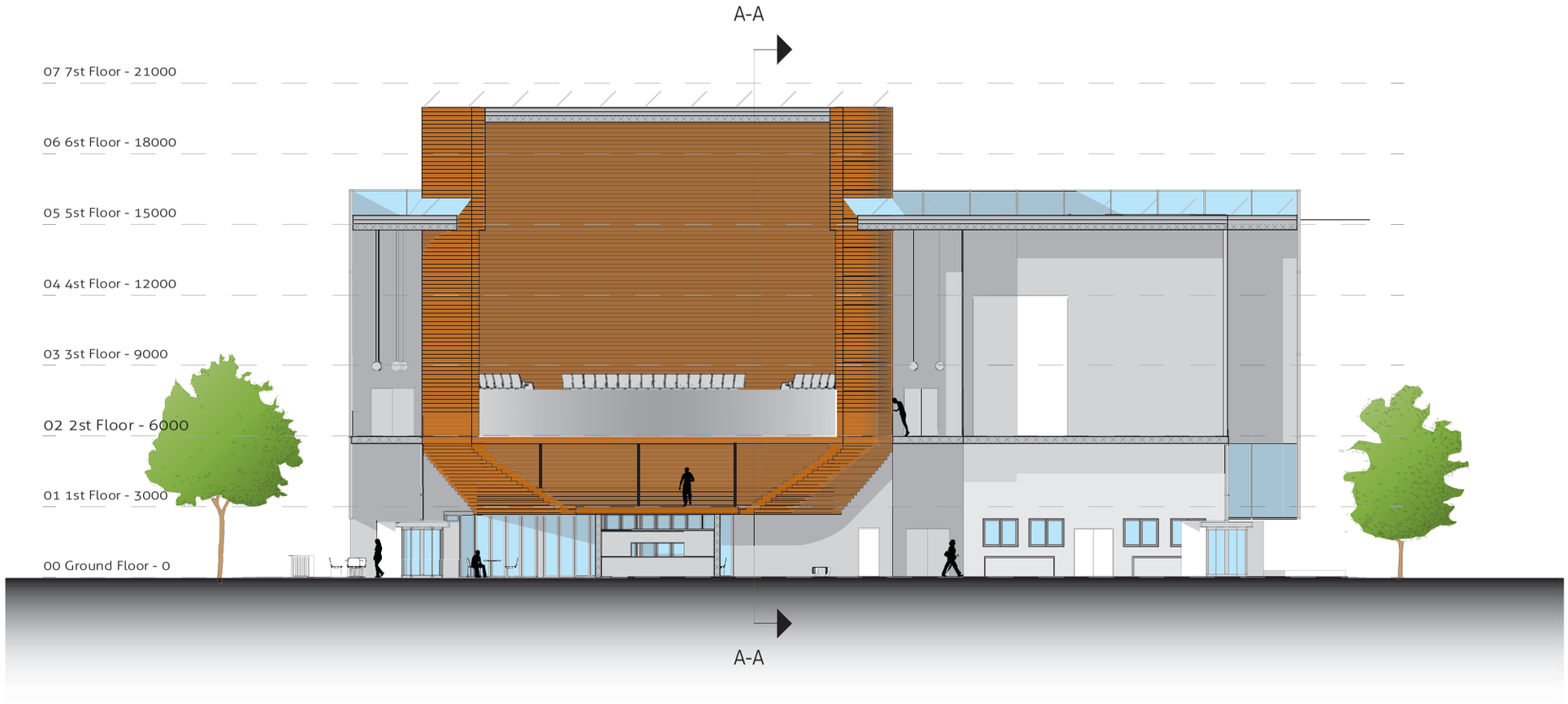


SECTION A-A, 1:250



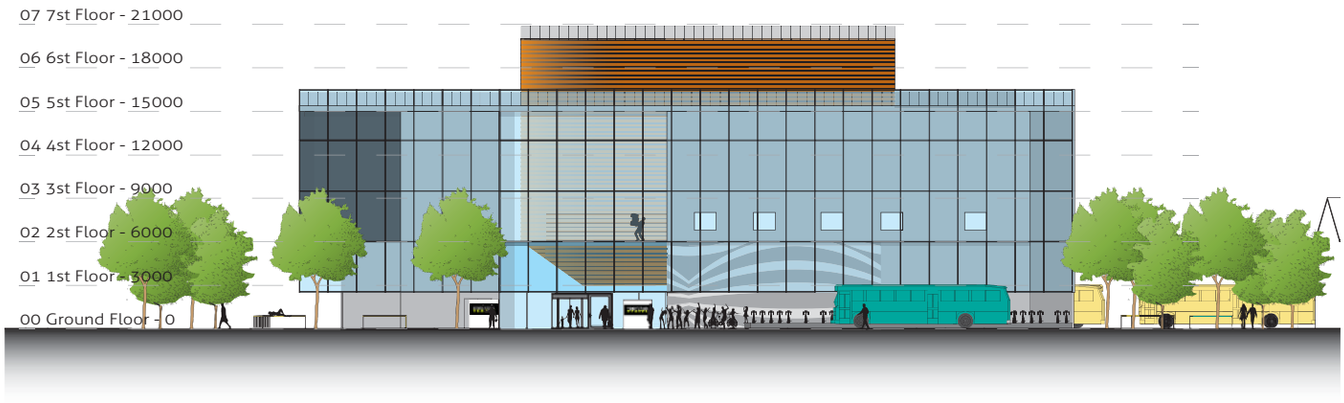


SECTION B-B, 1:250



FACADES, 1:500

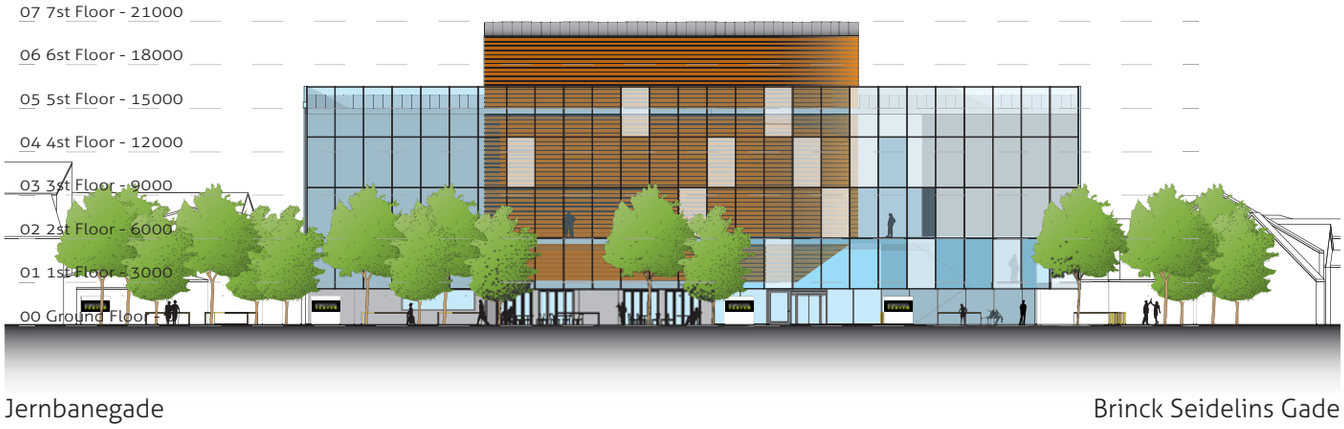
North



Brinck Seidelins Gade

Jernbanegade

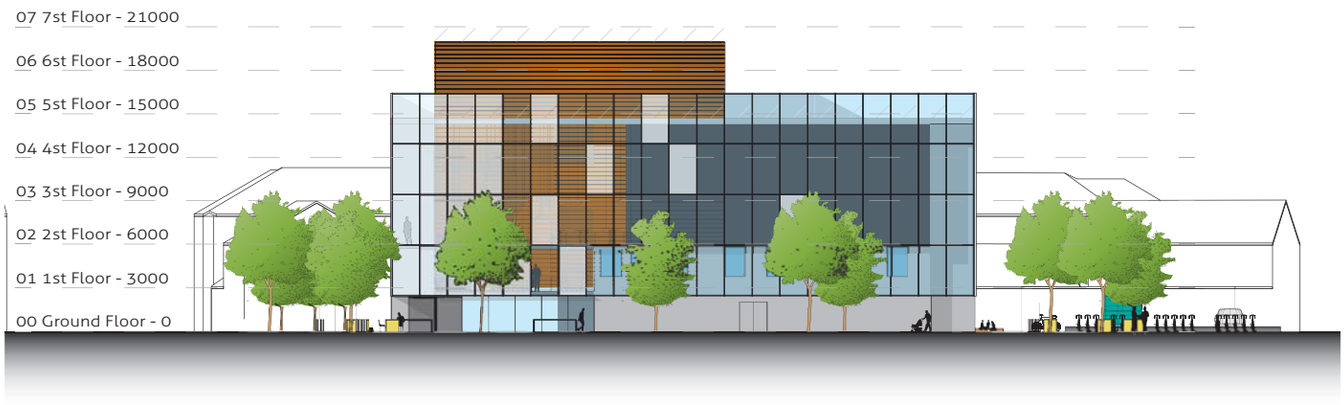
South



Jernbanegade

Brinck Seidelins Gade

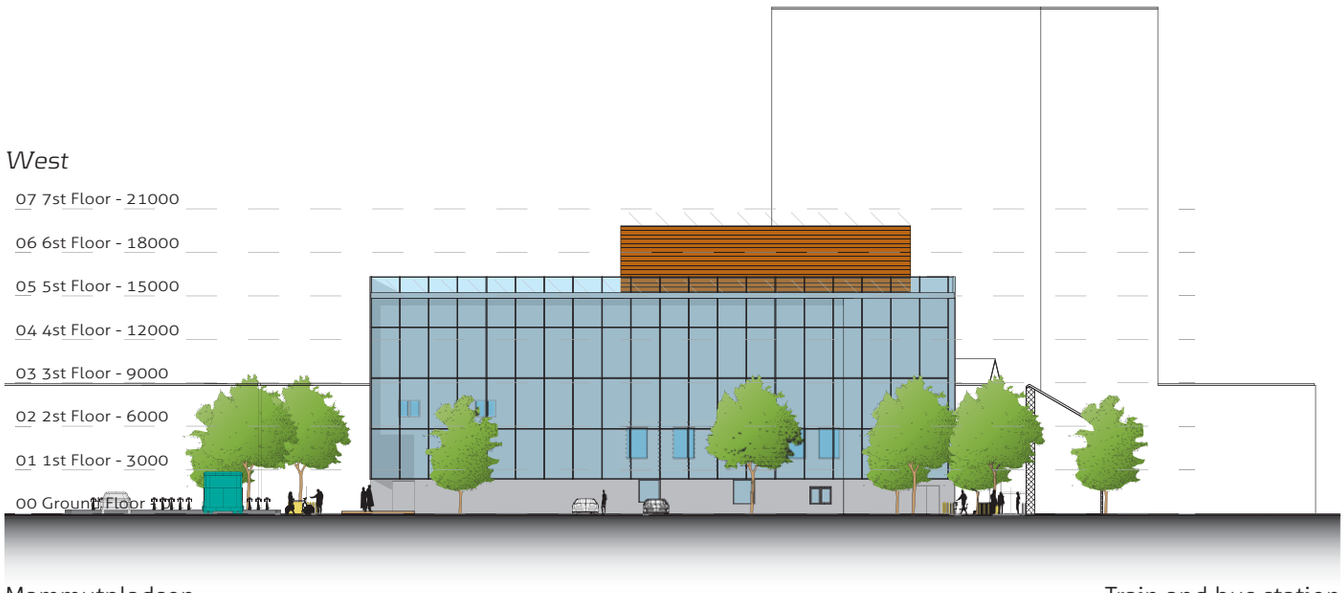
East



Train and bus station

Mammutpladsen

West



Mammutpladsen

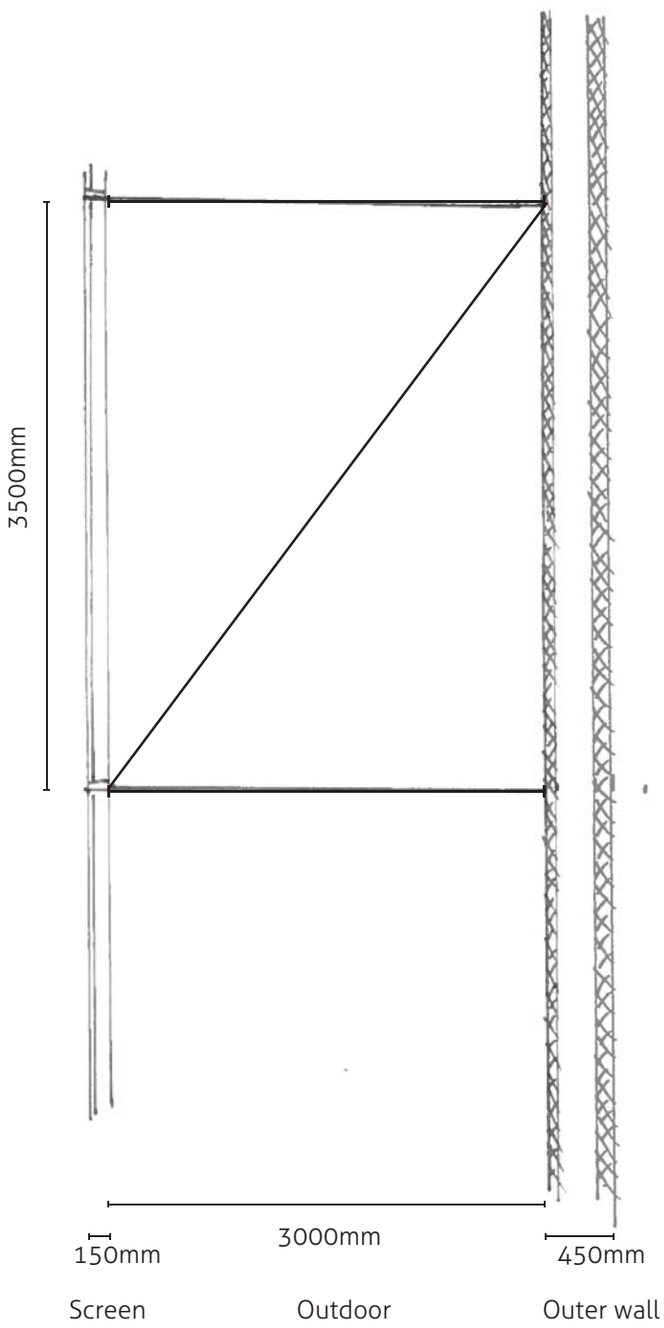
Train and bus station

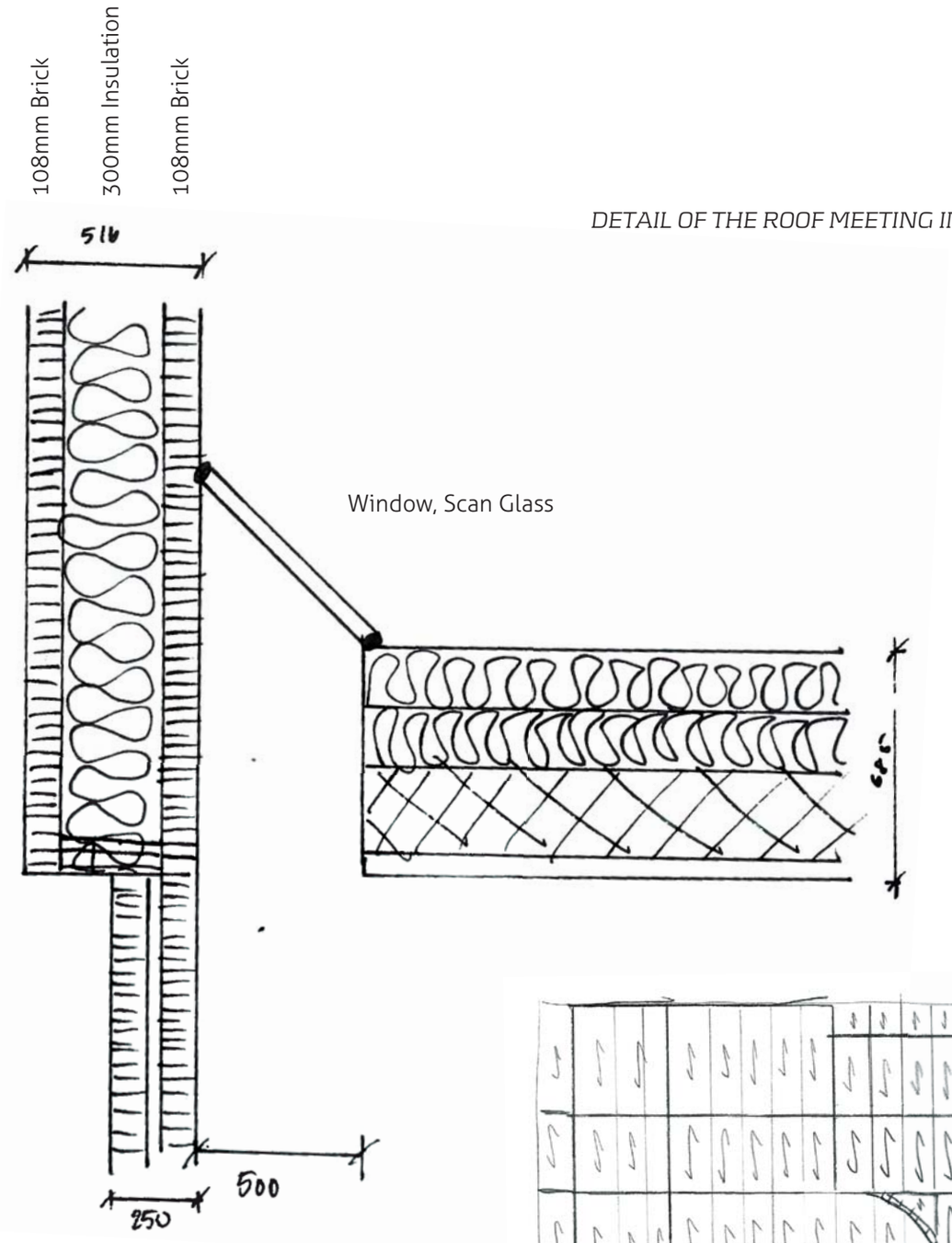
DETAIL DRAWING

The details illustrate some of the more important transitions between different elements. To the right is a detail of the screen. It shows how the screen is attached to the outer wall to make sure it is stabilized.

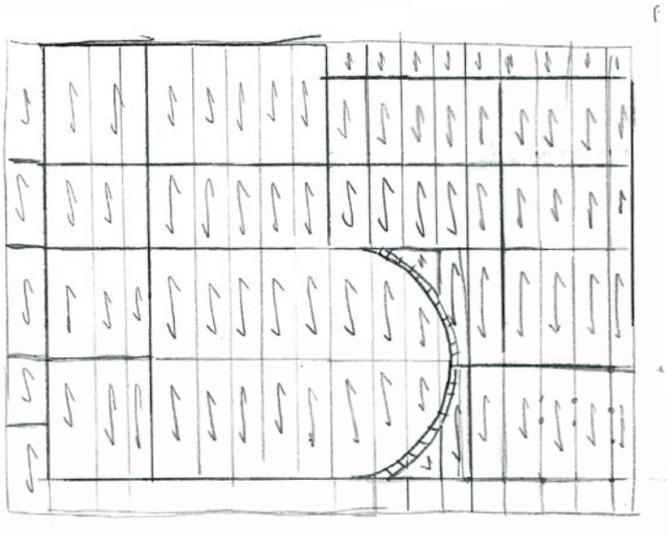
At the opposite page is the meeting point between the roof and In-the-round. These elements are creating a gap for skylight to penetrate through. The gap is closed by a window.
Below an illustration shows the span of the roof elements, where most of the slaps rests at the concrete bearing walls. Some places there will be a need for a beam to carry the loads.

DETAIL OF THE SCREEN, 1:50





DETAIL OF THE ROOF MEETING IN-THE-ROUND, 1:20

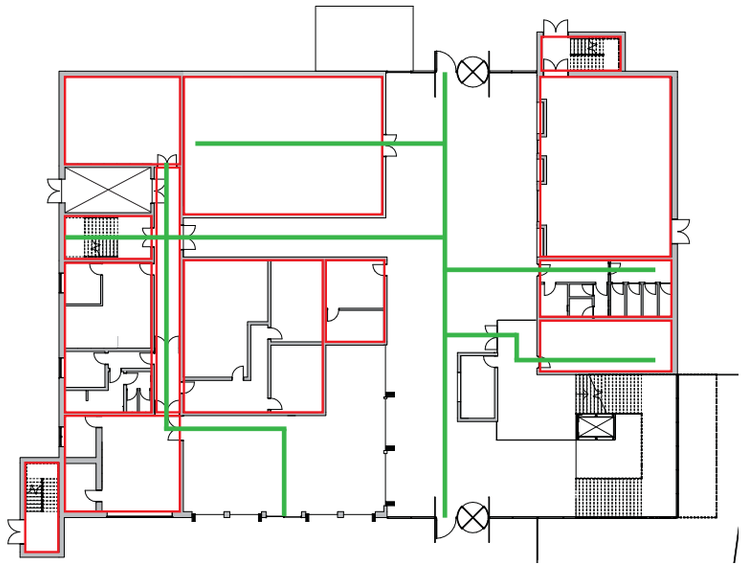


SKETCH OF THE SPANS OF THE CONCRETE SLAPS

Escape routes

Fire cells

FIRE SAFETY



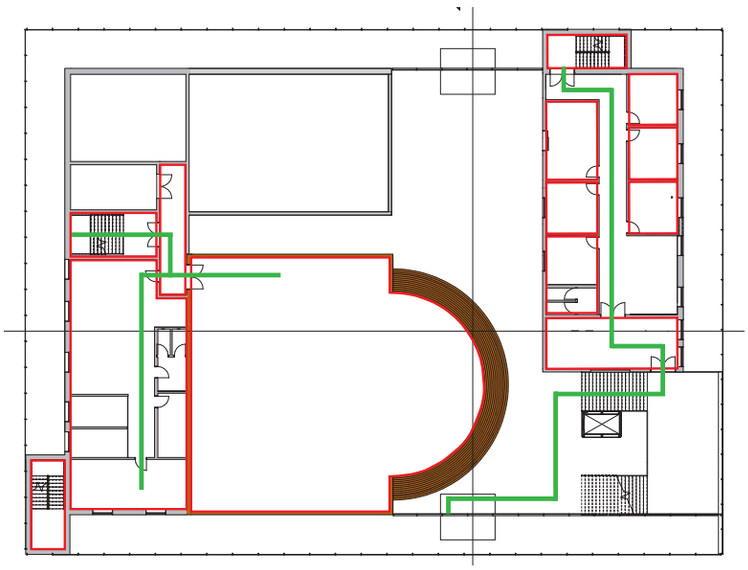
Ill. Ground floor: Fire cells and escape routes

During the integrated design the following aspects in regards to fire safety have been considered:

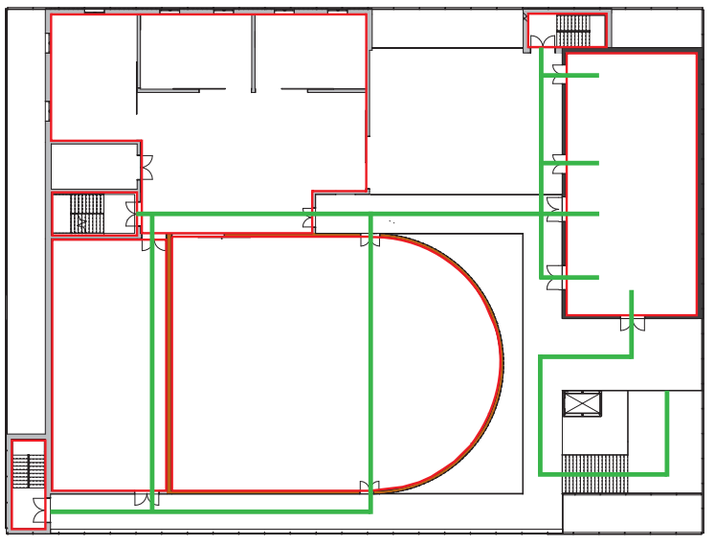
- The fire brigade access opportunities and access to the building
- There should be no longer distance than 25 meters from any room in the house to an emergency exit
- Safe passage of 1,3 meters on all evacuation routes

The Theatre- and Experience House is a building within usage category 3. Category 3 includes buildings for daily occupancy with many people who do not necessarily know the fire escape routes in the building but are able to, by own means, to reach safety [BR10 2013]

The Theatre house is divided into fire cells. See illustrations to the right.
Separating fire cell walls are carried out as EI 60 and doors are carried out as EI_2 30 according to 'Eksempelsamling' chapter 5.2.4.
The bearing walls and columns of the building are carried out as R 60 A2-s1, d0 according to 'Eksempelsamling' chapter 3.3.



Ill. 1st floor: Fire cells and escape routes



Ill. 2nd floor: Fire cells and escape routes

Supply

Exhaustion

Aggregate

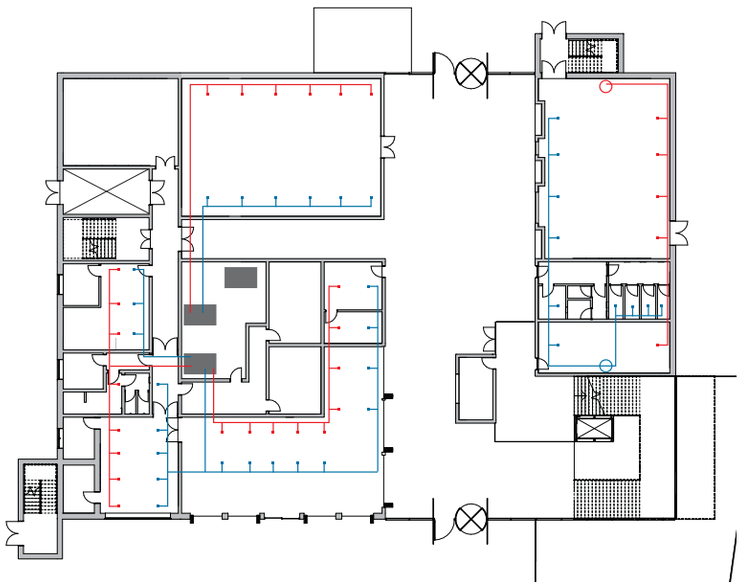
VENTILATION

In regards to ventilation of the house there is prepared a strategy for winter and summer which are described in the following.

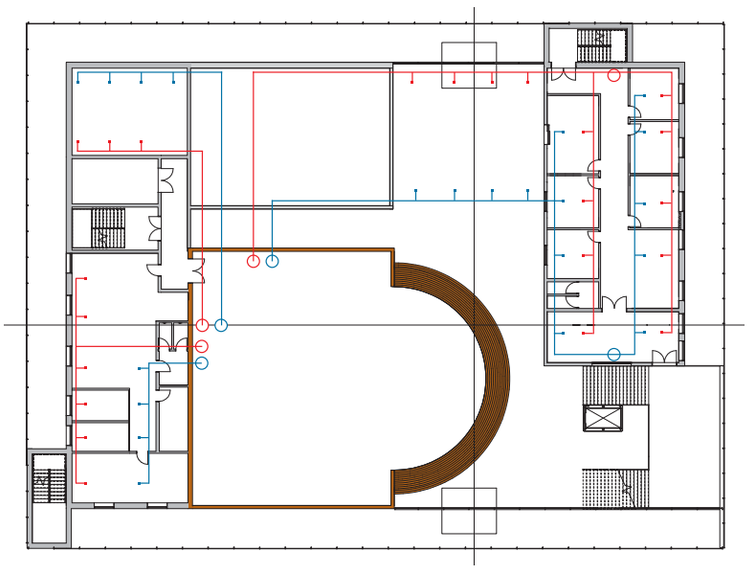
Winter
In winter time the whole building is mechanical ventilated. The mechanical ventilation is controlled by pollution from occupants as well as the building. It is estimated that mixing ventilation should be used as ventilation principle within working rooms such as the administration, actor area and sewing and washing due to the low ceiling height. Also mixing ventilation ensures that all parts of the room are ventilated equally, have a stabile flow of air and a uniform temperature. Within the stages, workshop and foyer it is estimated that displacement ventilation is more efficient because of the high ceiling height.

Summer
In summer time hybrid ventilation is used within parts of the building which can contribute to lower the energy consumption. Hybrid ventilation is used within the foyer, kitchen, workshop, administration, café, sewing and washing as well as the actor area. The natural ventilation principle is single-sided ventilation within all the rooms except from the foyer where thermal buoyancy will be the ventilation principle. Window openings in the foyer are mechanical controlled relative to pollution and temperature.

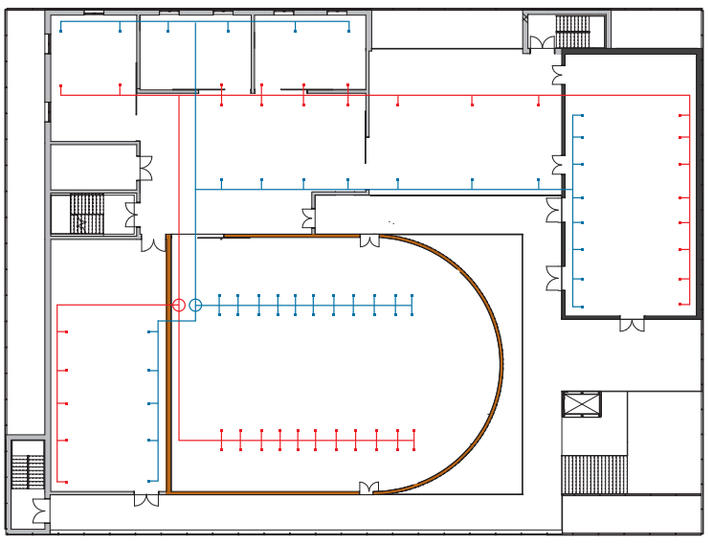
The building is divided into three separated ventilation systems which each have a central aggregate. The technical room for the aggregates is located at the ground floor. Illustrations to the right show the ducting in the building.



Ill. Ground floor



Ill. 1st floor



Ill. 2nd floor

REFLECTION

This project is a design proposal for an architectural competition brief developed by Hjørring Municipality. The project emphasizes the creation of a connection between theatre and city. The following comment on the final design and how it answers the problem statement and reflects the vision of the project.
Furthermore, it is described how both aesthetic and technical parameters are integrated in the design through an integrated design process.

Idea and vision
To summaries, the problem statement of this project was to explore how to design a sustainable Theatre-and Experience House that accommodate unique and intimate theatre spaces as well as public spaces that fosters social and cultural life in the centre of Hjørring. The sketching therefore has alternated between theatre design and design of a public space in connection with the city. This led to the concept of a transparent house with visual contact between inside and outside. A house which engages people who passes by and hereby becomes a link between the public transport system and the city centre. The coherent coating running from the bus station, across the site and through the public spaces within the house becomes a physical link between house and city. A screen of glass points three meters out from the theatre volumes and creates a transition zone between inside and outside.
The new Theatre- and Experience House should attract more people to the area and hereby strengthen social activity and meeting between people with interests within music, theatre and culture. Design of the theatre, in that connection, came to focus on the exterior expression of different theatre functions. The backstage area of a theatre is almost like a factory where the final production is the theatre performance which is what people are to experience. Normally backstage functions are not visible for people to see. By making it possible for people to perceive movement between and identity of different functions, the theatre becomes more open to the public. The theatre identity is reflected in the public space and makes it unique.
Identities of the theatre stages are accessed through the choice of materials. The different stages have different exterior expressions. The Black Box is of black concrete so that it, from a distance, can be perceived as the Black Box. The Music stage is of concrete with an organic pattern that reflects the waving of sound. The large theatre stage, In-the round, is of brick which relates to the area. Also, In-the-round differs from the other volumes of the building by its round shape. The round shape expresses the seating inside the stage on the outside. As a contrast to the round shape all other volumes are rectangular. This makes the round shape stand out. In the public space one can move around and experience the round shape from a number of different perspectives. Parts of the backstage area are of semi-transparent glass which makes it possible for people in the foyer to experience movement and activity as silhouettes. This part of the backstage area also becomes a light structure between massifs.
The different volumes bring people together in an experience environment. The building expression will change according to time and activities. In the evening activity is expressed by lighting. Areas with activity inside the house will light up.

The design solution is a symbiosis of aesthetic and functional parameters and integration of technical aspects in regards to an energy optimized solution. This is for example expressed in the compact form of the house. Also parts of the glass facade towards south and west are of semi-transparent glass to shade from the sun and at the same time makes a varying facade with more private zones. This way aesthetics and spatial experience are combined with technical solutions. By integration of solar cells, the Theatre- and Experience House fulfil the energy frame of energy class 2020 which have been a goal of this project.

Integrated design
The vision is for the design to set an example of how to develop sustainable spaces in which cultural life can evolve. This is achieved by use of the integrated design methodology. It has resulted in a building design which

meets the goals in regards to energy consumption and indoor climate which also are reflected in the architectural expression. The functional and technical aspects have been drawn into the design process parallel to aesthetic aspects and gradually have affected the design towards the final solution.

Compactness of the building form has played a large role through out the sketching process. Also daylight, solar gain, orientation and implementation of solar cells have been considered in terms of energy. The glass screen continues one and a half meter above the roof to make solar cells on the roof part of the functions behind the screen.

In terms of the indoor climate considerations about acoustics, daylight, temperatures and pollution have been carried out. The final design solution with glass screen and heavy massive volumes inside is the result of more simulations where requirements to the indoor climate changed the design. Size and placement of windows result from simulations of daylight conditions inside the building. Choice of materials inside the theatre stages were done from calculations of the acoustics as well as considerations in terms of spatial experience. Displaced bricks in the large theatre stage both give a unique experience of the wall and lowers the reverberation time.

Overall the integrated design process has generated a sustainable design where aesthic, functional and technical aspects have been integrated.

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Web 12: http://www.komforthusene.dk/projektering/bygningens+udformning/sol+og+lys [16.05.13]
Web 13: http://www.danskbyggeskik.dk/pdf/get.action;jsessionid=E750DF05F209A74712103857B37B7203?pdf.id=1208 [17.05.13]
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07 Own illustration
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45 Own illustrations
46-48 Own photos
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APPENDIX

In the following the average air change rate for ventilation in the large theatre stage, In-the-round, is determined. The calculation is done according to CR1752.

Atmospheric indoor climate

Sensory calculation
The required ventilation rate for a good indoor environment will be calculated from constants in CR1752. The pollution sources comprise the occupants and the building. The ventilation rate is calculated to fulfill category A which means that 15 % of the occupants will be dissatisfied with the indoor air quality [CR1752, p. 23].
The required ventilation rate for comfort can be calculated from the equation:

$$Q_c = 10 \cdot \frac{G_c}{C_{c,i} - C_{c,o}} \cdot \frac{1}{\varepsilon_v}$$

Where:

Q_c	is the ventilation rate required for comfort (l/s)
G_c	is the sensory pollution load (olf)
$C_{c,i}$	is the desired perceived indoor air quality (dp): 1,0 dp [table A.5]
$C_{c,o}$	is the perceived outdoor air quality at air intake (dp): 0,1 dp [table A.9]
ε_v	is the ventilation effectiveness: It can be assumed that the air is entirely mixed and then the ventilation effectiveness is 1,0

Pollution load caused by occupants:
350 · 1 [table A.6]

Pollution building:
442 · 0,1 [table A.8]

G_c = (350 · 1) + (442 · 0,1) = 394,2 olf

$$Q_c = 10 \cdot \frac{394{,}2\ olf}{1{,}0\ dp - 0{,}1\ dp} \cdot \frac{1}{1{,}0} = 4380\ l/s$$

Converting it to m^3/h:

$$\frac{Q_c}{1000\ l} \cdot 3600\ s = \frac{4380\ l/s}{1000\ l} \cdot 3600\ s = 15768\ m^3/h$$

Converting it to h^{-1}:

$$\frac{15768\ m^3/h}{V\ m^3} = \frac{15768\ m^3/h}{(442\ \cdot 15\ )m^3} = 2{,}4\ h^{-1}$$

	In-the-round
People load	360
Room height	15,0
Room size, m^2	442,0
Room volumen [m^3]	6630,0
Air change, l/s	4380,0
Air change, m^3/h	15768,0
Air change, h^{-1}	**2,4**

Co2 pollution
Designing a theatre with a high occupancy which changes in a short time, calculation of the required ventilation rate according to CO2 is carried out.
The required ventilation rate according to CO2 is calculated from this equation:

$$n = \frac{q}{C - C_i}$$

where:

n	is the ventilation rate required for comfort (m^3/h)
q	is the pollution (m^3/h)
C	the concentration of CO2 in the indoor air: 0,1 % = 0,001 [BR10]
C_i	the concentration of CO2 in the supplied air: 0,035 % = 0,00035 [CR1752, p. 24]

The calculation is based on the fact that one person with activity level 1,2 met produce a CO2 level of 19 l/h [CR1752, p. 26, table A.6]. The concentration of CO2 in the air cannot exceed 0,08 % = 0,0008 according to UBST [COWI and SBi 2008]
The concentration of CO2 in the atmosphere is 0,035 % = 0,00035 according to CR1752.

First q is determined for 350 persons:

$$q = 350 \cdot \frac{19 \frac{l}{h} pr.pers}{1000\ l/m^3} = 6{,}65\ m^3/h$$

Now the required ventilation rate can be determined:

$$n = \frac{6{,}65\ m^3/h}{0{,}0008 - 0{,}00035} = 14777{,}8\ m^3/h$$

Converting it to h^{-1}:

$$\frac{14777{,}8\ m^3/h}{V\ m^3} = \frac{14777{,}8\ m^3/h}{442\ \cdot 15\ m^3} = 2{,}2\ h^{-1}$$

Thermal indoor climate

We know that the air change rate which is required according to atmospheric indoor climate is 2,4 h^{-1}. Now it will appear if the thermal indoor climate requires a higher air change rate. The thermal indoor climate is found with an outdoor temperature on 16 C and an indoor temperature on 22 C. Following equation is used:

$$n = \frac{\frac{\Phi_i + \Phi_{sun}}{25 - (T_i - T_u)} - H_t}{H_{v1}}$$

Internal heat load for 24 h, $\Phi_{i,\ døgn}$ [24-avarage spreadsheet]:

Pers	350 pers of 76 W in 12,5 % of the time = <u>3325 W</u>
Equipment	One large copy machine produce approximately 730 W when it is in use. From this the equipment are estimated to use twice as much: = 4 · 730 W = 2920 W In 25 % of the time = <u>730 W</u>
Light	8 W/m^2, 3536 W, in 25 % of the time =<u>884 W</u>

(pers W + equipment W + light W) = (3325 *W* + 730 *W* + 884 *W*) · 24 *hours* = <u>118536 *Wh*</u>

Total solar radiation (24 hours) in August, 2 windows, $\Phi_{sun,\ døgn}$:

$$\Phi_{sun,døgn} = g \cdot f_\beta \cdot f_{shade} \cdot f_{shadow} \cdot f_{glas} \cdot A_{win} \cdot I_{sun}$$

No windows:
I_{sun} = 0,0 Wh

Heat loss due to transmittance , H_t:

$H_t = A_t \cdot U \cdot (1 - b)$

Where:

A_t	the transmission area (m^2)
U	the transmission coefficient (W/m^2 K)
b	the temperature factor for the building component

$H_{t,\ window}$ = 0,0 W/°C
$H_{t,\ walls}$ = ((15,5 · 15 · 2)+(19,2 · 15)+(30 · 15))m^2 · 0,12 · (1-0) = 1203 m^2 · 0,12 · (1-0) = <u>144,4 W/°C</u>

Heatloss due to ventilation, H_{v1}:

$H_{v1} = \delta \cdot C_p \cdot V \cdot n$

Where:

δ	the air density (1,2 kg/m2)
C_p	specific heat capacity of air (1005 J/kg °C) – find kilde
V	Volume (m^3)
n	air change rate of n = 1 h^{-1}

H_{v1} = 1,2 kg/m^2 · 1005 J/kg C · (442 · 15)m^3 · 1 h^{-1} = 7995780 J/h °C

$$\frac{7995780 \frac{J}{h} C}{3600} = 2221\ W/C$$

Now all the factors can be inserted in the formula presented above, and the average air change is found:

$$n = \frac{\frac{118536\ Wh + 0\ Wh}{25 - (22\ C - 16\ C)} - 144{,}4\ W/C}{2221\ W/C} = 2{,}7\ h^{-1}$$

Converting it to m^3/h:
2,8 h^{-1} · 442 · 15 = <u>18264,4 m^3/h</u>

Converting it to l/s:
(18264,4 m^3/h / 3600) · 1000 = 5073,4 l/s

l/s pr. m^2:
5073,4 l/s / 442 m^2 = 11 l/s pr. m^2

	In-the-round
Room height	15,0
Room size, m^2	442,0
Room volume, m^3	6630,0
Wall, m^2	1203,0
ϕ_i, Wh	118536,0
ϕ_{sol}, Wh	0,0
H_T, W/K	120,3
H_{v1}, W/K	2221,0
n, h^{-1}	**2,7**

Necessary amount of ventilation units for In-the-round, stage

The basis for the calculation is a displacement (fortrængningsarmatur) unit, which can be used below the seats in the theatre stage for supply. The calculation is based for full load in the room with 360 persons.

The unit is 500x100mm and its area is:

$$\frac{(500 \cdot 100)}{10^6} = 0{,}05\ m^2$$

The maximum air velocity 2.0 m/s is used. Then we have the following discharge m^3/h:

$$0{,}05m^2 \cdot 2\frac{l}{s} \cdot 3600 = 360\frac{m^3}{h}$$

Since the necessary air change rate for the stage is

$$6630m^3 \cdot 2{,}4h^{-1} = 15912{,}0\ \frac{m^3}{h}$$

Then the amount of units for the stage is

$$\frac{15912{,}0\frac{m^3}{h}}{360{,}0\frac{m^3}{h}} = 44{,}2\ units$$

There will be installed 45 unites in the In-the-round, since the air velocity will be reduced if the ventilation duct is minimized.

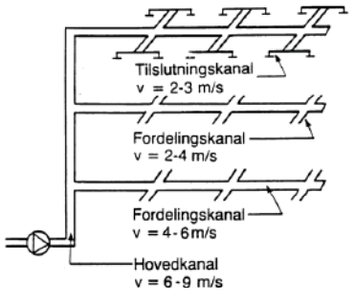
Dimensioning the ducts for In-the round, stage

In the following is the duct from the central aggregate to In-the-round.

The necessary air change rate for the room is

$$15912{,}0\frac{m^3}{h} = 4{,}42\frac{m^3}{s}$$

From a lecture at 6.th semester (spring 2011) by Henrik Brohus, AAU, see the illustration below, it is known that the maximum air velocity for a distribution channel, second, at 4.0 m/s.



Therefor the minimum area for the channel is

$$\frac{4{,}42\frac{m^3}{s}}{4{,}0\frac{m}{s}} = 1{,}11m^2$$

The channel is round and the minimum radius is

$$A = r^2 \cdot \pi \rightarrow \sqrt{\frac{1{,}11m^2}{\pi}} = 0{,}60m$$

Necessary amount of ventilation units for the administration, office

The basis for the calculation is a non-perforated unit, which can be used in the ceiling for supply.

The unit is Ø400 mm and its area is:

$$\frac{(\left(\frac{200mm}{2}\right)^2 \cdot \pi)}{10^6} = 0{,}03\ m^2$$

The maximum air velocity 2.0 m/s is used. Then we have the following discharge m^3/h:

$$0{,}03m^2 \cdot 2\frac{l}{s} \cdot 3600 = 226{,}19\frac{m^3}{h}$$

Since the necessary air change rate for the stage is

$$3{,}0m \cdot\ 194m^2 \cdot 2{,}09h^{-1} = 1216{,}38\ \frac{m^3}{h}$$

Then the amount of units for the stage is

$$\frac{1216{,}38\frac{m^3}{h}}{226{,}19\frac{m^3}{h}} = 5{,}38\ units$$

There will be installed 6 unites in the administration, since the air velocity will be reduced if the ventilation duct is minimized.

Dimensioning the ducts for the administration, office

In the following is the duct from the central aggregate to In-the-round.

The necessary air change rate for the room is

$$1216{,}38\frac{m^3}{h} = 0{,}34\frac{m^3}{s}$$

From a lecture at 6.th semester (spring 2011) by Henrik Brohus, AAU, it is known that the maximum air velocity for a distribution channel at 3.0 m/s. therefor the minimum area for the channel is

$$\frac{0{,}34\frac{m^3}{s}}{3{,}0\frac{m}{s}} = 0{,}11m^2$$

The channel is round and the minimum radius is

$$A = r^2 \cdot \pi \rightarrow \sqrt{\frac{0{,}11m^2}{\pi}} = 0{,}19m$$

Necessary amount of ventilation units for the Black Box, stage

The base for the calculation is a non-perforated unit, which can be used in the ceiling for supply. It needs to be flexible according to different production. The calculation is based for full load in the room with 150 persons.

The unit is Ø400 mm and its area is:

$$\frac{(\left(\frac{400mm}{2}\right)^2 \cdot \pi)}{10^6} = 0{,}13\ m^2$$

The maximum air velocity 2.0 m/s is used. Then we have the following discharge m^3/h:

$$0{,}13m^2 \cdot 2\frac{l}{s} \cdot 3600 = 904{,}78\frac{m^3}{h}$$

Since the necessary air change rate for the room is

$$9{,}0m \cdot \ 200m^2 \cdot 3{,}78h^{-1} = 6804{,}0\ \frac{m^3}{h}$$

Then the amount of units for the stage is

$$\frac{6804{,}0\frac{m^3}{h}}{904{,}78\frac{m^3}{h}} = 7{,}52\ units$$

There will be installed 8 unites in the Black Box, since the air velocity will be reduced if the ventilation duct is minimized.

Dimensioning the ducts for Black Box, stage

In the following is the duct from the central aggregate to In-the-round.

The necessary air change rate for the room is

$$6804{,}0\frac{m^3}{h} = 1{,}89\frac{m^3}{s}$$

From a lecture at 6.th semester (spring 2011) by Henrik Brohus, AAU, it is known that the maximum air velocity for a distribution channel at 4.0 m/s. therefor the minimum area for the channel is

$$\frac{1{,}89\frac{m^3}{s}}{4{,}0\frac{m}{s}} = 0{,}47m^2$$

The channel is round and the minimum radius is

$$A = r^2 \cdot \pi \rightarrow \sqrt{\frac{0{,}47m^2}{\pi}} = 0{,}39m$$