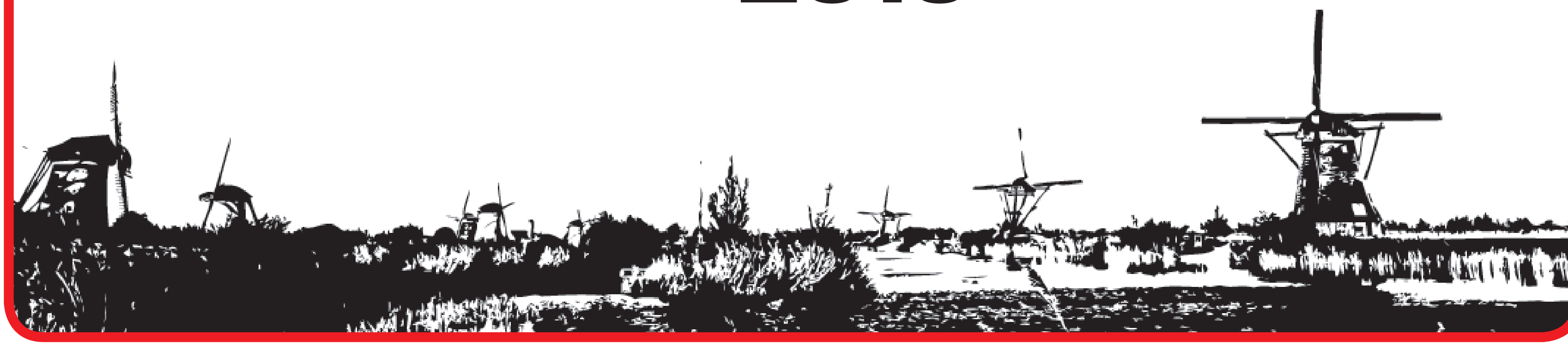
International Design Studio 2010



This project has been done in cooperation with Pioneering - Workgroup Master Industrial Design/ Experimental building Lab and Workgroup Industrial Sustainable and Flexible Buildings

vernieuwt de bouw
pioneering

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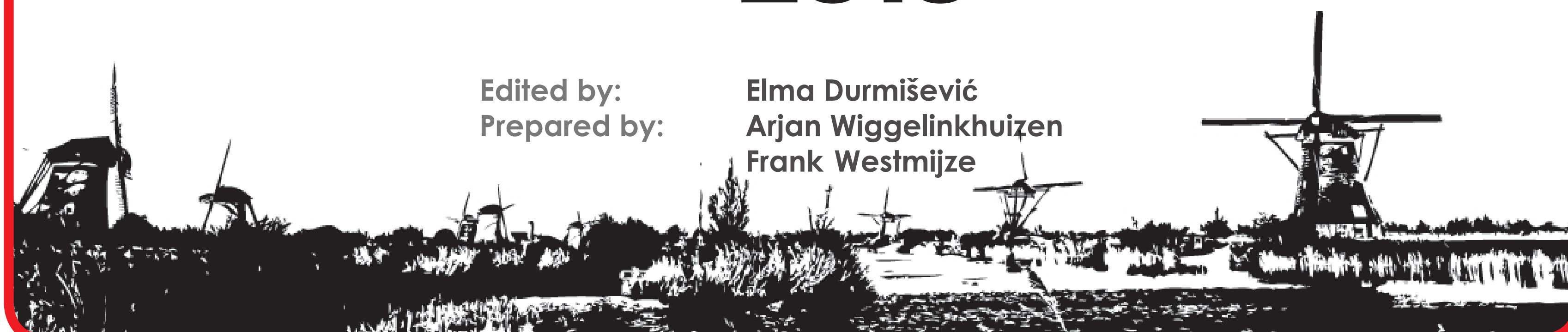
Green Transformable Buildings Center

International Design Studio 2010

Edited by: Elma Durmišević

Prepared by: Arjan Wiggelinkhuizen

Frank Westmijze



Coordinators

Dr. Elma Durmišević
University of Twente

Dr. Birgül Çolakoğlu
YTU Istanbul

Dr. Adnan Pašić
University of Sarajevo

Staff

Prof. Jan Brouwer
Ahmed Hadrovic
Amira Salihbegovic MSc.
Senaida Halilović MSc.
Res. Assist. Serkan Uysal

Students

Enschede
Mark Boswerger
Karin de Groot
Jochem Nijs
Guus Rammeloo
Frank Westmijze
Arjan Wiggelinkhuizen

UNIVERSITY OF TWENTE.

Istanbul
Öykü Ebru Eryeli
Seyla Enbatan
Gözde Kügükoğlu
Merve Ulucan
Deniz Yazici

YILDIZ TEKNİK ÜNİVERSİTESİ 1911

Sarajevo
Mersiha Čerim
Jasmina Koluh
Mirna Krešo
Gorica Mehić
Damir Zečević
Svjetlana Zečević

MCMXLIX UNIVERSITAS STUDIORUM SARAIEVOENSIS

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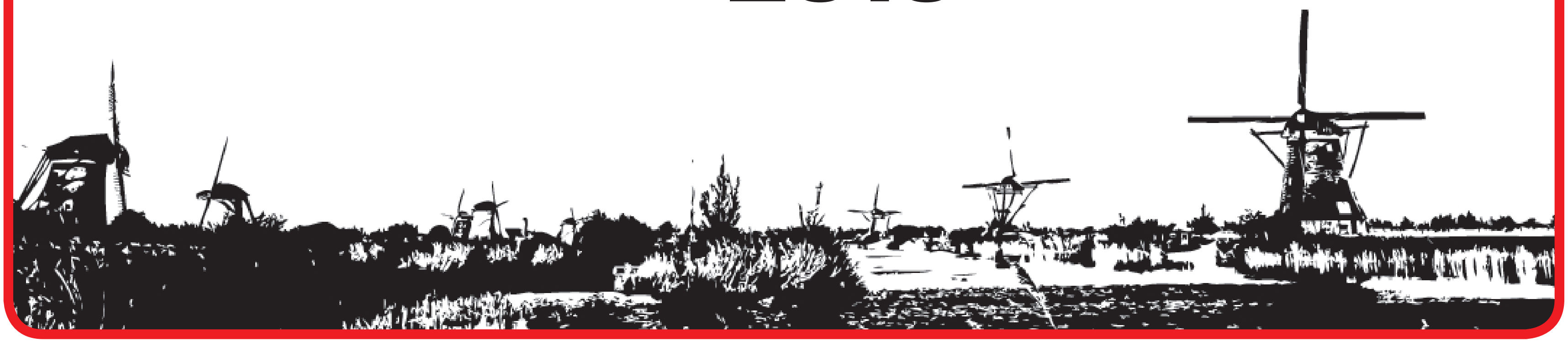


Mark


Seyla


Mirna


Guus


Öykü


Jasmina


Jochem


Gözde


Mersiha


Arjan


Deniz


Gorica


Damir


Karin


Merve


Svjetlana


Birgul


Adnan


Frank


Jan


Elma

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Chapter 0 - Introduction

Foreword

The project presented in this publication is a result of an international cooperation between University of Twente from Enschede, Yildiz Technical University from Istanbul and University of Sarajevo. During this International Master Course, students of architecture and industrial design from three universities were working on design of green and transformable building structure.

The results of this workshop will form a base for the development and construction of an experimental green building lab at the University of Twente. Experimental Green building Lab is a place for innovation in green and transformable techniques. This is an ongoing process, therefore the lab will be a dynamic structure that will allow yearly reconfigurations and upgrading of the building. At the same time the development of green transformable Building Lab is a open platform for cooperation between Educational Institutions : Universities, Saxion and ROC and the Industry.

The result of this years International Design Studio is the design of a energy neutral, C2C and flexible
multi-purpose green building lab whose parts could be dismantled, replaced or reused in different configurations. This cooperation will be followed up by five years of joint workshops supported by the Building cluster of innovation platform Twente, Pioneering workgroup IDF-Pioneering, the Netherlands Embassy in Sarajevo, Ministry of VROM, Rijksbouwmeester, Berlage Institute and a successful cooperation with University of Sarajevo and Yildiz technical University.

This program is aimed at integrating issues of flexibility, multifunctionality, energy and material reduction, reuse into one green design and engineering strategy that is based on Design for Disassembly approach to buildings.

The collaboration of the three universities on this program will continue in the coming years.

dr. Elma Durmišević

Introduction to the workshop framework

GREEN TRANSFORMABLE BUILDINGS Overview

Background

Emerging whole Life Cycle Design requirements imposed on building design and engineering will require fundamentally different way of design and construction in the future.

Buildings in the 21st century need to be more proactive in terms of energy production, water reuse, adaptations to the necessary comfort level and individual user demands and material reuse. Building structures will need to be put together in an intelligent way so that different climate, energy, aesthetic, spatial and material concepts could be integrated into the building structure in the course of time. Buildings in the future will become open platforms, where new technologies and requirements can easily be integrated and adopted. In place of demolishing parts of the building or whole building and systems in order to upgrade them and increase their performance it should be possible to reconfigure them without demolition and material/energy wastes. Their systems need to be replaceable and reconfigurable and materials up-cycling. Basically buildings in the future will need to poses embodied transformation capacity on three levels. spatial, structural, material. Design methodology need to adopt Design for disassembly approach in order to provide such high transformation capacity of buildings.

In other words a new alternative building methods are required that will provide a precondition for such dynamic and adaptable structures.

This years international design and construction studio is a part of a broad platform for collaboration between educational institutions, construction industry and government which has been initiated at the University Twente within a centre for Green Transformable Buildings. The aim of the initiative is to set up a trend for the building construction in 21st century together with the construction industry by developing new building methods and systems and implementing them in a experimental green building Lab projects at the campus of the University Twente. The experimental green building lab is being developed in close cooperation with a Building Cluster of Innovation Platform Twente and construction industry.

Project objevtives and requirements

International design and construction studio focuses on design and construction of a Flexible building which can be transformed for different purposes and whose systems and components could be reconfigured and reused again for different purposes. The buildings structure will be transformed every year for the coming 5 years. This means that a flexible and dynamic structure needs to be put in place that will make different additions, replacements and upgrade of use, energy and climate concepts possible. That also means that every year a new unit can be added to the existing structure and that parts of existing building can be reconfigured or replaced.

The theme of the Design Studio is development of Green Transformable building. The task of IDS studio is to develop a integrated design concept for a living multipurpose building of maximum 150m2 that will actively interact with new climate, energy/water concept, and material cycle and be a showcase for green transformable structures.

Concept of Green Transformable buildings address issues as flexibility, design for disassembly, energy production, closed material/water cycle in construction and use of ICT in design and construction.

A total of 20 students from three universities (Twente, Istanbul, Sarajevo) will work in mixed teams. The collaboration will be structured around the workshops in Istanbul, Sarajevo and Enschede.

During the last workshop in Enschede students will work together with construction industry on finalisation of their own design. Building will be assembled on the campus of the University of Twente as a part of a centre for green transformable buildings. Once assembled on the site the building will be upgraded and transformed every year. That means that parts of the building will be disassembled reconfigured or new parts/units will be added to the existing structure The main feature of the building must be that the structure provide enough transformation capacity for new additions and transformations.

Development/ course structure

Phase 1 – Design of overall building with integrated green and transformable functionalities

Design a pavilion that has capacity to be transformed from one use scenario to another on a weakly base without demolition and additional material use. Both, multi-functionality of space and components should be taken into account. Pavilion should accommodate different functions and its components should be removable and reusable in different situations or configurations. The base of the structure should provide enough capacity so that parts and units can be added/attached or removed and reconfigured for other application. Required use scenarios that need to be incorporated into design:

Scenario one: use pavilion as exhibition space with necessary service spaces as toilets small Coffee corner with possible summer extensions, wardrobe and storage space, internet corner.

Scenario two: use building as auditorium for lec tures (capacity 50 visitors), audio video perform ances, studio space, workshops, summer courses, debates and similar performance events with necessary service spaces as toilets small coffee corner, wardrobe and storage space.

Scenario three: use building as office space, meeting rooms for 10-15 users.

Scenario four: use part or whole building as apartment units

Phase 2 Design of individual systems

Design individual subsystems taking into account aspects of multi-functionality and transformation of the subsystem or its components so that they can be used for different purposes or they can be transformed in order to be used for different purposes. Consider aspects of Design for disassembly and accordingly reuse and reconfiguration when working closely with construction industry on design and finalisation of subsystems and its connections.

Course objectives

Design, prototyping and construction (together with construction industry) of a polyvalent buildings with focus on spatial transformation, energy production and saving, closed water cycle, C2C, reconfiguration, multyfunctionality of systems and components, design for disassembly, reuse of component and digital manufacturing.

Stage 1: International design studio in Istanbul

Stage 2: International design studio in Sarajevo

Stage 3: International design studio in Enschede

The international studio will discuss the following key problems:

The complex relationship between transformation of structures and functions, energy/ climate/ water/material concepts.
Streamline interaction processes between design, engineering, analysis and manufacturing.
Integration of individual systems into a open platform concept.
The development of new materials and production for interactive skins of buildings.
Influence of production methods on design / engineering components.
Reflections on building technology,
The design, development and prototyping of building systems
Life cycle Design methodology for systems design and product development,

Possible Technologies to be integrated:

Industry that have shown the interest to develop experimental green transformable buildings project together with students during this course are dealing with the following techniques:

Wood structures and laminated wood constructions
Stone structures
Passive floor heating and cooling systems
Demountable units that can be hanged on the building structure
Energy saving installation techniques
Water management company
Light materials/textile
Constructors

Course goals:

The students will learn systems design techniques that integrate green and transformable aspects into a overall building design.

As an interactive virtual studio the design teams will develop the design project during the semester.

During the interactive sessions with external panels of industry and professionals students will work towards optimization of the overall design solutions for the manufacturing and construction at the University of Twente.

As the final project at the end of the semester the student from all three universities will fabricate drawings, models and mock ups of the final design and present it to the industry.

dr. Elma Durmišević

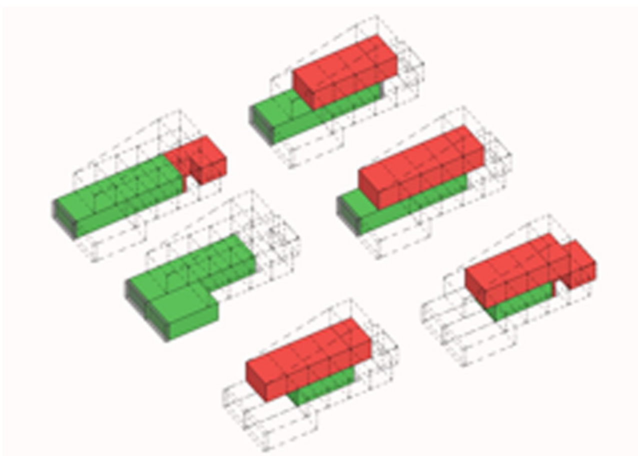
Design for Disassembly for Buildings

Background

One long-standing conviction held by many is that buildings last longer when made of more durable materials. However, everyday demolition practice proves the opposite. Buildings are designed to last 70 -100 years yet , today buildings with an age of 15 years are demolished to give a way to new construction. Developers and real estate managers warn that there is a miss-match between the performance of existing building stock and the dynamic and changing demands with respect to the use of buildings and their systems. 50% of investments in building construction in the Netherlands are spent on adaptation and 42% of new construction is due to the replacement of demolished buildings. Besides, European building industry accounts for 40% of the waste production 40% of the energy consumption and CO2 emissions and 50% of material resources taken from the nature are building related (CSB 2007).

Demolition in general can be defined as the process whereby the building is broken up, with little or no attempt to recover any of the constituent parts for reuse. Most buildings are designed for such end-of-life scenario. They are designed for assembly but not for disassembly and recovery of components. Different functions and materials comprising a building system are integrated (during construction) in one closed and dependent structure that does not allow alterations and disassembly. The inability to remove and exchange building systems and their components results not only in significant energy and material consumption and increased waste production, but also in the lack of spatial adaptability and technical serviceability of the building.

If the building sector is to respond to global environmental and economic challenges it needs to adopt new ways of construction.
Rather than destroying structures and systems while



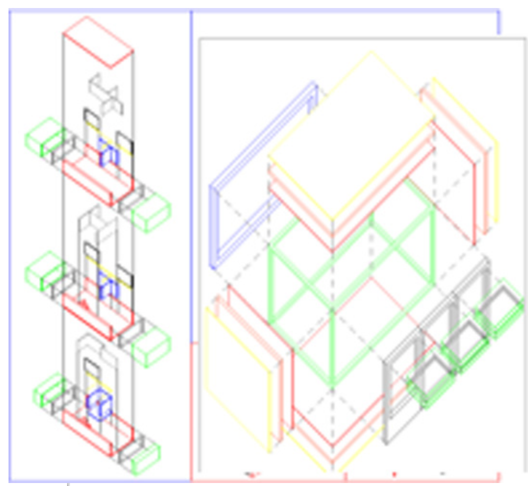


Figure left:4D architects amsterdam– transformation study; right Richard Horden European House

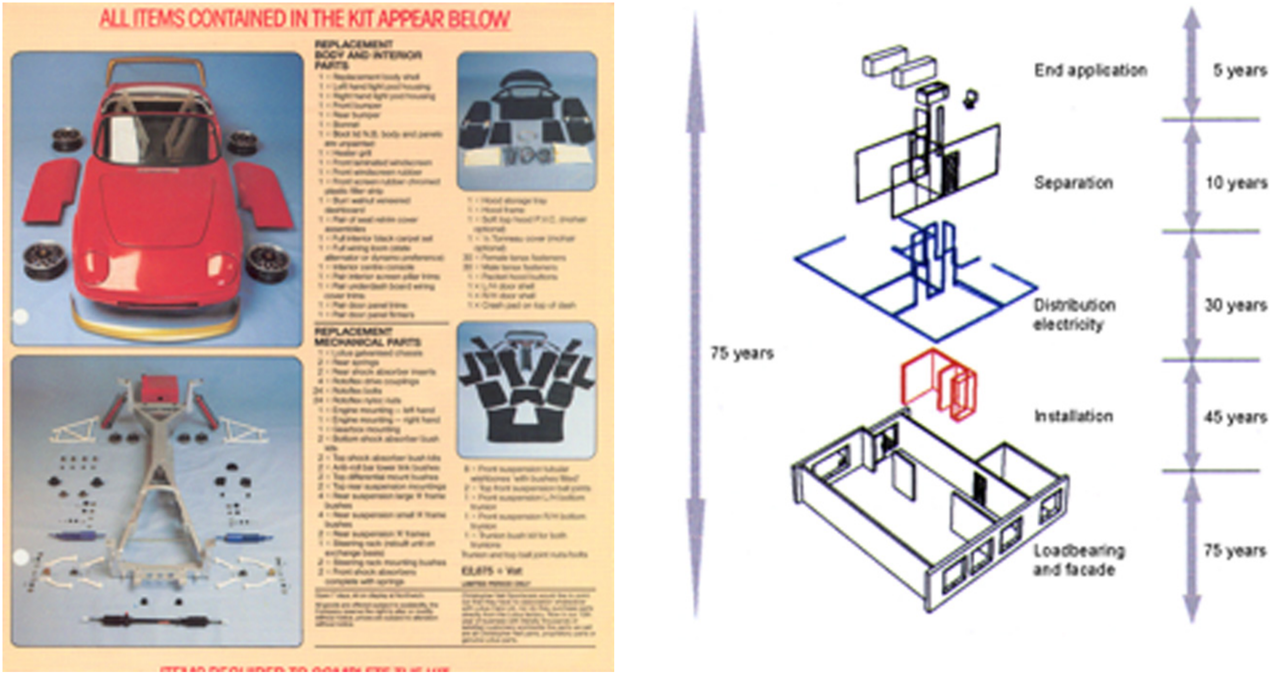


Figure: design for disassembly in car industry translated to the building construction (one concept)

adapting building to fit into new requirements, it should be possible to disassemble sections back into components and to reassemble them in new combinations. This means that we must consider how we can access and replace parts of existing building systems and components, and accordingly, how we can design and integrate building systems and components in order to be able to replace them later on.

Re-configurable building structures with high disassembly potential

The moment when buildings start to transform is the moment when structures can be reconfigured and reused, or simply demolished and sent to waste disposal sites. At that moment, the nature of the technical composition of building is crucial for the life cycle of buildings and materials. The focus in the debate regarding the durability of structures should involve not only materials, but interfaces, arrangements of materials and technical composition of structures. It is not only a type and durability of material(s) but more importantly an arrangement of materials that determines the life cycle of buildings and their products.

Building components and systems have different degrees of durability. While the structure of the building may have the service life of up to 75 years, the cladding of the building may only last 20 years. Similarly, services may only be adequate for 10 years, and the interior fit-out may be changed as frequently as every three years. Nevertheless, it is quite normal for parts with short durability to be fixed in permanently, preventing easy disassembly.

Therefore, at the end of components or building service life there is usually little option but for demolition, with associated waste disposal.

If we recognise the potential of disassembly, it is possible to divert the flow of materials from disposal to reuse and save not only materials but also the energy embodied in materials. One believes that energy embodied in materials will probably become greater problem than operational energy of buildings.

Taking this into account the design of sustainable building runs the danger of being carried out on an ad hoc basis without disassembly aspects of the building structure being an integral part of the design process. One can argue

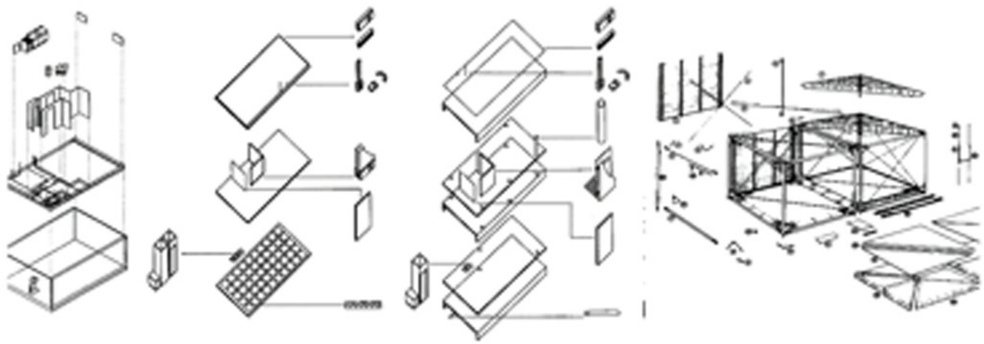


Figure: different transformation scenarios correspond to different arrangement and hierarchy of subsystems and components

that the sustainability of design in the future will relay strongly on disassembly
potential of building assemblies.

The design for disassembly (DfD) aim at design of transformable building structures made of components assembled in a systematic order suitable for maintenance and reconfiguration of variable parts. Every scenario for transformable building or system results in different technical composition and different hierarchy of parts. (figure 2) This DfD concept affects design of all material levels that are accounted for technical composition of buildings and accentuates interdependent relation between transformation process and disassembly technologies. Considering this, one can say that this concept introduces three dimensions of transformation in the buildings namely spatial, structural and material transformation. The key to each dimension of transformation and ultimately towards a three dimensional transformable building, is disassembly. By adoption of the concept of design for disassembly(DfD), spatial systems of a building become more amenable to modifications and change of use. New steps in exploitation of structure by reuse and reconfiguration can be achieved, and conscious handling of raw materials through their reuse and recycling is stimulated.(Durmisevic 2006)

Main characteristics of buildings designed for disassembly are:

(0) Setting the boundary conditions for transformation and specification of the long and short term use scenarios.

(1) Separation of material levels, which correspond to independent building functions as presented in figure 2,

(2) creation of open hierarchy of distinct sub assemblies,

(3) use of independent interfaces as intermediary between individual components,

(4) application of parallel instead of sequential assembly/disassembly processes, and

(5) use of dray - mechanical connections in place of chemical connections.

In order to achieve this a fundamental change in architect's perception of buildings is needed in terms of:

Conceiving building not as a static but a dynamic and open structure that can easily adopt to the changing requirements

Extending the transformation capacity of buildings and systems by considering the whole life cycle of the building and building systems.

Treating building materials as a long-term valuable assets through their whole life cycle by utilising reconfiguration, reuse and remanufacturing options on building, system and material level

Considering waste and demolition as a design error

Decoupling fixed function-material relationship in buildings by design of re-configurable systems

Involving construction industry into the whole life cycle of the building and building systems

A typology of technical configuration of a building is a indicators of building sustainability. A major shift towards greed design and engendering involves shift from design of close building systems and assemblies towards design of open and transformable building structure with high disassembly potential. These structures are made of independent and exchangeable building components and systems. Such a concept allows for future alterations to external screening, and to internal partitioning. It allows for services to be independent of the fabric, to provide for accessibility, servicing, and alteration. It creates the precondition for reuse and recycling and opens the way for designs of greater diversity.

dr. Elma Durmišević

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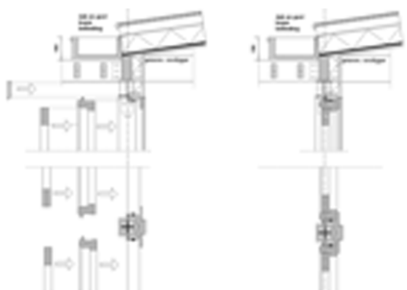


Multi-criteria design matrix

Prior to the design of the pavilion a Multi-criteria design matrix has been discussed with students. This matrix consists of main design criteria and sub criteria on one side and weighting of the criteria and sub-criteria on the other side. Criteria and weights are result of the program analyses. The discussion about each criteria and sub-criteria helps to understand the scope of the program and the essence of design tasks.
During the conceptual design phase student have been asked to develop three alternative design solutions and to evaluate them according to the Multi-criteria design matrix. This evaluation has been used as criteria to chose the final solution. This cycle from design in alternatives, evaluation to the choosing the final solution has been repeated num- ber of times during each design phase.

dr. Elma Durmišević

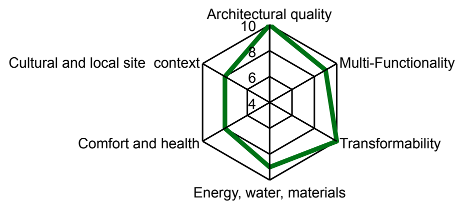
MCDM	criteria and importance		
Project: Green Transformable building (master course 2010)			
By: Elma Durmisevic			June 2010
Deasign Aspects	**weight**	**CRITERIA**	**weight**
Architectural quality	10	identity	10
		scale/proportion	9
		integrity/coherence	9
		inviting building	8
		expression of transformability	9
		appearance of spatial adaptation	7
Multi-Functionality	9	spatial capacity (adoptability to different functions)	10
		installation capacity	10
		structural capacity	10
		possibility to install equipment	9
		suitability for the internal flexibility	8
		safety /security (fire safety)	9
Transformability	10	easy transformation from one use concept to another	10
		possibility to separate or combine two or more functions	9
		extendibility / shrinking of space	10
		transformation of open area into a closed area and opposite	8
		adaptability to the weather conditions and day-night configuration	9
		reliability of the integration/connection between components	9
		adaptability to different inner climate concepts	9
		decoupling and reassembly of parts / units of the building with different functions	10
		flexible integration of systems (building and HVAC)	10
		reconfigurable building systems	9
Energy, water, materials	9	energy performance of the building - energy neutral	10
		renewable energy	9
		stimulus for low energy user behaviour	8
materials		low environmental impact of used materials	10
		C2C	8
		re-usability of disassembled components	10
water		reuse of different water streams	9
Comfort and health	8	thermal comfort (winter)	10
		thermal comfort (summer)	10
		indoor air quality	10
		ease of usability of the structure and spaces	8
		visual comfort	9
Constructability, and handling of components	9	high level of industrialisation/prefabrication for fast assembly,dissasembly	10
		easy to assemble, disassemble and reassembly	10
		transportability of the components/systems	9
		easy to store	8
		easy reconfiguration of prefabricated components for reuse	9
		transportability of the components/systems	8
Cultural and local site context	8	integration of cultural behaviour aspects to the design	8
		integration of cultural aesthetic qualities	8
		local climate conditions	10
Cost	7	Investment cost	8
		Annual exploitation cost	10
		life cycle costs	10

MCDM criteria and importance

Project: Green Transformable building (master course 2010)

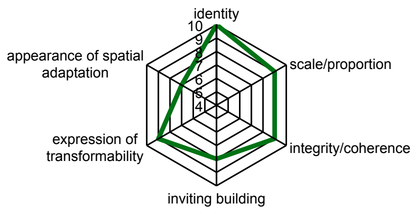
By: Elma Durmisevic June 2010

main criteria

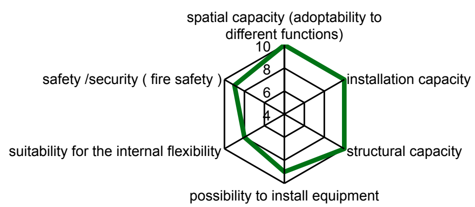


Summary of main criteria	weight
Architectural quality	10
Multi-Functionality	9
Transformability	10
Energy, water, materials	9
Comfort and health	8
Cultural and local site context	8
Cost	7

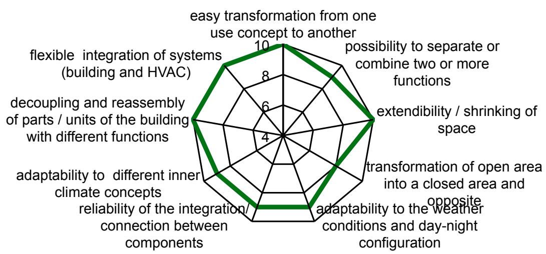
architectural quality



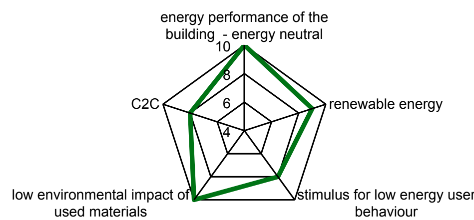
functionality



transformability



sustainability



Collaborating companies

Van Dijk Bouw is a construction company. At the moment they are developing the concept ‘Passend wonen’, a sustainable building concept that is cradle-to-cradle inspired.

De Groot Vroomshoop is a construction company who produces load bearing structures and facade elements with laminated wood.

Hodes is a contractor and specialized in realizing flexible houses. They developed a flexible living concept, named Qbiz, that is based on concrete prefab elements with steel connection for high accuracy

Plegt-Vos is a construction company. They are one of the initiators of the Mind Building System, a system integrated concept

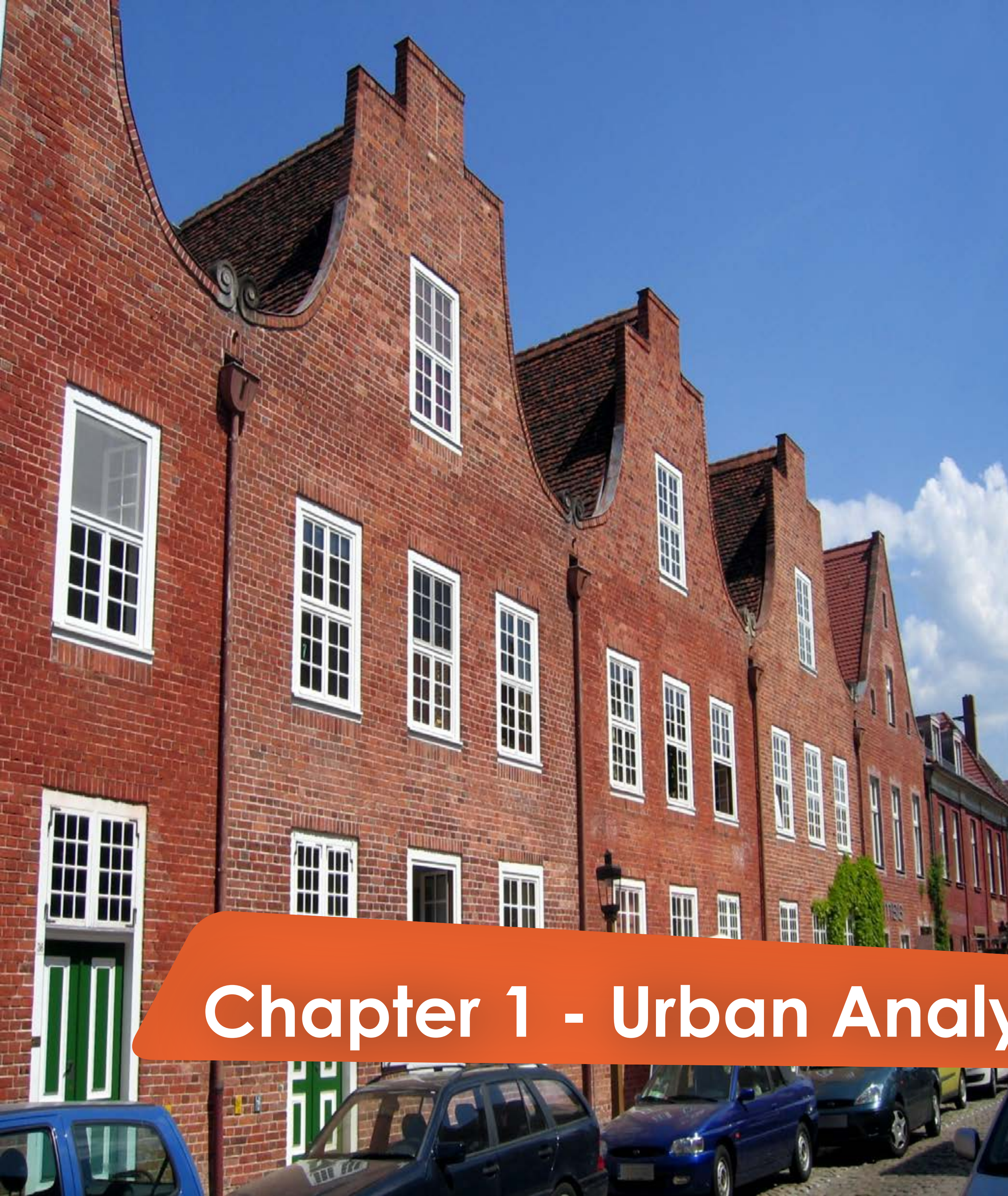
Bluedec is a producer of insulation material that is based on aerogel. Bluedec works 2 to 8 times better than conventional insulation

Winkels Techniek is a supplier of a wide range of plug-and-play-components for installations

Kersten Retail develops and realizes technical installations and intelligent facilities for the retail-environment

ClimaLevel offers an low temperature heating floor system that integrate installations such as electricity and ventilation

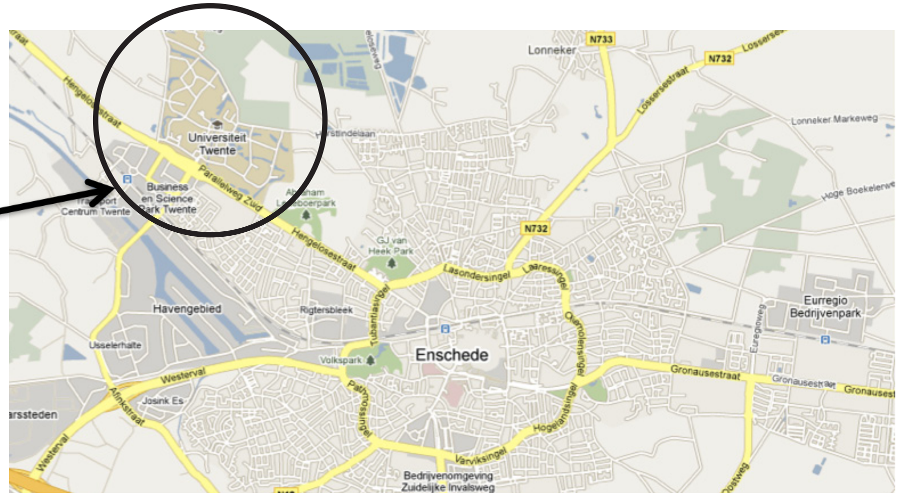
HSH-Fiwihex produces fine wire heat exchangers. They developed the breathing window (air-to-air system) and radiators working with low temperatures (water-to-air system)



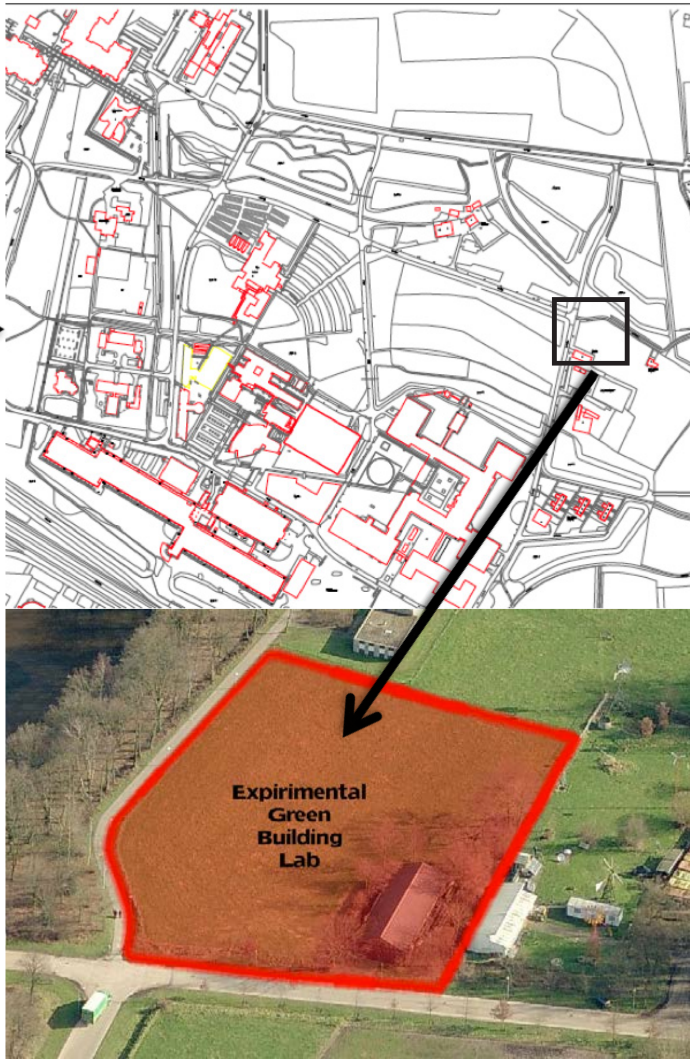
Chapter 1 - Urban Analysis

Urban analysis

Site analysis



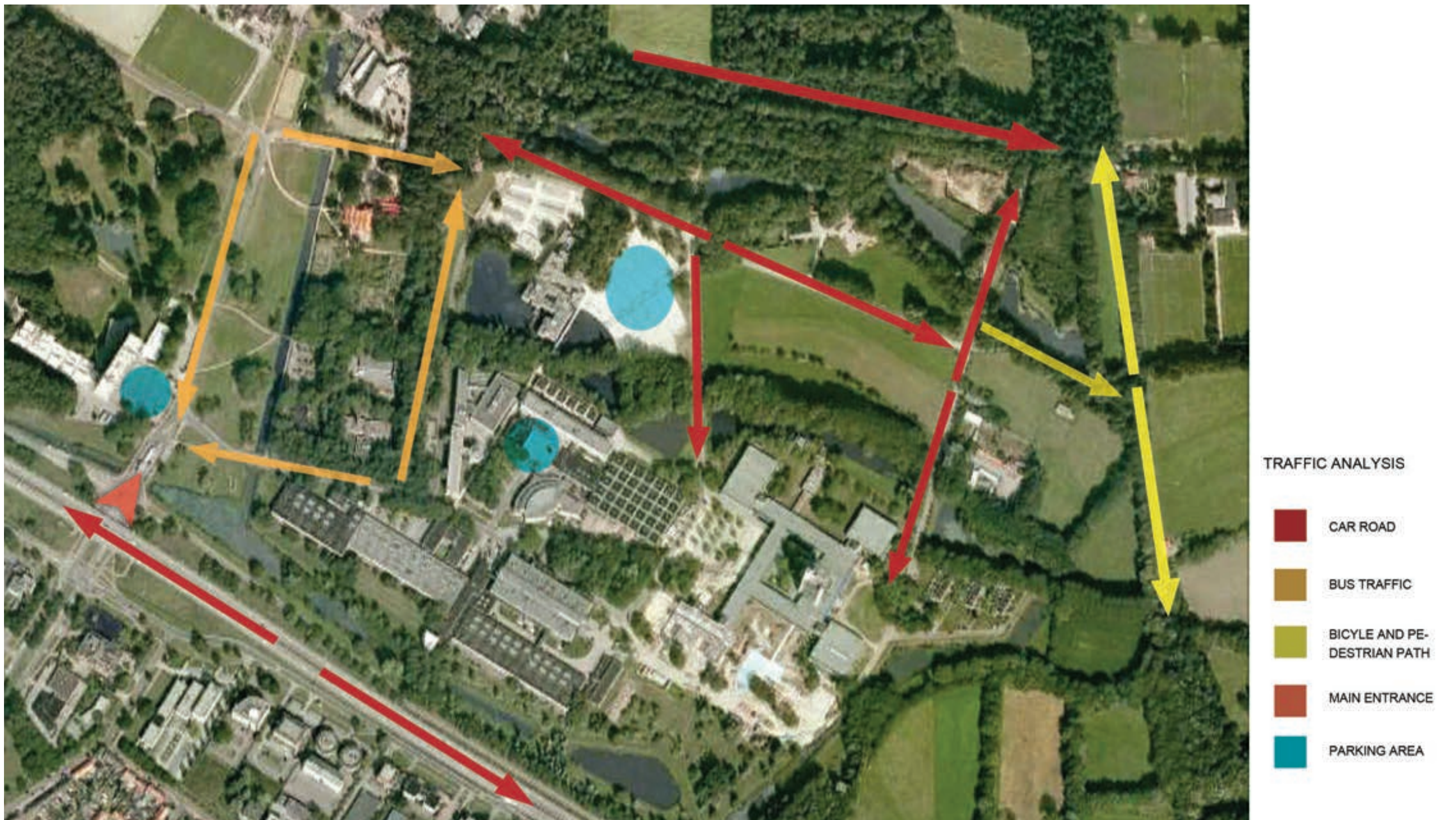
The experimental builing lab will be located on the campus of University of Twente. This is in the east of the Netherlands, near the German border.



The area of the building is surrounded with trees. There are not many buildings in the adjacent site. There is a Biomagnetic Centre on the east and WOT Development Technologies on the south side.

Traffic analysis

The main entrance of the campus is not close to the building site and the approach to the site is provided by cars, bus, bicycles and walking. There are bus-stops close to the building site. There are some parking areas in the campus and the large one near the Cubicus building may be used by the users of the building. As the people prefer using bicycles in the campus, there are continuous bicycle roads in the campus and two sides of the building area is used by the bicycle users.



Environmental impact

Holland enjoys a moderate climate as it is close to the sea and flat in its terrain. Rains are frequent in the summer season, and may continue for approximately ten or twelve days in a month.

January and February are considered the coolest months of the year, whereas July and August are the warmest. Holland experiences snow, rainfall, and hail. Summer season in Holland is comparatively warmer. Temperatures decrease to an average of about 16 to 17 degrees centigrade. This can be noticed in the months of July and August. Spring is the driest season in Holland.

	Winter	Spring	Summer	Autumn
Average temperature	2,6 °C	8,6 °C	16,2 °C	9,6 °C
Min temp	-0,2 °C	3,8 °C	10,8 °C	5,8 °C
Max temp	5,1 °C	13,0 °C	21,3 °C	13,4 °C
Rain	190 mm	168 mm	202 mm	198 mm
Sun	161 hrs	450 hrs	548 hrs	285 hrs
Wind direction	203 degree	273 degree	264 degree	208 degree
Wind speed	2,4 m/s	1,3 m/s	1,3 m/s	1,9 m/s
Humidity	88 %	78 %	78 %	87 %

Sun direction at the site

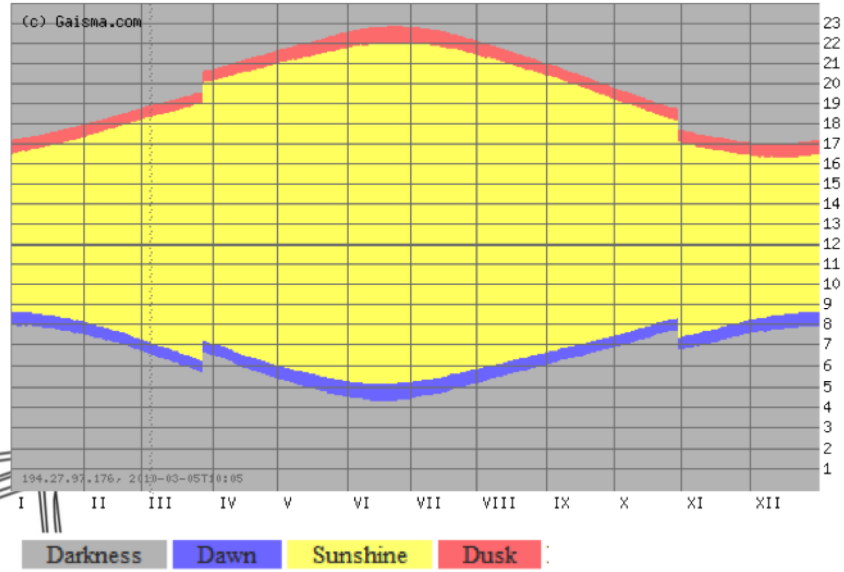
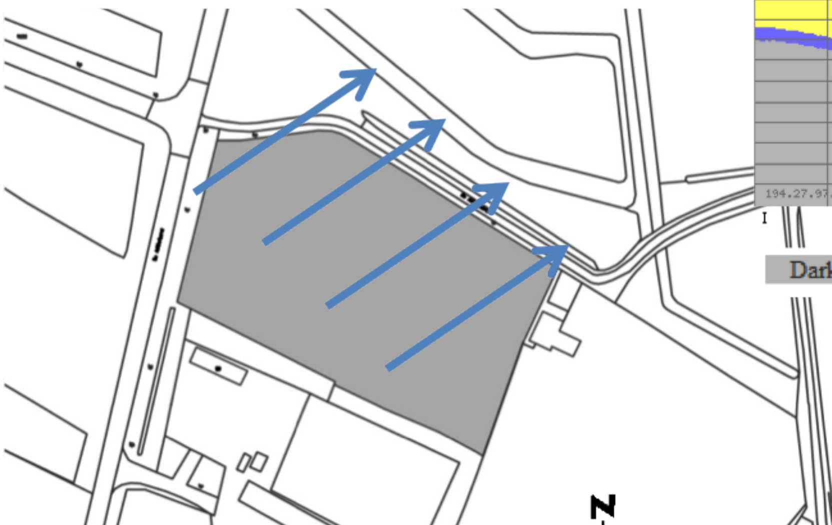
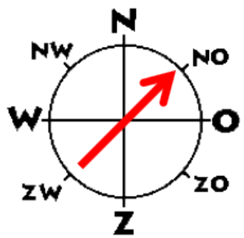
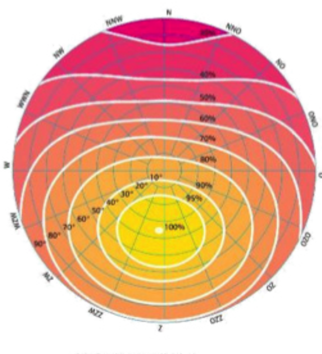


Diagram of sunlight in the Netherlands

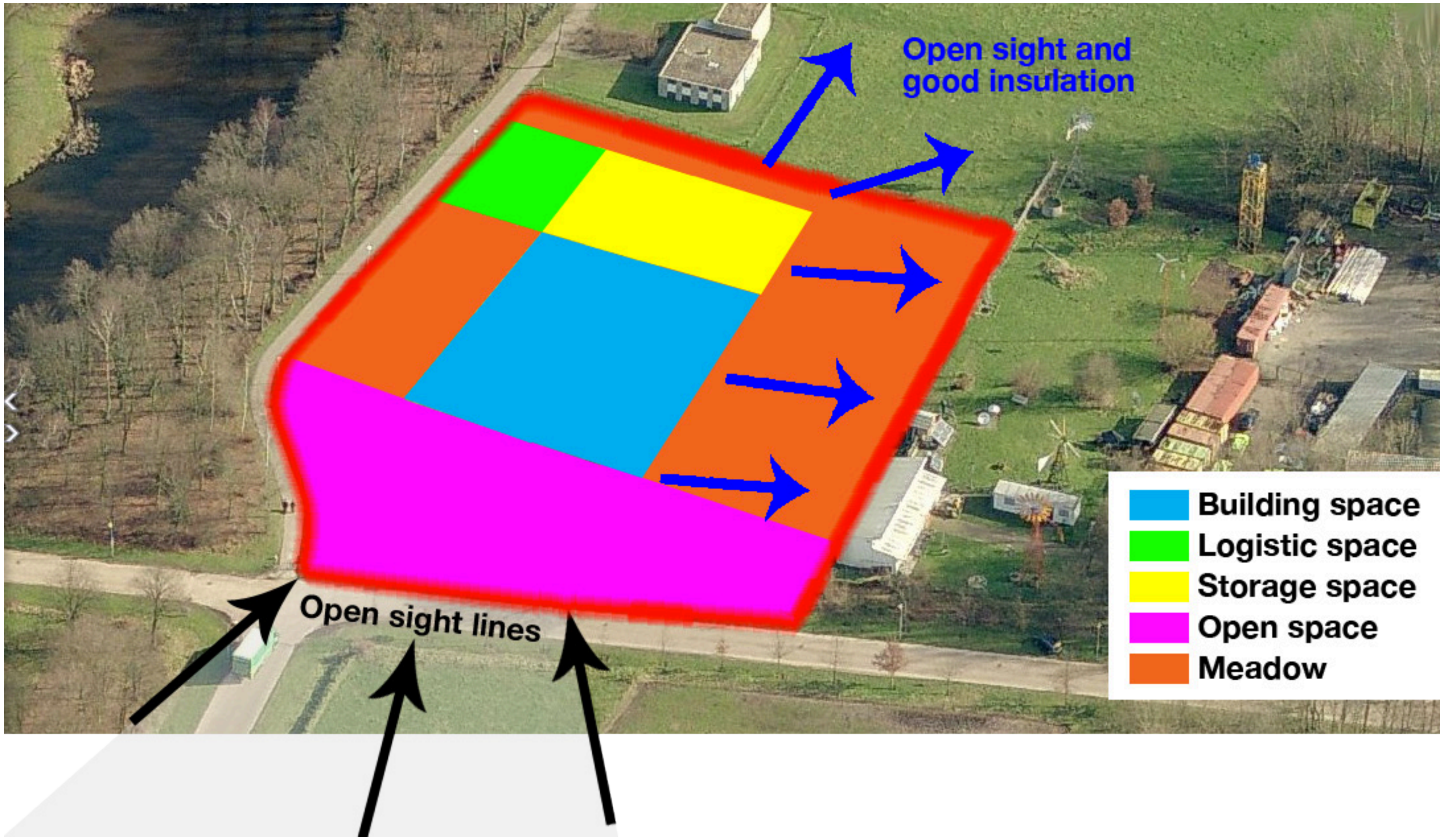
Wind direction at the site







Best angle for solar energy:
36 degrees pointed at the south



The building is located directed at the west as the main traffic is on the west and some large space is left in front of the building for the peaceful entrance with some green and relaxing areas. The road on the north is used by the bikes and pedestrians. As the road has no traffic with cars, the logistics entrance is taken on this road. The back of the building is used for the service courtyard. Also the bicycle parking area is left on the service courtyard.

When the building is placed in the middle of the field, the shadows of the trees play no big part for the building design. The nearest building is also too far away ro cause any effect.





Chapter 2 - Concept Design

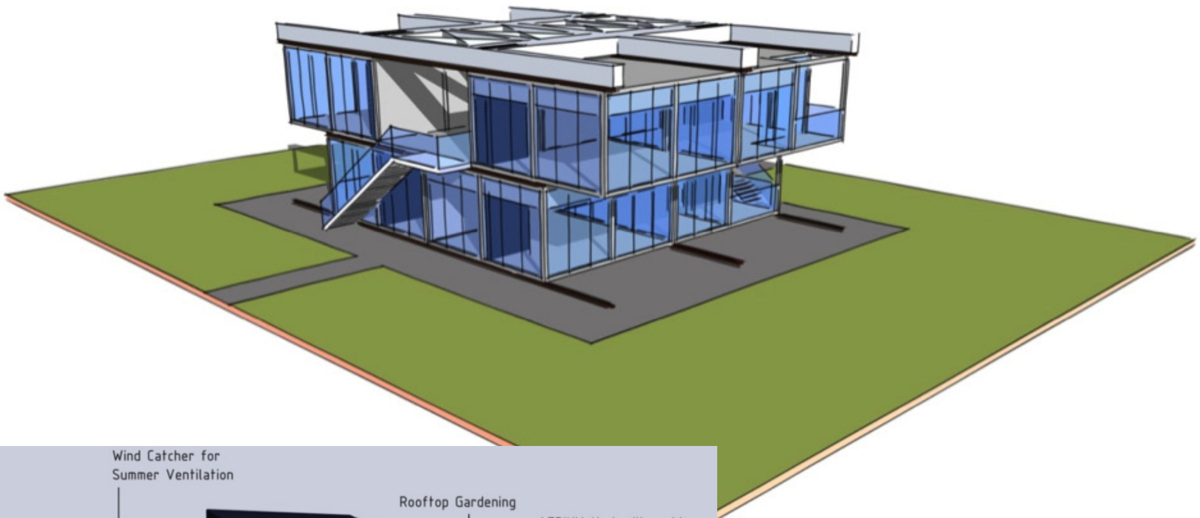
Introduction

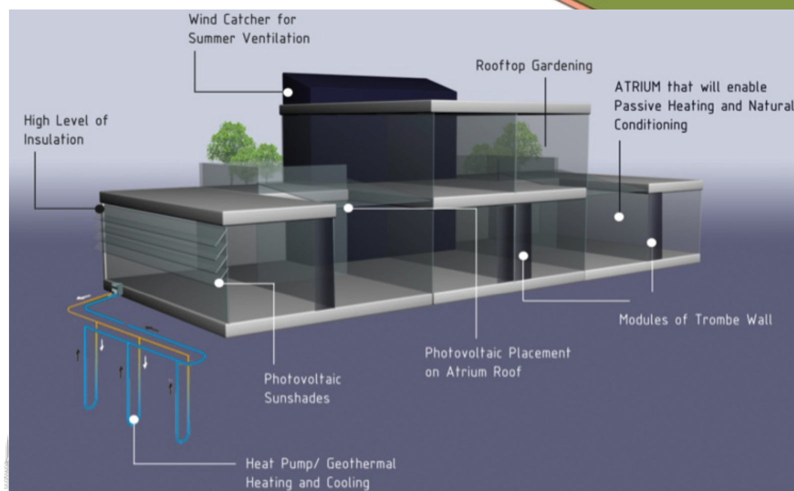
During the Istanbul and Sarajevo workshop all the groups have been working on the concepts for the green transformable building. During this concept phase work has been done on many different concepts and variations. During this iterative process many variations and options have been developed. It would be impossible to show all these options, the contents of this book have been limited to the most interesting concepts.

Group 1

Concept 1

Guus, Jochem, Gorica, Jasmina, Seyla, Merve



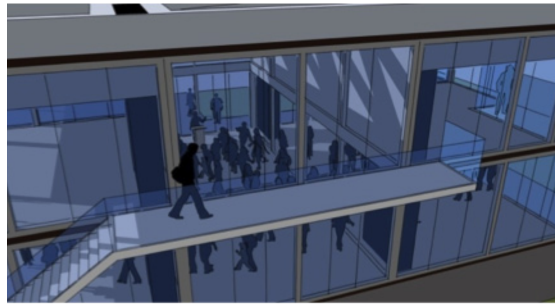


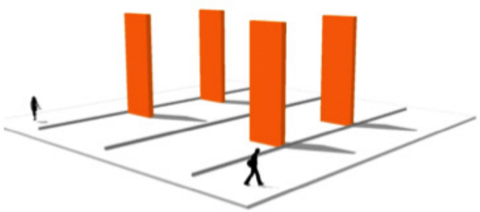
The first concept is focused on a sliding principle that provides flexibility for the several use scenarios of the building. The top floor consists of various modules that are suspended from rails which is integrated in the roof. The modules can slide inward and outward for both the top and bottom floor. By separating the modules it is possible to use the modules as separate apartments while in the combined lay-out it can function as an office or an auditorium.

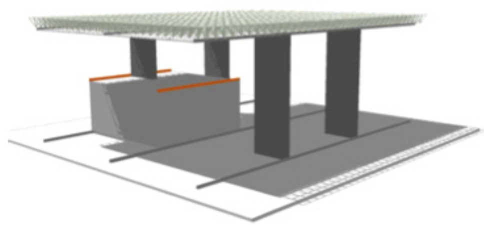
Several possibilities were investigated regarding renewable energy technologies. These options included photovoltaic sunshades, a wind catcher for summer ventilation, a heat pump and the use of rooftop gardening.

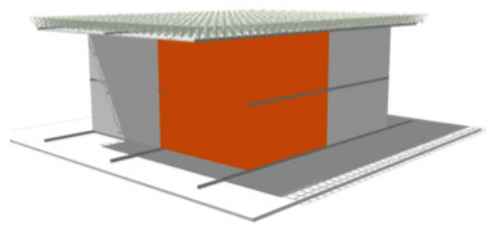
The structure of this concept is created by placing four columns on a platform. These columns also function as installation shafts. On top of the columns, a light-weight roof structure is placed. Underneath this roof several modules are hanged at a rails which make it possible for the modules to move in one direction. The top and bottom modules can slide independently from each other.

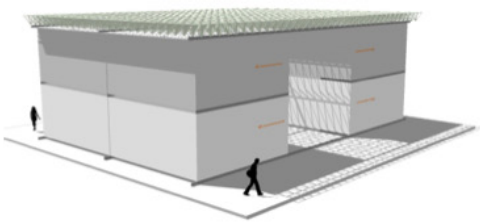
If the modules are slid inward, a large space is obtained which can function as an atrium. At the sides, walkways are placed to access the various rooms in the building. These walkways also are flexible and can be moved if the use scenario of the building changes.

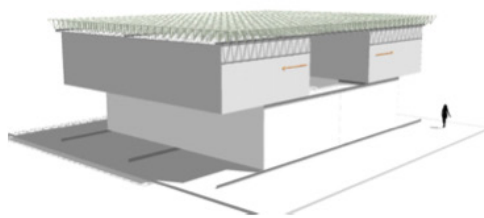


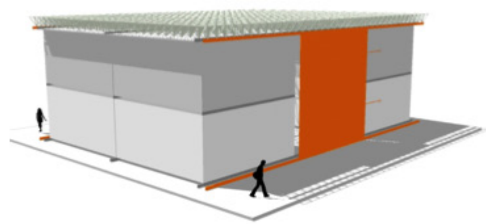




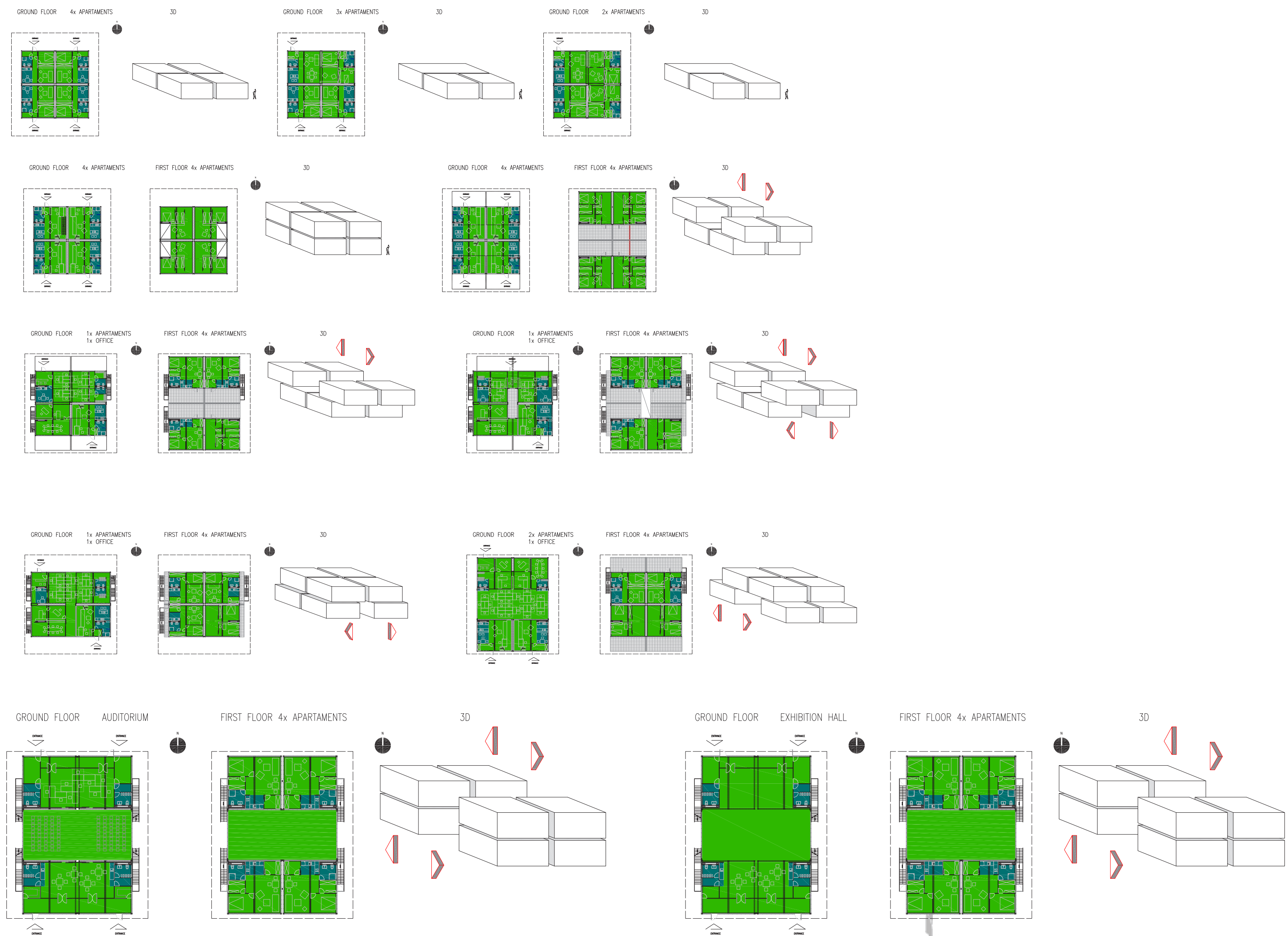




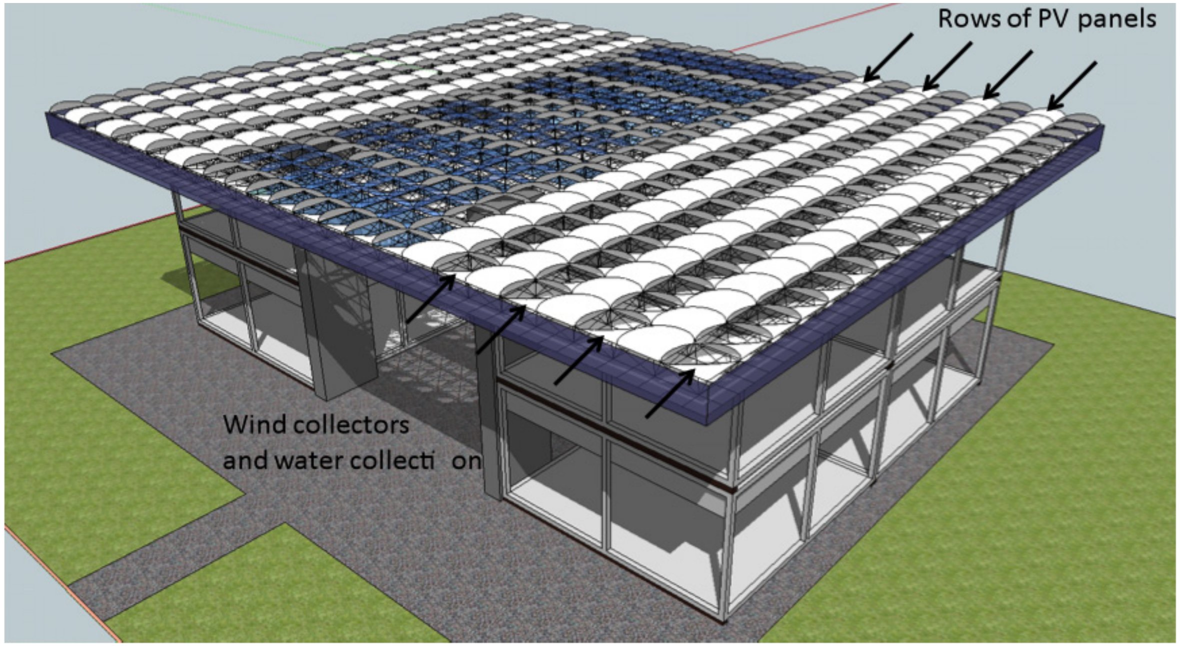




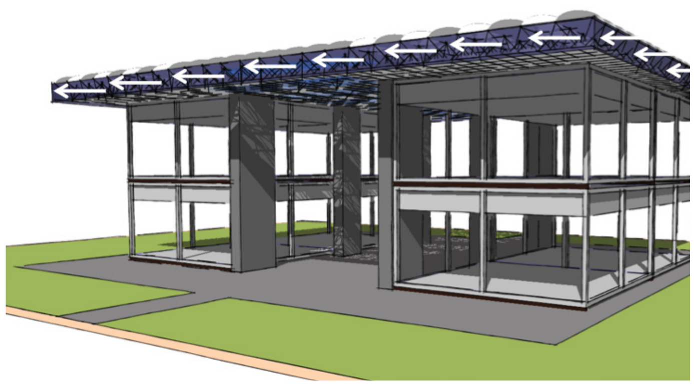
Transformations



Concept 2

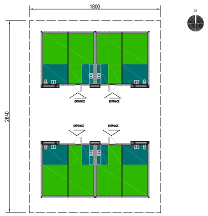


Concept 2 focuses at a special roof structure that incorporates several climate solutions such as PV panels and solar collectors, as well as wind and water collectors. The large roof surface provides enough space to generate enough electricity and heat for the building in the different use scenarios. The special shape of the roof also makes it possible for the wind to blow underneath it, which will keep the building cool in the summer. In winter the sides of the roof will be closed so the air in the roof will stand still and functions as an extra insulating layer. In the middle of the roof there are transparent modules which let light through so the middle of the building can form an atrium.

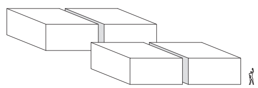


Transformations

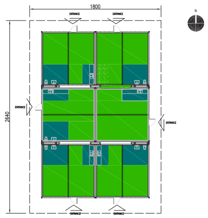
GROUND FLOOR 4x APARTAMENTS



3D



GROUND FLOOR 5x APARTAMENTS



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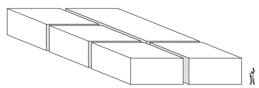
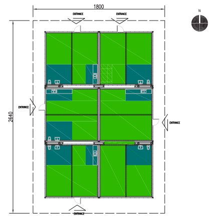


GROUND FLOOR 4x APARTAMENTS



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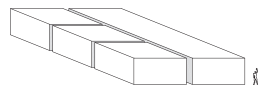
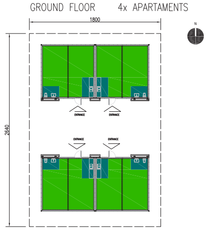
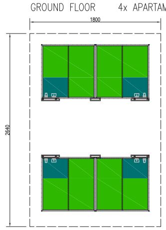


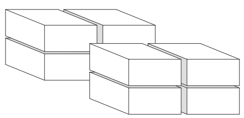
GROUND FLOOR 4x APARTAMENTS



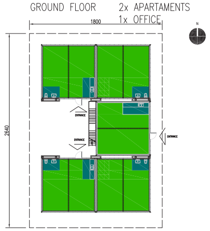
GROUND FLOOR 4x APARTAMENTS



3D

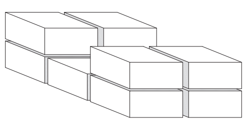


GROUND FLOOR 2x APARTAMENTS
1x OFFICE

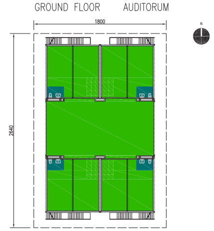


GROUND FLOOR 4x APARTAMENTS

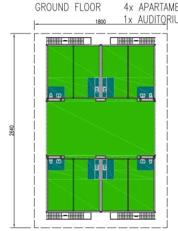
3D



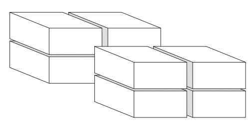
GROUND FLOOR AUDITORUM

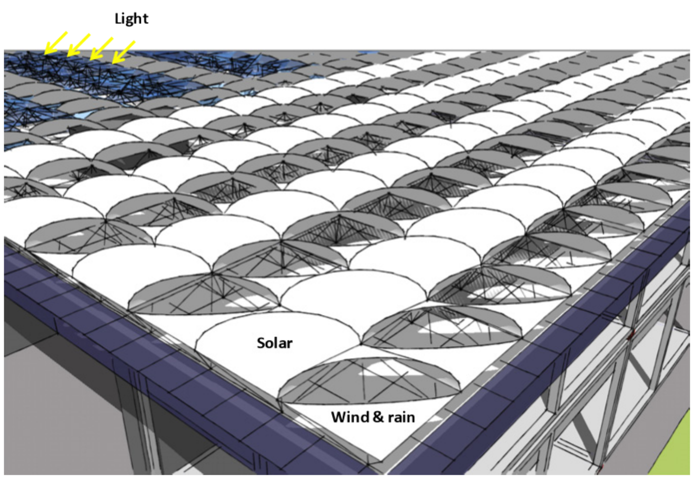


GROUND FLOOR 4x APARTAMENTS
1x AUDITORIUM



3D

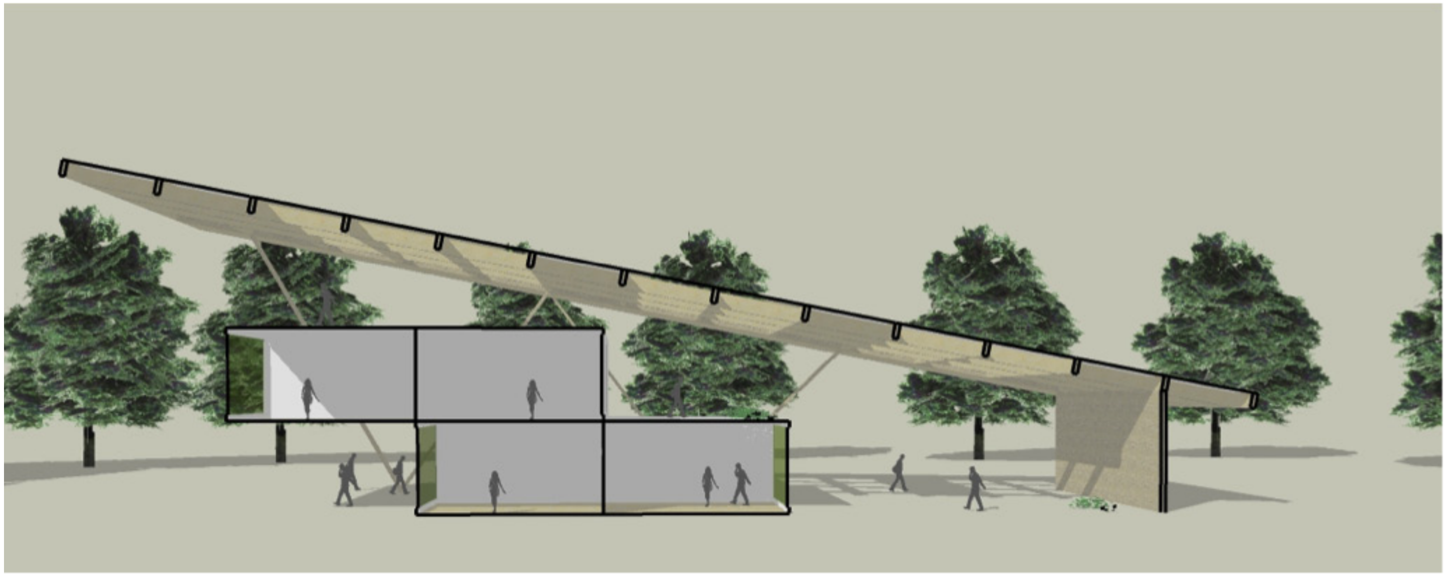


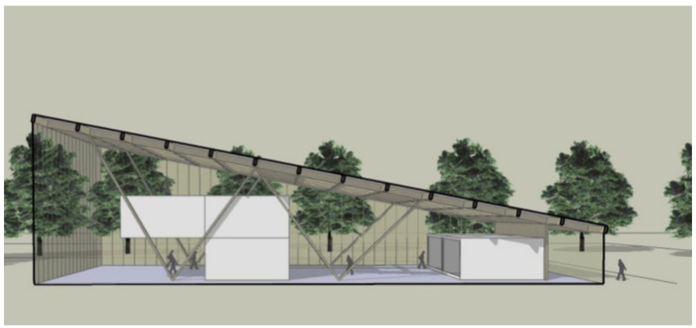


In summer, the space that is available in the middle of the building is open so it can function as a garden, which provides a cooler climate for the building. In the winter the garden can be closed so it can be an atrium which absorbs heat from the sun and is used to warm up the building.

The roof is composed of arc-shaped modules that catch sunlight, wind and rain. Water is stored underneath the building and is used to flush toilets in the building. The wind that blows into the modules is used to cool the building in the summer, and partly is converted to electricity with small generators.

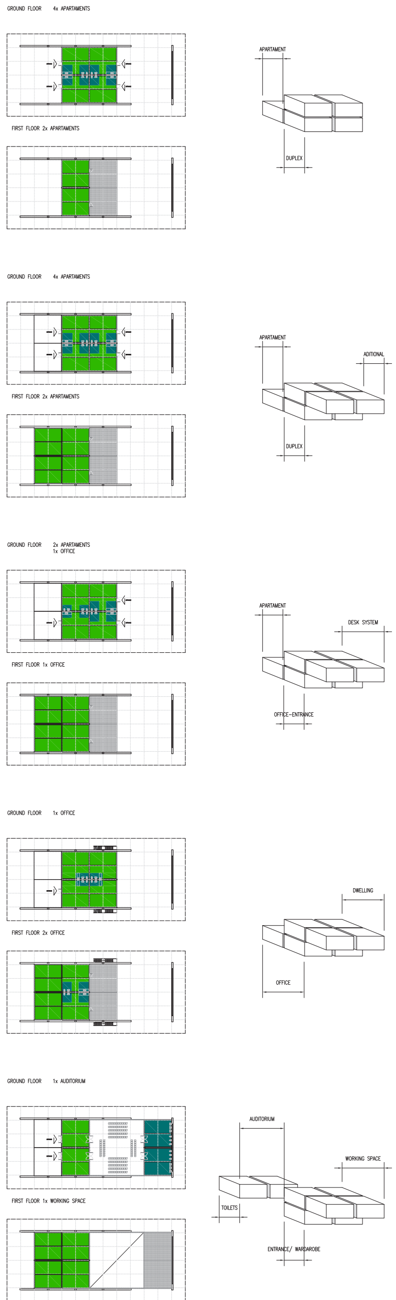
Concept 3

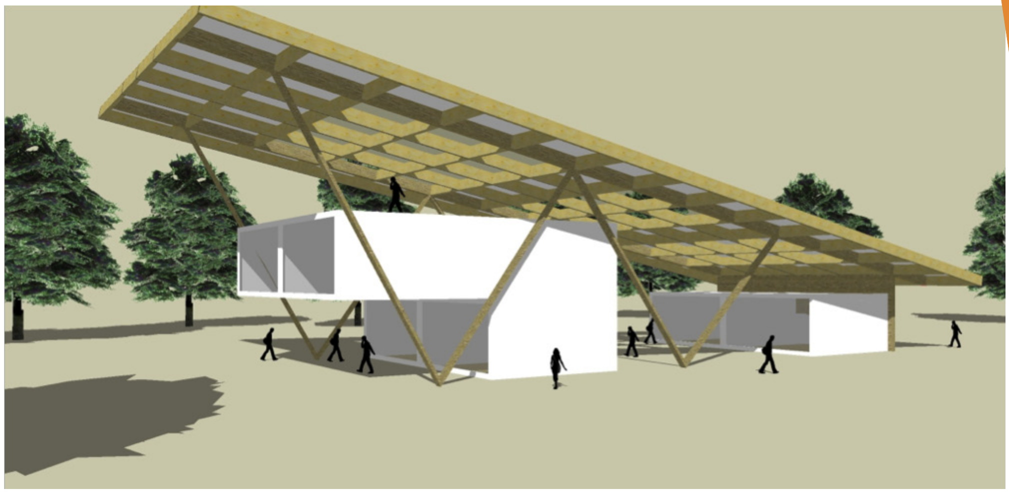




Concept 3 consists of two separate structures that complement each other. The large roof structure is used for providing shelter as well as generating heat and electricity with renewable energy technologies. The slope of the roof is aimed at the sun and provides the best angle for solar energy purposes. Also, a part of the roof is filled with plants that form a green-roof.

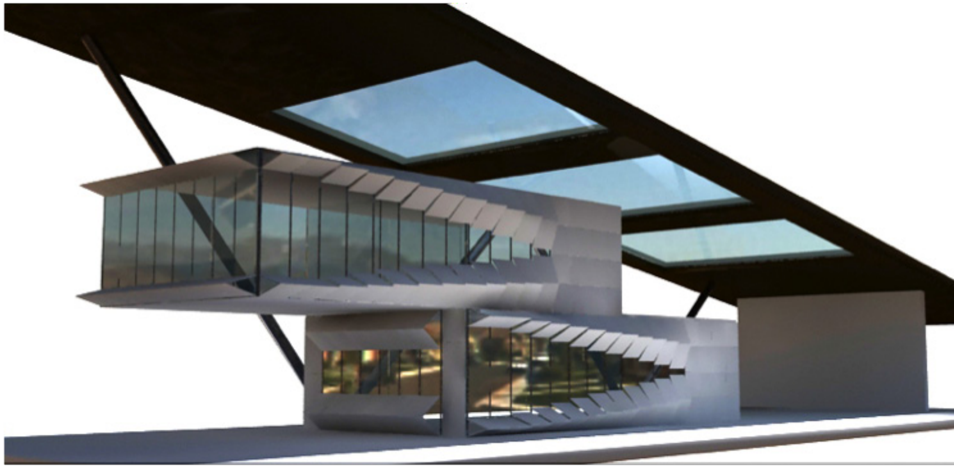
In the summer the roof is open, while in the winter there is a second skin with glass that keeps the building warm. In this concept there are several possibilities to arrange the modules according to the demands per scenario.





The modules can be placed against each other or placed apart. The space in between the modules can be used for a terrace. This space also can be used for the auditorium.

The large roof structure provides good architectural quality. Furthermore, in the figure it is shown how a new type of façade can be applied which functions as a sort of zipper that protects the inside of the building from the sun and offers privacy for the users inside the building.



Multi criteria matrix

Aspects	Concept 1 and 2	Concept 3
Transformability	+	++
Energy, water, materials	++	++
Architectural quality	+	++
Comfort and health	+	+
Constructability and handling	++	+/-

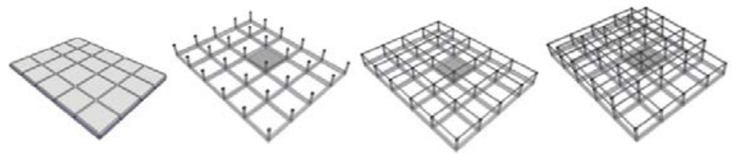
Concept 1 and concept 2 may be evaluated as one concept as there are some little adjustments in their projects. Exterior stairs and rails on the platform are removed in the second concept and the roof structure has changed. In terms of transformability, although the idea of the floor plans are similar to each other, the third concept is more flexible. Concept 3 has the second skin with glass and it can be both open and closed. On the other hand, the second concept has the only possibility to be semi-open. In terms of energy, water and materials, both concepts are good as they incorporate several climate solutions. Their roof structures use renewable energy technologies. The roof of the second concept has modules designed for catching sun and wind with pv panels, wind and water collectors. The roof structure of the third concept provides shelter with its slope which changes according to the angle responding the solar energy purposes. Also it generates heat and electricity. In terms of material, wood is used in the roof of the third concept and steel is used in the second one. In terms of architectural quality, both of them have potential. The second one is more compact but the third one has more possibilities to arrange the modules. In terms of constructability and handling, the second one is easier and faster. It is compact and the structure consists of a platform on top of four columns and its a light-weight roof structure. On the other hand, the third one has two separate structures and construction problems. In the end, the second concept is chosen because of its higher potential in general and also lack of time to evaluate all problems and qualities of concept 3.

Group 2

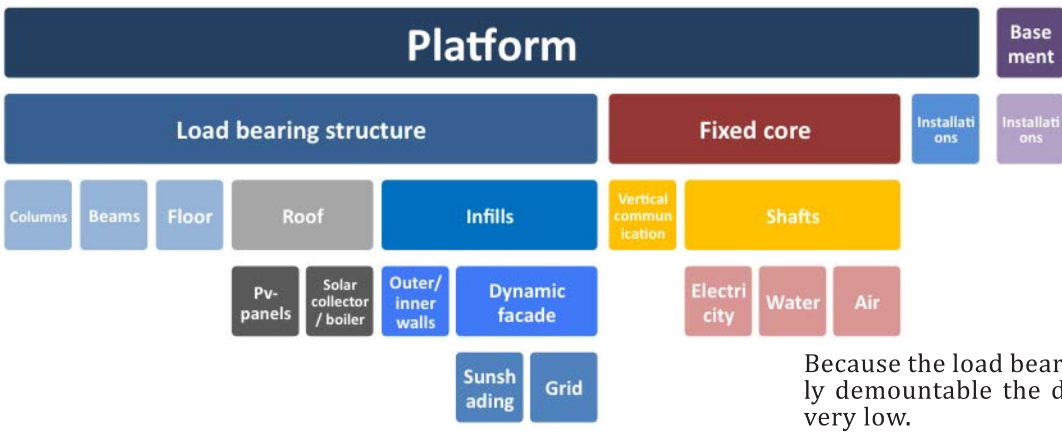
Concept 1

Mark, Karin, Mirna, Mersiha, Deniz, Gözde

This concept is based on the flexibility of the load bearing structure. The load bearing structure consist of elements that are demountable. The only fixed part in the construction is the central core which function as (1) stability core, (2) vertical communication; (3) distribution of installations and (4) stimulation of natural ventilation with a solar chimney

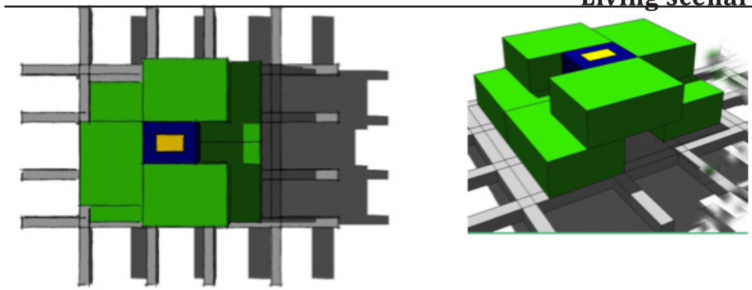


The platform is the basis for the load bearing structure. On this platform beams and columns can be easily added, whereafter infills can be attached.

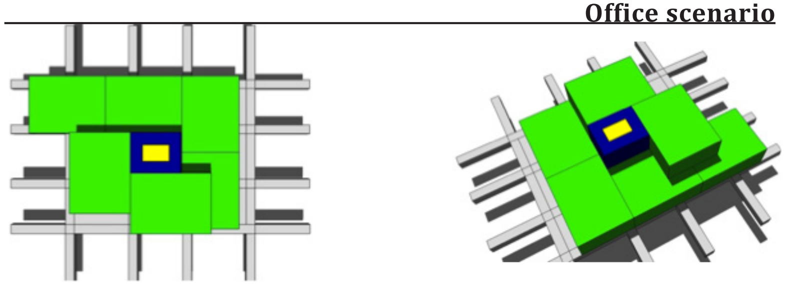


Because the load bearing structure with the infills are fully demountable the dependacy between subsystems are very low.

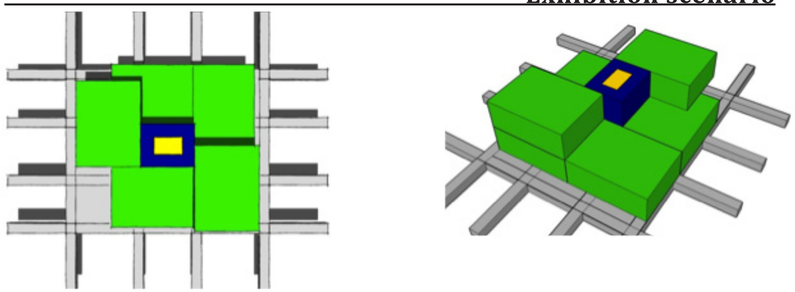
Living scenario



Office scenario



Exhibition scenario

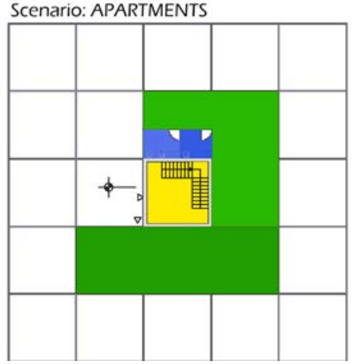


As mentioned the load bearing structure is fully demountable and therefore has a high level of flexibility. The basis of the load bearing structure is the grid, transformations from one scenario to another scenario can be easily made by adding or extracting elements to the grid.

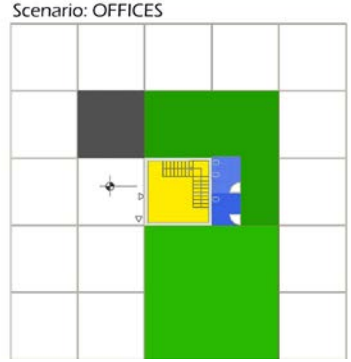
The core is the central part of the building. In this core the vertical distribution of streams take place. Therefore wet spaces, like kitchens and bathroom, are positioned at the core (figure below).

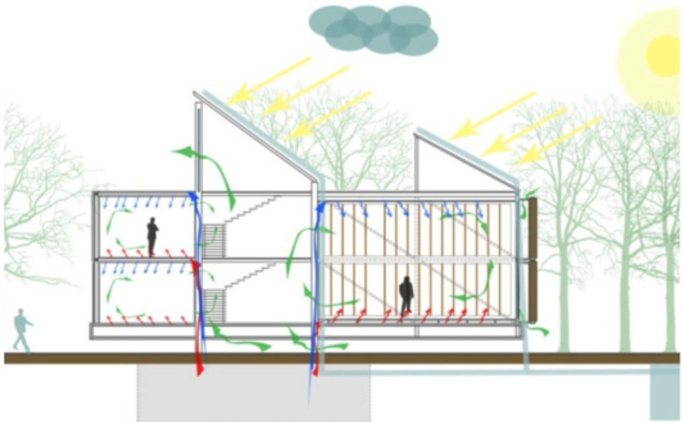
At the left you see different sketches which are made in the beginning of the design proces to show the three different scenarios.

Scenario: APARTMENTS



Scenario: OFFICES



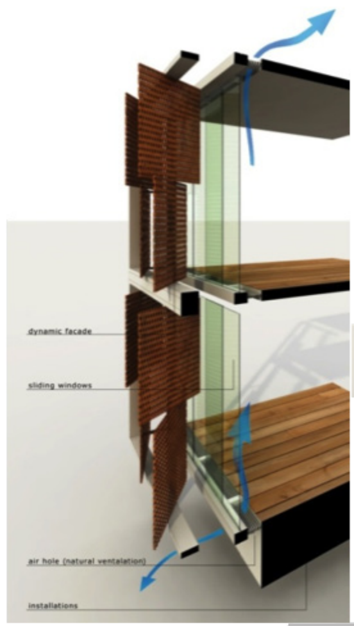


The platform is lifted so fresh air can enter the core from beneath and ventilate the rooms in a natural way. The roof is angled so it catches a lot of sunlight which heats up the air and stimulate a solar chimney effect for natural ventilation.

The roof of the central core is under angle because of two reasons: (1) photovoltaic panels are placed for generating energy and (2) rainwater can be collected for reuse as toilet water.

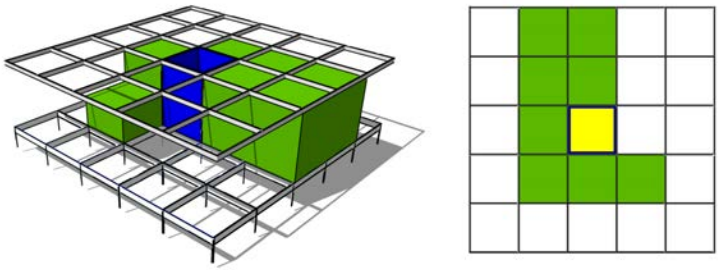
This facade is dynamic because of the sunshading. The facade is supplied with perforated panels that rotate according to the position of the sun. In the winter the facade will be more open than in summer.

Also the facade has inlets to stimulate natural ventilation, in combination with the core.

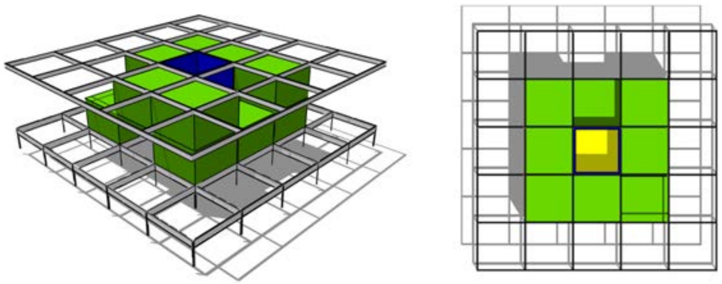


Concept 2

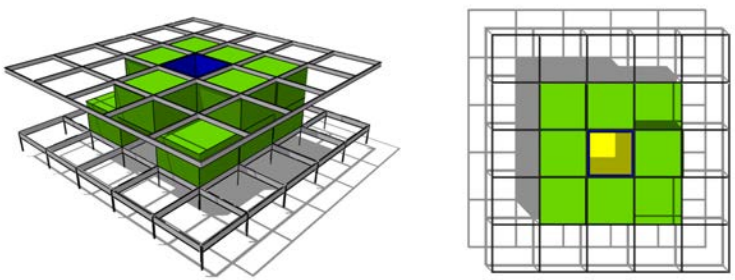
Scenario: OFFICE



Scenario: APARTMENTS



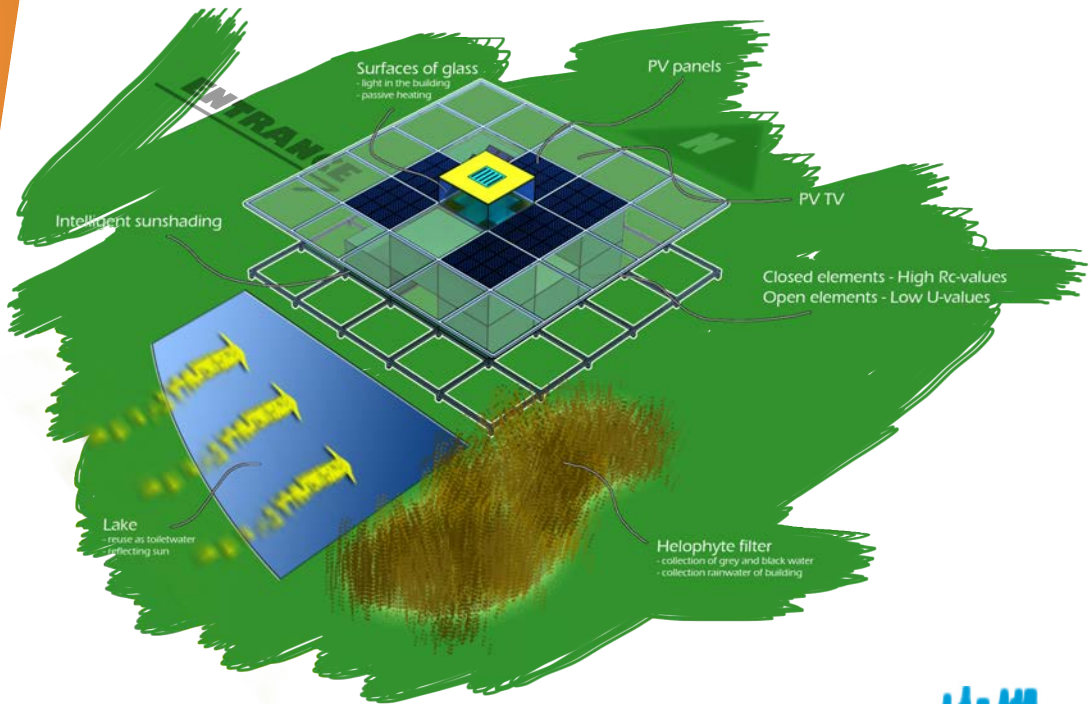
Scenario: EXHIBITION



The transformability in this concept is based on sliding units. Because of the load bearing structure (the core and the two platforms) there is an ability to slide the different units along the two platforms. With a mechanism the different units slide along the platform. Therefore a lot of configurations for the different scenarios are possible.

For the exhibition and office scenarios a heigth of six metres is necessary which can be created with an interface that joins two different stories.

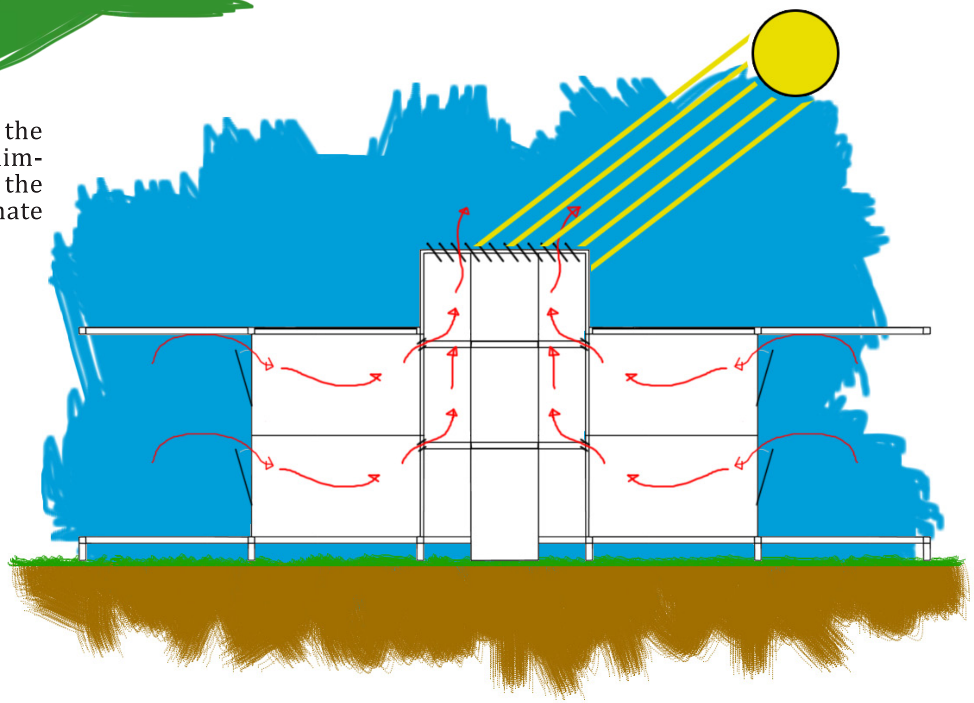
For the different scenarios open spaces can be created. For apartments private balconies or terraces can be created. For exhibition public terraces can be created.



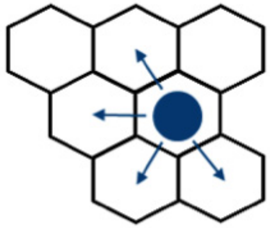
For the energy supply of the building the second platform is supplied with opaque and transparant pv panels. The roof will collect rainwater and distribute it to the lake in front of the building. The grey water of the building will be distributed to a helophytefilter. After the water is filtered it will be distributed to the lake. The water in this lake will be reused for toiletwater.

Because of the second platform at the top of the building there might be problems with light that enters the building. Therefore the lake is reflecting natural light into the building.

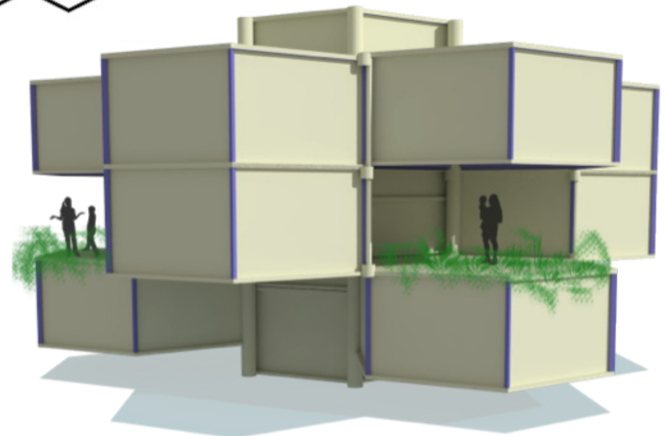
In combination with openable windows the central hallway will function as a solar chimney as can been seen in the figure on the right. In the Summer a good indoor climate can be secured.

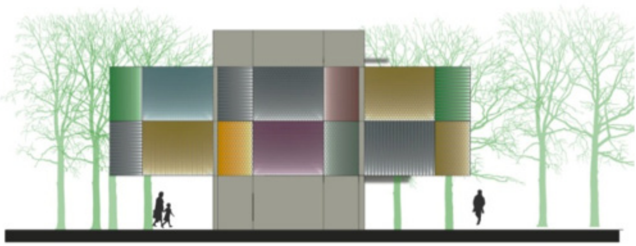


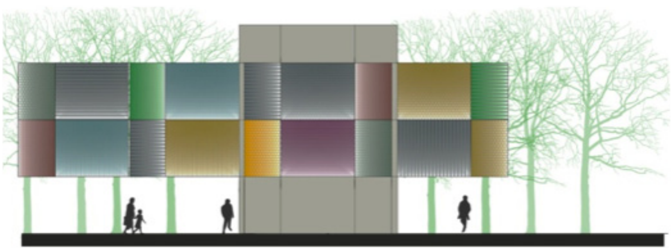
Concept 3

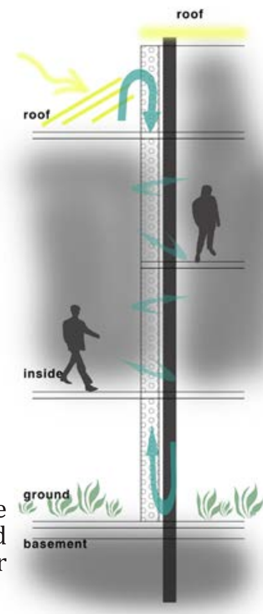


In this concept the choice was hexagons because they represent the most sustainable shape if you looking at things of this aspect. From the functional aspect this is a good shape as well, because it has an advantage of the short distance from one room to another. With each room there is possibility to enter six different rooms. The hexagonical rooms are attached to a central core.



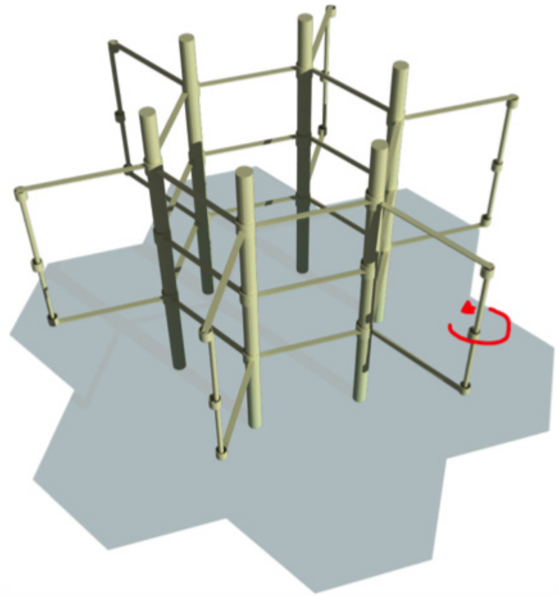


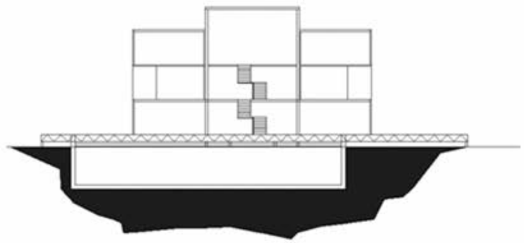


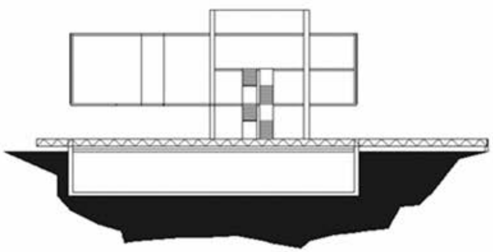


The columns of the core are hollow and support fresh air for the different spaces.

The load bearing consist of a basic structure as can be seen in picture on the right. When we talk about transformation, in this case the concept is based on rotation. Entire unit is rotating around main columns in the centre. Scenarios can be transformed in an easy way and within a short period of time. The infill are the only elements that have to be added during the transformation process. The flats have the possibility of different interior transformation. The building is recognizable and dynamic and has a strong identity because it has the ability of constant and rapid transformation. But such a transformation requires complicated details that should carry heavy units and transform it in the same time. The foundation is very simple. It's based on six columns that carry and transmit the forces to the ground on these points only. It is a compact building with a potential to grow horizontally and vertically by adding units. It has the opportunity to be on a platform that can be rotating continual. It gives extra points to the architectural quality of the building.







Multi criteria matrix

Aspects	Concept 1	Concept 2	Concept 3
Architectural quality	+/-	+	+
Transformability	+	+/-	+/-
Energy, water, materials	+	+/-	-
Comfort and health	+	+/-	+/-
Constructability and handling	+	-	-

Concept 1: This building has a high transformability capacity. The load bearing structure of this concept is very flexible, adding or extracting elements can be managed in an simple way. Standard interfaces of installations can been made which can be contributed to a good indoor climate. This concept however does not show the expression of transformability (for the different scenarios) and scores therefore lower on architectural quality.

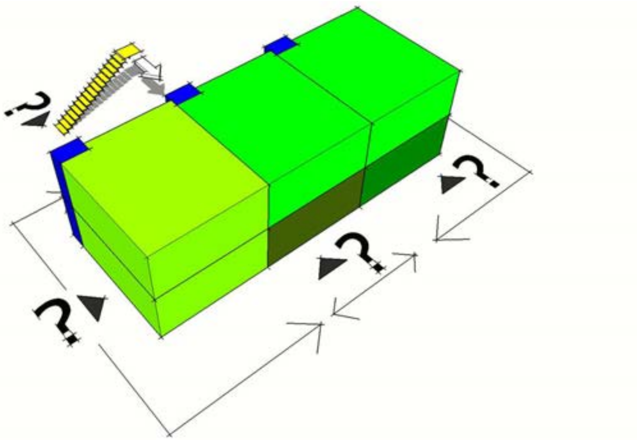
Concept 2: the second concept scores high on transformability, because a lot of configurations are possible. However it is questionable if the mechanism for the sliding will work properly. Also the second platform has some disadvantages for the indoor climate. Because of the sliding mechanism the building is special and has its own identity.

Concept 3: This building is made for transformation and has therefore good architectural quality. However it is questionable how and if the joint of the load bearing structure would work because of the heavy construction. In this concept a lot of subsystems are dependant from each other which make the constructability and handling complicated.

Group3

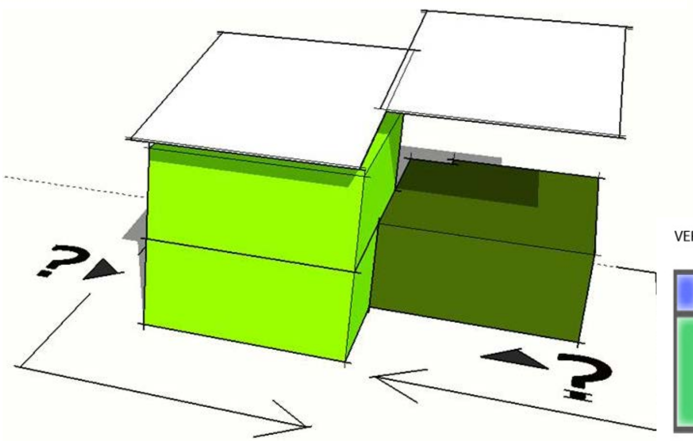
Concept 1

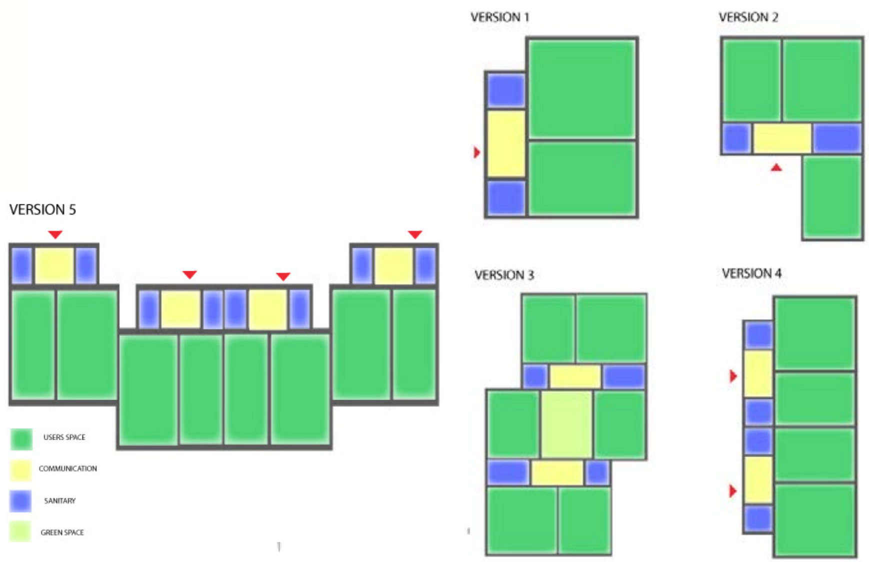
Frank, Arjan, Svjetlana, Damir, Öykü

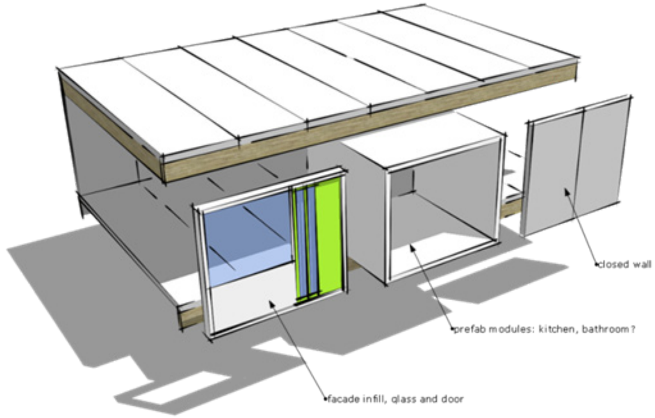


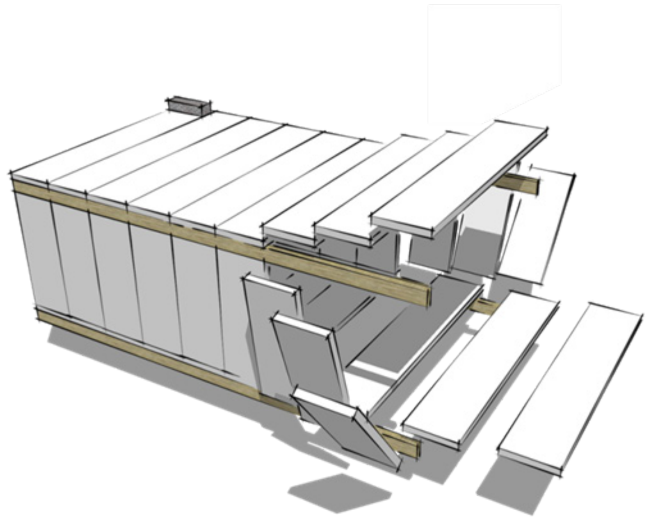
FlexScore is a building which consists of one or more fixed shafts. These shafts act as stabilizing elements and provide distribution of necessary installations. Because of the flexibility of the infill, it is possible to place vertical communications, stairs, either in private spaces or on the outside in the public domain.

FlexScore -Installation shafts - by placing several installation shafts and stability elements next to each other, larger building can be designed. Flexibility in the infill ensures that rooms can be combined, divided or re-arranged. Different spatial configuration - reconfiguration is not only possible by changing infill inside the basic load bearing structure, but also by adding completely prefabricated modules inside or outside of the facade.



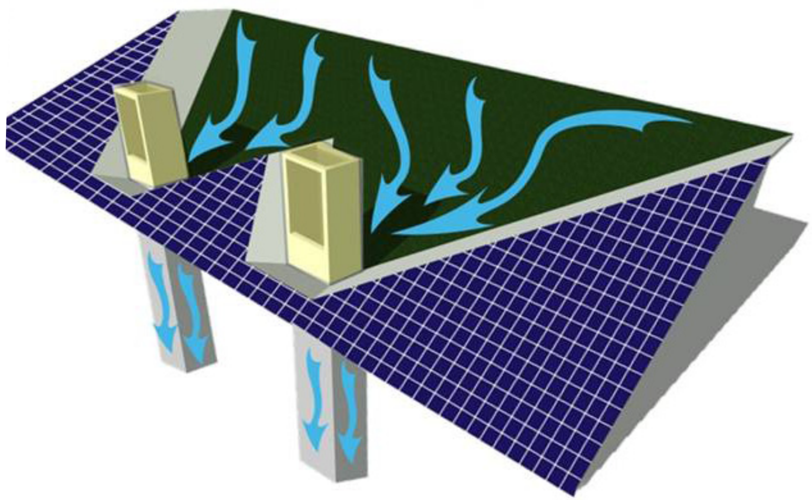






One of the aspects to reach a zero energy structure is the climate concept. In this concept, a second skin is made from a glass and by that provides better insulation properties.
During the summer, the second skin can generate a thermal updraft which can help with natural ventilation. During the winter, the second skin and possible atrium help to maximize solar gain. This lowers the external energy needed for heating.

The titled roof helps in collecting rainwater and provides better placement for photo voltaic panels. The ridge at the top also helps with improving ventilation because of the venturi effect.
Green roof and wall elements help to maintain a lower temperature during summer time, improve air quality and act as architectural elements.



PRINCIPLES OF CONCEPT 1

Basic components
Load bearing construction, fixed installation shafts, titled/green roof, prefabricated modules.

Daylight system provides solar protection and guarantee a high amount and quality of light inside of building.

High efficient sun protection louvers passive cooling capacity and illumination, high level of comfort and savings.

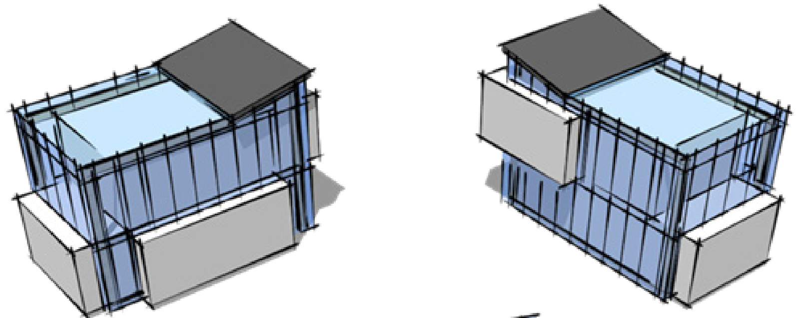
Technical installations are also beneath a raised floor ~ flowing of fresh air and serve as air exhaust in the floor.

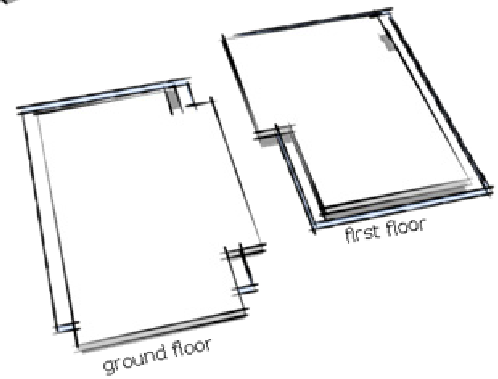
Using of wood facade ~ reduction of the primary energy.

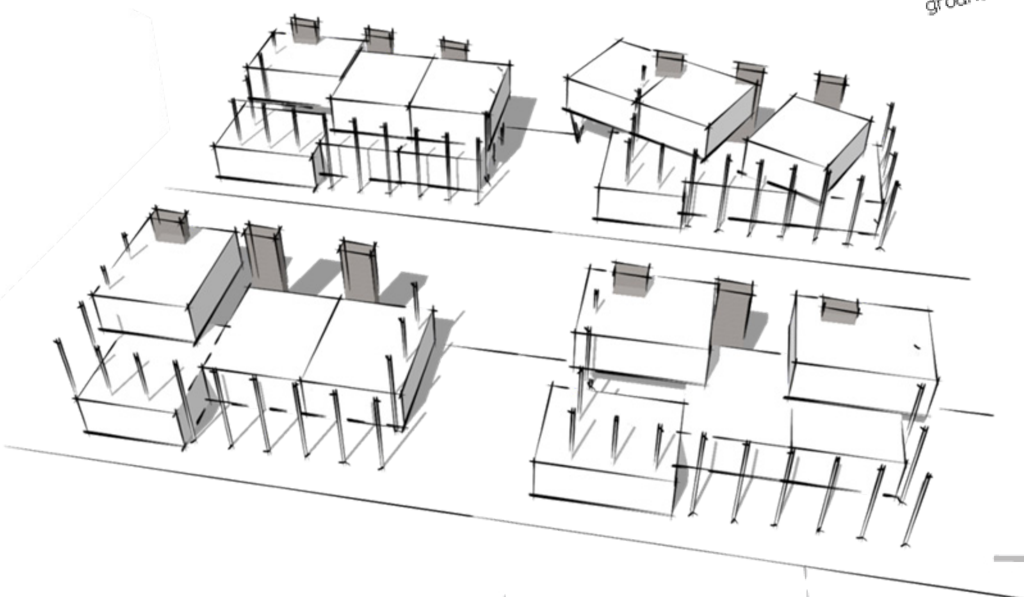
The fully opened south facade ensures good daylight and afford view of the building. Blinds prevent access of sunlight and the glare caused when the sun is at low angle of inclination.

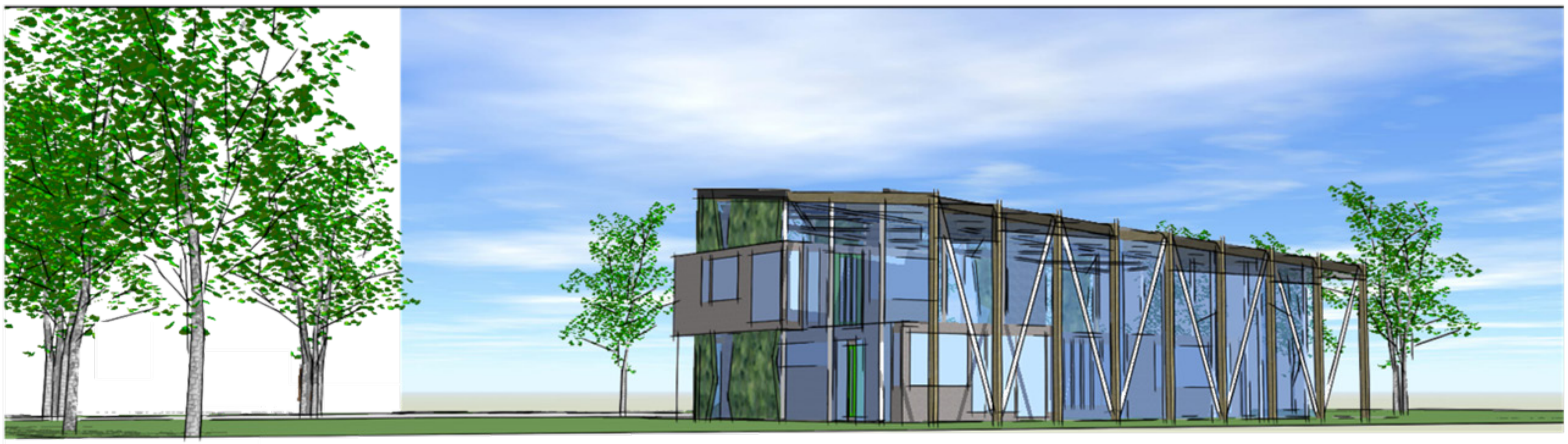
Atrium as urban garden space ~ natural ventilation.

Opening flaps on facade ~ allow a well regulated circulation of fresh air, automatically opened and closed depending on the interior and exterior temperature.









Concept 2

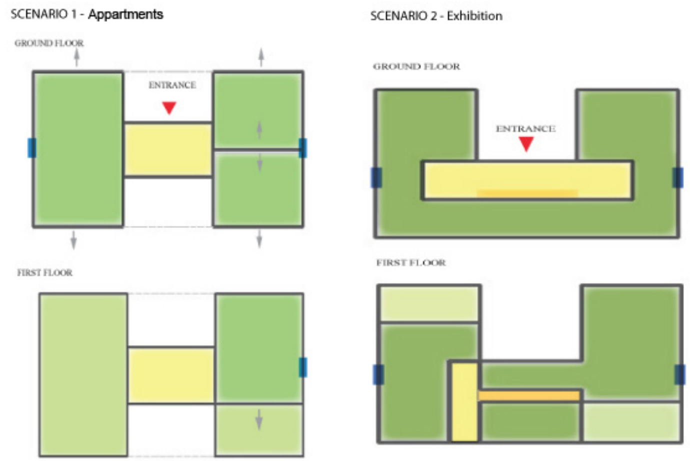
The first concept was based on design of two rectangular shaped units which are connected with element, used as a common space.

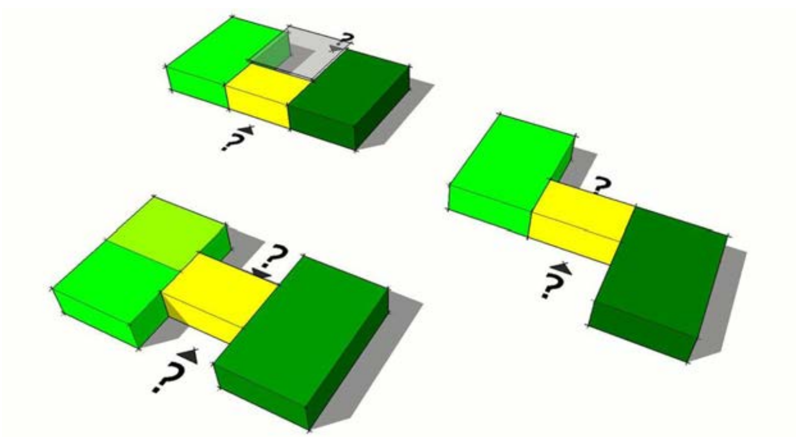
The layout of Nerdlanubic consists of two units , connected with an entrance unit, used as a common area for users. Units can be divided into smaller ones, for example 1 unit of 100 m2 can be divided into 2 x 50m2, depending on users needs.

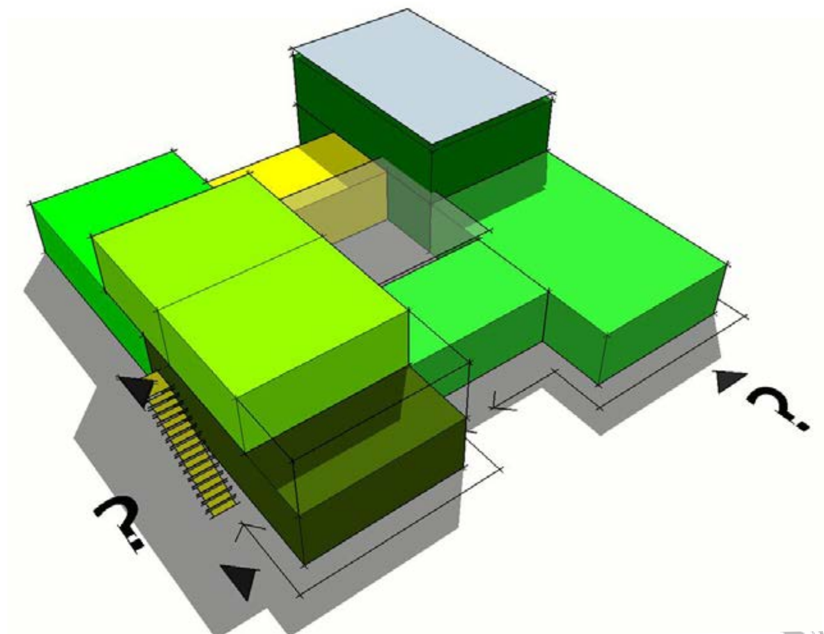
With that possibility, flexibility is provided so the units could be easily transformed into different layouts.

After analyzing which shape is better to provide more flexibility, H-shape is choosen so the units could be easily transformed into different layouts and by that flexibilty is provided.

Transformability in vertical and horizontal direction - evaluation from simple shape to the more complicated shape, depending on users needs and location site.

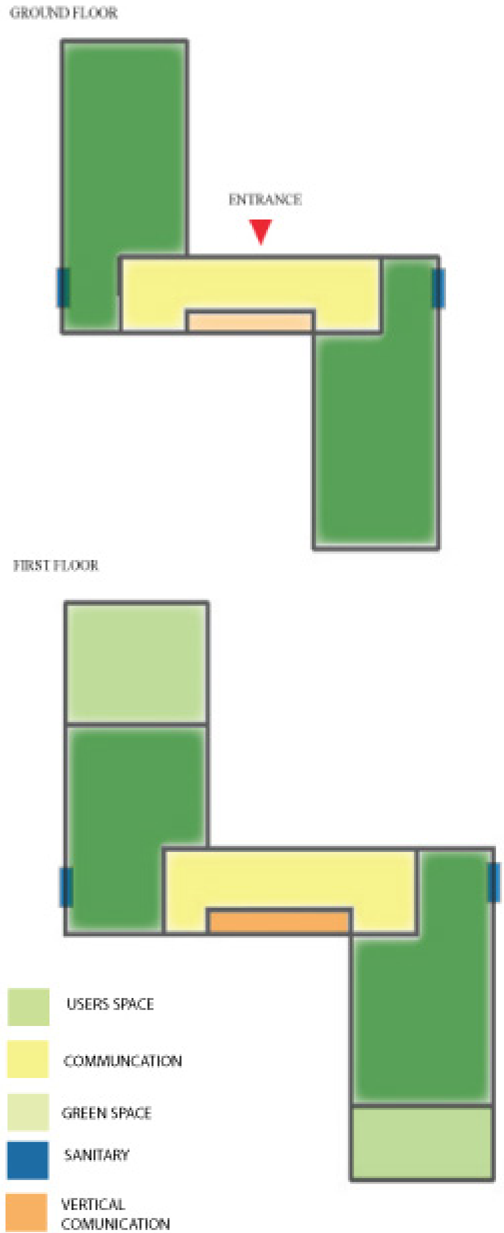






SCENARIO 1 - Office

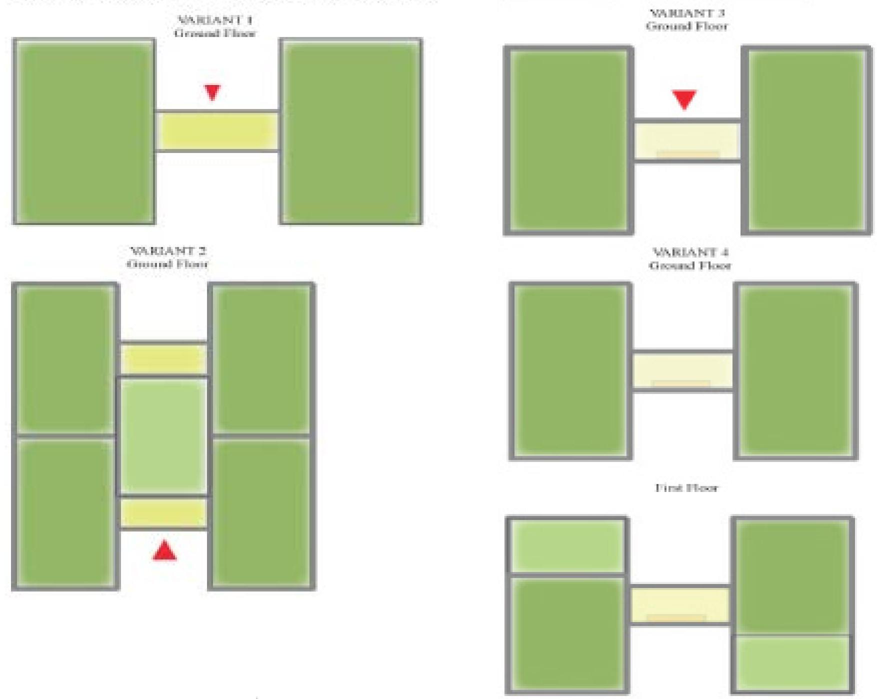
H~sh



Horizontal transformability is provided by adding elements on existing layout. Existing layout consists of two units connected with common element for users. Adding similar two units like a mirror, atrium is designed. It can be used as a common area for users with green space, providing private, intimate space . In atrium, only users of units can enter, so the entrance from outside is not possible.

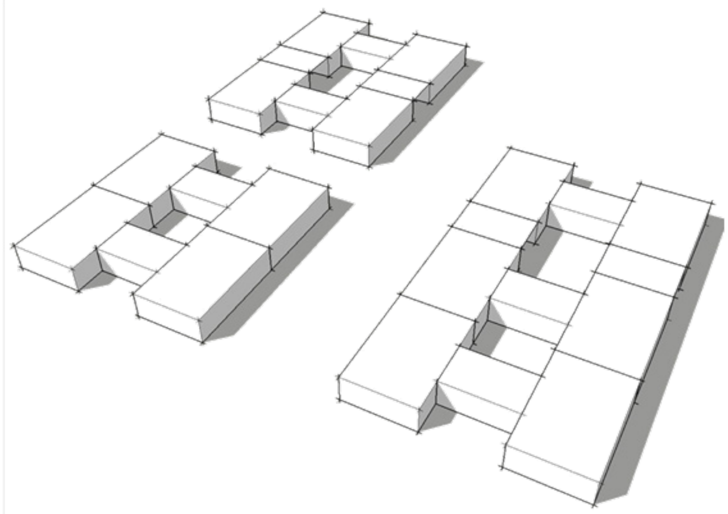
Vertical transformability is provided by adding vertical communication, stairs, into common area which connects two units. That way, we have vertical transformability, two story building which is designed, with layout which can be different created.
Combinations of green space and solar chimney providing natural ventilation and comfortable space all over the year (during hot summers and cold winters), green roof with solar panels, outside added stair elements (interesting architectural design).

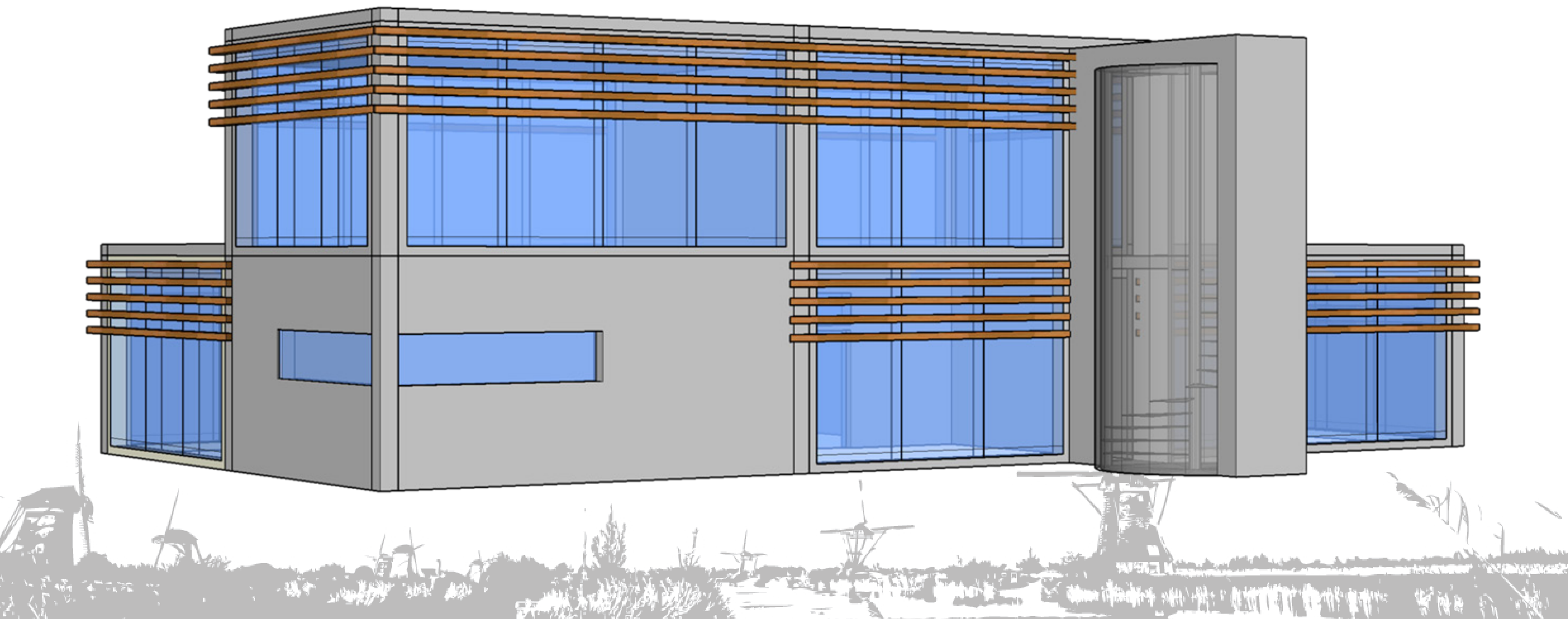
shape OF LAYOUT ~ CHOOSEN SO IT COULD BE EASILY TRANSFORMED IN DIFFERENT UNITES ~ FLEXIBILITY IS PROVIDED

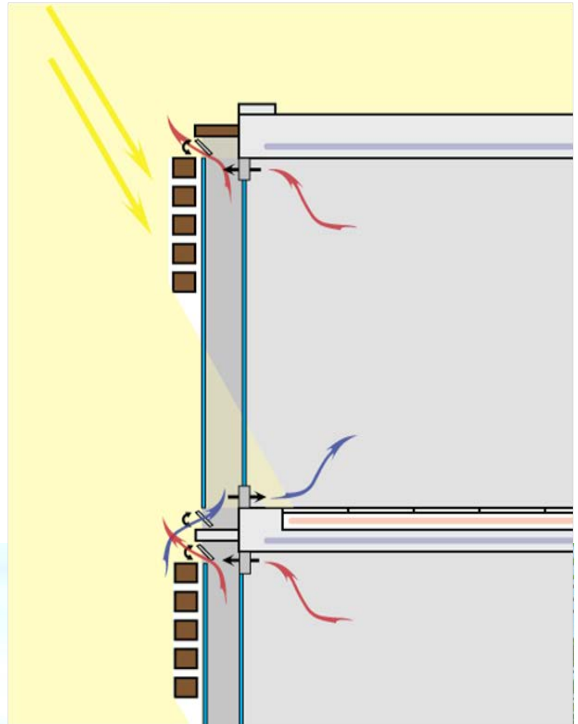


Principles of Concept 2

- Basic component :
Load bearing columns ;
Installations through columns (centered on load bearing sides of units);
Different dimensions based on adding wall elements.
- Creating "urban garden" space - allows natural ventilation and at the same time provides high-quality leisure space;
- Outer atrium space - high degree of thermal protection which allows a thermal activation of building elements;
- Under floor heating / cooling installed in floor construction, natural ventilation - manually opening or closing windows in the atrium or on the outside;
Mechanical air supply is planned only for inner areas - guarantee a high level of thermal comfort over the entire year;
- Significant reduction in the energy requirements for air extraction.
- Good lighting conditions or visual link with external space - provided with the rear walls executed in glass.
- PCM elements ad roof covered wit PV installation, green roof;
- South facing building - fully glazed south faces.
- Result : combination of comfort, space and light.







Multi criteria matrix

Aspects	Concept 1	Concept 2
Transformability	+/-	+/-
Energy, water, materials	++	+
Architectural quality	+	++
Comfort and health	++	+
Constructability and handling	+	-

Concept 1 is the preferred options because of the better aspects of constructability and handling, the load bearing seperates the roof from the rest of the construction. Also, the second skin enables energy savings because of the improved insulation and decreased need for heating because of solar gain. The architectural quality is less than concept two, because it becomed to massive. Further exploration could focus on improving this, by giving more focus to the transformability of the design.

Combination of concepts

Following the workshop in Sarajevo the most interesting parts of the different proposed concepts were combined. This led to a single design, on which all the groups would be working together.

Different aspects taken from different concepts:

A flexible **load bearing structure**, based on a grid of 5.4 meters by 5.4 meters. Material options that will be investigated are steel, wood and a hybrid version. Stability will be added by concrete walls which will be combined with the needed installations shafts. Everything will be placed on top of a standardized foundation and deck. To quickly add more volume consoles can be suspended from the outside of the façade, these can be used as extra interior space or as a balcony.

The **climate concept** is created to minimize the energy demand and to test different system combinations. Different concepts have been proposed for different parts of the building. The flexibility of the climate concept is obtained by maximizing the flexibility of the installation distributions and the climate control products.

The **installations** will be made as ‘plug and play’ as possible. The vertical shafts distribute it from the technical space to the different floors. Horizontal distribution will be integrated with the flooring system which will also contain many of the climate control products. Some other climate control products will be integrated with the façade elements.

The interior arrangement will be made with **infill** which will be designed to be as flexible as possible, it consists of different elements which can be placed and exchanged to obtain internal flexibility.

During the detail phase much attention has been paid to minimizing the amount of relations. By doing this the building system is supposed to become a loosely coupled system. Different external parties should be able to design components that fit together well by complying with the constraints set by the interfaces.

Architectural quality

The transformation of the building is based on adding or extracting elements, the expression of transformability should be expressed in the facade (e.g. sunshading). Also the façade should be recognizable and give the building identity.

Multi-Functionality

The building can be easily transformed from one scenario to another because of the construction. With this concept infill’s can be easily added or removed to adapt to future needs. Attention should be paid for the distribution of installations. Because the installations have to be flexible the installations would be made as ‘plug and play’. With transforming the building the installations can be adapt easily.

Transformability

The construction has been build up by standard elements, the exchangeability and the reusability of components is therefore high. The building can be easily extended or shrinked. To the construction façade frames and infill’s can be attached (and detached). Research should be done for the climate concept when scenario changes.

The load bearing structure will be at the top of the hierarchy which means that this subsystem has a lot of interfaces with other subsystem. All subsystems are connected to the construction.

Energy, water and materials

For the final concept aspects from different groups are integrated, therefore a final energy-concept is not clear. For the energy performance of the building should fit the requirements.

Comfort and health

From the requirements a climate system should be developed. The core (or atrium) of the building will function as a solar chimney. Additional components should be added to the infills and construction to provide a good indoor climate.

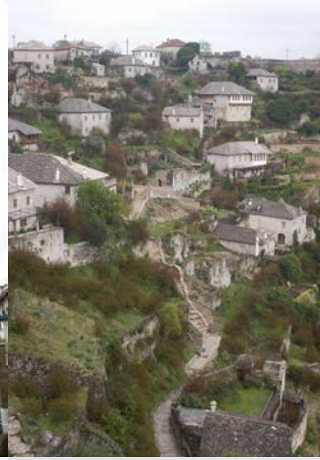
Constructability and handling of components

The load bearing structure is easy to assemble because of the standard elements. After the construction has been assembled different infills (e.g. roof, façade and interior walls) can be added. Also future transformations can be easily managed because the construction with its interfaces are loosely coupled.

Cultural and local site context

A good research for the location has already been done. Because the final concept will be an integration of aspects from the different groups the new concept should also fits in its environment according to the research.










TEČNI
Jogurt

Chapter 3 - Final Design

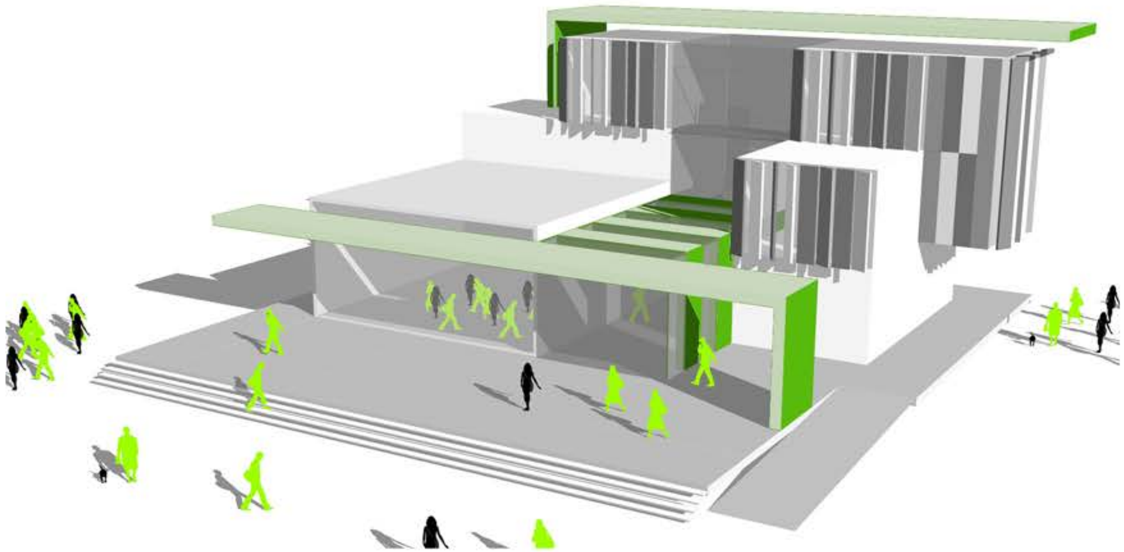
Introduction

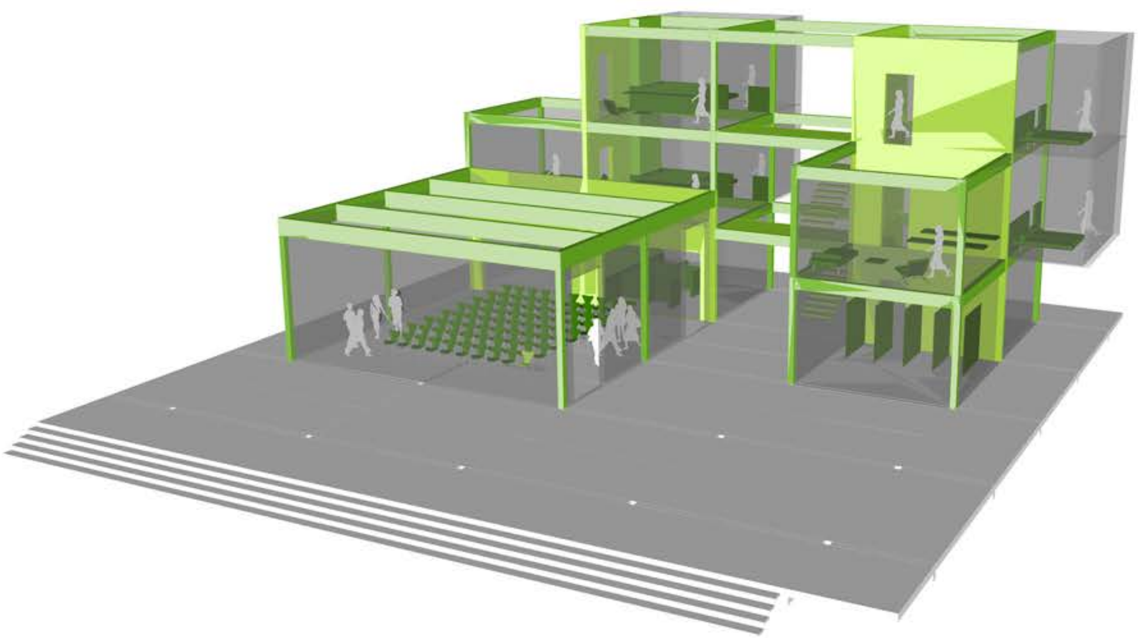
At the end of the workshop in Sarajevo the different groups presented their final concept. The jury evaluated the different concepts according the design matrix. For the final concept the jury decided to integrate different systems for the three groups. Group 1 should work on the floorplans and installations, group 2 should work on the climate concept and the envelop and group 3 was responsible for the load bearing structure and infills.

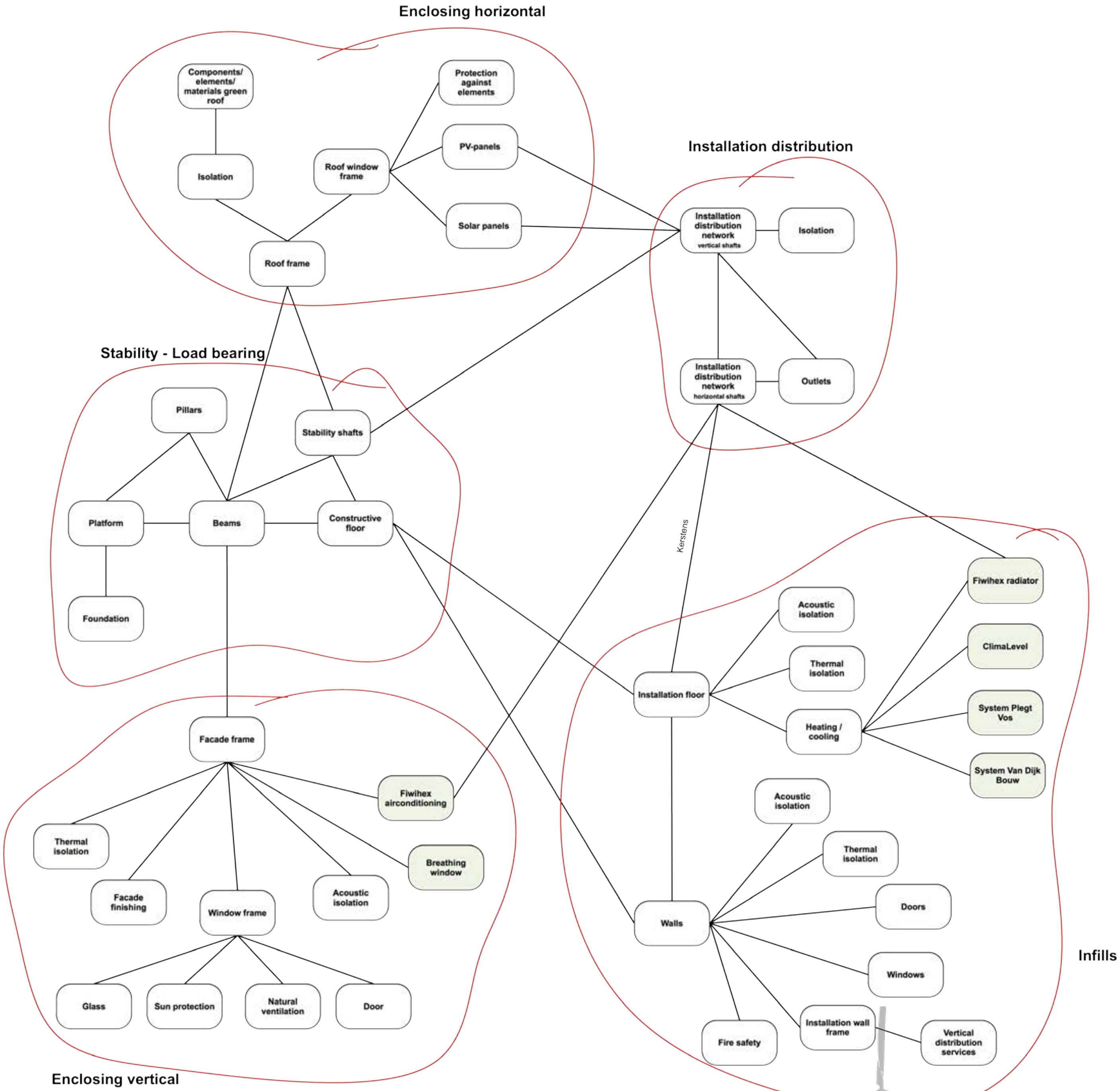
For the final concept a proposal for a loosely coupled system has been made. To show the dependencies of the different subsystems a relational diagram is made. In the diagram can be seen where the interfaces are between the subassemblies. It is very important that these interfaces are well communicated within the different groups. During the design process the relational diagram has been changed several times, on the next page the final diagram is shown.

A hierarchy of the building has been made to show which subsystem are at the top of the hierarchy and therefore the most fixed. Changes to these components will have biggest impact on the design and often can't happen without removing super imposing systems.

After the hierarchy is defined the groups start to work on their subsystems. The different systems and the hierarchy within that subsystem will be explained in this chapter. For this phase the coordinators of the group work as systems integrators to communicate the different interfaces.






Enclosing horizontal
Components/ elements/ materials green roof
Isolation
Roof window frame
Protection against elements
PV-panels
Solar panels
Roof frame
Installation distribution
Installation distribution network vertical shafts
Isolation
Installation distribution network horizontal shafts
Outlets
Stability - Load bearing
Pillars
Stability shafts
Platform
Beams
Constructive floor
Foundation
Kerstens
Fiwihex radiator
Acoustic isolation
Thermal isolation
ClimaLevel
Installation floor
Heating / cooling
System Plegt Vos
System Van Dijk Bouw
Acoustic isolation
Thermal isolation
Doors
Walls
Windows
Infills
Fire safety
Installation wall frame
Vertical distribution services
Facade frame
Fiwihex airconditioning
Thermal isolation
Breathing window
Facade finishing
Window frame
Acoustic isolation
Glass
Sun protection
Natural ventilation
Door
Enclosing vertical

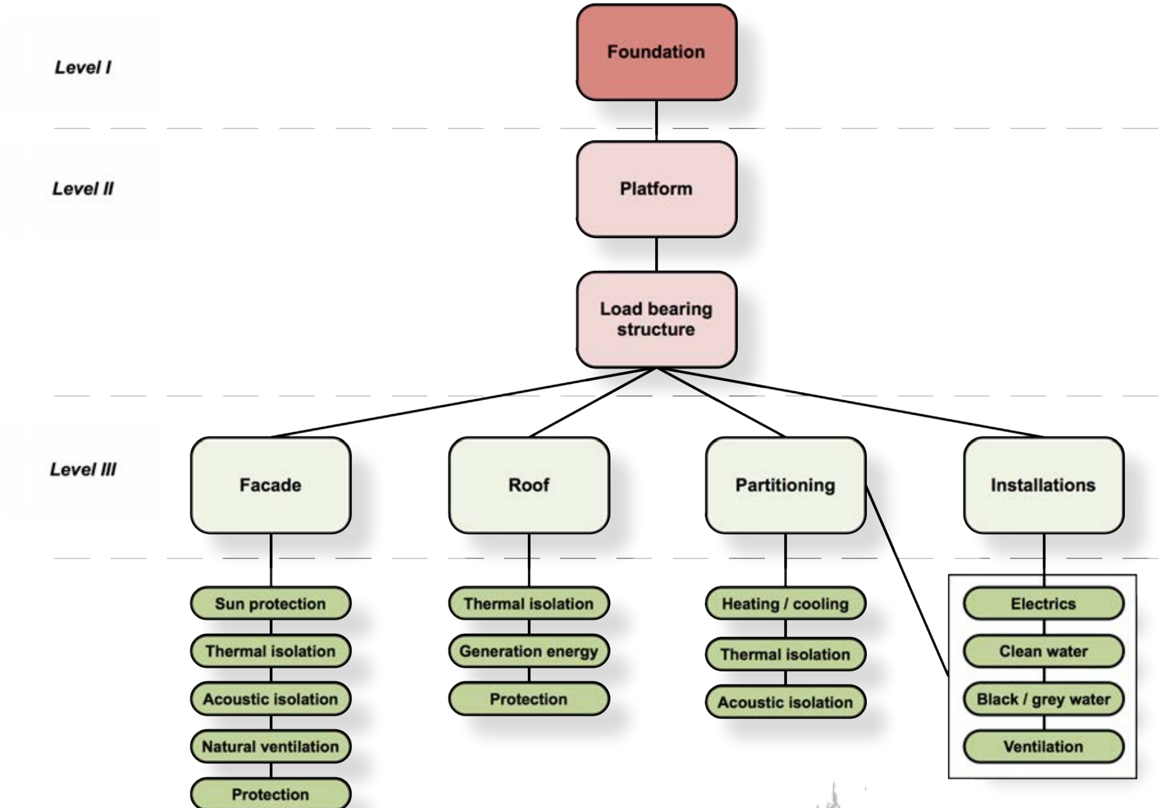
Relational diagram

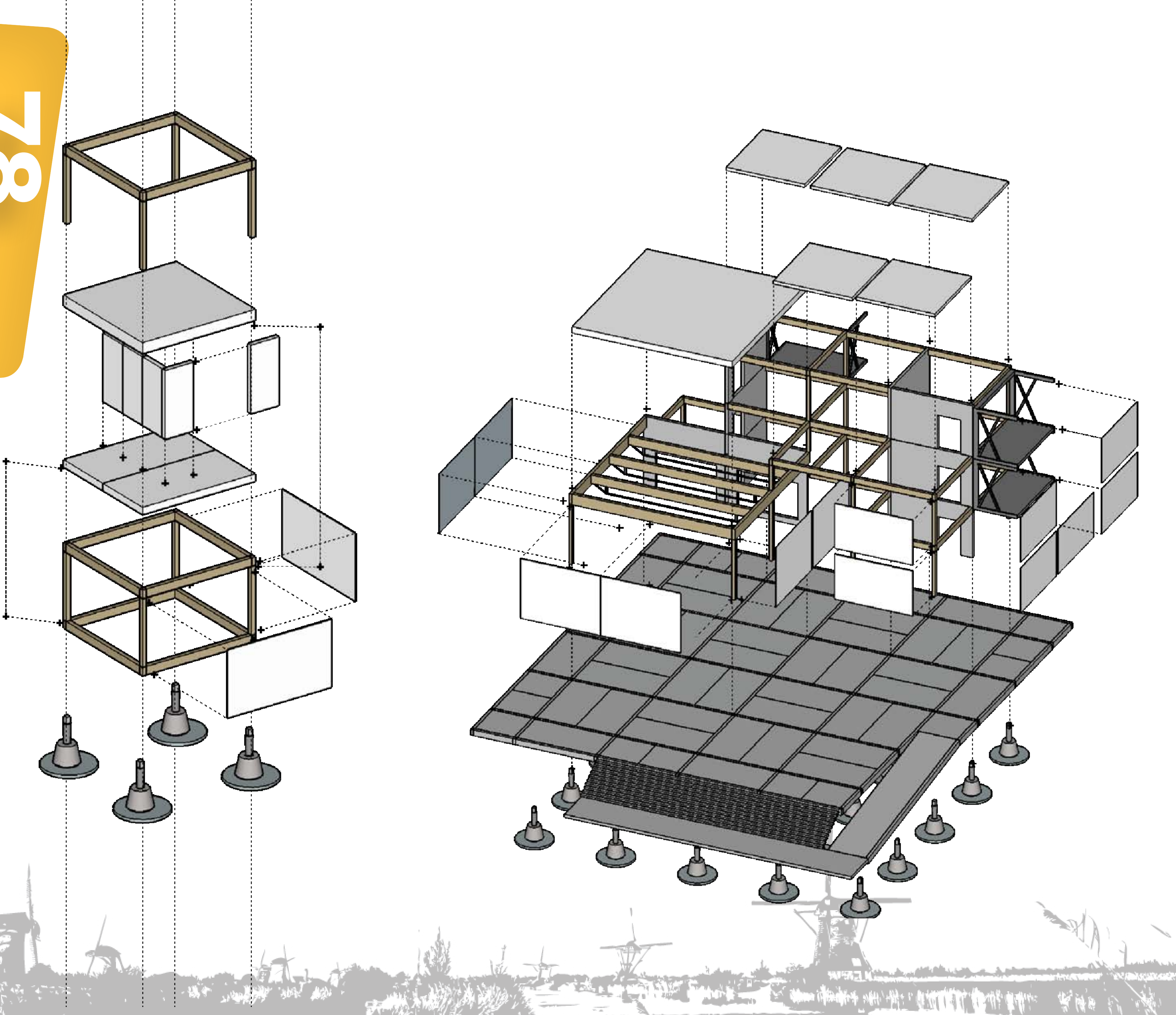
A relational diagram will show the dependency between different sub-assemblies and their number of relations. The diagram shows what parts are affected when a sub-assembly changes and how this affect other sub-assemblies.

The main rule of a relational diagram is that most sub-assemblies are only dependant of the load bearing structure; therefore components can be easily adjusted without affecting other subsystems.

On the left the relational diagram of the green transformable building is shown. It shows that the different sub-assemblies are all have interfaces with the load bearing structure. Therefore an adjustment of the load bearing structure has the biggest impact. This can also be explained by the figure on the right where can be seen that the load bearing structure is at the top of the hierarchy.

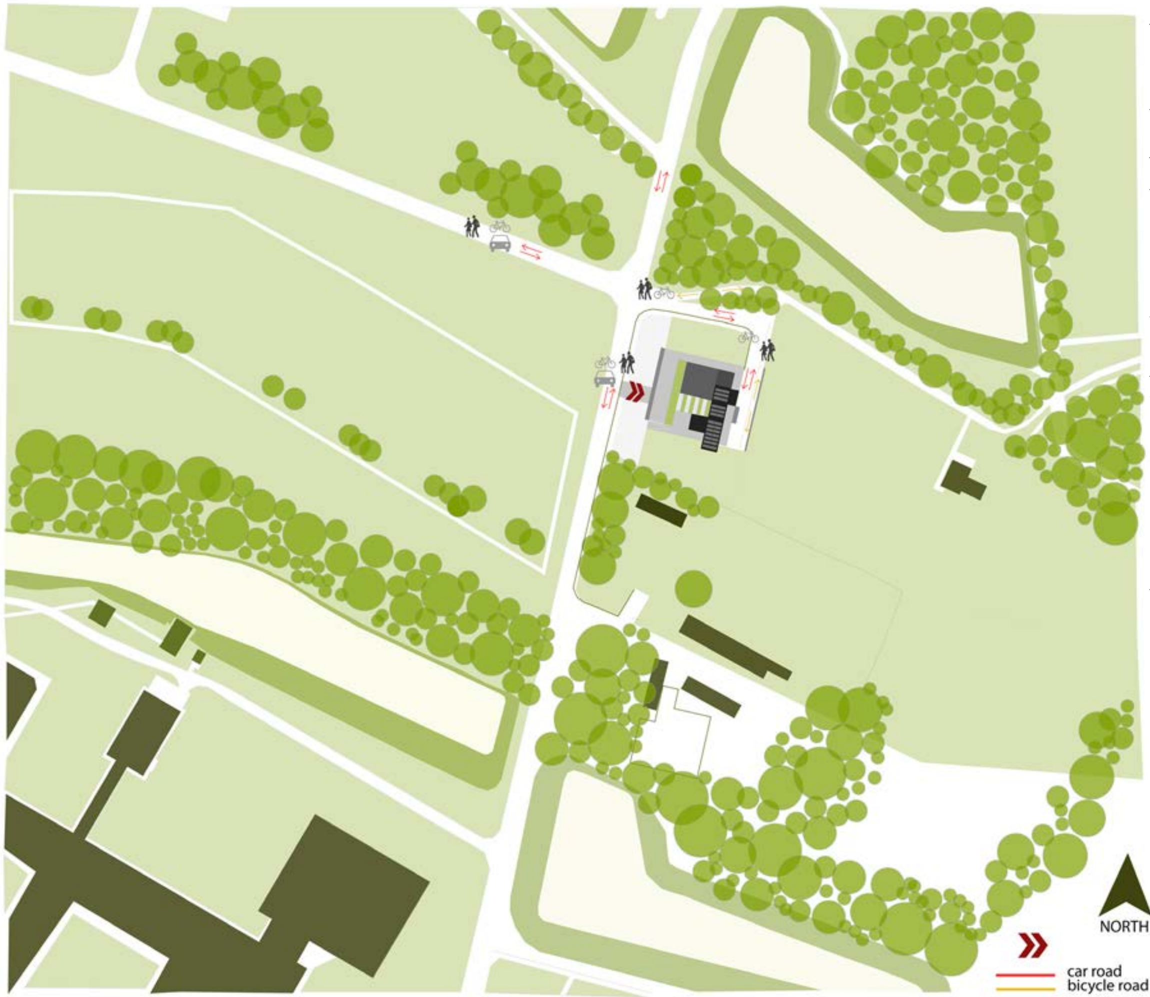
The dependency between the other subsystems is very low because it does not have many relations. All sub-assemblies have only one relation with the load bearing structure except the distribution of installations which have relations with the infill's and the roof. This because different flows (sub-assembly installation distribution) have to be distributed by the walls and floors (sub-assembly infill's).
The hierarchy on the picture below shows the transformability capacity of the building. We can see that if we want to transform the foundation we have to adjust the whole load bearing structure. Therefore the foundation should be sturdy enough to bear future scenarios. As in both diagrams can be seen the façade and the roof have only an interface with the load bearing structure. When the building is changing from scenario (e.g. the auditorium have to be offices) the design of the building can be transformed easily. The same applies for the infill's and installations.





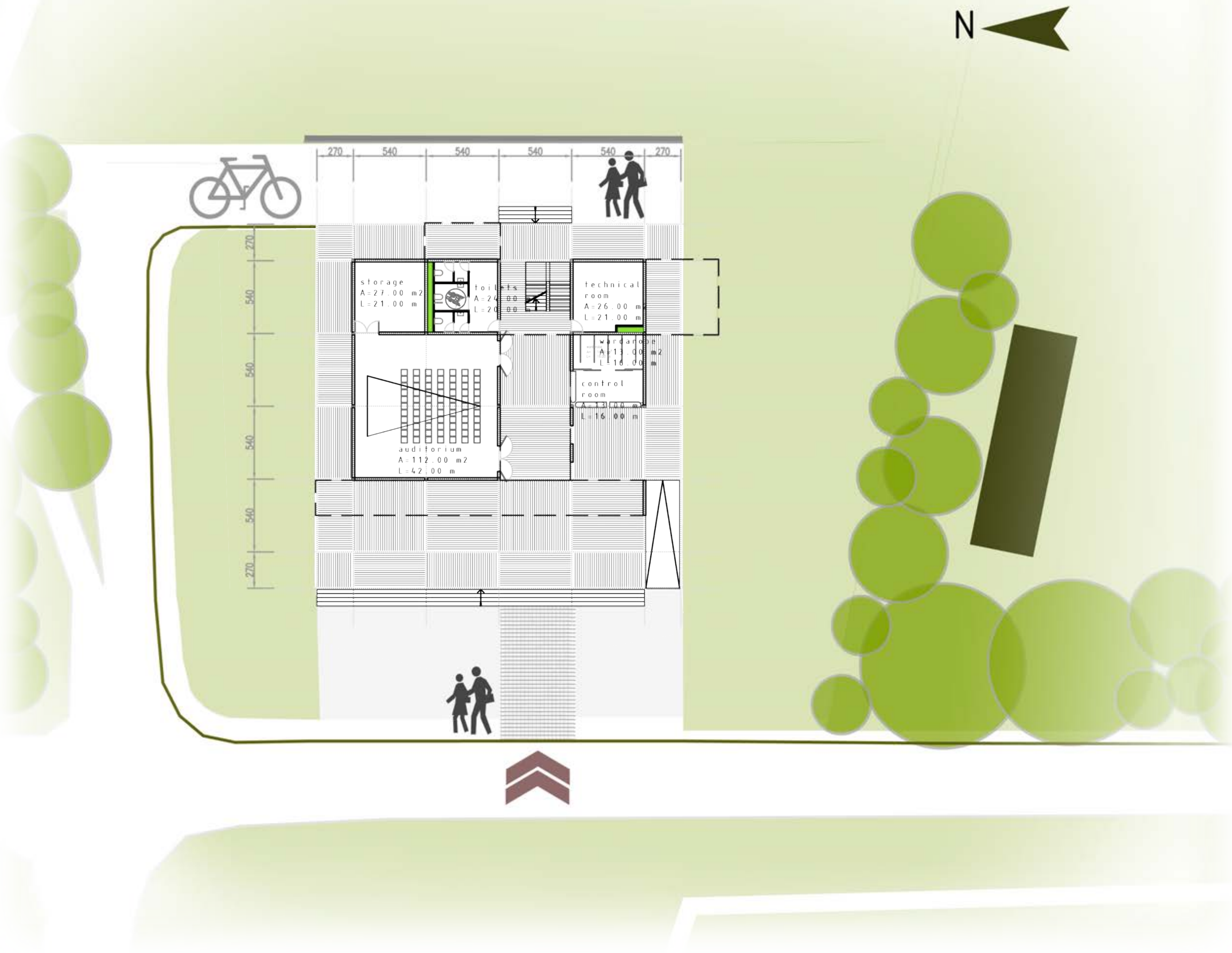
Location

Extended site analysis

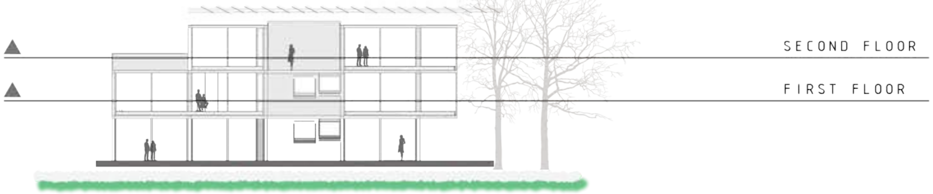


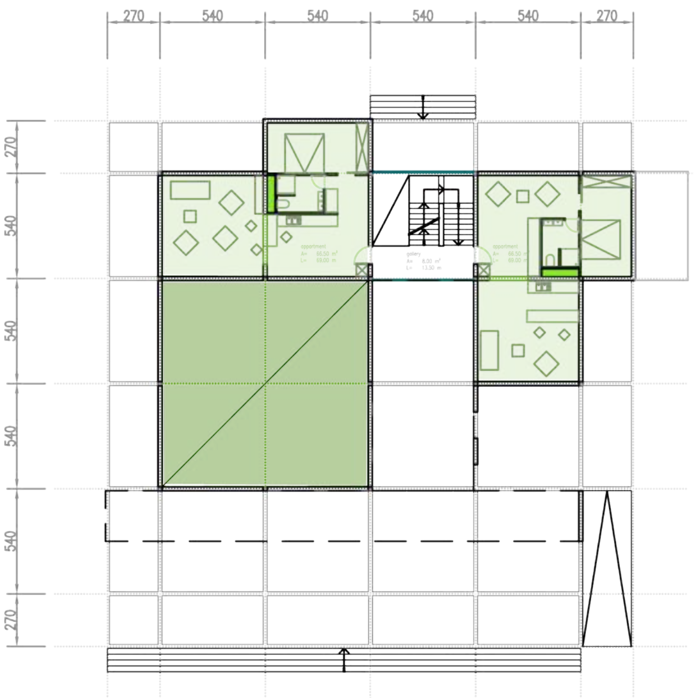
We used the advantage of existing roads, meaning cars and bicycles roads and we incorporated it in environment of new building. We established new roads which are incorporated with existing elements of environment. We are introducing new service entrance area from the back of the building. Orientation of the entrance stands parallel with roads because of the logical connection, views on building and quality of position of inside space. We predicted parking for bicycles behind the building we excluded the cars because of reducing CO_2 emissions. We want to encourage using of cars. We predicted a lot of open space in front of building for different events because we want to have a lot of event because there is no space without events.

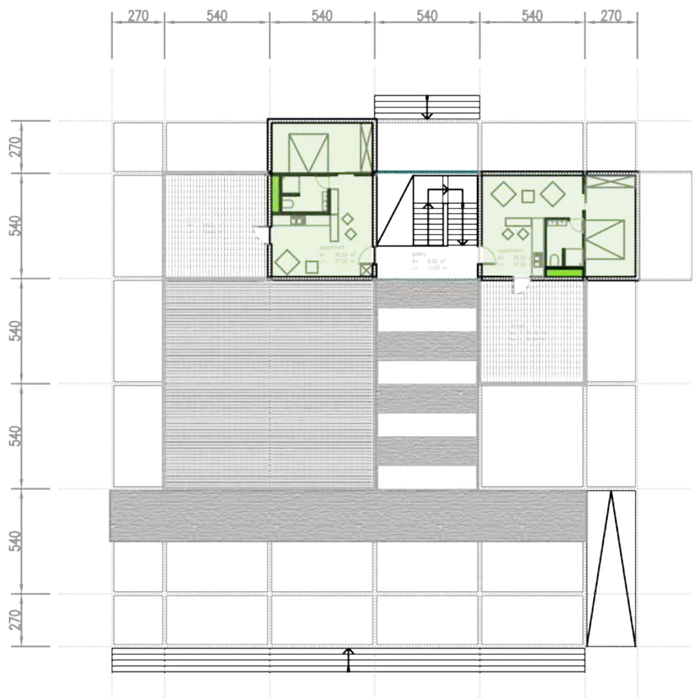
GROUND FLOOR



FIRST FLOOR AND SECOND FLOOR



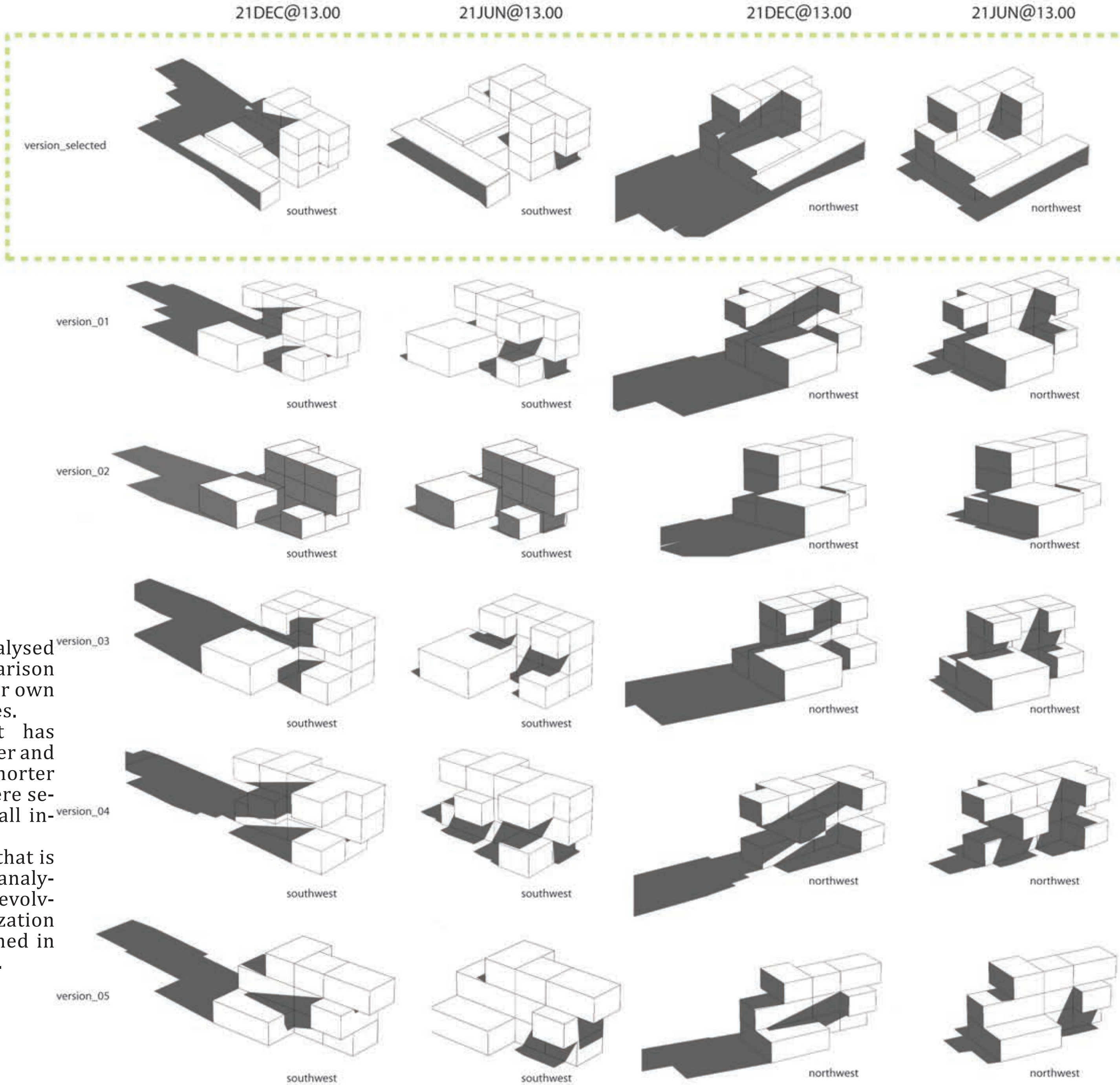




HERE ARE PRESENED FOUR APPARTMENTS, AS WE SHOWED ON FIRST PAGES EACH APPARTMENT SPACE COULD BE TRANSFORMED INTO OFFICE OR WORKSHOP SPAVE. ON THE FIRST FLOR THERE ARE TWO APPARTMENTS OF 66,50 m2 AND ON THE SECOND FLOOR THERE ARE T WO APPARTMENTS OF 40,50 m2.

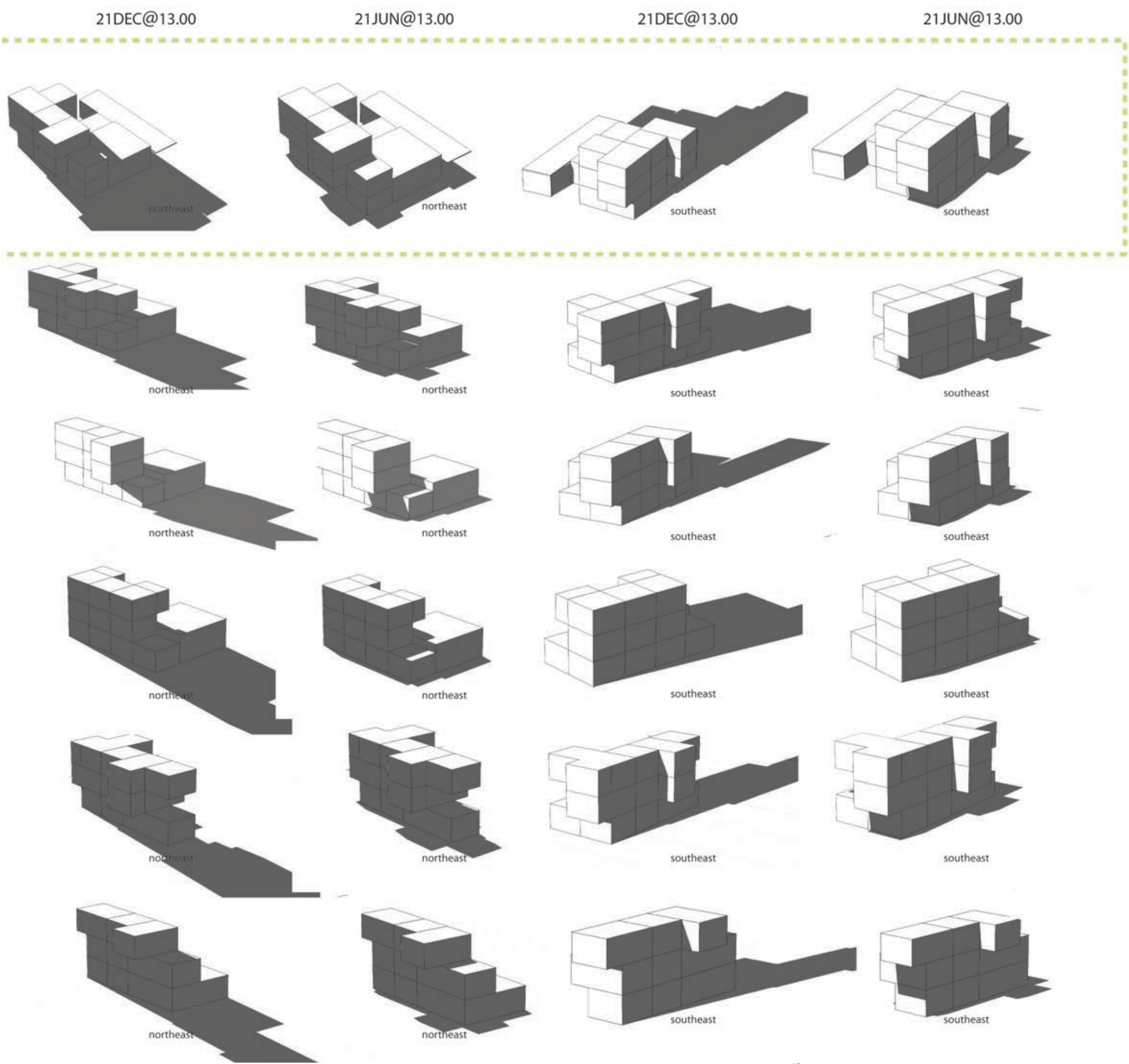
Floorplans

After analysis that we made in ecotec about the shadows of the building and it's parts we made conclusion the this floor plants are the most appropriate. In ground floor you can see devision of semi-public and public space. We have street that has main two functions beside the others. One is as it name explain public functional and the other is as foyer or entrance to auditorium. It is connecting to tree different functions. As we divided floor plans in horizontal way we did it also vertically. All the time we are suggesting and putting points on possibility we have, auditorium in ground floor, offices in first floor, apartments on second floor, even we are trying to connect a functions like working and living in same gallery.



Ecotect

All the versions are analysed by Ecotect for comparison about the effect of their own shadows on themselves.
21th December that has longer shadow in winter and 21th June that has a shorter shadow in summer were selected to get the overall information of the year.
Also this information that is acquired from these analyses were used for evolving the facade organization which will be mentioned in the Enveloppe section.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21JUN@13.00
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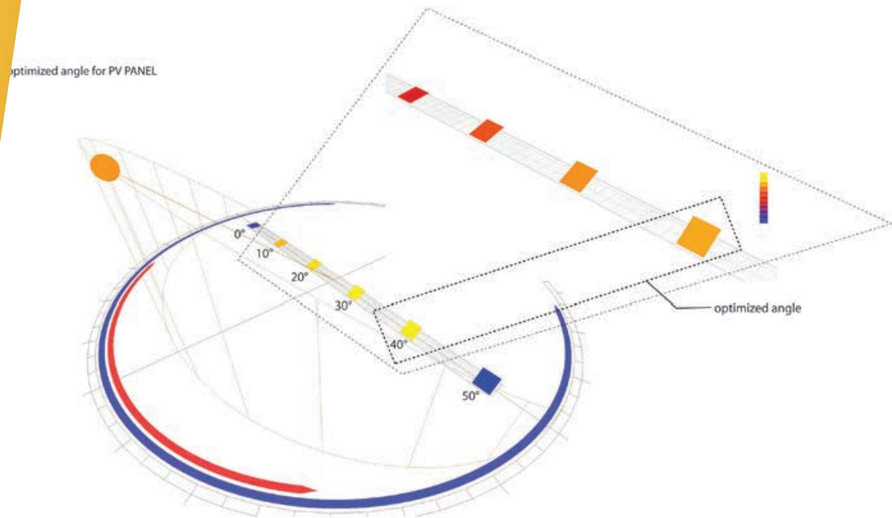
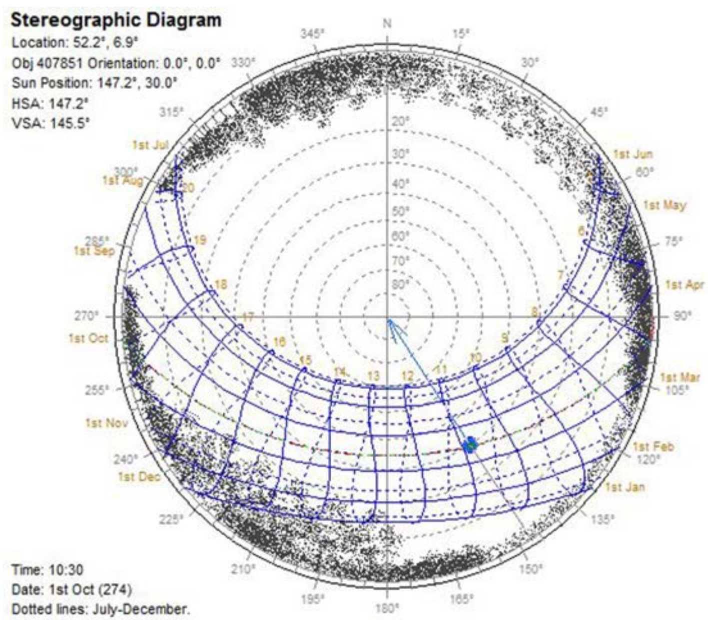

ptimized angle for PV PANEL
0°
10°
20°
30°
40°
50°
optimized angle


Stereographic Diagram
Location: 52.2°, 6.9°
Obj 407851 Orientation: 0.0°, 0.0°
Sun Position: 147.2°, 30.0°
HSA: 147.2°
VSA: 145.5°
Time: 10:30
Date: 1st Oct (274)
Dotted lines: July-December.
N
1st Jun
1st May
1st Apr
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1st Jan
1st Jul
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1st Oct
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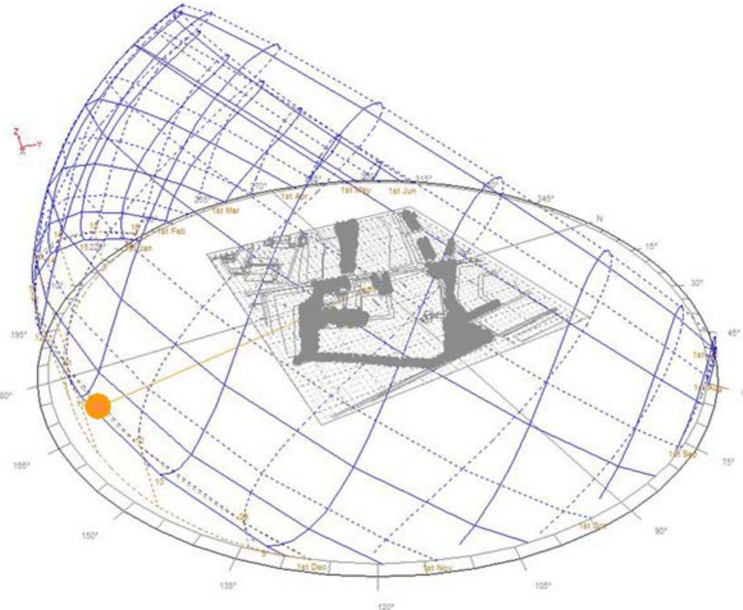
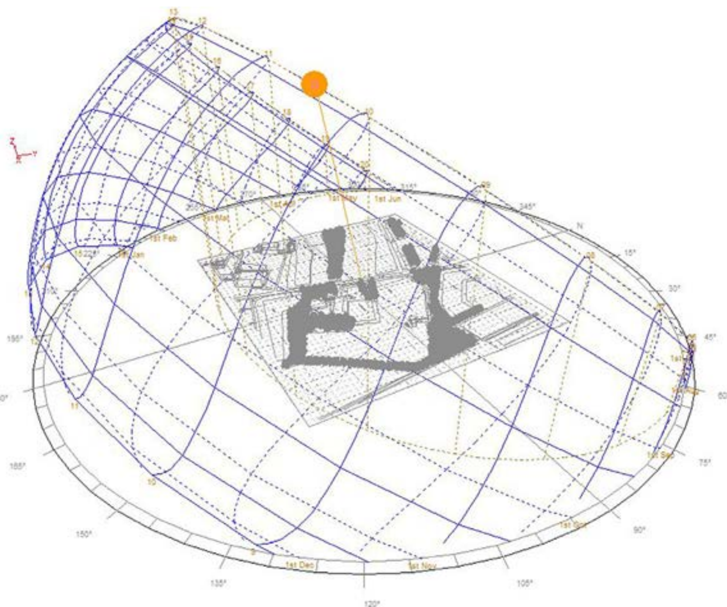


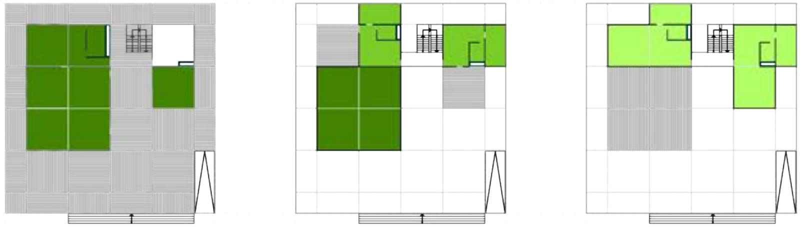


Serie 1

AUDITORIUM +

OFFICES +

APPARTMENTS



AUDITORIUM +

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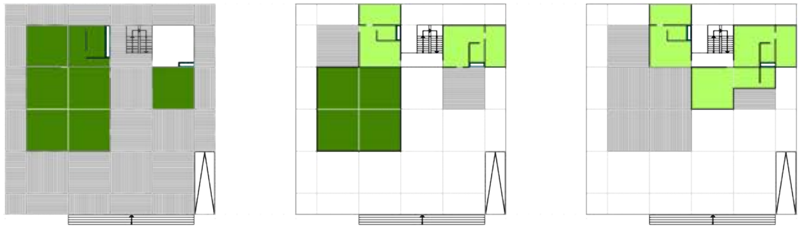

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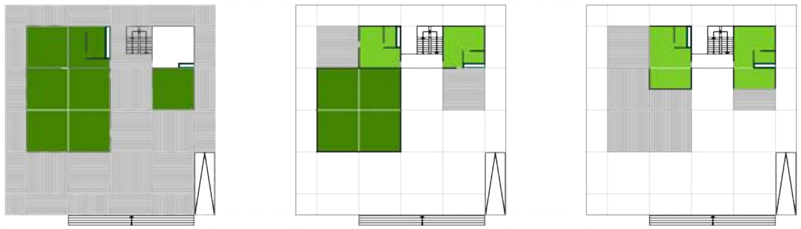

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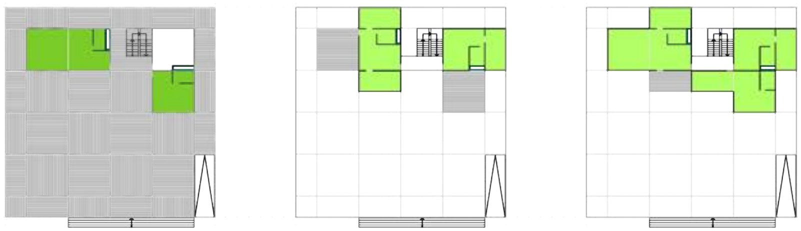
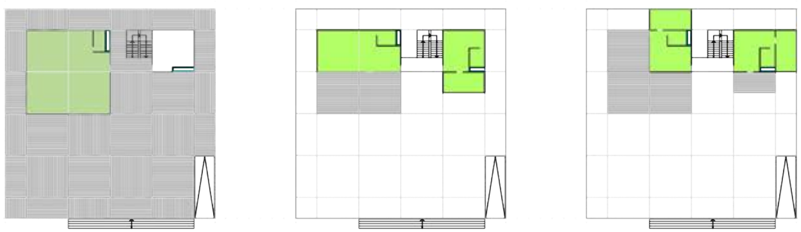


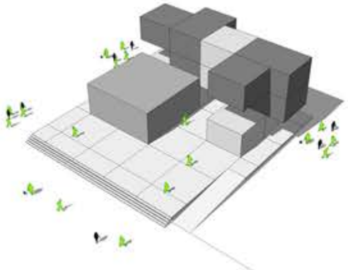
WORKSHOP +

APPARTMENTS



Serie 1

AUDITORIUM +
OFFICES +
APPARTMENTS



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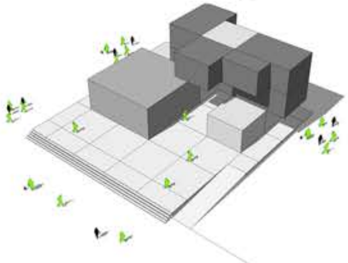

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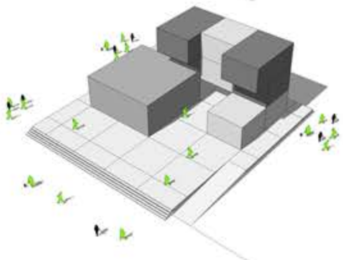

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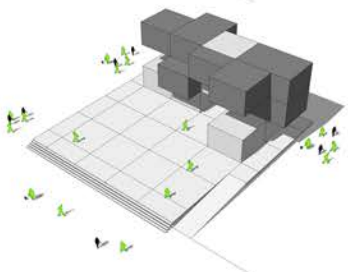

WORKSHOP +
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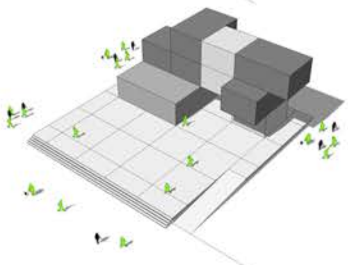


Floorplans & transformations

The position of the installation shafts is important because of the future transformation of the building. Different configurations for these shafts have been made and we finally came up with two possible configurations.

In the first configuration the shaft is positioned at the atrium as can been seen in the figures on the left. Several floorplans for this configuration has been made. With this serie it appeared that there are some problems with the installations when transforming the building.

With the second configuration the installations can be used in a more flexible way and most of the problems can be solved. The position of the installations shaft can be seen on the next page. With this configuration it appeared that there are more possibilities to add two extra apartments. With the second serie the building has a bigger transformation capacity.

Serie 2

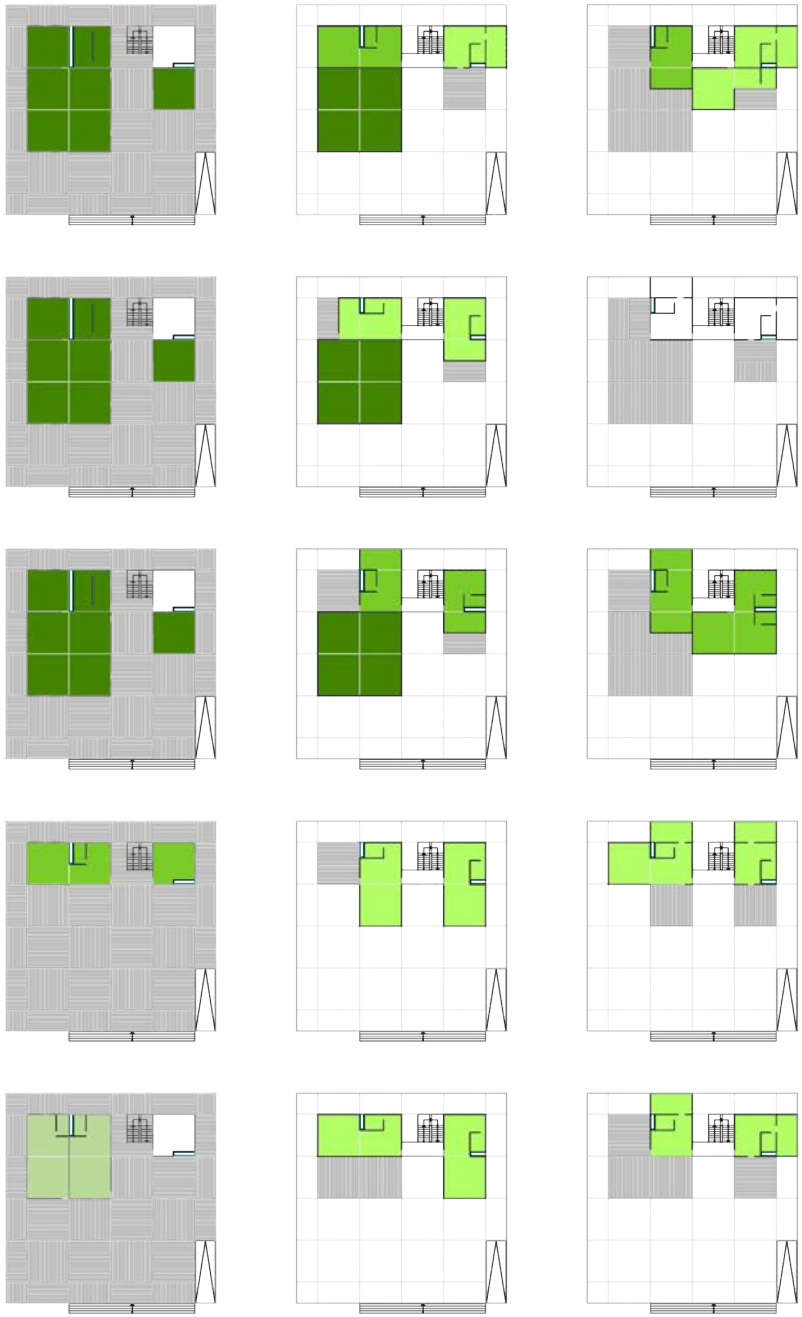
AUDITORIUM +
OFFICES +
APPARTMENTS

AUDITORIUM +
APPARTMENTS

AUDITORIUM +
OFFICES

OFFICES +
APPARTMENTS

WORKSHOP +
APPARTMENTS

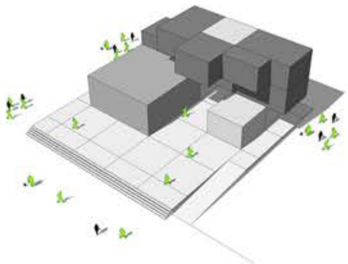


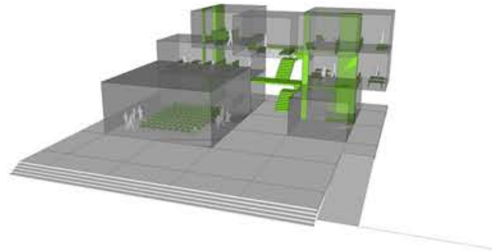
Serie 2

AUDITORIUM +

OFFICES +

APPARTMENTS





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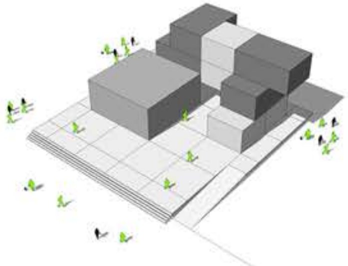

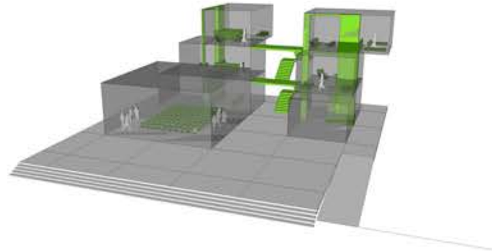

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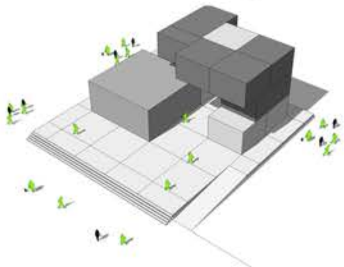

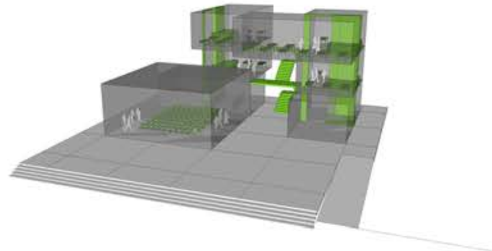

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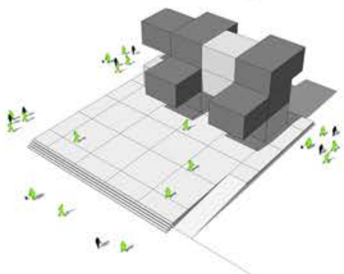

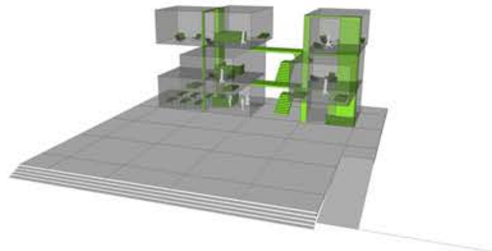

WORKSHOP +

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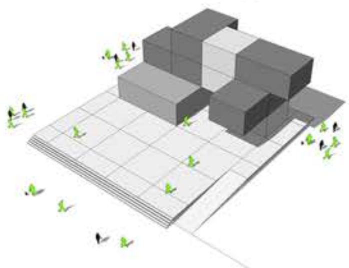
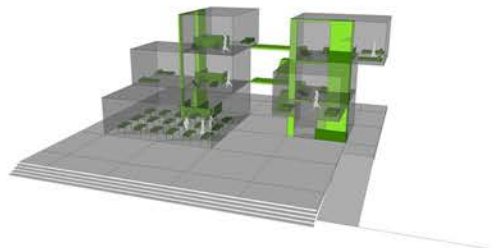




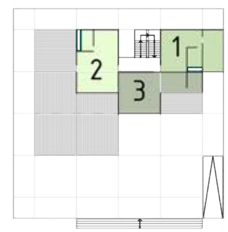
Typology of Units - Number 1

Apartments

Offices

Typology of Units - Number 2

Apartments



Offices

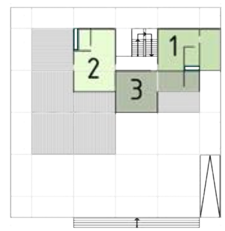
Typology

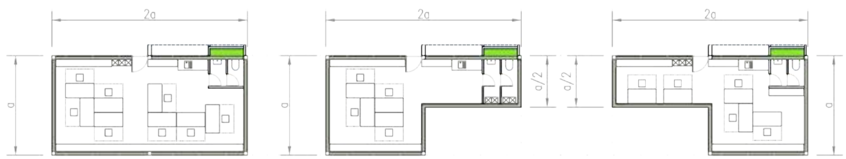
For the optimal orientation of the spaces configurations of the different scenarios have been made. Future transformations are also taken into account. Functional quality of these configurations depends on the orientation of the different spaces.

Because of the sunlight apartments should be oriented to the south and east. The west and north are not preferable for living spaces, therefore offices and workshops should be positioned at these sides. Typology one and two are most preferable for the apartments because of the orientation on the south and east. Typology three is mainly faced on the west and therefore not suitable for apartments, here offices or workshops should be positioned.

Typology of Units - Number 3

Apartments





Offices

Climate Concept

For the climate concept of the building several systems of the participating companies will be used. The building has four apartments and we want to integrate the companies, therefore every space has a different climate system. A requirement is that the used systems have to be flexible and demountable. Most of this flexibility has been solved with a flexible floor which will be explained in the paragraph infill.

Breathing window
Every room of the building will be supplied with a breathing window from HSH-Fiwihex. The breathing window is fine-wire-heatexchanger and replaces the traditional lowered ceiling with centrally controlled heat-exchangers. The breathing window can be placed next to windows or in the skin of the building.

Two fans in the top part of the breathing window result in opposite air streams: polluted air is blown out and fresh air streams in. In the breathing window heat will be exchanged.

Auditorium
For the auditorium the system of ClimaLevel will be used. ClimaLevel integrates heating, cooling and the supply of fresh air with a low temperature system. A disadvantage of the system is that ClimaLevel is not demountable because of the finishing of the floor. The question from ClimaLevel was how this system could be made flexible.

For a future scenario the auditorium should be function as an apartment or office, these scenarios are different in size. Therefore the auditorium has been divided into different dynamic zones which can be controlled individually. This solves the problem for the future scenario. For example when the auditorium transforms to two apartments the climate system for the two apartments are decoupled. When the apartments needs more cooling or heating requirement e.g. additional Fiwihex systems can be applied.

The façade of the auditorium will be glazed panels filled with aerogel. The aerogel will function as isolation material for the façade. The material also gives the building aesthetical value.

Apartment
In the first scenario the building will have four apartments. All offered systems cannot be used in one apartment, therefore every apartment has a different climate system.

For the apartments on the first floor a raised floor will be used. The heating and cooling are based on existing systems of Plegt Vos and Fiwihex which are combined as can been seen in the picture on the right. The vertical distribution of the different installations will be distributed by a vertical shaft offered by Van Dijk Bouw.

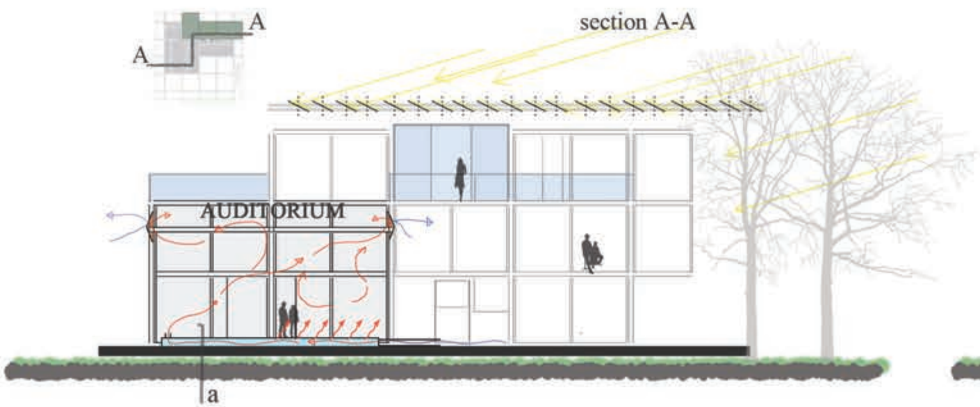
On the second floor systems of HSH-Fiwihex will be used. They offer two systems: (1) Alpha 16/32 ZLT which replaces the traditional radiator. Air from inside will be used to provide heating or cooling; (2) Delta 24 ZLT which will be used in a lowered ceiling or be integrated in the facade. For one apartment the Alpha 16/32 ZLT will be used, for the other Delta 24 ZLT.

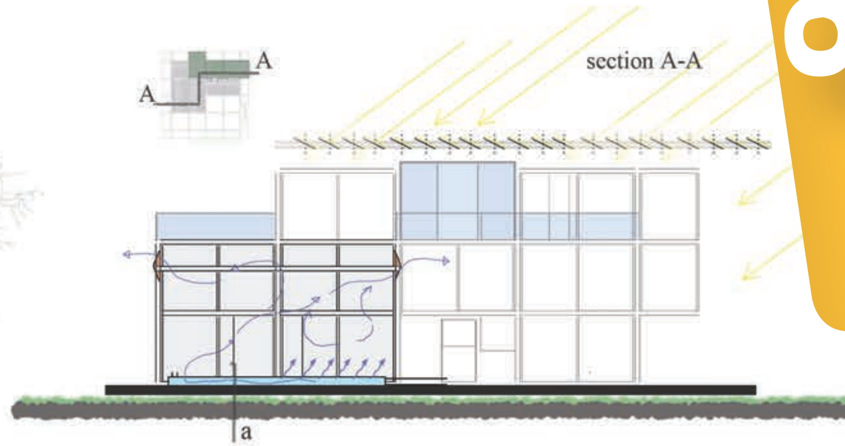
Solar chimney
The atrium catches a lot of sunlight, therefore the atrium in combination with openable windows can act as a solar chimney to stimulate natural ventilation as can been seen in the figure on the right.

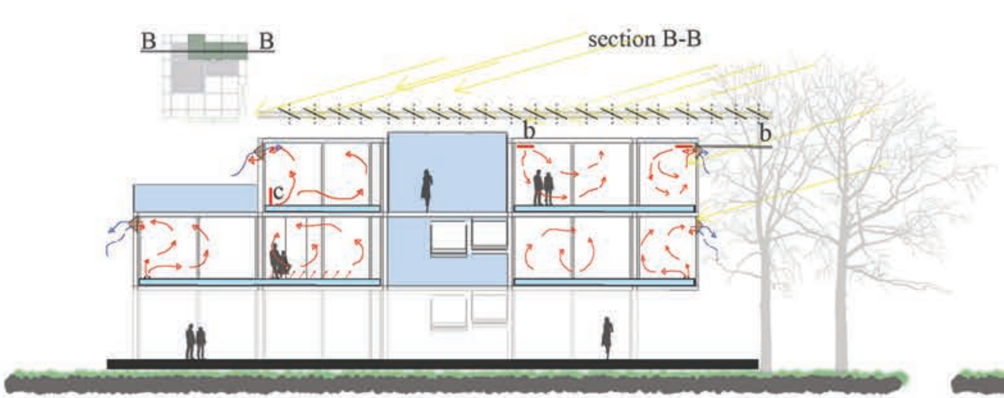
Roof

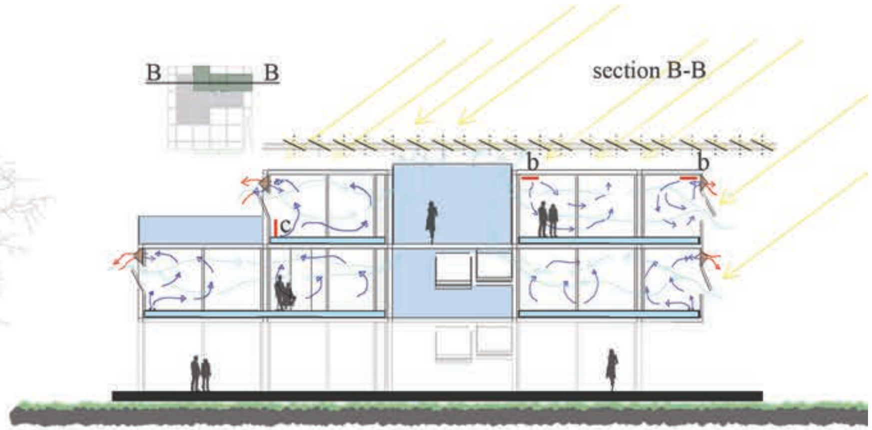
The building have to be energy-neutral and is therefore supplied with photovoltaic panels to generate energy for the building. Also solar panels are applied to supply the building with hot water.

With the roof rainwater will be collected and distributed trough the shafts in storage in the ground. This rainwater will be used for the toilets.



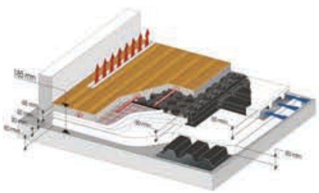






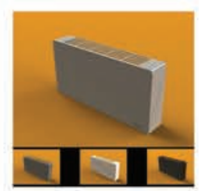
WINTER

SUMMER



detail a

detail b



detail c

Foundation

Foundation

The part of the building's structure that transfers the weight of the building into the ground strata. It can be broken into two categories. Shallow foundations spread the loads and generally go no more than one meter into the ground. When the top layers of soil are too weak a deep foundation has to be used. There are different piles that can transfer the loads to stronger underlying soil layers. Because of the big differences in ground conditions there is a wide range of products that are used for conventional buildings.

Standardization and variation

Standardization of foundation elements should improve the industrialization and reuse potential. Different functions of the foundation have been analyzed and are mapped to separate physical components.

Supporting the weights and loads on the building and transferring these forces to the ground regardless of soil conditions .

Easy placement and alignment.

Secure connection to the superimposing parts of the building.

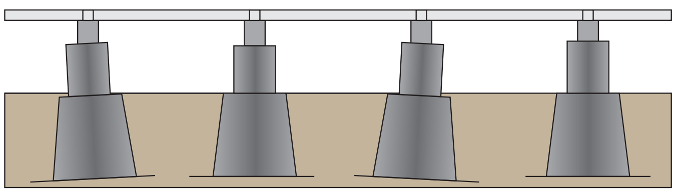
Maximizing standardization while maintaining flexibility in use and reuse.

Maximize effective use of materials.

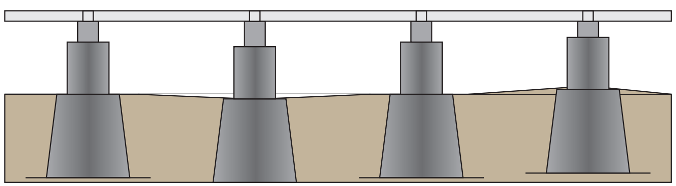
Basic element; the basic part which functions as the basis for the foundation. Other components are connected to this element. It is circular to improve material efficiency and make alignment unnecessary and placement easy.

Supporting the building under different ground conditions; a ground plate can be connected to the basic element. This part ensures the foundation can support the building under different conditions and spreads the forces to the ground strata. The size of this part is variable so it can be adapted according to the building weight and ground conditions. This is the first component that is placed at the start of construction. The round form makes sure placement only consists of finding the right spot, with no further alignment of the base necessary. If the top layers are too weak a driven pile can be used instead of a ground plate.

Connection to superimposing parts; the same connection that is used to connect the wooden columns on top of is other is used to fix the columns to the deck.



Angle variations of the soil

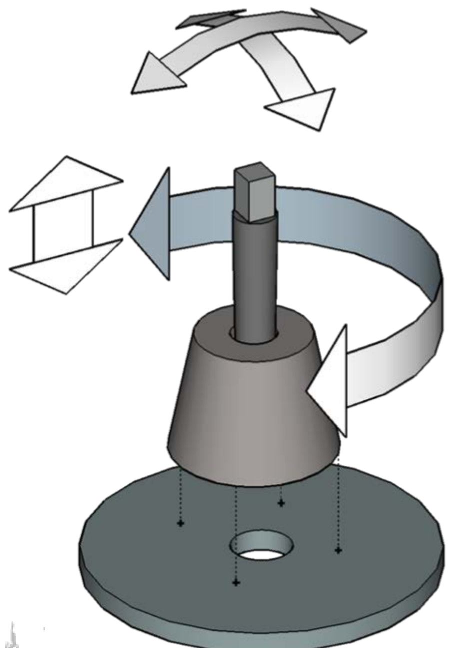


Height variations of the soil

Horizontal and vertical alignment

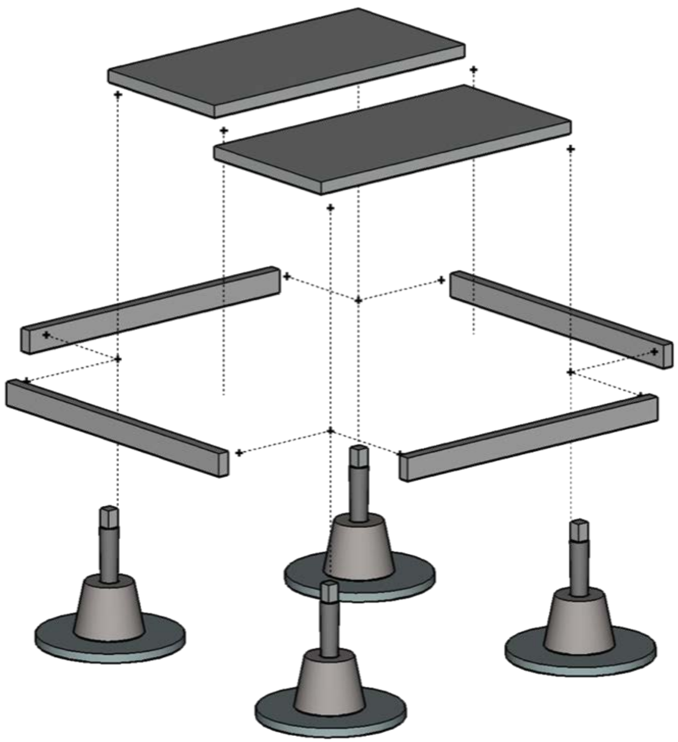
It should be possible to align the foundation elements when the underlying ground is not completely level. By providing a minimal amount of movement in the connections points to the superimposing elements all these points can be aligned to the horizontal and vertical planes.

Ball and socket joint, for angle and horizontal position, can not be used when foundation is put under tension. Completely reusable!
Alignment plate with some threads and bolts, after precise alignment the component is filled with concrete (based on existing system mentioned by Plegt-Vos). Reusable except for the alignment plate.



The deck is formed by placing reinforced concrete beams between the foundation elements and placing the deck plates.

In some cases a stability wall will be directly connected to the foundation elements, in this case the concrete beams will not be placed. After fixing the stability walls in place the deck plates can be placed in the exact same manner.



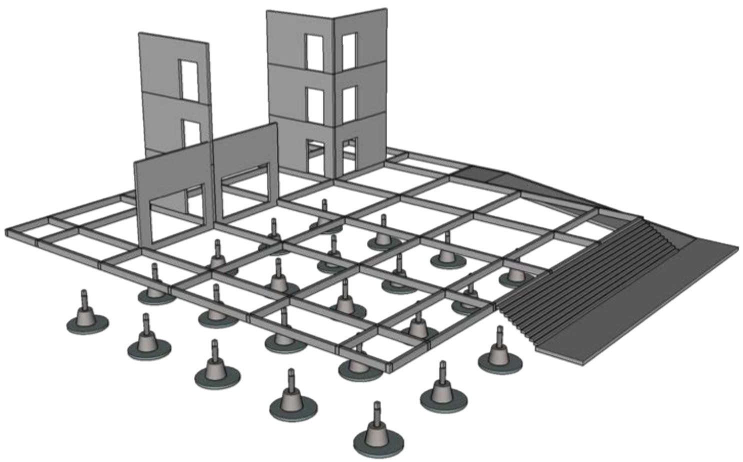
Stability

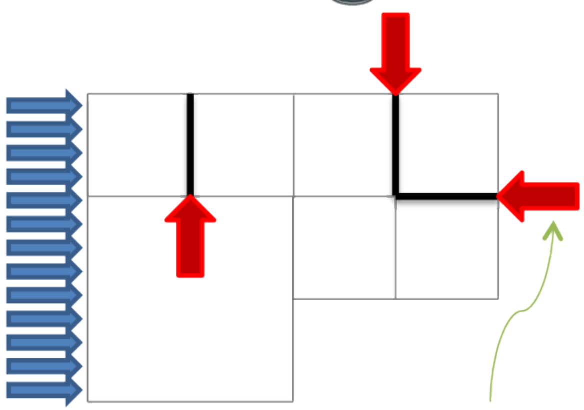
The stability walls counteract the horizontal forces on the building. Horizontal bracings lead these forces to the stability elements which in turn guide them to the foundation. The vertical installation shafts are integrated with the stability walls.

Each of the vertical walls are segmented (divided per floor) to improve constructability and handling. To make sure it still acts as stability all the connection points between the elements and the foundation should be strong enough.

Each of the stability walls will have openings; these allow the connection of rooms or can be closed with 'plugs' which can serve several functions. The wall is 20 cm thick so it fits together in the building grid with the rest of the flexible assembly made from laminated wood

Concrete with reinforcing steel will be used for these elements; it will be the most fixed part of the structure (with exception of the foundation). Demountable connections ensure the parts can be removed at the end-of-life of the building. There is potential for reuse within other buildings which use the same grid size of 5.4 m x 5.4 m.

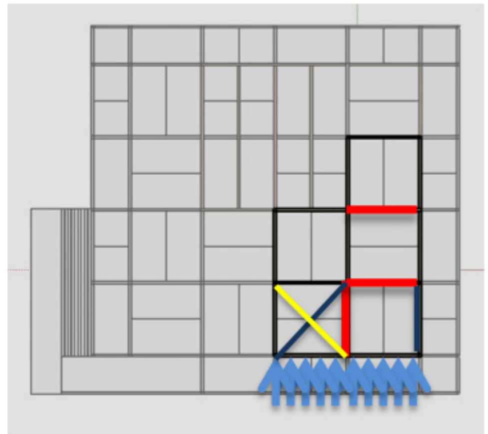




Bracing in horizontal planes not shown here, arrows just indication of existing forces.

Horizontal bracings

Shown below are some schematics from different horizontal planes. It shows different horizontal forces acting on the building and which floor sections are put under tension or compression. Because of the adaptations that should be possible to the buildings all the placed floorsections should be strong enough to act as bracing.

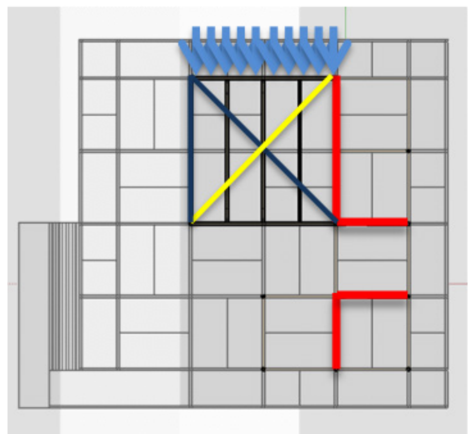


Stability vertical

Horizontal forces

Tension

Compression



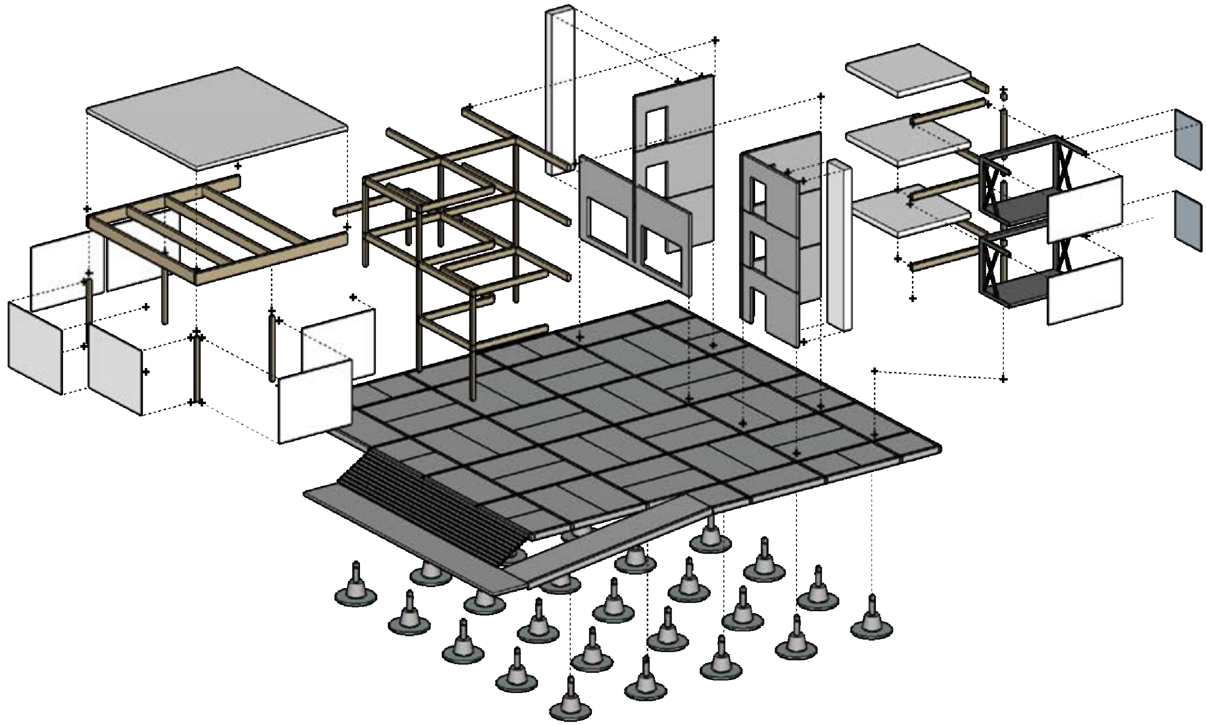
Load Bearing Structure

Flexible assembly

This part is connected to the stability walls and the deck. Laminated wood was chosen because of its positive aspects. E.g.; it provides great insulation, is made from renewable resources and has great esthetical quality.

Dimensions of beams and pillars:
Pillars: profile of 200 mm x 200 mm
Beams: profile of 400 mm x 200 mm

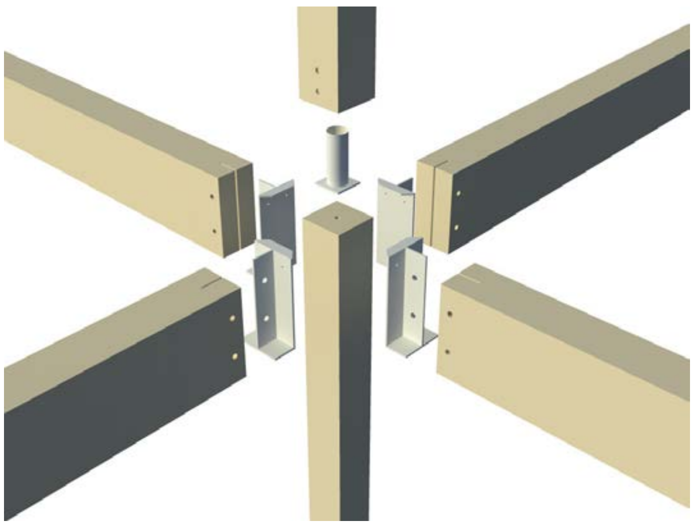
These numbers should be seen as indicative dimensions. They have been established in collaboration with several of the collaborating businesses. Further development should at least include verification of these dimensions according to the actual loads and building regulations regarding deformations and fire safety.

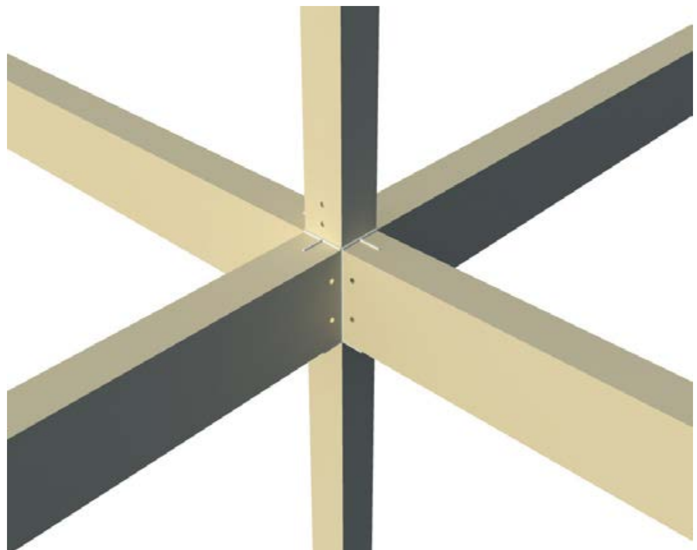


Connection elements

Flexible load bearing structure; To ensure the maximum amount of transformation potential new connections between pillars, beams, deck and other components have been defined. These steel connection elements only have to be placed where necessary. When changes are made to the construction connection points can be added wherever needed.

Impositions of floor sections; The parts that will support the floor sections have been standardized to obtain a maximum in flexibility. There are two variations, support by wooden laminated beams or by the concrete stability wall. To standardize this the floor sections have been placed between the load bearing beams and in both variations a metal profile supports the bottom ridge of the floor section.

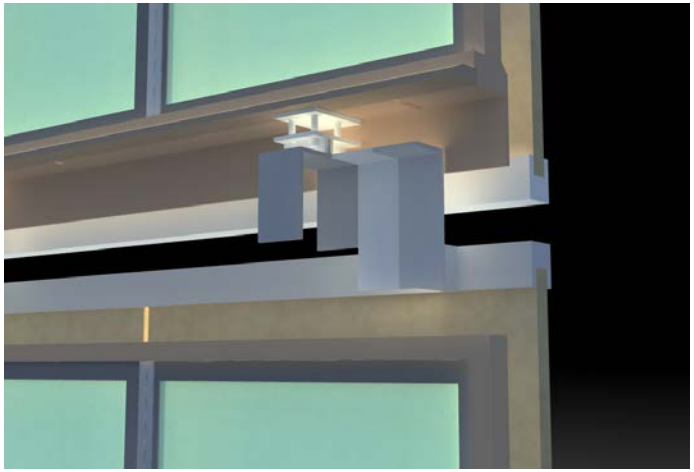


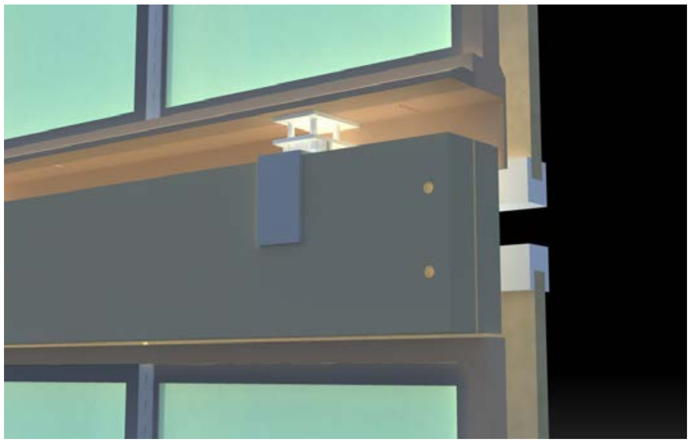


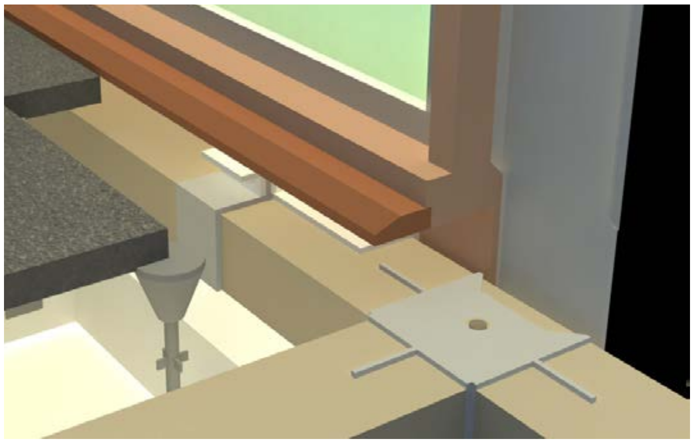
Facade frame

Because of the heightened floor tiles on the inside space the inner facade layer itself is raised to the floor level. This is necessary to allow occupants to use possible doors as well as providing room for installations. Under the sill of the inner facade layer is at least 0.15 meter available for installation pipes and ducts.

The outer facade layer consists of two rails between which panels can be positioned and slided. The space between the layers can be used to place climate installations such as the Fiwihex air heating. The facade consists basically of an inner and outer layer. The inner layer is able to fully close the space, the outer only protects against sun and weather. The layers are separately connected to the load bearing beams while leaving enough room to connect the inside components.

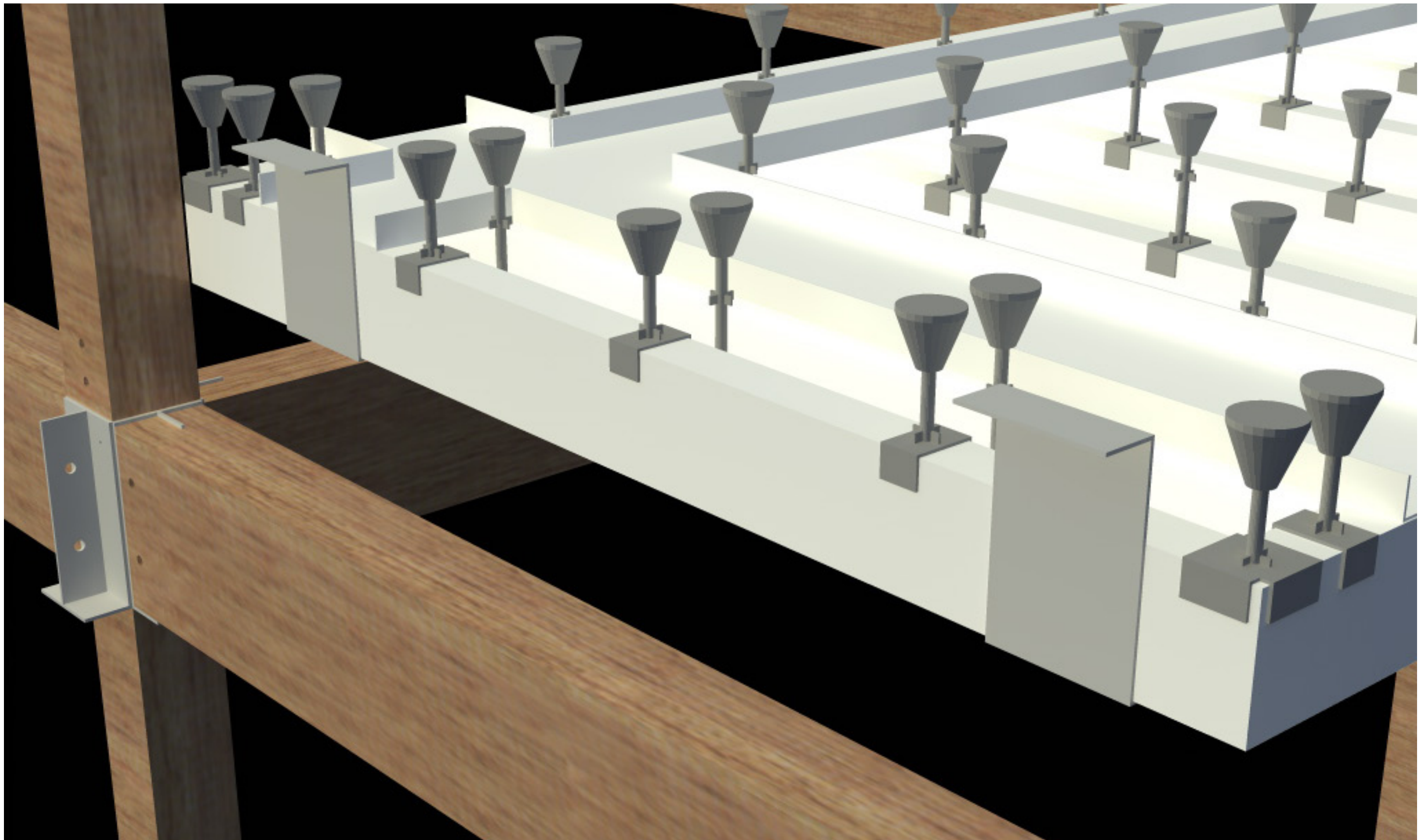






Floor support

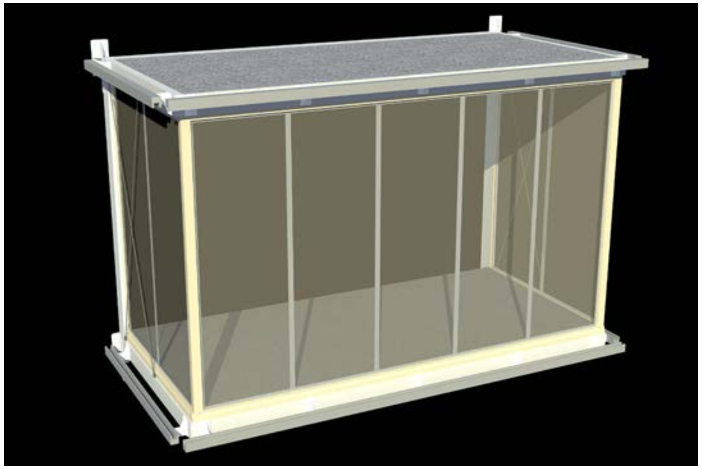
The floor sections are placed between the load bearing beams, laying on metal profiles. By including acoustic dampers in the connection the components are uncoupled. The floor sections are comprised of a wooden beam structure which supports dozens of studs which in their turn support the floor tiles. On top of these floor tiles a finishing layer such as parquet or carpet can be layed. By placing dampening material between the different components acoustic decoupling is achieved.

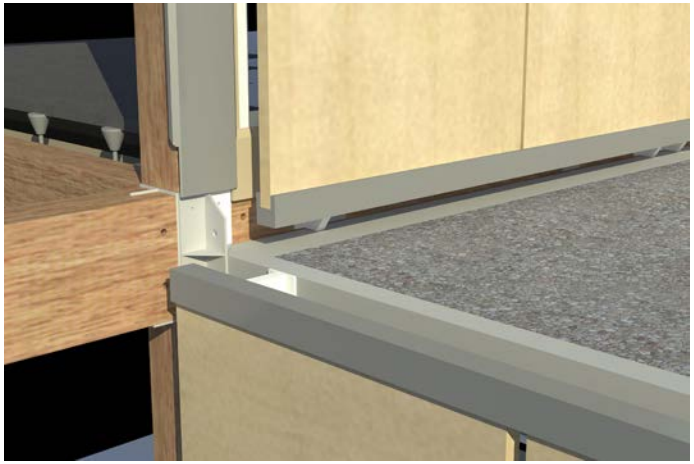


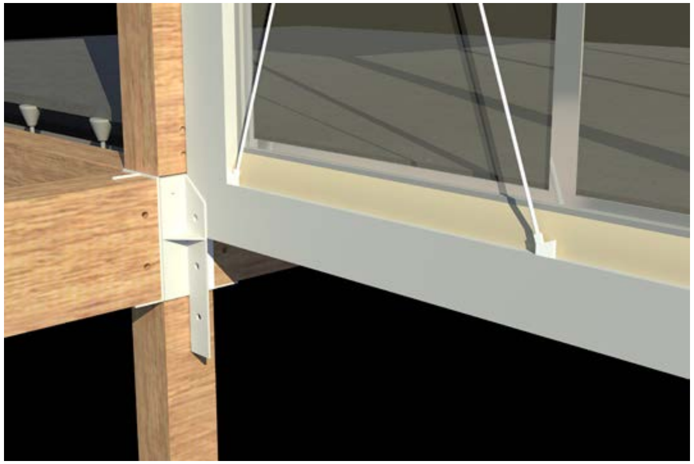
Outside console

To quickly add extra space prefabricated consoles can be connected to the facade. It is based on work done by 4D architects. The installations are connected in the same way as in the other flexible floors and the facade elements can be used as well.

The connection that fixes this console to the facade is based on the allready defined connection elements. Small changes enable them to act as connection points for several consoles which can be placed next to eachother. The only shared components for adjacent consoles is the connection element. So if changes are made to the building by adding or removing one of these consoles the amount of different action to be undertaken is minimized.



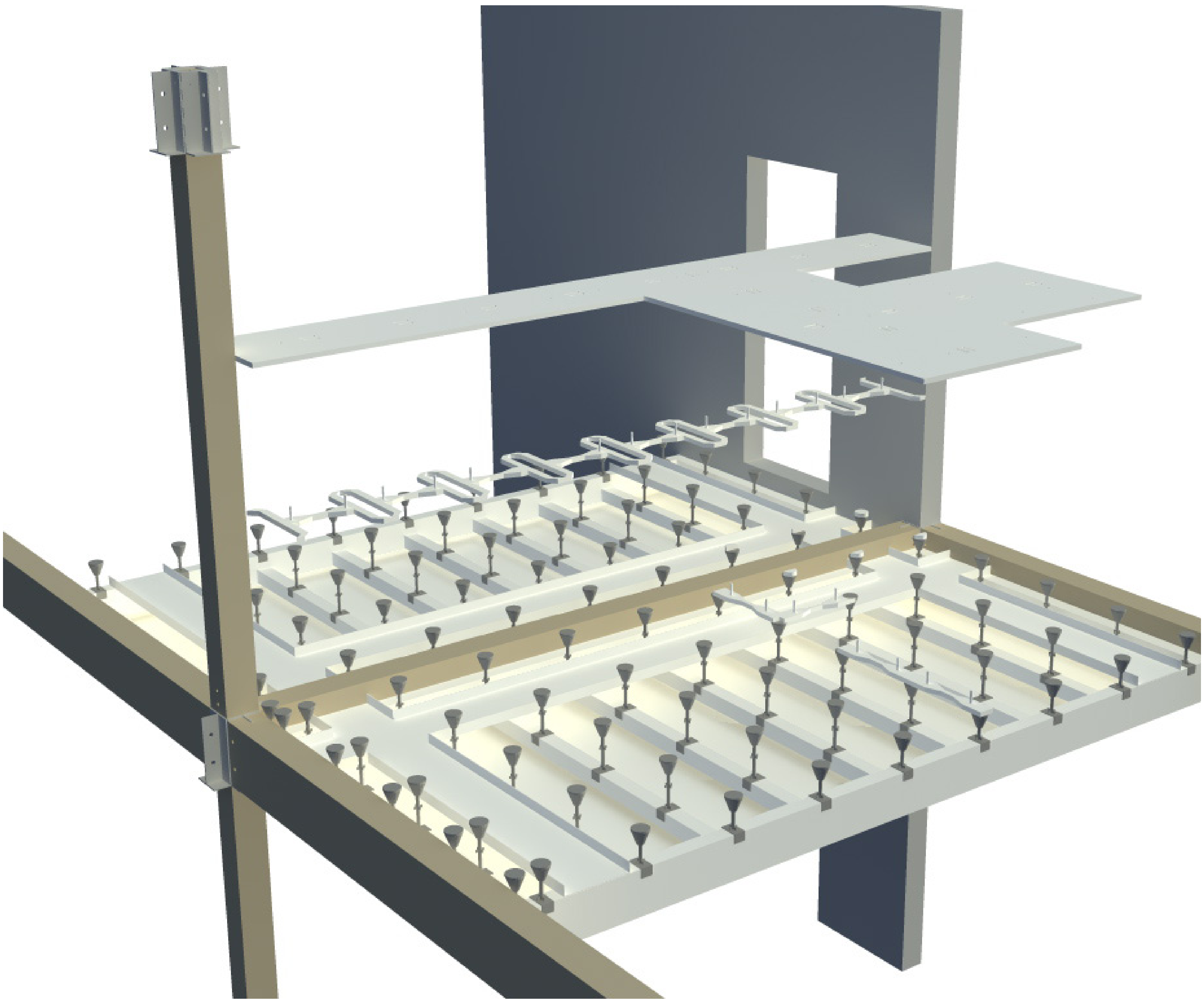




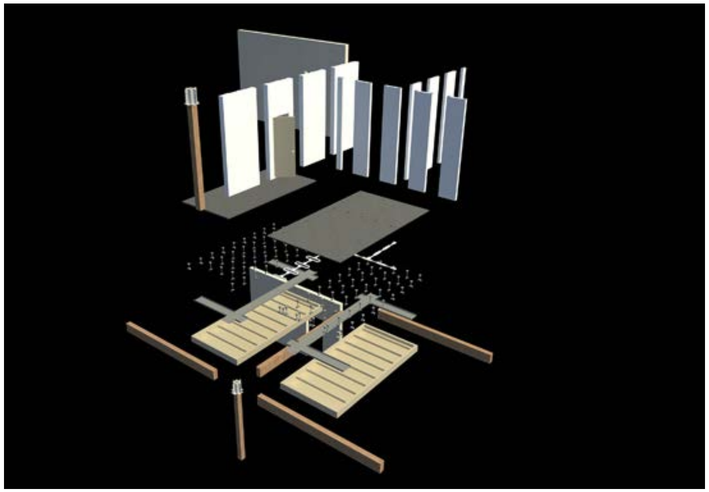
Constraints on other systems

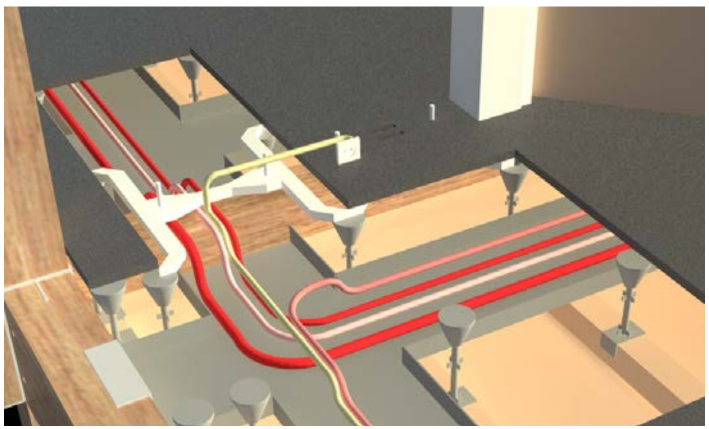
The load bearing system is the basis of the whole structure. To ensure that the rest of the components do not cause loads that exceed the maximum several limitations have been given to the different subsystems. Because the dimensions of the load bearing system are still indicative these weights have to be checked during further development. The main aspect that is shown is that the other components should be design to be light weight. Other constraints have also been put onto the other systems, these include locations of installations connections, some of the outer dimensions for floors, facade and roof elements, etc.

Component:		*Unit*
Floor	*150*	*Kg/m^2*
Inside walls	*75*	*Kg/m*
Facade elements	*100*	*Kg/m*
Roof	*100*	*Kg/m^2*
Roof (extensive green)	*150*	*Kg/m^2*
Roof (intensive green)	*350*	*Kg/m^2*



Infill
Floors and walls



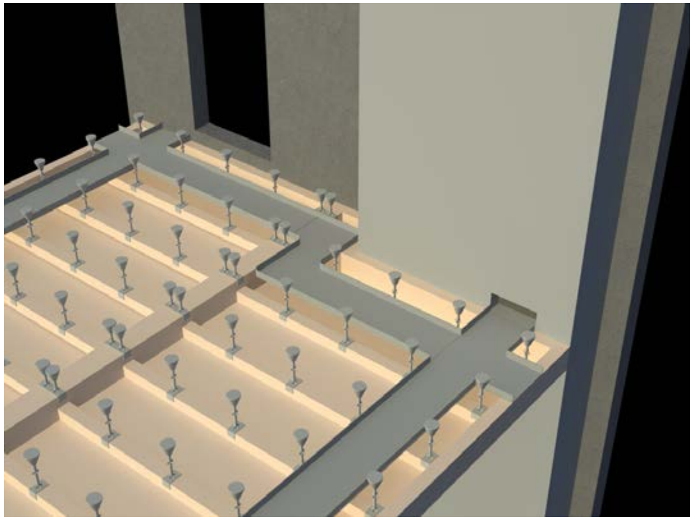


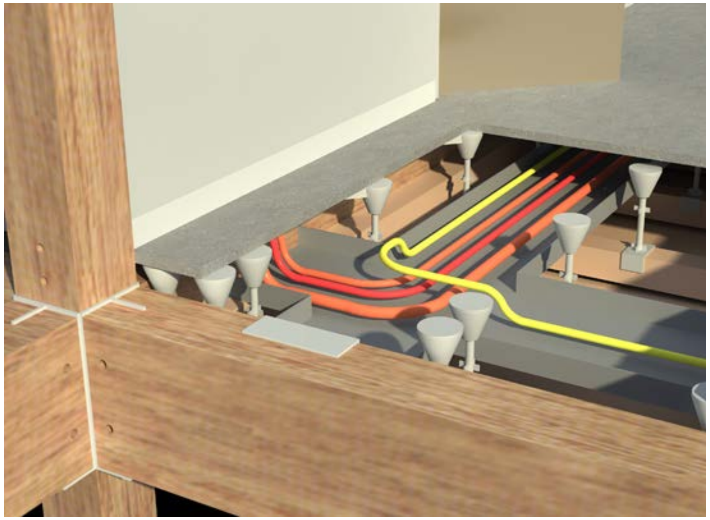
For the infill of this building it is important that all the parts off the infill are flexible and they can be easy handled. A very flexible floor and a wall is designed.

Floors

Main concept of the floor
The floor exists of a laminated wooden frame which can be placed into the main building structure. Studs are put onto the frame and floor tiles are laid on top; closing the floor. The floor exists of a grid of 0.60 meters. Finishing can be laid over the tiles to complete the whole floor construction. The ceiling is made of a ceiling layer connected under the frame. Between the wooden frame and the flexible construction, thermal isolation, acoustic isolation and other layers can be included. The floors in the room with a shaft differ slightly from the other floors in the beam layout and gutters.

Gutters
In the floor there is an open space. In this space gutters for the cables, channels and pipes are included which are connected to the shafts. The gutters are laid 0.90 meters from the flexible construction. Every 5,40 by 5,40 meter grid gutters are included in every floor component. So, the cables, channels or pipes can be transported horizontally from one end of the building to another. For a vertical connection prefab floor tiles with holes are used, as well as hatches included in certain floor tiles.





Companies

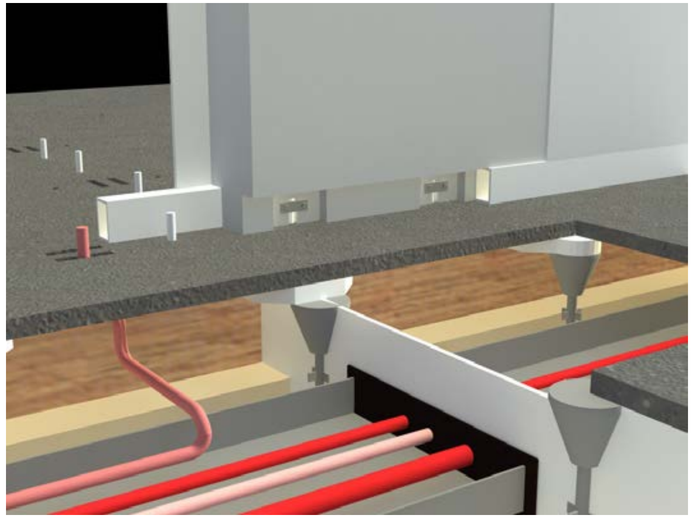
The floor which is designed used the concepts of the following companies: Van Dijk, Plegt-Vos, HSH Fiwihex and De Groot Vroomshoop. From the concept of Van Dijk the division of the installations (cables, channels and pipes) is included in the concept. The heated or cooled air which is spread out under the floor is taken from the company Plegt-Vos. A Fiwihex system is placed in the floor for heating or cooling the air. Because the frame is made of laminated wood the company De Groot Vroomshoop is also playing a part in the project.

Climalevel floor

The Climalevel is a component with a larger height. When installing a Climalevel floor the floor tiles are not needed and removed. The studs are lowered to lower the Climalevel component to the same floor height as the surrounding tiles. This floor is applied in the auditorium and lies close to the glass facade.

Walls

There are two types of infill walls. One is the dwelling partitioning wall, the second are the inner partitioning wall. The walls exist of pre-fabricated wall segments which include all the needed layers (for example isolation). A finishing layer can be placed against the wall. The basic layout of the walls consist of a metal frame, insulation, skirting on both sides at floor level and recesses to fix the holding pin. The walls are placed on top of the floor tiles and secured against the ceiling. By placing them on top of the tiles, sound insulation can be achieved. The partitioning of rooms and spaces by the walls are completed beneath the floor tiles by different types of insulation components (fire, sound, heat, air).



Dwelling partitioning wall

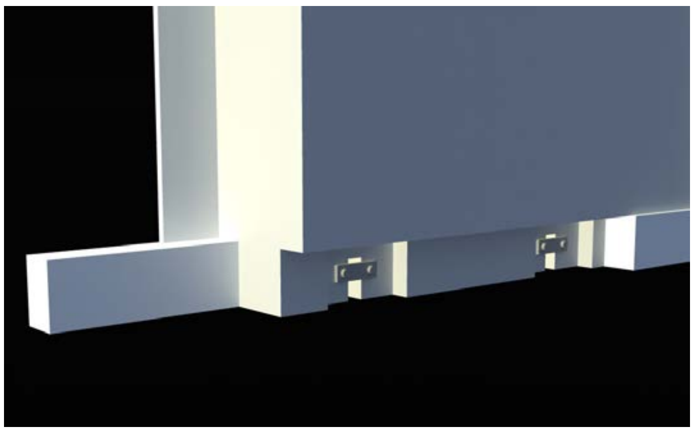
These walls have a depth of 0.18 meters. There are different panels needed to make each combination possible. For instance to incorporate a single or double door. The elements are 1.40, 1.20 and 0.8 meters long.

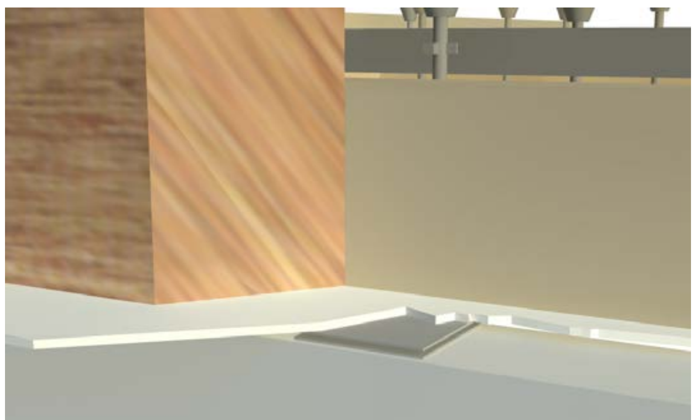
Inner partitioning wall

The partitioning walls have a depth of 0.10 meters. make all the configurations in combination with the grid of 0.60 meter the walls are made with different measurements. The lengths of the panels are 0.60, 0.55, 0.50, 0.20 and 0.15 meters.

Skirtings

In the walls there must also be room for cables, channels and pipes. Skirtings on both sides of the wall are used to place these components. The connection between the main pipes and channels and the installations is made by placing the lines through the shaft, along the floor gutters, into the walls. For every connection or extreme corner, plugs and piping of Winkels are used. This provides flexibility and ease of use.





Connection wall with the floor and ceiling

The partition walls are fixed to the floor and ceiling by placing them on the grid and clamping the wall against the ceiling. Beneath the floor tiles metal girder can be placed which have pins that protrude above the floor tiles. The walls have recesses in which these pins can be secured. At the top of the walls clamps are extended to firmly lock the partition wall between the floor and ceiling. The floor tiles beneath and bordering to a wall have different measurements than the normal tiles because of the grid in the floor.

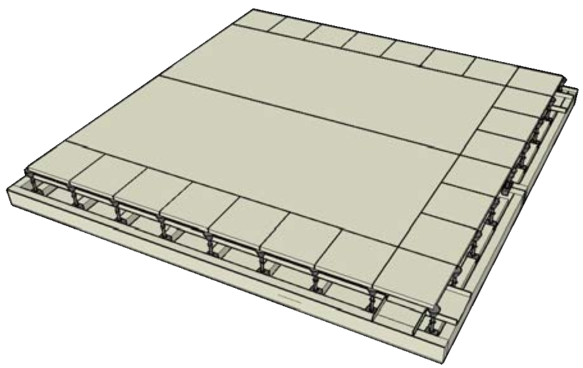
Semi-flexible floor

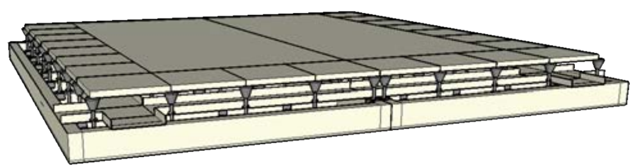
The floor which is designed for this experimental building concept is very flexible. This has been done to enable the major functional changes when switching between scenarios. The floors from the companies Van Dijk, Plegt-Vos and ClimaLevel are not flexible enough for these changes. Most of these companies will not be able to use this flexibility fully because major changes between scenarios are not common enough. The extra cost involved with the extra flexibility of this floor impedes the adoption of the technology.

To solve this problem a compromise is proposed. It will not be used inside the experimental building but we are of the opinion it will be an interesting direction for the collaborating companies. It consists of a floor section nearly identical to the one designed for the actual building. It has some of the same key aspects; lightweight, installations integrated between the constructional beams, the same interfaces on the supporting ridges. But instead of allow full access to every part of the floor only certain sections are reachable by removing the floor tiles. This will significantly reduces the total costs as most of these are involved with the removable floor tiles and being able to support these.

Because the installations can only be reached to a certain extent, it also work together better with the Powerbox from Kersten Retail. The amounts of positions where installations can be connected are reduced, allowing for more standardized components with larger sizes.

The concept shown here is only one of the options; further development is needed to find the optimal compromise between flexibility and involved costs.

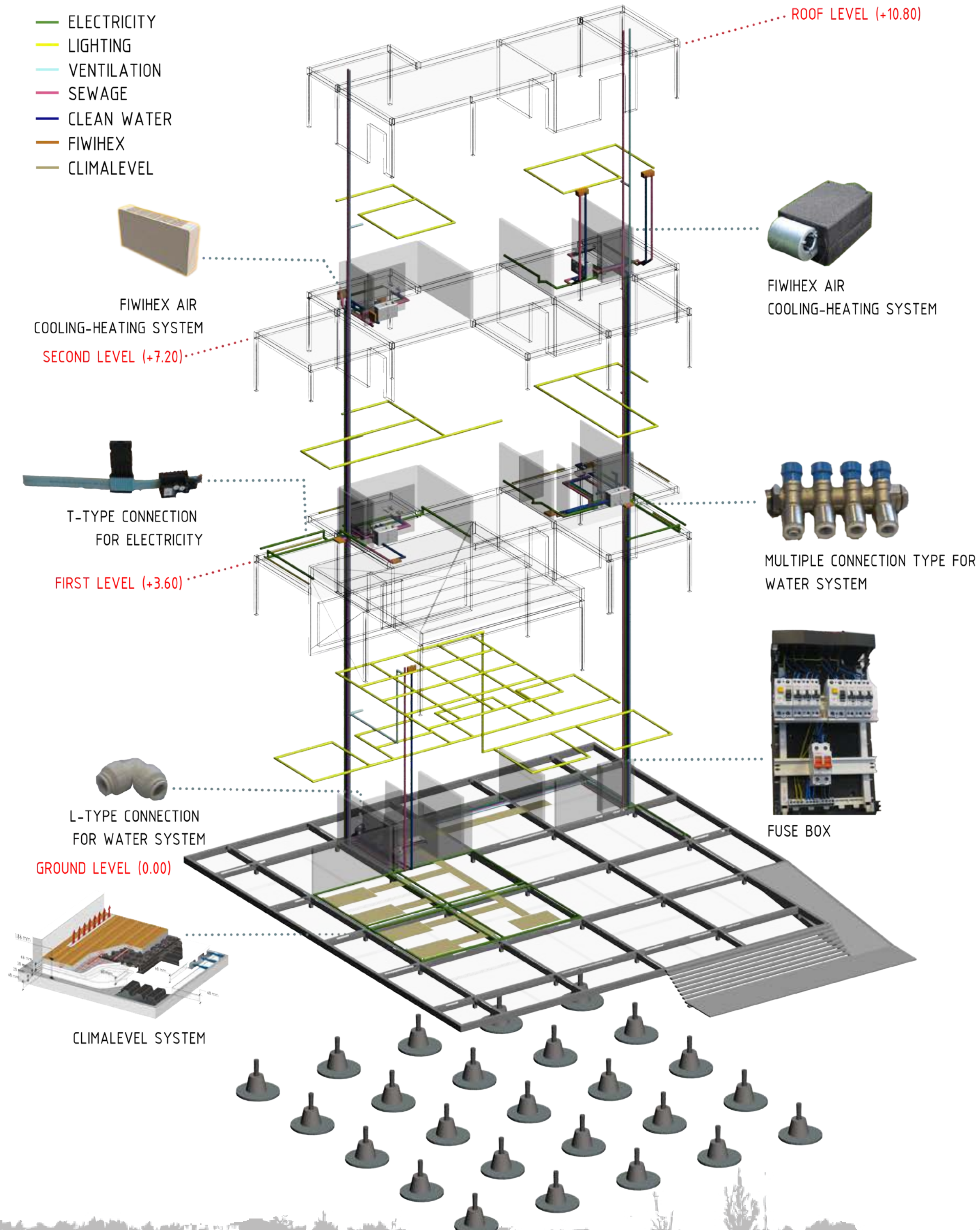


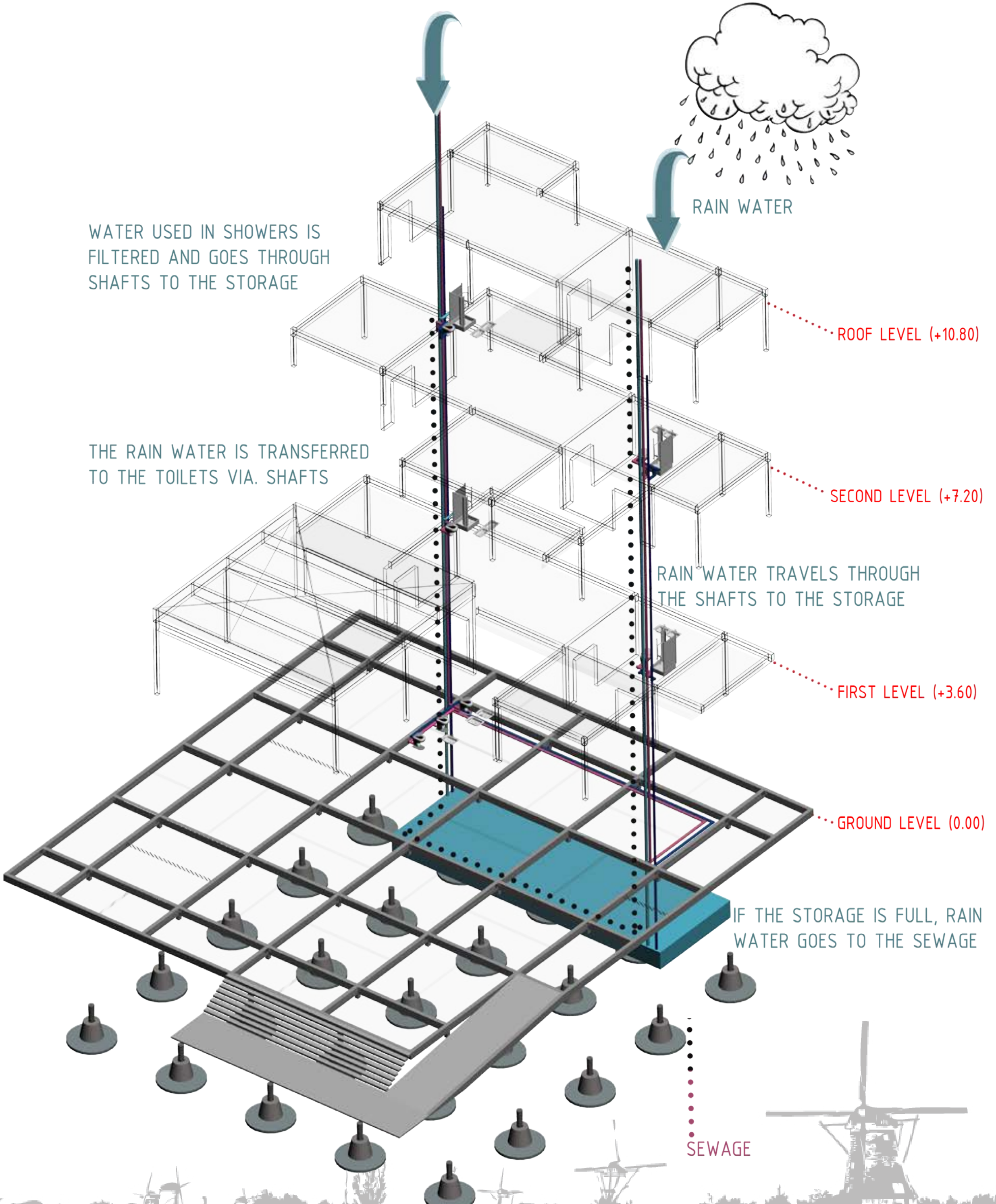


Installations

The general principle for the electricity, sewage, clean water, air conditioning systems are illustrated on the figure above. For electricity and clean water the gutter system that frames all the floors is used and the pipes are connected to the equipment within the floor or wall according to the type of the equipment. The heating and cooling system is solved with ClimaLevel and Fiwihex systems considering the requirements of each space. In auditorium, for example, ClimaLevel system is used in the floor so that a multi-functional, flexible and transformable space can be acquired. On the other hand, we use Fiwihex system in apartments so that we acquire the heat gain or heat loss spending less energy compared to the traditional systems. This system requires its own circulation system including, hot water, cold water and waste water. In electricity and water distribution; we use a flexible plug-in system that can be changed easily in future use. The difference of the installation system from traditional one is that it is a flexible, transformable, industrialized system, allowing changes for future use without waste of material and time.

Principle of the rainwater collection and water reuse system is based on three elements: collecting pipes, storage and filter. The collected rain water is taken into the storage on the ground through rainwater collection pipes and goes to the toilets. The system re-uses the water used in the shower after filtering. The filtered water coming from the shower is also collected in the storage and used in the toilets. If the storage is full, excess water goes to the sewage.


ELECTRICITY
LIGHTING
VENTILATION
SEWAGE
CLEAN WATER
FIWIHEX
CLIMALEVEL
ROOF LEVEL (+10.80)
FIWIHEX AIR
COOLING-HEATING SYSTEM
SECOND LEVEL (+7.20)
FIWIHEX AIR
COOLING-HEATING SYSTEM
T-TYPE CONNECTION
FOR ELECTRICITY
FIRST LEVEL (+3.60)
MULTIPLE CONNECTION TYPE FOR
WATER SYSTEM
FUSE BOX
L-TYPE CONNECTION
FOR WATER SYSTEM
GROUND LEVEL (0.00)
CLIMALEVEL SYSTEM



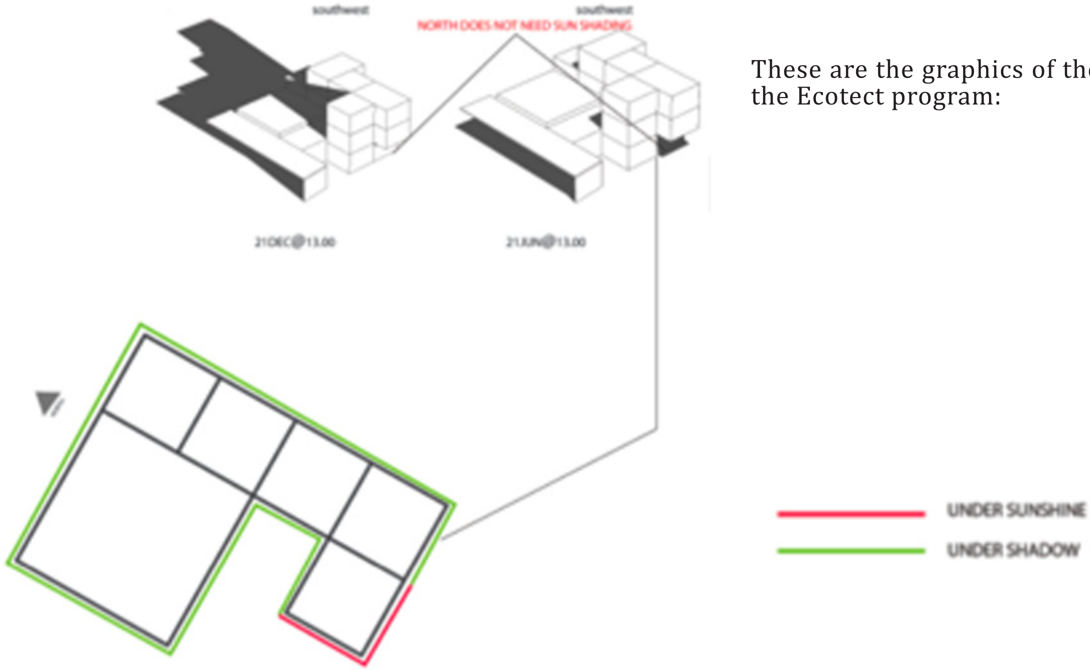
RAIN WATER
WATER USED IN SHOWERS IS FILTERED AND GOES THROUGH SHAFTS TO THE STORAGE
ROOF LEVEL (+10.80)
THE RAIN WATER IS TRANSFERRED TO THE TOILETS VIA. SHAFTS
SECOND LEVEL (+7.20)
RAIN WATER TRAVELS THROUGH THE SHAFTS TO THE STORAGE
FIRST LEVEL (+3.60)
GROUND LEVEL (0.00)
IF THE STORAGE IS FULL, RAIN WATER GOES TO THE SEWAGE
SEWAGE

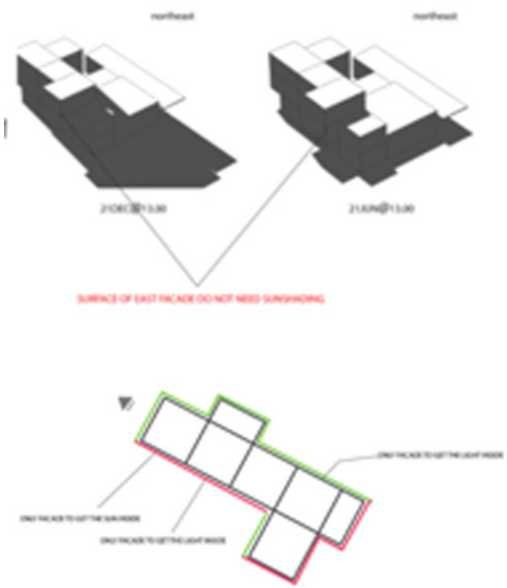
Enveloppe

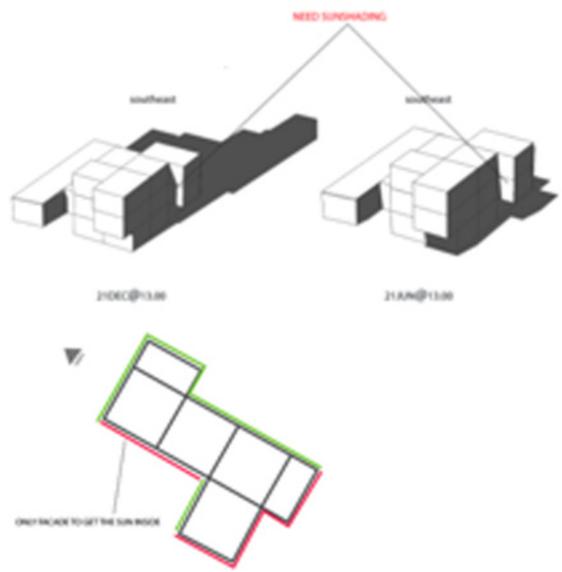
Facade and Roof

For this project it was necessary to fulfill a couple of basic requirements integrated in one functional system for the façade elements and the roof. Both together can be seen as the envelope of the building.
The most important were, for the first, the sustainable climate concept planned on being used in this project, the final design of the envelope according to the analysis of the sun exposed surfaces, functionality of it's inside spaces, achievement of the easiest possibility of demountability, and at the same time architectural quality.
Analysis
The volumes of the building were analyzed by Ecotect program for evolving the facade organization.
It provides us possibilities to combine the summer and winter shadows that fall down the surfaces of the solid model.

These are the graphics of the analyzed building given by the Ecotect program:







The conclusion that we have got from the Ecotect analysis is that northern and eastern facades do not need sun shading, while almost all southern and western facades do.
The only exception of this situation is the southern facade of the technical room.
Since the northern apartments' bedrooms do not get any warming sun inside during the winter, extra heat insulation is needed in this part of the building.
Comparing the information with the floor schemes, the northern apartments have only west orientation to get the sun inside. On the other hand, the entrances of the southern apartments do not have any warming sun, but just have eastern facade to get the light inside the building.
The final result of all mentioned requirements is the following overall of the building.

Facade

Facade is made of the three basic materials: wood, glass, and the compact combination of aerogel and glass as panels.
With the use of the glass panels we ensured a lot of natural light and ventilation for most of the spaces integrated into this building system. All of them have the possibility of opening with the sliding mechanism integrated into their frames which are separately added as the certain infills into load bearing structure. This makes them easily demountable.
The composite combination of Aerogel and glass made in the form of panels are modular to all the other used, wooden and glass panels. They are appearing in combination with the glass ones and behave as moveable (also sliding) panels, at the same time as a good thermal insulator of the spaces.
The final layer of the façade consists of folding wooden panels mounted onto special sliding carriers on the outside of the load bearing structure. These panels have different perforations depending of the necessity of the sun protection according to the analysis of an Ecotect, and the privacy of specific areas. These kinds of designed panels give an opportunity of complete or semi closing façade surfaces, in dependence of the privacy and sun protection necessity. All of the panels are such dimensions and weight that one man can take them off if needed.
The central communicational unit was designed with the possibility of opening its west and east transparent sliding panels for the effect of the alternated solar chimney. It had to be elevated for at least one meter in comparison to the adjacent roofs, which would create a new problem for the roof requirements and its integrated PV and solar panels. In that case this elevation would create shadows on these PV and solar panels. This will be addressed in the following part.

Roof

The roof system had its own special requirements. One of them was an integration of PV, and solar panels.
Since the levels of the building's last floors were different in a vertical plan, it was impossible to place enough PV and solar panels onto the same surface without shadows evoked from these vertical differences causing problems.
Therefore, the roof as the system is made out of two parts. The first, basic one covering the building from rain and isolation aspects and a second one –an elevated slab with integrated PV and solar panels leaning on the primary load bearing system framing the building the same way as the entrance part does. Through this central communication which has the possibility of opening the roof panels for the purpose of ventilation, we enabled the four side natural air circulation of the facade and the roof for the alternated solar chimney effect. The rain water collection is solved by the principal of the flat roof drainage, whose pipes lead through the shafts inside the building to the rain collection cistern.

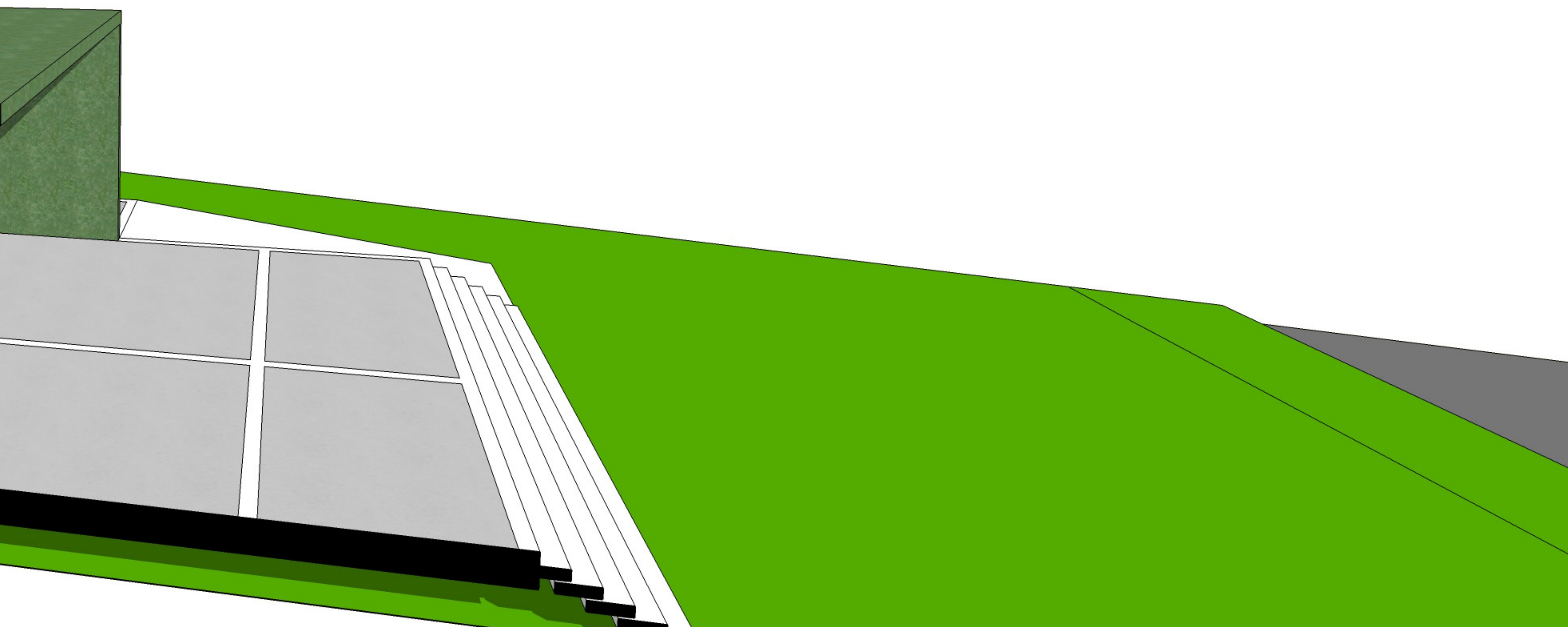
south facade

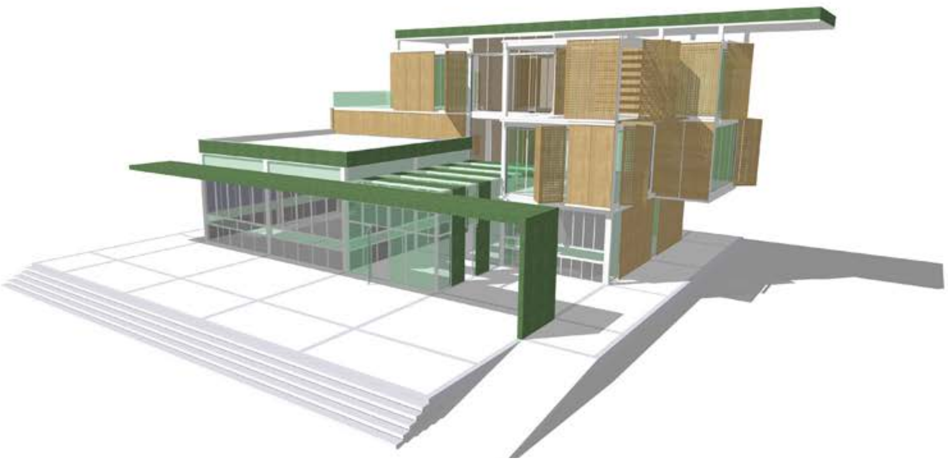
west facade

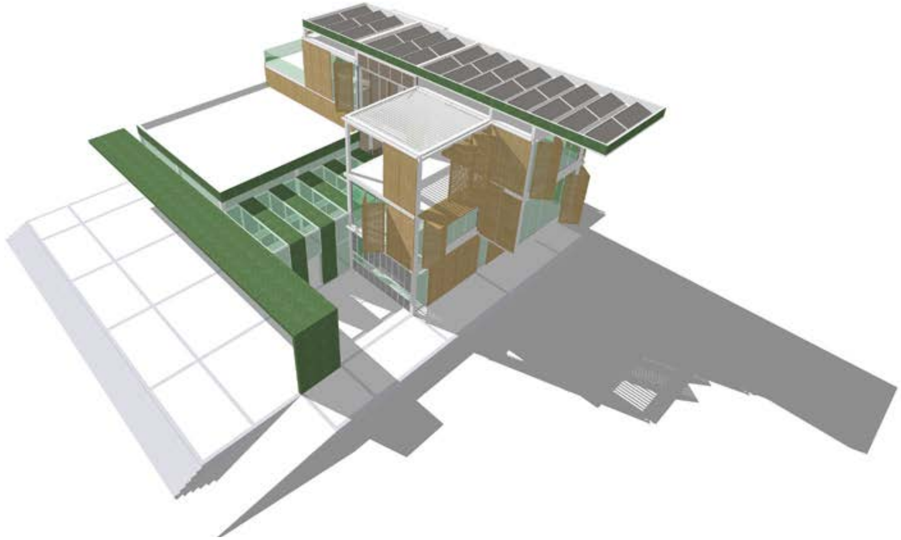
east facade

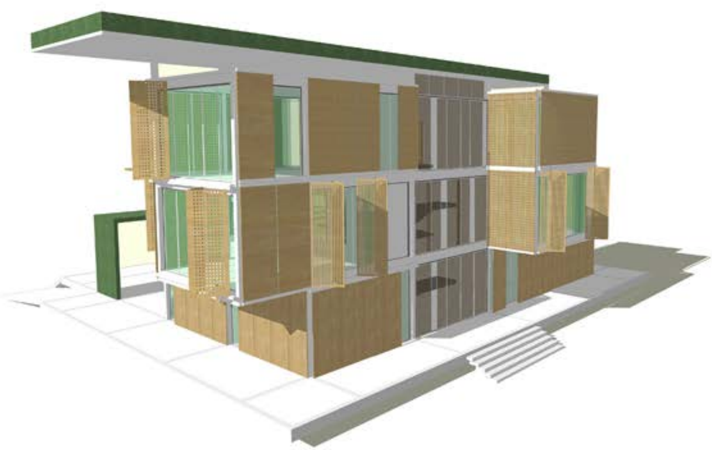
north facade

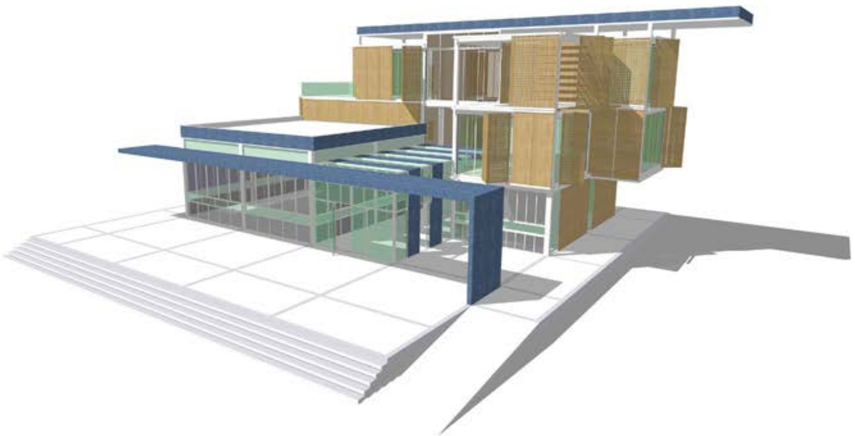
Color variations

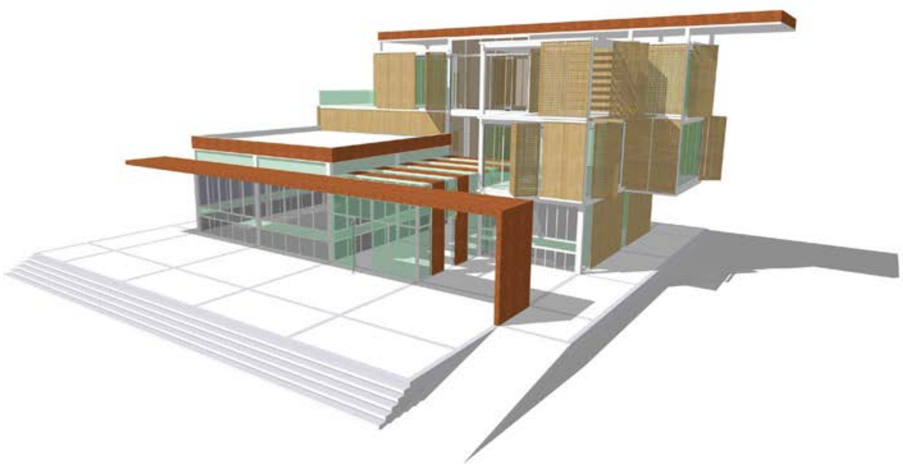




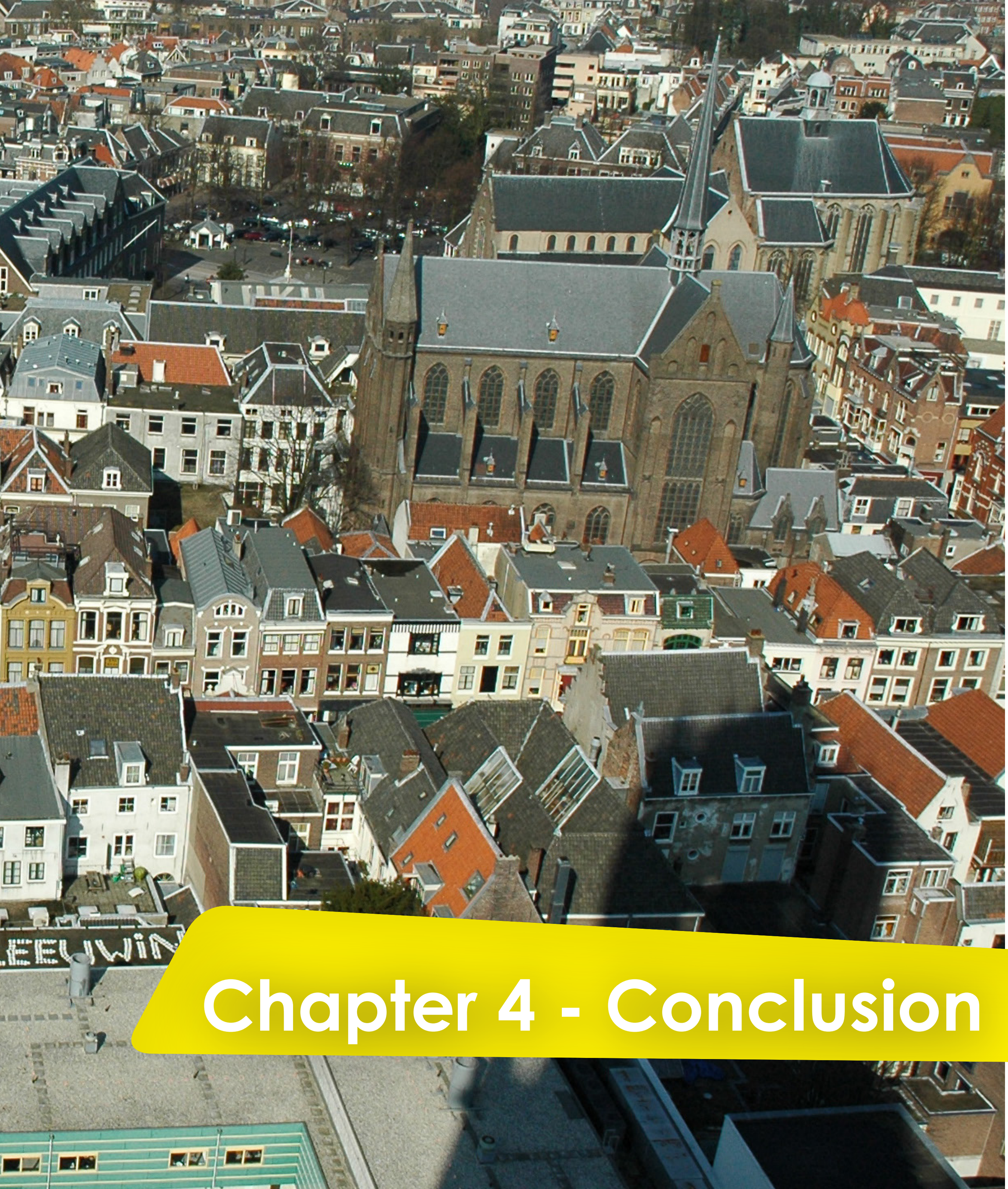









Presentation Panels →
Chapter 3
Introduction
Chapter 2
Combination of concepts
Chapter 4
Chocomel



Chapter 4 - Conclusion

Conclusion

Evaluation based on the multi criteria matrix

Architectural quality

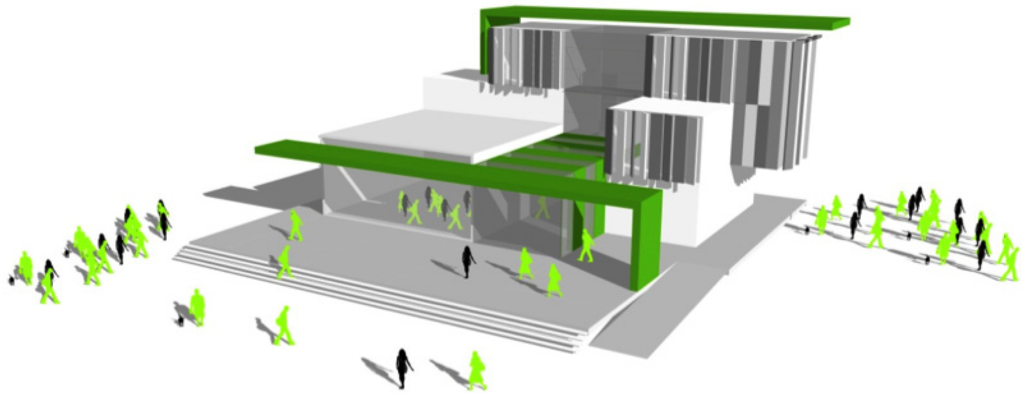
A clear identity was established by adding some elements to the entrance of the building as well as the roof. The entrance creates an inviting builing, it draws visitors to the entrance and the corridor leading to the auditorium and the stairs, which lead to the appartments. The transformability and spatial adaptation is visible because of the segmentation in the load bearing structure and the façade elements.

Multi-functionality

The spatial capacity has a lot of potential. The grid size chosen for the load bearing structure allows for big rooms to be created. 5,4 meter span is expected to be enough for most of the different desired function. On section with a roof span of 10.8 is created to allow for an auditorium, workshop space or an exhibition hall.

The capacity of the climate installations can be easily adapted when room arrangements are changed. Also, systems can be easily exchanged because of the standardized installation shafts, the installations in the floors, walls and ceilings can be completely removed or changed. In case the capacity of ducts and pipes in the installation shafts is not sufficient more space has already been reserved. The internal flexibility is created by a completely demountable wall system, which also integrates the possibility to guide electricity and water to every desired location.

For fire safety attention has been put into creating different segments in the building. Flexible floors and ceiling can be compartmented to avoid fire spreading easily. At the same time this helps improving the acoustical and thermal insulation between the different rooms. To comply with safety regulations the different pieces of infill



will also have fire retardant materials integrated into the components. Also, the stairs are positioned in the most rigid part of the building and the dimensions of the laminated wooded beams ensure the burn depth during a fire will not be enough to cause a structural failure.

Transformability

The transformability is capacitated by the flexible load bearing structure and the fixed stability walls which have been placed in the most optimal position to allow for different configurations. The infill allows for easy changes inside the spaces. The flexibility of the infill and façade enables parts of the building to be closed or open, this adaptability is not one that can be used on a daily basis but further development of infill should make this possible.

The façade elements allow for changes from day to night and according to the outside climate. This works together with the flexibility of the climate control systems. In some cases capacity has been determined according to extreme situations, for example 80 persons in the auditorium. There a system based on climalevel allows for quick changes according to the number of persons in the space. Also, in other cases the installations can be easily adapted as already has been stated in the part about multi-functionality. The plug and play system enables optimal transformability of all the installations, within certain guidelines set forth by the shapes and positions of the connections. Also, the technical space has been overdimensioned, to allow future additions to be placed without interfering with the already installed machines.

Disassembly and reassembly/configuration is possible because of the demountability of all the major components. During this project more focus has been put into this than the demountability of the underlying systems. This was done because the loose coupling of the load bearing system has the most effect on the eventual reuse and reconfiguration of the structure. The disassembly of specific components has also been addressed; this will be mentioned further in the next section.

Energy, water and materials

The building is supposed to be an energy neutral building, while it is not a 100 percent clear if this is the case, all the components have been developed with this in mind. Infill, façade and roof will have high insulative values because of the high tech insulation that can be applied. The climate concepts and components have been chosen to be as effective as possible with a low energy demand. And to compensate for the electricity that will be used photovoltaic panels will be placed on the roof. At the moment the building itself does not specifically stimulate low energy use, this

For the different components it is also attempted to use the cradle to cradle philosophy as much as possible. This means efficient use of materials and potential of reuse and upcycling after end of life. Connections are not permanently fixed and most of the chosen materials can either easily be returned to the biosphere or reused multiple times within the techno sphere. It is however impossible to give a final evaluation of how far cradle to cradle has been applied, as most of the specific details will be part of further development. And next to the physical decomposition it also depends on the applicability of the applied interfaces. If the building is disassembled after ten years the interfaces may have become obsolete because of further development by other industries. While we cannot predict whether this will be the case it is necessary to design for both return to the techno sphere and the biosphere.

Concerning the collection and reuse of water; this has not been fully addressed. The roof can collect water and collect this in the technical space. The rest of the installations are flexible enough to allow the installment of different water streams, to use it for toilets or watering the roof. This problem was seen as being too specific to be addressed further in this project. The flexibility of the installation system is deemed high enough to still apply the water separation and reuse principles later on.

Comfort and health

The climate concept has been created to make it possible to achieve a normal and comfortable inside climate. This is affected by the position and direction of heating, cooling, the applying of sun shading and other systems. Most of the ventilation can come from outside, special attention has been put into the efficient heating of fresh air that comes inside with recuperated heat while avoiding this such as draft.

Visual comfort comes from the use of glass in the façade; the sun shading is variable which allows for an unobstructed view. And from the outside the building is pleasing to the eye, as stated earlier green elements to create architectural quality while also lowering heat during summer because of evaporative heating and creating the possibility for higher biodiversity close to the structure.

Constructability and handling of components

These aspects have been addressed into the design by trying to keep in mind the different sizes and weights of components, the reachability of connections and making alignment and assembly as easy as possible. One clear example is the size of the floor sections. By making this 5.2 x 2.6 m^2 instead of 5,2 x 5,2 meter square it should be easier to transport, carry and install while at the same time improving industrialization and prefabrication.

Evaluation of the project

The first thing that should be said is that system integration is a very difficult task. It involves combining multiple disciplines into a design process which should lead to an integrated, life-cycle balanced set of solutions that are aimed at satisfying the needs and desires of the customer. The desire to obtain a very loosely coupled system and the low level of prior experience on system integration and designs of this complexity caused some problems. This combined with the difficulty with communications between the workshops weeks caused some delays within the process.

We think some of these problems can be solved by appointing a system integrator earlier on. While each of the coordinators probably should have acted as system integrators this wasn't defined enough, causing problems during collaboration. When eventually the tasks of two coordinators were changed to system integrators during the final workshop week everything went more smoothly. This change in function caused them feel more responsible about the work of all the different groups instead of their particular parts. If this had been made clear earlier the design process would probably have gone smoother.

The problems with communication were also one of the conclusions of the project in 2009. While we tried to improve based on their recommendations (using one single database to share work and testing the communication system prior to using it) not everything seemed to work. The database on surfgroepen was still too rigid to use quickly, most of the project members found other ways of quickly sharing documents and files with other people. This did however affect the overview that the other people could have on all the work. Similar to last year, this problem was quickly resolved in the final workshop, quick 'eye to eye' communication proved to be the solution to the communication problem.

Even with all these difficulties the whole project can be seen as one big learning experience. It has been very interesting to work together with people from other disciplines and cultures. Both the industrial designers and the architecture student learned from each other key aspects or their domain.