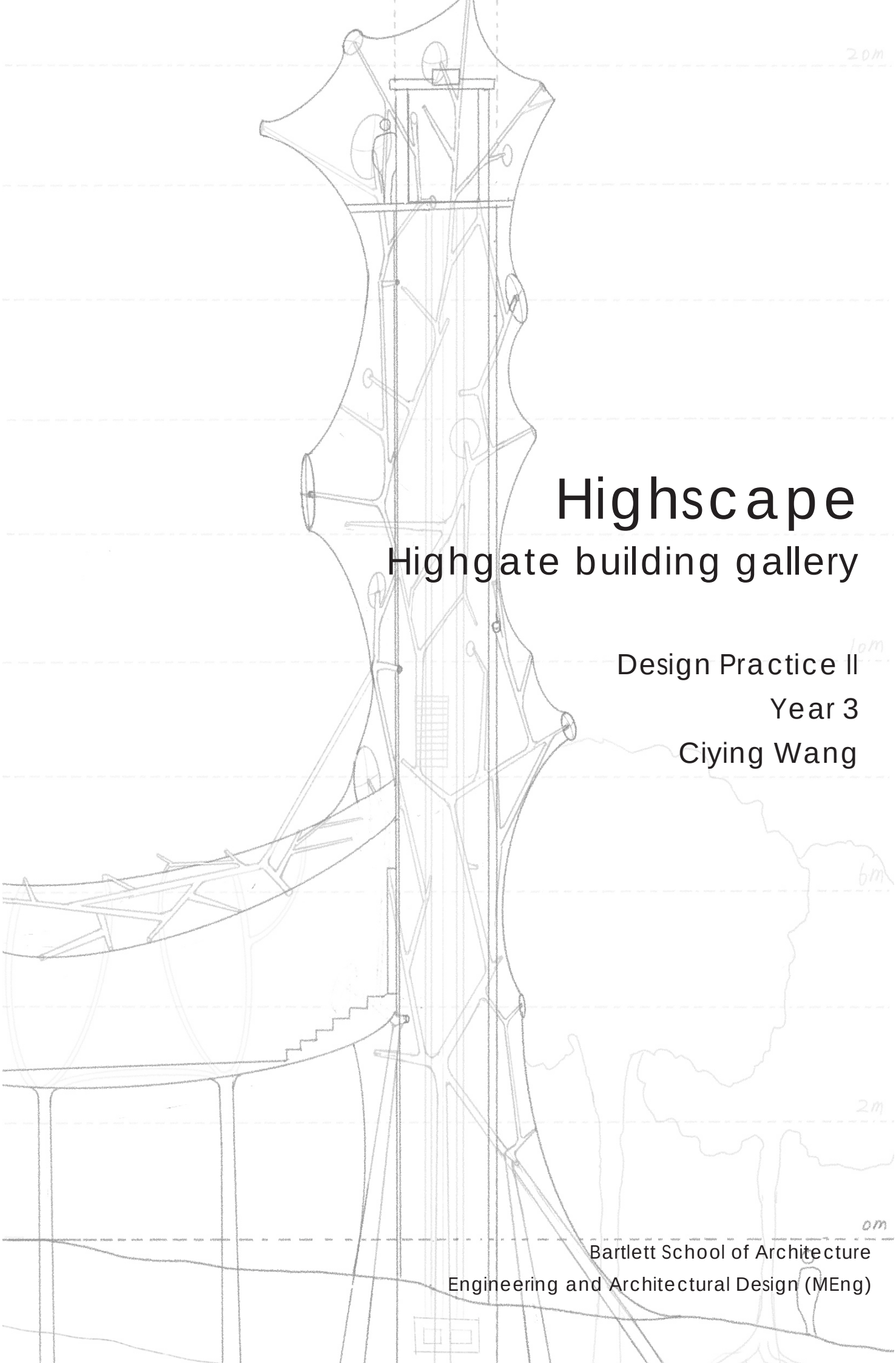


Highscape

Highgate building gallery

Design Practice II

Year 3

Ciying Wang

Bartlett School of Architecture

Engineering and Architectural Design (MEng)

Highscape

Highgate townscape - how to read buildings?

What - This project proposes a gallery combined with a workshop and an observation tower.

Why - A new development of residential buildings has provoked concern that heritage architecture in Highgate, which local residents are so proud of, will be affected. It is proposed in this project that a gallery of local architecture can be designed to celebrate Highgate heritage, and an observation tower can enable a bird view above this crowded area and an appreciation what is considered to be normal.

Where - The site is in Townsend Yard where the new development in the news is located. It is a rarely found area where busy high streets are just adjacent but rural charm can also be found in the garden behind.

When - The construction starts from 2025 and should finish before 2028. The life span of the gallery is designed to be over 100 years.

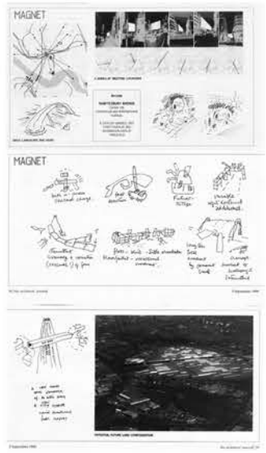
Who - The client of this project is three Russian billionaires who want to make their way into the Highgate community. Highgate, famous for its elite residents and local pride, has protested against new investment from overseas billioniares. As a gesture of showing respect for local heritage and demonstrating architectural taste, they want to fund this gallery project and don't care too much about its cost.

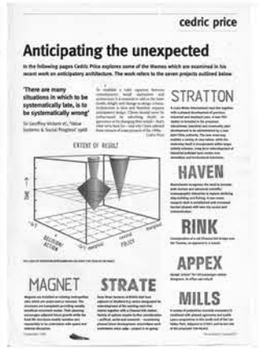
How - Daylight, which the local site is deprived of, will serve as the main environmental parameter and design tool. The project is informed by 5 influences - articles, observations, performance materials, occupats of buildings & research - which drive the iterations of designs. Local heritage buildings scattering around streets and corners in Highgate, a series of installations will suture the urban fabric along the architecture journey.

Contents

CONCEPT

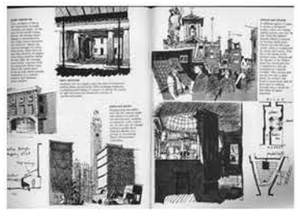
The diversity of architecture and richness of townscapes has given Highgate ubiquitous charm. North Hill , the highest point in Highgate, the jewel in the crown , is considered the most architectural diverse street in England, where almost every genre of vernicular architecture is represented. This project uses Cedric Price's Magnets and Gordon Cullen's Townscape as its references, sheding light on how urban fabrics can be sutured together by enhancing connections with interventions and by putting microcosms of architectural fragments and understanding the relationship between them.





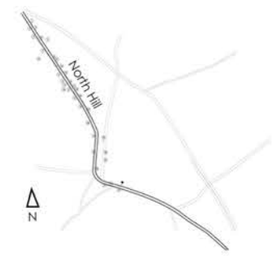
Magnet was Cedric Price's latest project, which proposed ten short life structures for cities which would provide public amenities and stimulate new patterns of public movement. Demonstrating his ideas of 'anticipatory architecture,' the Magnets were designed as temporary, mobile, structural adjustments to the public realm. The Magnets included Stairways, Promenade, Arcade and Pier, which would improve access, allow better views of the urban landscape and create new public spaces as well as increasing the use of existing spaces. Magnet inspires this project which aims at designing small interventions in the urban fabric and stitching together architectural fragements of Highgate.

Highgate has always been an attraction to people of fame.



The Concise Townscape by Gordon Cullen has defined three concerns that give pleasure to humans by building the quality of cities and urban spaces:
- optics: visual ability of humans to enjoy cinematic view, movement, beautiful sequences;humans can feel these while moving through spaces in the city and they visualize the changing scenery;
- place: a quality of urban spaces that could give a feeling of in or out of the environment;
- content: the detail of urban spaces such as color, texture, style, scame and uniqueness.

North Hill, Highgtate is probably the most architecturally diverse street in the UK.



Irregularity; variety

Regularity; public to private

Enclosure; curve; surprice

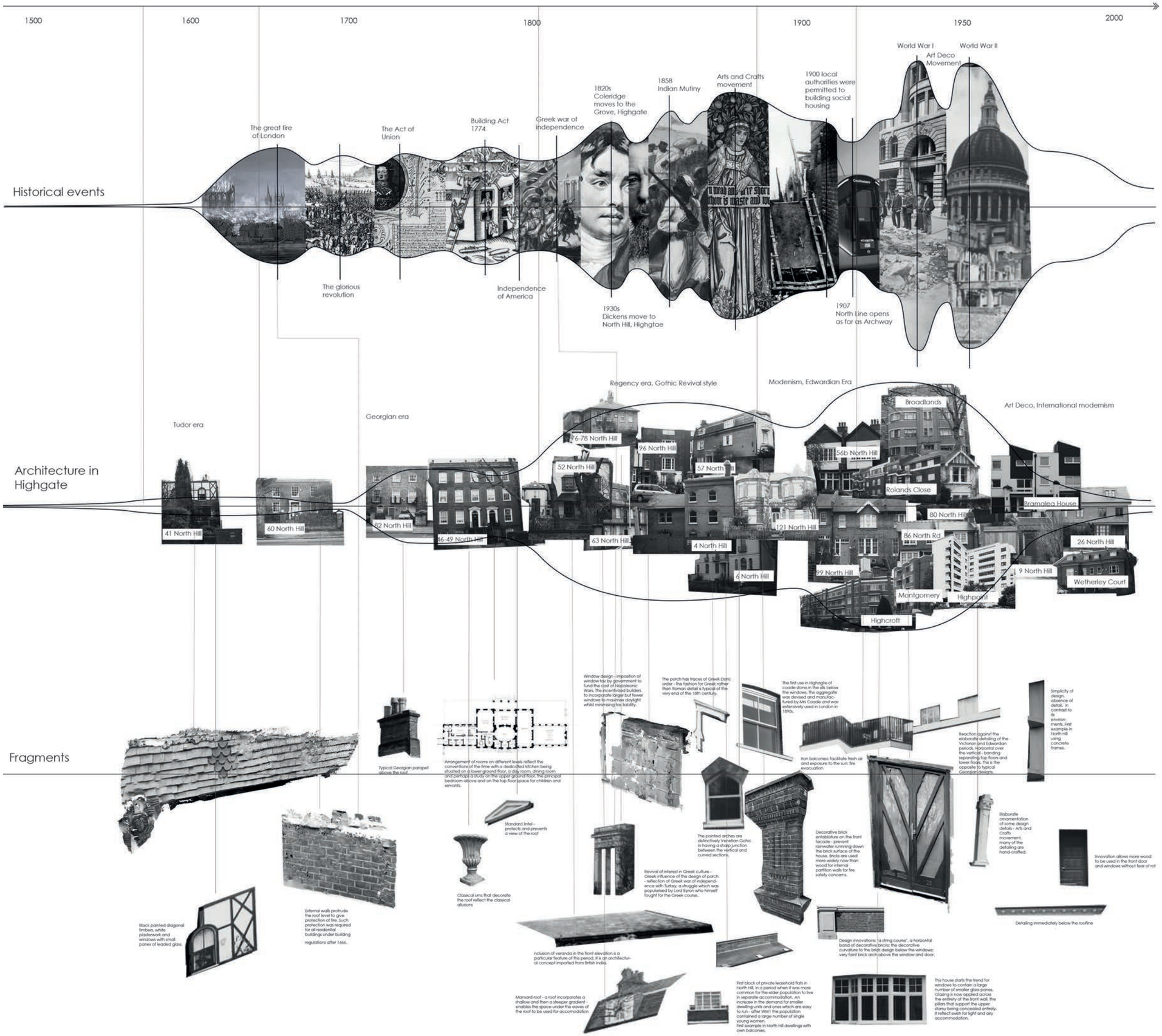
Here and there

CONCEPT

Architecture documents history. Historical events such as the great fire in London 1666, Indian mutiny 1858 and the world wars all in various ways shape the architecture in Highgate into the way they have been.

Architectural fragments document the change of architectural details. These details are the windows to people's hopes, worries, fears and customs of their times.

By exhibiting the building fragments in Highgate, this gallery serves as a know-what, know-how and know-why space. Information of what these elements function as, how they are constructed and why they are the way they are is fundemental to understanding the architecture in Highgate.



North Hill, Highgate

The site of this project is ownsend Yard, North Hill, Highgate. Here locates Shepherd's Cottage, which was built in the 17th century and is one of the only buildings of this kind remained. The North Hill area of Highgate is known for its diversity of architectural styles. An architectural route from Highgate Underground Station to Townsend Yard is designed, which allows visitors to appreciate Highgate architecture. A gallery sits in the end of the tour and provides a place to view from the height.

North Hill area

1 Highgate Underground Station
2 Gate House (highest point of Highgate)
3 Highgate High School
4 Townsend Lane
5 Shepherd's Cottage
6 OMVed Gardens
7 Waterlow Park

Main road
Walkpath

Greenery (gardens, parks, forests)

Buildings (residential ,retail, factory)

Topography

Bedrock: Claygate Member - Sandstone
(CLGB-SDST)
Density: Medium Dense
Sand > Loam

Bedrock: Bagshot Formatiom - Sand
(BGS - SANDU)
Density: Stiff
Sand

Architecture of historical importance

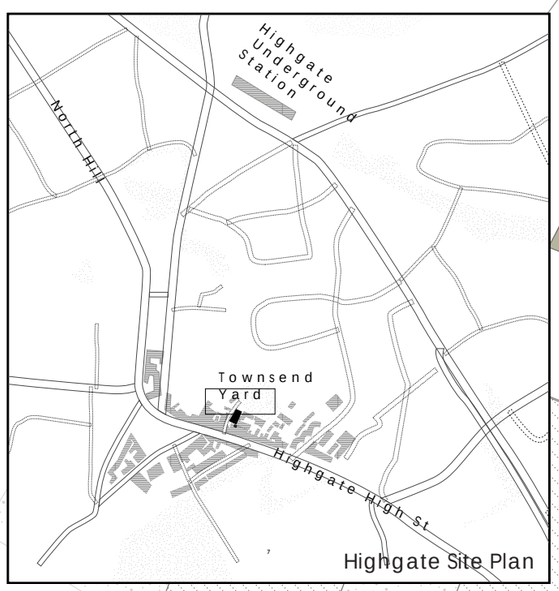
North Hill architecture route

Bird view to buildings

Noise level

A3 1:250 N

SITE: TOWNSCEN YARD



Highgate Site Plan

OMVed Gardens

Townscend Yard

Highgate High Street

1 Shepherd's Cottage
2 Garage (to be removed)
3 LLI Interior Design Company
4 SecureASale Ltd (property investment company)
5&6 Parking Lot
7 Factory

Site
Trees
Original development
Buildings (residential)
Buildings (retail, factory & company)
Courtyards
Roads
Circulation
Field of vision for passers-by (before new developments)
Wind (breeze from forest & corridor wind)
Humidity

A3 1:250
N

SITE

The site of this project is Townsend Yard, North Hill, Highgate. Here locates Shepherd's Cottage, which was built in the 17th century and is one of the only buildings of this kind remained. The North Hill area of Highgate is known for its diversity of architectural styles. An architectural route from Highgate Underground Station to Townsend Yard is designed, which allows visitors to appreciate Highgate architecture. A gallery sits in the end of the tour and provides a place to view from the height.

Highgate Building Gallery

Ground plan

A1 1:50

N

2m

1m

5m

OMVed Gardens

11

6

10

7

5

1500s-1700s

1700s-1800s

9

1800s-1850s

8

1850s-1900s

4

1900s-1950s

1950s-2000s

1

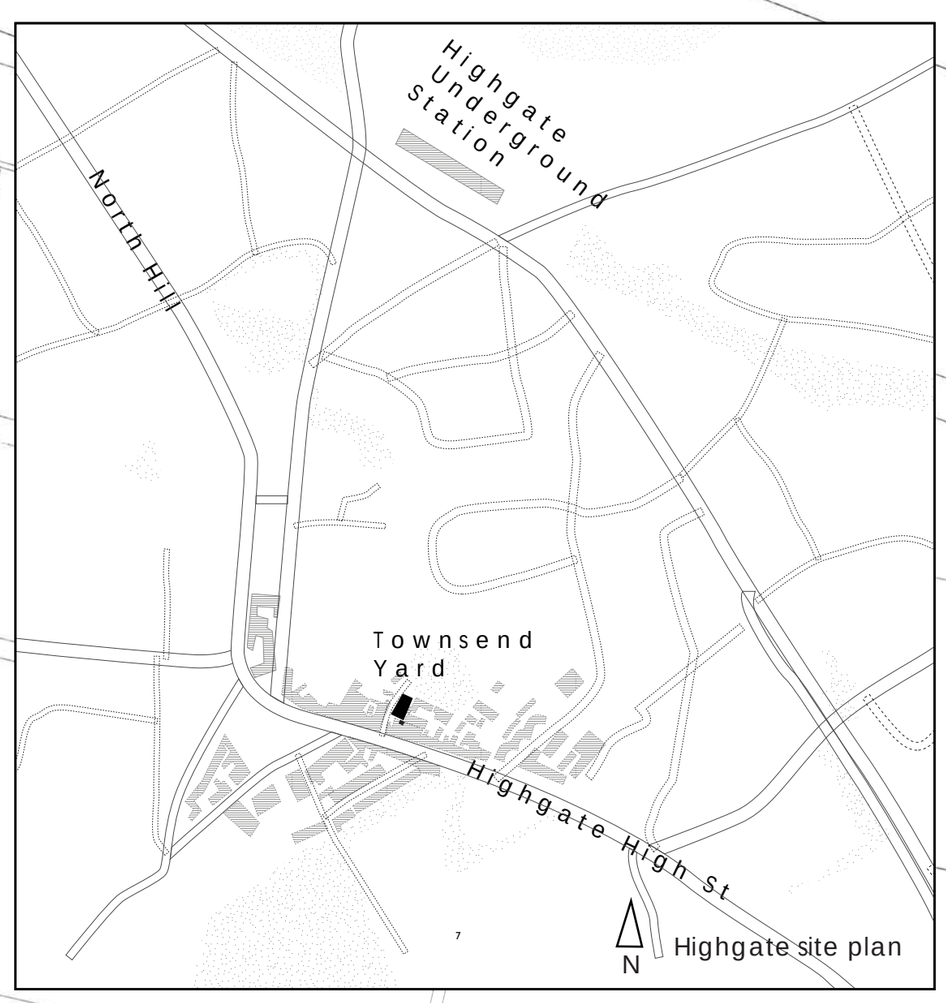
2

3

1

Highgate High Street

1 Shepherds's Cottage
2 Entrance to gallery
3 Entrance to workshop
4 Workshop
5 Store room
6 Bathroom
7 Exhibition space
8 Hallway
9 Parallax exhibition
10 Air source heat pumps
11 Tower



Highgate site plan

Highgate Building Gallery

Basement plan

A2 1:50

Highgate Building Gallery

First floor plan

A2 1:50

Highgate Building Gallery

Short Section Looking North

A1 1:50

2m

1m

5m

Shingle roof with reflective tiles

Roof glazings

Conveyor belts

Chilled beams

Ventilation ducts

AHU and heat pumps

MEZZANINE

WORKSHOP

PARALLAX EXHIBITION

PROMANADE

MODEL & DRAWING ARCHIVE

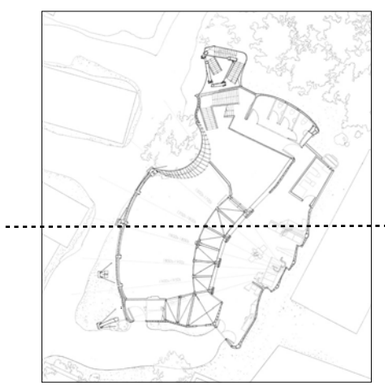
Linear suspended LED lighting

Conveyor belts

Chilled beams

Underfloor heating pipes

Displacement ventilation ducts



Archive

Entrance

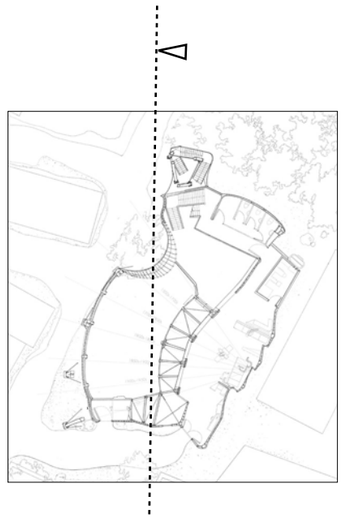
Cinema

Parallax exhibition

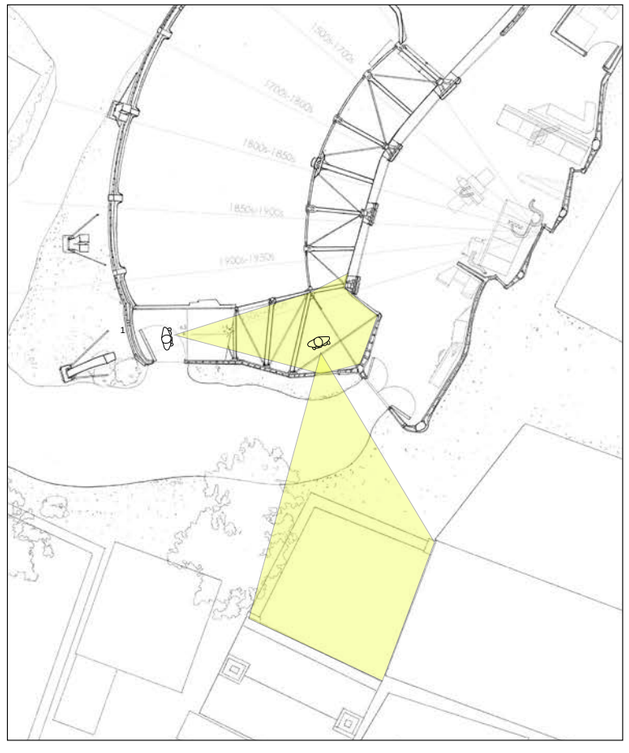
2m

1m

5m

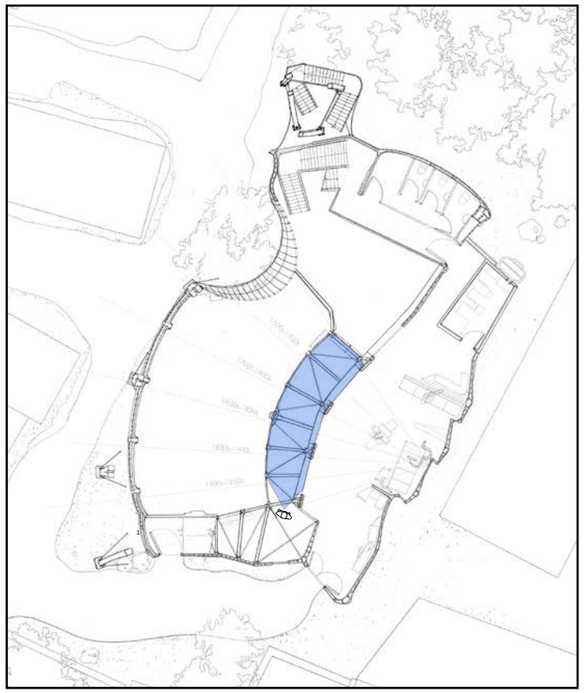


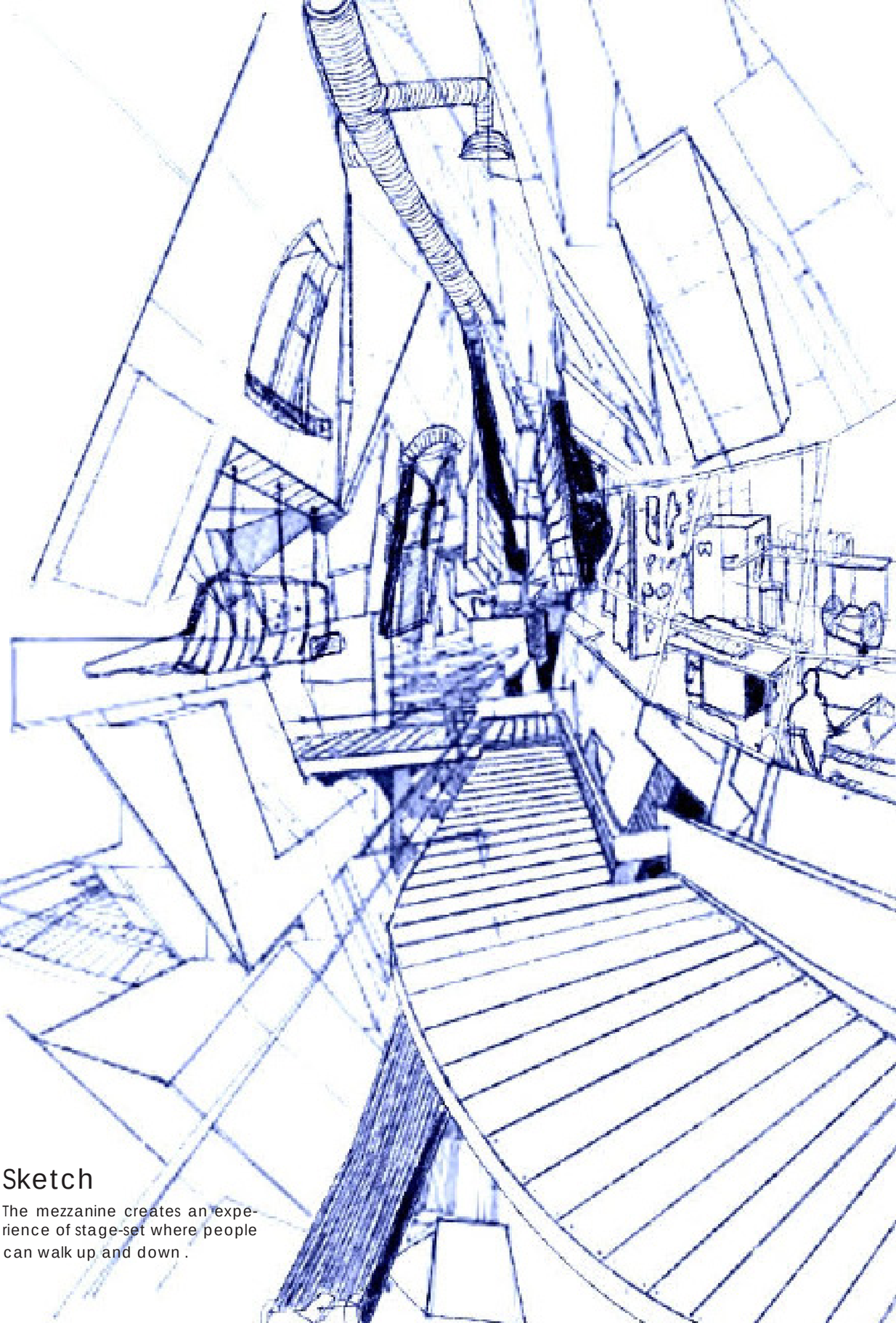
ENTRANCE



MEZZANINE

Inspired bu Dogville and Mnemonic Theatre, the mezzanine space of the gallery will be like a stage set where fragments of Highgate architecture are displayed and visitors will walk between them. Put on a two-dimensional plane, the space has a sense of three-dimensionality and provokes imagination.





Sketch

The mezzanine creates an experience of stage-set where people can walk up and down .

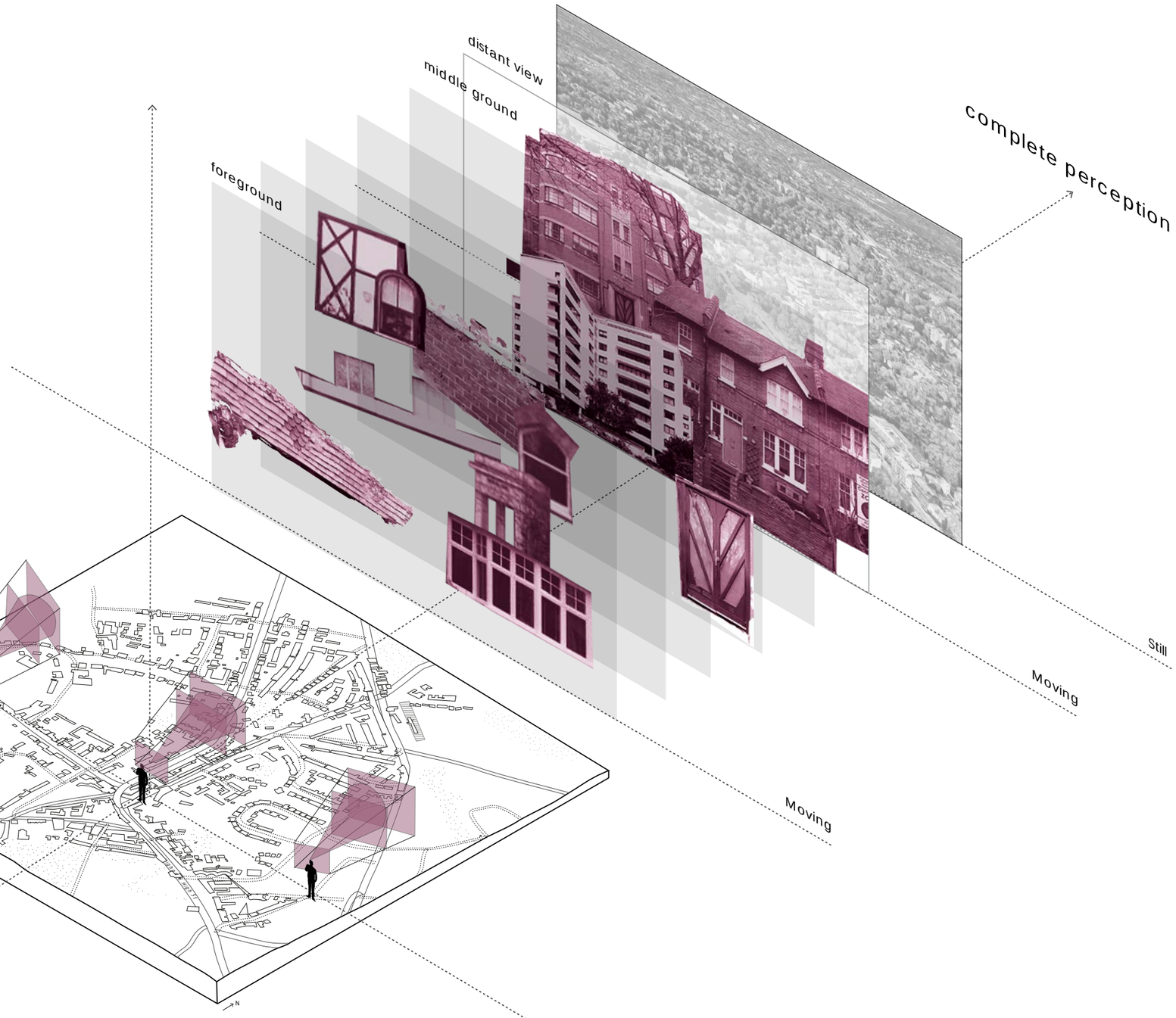
EXHIBITION SPACE

' The architectural synthesis of fore-ground, middle ground, and distant view, together with all the subjective qualities of material and light, form the basis of complete perception.'

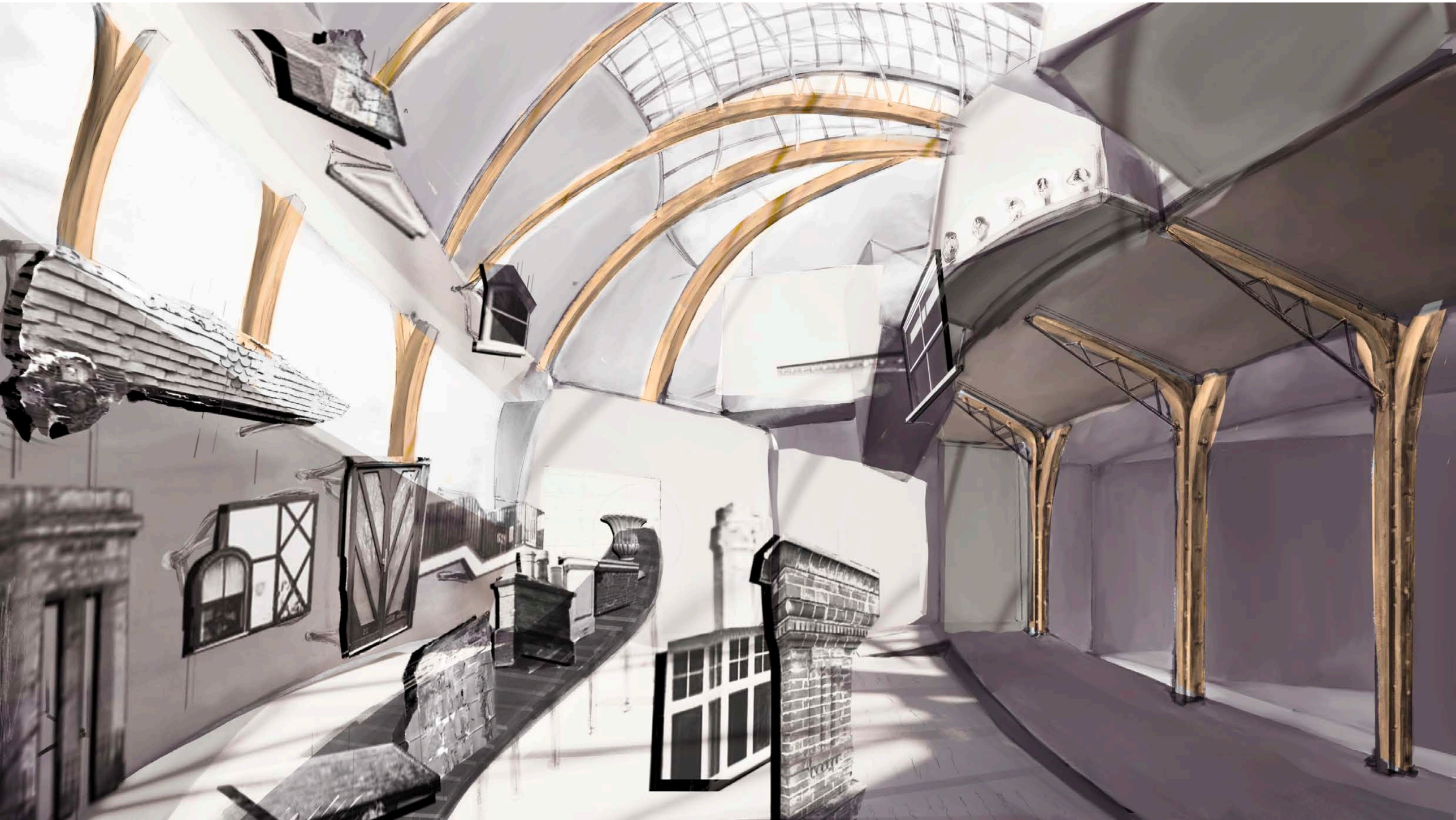
'A determinate point of view necessarily gives way to an indeterminate flow of perspectives.'

'The turn and twist of the body engaging a long and then short perspective, an up-and-down movement, an open-and- closed or dark – and – light rhythm of geometries – these are the core of the spatial score of architecture.'

——Parallax, Steven Holl

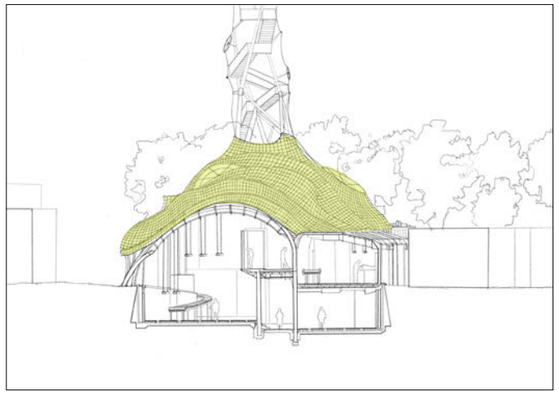


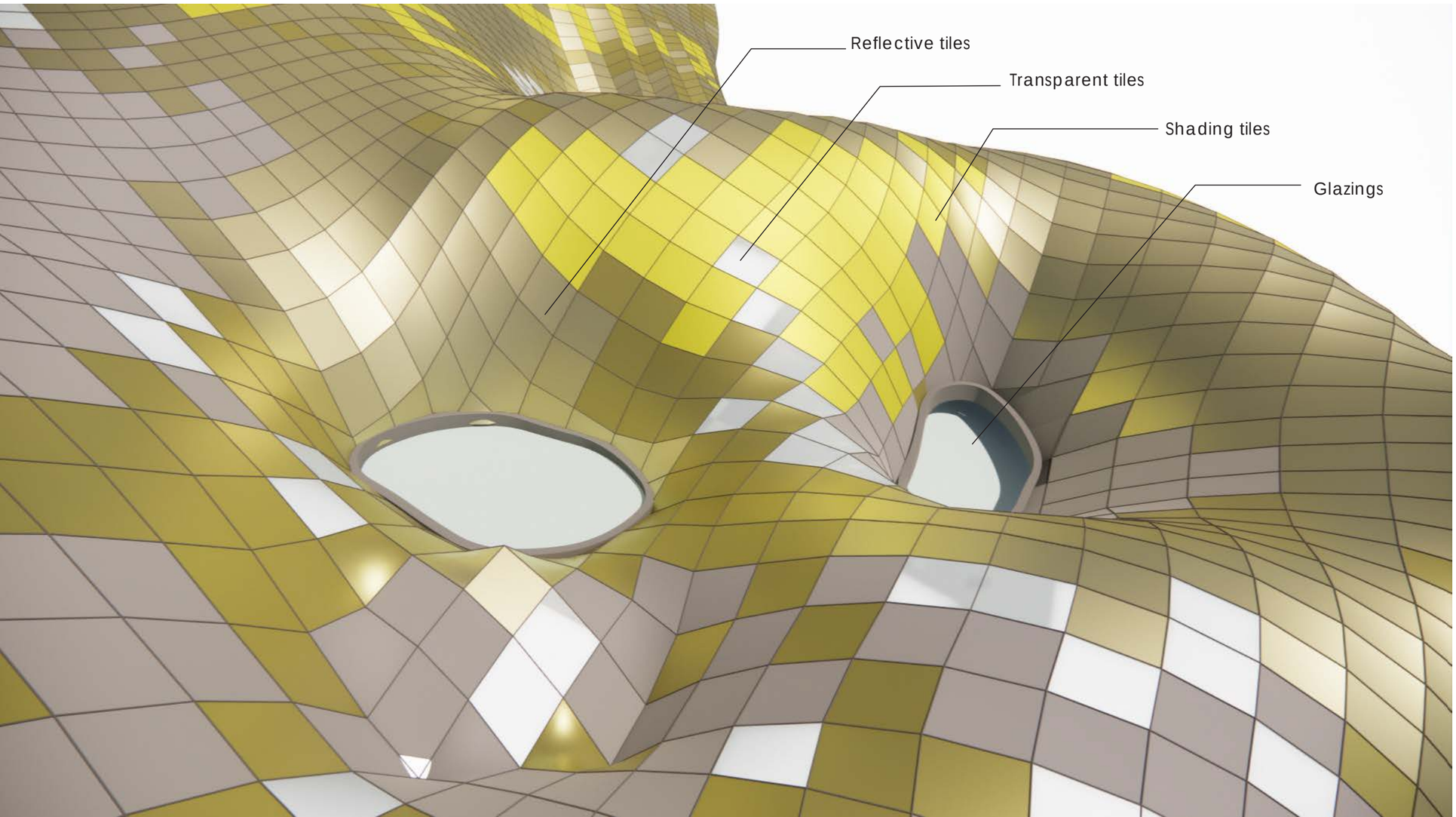
PARALLAX EXHIBITION

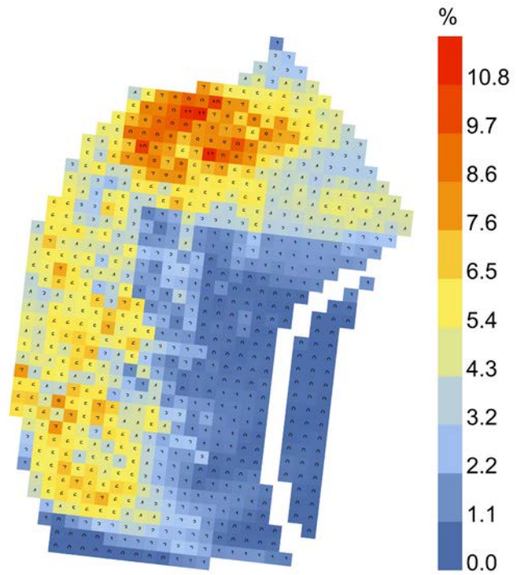


ROOF

How to maintain ideal daylight level inside the gallery and provide diffuse light to the surrounding at the same time?



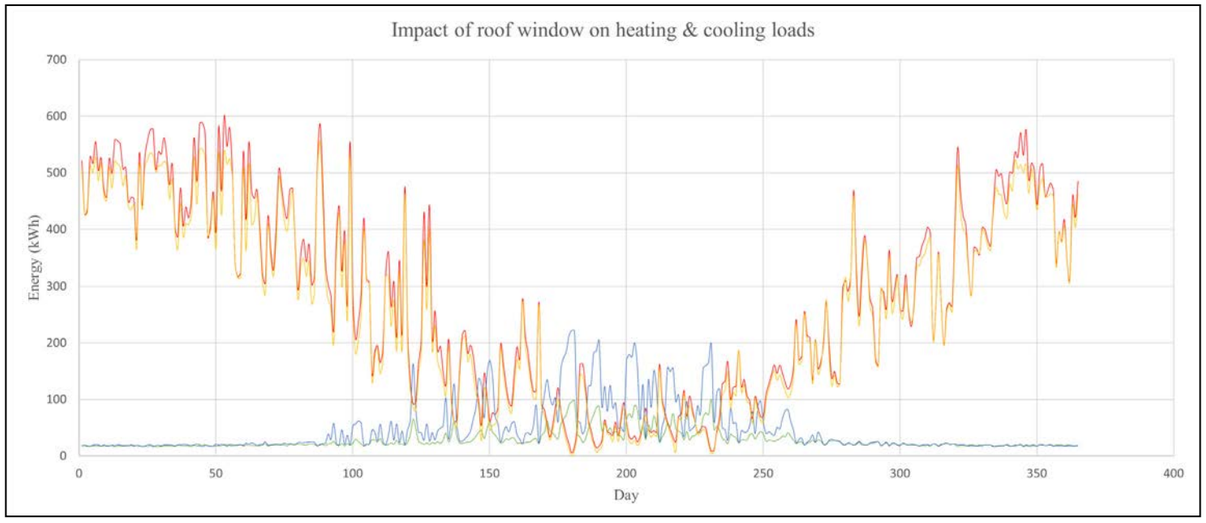


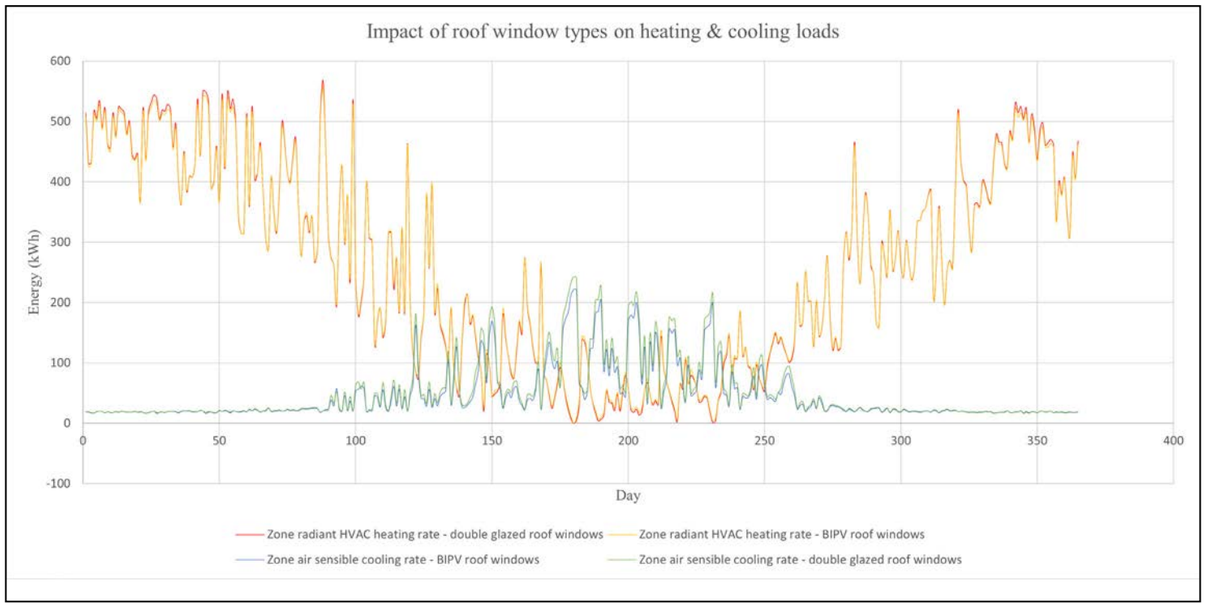


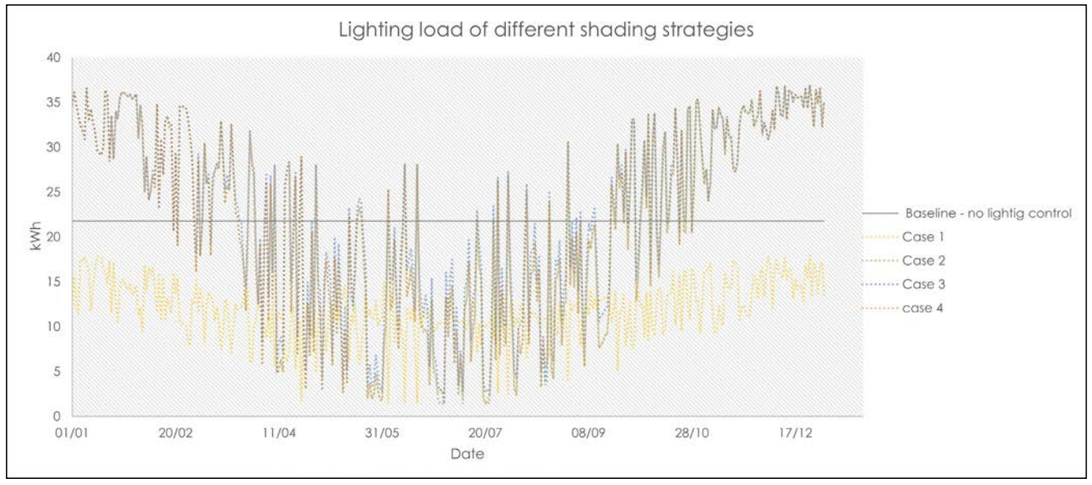
Simulation results of annual daylight factor in the exhibition space

ROOF

Roof design and heating, cooling and lighting load



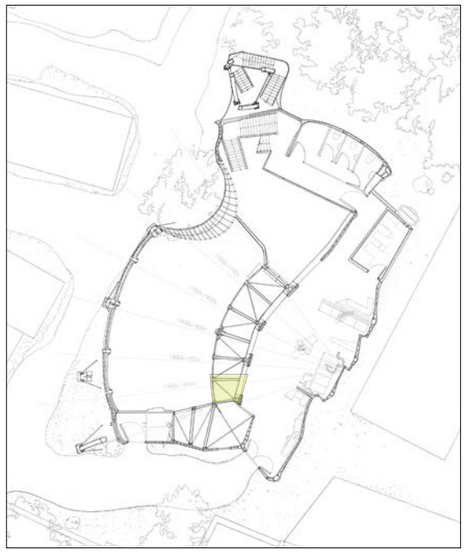




	Roof window material		Shading		lighting control
	material	transmission (SHGC)	type	schedule	
1	Triple glazing, clear , 1m louvre - triple LoE film (33) Bronze 6mm/3mm Air	0.17	Medium reflectance-low transmittence shading - midpane	solar irradiance on window >200 W/m2 and outside air temp >24 oC	on
2				Glare	
3				Daycooling and solar >200 W/m2	
4				Horizontal solar irradiance >200 W/m2 and outside air temp >24	

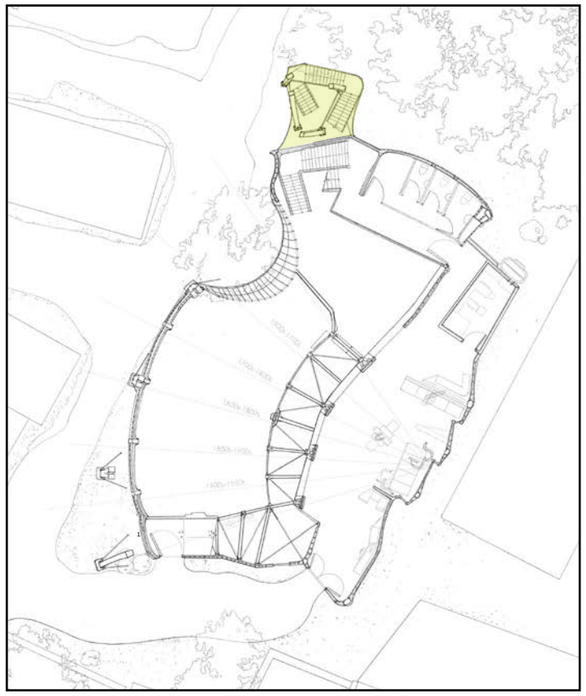
Roof

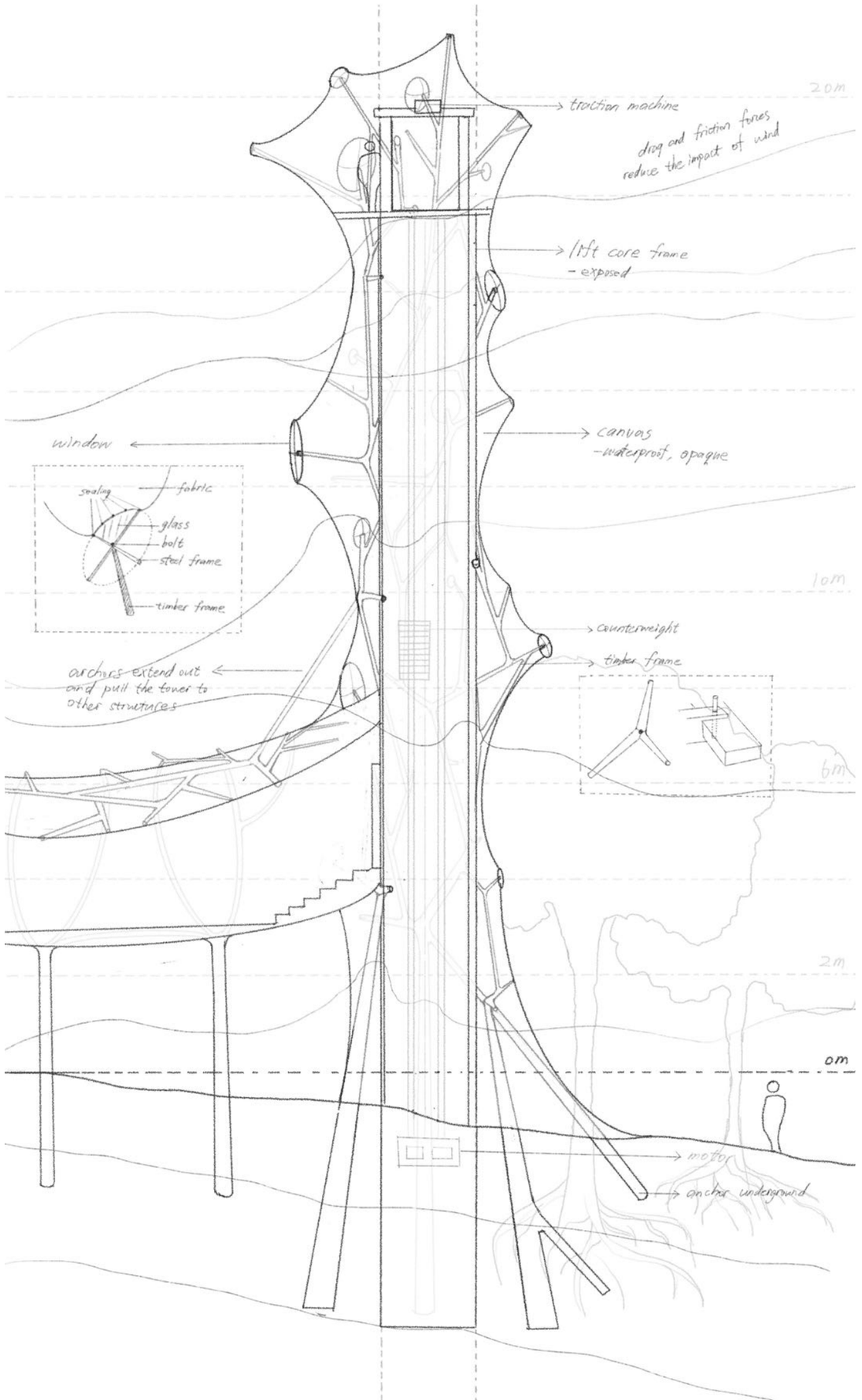
1. Roof shingles of different reflectance, transmittance and transparency
2. Steel frame
3. Chilled beams hidden between roof layers
4. Structurally optimised steel components which connects timber and steel frames
5. Glazings
6. Suspended LED lighting
7. Glass Fibre Reinforced Polyester (GFRP)
8. Windows to the workshop



TOWER

Conceptual drawing: the use of dendriform shapes in the structural design.



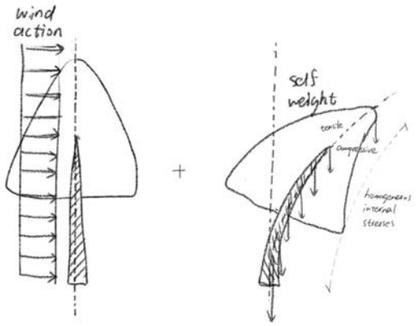


TOWER

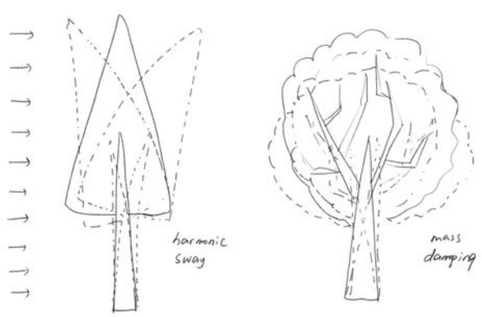
Research: dendriform shapes

Dentriform shape

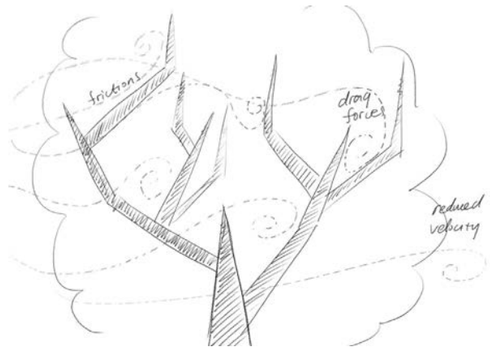
One of the biggest challenges of tower design is how the structure resists wind load. Tree chunks and branches are excellent in this aspect. Trees have evloped to configure their own shape so that they can withstand against strong wind force and tackle resultant bending moments. Axial compression due to their weight is another load that is carried by tree stems and trunk. In bending condition, when the tree is exposed to wind, the stresses change from tensile at the convex side to compressive at the concave side of a component. On the other hand, internal shear stresses prevent component parts from slipping on shear-loaded interfaces. Structurally, for a good performance, these internal stresses must be homogeneous for distributing the loads evenly. Trees have optimized their shape to follow this structural demand.

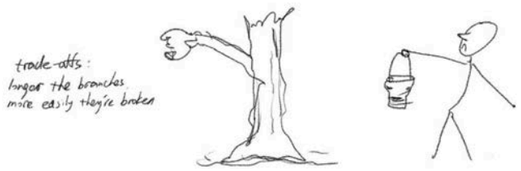


Under the wind loading forces, the group of complex patterned branches as a mass contributes a dynamic damping, known as mass damping, which acts to reduce dangerous harmonic sway motion of the trunk and so minimizes loads and increases the mechanical stability of the tree.



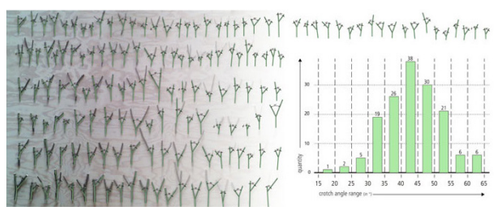
The fractal skeleton of a tree diverges the heavy wind to lower the impact on its tree-body. Besides, higher fractal dimension of branches helps to increase the drag forces and frictions in trees, thus lessens the wind velocity on its path especially during storms.

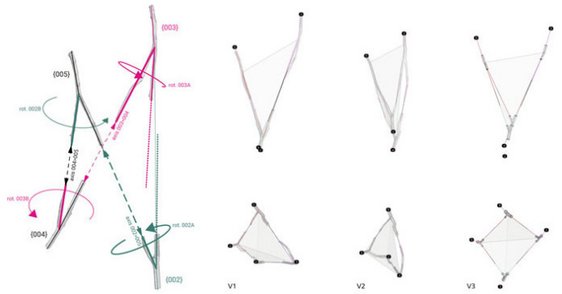




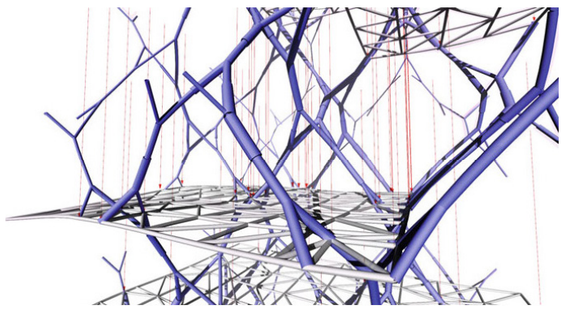
The main research applied in this project is '*Natural Complexity. An Introduction to Structural Design with Tree Forks*' by Lukas Allner and Daniela Kroehnert from Univerity of Applied Arts Vienna. The paper has provided innovative framework and workflow of wood design, and explores the possibility of using dentriform shapes in structures.

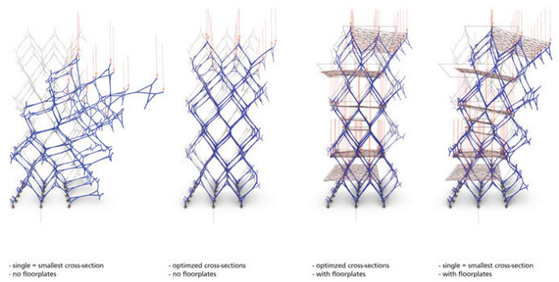
The research starts by looking into a specific species of trees, Hornbeam, which is characterised by a high rigidity and a tendency to extensive branching. The crotch angle ranges of it are recorded.





The geometries are abstracted into nodes and axes, and elements of branches are connected together.

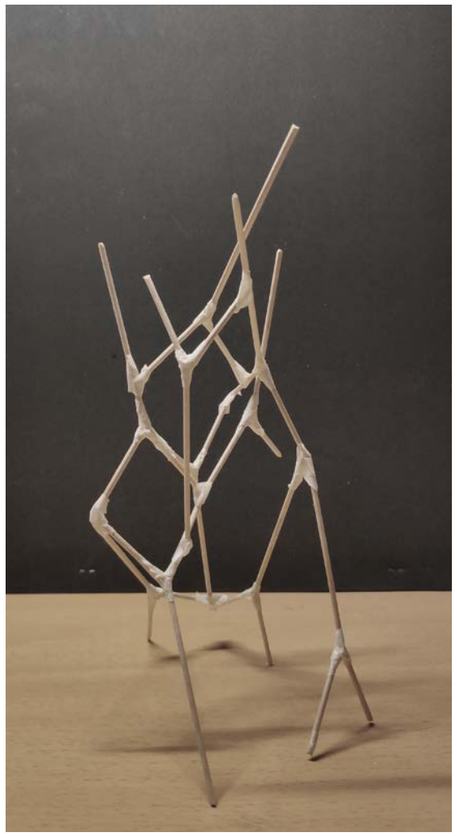




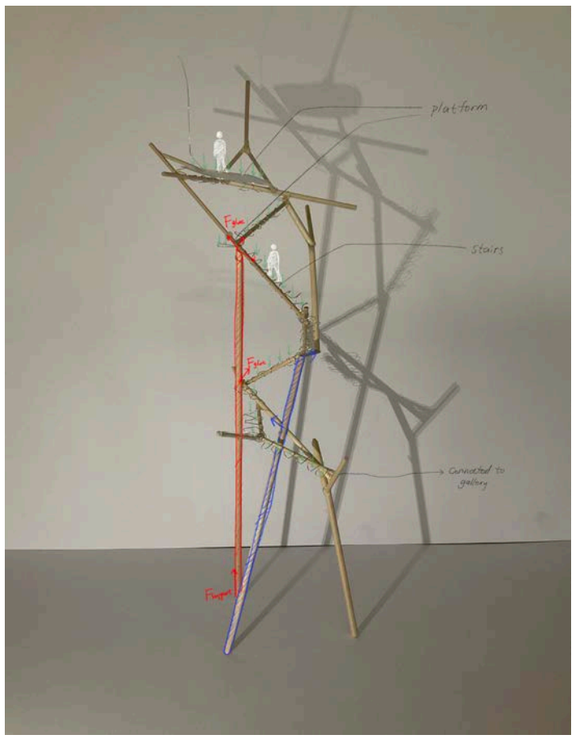
Y-shaped elements are connected into tetrahedron modules, and tetrahedron and octahedron frameworks can be formed.

TOWER

Iterative models



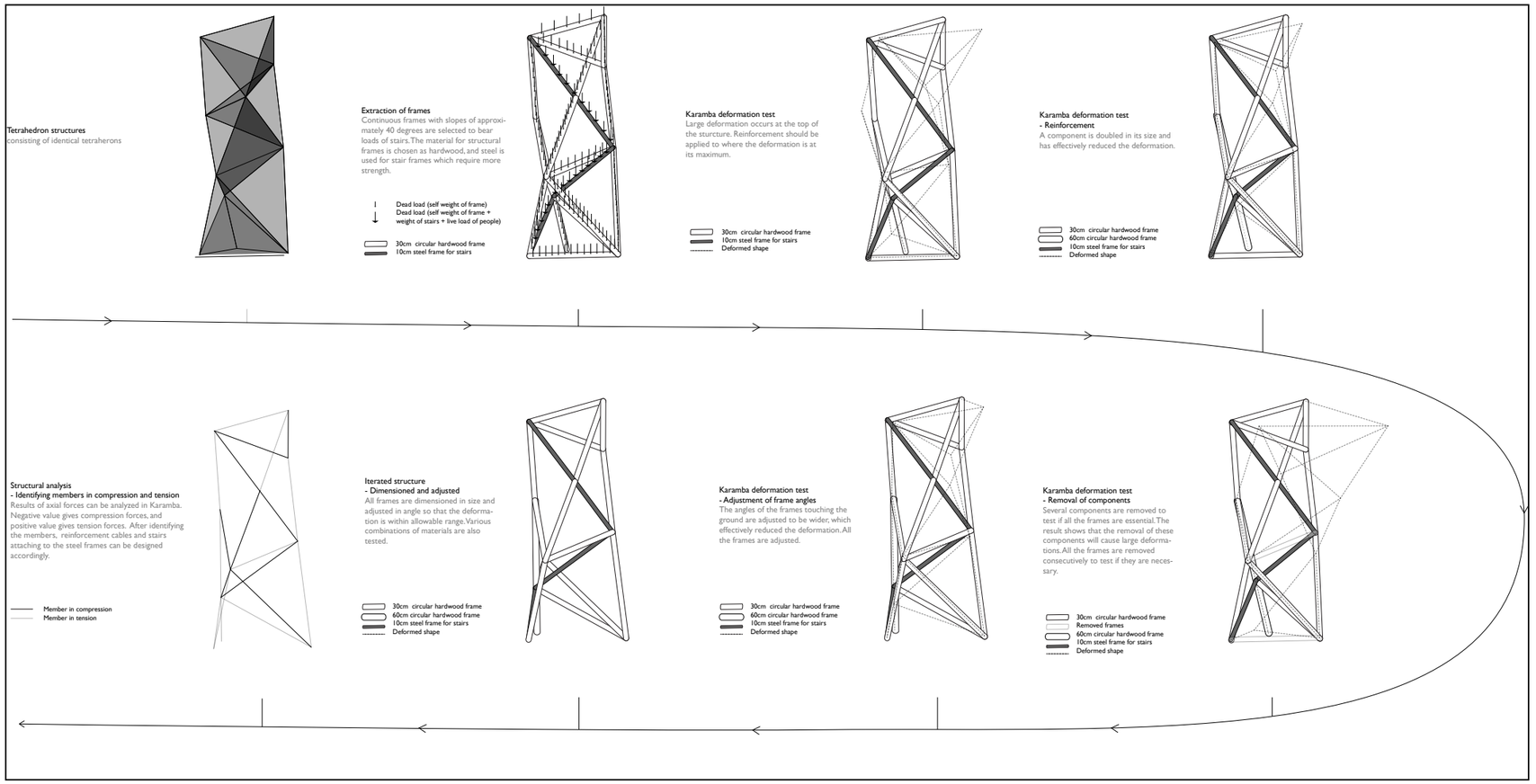
Procedural assembly parts are put together in iterative steps. Instead of a global logic controlling the formation, local parameters define the aggregation in every step. The form of aggregation is found in the process of making. Self organised structures can be adapted to local conditions by maintaining an overall systematic coherence dependent of the respective ruleset.



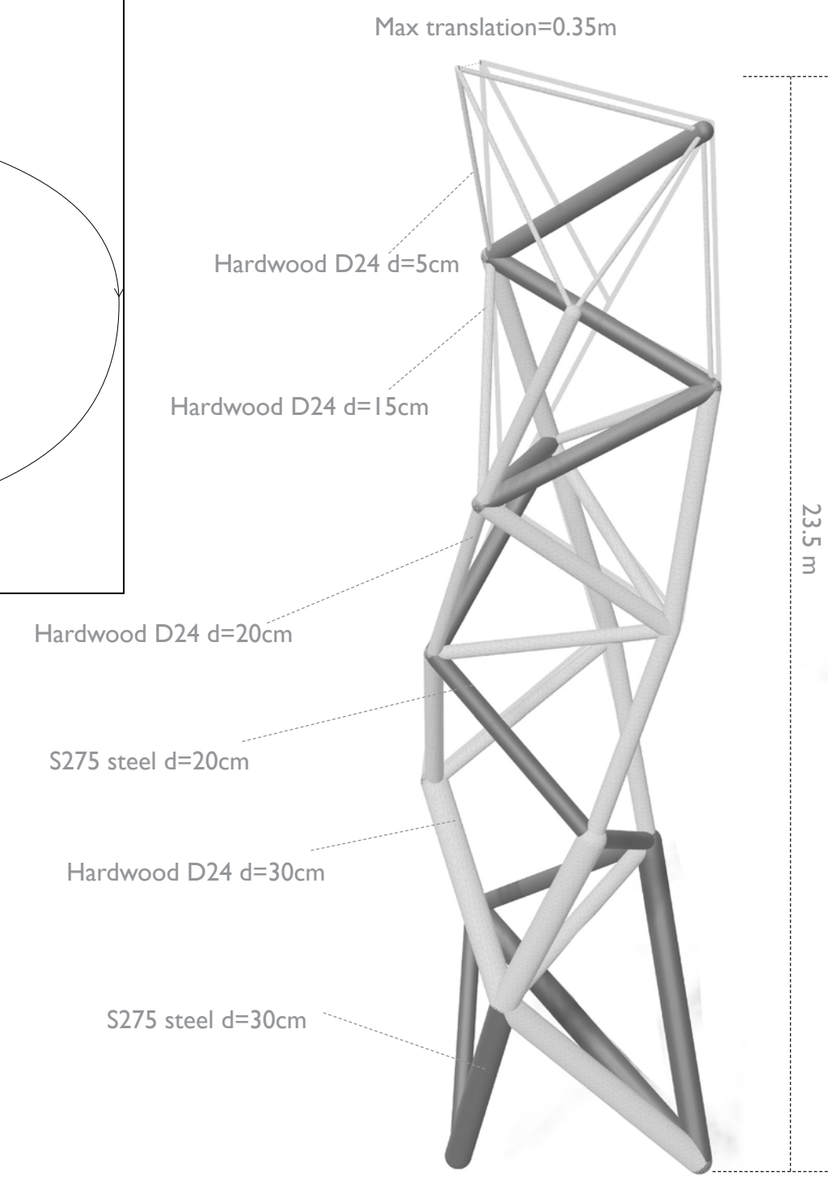
Preliminary force analysis of structural members of the tower. Because of the eccentricity of angles and configurations, the identification of compressive and tensile forces is difficult. Karamba 3D is later applied to analyze and optimise the structure.

TOWER

Iterative structural optimisation by Karamba 3D



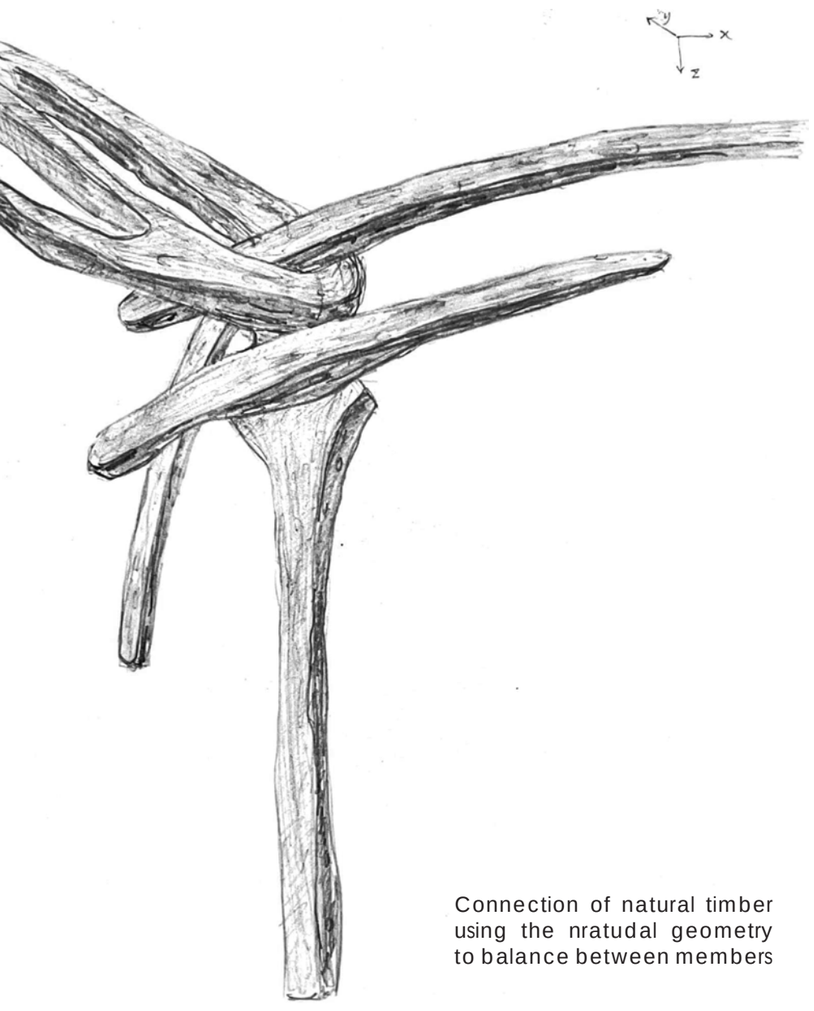
Structural opmitisation outcome



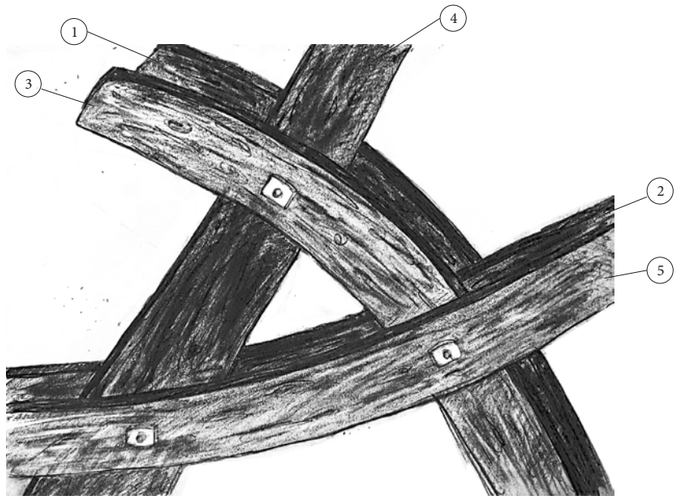
TOWER

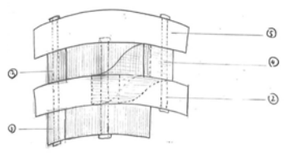
Connection details

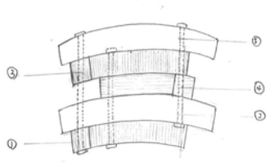
Timber members are connected in various ways, posing a series of structural challenges. Instead of making the connections as invisible as possible, large connections where visitors can appreciate the details of connections can provide richer experiences. Several connection mechanisms of wooden membes are explored.

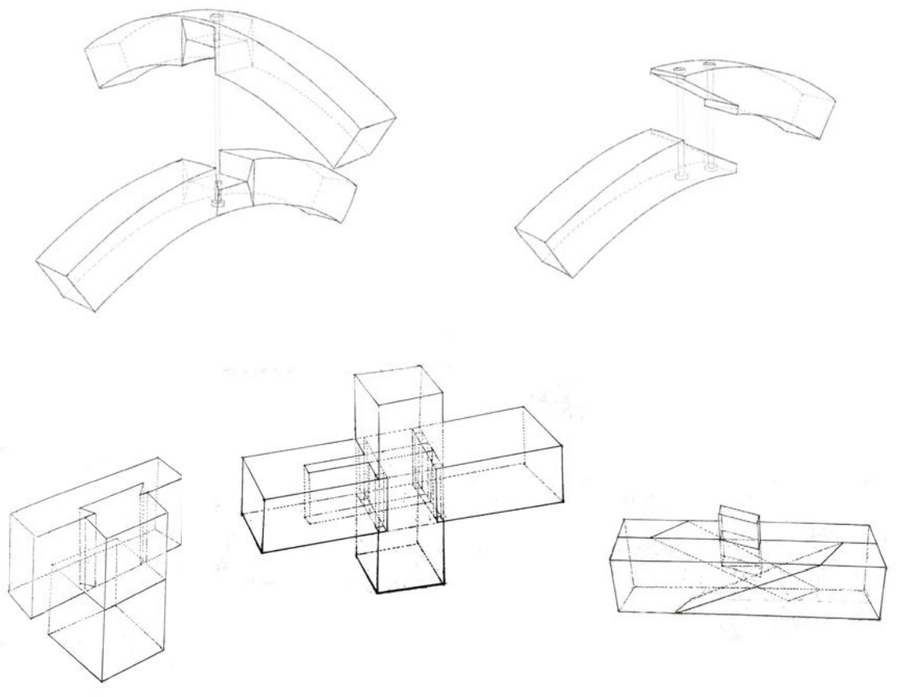


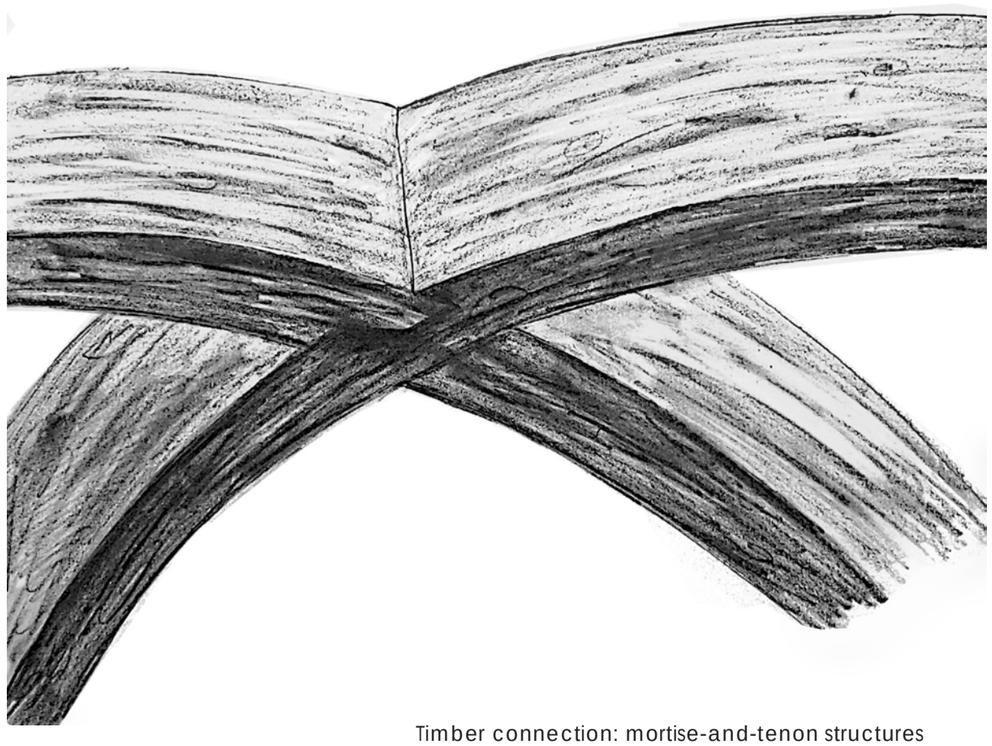
Connection of natural timber using the nratudal geometry to balance between members







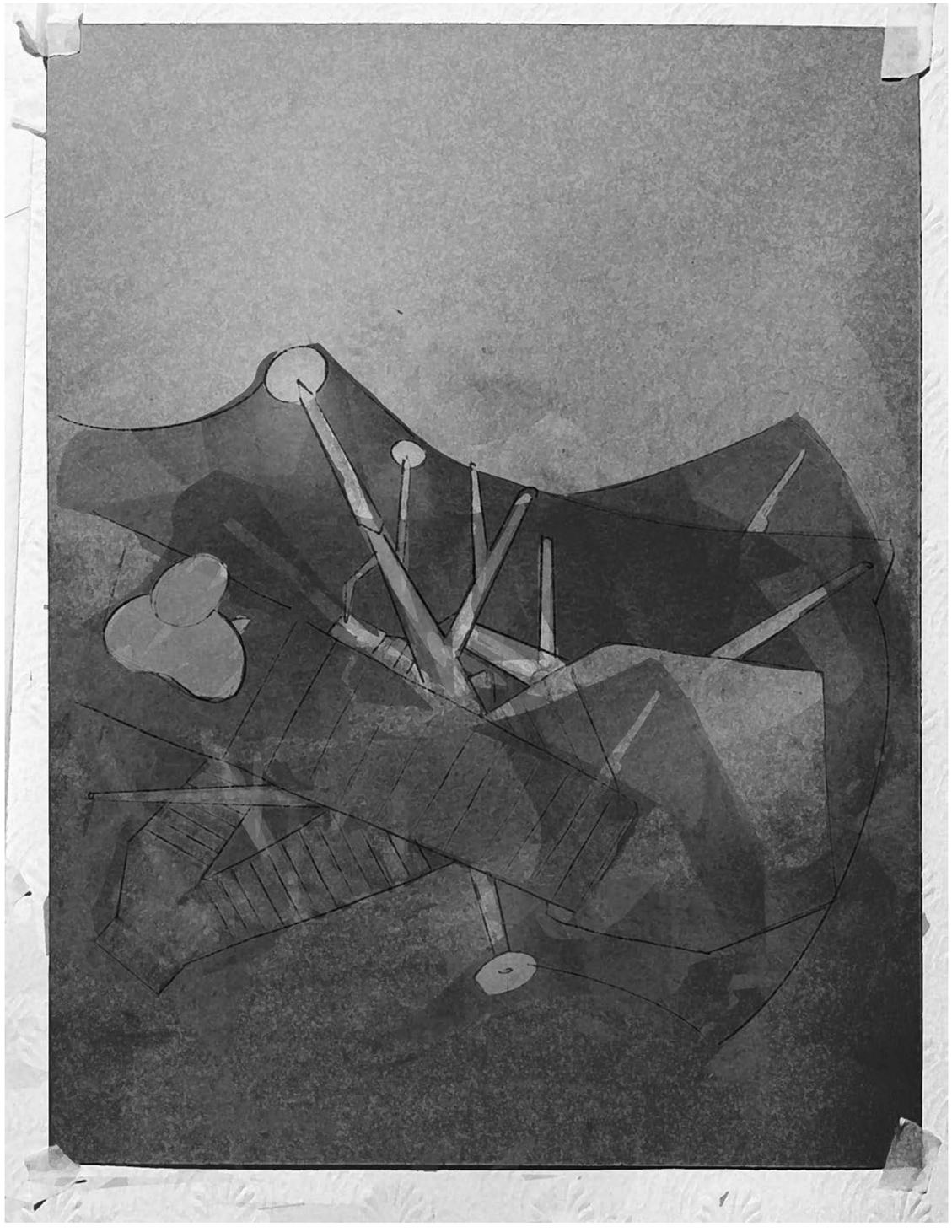




Timber connection: mortise-and-tenon structures

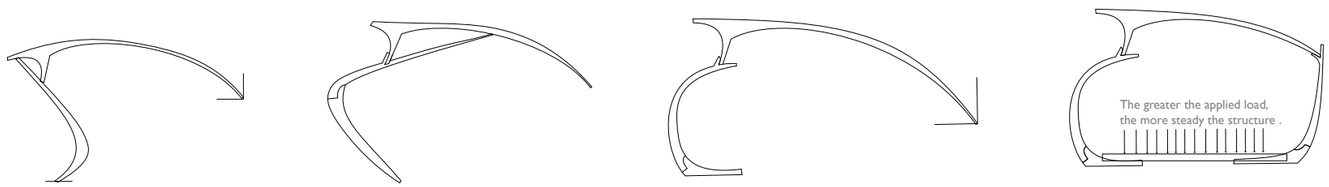
TOWER

View from above

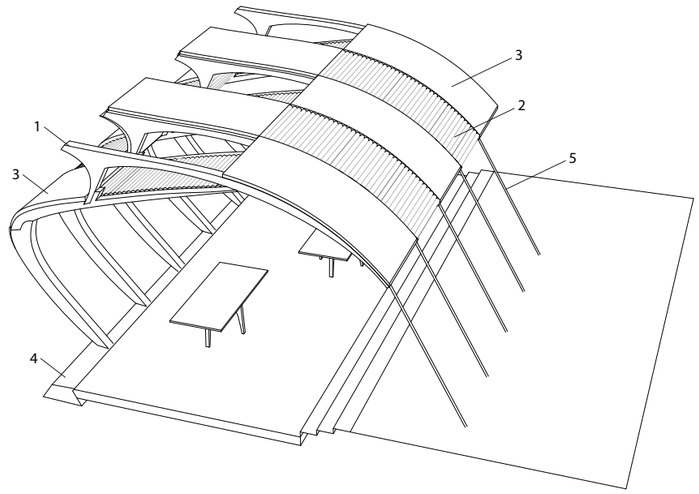


WORKSHOP

Frame structure

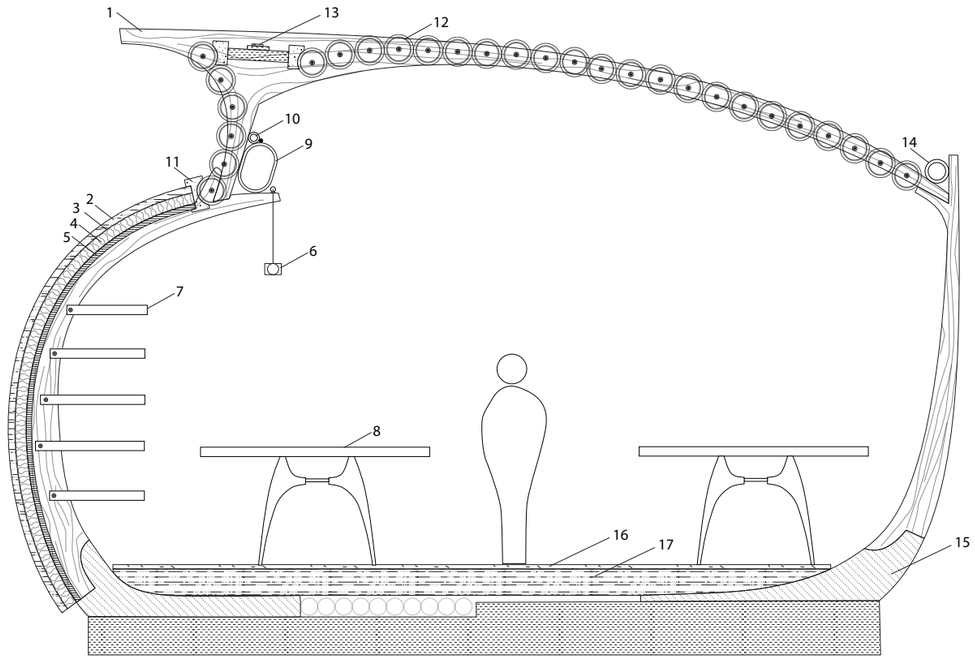


Mechanism of using the tensions of natural wood to create a framed structure.



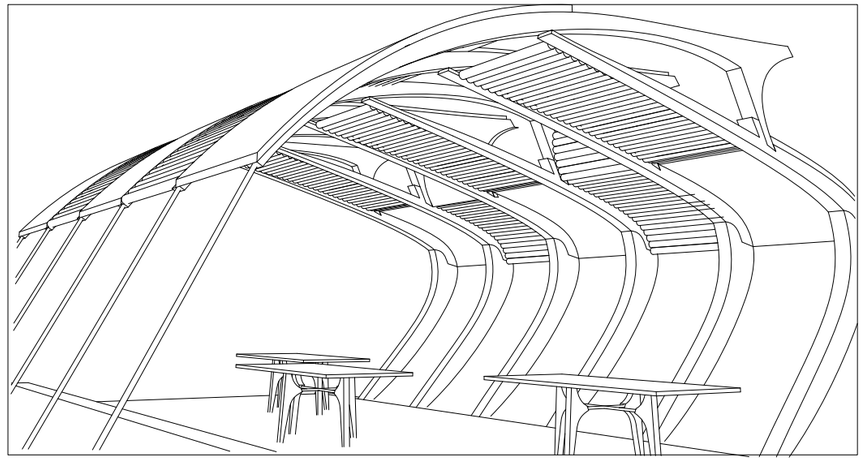
1. Hard wood frames
2. Glass tubes - glazing
3. Aluminium panel
4. Metal base
5. Cable

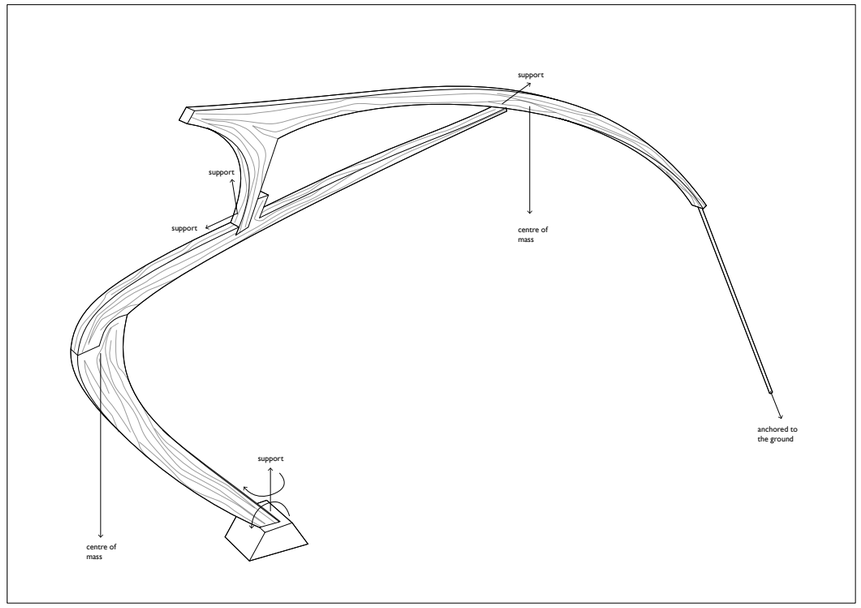
Workshop iteration 1

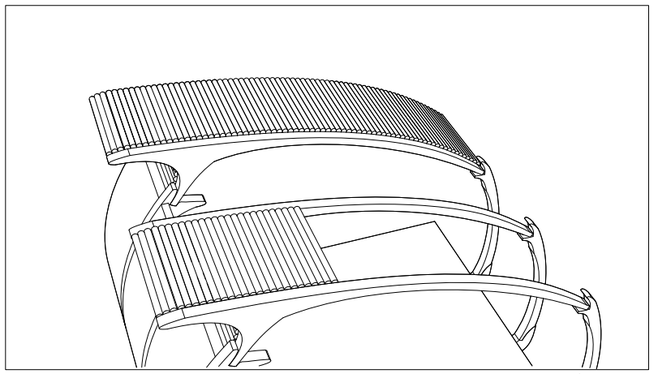


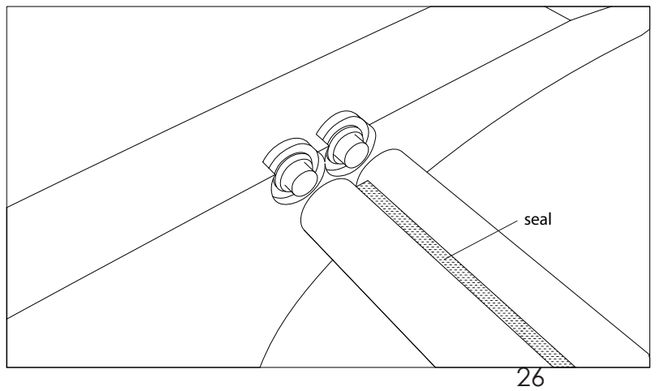
1. Hard wood - whole pieces
2. 25mm boarding with water-proof coating
3. Bituminous felt
4. Glass wool board 5cm
5. 25mm boarding
6. LED lighting
7. Shelves neiled to frames
8. Workshop tables
9. Ventilation ductwork
10. Pipe works and miscellaneous wires
11. Metal connecter
12. Vacuum glass tubes as glazing and insulation (firmly sealed between tubes)
13. Operable ventilation valve
14. Drainage pipe
15. Metal foundation
16. Floor coating
17. 100mm boarding

Section of Cafe





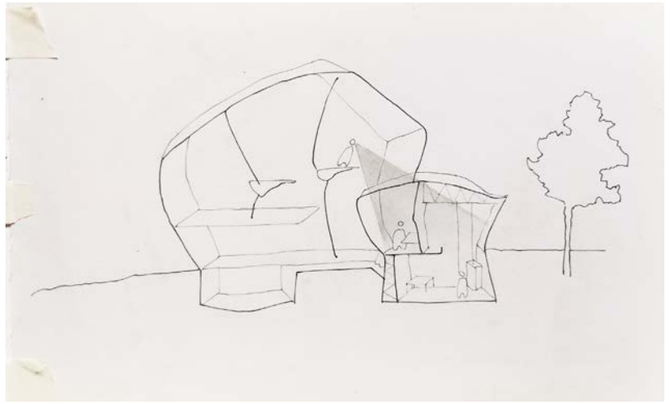




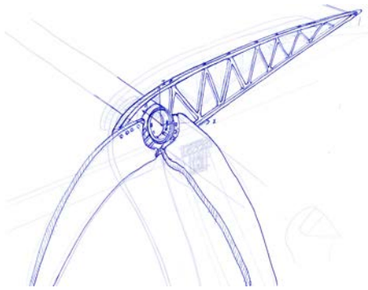
WORKSHOP

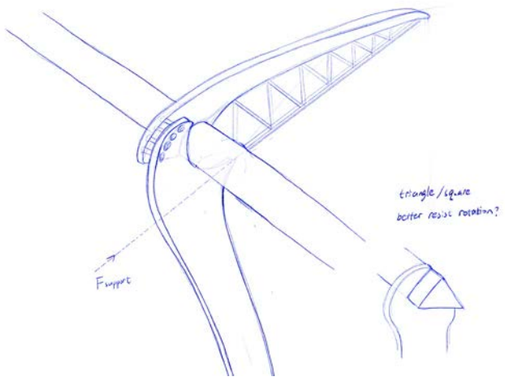
Enabling people to see from gallery

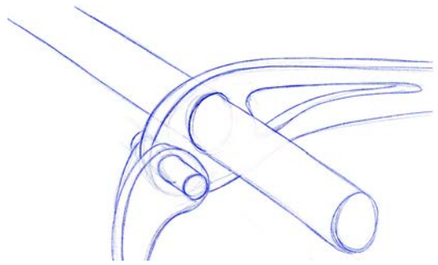
Central structures are designed to integrate the gallery and workshop spaces.

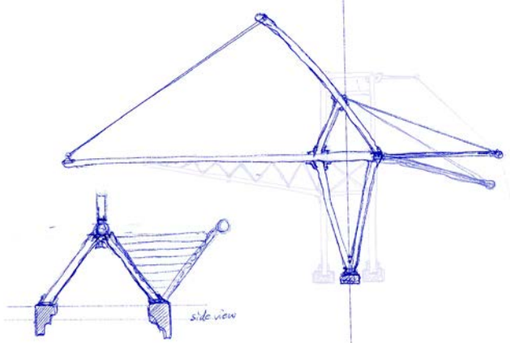


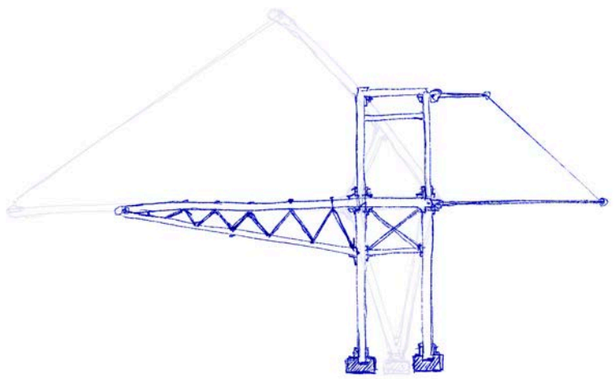
Cross section: visitors in the gallery can observe how building fragements are made in the workshop .



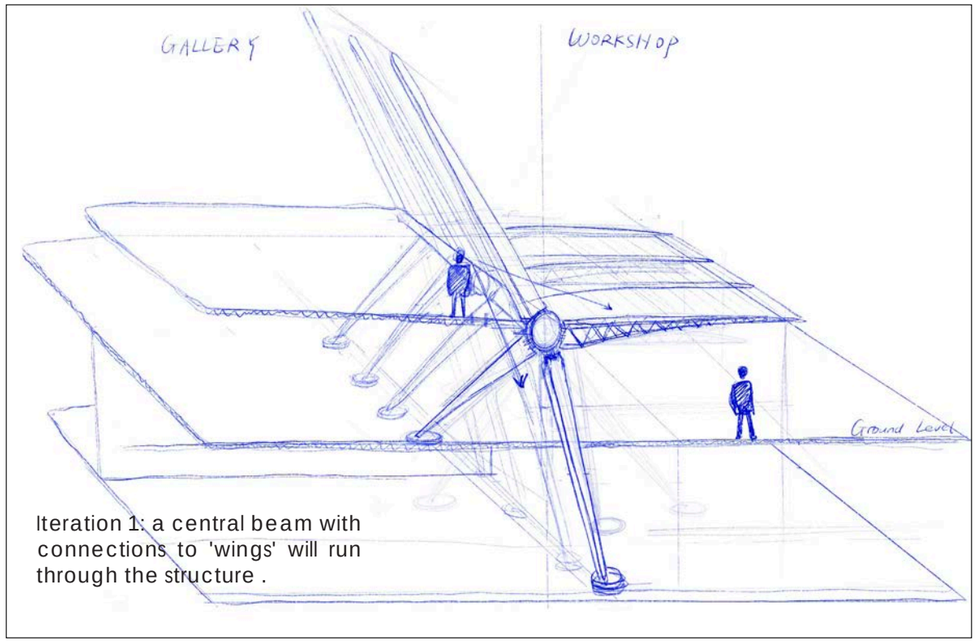




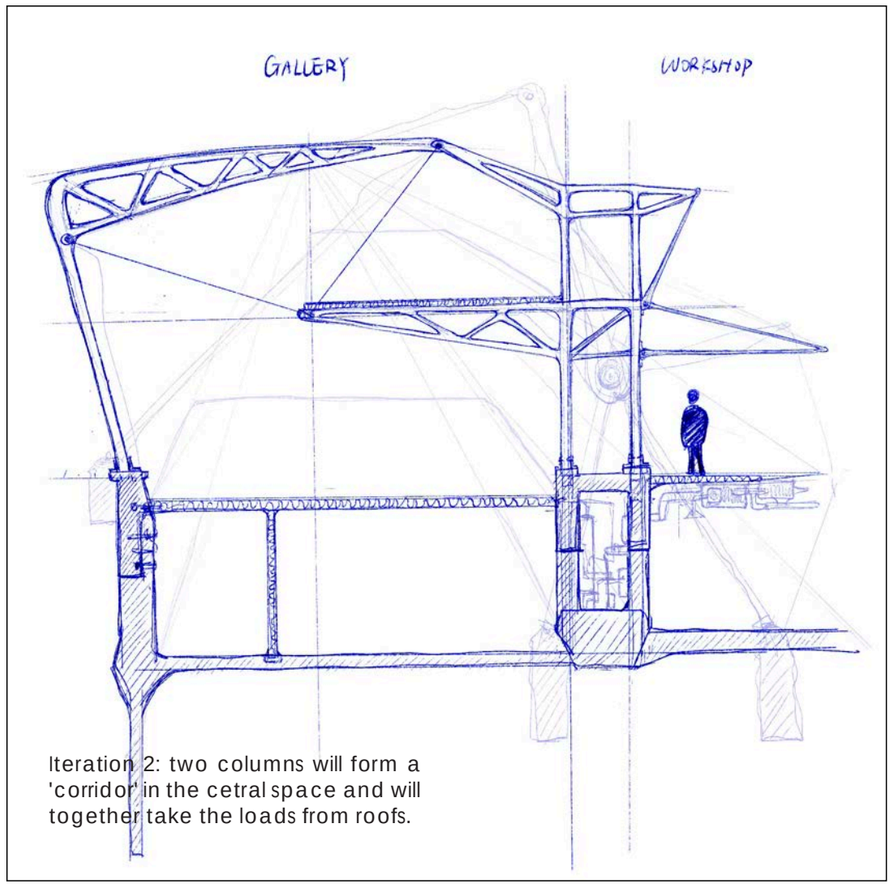




Connection details of columns and trusses to carry the loads from roof and mezzanine



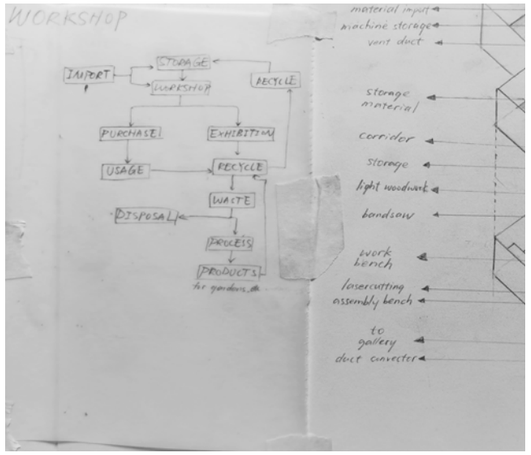
Iteration 1: a central beam with connections to 'wings' will run through the structure .

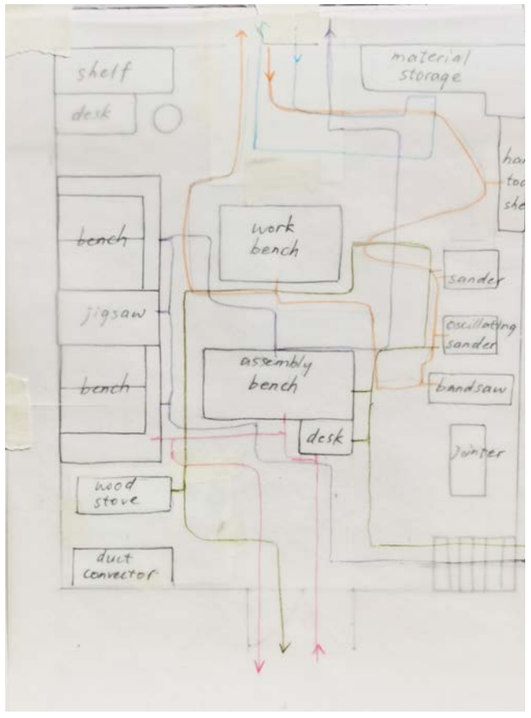


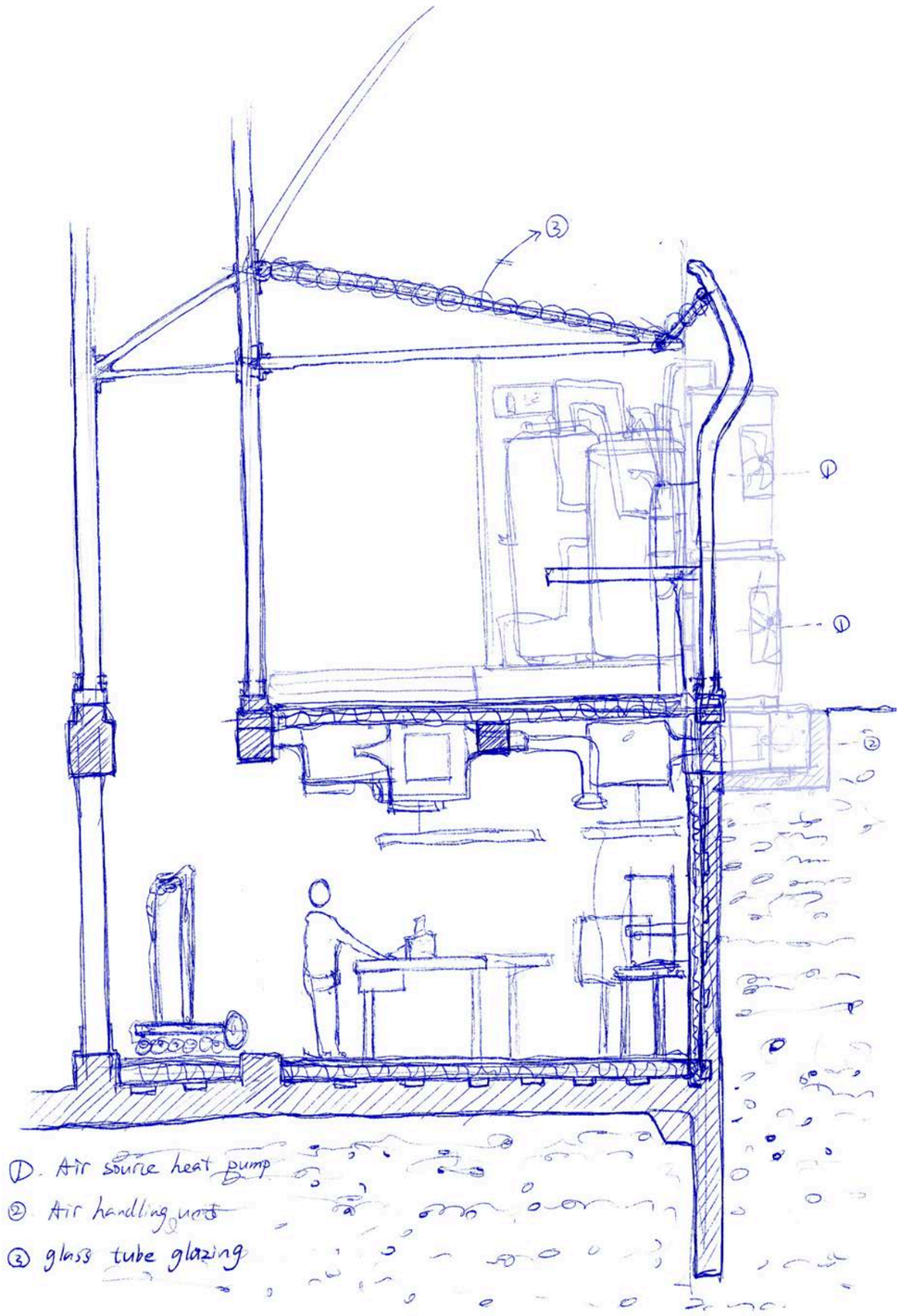
Iteration 2: two columns will form a 'corridor' in the cetral space and will together take the loads from roofs.

WORKSHOP

Activity, circulation and construction



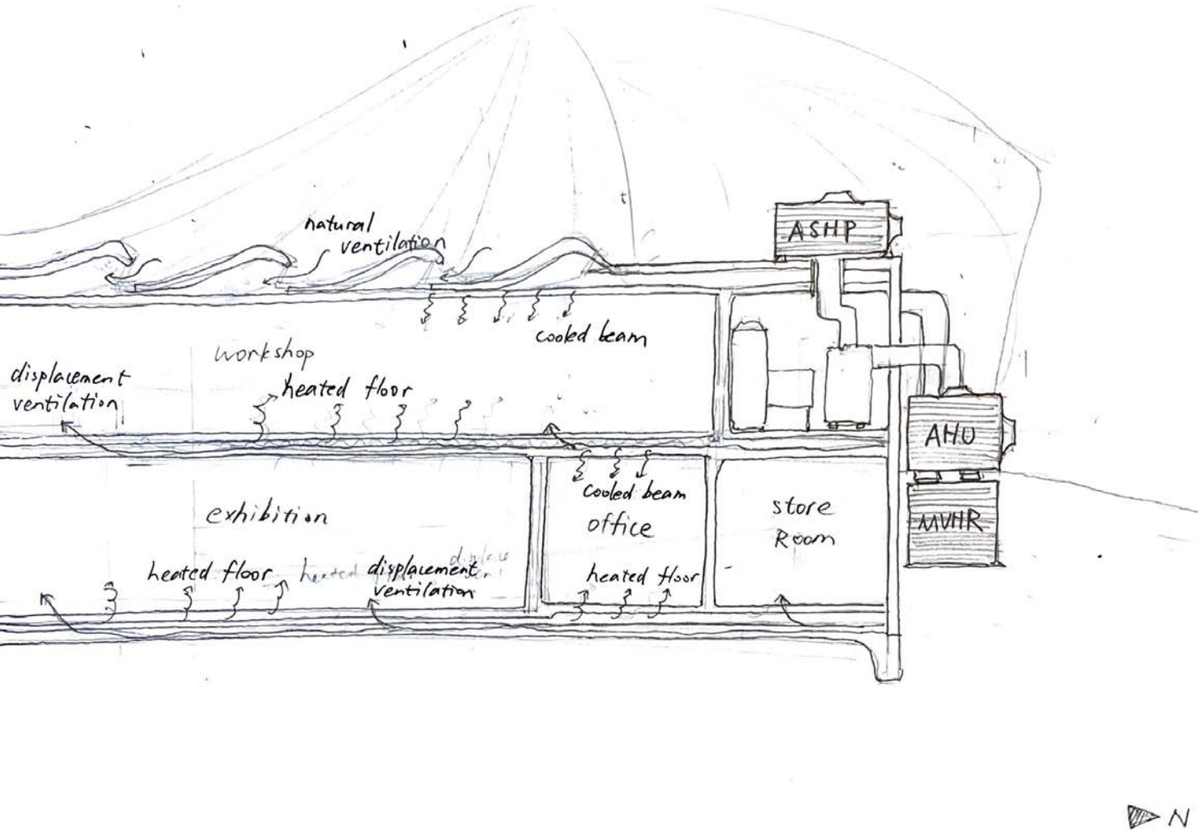


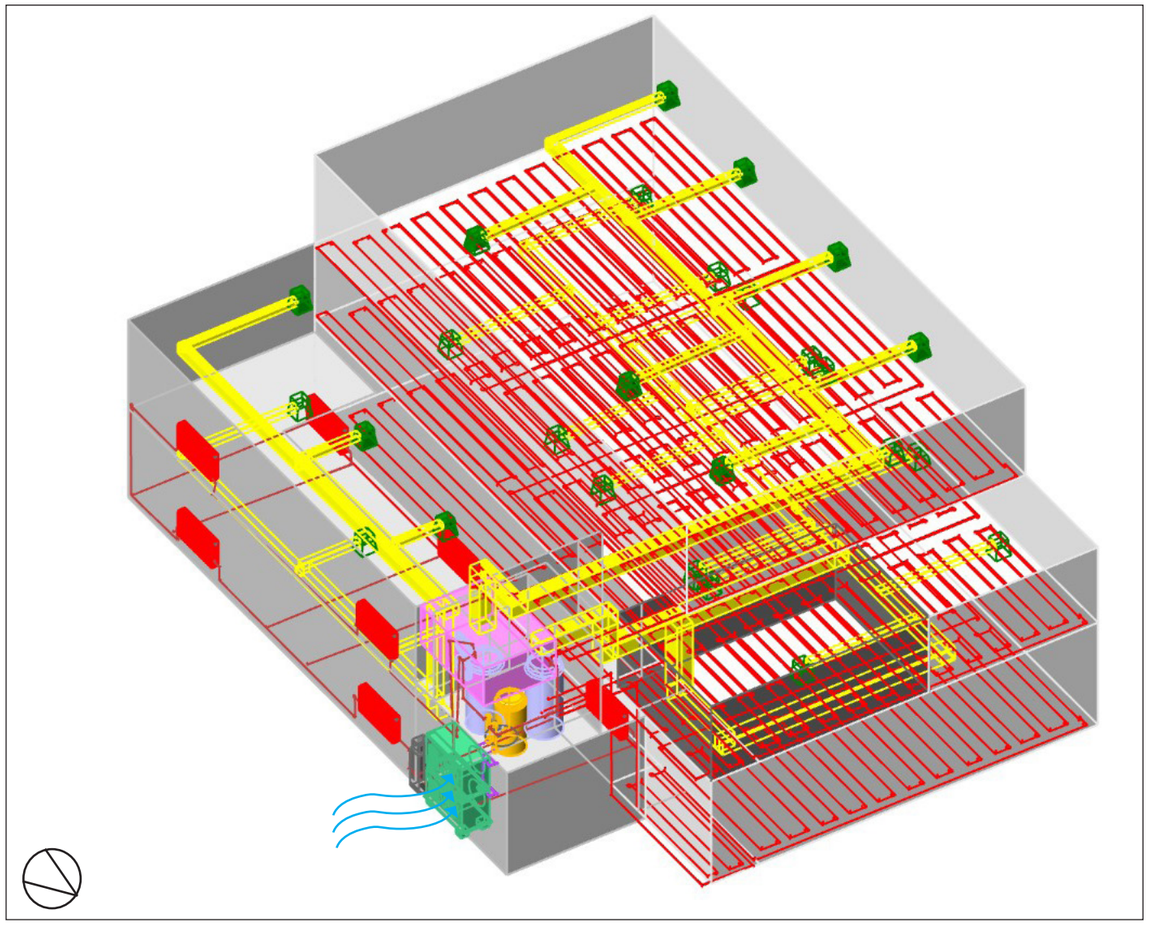


HVAC system

ASHP+MVHR

Air Source Heat Pumps (ASHP) and Mechanical Ventilation with Heat Recovery (MVHR) systems are selected for this project.





Air source heat pumps
Hot air
Water tanks
Convectors
Air handling units
Ventilation ducts
Ventilation diffusers
Radiators in the workshop
Hot water in nderfloor heating in the gallery

ASHP general arrangement

A plant room of 20m2 is designed to contain water tanks, convectors and relevant facilities. Heat pumps that extract air need to be installed outside of the plant room, and a seperate AHU should be installed on the roof. The heat pumps need to be at a distance from surrounding buildings to enable enough fresh air to be extracted, which sets a series of constraints. Plants and services are put to the North side to reduce their impact on surrounding buildings.

HVAC system

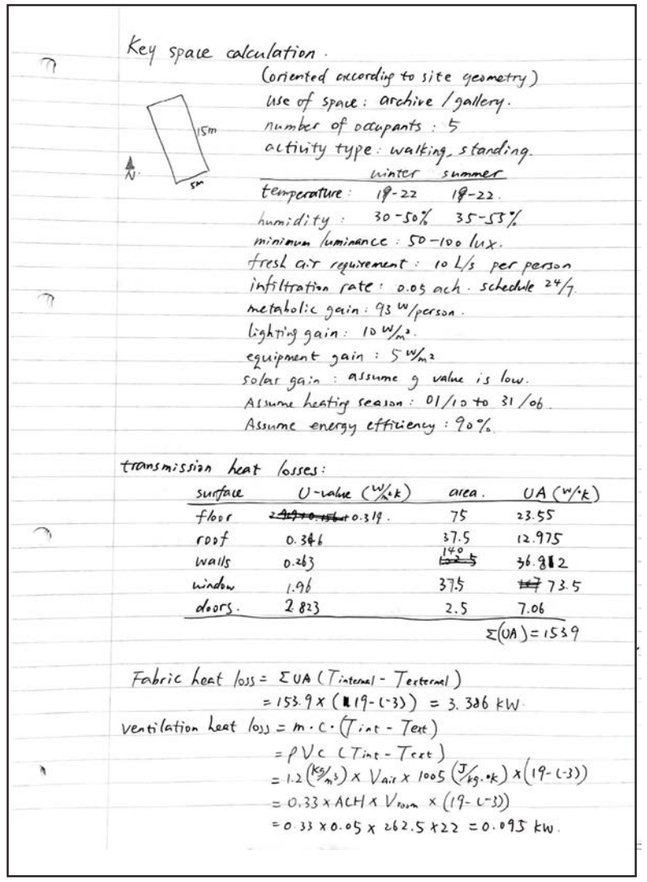
Key space calculation

The results of normalised heating load for Design Builder simulation and the hand calculation are similar (83.75 kwh/m2 and 80.9 kwh/m2), which means that the hand calculation can be used to validate simulation results, given the correct parameters are used or generated.

Utility Use Per Conditioned Floor Area

	Electricity Intensity [kWh/m2]	Natural Gas Intensity [kWh/m2]	Gasoline Intensity [kWh/m2]	Diesel Intensity [kWh/m2]	Coal Intensity [kWh/m2]	Fuel Oil No 1 Intensity [kWh/m2]	Fuel Oil No 2 Intensity [kWh/m2]	Propane Intensity [kWh/m2]	Other Fuel 1 Intensity [kWh/m2]	Other Fuel 2 Intensity [kWh/m2]	District Cooling Intensity [kWh/m2]	District Heating Intensity [kWh/m2]	Water Intensity [m3/m2]
Lighting	43.80	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
HVAC	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	83.75	0.01
Other	13.59	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	57.39	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	83.75	0.01

DesignBuilder simulation results



Key space calculation.
(oriented according to site geometry)
use of space: archive / gallery.
number of occupants: 5
activity type: walking, standing.

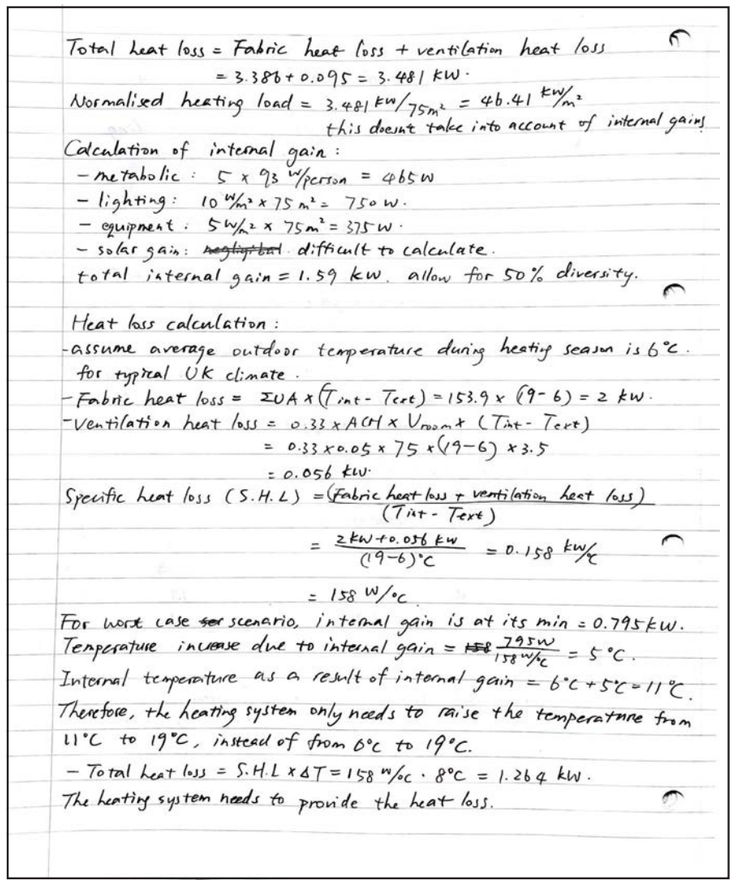
	winter	summer
temperature:	18-22	18-22.
humidity:	30-50%	35-53%

minimum luminance: 50-100 lux.
fresh air requirement: 10 L/s per person
infiltration rate: 0.05 ach. schedule 24/7
metabolic gain: 93 W/person.
lighting gain: 10 W/m².
equipment gain: 5 W/m²
solar gain: assume g value is low.
Assume heating season: 01/10 to 31/06.
Assume energy efficiency: 90%.

transmission heat losses:

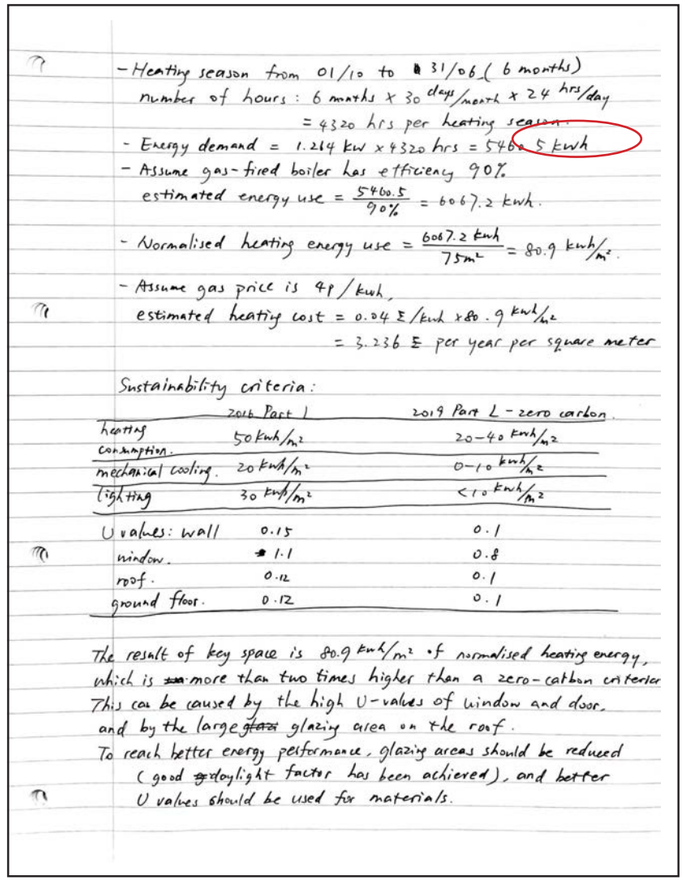
surface	U-value (W/m²k)	area.	UA (W/K)
floor	~~2.857~~ 0.319.	75	23.55
roof	0.346	37.5	12.975
walls	0.263	~~140~~ 132.5	36.982
window	1.96	37.5	~~117~~ 73.5
doors.	2.823	2.5	7.06
		Σ(UA) = 153.9	

Fabric heat loss = ΣUA (T internal - T external)
= 153.9 x (19-(-3)) = 3.386 kW.
ventilation heat loss = m · c · (T int - T ext)
= ρ V c (T int - T ext)
= 1.2 (kg/m³) x V air x 1005 (J/kg·k) x (19-(-3))
= 0.33 x ACH x V room x (19-(-3))
= 0.33 x 0.05 x 262.5 x 22 = 0.095 kw.



Total heat loss = Fabric heat loss + ventilation heat loss
= 3.386 + 0.095 = 3.481 kW.
Normalised heating load = 3.481 kW / 75m² = 46.41 kW/m²
this doesn't take into account of internal gains
Calculation of internal gain:
- metabolic: 5 x 93 W/person = 465 W
- lighting: 10 W/m² x 75 m² = 750 W.
- equipment: 5 W/m² x 75 m² = 375 W.
- solar gain: ~~negligible~~ difficult to calculate.
total internal gain = 1.59 kW. allow for 50% diversity.

Heat loss calculation:
- assume average outdoor temperature during heating season is 6°C. for typical UK climate.
- Fabric heat loss = ΣUA x (T int - T ext) = 153.9 x (9-6) = 2 kW.
- Ventilation heat loss = 0.33 x ACH x V room x (T int - T ext)
= 0.33 x 0.05 x 75 x (19-6) x 3.5
= 0.056 kW.
Specific heat loss (S.H.L) = (Fabric heat loss + ventilation heat loss) / (T int - T ext)
= 2 kW + 0.056 kW / (19-6)°C = 0.158 kW/°C
= 158 W/°C.
For ~~worst~~ case scenario, internal gain is at its min = 0.795 kW.
Temperature increase due to internal gain = ~~158~~ 795 W / 158 W/°C = 5°C.
Internal temperature as a result of internal gain = 6°C + 5°C = 11°C.
Therefore, the heating system only needs to raise the temperature from 11°C to 19°C, instead of from 6°C to 19°C.
- Total heat loss = S.H.L x ΔT = 158 W/°C · 8°C = 1.264 kW.
The heating system needs to provide the heat loss.



- Heating season from 01/10 to 31/06 (6 months)
number of hours: 6 months x 30 days/month x 24 hrs/day
= 4320 hrs per heating season.
- Energy demand = 1.214 kw x 4320 hrs = 5460.5 kwh
- Assume gas-fired boiler has efficiency 90%
estimated energy use = 5460.5 / 90% = 6067.2 kwh.
- Normalised heating energy use = 6067.2 kwh / 75m² = 80.9 kwh/m².
- Assume gas price is 4p/kwh,
estimated heating cost = 0.04 £/kwh x 80.9 kwh/m²
= 3.236 £ per year per square meter

Sustainability criteria:

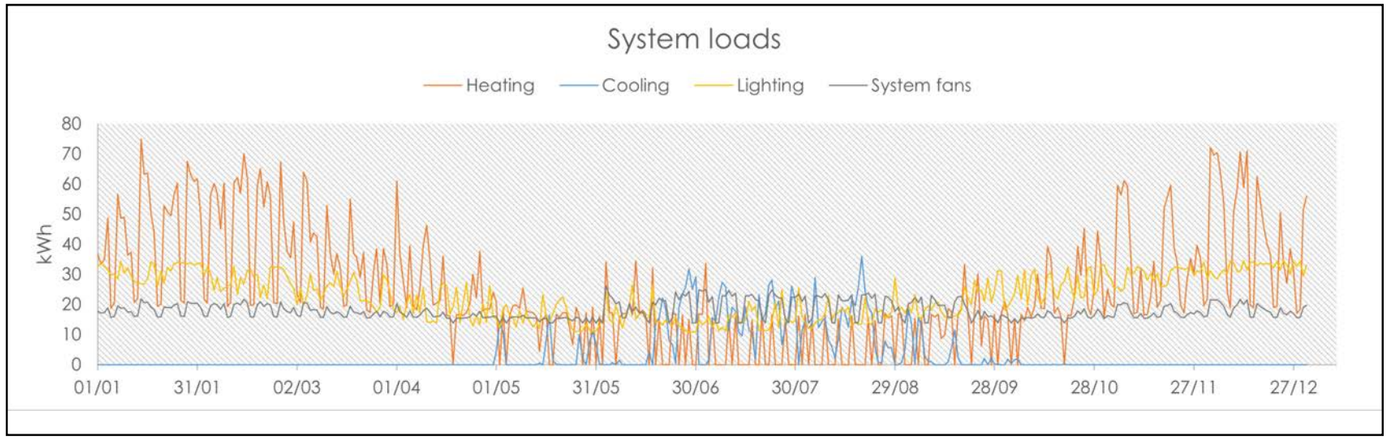
	2016 Part L	2019 Part L - zero carbon
heating consumption.	50 kwh/m²	20-40 kwh/m²
mechanical cooling.	20 kwh/m²	0-10 kwh/m²
lighting	30 kwh/m²	<10 kwh/m²
U values: wall	0.15	0.1
window.	1.1	0.8
roof.	0.12	0.1
ground floor.	0.12	0.1

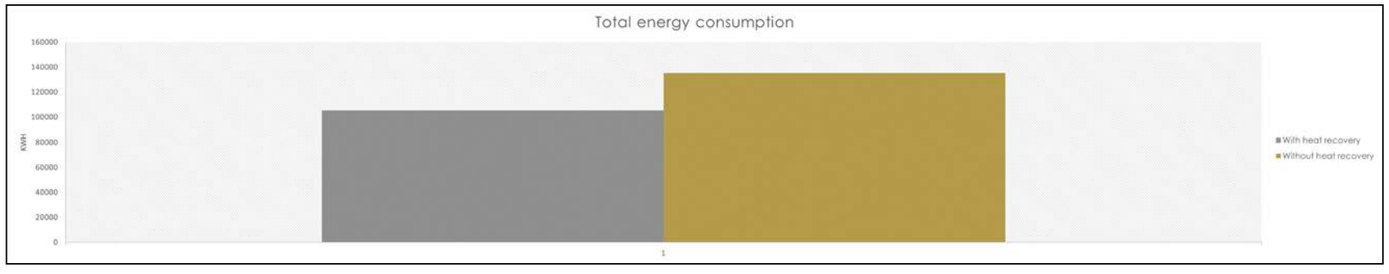
The result of key space is 80.9 kwh/m² of normalised heating energy, which is ~~as~~ more than two times higher than a zero-carbon criteria. This can be caused by the high U-values of window and door, and by the large ~~glass~~ glazing area on the roof.
To reach better energy performance, glazing areas should be reduced (good ~~sky~~daylight factor has been achieved), and better U values should be used for materials.

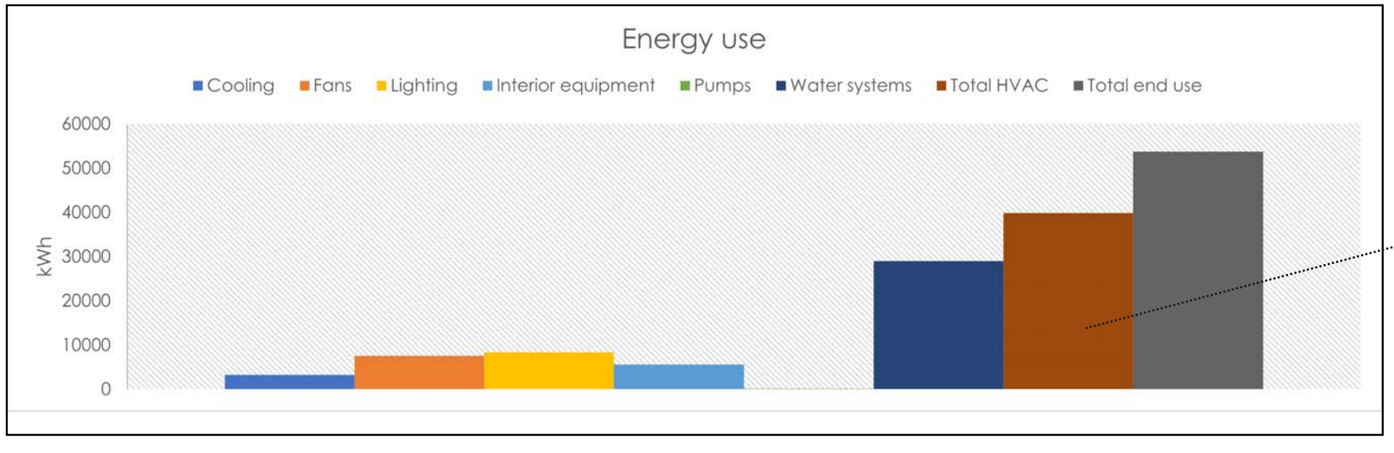
Hand calculation :energy consumption of the key space

HVAC system

Simulation results

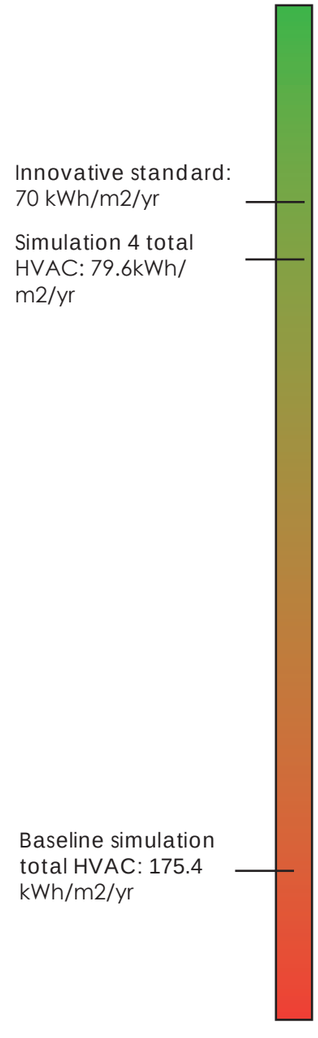






Total HVAC load: 79.6 kWh/m2/yr

The final iteration of energy simulation in DesignBuilder gives an annual HVAC consumption of 79.6 kWh/m2/yr, which is slightly above the innovative standard set by Max Fordham but has improved massively compared with the baseline simulation. The approaches to reducing energy consumption include daylight study, change of U values, change of activity template, adjustment to prevent overheating issues, etc.



Structure

Column and slab sizing for mezzanine