



The Studio of Tomorrow

(*“People throughout the Netherlands are urged to work from home and/or spread working hours as much as possible, and also not to organise meetings at work for more than 100 people.”*)

“Mensen in heel Nederland wordt opgeroepen zoveel mogelijk thuis te werken en/of de werktijden te spreiden, en ook op het werk geen bijeenkomsten te organiseren voor meer dan 100 personen”

– Bruno Bruins, minister of medical care,
on the measures regarding the COVID-19 virus (12-03-2020)

By Bryan Lufkin  13th March 2020

Companies around the globe have rolled out mandatory remote work. Whether you're a newbie or WFH veteran, here's what you need to do to stay productive.

Why We'll Be Working From Home Long After Coronavirus

71% of French workers who had never previously worked at home before the pandemic say they now would. Shifts to working from home are likely to remain after coronavirus

Working from home "the new normal" for architects and designers



Cajsa Carlson | 1 April 2020 | 15 comments

Coronavirus lockdowns will have a profound impact on how creative businesses work in future, according to architects and designers including [Carlo Ratti Associati](#), [BIG](#), [Snøhetta](#) and [Pearson Lloyd](#).



Rachael Burford For Mailonline, "Incredible Photos Reveal What Life Was like for People in the 19th Centuries," Daily Mail Online (Associated Newspapers, November 25, 2016), <https://www.dailymail.co.uk/news/article-3969174/A-Lost-England-Incredible-black-white-photos-reveal-life-like-people-19th-early-20th-centuries-issues-faced-not-different-ones-today.html>.



Mediastorehouse, "Prints of English Factory, c1915, an Ordnance Works (Vickers), c1915," Media Storehouse Photo Prints, accessed November 3, 2022, <https://www.mediastorehouse.com/oranger-art-on-demand/industry/english-factory-c1915-ordnance-works-vickers-12242832.html?prodid=73043>.



Yeoman Lowbrow, *Office Structure as Machinery, Paleotechnology: A Curious Glimpse Into An 80s Computer Book* (Flashbak.com, April 10, 2014), <https://flashbak.com/paleotechnology-a-curious-glimpse-into-an-80s-computer-book-2714/>.



Hiro Lift, "Konstruktionsabteilung zeichner," Flickr Yahoo!, March 21, 2014, <https://www.flickr.com/photos/hirolift-treppenlift-aufzug/13308536174/in/album-72157642640959984/>.

“Evolution - yes; revolution - not yet”

Technology offers opportunities today that weren't available yesterday



“How should flexible working be translated into the physical workplace of architectural offices?”

as the new work norm for architects



“How should **flexible working** be translated into the physical workplace of architectural offices?”

as the new work norm for architects

“How should **flexible working** be translated into the physical workplace of
architectural offices?”

in the Netherlands



Beltman architecten

Age

151 years

Size

19

Location

Enschede

Founder

Gerrit Beltman

Projects

Residential,
Healthcare,
Education,
Interior,
Utility,
Renovation,
Reallocation



Vakwerk

Age

6 years

Size

32

Location

Delft

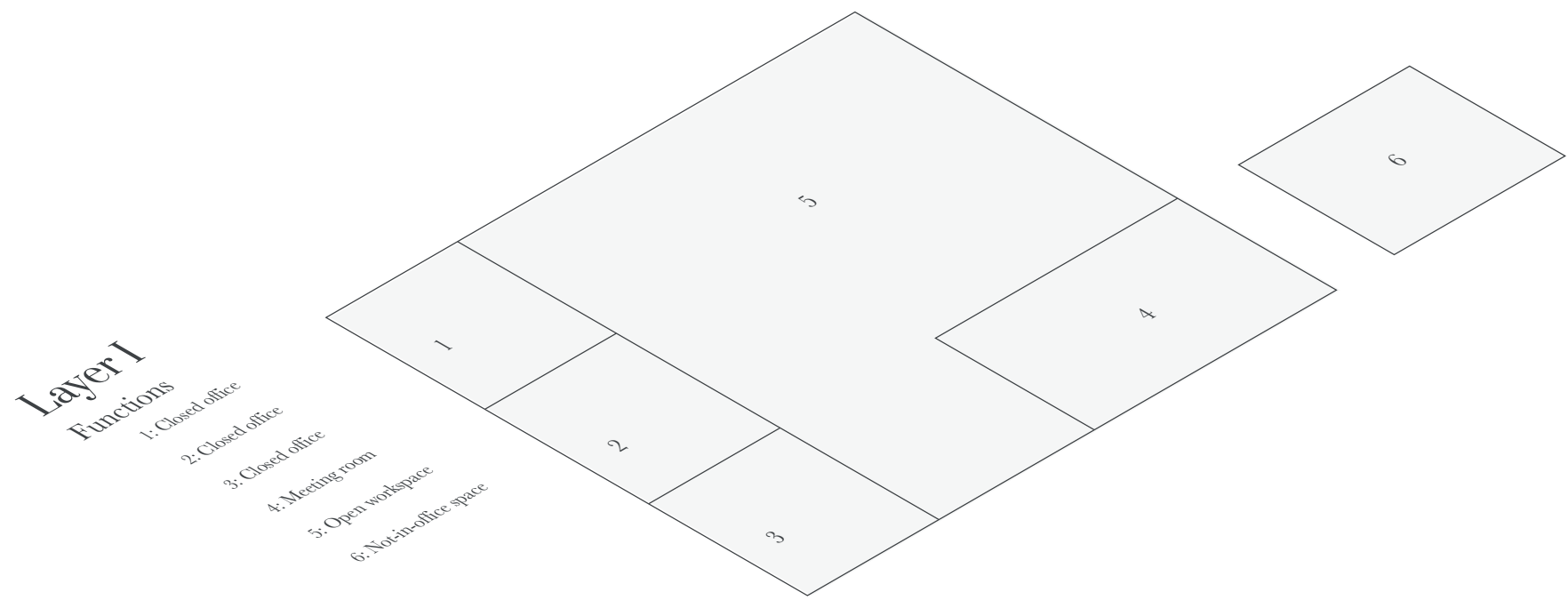
Founders

Ellen van der Wal
Francesco Veenstra
Paul Ketelaars

Projects

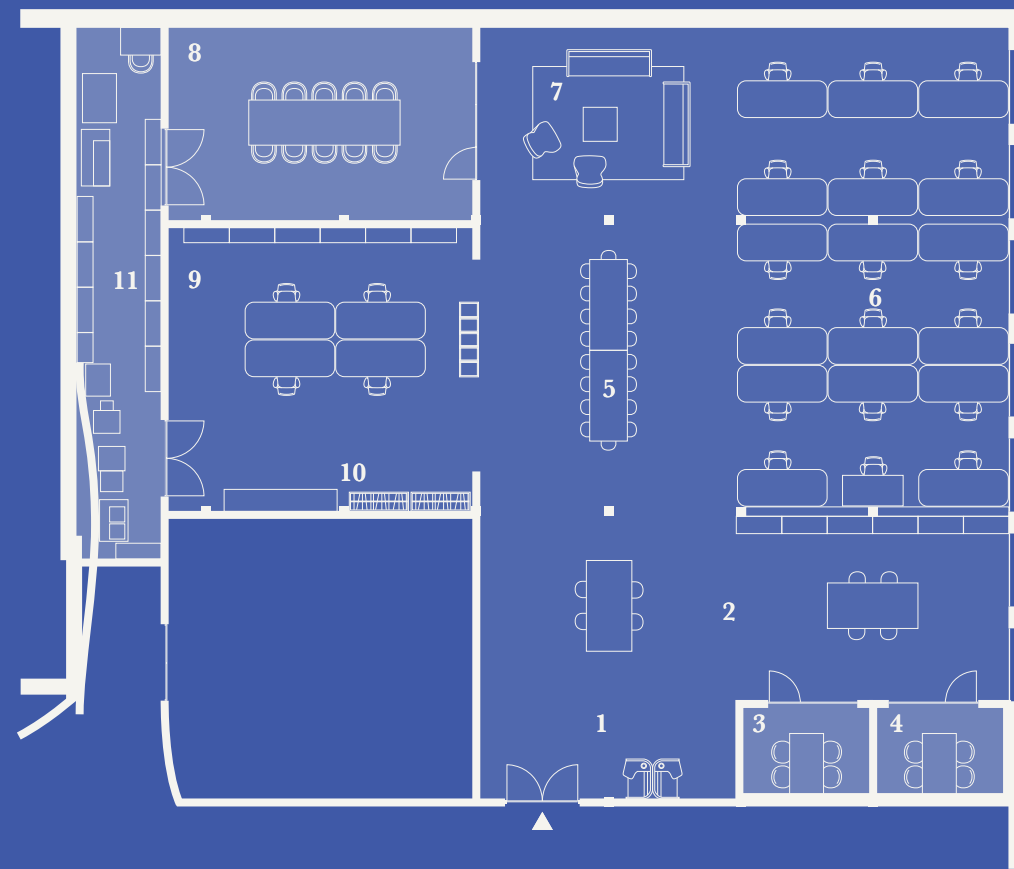
Residential,
Healthcare,
Education,
Offices,
Cultural,
Reallocation

Methodology



Plan analysis

Beltman

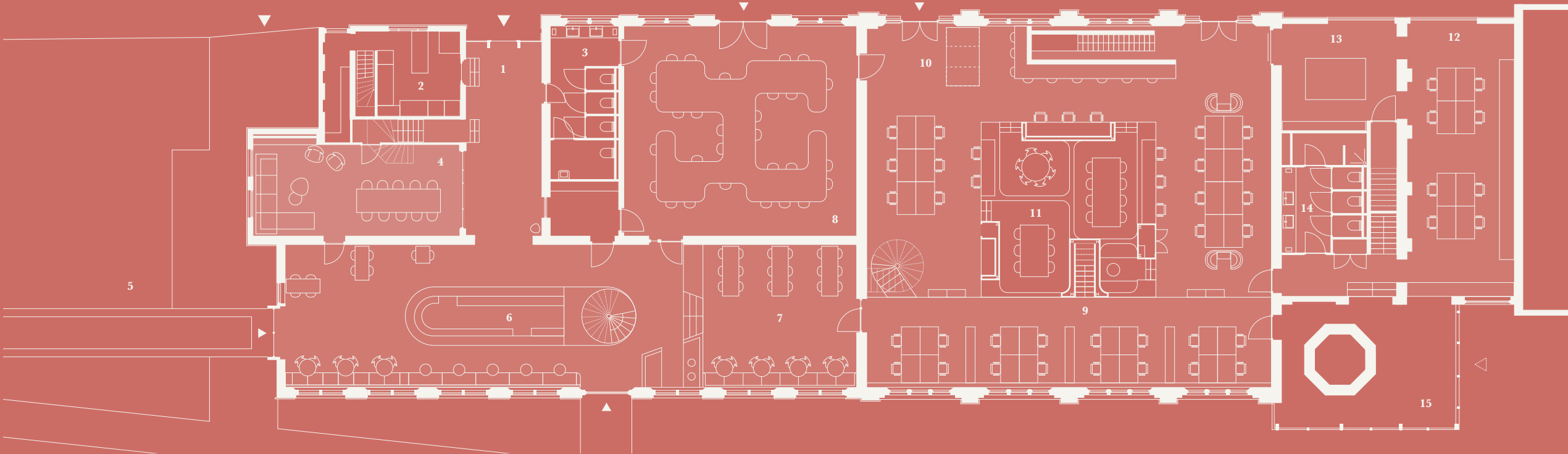
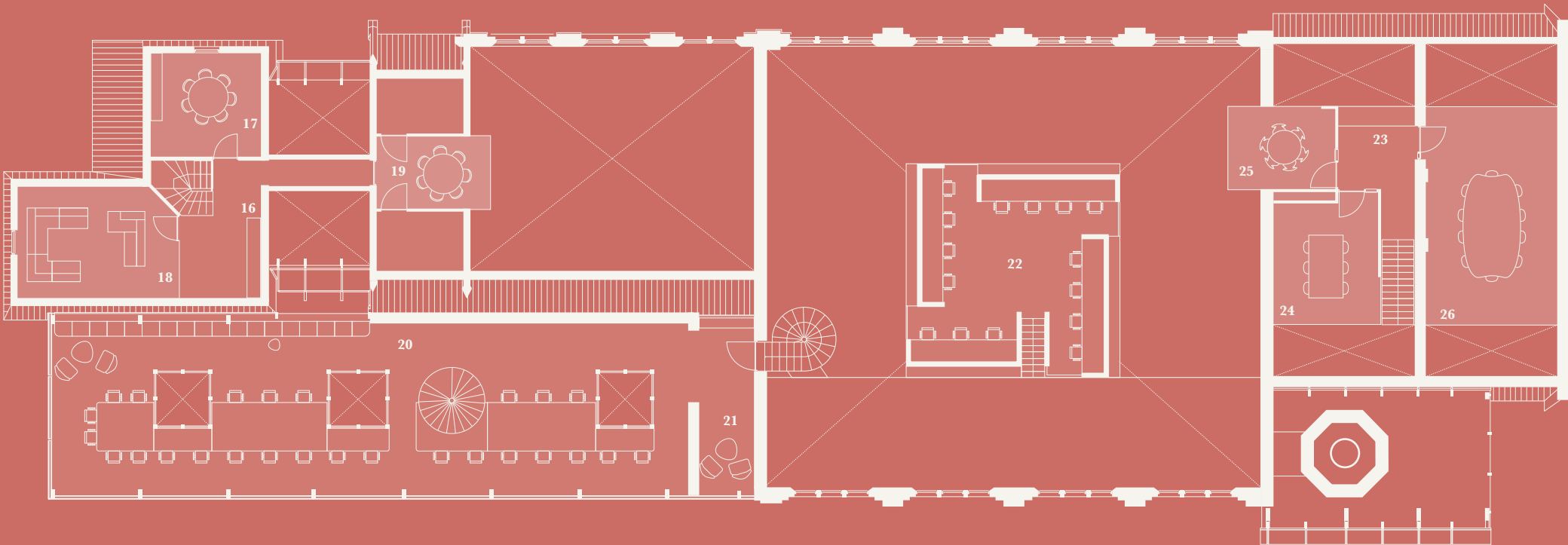


LEGEND

- 1: entrance
- 2: open flexible working space
- 3: closed meeting room
- 4: closed meeting room
- 5: lunch/coffee area
- 6: open fixed working space
- 7: lounge area
- 8: closed meeting room
- 9: open fixed working space
- 10: kitchen
- 11: storage room

Plan analysis

Vakwerk

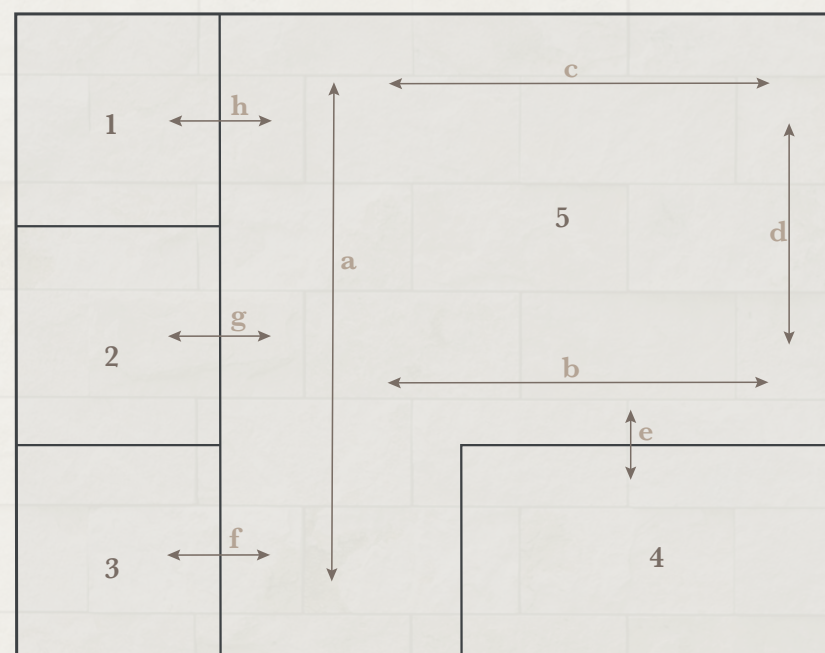


- LEGEND
- | | |
|---|-------------------------|
| 1: entrance | 16: hall |
| 2: storage room restaurant | 17: closed meeting room |
| 3: bathrooms restaurant | 18: closed lounge area |
| 4: closed meeting room | 19: closed meeting room |
| 5: garden restaurant | 20: open working space |
| 6: cvrestaurant | 21: lounge area |
| 7: restaurant | 22: open working space |
| 8: closed meeting room | 23: hall |
| 9: open shared working space | 24: closed meeting room |
| 10: open shared working space | 25: closed meeting room |
| 11: open meeting rooms | 26: closed meeting room |
| 12: closed working space | |
| 13: lounge area | |
| 14: bathrooms | |
| 15: closed meeting room/multifunctional space | |
- (under construction)

Methodology



THE CODING METHOD



FUNCTIONS – numbers

- 1: Closed office
- 2: Closed office
- 3: Closed office
- 4: Meeting room
- 5: Open workspace

ROUTES – letters

ACTIVITIES – symbols

- Work
- Meeting
- ▲ Call (meeting)
- ★ Break
- ▽ Kitchen
- Bathroom

THE CODING METHOD



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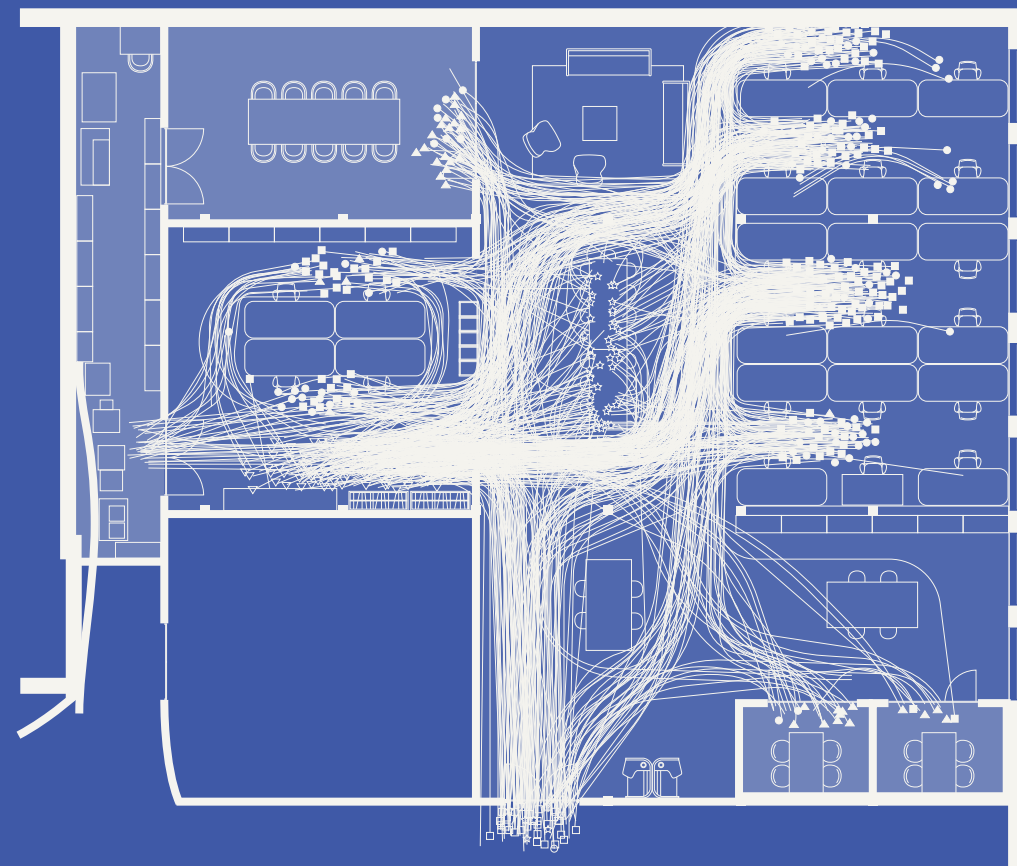
1 B L b □
 b I C N A 1 ★
 g N 10 0
 b J B C N g ▽
 b J B C N g ▽
 b J B C N g ▽
 b K B C S ★
 b I B S ★
 g N C B ★
 4 F C N ▽
 1 A S ★
 b K D 8 0
 g N A D S ★
 g N A 8 0
 S B D J b □
 S B h b □
 S B 1 ▽
 S m g □
 1 A N g C I J b □
 b J B C A 1 ▽
 b J I b □
 1 B F 4 □
 b I J b □
 1 A N g ▽
 g 0 g 0
 1 B J □
 g A D J b □
 b J D A G A 1
 8 D h b □
 b D A N g A 1 0
 b Δ -
 1 L B D h b □
 b B 0 2 g ▽

g N A D L b □
 b L B C A 1 ▽
 1 A m g □
 b h Δ -
 1 A C S B L b □
 b J I b □
 b I B J b □
 b J I b □
 b I B J b □
 b I B J b □
 g N B C A J b □
 g N B C A J b □
 b J I b □
 8 A N g □
 b J B C N g ▽
 8 A m N g ▽
 g N A C B J b □
 g N m g □
 g N ▽ □
 4 F B L b □
 b L Δ -
 g m o n v o n □
 g N A C B F 3
 3 F B C A N g □
 b I B C A N g ▽
 b h B D A N g □
 g N A C B F 3 0
 g N A S C B I b □
 g N A C B I b □
 b L B C A 1
 b K B D A N g □
 g N A D B K b □
 1 A C B L b
 b K B D A 8 0
 8 A N g ▽
 g M A C B F 3 0

g A 8 0
 g A 1 ▽
 b h B O A 2 g ▽
 b h B Q 4 □
 1 A N g A 8 0
 1 A N g A C B J b □
 b J B C A N g ▽
 g N h C S B h b □
 4 F B 1 ▽
 1 B F 4 □
 b J B C A 1 ▽
 4 F B A N v A 1
 1 B J b □
 b L B I b □
 b I B J b □
 b I B L b □
 b J I b □
 b I J b □
 b L B O A N g ▽
 g N A D B L b □
 b J 0 -
 b L Δ -
 b J B I b □
 b I B J b □
 b I B C A N 0 g o n h C B I b □
 b J B C A 1 ▽
 8 A N g N S N g □
 8 A D B L b □
 8 N A 1
 b L O k □
 P i m p j e 1
 1 B 3 4 □
 b I B C A 1 ▽
 b K B S C N g ▽
 g m A D B L b

Space syntax

Beltman



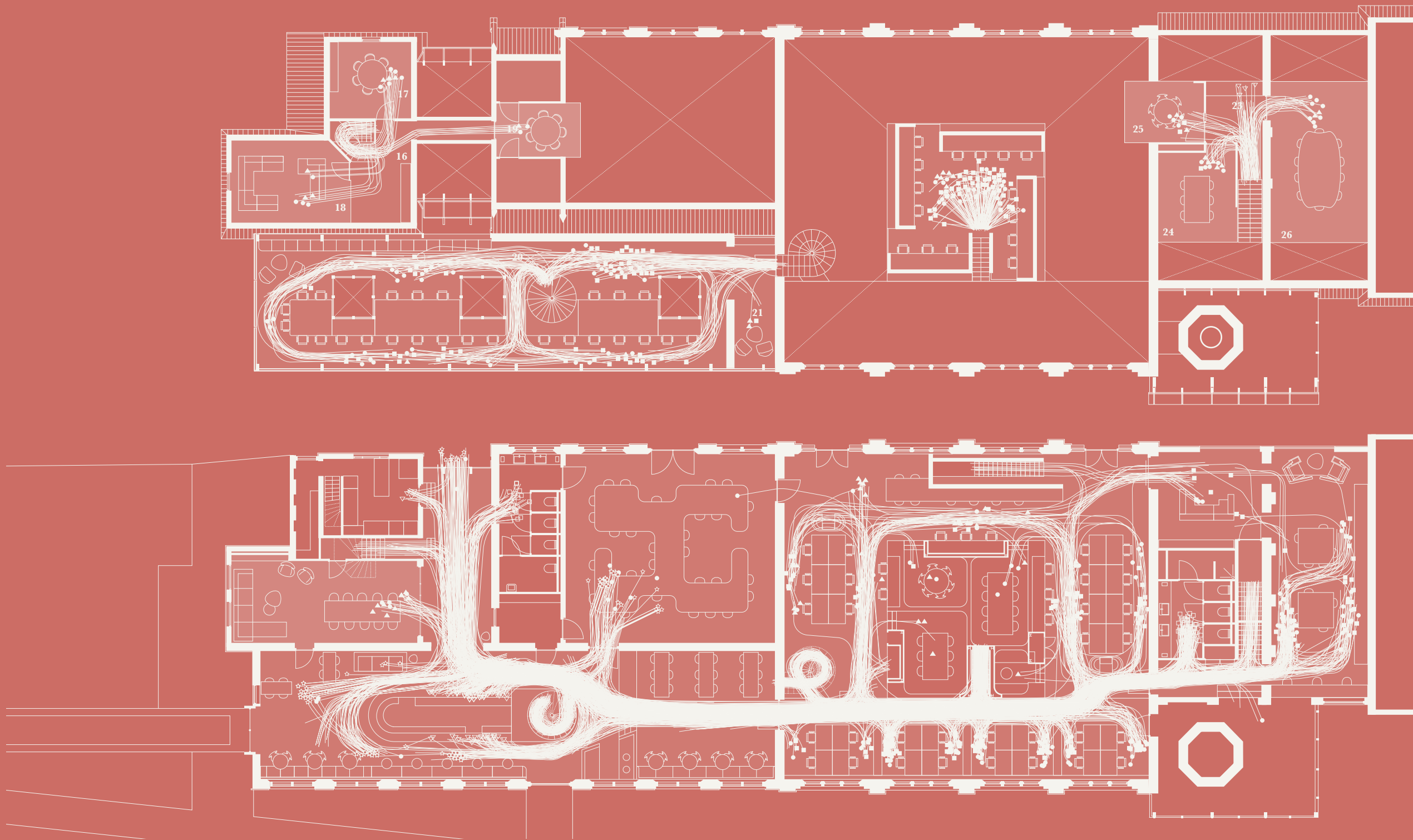
LEGEND

- meeting
- work
- ▲ call (meeting)
- ☆ break
- ▽ kitchen
- bathroom

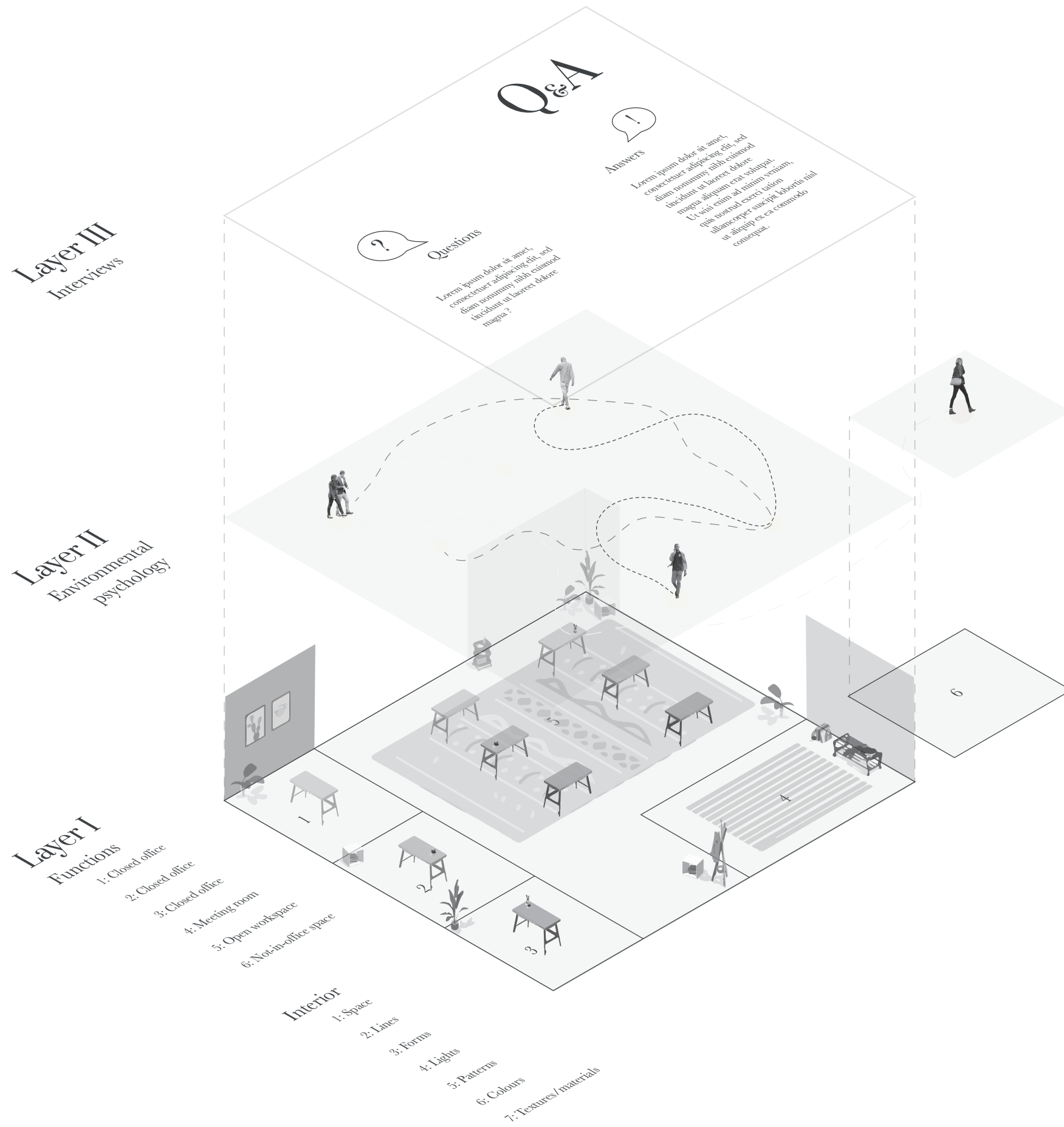
Vakwerk

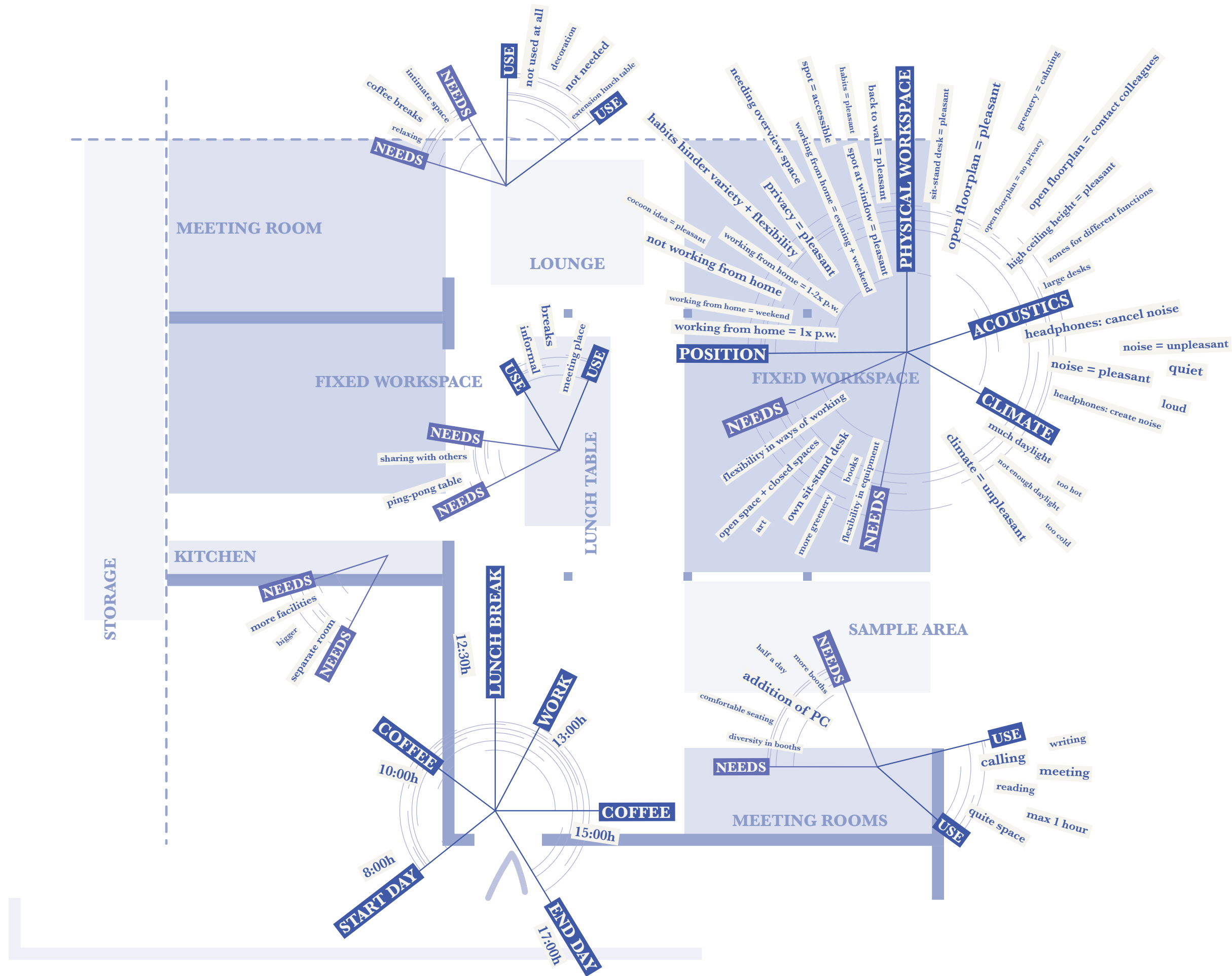
Space syntax

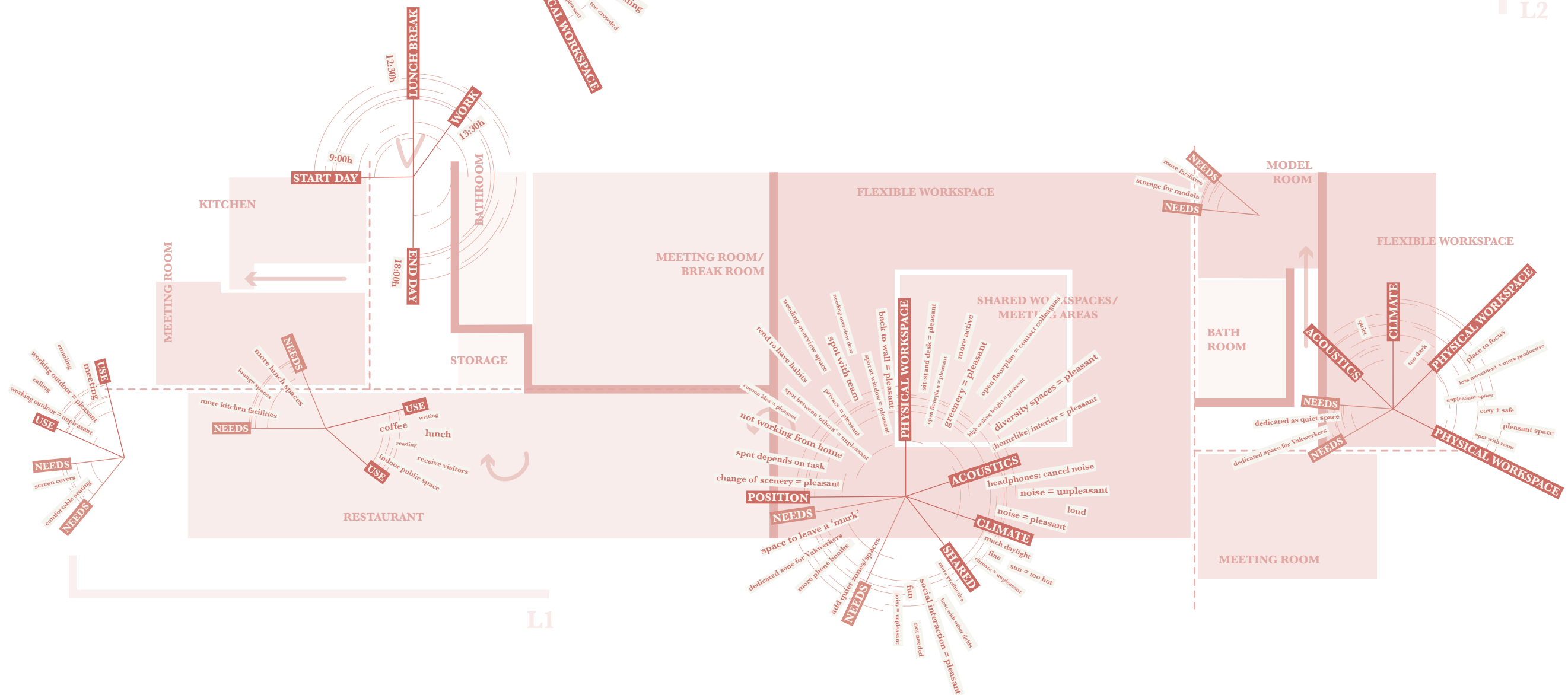
- LEGEND
- meeting
 - work
 - ▲ call (meeting)
 - ☆ break
 - ▽ kitchen
 - bathroom



Methodology

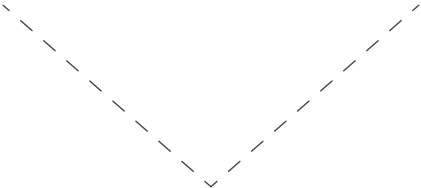






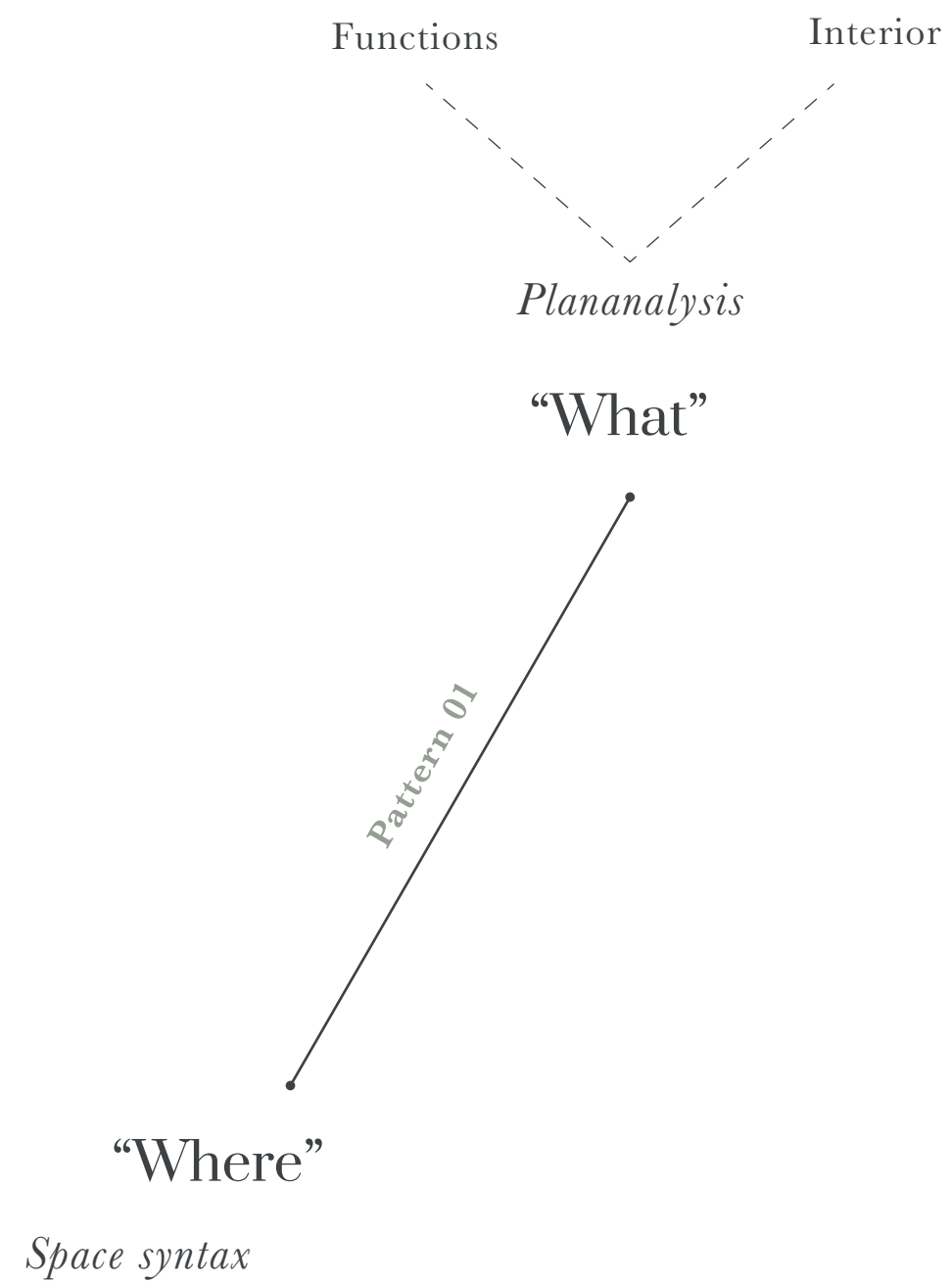
Functions

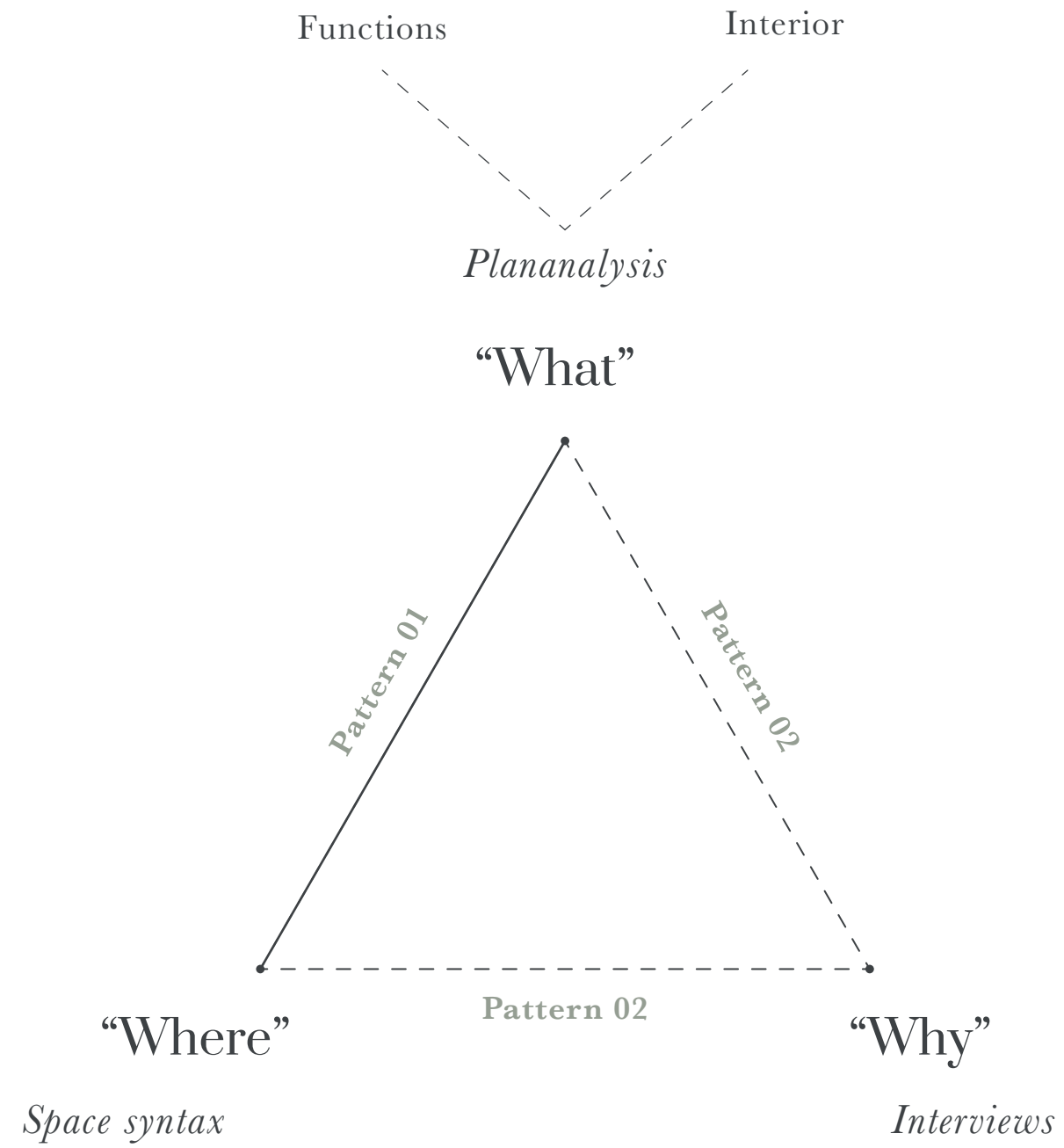
Interior

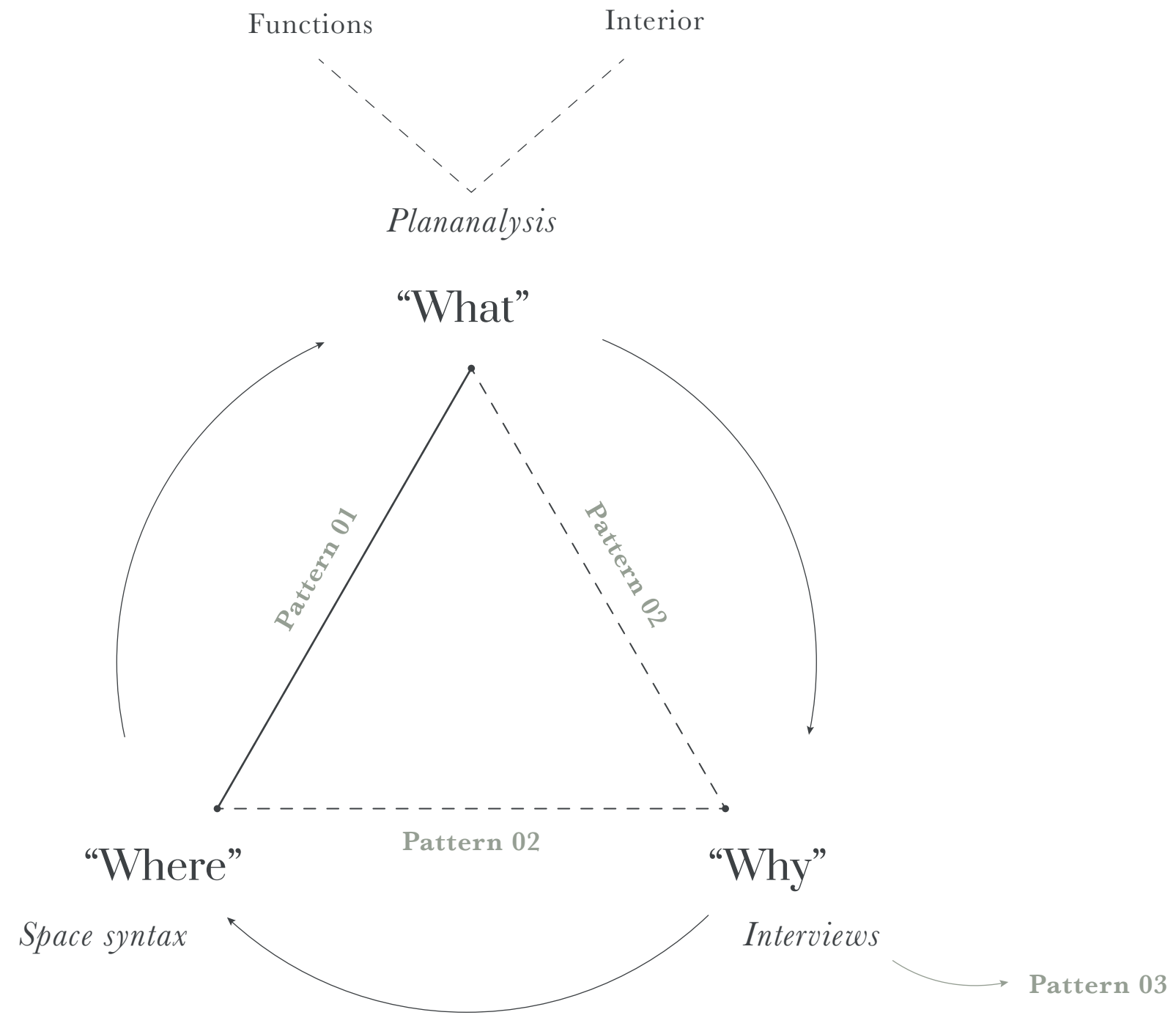


Planalysis

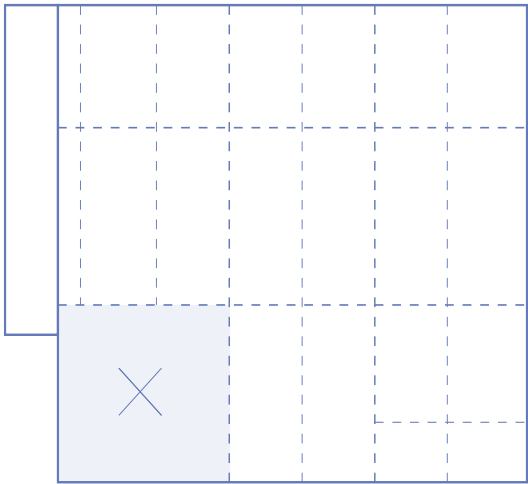
“What”



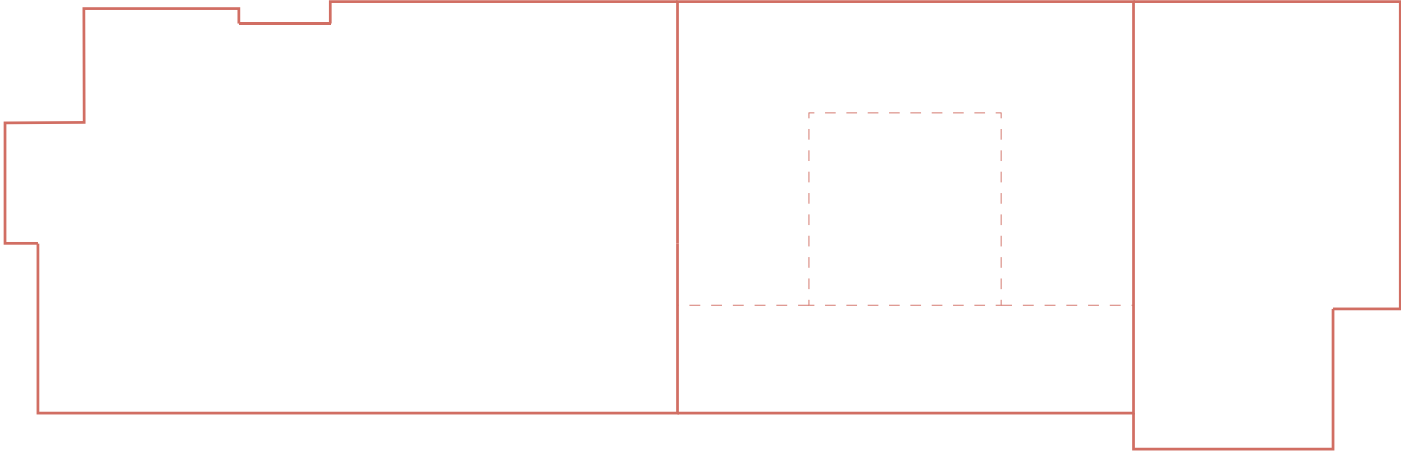




Beltman



Vakwerk



Beltman

Vakwerk

Activity: Work

34°%

52,2°%

Fixed space

34°%

-

Flexible space

-

49,8°%

Modelling space

-

2,4°%

Activity: Meeting

14,3°%

28,8°%

Meeting space

8,3°%

11,8°%

Meeting booth

6°%

-

Phone booth

-

3°%

Multi-functional space

-

14°%

Activity: Break

20,8°%

15°% (+ outside)

Lunch space

12,3°%

15°%

Lounge space

8,5°%

-

Garden space

-

outside

Exhibition space

-

-

Activity: Extra

20,5°%

14,3°%

Entrance

12,3°%

2,8°%

Storage

8,3°%

2,5°%

Hallway

-

5°%

Bathroom

-

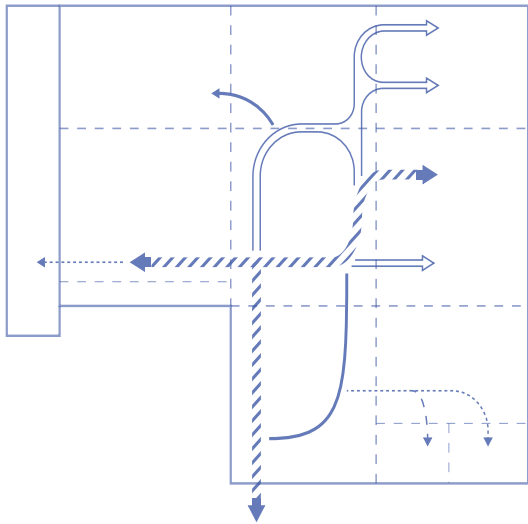
4°%

Sample space

10,4°%

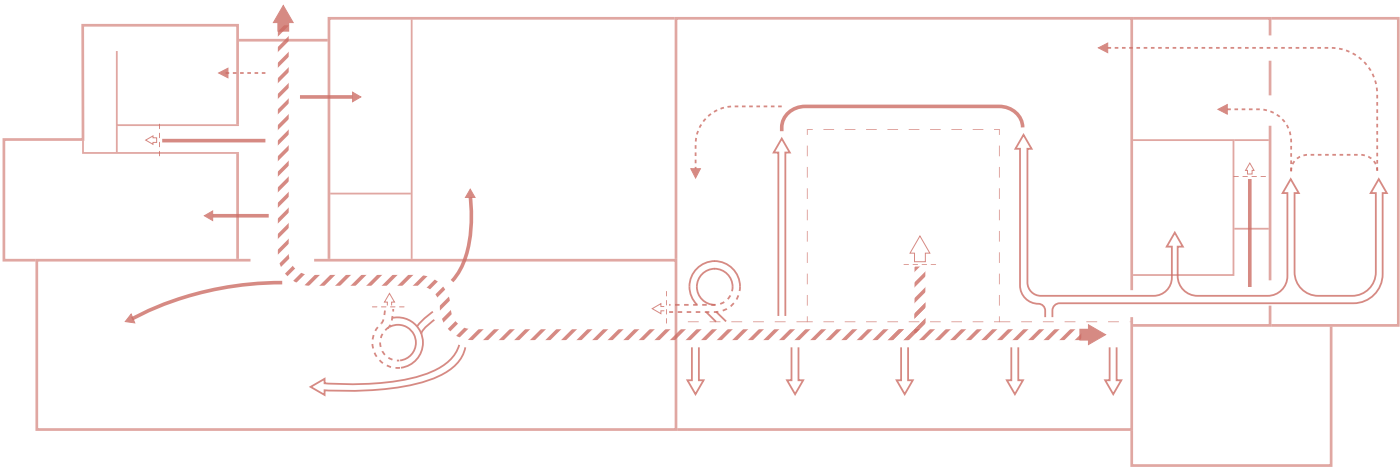
-

Beltman



LEGEND
primary route
secondary route
tertiary route
quaternary route

Vakwerk



LEGEND
primary route
secondary route
tertiary route
quaternary route

Beltman

Employees: 20

Work stations: 20

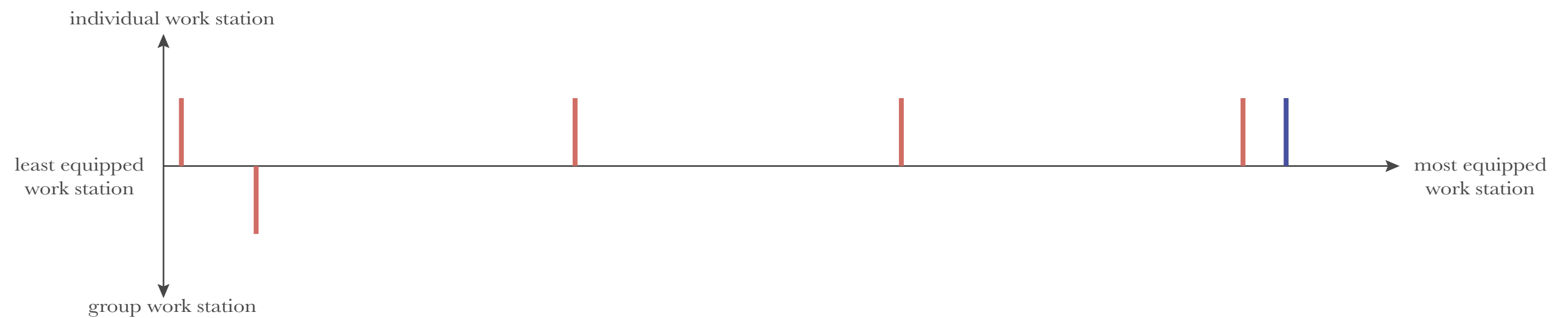
1 work station per employee

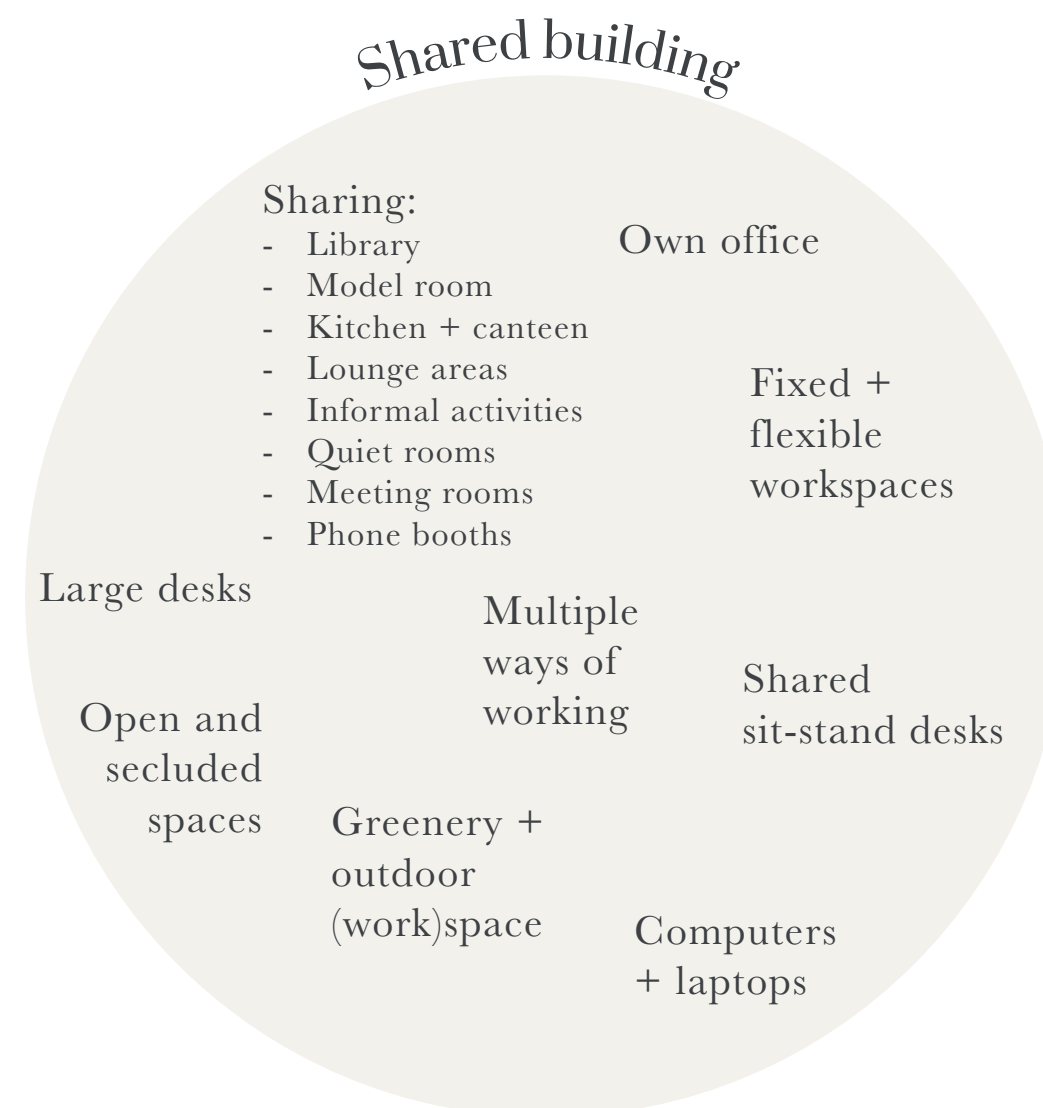
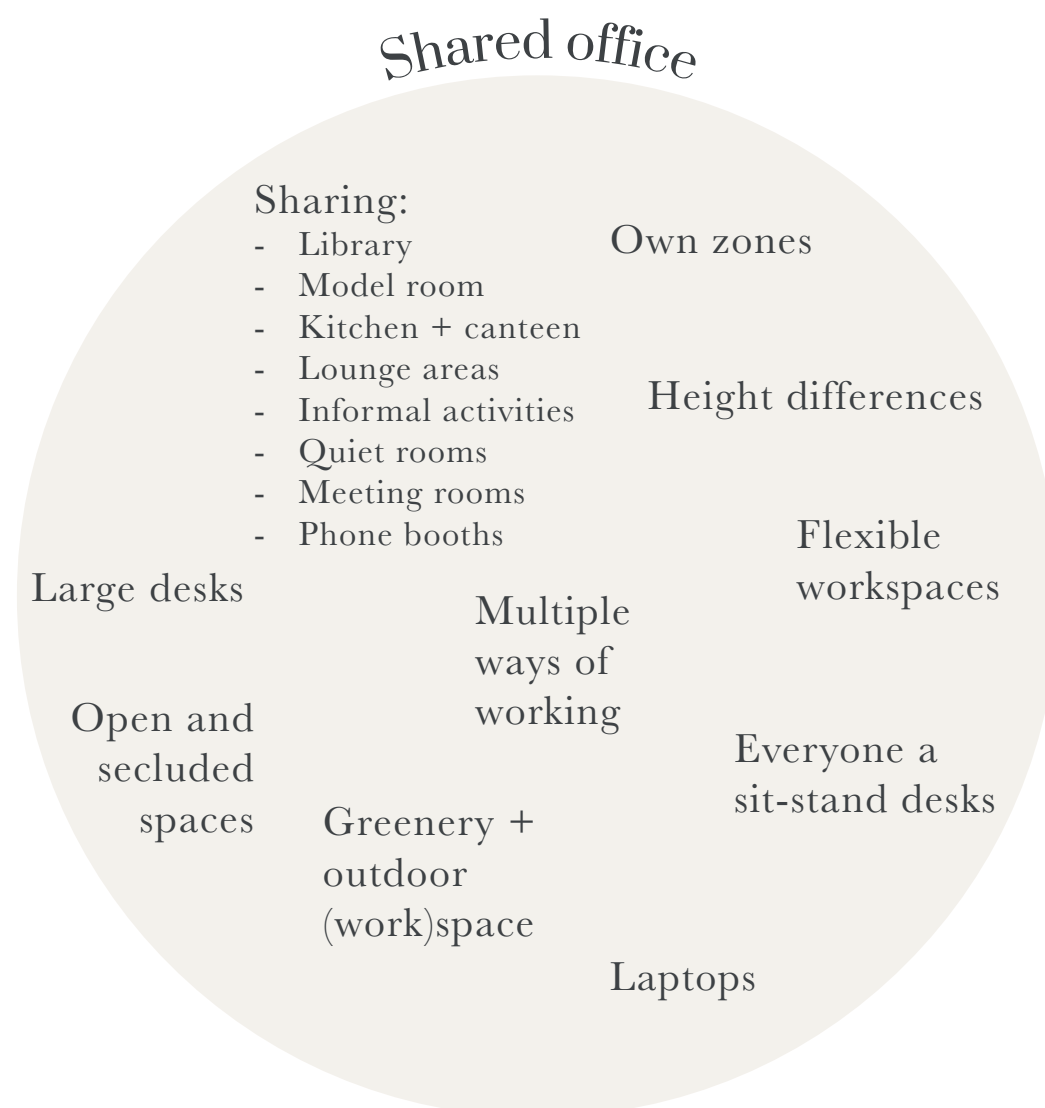
Vakwerk

Employees: 30

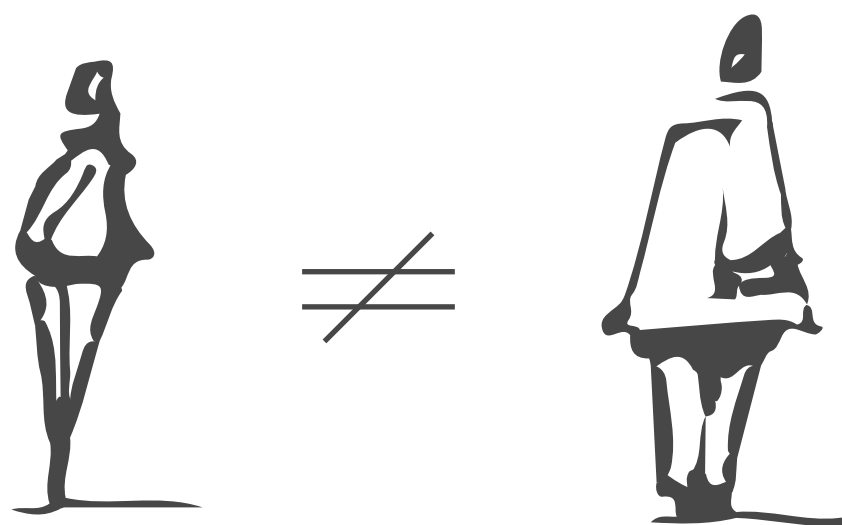
Work stations: 120

4 work stations per employee





Freedom of Choice





the cubicle office



the open-plan office



the cubicle office



the open-plan office

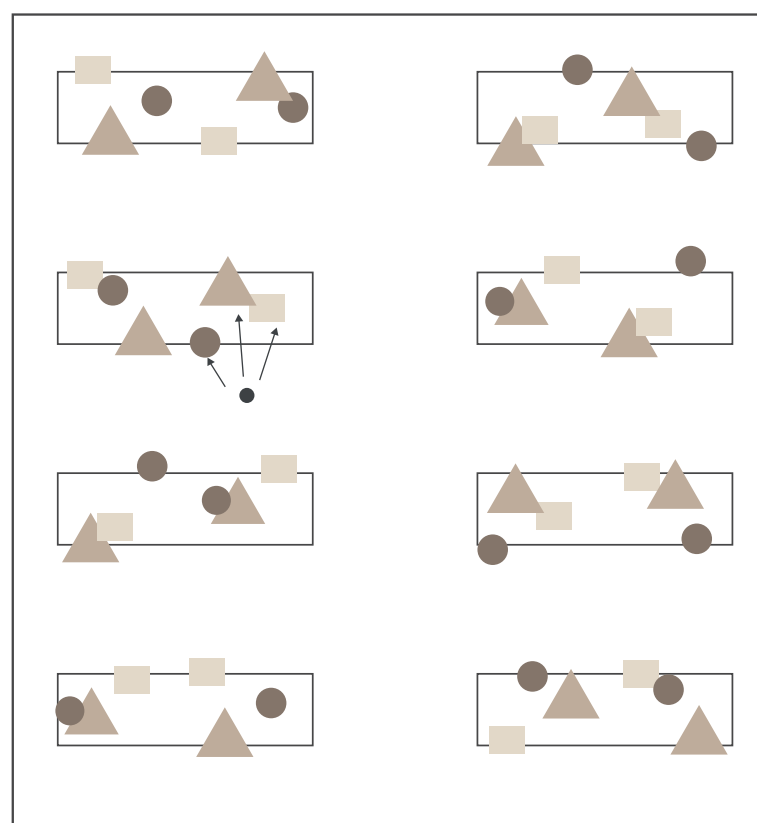


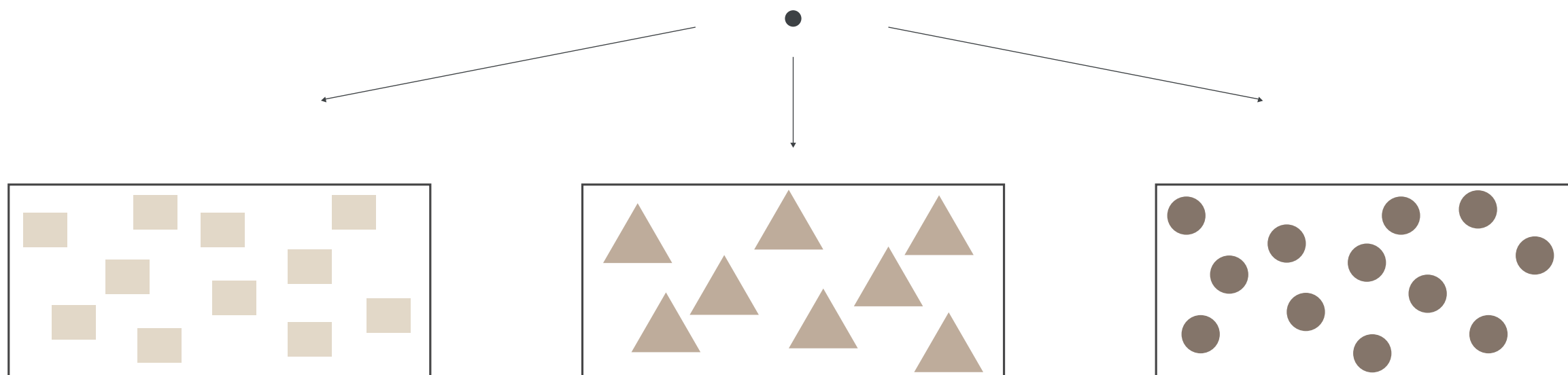
*Beltman
architecten*



Vakwerk

What is the solution?





Activity-Based Workplace Design

Activity-Based Workplace Design

[ac-tiv-i-ty beyst wurk-pleys dih-zahyn]

1. With ABW design, organisations create office space that matches the type of work (ie.: the activity).
2. In the modern office, office workers are no longer tethering themselves to one stationary, assigned desk. Instead, they are able to let their task help determine how and (and where) they complete it.

Discover YOUR way of working

“How should flexible working be translated into the physical workplace of architectural offices?”

What activities?

What spaces?

What needs?

Main entrance

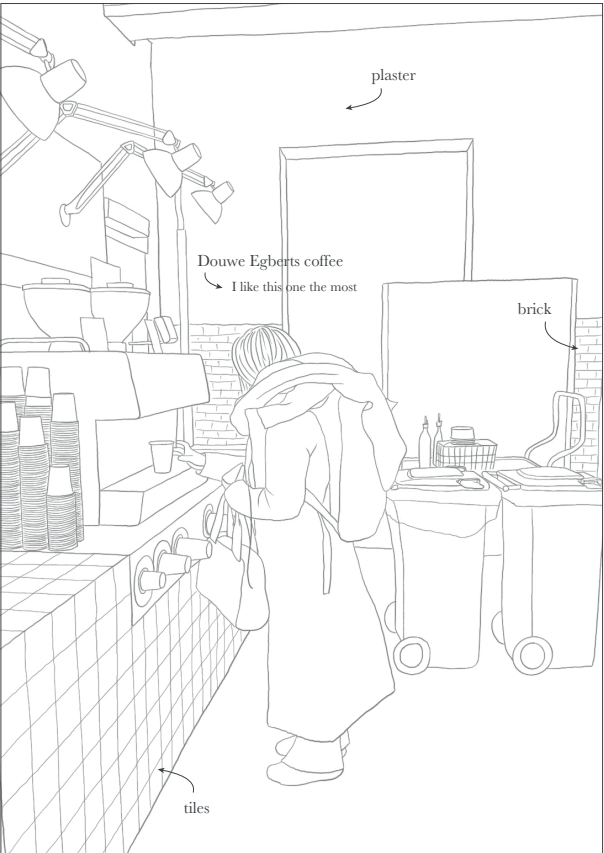
Arrival at faculty



09:00h

Ketelhuis

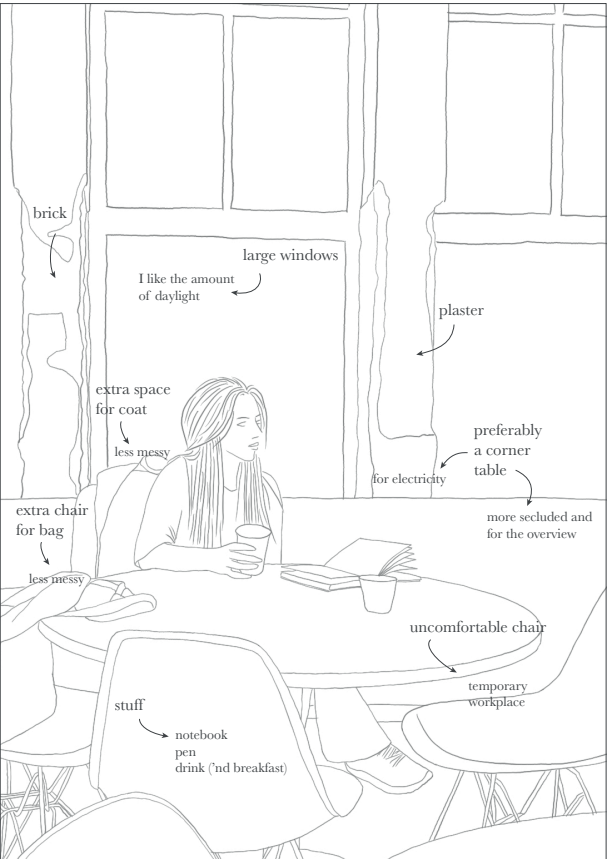
Break - getting coffee



09:05h

Espresso Bar

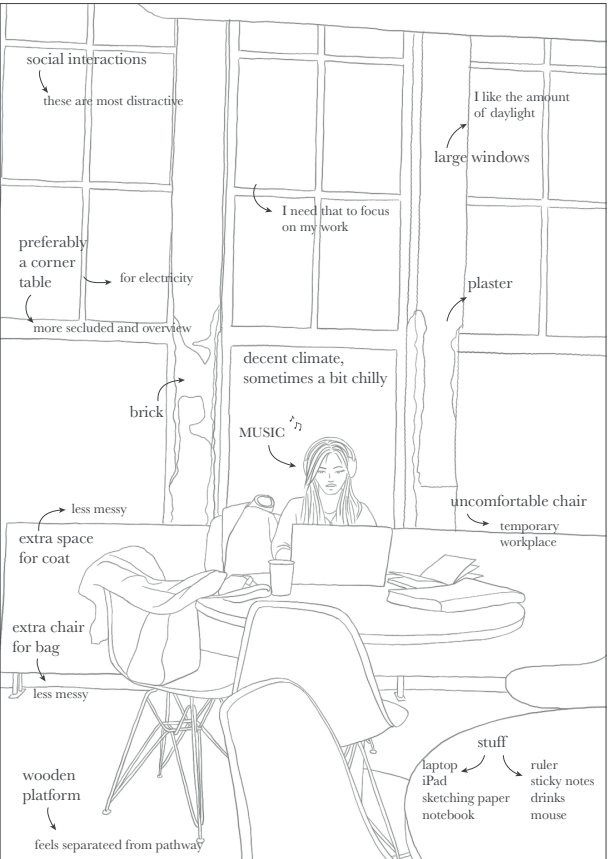
Meeting



09:00 - 10:00h

Espresso Bar

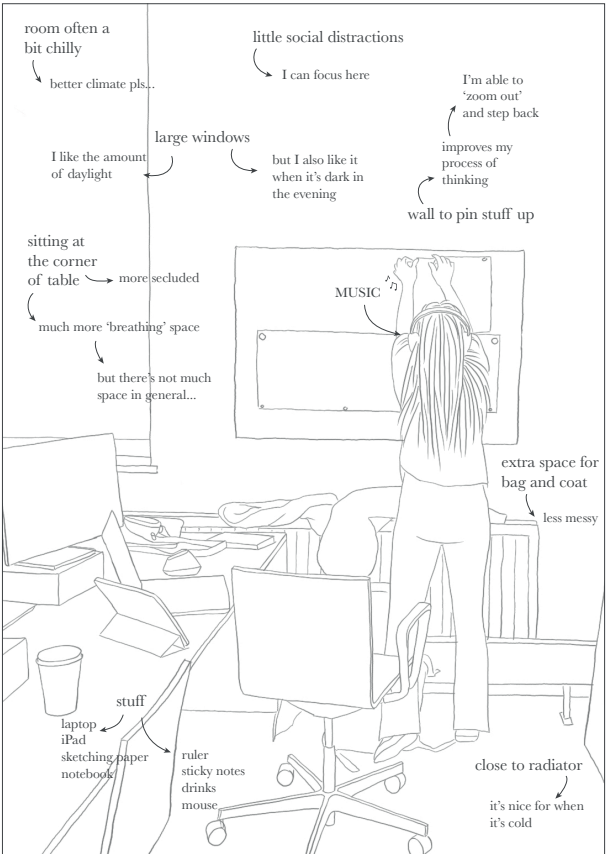
Work - writing/reading/research (low-medium concentration)



10:00 - 12:30h

Computer space

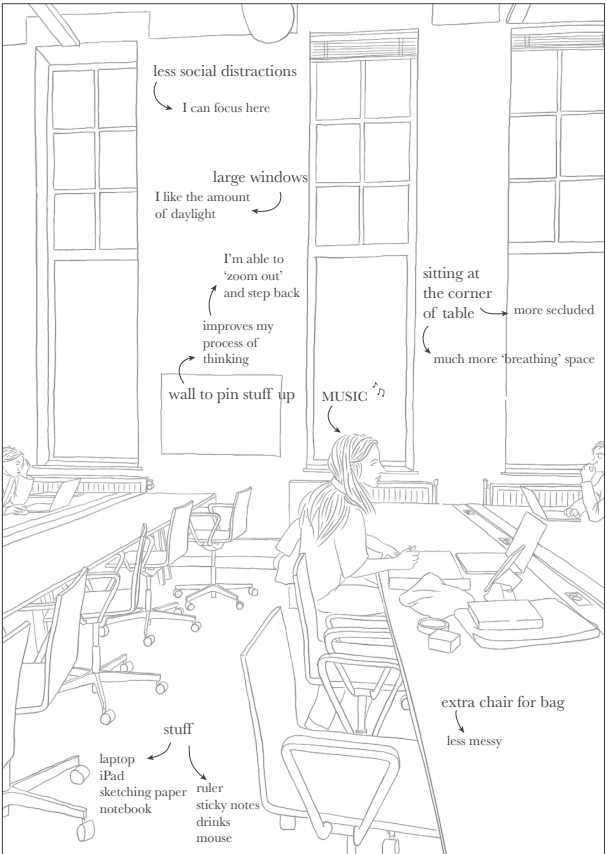
Work - writing, reading, research (high concentration)



10:00 - 12:30h

Computer studio space

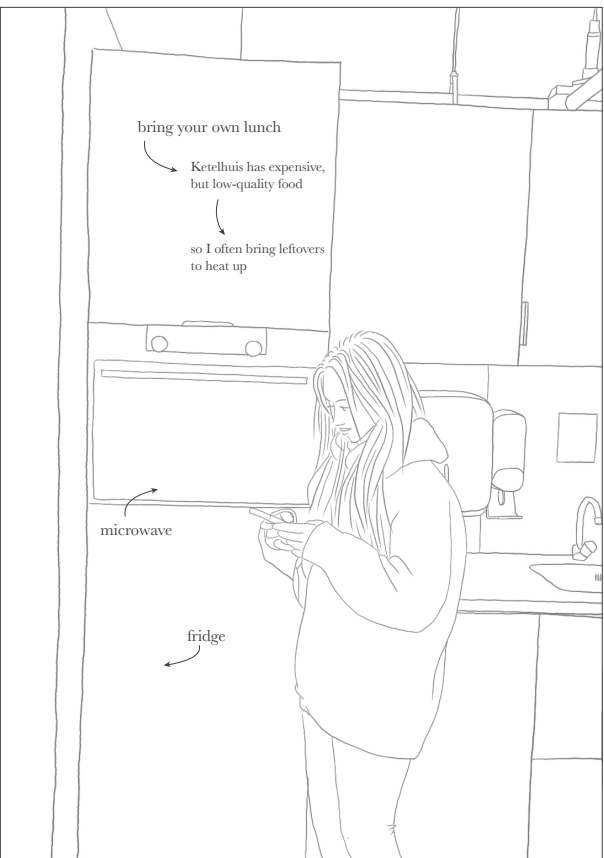
Work - sketching/designing (medium-high concentration)
Tutoring



10:00 - 12:30h

Pantry

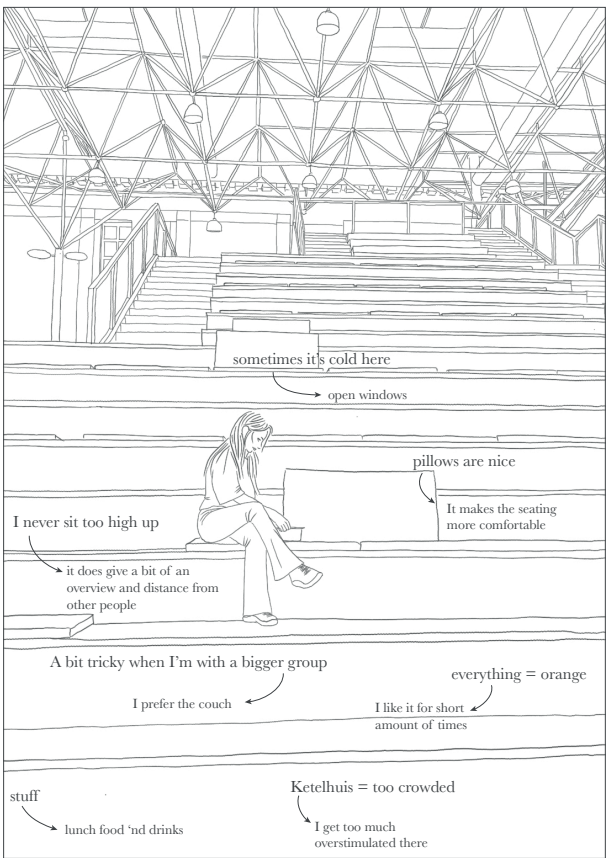
Preparing lunch



12:30:00h

Orange Hall

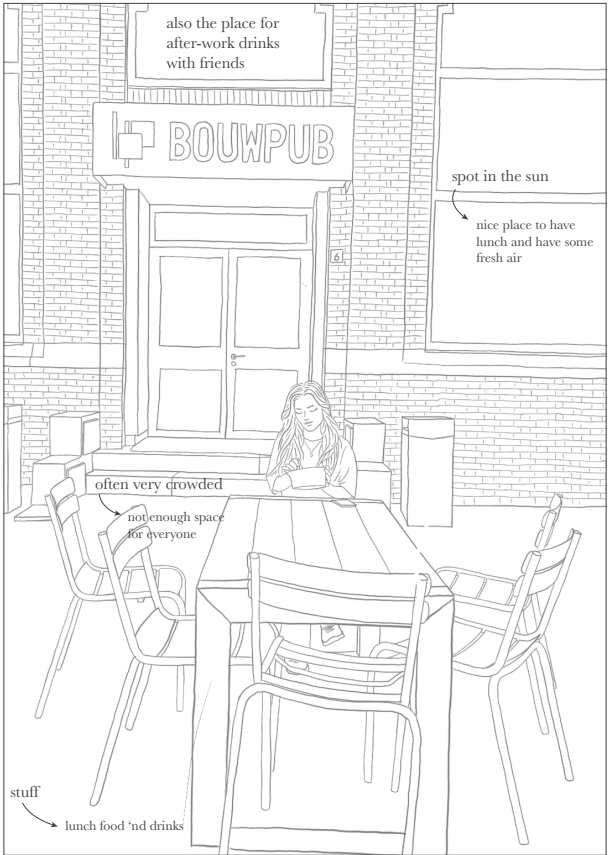
Lunch (winter/cold and rainy days)



12:30 - 13:30h

Bouwpub

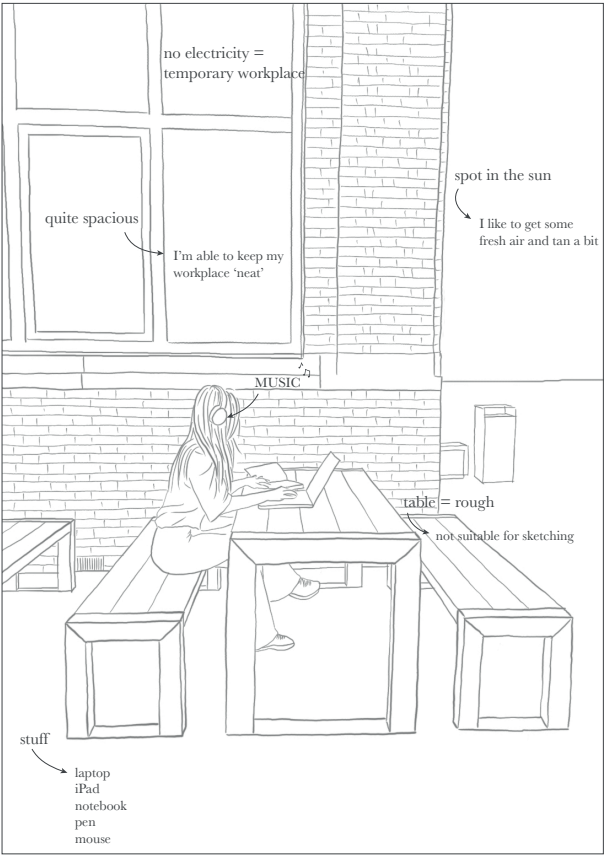
Lunch (summer/warm days)



12:30 - 13:30h

Bouwpub

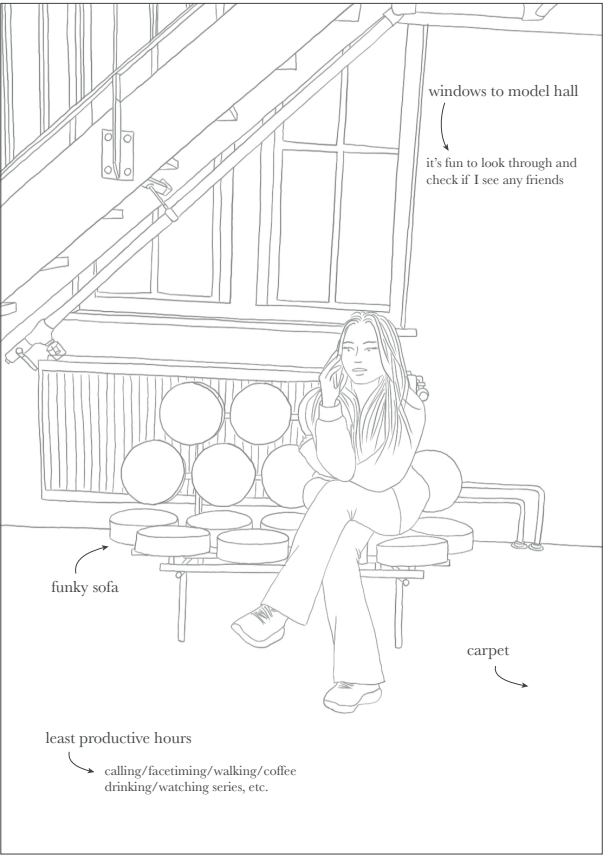
Work - writing/reading/research (low-medium concentration)



13:30 - 16:00h

Hallways

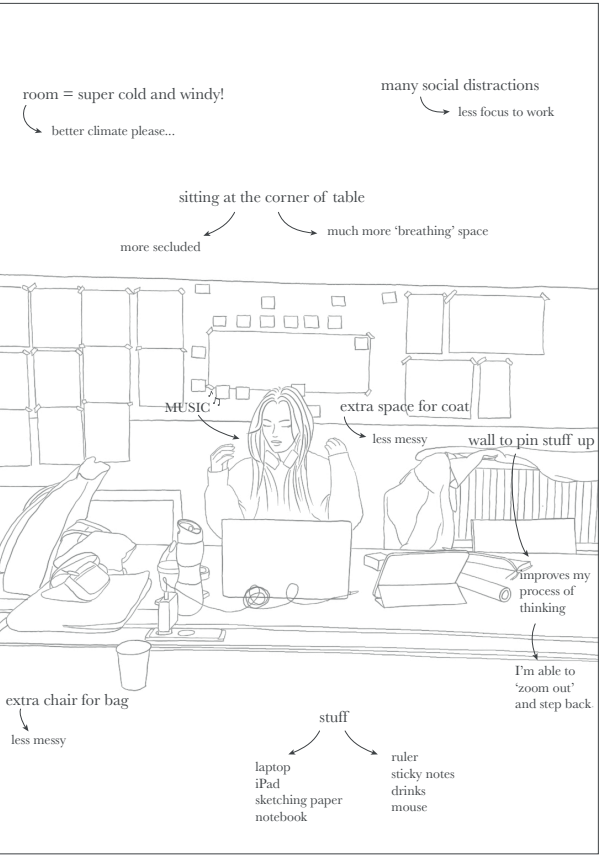
Break - coffee and walks



14:00 - 16:00h

Explore Lab studio space

Work - sketching/designing (low concentration)
Tutoring

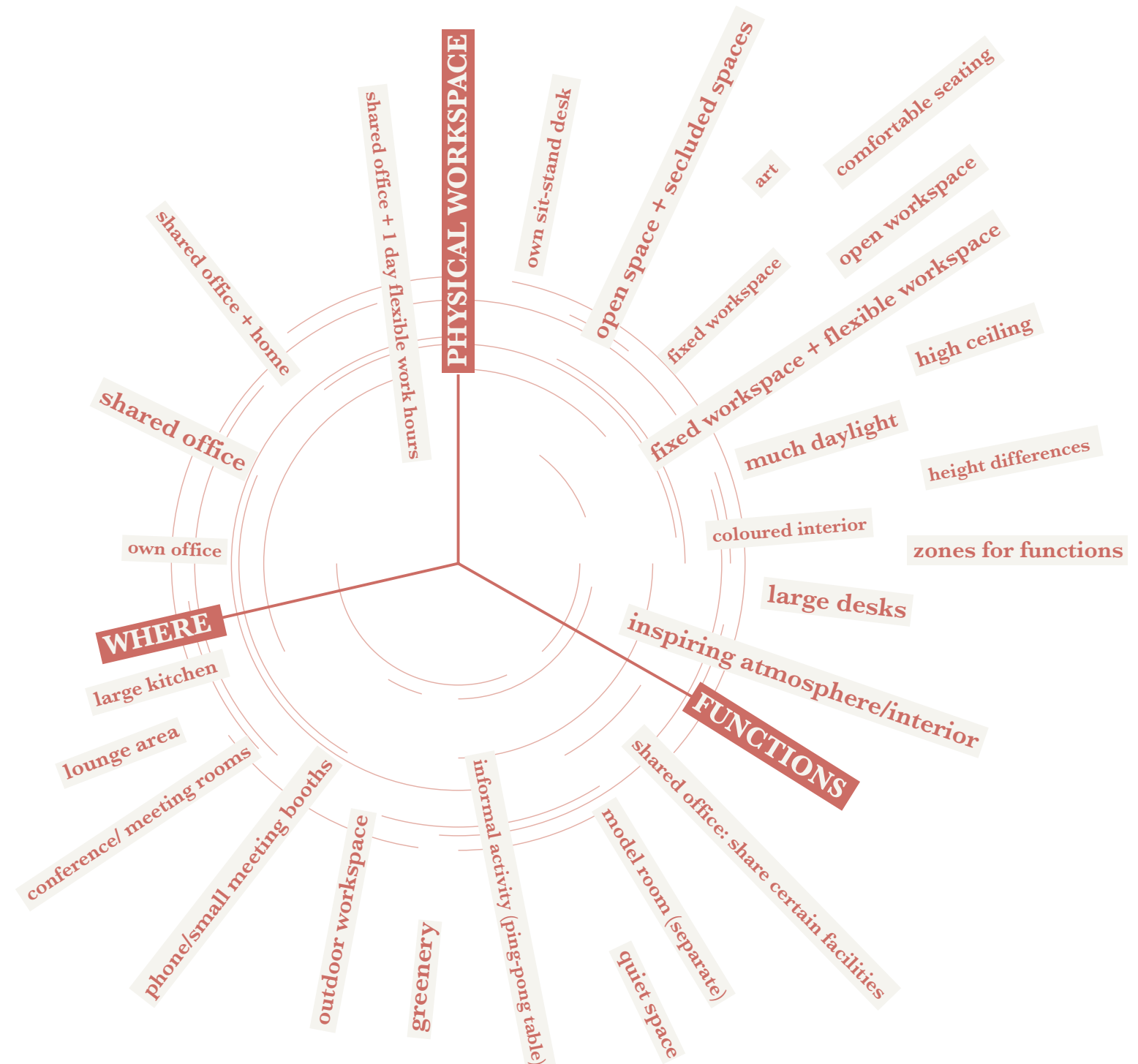


16:00 - 18:00h

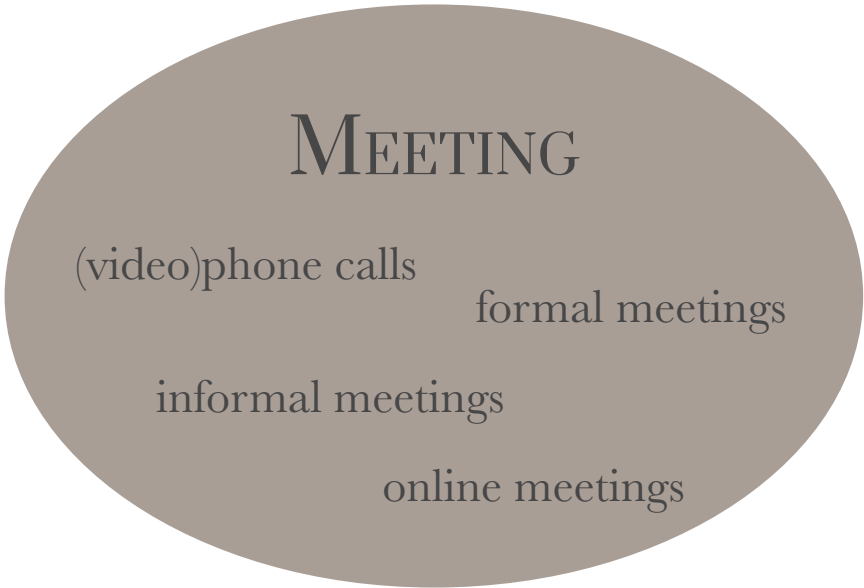
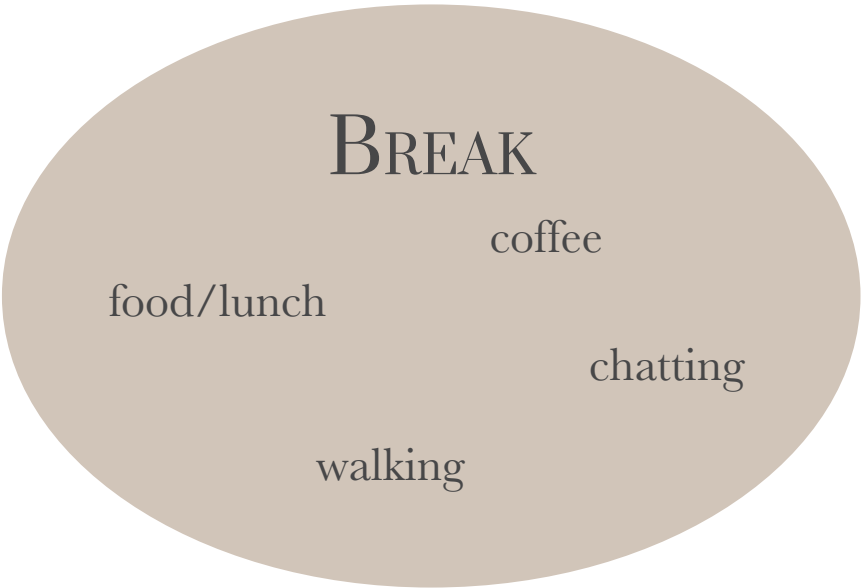
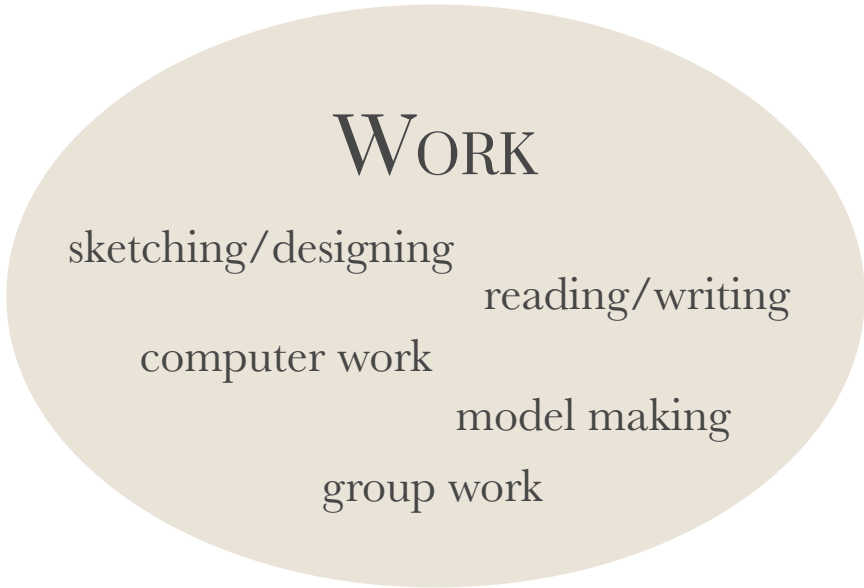
Beltman



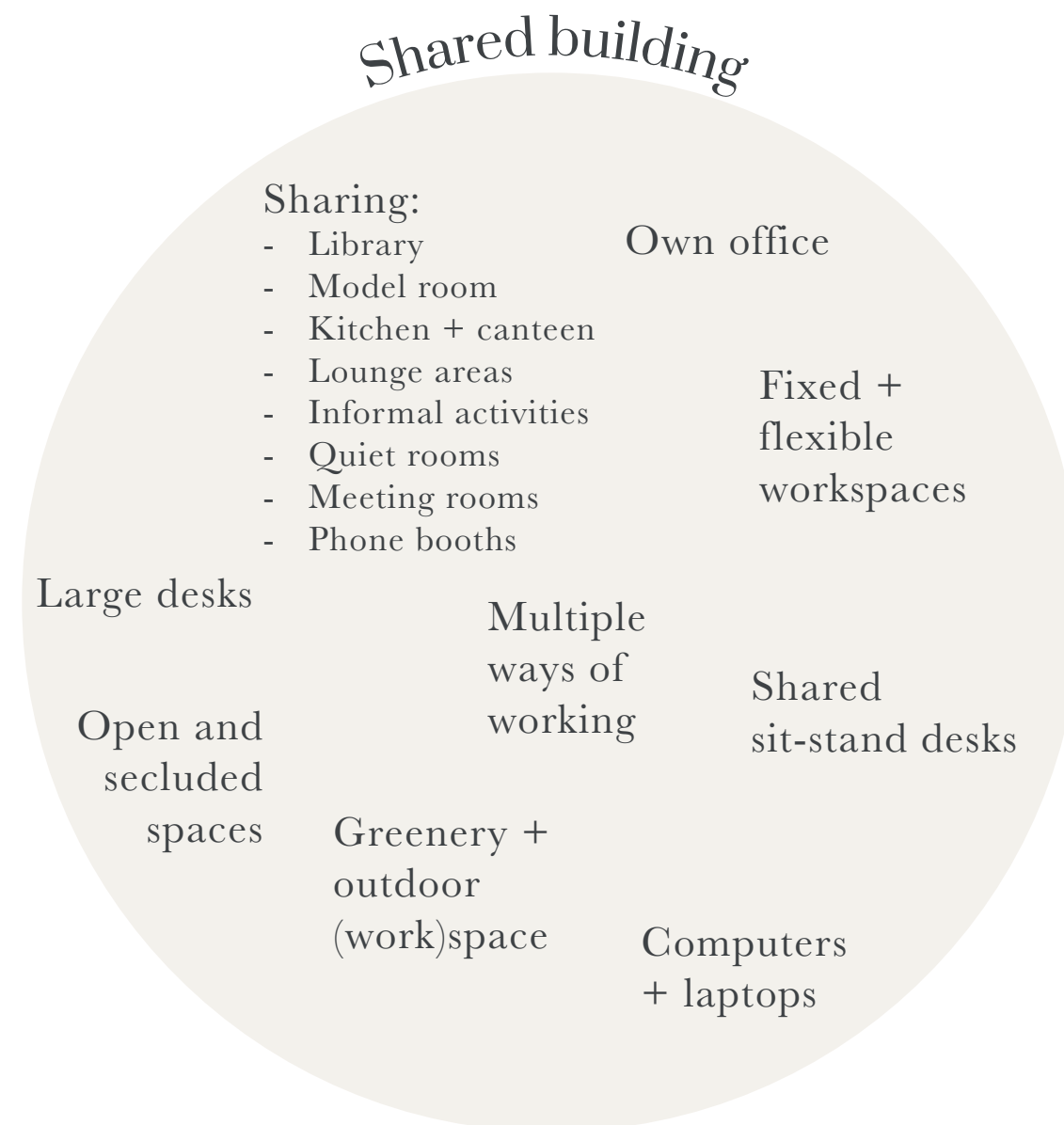
Vakwerk



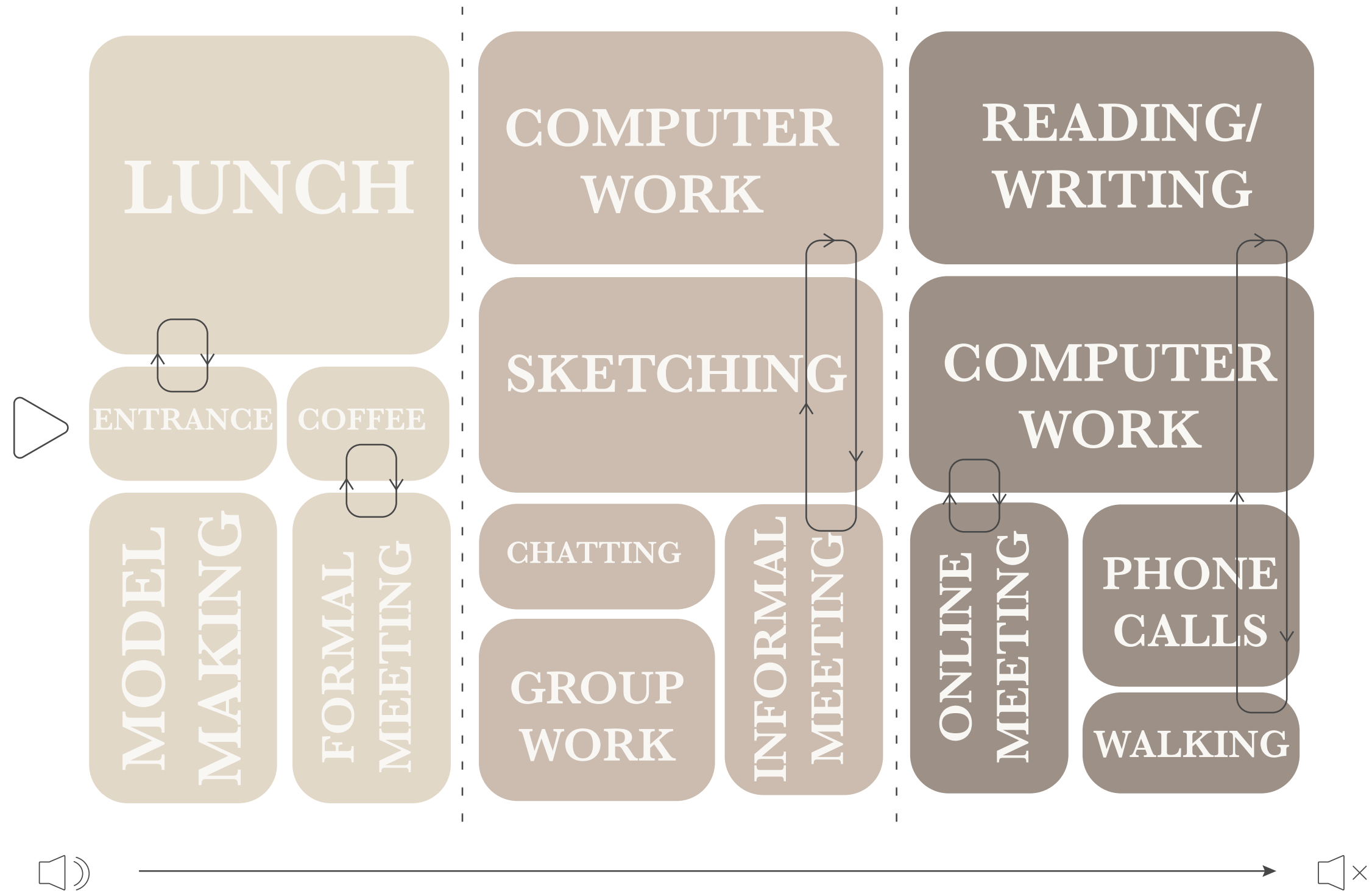
Activities



The Studio of Tomorrow



Sound zones

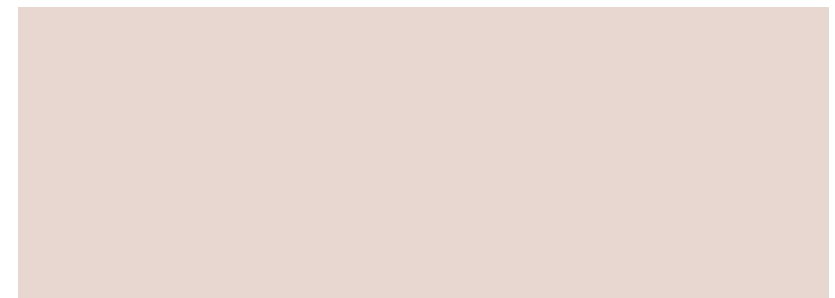
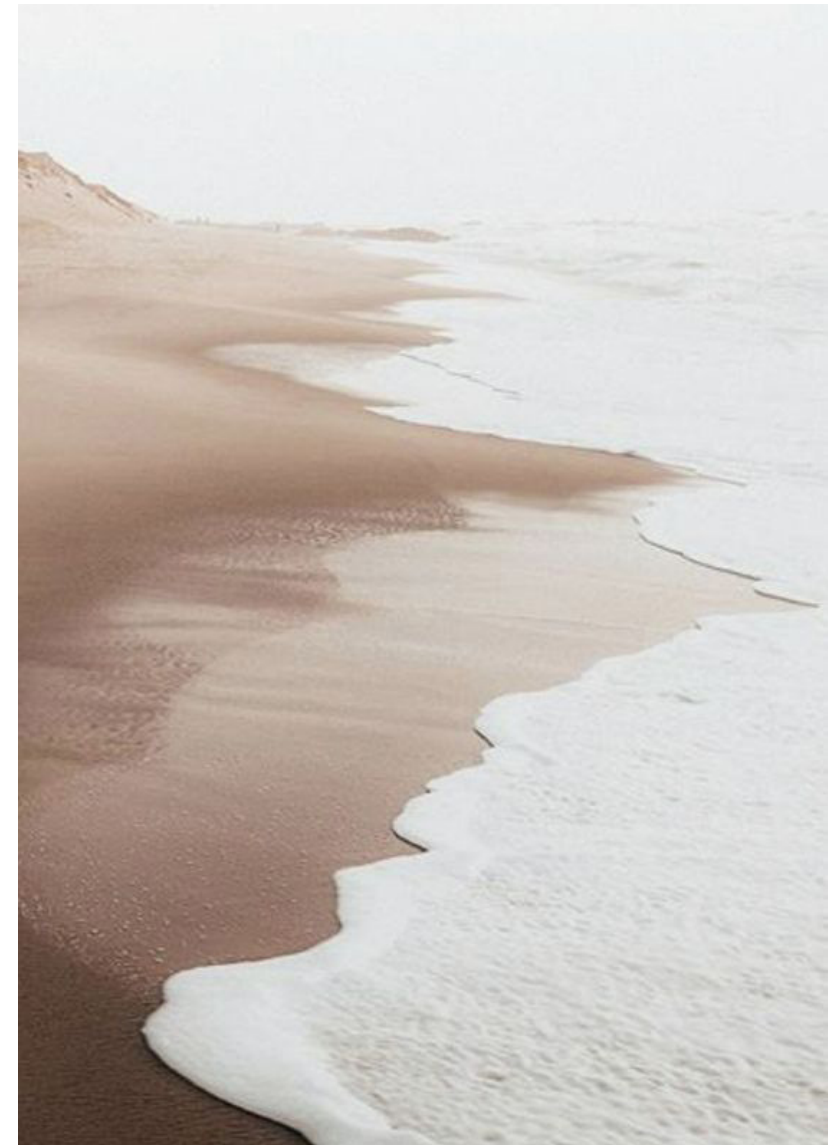


Sound zones

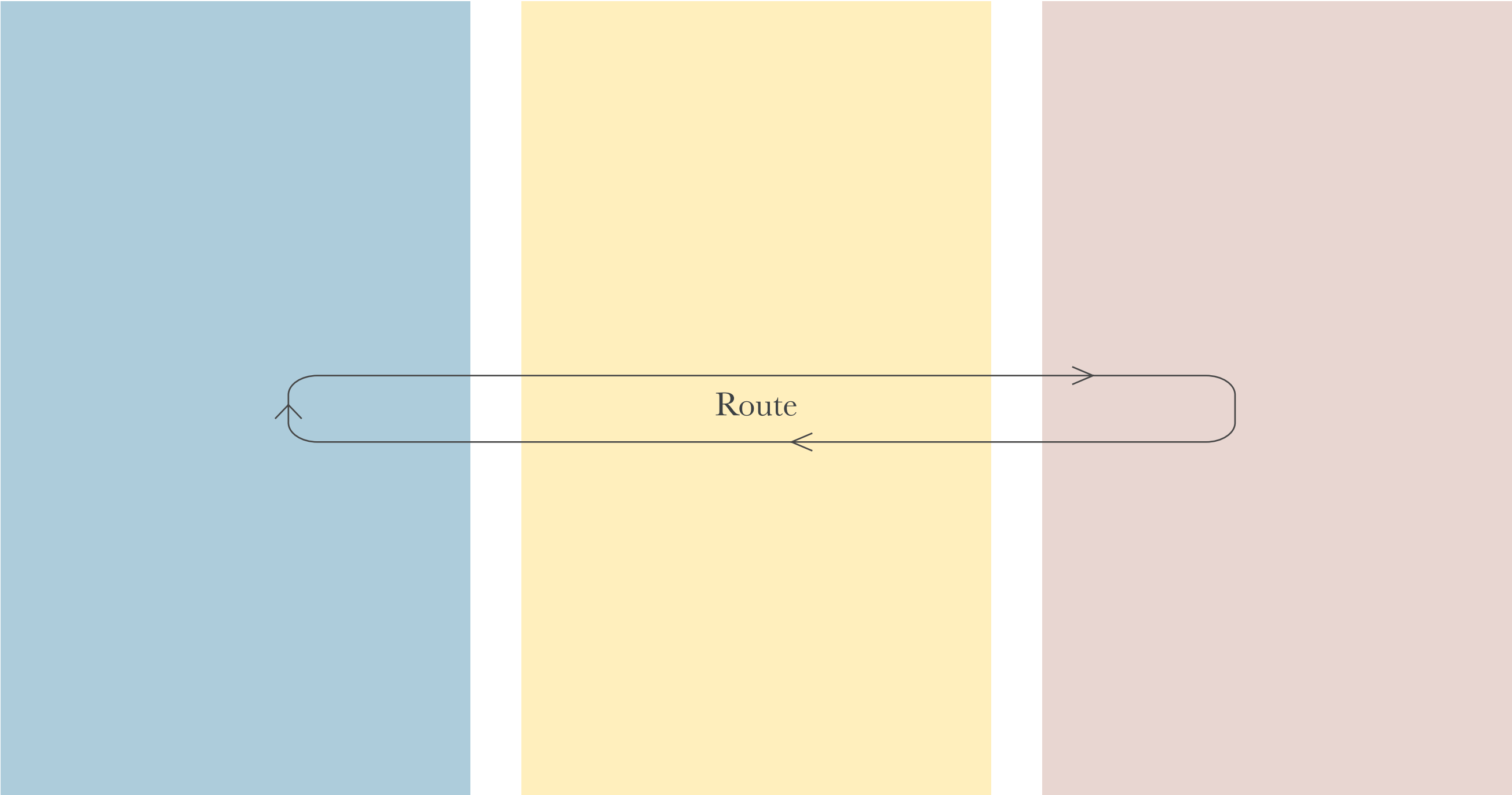
52/114



Sound zones

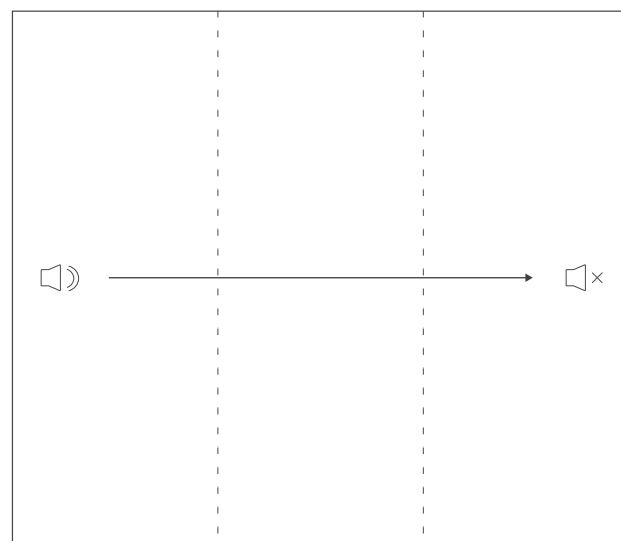


Sound zones



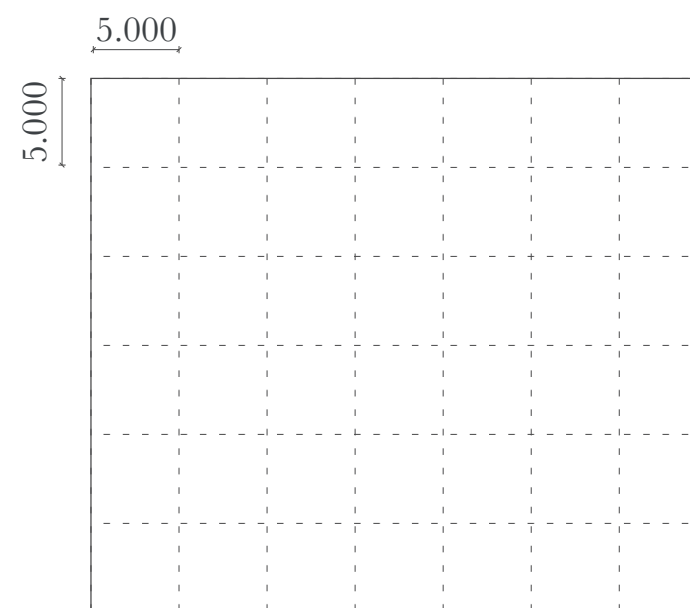
To design different experiences

To design different experiences
+ within the context of the warehouse



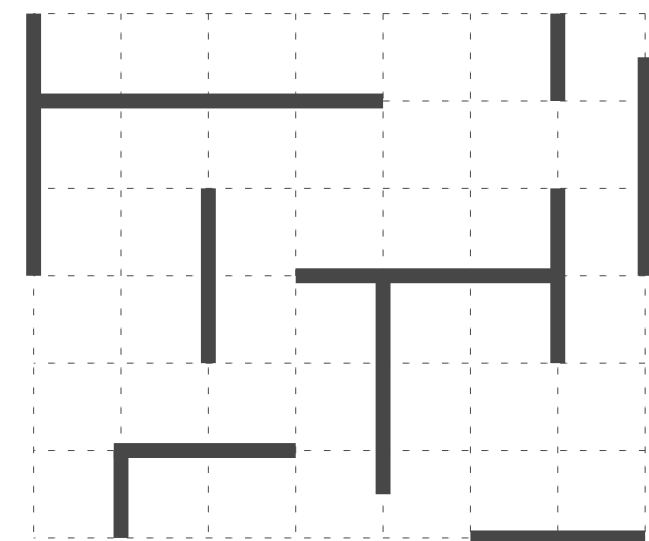
Activity-Based Design

+

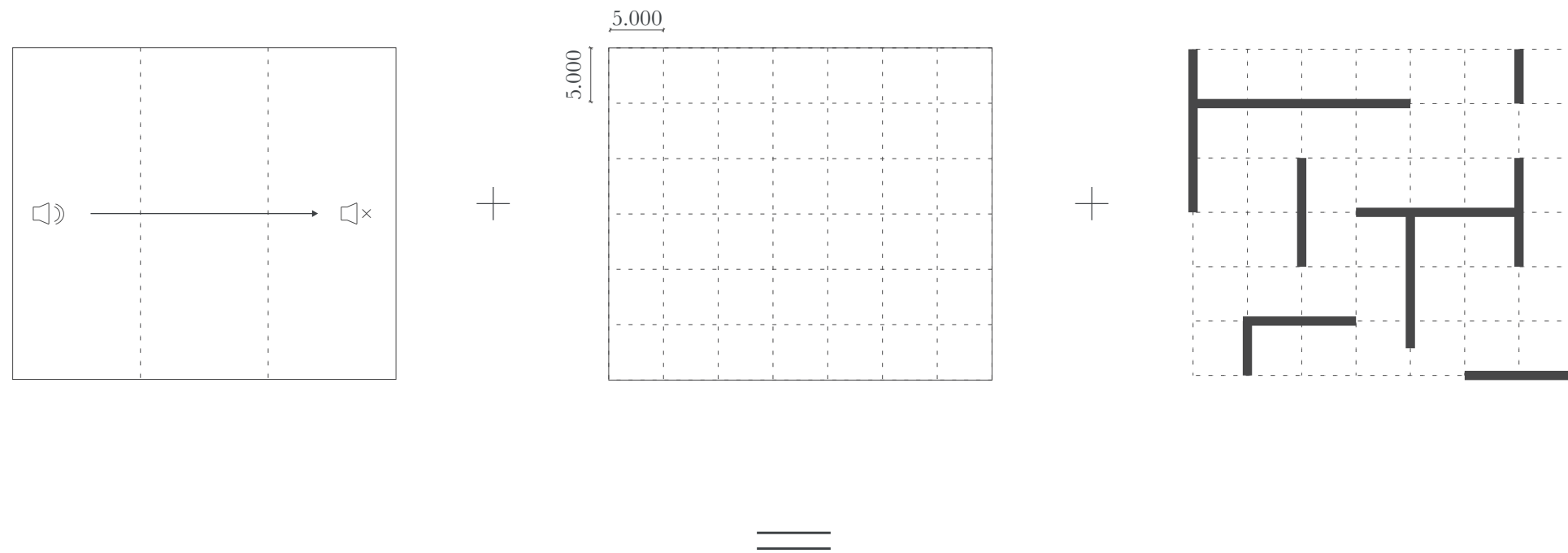


Grid warehouse

+



Principle



Variations in SPACES and EXPERIENCES

DELFT

58/114

N 51.993786

W 4.367017

N

city centre

station
Delft

architecture
faculty

W

E

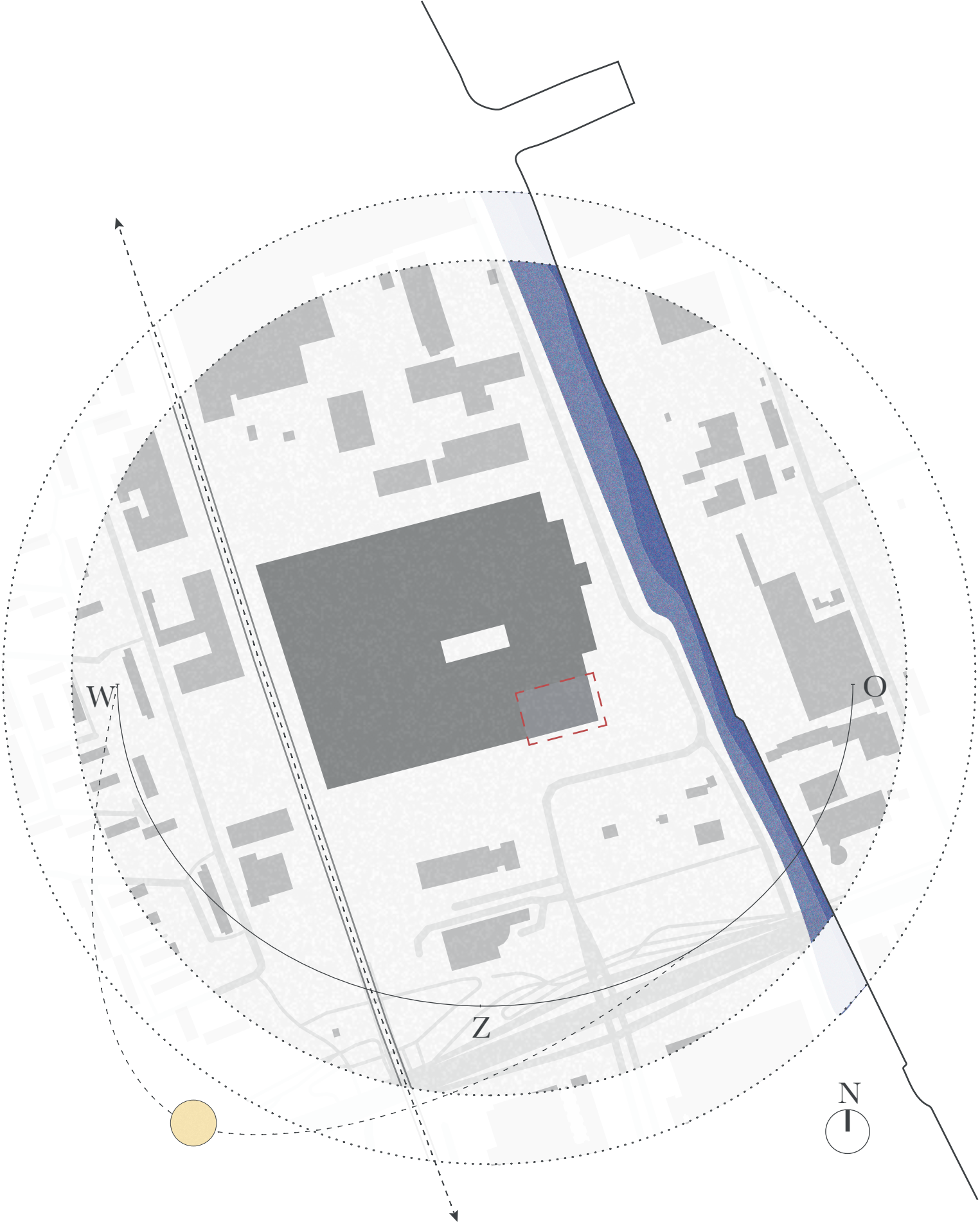
+

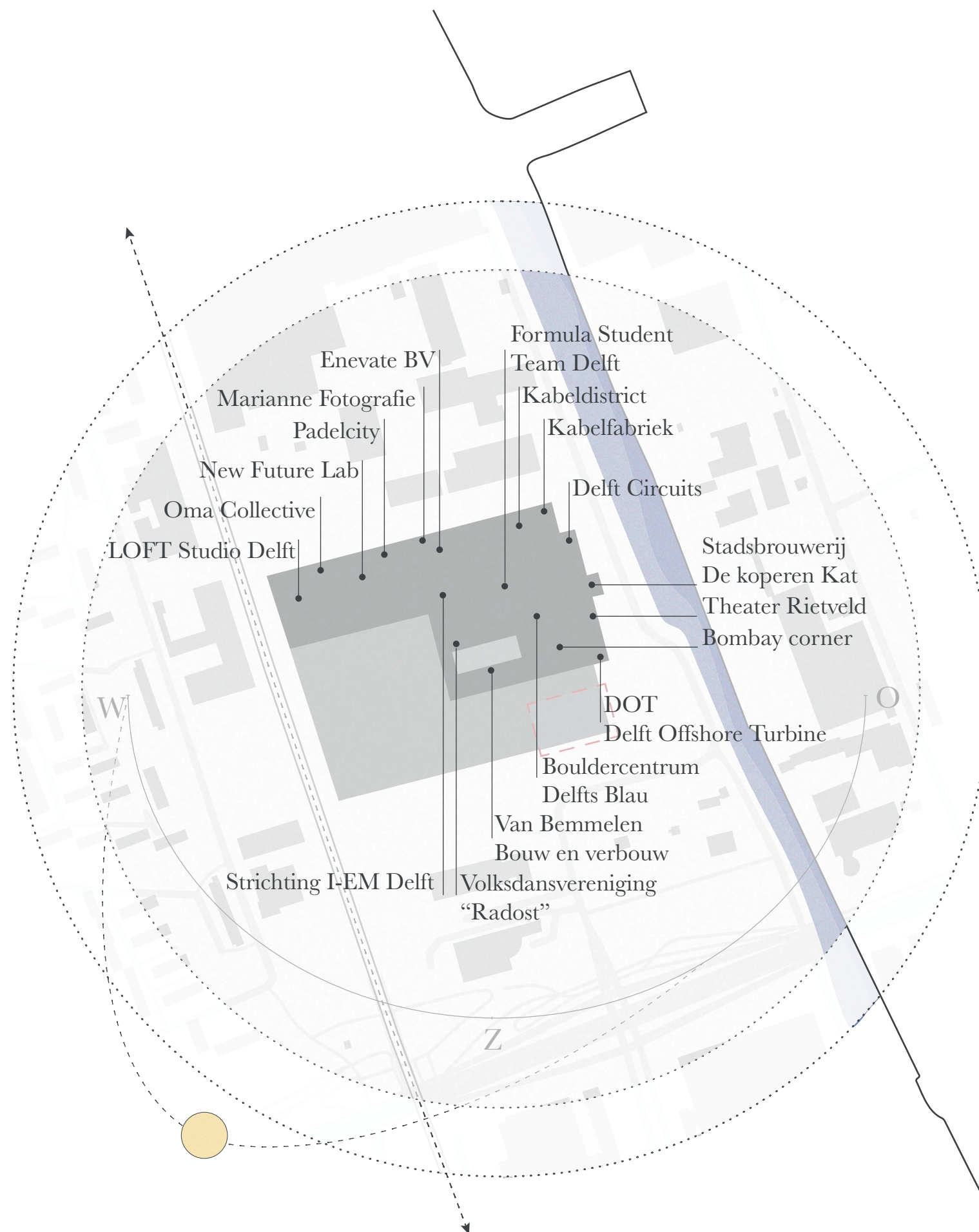
SITE
station
Delft campus

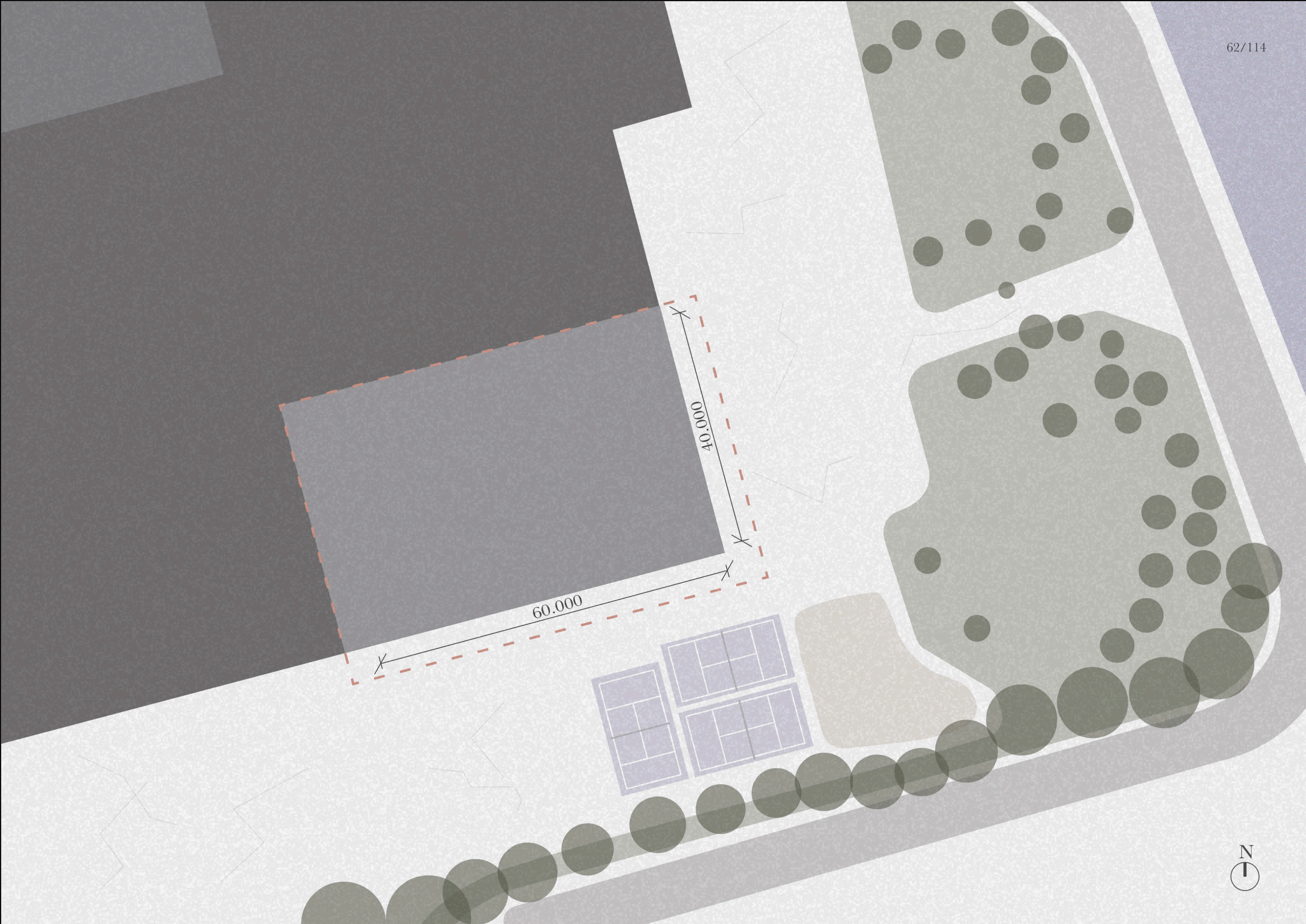
S



Kabelfabrik







Entrance pathway
East facade



Main entrance
East facade



Old warehouse door
South facade

Corner second facade
South facade



Second facade
East facade



Close-up window
South facade

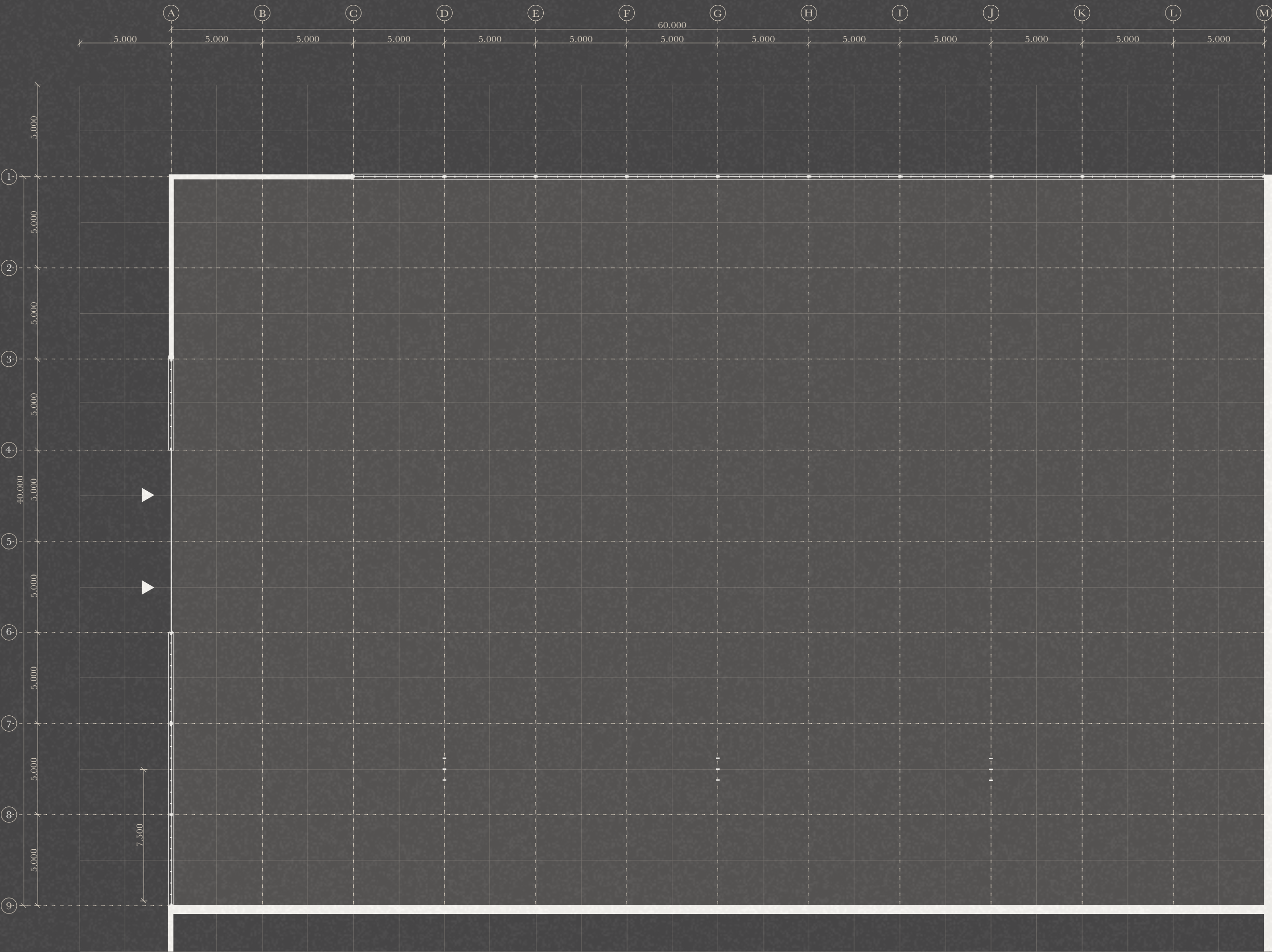
Columns
South-East to North-West view

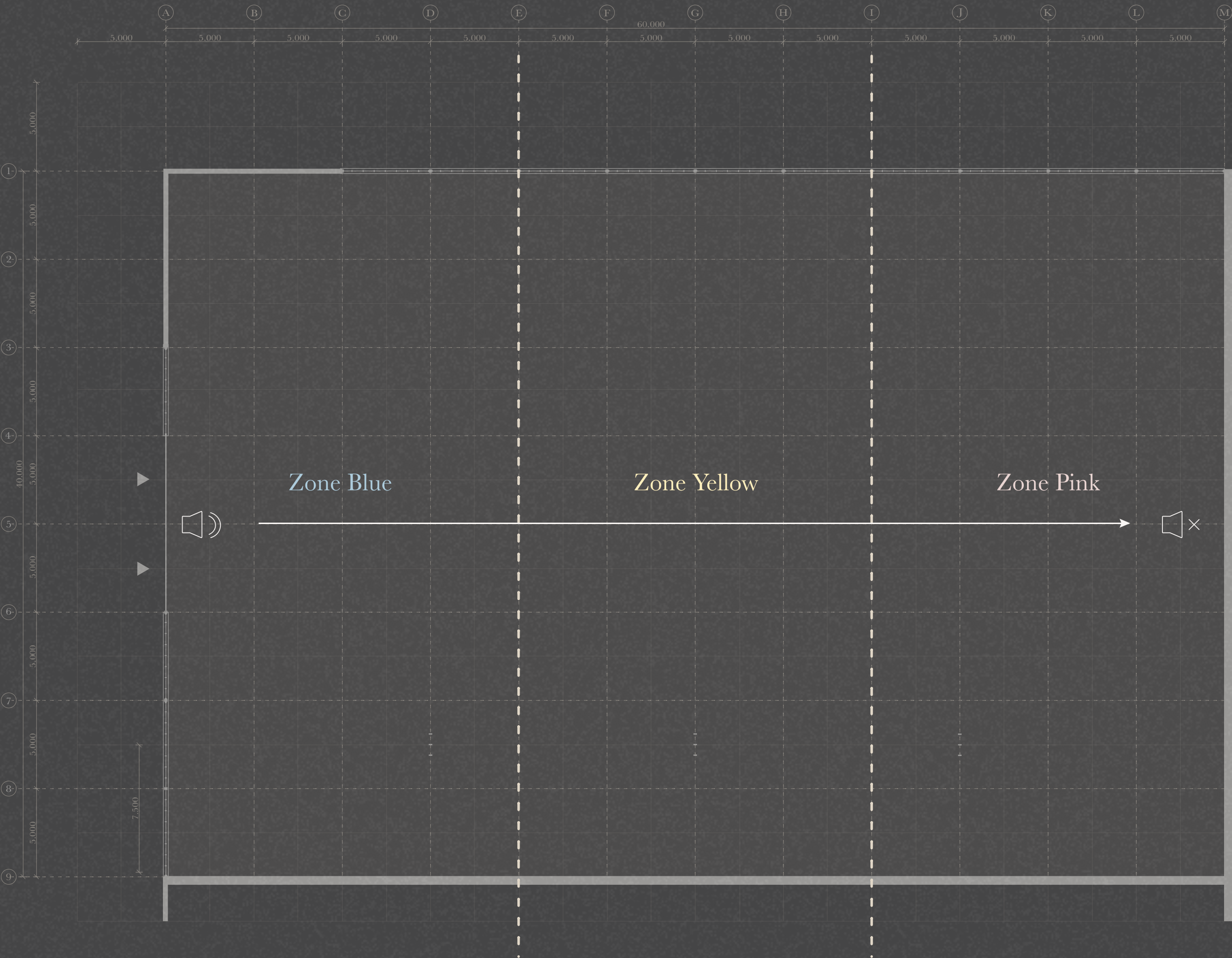


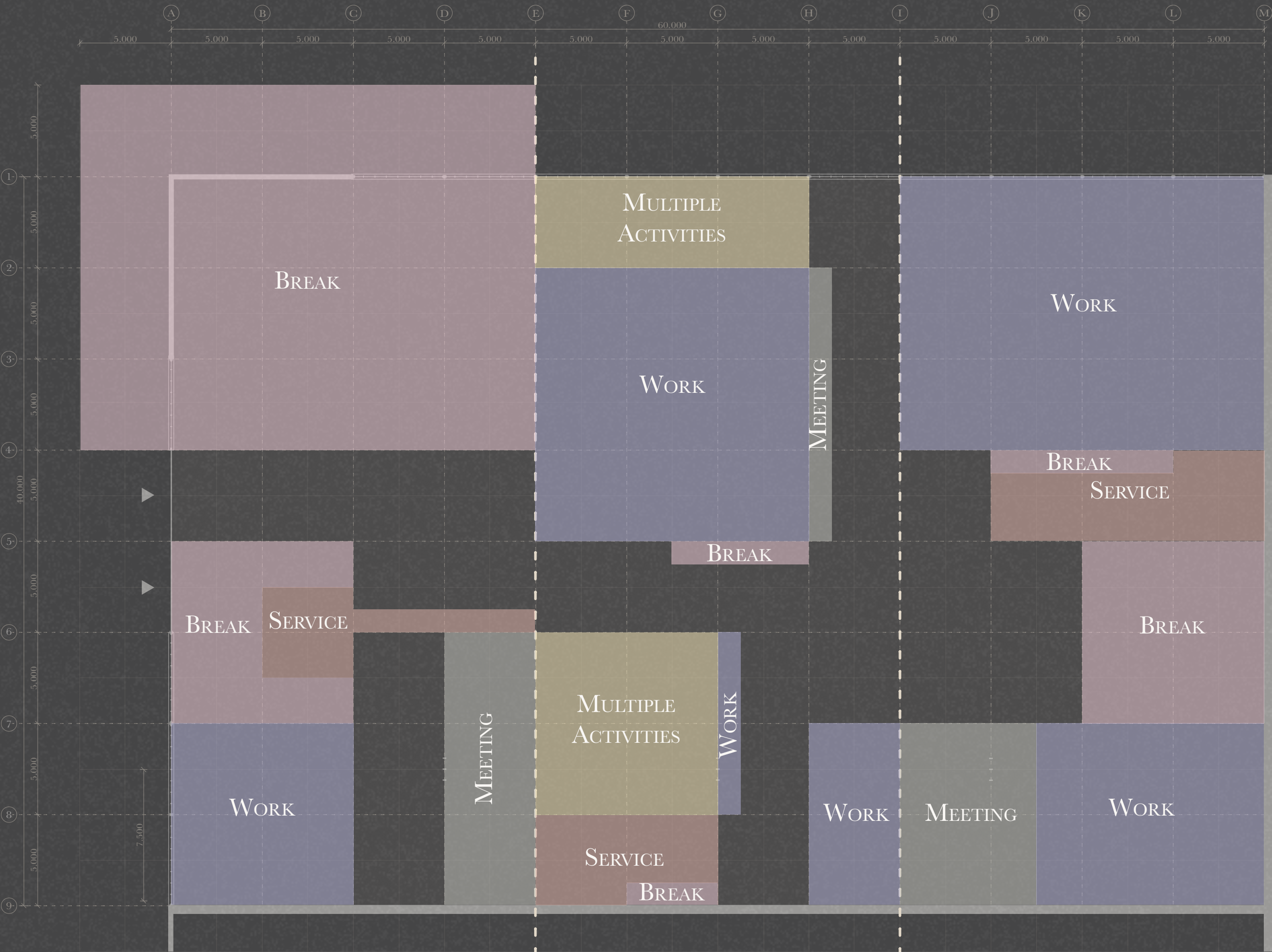
Indoor warehouse
South to East view

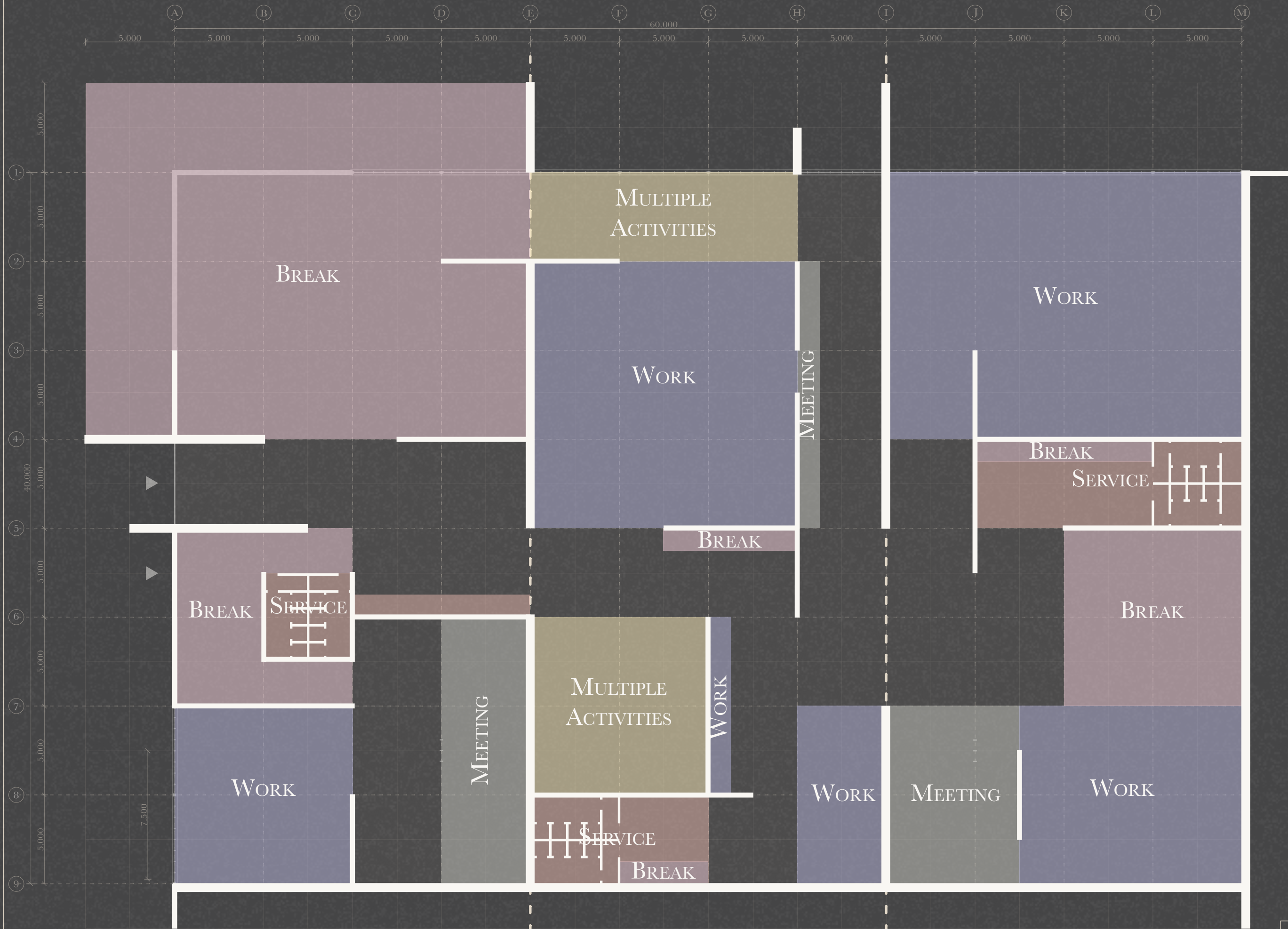


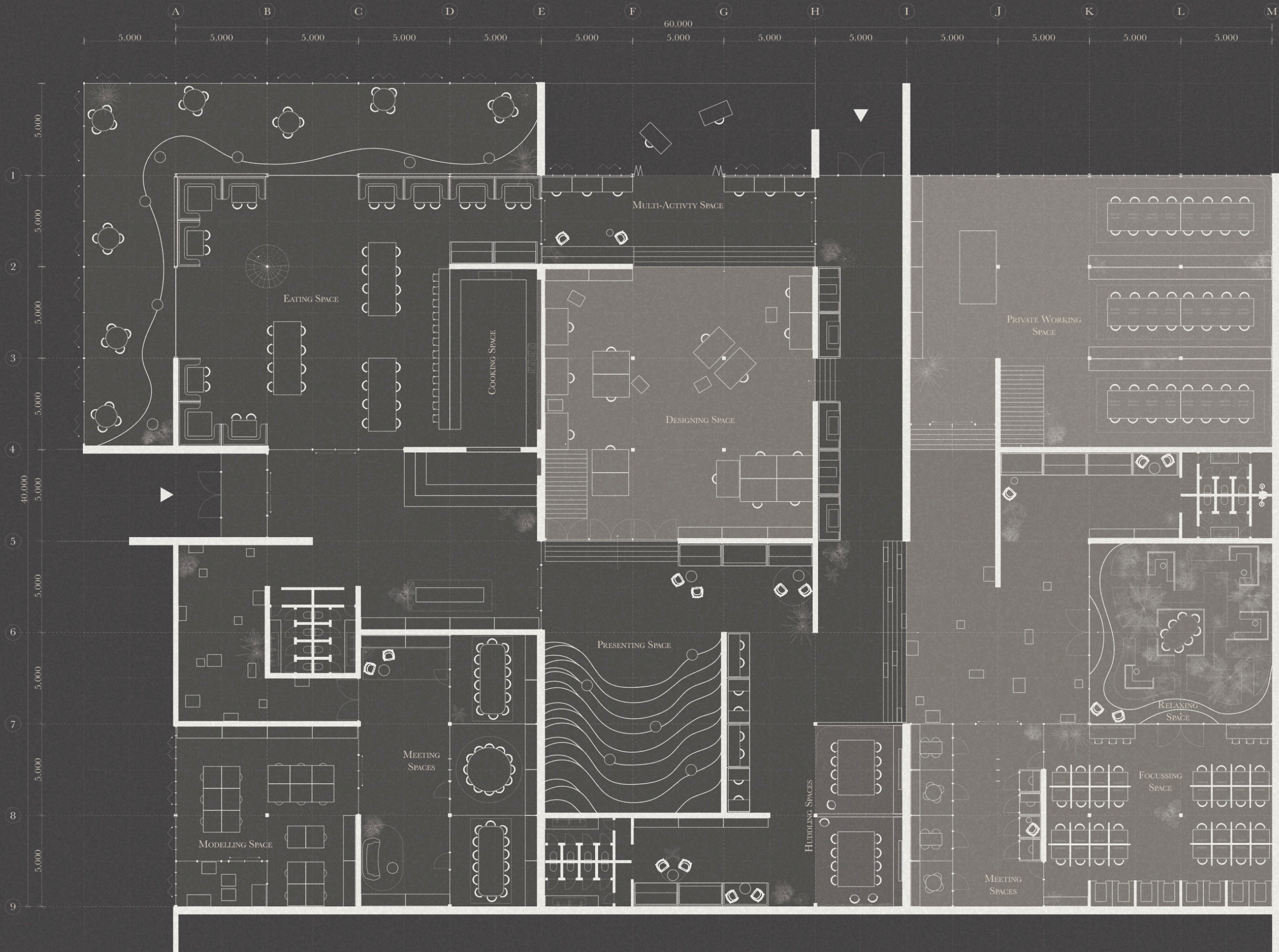
Indoor warehouse
South to West view

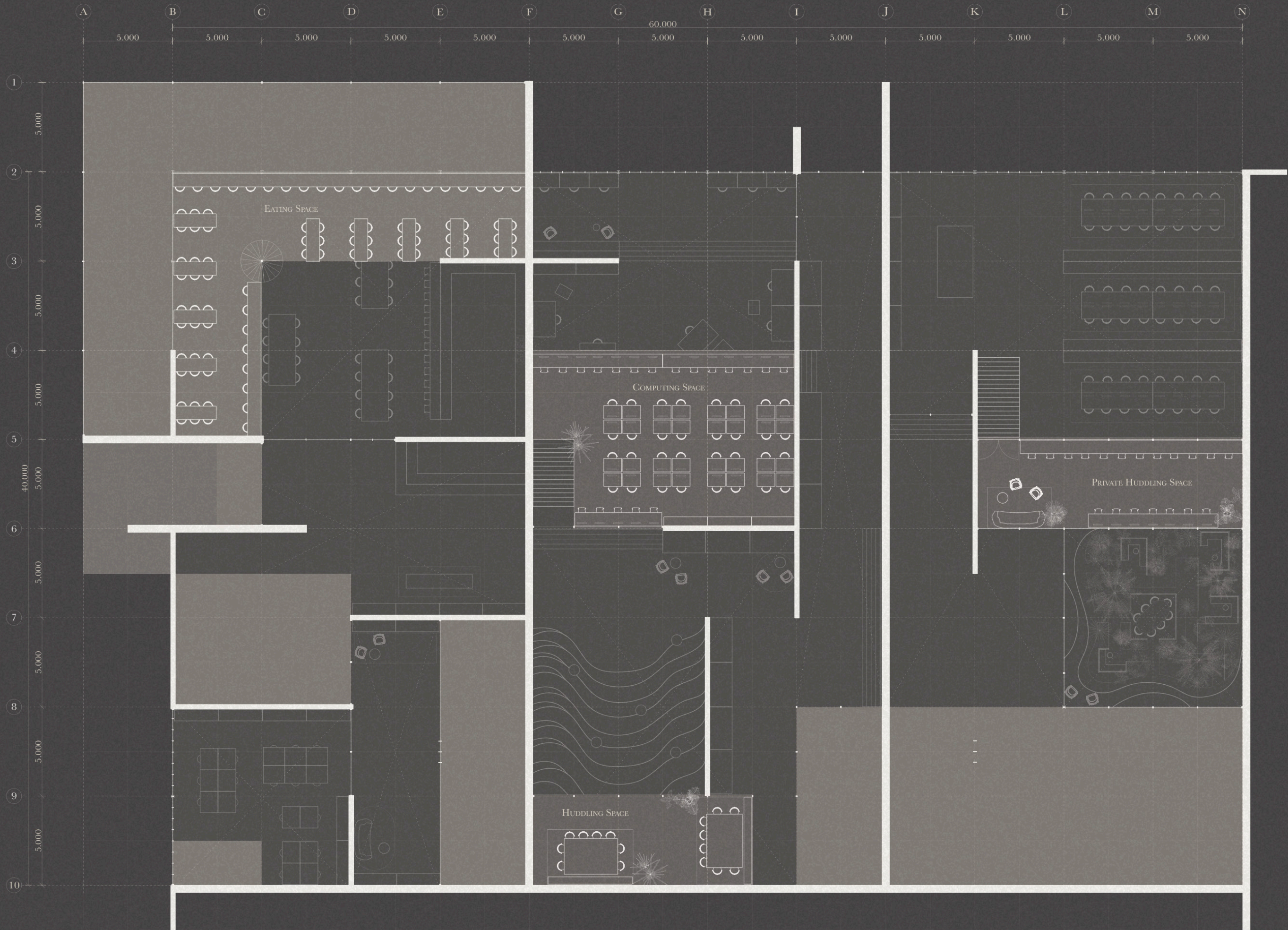


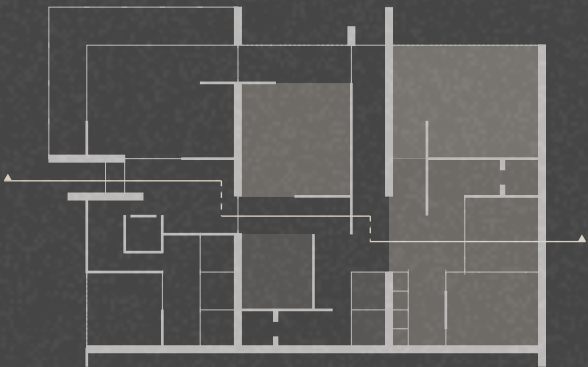
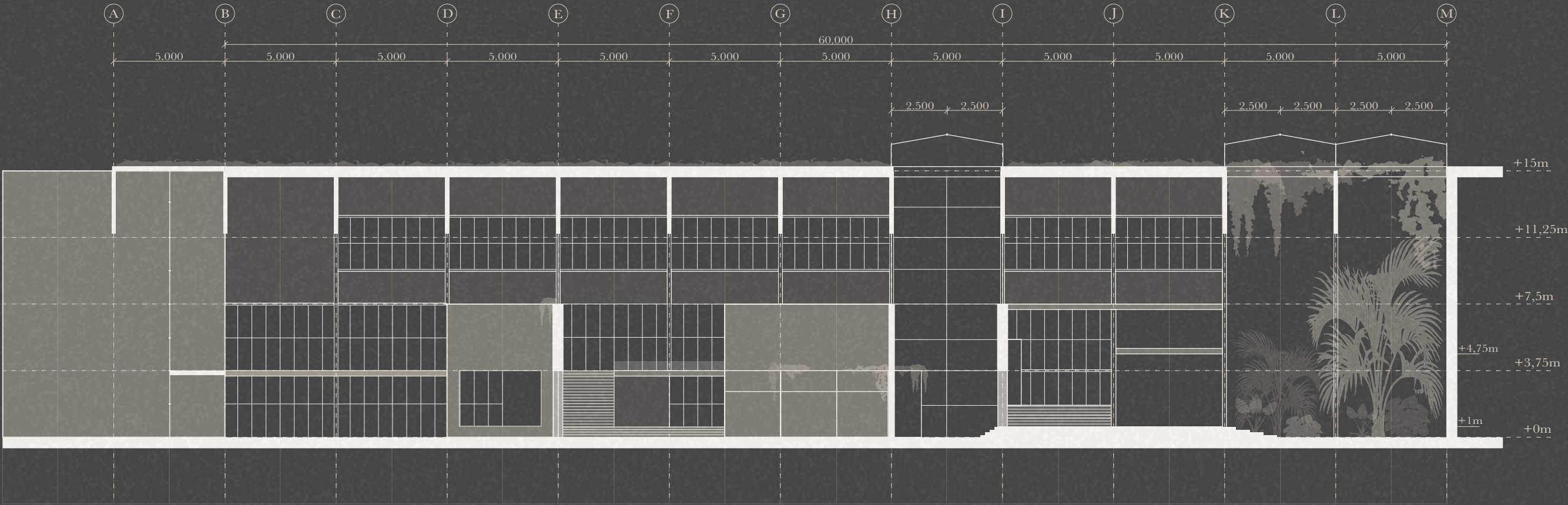


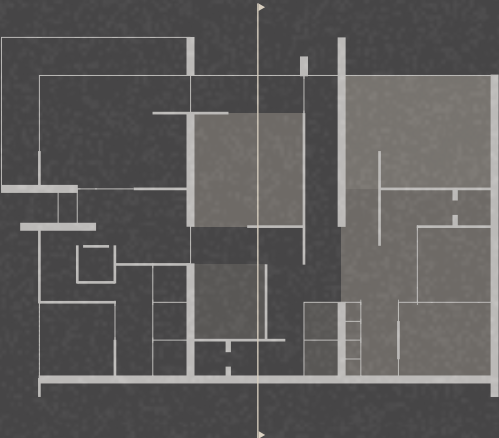
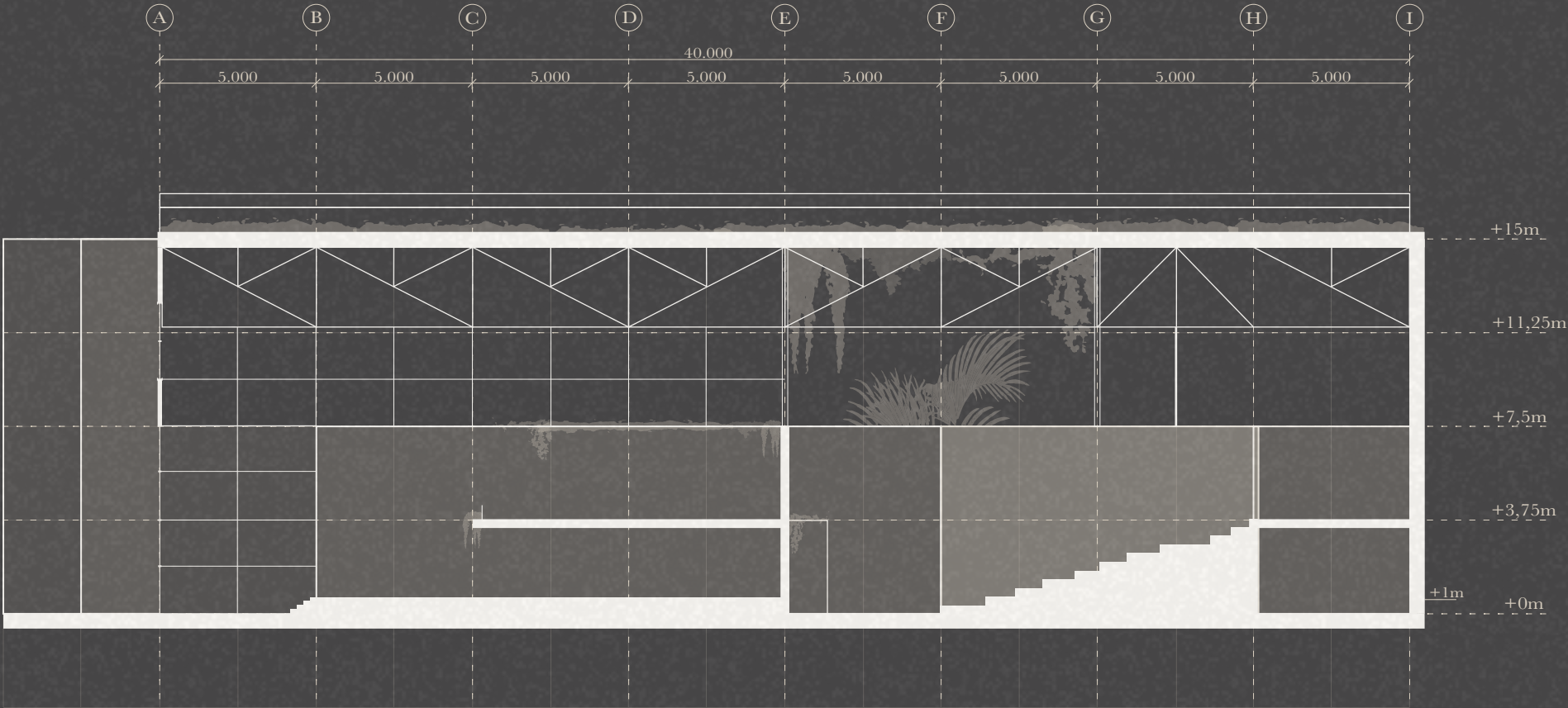




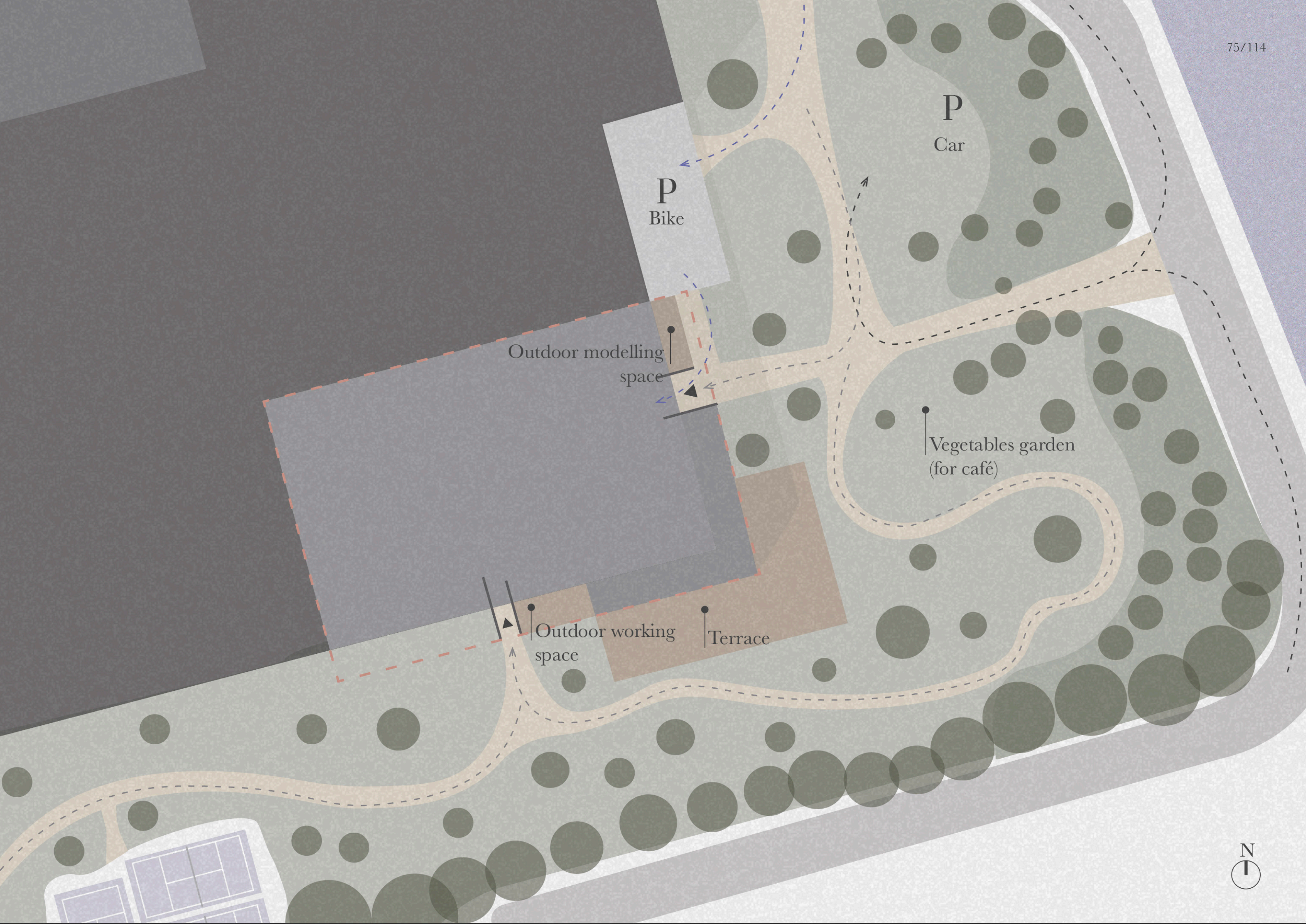












P
Bike

P
Car

Outdoor modelling
space

Vegetables garden
(for café)

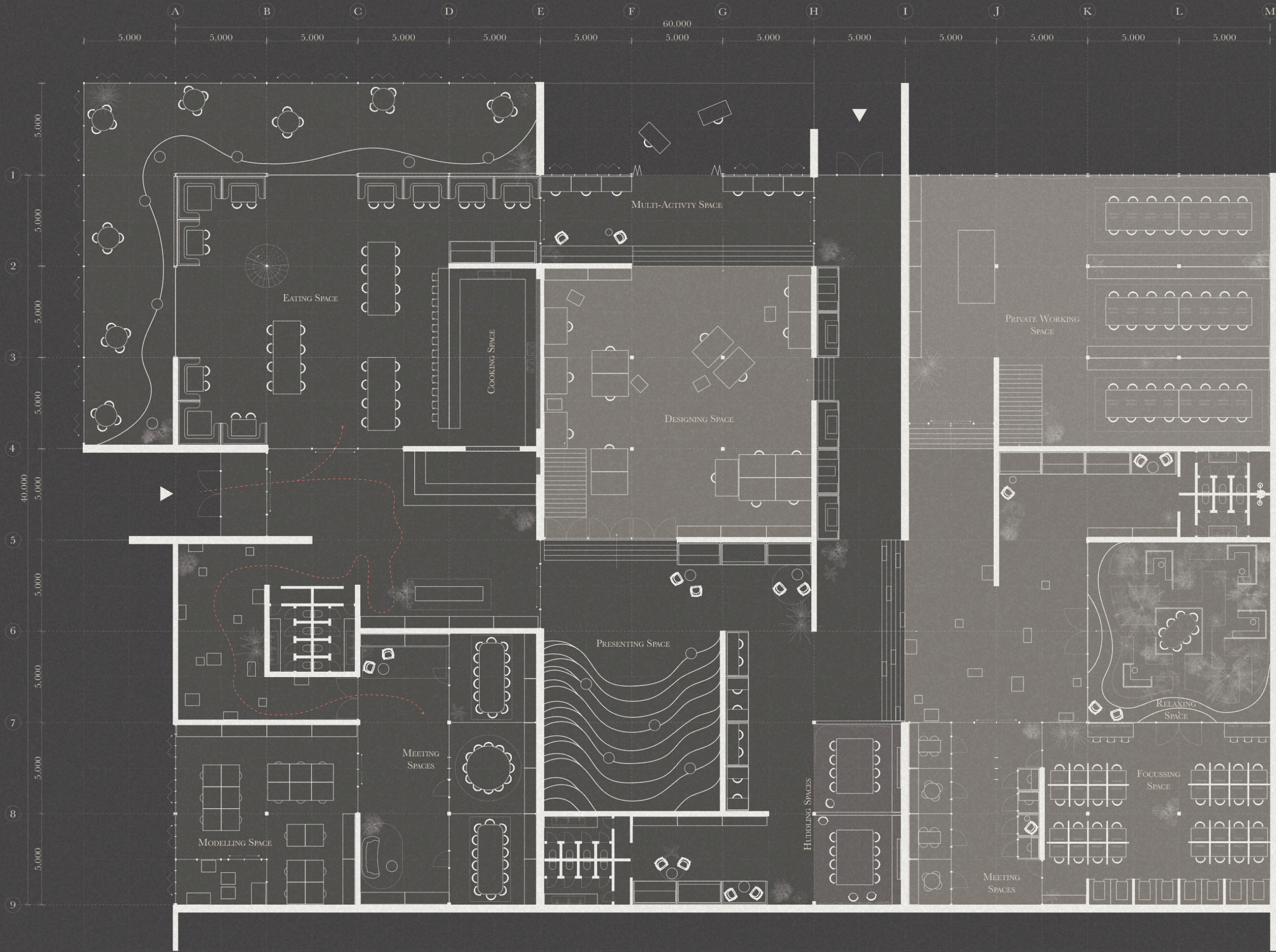
Outdoor working
space

Terrace



But first coffee





But first coffee

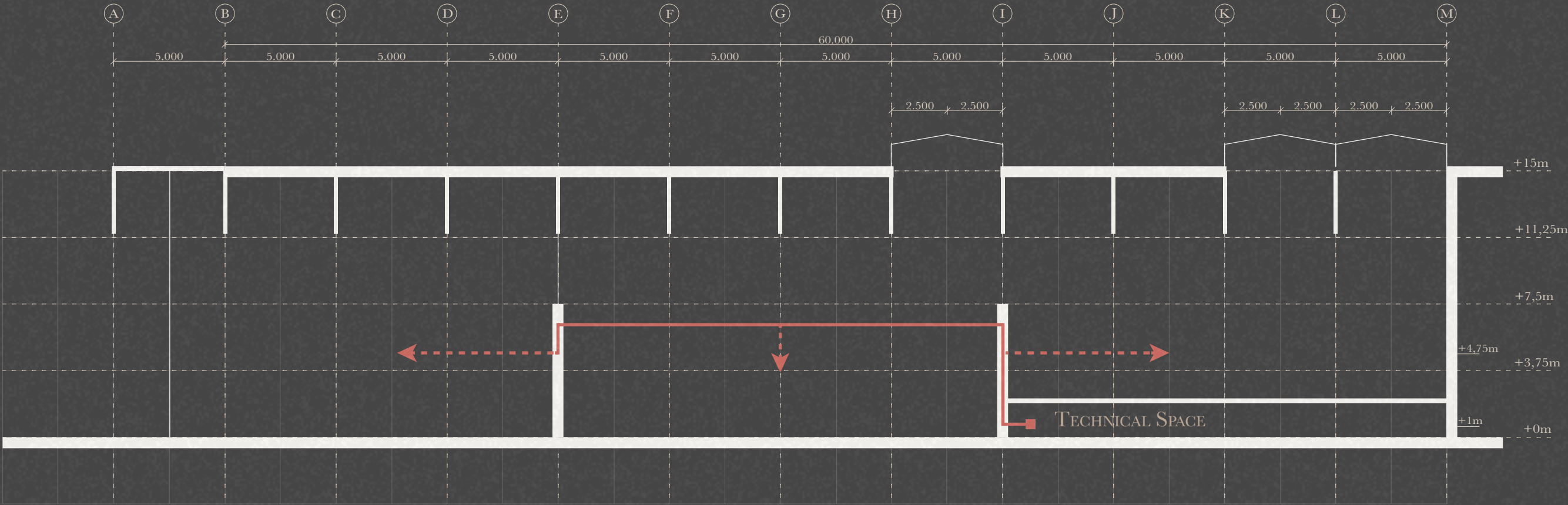




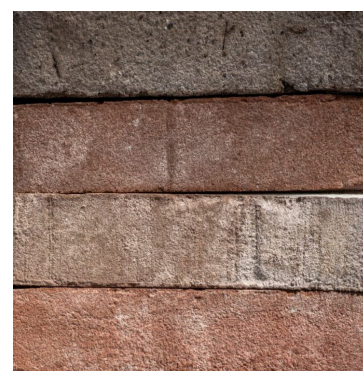
Vakwerk

But first coffee



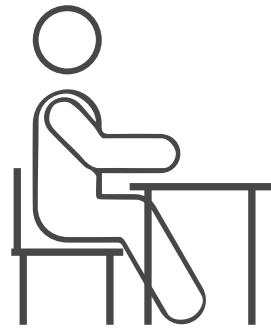




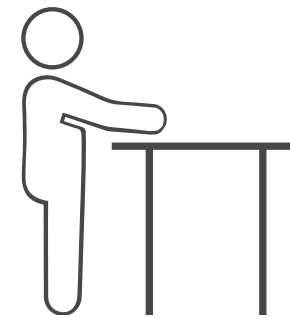




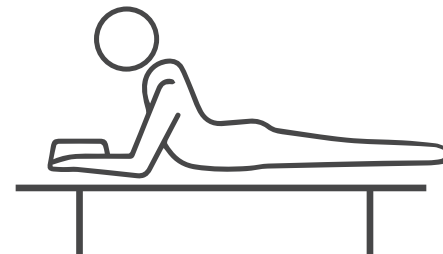
I: Sitting



II: Standing

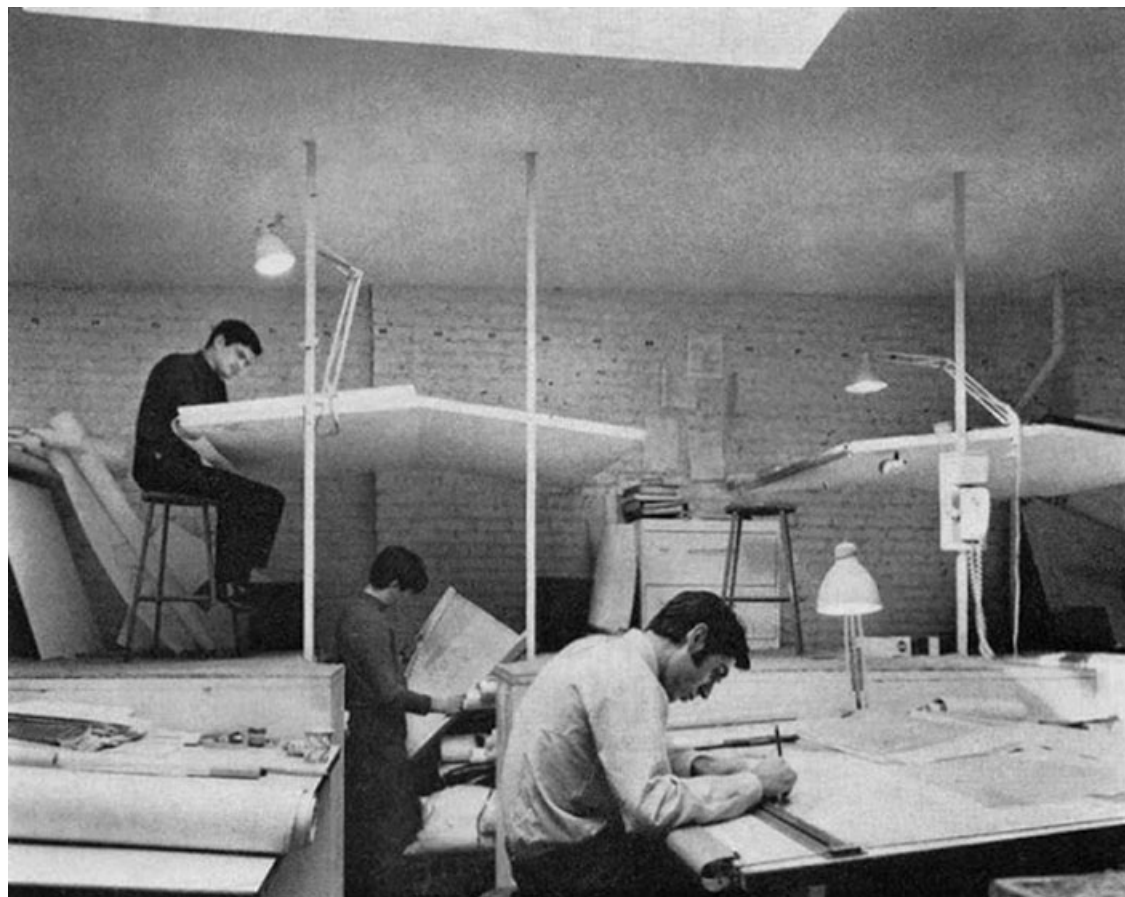


III: Laying



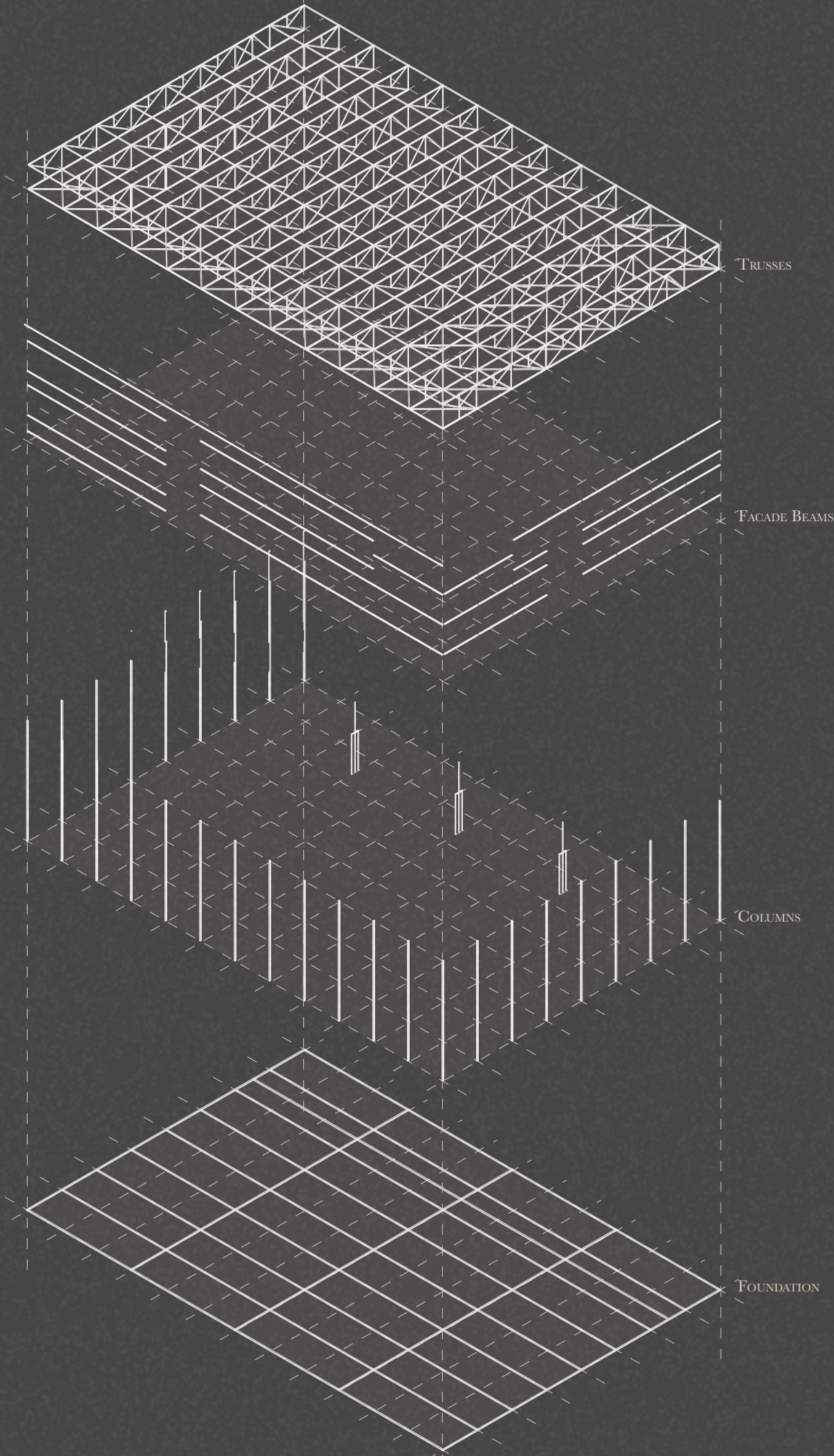
IV: Walking



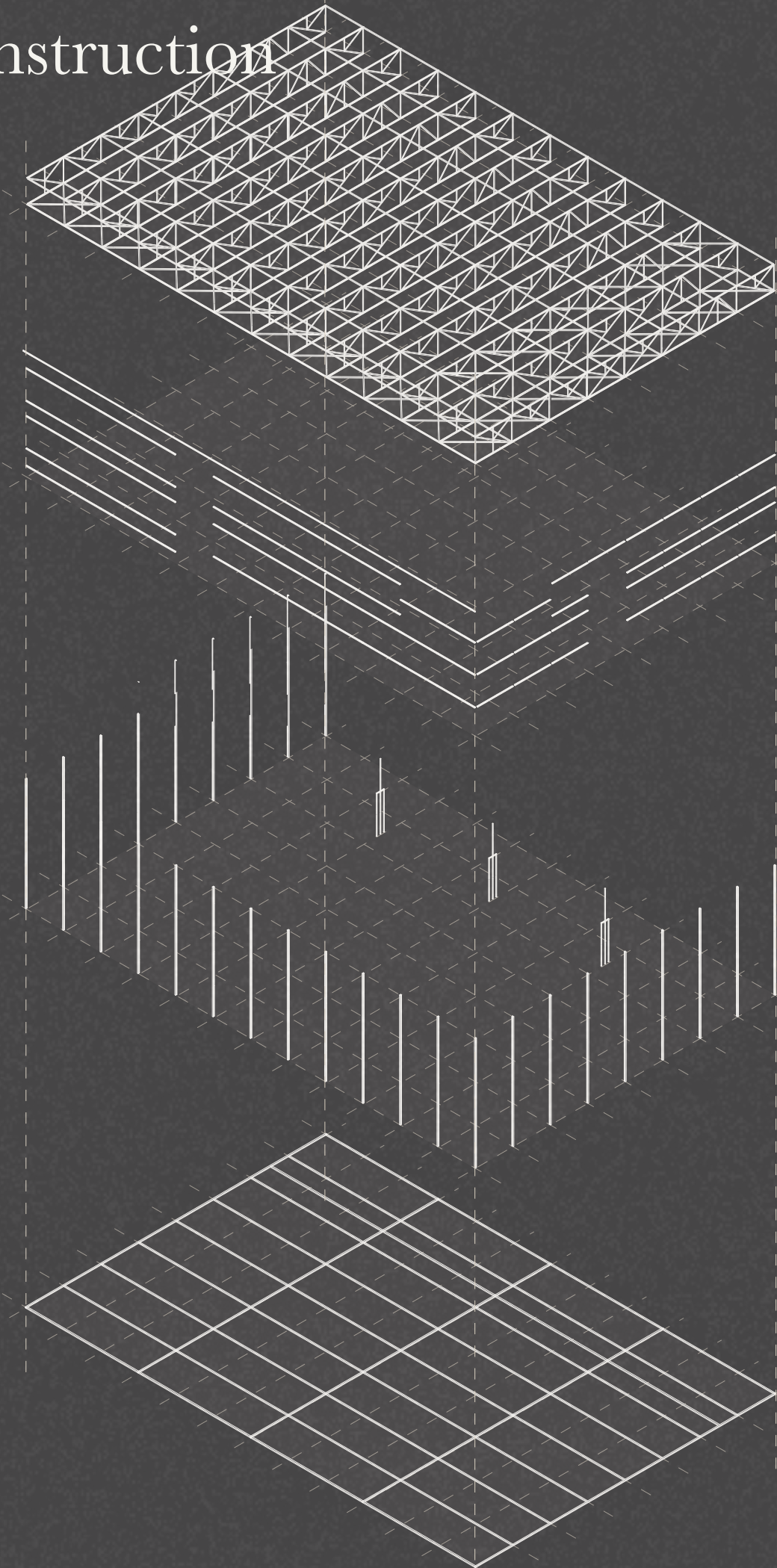




Existing construction



New construction

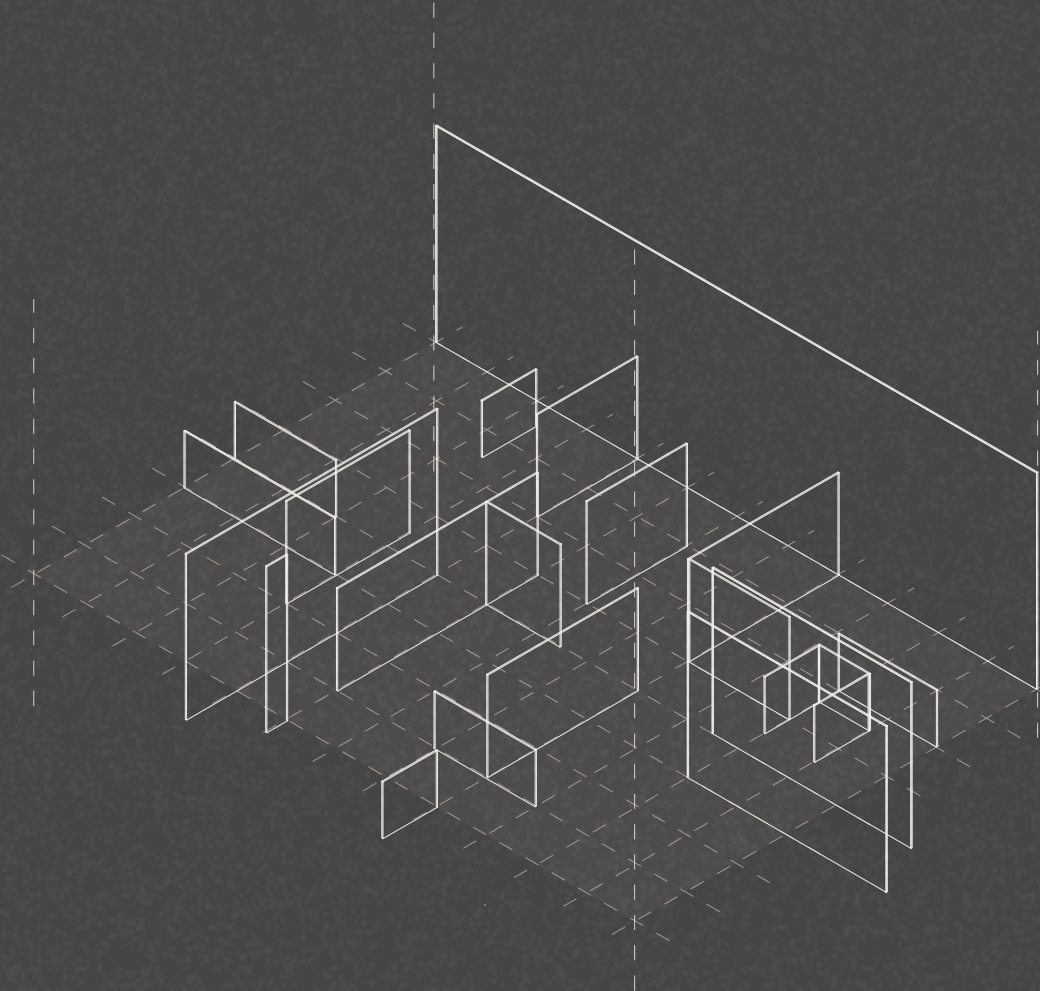


TRUSSES

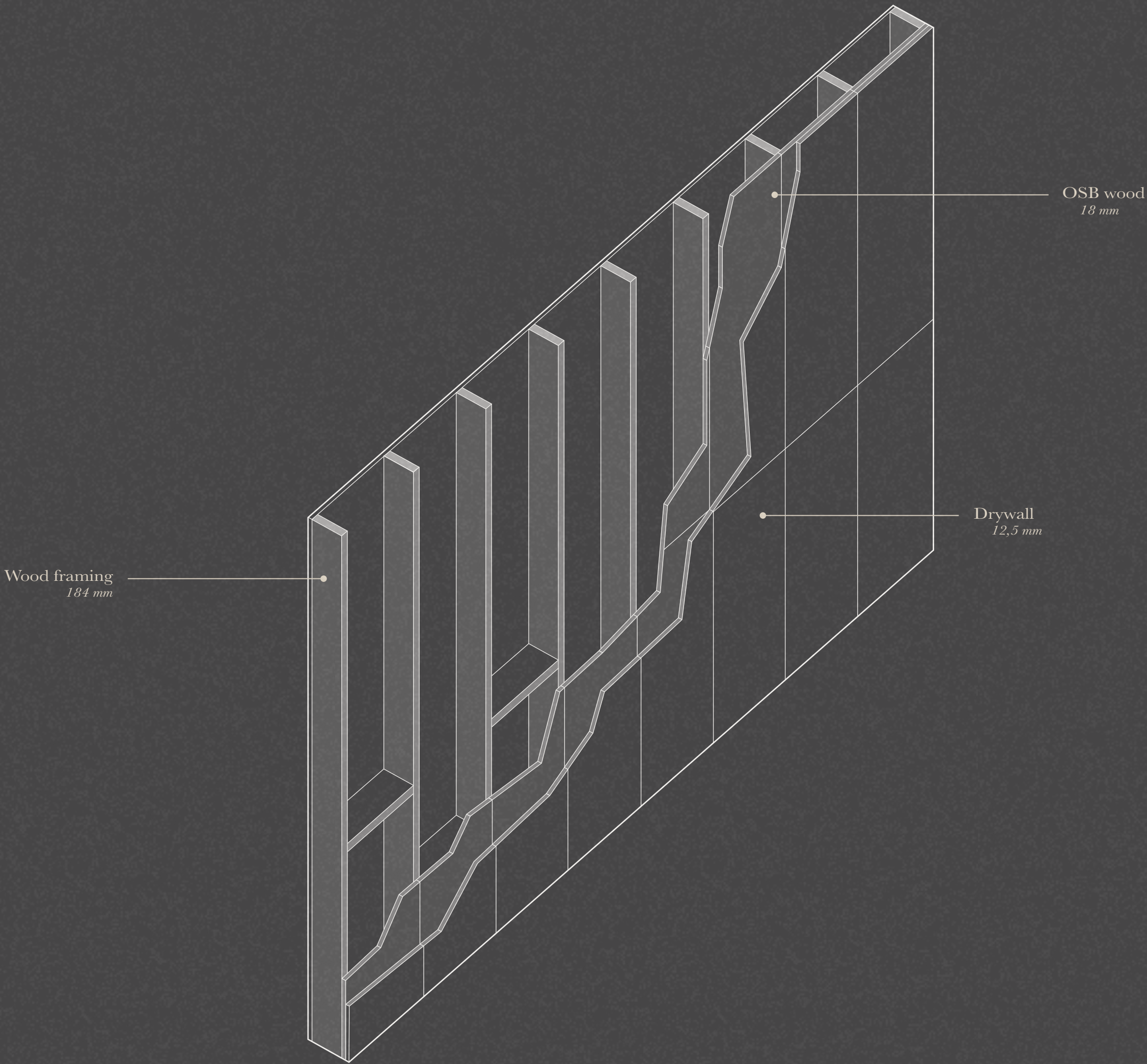
FACADE BEAMS

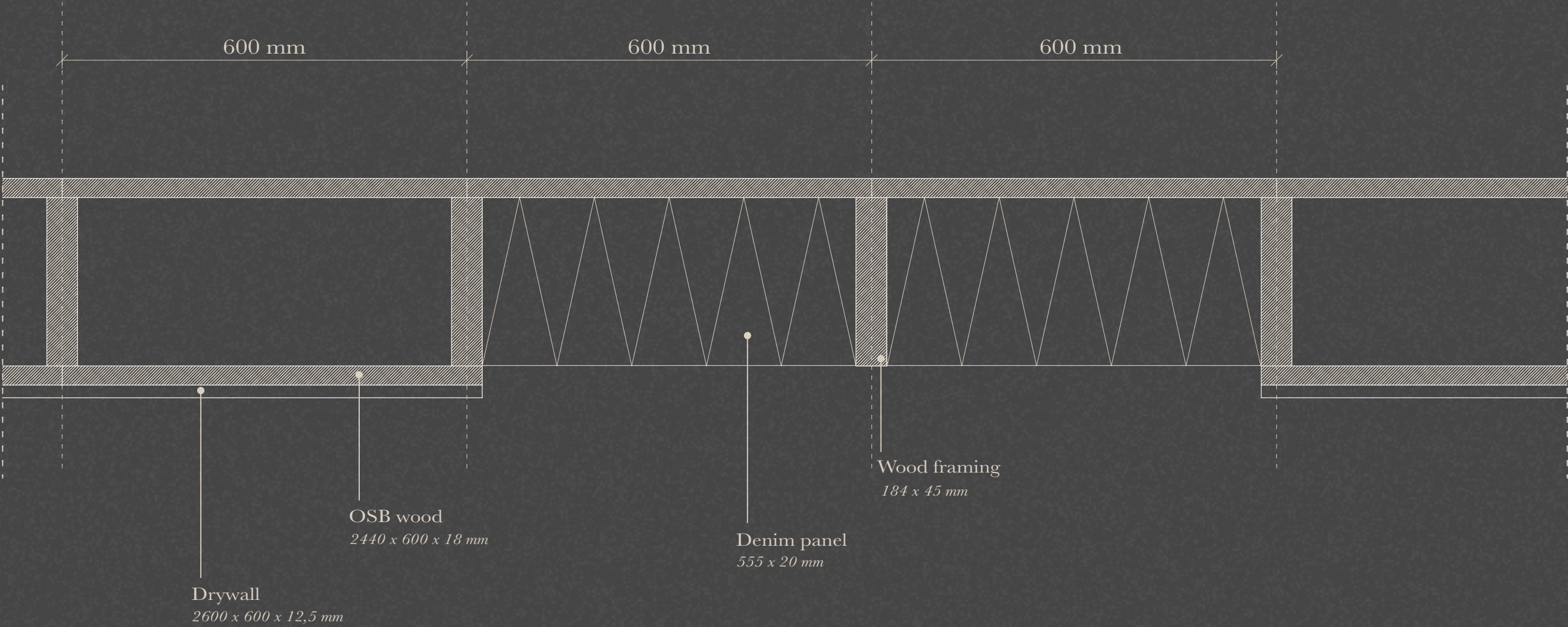
COLUMNS

FOUNDATION



WALLS

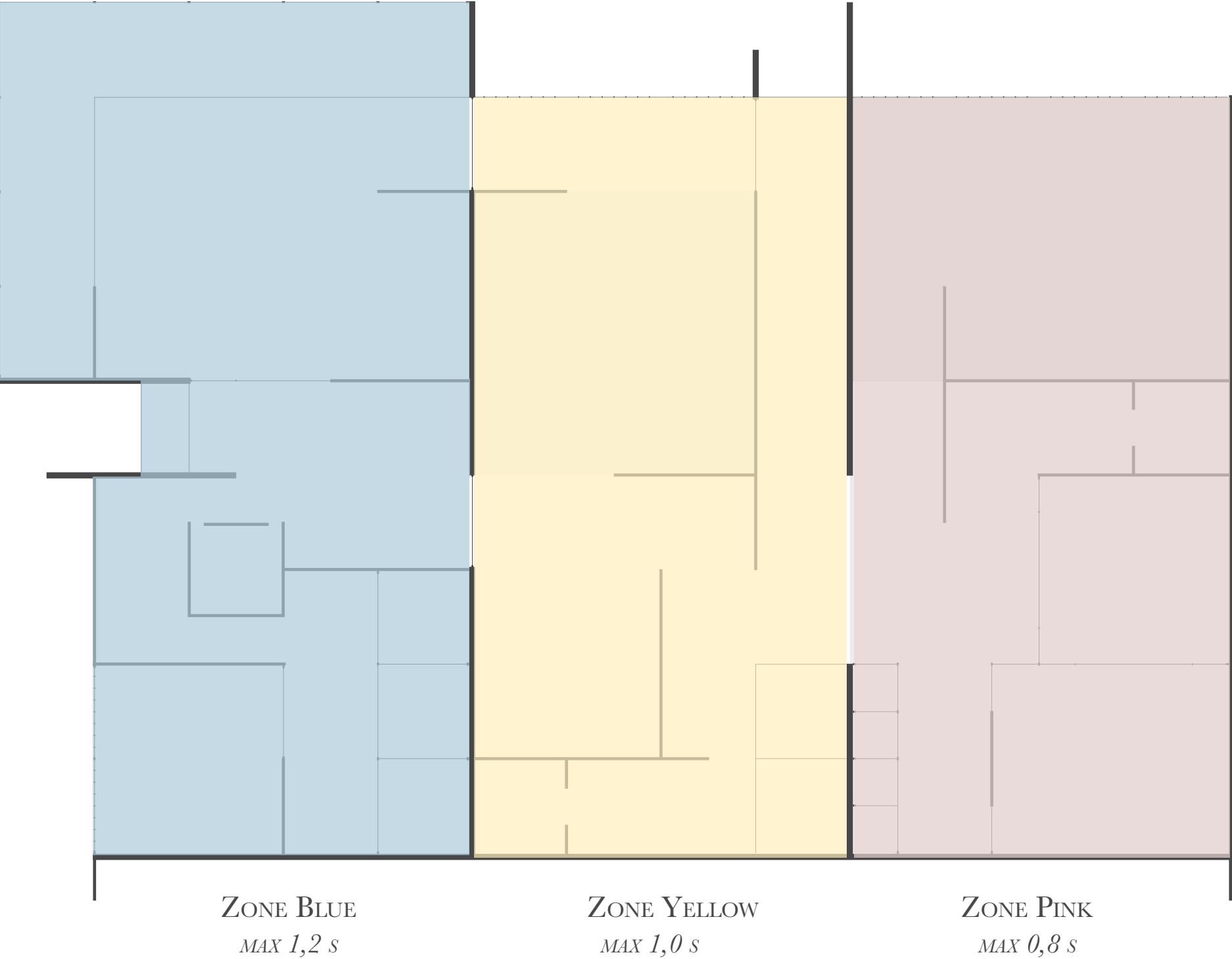






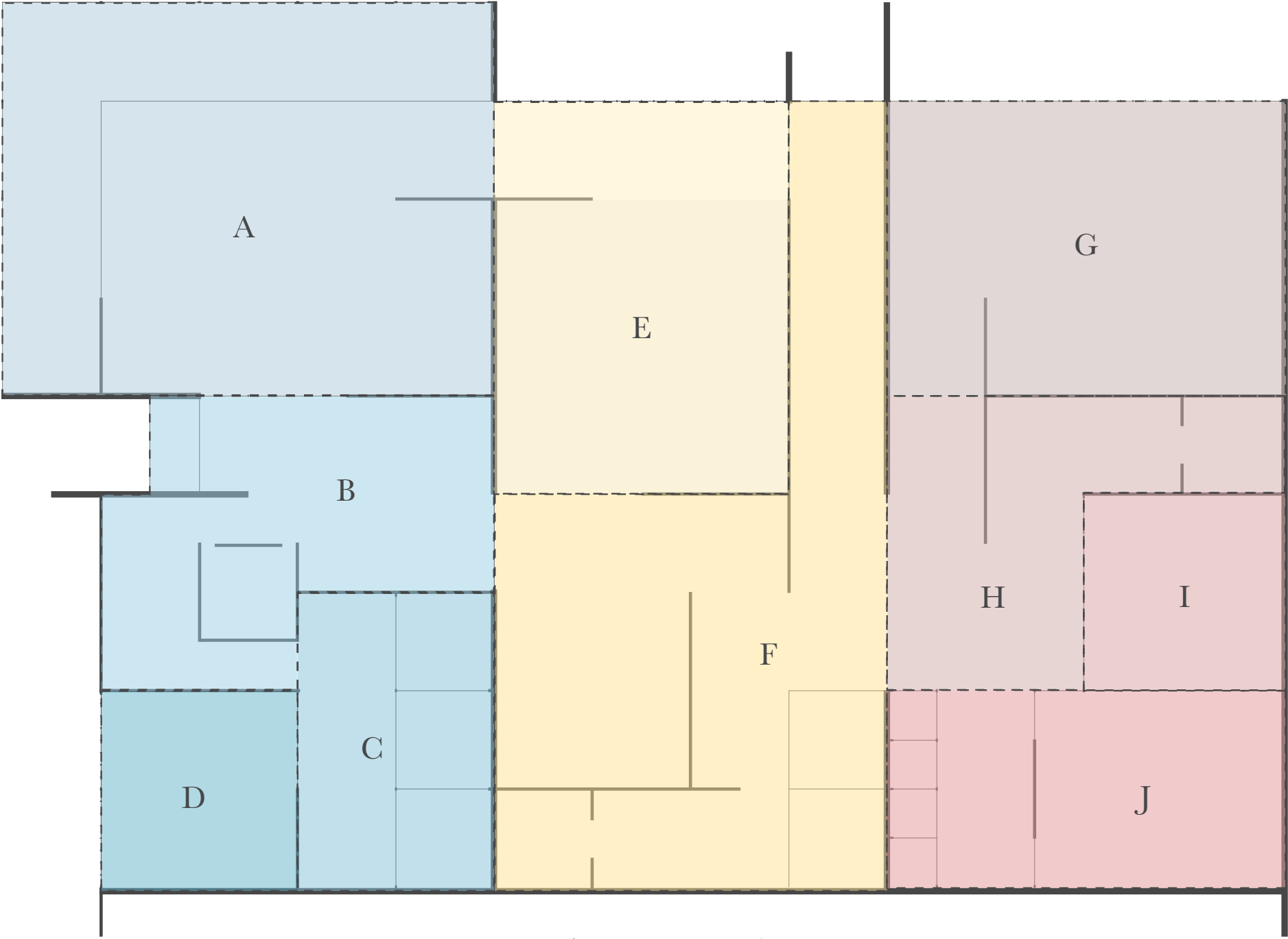
Acoustic Zones

Reverberation time per acoustic zone

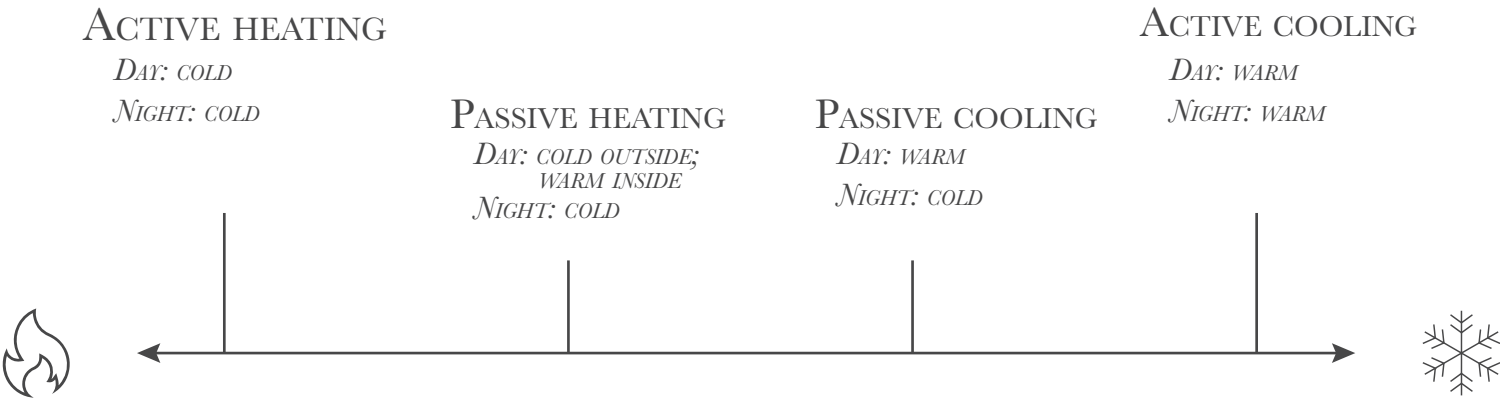


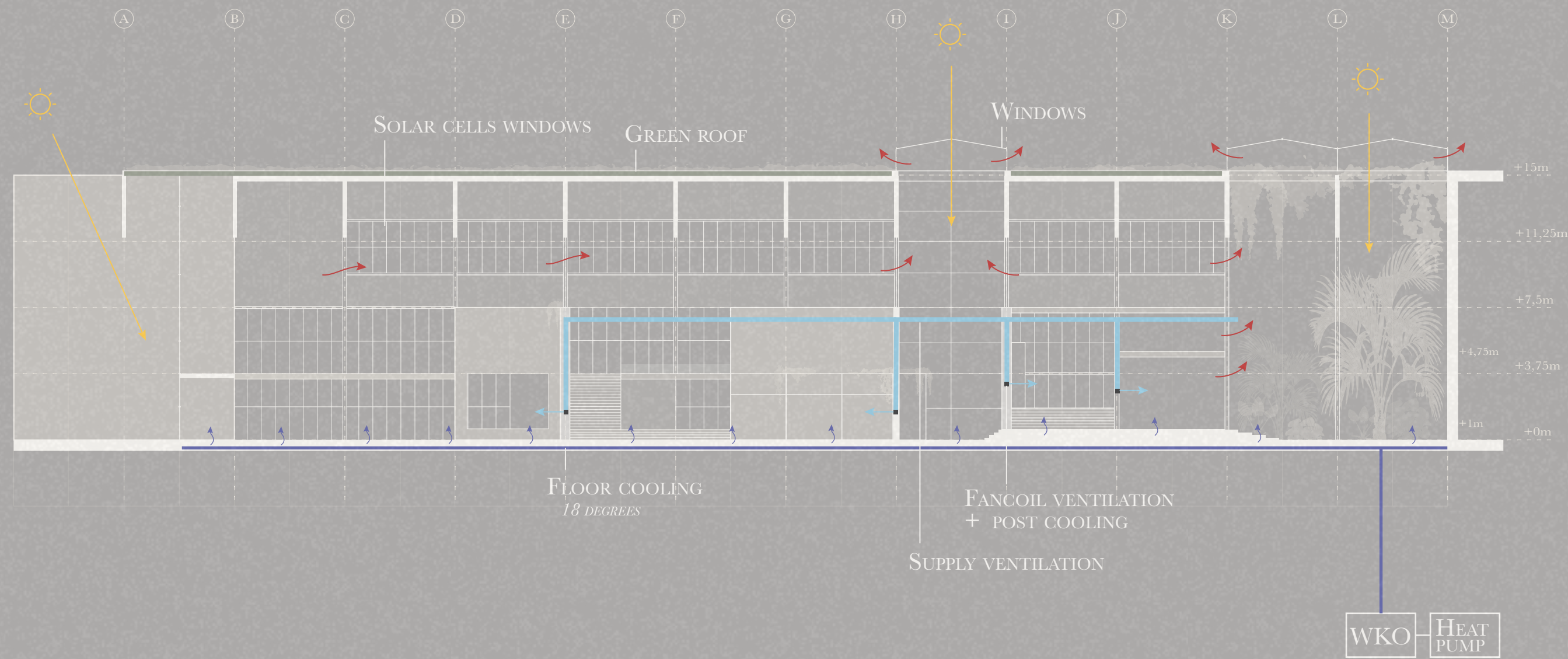
Climate Zones

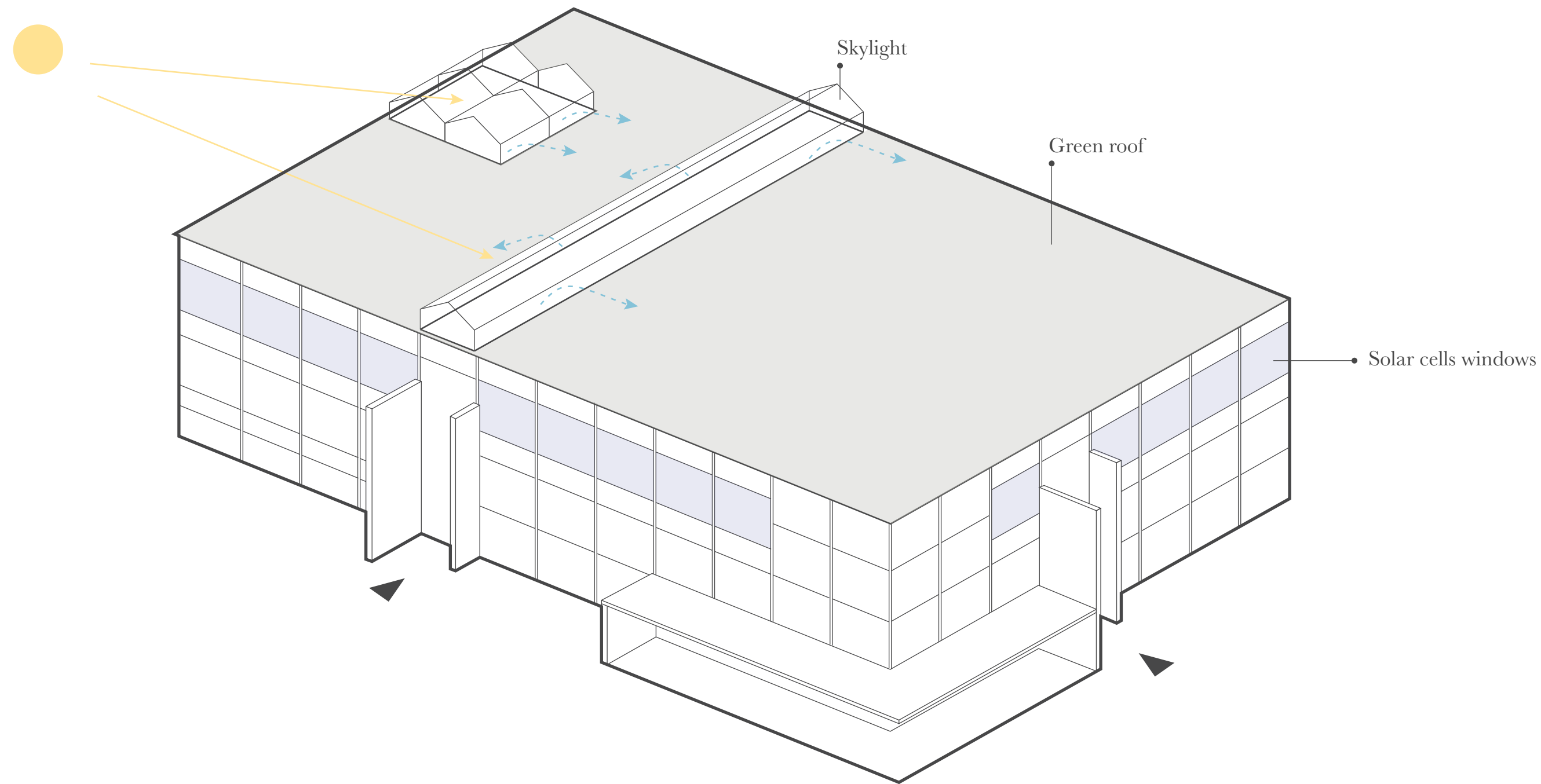
Climate zones



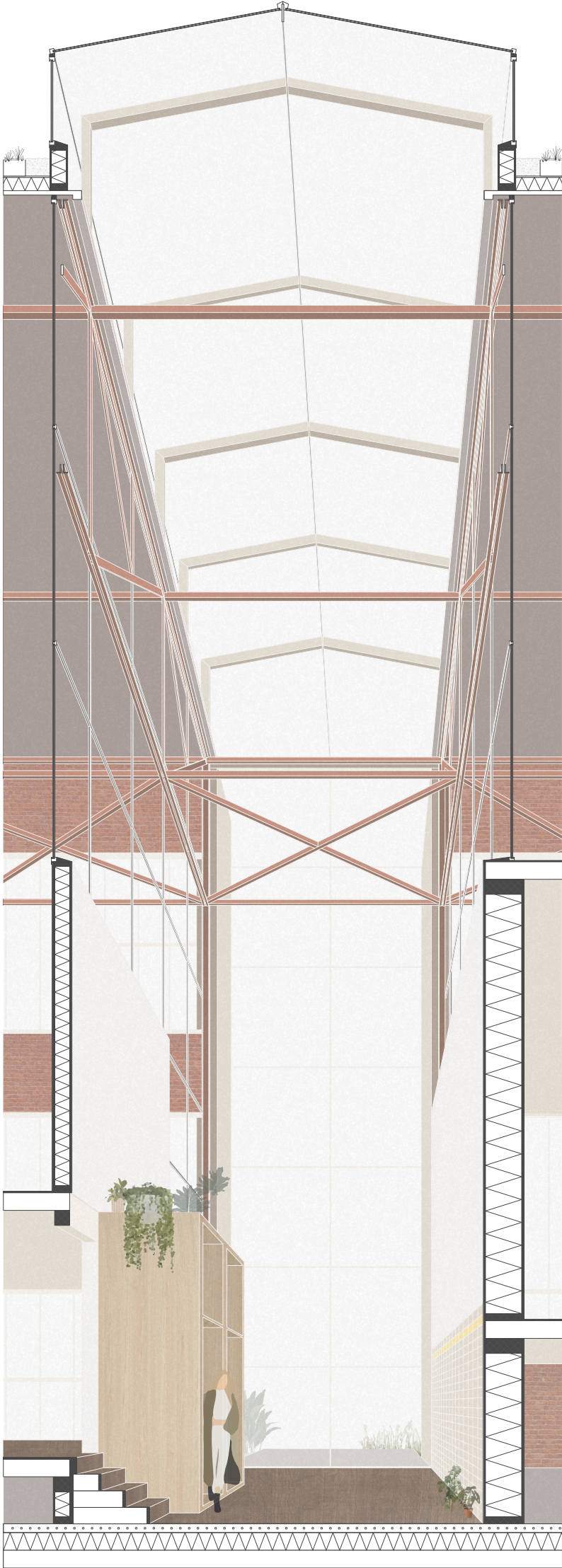
TEMPERATURE: 20 CELSIUS











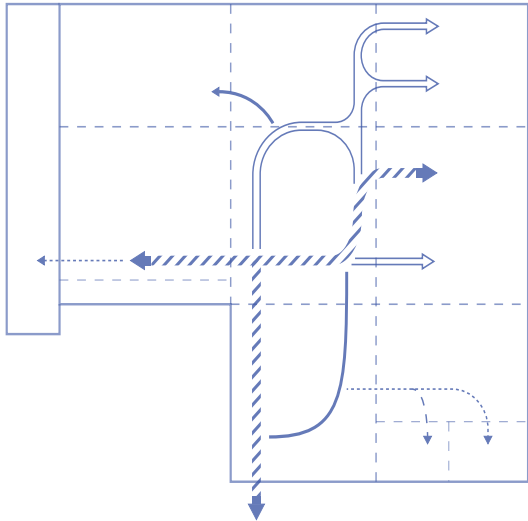


Studio of Tomorrow
Meeting space
Focussing space
Breathing space

Comparison case studies

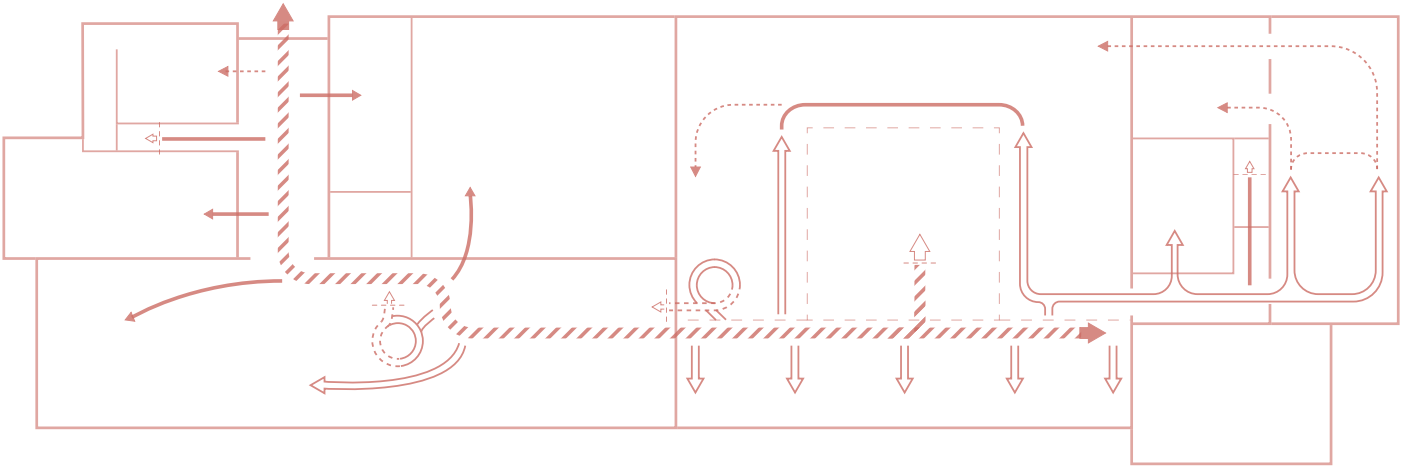
Route

I: Beltman



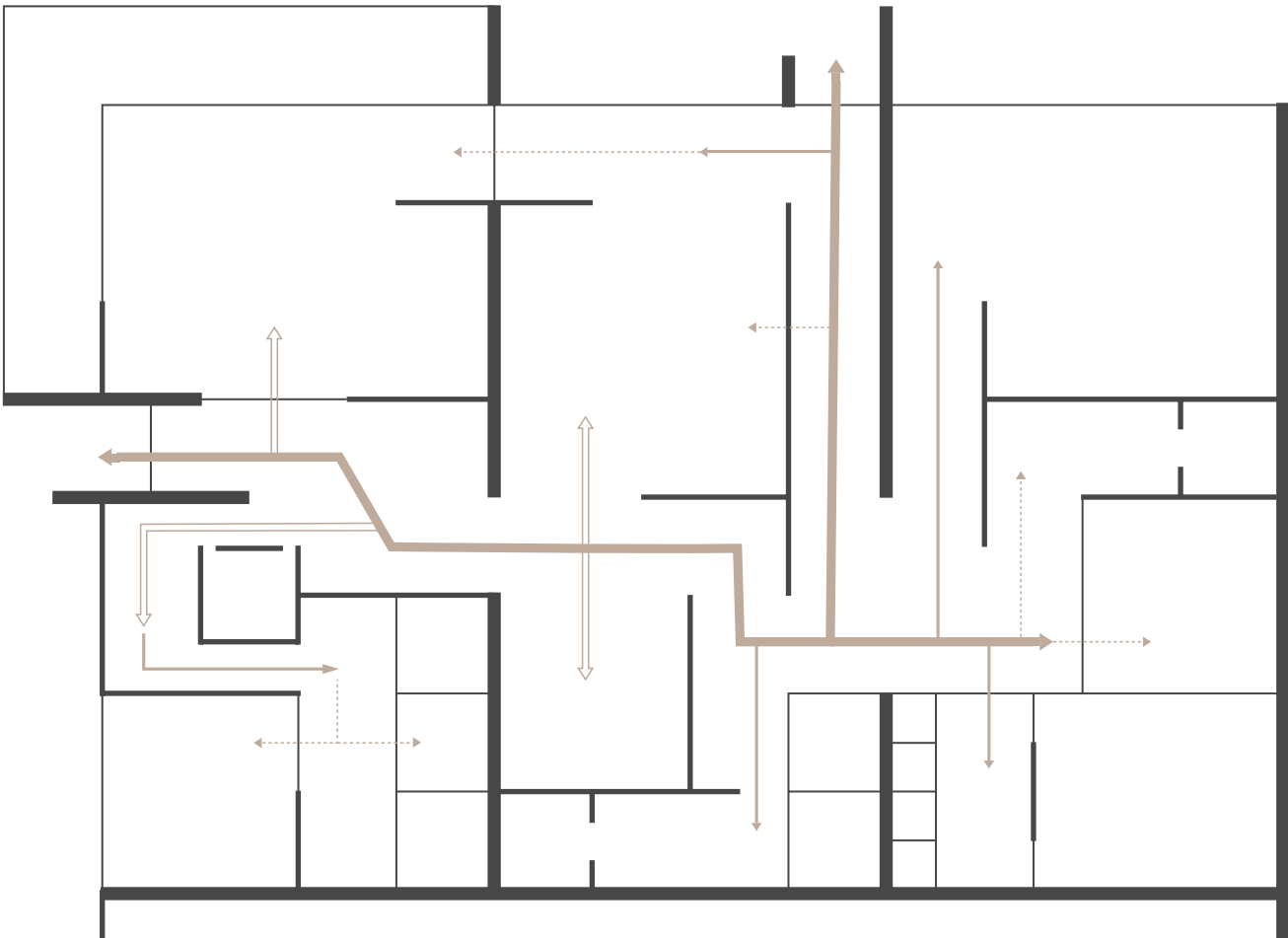
LEGEND
primary route
secondary route
tertiary route
quaternary route

II: Vakwerk



LEGEND
external/internal meetings
internal meetings

III: Studio of Tomorrow

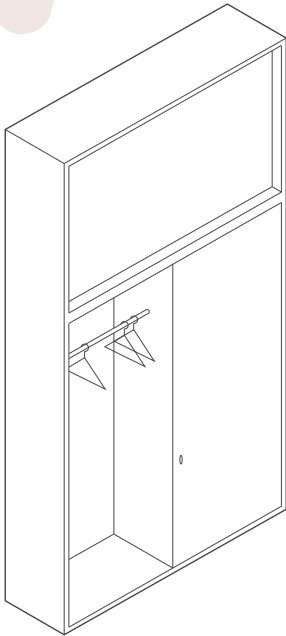




Studio of Tomorrow
Meeting space
Focussing space
Breathing space

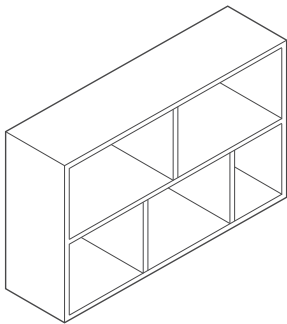
Units catalogue

I: Garderobe



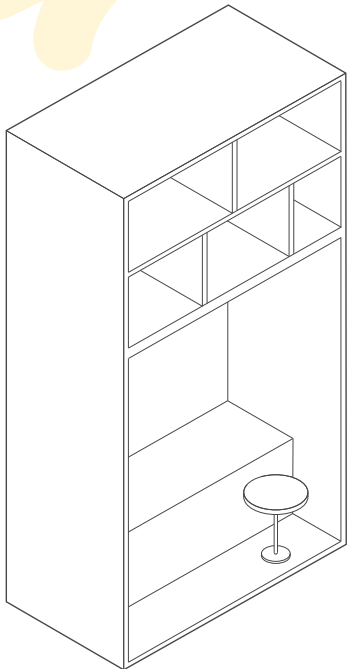
Height: 3,75 m
Width: 2,50 m
Depth: 0,60 m

II: Storage



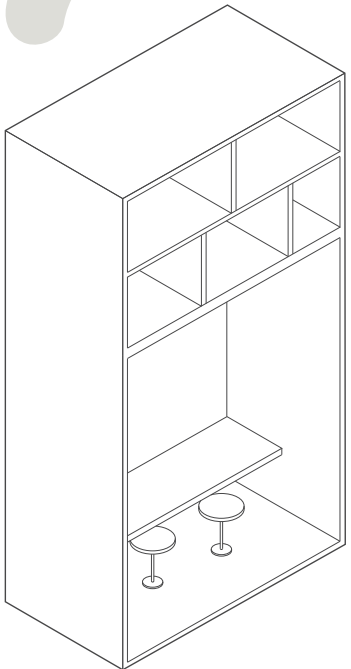
Height: 1,25 m
Width: 2,50 m
Depth: 0,60 m

III: Lounge



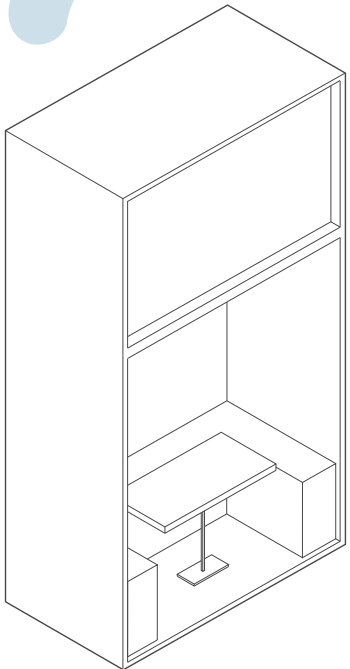
Height: 3,75 m
Width: 2,50 m
Depth: 1,20 m

IV: Work station



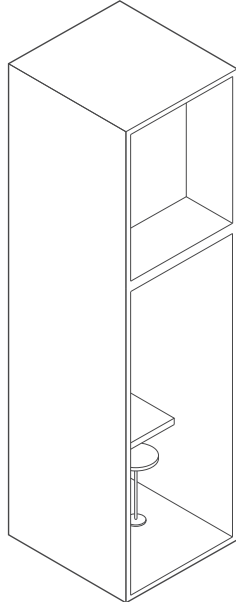
Height: 3,75 m
Width: 2,50 m
Depth: 1,20 m

V: Meeting booth



Height: 3,75 m
Width: 2,50 m
Depth: 1,20 m

VI: Phone booth

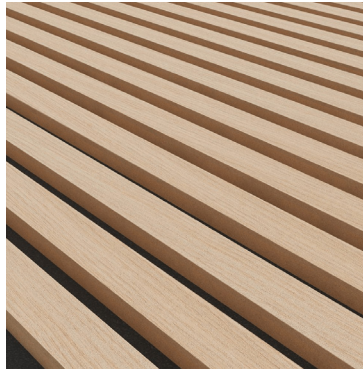


Height: 3,75 m
Width: 1,25 m
Depth: 1,20 m



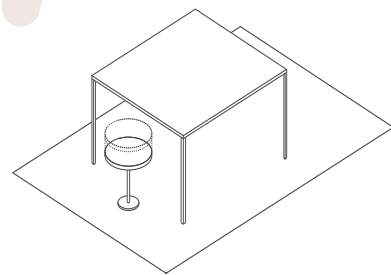
Studio of Tomorrow
Meeting space
Focussing space
Breathing space





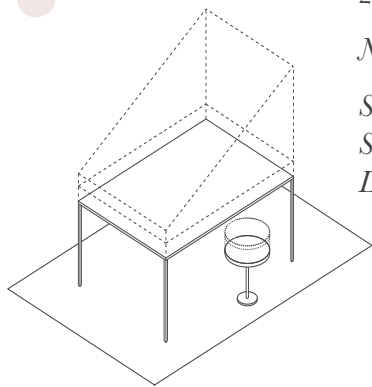
Workstations catalogue

I: Modelling station



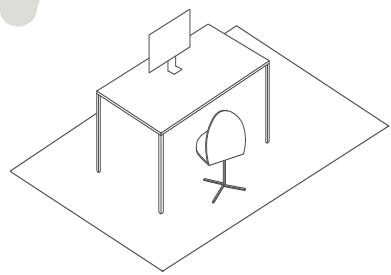
1,2 x 1 m
No electricity
Sitting
Standing

II: Designing station



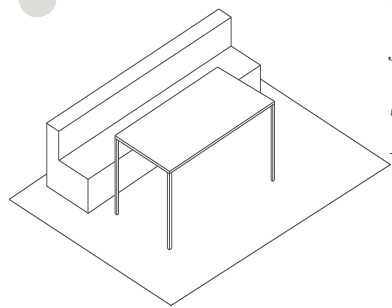
2 x 1,2 m
No electricity
Sitting
Standing
Laying

I: Focussing station



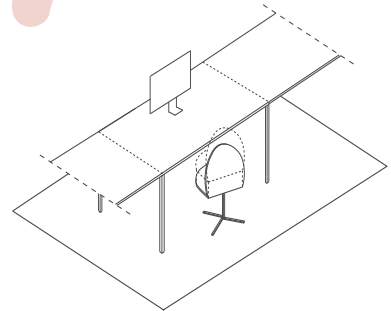
1 x 0,75 m
Screen
Sitting

II: Focussing station



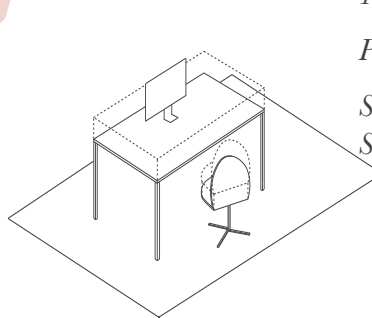
1 x 0,65 m
No electricity
Sitting
Laying

III: Computing station



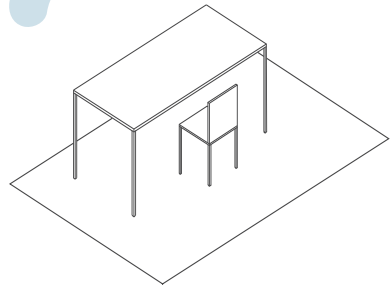
1 x 0,75 m
PC
Sitting

IV: Computing station



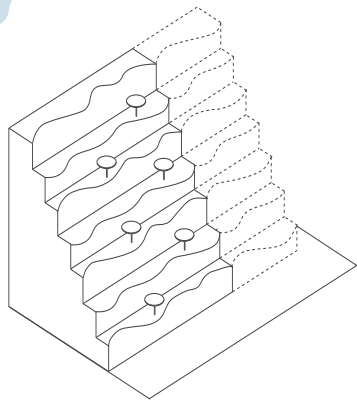
1 x 0,75 m
PC
Sitting
Standing

III: Multi-activity station



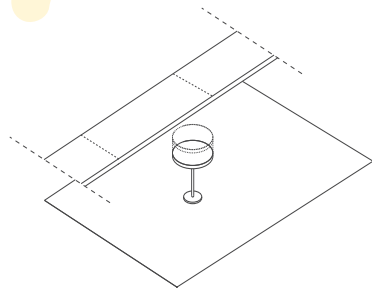
1 x 0,75 m
No electricity
Sitting

IV: Presenting station



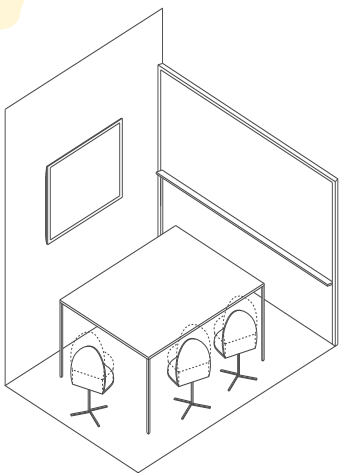
Height: 3,75 m
No electricity
Sitting
Laying

V: Huddling station



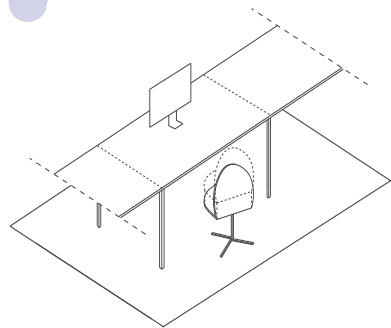
1 x 0,75
No electricity
Sitting
Standing
Walking

VI: Huddling station



3 x 2 m
TV
Whiteboard
Sitting
Standing
Laying
Walking

V: Fixed working station



1 x 0,75 m
PC
Sitting

The diagram illustrates the relationship between different types of work stations. A horizontal axis represents the spectrum from 'least equipped work station' on the left to 'most equipped work station' on the right. A vertical axis represents the spectrum from 'individual work station' at the top to 'group work station' at the bottom. Vertical bars of different colors (red, brown, blue) are placed at various points along the horizontal axis, indicating the presence of specific work stations. The bars are distributed across the spectrum, with some appearing as single bars and others as pairs or groups. The colors of the bars (red, brown, blue) likely represent different categories or types of work stations, as suggested by the legend in the adjacent figure.

Comparison case studies

Work stations

I: Beltman

Workspaces: 34%

5 m² per work station

II: Vakwerk

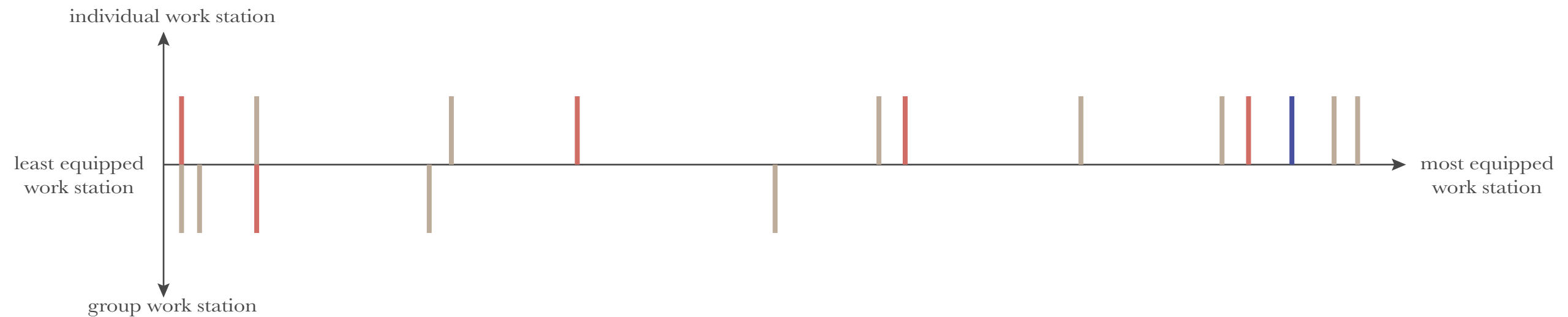
Workspaces: 52,2%

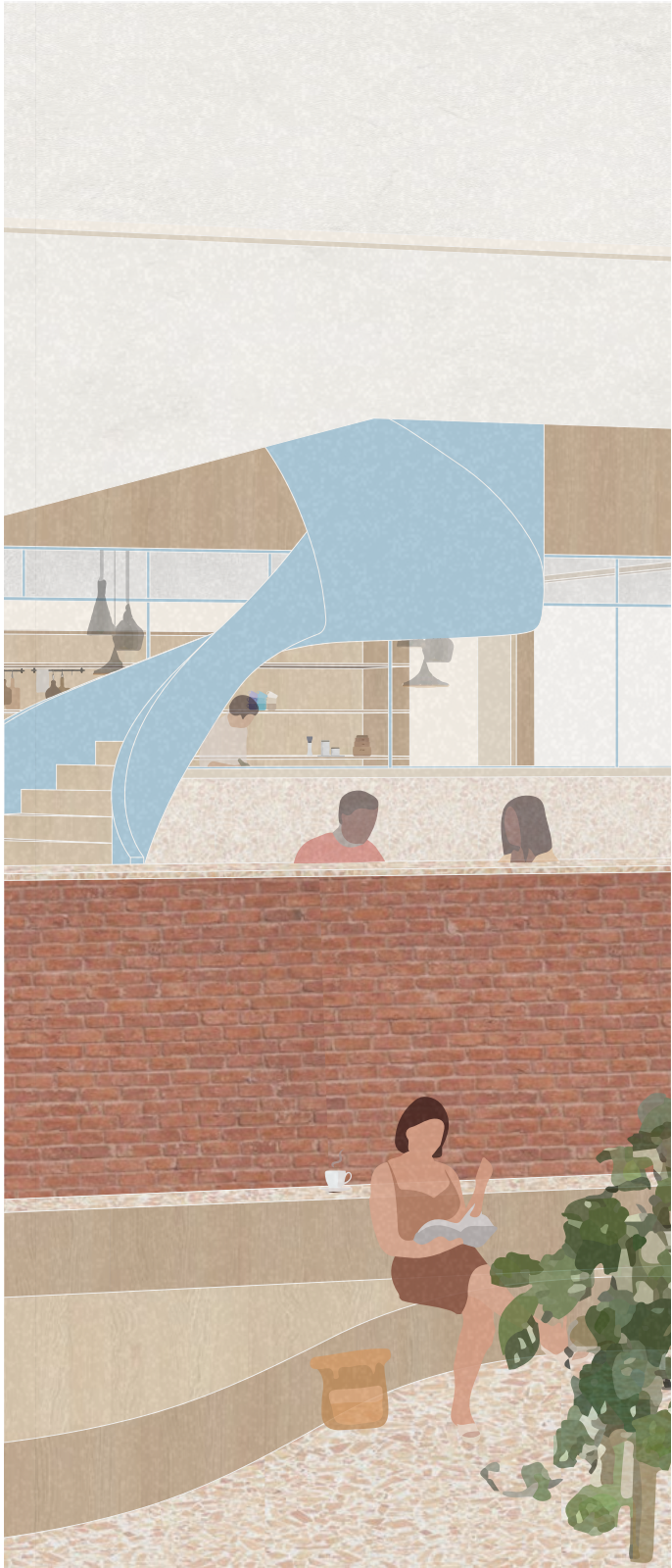
4 m² per work station (average)

III: Studio of Tomorrow

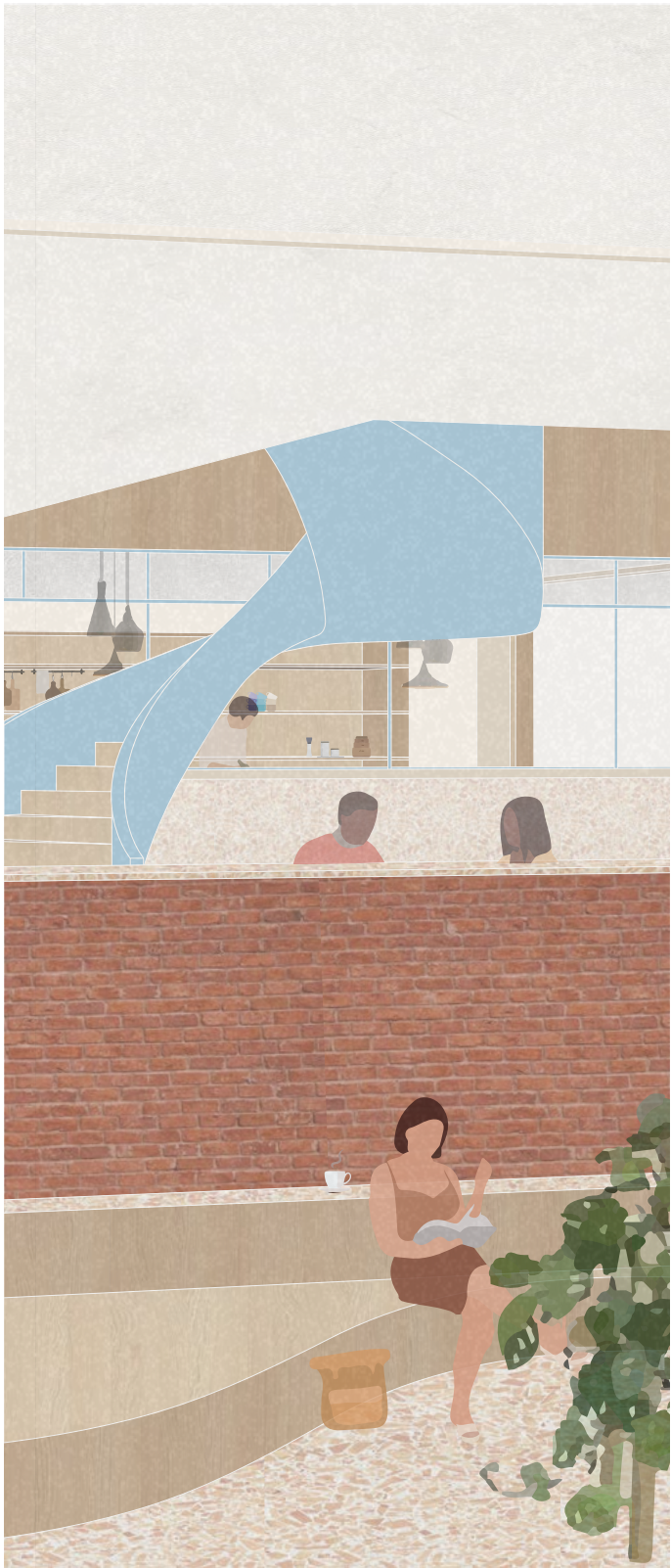
Work stations: 50%

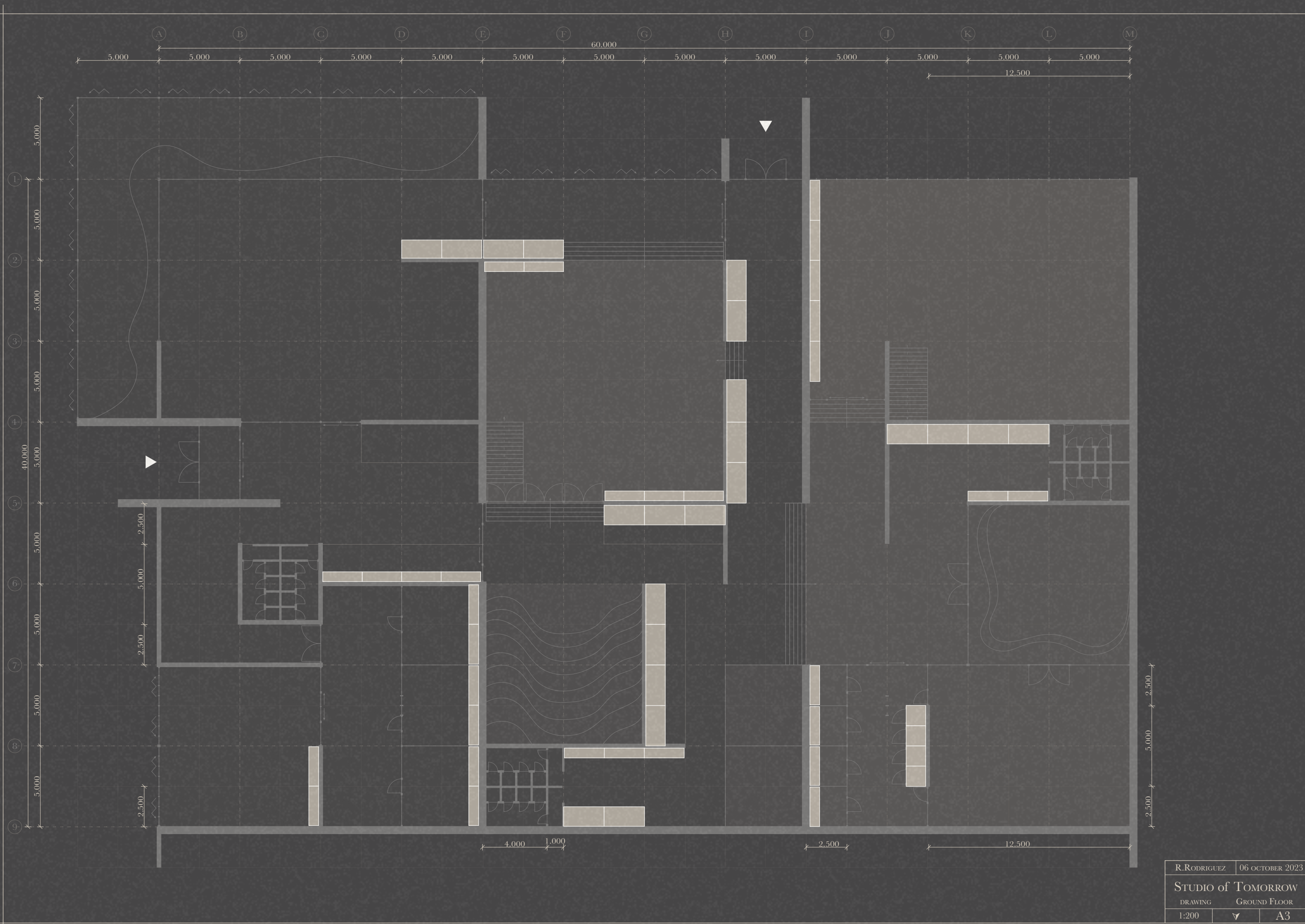
5 m² per work station (average)







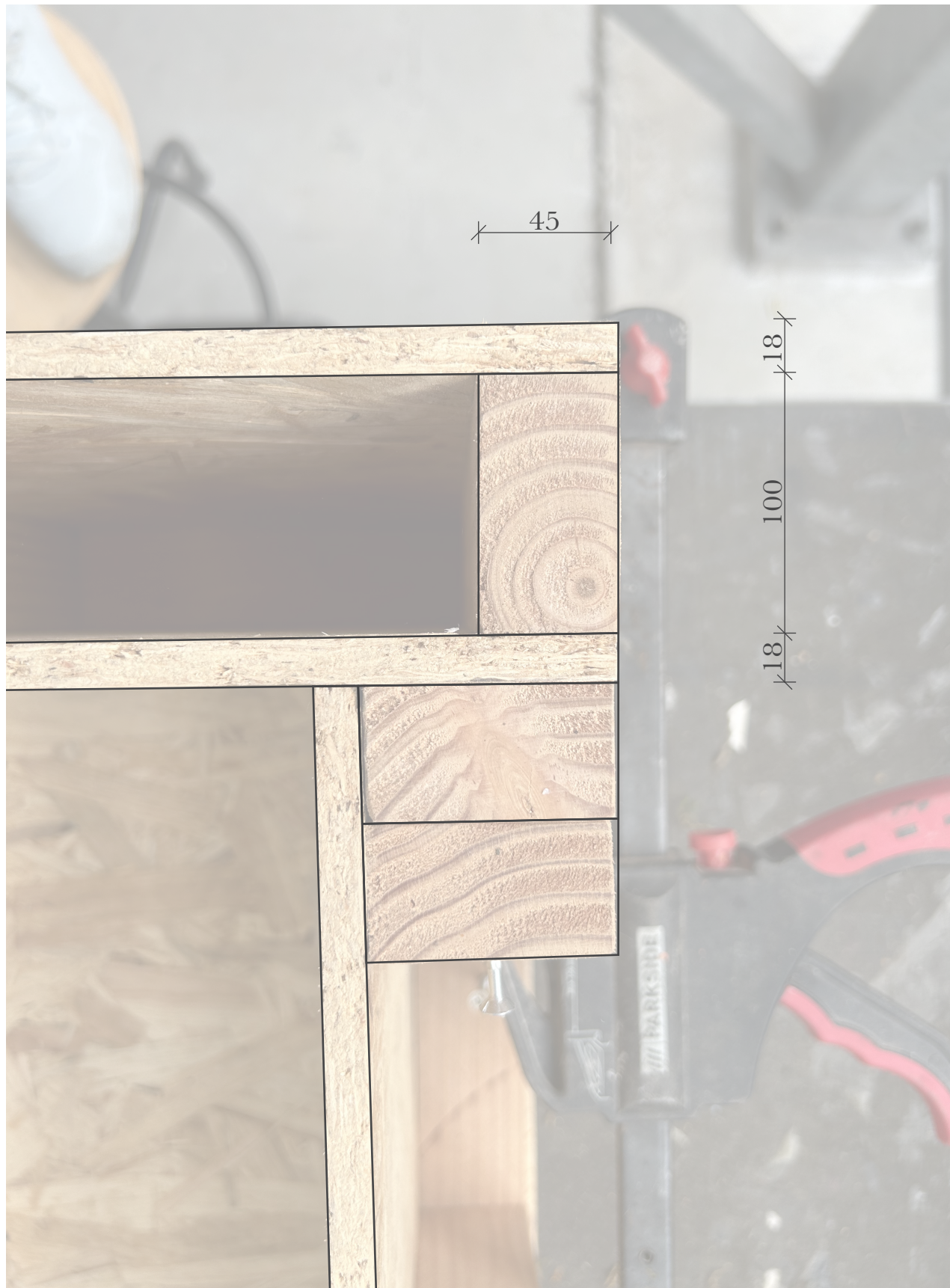




Units construction



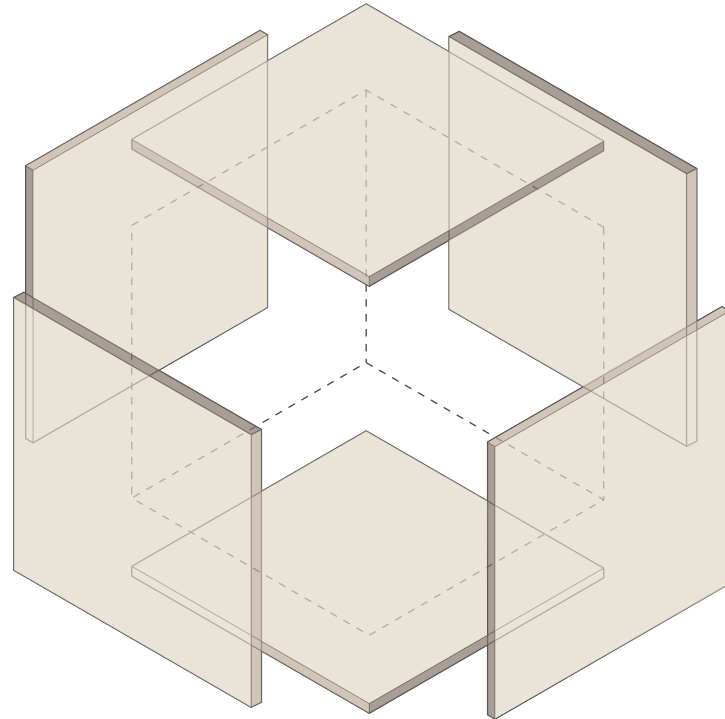
Units construction



Acoustic measurements

Quiet Space

I: Create enclosed space



II: Use acoustic positive materials



Carpet



Textile

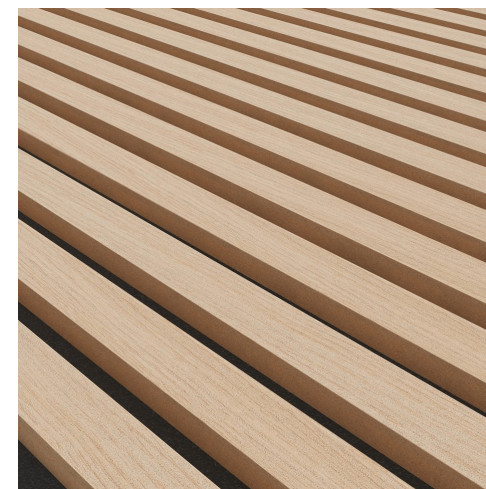


Velvet wallpaper



Foam wallpaper

Reverberation time: 0,6 s

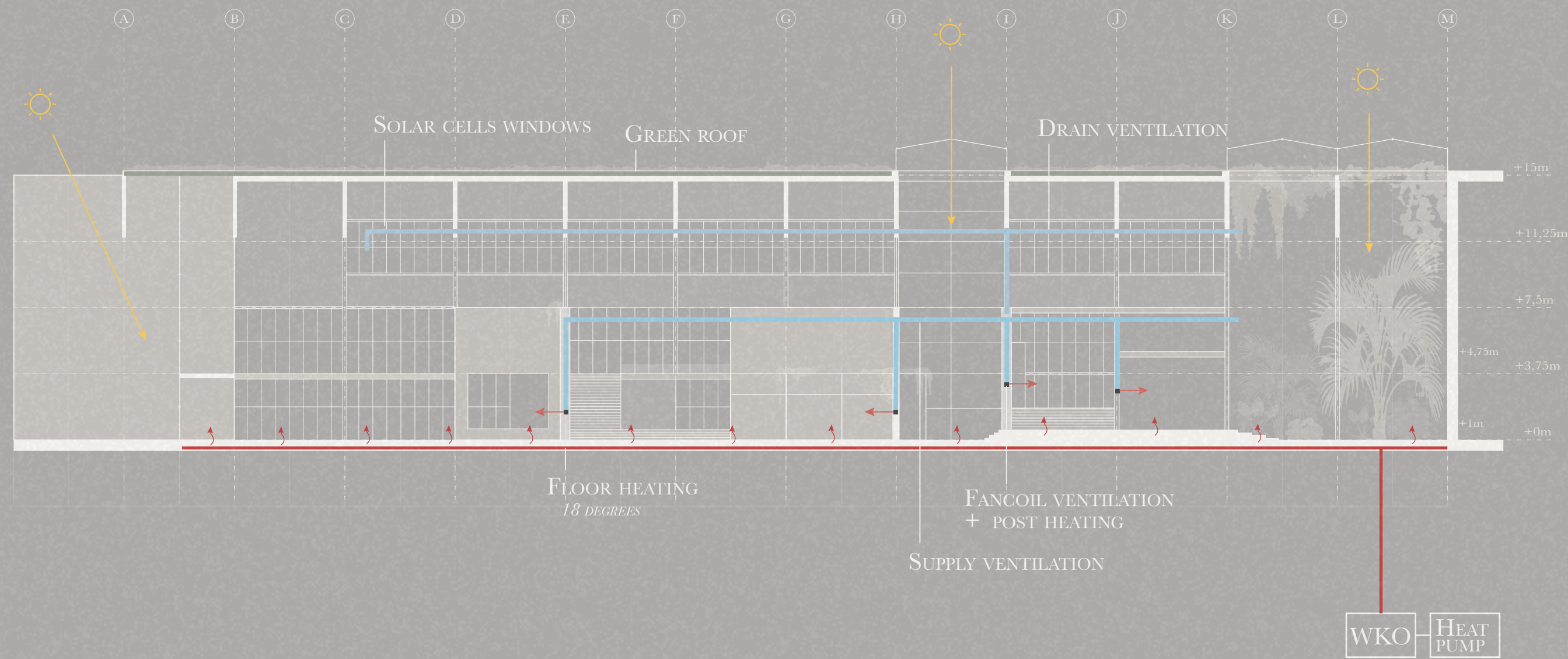


WoodUpp ceiling



Desk screen

Climate winter

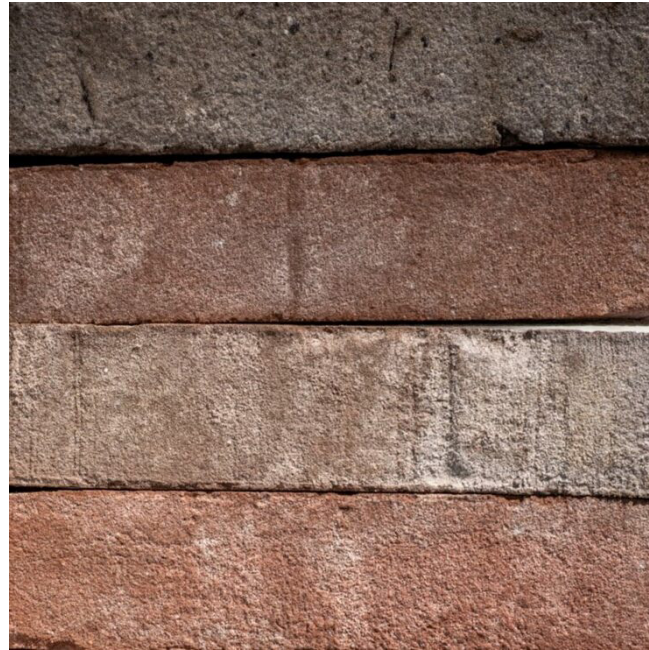


Sustainability

Brick



Existing



Waste based brick

Stonecycling

Wood



Reclaimed wood

Buitenleven Second Life



Wood terrazzo

Foresso

Insulation



Recycled plastic

Supasoft Insulation



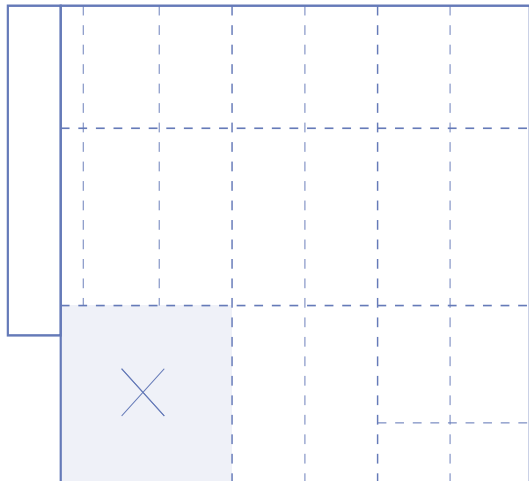
Denim panel

Akopanel

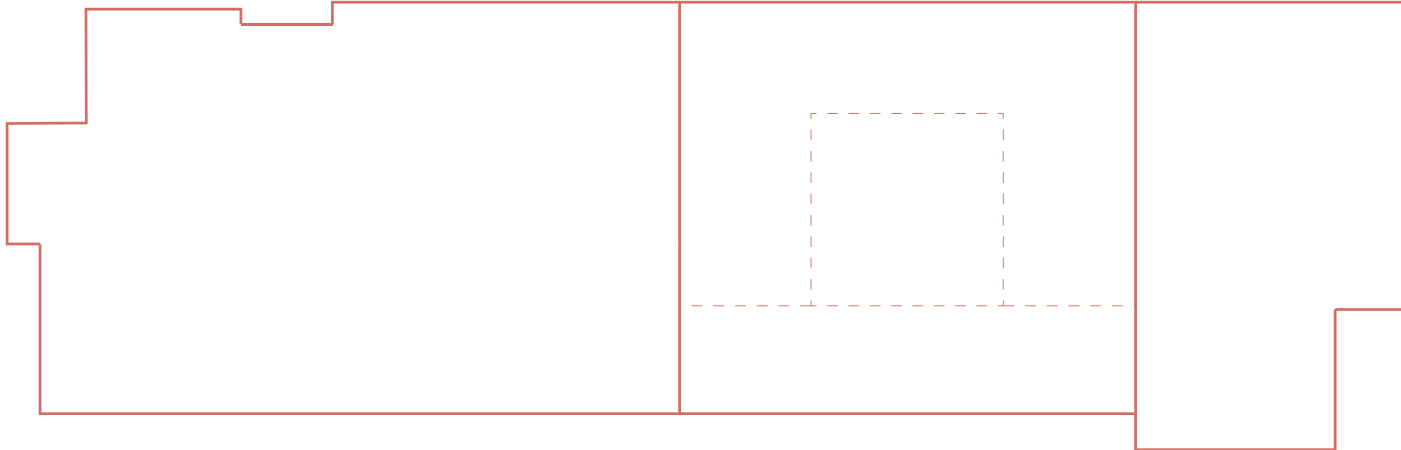
Comparison case studies

Layout

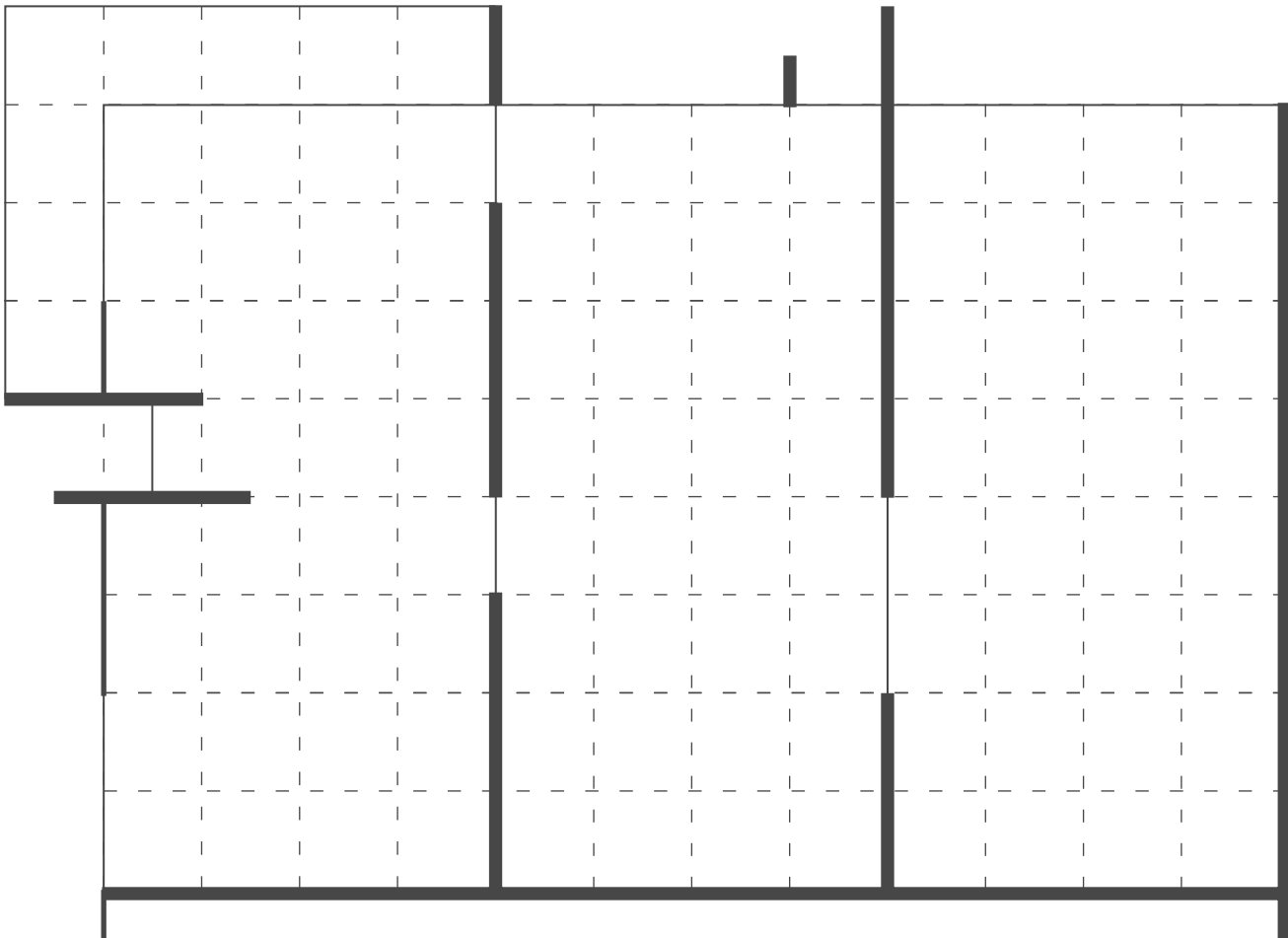
I: Beltman



II: Vakwerk



III: Studio of Tomorrow



Comparison case studies

Activities

I: Beltman

II: Vakwerk

III: Studio of Tomorrow

Activity: Work	34%	52,2%	38%
<i>Fixed space</i>	34%	-	10%
<i>Flexible space</i>	-	49,8%	25%
<i>Modelling space</i>	-	2,4%	3%
Activity: Meeting	14,3%	28,8%	16,3%
<i>Meeting space</i>	8,3%	11,8%	9,7%
<i>Meeting booth</i>	6%	-	1%
<i>Phone booth</i>	-	3%	0,4%
<i>Multi-functional space</i>	-	14%	5,2%
Activity: Break	20,8%	15% (+ outside)	27,2%
<i>Lunch space</i>	12,3%	15%	19,5%
<i>Lounge space</i>	8,5%	-	2,7%
<i>Garden space</i>	-	outside	3%
<i>Exhibition space</i>	-	-	2%
Activity: Extra	20,5%	14,3%	22,9%
<i>Entrance</i>	12,3%	2,8%	4,5%
<i>Storage</i>	8,3%	2,5%	10%
<i>Hallway</i>	-	5%	6,2%
<i>Bathroom</i>	-	4%	2,2%
<i>Sample space</i>	10,4%	-	-

Comparison case studies

Work stations

I: Beltman

Employees: 20

Work stations: 20

1 work station per employee

II: Vakwerk

Employees: 30

Work stations: 120

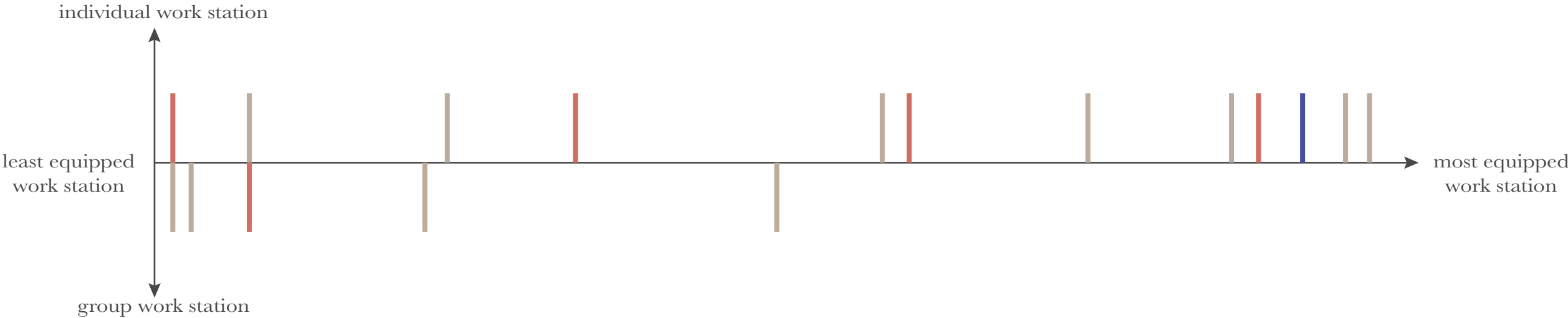
4 work stations per employee

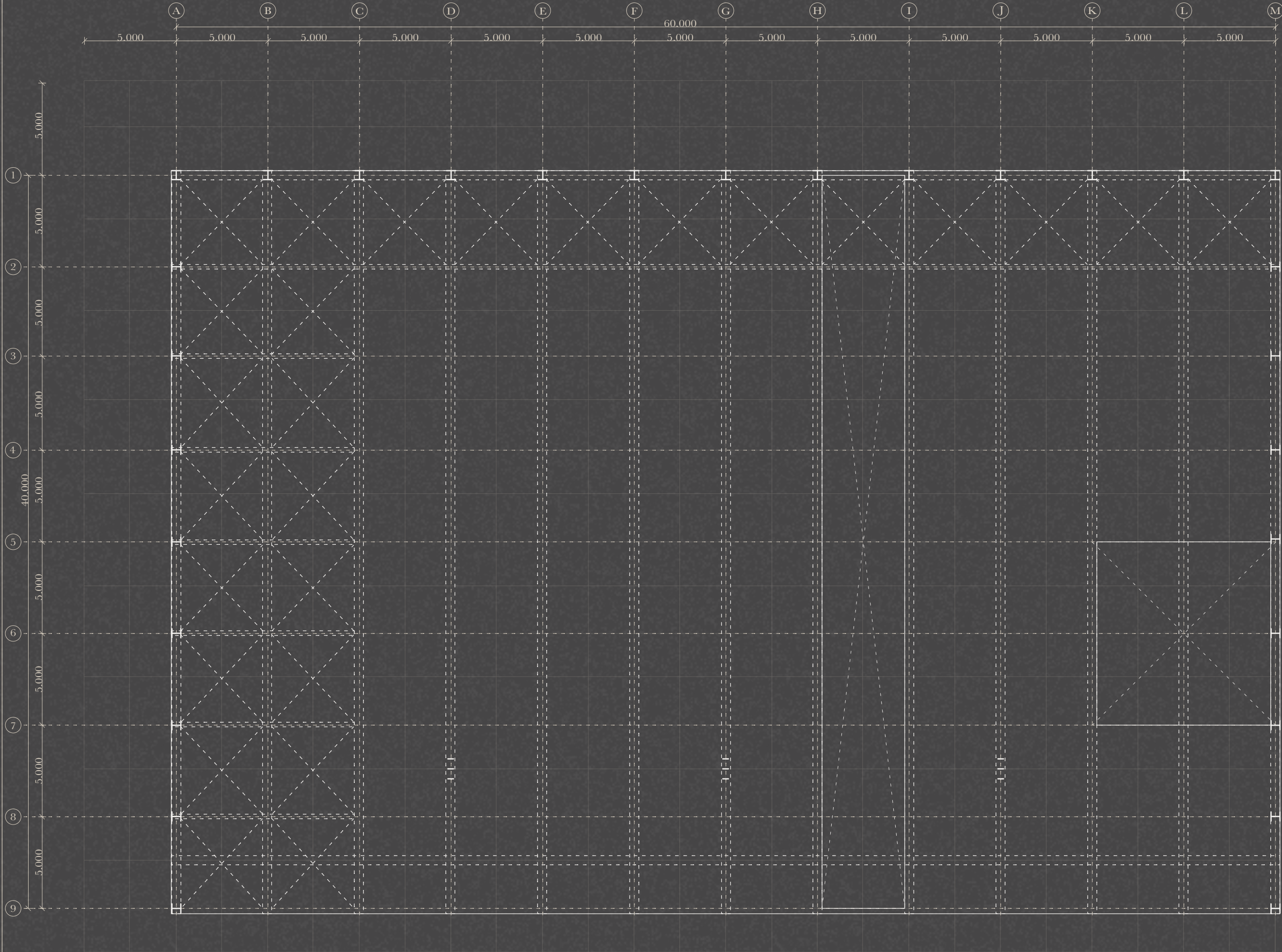
III: Studio of Tomorrow

Employees: 48

Work stations: 310

6 work stations per employee





Stappen		
1	Kies gebouw of vertrek dat wordt berekend	
2	Bereken netto-vloeroppervlak	
	lengte	60 m
	breedte	40 m
		2400 m ²
3	Bereken netto-inhoud (tussen vloer en plafond)	
	Gemiddelde ruimtehoogte tussen vloer en plafond	
		15 m
		36000 m ³
4	Kies ontwerp binnenluchttemperatuur en ontwerp buitenluchttemperatuur	
	T _{binnen} =	25 °C
	T _{buiten} =	30 °C
5	Bepaal externe warmtelast	
	Methode 1: voor het geval van 1 zonbelaste gevel	
	Oppervlak lichtdoorlatend deel gebouwschil (exclusief kozijn)	
	A _{glas} =	105 m ² ca. 90% van glas + kozijn
	Gemiddelde ZTA-waarde	
	ZTA =	0,6
	Gemiddelde ongunstige intensiteit zonnestraling (bouwfysisch tabellarium)	
	Q _{zon} =	390 W/m ²
	Externe warmtelast = A _{glas} * ZTA * Q _{zon}	
		67316,94 W
		28 W/m ²
	zonbelasting volgens methode 2	
	Methode 2: totale zonbelasting zelf bepaald (bijv. mbv sheet 'zonbelasting')	
	Deze methode kan worden gebruikt in geval van meerdere zonbelaste gevels	
	Als voor Q _{zon} , totaal een waarde wordt ingevuld, dan wordt deze in de berekening meegenomen	
	Q _{zon} , totaal	67.317 W (Totale zonbelasting door alle gevels!)
6	Bepaal interne warmtelast	
	Aantal personen	
		50
		4000 W
		2 W/m ²
	Vermogen verlichting	
		1 W/m ²
		2400 W
		1 W/m ²
	Vermogen computers	
		1 W/m ²
		2400 W
		1 W/m ²
7	Bereken ventilatiekoudeverlies	
	Ventilatievoud	
	n =	1
	Ventilatievolumestroom Q _{vent}	
		36000 m ³ /h
		10,000 m ³ /s
	Warmteterugwinpercentage (voelbare warmte) w _{tw}	
		1%
	Infiltratievoud	
	n =	0,2
	Infiltratievolumestroom Q _{inf}	
		7200 m ³ /h
		2,000 m ³ /s
	Volumieke massa lucht ρ	
		1,2 kg/m ³
	soortelijke warmtelucht c = 1.000 J/kgK	
	hangt af van buitentemperatuur	
	Ventilatiekoudeverlies = (Q _{vent} * ((1- w _{tw}) + Q _{inf})) * ρ * c * (T _{buiten} - T _{binnen})	
		exclusief ontvochtiging
		71.400 W
		30 W/m ²
		inclusief ontvochtiging
		153067 W
		64 W/m ²
	24°C, 50%RV binnen; 28°C, 60%RV buiten	
8	Stel totaal koudebehoefte vast	
	exclusief ontvochtiging	
		147.517 W
		61 W/m ²
	inclusief ontvochtiging	
		229.184 W
		95 W/m ²

Resultaten en kentallen

Samenvatting koudebehoefte:			
Uitgangspunten			
Netto vloeroppervlak	2400	m ²	
Volume	36000	m ³	
Zonbelasting volgens methode 1:	nee		
Zonbelasting volgens methode 2:	ja		
oppervlakte raam	nvt	m ²	
ZTA waarde	nvt		
maximale zonintensiteit	nvt	W	
Ventilatievoud	1	/h	
warmteterugwinpercentage	1%		
infiltratievoud	0,2	/h	
Resultaten			
		W/m ²	
Zonbelasting	28		
Interne warmtelast	4		
ventilatie & infiltratie koudeverlies	30		
Koudebehoefte:	61		

7	Stel totaal warmteverlies vast	432180 W	180 W/m ²
---	--------------------------------	----------	----------------------

Stappen			Resultaten en kentallen		
1	Kies gebouw of vertrek dat wordt berekend				
2	Bereken netto-vloeroppervlak				
	lengte	60 m			
	breedte	40 m	2400	m ²	
3	Bereken netto-inhoud (tussen vloer en plafond)				
	Gemiddelde ruimtehoogte tussen vloer en plafond				
		15 m	36000	m ³	
4	Kies ontwerp binnenluchttemperatuur en ontwerp buitenluchttemperatuur				
	T _{binnen} =	22 °C			
	T _{buiten} =	10 °C			
5	Bereken transmissiewarmte WINST !!				
	Oppervlak dichte delen gebouwschil				
	A _{dicht} =	2030 m ²			
	Gemiddelde U-waarde dichte delen gebouwschil				
	U _{dicht} =	1,00 W/m ² K			
	Oppervlak raam gebouwschil (glas + kozijn)				
	A _{raam} =	970 m ² (is inclusief kozijn)			
	Gemiddelde U-waarde raam gebouwschil				
	U _{raam} =	1,00 W/m ² K (is inclusief kozijn)			
	Transmissiewarmte WINST = (A _{dicht} * U _{dicht} + A _{raam} * U _{raam}) * (T _{buiten} - T _{binnen})		-36000	W	-15 W/m ²
5	Bepaal externe warmtelast				
	<i>Methode 1: voor het geval van 1 zonbelaste gevel</i>				
	Oppervlak lichtdoorlatend deel gebouwschil (exclusief kozijn)				
	A _{glas} =	873 m ² ca. 90% van glas + kozijn			
	Gemiddelde ZTA-waarde				
	ZTA =	0,6			
	Gemiddelde ongunstige intensiteit zonnestraling (bouwfysisch tabellarium)				
	Q _{zon} =	W/m ²			
	Externe warmtelast = A _{glas} * ZTA * Q _{zon}		67317	W	28 W/m ²
			zonbelasting volgens methode 2		
	<i>Methode 2: totale zonbelasting zelf bepaald (bijv. mbv sheet 'zonbelasting')</i>				
	<i>Deze methode kan worden gebruikt in geval van meerdere zonbelaste gevels</i>				
	<i>Als voor Q_{zon,totaal} een waarde wordt ingevuld, dan wordt deze in de berekening meegenomen</i>				
	Q _{zon,totaal}	67.316,94 W (Totale zonbelasting door alle gevels!)			
6	Bepaal interne warmtelast				
	Aantal personen		24720	W	10 W/m ²
	Vermogen verlichting		12000	W	5 W/m ²
	Vermogen computers		72000	W	30 W/m ²
7	Bereken ventilatie WINST				
	Ventilatievoud				Zie Bouwbesluit
	n =	1	36000 m ³ /h		4,2 dm ³ /sm ²
	Ventilatievolumestroom Q _{vent}		10,000	m ³ /s	
	Warmteterugwinpercentage (voelbare warmte) wtw				
		0%			
	Infiltratievoud				
	n =	0,2	7200 m ³ /h		0,8 dm ³ /sm ²
	Infiltratievolumestroom Q _{inf}		2,000	m ³ /s	
	Volumieke massa lucht ρ				soortelijke warmtelucht c = 1.000 J/kgK
		1,2 kg/m ³ hangt af van buitentemperatuur			
	Ventilatiwarmtewinst = (Q _{vent} * ((1- wtw) + Q _{inf})) * ρ * c * (T _{buiten} - T _{binnen})				
	exclusief ontvochtiging		-172800	W	-72 W/m ²
8	Stel totaal warmtebalans vast		32763	W	14 W/m ²
	exclusief ontvochtiging				
	LET OP:				

Samenvatting stationaire warmtebalans tussenseizoen				
Uitgangspunten			$T_{\text{binnen}} = 22\text{ }^{\circ}\text{C}$	
Netto vloeroppervlak			$T_{\text{buiten}} = 10\text{ }^{\circ}\text{C}$	
Volume	2400 m ²			
opp. dichte gebouwschil	36000 m ³			
gemiddelde U-waarde dichte schil	2030 m ²			
opp. ramen en deuren	1,00 W/m ² K			
gemiddelde U-waarde ramen en deuren	970 m ²			
Zonbelasting volgens methode 1:	nee	1,00 W/m ² K		
Zonbelasting volgens methode 2:	ja			
oppervlakte raam	nvt	m ²		
ZTA waarde	nvt			
maximale zonintensiteit	nvt	W/m ²		
Ventilatievoud	1 /h			
warmteterugwinpercentage	0%			
infiltratievoud	0,2 /h			
Resultaten			W/m ²	
transmissiewinst			-15	
ventilatie- en infiltratiewinst			-72	
Zonbelasting			28	
Interne warmtelast			45	
warmte / koudebehoefte			14	
negatief getal = warmte stroom uit de ruimte				
positief getal = warmtetoevoer aan de ruimte				

Stappen

1	Kies gebouw of vertrek dat wordt berekend		
2	Bereken netto-vloeroppervlak		
	lengte	60 m	
	breedte	40 m	
	Netto vloeroppervlakte A	2400	m ²
3	Bereken netto-inhoud (tussen vloer en plafond)		
	Gemiddelde ruimtehoogte tussen vloer en plafond hoogte	15 m	
	Netto inhoud V	36000	m ³
4	Bepaal warmtelast ten gevolge van zoninstraling		
	Eenvoudige methode: voor het geval van 1 zonbelaste gevel		
	Oppervlak lichtdoorlatend deel gebouwschil (exclusief kozijn)		
	A _{glas} =	873 m ²	ca. 90% van glas + kozijn
	Gemiddelde ZTA-waarde	0,6	
	ZTA =		
	Gemiddelde ongunstige intensiteit zonnestraling (zie tab zonbelasting)		
	q _{zon} =		W/m ²
	Uitgebreide methode: totale zonbelasting zelf bepaald		
	Je kunt hiervoor de tab zonbelasting gebruiken.		
	Deze methode kan worden gebruikt in geval van meerdere zonbelaste gevels		
	Als voor Q _{zon,totaal} een waarde wordt ingevuld, dan wordt deze in de berekening meegenomen		
	Q _{zon,totaal}	67.316,94 W	(Totale zonbelasting door alle gevels!)
	Warmtelast door bezonning Q _{zon} = A _{glas} * ZTA * q _{zon}		
		67317 W	28 W/m ²
5	Bepaal interne warmtelast		
	Aantal personen	309	24720 W
	Vermogen verlichting	5 W/m ²	12000 W
	Vermogen computers	30 W/m ²	72000 W
	Totale interne warmtewinst Q _{intern}	108720 W	45 W/m ²
6	Bereken warmteverliescoëfficiënt voor transmissie		
	Oppervlak dichte delen gebouwschil		
	A _{dicht} =	2030 m ²	
	Gemiddelde U-waarde dichte delen gebouwschil		
	U _{dicht} =	1 W/m ² K	
	Oppervlak raam gebouwschil (glas + kozijn)		
	A _{raam} =	970 m ²	(inclusief kozijn)
	Gemiddelde U-waarde raam gebouwschil		
	U _{raam} =	1 W/m ² K	(inclusief kozijn)
	Warmteverliescoëfficiënt transmissie H _{transmissie} = (A _{dicht} * U _{dicht} + A _{raam} * U _{raam})		
		3000,0	W/K
7	Bereken warmteverliescoëfficiënt voor ventilatie en infiltratie		
	Ventilatievoud		
	n =	1	
	Ventilatievolumestroom Q _{vent}		
	Warmterugwinpercentage (voelbare warmte) wtw		
	η =	0%	
	Infiltratievoud		
	n =	0,2	
	Infiltratievolumestroom Q _{inf}		
	Volumieke massa lucht		soortelijke warmtelucht c = 1.000 J/kgK
	ρ =	1,2 kg/m ³	hangt af van buitentemperatuur
	Warmteverliescoëfficiënt ventilatie H _{ventilatie} = (Q _{vent} * (1- wtw) + Q _{inf}) * ρ * c		
	exclusief ontvochtiging		
		14400,0	W/K

Resultaten en kentallen

8	Vermogen verwarming / koeling								
	Vermogen verwarming								
	$Q_{\text{verwarming}} =$	89400 W	(positief getal)		89400 W		37	W/m^2	
	Vermogen koeling								
	$Q_{\text{koeling}} =$	89400 W	(positief getal)		89400 W		37	W/m^2	
9	Warmtestromen								
	Totale warmtewinst $Q_{\text{winst}} = Q_{\text{zon}} + Q_{\text{intern}} + Q_{\text{verwarming}}$				265437 W		111	W/m^2	
	Totale warmteverlies $Q_{\text{verlies}} = Q_{\text{koel}}$				89400 W		37	W/m^2	
	Totale warmteverliescoëfficiënt $H_{\text{totaal}} = H_{\text{transmissie}} + H_{\text{ventilatie}}$				17400,0 W/K				
10	Temperaturen								
	Buitenluchttemperatuur								
	$T_{\text{buiten}} =$	10 °C							
	Temperatuurverschil $\Delta T = (Q_{\text{winst}} + Q_{\text{verlies}}) / H_{\text{totaal}}$				10,1 K				
	Binnentemperatuur $T_i = T_o + \Delta T$				20,1 °C				
Samenvatting stationaire warmtebalans									
Uitgangspunten			Resultaten						
Netto vloeroppervlak			2400 m ²	Warmtewinst door bezonning			67317 W		
Volume			36000 m ³	Interne warmtewinst			108720 W		
opp. dichte gebouwschil			2030 m ²	Warmtewinst door verwarming			89400 W		
gemiddelde U-waarde dichte schil			1 W/m ² K	Warmtewinst door koeling			-89400 W		
opp. ramen en deuren			970 m ²	Totale warmtewinst			176037 W		
gemiddelde U-waarde ramen en deuren			1 W/m ² K						
Zonbelasting volgens methode:			uitgebreid	Warmteverliescoëfficiënt transmissie			3000 W/K		
oppervlakte raam			nvt m ²	Warmteverliescoëfficiënt ventilatie			14400 W/K		
ZTA waarde			nvt	Totale warmteverliescoëfficiënt			17400 W/K		
maximale zonintensiteit			nvt W/m ²						
Ventilatievoud			1,000 /h	Resulterende temperatuur					
warmterugwinpercentage			0%	$T_{\text{buiten}} =$			10 °C		
infiltratievoud			0,2 /h	$T_{\text{binnen}} =$			20,1 °C		

