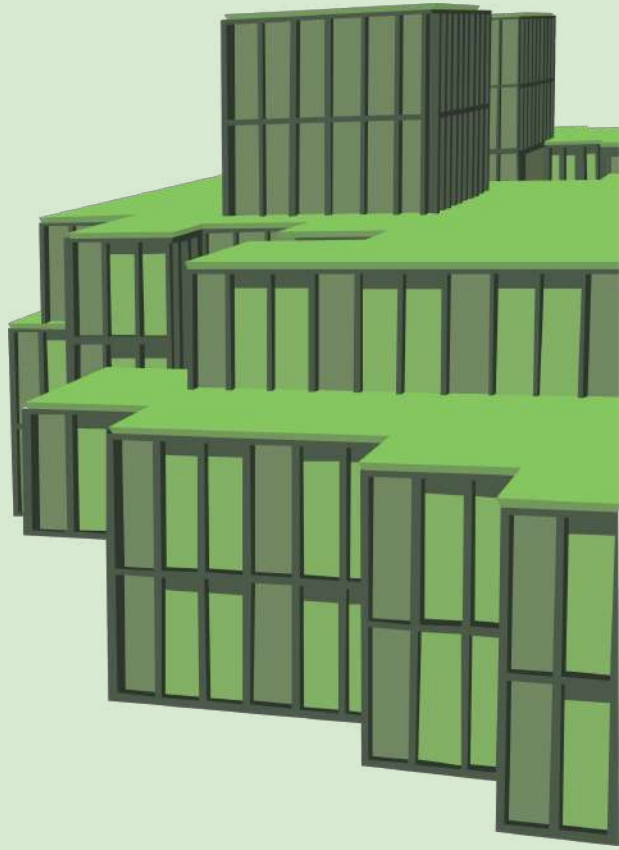
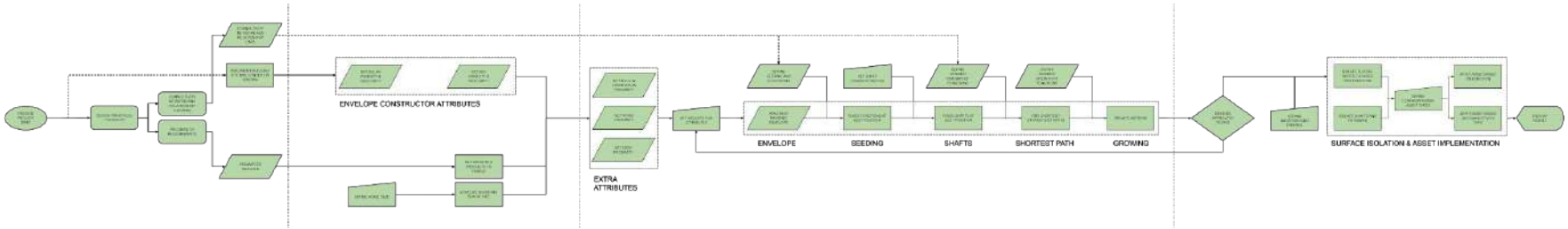
PANDORA

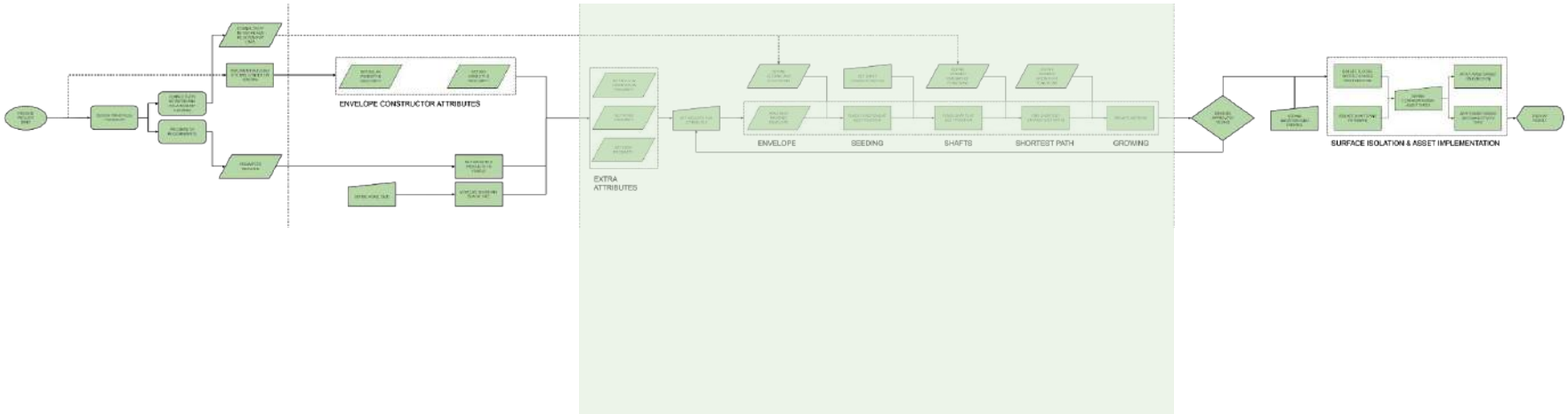
Michelle A. Menkiti
Jolt Wiersma
Arthur Masure

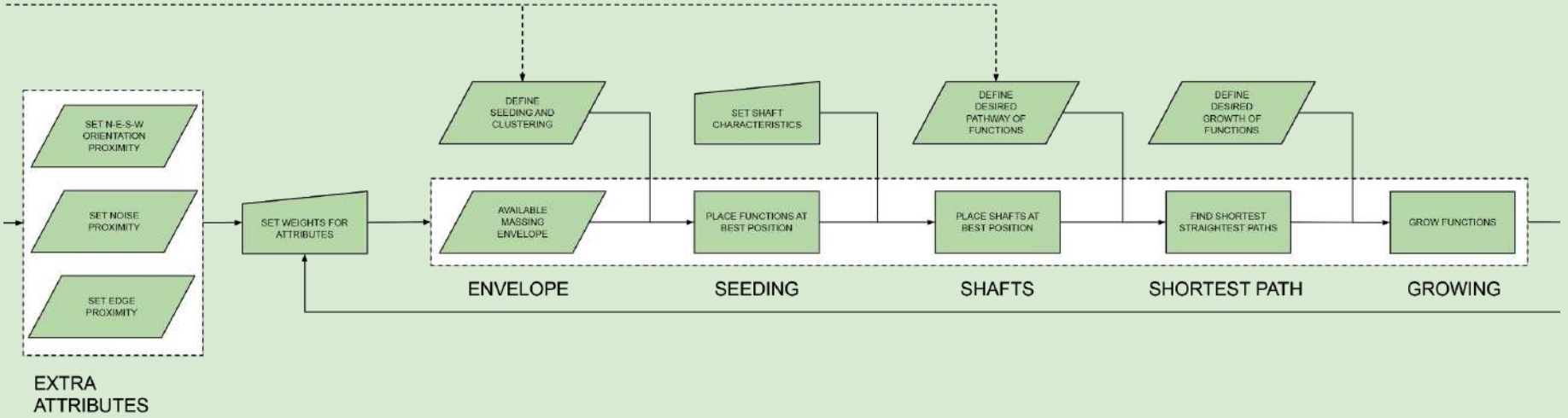


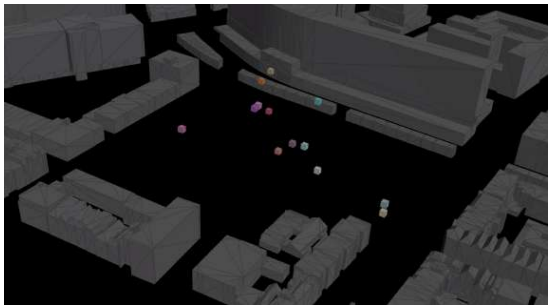
PITCH


ENVELOPE CONSTRUCTOR ATTRIBUTES
EXTRA ATTRIBUTES
ENVELOPE
SEEDING
SHAFTS
SHORTEST PATH
GROWING
SURFACE ISOLATION & ASSET IMPLEMENTATION

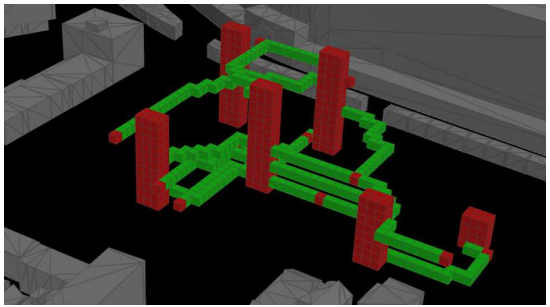
PITCH


ENVELOPE CONSTRUCTOR ATTRIBUTES
EXTRA ATTRIBUTES
ENVELOPE
SEEDING
SHAFTS
SHORTEST PATH
GROWING
SURFACE ISOLATION & ASSET IMPLEMENTATION

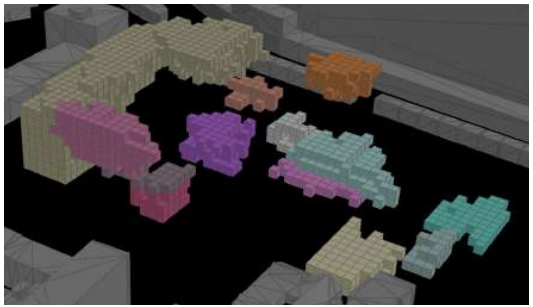




SEEDING



CIRCULATION



GROWTH

PANDORA

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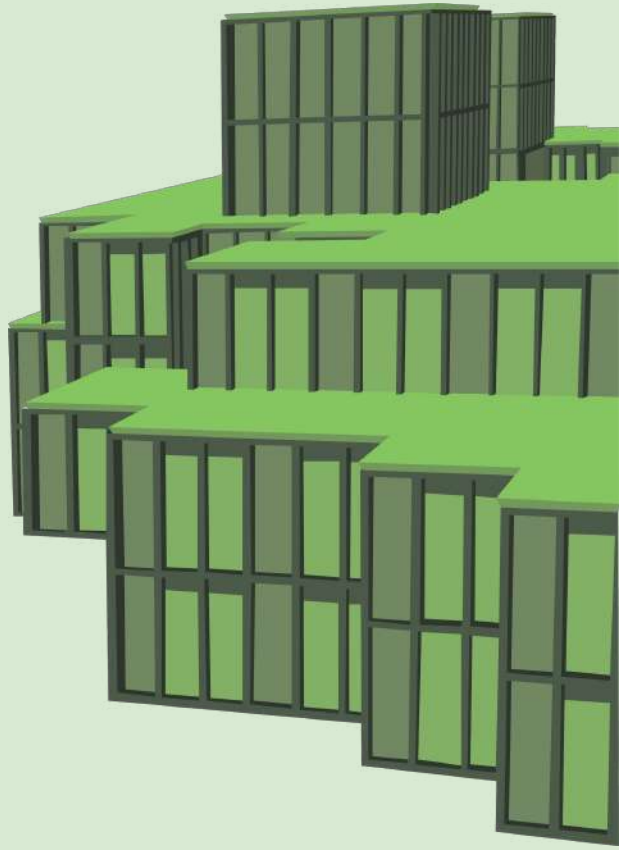
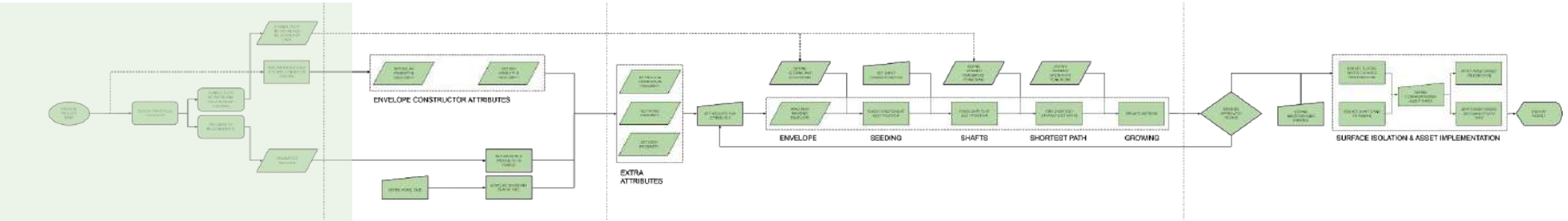
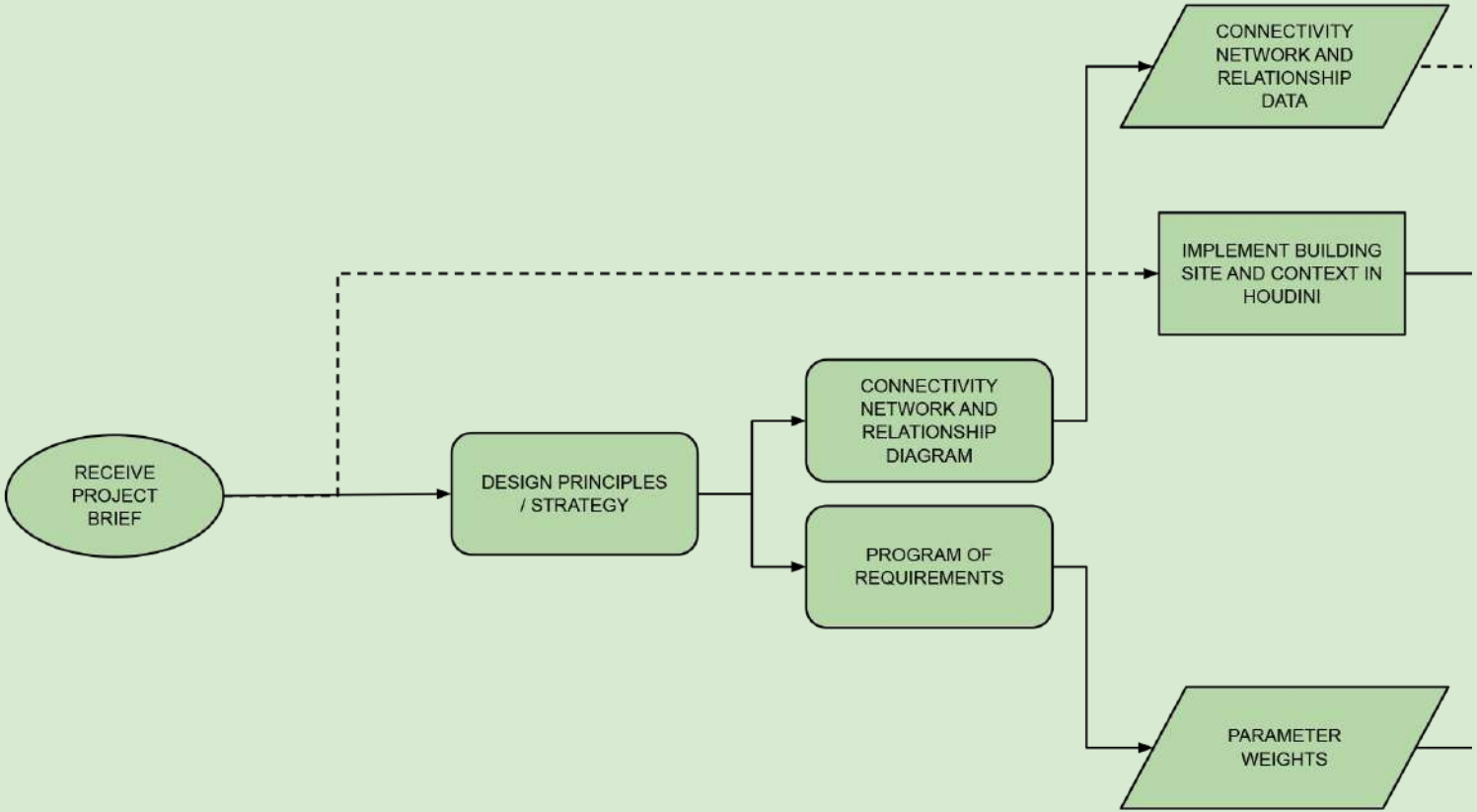


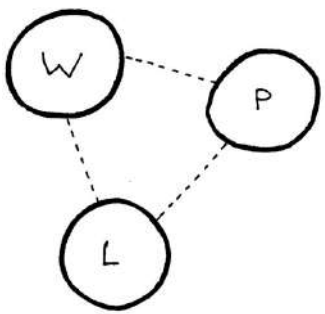
CONTENTS

SPACE PLANNING

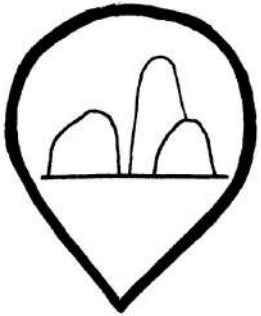


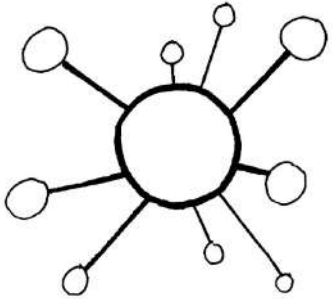

RECEIVE PROJECT BRIEF
DESIGN PRINCIPLES / STRATEGY
CONNECTIVITY NETWORK AND RELATIONSHIP DIAGRAM
PROGRAM OF REQUIREMENTS
CONNECTIVITY NETWORK AND RELATIONSHIP DATA
IMPLEMENT BUILDING SITE AND CONTEXT IN HOUDINI
PARAMETER WEIGHTS

DESIGN PRINCIPLES AND STRATEGY



Clusters


Landmark

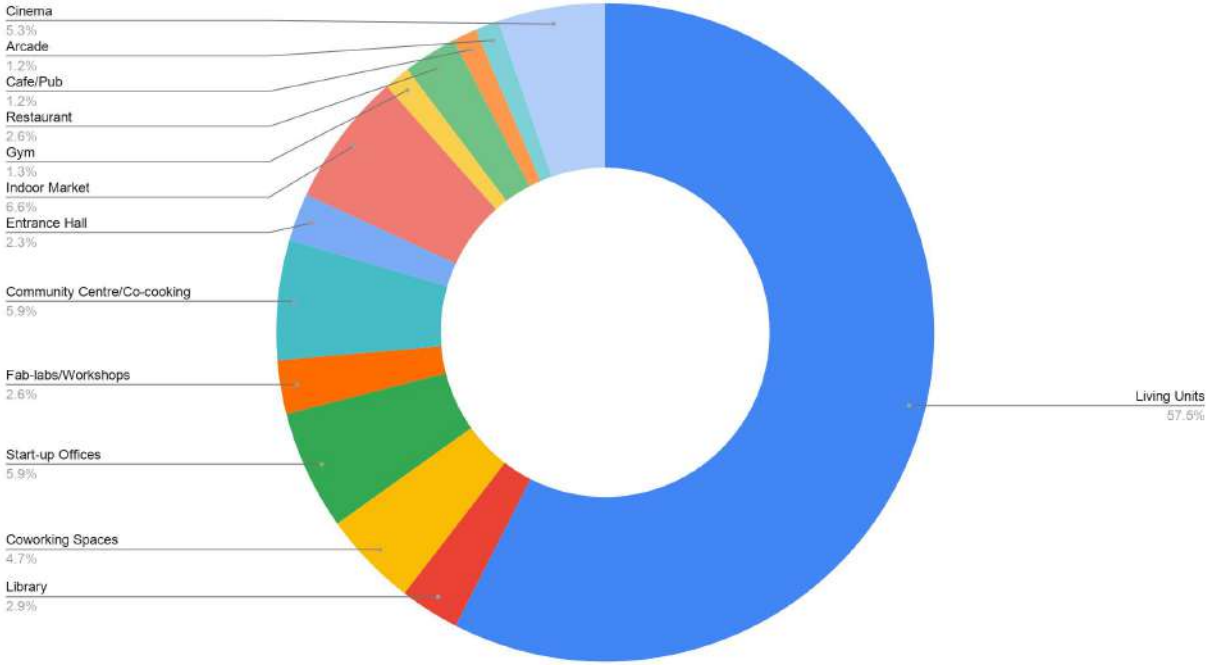

Central space


Path through building

1. Create separate but well-connected clusters of programs → **Seeding**
2. Create an interesting and noteworthy structure → **Growing**
3. Create a central space in the plot → **Paths**
4. Path through Building → **Porous Structure**

PROGRAM OF REQUIREMENTS

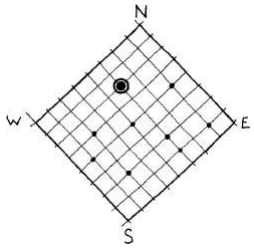
Area of functions



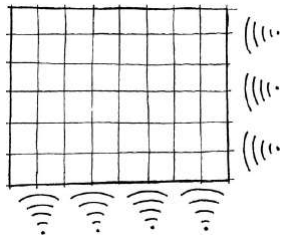
PROGRAM OF REQUIREMENTS

Weighting functions per attribute

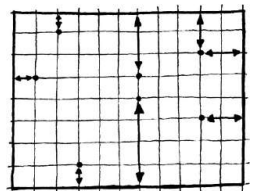
Functions	Solar View	Sky View	Proximity to Noise	Proximity to Edge	Proximity to N	Proximity to E	Proximity to S	Proximity to W
Living Units	0.8	0.5	0.01	0.1	0.1	0.7	0.9	0.8
Library	0.9	0.2	0.01	0.8	0.2	0.8	0.7	0.5
Coworking Spaces	0.6	0.8	0.2	0.4	0.5	0.5	0.5	0.5
...	...	...	...	...	...	...	...	...



Proximity to N-E-S-W

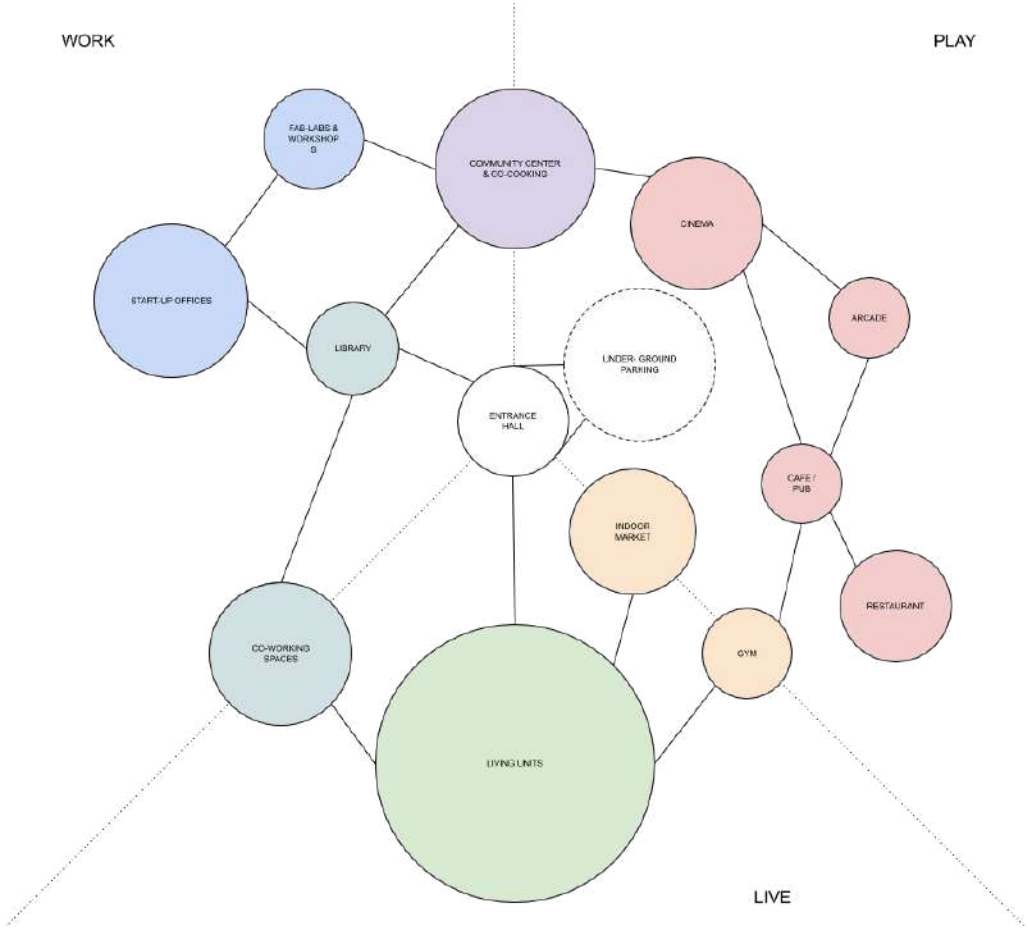


Proximity to Noise



Proximity to Edge

CONNECTIVITY NETWORK & RELATIONSHIP



Applied during seeding

- Clustering and initial seeds

Applied during pathmaking

- Each connection is a desired shortest path
- Creation of REL diagram

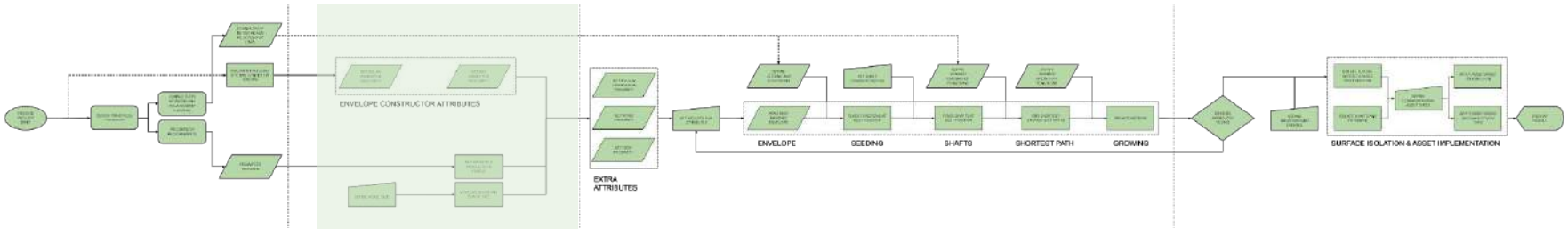
REL DIAGRAM

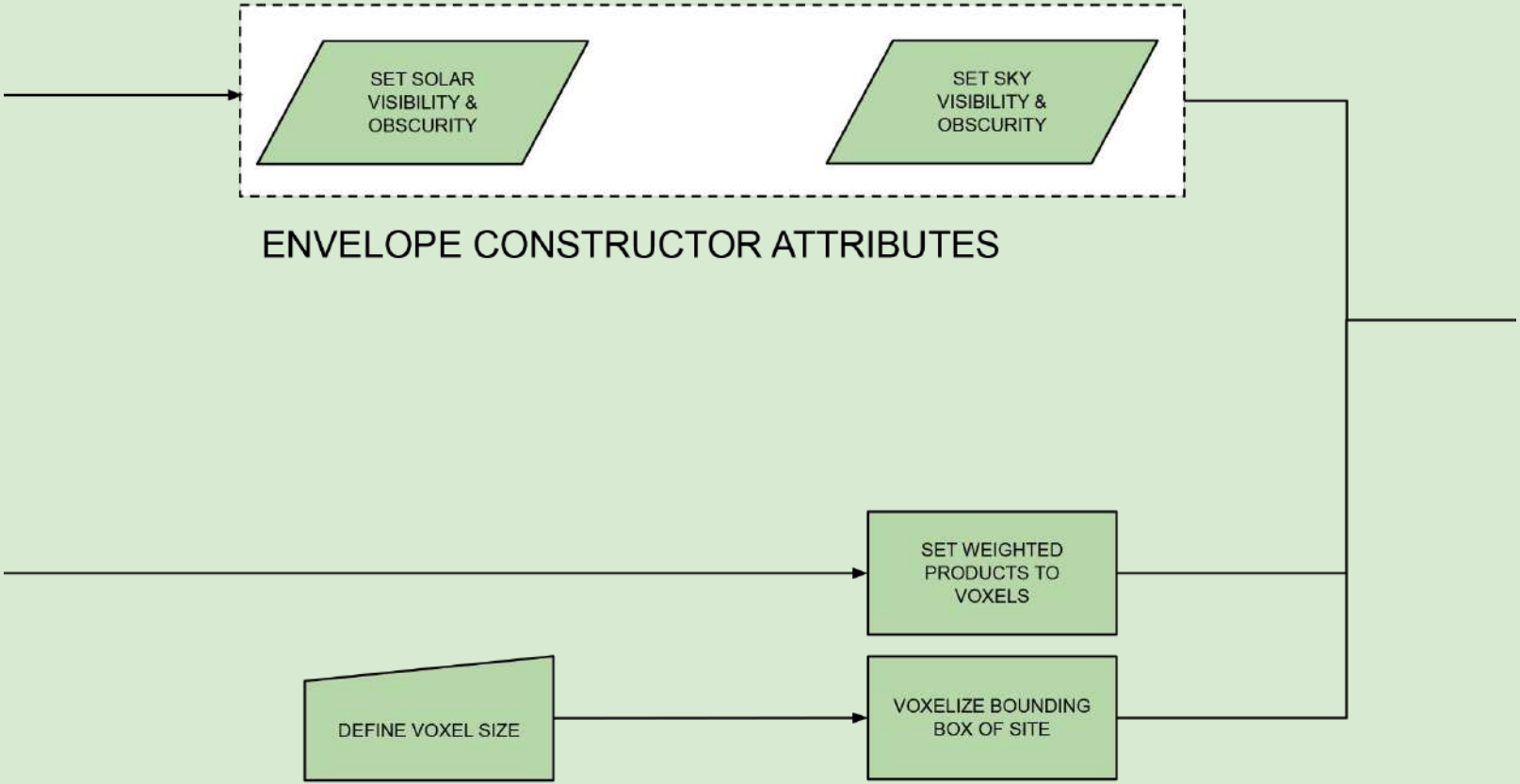
	LIVING UNITS	STARTUP OFFICES	ARCADE	LIBRARY	COWORKING	FABLAB	COMMUNITY CENTRE	ENTRANCE HALL	INDOOR MARKET	GYM	RESTAURANT	CAFE/PUB	CINEMA
LIVING UNITS													
STARTUP OFFICES	3												
ARCADE	3	4											
LIBRARY	2	3	3										
COWORKING	1	1	4	1									
FABLAB	3	1	3	2	3								
COMMUNITY CENTRE	2	2	2	1	2	1							
ENTRANCE HALL	1	2	3	1	2	2	1						
INDOOR MARKET	1	3	4	2	2	3	2	1					
GYM	1	4	2	3	2	4	3	2	2				
RESTAURANT	3	4	2	4	4	4	3	4	4	2			
CAFE/PUB	2	4	1	3	3	3	2	3	3	1	1		
CINEMA	3	3	1	2	3	2	1	2	3	2	2	1	

1. For each function, set the number of connections that are passed along while travelling to another function

2. Only form the shortest path between those functions who only have 1 connection

CONFIGURATION

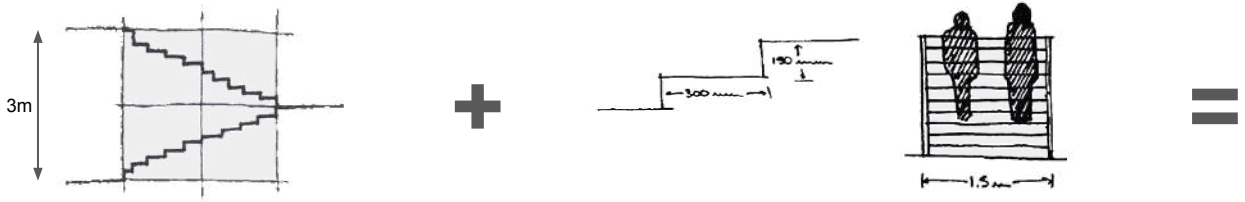



SET SOLAR VISIBILITY & OBSCURITY
SET SKY VISIBILITY & OBSCURITY
ENVELOPE CONSTRUCTOR ATTRIBUTES
SET WEIGHTED PRODUCTS TO VOXELS
DEFINE VOXEL SIZE
VOXELIZE BOUNDING BOX OF SITE

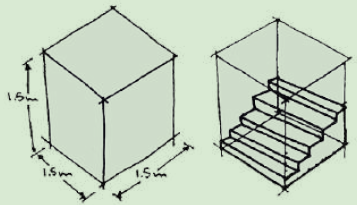
VOXEL SIZE

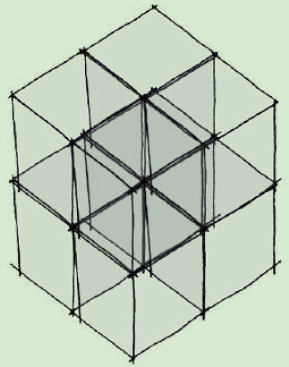
3 x 3 x 3 m based on **1.5 x 1.5 x 1.5 m**

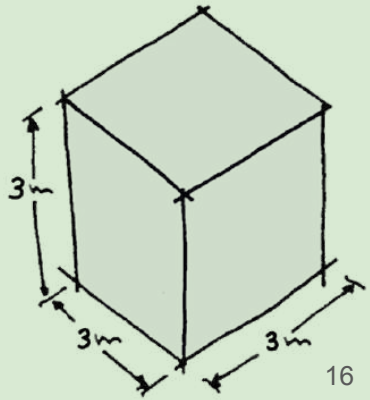
- Based on a 3m ceiling height
- Based on a 1.5m stairway width



Used as template in creating ***lift / stairwell shafts***
Used as template in defining ***growth heights***
Used as template in creating ***floorplans*** and ***assets***



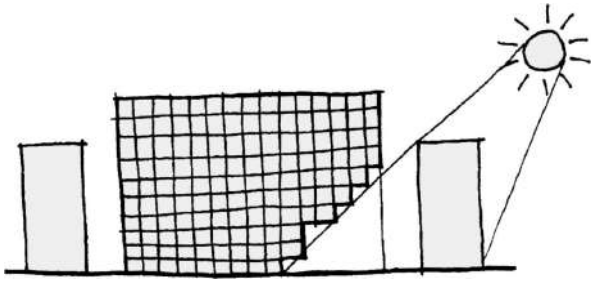


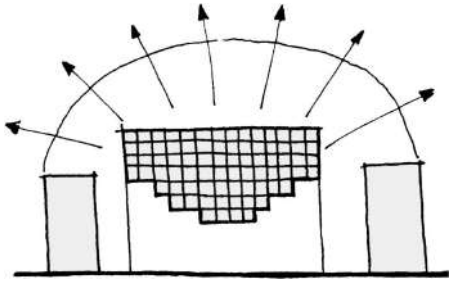


ENVELOPE CONSTRUCTOR ATTRIBUTES

SOLAR AND SKY VISIBILITY

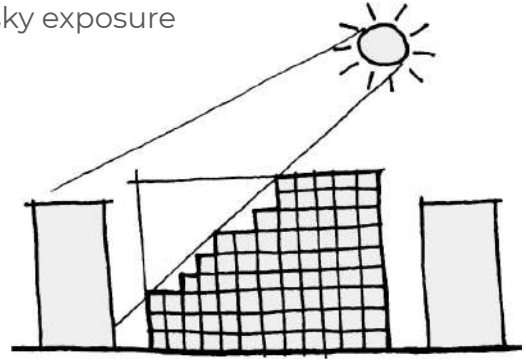
Site light and sky exposure

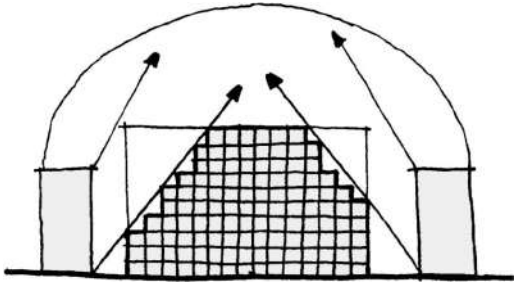




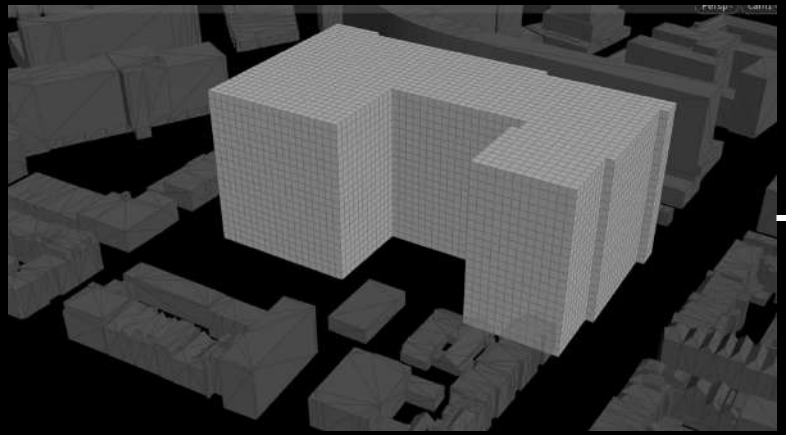
SOLAR AND SKY OBSCURITY

Context light and sky exposure

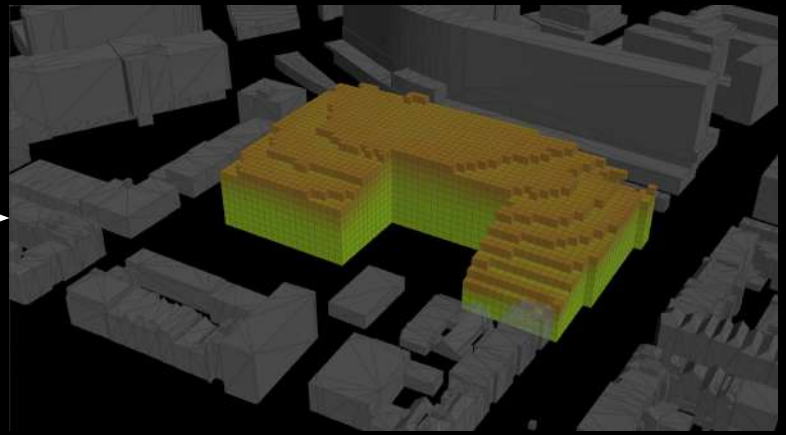




CHOSEN MASSING ENVELOPE

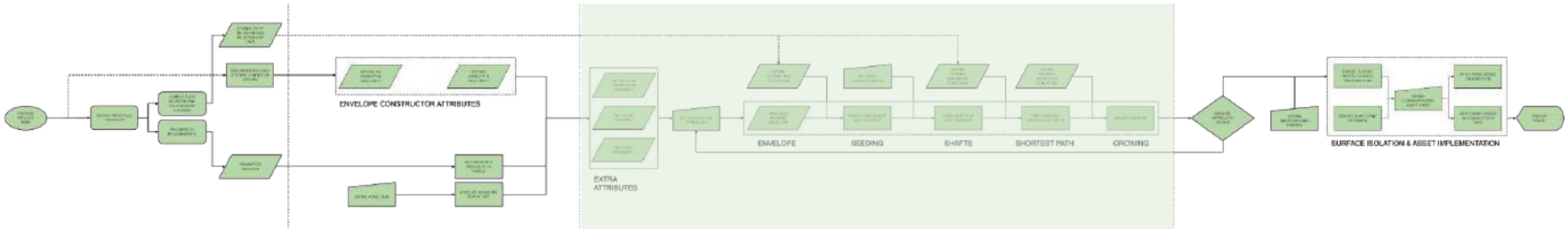


Voxelized Bounding Box



Massing Envelope

MASSING


ENVELOPE CONSTRUCTOR ATTRIBUTES
EXTRA ATTRIBUTES
ENVELOPE
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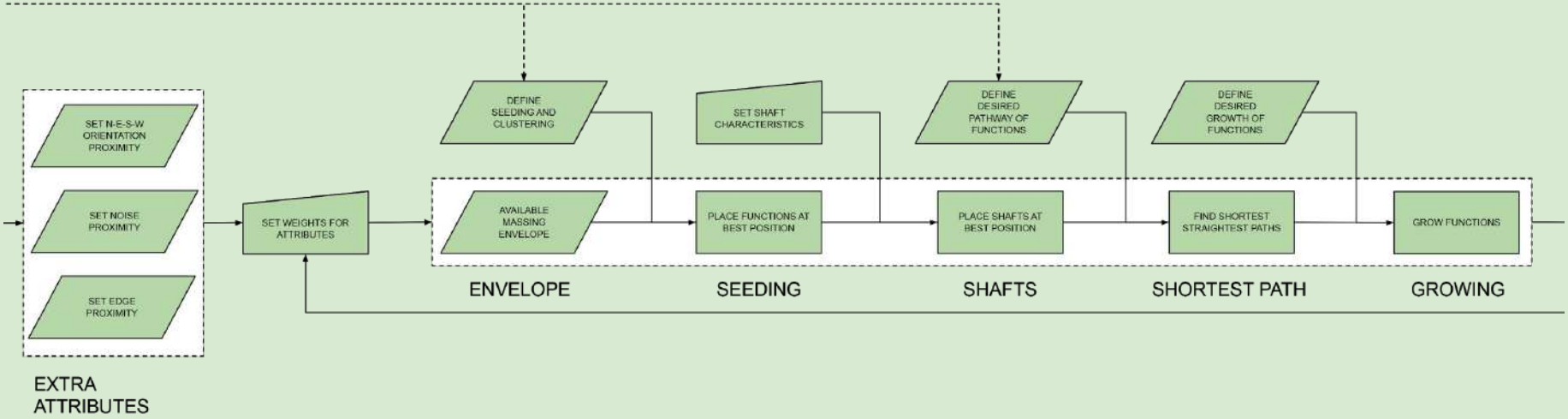
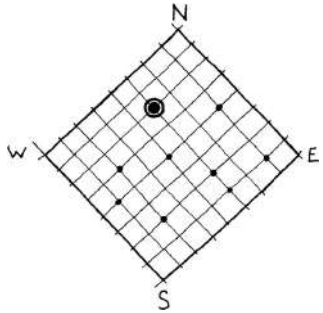
SURFACE ISOLATION & ASSET IMPLEMENTATION


SET N-E-S-W ORIENTATION PROXIMITY
SET NOISE PROXIMITY
SET EDGE PROXIMITY
EXTRA ATTRIBUTES
SET WEIGHTS FOR ATTRIBUTES
DEFINE SEEDING AND CLUSTERING
AVAILABLE MASSING ENVELOPE
ENVELOPE
SET SHAFT CHARACTERISTICS
PLACE FUNCTIONS AT BEST POSITION
SEEDING
DEFINE DESIRED PATHWAY OF FUNCTIONS
PLACE SHAFTS AT BEST POSITION
SHAFTS
DEFINE DESIRED GROWTH OF FUNCTIONS
FIND SHORTEST STRAIGHTEST PATHS
SHORTEST PATH
GROW FUNCTIONS
GROWING

EXTRA ATTRIBUTES

AND SETTING THEIR IMPORTANCE

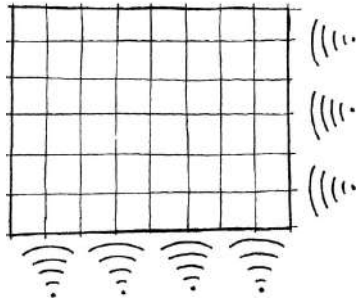
ORIENTATION PROXIMITY



North-East-South-West

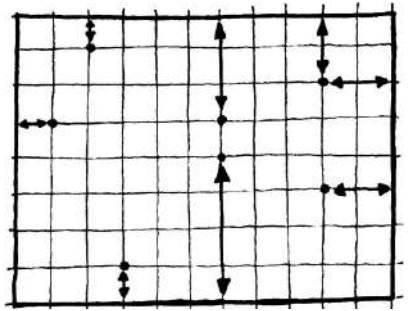
N
E
S
W

SOUND PROXIMITY



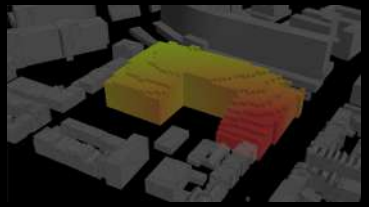
Road (traffic) adjacency

EDGE PROXIMITY

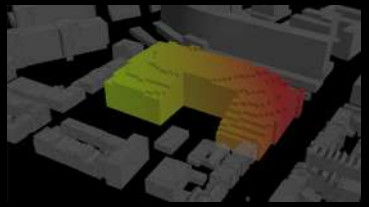


Facade or roof closeness

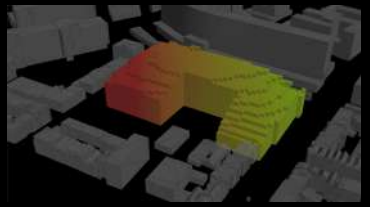
CHOSEN ATTRIBUTE STRENGTHS



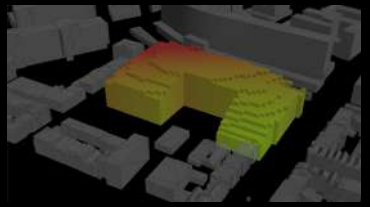
Proximity North



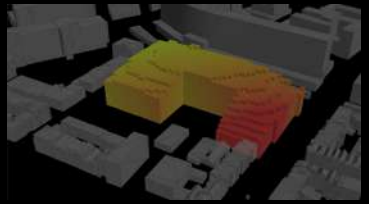
Proximity West



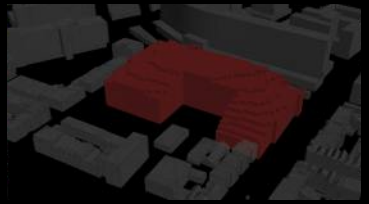
Proximity East

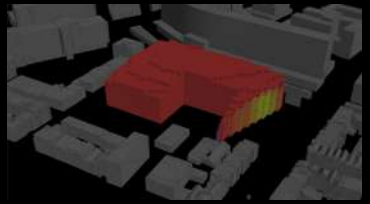


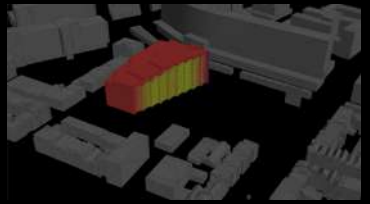
Proximity South



Proximity Noise







Proximity to Edge

IDEAL SPOT

NON-IDEAL SPOT

SEEDING (most important)

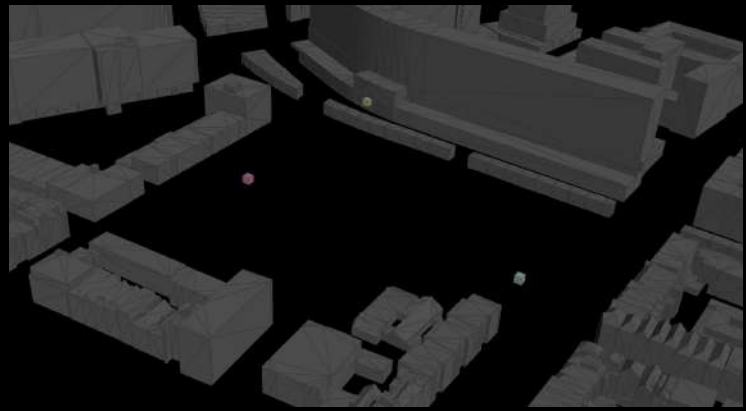
//Designers are able to choose the 3 most important functions to be seeded in order of importance

Set *MOST IMPORTANT function*
Set *Second MOST IMPORTANT Function*
Set *Third MOST IMPORTANT Function*

For 3 MOST IMPORTANT Functions
    Create an empty list for voxel weights and voxel IDs
        For all voxels in cloud
            Get ***voxel weight*** and add to voxel weights list
            Get ***voxel ID*** and add to voxel ID list

    Sort voxel weight list by decreasing value
    Sort voxel ID list accordingly

    Set as ***parent voxel*** if voxels is unoccupied



*In our design **LIVING UNITS**, **STARTUP OFFICES** and **ARCADE** were seeded first as they contrasted the most in terms of program and spatial requirements*

SEEDING (other functions)

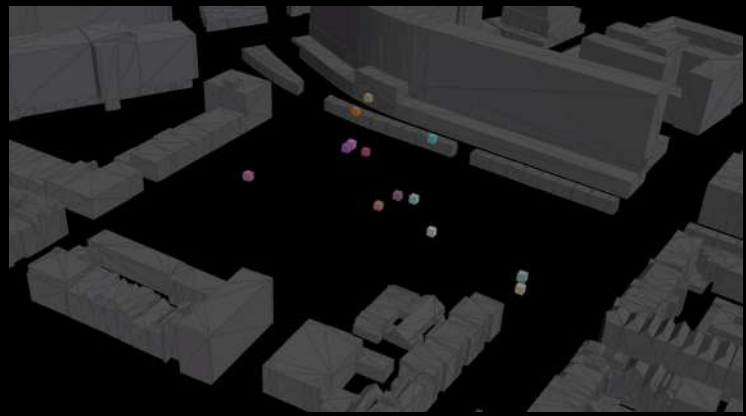
//Changing WP values on seed placement

Set *RELATIONSHIP CLOSENESS*
Set *RANGE*
Set *WP SCALE FACTOR*

Create a list of all functions

For each function
    If function has not already been seeded
        For all seeds
            Get their ***parent*** value
            Get ***relationship*** between seed and function
            If ***relationship*** exists
                For all points
                    If within a certain distance
                        Increase ***wp*** value of point

Seed functions at voxels with highest ***wp***



Other functions seeded in relation to most important seeds and each other

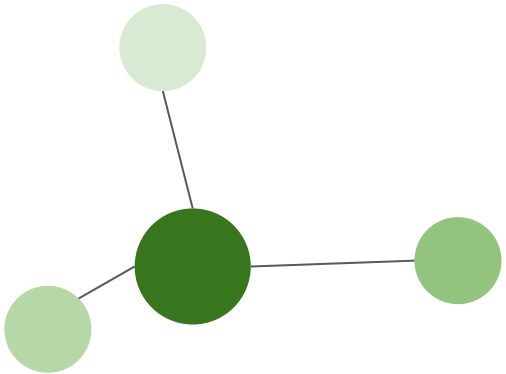
SEEDING (other functions)

Our attempt at Graph Relaxation

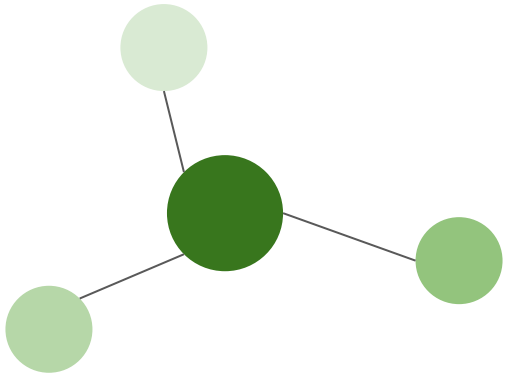
Certain function are “pinned”

Corresponding Functions are seeded in relation to them (based on distance).

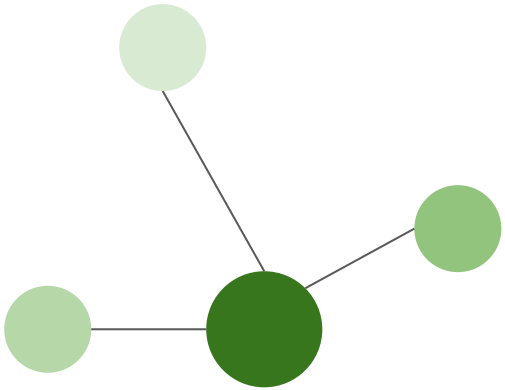
	LIVING UNITS	STARTUP OFFICES	ARCADE	LIBRARY	COWORKING	FABLAB	COMMUNITY CENTRE	ENTRANCE HALL	INDOOR MARKET	GYM	RESTAURANT	CAFE/PUB	CINEMA
LIVING UNITS													
STARTUP OFFICES	3												
ARCADE	3	4											
LIBRARY	2	3	3										
COWORKING	1	1	4	1									
FABLAB	3	1	3	2	3								
COMMUNITY CENTRE	2	2	2	1	2	1							
ENTRANCE HALL	1	2	3	1	2	2	1						
INDOOR MARKET	1	3	4	2	2	3	2	1					
GYM	1	4	2	3	2	4	3	2	2				
RESTAURANT	3	4	2	4	4	4	3	4	4	2			
CAFE/PUB	2	4	1	3	3	3	2	3	3	1	1		
CINEMA	3	3	1	2	3	2	1	2	3	2	2	1	



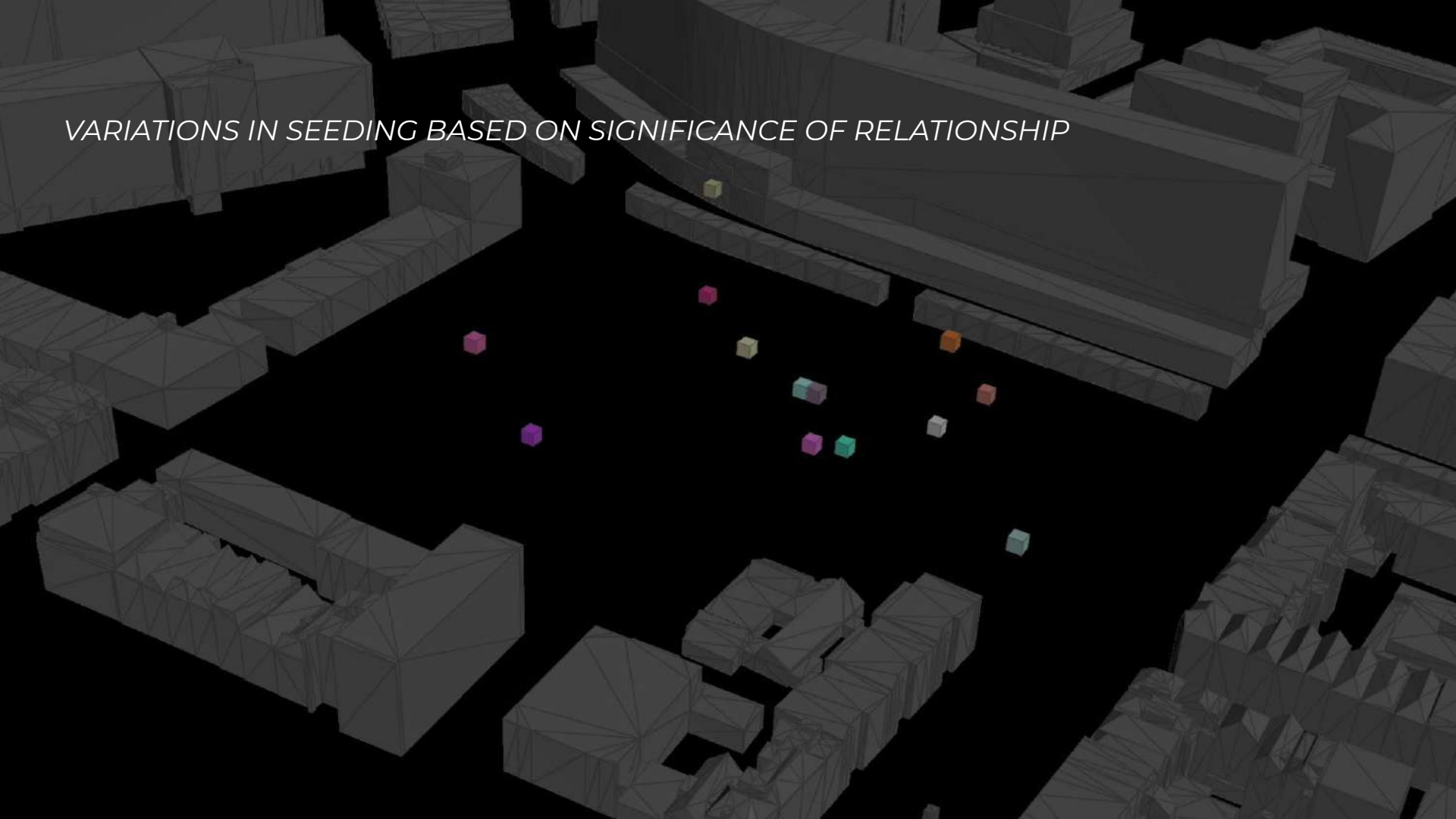
Closeness 1



Closeness 2



Closeness 3


VARIATIONS IN SEEDING BASED ON SIGNIFICANCE OF RELATIONSHIP

PLACING SHAFTS

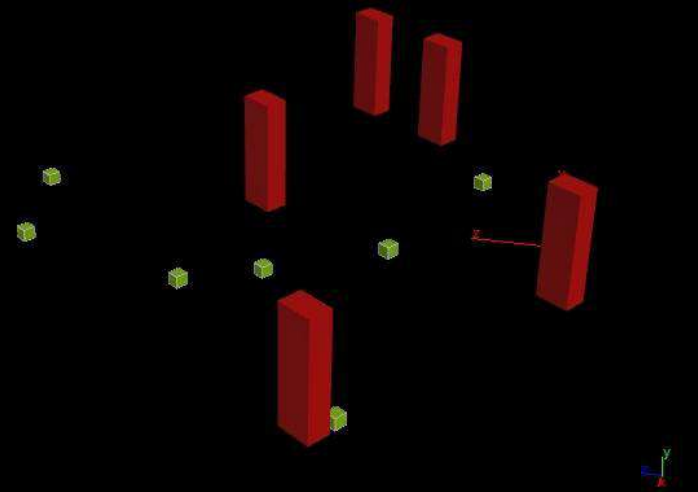
Set *shaft count* *to 0*
Set *maximum shaft count*
Set *maximum shaft-function distance*
Set *minimum shaft-shaft distance*

As sliders, these are set to values that result in a shaft placement conforming to our initial design principles and strategy

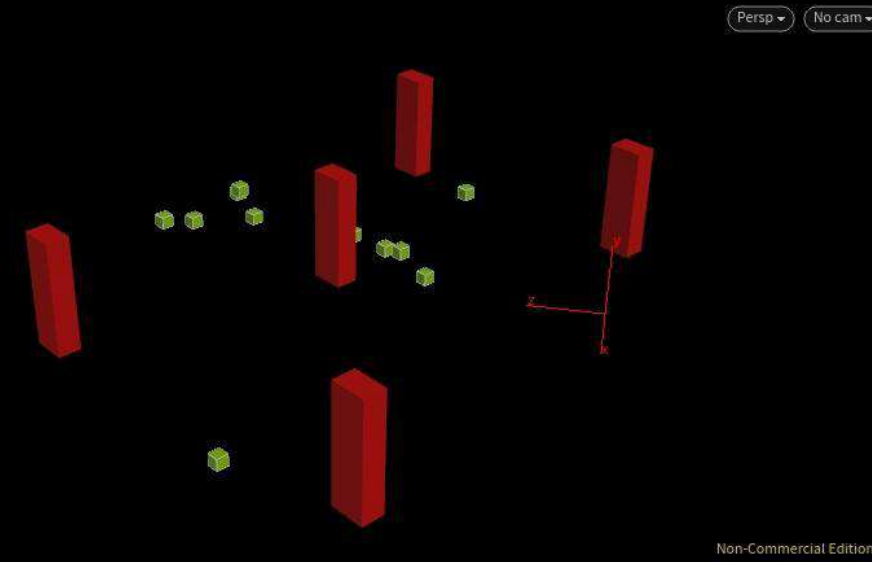
If *shaft count* *is less than* *maximum shaft count*
For all points on the ground floor
If there are no seeds above that point
If the distance from point to any seed is less than *maximum shaft-function distance*
If there are other shafts
If the distance from point to any shaft is more than *minimum shaft-shaft distance*
In attribute ***shaft origins*** *and* ***occupied***, set new value
Increase the *shaft count*
Else
In attribute ***shaft origins*** *and* ***occupied***, set new value
Increase the *shaft count*

Identify shaft locations by value in attribute ***shaft origins*** and copy shaft geometry to those points

VARIATIONS IN SHAFT PLACEMENT



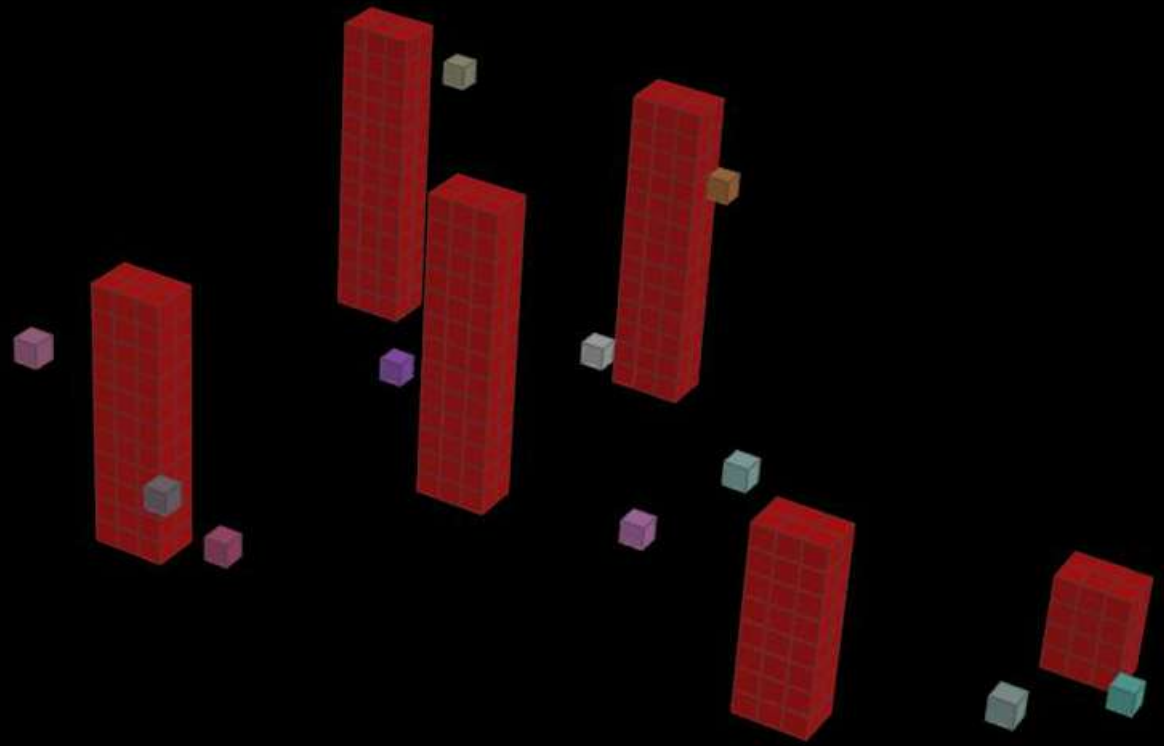
Movement of shafts with new seed positions



Movement of shafts with new shaft parameters

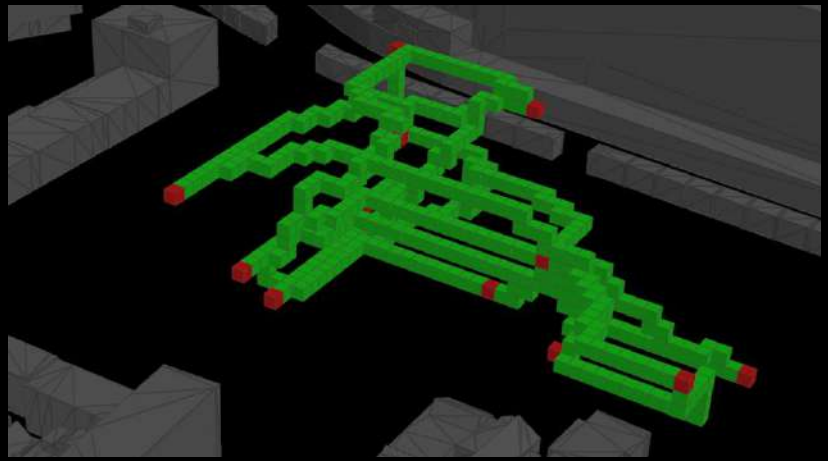
- *Min. distance between each other*
- *Max. distance from a seed*

CHOSEN SHAFT PLACEMENT

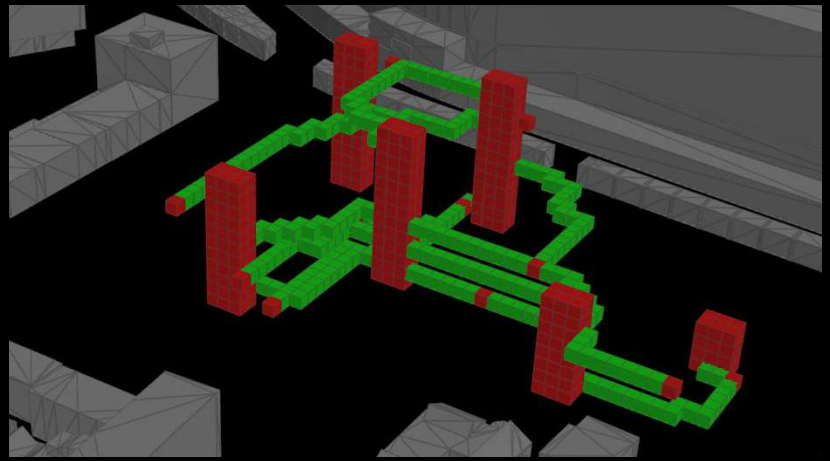


SHORTEST HORIZONTAL PATH

VARIATIONS IN SHORTEST PATH

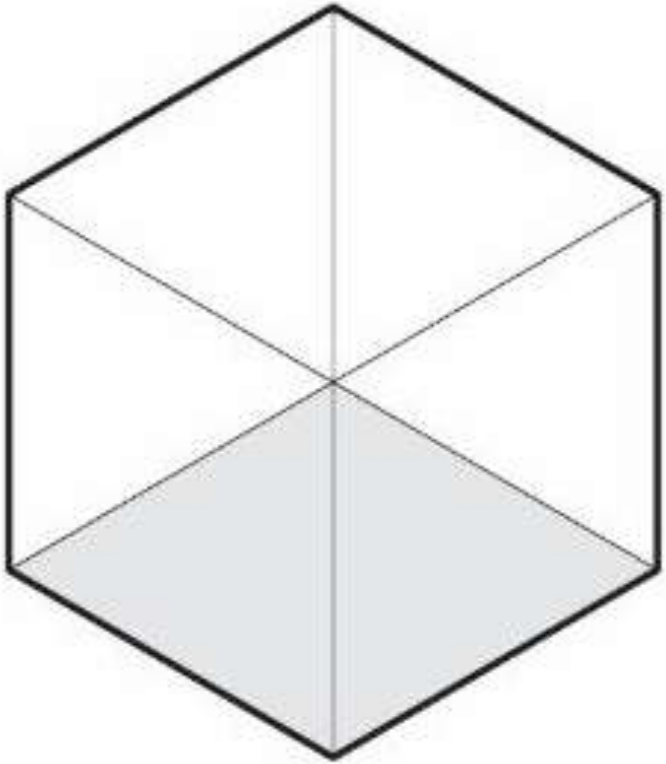


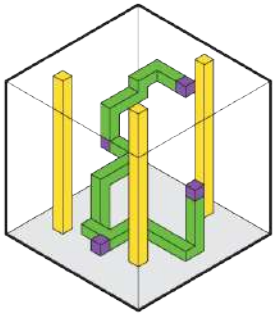
Original Seed-Seed Connections (with vertical paths)



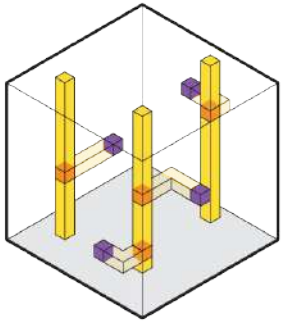
Current Seed-Shaft-Seed Connections (without vertical paths)

PSEUDO PROCESS OF SHORTEST HORIZONTAL PATH GENERATION

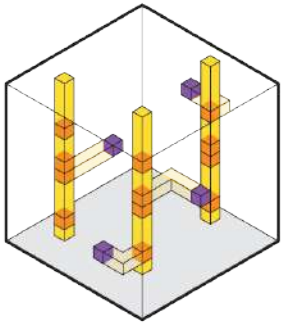




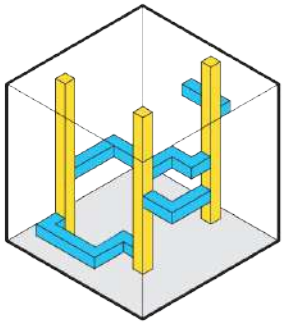
1. Original shortest path includes vertical parts



2. START the path from the seed but END it in a shaft on the same level



3. Get the the level in the shaft corresponding to the original end



4. START new path from that shaft level to the ORIGINAL END

PSEUDO PROCESS OF SHORTEST HORIZONTAL PATH GENERATION

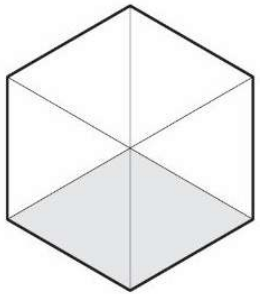
POINT ID	SEED NUMBER	CLOSEST SHAFT	SAME LEVEL POINT ID IN SHAFT A	SAME LEVEL POINT ID IN SHAFT B	SAME LEVEL POINT ID IN SHAFT C	SEED CONNECTIONS
225	1	B	250	200	275	1:3
463	2	A	400	450	438	2:1
313	3	C	325	375	363	3:2
388	4	C	333	300	350	4:2

DESIRED PROCESS:

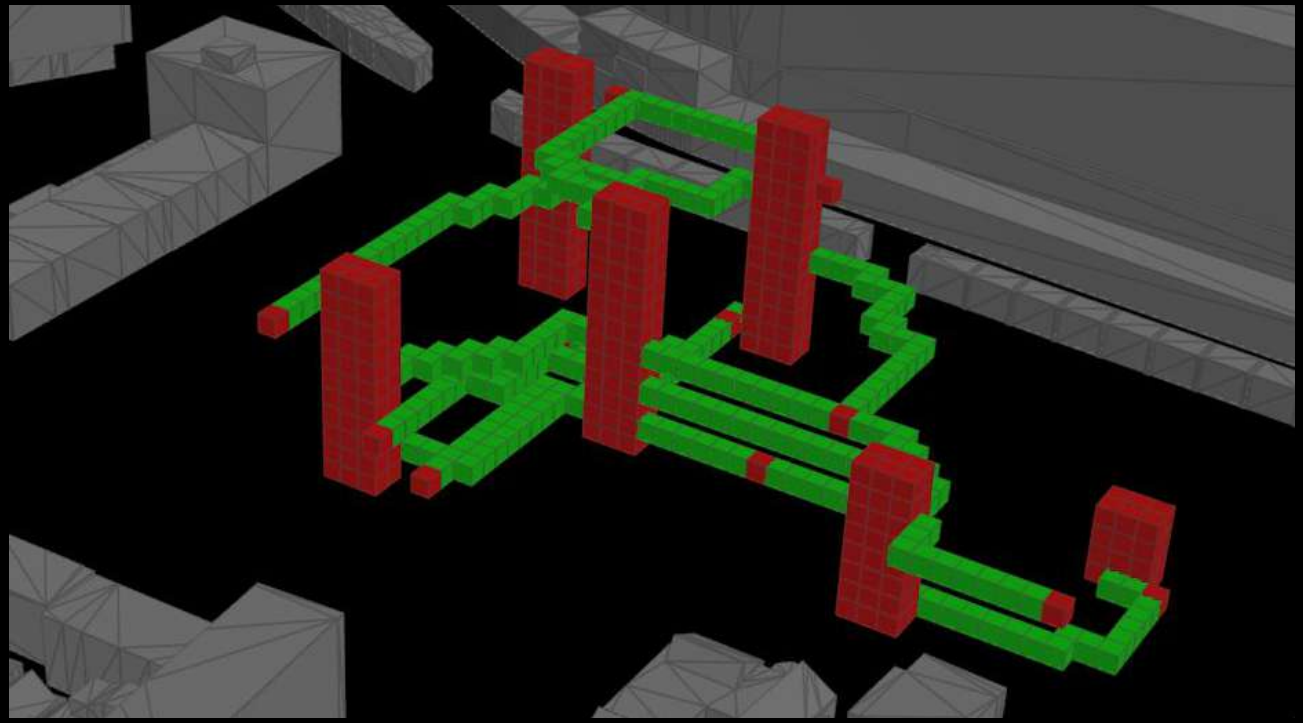
- START SEED = 1
- VIA SHAFT = B
- END SEED = 3

PSEUDO PROCESS:

- INITIAL START POINT ID = 225
- INITIAL END POINT ID = 200
- FINAL START POINT ID = 375
- FINAL END POINT ID = 313



SHORTEST PATHS



GROWTH CLOUD

- *AREA*
- *SQUARENESS*

For every seed/function (in attribute ***seeds***)
Get the *number of children*
Get desired growth *area* (in attribute ***area*** specified from .CSV)
If *area* is less than *number of children*
For every *child*
Get and add *neighbour point id's* to a list
Get and add *neighbour point wp's* to a list
For every neighbour (in *neighbour point id's*)
Set *neighbour point wp* to a new value based on a *squareness* value
If *neighbour point id* is not occupied (in attribute ***occupied***)
Add *neighbour point id* into an *available boundary point id's* list
Add *neighbour point wp* into an *available boundary point wp's* list
Sort both lists based on weighted product (wp's)

GROWTH CLOUD CONTINUED

- *GROWTH HEIGHT*

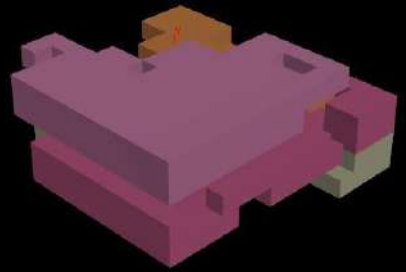
Get and add *y-value of seed* to *y-values* list
For every point in *available boundary point id's* (sorted based on wp)
    Get *y-value of point*
    If *y-value of point* is not the same as *y-value of seed*
        If *y-value of point* is not in *y-values* list
            Get growth *height* (in attribute ***growth*** specified from .CSV)
            Set *current height* to length of *y-values* list
            If *height* is less than or equal to *current height*
                Go to next point in *available boundary point id's*
            Else
                Add *y-value of point* to *y-values* list
                GROW ONTO THE *boundary point id*
        Else
            GROW ONTO THE *boundary point id*
Else
    GROW ONTO THE *boundary point id*

GROW ONTO THE *boundary point id*

1. Set *boundary point id* to occupied in attribute ***occupied***
2. Set *boundary point id* as new *child*
3. Newly iterate on this *child*

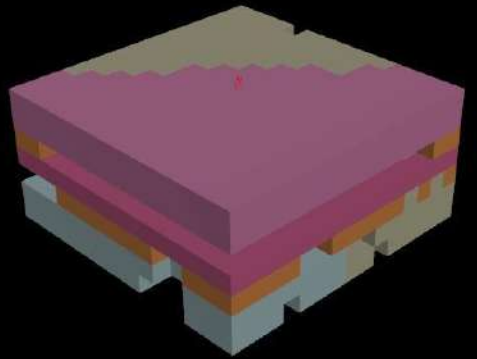
VARIATIONS OF GROWTH LEVEL

^ All function: growth 1 level

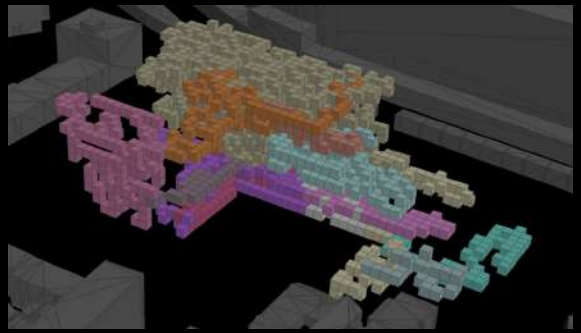


^ All function: growth 2 levels

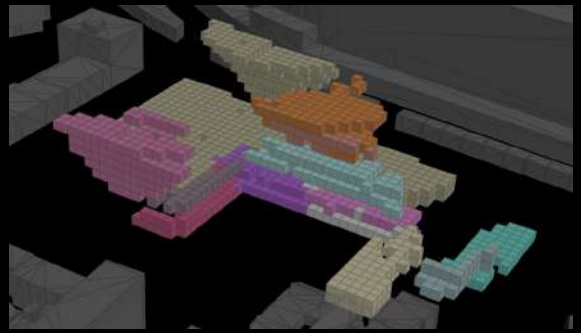
v Each function: growth on level specified by a .CSV



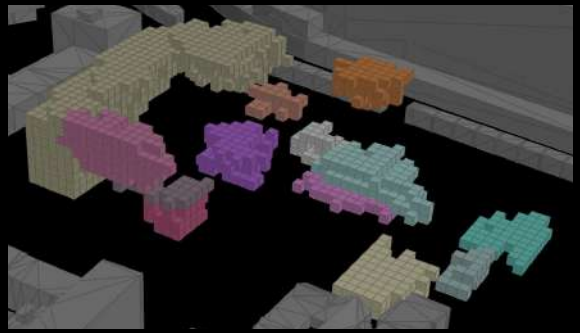
VARIATIONS IN SQUARENESS



Squareness = 0.9



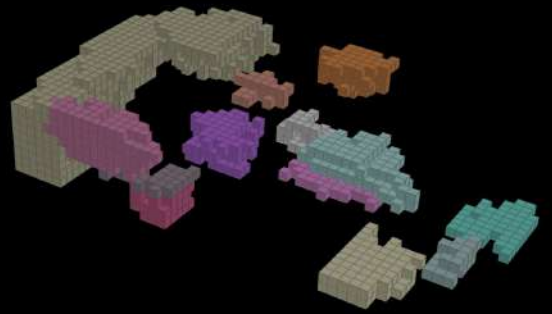
Squareness = 1.0



Squareness = 1.5

Chosen Squareness

GROWN FUNCTIONS



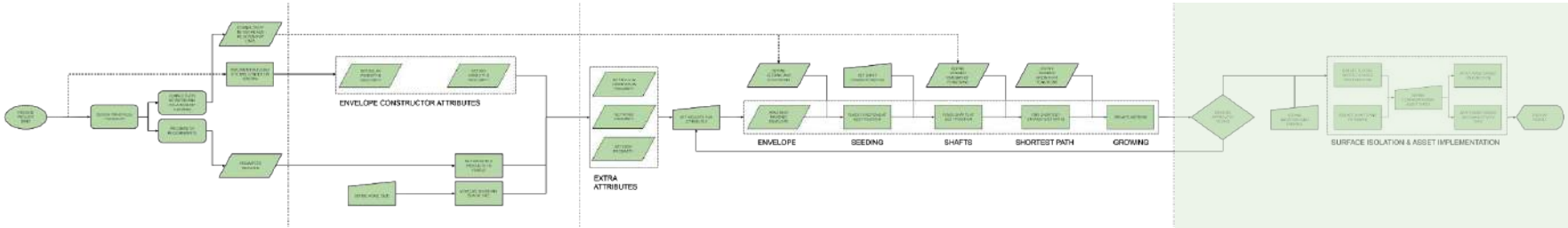
LIVING UNITS
START-UP OFFICES
ARCADE
LIBRARY
CO-WORKING SPACE
FAB-LABS
COMMUNITY CENTER
ENTRANCE HALL
INDOOR MARKET
GYM
RESTAURANT
CAFE / PUB
CINEMA

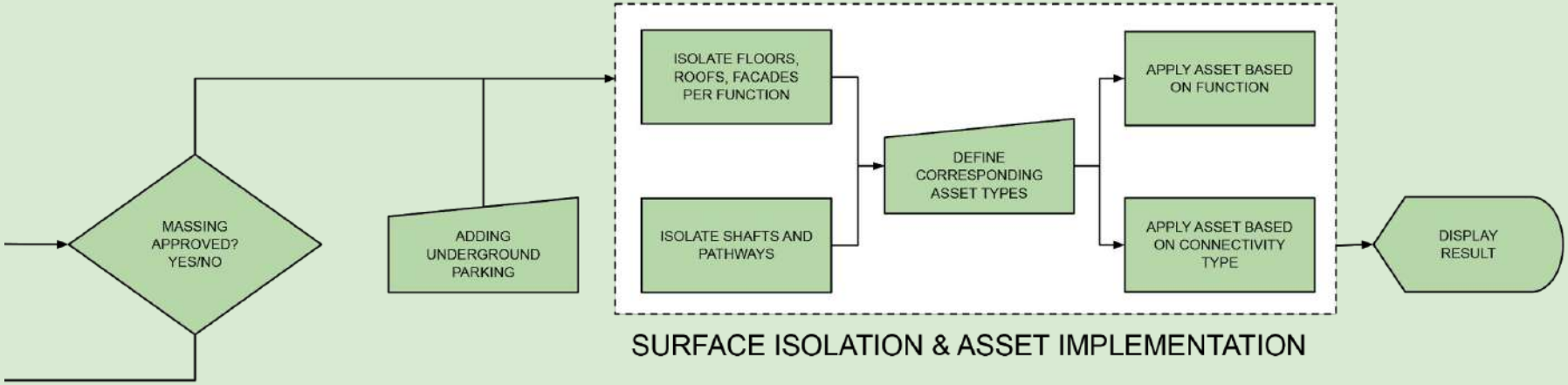
ENVELOPE > SEEDS > SHAFTS > SHORTEST PATH > GROWTH CLOUD

ALL ALGORITHMS IN ORDER: DEVELOPMENT OF ACTUAL BUILDING:

LIVE-WORK-PLAY CLUSTERS

F O R M I N G


ENVELOPE CONSTRUCTOR ATTRIBUTES
EXTRA ATTRIBUTES
ENVELOPE
SEEDING
SHAFTS
SHORTEST PATH
GROWING
SURFACE ISOLATION & ASSET IMPLEMENTATION



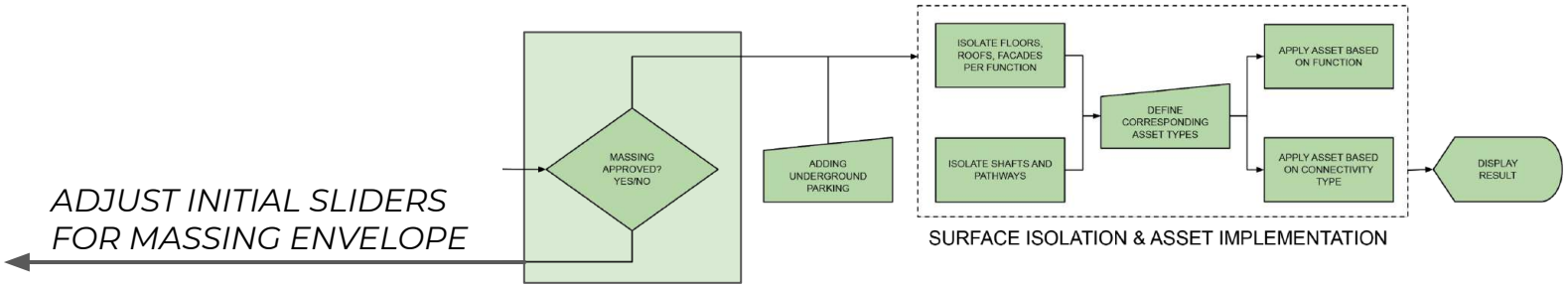
SURFACE ISOLATION & ASSET IMPLEMENTATION

TWEAKING OF GROWTH CLOUD

If, based on our design principles and strategy we accept the growth cloud, we continue with it for forming the building.

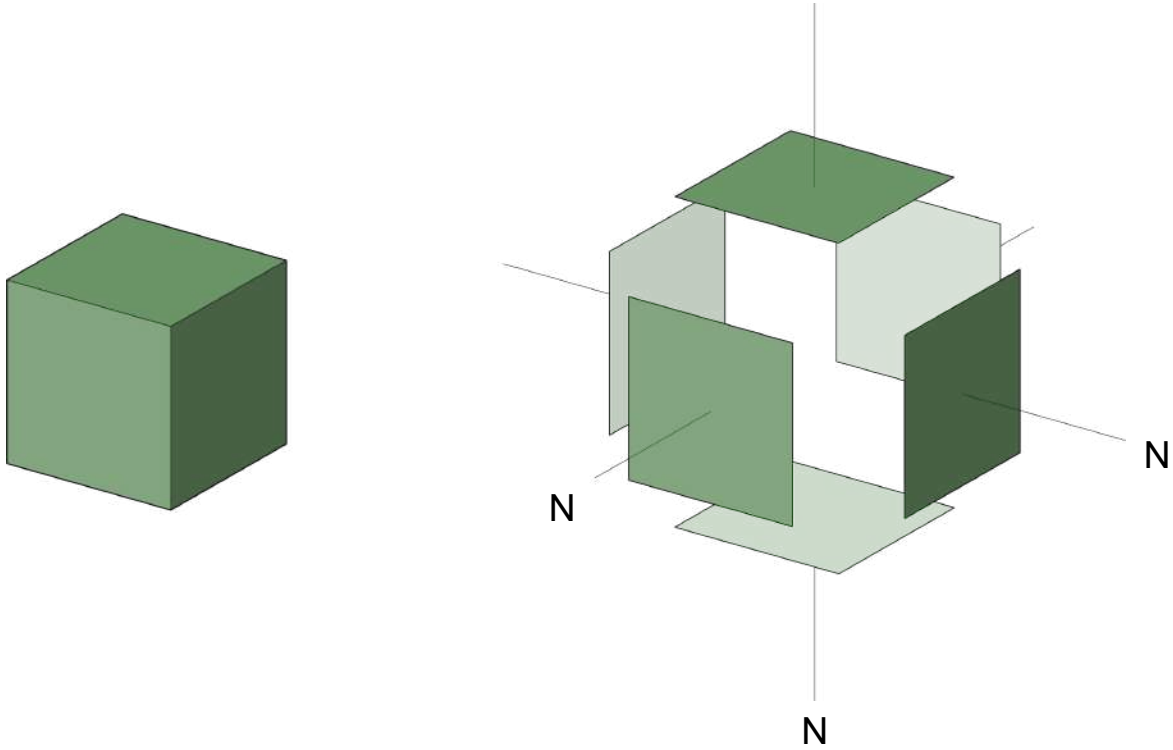
Otherwise, we return to massing by adjusting the weights given to the attributes that construct the envelope (change sliders)

- This is why ultimately our final envelope only gives significance to the solar and sky visibility



SURFACE ISOLATION

The roofs, facades in all orientations, and floors are isolated from each other by grouping them by similar normals



ASSET IMPLEMENTATION

ASSET TYPES

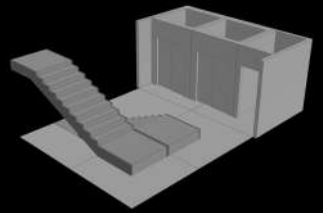
Wall: fully closed

Wall: fully windowed

Wall: partially windowed with balcony

Roof: vegetated
(as remaining function)

Wall: partially windowed
(+ 5 other variations)



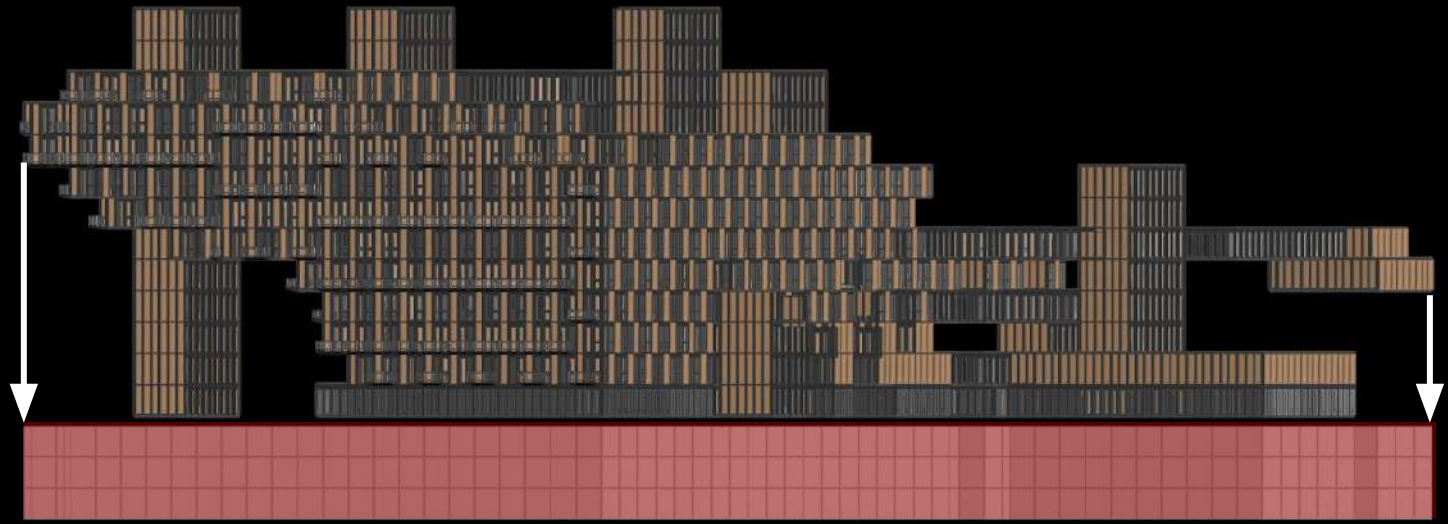
Lift/Stairwell Shaft

ASSET APPLICATION

- Per function (based on orientation)
- Per connectivity type (based on shaft or pathway)

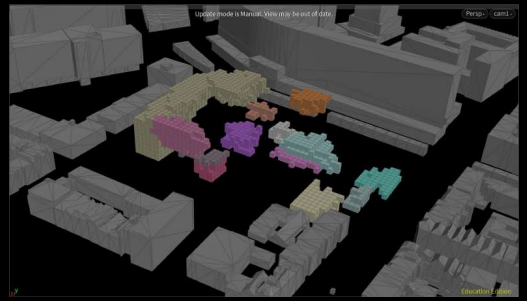
UNDERGROUND PARKING

Parking is added underneath the building, but only under the building’s projection shadow on ground level



PANDORA

URBAN PLAN



Functions grown

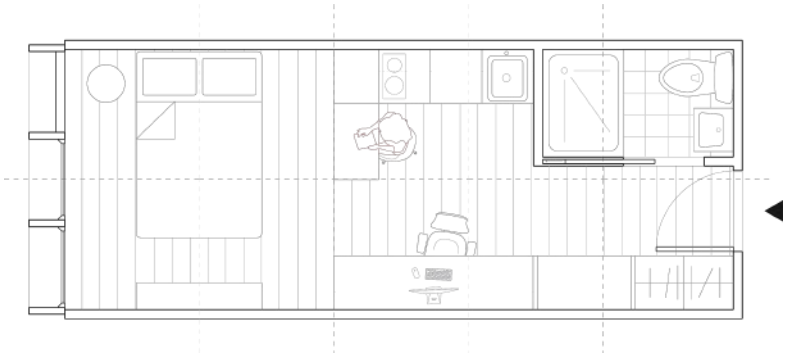
Asset placed

ELEVATION

LIVING UNITS
START-UP OFFICES
ARCADE
LIBRARY
COWORKING SPACES
FABLAB
COMMUNITY CENTRE
ENTRANCE HALL
INDOOR MARKET
GYM
RESTAURANT
CAFE / PUB
CINEMA

SECTION Through Living Units

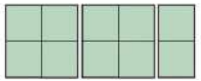
PLANS



Student Room

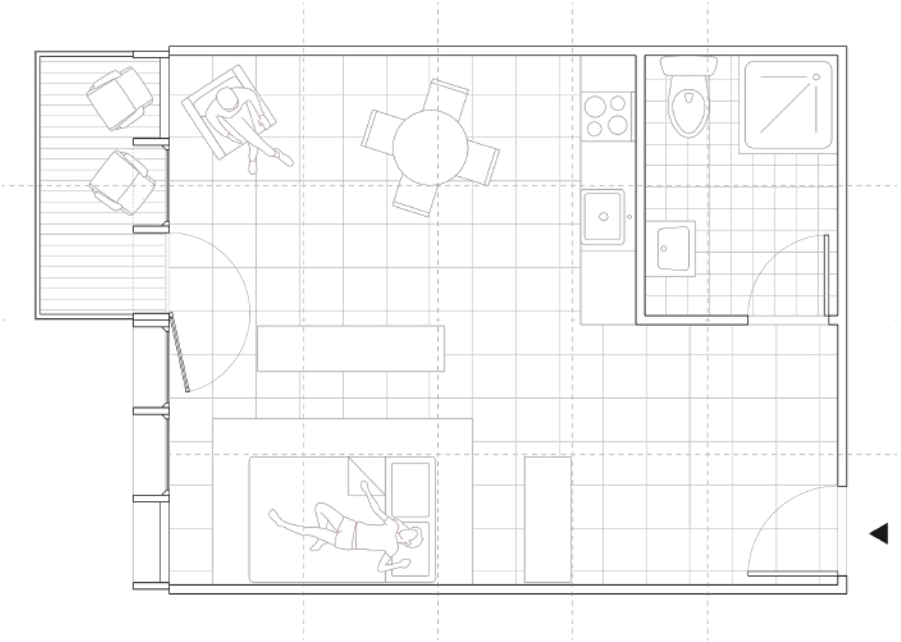
1 Person -- 22.5 m^2

Drawn at scale 1:30



2.5 *3x3 voxels*
10 *1.5x1.5 voxels*

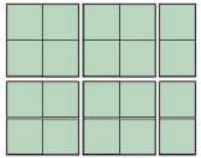
PLANS



Student Studio / Starter Housing

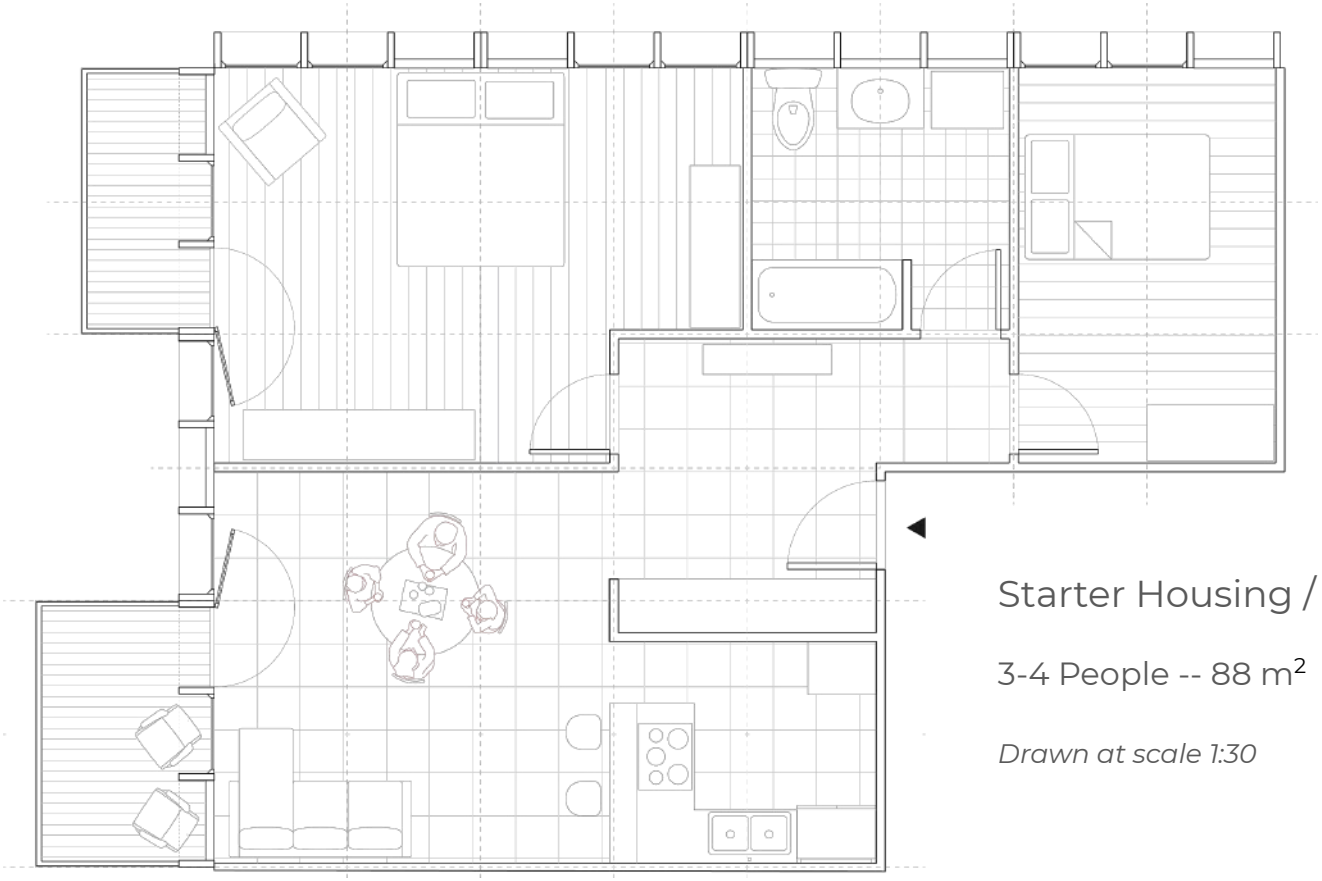
2 People -- 45 m^2

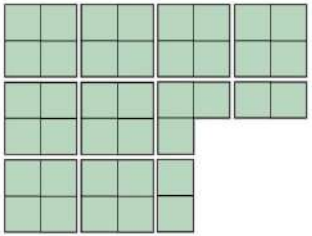
Drawn at scale 1:30



5 *3x3 voxels*
20 *1.5x1.5 voxels*

PLANS





9.75 *3x3 voxels*
39 *1.5x1.5 voxels*

Starter Housing / Assisted Living

3-4 People -- 88 m^2

Drawn at scale 1:30

PLANS - EXAMPLE LAYOUT

Questions?