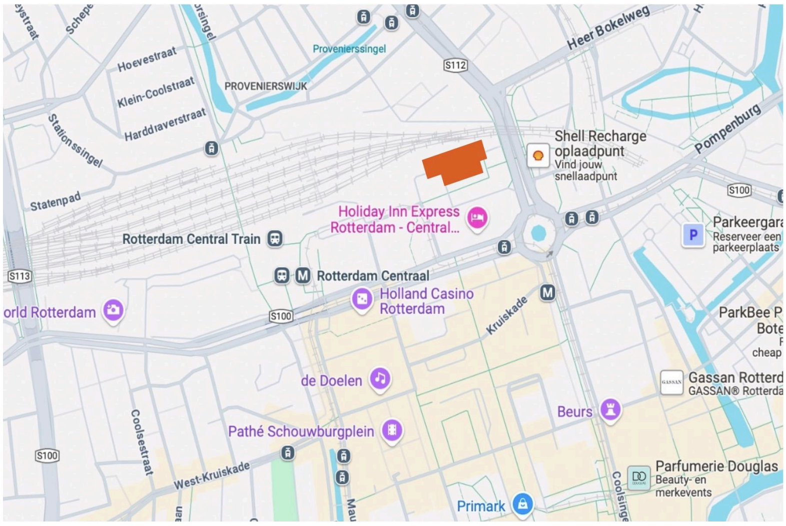
Documentation Design studio minor

Who are we
Boris Annink, Computer Science and Engineering
Britt van den Beemt, Maritime Engineering
Kars van Welie, Architecture

Location analysis

We started by making an analysis of the location in Rotterdam. In the image below can the site be seen with its surroundings. A very noticeable thing is that the area surrounding the site is very densely built. Also, the site lies close to the central train station of Rotterdam and there are also train rails near the site. This should be taken into consideration since it is probably not a good view and a lot of noise will be generated there. Another thing that can be seen in the image is that there is not a lot of greenery surrounding the site and also water is not close by. This does not make it a very comfortable spot yet. And the last thing to take into account for the location analysis is that there is a biergarten on the site. It is important that we build around that biergarten so it can continue to exist.



Facilities

Basic facilities

Aside from these facilities above we also looked at the more ‘boring’ facilities the building needs. Such as parking for cars and bikes for private and public use and what type of housing we wanted in the building.

We start with private parking. We figured there would be 400 potential car owners, the elderly and the starter housing. Considering that students do not have their own cars and some elderly or starters do not own one as well we made the assumption that there would be 320 needed. We know that on a site of 100 m x 100 m, 400 cars can be parked. So 320 * 10000/400 = 8000 m2 is needed to be able to park all cars for private use. For bikes we made the assumption that every resident owns 1.33 bikes. Considering that there are 1200 people living in the building we could say there are 1596 bike parking spots needed. We round that up to 1600 bikes. In the biking garage of the central train station of Delft 2400 bikes can be placed in 2000 m2 of space. So 1600 * 2000/2400 = 1334 m2.

For public parking there are two rules to follow for the amount of vehicles that can be placed. For 200 m2 of extra facilities 4 car parking spots are needed and 10 bike parking spots. There is a total of 5450 m2 of extra facilities so the following calculation can be made. 5450/200 = 27.25. 27.25 * 4 = 109 car parking spots and 27.25 * 10 = 273 bike parking spots. Using the same calculations as for private parking we need 230 m2 for bike storage and 2500 m2 for car parking.
For the types of housing we have starter units, elderly housing and student housing. For that last one we can divide it again into three different sizes: for one person, for four persons and for eight persons. We decided on having different types since living alone ór living with eight other people is not for everyone and we want the building to be accessible for everyone. 400 students should fit into the building, 100 in one person apartments, 140 in four person apartments and 160 in eight person apartments. That results in having 100 * 25 m2 = 2500 m2 of one person apartments, 140 * 25 m2 = 3500 m2 of four person apartments and 160 * 25 m2 = 4000 m2 of eight person apartments. For the elderly we decided on 60 m2 per apartment with 5 m2 outdoor space, this would be a balcony, which brings us to a total of 200 * (60 + 5) m2 for elderly housing. And lastly for starter housing we considered an apartment of 70 m2 with 5 m2 of outdoor space so that bring us to a total of 200 * (70 + 5) m2 of starter housing.

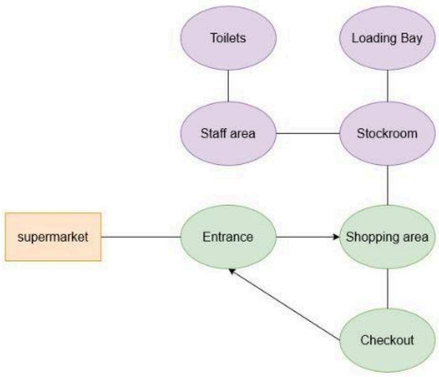
Extra facilities
A choice has to be made between which public facilities should be in the building. This should be a total of four facilities. To make this choice we looked at facilities in the neighborhood and which facilities we can add to improve the neighbourhood. The first facility we wanted to add was a supermarket since there are not any supermarkets close by. We also decided to add a gym to the building since there will be a lot of students and starters living in the building and that is usually the target group for gyms and it would make it attractive to live there for these people. We decided that the site would not be a perfect location for a care centre for elderly since these care centres do not have to be so close to the centre of the city. Most of the time these people want a more calm environment to live in. Though we did decide to put an art gallery in the building. This is because an art gallery is nice for the people who live close to become more connected to culture and because it is perfect to be close to the train rails and very accessible since it is close to the train station. And lastly we had to choose between a cafe or a restaurant. We decided that we did not need both since they are very similar in many aspects. There are many good restaurants close by and a cafe is less of a barrier to go for a coffee for the students and starters in the building. It could also be a simple facility for the elderly to go for a quick coffee without having to actually go into the city.

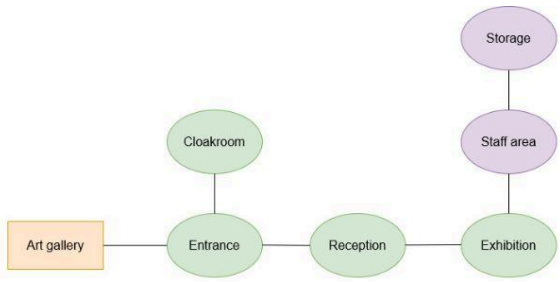
Design goals
We want the building to be as comfortable as possible for all residents. Since there are variations in the phases of which the residents are in we want to make it attractive for every one of those residents. We tried to do that to place extra facilities in the building that can be used by either one of the starters, elderly or students. Aside from that we also want the building to fit into the neighbourhood, this was another criteria when choosing which facilities to add. For the exterior of the building we also have some requirements. We want it to fit into the neighbourhood in terms of the effects of the building on the surrounding buildings. We will look at sun and shadow casting and maybe at what the view from the apartments will be. We will also be looking at adding greenery, analysing noise and have an interesting design that will make the area attractive to look at.

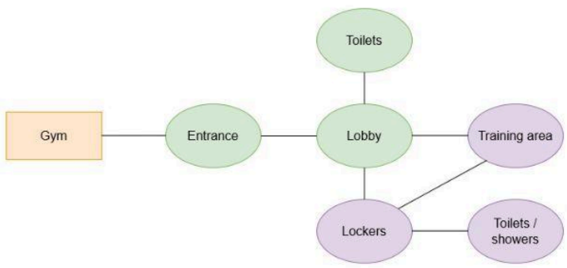
Product

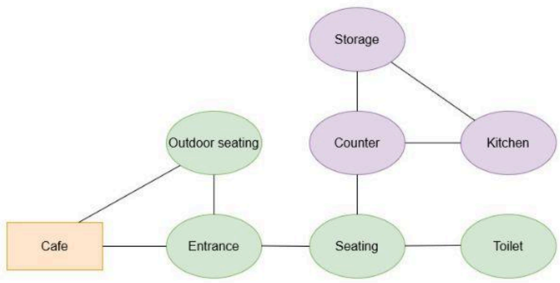
Based on the requirements for the functions and the design goals, flowcharts are made to express the information in a more visual way. The flowcharts can be found below. They express the connections that are made between the functions, private as well as public.

Public facilities

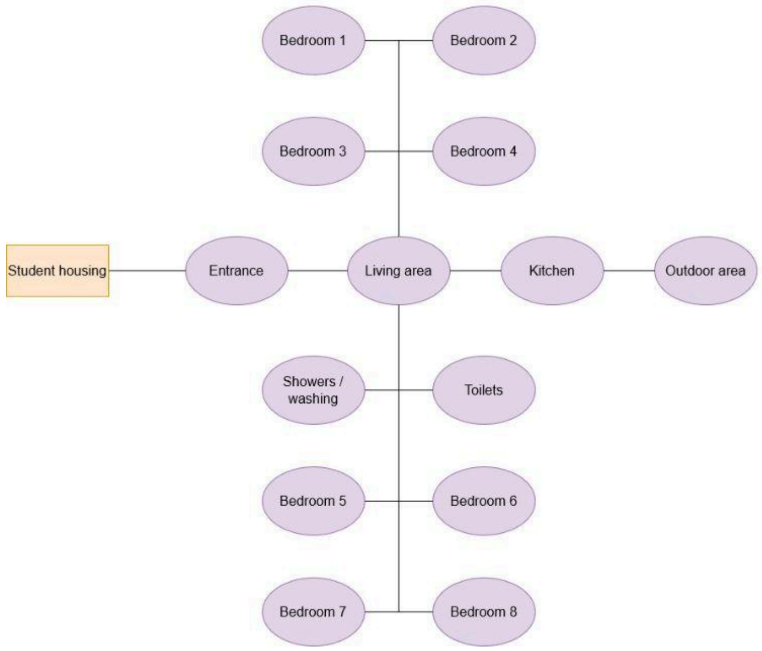




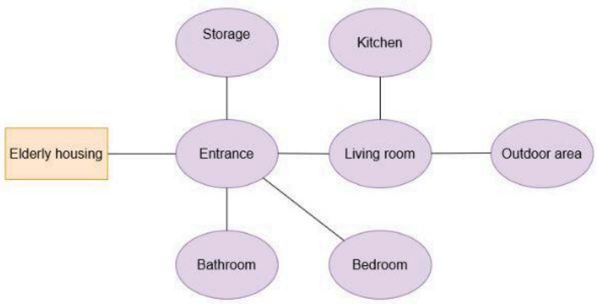




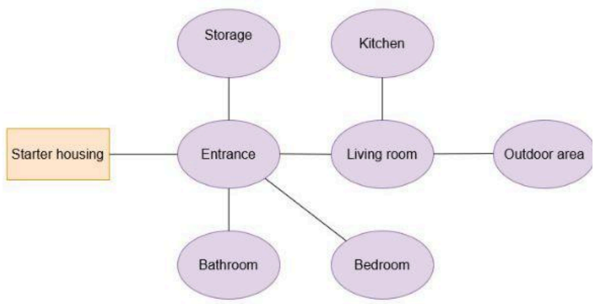
Housing facilities



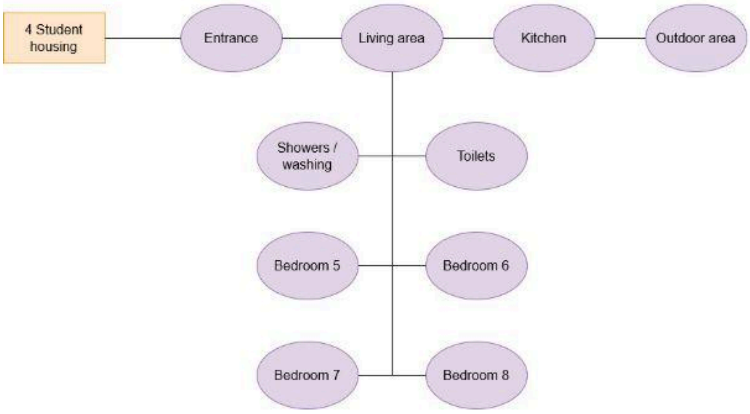
Bedroom 1
Bedroom 2
Bedroom 3
Bedroom 4
Student housing
Entrance
Living area
Kitchen
Outdoor area
Showers / washing
Toilets
Bedroom 5
Bedroom 6
Bedroom 7
Bedroom 8

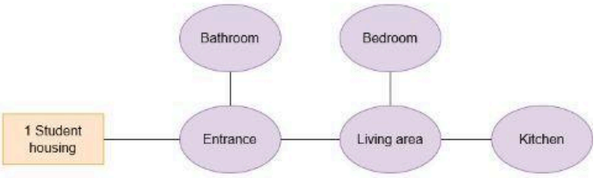


Storage
Kitchen
Elderly housing
Entrance
Living room
Outdoor area
Bathroom
Bedroom

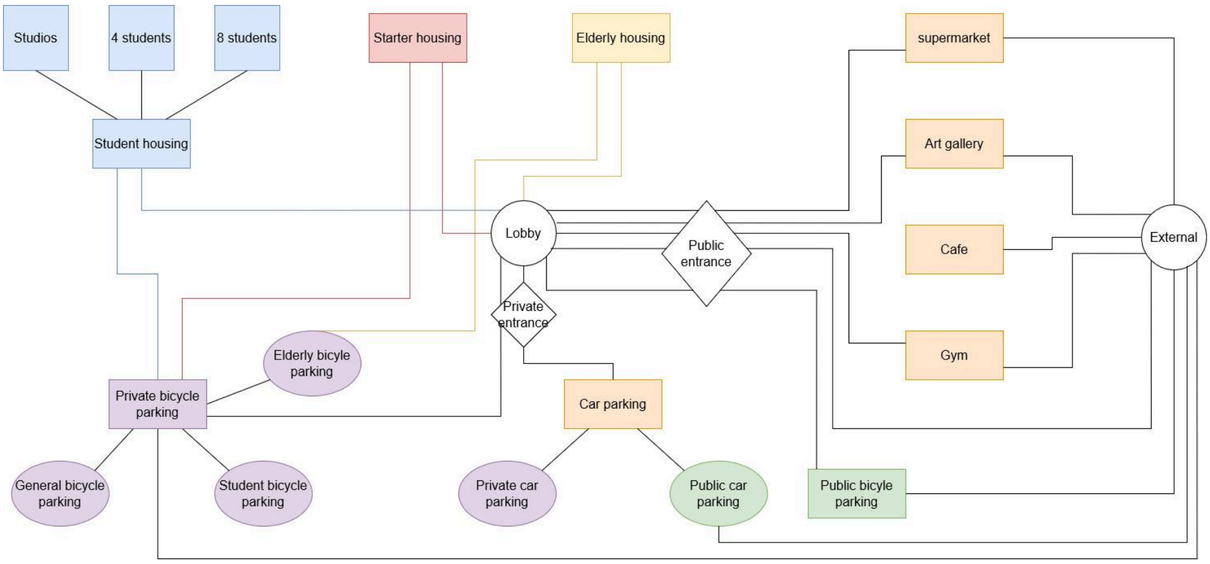


Storage
Kitchen
Starter housing
Entrance
Living room
Outdoor area
Bathroom
Bedroom





Connections between functions



Shaping the building

Voxel size

For this assignment we had a voxel size of 3x3x3 metres. The main reason for this is the height of the ceiling. On average in The Netherlands, this lays around a height of 2.40 metres. Also taken into account is the thickness of the floors and the placement of cables and sewage for example, so in total a voxel height of 3 metres would be reasonable. Also, if you choose to have smaller voxels, the computation of the model will take longer, so this is an efficient size. In the table below it can be seen how many voxels each function requires based on the area we calculated for each function.

Adjacency of functions

In the table given below, the adjacency between the functions of the building is shown. The numbers in the table are on a scale of zero to five. If zero is displayed, it means that it is the same function in both the row and column. If one is displayed, it means the functions should be close to each other and if the functions should be as far away from each other as possible, five would have been put down. The values are determined from personal experience and the mindset: ‘If I lived there, how close would I want this function to be?’.

	Student 8x	Student 4x	Student 1x	Starter	Elderly	Supermarket	Artgallery	Gym	Cafe	Lobby	Car parking	Bike parking
Student housing 8x	0											
Student housing 4x	3	0										
Student housing 1x	3	3	0									
Starter housing	4	4	2	0								
Elderly housing	4	4	1	2	0							
Supermarket	4	4	4	3	1	0						
Artgallery	5	5	5	3	3	1	0					
Gym	3	3	3	2	4	2	2	0				
Cafe	5	5	5	2	3	1	3	2	0			
Lobby	4	4	4	3	1	2	3	2	2	0		
Car parking	5	5	5	5	3	1	1	1	1	1	0	
Bike parking	5	5	5	5	3	1	1	1	1	1	3	0

function weights

Each function has its preferences regarding light, noise, and height.

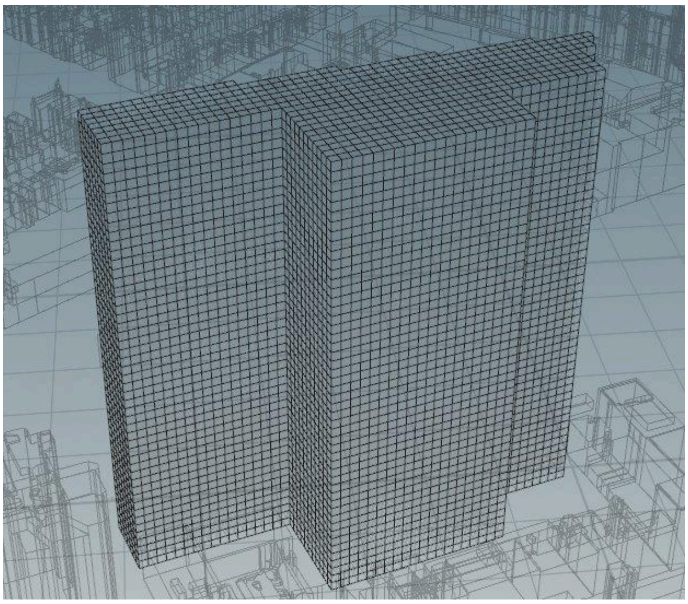
Function	**Noise**	**Sunlight**	**Daylight**	**Groundlevel**
Student 8x	0.7	0.6	0.9	0
Student 4x	0.7	0.6	0.9	0
Student 1x	0.7	0.6	0.9	0

Starter	1	1	1	0.5
Elderly	0.9	1	1	0.7
Supermarket	0.2	0.1	0.3	1
Art gallery	0.6	0.3	0.4	0.9
Gym	0.3	0.3	0.3	1
Cafe	0.6	0.6	0.7	1
Lobby	0.5	0.5	0.5	1
Car parking	0	0	0	0.9
Bike parking	0	0	0.2	0.9

From Mass to Building

Voxalization

The first step for designing the building was to create a voxel cloud. For this, we first needed to create a point cloud, and then we added a box of 3x3x3 metres to each point. These boxes were connected with each other and thus, the voxel cloud came to life. The voxel cloud has the maximum amount of voxels that the building has access to. The point cloud is not the full site; however, space was left on the sides for walkways, roads, and Biergarten.



Analyses

Multiple analyses have been done on the site of where the building is located. We did a sunlight, daylight and noise analysis. Based on these analyses, the functions can be placed within the building. So, if a function requires lots of sunlight, it will be placed close to the voxels that experience a lot of sunlight. The same with the other two analyses. These analyses will help to make the building as best arranged as possible.

Sunlight

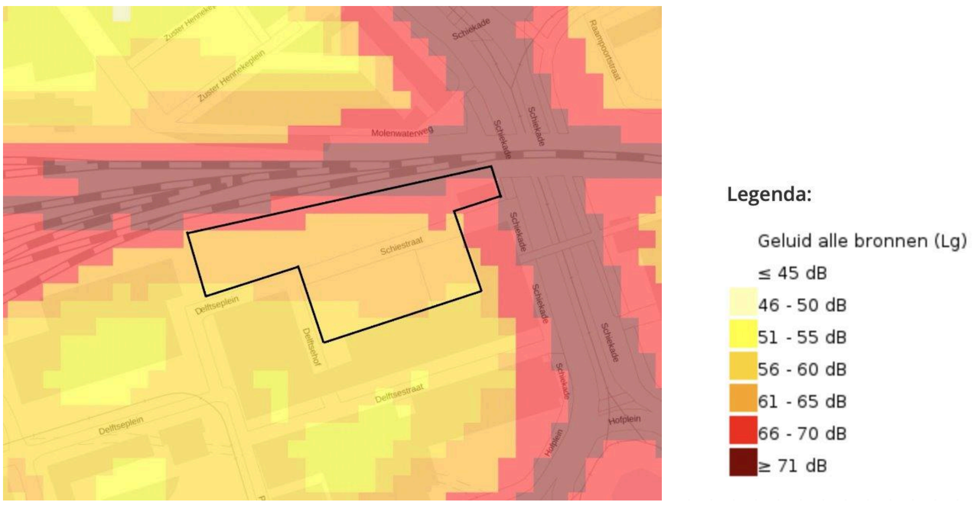
The sunlight analysis is measured by calculating how much the sun would be visible throughout the year for each voxel. Sun data was taken from 'SunEarthTools.com' and contained the expected position for each hour. To calculate the amount of sun, we draw rays between the expected sun positions and each voxel and find how many are blocked by surrounding buildings.

Daylight

Another measure we used was daylight, which is light that is not directly from the sun but scattered around by the atmosphere. To calculate, we used a similar approach as with the sunlight analysis, but instead, we drew the rays to random points in the sky. For each voxel, 64 random points were chosen.

Noise

As shown in the figure below, quite a bit of noise surrounds the site where the building needs to be placed. On the right, you can see the legend with the number of decibels produced. The north side of the building experiences quite a lot of disturbance from noise pollution caused by the many train tracks there. A big road on the east side of the building also causes a lot of noise disturbance. On the other sides, there are still quite some decibels of sounds, but it is way less. We let the function distribution within the building depend on the noise from the tracks and the road. We believe that students will have less of a problem living in an area that has more background noise and that the elderly will be on the other side of the building completely. We did the same for different functions, and this analysis is implemented in the growing algorithm to place the functions in the best way possible. To get the results for each voxel, we overlaid the map onto the site and measured for each voxel the amount of noise on that position. If a voxel was off of the ground the dB value would be lowered by 6.02 dB each time the distance doubles

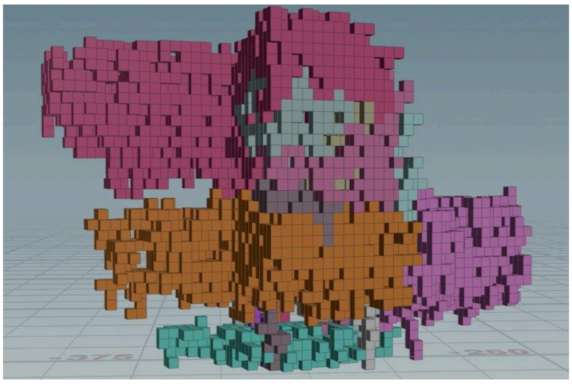


Growth seed placement

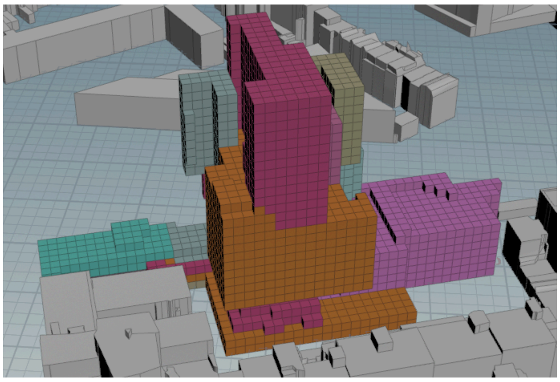
Before we can use the growing algorithm, we need a place to start growing from. These points are called seeds. To place the seeds, we calculate the desire of each function to be at a particular voxel. This is calculated using the dot product between the function weights and the analysis results. The voxel on the ground floor with the highest result will be selected for each function.

Growing algorithm

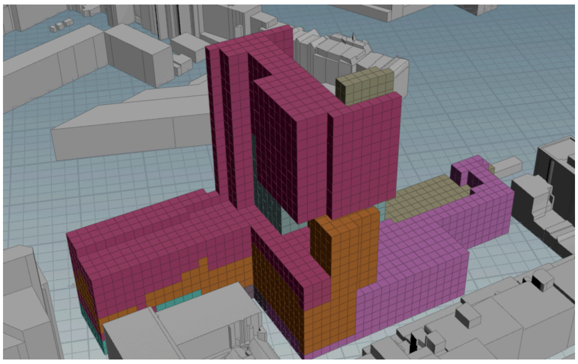
Now that we have the seeds, we can start growing them. We do this by finding the adjacent voxels for each function and adding the voxel that is considered the best. A voxels worth is calculated in a similar way as for the seeds, but with the addition of blockiness and flatness. Blockiness is a multiplier for the result that is applied by each adjacent voxel that is already in the function. Meaning that missing corners are more likely to be added and the function as a whole will be more likely to resemble a large block. Flatness is a similar multiplier, the difference being that it only multiplies to the sides. This means that the function is more likely to grow horizontally over vertically.



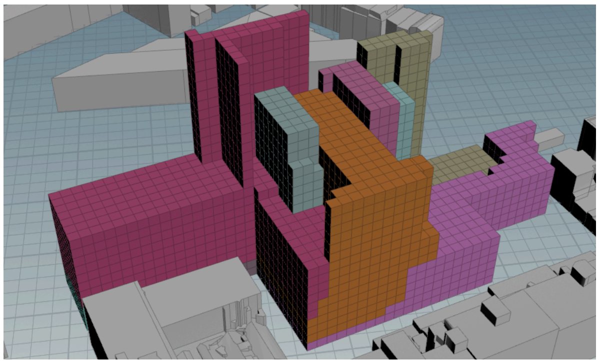
Blockiness: 1
Flatness: 1



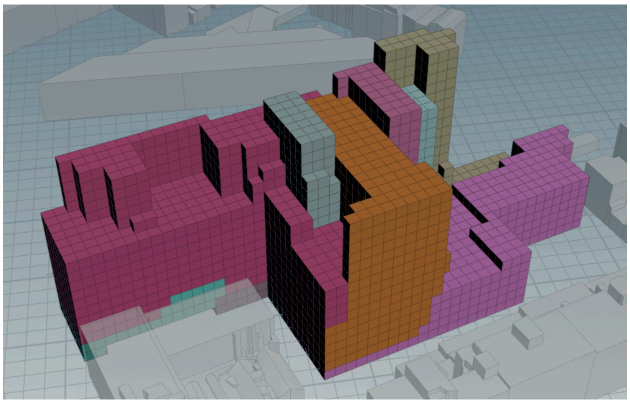
Blockiness: 1.25
Flatness 1.01



Blockiness: 1.5
Flatness: 1.01



Blockiness: 1.75
Flatness: 1.01



Blockiness: 2
Flatness: 1.01

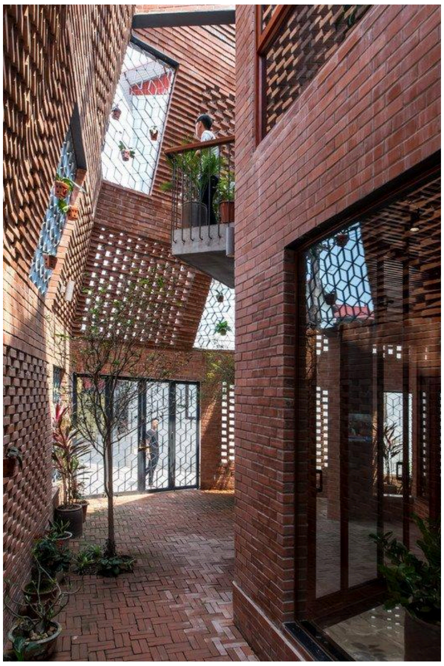
Forming Placement

Inspiration facade

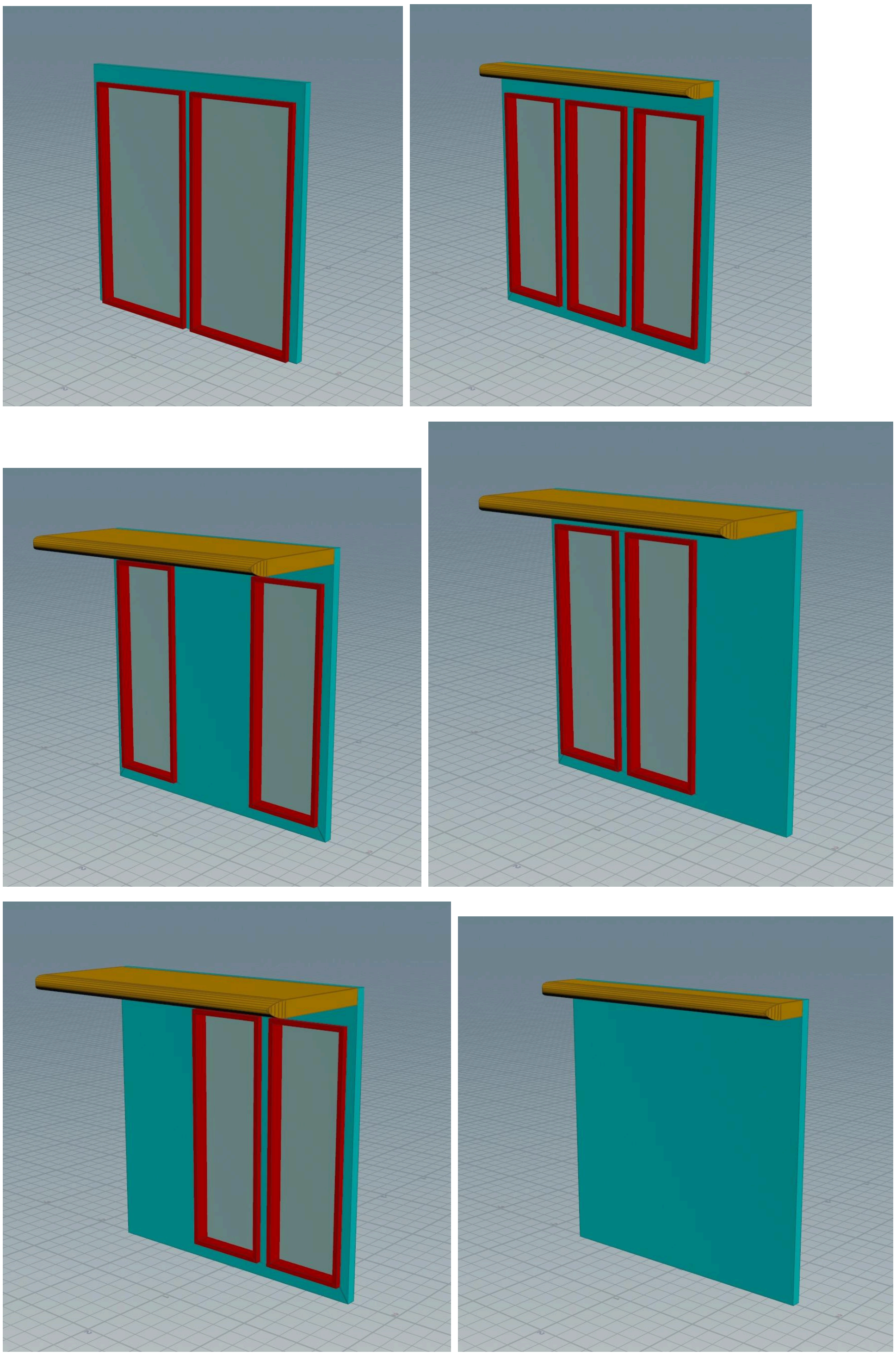
Traditional Dutch architecture often incorporates brick. To make the building fit in more in the surrounding area it was chosen to use the same material as surrounding buildings. There is not simply one way to build a wall with brick but rather countless ways to achieve different effects. This is why it is important that our building should use the same masonry bonds as surrounding buildings. However, it would still be nice to include some parametric brick elements into parts of the facade.

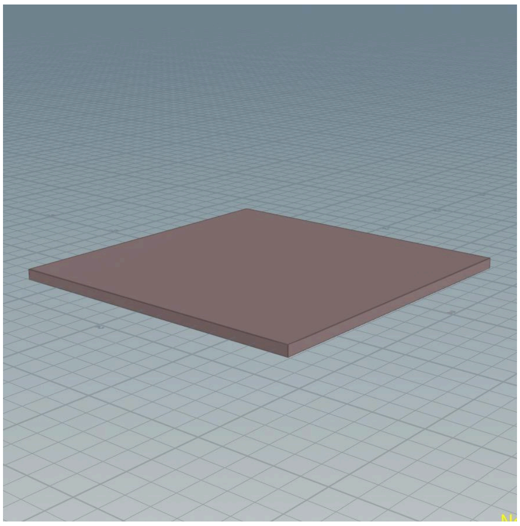
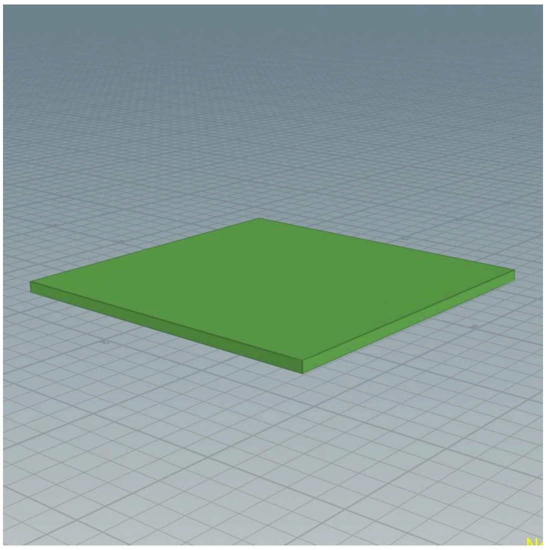
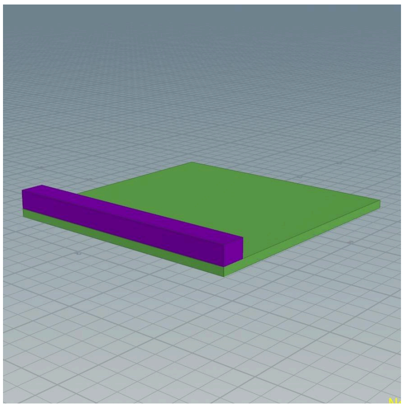
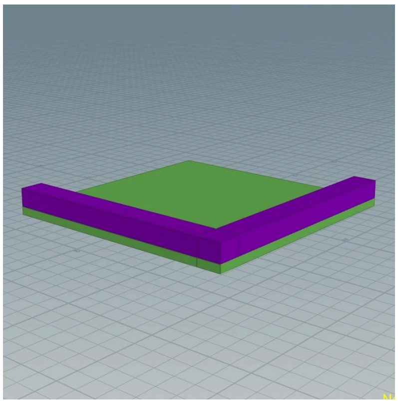
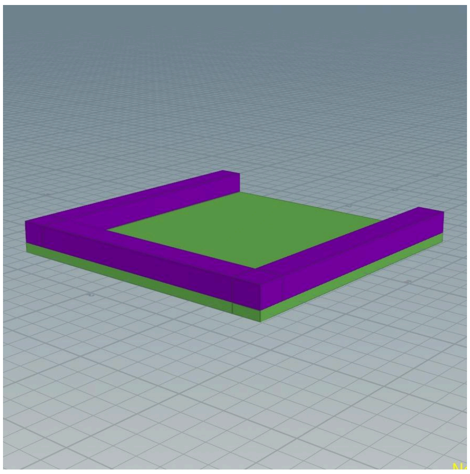
Darker colours contrast nicely with brick. That is why the canopies on the building are made of concrete that are made darker using pigment. Concrete can be poured into almost any shape which could make for interesting parametric facade elements. Unfortunately the final canopies are quite simple.

Lastly plants play a big part in the final look of the building. These plants help cool the building down in summer and help with water retention. This way the urban heat island effect is reduced.



Facade tiles

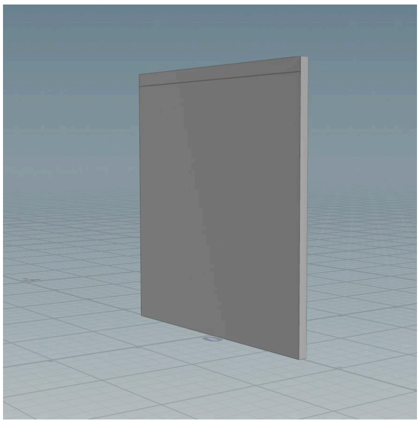
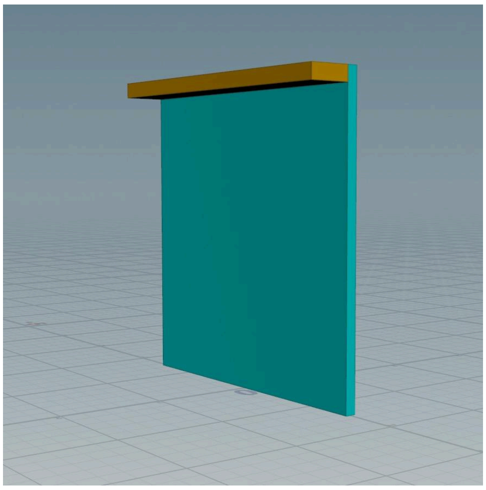
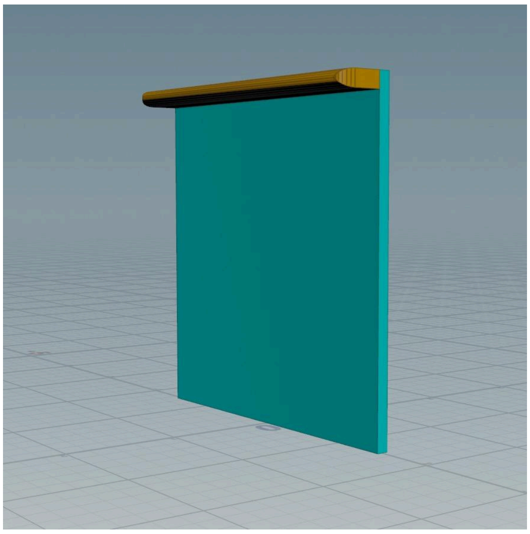
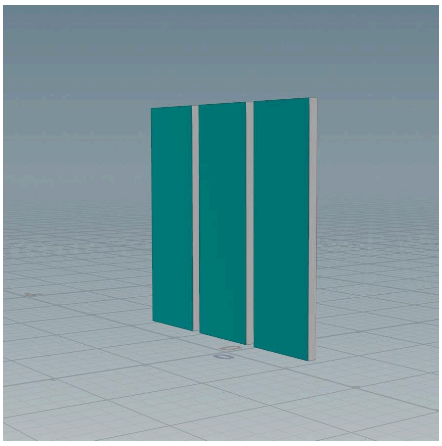
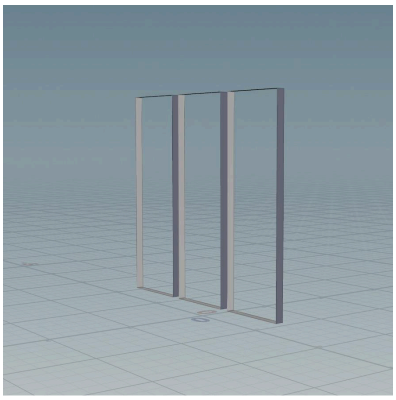
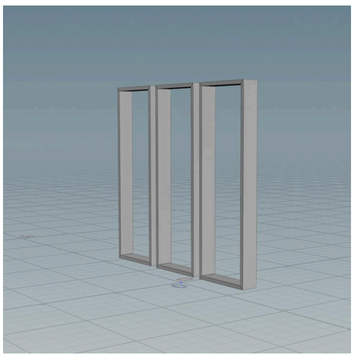
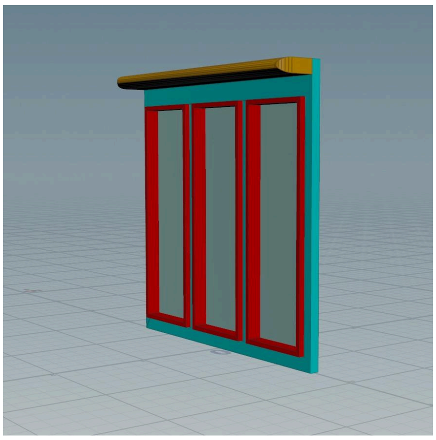


Construction of the tiles

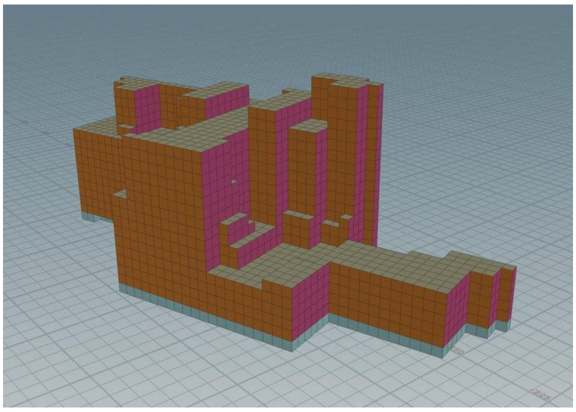
For the facade tiles, different versions were made that are going to be displayed randomly across the facade. First the 'blue box' was made and from that the windows and canopies were added. This was done by cutting out boxes from the blue wall with the sizes of the windows and deleting the insides of those boxes so that only window frames were left. With polyextrude those window frames got a thickness and with a transform node they became wider so that they protrude out of the blue wall and give the design some dimension. Into the window frames, windows were added as very thin boxes. All of the components were merged together and the first facade tile came to life. The same

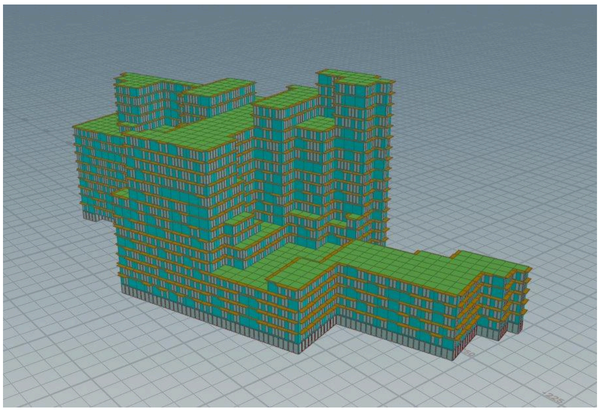
was done with the other facade tiles with the only difference that the amount and width of the windows was changed.
In the case that a facade tile would also need a canopy, there were some extra steps that needed to be done. On the blue wall first another box was added. Next, that same box that represents the canopy would be rounded at its edge with the function PolyBevel. For the different facade tiles, different wides of the canopy were used and different combinations of windows. In the images below the process of putting the tiles together is shown in a visual way.

For the construction of the tiles on the roof and the floors a similar technique was used although this process was less complex to apply. For the floors, only boxes had to be made and for the roof four different types of tiles were made. The first is just a box like the floors, for the other ones, boxes were applied to the top of the other box to make a border around the edges of the building. These last three would only have to be at the edges of the building and everything in between will be filled with the regular roof tiles.

Construction of tiles on voxel cloud





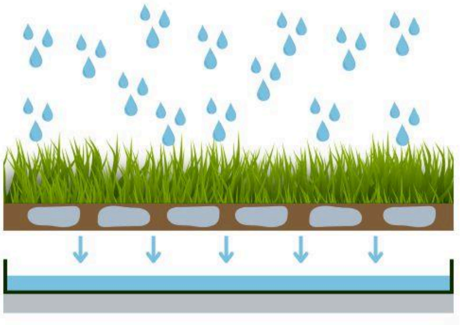
The first step for placing the tiles is to divide the faces into different groups. For this it 6 groups were created: North, east, south, west, the ground floor and the roof. These groups each pull their facade types from a list and are randomized. The types of tiles that get used from the list is different for each group. For example the roof only uses the roof tile while the south face uses three different tiles.

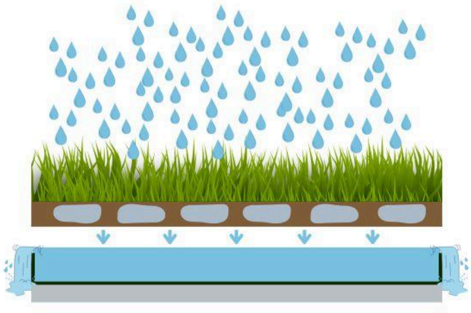
The south side uses tiles that block the most amount of sunlight while the north only uses tiles that maximize light entering the building. The east and west facades use intermediate types of tiles.

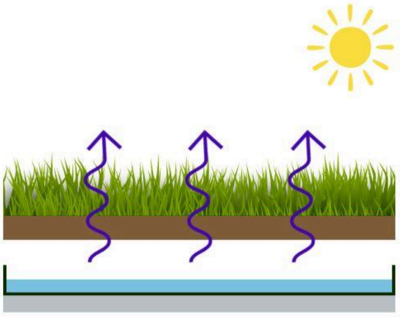
Roofs and undersides

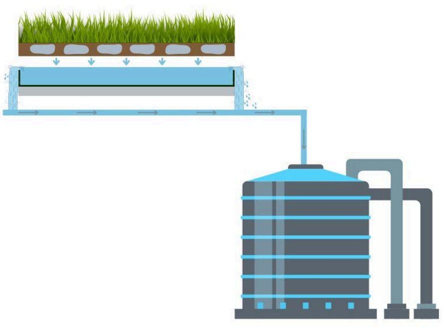
It is required to have at least 8000 square metres of greenery attached to the building. This can either be on the facade, roof or in a garden. Since there also has to be a solution to collect and store rainwater, these processes can be combined. The idea is that below the layer of grass there is a mechanism to collect the rainwater that comes through. First the water slides into a tank. There can be a minimal amount of water be stored here when the rainfall is also minimal. When the sun shines again the water from these tanks can evaporate again to the air. This last bit is not also a convenient way to get rid of the water again, but it also cools the air around the building. Because of that the plants will grow in a better environment and it will be more attractive to sit on the roof during hot periods of time.

In case this tank filled with water overflows because of heavy rainfall, the remaining water will be guided to a bigger tank further away within the building where it can be stored. All the overflowing water from the tanks on the roof will be able to be stored in this tank. This stored water has a purpose as well, it can be used to flush the toilet with or to heat the water and let it flow through heaters in the houses. For these two processes the water does not need to be filtered. If it ís filtered, it can be used for showering as well. The tank will be big enough to contain two full days of heavy rainfall. In case it rains longer than this, the water will be sent to the sewage canals. Below, images can be found that explain this process in a visual way.









of facade