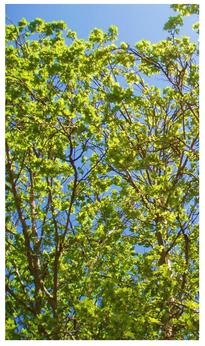
The University of Tokyo
Adaptive Morphology 2016
Kuma + Obuchi + Ichikawa Studio
Rafael Pacheco Gonçalves

CELLA HOTEL

CONCEPT // TREES AND BUILDINGS

Plants and buildings share more similarities than what is easily grasped by a common glimpse. In fact, both are structures whose main division consist on under the ground level and above it –and such division and the environment around its development is the starting point for all other decisions.
Also, both structures share a quite obvious but important fact: They are supposed to stand still in a single position until the end of their lifes. Plants deal with this issue using evolutionary tactics to ensure CO2 absorption, nutrients' transport and absortion as well as plenty of light hitting its surface. Usually architects design buildings to adapt to local conditions – which is,somehow, close to the plants approach – to ensure light, ventilation, safe structure and good functionality. Architects and plants also aim on the aesthetics – to attract users and develop an architectural concept in the first case or gather attention of annimals for reproduction purposes in the second.



INVESTIGATION OF ROUGHNESS CONCEPT IN NATURE

As of the Studio project for Hotel near GaienMae station in Tokyo in a site near the New Tokyo Olympic Stadium, several discussions about the roughness of a building were rised in order to develop a design that would maximize it. But would roughness be only a value?
The studio concept used a relation between *Volume and Surface area* to grasp the roughness ratio of a building. Such formula was mostly used by analyzing exterior surfaces of existing buildings using *Grasshopper* inside *Rhinoceros'* environment.
From the Vegetal Morphology work of Gonçalves and Lorenzi (2007), the same parameters are mentioned and correlated as one of the main variables for plants' formal development. As the authors explained, several shape adaptions in evolutionary processes had this relation as a key factor for maximizing light gathering surfaces, reduce water waste or even minimize possible damages due to crash with other objects. As an example, cactus species need less surface area due to desert climate as amazon species need more light due to the dense vegetation layer that reduces sunlight under trees.

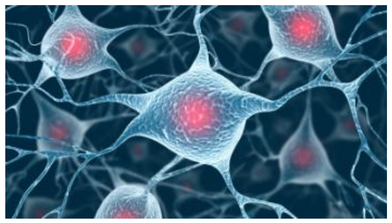
INVESTIGATION OF NETWORK IN NATURE

Some plants differ their network systems related to the environment demands. Grasping site's surroundings has the same power, in order to make it shorter, as it is one of the Studio's objectives. In its first evolutionary stages, plants were much smaller and underwater, not really demanding unique strategies related to the transport of nutrients. At these times, the flow of needed energy happened from cell to cell. As species grown wider and taller, such strategy was replaced by conductive tissues: xylem and phloem, to increase efficiency in larger systems.
In past, several architecture styles had buildings with no circulations between rooms – such as portuguese houses; Such kind of network can be compared to primitive plants. The most adopted solution nowadays has circulations as the network system connecting all the rooms.
As the studio project is mostly vertical, the provided solution should be close to plants whose geometries tend to use the same main axis, thus developing a compact network. The network system is based on the main flow of users of this knd of building: from entrance to guest room. By default, to mimic roots of a tree's method for gathering nutrients, all the possible entrances were considered – leading to a good solution made of shorter paths.

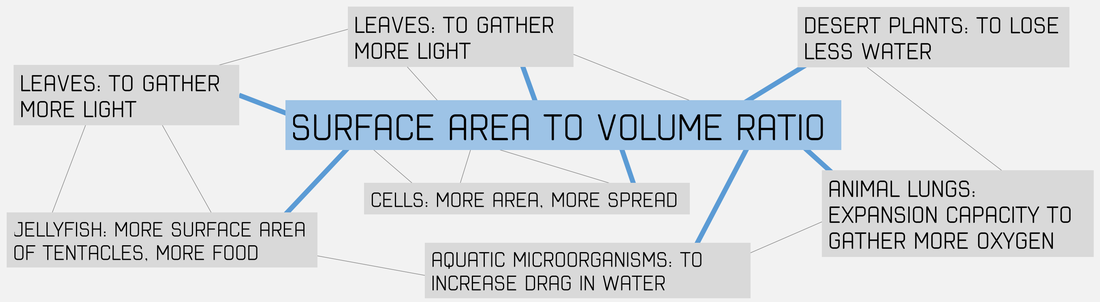
ROUGHNESS =

SURFACE AREA /

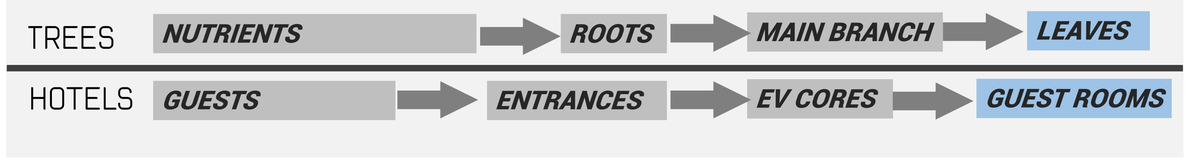
VOLUME



WAYS NATURE APPLIED SURFACE AREA TO VOLUME RATIO



MAIN FLOW OF TREES AND HOTELS' NETWORK



FINDING A SOLUTION: EVOLUTIONARY DESIGN

The methods developed by the studio trust on the evolutionary tool Galapagos,that can be used for evolutive simulation inside the Rhinoceros workable area. Connecting the strategies used to plants during thousands of years to architecture, such relation should also aim on the consequences to the building, such as ventilation, sun exposure or visual sensations to the users. By conclusion, the roughness is more than a number, but a factor that stimulates others that are important in architectural design. Such effect happens as well with the network systems: Choosing shorter paths may lead to several impacts on people's flow and effectiveness of the operations.

SURFACE AREA TO VOLUME RATIO: ARCHITECTURAL BENCHMARK

To grasp roughness in architecture, benchmark models were used to check possible roughness and network relationship. The example below is Edifício 360, in São Paulo, Brazil, which gets more rough due to the balconies purposed by Isay Weinfield, Brazilian architect.

SOLUTION FLOWCHART

CREATE SEVERAL POINTS IN THE SITE - POSSIBLE CORES

↓

CHOOSE THE CORES RANDOMLY (ALSO THE NUMBER OF CORES)

↓

CREATE CIRCLES. THE RADIUS SHOULD BE EQUAL TO THE MIN DISTANCE TO THE SITE BOUNDS. CREATE A SINGLE CURVE

↓

DIVIDE THE CURVE AND GET THE ROOMS. GET THE CORE COMBINATIONS THAT WILL PROVIDE MORE ROOMS

↓

OUT OF THE BEST SOLUTIONS, GET THE NETWORK OF THEM. PICK THE MOST COMPACT.

↓

GET THE POINT CLOSEST TO ALL ROOMS AND ENTRANCE. THIS IS LEISURE SPACE CORE. (POOL, GYM...)

↓

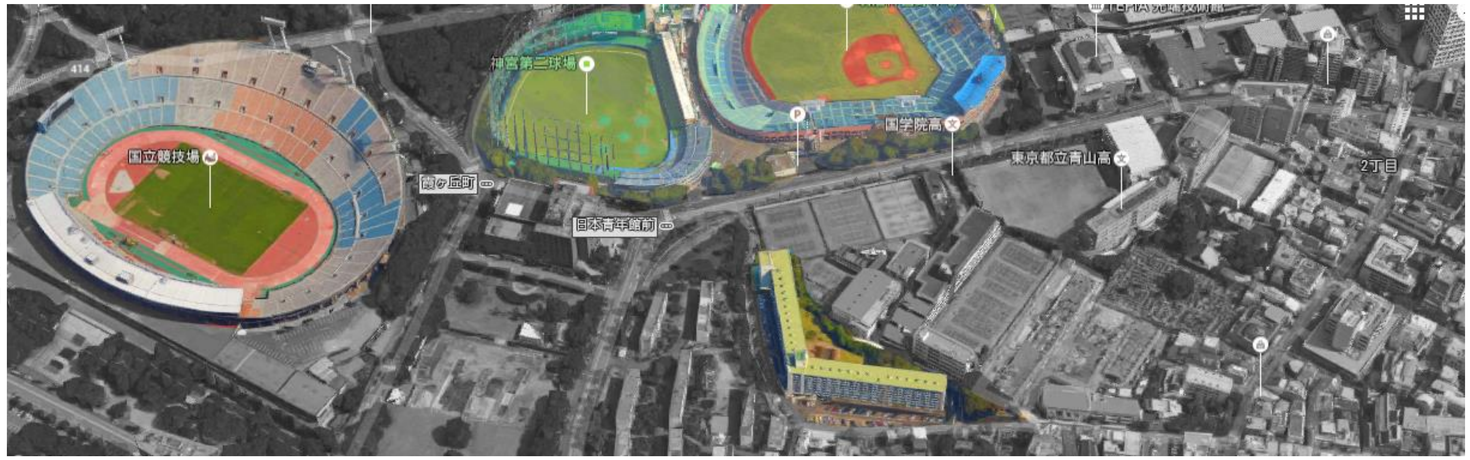
HOTEL SHAPE

ABOUT THE SITE

- Tokyo-Japan//Shibuya-Ku //MeijijinguMae 2Chome 2-39
- Allowed building height: 80m
- Site area: **8,760m²**

The site is located on a region of high real estate value due to Tokyo's Olympic Stadium and sports facilities. Close to the area the guest will have several stations, such as Gaien Mae station. The site is mostly flat and nowadays has residential use.

THE SITE AND ITS MAIN REGULATIONS WERE USED TO DEVELOP THIS PROJECT AS MAIN PARAMETER.



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STEP 01

FIND THE BEST SHAPE CONTOURS RELATED TO SITE AND PROGRAM.

PROBLEM 01: HOW MANY ELEVATOR CORES THE BUILDING SHOULD HAVE?

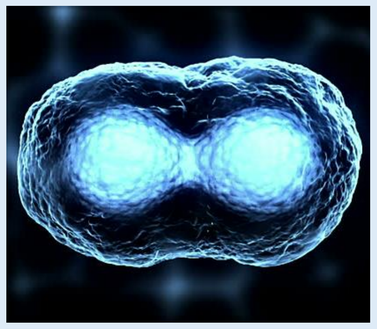
From the given site, the main constraint for this operation is the site limits due to Tokyo's regulations. From this site, a grid of points is created, thus, allowing a range of acceptable solutions within the construction limitations. After this, some of these points are chosen randomly and treated as possible core.
By simulating the union of simple cells, these cores connect themselves, generating a master curve that will give the number of rooms, which is the factor desired to be maximzed in order to make the client's investment worth it.

CONSTRAINT: SITE

VARIABLE: CORE POSIT.

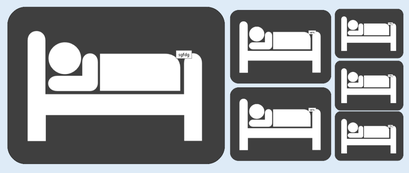
VARIABLE: ROOM SIZE

The second important variable for this project is related to the purposed type of hotel. The room size is the value used for dividing the main curves. For this single study it is purposed a hotel that aims on young people groups willing to visit Tokyo, specially on 2020 summer olympics.
At this stage it is thought that the rooms should have more than two beds and should be charged similarly to rent – as like other famous services, such as AirBNB. This requirement gives the size of the rooms.



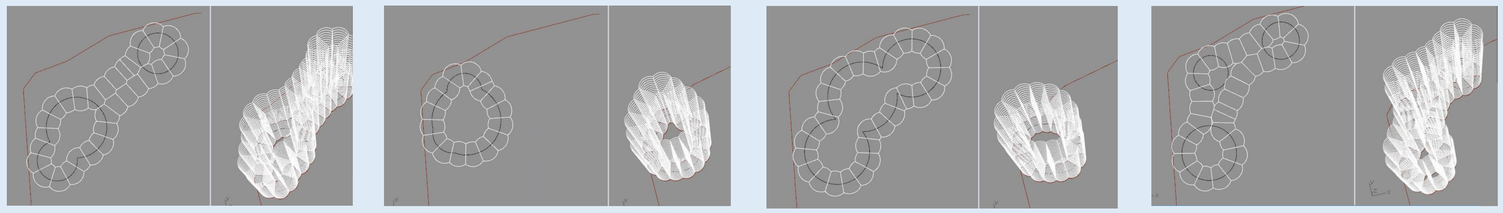
RISE CLIENT'S PROFIT

After applying this logic to Evolutionary Optimization tool (Grasshopper's Galapagos), the main result was obtained, providing also the best possibilities for number of floors.



CONVENTIONAL HOTEL: PRICE PER PERSON

STUDY HOTEL: PRICE PER ROOM



1. SHAPE TRIALS

2. RESULTS

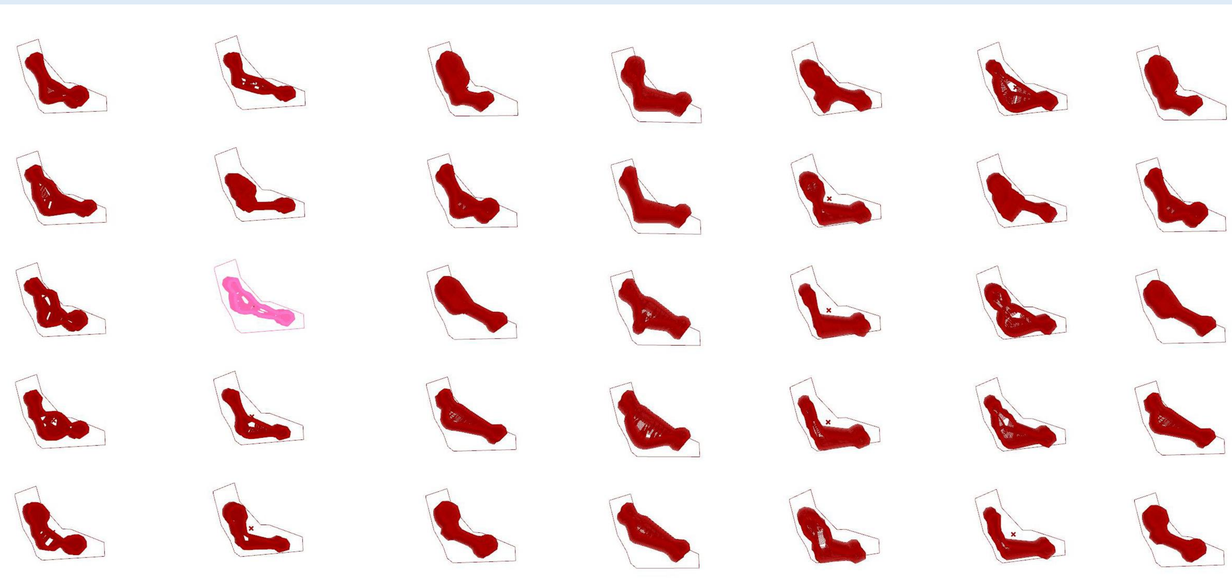
3. BEST RESULTS

For this study, the maximum number of rooms was 48. Mostly the evaluation returned 3 cores as an good number, with incidence of 2 and 4 cores as well.

CONCLUSION OF STEP 1:

IF THE NUMBER OF ROOMS IS RAISED, THE OUTER SURFACE IS DEMANDED TO BE BIGGER, THUS INCREASINGG ROUGHNESS IN BUILDING SCALE

AVERAGE: 48 ROOMS - 3 OR 4 EV CORES



STEP 02

EVALUATE THE BEST SOLUTIONS OF FIRST CRITERIA THROUGH NETWORK EVALUATION.

PROBLEM 02: WHICH SOLUTION RETURNS A COMPACT NETWORK WITH 500 ROOMS?

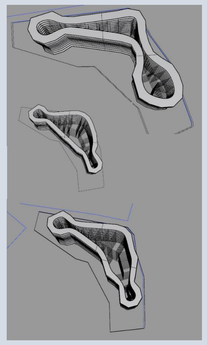
At this stage the most important factor is the network. To evaluate the solutions, the most common user flow is adopted as parameter: The movement from entrance to the guest room. Inspired on how plants gather nutrients with roots, this hotel project lays on the Idea of a free entrance, in which the guests or visitors can enter through all site boundaries in touch with the street.
All the solutions gathered in the last step had their results evaluated for a minimum of 500 rooms – considering this as a possible demand from the client. The smallest of the networks leads to the shape that is going to be developed ahead. This will also help on deciding the final number of elevator cores.

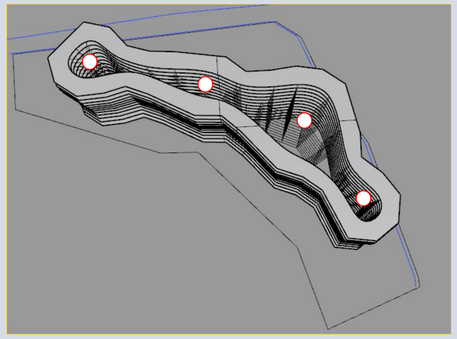
FREE ENTRANCES: MIMIC PLANTS BEHAVIOUR

MAIN USERS FLOW: ENTRANCE TO GUESTROOM

MAX NUMBER OF ROOMS AND COMPACT NETWORK LEADS TO OPTIMIZED RESULT

INITIAL CORE NUMBER	CORE NUMBER AFTER STEP 01	GUEST ROOM NUMBER	NETWORK SIZE FOR MAKING 500 ROOMS (MASS ADDITION)
4	4	42	10882m
4	2	42	12879m
5	2	44	12044m
5	3	44	13467m
4	4	45	11561m
4	3	44	12149m
5	3	44	12611m
4	2	41	13794m
3	3	41	12178m
4	2	41	12878m
4	3	43	14175m





STEP 03

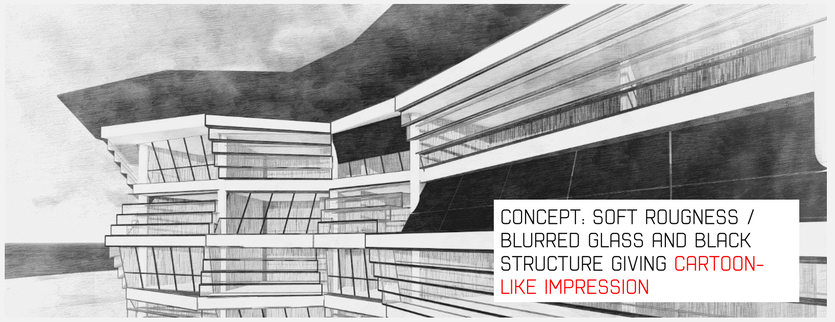
CREATE THE HOTEL FACADE AND INTERIOR CONCEPT. GET THE POSITION OF ROOMS.

After defining the hotel shape, the main goal is to make it feasible. The roughness of the hotel is one important factor for the design so, in order to mimic nature's behavior of using this numeric proportion in order to accomplish some task, this project intends to use the roughness of exterior surface to gather more light to each room and expand the view possibilities.

ENTIRE ROUGHNESS > EVERY SINGLE ROOM IS IMPORTANT

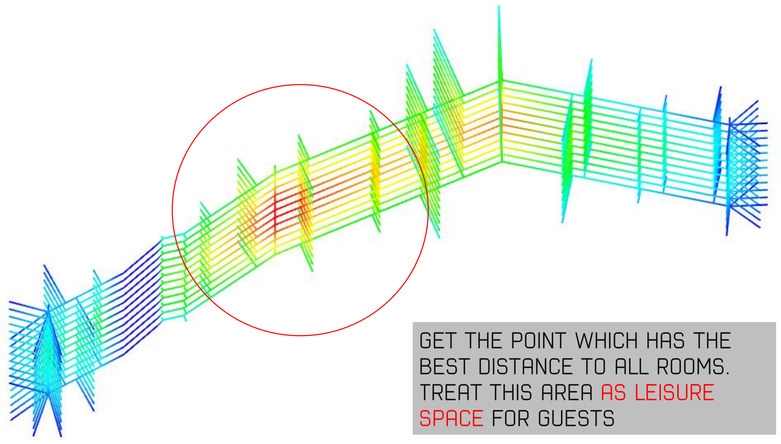
USE ROUGHNESS TO EXPAND VIEWS AND GATHER LIGHT

Based on benchmark study of 360 building in Brazil, the hotel is composed of 2 kinds of room, making a chess-like pattern that increases surface count, similar to the effect obtained by the balconies of the brazilian project. Despite the rough shape, the use of glass makes the whole volume less heavy in the middle of other buildings.



CONCEPT: SOFT ROUGNESS / BLURRED GLASS AND BLACK STRUCTURE GIVING CARTOON-LIKE IMPRESSION

Based on benchmark study of 360 building in Brazil, the hotel is composed of 2 kinds of room, making a chess-like pattern that increases surface count, similar to the effect obtained by the balconies of the brazilian project.
In order to develop common use areas, the Min-Sum graph algorithm was used to get the optimum point from all the rooms. Areas which users are mostly non-guests were all put in the first floor, such as audtiorium, smal cafe and meeting rooms. As of admnistration, part of it is on underground level.



GET THE POINT WHICH HAS THE BEST DISTANCE TO ALL ROOMS. TREAT THIS AREA AS LEISURE SPACE FOR GUESTS

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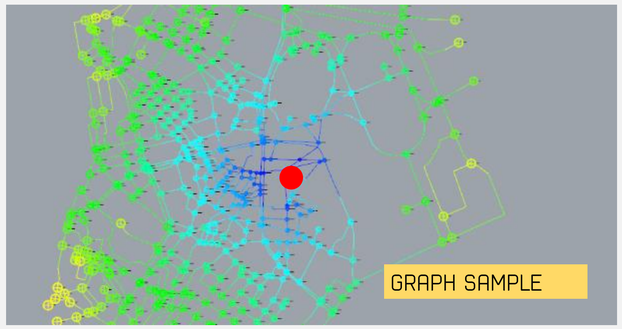
STEP 04

FIND THE OTHER POSITIVE POINTS OF THE SOLUTION. GRASP MANAGEMENT SOLUTIONS FOR THE OBTAINED SOLUTION.

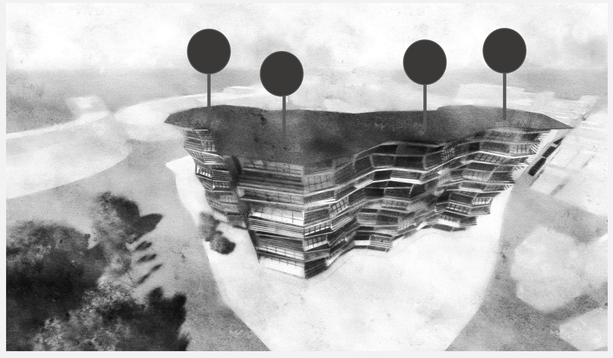
AS THE FINAL SOLUTION HAS 4 CORES. HOTEL MANAGEMENT IS DIRECTED TOWARDS CHOOSING THE BEST ROOM RELATED TO THE PLACES THE GUEST MAY WANT TO GO.

SITUATION> BUSINESS WOMAN THAT WILL MOSTLY USE GINZA LINE AS SHE ARRIVES IN TOKYO.

HOTEL USES GRAPH THEORY TO FIND THE BEST ROOM TO REDUCE WALKING DISTANCE.



GRAPH SAMPLE



CELLA HOTEL: DEVELOPED SHAPE

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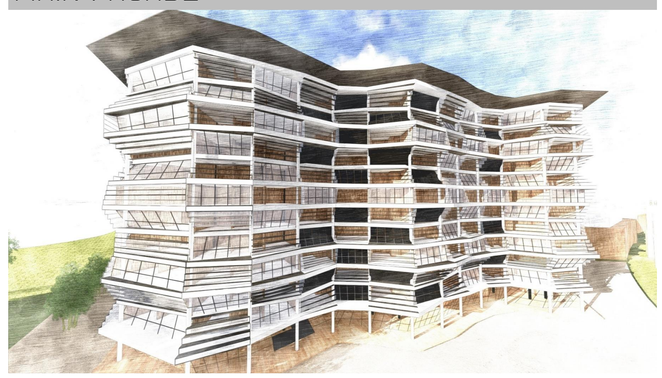
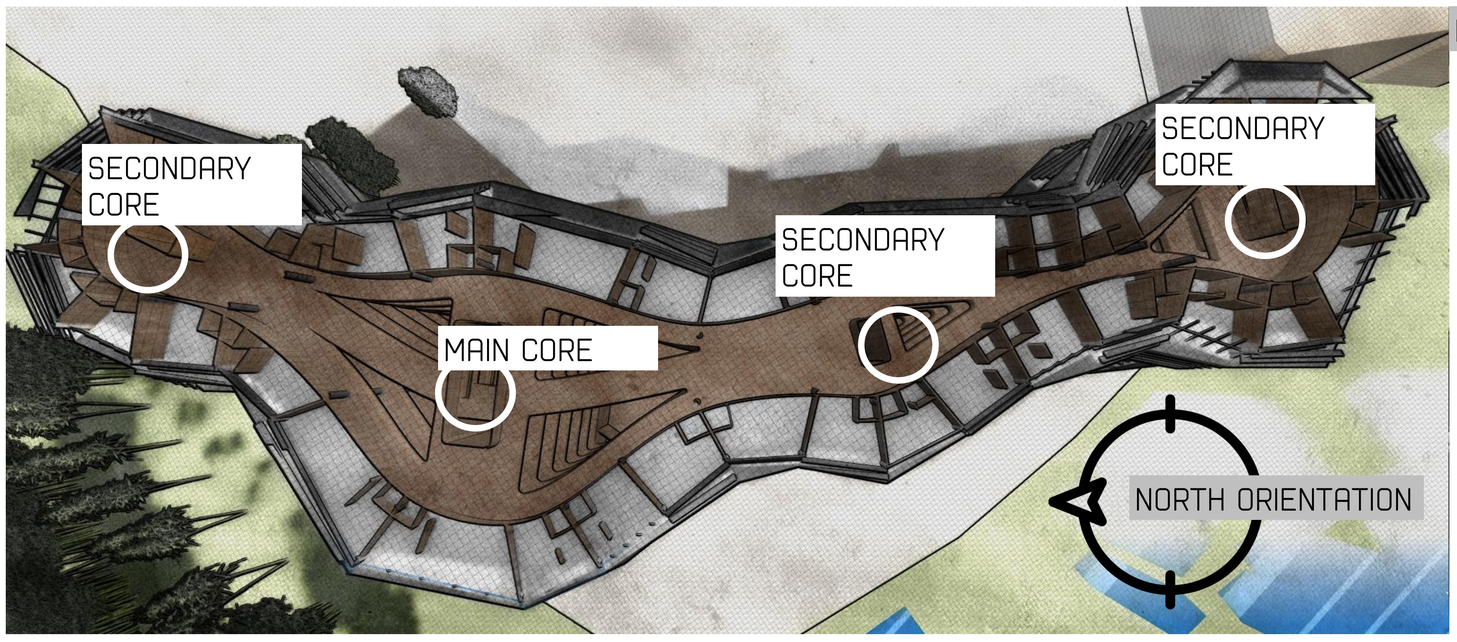
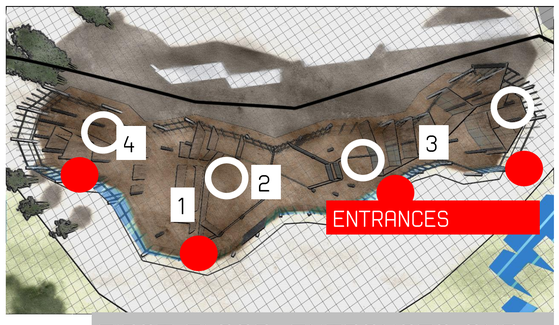
MAIN FACADE





FLOOR CONFIGURATION

ROOMS ARE MOSTLY 8M x 4M SIZED. ALL OF THEM HAVE BUILT IN SMALL KITCHEN AND ROOM AREA, SIMILAR TO 1K APARTMENT LAYOUT.



FIRST FLOOR: ENTRANCES AND CONFERENCES

1. MAIN LOBBY
2. AUDITORIUM
3. MEETING SECTOR
4. CAFÉ