-

Favela Cloud

-

An Urban Cobogó

-

Johan Kure, Kemo Usto & Thiru Manickam

-

MA4-ARK53 - May 2012

-

-

Favela Cloud

-

An Urban Cobogó

-

Supervisors: **Victor Andrade**
Dario Parigi

Authors: **Johan Kure** **Kemo Usto** **Thiru Manickam**

New constructions in the favela
-
Favela Cloud

Can we as architects work with the movement and complexity of the informal city instead of against it?
Could emergent settlement tendencies as seen in slums of the third world become more than a problem, a new way of living and an example to learn from?

Favela Cloud is a conceptual proposal for a future architectural development of Favela Santa Marta, a vision for a new way of building inhabitable structures in a favela. The design proposes an alternative way of developing the build environment, drawing on the social and organizational qualities of the favela itself. Based on the self-organization logic of the favela the proposal exhibits an additive system that can grow and adapt to the site conditions, hovering above buildings and vegetation to utilize the existing paths and openings in the favela.

The program at the chosen site in Santa Marta includes an open sports plaza with a football court, climbing wall and swimming pool. Functions intended to reach a broad audience and enhance the social life within the favela.
The cloud includes new dwellings, as well as flexible platforms for cultural functions such as a library and media space, dance studio and learning centre. The intention is to merge a diverse program into a flexible architectural design that can evolve according to future needs.

The design is intended to be a new landmark in the city, functioning as a communicator to the formal city. Due to the central location of Santa Marta, Favela Cloud will be visible from Christ the Redeemer, the Sugarloaf and a large part of the adjacent neighbourhood of Botafogo.

Inspired by the cobogó brick, which is widely used in the Brazilian context, the cloud is designed to act as an urban cobogó shading the open spaces inside the cloud as well as the public plaza underneath. The cobogó becomes an environmental skin dealing with issues such as shading, ventilation and structural properties.

Favela Cloud is a complex architectural composition developed by means of computational strategies to control the complex relationships between organization and environmental modulation.

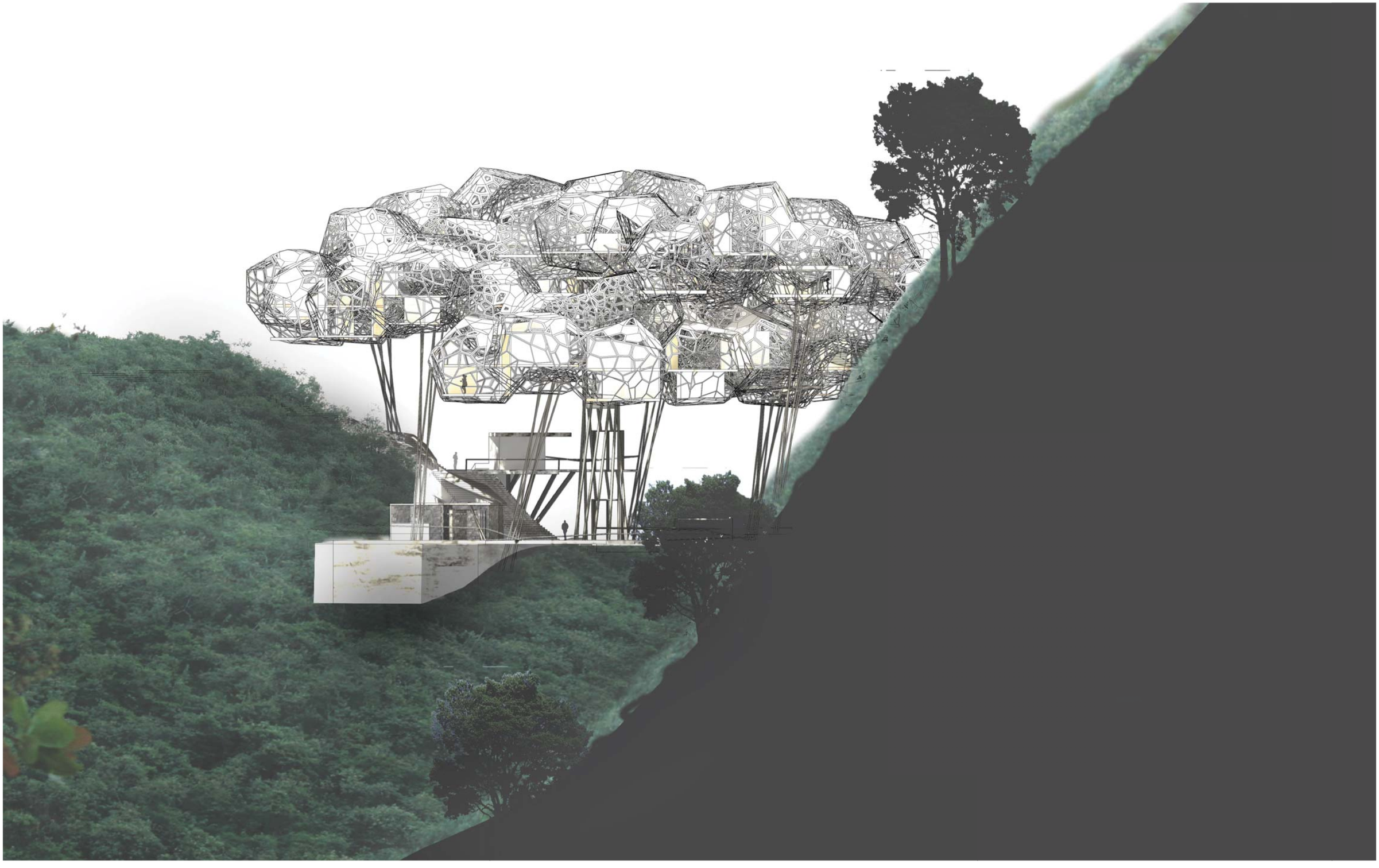
Ill. 01 View from Botafogo

“If we allow the market to be the only source of novel forms, culture will become stagnant and homogeneous. The fundamental challenge for architects and other producers of culture is to imbue the production of forms with a diversity of goals and causes which are not sole market-driven, thereby contributing to an environment that connects individuals to a multitude of choices” - Moussavi

Ill. 02 Site overview

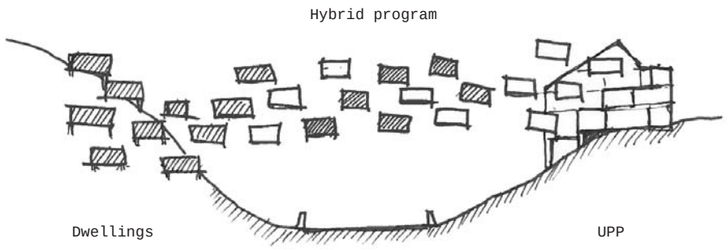
Ill. 03 East facade

Ill. 04 South facade



Ill. 05 North facade

-
10
-



Ill. 06

Hybrid Organization

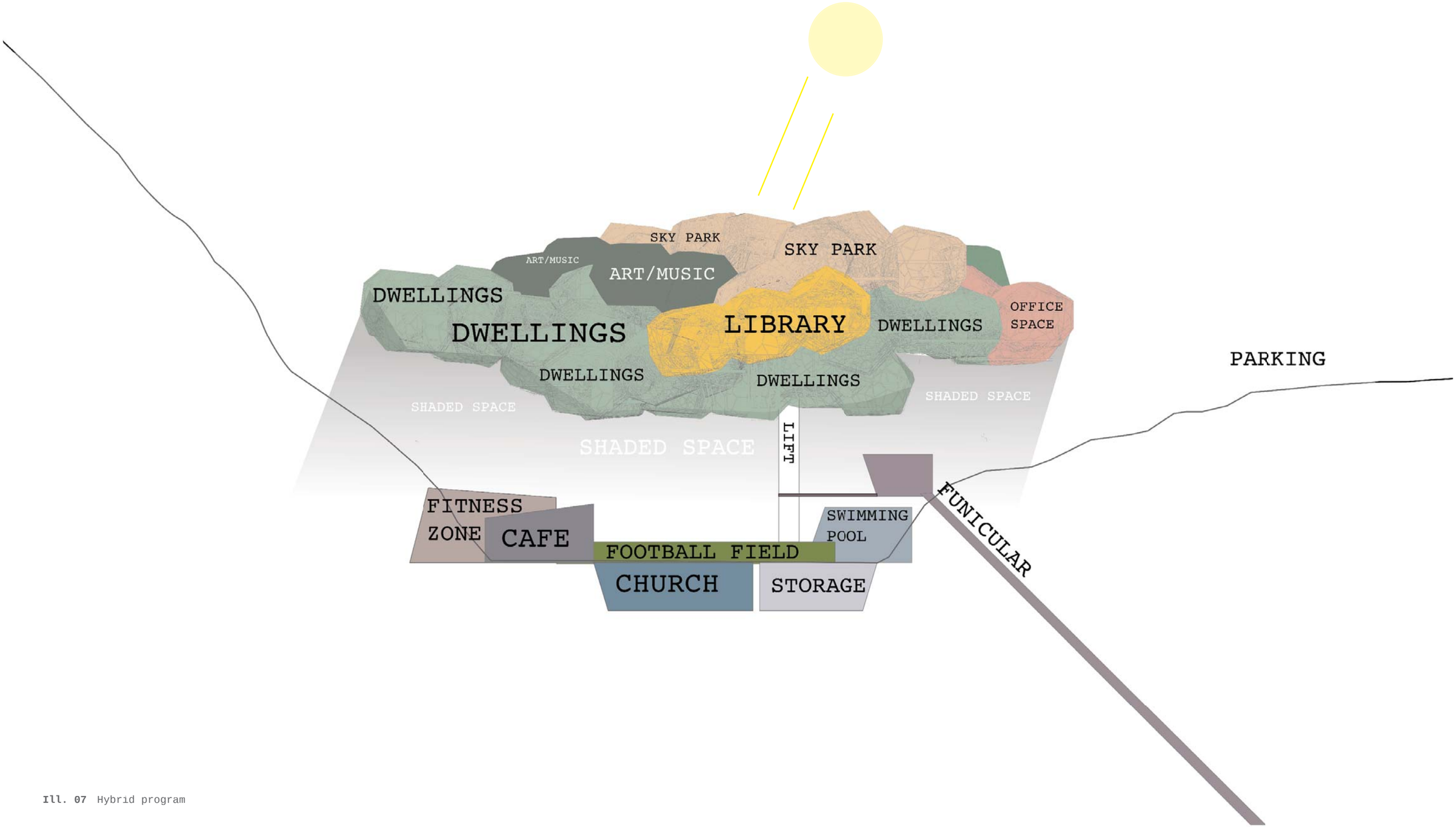
-

Merging functions

The vision for the cloud is the creation of urban hybrid architecture. It is a mixture of public and private functions with flexible spaces providing room for a multitude of planned and unplanned activities.

The project consists of two main parts. At ground level there is a base designed as an open plaza, which serves as a recreational area supporting an area related to physical activities such as football, swimming, climbing and outdoor fitness zone.

Dwellings and public functions are distributed throughout the cloud and connected by a single path serving as a fluid and continues spine throughout the building. The intention is a symbiotic spatial organization where the different functions act together to form a synthesis, hybrid architecture, the Favela Cloud.



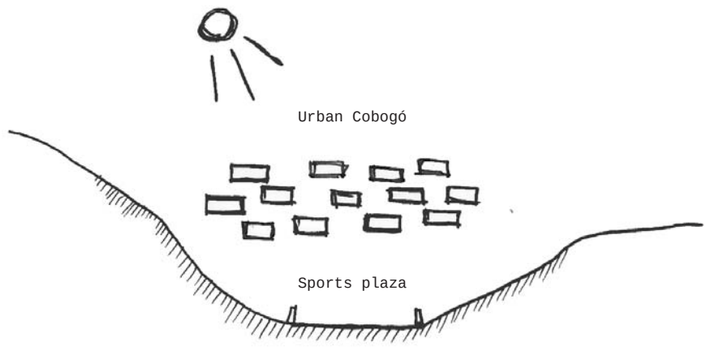
Ill. 07 Hybrid program

-
12
-

The Cloud

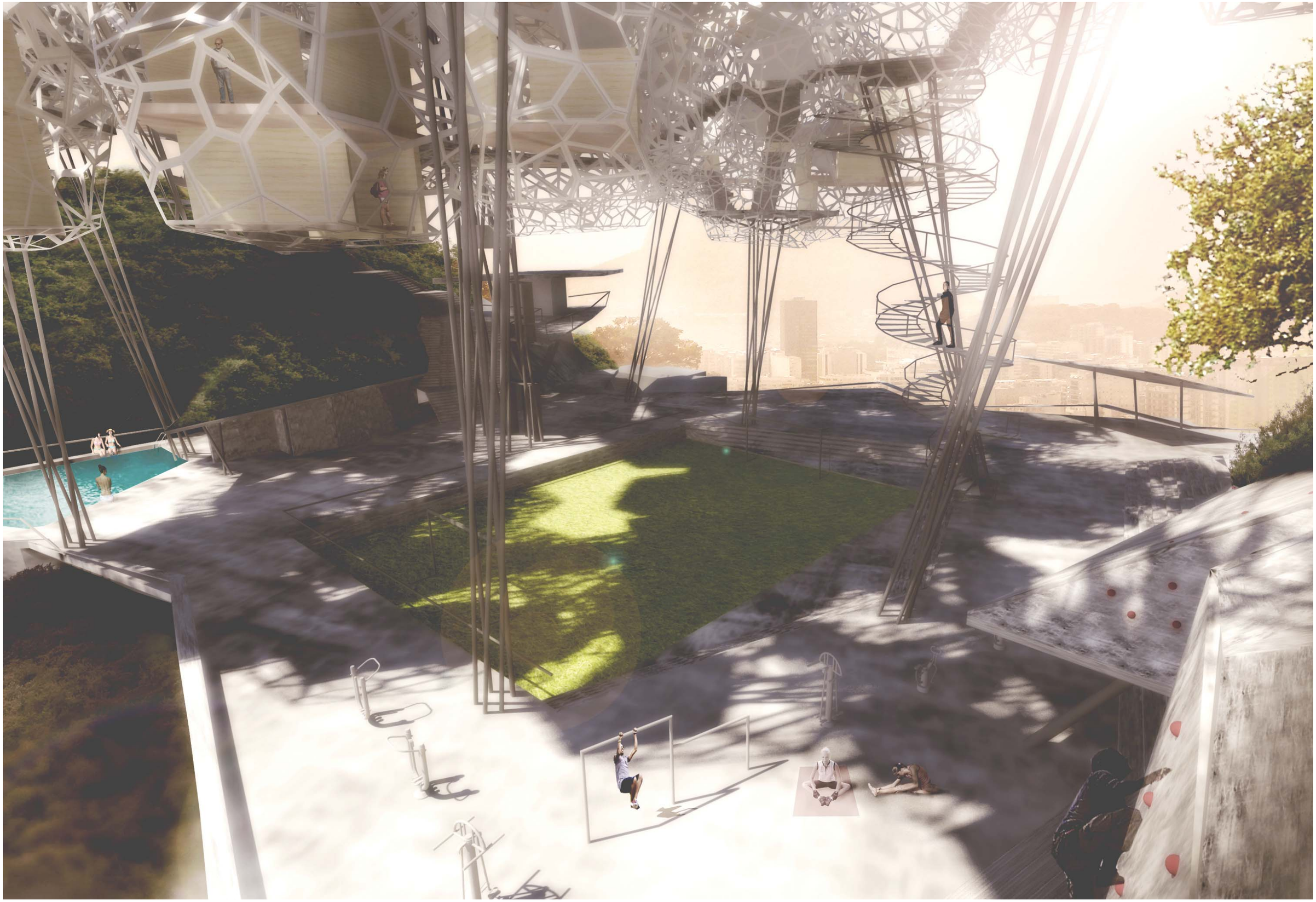
-

An urban Cobogó

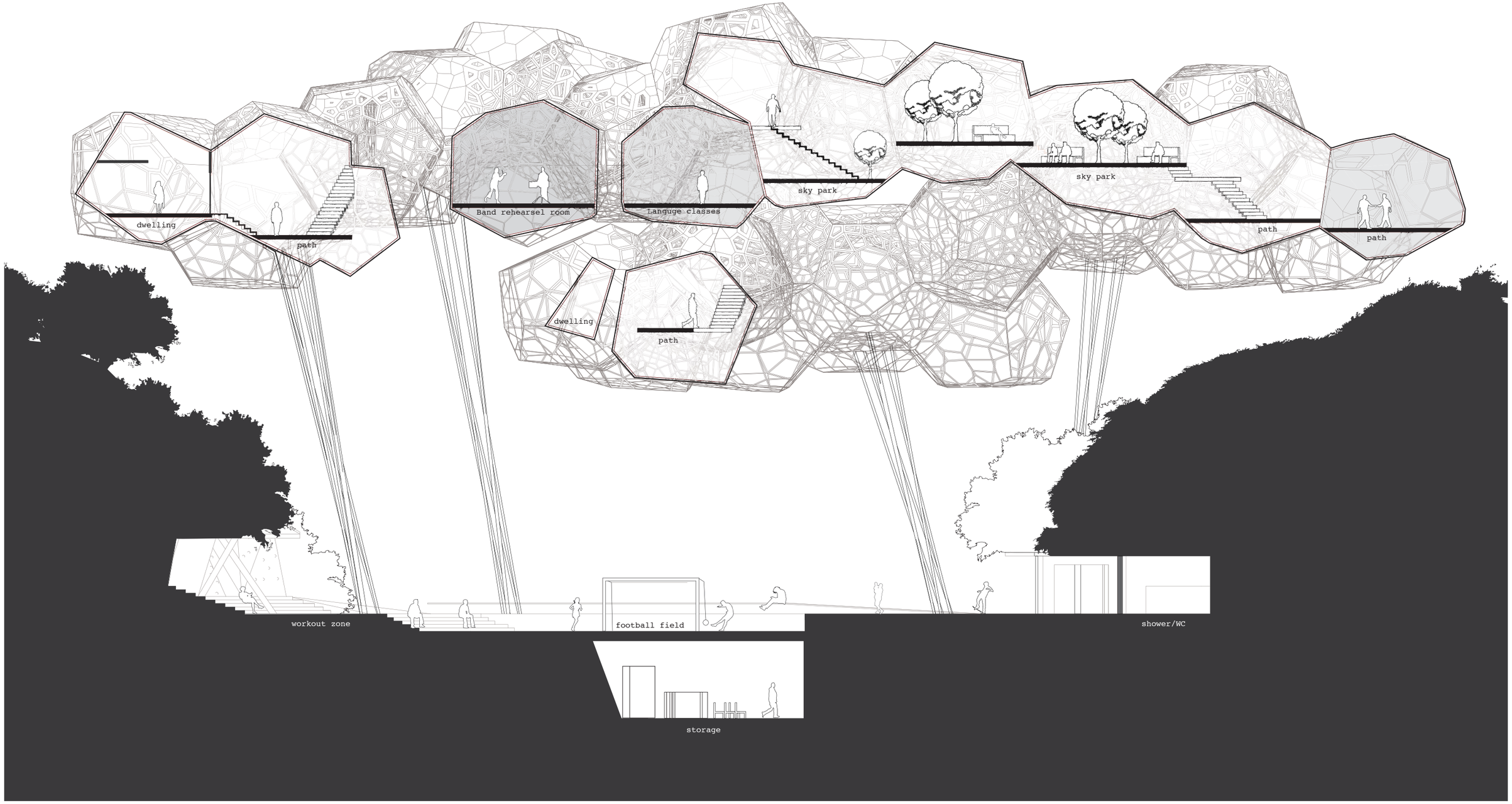


Ill. 08

The cloud concept derives from the vision to create an urban cobogó. It becomes a structure that provides shading for a public space, which is otherwise directly exposed to the sun.
The idea is based on the elevation of the building volumes into a spatial organization over the football court. The structure will work as an active element enhancing the urban space beneath it.
The move is made possible by a highly complex skin acting as a framework to support the platforms containing the various programs. The skin wraps the hybrid program of the cloud and act as shading for the spaces underneath.



Ill. 09 Urban cobogó



Ill. 10 Section AA - 1:200

Sports Plaza **Total area :2530 sq m**

Open plaza: 1220 sq m
- Playscape
- Observation deck

Café: 65 sq m
- Bar: 15 sq m
- Storage: 5 sq m

Football area: 566 sq m
- football field: 435 sq m
- sitting area: 85 sq m
- substitute area: 46 sq m

Workout zone: 90 sq m

Swimming pool area: 200 sq m
- Pool: 120 sq m

Church: 120 sq m

Storage: 150 sq m

Toilets/shower/dressing room: 60 sq m

Ill. 11 Room program - the plaza

Cloud room program **Total area : 2200 m²**

7 single dwellings: 440 m²
- Level 01: 45 - 20 sq m
- Level 00: 30 - 15 sq m

4 double dwellings: 480 m²
- Kitchen platform: 40 - 20 m²
- Living platform: 45 - 25 m²
- Sleeping platform: 35 - 20 m²
- Flexible platform: 40 - 25 m²

Media space: 45 m²

Library: 95 m²

Band rehearsal room: 45 m²

Language classes: 45 m²

Police unit: 35 m²

Flexible office space: 45 m²

Art classes: 60 m²

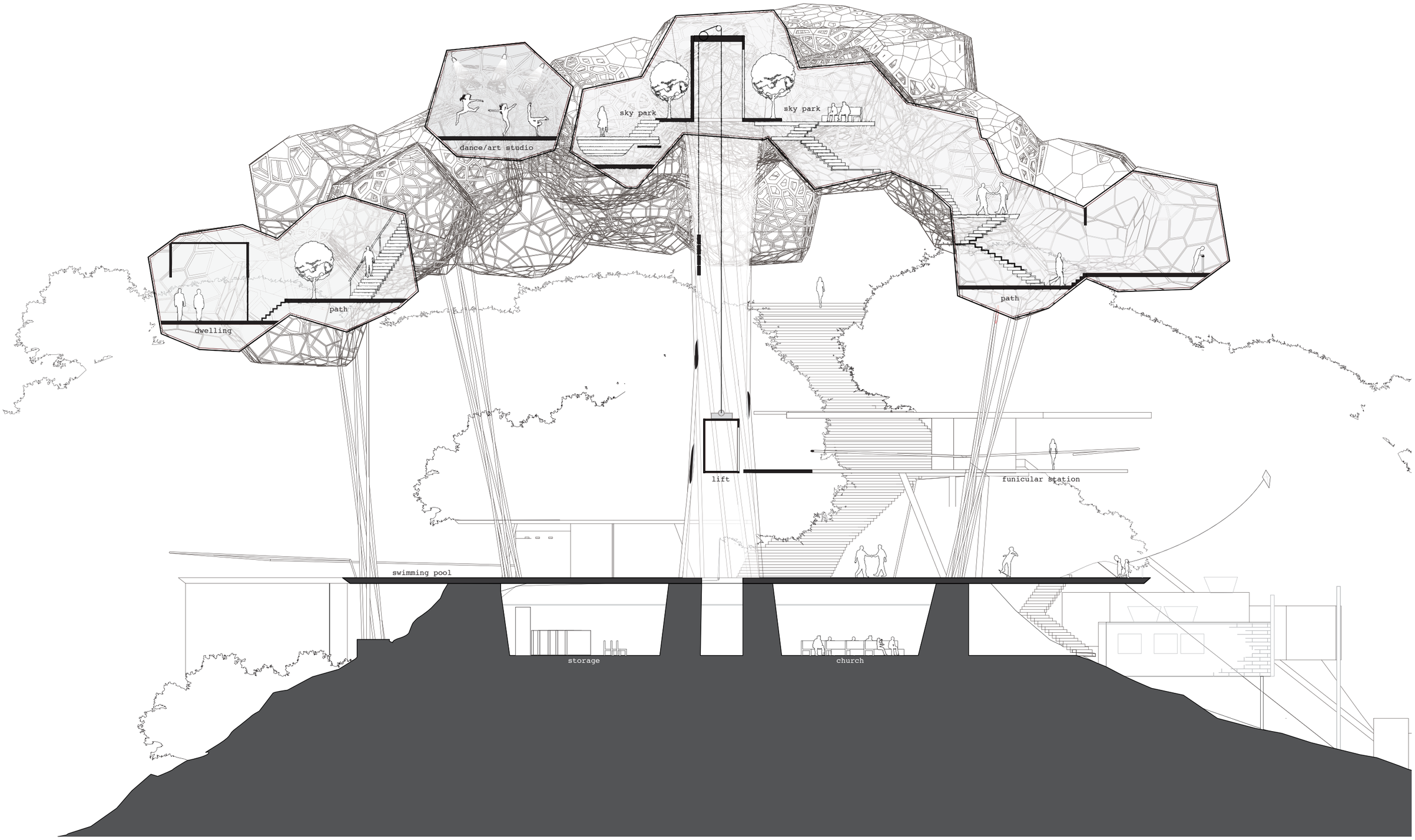
Acting class: 45 m²

Dance practice / Capoeira: 45 m²

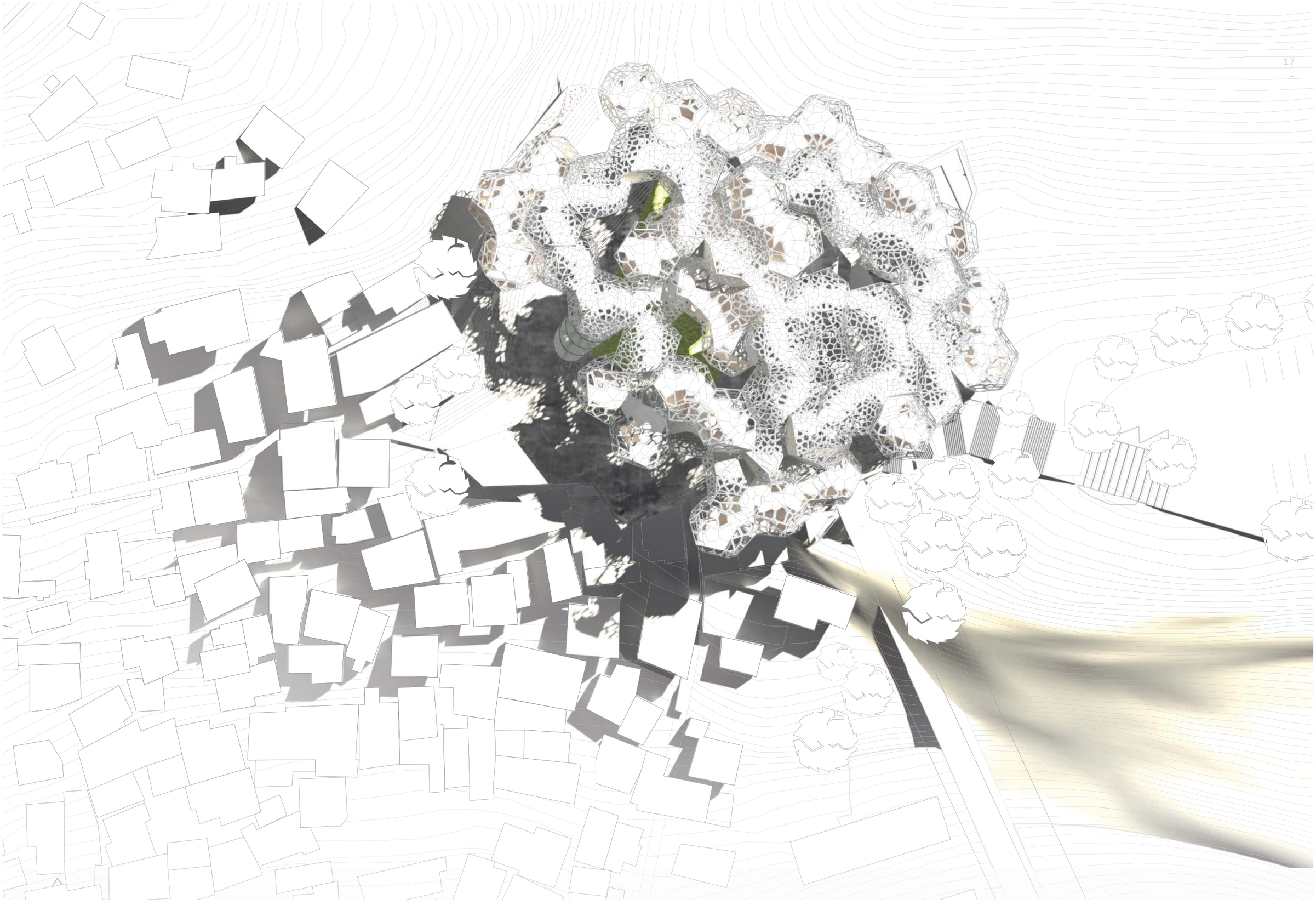
Public toilets: 40 m²

Public path: 870 m²
- Sky park: 220 m²
- Cluster platforms: 30 m² each

Ill. 12 Room program - the cloud

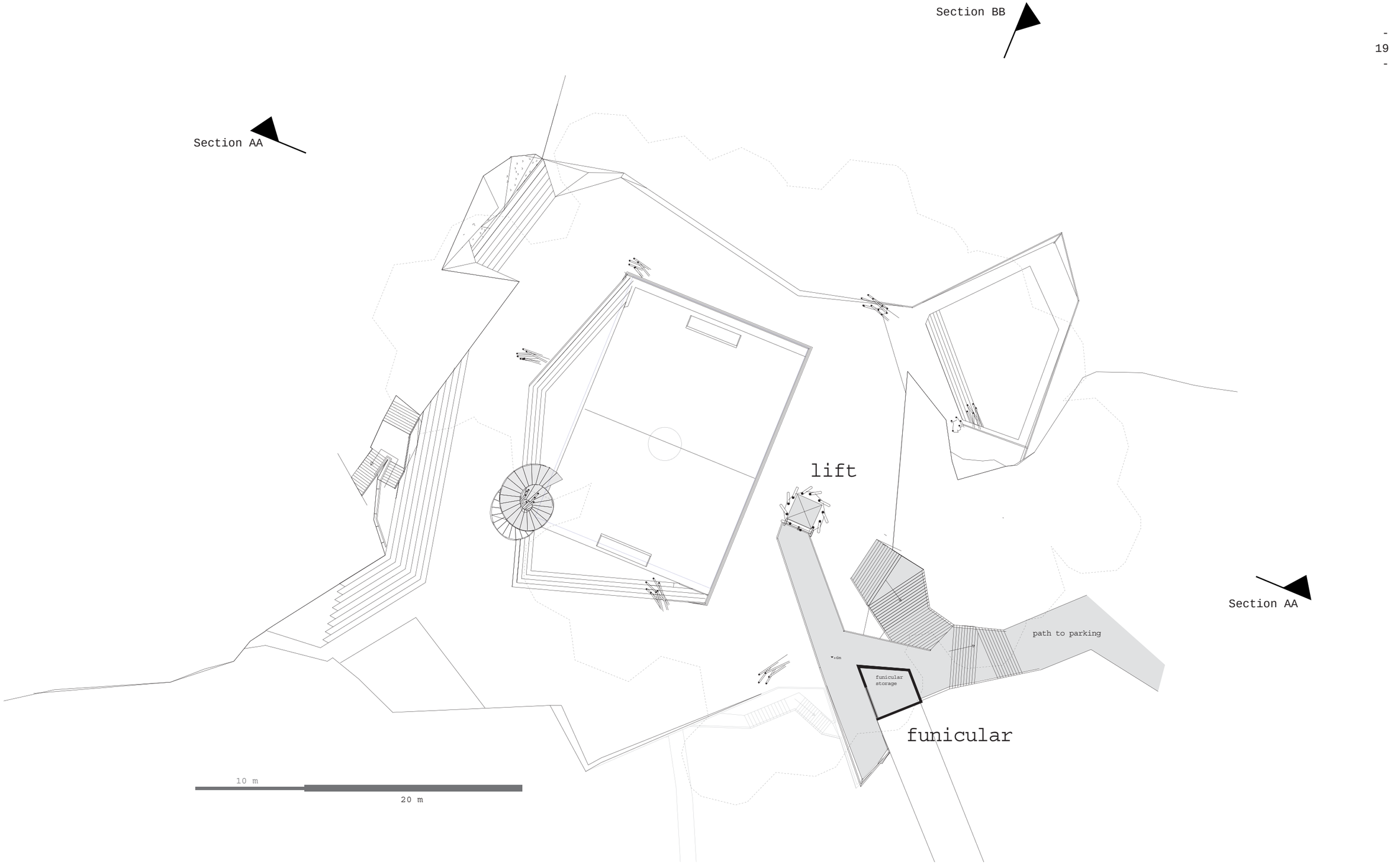


Ill. 13 Section BB - 1:200

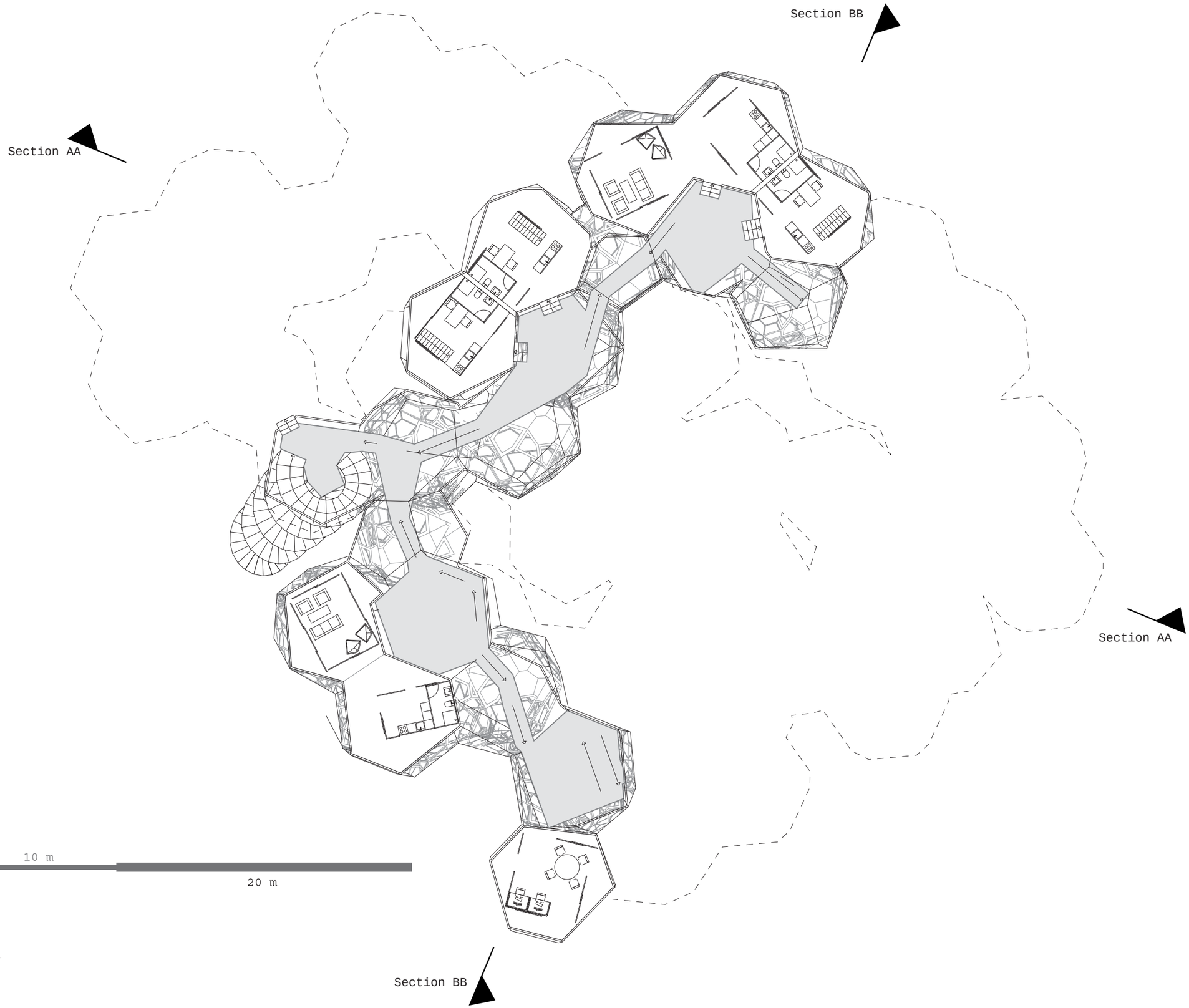


Ill. 14 Situation plan

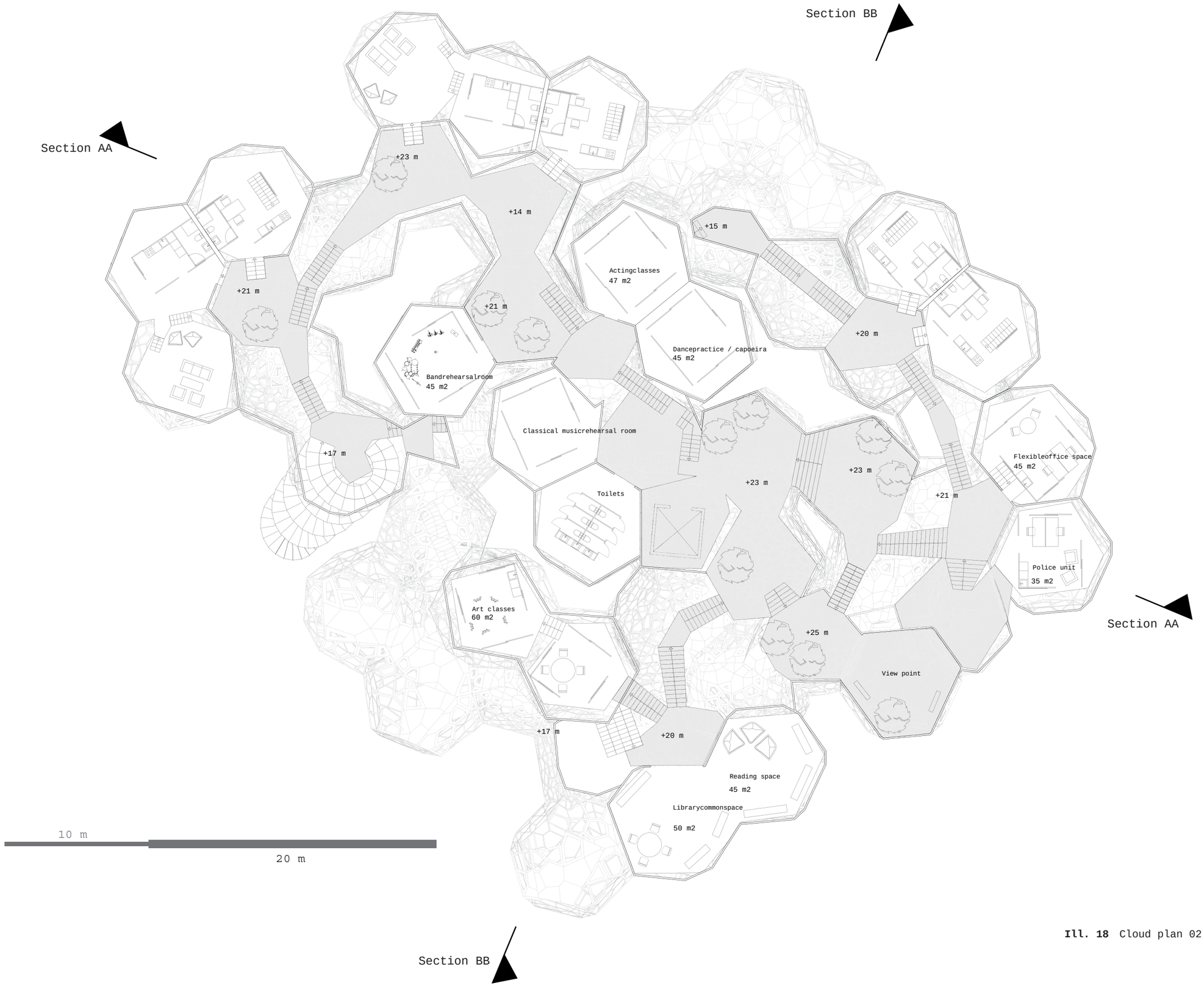
Ill. 15 Base plan 00



Ill. 16 Base plan 01



Ill. 17 Cloud plan 01



Ill. 18 Cloud plan 02

“The architect must renew architecture from the moment when it was abandoned; and he must try to bridge the existing gap in its development by analysing the elements of change, applying modern techniques to modify the valid methods established by our ancestors, and then developing new solutions that satisfy modern needs.” - Hassan Fathy

Favela Cloud process

-

Growth and environmental modulation

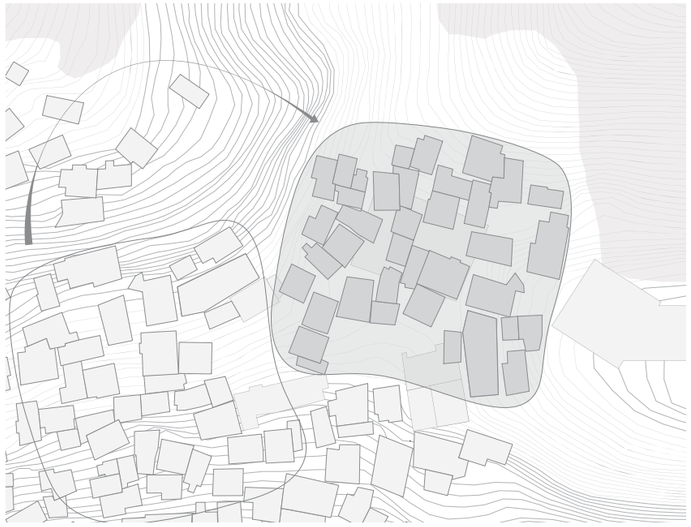
Favela logics

-

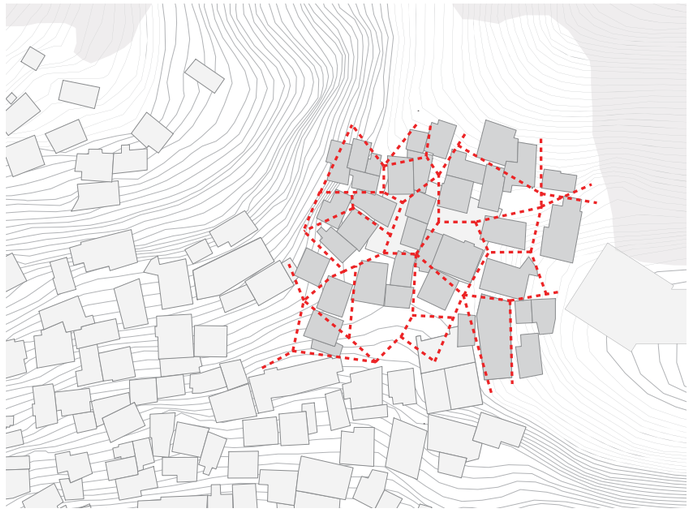
Understanding scale and connectivity

Favela Cloud not only interprets the path and the mix of functions found in the favela, but also the spaces in the cloud are based on the favela itself.
As a study in the logic of the favela and as a conceptual move, a part of the favela is overlaid the football field. The analysis of dimensions, scale and connections serves as a basis for the experiments with self-organization systems to generate the Favela Cloud. The first studies are done with the 2D mathematical pattern named voronoi. This system exhibits a close relationship to the volumes and paths of the favela fabric, but the application of the system in 3D doesn’t add up to the same extend and thus another three-dimensional algorithm is developed. Focus in this part of the design is on the natural growth of the Favela Cloud.

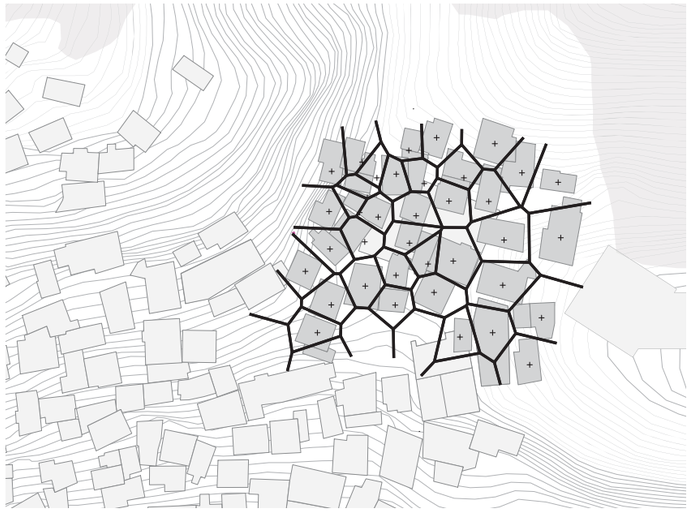
Ill. 19 An area of the favela with the same extend as the site are marked out.



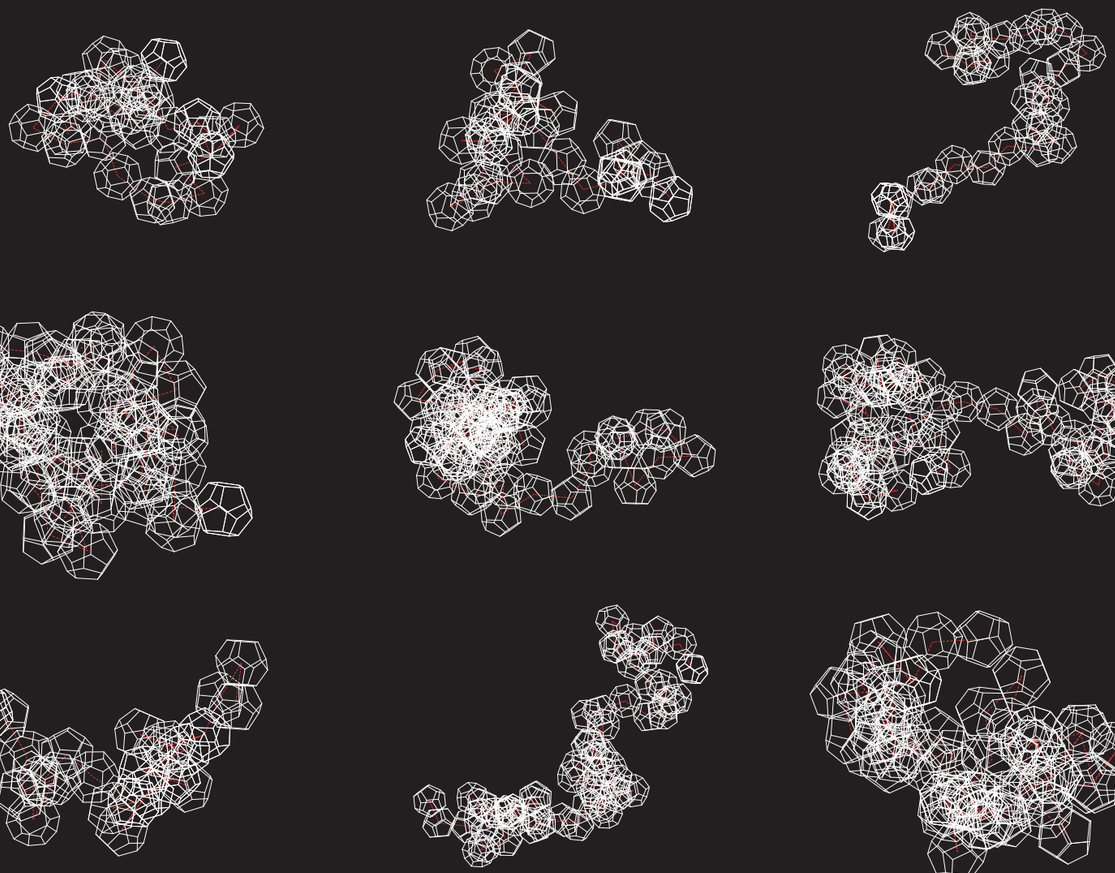
Ill. 20 The patch are shifted onto the site.



Ill. 21 Paths are drawn in between the building volumes.



Ill. 22 Points are generated at the area centroid of each building volume and a voronoi grid are generated from the points.



Ill. 23 Algorithmic form explorations

Growing architecture

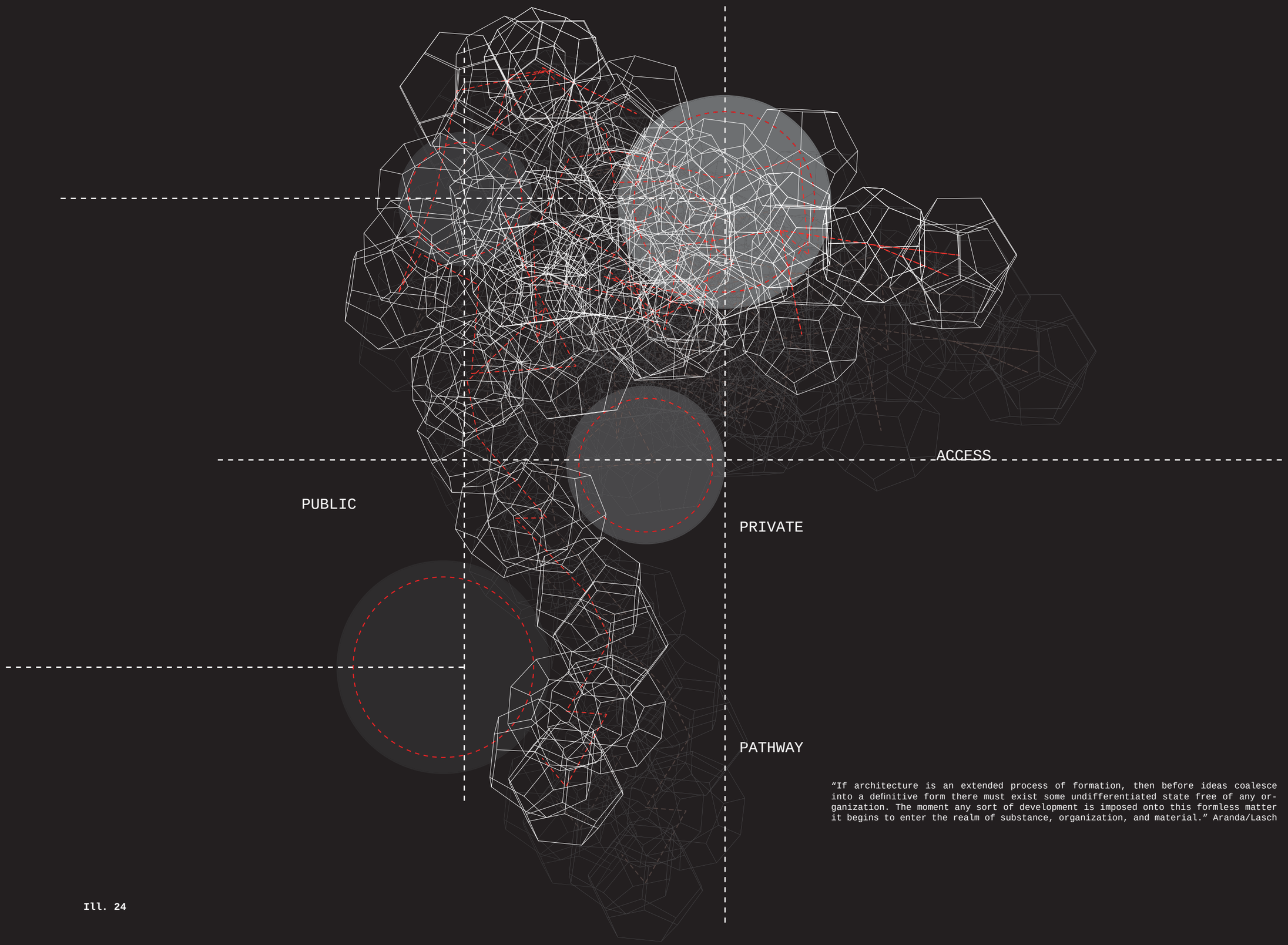
-

An additive favela structure

Deeply rooted in the term favela is the concept of a bottom-up growth process and the self-builders adapting to the formal city, the landscape and the existing buildings. The emergence of the favelas seen in relationship to the growth of the city lacks the constraining boundaries of the infrastructure. This unexpectedness and unpredictability, but yet still highly organized is what typically defines the favela. The complex formation is derived through these dynamic processes. A formation of ever changing spaces that on an abstract level could resemble the self-organization, seen in natural growth phenomena, such as crystallization.

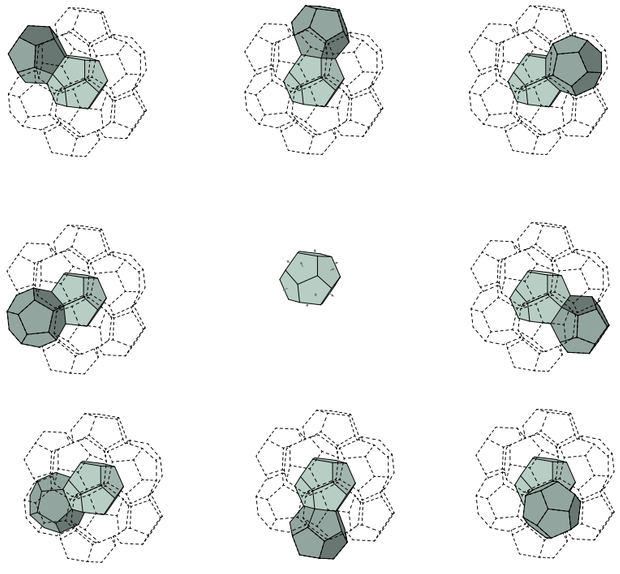
The invisible infrastructure and absence of the grid plan, addresses the needs for a different way of designing within the favela to keep the complexity and unique unexpected spaces in a contemporary architectural development. A kind of building system that can respond to the future urban sprawl.

Could architecture become more than formalistic design? Could it be an architecture that takes inspiration in the self-organization seen in the favelas? Perhaps an architectural system that is more than a predesigned layout? A system that aims to incorporate functionality and organization for future needs. A vision from where a novel complex architecture can evolve, becoming more than an architect could imagine. What if architecture was a growth pattern, which incorporates the visions for inhabited spaces and still evolve, expand and even become a living organism as the favela?



“If architecture is an extended process of formation, then before ideas coalesce into a definitive form there must exist some undifferentiated state free of any organization. The moment any sort of development is imposed onto this formless matter it begins to enter the realm of substance, organization, and material.” Aranda/Lasch

Ill. 24



Ill. 25 The dodecahedron - possible directions of growth

Attractor based aggregation

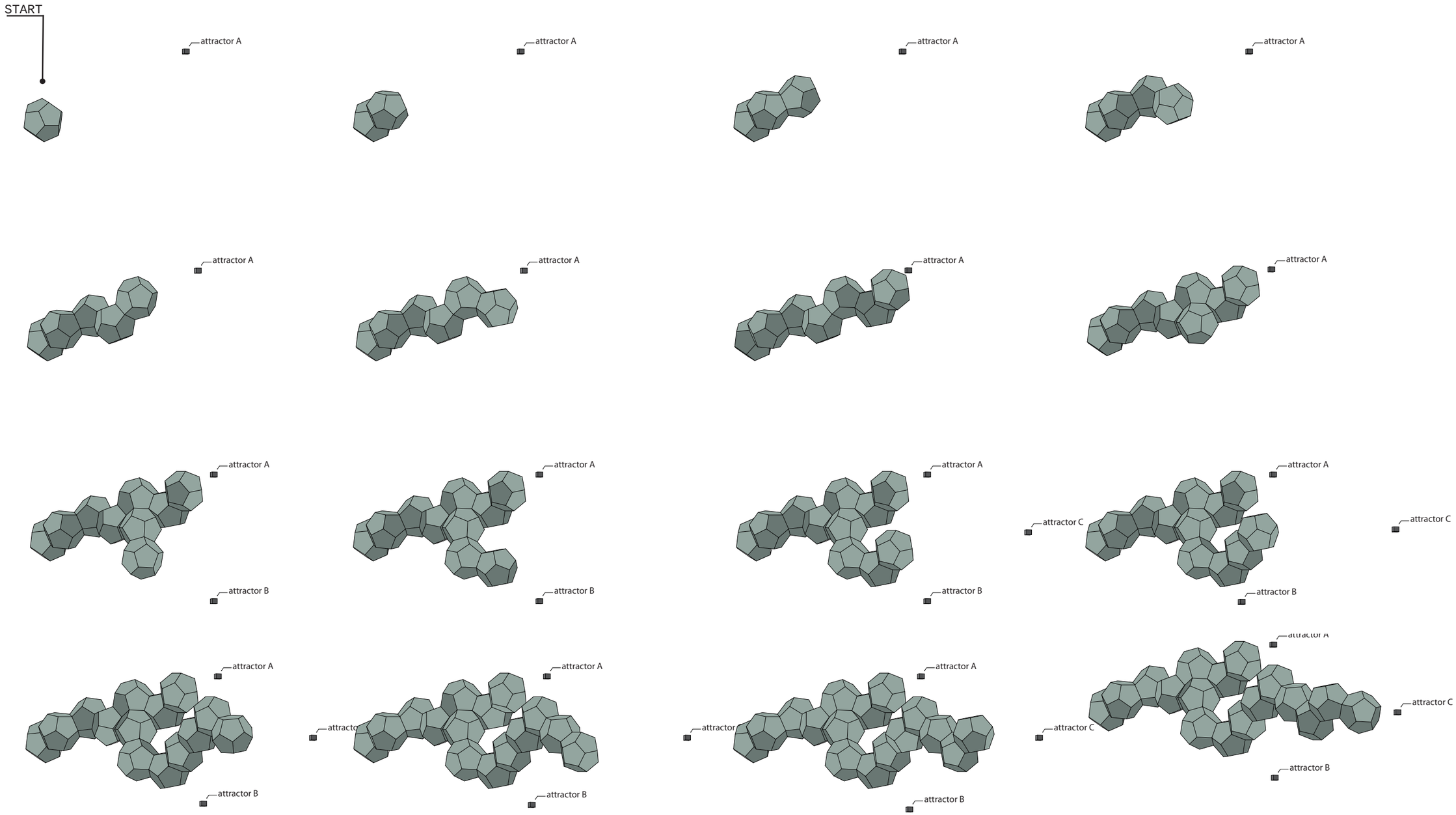
-

Logic and growth of the system

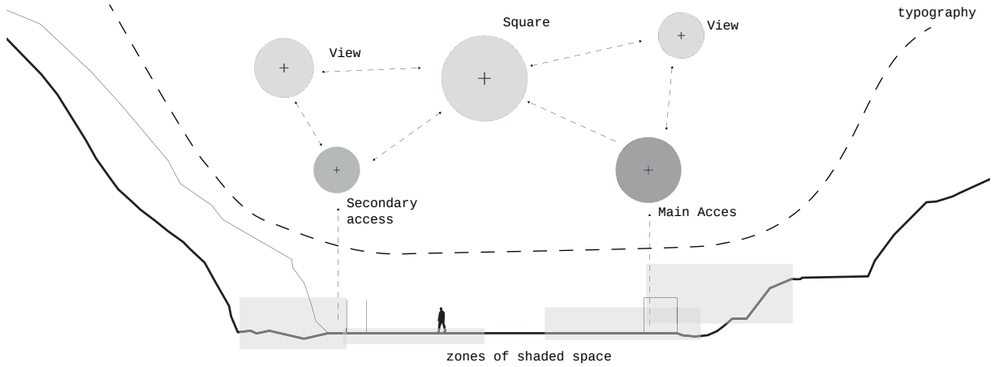
Based on the earlier studies in the logic of the favela and self-organization a 3-dimensional attractor based aggregation system is developed, based on the dodecahedron.

The aggregation system takes offset in the dodecahedron as base geometry and applies bottom-up logic to it. In this way it is possible to develop a system that incorporates parameters from the organization logics as guidelines to evolve the shape into a dynamic cloud space.

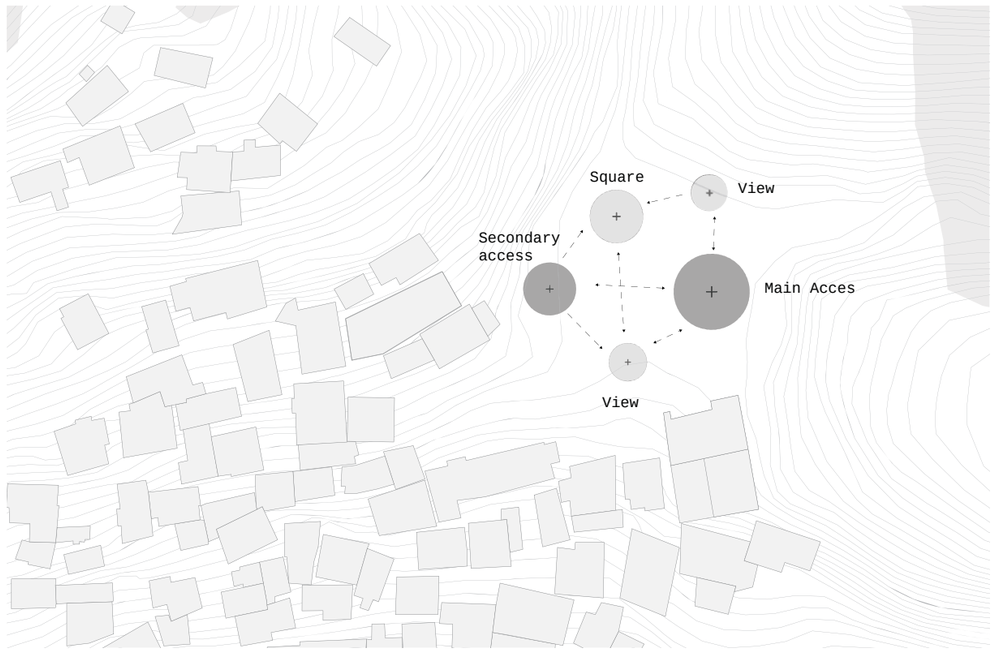
The dodecahedron is build up by 12 pentagons connected into a closed volume. This means that the geometry has 12 sides and thus 12 directions in which it geometrically can grow according to the logic of the system. It is used to control how the path of the cloud is connected and formed. The aggregation system works from a starting volume and a set of attractors controlling the direction of growth. The algorithm output a number of solutions that match the given parameter.
The task of the designer is then to setup the right parameters, evaluate and redefine the system and not the form. Like the favela it is an organizational system that isn’t about the formal shape but a system that follows and adapts to the needs in the favela. A vision of a system that could evolve, expand and reconfigure according to the future needs in an additive manner.



Ill. 26 A number of steps showing the growth of the final cloud path, according to four attractors related to the site.



Ill. 27 Attractors - Cloud access



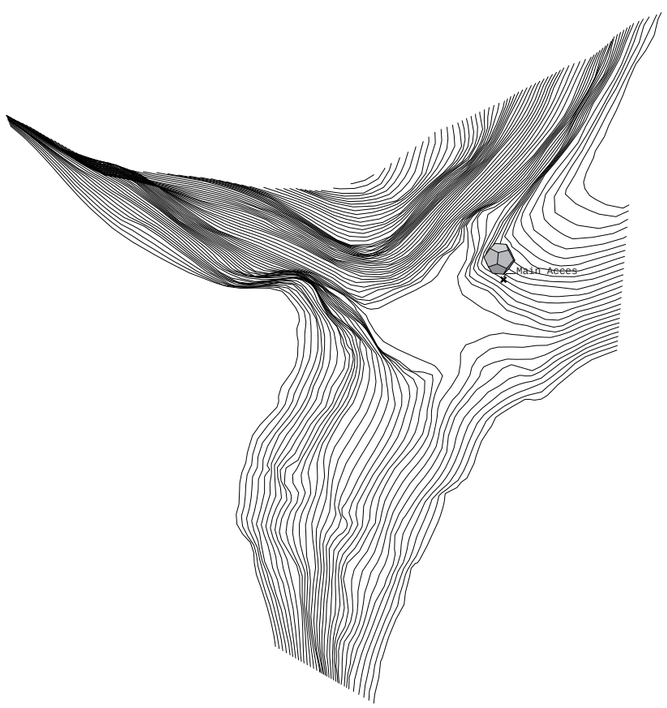
Ill. 28 Attractors - base program and landscape

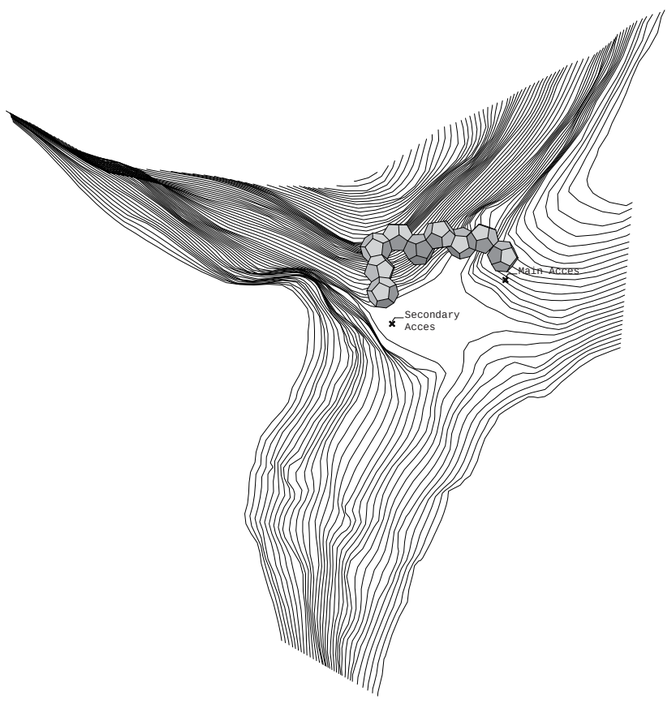
Volumetric design

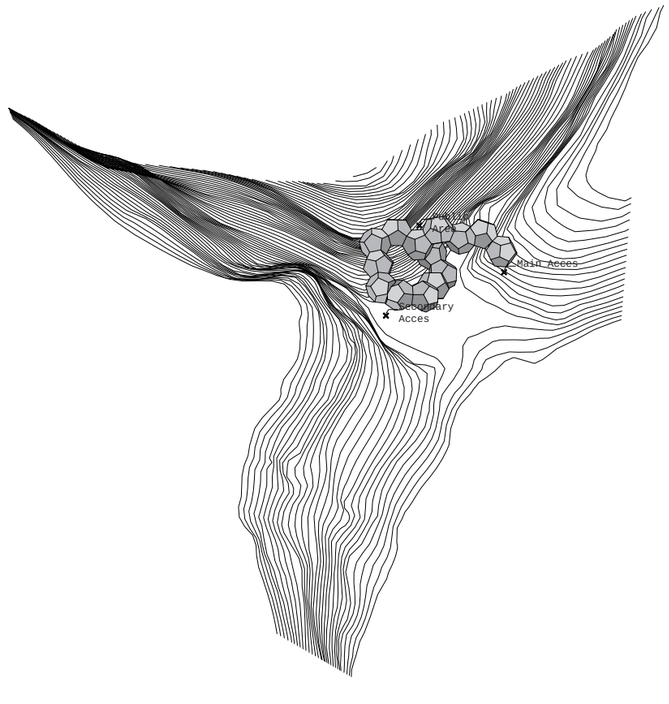
-

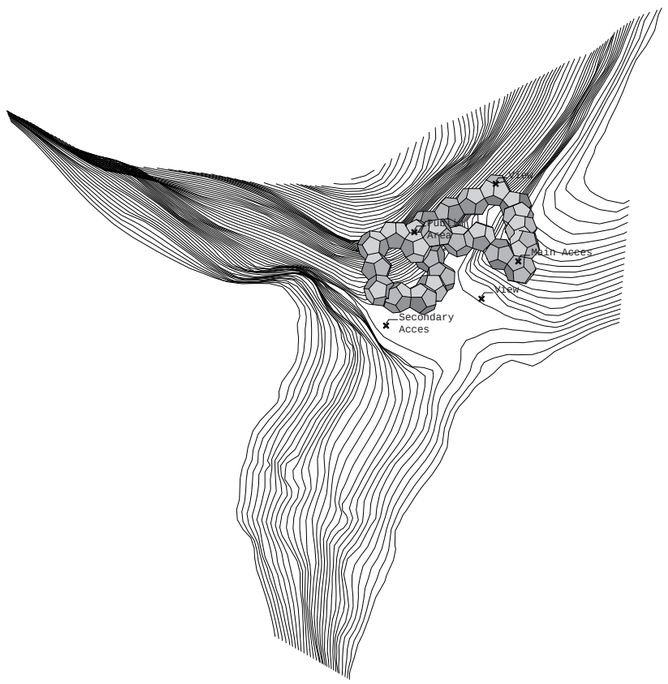
Informal connectivities

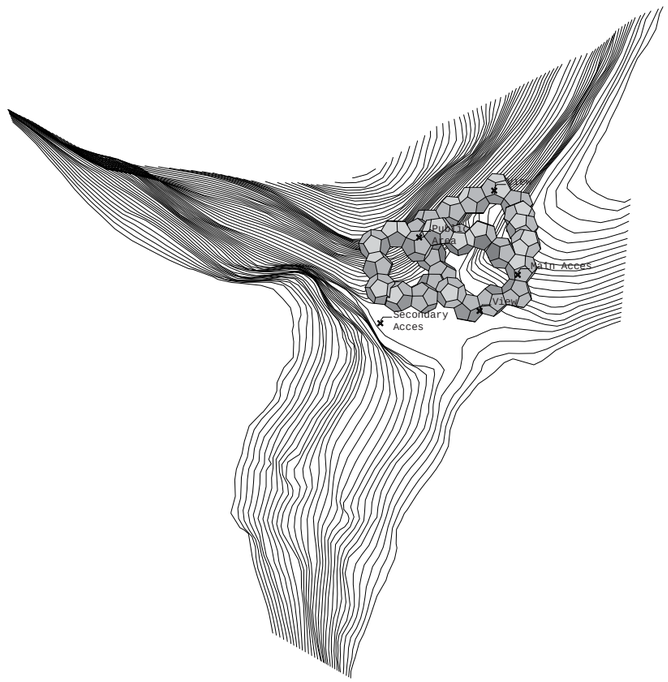
The attractors are related to accesses and program at the ground level of the site. The setup is to define the main access as the growth starts which in this case is the lift core. Next is to define the different attractors and their hierarchy and connectivity. The setup generates a pathway according to the rules of the dodecahedron. This means it will not be a straight connection, but a 3 dimensional flow of volumes. The dodecahedrons defining the pathway will also function as flow and structural core for the programs within the cloud. The additional functions are then attached to the pathway according to views and spatial organization. The more public functions such as dance studio, classrooms and library are aimed towards the inner boundary where the main accesses are positioned. The dwellings that need more privacy are located towards the outer boundary, providing light and views to the city.

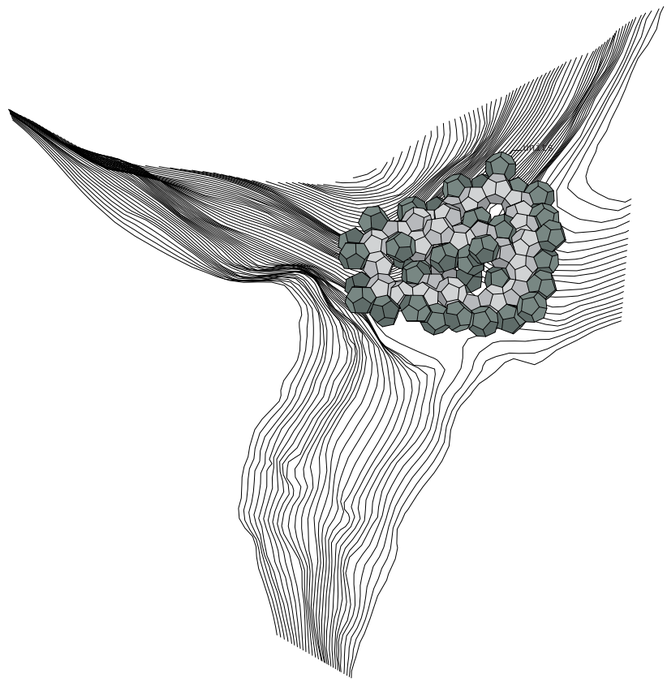




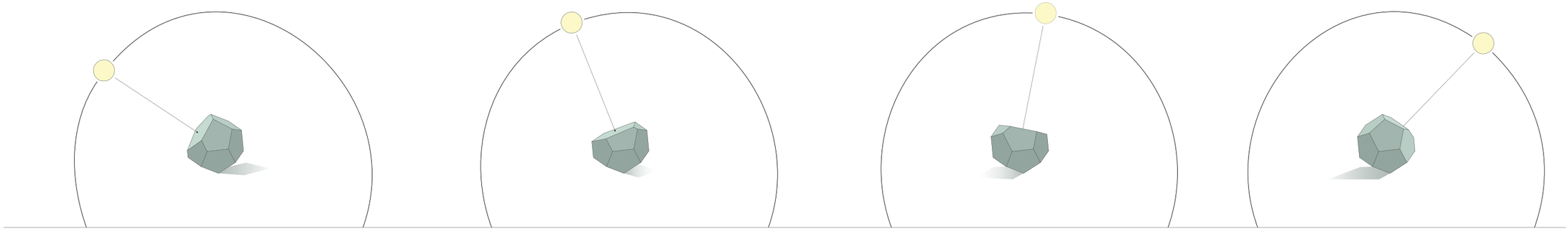


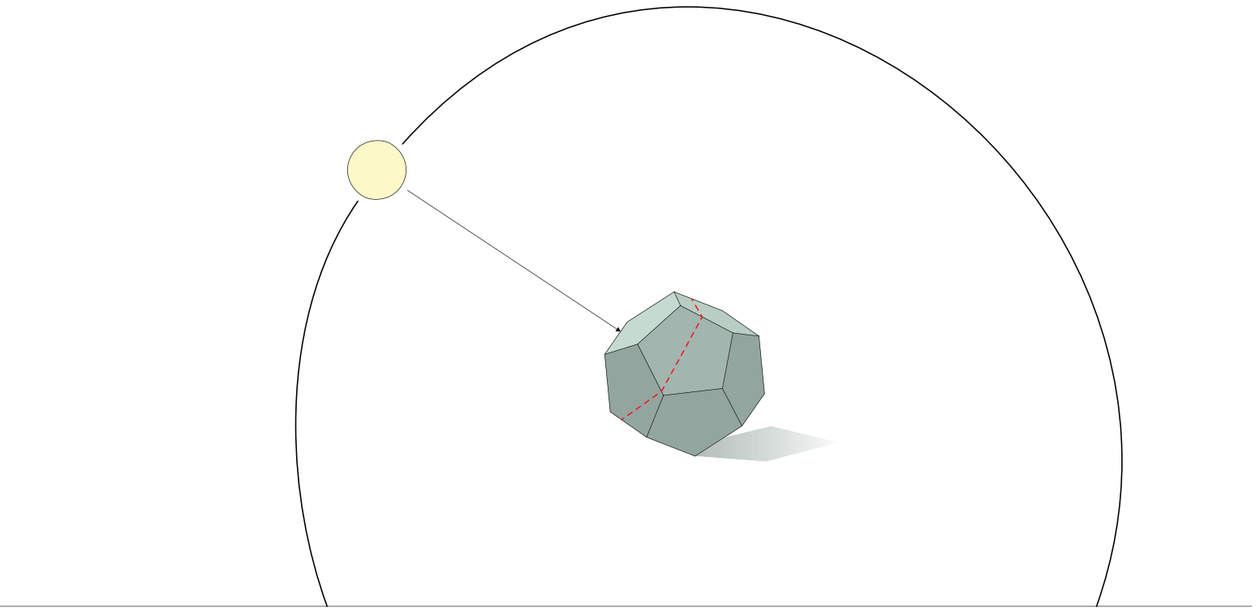






Ill. 29 Cloud path growth on site





Ill. 30 Dodecahedron cutting according to sun path

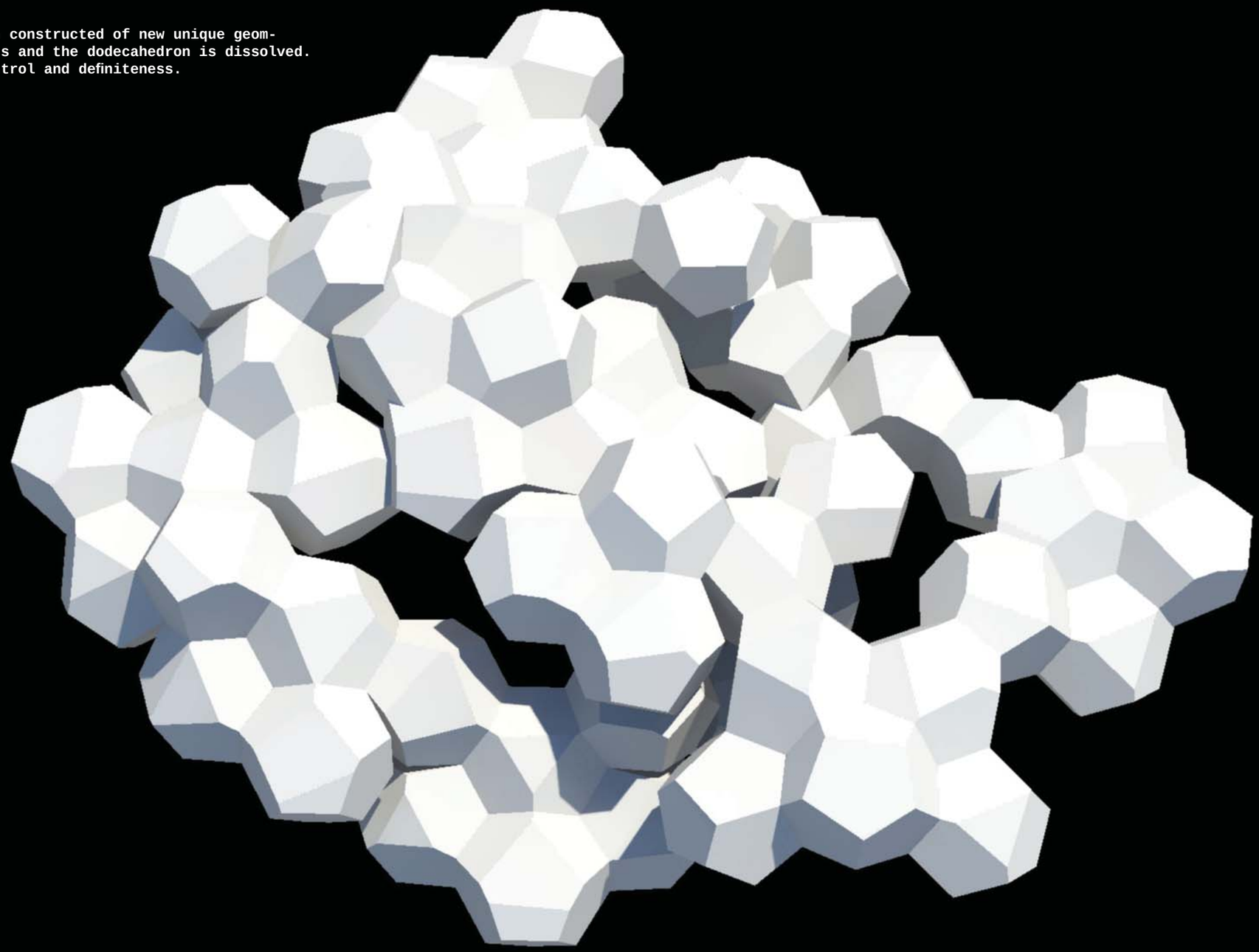
Shape

-

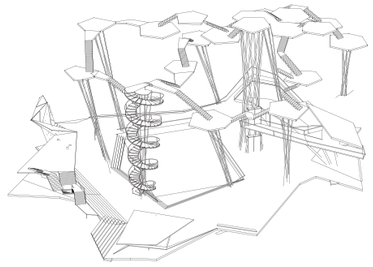
Cuts according to sun path

The dodecahedrons, which are mathematical shapes, have a tendency to appear rigid and heavy. This is far from what the concept of the cloud is. Instead the cloud aims for lightness and a dynamic expression. Therefore a strategy was developed to break the rigid geometry according to environmental and spatial properties.
The roof is cut according to the sun path. This operation creates new facets that provide shade to the dwellings and path, but it is also suited for photo voltaic cells. The other cuts on the bottom and sides are done to improve the usable spaces within the geometries which are inhabitable.

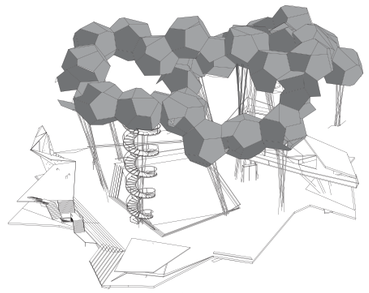
The overall shape is then constructed of new unique geometries with varying facets and the dodecahedron is dissolved. The form has lost its control and definiteness.



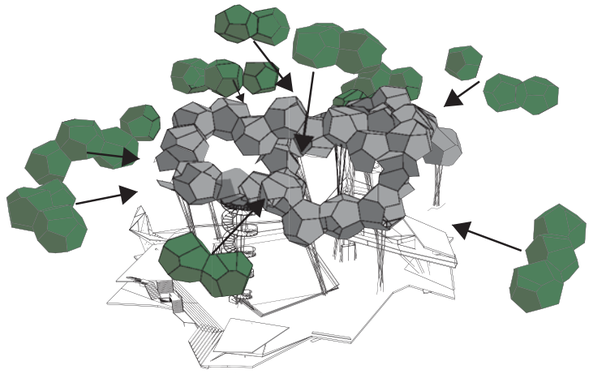
Ill. 31 The cloud volume after cut operations



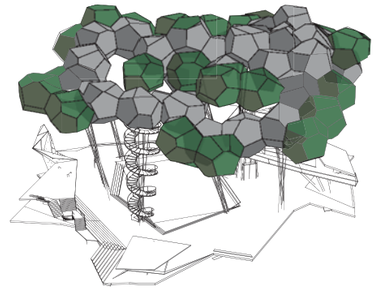
columns and platforms



main path/structural spine

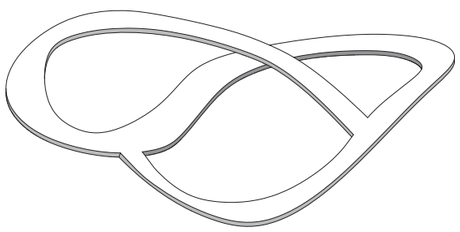


volumes attaching to the spine

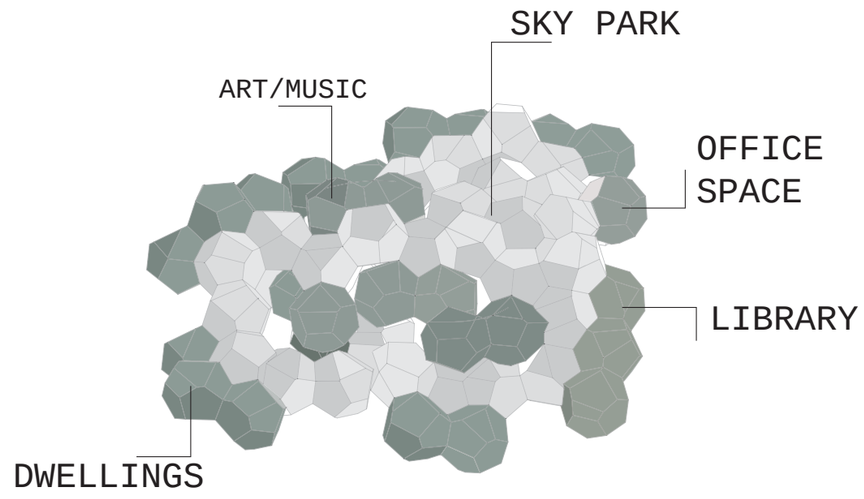


wholesome shape

Ill. 32 Structural concept of the overall building



Ill. 33 Path diagram

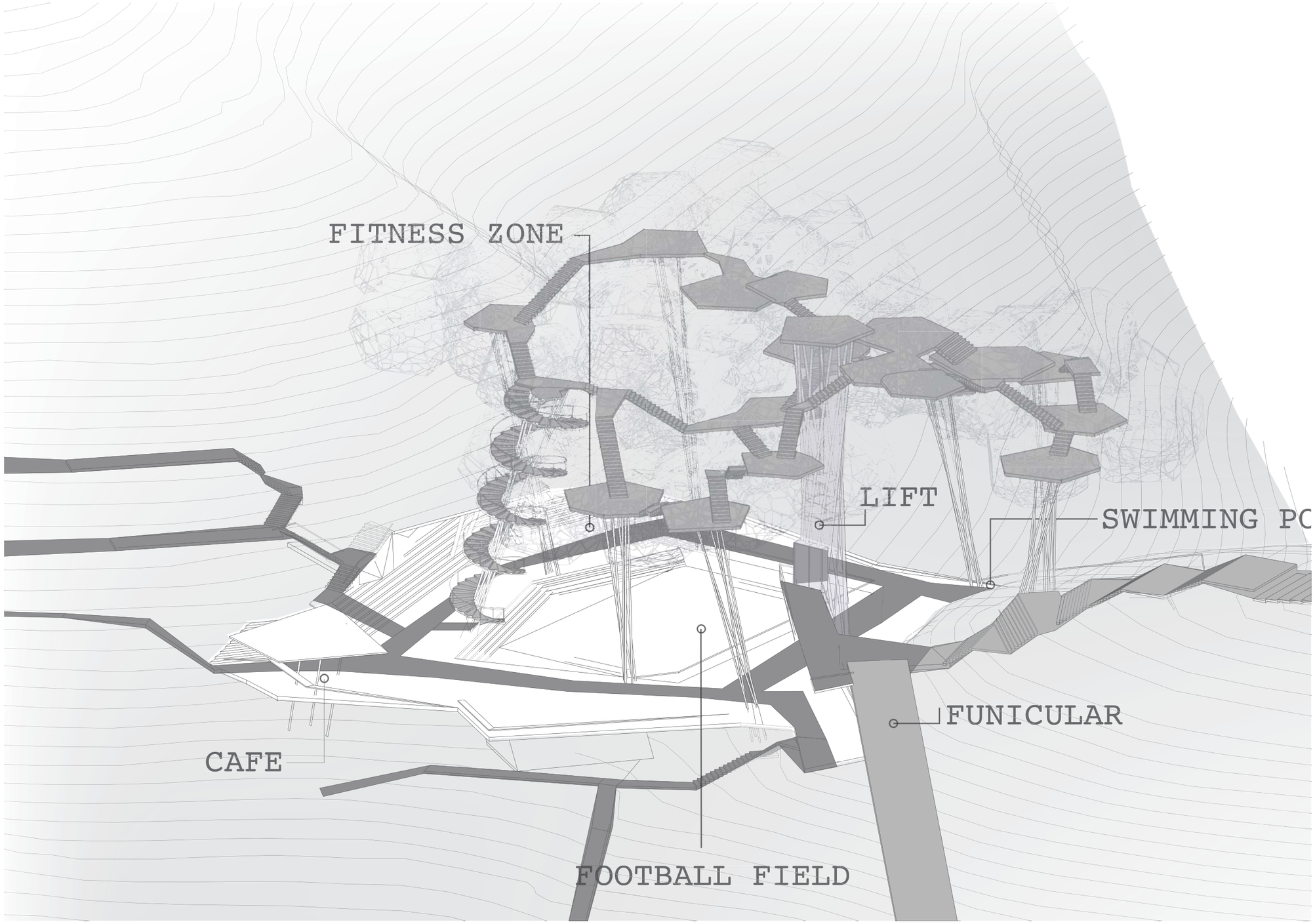


Ill. 34 Organization

Pathway & Organization-
Interwoven spaces

A three-dimensional path is generated inside the attractor-generated volumes. The path connects the different functions within the cloud in a complex almost chaotic, but defined organization. It is not a simple, flat path, but so is the favela either which is defined as a highly complex patchwork of functions, needs and availability that organize the pathways. The non-formalistic path layout is one of the key characteristics that are seen in the favela, which is what we believe gives the potentials for the informal activities and spaces to emerge within the favela.

It is a system that in theory could grow to cover more of the favela and the units could be attached according to the new configurations.



Ill. 35 Column - platform diagram

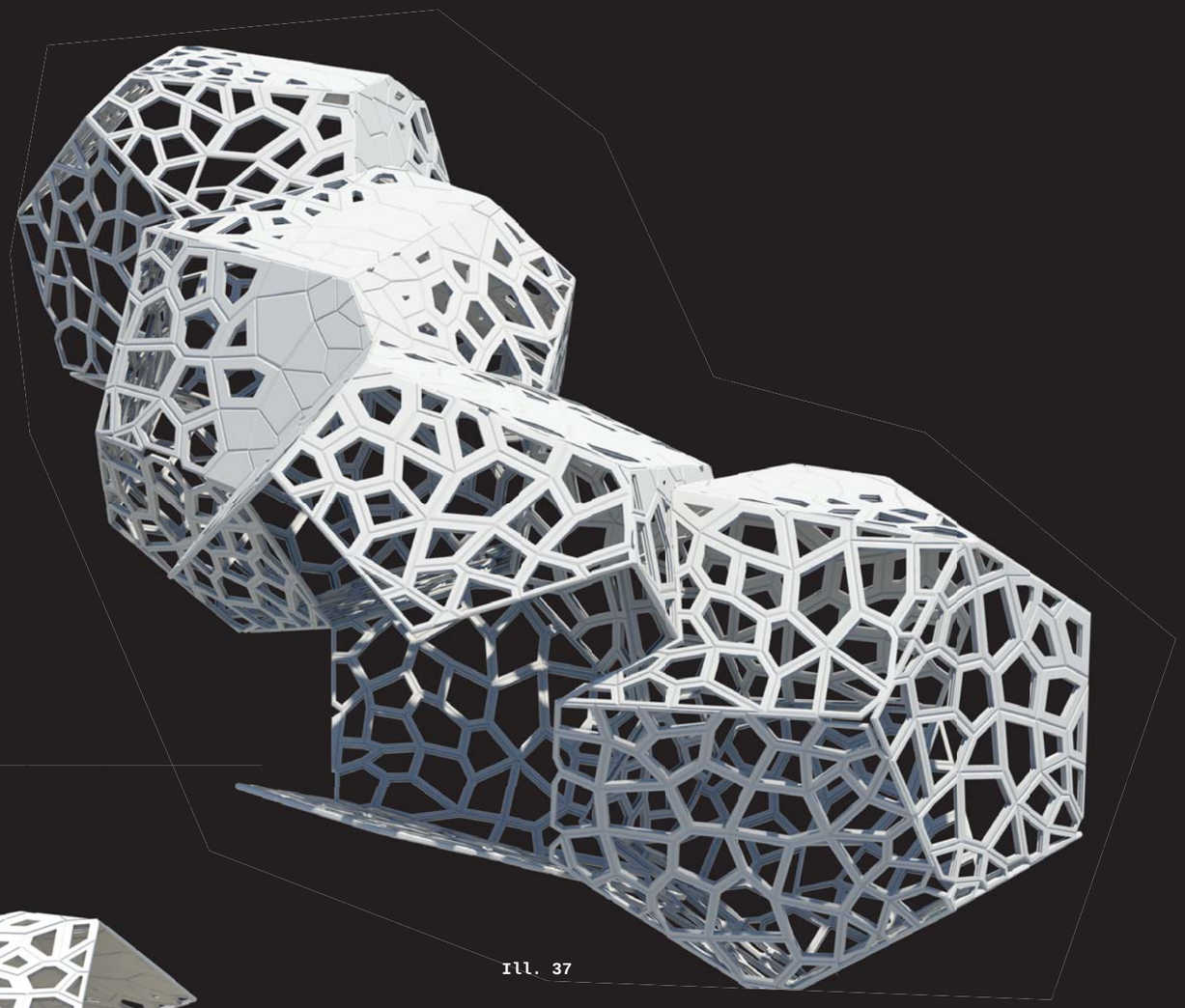
URBAN COBOGÓ

A skin that will perform both environmentally and as ornament to give the cloud a light and porous appearance that creates beautiful and comfortable spaces within and beneath the cloud.

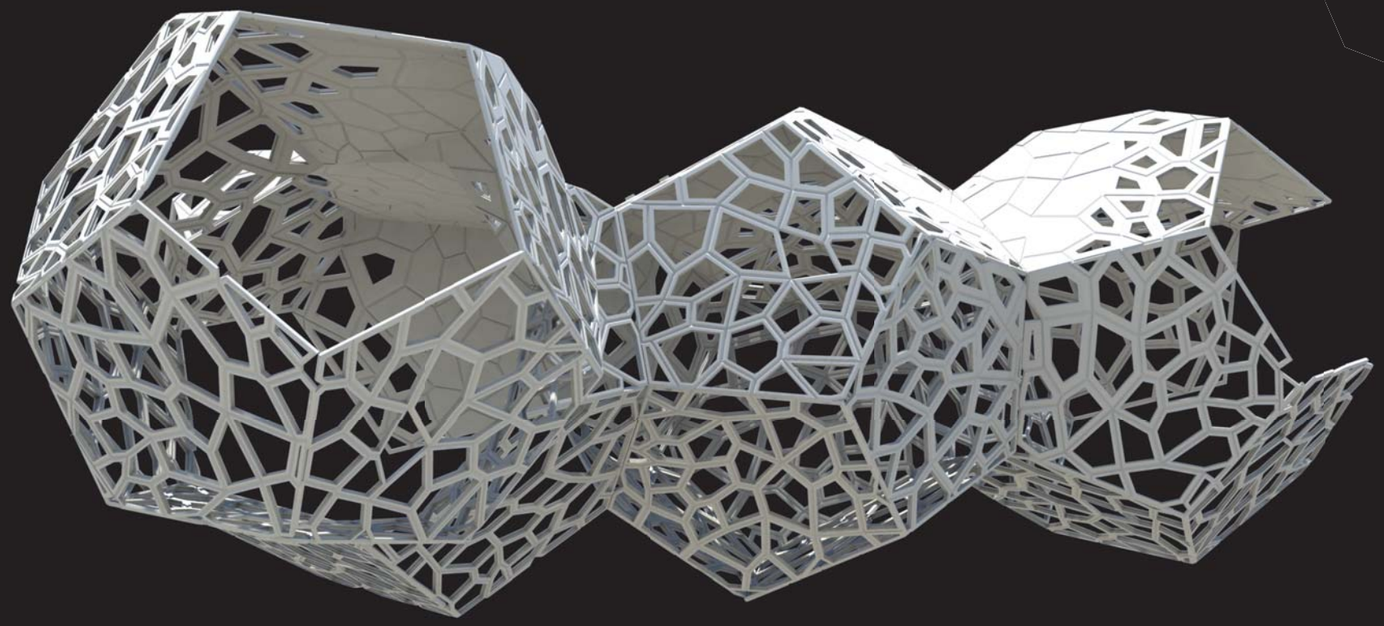
Material:Polycarbonat & Photovoltaic cells

Surface area: 3985 m2

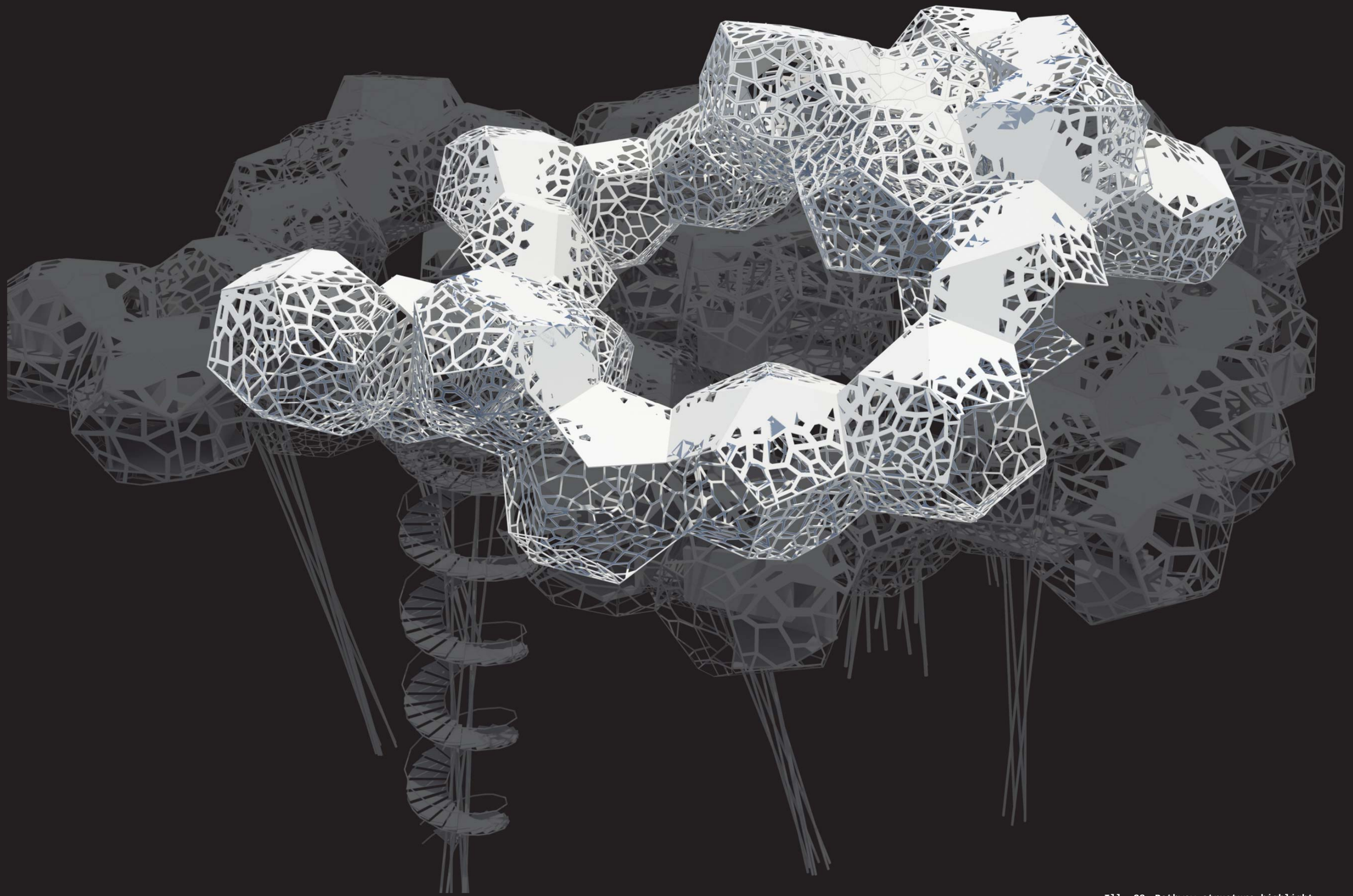
Number of panels: 15840



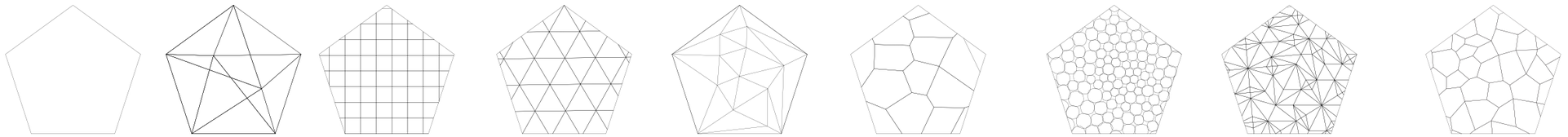
Ill. 37



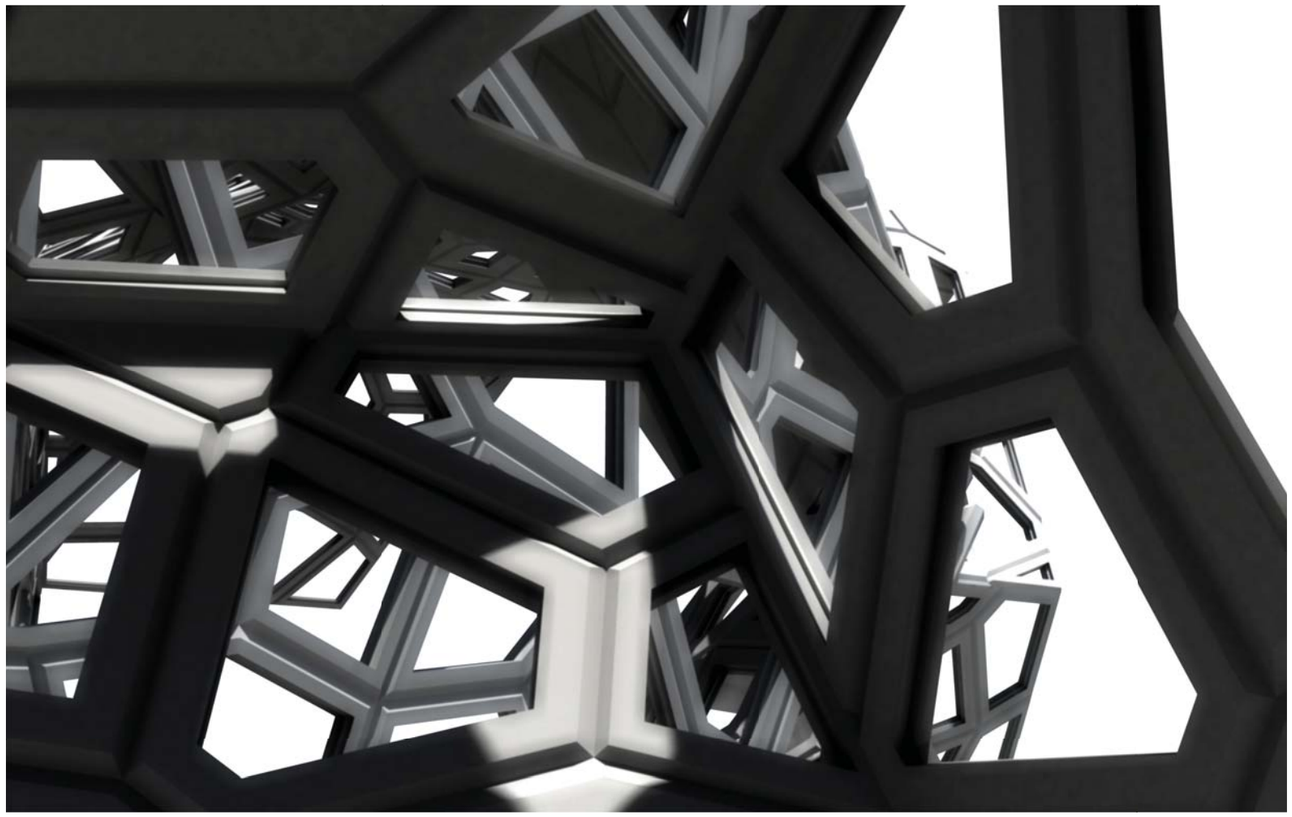
Ill. 36



Ill. 38 Pathway structure highlight



Ill. 39 Test of different tiling and subdivision systems applied to the pentagon



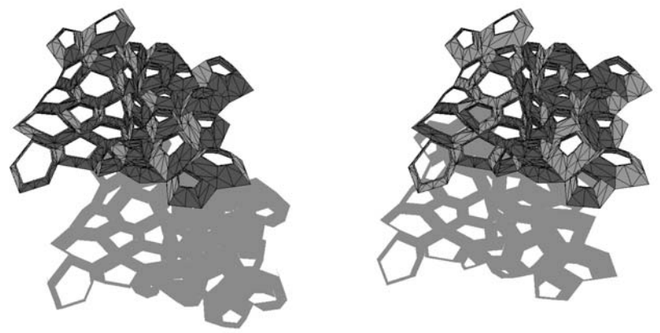
Ill. 40 Spatial Cobogó

Cobogó

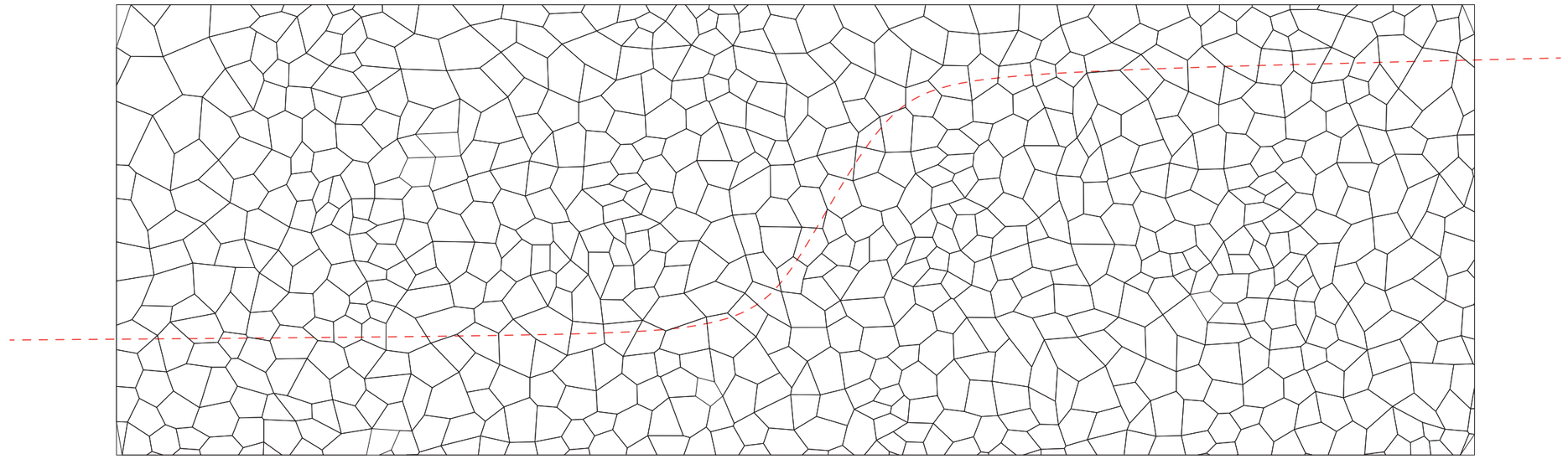
-

Opening and ornamentation

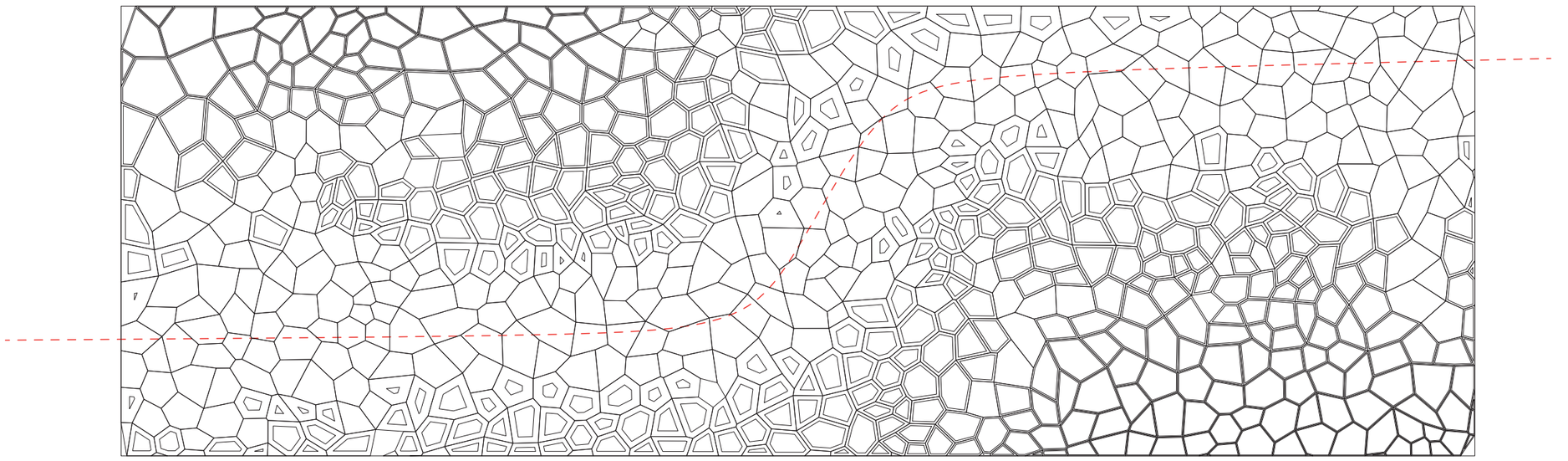
Inspired by the cobogó bricks, which are widely used in the Brazilian context, a tiling pattern is developed. The pattern is created from the intersection of dodecahedrons packed in space and then extracted to a two-dimensional pattern that is applied to the facets of the cloud.
The intension with the cobogó is to develop an environmentally performing skin that can become a structure that provides solar energy, shading, ventilation and views both inside and beneath the cloud.



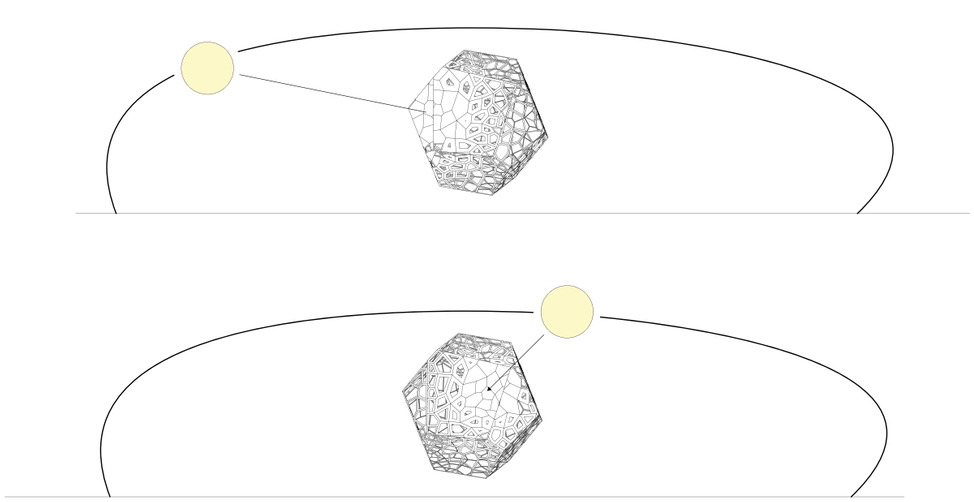
Ill. 41 Shadow studies



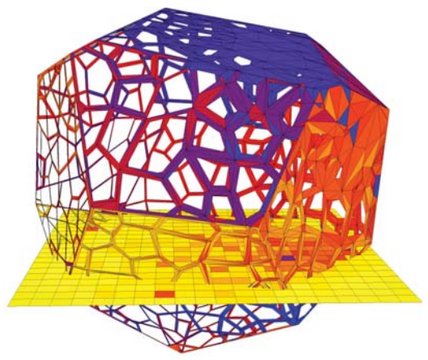
Ill. 42 New cobogó pattern without offset



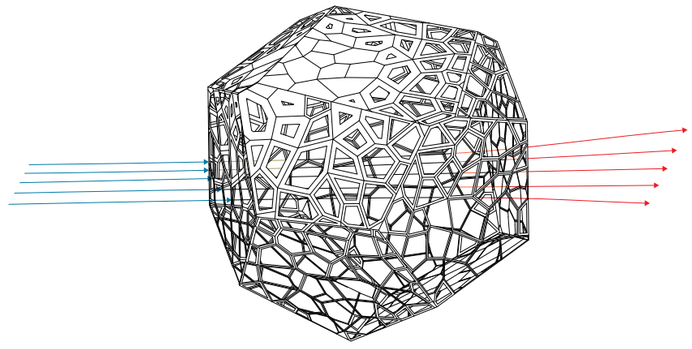
Ill. 43 New cobogó pattern with offset



Ill. 46 Cobogó modulation according to the sun path



Ill. 44 Cobogó and shading



Ill. 45 Cobogó and ventilation

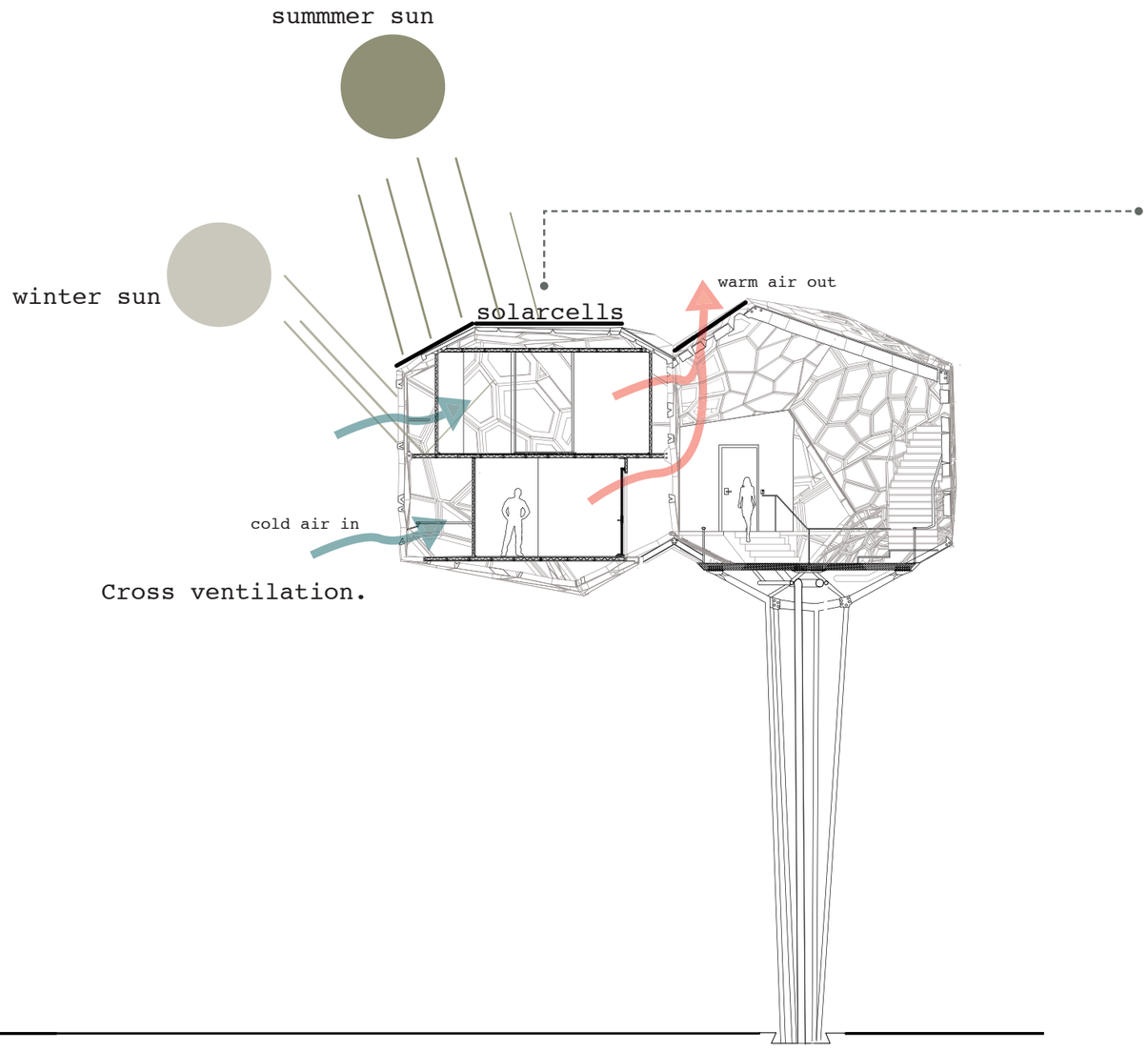
Environmental strategies

-

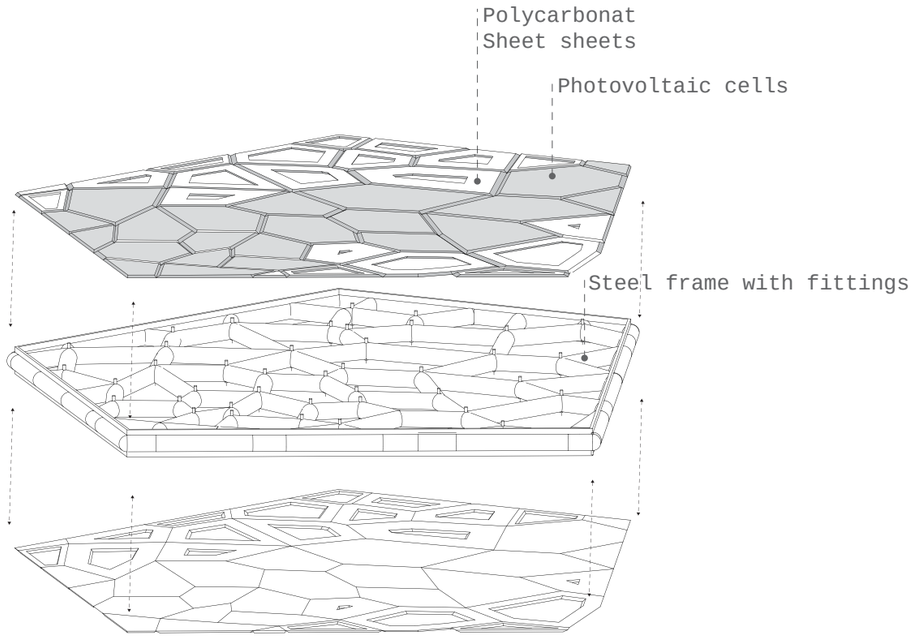
Shading and Ventilation

The environmental strategies are seen as active parameters to guide the design thinking of the cobogó, its properties and how the spaces within the cloud can work in synthesis with the cobogó skin

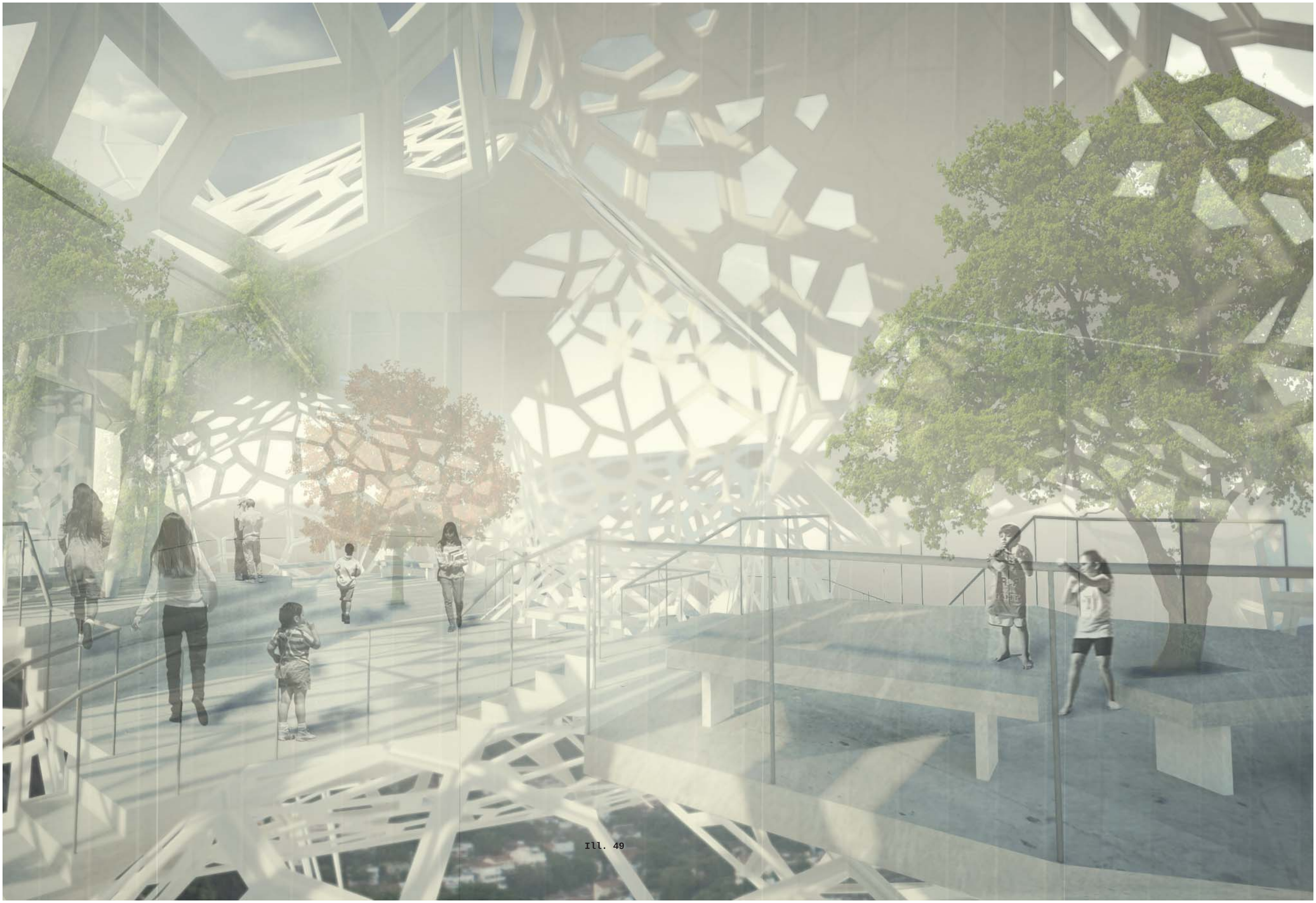
- Use Photovoltaic cells as shading.
- Maximize surface area of the envelope ratio.
- Light and high reflective materials with low heat accumulation to avoid heat storage
- Reduce solar exposure of the internal spaces.
- Maximize cross ventilation, through large openings to the internal spaces, and are able to capture all available breezes.
- Ventilation of wall structures and the building envelope. To ensure cooling the whole day
- Elevated floors to reduce heat gains from ground.



Ill. 47 Principles for climate responsive design



Ill. 48 The design implements photovoltaic cells on the skin as part of the “cobogó” to create shades.



Ill. 49

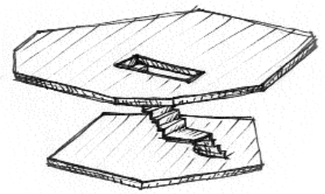
Ill. 50 Sky park

Sky park

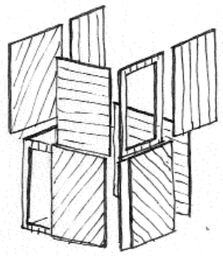
-

Shadow and public space

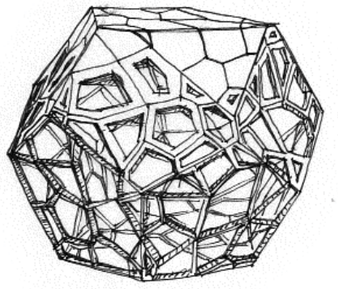
The sky park is an open public part of the Favela Cloud. The lift ends here and a set of stairs distributes people in three possible directions. The space is an open green space and can be used for different activities depending on the need. A place to sit and enjoy the fresh air, shading and beautiful views.



Platforms and access



Sliding wall elements



Skin and structural cell

Ill. 51 Dwelling elements

Dwelling clusters

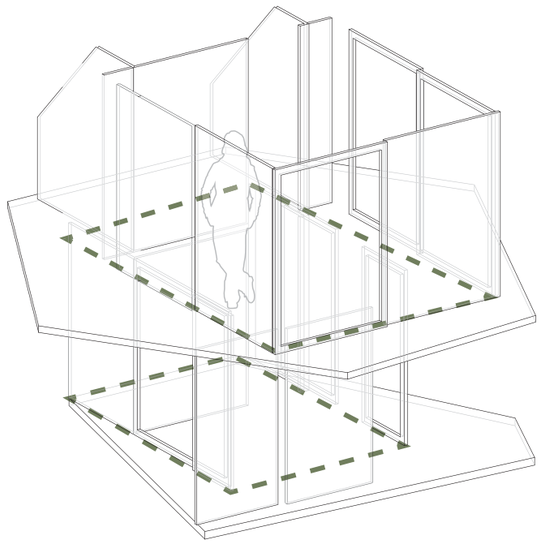
-

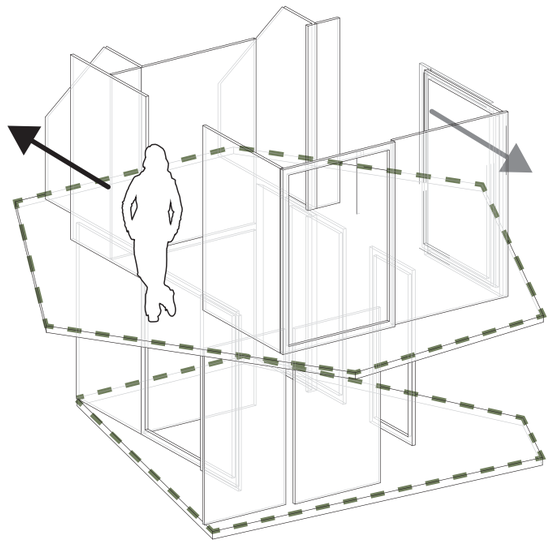
Connecting to the path

The dwelling units are connected and clustered around the path and platforms. These platforms functions as access area for the dwelling, but also as spaces for informal gathering within the favela among the dwellers. Activities such as BBQ or playscape for children can be imagined taking place on these platforms with a beautiful view of the favela and the city.

Inside the carrying structure of the cobogó skin are a set of free plans and light wall elements. It creates open and flexible spaces, which are customizable by the user to adjust them to their individual needs.

Ill. 52 Dwelling cluster





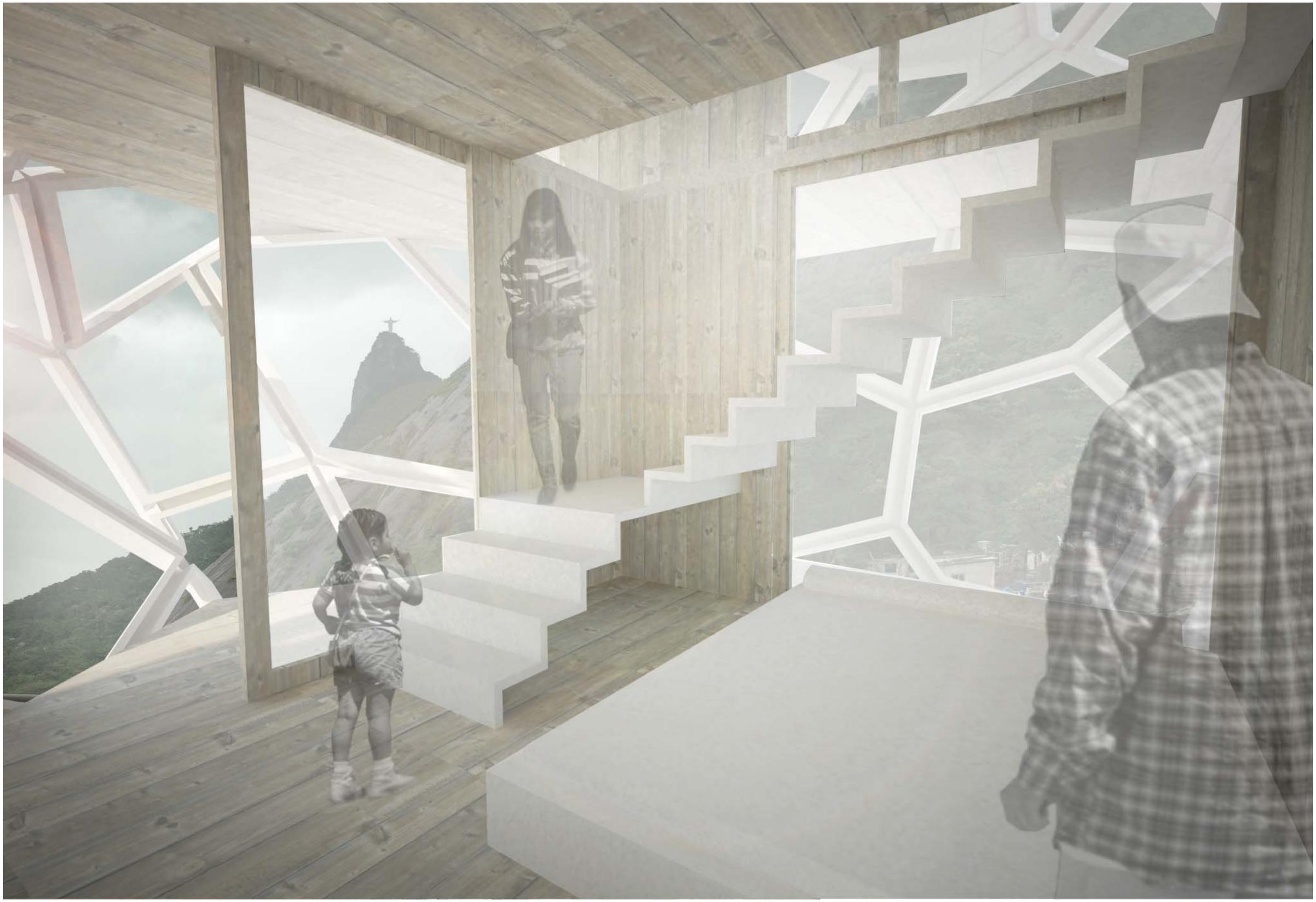
Ill. 53 Sliding walls principle: extentions of space

Flexible and light dwellings

-

Paper house sliding walls

The dwelling design takes inspiration in Japanese paper houses which are built up by flexible and light walls. This means that dwellings inside the cell have the flexibility to open and close according to the outdoor climate. The sliding walls can be opened up for views and cooling and closed when more privacy is needed or closed to protect from the cold winds during winter. The materials within the apartment are thin wood panels that easily can be ventilated to ensure a comfortable climate within the dwellings and be controlled by the user as needed.



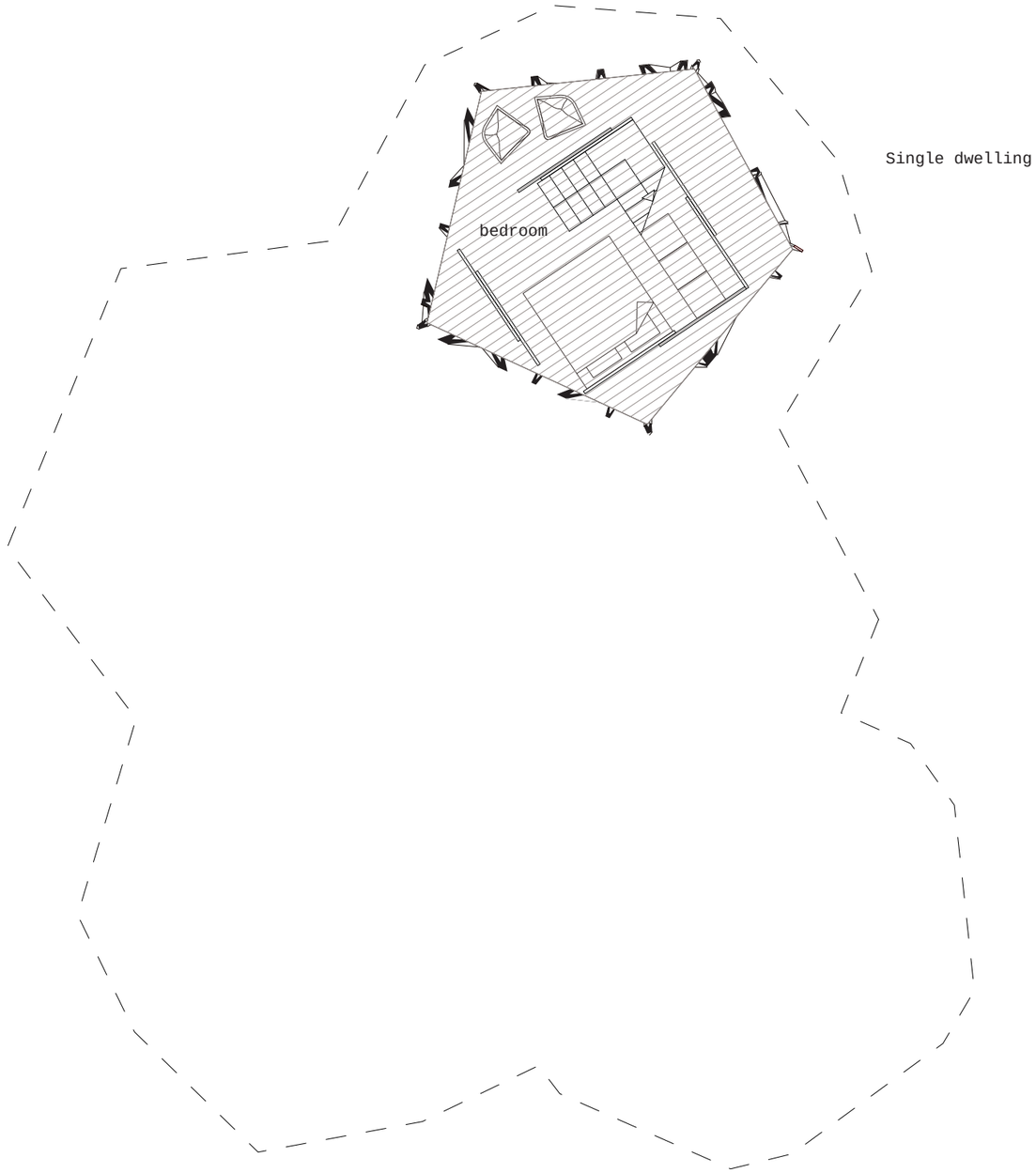
Ill. 54

Dwelling cluster plans

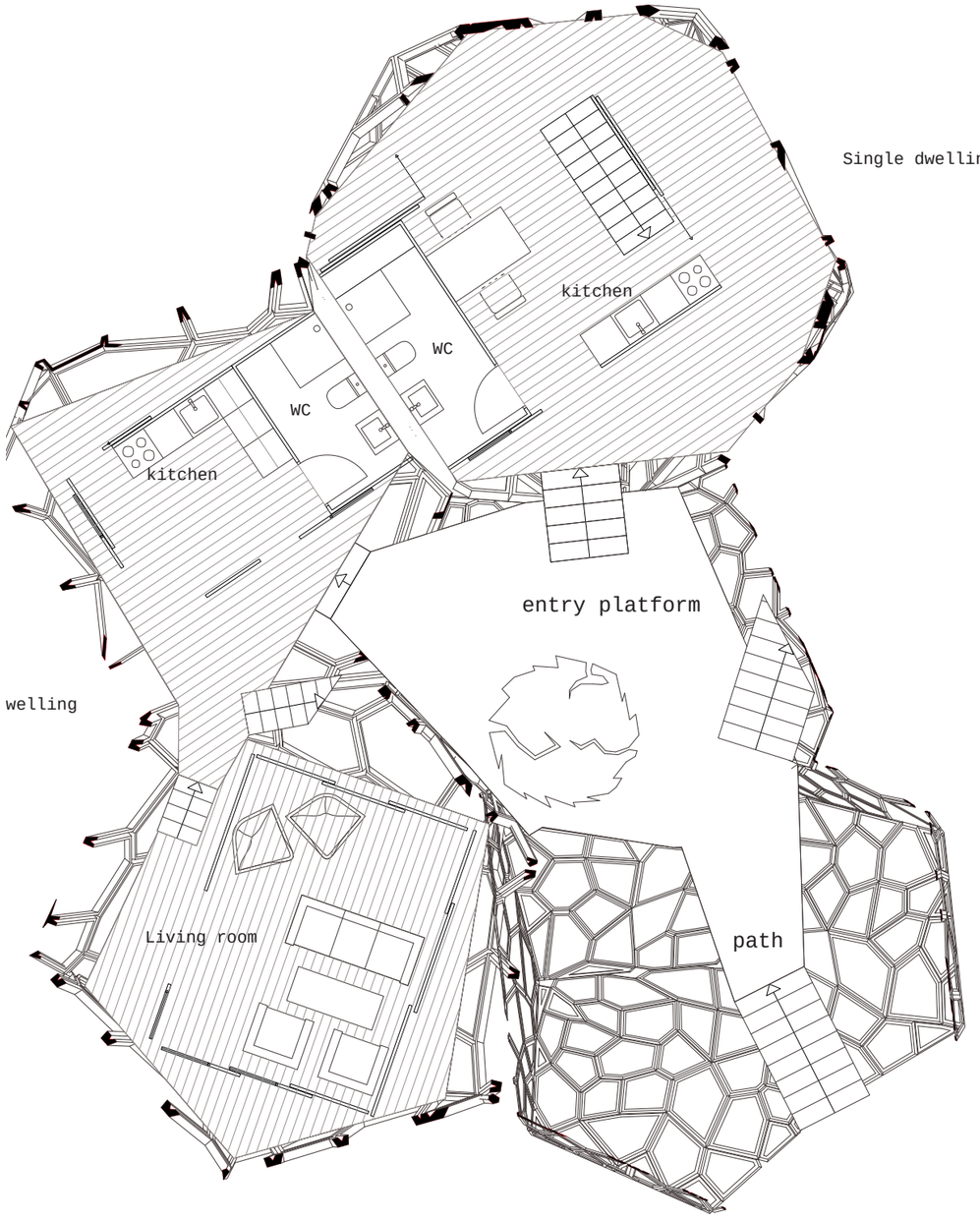
-

A single and a double dwelling

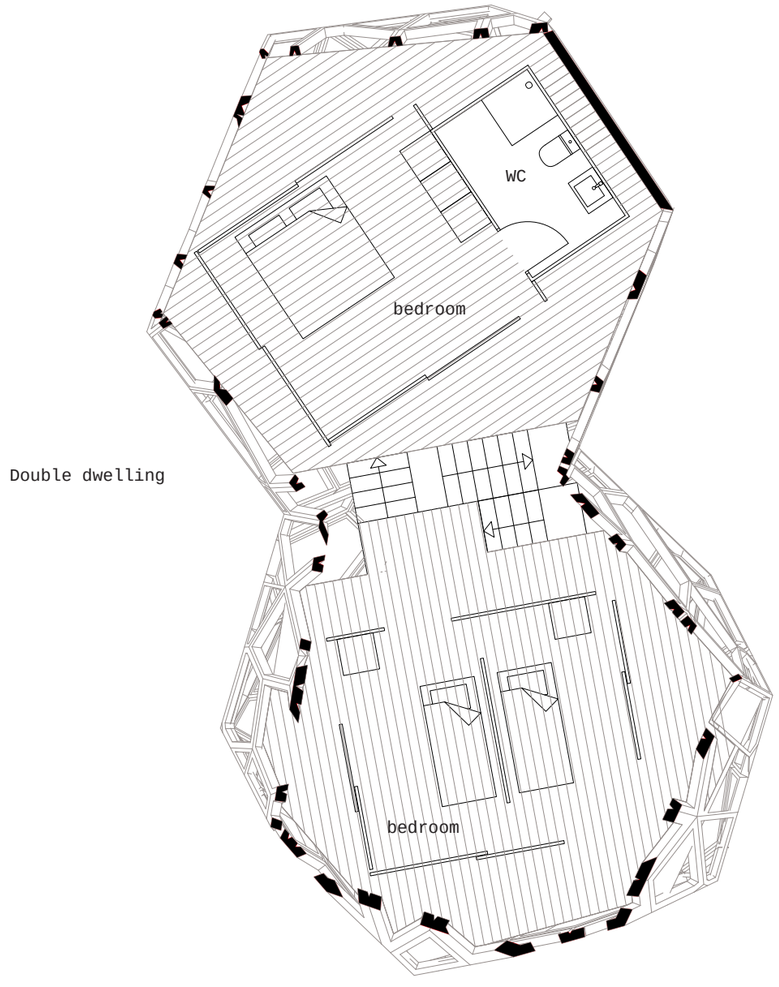
The flexible modular system of the dwellings makes it easy to expand and customize the dwellings. A cluster consists of two or three dwellings and to start with the dwellings can be either a single or a double unit. Meaning that a single unit holds two plans inside a cobogó cell and that the double unit inhabits two cells, resulting in four plans in four different levels. The stair is therefore introduced again as a central element in the dwelling. In the double dwelling the stair is placed between the two volumes two create a spatial element that connects all plans in one continuous move.
Bathrooms are placed against one of the connecting walls as well to provide a single wet wall with utilities for bath and toilet etc.



Ill. 55 Dwelling Cluster Level -01



Ill. 56 Dwelling Cluster Level 00



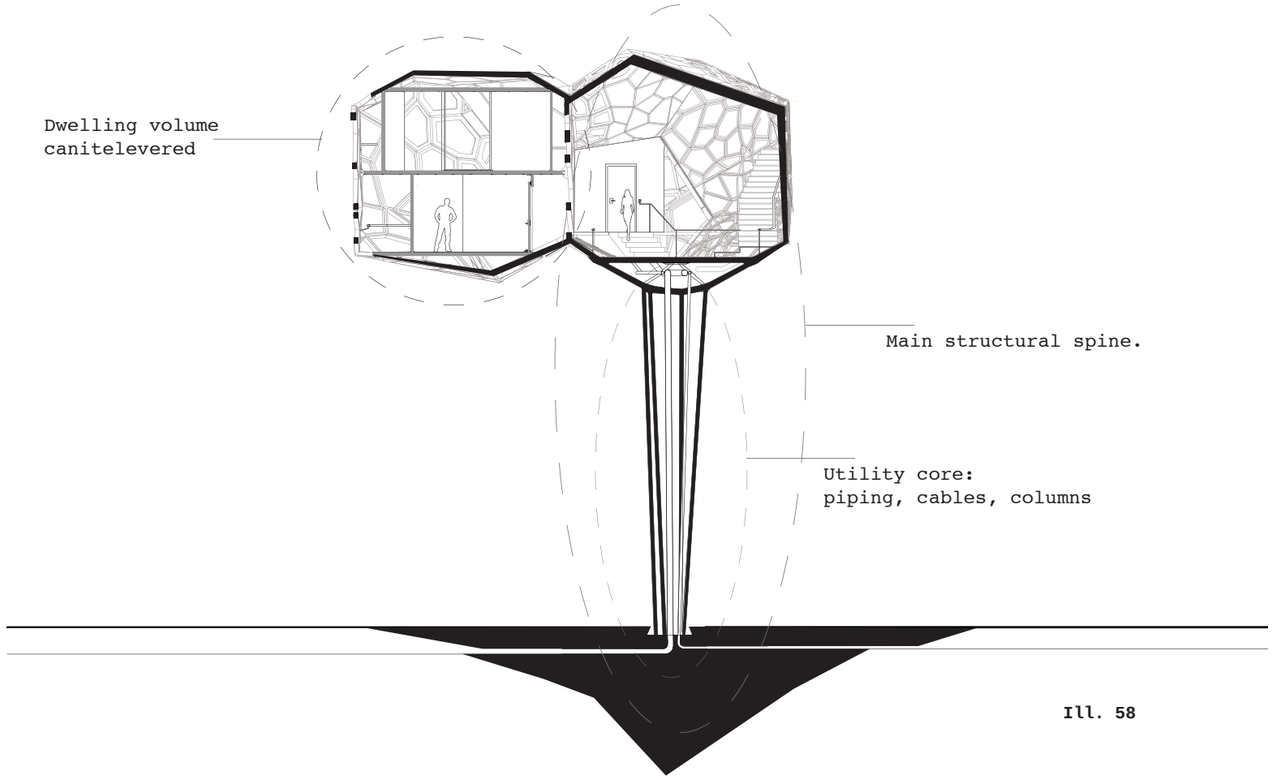
Ill. 57 Dwelling Cluster Level 01

-
50
-

Structural diagram - overall

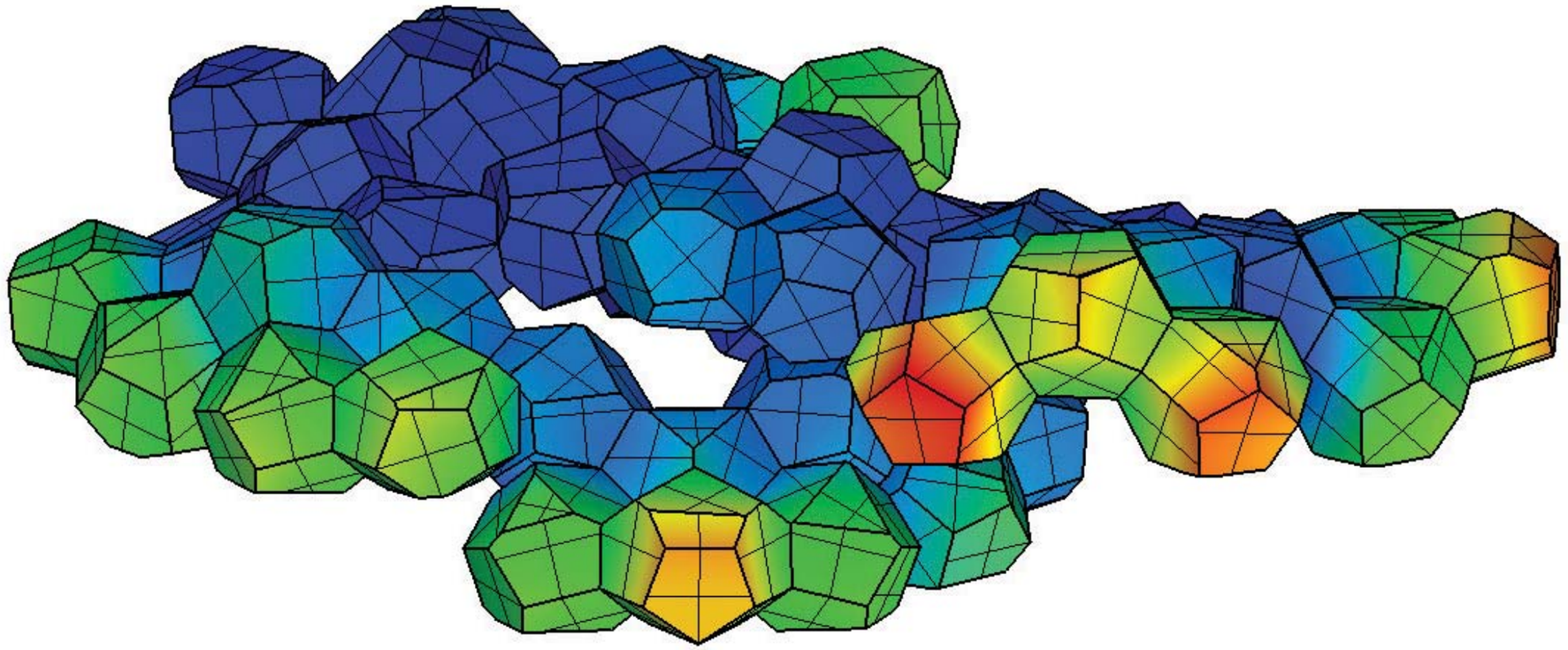
-

Columns, scan & solve

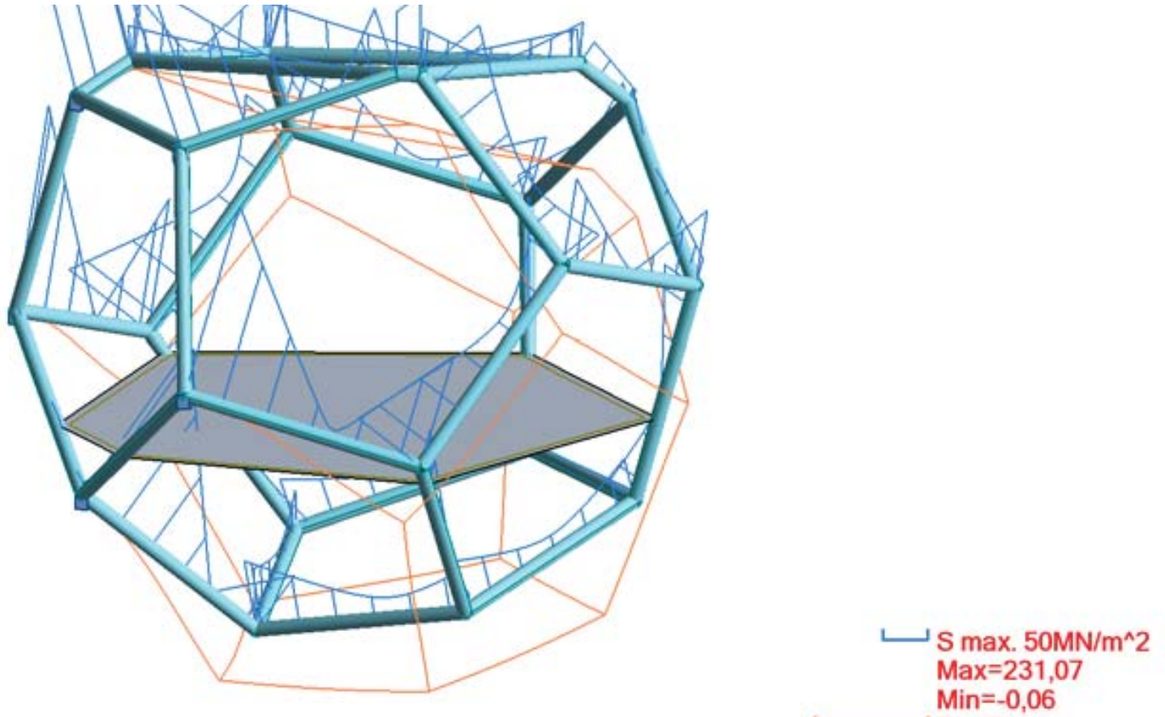


Ill. 58

The structural system for the cloud consists of three layers. The main structure is the columns, which carry the cloud through the platforms. The platforms with the dodecahedrons functions at the secondary structure that connect the columns, creating a structural frame that also includes the utility cores.
The dwelling units are then attached to the structure from where they are cantilevered through the structural skin. The maximum stresses in the structure will be obtained in the pathway structure and the maximum deflections will happen in the cantilevered units. The design due to time limitation will only look at dimensioning the structural grid carrying the dwellings. The calculation should be seen as a design driver to understand the dimensions for cloud girder and how it could be configured to give the cloud a lighter appearance locally and globally.



Ill. 59 Displacement diagramme



Allowed deflection l/200 = 1.5 cm
Fail

Ill. 60 Structural calculations in Robot Structural Analysis

Structural investigations

-

Dwelling unit cantilever

The main focus in the design process has been on the structural configuration of the dwellings according to the designed cobogó pattern. This concentrates the structural part to an understanding of the modular unit concept of a dwelling volume connecting to a path volume.

The Cobogó pattern act as a structural skin of steel members and the structural investigations have been focused on the dimension of the steel grid of the dwelling units. This is done to emphasize the understanding of the modular system concept.

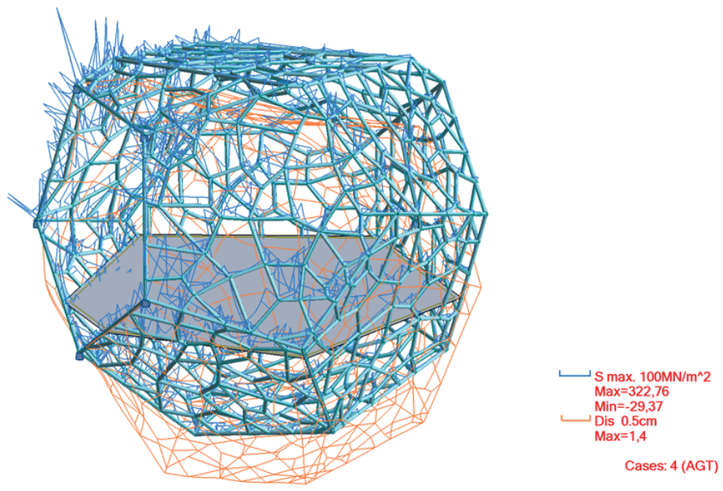
The cobogó pattern which controls the overall structural grid is designed asymmetrically and globally non-repetitive, meaning that every member varies in length and node connectivity. Every bar members also varies in length and the supports are placed asymmetrically. It is therefore necessary to calculate the whole dwelling unit as one structure.

The structure is analyzed in the finite element program called Robot Analysis from Autodesk. The open programming interface in the Robot API has made it possible for us to program a direct link from our 3D software. Thus it’s possible to create variations in the structure without having to redraw every structural element, loads, and supports over and over again.

Due to the complexity of the structure and the focus on an iterative process, the calculations are simplified to only consider loads in form of permanent and service loads. The structural calculations are not meant as a final calculation, but an indicator of the structure to inform the design process and the understanding of the system to develop the pattern in the structural configurations.

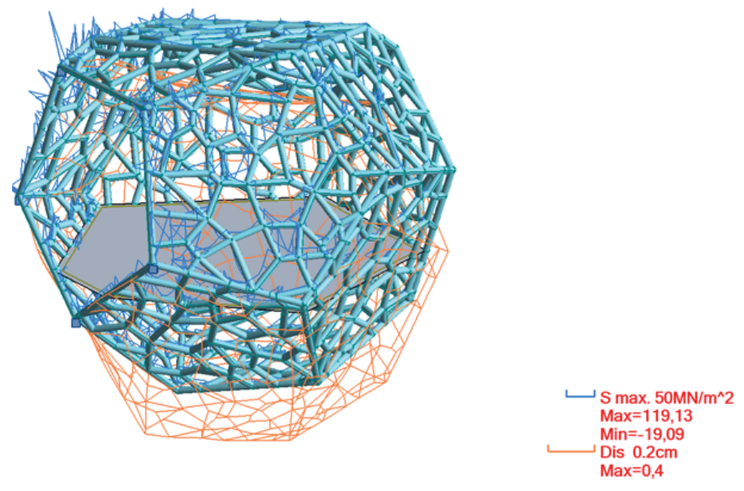
The permanent load is calculated for one of the dwellings and defined as rough estimation of 4 KN per m2 for a slab, which is considered by us to be equal to an average light weight dwelling construction.
The structure will be evaluated for the maximum bar deflection in SLS, and a qualitative consideration made where every bar member deflection should not exceed their relative length/200.

Serviceability limit state (SLS) $p_d = \gamma_G g_k + \gamma_Q q_{k,1}$



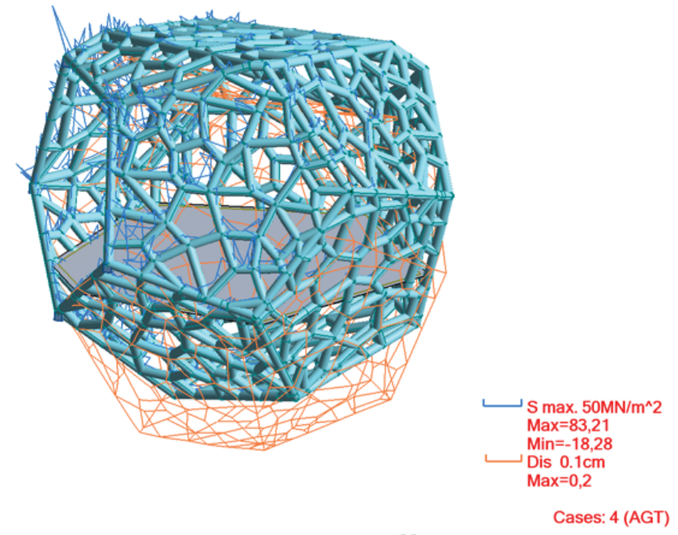
Ill. 61

Allowed deflection l/200 = 0.3 cm
Fail



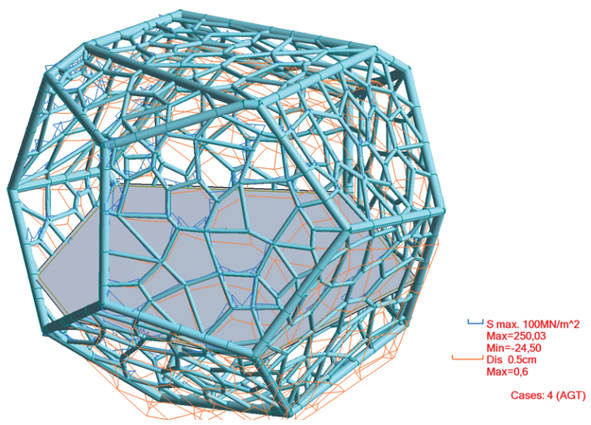
Ill. 62

Allowed deflection l/200 = 0.3 cm
Fail



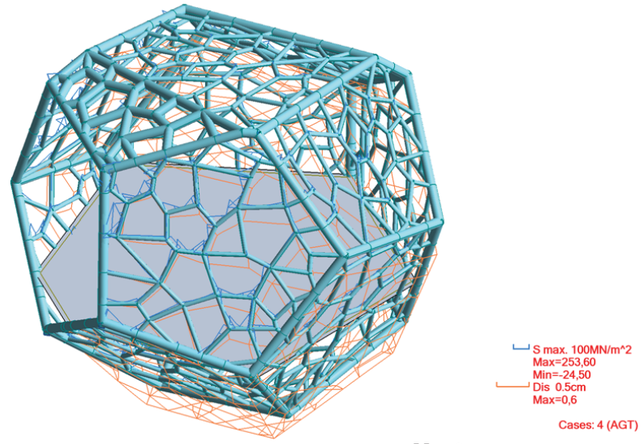
Ill. 63

Allowed deflection l/200 = 0.3 cm
Fail



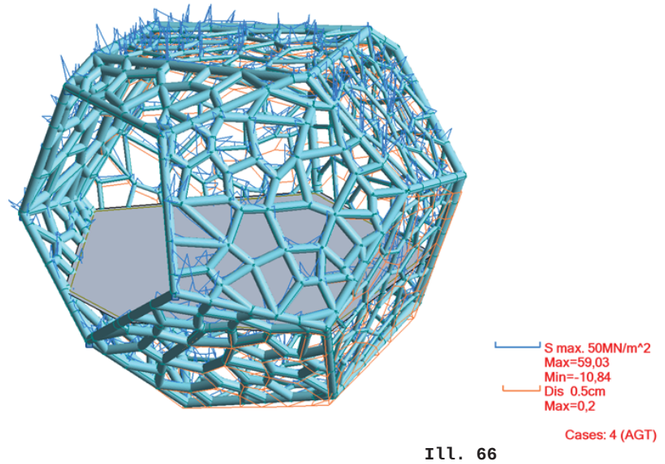
Ill. 64

Allowed deflection l/200 = 0.3 cm
Fail



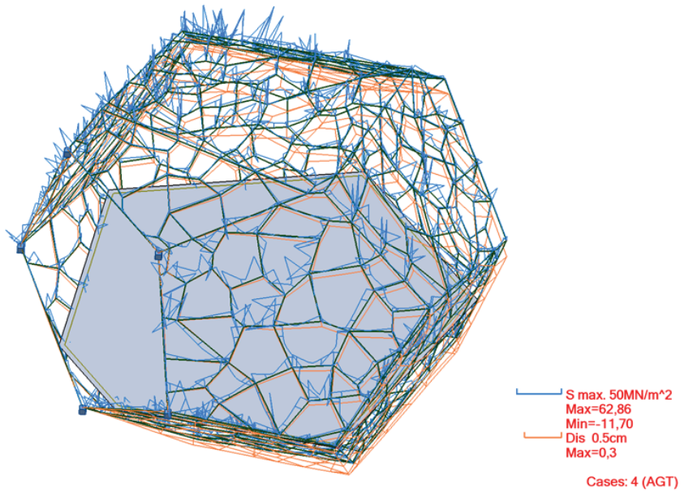
Ill. 65

Allowed deflection l/200 = 0.3 cm
Fail

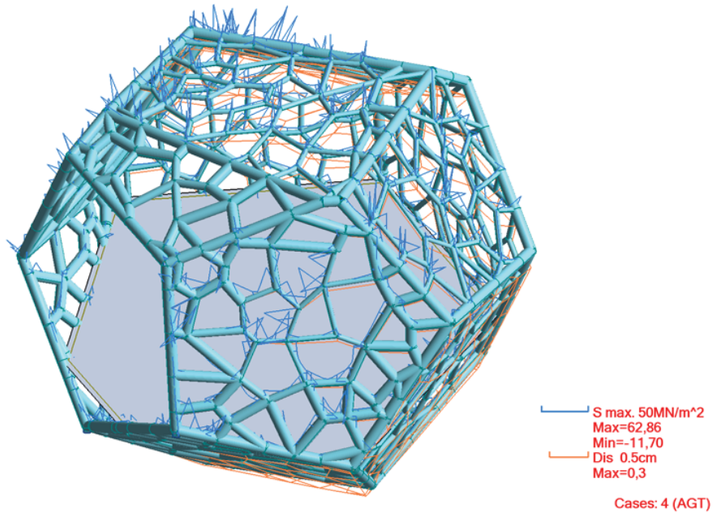


Ill. 66

Allowed deflection l/200 = 0.3 cm
Succes



Ill. 67



Ill. 68 Final configuration for further development

Allowed deflection l/200 = 0.3 cm
Succes

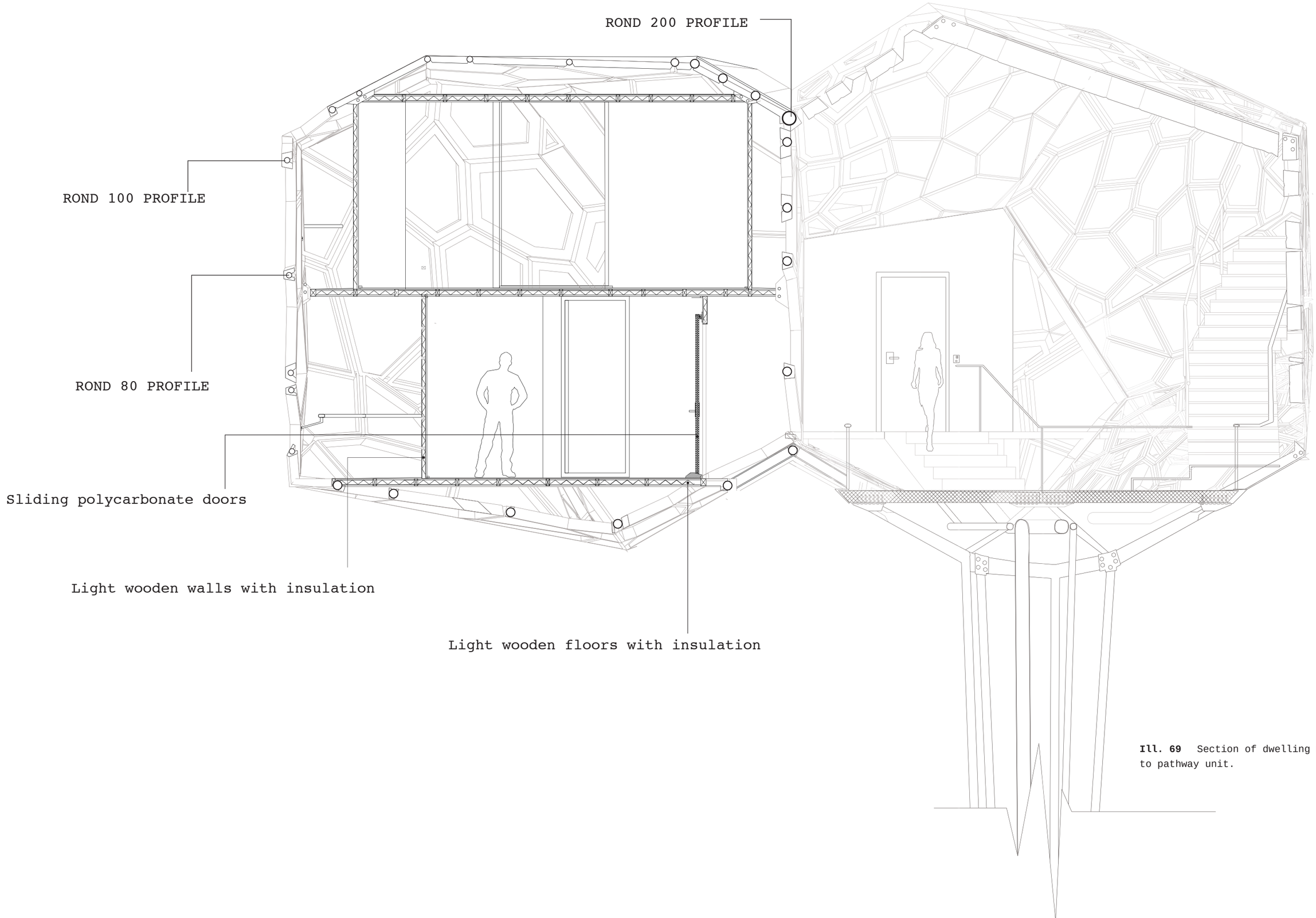
Structural investigations

-

Grid member profiles

The structural system consists of a varied set of steel members in a girder construction. The members are calculated with the following profiles.

80, 100, 150 & 200 ROND profiles, which are distributed according to the stresses in the unit. As the picture fig. 68 show that the thickest profiles are concentrated around the frame edges and up to the connection to the path structure which is the caring structure for the cantilevering units. This is also where the biggest stresses will be obtained.



Ill. 69 Section of dwelling unit connected to pathway unit.

-
56
-

Conclusion

-

A Favela Cloud

The Favela Cloud proposal takes its inspiration from the spatial qualities experienced in the favela and incorporates them into a visionary proposal, a novel way of thinking spaces within the favela. Central to this new organization is the hybrid program of the Favela Cloud. The design deals with a combination of dwellings and functions related to knowledge and learning. The programmatic and organizational complexities are handled through the means of computational design strategies to achieve differentiated and beautiful spaces.

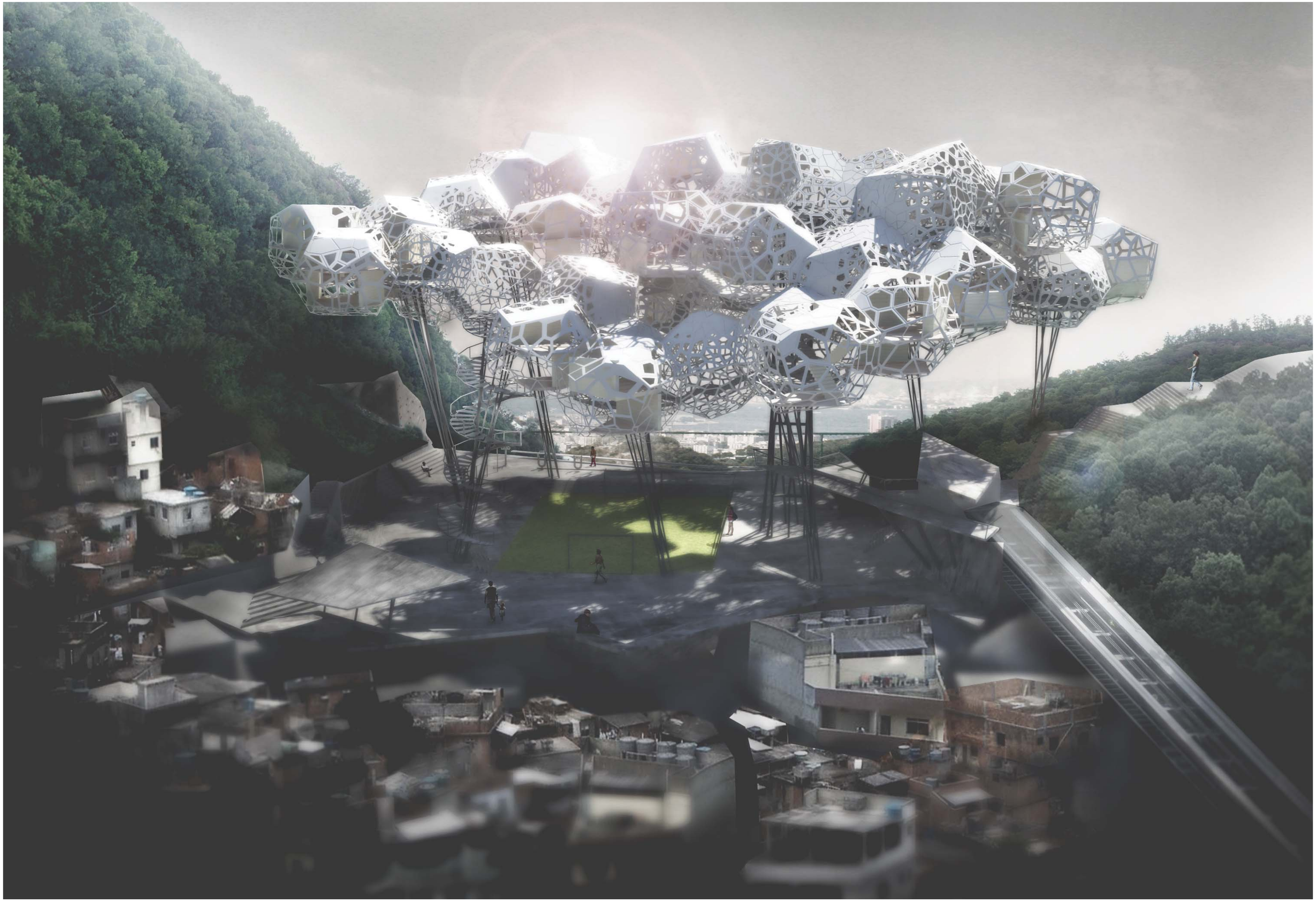
The project holds 68 units aggregated in a complex order. Together they create a unique pathway resembling the flows of the favela. A pathway which supports the vision for creation of differentiated spaces, a gradient of unexpectedness and unpredictability in which social activities can emerge.

The programmatic organization follows the path in a fluid interwoven configuration. A configuration that intertwine private and cultural functions, improving the space for informal social activities in the favela. It incorporates functions such as spaces for performance, cultural activities, learning facilities and dwellings.

An urban cloud that takes offset in the cobogó, a widely used building component in the Brazilian context. The project transforms the concept of the cobogó into a large-scale structure. A porous volume that houses a mixed program, wrapped in an environmentally performing skin. The skin allows the building to breathe through custom designed panels, that provide shading and ventilation openings varying in shape and dimensions, to facilitate the specific spaces within and beneath the cloud and to allow functioning as an urban cobogó.

Hovering over favela Santa Marta, the Favela Cloud is visible from many directions across Rio. The shape and cell structure resembles clouds passing the mountains top of Rio de Janeiro. The Favela cloud will become a landmark communicating the progress of the favela to the formal city of Rio de Janeiro.

Ill. 70 A number of activities are intended to take place at the sports plaza surrounding the football field. The plaza provides facilities for swimming, fitness and climbing in the shade of the Favela Cloud.



Perspective

-

Learning from Rio

The Favela Cloud project is the result of a learning process evolving around the contextual understanding of Favela Santa Marta in Rio de Janeiro. A three-month stay in Rio de Janeiro became the foundation for the knowledge gained and many of the decisions taken during the design process. Studying the site in person was crucial to achieve a deeper understanding of the issues and the possibilities of the informal city. Our understanding evolved from a naive and generalizing approach to the favela, to an understanding of the wide differentiation of the favelas. A favela is not just a favela, but every favela has its own culture, structure and issues ranging from political initiatives to landscape typography. Thus each favela will need a customized approach for future development, but the underlying principles for an emergent development will have to be there to follow the natural pattern of the favela.

The first part of the project was dedicated to get an understanding of the site, the context and the cultural differences. This was a difficult process, because the first huge task was to find a site and a design task based on the studies of favela Santa Marta and the possible issues of the favela.

The studies were in the beginning focused on path complexities as we experienced it in the favela. Paths that appear chaotic and random but are incredibly fascinating spaces to walk, observe and stay in. The relation between scale, density and twisted connections between spaces in the favela was something that we believe is one of the key parameters for a socially engaging environment in the favela.

The favela organization, social life and openness are some of the parameters we tried to understand and implement in our design. This was a difficult task, because how do you do that and still design a new architectural configuration that isn’t just a copy? To understand the characteristics of the favela and implement them in our design we started to dissect the favela to understand and extract its properties as inspirational foundation for our design approach.

One thing that really struck us during our stay is the huge social segregation in Rio de Janeiro. People outside the favela still look at the favela with prejudice, even the pacified ones such as Santa Marta, which has almost become a middle class area is still judged by its past. This became a generator for our design during the design process and we started to see our design as more than just a social building that could improve some of the dwellings in the favela. Instead the focus changed to at the design of an architectural statement on how we can build future architecture that takes inspiration in the complexities of the favela.

Our specialization in the usage of digital tools to facilitate complex relationships in the design had an impact on how we approached the vision for our site. Through the means of digital tools, we implemented our knowledge about the favela and the environment to guide the design process. This environmental understanding was the generator for the cobogó and skin development strategies.

The project is about pushing the boundaries of how we perceive architecture in the favela and how the build environment can evolve into an experiment in new city logics. How novel architecture can emerge, learning from and transforming the existing site.

Favela Cloud is the result of a learning process, a process of understanding a new context and drawing on the knowledge of the site together with discussions on cultural implications and best practices to be able to propose a novel design strategy which exhibits some qualities related to the favela as well as qualities related to the background of the designers themselves.

Ill. 71 Inhabitable ground and flexible space in the favela