

MITOSIS

Biophilic Regenerative Ecosystem



GG-loop

Introduction

The need for healthy homes has hardly ever been more apparent than during the current global condition. The current efforts to reduce the negative impacts of buildings are inadequate. Therefore the built environment must be designed in a different way. To bring **regenerative** collective habitation to all scales of development, Amsterdam architecture practice GG-loop, sharing the vision with Arup, is developing Mitosis: a modular building system created by a parametric design tool following biophilic and user-centric design principles.

Mitosis creates regenerative ecosystems with a positive ecological footprint. It balances the technical benefits of an environmentally conscious construction with the qualities of an organic and **healthy environment** in which its residents coexist harmoniously. Mitosis generates urban clusters using prefabricated **timber and bio-based** modules that are cost-efficient and flexible in its construction.

With its **biophilic design** principles, Mitosis is applicable to diverse urban scales, ranging from off-grid single family detached houses to high density mixed-use urban developments. It generates experiential spaces that respect both the environment and its direct inhabitants, reconnecting both in a balanced ecosystem.



“In the wilderness is the
salvation of the world.”

Henry David Thoreau (1817-1862)
American Author



Mission

Due to the global condition, the built environment must be designed in a more holistic and environmentally conscious way. GG-loop's goal is to develop an architectural solution that "gives back" to the Planet and can serve as a benchmark for the real estate and urban development sector.

By involving stakeholders in the entire decision-making process, Mitosis encourages dialogue between stakeholders and inhabitants in order to work together towards maintaining Mitosis' **resilient community** and sustaining its long-term goal of conservation, self-sufficiency and regeneration.

Mitosis' vision is to deepen the understanding of its relationship with Nature, to raise awareness and sensitize both professionals and the general public regarding the importance of biophilic architecture as an answer to the current climate condition.

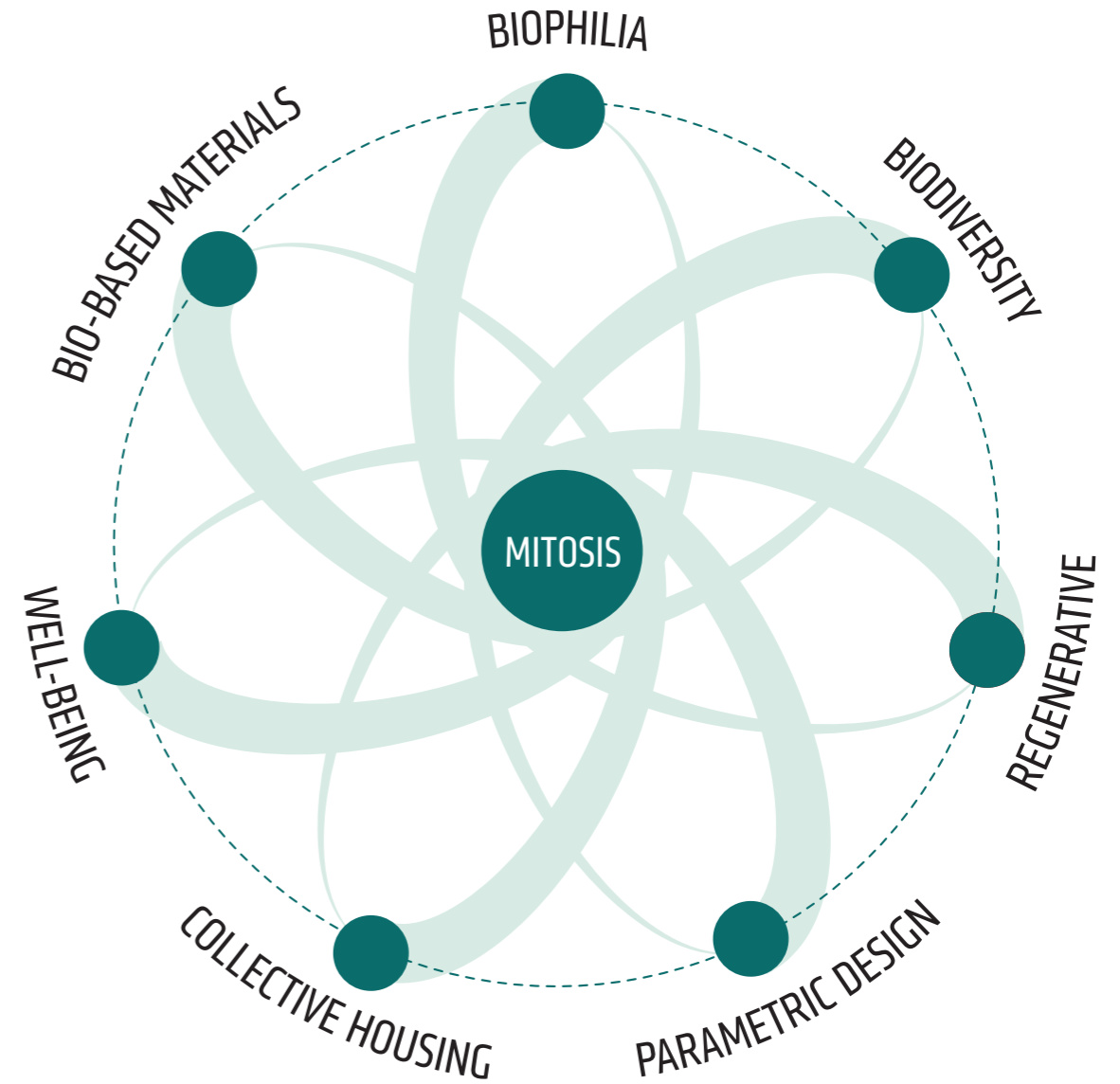
Sharing the same vision as Arup, GG-loop works to inspire and provide healthy sustainable living communities and **net-positive** impacts on ecology and society. By working with the natural environments rather than against it, the natural balance and health of the planet can be restored.



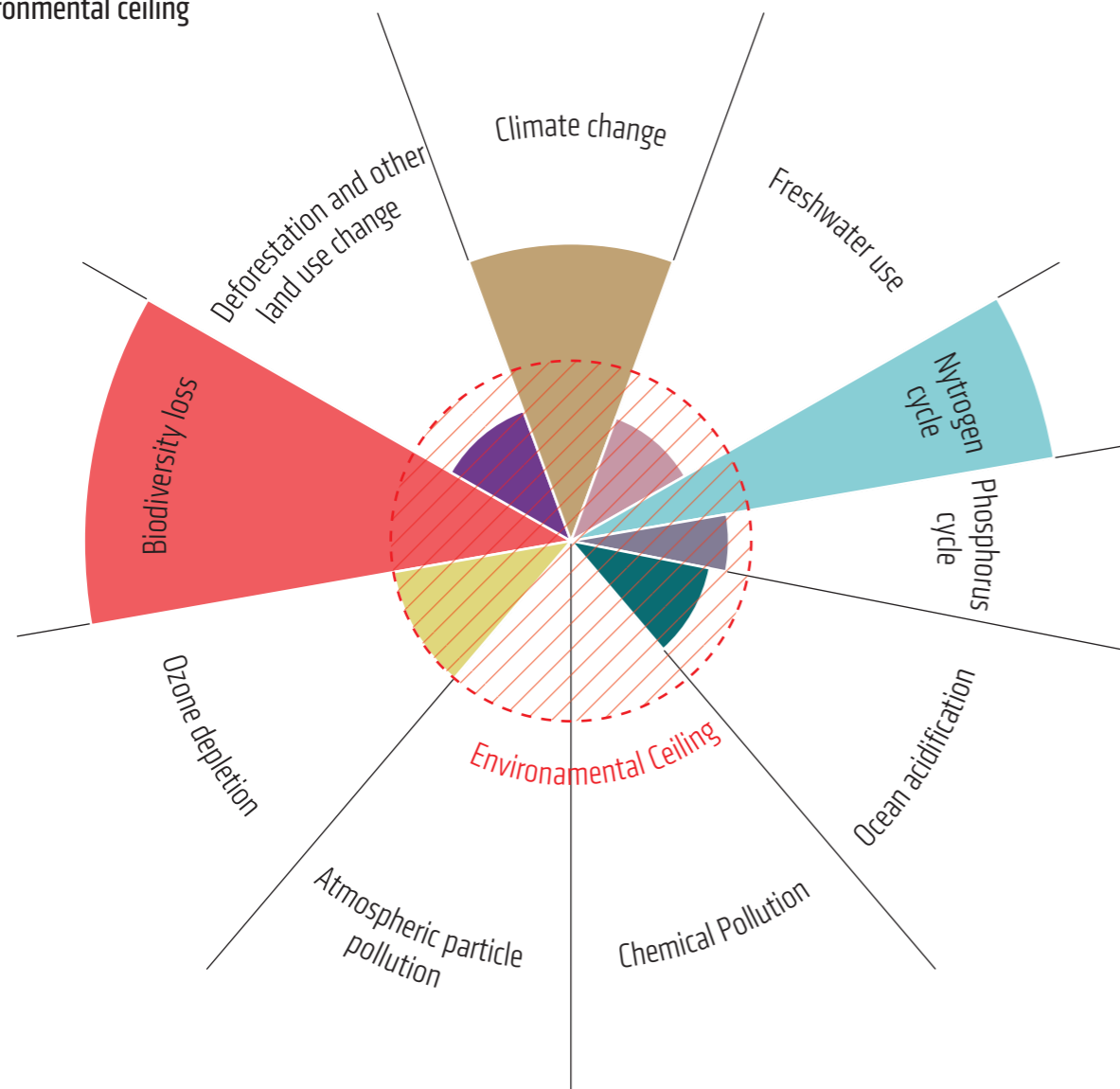
Summary

Welcome to the city of Mitosis, developed by GG-loop as a response to the current global climate condition and rising world population.

- Mitosis follows a holistic **biophilic approach** and builds an ecosystem where dwellers experience a unique way of living and fulfil their innate desire to reconnect with nature.
- Mitosis uses **bio-based building materials** such as CLT (cross-laminated timber) that sequesters CO2. The building techniques are environmentally positive and the processes are optimised in order to improve construction efficiency.
- **Biodiversity** is restored on the building plot, allowing residents to coexist harmoniously with nature in order to strengthen the quality of their life and of their surroundings.
- Mitosis embodies a **regenerative** design process, focusing on creating resilient and fair systems that integrate the needs of society and of nature. The goal is to achieve net-positive impact for ecology and society.
- A **parametric design tool** has been developed in order to generate an optimized volume and scale of Mitosis based on the specific conditions on the given site and the needs of all the stakeholders.
- Mitosis supports **collective housing** with facilities that encourage social cohesion and create a community culture of "pro-environmental" practices.
- **Health and well-being** is fostered through careful material choices, flexible layouts, organic interiors and large outdoor spaces.



Planet Earth limits:
the environmental ceiling



Svedin U. (2012). "Global conditions for the future of agriculture in the Anthropocene." A planet for life. Retrieved 02 November 2020.

Anthropocene

In the 80's, biologist Eugene F. Stoermer coined a specific name, **Anthropocene**, for the current geological era (-*cene*), attributing the main causes of this change to man (*anthropo-*). The term over time has taken on an increasingly negative meaning supported by the irrefutable reality of climate change.¹ Given the responsibility that architects and urban planners have, the race towards solutions such as biophilic architecture, has manifested also in the sector.

¹ Revkin, Andrew C. (11 May 2011). "Confronting the 'Anthropocene'". The New York Times. Retrieved 25 March 2014.

Biophilia

In the mid-19th century, naturalist and philosopher Henry David Thoreau described how "wild nature" was the key to safeguarding the world, and how humans can benefit from embracing and improving their relationship with their surrounding.² The "**Biophilia Hypothesis**", a concept introduced in the 60's by the German social psychologist Erich Seligmann Fromm, and further explored by the American biologist Edward Osborne Wilson in the 80's, states that humans are attracted to coexist with other living systems, both fauna and flora.³ Biophilia literally means "love for life". Today, studies held throughout the globe prove that biophilic design has biological and emotional benefits: stress reduction, enhanced cognitive function and faster healing.

² Thoreau, H. D. (1854). Walden; or, Life in the Woods. Boston, MA: Ticknor and Fields.

³ Wilson, Edward O. (1984). Biophilia. Cambridge, MA: Harvard University Press.





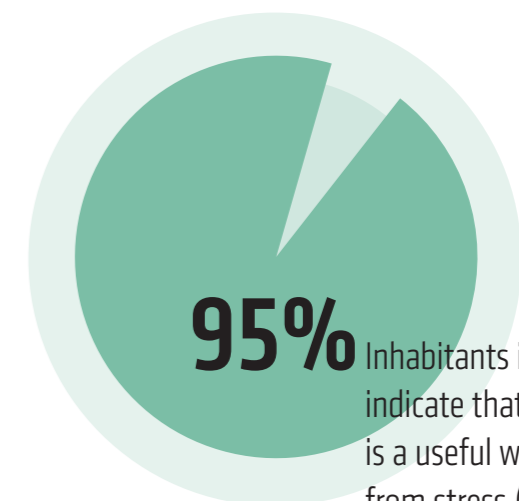
Need for Restoration

In the last decades the desire to reconnect with nature has been manifested in architecture through the integration of **green systems** in outdoor (green façades, controlled vegetation on balconies, terraces and roof-gardens) and indoor environments (patios, green walls, pots).

GG-loop's vision goes further than the integration of just green systems, but rather creates a built environment that restores and nurtures its surroundings, and that serves as a catalyst for positive change.

Being in direct contact with nature has proven to help physical and mental health and overall **well-being**, as well as technical benefits of acoustics improvement, CO2 and urban heat reduction.⁴

At the Wageningen University (NL), Agnes van den Berg asserts that in compact cities the desire for Nature is not just a rural romanticism but an actual **restoration tool**.⁵ Robbert Snep, Senior researcher in Green City from the same University, stresses the importance of enhancing **biodiversity** in the built environment listing the benefits of it like social cohesion i.e.⁶



95% Inhabitants in the Netherlands indicate that visits to nature is a useful way to obtain relief from stress (Frerichs, 2004).

⁴ Brown, Barton & Gladwell, 2013; van den Berg, Hartig, & Staats, 2007; Tsunetsugu & Miyazaki, 2005.

⁵ Van den Berg, A. E., & van den Berg, M. M. H. E. (2015). Health benefits of plants and green space: Establishing the evidence base. *Acta Horticulturae*, 1093, 19-30.

⁶ Snep R.P.H., Clergeau P. (2013) Biodiversity in Cities, Reconnecting Humans with Nature. In: Loftness V., Haase D. (eds) *Sustainable Built Environments*. Springer, New York, NY.

Reconnect with Nature

The "Biophilia Hypothesis" reveals why humans have an intrinsic need to connect with nature and other living systems. Mitosis adopts the 14 principles of biophilic design and articulates the relationships between nature, human biology and the design of the built environment. Its construction is organic and flexible, providing large areas of urban and vertical farming, greenhouses, wildlife corridors and integration of habitat creation, that encourage shared outdoor activities among residents.

Exposed to green shared areas, tiny forests and gardens that cascade up and down the entire building, dwellers can benefit from the direct and indirect connection with nature. By applying elements of nature and providing available renewable resources in shared facilities and infrastructures of community living, dwellers can create a culture of **pro-environmental practices** and share their expectations of sustainability. This helps create healthier environments and improve social interaction.





Biodiversity

Enhancement of biodiversity in the urban fabric has a beneficial impact on the quality of life and the environmental education of the inhabitants. Inspired by Singapore's "city in the garden" vision, Mitosis forms its own "garden city" by integrating plant and animal life throughout the buildings, allowing inhabitants to coexist harmoniously with the biodiversity of local flora and fauna. Mitosis is designed to co-evolve with its surrounding, by recreating ecosystems appropriate to the climate, site and residents. In this way, Mitosis can facilitate the conservation and improvement of the biodiversity that exists on the site.



Parkroyal on Pickering by WOHA | Singapore | Photo: Patrick Bingham-Hall | 2013



Collective housing

Shared presence is a foundational block of forming **social cohesion**.⁷ MitoSis provides shared spaces and amenities that encourages neighbours to engage in pro-environmental practices and support each other in adopting more sustainable habits. The town of Ostuni, located in southern Italy, is one of the key inspirations for MitoSis. Residential houses are located around “clastro” public squares that are mostly privately used. Neighbours share and maintain the open spaces together in the form of gardens and gatherings.



Ostuni, Italy | Booking.com | 2020

⁷Festinger, L., Schachter, S., & Back, K. (1950). Social pressures in informal groups; a study of human factors in housing. Harper.



Metabolism

Informed by the influential Japanese Metabolism movement born in the 60's, MitoSis explores how buildings can grow, evolve, heal and self-sustain, similar to human bodies, as well as use **biological metaphors** to design buildings capable of regeneration, resilience and self-sufficiency. With the parametric design tool, MitoSis is generated based on specific conditions and performance indicators, making it capable of extension and flexibility, with its framework of smaller components that can be added or replaced.



Les Etoiles by Jean Renaudie and Renee Gailhoustet | Ivry-Sur-Seine, France | 1969-1975

What is Mitosis?

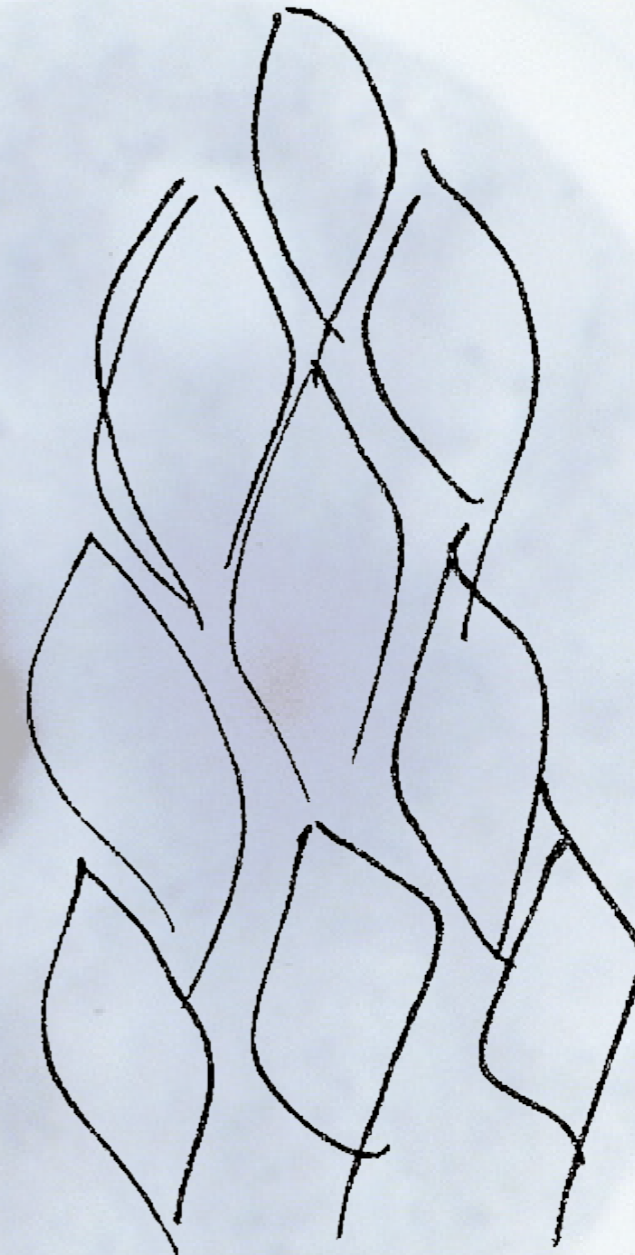
The name Mitosis refers to the biological process of a single cell dividing itself into two identical daughter cells. It represents the modularity and the long-term adaptation of the system and serves as a metaphor for a flexible co-living organism where each residential unit coexists in symbiosis with all the others and its environment.

Mitosis is the follow-up of a multi-awarded pilot project completed by GG-loop in 2019: **Freebooter**, a pair of prefabricated CLT (Cross Laminated Timber) apartments in Amsterdam, wrapped in a parametric timber louvered facade. The building was created using biophilic principles, connecting architecture with nature in order to improve the life quality of the people who use the building. GG-loop's ambition to bring these qualities to multiple scales has resulted in Mitosis.

Mitosis is developed by **parametric and BIM 3D modeling software**. It generates dwelling clusters composed of prefabricated CLT modules through a complex **iterative process**. The volumes and internal layouts derive from the calculation and simulation of parameters related to specific conditions of a given site and stakeholders' needs.

"Arup believes that with the help of parametric design tools and digital construction methods, Mitosis can utilize the benefits of mass **production** (faster construction times, less waste, lower unit cost), while creating a mass **customized** product that suits the needs specific to the site and stakeholders. The material CLT is light and easy machinable, which makes it especially suitable to create customized components that are easy to assemble."

By accommodating for all sizes, typologies and performance levels, Mitosis moves beyond the basic concept of sustainable design and shifts towards a design that focuses on producing net-positive impacts on the environment.



Bio-based Materials

Wood remains one of nature's most regenerative and adaptable materials that can be harvested. Because it stores CO₂ rather than producing it, wood is one of the most environmentally friendly materials used for large scale constructions. Therefore, the urban clusters of Mitosis are made from prefabricated CLT, a type of composite wood material derived from advanced engineered timber, and other bio-based materials, such as natural fibres for insulation, wax and water-based paint for coating, bio-resins for flooring.

Depending on the scale of Mitosis, a hybrid construction consisting of CLT + concrete and steel can be adopted. **Lightweight** and easy to assemble, prefabricated timber speeds up **construction time** and reduces risks and worksite's general impact on its surrounding. This solution translates also into cost efficiency.

Using natural materials in internal spaces, helps decrease occupant stress, contributes to a comfortable internal climate, and can reduce exposure to high vapour pressure indoors.⁸ Mitosis not only considers the outdoor and indoor environmental quality, but also the logistics and suppliers. The materials for Mitosis are naturally sourced and certified by the Programme for the Endorsement of Forest Certification (PEFC) and Forest Stewardship Council (FSC). Mitosis follows rating programs such as WELL Building Standard and Living Building Challenge.

By consciously choosing materials that capture carbon and using resources more efficiently, Mitosis constructs a net-positive built environment that produces more energy than it consumes and uses resources in a circular way.

⁸ Hough R. (March 2019). Rethinking Timber Buildings: Seven perspectives on the use of timber in building design and construction. Arup, Retrieved 19 October 2020.





Jordaan District | Amsterdam | Aerial view: AirPano | 2020

Urban Fabric

Mitosis' urban fabric references the typical Dutch city centers. Streets and canals following different grid systems generate corner buildings with irregular triangular shapes, which became a trademark of the Netherlands' historical urbanism.

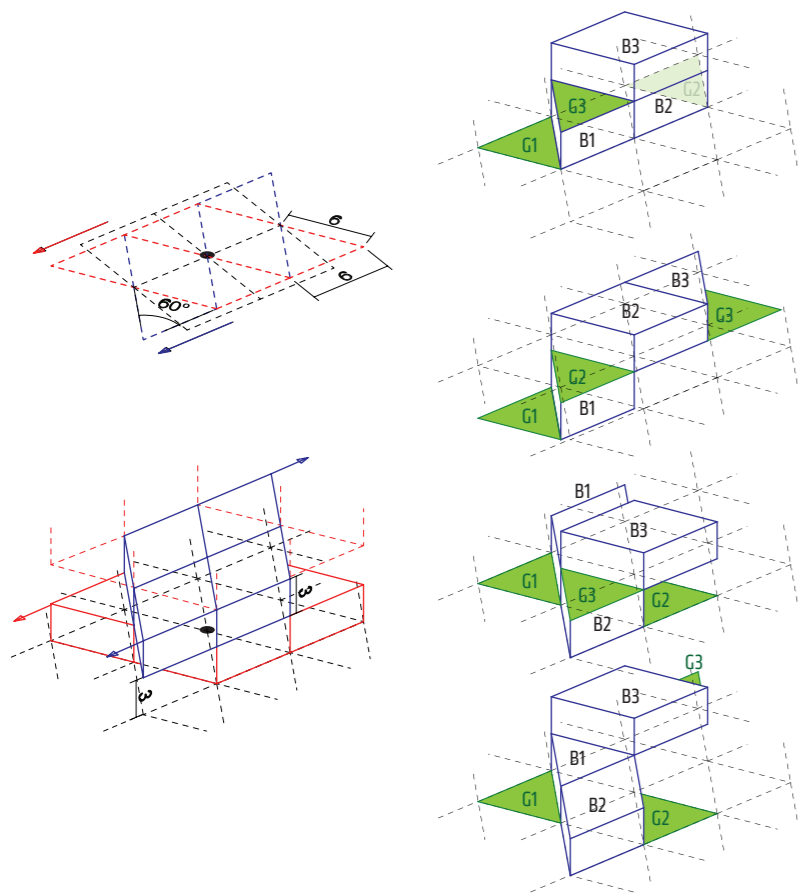
Furthermore, the configuration and material of these wooden buildings affect its interior, generating flexible, comfortable and dynamic spaces.



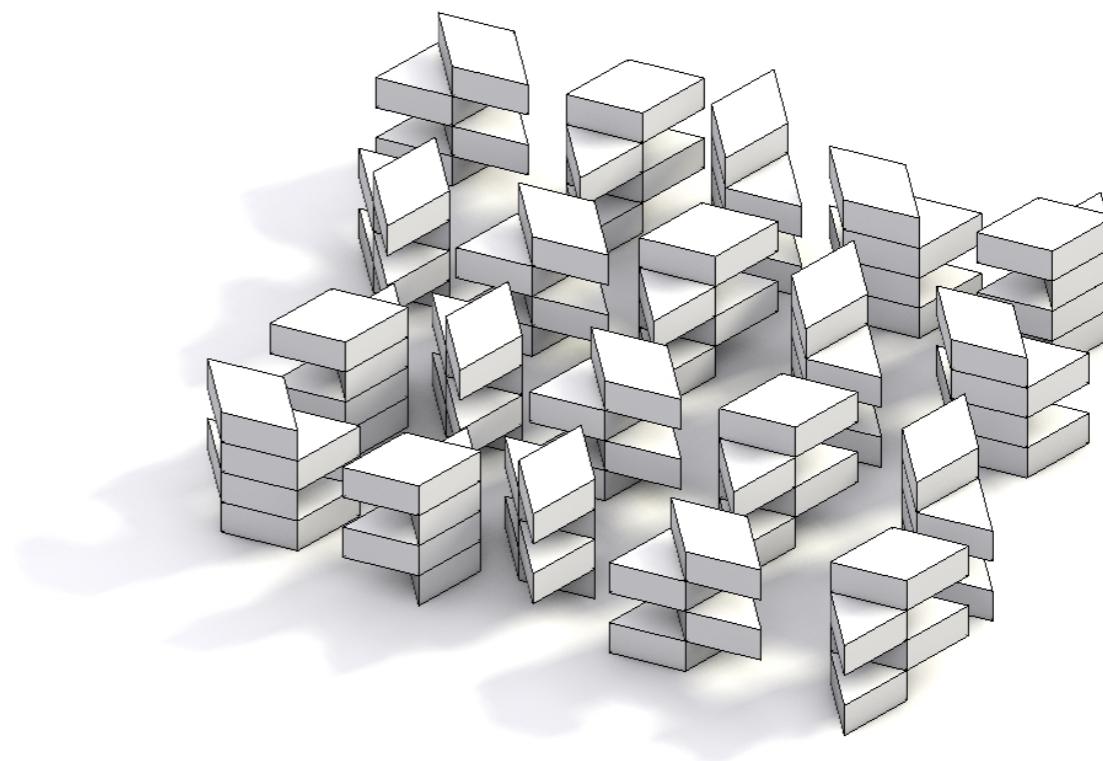
Prinsengracht 154 | Amsterdam | Photo: Cornelis van Wieren | 2011

Grid & Form

The distinct shape of the individual modules is integral to the functionality of Mitosis. Each individual module has been shifted into a **rhomboid** shape. Stacking these modules creates large areas for shared **outdoor living**, with each unit having at least one terrace. The overall volumes and internal layouts are organized following specific internal and external conditions of the site.



Mitosis at Small Scale.

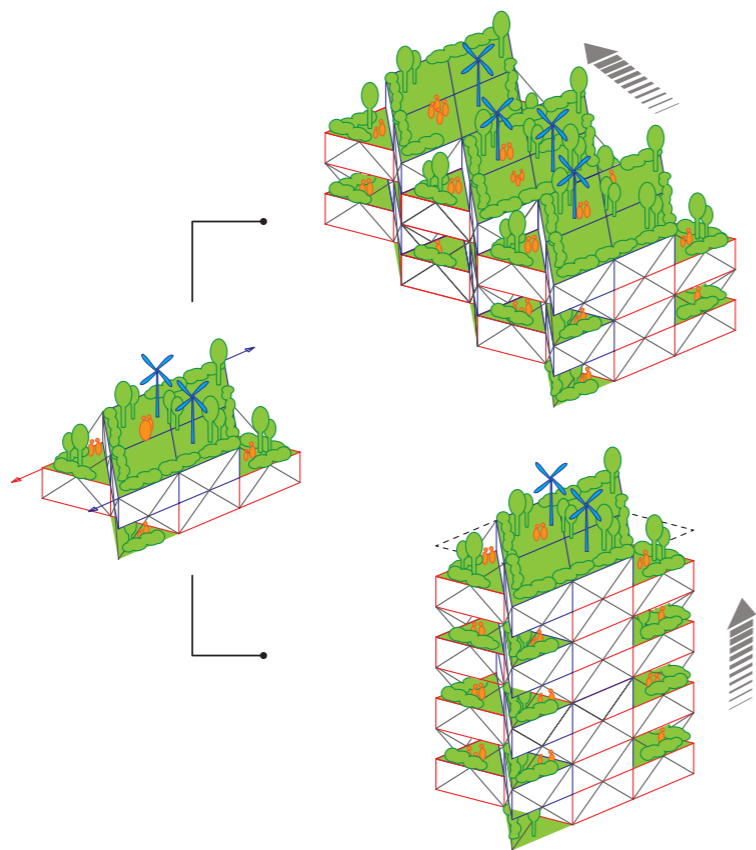


Adaptability

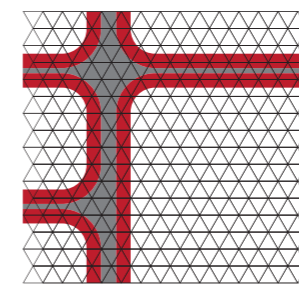
In order to determine the size of the model, the existing plot is first analysed, then the pedestrian and green paths within the area are calculated.

The amount and typologies of dwellings and public functions are determined within the program and local regulations, as well as the maximum heights of the buildings and building index.

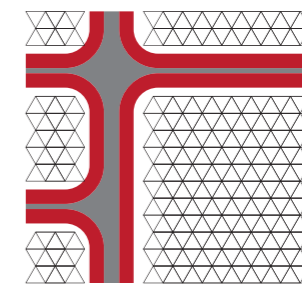
Then a model is generated based on the calculation and simulation of parameters related to specific conditions of a given site. Based on these metrics, the model goes through an iterative process till the optimal solution is provided.



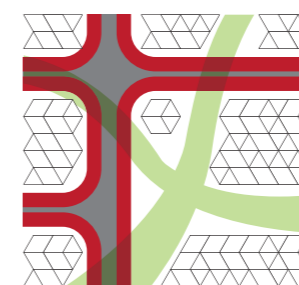
Mitosis Grid.



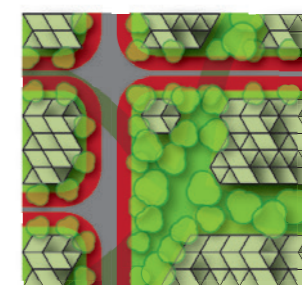
1. GRID POSITION



2. EXCLUSION



3. GREEN FLUXES



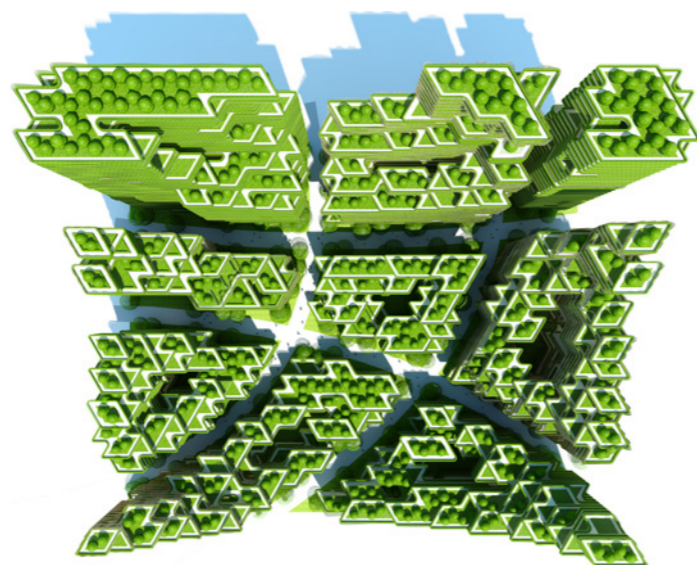
4. RESULT



Scalability

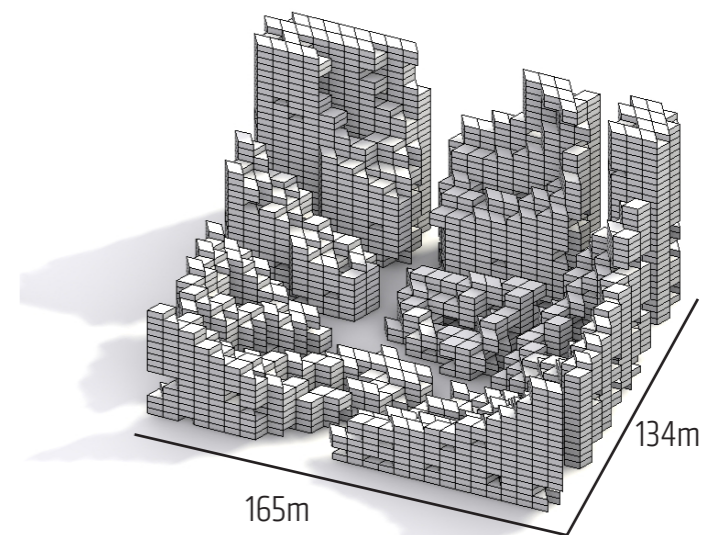
Due to its flexible structure and grid formation, Mitosis is able to host a variety of typologies that is malleable and customizable to the resident's needs. It is applicable to diverse urban scales, ranging from single family units to high density mixed-use urban clusters that incorporate **public functions** such as education, leisure, wellness and retail.

The vertical connections are placed externally to connect the units and terraces, creating a continuous ribbon of outdoor 'cloyster-like' spaces, fostering a sense of openness, belonging, protection and privacy for residents.



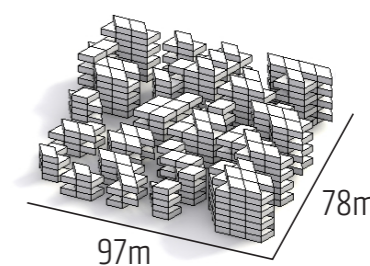
X-Large

Mixed
 Max 30 floors: H 92m
 8.22m²/m² ground
 24,66m³/m² ground
 26.36 modules/100m² ground
 5828 modules x 31.2m²



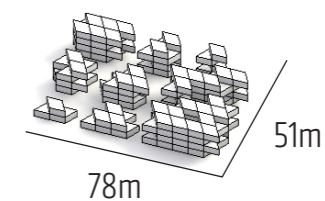
Large

Mixed
 Max 8 floors: H 24m
 2.00m²/m² ground
 6,02m³/m² ground
 6.4 modules/100m² ground
 484 modules x 31.2m²



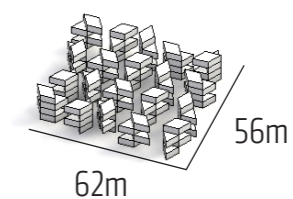
Medium

Mixed
 Max 5 floors: H 15m
 1.06m²/m² ground
 3,18m³/m² ground
 3 modules/100m² ground
 136 modules x 31.2m²



Small

Single family units
 Max 4 floors: H 12m
 0.74m²/m² ground
 2,22m³/m² ground
 2.4 modules/100m² ground
 83 modules x 31.2m²



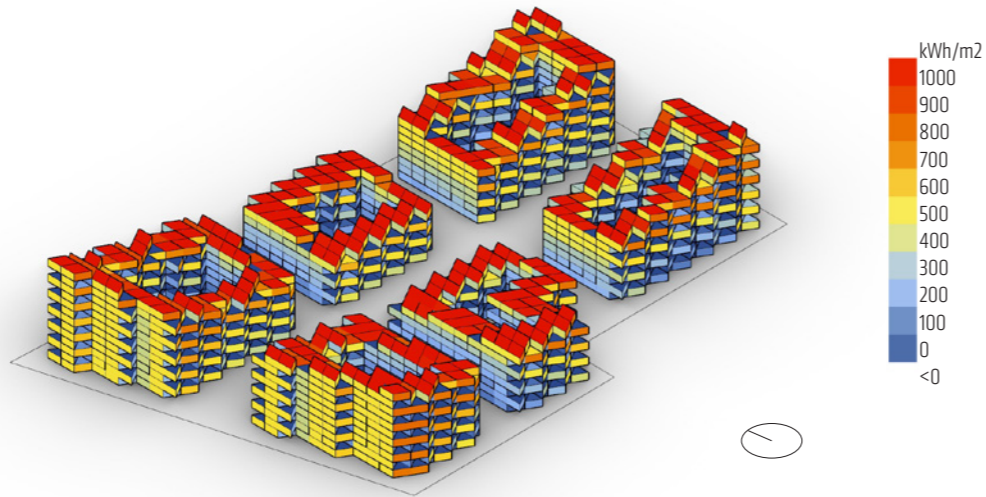
Optimization

Mitosis takes into account the calculation and simulation of parameters related to specific conditions of a given site, such as solar radiation, wind impact, privacy, population density, common spaces index, and vertical connections. The example below shows 3 different scenarios Mitosis can offer on a specific site, optimised in shape and scale based on the calculation of solar radiation, circulation and density.

Orthogonal Urban Grid

Max floors : 13
Bld index: 2.66m³/m²

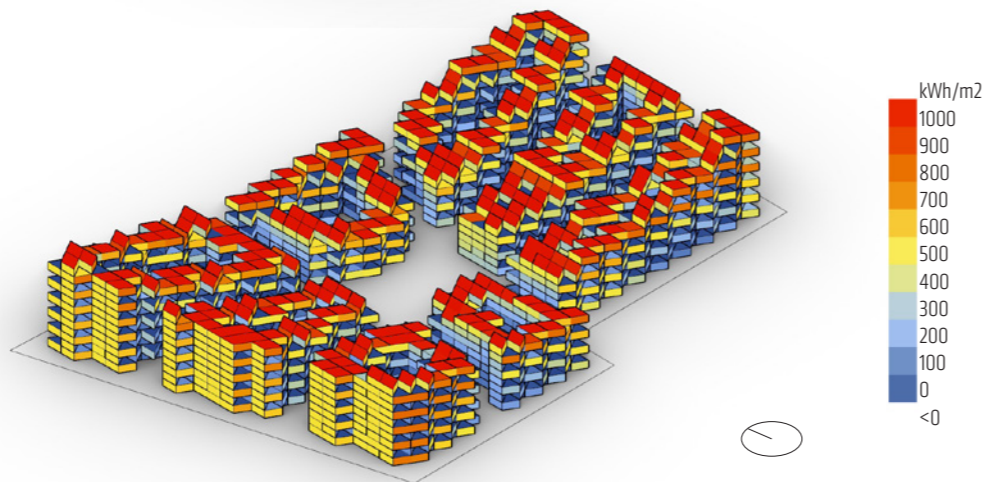
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Path Width: 9.00 m



Flowing Urban Grid

Max floors : 12
Bld index: 2.55

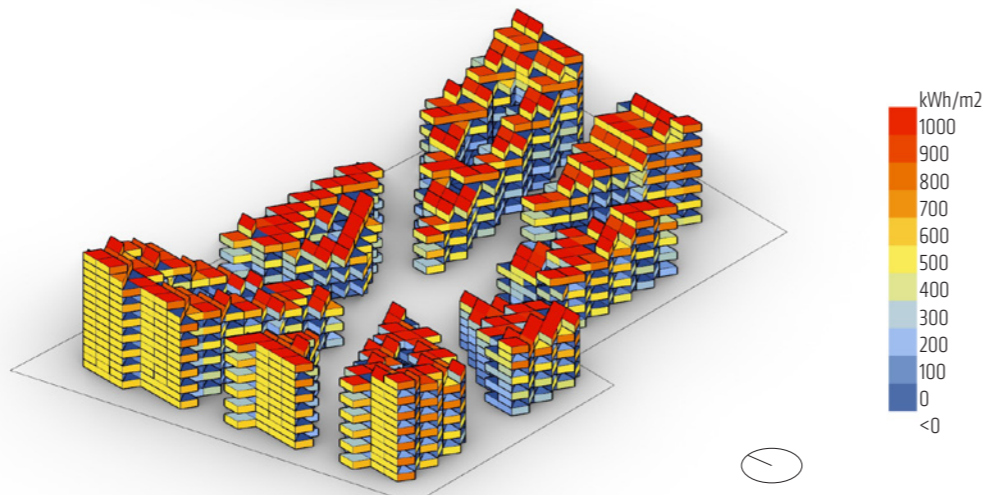
Path Length: 2145.89 m
Path Width: 7.00 m



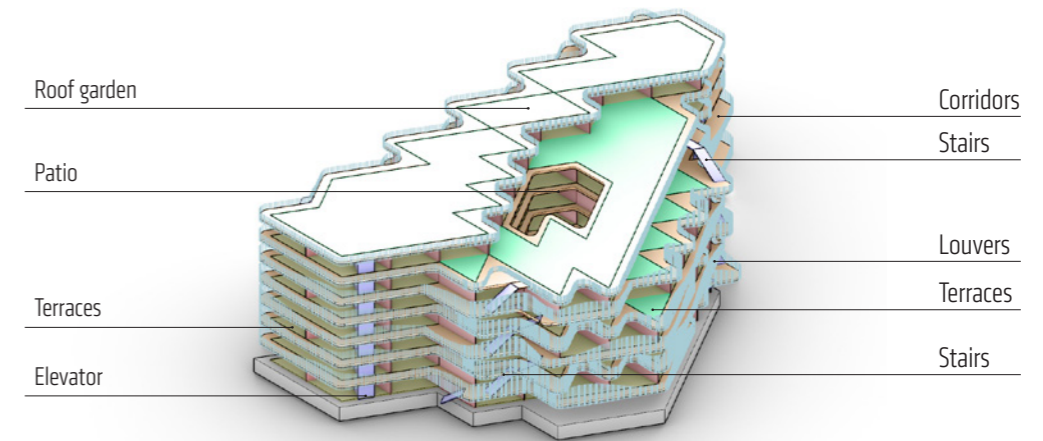
Radial Urban Grid

Max floors : 15
Bld index: 2.52

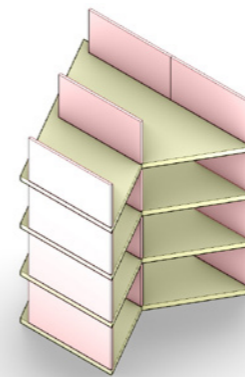
Path Length: 2681.30 m
Path Width: 9.00 m



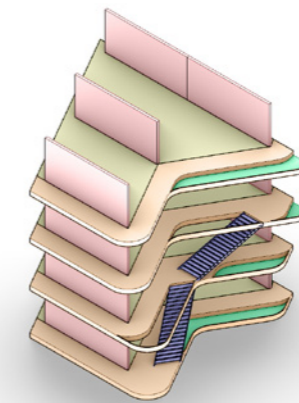
Construction



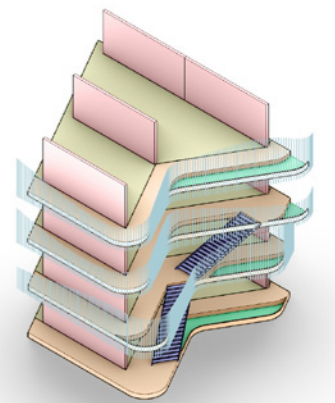
Slabs and Walls



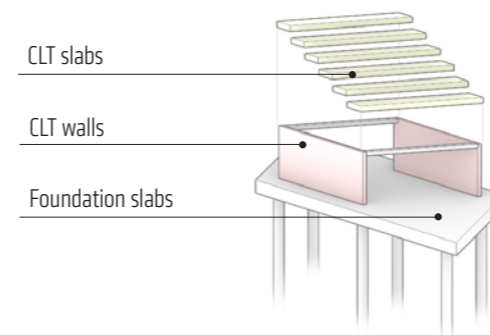
Balconies, Stairs and Green



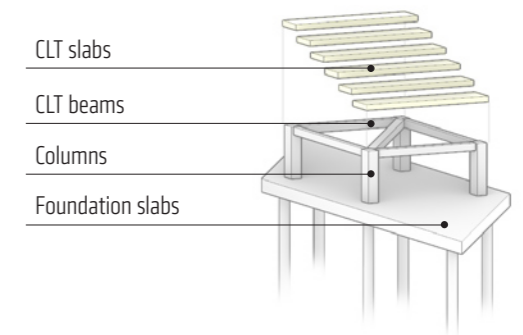
Facade-Louvers



Slab option 1
Load Bearing Walls

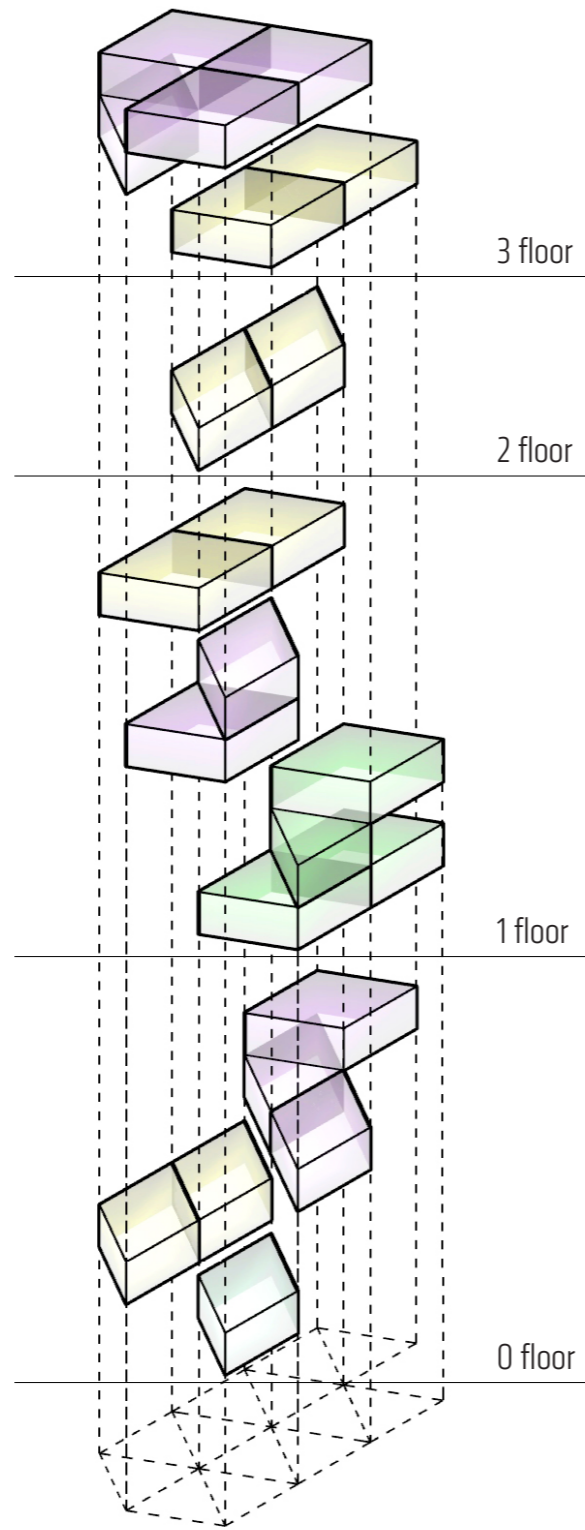
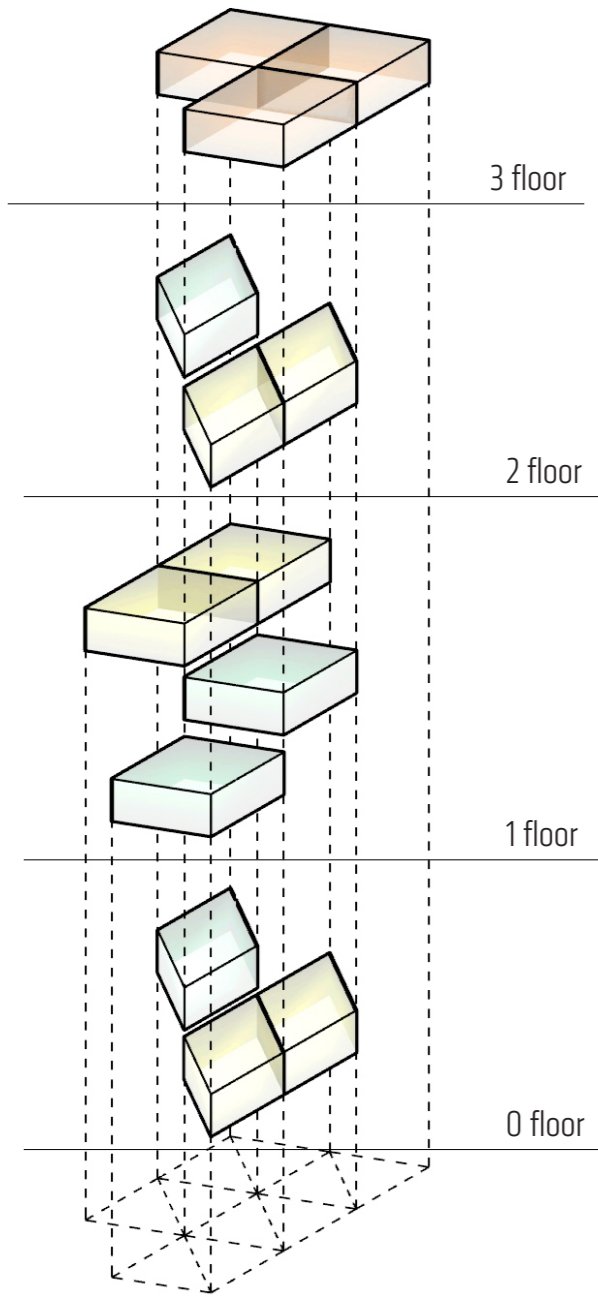


Slab option 2
Columns Structure



Configuration

X-Large - Mitosis adapted to more dense urban environme



Typology	n.	m ²
1 module	4	124,8
2 module	3	187,2
3 module	1	93,6

Typology	n.	m ²
1 module	1	31,2
2 module	4	249,6
duplex	3	280,8
triplex	1	124,8

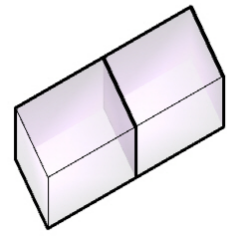




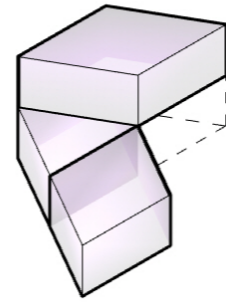


Configuration

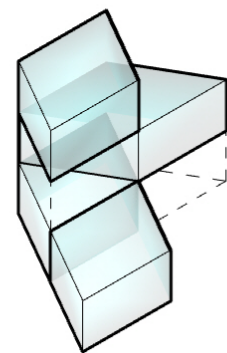
Small - Mitosis from a tiny house of 30m² up to a quadruplex 120m²



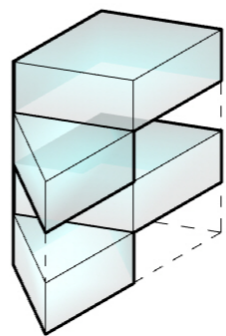
Typology	n.	sqm
single floor	1	62,4



Typology	n.	sqm
duplex	1	93,6



Typology	n.	m ²
triplex	1	124,8



Typology	n.	m ²
quadruplex	1	124,8









“We aim to generate a healthy, emotional and productive habitat for rest, work and living at 360° with Nature.”

Giacomo Garziano
Founder of GG-loop



Freebooter | Amsterdam | GG-loop | Photo: Juliana Gomez | 2019



GG-loop

Established in 2014, GG-loop believes that design is not simply about creating functional objects and spaces. Instead, design should tell a story, taking its user on a journey.

GG-loop tackles design challenges with this in mind, articulating a vision for projects that is at once future-forward, organic and refined.

With a studio in Amsterdam, design outcomes are embedded in a recurrent back story with an emphasis on objects and spaces that envelop the user.

GG-loop also harnesses the history and craftsmanship within a country yet offers a global perspective in terms of forms and trends.

The 'loop' to which the studio's name refers comes from the studio's iterative process of inquiry into a project or brief, to explore an underlying design idea.

GG-loop's realised projects include Freebooter (2019) and The Seed of Time (2015). The studio won awards such as the Frame Award (NL), the WAF Award (UK), and the Best of Year 2019 Award (NY).

GG-loop was founded by Giacomo Garziano, a graduate of Facolta' di Architettura di Firenze (2008). Garziano has more than 10 years of experience working for studios such as NIO Architecten and UNStudio.

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Arup for the overall support
Hexa Pixel for "Mitosis-XL" renders**

Freebooter | Amsterdam | GG-loop | Photo: Michael Sieber | 2019

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