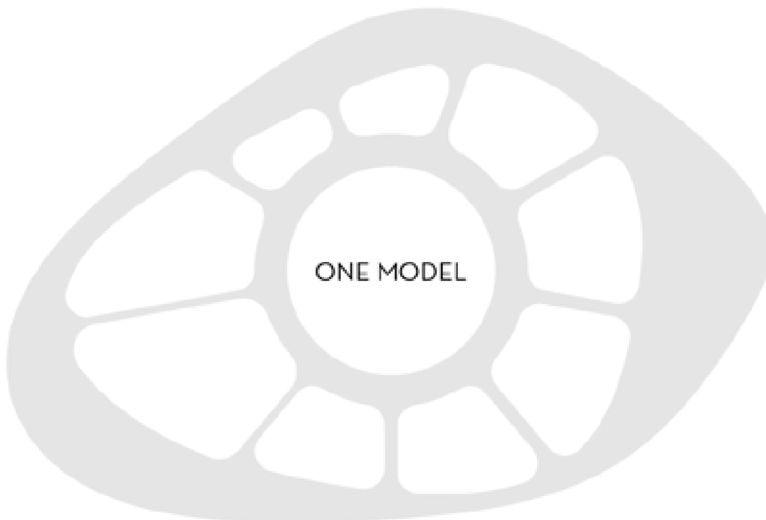
EVOLUZIONE

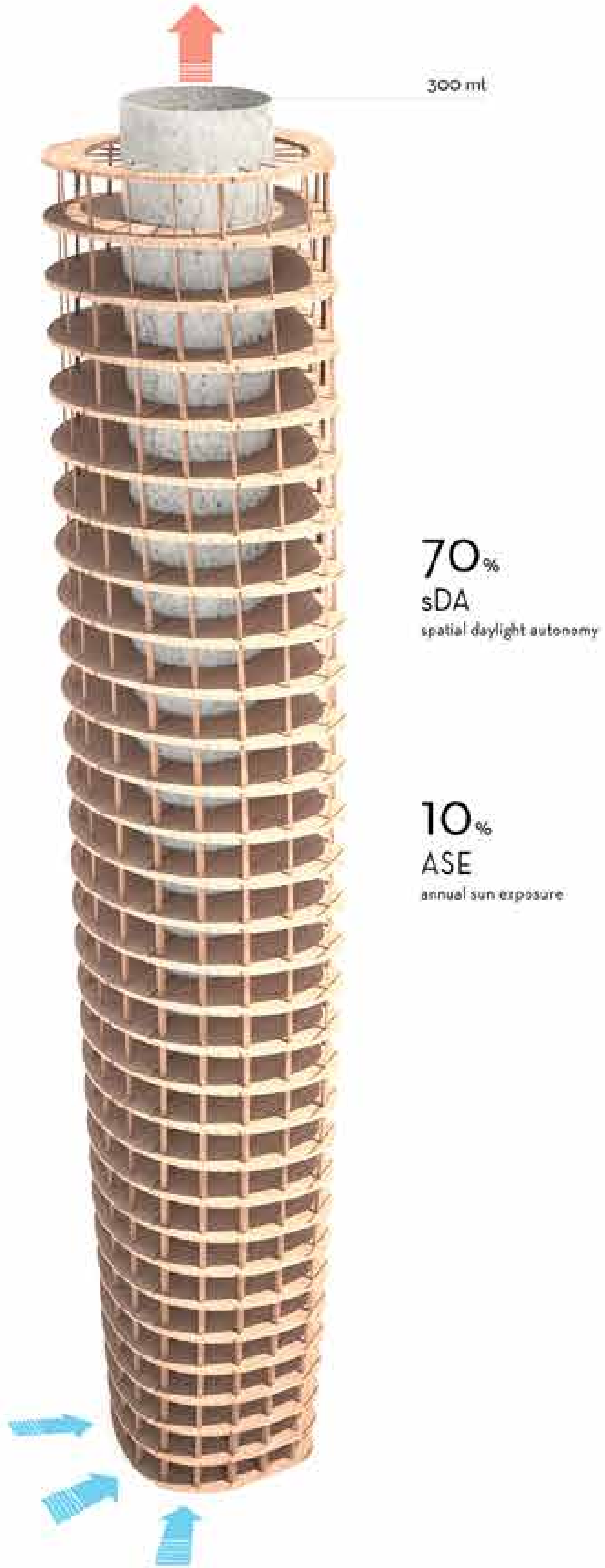
For the SKYHIVE Skyscraper Challenge, we propose, rather than a form, an architectural model characterized by variety and thus by adaptive behaviour; an iconic prototype for a sustainable human evolution. The context of the project is planet earth, a variegated realm characterized by a range of site-specific environmental forces capable of informing the design process. Following the rules of nature, a form-finding strategy based on parametric design and evolutionary principles minimizes the use of matter and energy consumption through the specific climate data interpretation. In this context, natural lighting, strictly related to the office workers well-being, becomes one of the major driving forces. The result is a skyscraper capable of meeting the requirements of flexibility, comfort and sustainability related to a working environment in continuous evolution.



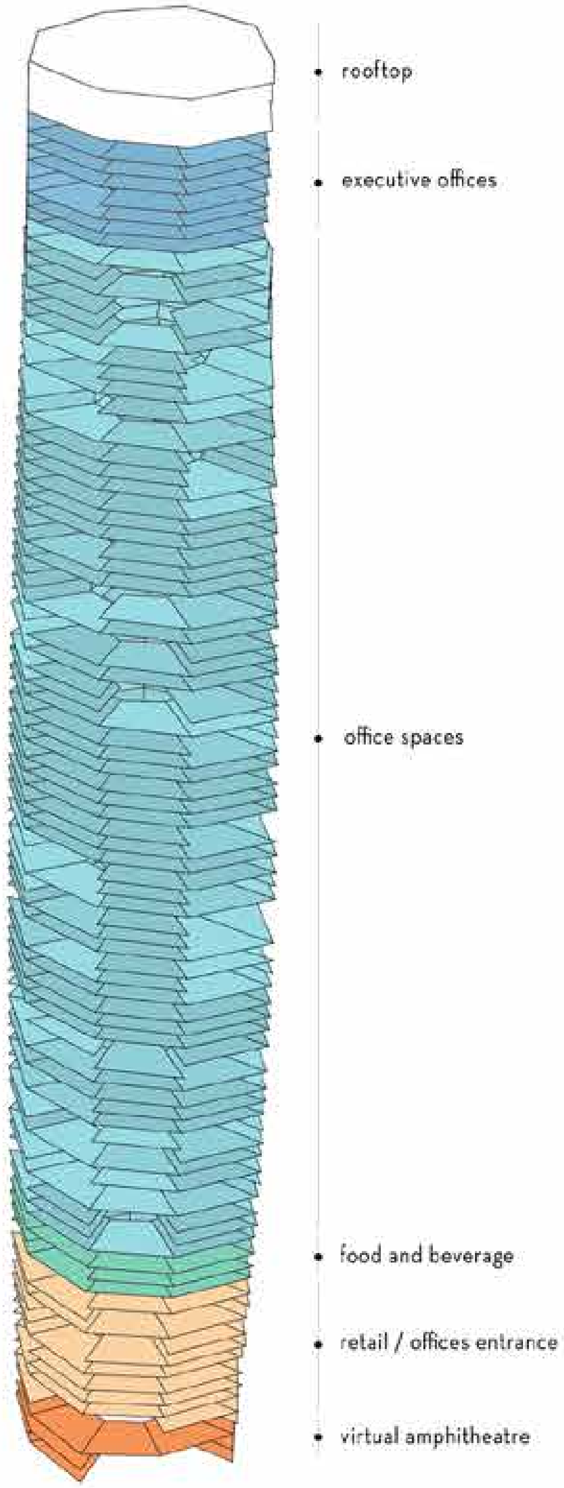
ADAPTIVE MODEL

The architectural organism is composed of three deeply integrated systems: the core, the cluster and the envelope. They adapt their dimensions and functions to the context in order to maximize energy efficiency and comfort.

NATURAL LIGHTING AND VENTILATION



SMART WORKSPACE



TIMBER STRUCTURE

The free formed structure is made of Cross Laminated Timber and Glulam. The use of this renewable material sensibly reduces the carbon footprint of the skyscraper.

RESPONSIVE CORE

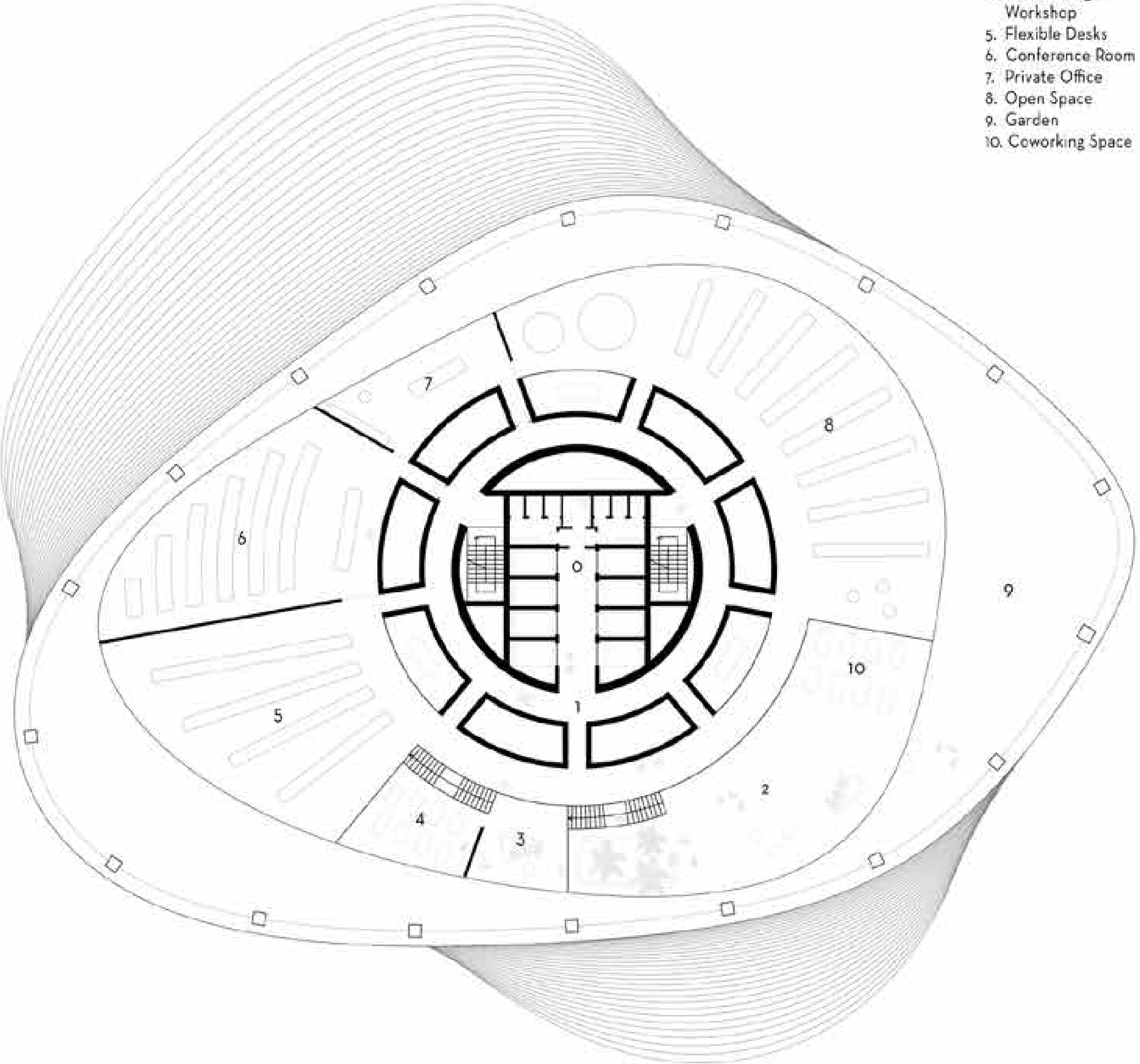
An artificial intelligence is integrated into the concrete core structure. It acts as a thermoregulator by controlling temperature, humidity and air quality.

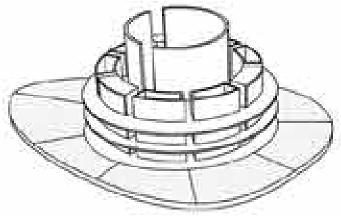
CLUSTER SYSTEM

The flexible cluster system is capable of adapting to the requirements of smart working by offering a wide variety of spatial solutions.

OFFICE PLAN

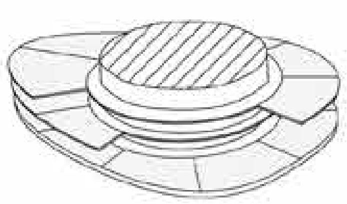
0. Vertical Distribution
1. Ring
2. Atrium
3. Terrace
4. Double-height Workshop
5. Flexible Desks
6. Conference Room
7. Private Office
8. Open Space
9. Garden
10. Coworking Space





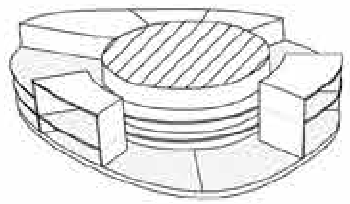
CORE/ ring

Distrubution, Natural Ventilation, Structure, Big Data



CORPORATION/ flexibility

Open Spaces, Atrium, Conference Rooms



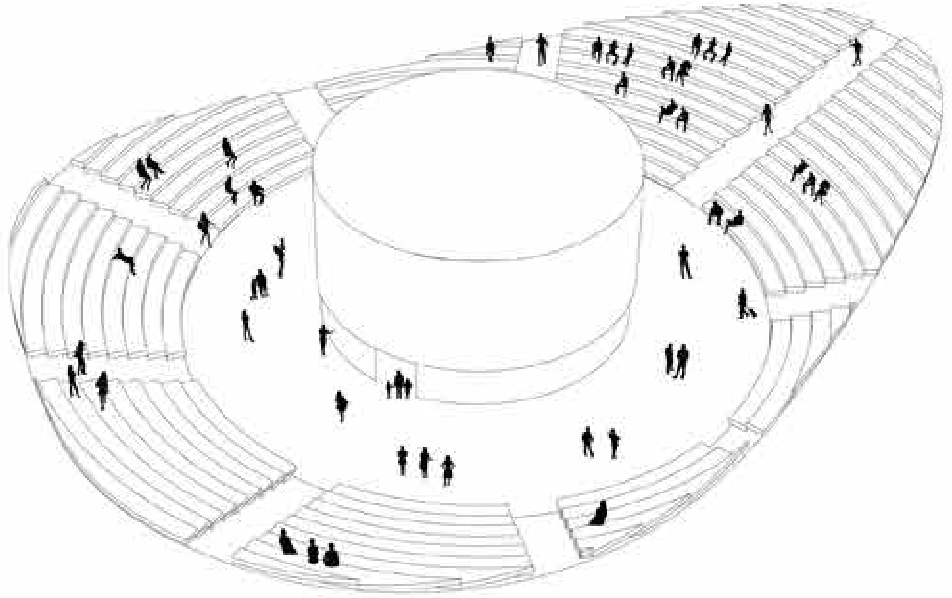
PRIVATE/ variety

Simplex, Duplex,Triplex Uniqueness

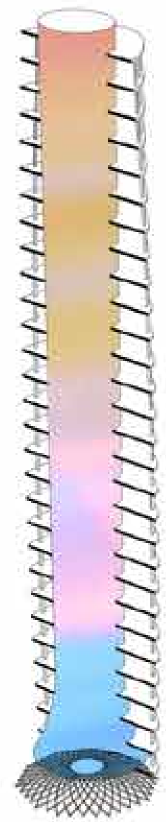
CORPORATION ATRIUM coworking space

VERTICAL NETWORK

Designed to contain different smart working scenarios, the adaptive model achieves an efficient use of space by combining real and virtual. The core that goes through the whole building is a smart multifunctional element. Apart from the structural and distributive function, it performs as a thermoregulator and digital infrastructure. The artificial intelligence, responsible for the active management of the building and the data storage, encompasses the whole building connecting the single part of the cluster with each other and with the rest of the world. The center of this system is the Virtual Amphitheatre, the prototype of a conference hall, in which, new techniques and technologies melt with new working models. The space is conceived to be flexible and capable of accommodating different events ranging from art expositions to live conferences. Placed at the base of the skyscraper it represents a contact point between the building, its professionals and the surrounding community.



virtual amphitheatre



responsive core

[2]

[*Computational Design*]

Nature and Form-Finding
Design with Genetic Algorithms

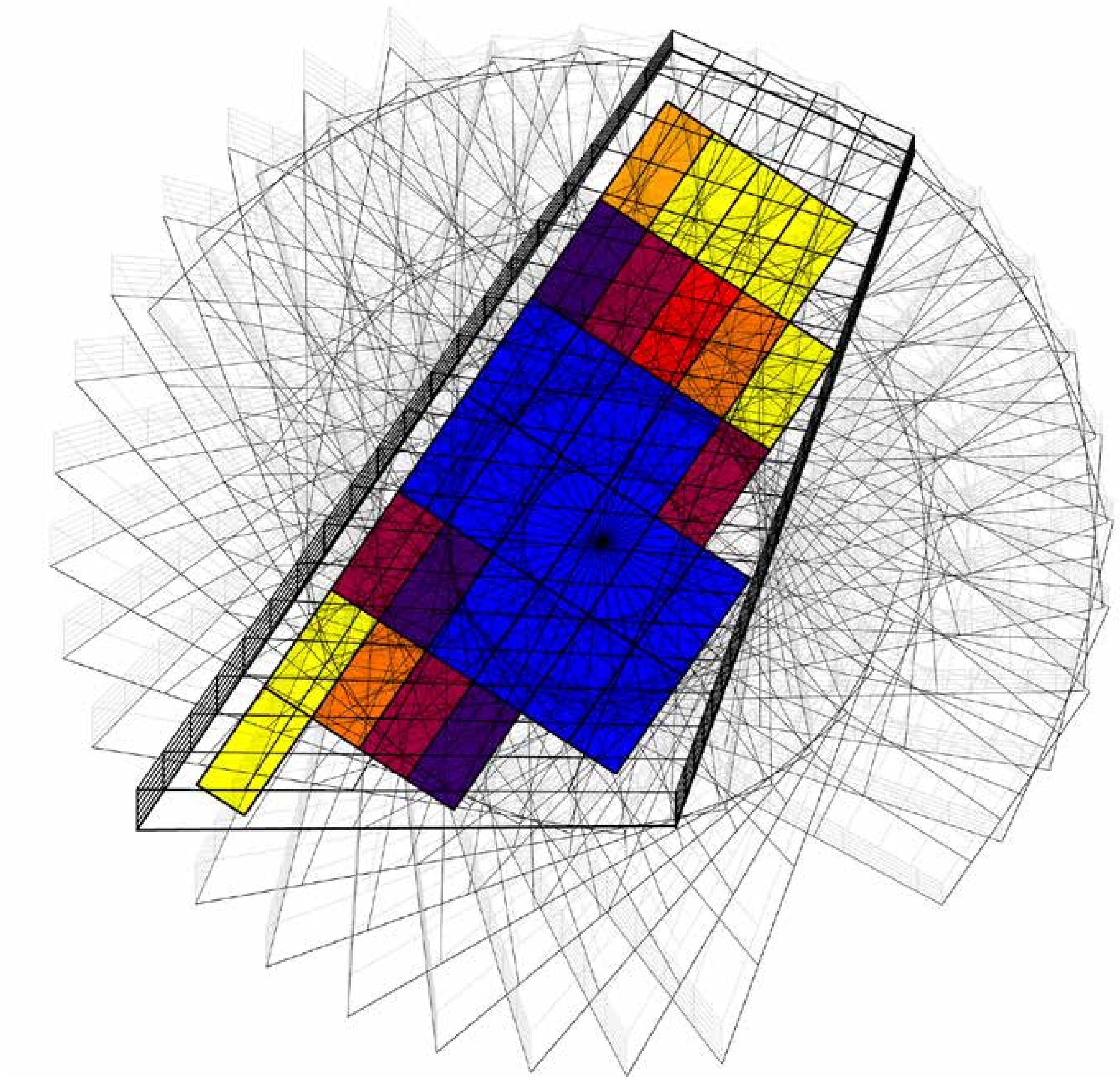
In the last century, a large number of architects and engineers have developed a variety of form-finding strategies, and some of them have looked to natural systems with the aim to transfer their principles into architecture. Nowadays through digital techniques, the designer can emulate or invent new processes to create architectural forms characterized by the same efficiency and beauty of natural systems. In particular, the efficiency of living systems is the result of a slow evolutionary process, as explained by Darwin's theory of evolution. The possibility to apply this process to Architecture through Genetic Algorithms puts in the hands of the designer a powerful tool, which can be used, in a wide variety of applications.

This research deepens the possibility to design, through generative systems and evolutionary principles, an architectural model able to adapt to different contexts and conditions, providing different solutions as the result of the interaction with the surrounding environment. By means of a case study, I structured a form-finding strategy based on Genetic Algorithms aiming to reduce the energy consumption of the building and the weight of its structure.

Genetic algorithms are extremely versatile tools, and the results obtained in two fields as different as structural analysis and environmental analysis confirm the success already achieved in a variety of fields. In this research, the weight of the structure and the energy consumption of the building are used as fitness, however, in Architecture, several properties can be optimized such as lighting, acoustics, and view. It is an open list, and in theory, each parameter that affects the Architect's choices during the design process can be added to the concept of fitness.

Generation 0

ENVIRONMENTAL OPTIMIZATION

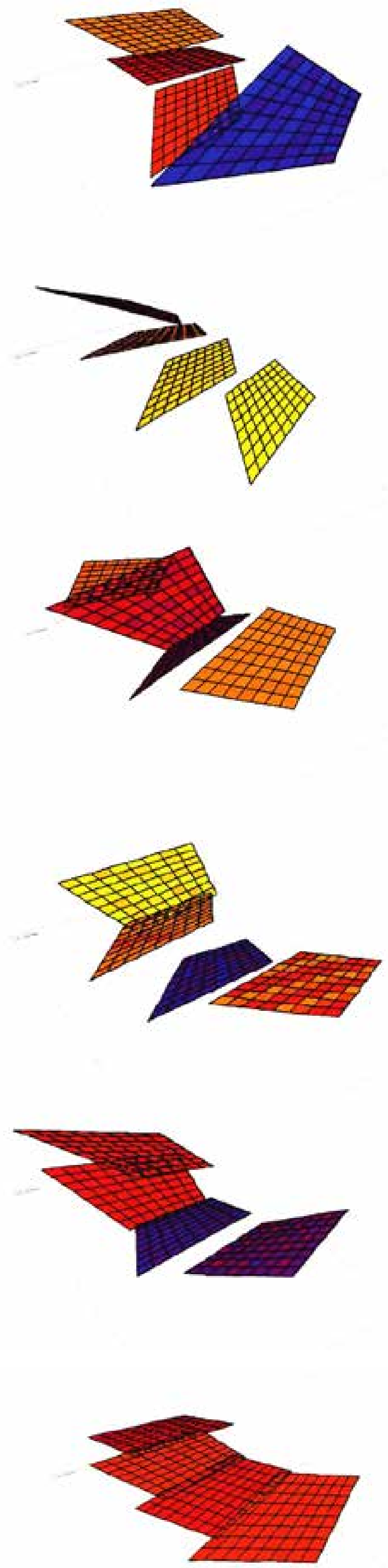


Daylight Analysis

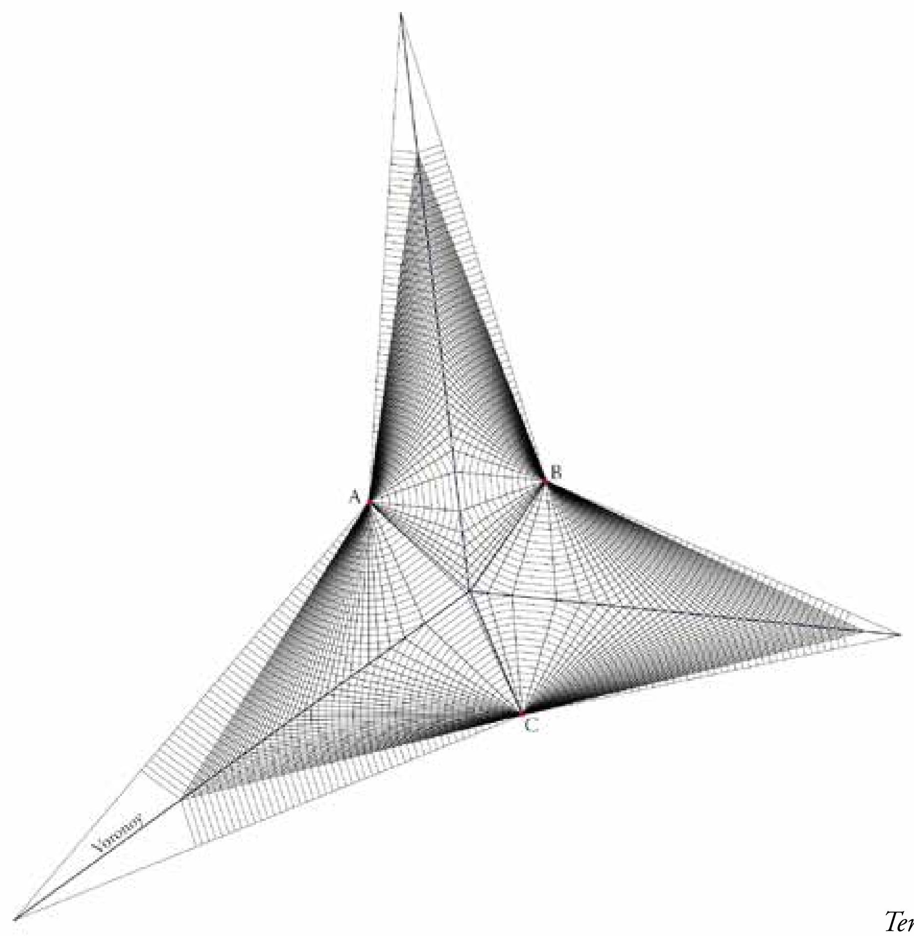
In the thermal analysis of a building, a broad range of parameters enters the field defining aspects such as the properties of heat flows and materials, the efficiency of the heating system, the behavior of inhabitants.Varying something in the project these parameters change in such a way that can be counter-intuitive for the designer. Genetic algorithms can find an elegant solution to this complex design problem.

Since small changes to a design can have large and unexpected effects on a building's performance the possibility to have a continuous feedback is a great source of help. Energy models realized with Grasshopper's plug-in Ladybug and Honeybee can quantify the overall energy consumption of the building through validated simulation engines like EnergyPlus, Radiance, Daysim and Openstudio. Thanks to the way they are integrated, these tools can inform the design process, providing instant feedback. In this way, analysis tools, which were previously utilized only in the final stage of design to validate the designer's decisions, become tools capable of helping the designer during the decision-making phase.

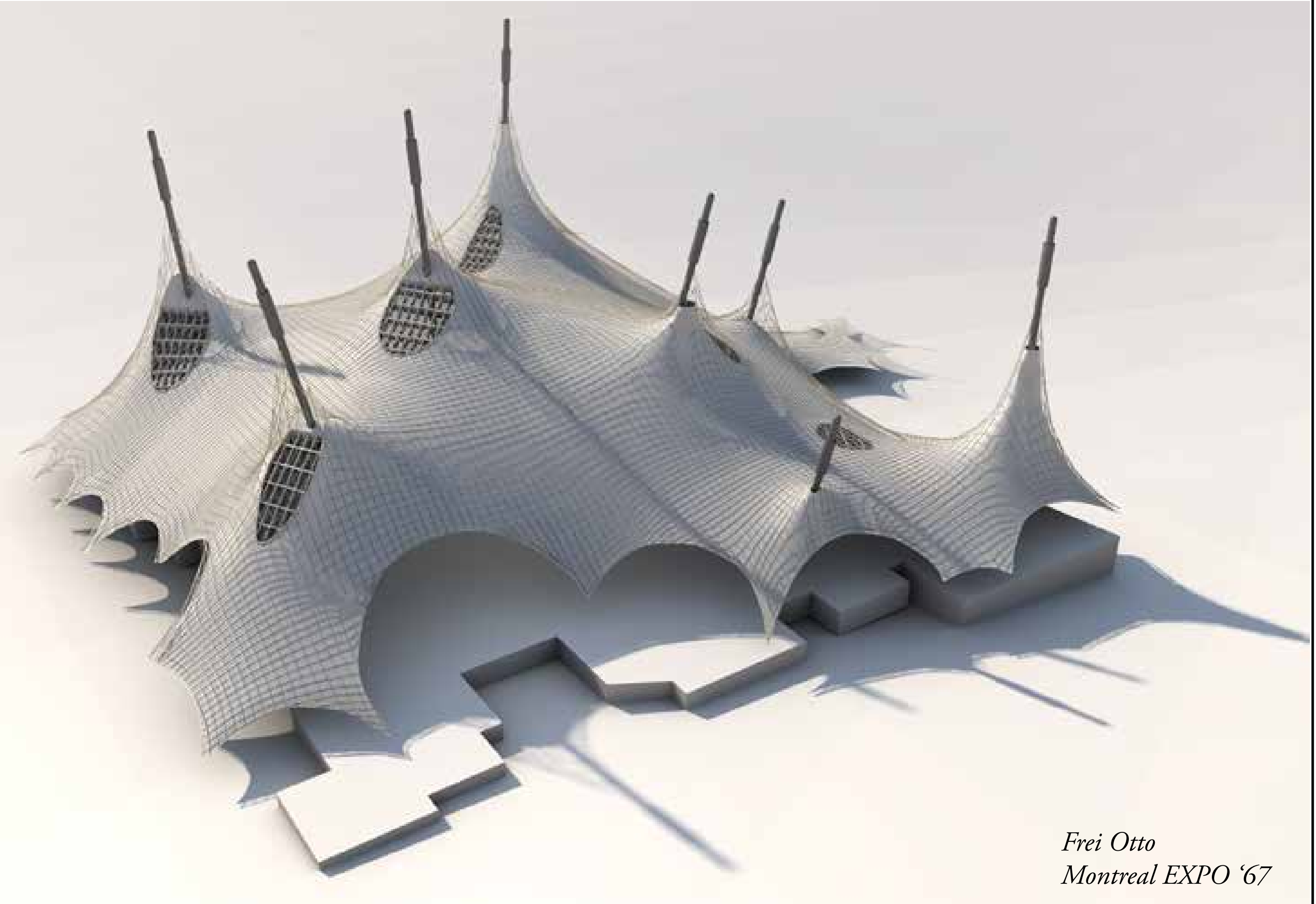
In this project, energy consumption is used as fitness in an optimization process based on genetic algorithms. An energy model is associated to each architectural organism, individual of a genetic population. This model is intended to evaluate the efficiency of the formal solution from an energetic point of view by calculating the overall energy consumption as the sum of Heating, Cooling, Lighting, Equipment and Hot Water.



Energy Production



Tensostructure's Nest



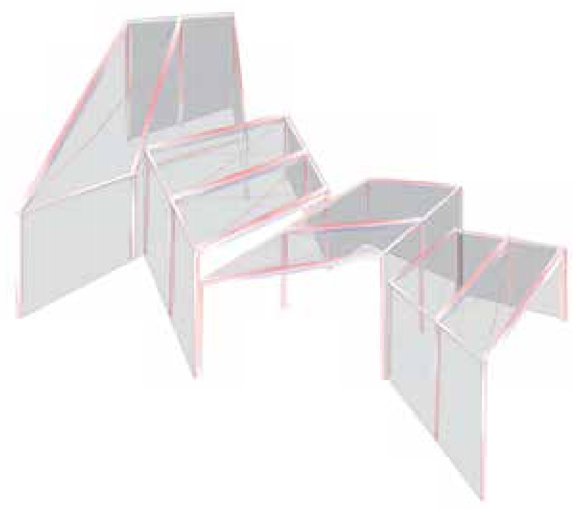
Frei Otto
Montreal EXPO '67

STRUCTURAL OPTIMIZATION

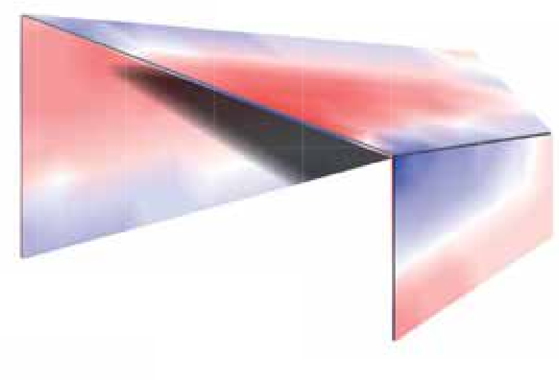
In the first half of the twentieth century, several architects and engineers such as Robert Maillart, Pier Luigi Nervi, Sergio Musmeci, Eduardo Torroja, Riccardo Morandi, Felix Candela, Heinz Isler, Eladio Dieste, Buckminster Fuller, and Frei Otto stood out for their investigation about the relationship between force and form. Introducing an hands off approach to design, these architects go beyond the traditional drawing techniques using rather a set of experimental tools based on physical models (soap films, suspended fabric and branched structures) developing a natural approach to design which results in a rational use of energy, extreme lightness, and naturality.

I started this study in 2014 after the Workshop Form-Finding Strategies lead by Arturo Tedeschi and Maurizio Degni in Milan. On this occasion we reproduced the Basento Brige of Sergio Musmeci and learn about mesh discretization, physical models and structural optimization strategies using Grasshopper, Weavebird, Kangaroo, Millipede and Galapagos. My interest in this field led me to further investigations such as the study on minimal surfaces done for the reproduction of the Frei Otto's German Pavillion for Expo '67. In this case a particle-spring system was developed through the physical engine Kangaroo to reproduce the behavior of a soap film.

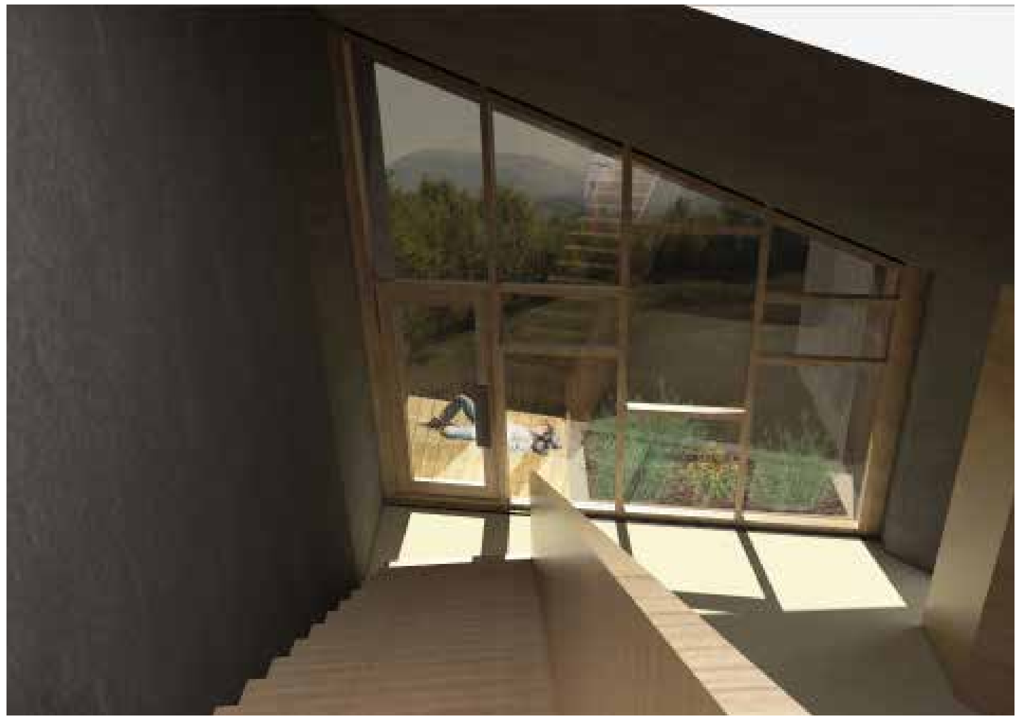
In my thesis, the cost of the structure evaluated using Karamba (Parametric Engineering) was used as fitness in a multi objective optimization process based on Genetic Algorithms.

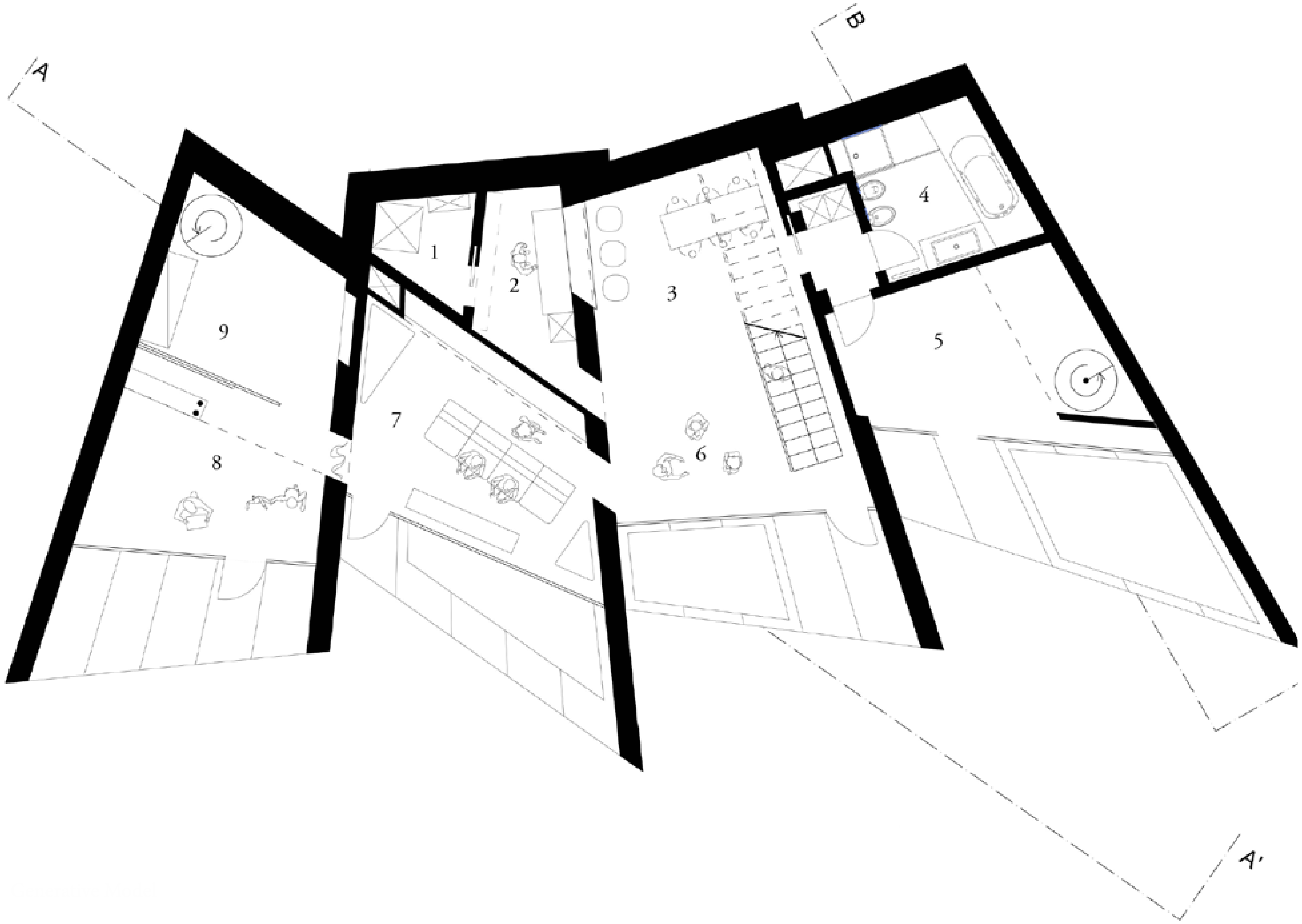


Steel Structure



CLT Structure

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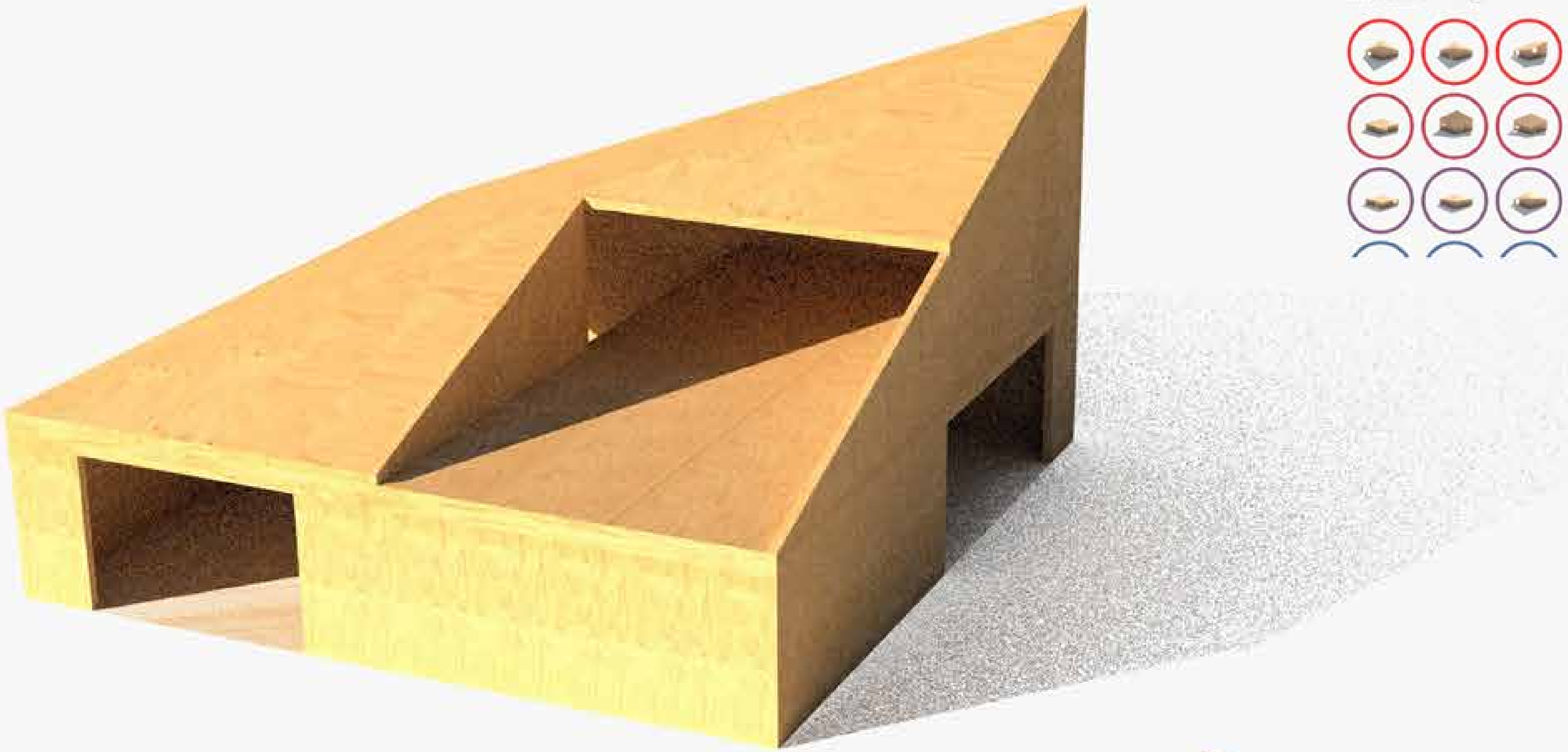
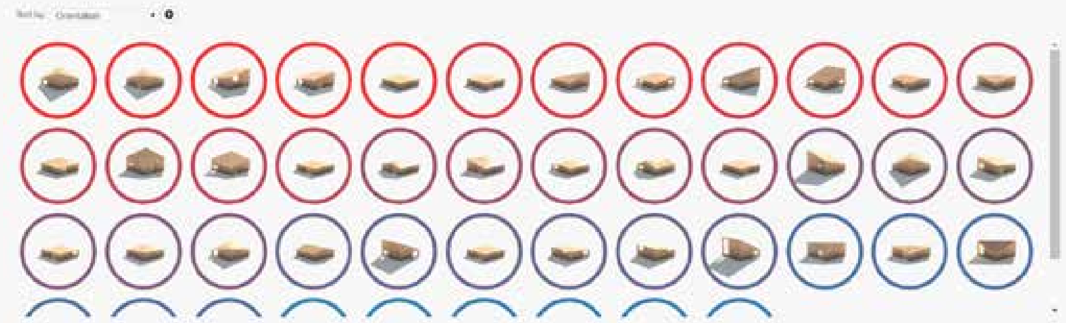
DIGITAL WOOD DESIGN





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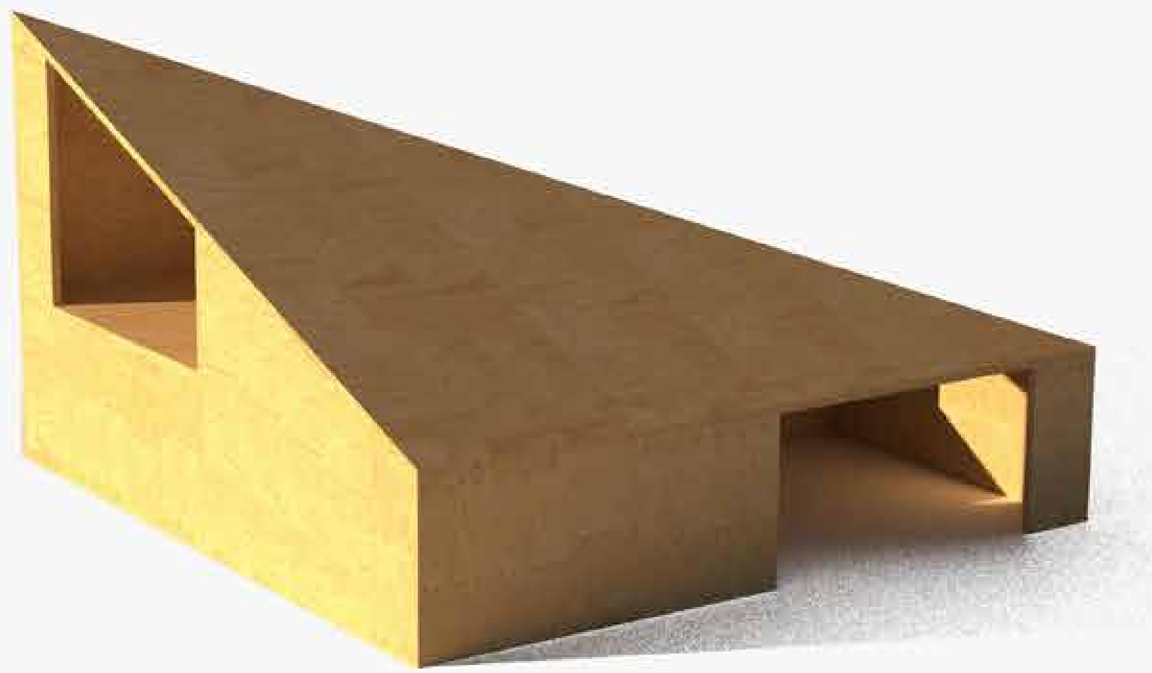


DIGITAL WOOD DESIGN

a research project by

Alessandro Buffi, Automatic Drawing Lab, University of Perugia

Supervisors: Prof. Fabio Bianconi, Ph.D. Marco Filippucci

Funded by Abitare +

[3]

[History and Restauration]

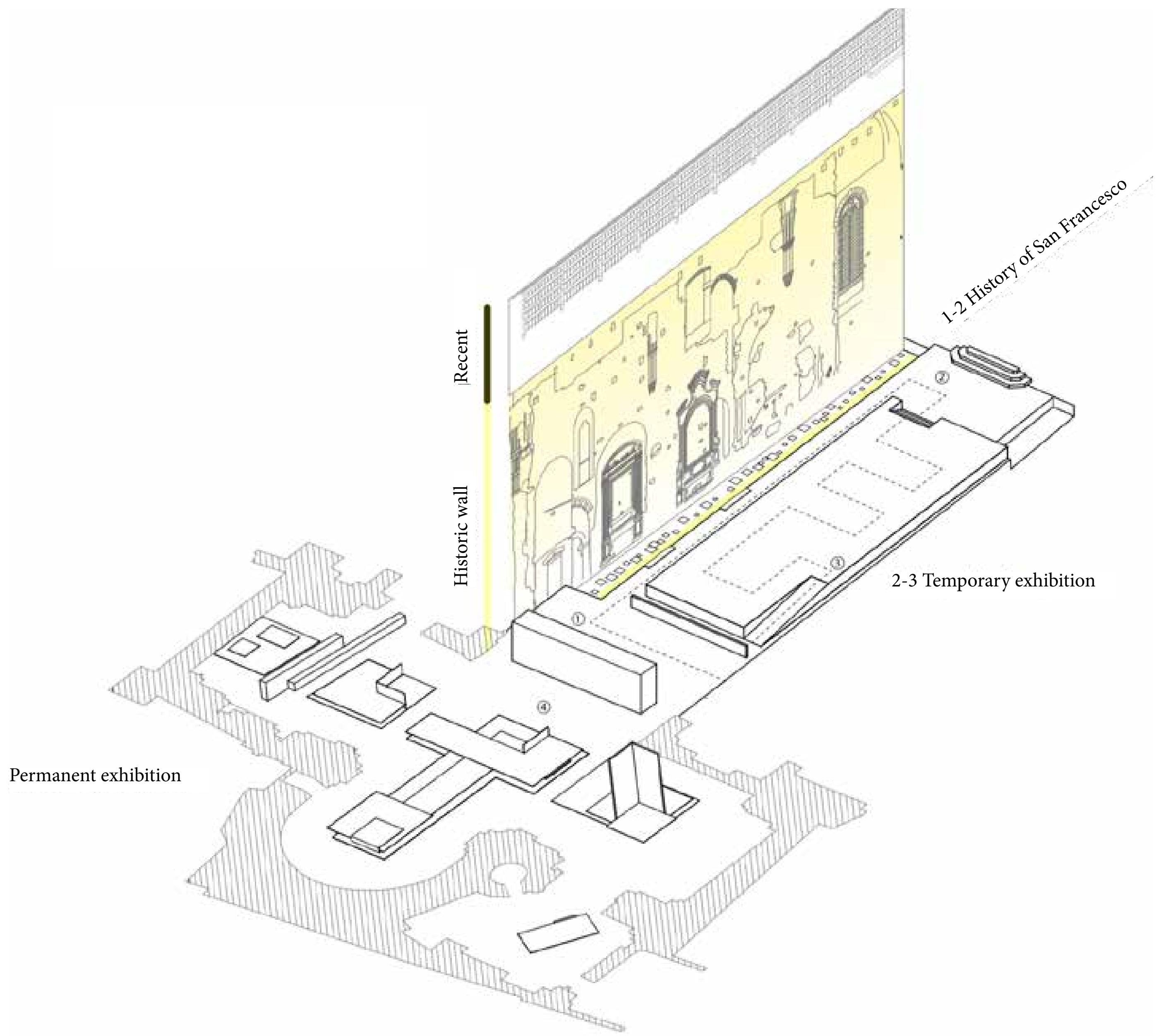
San Francesco al Prato's Museum
Exibition Areas for the Accademy of Fine Arts

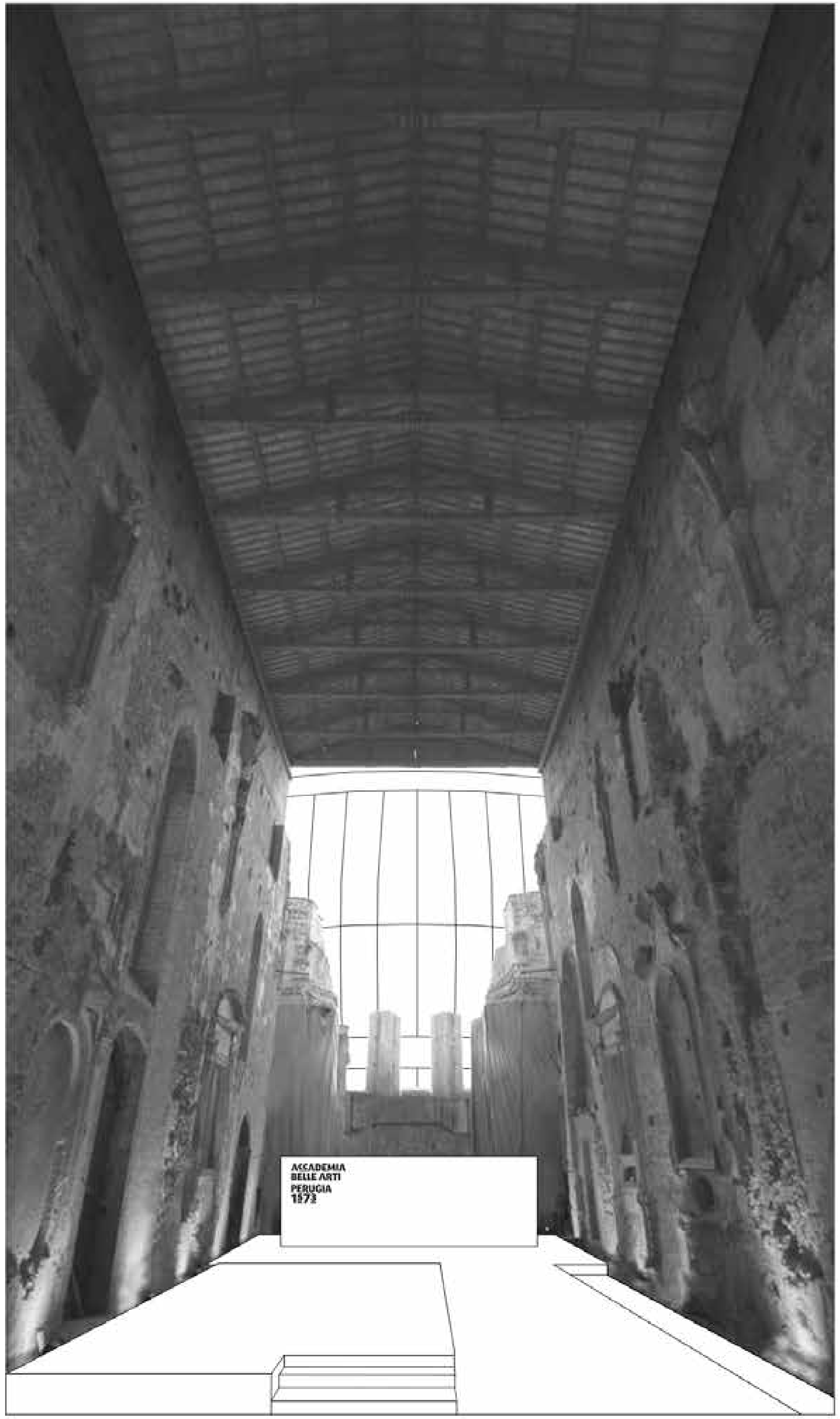
The church of San Francesco al Prato, dating back to the 12th century, is one of the first built after the death of St. Francis, and has had a significant social-artistic significance in the history of the city of Perugia, over the centuries. With a single nave, preserving the original structure, it has been for years hidden over the collapse of the vaults, due to landslide movements of the hill. In the thirties and sixties of the twentieth century the desecrated temple was internally demolished and only the beginning of the second Millennium saw the start of a radical restoration, never ended.

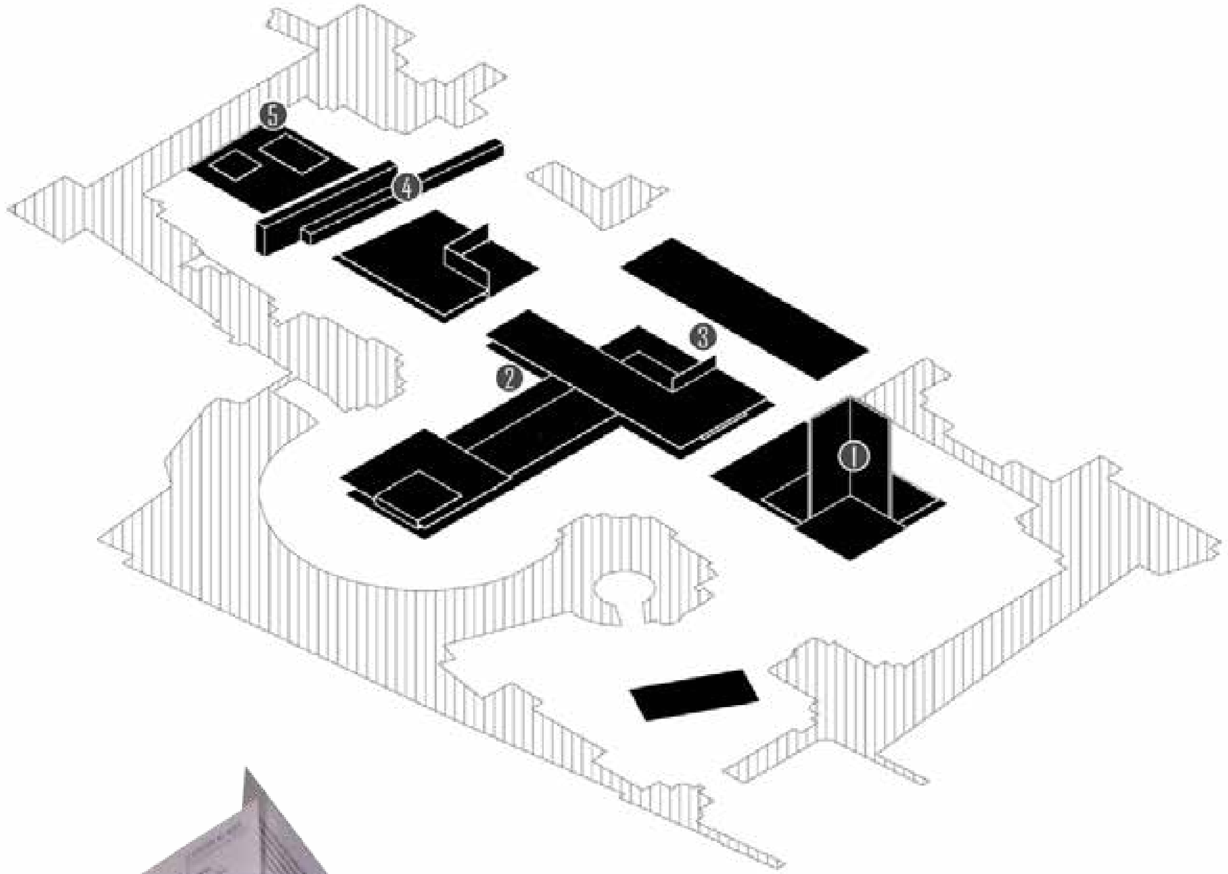
This project propose to perform a soft restoration of the interior space and to create an expositions area, splitted in two sections, respectively dedicated to temporary activities and to the exposition of the chalk sculpture owned by the Accademy of Fine Art of Perugia.

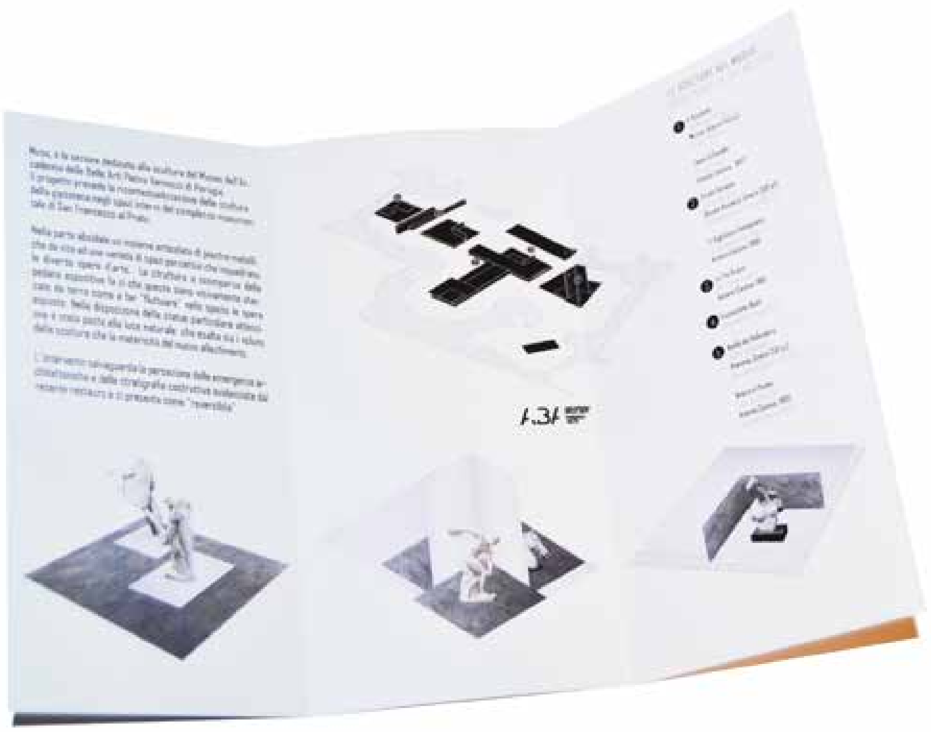
Special focus was placed to the permanent exhibition area set in the apsidal part of the church. Here an articulated system of metal plates creates a variety of perspective spaces for the artworks. The concealed structure of the pedestals ensures that they are visually detached from the ground as if the exhibited sculpures were "floating" in the space. In the disposition of the artworks particular attention was paid to natural lighting, that enhances the volums of the sculptures as well as the texture of the new setting-up.

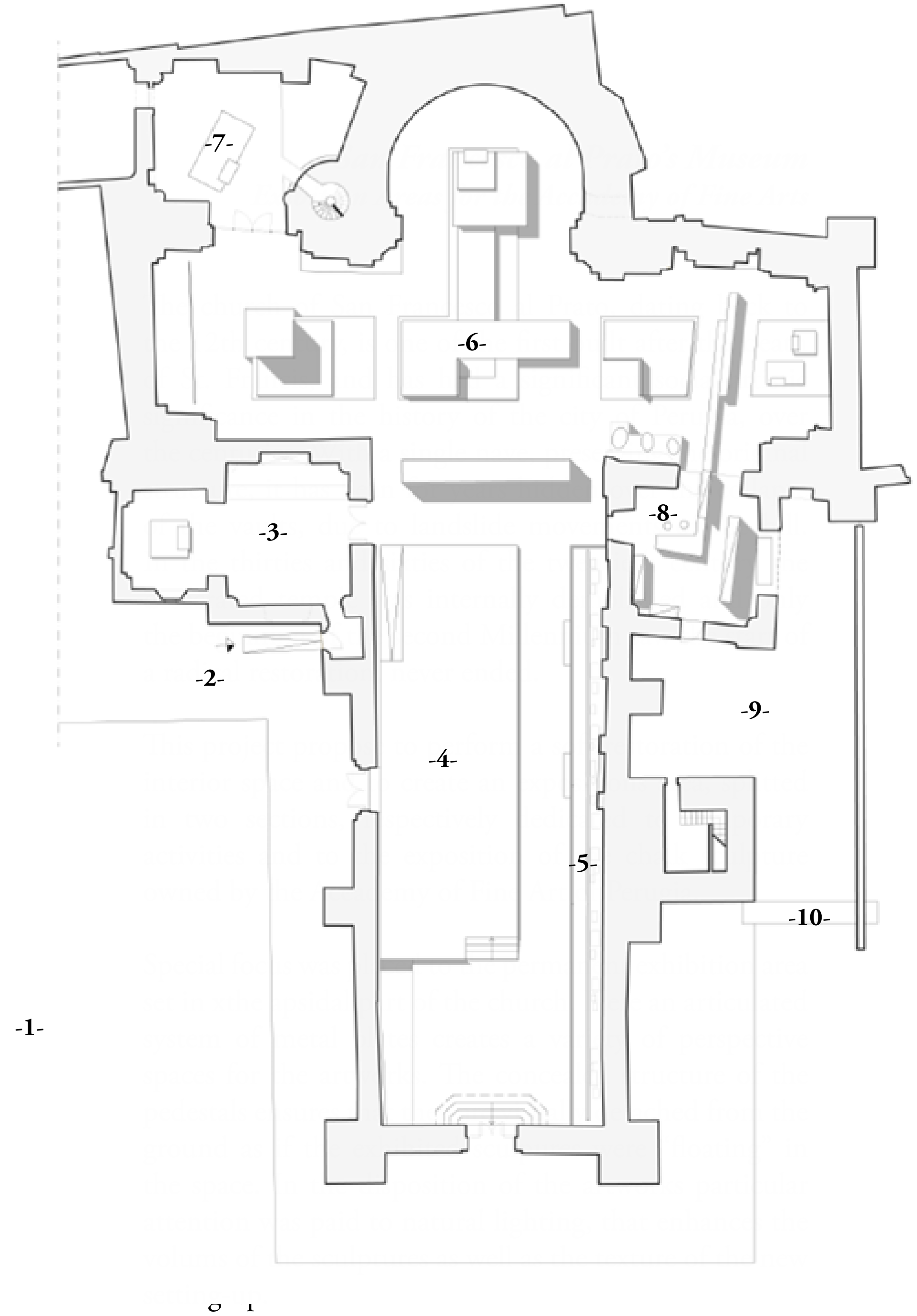
LIGHT & HISTORY



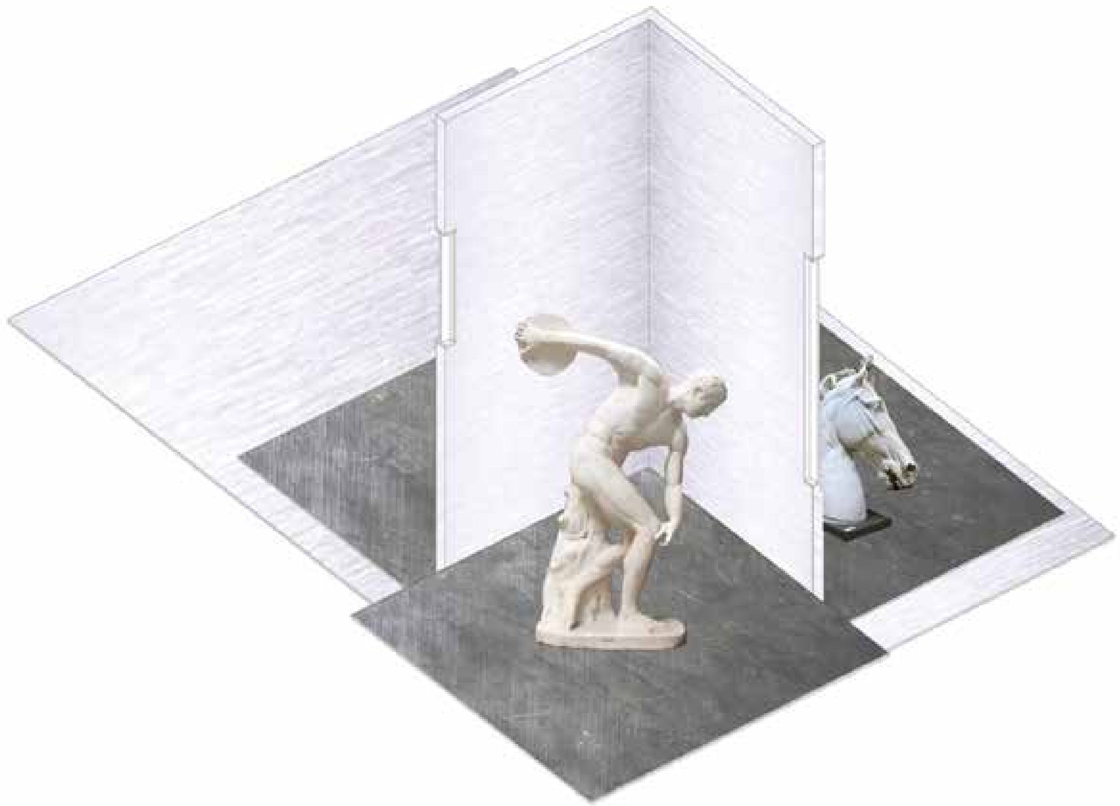






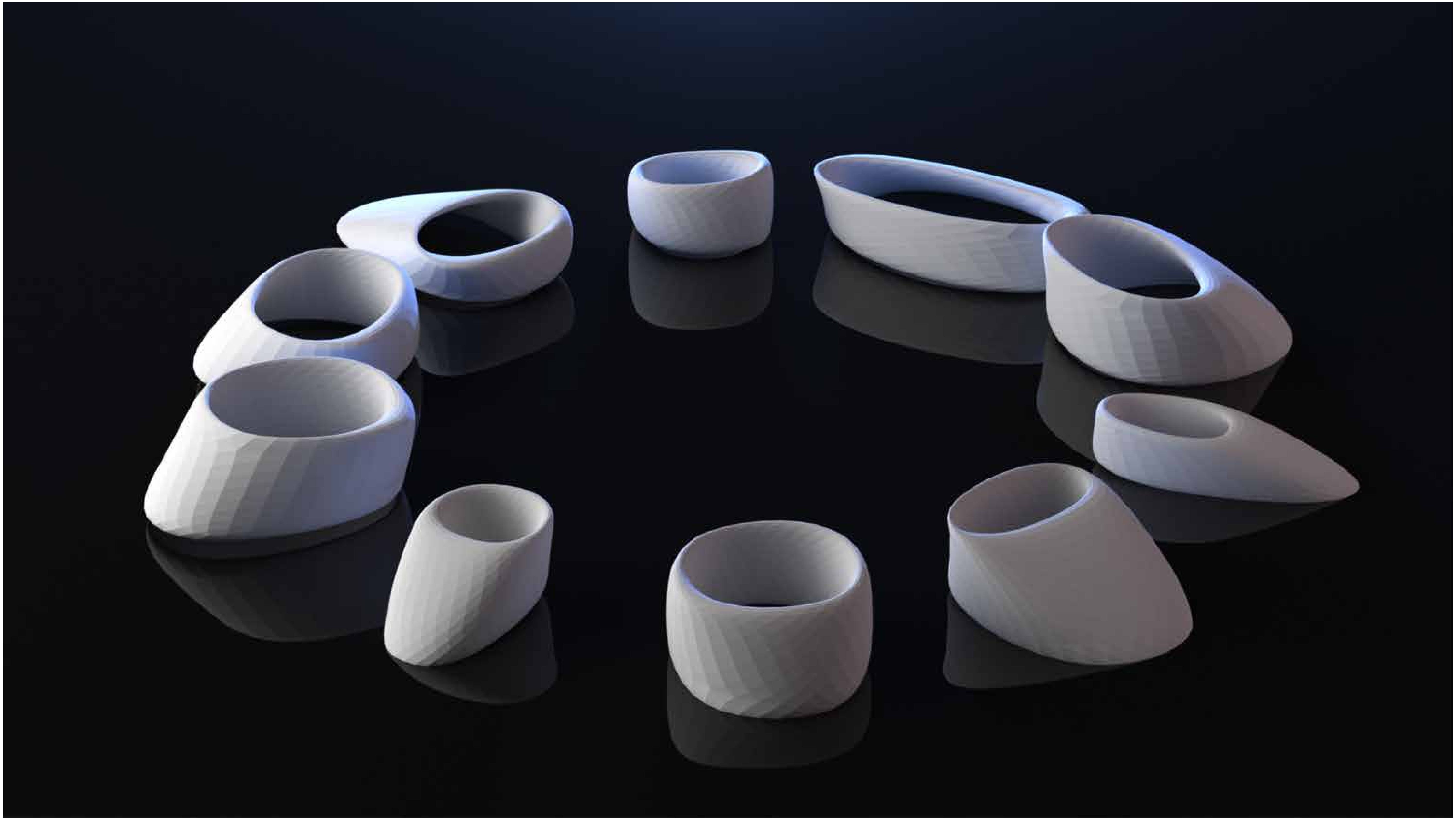


1. Piazza San Francesco 2. Main Entrance 3. Reception 4. Temporary Exposition 5. Church History 6. Gipsoteca Permanent Exhibition 7. Hortus Conclusus 8. Bookshop 9. Archeological Garden 10. Exit

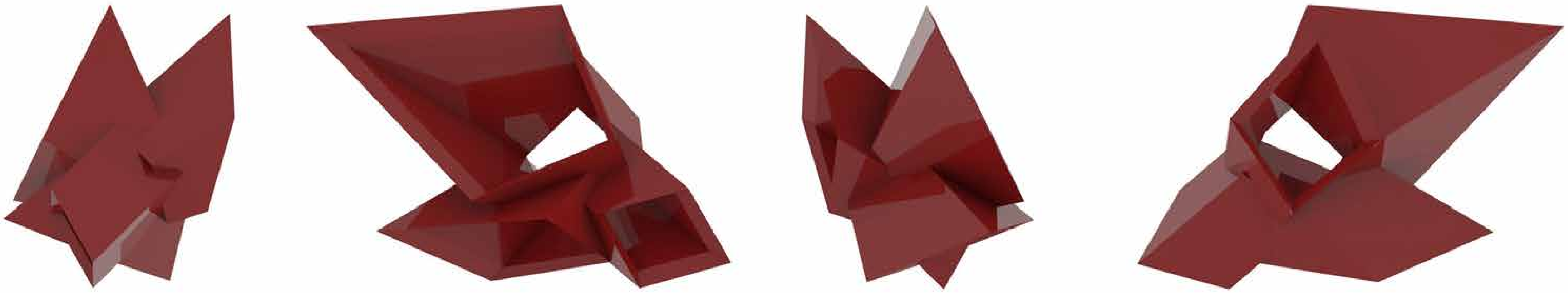


[4]

[Product Design]



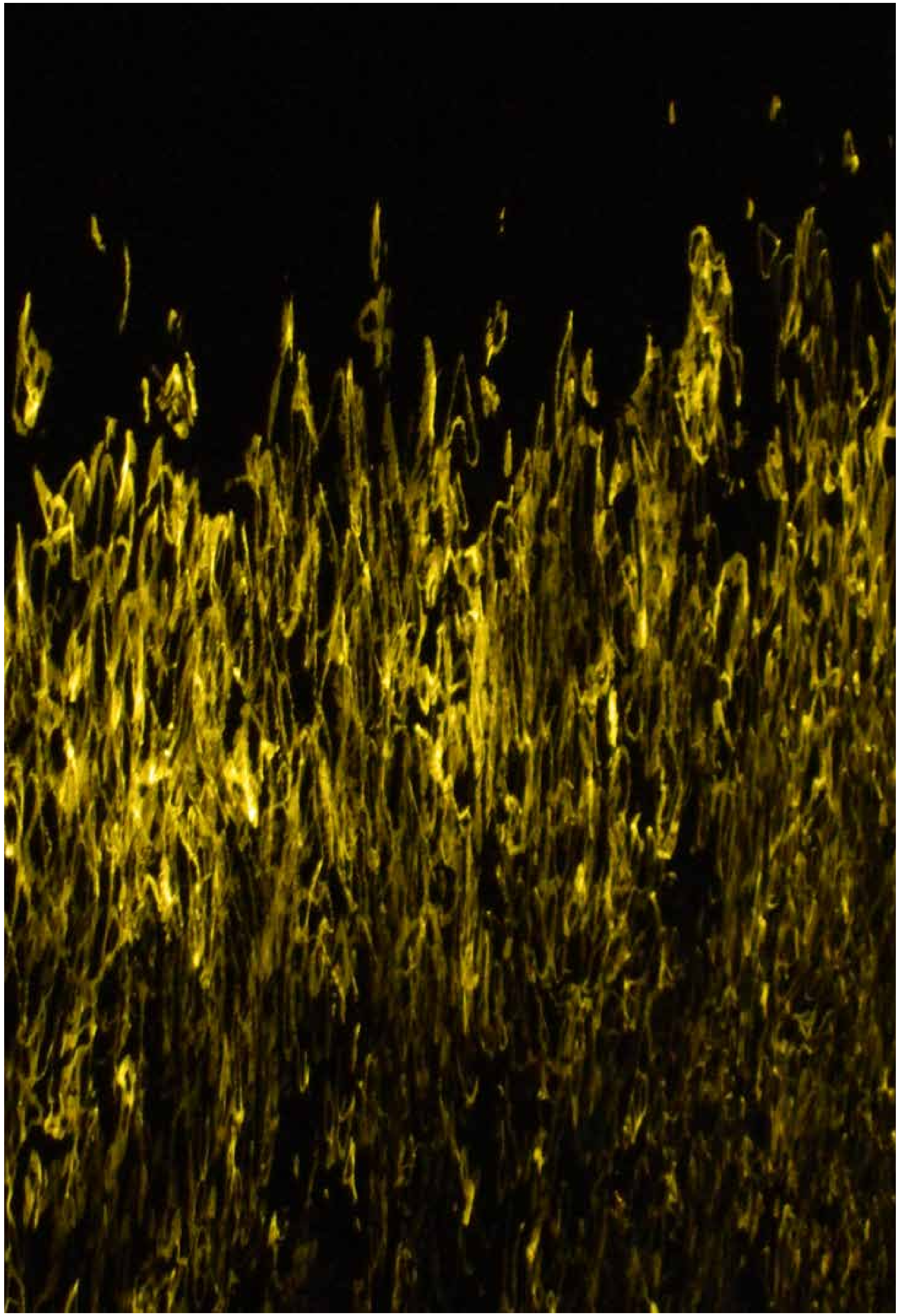
Klein Serie N°1



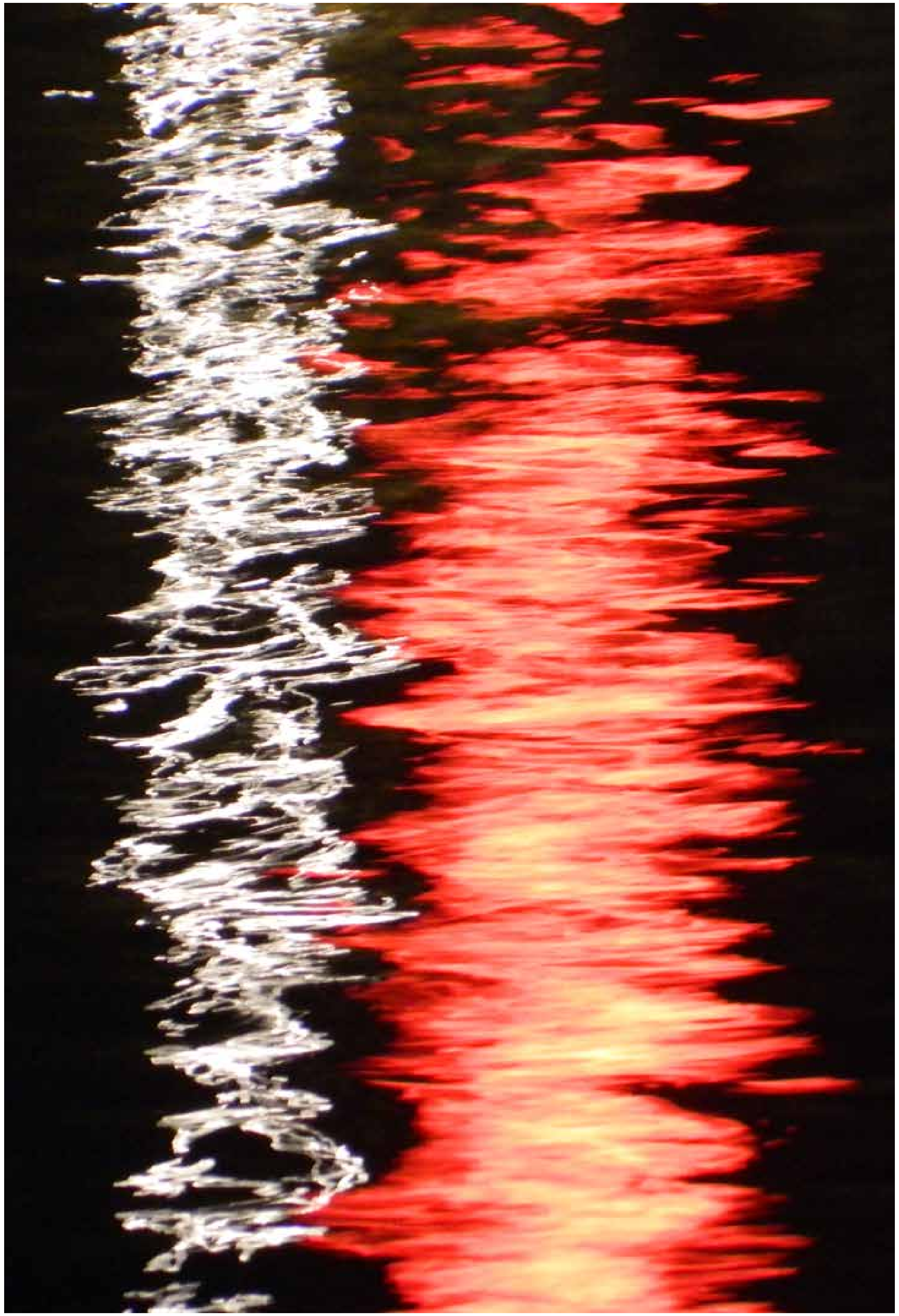
Light Shards

[5]

[Photography and Art]



Abstraction



[To be continued]

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