... The examples in this book however let us project beyond those standard practices and common processes, and make the argument that there is a generation of younger architects that not only fully understand the potential of digital fabrication, but attempt to go deeper into the question of materiality, inscribing new forms into stone thus penetrating material with profound thought.

... Successively, the merit of each design lies in the ingenuity to develop a customized methodology, which joins cut stone blocks in an additive way such that the assembly of individual units increases the overall structural stability by exploiting material strength through compression, typically known as stereotomic aggregates.

... It is in this respect that the designer Giuseppe Fallacara succeeds to devise methods that permit him to investigate a trajectory with each project, installation or prototype, and which open up new avenues in design by bringing stone to the edge of performance failure and exploit deliberately many current technologies. The projects are therefore also a great didactic example of advanced methods in architectural design with stone, which again shows the larger picture of architecture that is in continuous evolution enriched by the new means of digitization but more than ever affords a life-long apprenticeship instilled by passion.

Christian R Pongratz

LES COMPAGNONS DU DEVOIR et du Tour de France

ISR FMP

Institut supérieur de recherche et de formation aux métiers de la pierre

Giuseppe Fallacara

ARCHITECTURAL STONE ELEMENTS
RESEARCH, DESIGN AND FABRICATION

ARCHITECTURAL STONE ELEMENTS

RESEARCH, DESIGN AND FABRICATION

Giuseppe Fallacara

Presses des Ponts

new fundamentals
RESEARCH BOOKS

ARCHITECTURAL STONE ELEMENTS

RESEARCH, DESIGN AND FABRICATION

Giuseppe Fallacara

Presses des Ponts

ARCHITECTURAL STONE ELEMENTS.
RESEARCH, DESIGN AND FABRICATION
New Fundamentals Research Books,
editorial series of the research group.

ISBN 978-2-85978-508-6

Presses des Ponts
15, rue de la Fontaine-au-Roi
75127 Paris Cedex 11

Imprimé en France

Cover: Hypargate, photo by GaZ Blanco

new fundamentals
RESEARCH BOOKS
Serie editoriale del gruppo di ricerca omonimo

This book is dedicated to my wife Benedetta,
who allows me to fly high with a mind free from all worries.

This book is published in partnership with:

Institut supérieur de recherche et de formation
aux métiers de la pierre

PÔLE D'INNOVATION

CONTENTS

FOREWORD

Christian R Pongratz

We all know that natural stone is a magnificent material since time immemorial, but let's consider first that for many epochs it was mostly the stability and protective functions provided through its ubiquitous use in buildings that made it the ideal choice. Further, it was not only to overcome weather and withstand enemies, but lend longevity in time to document the significant effort made by builders, enabled by powerful and wealthy patrons.

Today, for obvious reasons, being the esthetic appearance of the façade, restrictive building codes demanding energy savings as well as increasing cost factors, its once abundant use in architecture is turned into being part of many hot swappable material alternatives, though mostly dedicated towards expensive niche markets.

What has not changed is our minds association of stone with several key characteristics such as mass, strength, volumetric appearance, and concepts of dry joining, best described by the German word "Fuegung". But where do these important issues still appear as key drivers in the design process? Let's look at both ends of the idea to production cycle, architectural design and the manufacturing industry.

While most current stonework and, in particular, façade applications predominantly use thin planar stone tiles for ventilated cladding systems, where stone is only few centimeters thick, the limits in materiality are not pushed and a large variety of possible building designs is not taking advantage of, simply for reasons of market economies.

Christian R Pongratz is co-founder of PONGRATZ PERBELLINI Architects/ Cyberstone LLC and Professor of Architecture and Interdisciplinary Studies at NYIT. His firm won numerous international awards and honors developing research from the digital to material, which evolved into several books and cultivated design innovation such as in natural stone design.

This rather dull picture of contemporary architecture (what Koolhaas termed the generic city) could be distilled into one example on stone, by arguing that the compressive strength of the material is not exploited to the fullest.

Secondly, the stone industry invested heavily into new cutting equipment over the past decades, designing machines and implementing them into an optimized process by using 3 axis CNC machines until advanced multi-axis automated operations at the upper end of the building spectrum. It did accelerate the speed of manufacturing of simple and complex parts alike, yet removed even more the use of stone from being implemented as a construction element and made it simply one among many exterior building skin layers.

The examples in this book however let us project beyond those standard practices and common processes, and make the argument that there is a generation of younger architects that not only fully understand the potential of digital fabrication, but attempt to go deeper into the question of materiality, inscribing new forms into stone, thus penetrating material with profound thought.

If we consider for a moment the dialectic of form and matter in relationship to stone, it is precisely the interrelationship conceived between the two terms, that leads to affordances in architecture. The designer is transforming the material into something new, or to use Kahn's words, design enters the process in a certain moment using the laws of nature to excavate nature.

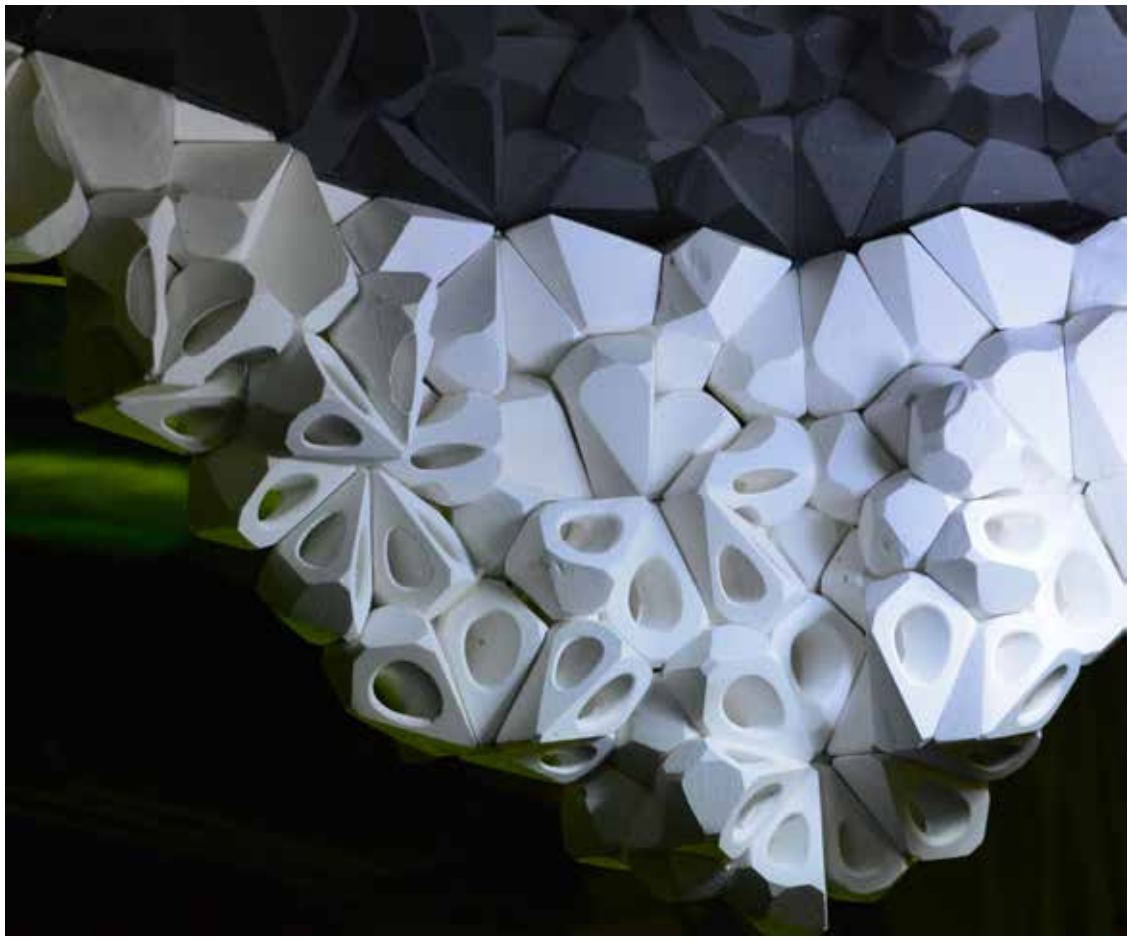
Without any doubt, the recent revolutionary changes in Architectural design, starting with the paperless studio at Columbia University and arriving at the contemporary appearance of a global digital practice, approaches nature with a new material driven canon fostered by the proliferation of dynamic associative design environments and the convergence of global knowledge and distributed design sensibilities.

All of those phenomena facilitated by digital technologies propel spatial complexities and formal intricacies within contemporary languages of architecture. We arrived to a moment where almost anything can be turned into form through digital design and a large part of this emerging shape repertoire can be fabricated in the shop, even in natural stone. At this point, the question appears why are we doing what we are doing and if the goals of a project are clearly outlined, how are we then integrating the key characteristics of stone as initially listed in my essay. Considering the *oeuvre* contained in this booklet and reviewing the breadth of project types, that the author Giuseppe Fallacara organizes into 7 chapters, there is a visible red line or research thrust throughout the work. I would summarize it into one underlying method, which is to design those projects out of multiple components in a bottom up manner and engineer their respective geometries through selected material removal processes. Successively, the merit of each design lies in the ingenuity to develop a customized methodology, which joins cut stone blocks in an additive way such that the assembly of individual units increases the overall structural stability by exploiting material strength through compression, typically known as stereotomic aggregates. While such an undertaking is not unusual, considering the global proliferation of advanced fabrication strategies and laboratories, there is a definite uniqueness in the sole usage of stone and by referring often to a newly interpreted repertoire of ancient technologies.

Returning to the previously mentioned notion of "Fuegung" or joining, we should emphasize that it is the precision empowered by advanced fabrication equipment, which facilitates anew the design of perfection in surface geometry and thus facilitates the matching dry joint of adjacent components without the necessity of additional mortars or adhesive bonds.

It is in this respect that the designer Giuseppe Fallacara succeeds to devise methods that permit him to investigate a trajectory with each project, installation or prototype, and which open up new avenues in design by bringing stone to the edge of performance failure and exploit deliberately many current technologies.
The projects are therefore also a great didactic example of advanced methods in architectural design with stone, which again shows the larger picture of architecture that is in continuous evolution enriched by the new means of digitization but more than ever affords a life-long apprenticeship instilled by passion.

Pongratz Studio, Fablab_production of multiples at many scales



Pongratz Studio, Sphenoid-close packing

N. de l'Armessin juven. et S. excud.

Habit d'Architecte

Se vend à Paris Chez N. de l'Armessin Rüe S.t Jaques devant la Rüe du Plâtre à la Coupe d'Or. Avec Privilege au Roy.

ADAUCTUS ARCHITECTUS NOVUS AND "ADJACENT POSSIBLE" OF NEW STONE ARCHITECTURE

Giuseppe Fallacara

G. Fallacara 2016, *Adauctus architectus novus*, Interpretation from Habit de l'Architecte, engraving attributed to Nicolas II Larmessin, probably made in the seventeenth century.

This book is a collection of twenty stone design elements, designed and built from 2013 to 2016, which are sorted according seven specific geometric/ constructive categories. The Projects describe an effort to demonstrate new applications, features, shapes and the unexpected and unexpressed potential of stone for a new contemporary design. The projects which are illustrated are elements of architecture and also elements of furniture that have the common feature of all be a great challenge to the inherent limitations of the stone material. We wanted to bet, with the companies that have actively contributed to the realization of prototypes, on the "limits" concerning the use of stone as a "resource for innovation" for contemporary architecture and industrial design.

All products clearly show the search for geometric complexity and limitation of the static and mechanical resistance of the element. Searching for the limit of the potential applications of a material is useful to broaden the knowledge of the same material and expand the frontiers of its achievements and uses. The stone, compared to modern materials, is considered difficult to submit to product design and contemporary architecture as well. In addition, it is considered to represent an old material, or rather strongly connected to the forms of the past and tradition.

On the contrary, it is known that, for a designer, there are no ancient or modern materials but it is the way the material is transformed, worked and shaped that makes it new and innovative rather than old and decrepit. It is important to note here that most of the formal innovations and applications, especially for the stone, derive from the knowledge and reflection on the architecture of the past. The study of ancient monuments makes it possible to understand the technical and building expertise and attempt to go further, following the famous phrase of Bernard of Chartres who said that one could look farther by standing on the shoulders of giants.

« *Dicebat Bernardus Carnotensis nos esse quasi nanos gigantium humeris insidentes, ut possimus plura eis et remotiora videre, non utique proprii visus acumine, aut eminentia corporis, sed quia in altum subvehimur et extollimur magnitudine gigantea* ».

Unfortunately, nowadays, a great number of people consider that it is quite "illogical" to think about recovering the techniques and the traditional use of stone in architecture and in contemporary design for several reasons. Above all, the lack of knowledge and culture about the stone as material that is acquired primarily at school, universities and in the general culture of a community as it was in the past and which has allowed to generate the great heritage of humanity which includes cities and historic monuments. Secondly, legislation does not foster the use of the stone material.

The rules and the current building regulations show evidence, both of the limits of the material and, on the other hand, the enormous difficulties of adapting the technique to the current standards. This second aspect derives directly from the first aspect that is the inadequate knowledge of the material and of its use in the history of building.

In any case, we know that many architects and engineers have a resilient desire, a constant thought, concerning the durability of an artifact that would inevitably lead to the highest position, always and everywhere, the stone architecture against that architecture built with all other possible materials that can be found on earth and are suitable for constructions.

Contrary to the concepts of "temporary" "provisional" transience, the stone building is still standing over the time. It witnesses itself and its author defying time and leaving its mark in history: this is one of the absolute values of our attention towards the stone. Incidentally, even in the current attention to the recycling of materials, it would be easier and logical to "recycle"/ "reuse" parts and elements of a stone construction compared to other materials. This is the lesson history has taught us through the admirable *spolia* architectures taken from former destroyed buildings and monuments, whose building elements can be inherited as to represent a younger genetic code. Here is just a "humanized" aspect of the stone, which from being a "non-living" thing becomes "alive" in the name of re-birth.

Certainly, the renaissance in the use of stone nowadays is related to the evolution of the digital fabrication in the dual aspect of both the technological evolution of the parametric and generative three-dimensional modeling software, provided by the robotics and numerical control machine tools applied to stone manufacturing. In the project-product process, a new and unprecedented direct relationship between designers and the final product is established thanks to robotic production of stone components. The contemporary designer is a "*Adauctus architectus novus*" or an "expanded designer" in the sense that he possesses new robotic arms which allow him to cut and shape the stone according to his direct requirements without any external mediation. In this perspective, the famous "dress of the architect" (the role of the architecte - *habit de l'architecte*) changes both because of the new tools at its disposal and of the new forms that he is able to produce.

In this new perspective, the role of the "fabricator", the person who creates the work, disappears. His role interposes between the author and the final work, but the designer becomes the maker of his work thanks to his new robotic arms that allow him to cut and shape the stone and to mount and assembly the masterpiece. The direct control of the author in making the work is the first step to redefine a new profession, paradoxically similar to the architect - master of the past.
In this new scenario, the new architect of the future is the author and creator of his own work or at least the one who ensures the final work the most suitable correspondence with the original idea of project without mediation and / or constructive interpretations by others. The new designer takes on new critical skills, goes back to the real construction and assumes the new ethical and civil responsibilities of his job. Thanks to the development and dissemination of digital knowledge related to manufacturing (FabLab - fabrication laboratory), this process of redefining the role of the designer could occur at any scale, from architecture to design product, and at any level of business activity, from big industries to the small workshop of the province. Now, it is an incessant cultural process, not only within the stone world, which is based exclusively on a new culture of doing and on the strong contact with the materials, and in learning and supporting the process concerning the incubation and birth of ideas. The latter is the most delicate and important aspect and a key point for the reformulation of university programs and teaching methods. In some ways, this book is a demonstration of how a new teaching method is possible based on the twofold aspect of the creation and construction, building and learning by doing.
The elements and prototypes presented in this book have been made, in most cases, during internships and theoretical and practical workshops in different Italian and foreign companies with the direct contribution of the students who performed the dual role of authors and apprentices of the stone masterpiece at the same time.

Some examples of the prototypes presented in these pages, are made within a broader research program entitled *Structural lithic morphology* to try to invent and develop new architectural elements in stone.

The lithic prototypes come to life under the influence of research and innovation aimed to expand the "adjacent possible" of stone, according to what Steven Johnson argues in "Where Good Ideas Come From: The Natural History of Innovation". The adjacent possible, according to the author's statements, is a "kind of shadow future, hovering on the edges of the present state of things, a map of all the ways in which the present can reinvent itself". That allows us to identify new possibilities and the potentialities of the stone, even with the risk of exceeding the morphological/structural boldness, absorbing the lessons of constructive-technological areas, including external contributions not strictly related to the logic of stone. As Steven notes, the adjacent possible "captures both the limits and the creative potential of change and innovation."

Johnson identifies seven creativity "models", through which it is possible to search for innovation. Some of them can be identified within the designer intellectual work:
Slow intuition, which is preserved and stored in mind for a long time before it is shaped by the lightning of the immediate intuition;
Serendipity, which is a neologism indicating the feeling you get when you discover something unsought and unexpected while you are looking for another.
Serendipity is not only a feeling, but indicates also the typical element of scientific research, when important discoveries have been made while looking for something else.

The term **exaptation** was coined in 1971 by the evolutionary biologists Stephen Jay Gould and Elizabeth Vrba: an organism develops a trait optimized for a specific use, but then that trait is redirected to a completely different function. A classic example are the feathers of birds, which initially appeared in dinosaurs to regulate body temperature and later evolved into flying instruments: a tool created by the evolutionary needs for a given purpose reveals unexpected utility for another purpose. A pen or feather adapted to warm up is "exaptated" for the flight.

According to Johnson, intuitions arise slowly over the time but they materialize rapidly thanks to the composition of the last tile to finish the mosaic, giving the complete vision of the scene.

The last tile comes like a thunderbolt! The innovative environments are those that encourage their residents to explore the adjacent possible, making available a wider and more versatile sample of spare parts - mechanical or conceptual - and promoting new ways to recombine them. There are many new solutions and brilliant ideas, at your fingertips. The matter is to use the available resources in a different manner, in order to create new combinations.

Most of the times innovative ideas do not arise from the strokes of genius, but from a good *bricolage*.

This adjacent possible concept is interesting and very useful in developing innovative routes.

Although we are accustomed to think about innovation as a leap ahead in time and space or sudden swerving due to the genius of the inventor, we must agree that the history of cultural, artistic and scientific progress is comparable to the "story of a door leading to another door, exploring the palace one room at a time". While researching, designing, making, building you may encounter errors or serendipity phenomena, which are both fundamental for scientific research: the best innovative ideas in our society were born from mistakes and "casual discoveries".

According to the principle of exaptation you can use technologies created for a specific field of application to a new domain of use: for example fibre-reinforced composite used for static consolidations, can become "hinges" to build and install a lithic arch in no more than 10 minutes, or create a new stone thin, light and durable.

We propose here some significant prototypes through which we hope to be able to provide a small contribution to this path, trying to define a concrete road that could mark the evolution of the speculation/design union.

Starting from a traditional logic, each of the prototypestries rejoins with the evolutionary path from which they belong.

Some of the prototypes here described have been presented at the Verona Marmomacc 2013, within the "Structural Stone" exhibition, entirely dedicated to morphological and constructive updating of load-bearing lithic architecture.

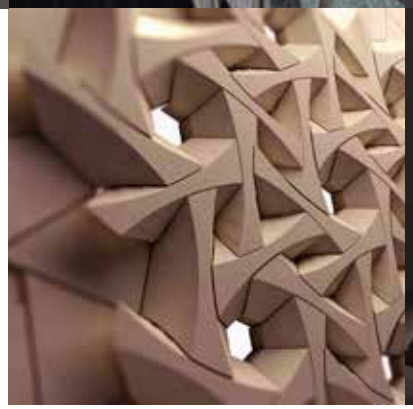
Each of them can be seen as the materialization of the close relationship, typical of lithic construction, which binds the genesis of form with its structural performance, also achieving the logic of mixed stone and steel structures within the wider research on reinforced stone.

I hope this book, in the form of a catalogue made of experiences, may arouse, on one side, the curiosity of those who have never worked with the stone and show, to the young architecture student, an alternative and experimental way to see and enjoy the world.

G. Fallacara with Morfologia Strutturale II – DICAR Poliba, Sentiments de stéréotomie et divertissement graphiques,
Paintings of a traveling exhibition, Paris, Troyes, Saint-Maximin, Melbourne, Moscow, 2015 – 2016.







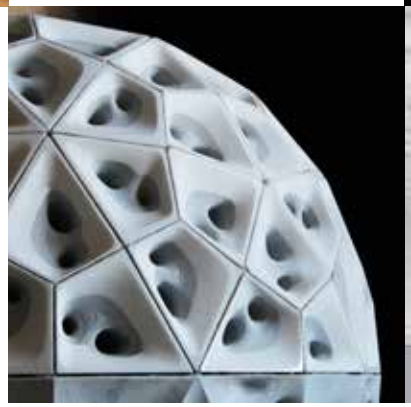
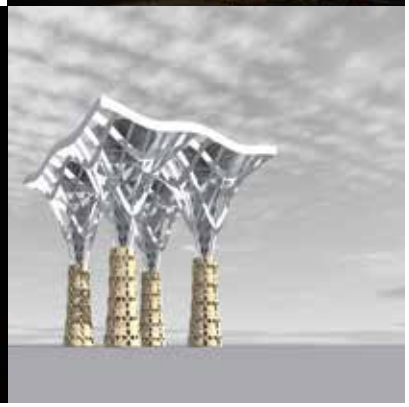
All the prototypes presented here aspire to become architectural organisms

E L E M



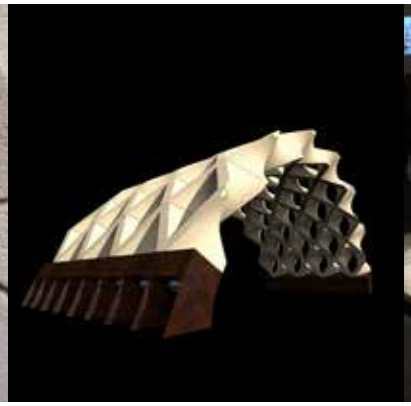




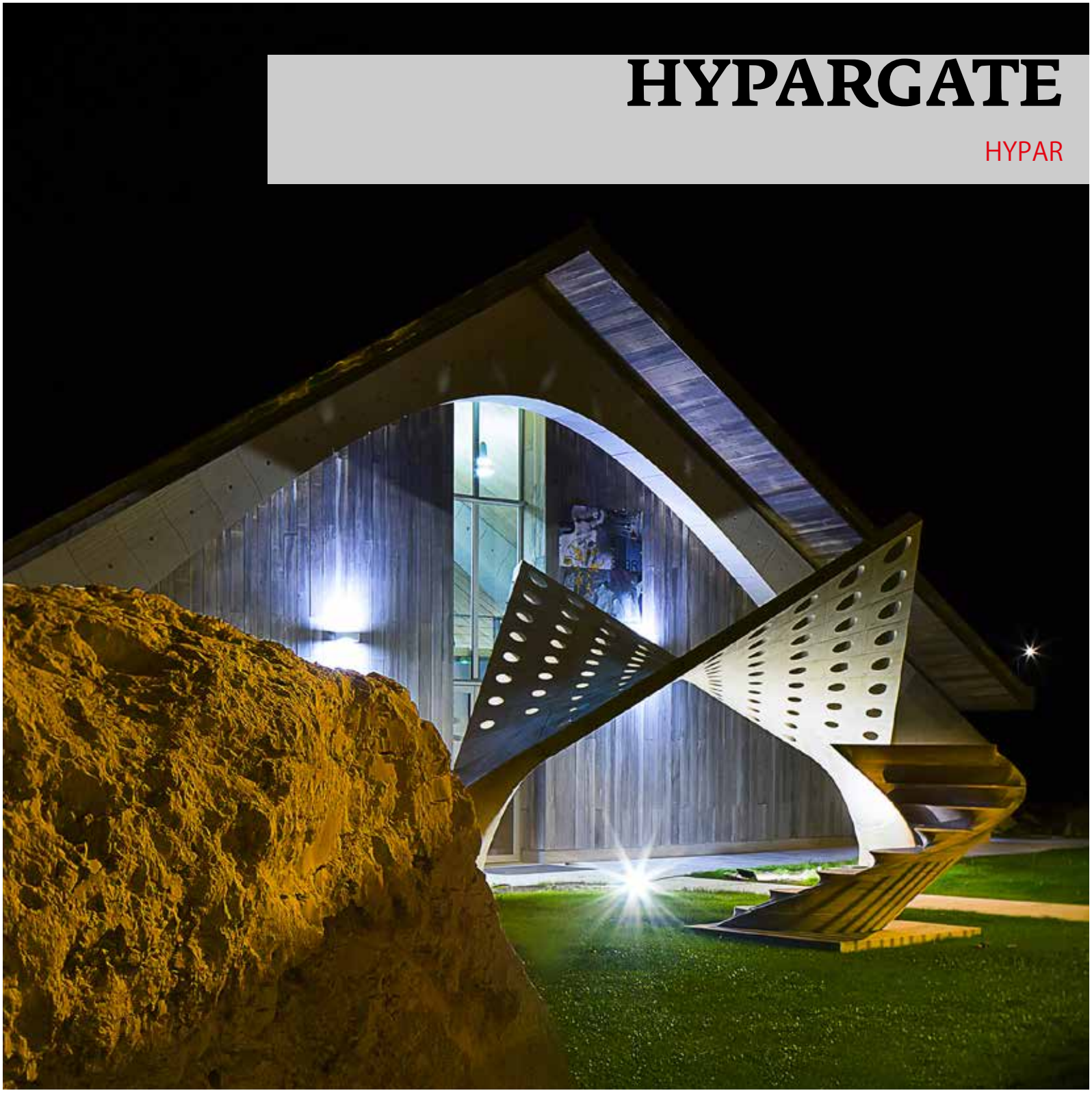
E N T S






HYPARGATE

HYPAR



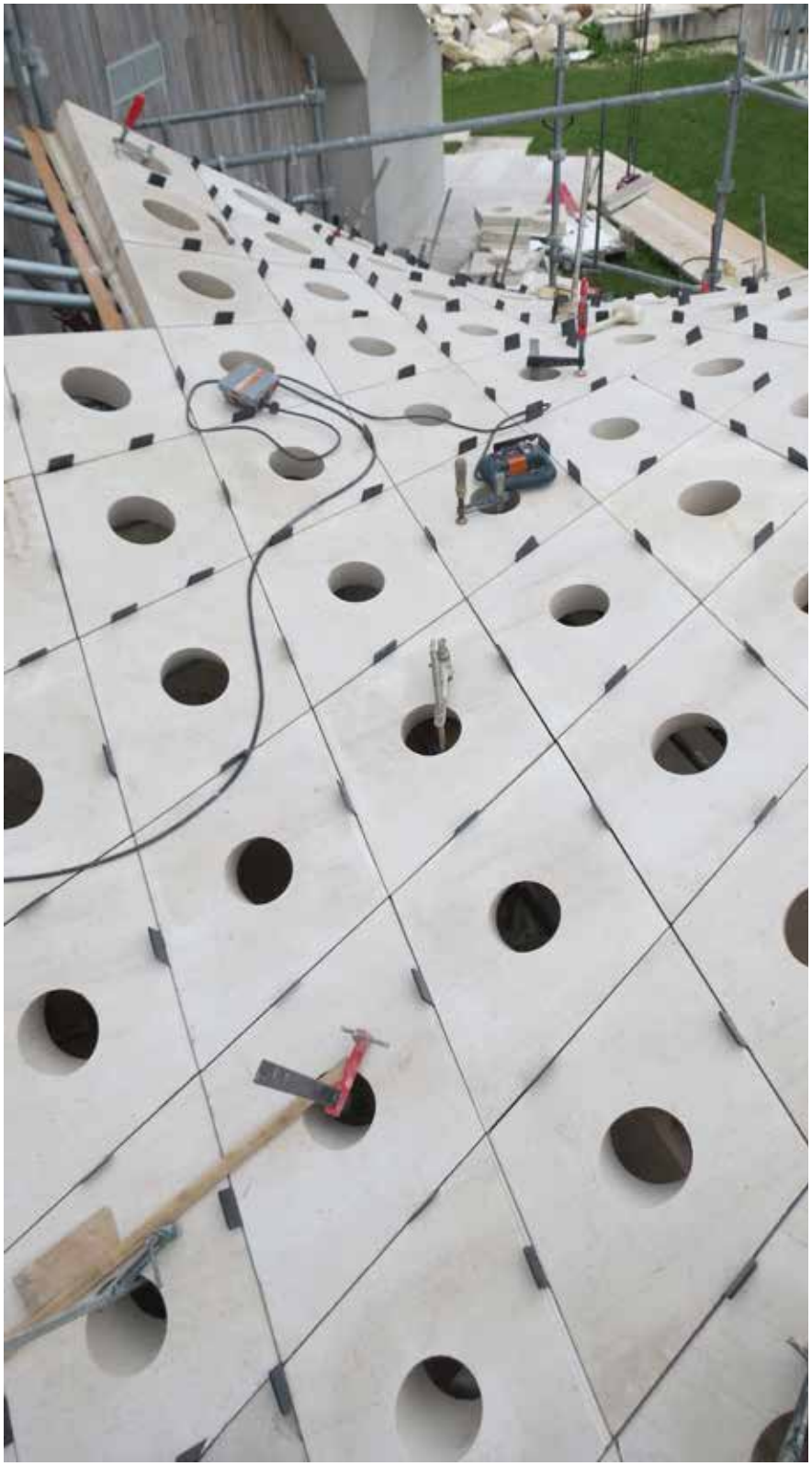
BUREAUX SNBR

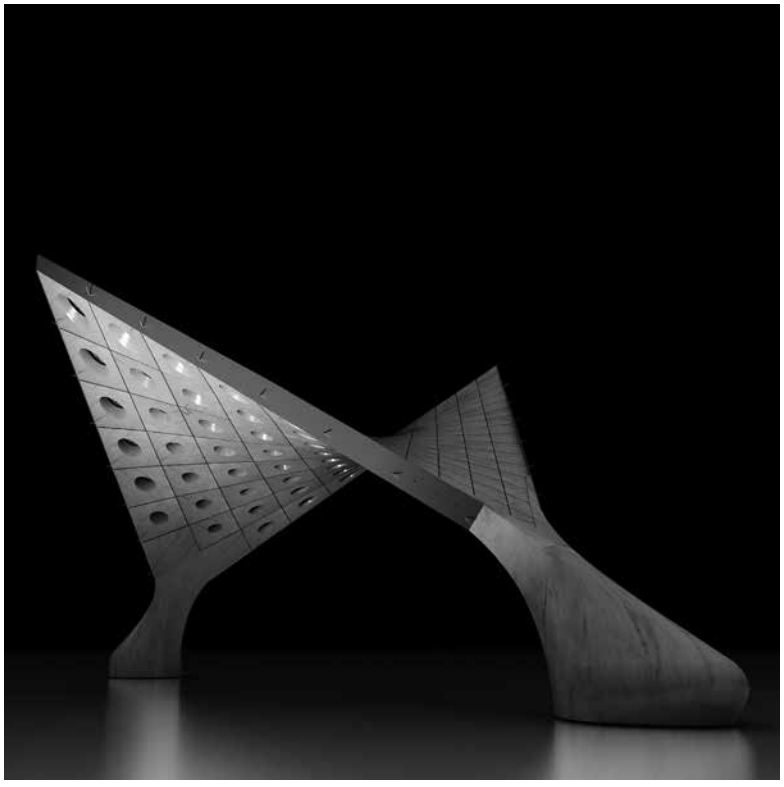
PARC DE LA STÉRÉOTOMIE
SAINTE SABINE DE TROYES

design	Giuseppe Fallacara
collaborators	N. Rizzi with V. Varano and D. Malomo (structural analysis), M. Barberio and N. Martielli (Archviz)
materials	pierre de Semond (Carrieres Lipiello & SA)
year	2014 - 2016

HyparGate is the first discrete hyperbolic paraboloid made of stone. The HyparGate covers a free area of 22 square meters thanks to the cantilever morphology of the shell. The hypar is a well-known ruled surface, which has been used in the last decades for many structural applications related to reinforced concrete shells. The full-scale construction is located in France and represents the entrance portal of the headquarters of the French company S.N.B.R.. The main idea is to replace reinforced concrete with pre-stressed stone through post-tensioning technique, in order to reduce the use of artificial materials in architecture, when possible. Post-tensioning is a form of prestressing. The main purpose is to establish an innovative connection between shape, structure and fabrication, coding the characteristics of hypar shells and generating a series of new self-supported vaulted morphologies through integrated parametric analyses. This computational approach underlines the potentialities of robotic fabrication in architectural fields, making an optimized voussoirs modelling possible using parametric softwares, and fabrication using robotic arms in combination with CNC manufacturing techniques like circular saw cutting, milling and diamond wire cutting.

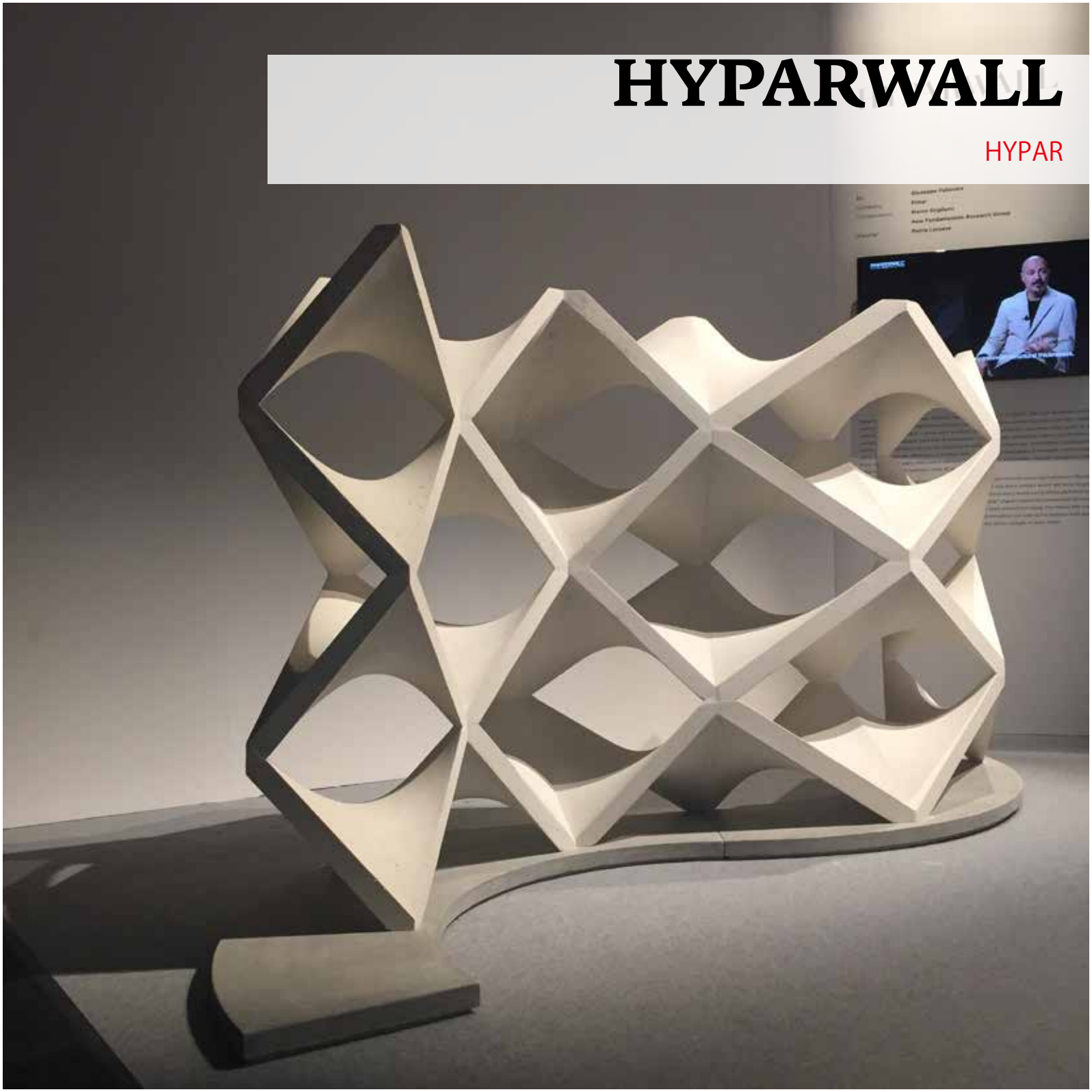
manufacturing company
S.N.B.R.
www.snbr-stone.com





HYPARWALL

HYPAR



MARMOMACC TRADE FAIR

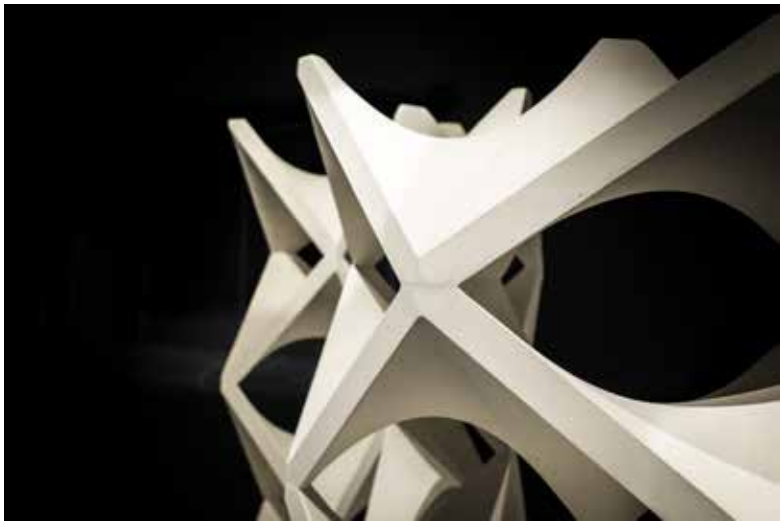
THE ITALIAN STONE THEATRE
VERONA

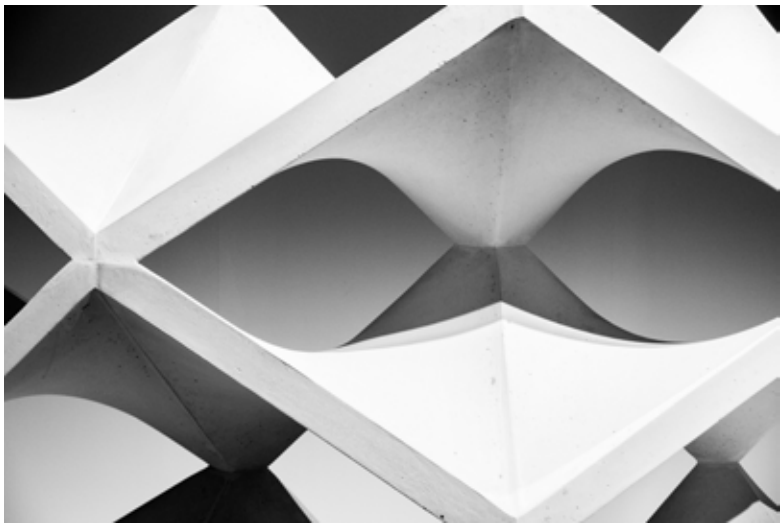
design	Giuseppe Fallacara
collaborators	M. Stigliano (design), D. Malomo (structural analysis), M. Barberio (Archviz)
materials	recomposed stone
year	2016

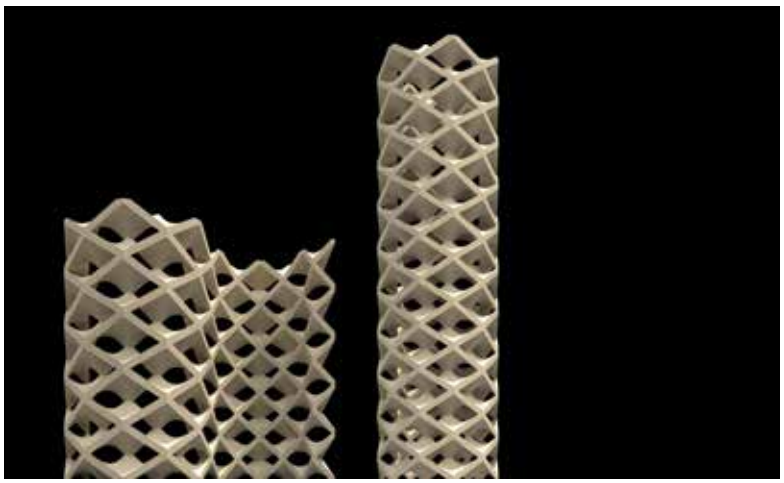
HypaWall is a modular perforated stone wall either exterior or interior ensuring multiple configurations: along straight, curved or cylindrical courses thanks just to two basic ashlars which are easy to produce and assemble. These ashlars are made from recomposed stone using waste Lecce Stone generated during other processing stages. The cemented ashlars have a “saddle” shape (hyperbolic paraboloid) that exploits the properties of grooved surfaces in order to optimise mass production using the mould and counter-mould technique. It is also possible to produce natural stone ashlars by cutting the material with diamond wire mounted on a robot arm. The two typical ashlars are mirror images of each other.

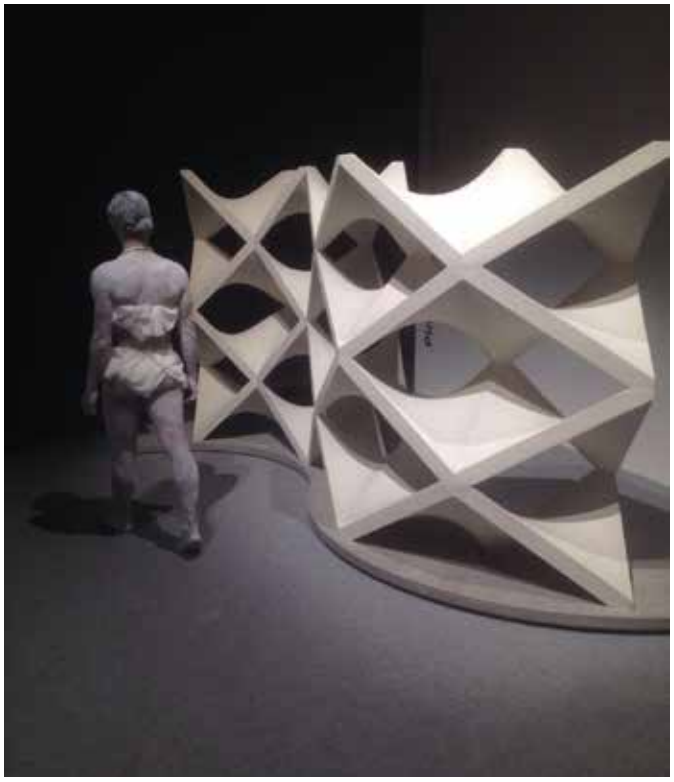
manufacturing company
PIMAR s.r.l.
www.pietraleccese.com

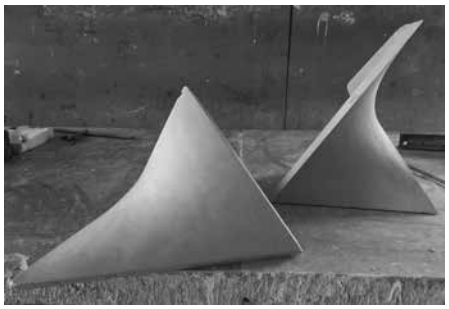
PIMAR
ITALIAN LIMESTONE

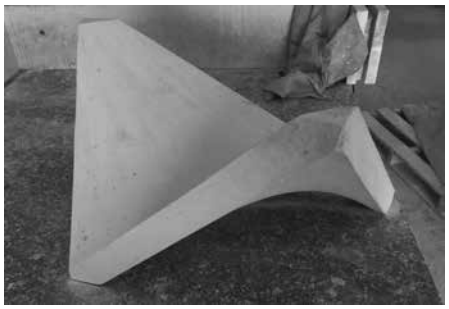


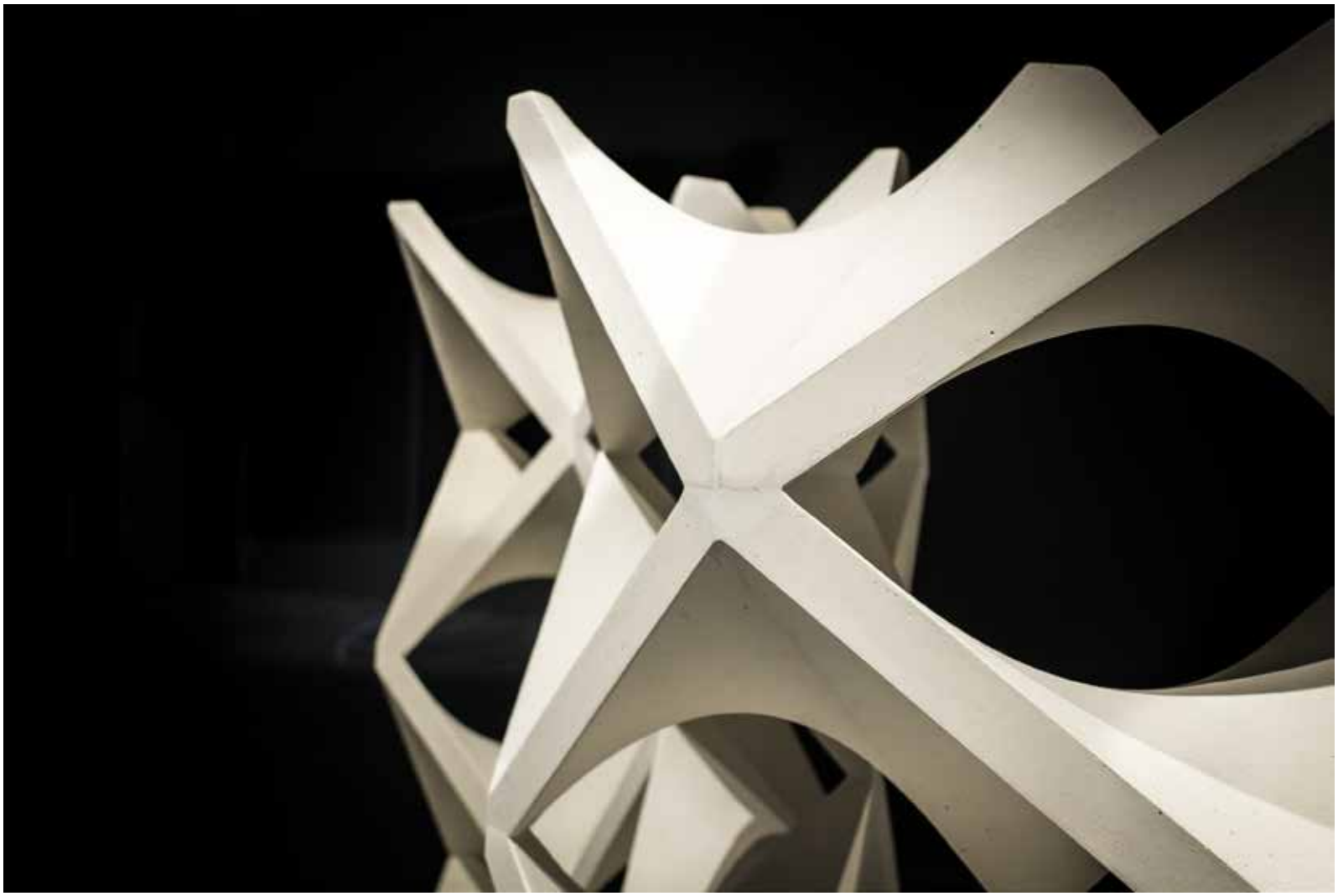






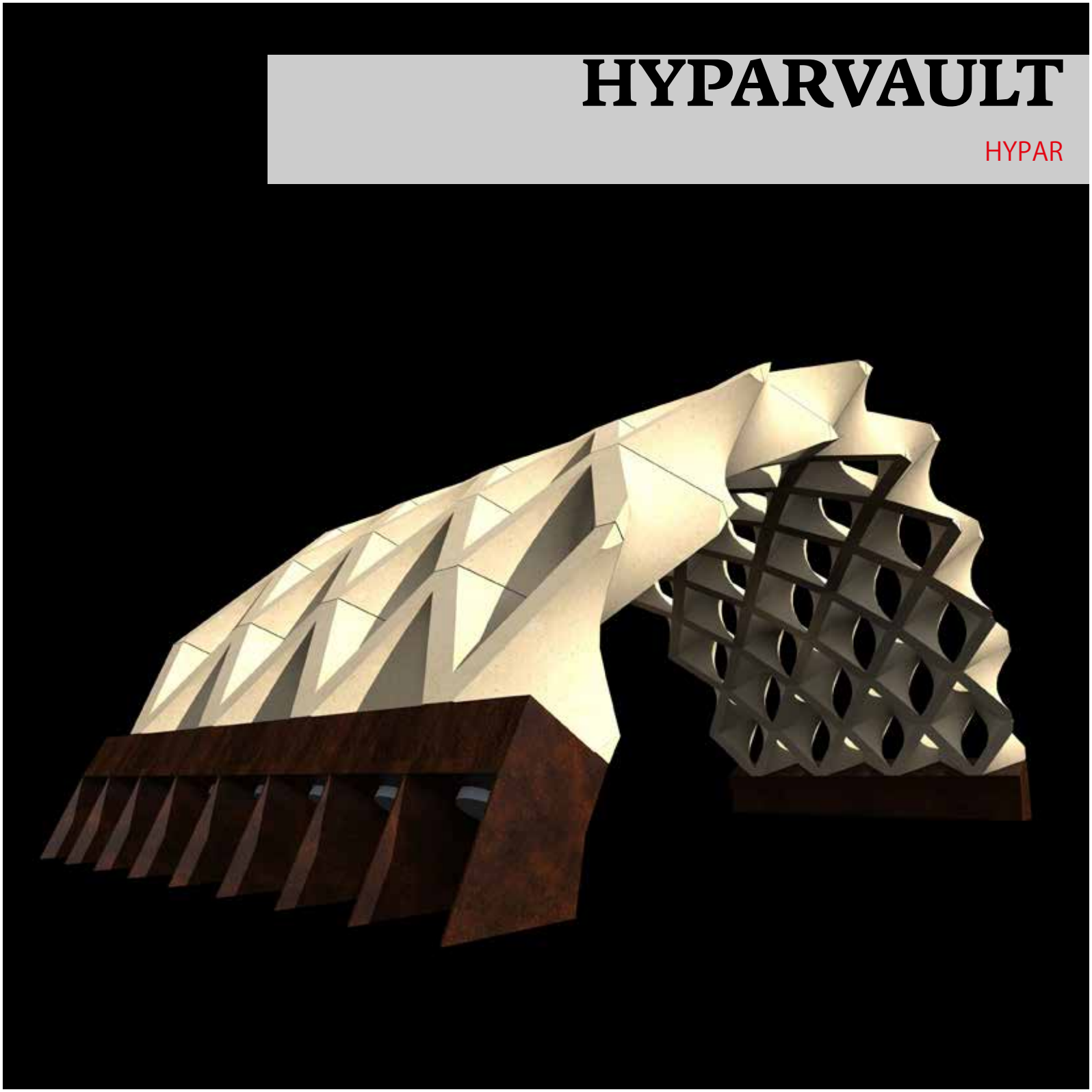






HYPARVAULT

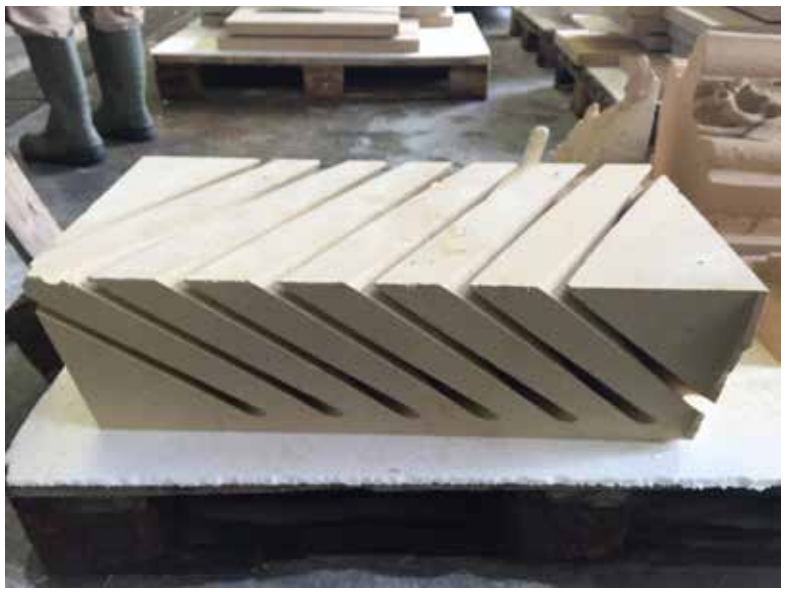
HYPAR



ROCALIA TRADE FAIR

NATURAL STONE EURO EXPO
LYON

design	Giuseppe Fallacara
collaborators	M. Stigliano (design), D. Malomo (structural analysis)
materials	pierre de Semond (Carrieres Lipiello & SA)
year	2016 - 2017



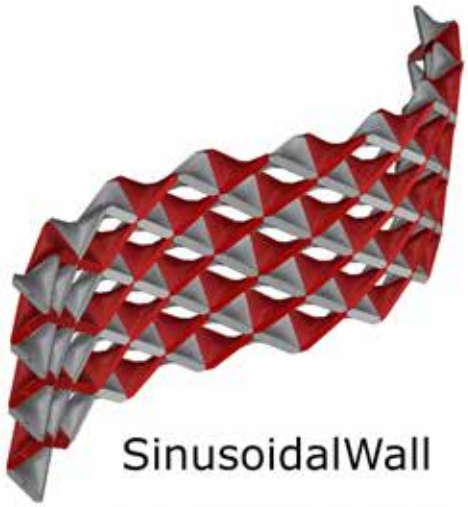
HyparVault is a barrel vault consisting of perforated stone blocks cut with wire diamond robots. It is a prestressed vault with post-tensioned steel cables. The vaulted structure is composed of only two types of ashlars with the same logic previously presented concerning the HyparWall system. In this specific case, the blocks with the hyperbolic paraboloid geometry have trapezoidal forms and they are axially perforated to allow the passage of the stainless steel cables inside. The prestressing of the structure occurs due to post-tensioning of steel cables which are fixed to the base of the barrel vault. The production of the entire natural stone ashlar is made by cutting the material with diamond wire mounted on a robotic arm without losing and wasting stone material.

manufacturing company

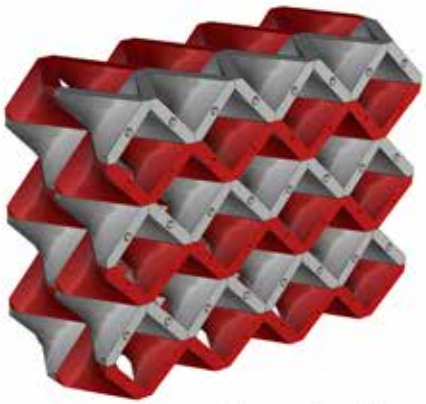
S.N.B.R.
www.snbr-stone.com

T&D Robotics s.r.l.
www.tdrobotics.com

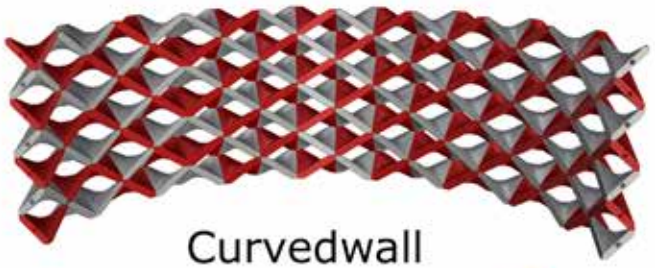
H.W.S. Hypar Wall System



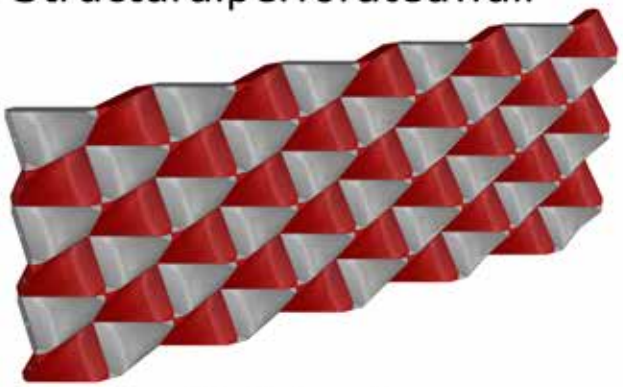
SinusoidalWall



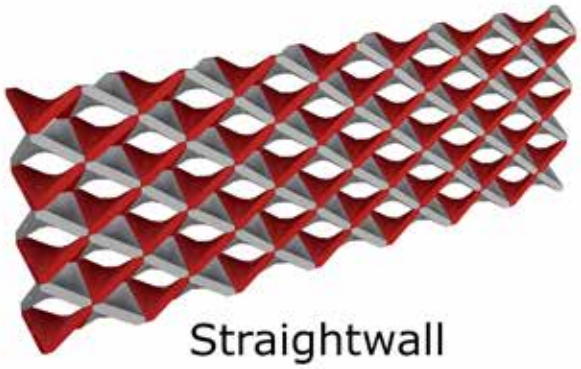
Structuralperforatedwall



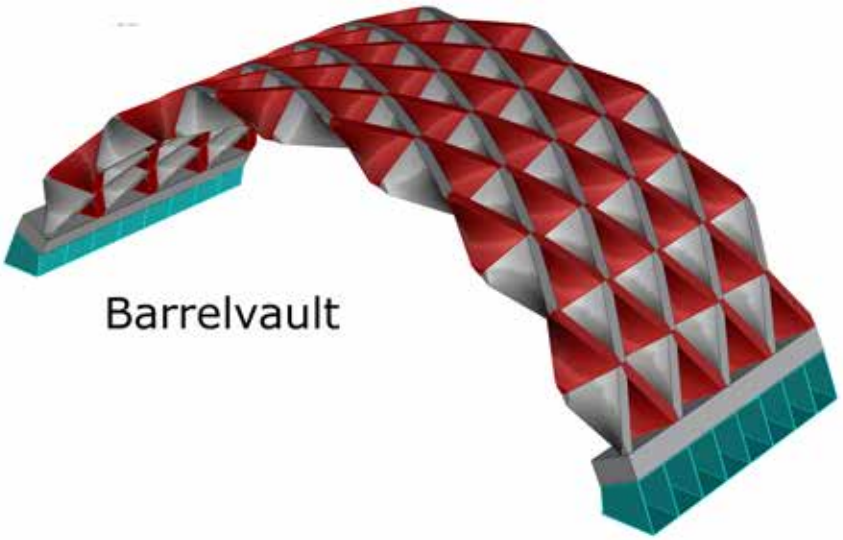
Curvedwall



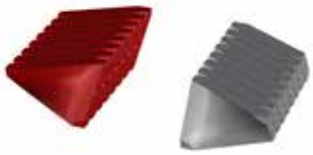
Solid wall



Straightwall



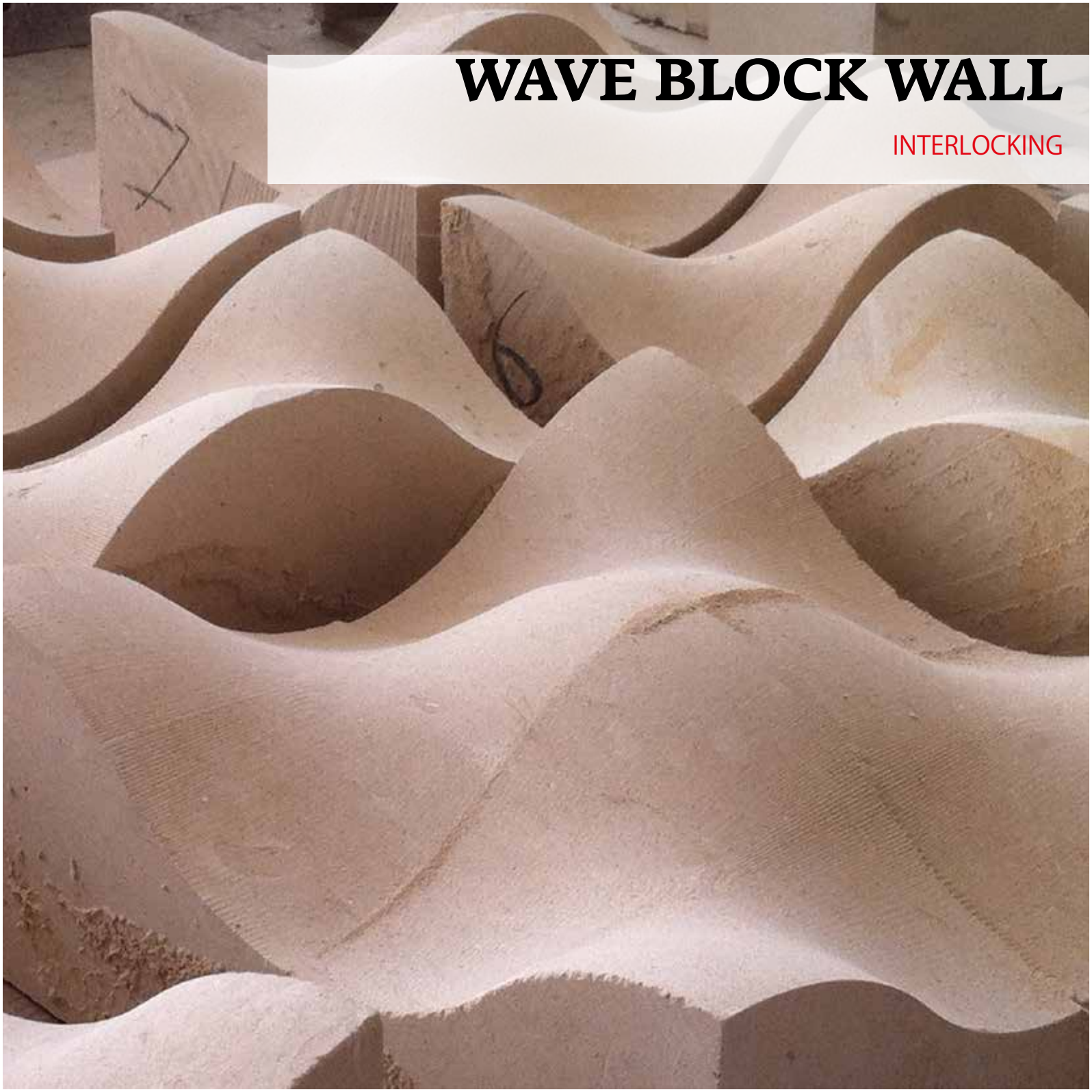
Barrelvault



Block "A" and "B"

WAVE BLOCK WALL

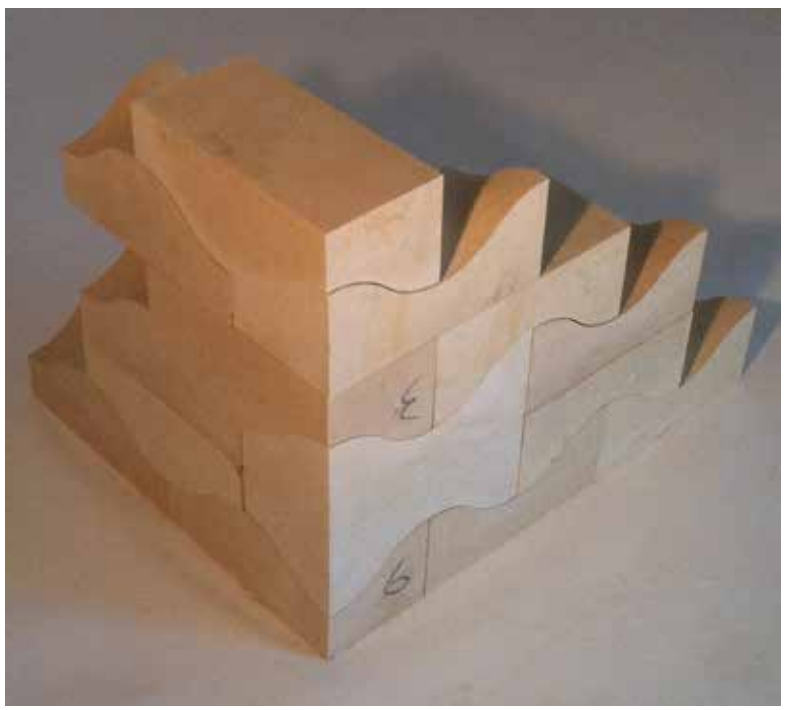
INTERLOCKING



MARMOMACC TRADE FAIR

STEREOTOMIC DESIGN
VERONA

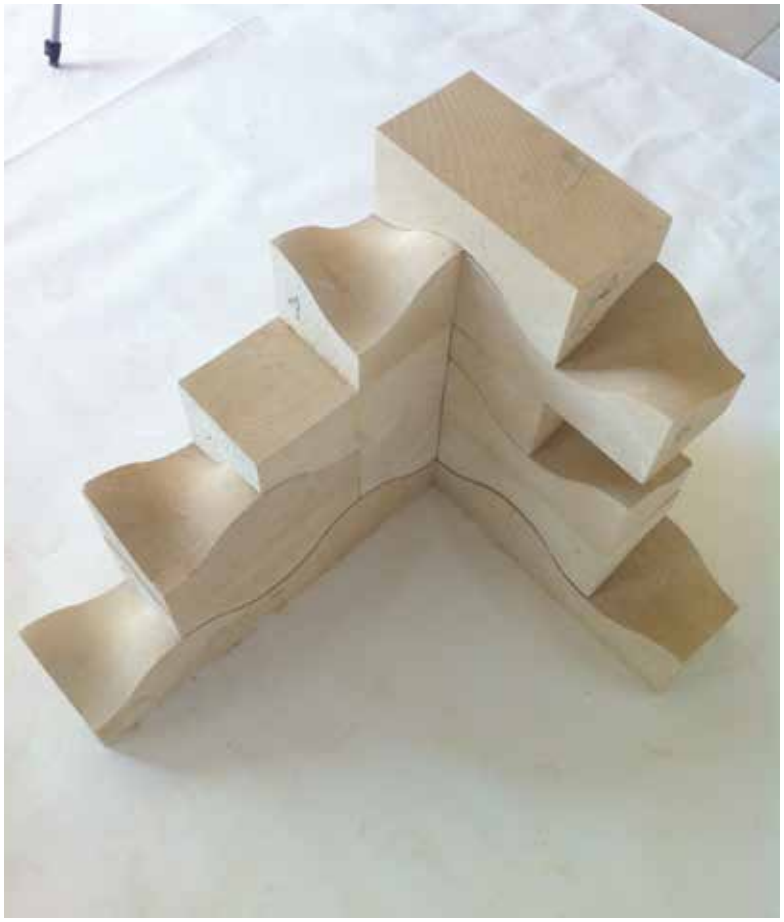
design	Giuseppe Fallacara, Yuri Estrin
collaborators	V. Minenna (Archviz)
materials	Pietra leccese - limestone
year	2014

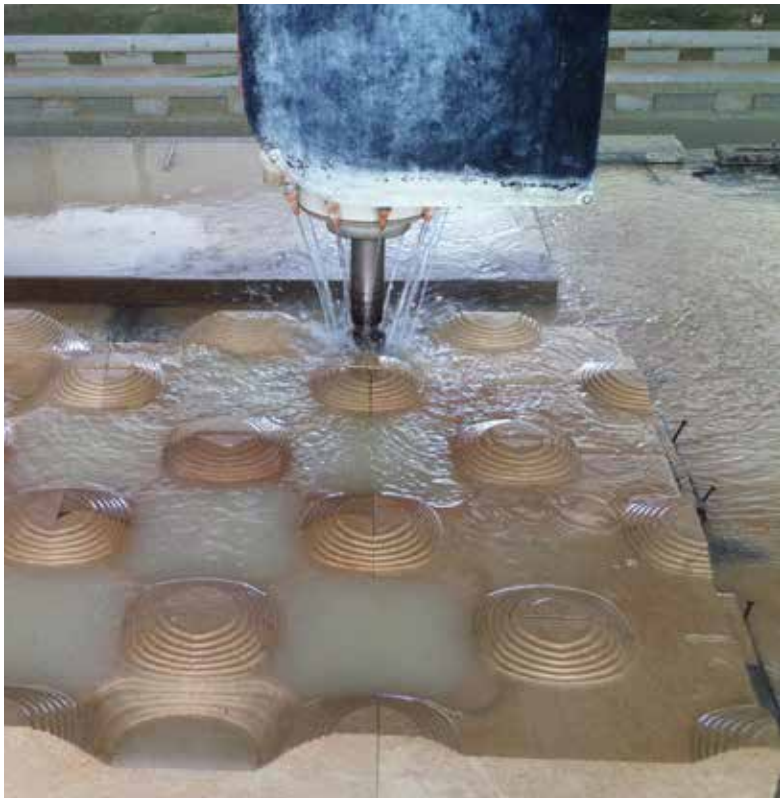


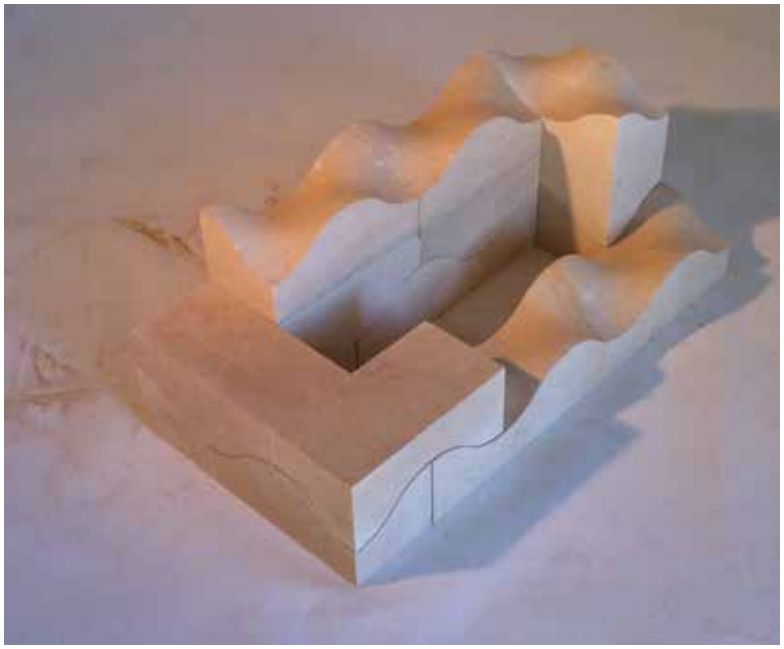
"Wave block wall" is an application of the patent by Yuri Estrin and his reserch team (A. Dyskin, E. Pasternak, Khor Han Chuan, G. Simon, A. Molotnikov and L. Goldin). This prototype is based on the principle of topological interlocking and analyzes the properties of the mortarless structures whose design is based on this principle. Our work focuses on structures built of osteomorphic blocks – the blocks possessing specially engineered contact surfaces allowing assembling various 2D and 3D structures. These structures are easy to build and can be made demountable. They are flexible, resistant to macroscopic fractures and tolerant to missing blocks. The blocks are kept in place without keys or connectors that are the weakest elements of the conventional interlocking structures. The overall structural integrity of these structures depends on the force imposed by peripheral constraint.

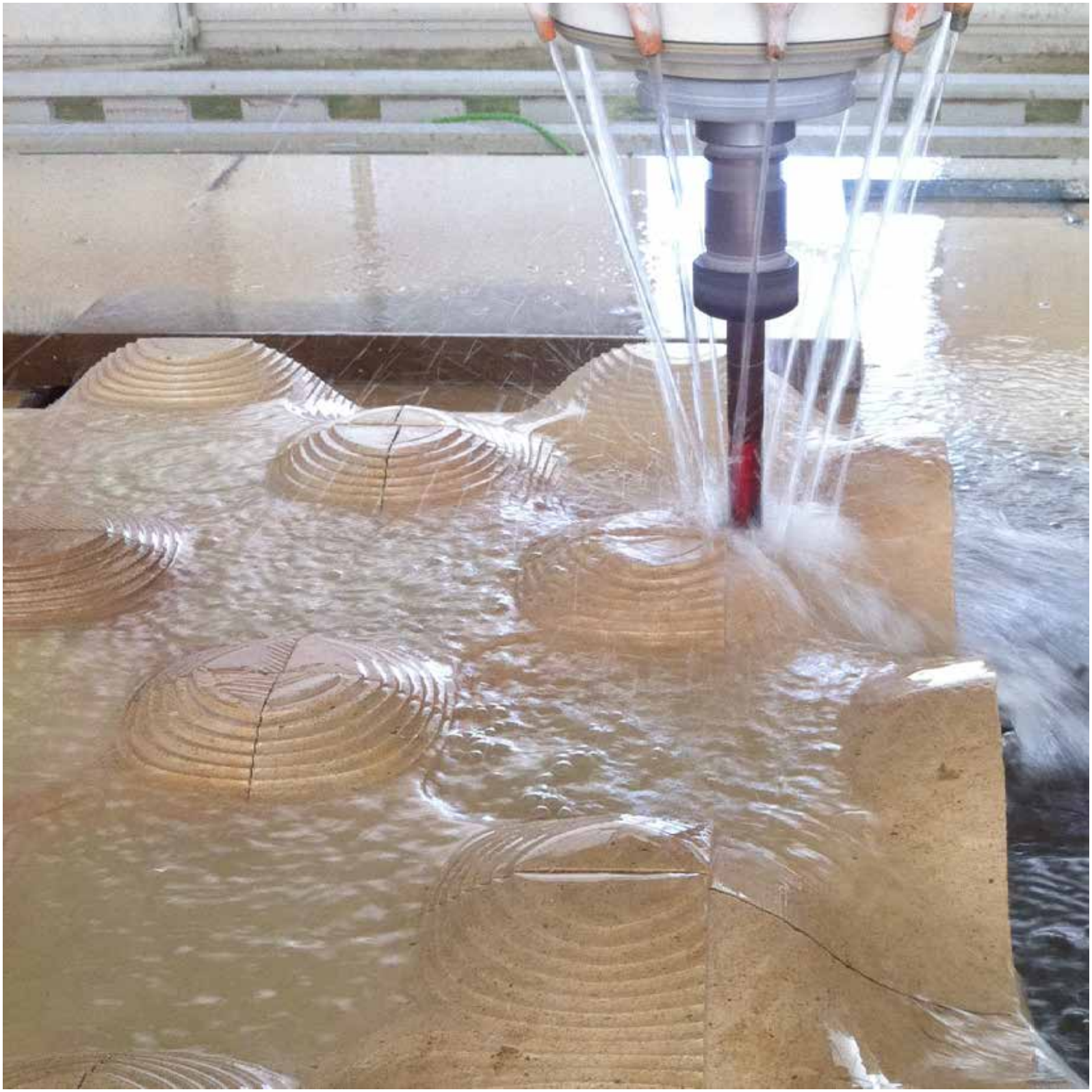
manufacturing company
PIMAR s.r.l.
www.pietraleccese.com

PIMAR
ITALIAN LIMESTONE



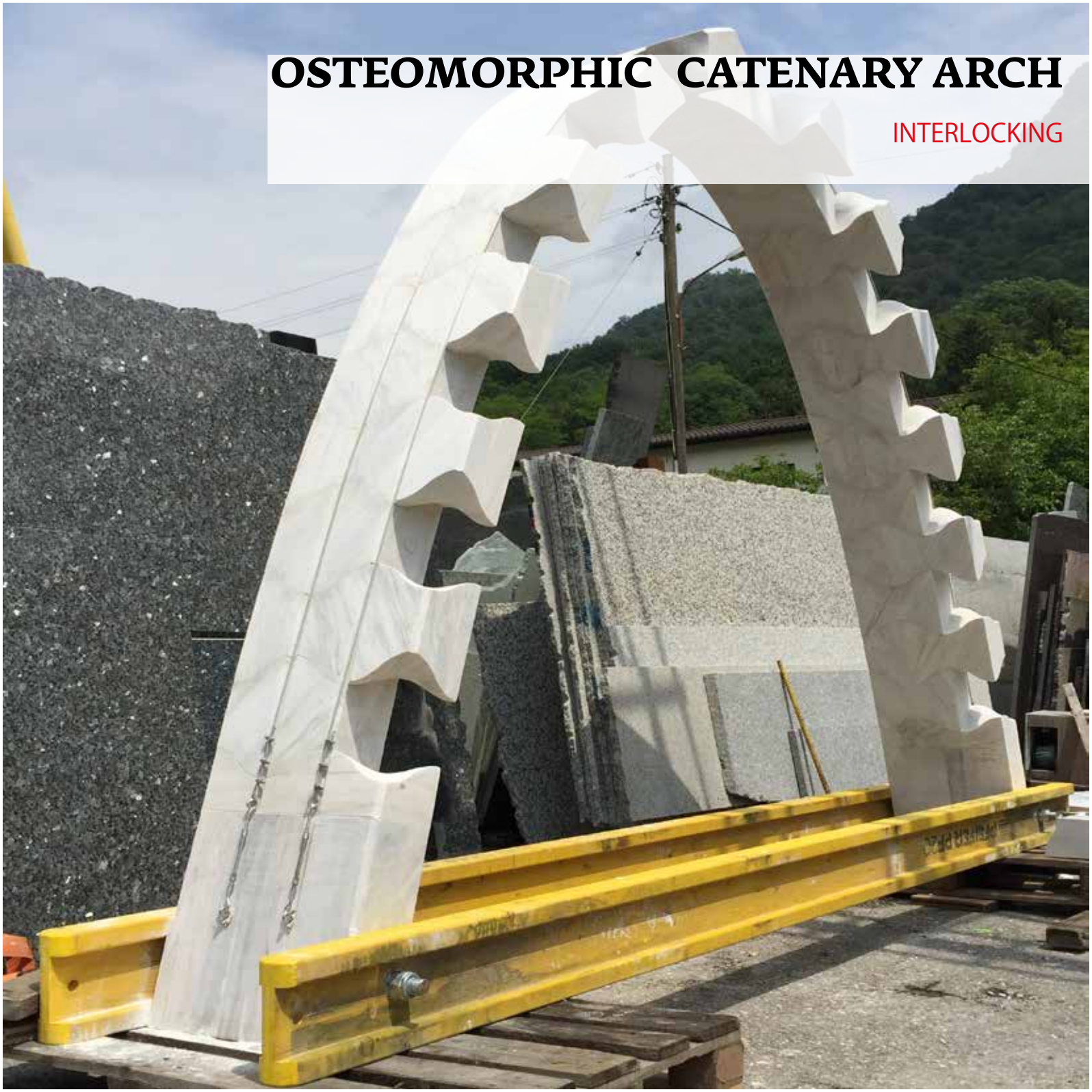






OSTEOMORPHIC CATENARY ARCH

INTERLOCKING



MARMOMACC TRADE FAIR

T&D ROBOTICS STAND
VERONA

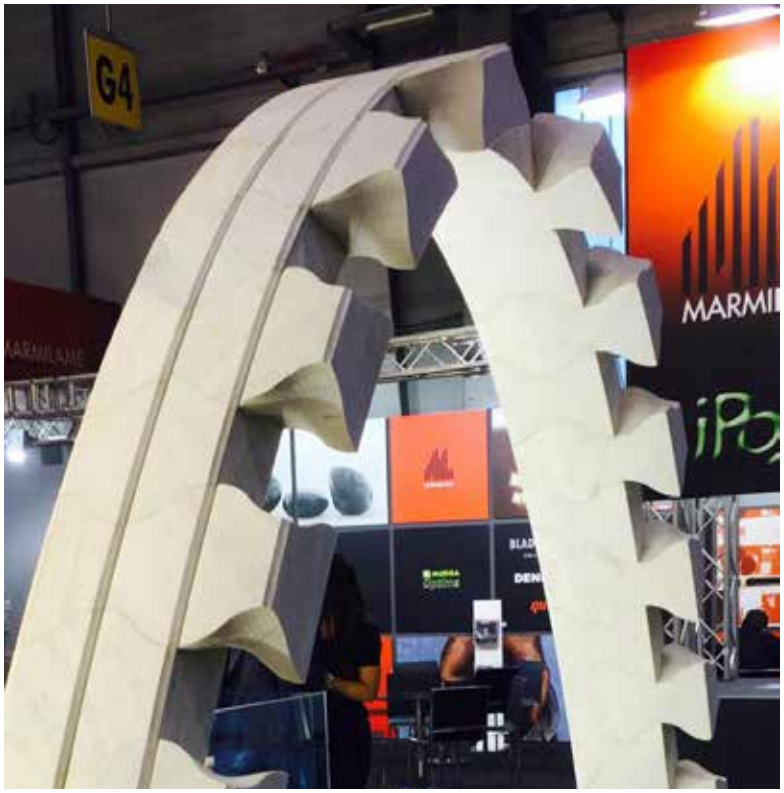
design	Giuseppe Fallacara
collaborators	V. Minenna (Archviz)
materials	Palissandro marble
year	2015

The catenary arch is an arch whose curve reminds of a long chain, held by both ends and left hanging. It looks like a parabola, but has a different geometry. The catenary arch is also called balanced arch because its shape allows a uniform load redistribution. Unlike other types of arches, it does not need either buttresses or other supporting elements and abutment. The catenary curve constitutes the base to match the osteomorphic stone blocks, similarly to the blocks having wave-shaped form composing the wall system described above. In this case, all the stone blocks undergo a topological deformation so they are geometrically similar but they have dimensional and angular variations being in a topological relationship. The realization of the individual blocks, by great geometric complexity, is only possible through the use of computerized numerical control machines. Each individual block was individually numbered in order to be easily identified for the next assembly step. Then, the blocks were placed on the ground and assembled to take the form of the catenary arch. The construction system applies also in barrel-vaulted systems with catenary section in a conception of mechanically mounting.

manufacturing company

GENERELLI sa
www.generelli.ch

T&D Robotics s.r.l.
www.tdrobotics.com


G4


B1


Vista concettuale del ponte

MODULAR STONE WALL

INTERLOCKING

SALONE INTERNAZIONALE DEL MOBILE

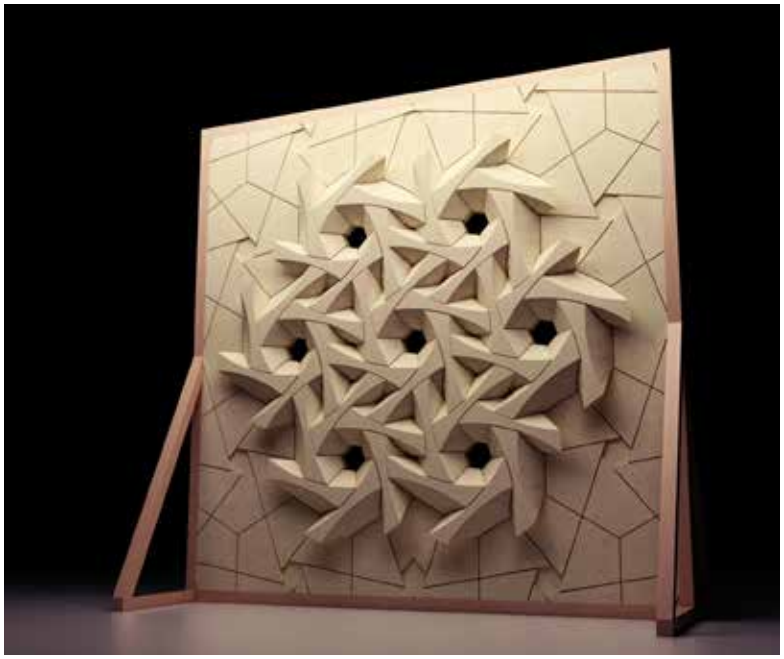
HABITAPULIA2020
MILANO

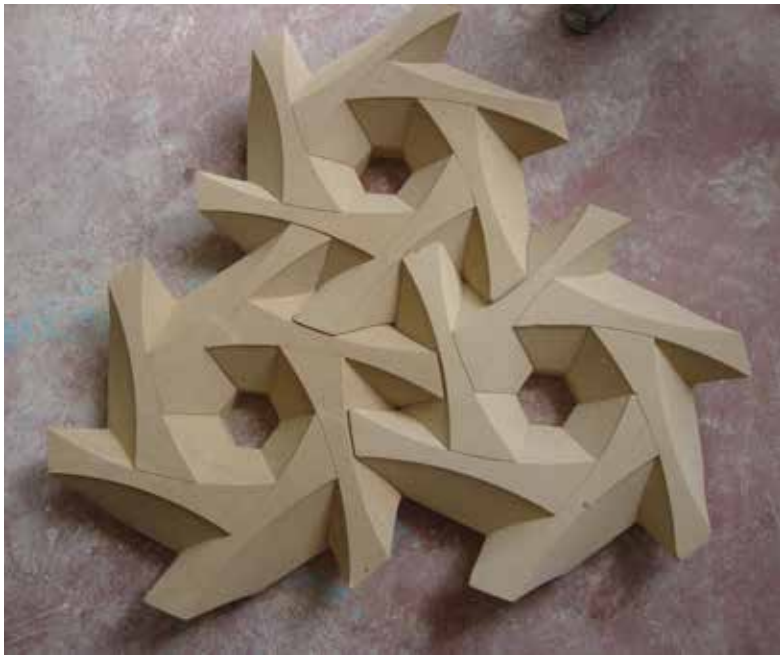
design	Giuseppe Fallacara, Marco Stigliano
collaborators	M. Barberio and M. Colella (Archviz)
materials	Pietra leccese - limestone
year	2014-2015

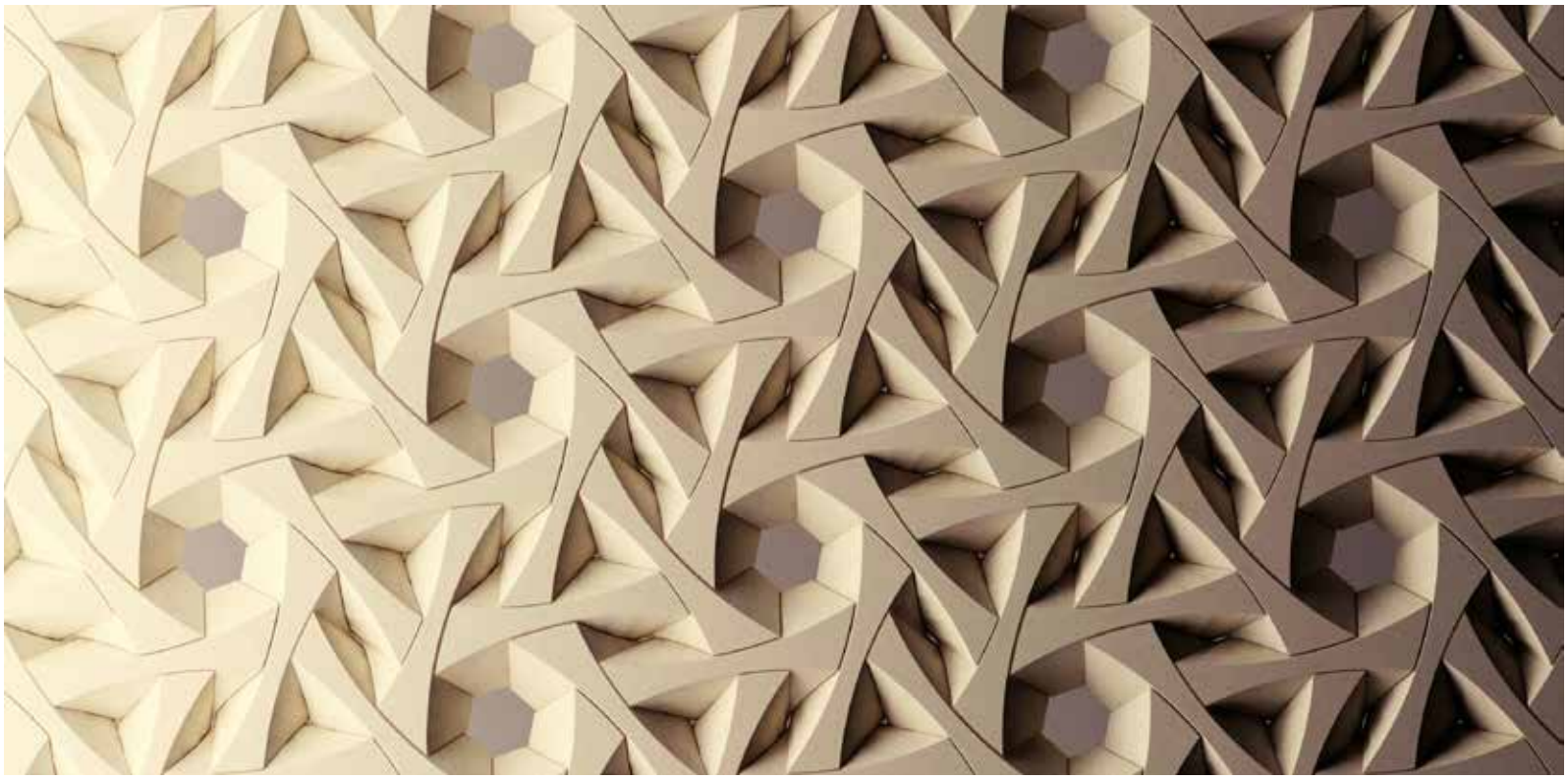
Modular Stone Wall is a decorative wall made of Lecce stone using innovative design taken from a variation of an ancient French patent (flat vault of Joseph Abeille) which constitutes a constructive system designed to build self-supporting vertical diaphragms, assembled thanks to the use of a few geometric ashlars. The mutual assembly of the individual blocks, interlocking with each other, visually gives the idea of solidity of the parts due to the particular topography of the entire construction system, which resembles to a fabric weave. The system can be used as porous wall to filter the sunlight and to decorate the building whose design and material typically reminds to the Mediterranean area, thanks to the use of solid geometric stone tile.

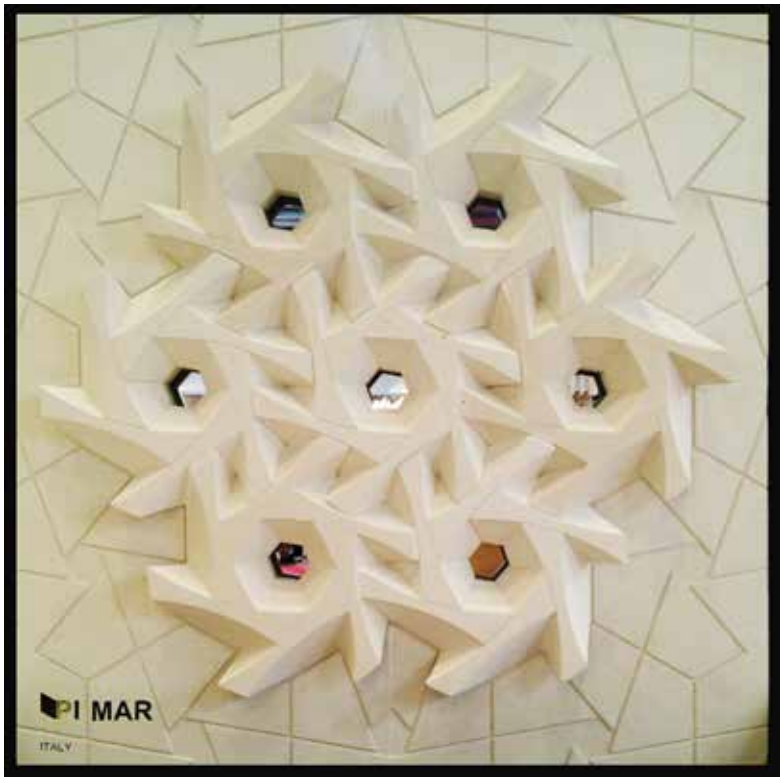
manufacturing company
PIMAR s.r.l.
www.pietraleccese.com

PIMAR
ITALIAN LIMESTONE





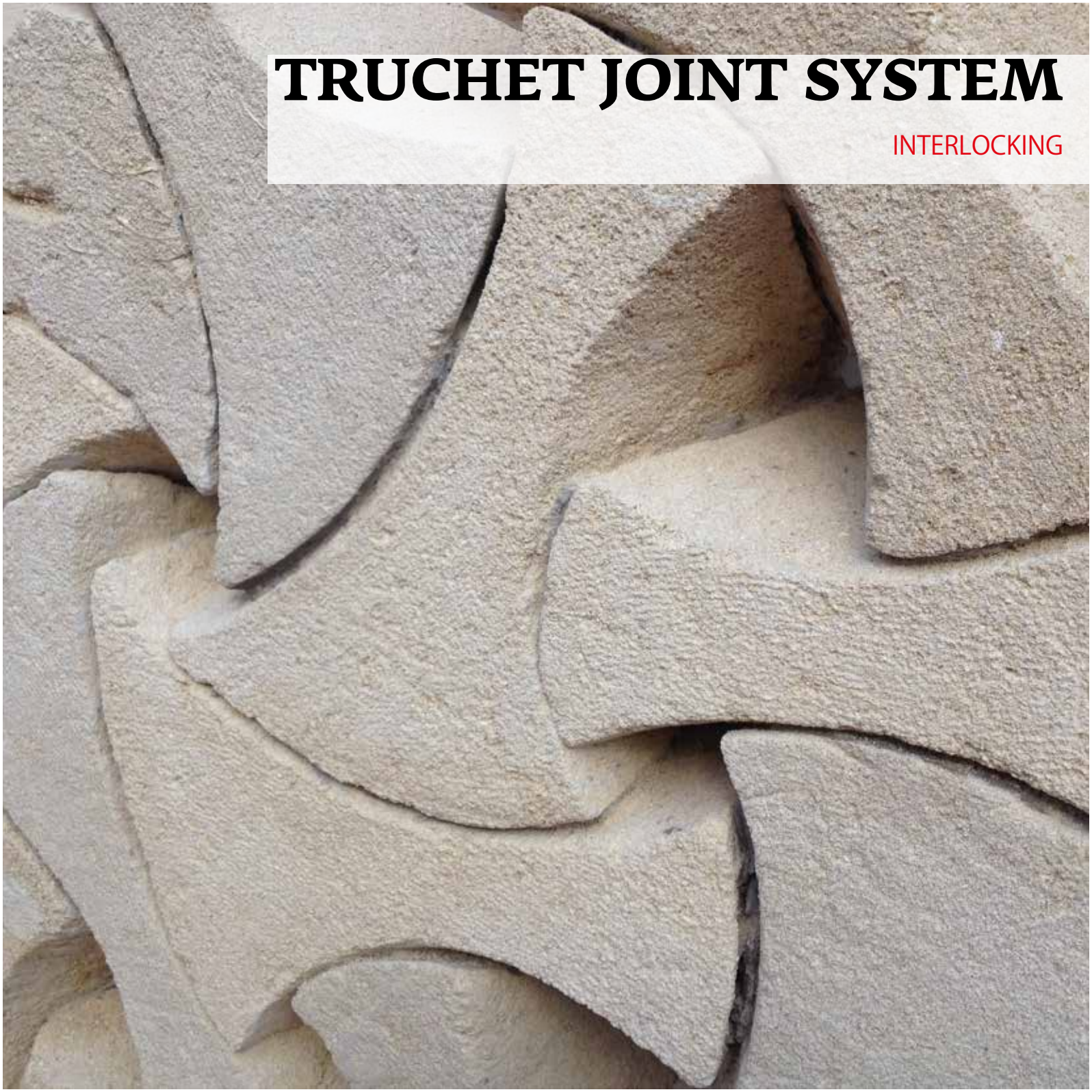



I MAR
ITALY


18C
I MAR

TRUCHET JOINT SYSTEM

INTERLOCKING

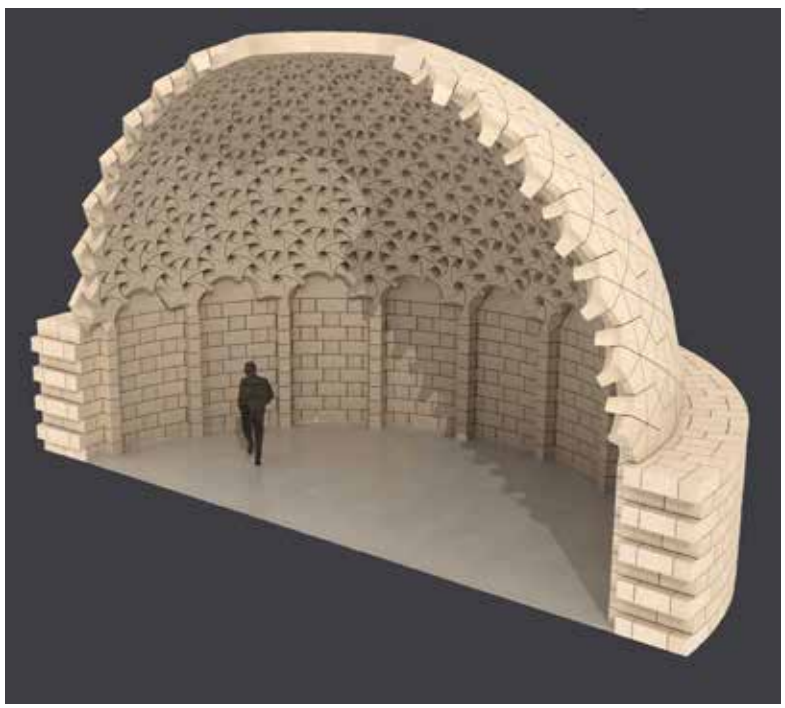


CESAR WORKSHOP

COURS DE ENSEIGNEMENT SUPÉRIEUR EN ARCHITECTURE ET RESTAURATION
TRANI

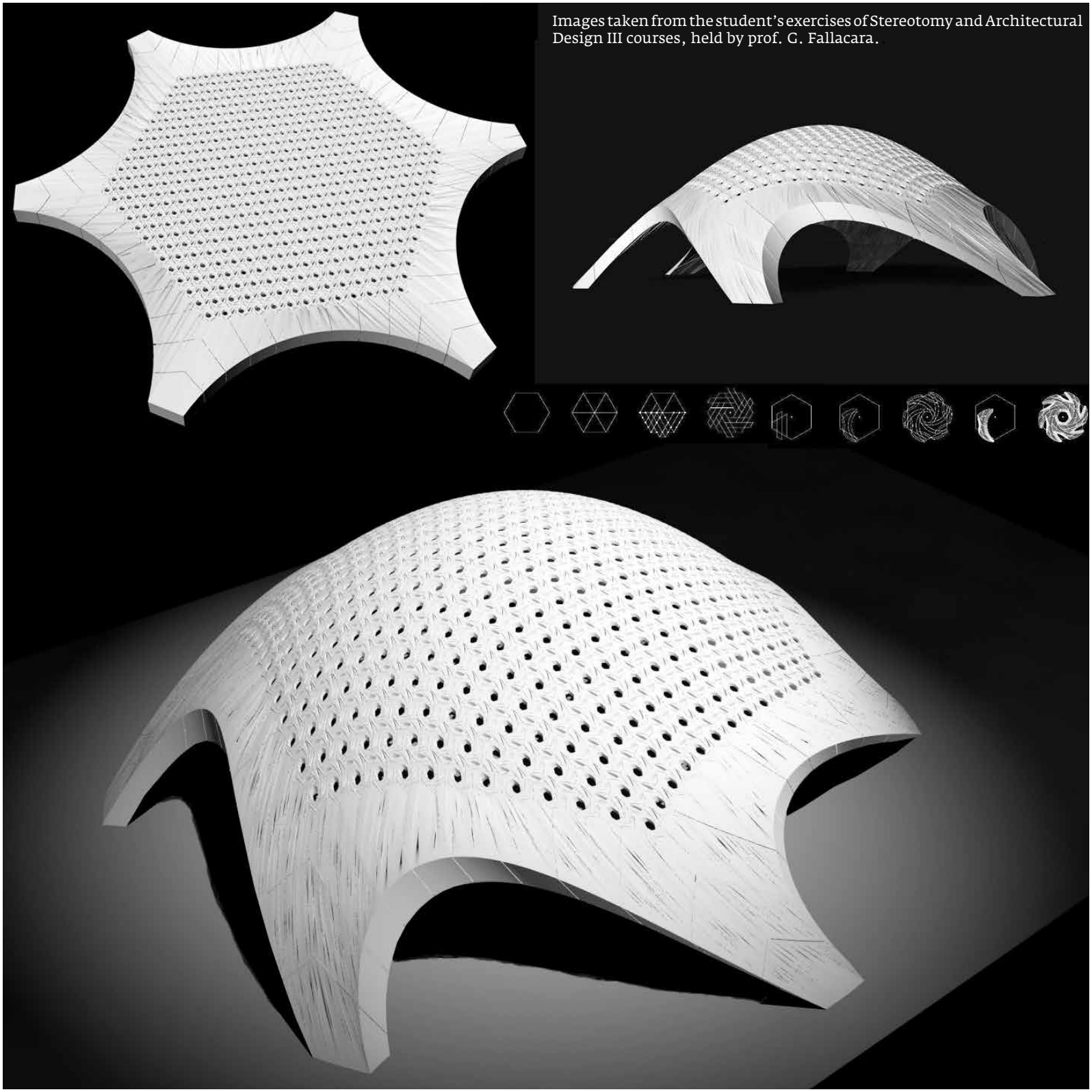
design	Giuseppe Fallacara
collaborators	L. Tamborero (fabrication)
materials	Tufo di Gravina
year	2014

The Truchet Joint system is a specific type of wall-building technique that takes its name from Dominican priest Sébastien Truchet (1657 – 1729) who invented the patent of the flat vault with blocks by curvilinear joints (variant of the straight flat vault of Joseph Abeille).
The stereotomic system known as voute plate is one of the most interesting technical-stylistic responses offered by stone masonry to the world of construction, a solution that, however, has been very rarely used. The basis assumption underpinning this type of vault is a static principle according to which the loading path above the structure is conducted both vertically and horizontally, using a careful weaving together of wedge shaped ashlars, creating a successfully compressed vault. Two surfaces are visible when the vault is completed, that is the square, homogenous and continuous web of the extrados, and the intrados, characterized by an interesting plaiting with curvilinear patterns.

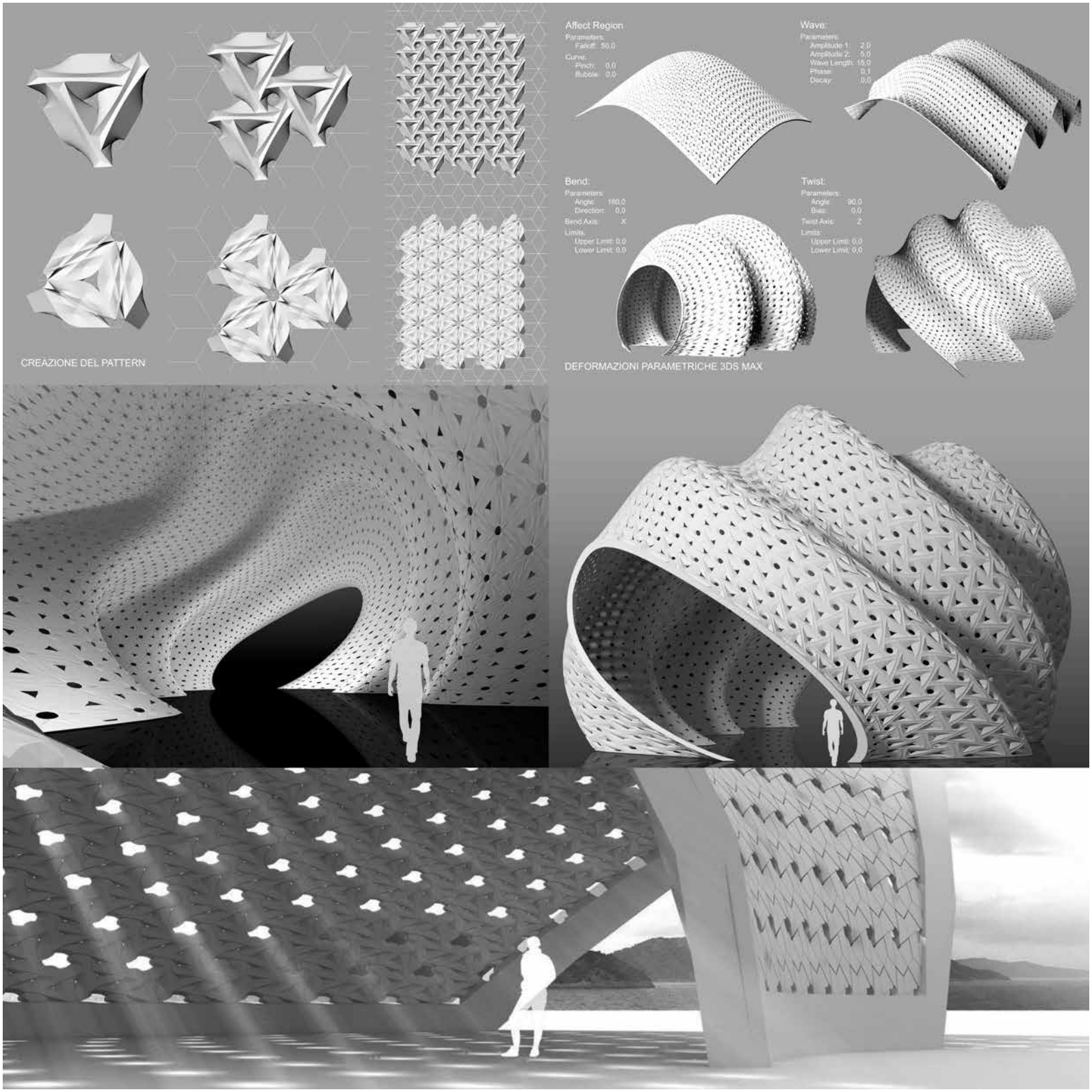


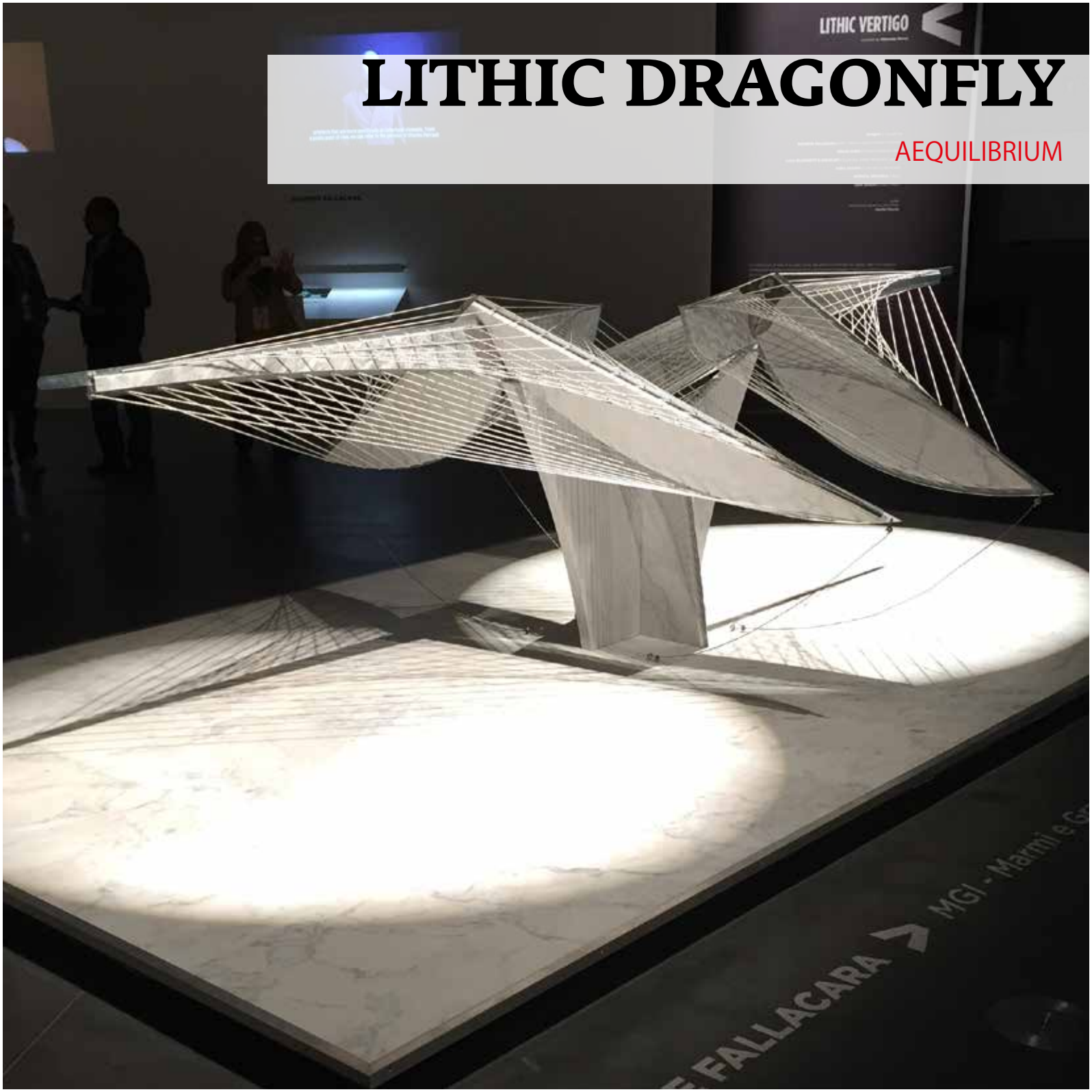
manufacturing company
ROMEO srl
www.ateliers-romeo.it

Ateliers Romeo



Images taken from the student's exercises of Stereotomy and Architectural Design III courses, held by prof. G. Fallacara.


Affect Region
Parameters:
Falloff: 50,0
Curve:
Pinch: 0,0
Bubble: 0,0
Wave:
Parameters:
Amplitude 1: 2,0
Amplitude 2: 5,0
Wave Length: 15,0
Phase: 0,1
Decay: 0,0
Bend:
Parameters:
Angle: 180,0
Direction: 0,0
Bend Axis: X
Limits:
Upper Limit: 0,0
Lower Limit: 0,0
Twist:
Parameters:
Angle: 90,0
Bias: 0,0
Twist Axis: Z
Limits:
Upper Limit: 0,0
Lower Limit: 0,0
CREAZIONE DEL PATTERN
DEFORMAZIONI PARAMETRICHE 3DS MAX



LITHIC DRAGONFLY

AEQUILIBRIUM

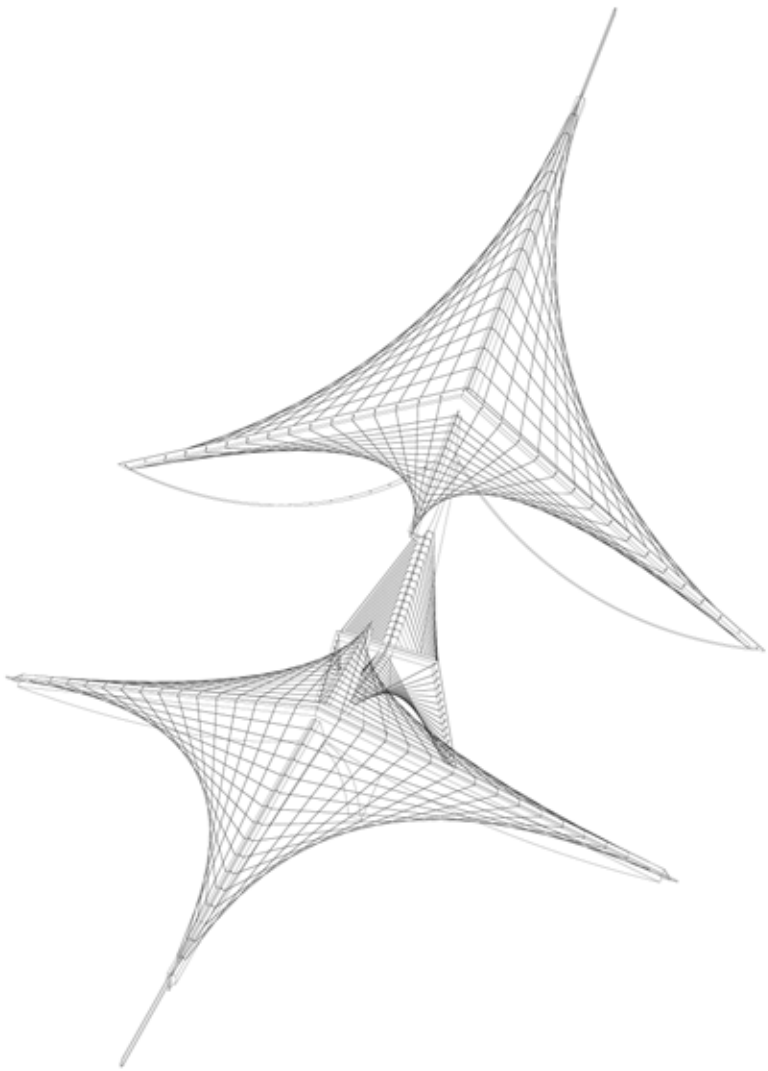
MARMOMACC TRADE FAIR

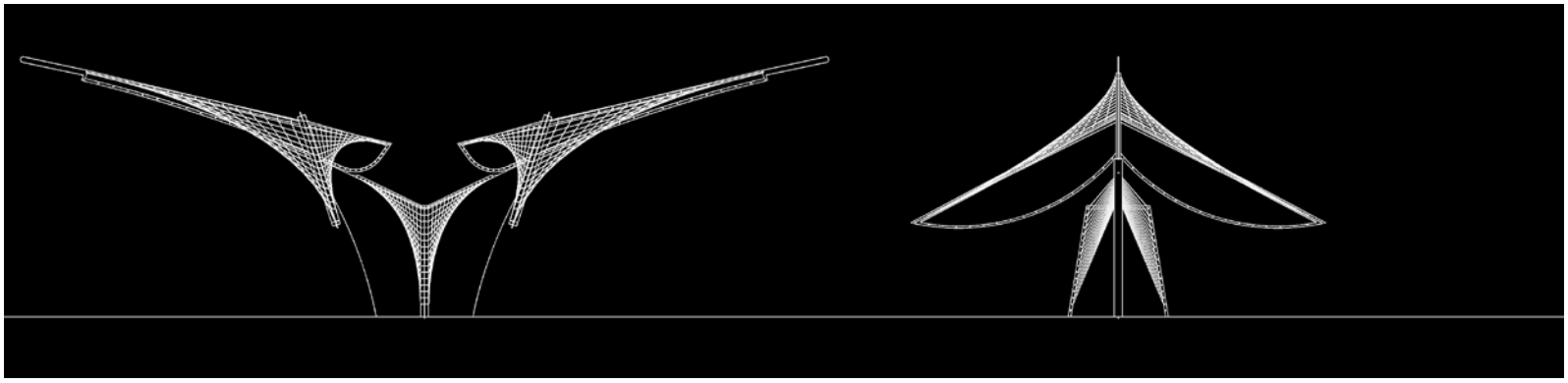
LITHIC VERTIGO
VERONA

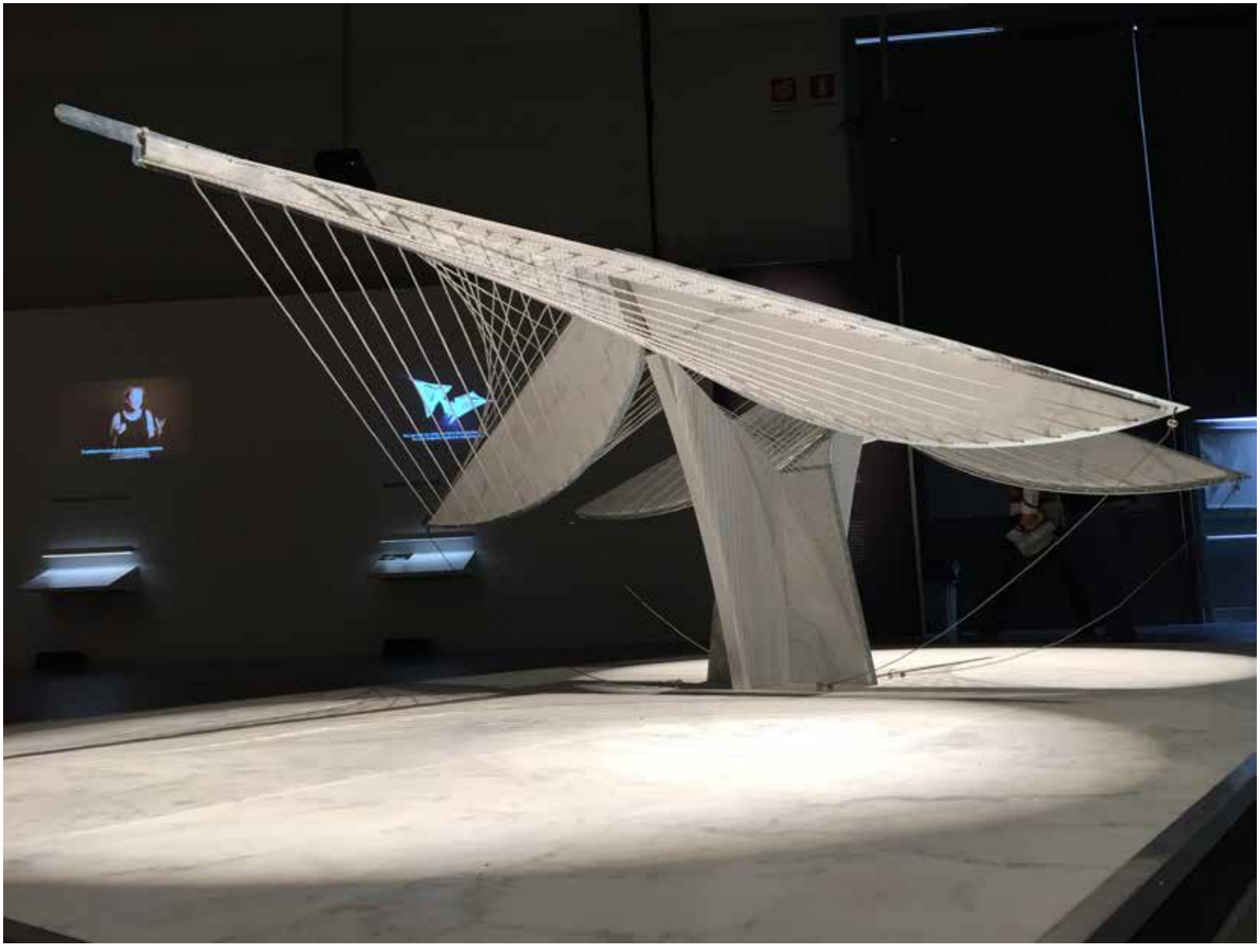
design	Giuseppe Fallacara
collaborators	D. Malomo (structural analysis), M. Barberio (Archviz and 3D modeling)
materials	Carrara marble
year	2015

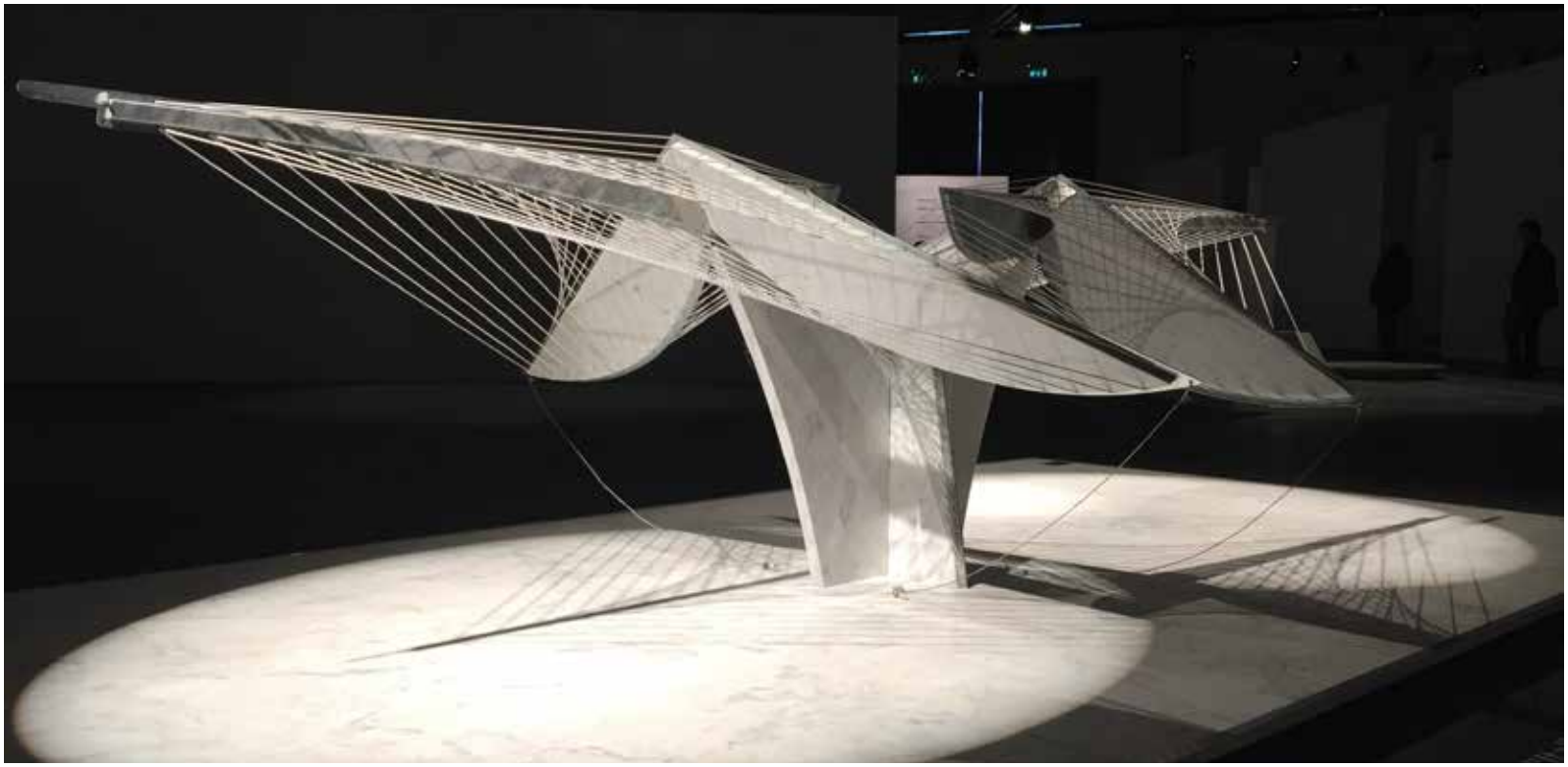
Vertigo is the feeling you can have when looking at an acrobat, who uses a pole as wings to keep his centre of mass aligned to the rope and maintain his balance. In nature, you may observe this phenomenon in the beautiful shape of a dragonfly. Lithic Dragonfly is a tribute to this paradox between “heavy materials” and “light forms”, as the ancient theoretical assumption made by Charles Perrault in his quest for authentic stereotomic design: the art of using the heaviness of stone to enhance the lightness of forms. As in stereotomy, forms requires static conditions and the exact form of the structure of the Lithic Dragonfly requires a condition of stable balance, in order to develop new self-balancing architectures made of cut stone. The experiences arising from the “Stone Balancing” activities are based on the available balance of stones and boulders of various shapes without any further support except for the forces of gravity. In other words, the implementation of a lithic sculpture in which the center of gravity coincides with the discovery of the successful realization of the artwork.

manufacturing company
MGI Italy srl
www.marmiegraniti.it



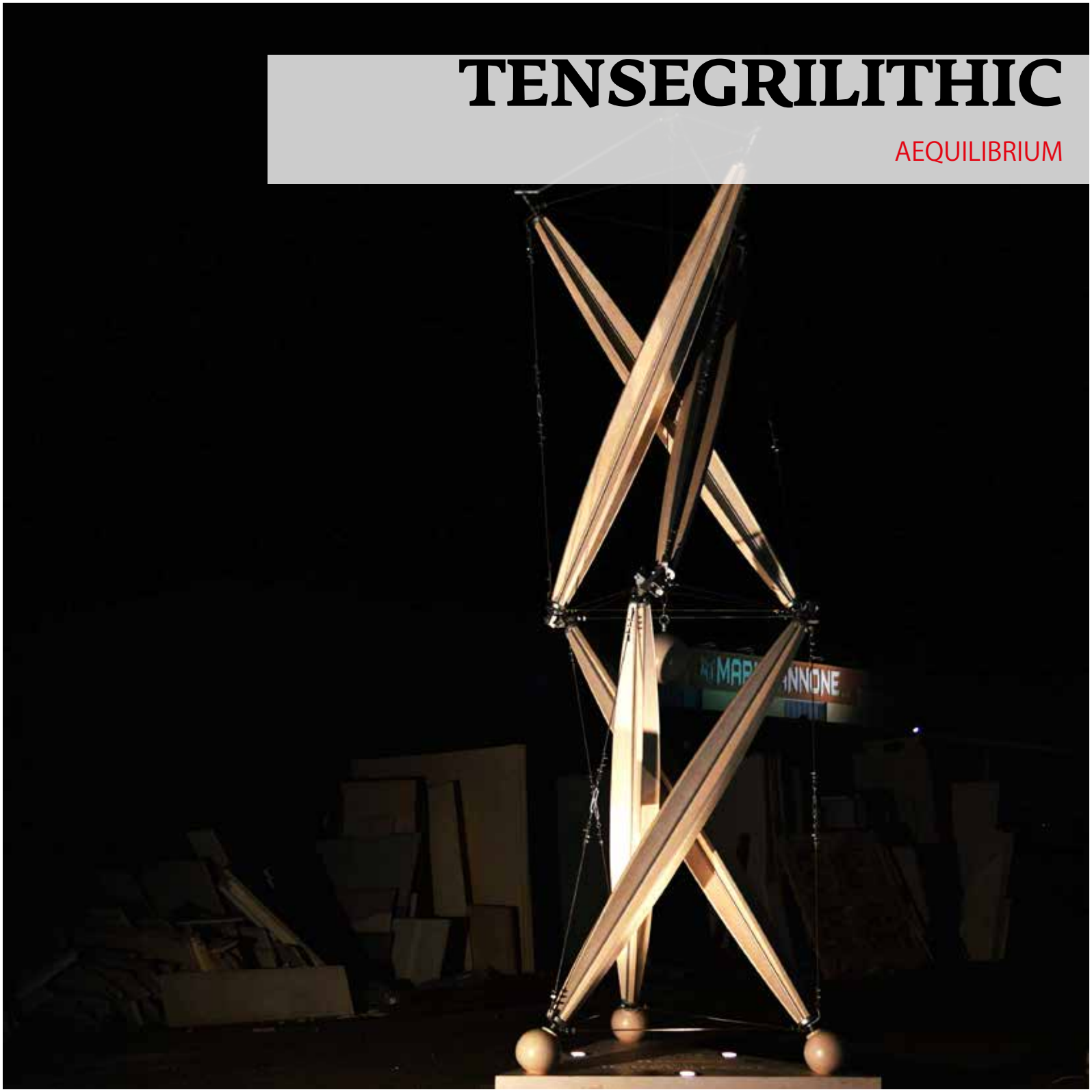






TENSEGRILITHIC

AEQUILIBRIUM



MARMOMACC TRADE FAIR

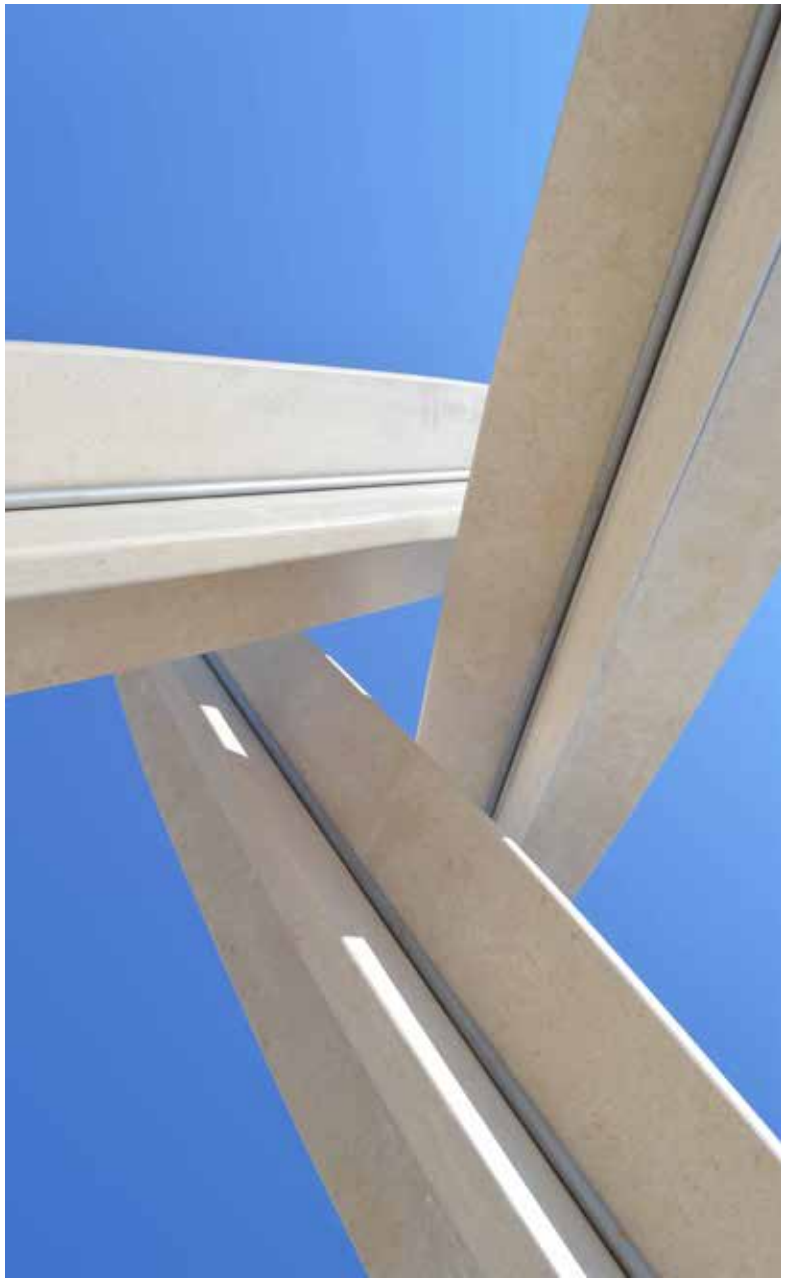
INSIDE MARMOMACC
VERONA

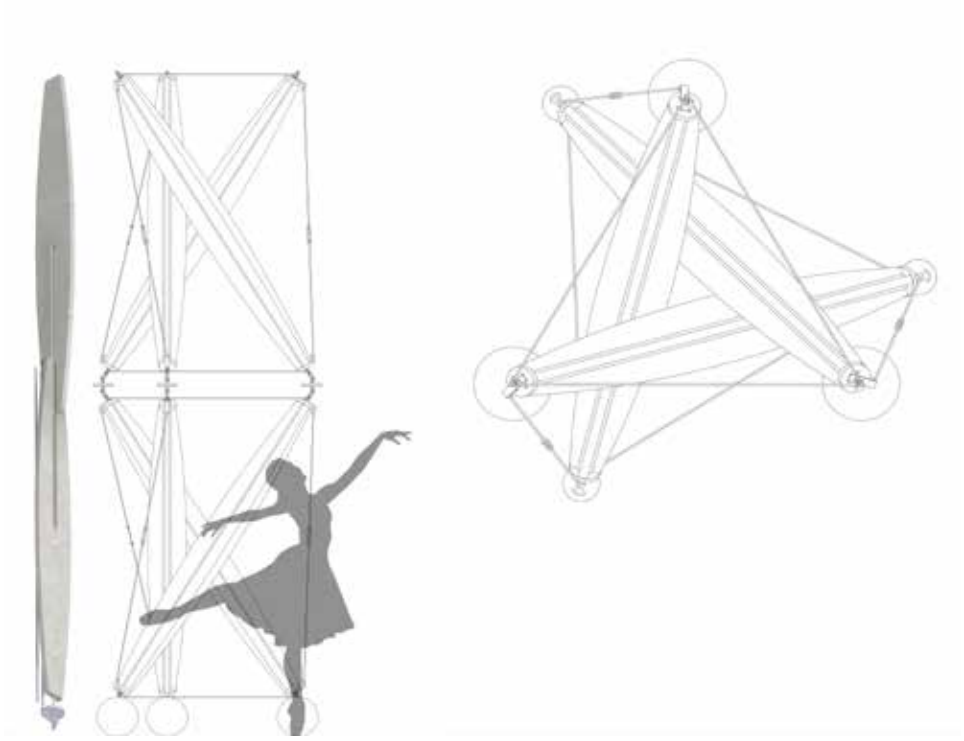
design	Giuseppe Fallacara, Marco Stigliano
collaborators	A. Mangione (2D drawings)
materials	Apricena stone and steel
year	2013

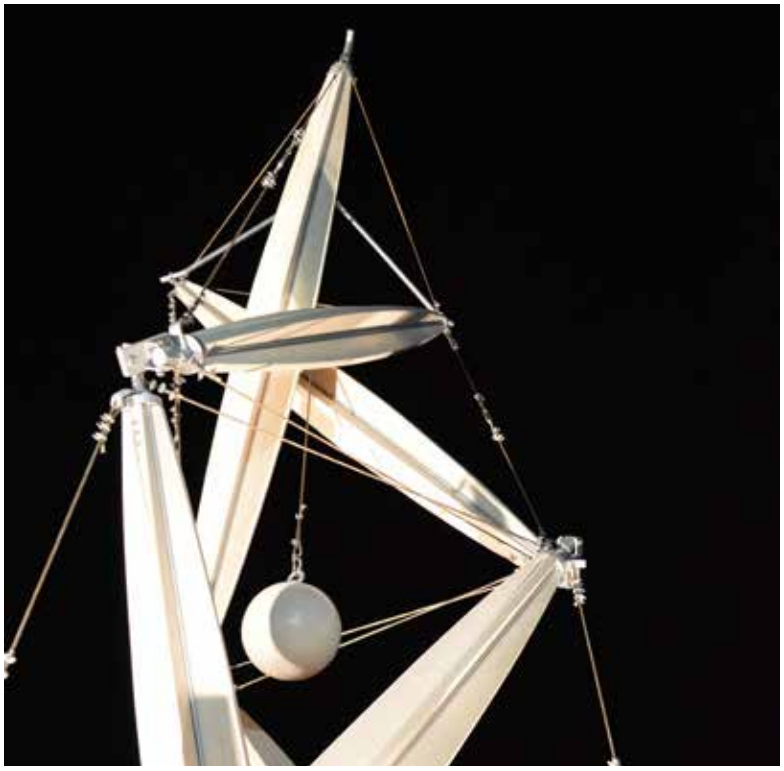
The "Tensegrilithic" prototype came about from the desire to create the first "Tensegrity" using stone materials. The "Tensegrilithic" prototype, takes its name from the English term "Tensegrity", that was coined in 1955 by architect Richard Buckminster-Fuller and derives from the combination of the words "tensile" and "integrity". It characterizes the ability of a system to stabilize itself mechanically through forces of tension and compression shared and balanced among each other. Compression and traction balance each other out within a closed vector system. Tensegrity structures comprise rigid bars and flexible cables. The cables are a continuous configuration that compresses the bars arranged intermittently within this configuration. Stone bars or struts, in turn, push the cables outwards. The advantages of the Tensegrity structure are: the **resistance** of the combined structure collection, that exceeds far the sum of the resistances of the individual components; the **lightness**: at par with mechanical strength, a Tensegrity structure weighs about less than half a compression structure; the **flexibility** of the system is similar to that of a pneumatic system.

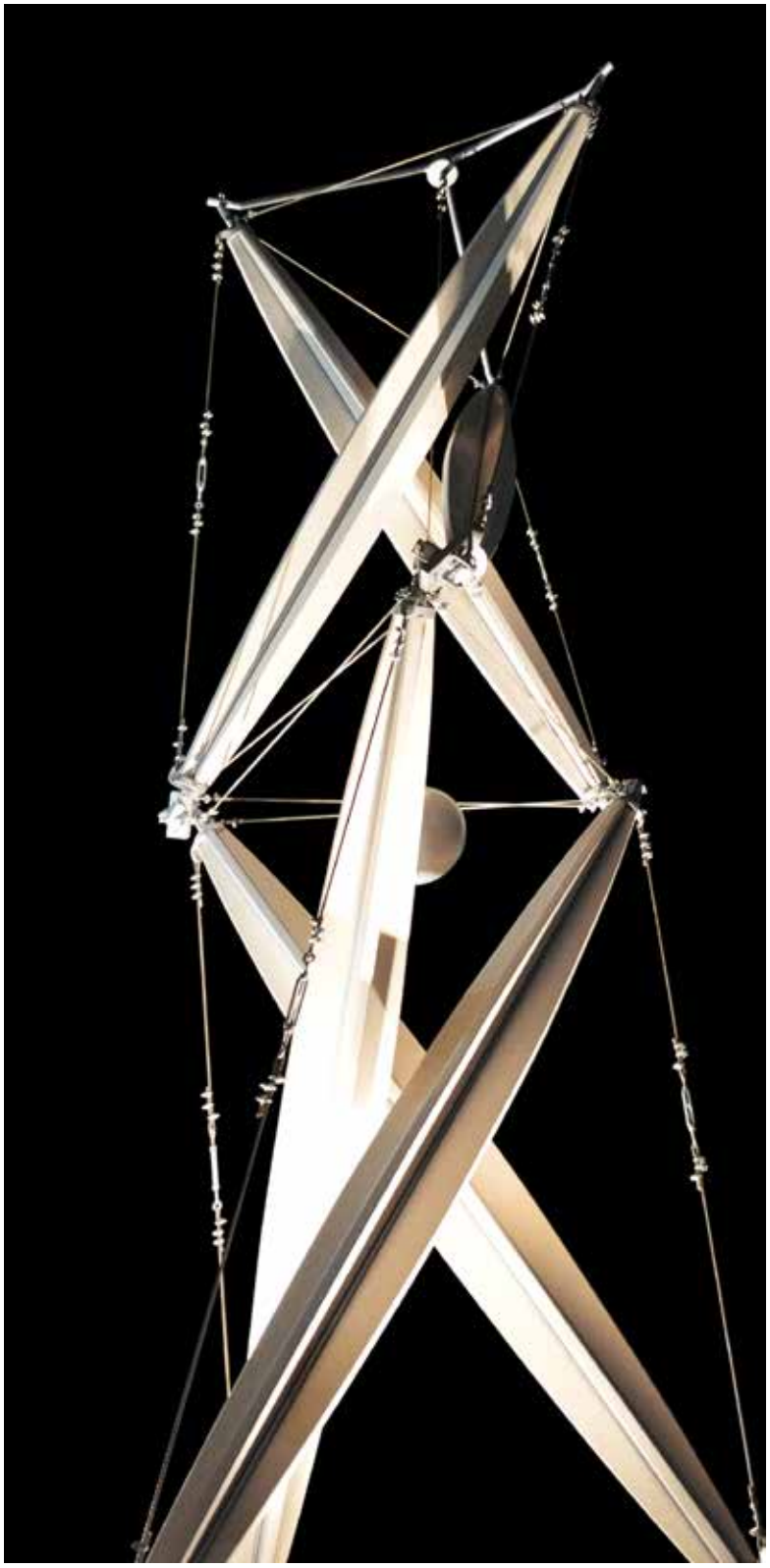
manufacturing company
MARMI IANNONE snc
www.iannonemarmi.it

MARMI **IANNONE**
Corato, Bari










CAPSULE
AEQUILIBRIUM

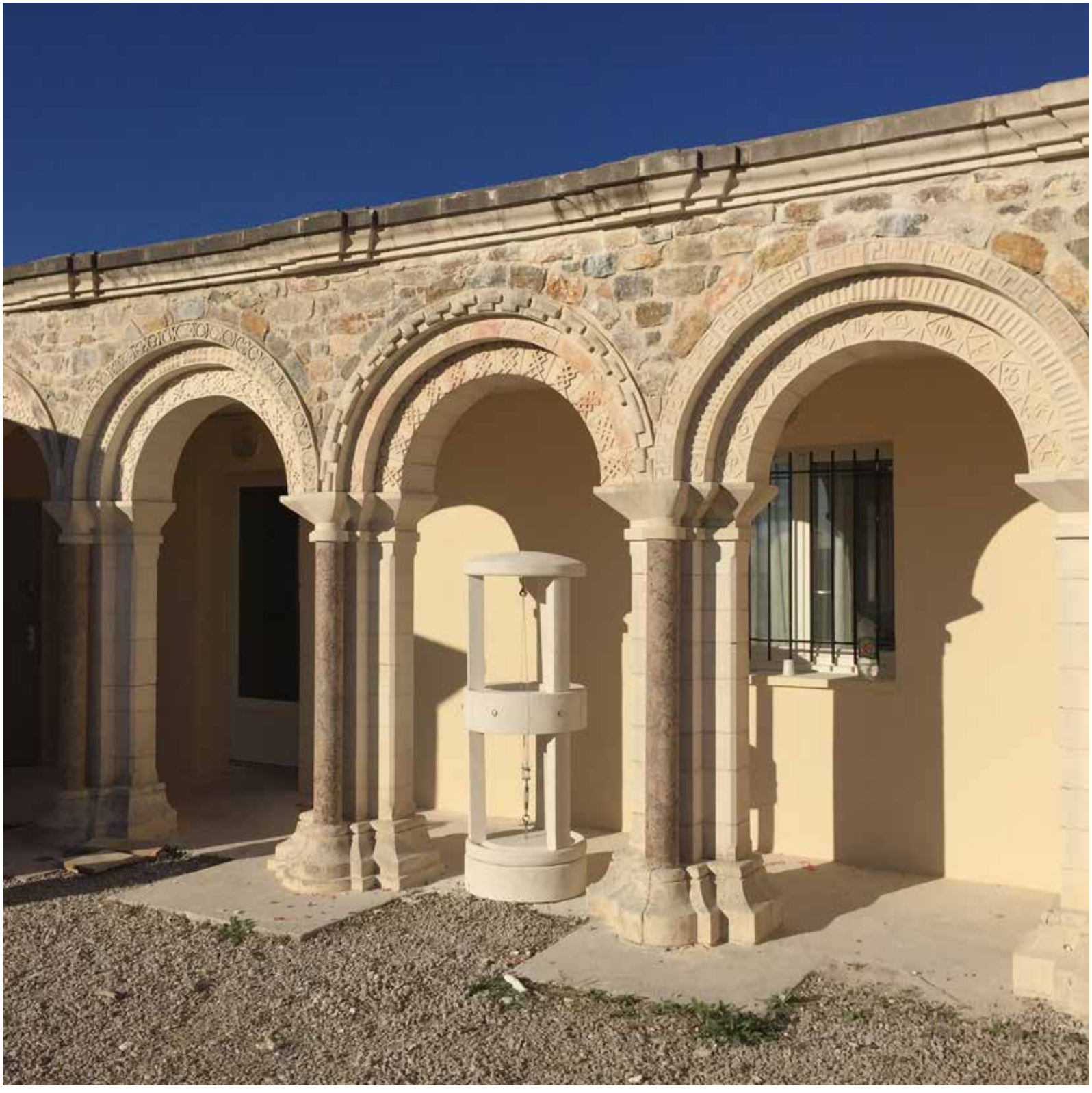
ASA ADVANCES IN STEREOTOMY ARCHITECTURE

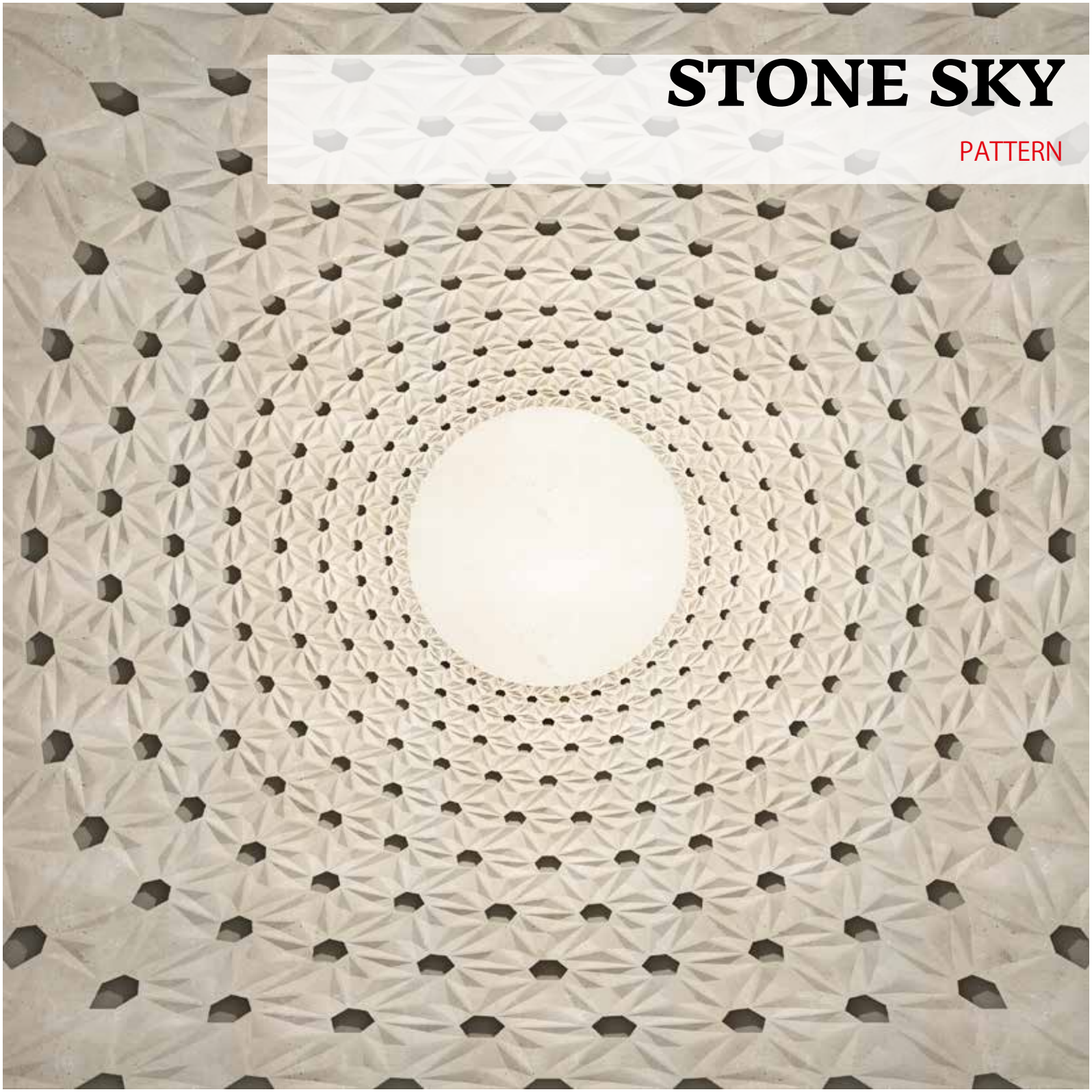
SUMMER SCHOOL
BRIGNOLES

design	Giuseppe Fallacara
collaborators	M. Barberio (Archviz)
materials	Pierre d'Estailiades
year	2016

Capsule is the name of a pre-stressed cylindrical stone cell. It is the proposal of a stone bell tower in total state of pre-stressing. All the single stone elements/ashlars blocks are joined and in compression using post-tensioned steel cables. The prototype has been realized to make a static and dynamic resistance test of the structure also subjected to horizontal stresses due to the particular conformation of the base of the capsule that does not allow to stabilize itself. This endurance test simulates the behaviour of the cylindrical structure under the wind load.

manufacturing company
Atelier de la Pierre d'Angle
www.facebook.com/Atelier-de-la-Pierre-dAngle

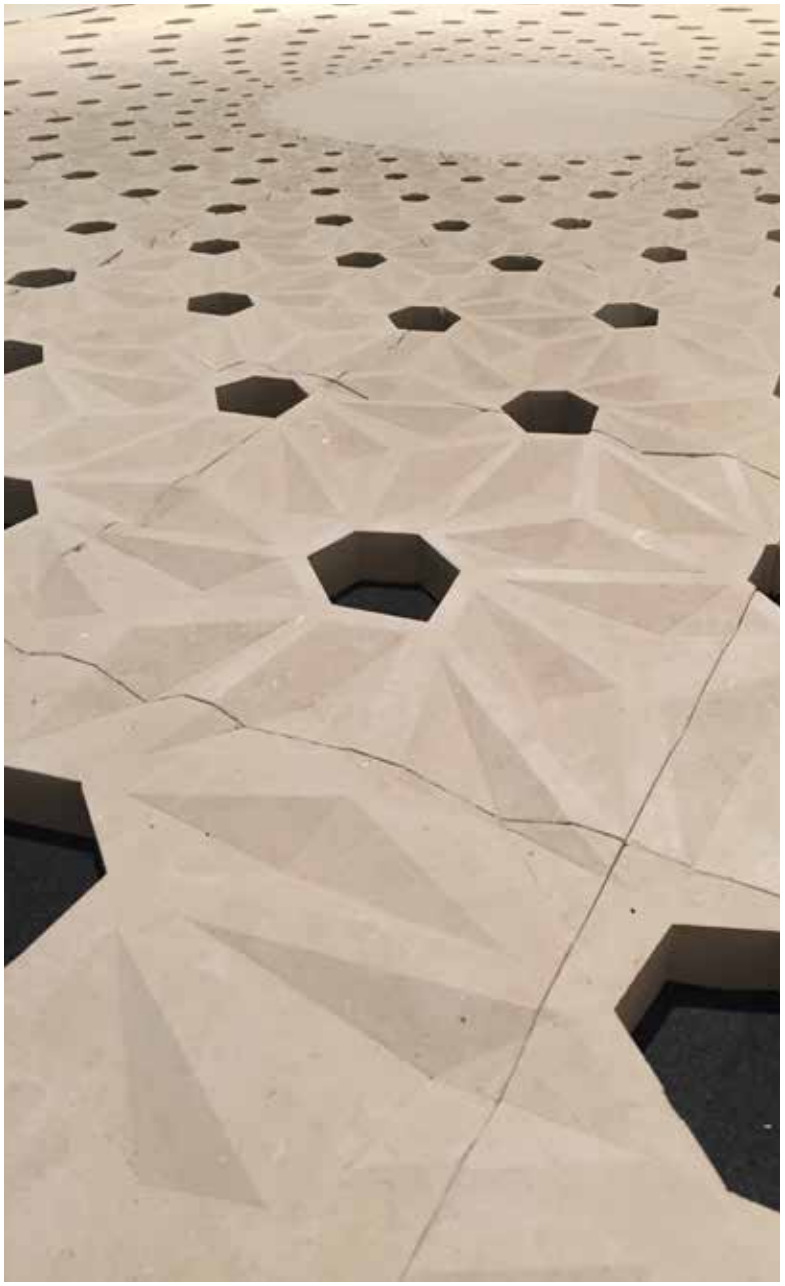



STONE SKY
PATTERN

MARMOMACC TRADE FAIR

CARPETS OF STONE
VERONA

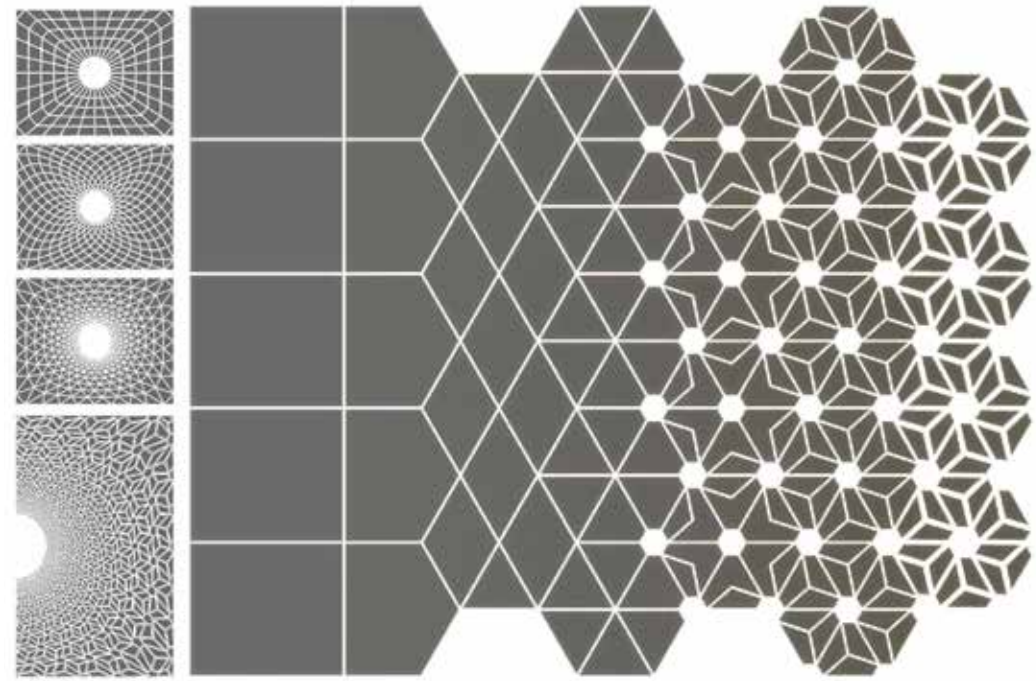
design	Giuseppe Fallacara
collaborators	M. Barberio (Parametric design)
materials	Pietra leccese - limestone
year	2015

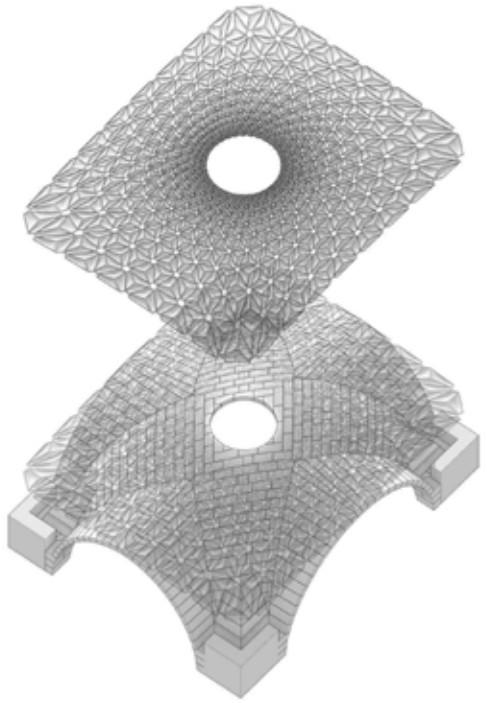


"Carpets of Stone" was the name of the presentation within the framework of Marmomacc 2015's "Italian Stone Theatre" and Stone sky is one of eight works presented. *Stone Sky - Above a starry sky* is an installation featuring Lecce Stone, used to cover the floor of the terraces above Lecce's traditional vaulted-ceiling rooms. This is the idea behind Stone Sky, a clear allusion to the Milky Way, the Galaxy par excellence, which contains our solar system. Placed above Salento's traditional vaulted structure, the three-dimensional geometry of this flooring/surface evokes the celestial space of the stars. Stone Sky is a star-studded carpet over a vaulted ceiling. This theme is encompassed within the broader theme of extrados domes with geometric decorations, which find their highest expression in Mediterranean Mamluk domes.

manufacturing company
PIMAR s.r.l.
www.pietraleccese.com

PIMAR
ITALIAN LIMESTONE





CREATRIVITREE

PATTERN

WORKSHOP AT NUST MISIS

FAB LAB MISIS
MOSCOW

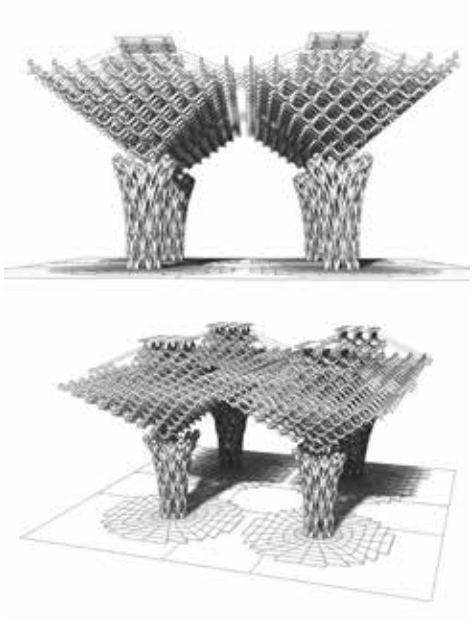
design	Giuseppe Fallacara
collaborators	V. Kuznetsov (FabLab MISIS - Fabrication)
materials	Pietra leccese - limestone and PLA
year	2016

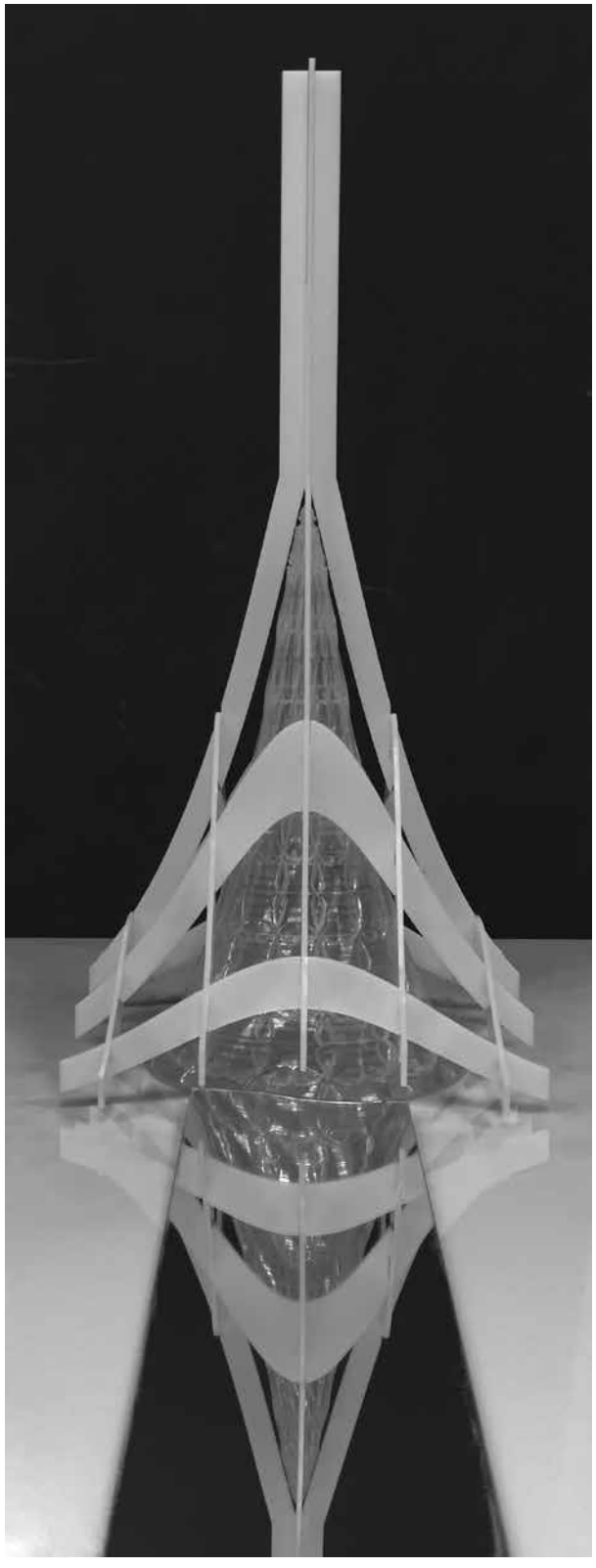
The workshops Creativi_tree (poetically, the tree of creativity aims to construct a demonstration-prototype concerning the potential of design tools and implementation in a modern Fab Lab. The prototype has the form of a tree and is composed of different parts built with different technology available in a Fab Lab: Laser cutting (roots), 3d Printing of large size (trunk), wood milling machine (ramifications). The basic theme of the prototype is the three-dimensional interlacing patterns, with different sequences and patterns, which uses different materials and which is made using different manufacturing techniques. Portion suspended from the ceiling. Portion resting on the ground. The trunk of the tree, resting on the ground, is a monolithic block of Lecce's stone decorated with a three-dimensional interlacement shape pattern. It was made by 3D parametric software and a CNC robot.

manufacturing company

PIMAR s.r.l.
www.pietraleccese.com

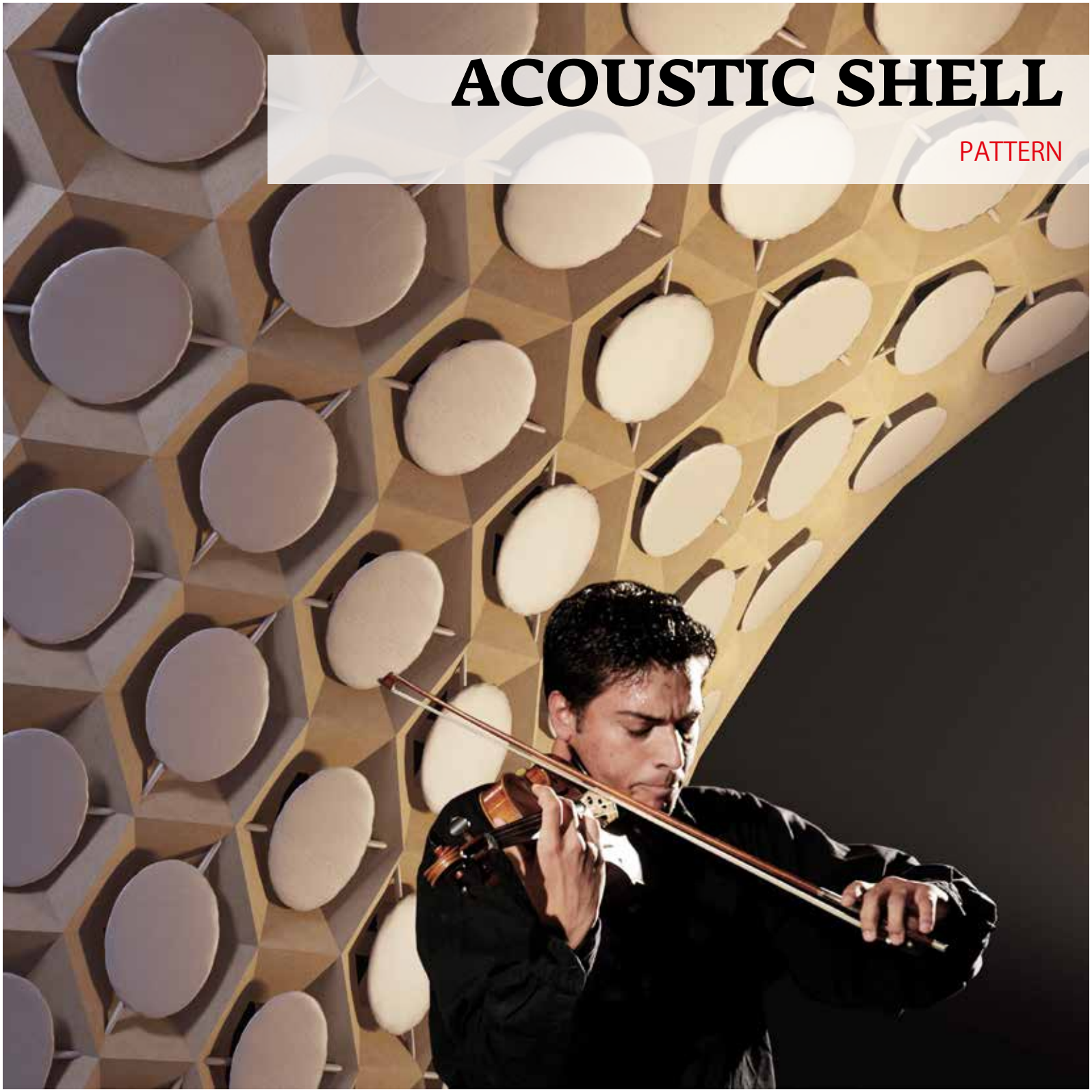
Misis Fablab
www.fablabs.io/fablab77





ACOUSTIC SHELL

PATTERN



CESAR WORKSHOP

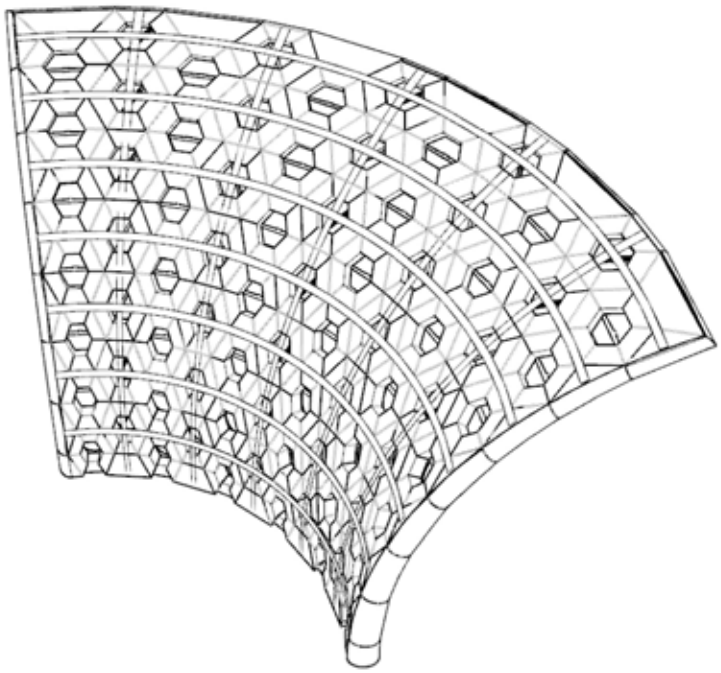
COURS DE ENSEIGNEMENT SUPÉRIEUR EN ARCHITECTURE ET RESTAURATION
TRANI

design	Giuseppe Fallacara
collaborators	M. Barberio (Parametric design), P. Vergonjeanne (fabrication)
materials	Travertino
year	2016

The acoustic shell is a double-curved stone shell creating a cantilevered fan-shaped structure. The shell is modelled through a topological deformation, starting from the flat configuration of the whole shell, which is then deformed until it assumes its final configuration. The shell is divided by hexagonal elements consisting of six prismatic blocks, pre-compressed between them thanks to a metal band. The hexagonal tiling was chosen because it is known that a hexagonal grid or honeycomb is the best way to divide a surface into regions of equal area with the least total perimeter (honeycomb conjecture). Although the double curved surface chosen for the shell makes impossible the use of hexagons of the same size, this type of tessellation is still very useful, because it avoids triangular tessellation (which the hexagonal comes from), that is inadequate for stone constructions. A double steel cable system ensures the static stability. The static principle at the basis is that the equilibrium of a shell under construction is obtained by introducing external forces that prevent the collapse of the structure.

manufacturing company
ROMEO srl
www.ateliers-romeo.it

Ateliers Romeo



STONE SKIN

SKIN

POLITECNICO DI BARI

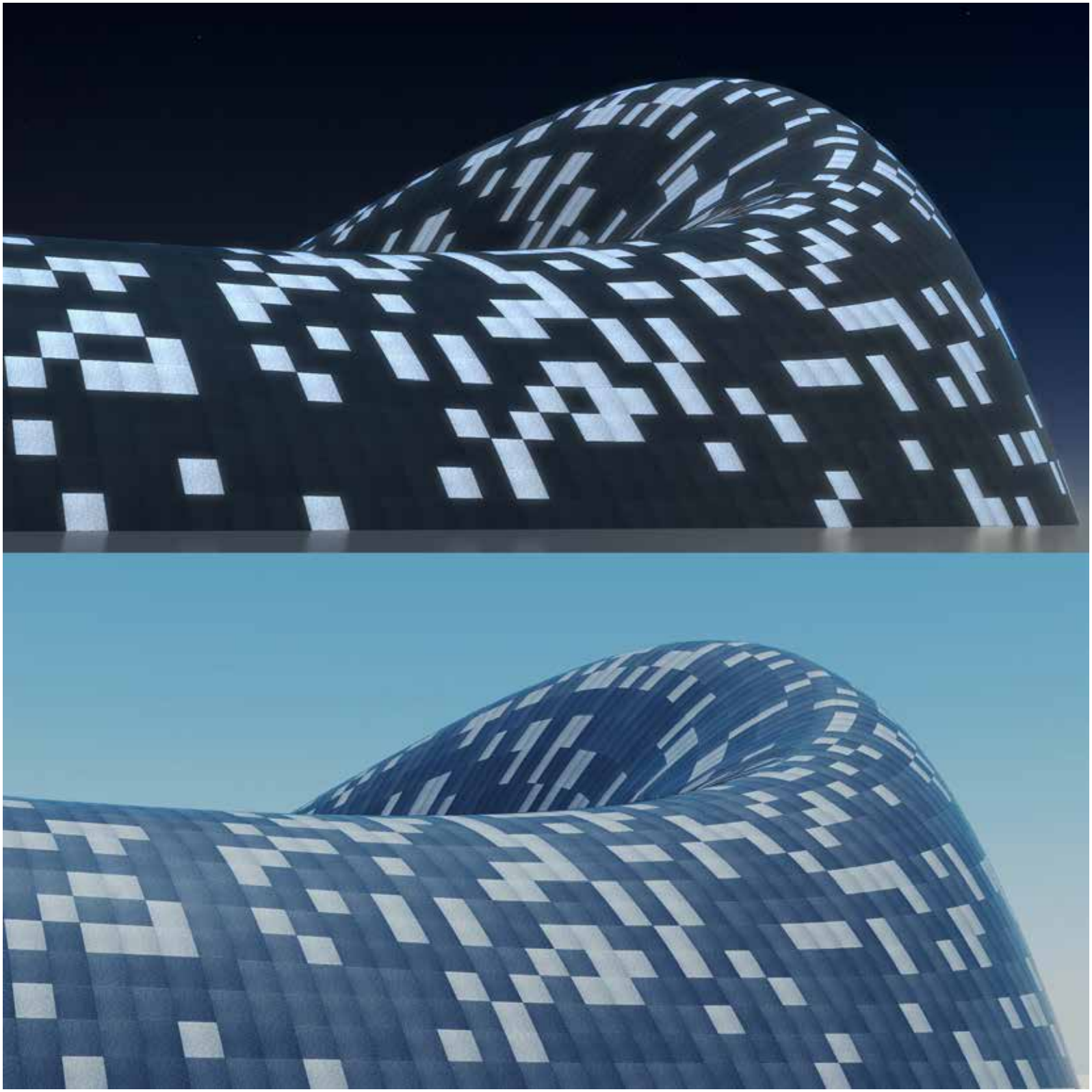
WORKSHOP ABOUT STRUCTURE AND ALGORITHMS
BARI

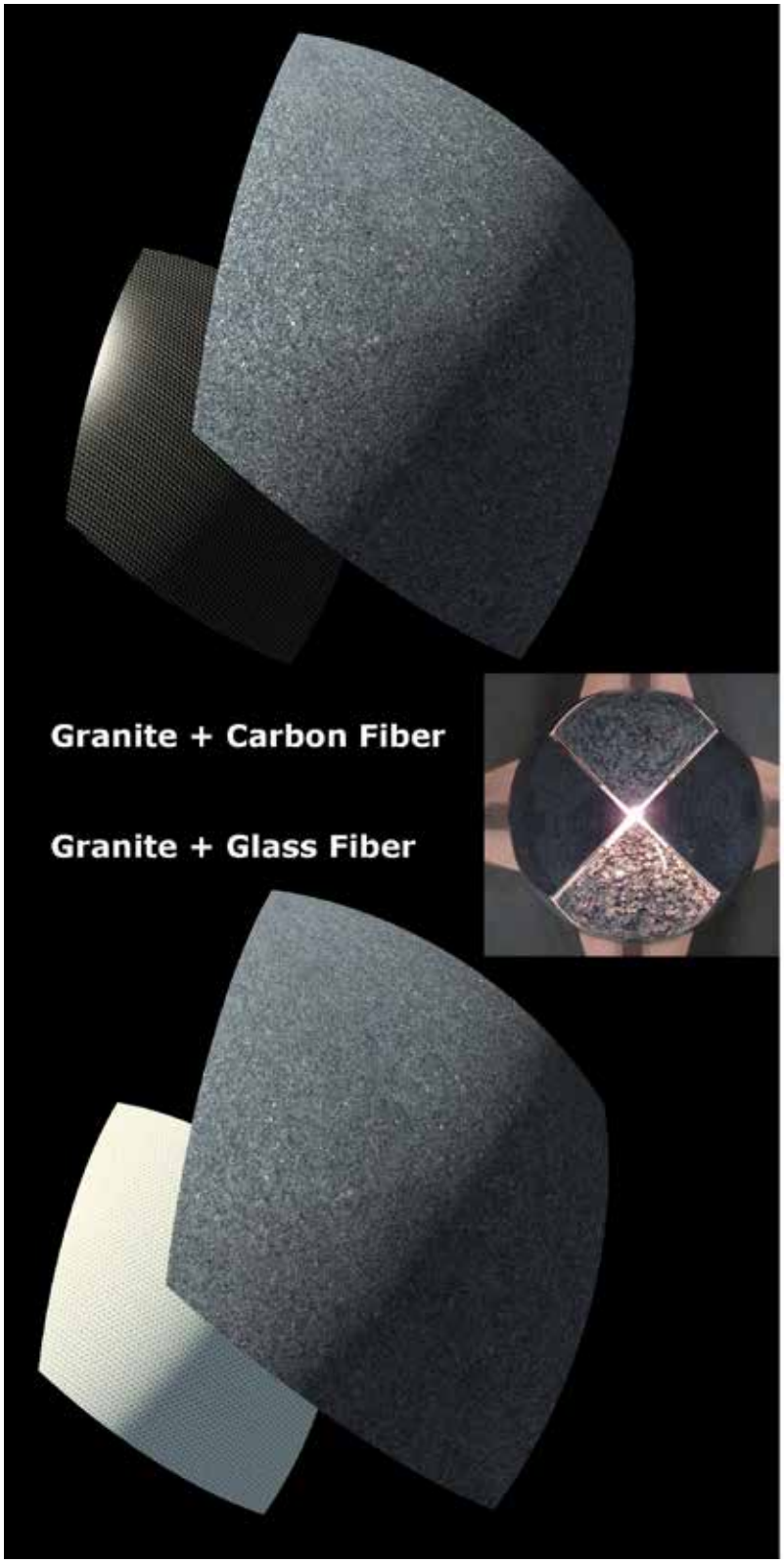
design	Giuseppe Fallacara
collaborators	M. Barberio (design), M. Generelli (Fabrication)
materials	Ticino granite, carbon fiber, glass fiber
year	2016
patent	CH 710 927 B1 Generelli SA

This research investigates the applications in architecture and industrial design of free-form panels made of natural stone, reinforced through the use of carbon fiber (or glass fiber) sheets on the back. The combination of these two materials allows reducing the thickness of the stone components up to few millimetres and the achievement of a great static performance. The double curvature panels can be coupled using magnetic bonding systems.

manufacturing company
GENERELLI sa
www.generelli.ch

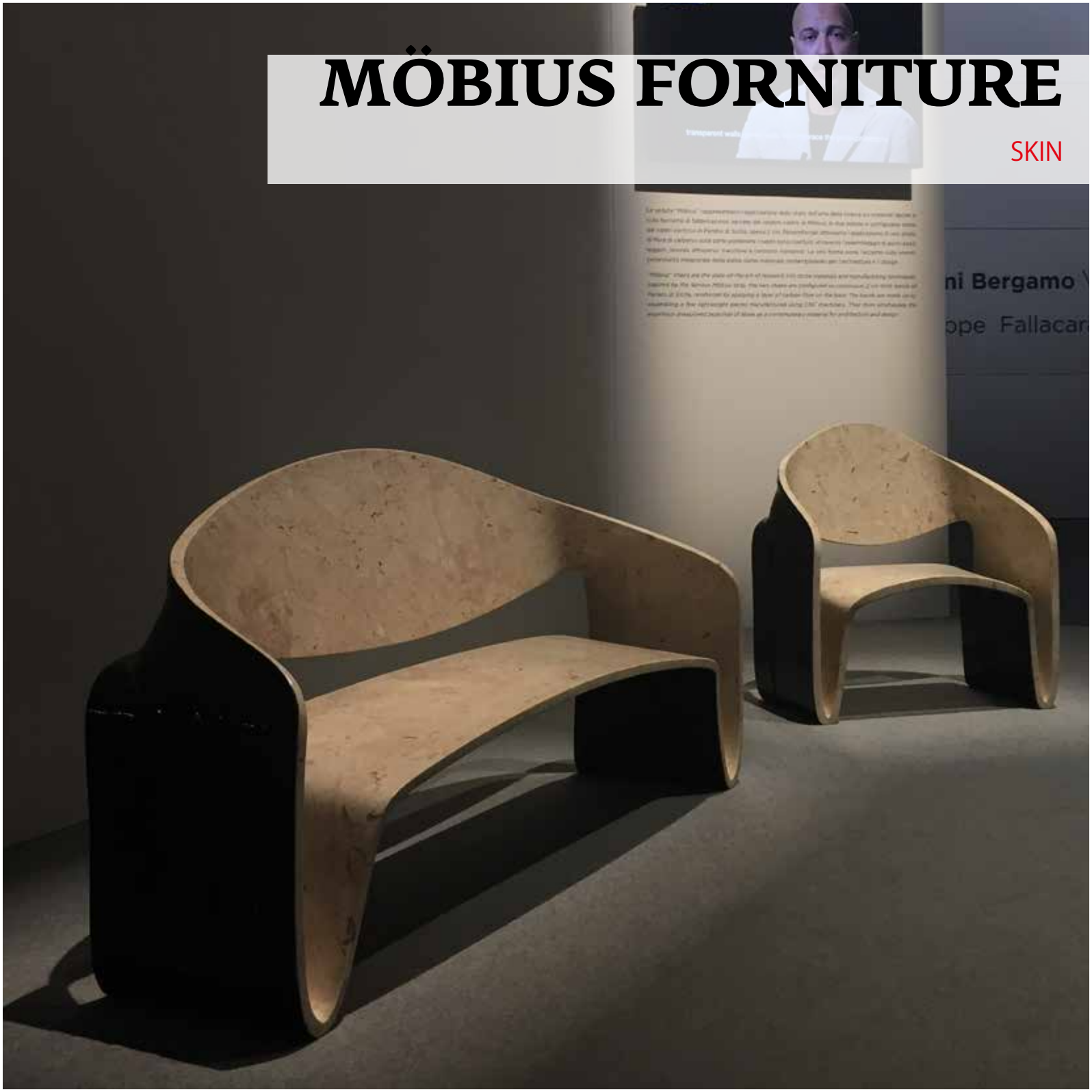
GENERELLI SA
Marmi e graniti La pietra per passione




Granite + Carbon Fiber
Granite + Glass Fiber

MÖBIUS FORNITURE

SKIN



MARMOMACC TRADE FAIR

THE ITALIAN STONE THEATRE
VERONA

design	Giuseppe Fallacara
collaborators	M. Barberio (design), D. Malomo (structural analysis), M. Generelli (Fabrication)
materials	Perlato di Sicilia Cofano stone and carbon fiber
year	2016

Möbius seats/furniture are the state-of-the-art of the research into stone materials and manufacturing techniques. Inspired by the famous Möbius strip, the two chairs are configured as continuous 2 cm thick bands of *Perlato di Sicilia*, reinforced by applying a layer of carbon fibre on the back. The bands are made up by assembling a few lightweight pieces manufactured using CNC machinery. Their shape emphasises the enormous unexplored potential of stone as a contemporary material for architecture and design. The series of seats is composed by a chair, sofa and chaise-longue.

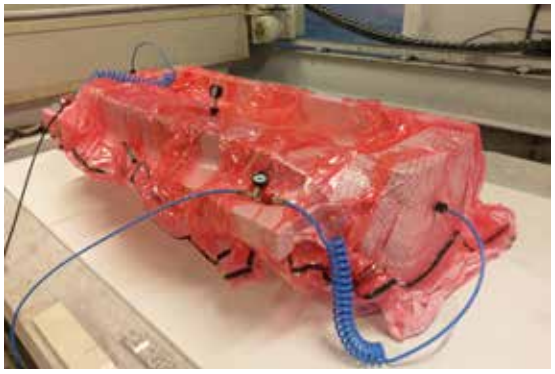
manufacturing company

GENERELLI sa
www.generelli.ch

MGI Italy srl
www.marmiegraniti.it

GENERELLI SA
Marmi e graniti La pietra per passione

mgi MARMI E GRANITI D'ITALIA
Sicilmarmi dal 1948




MARMI E GRANITI D'ITALIA
GENERELLI


MGI Marmi e G

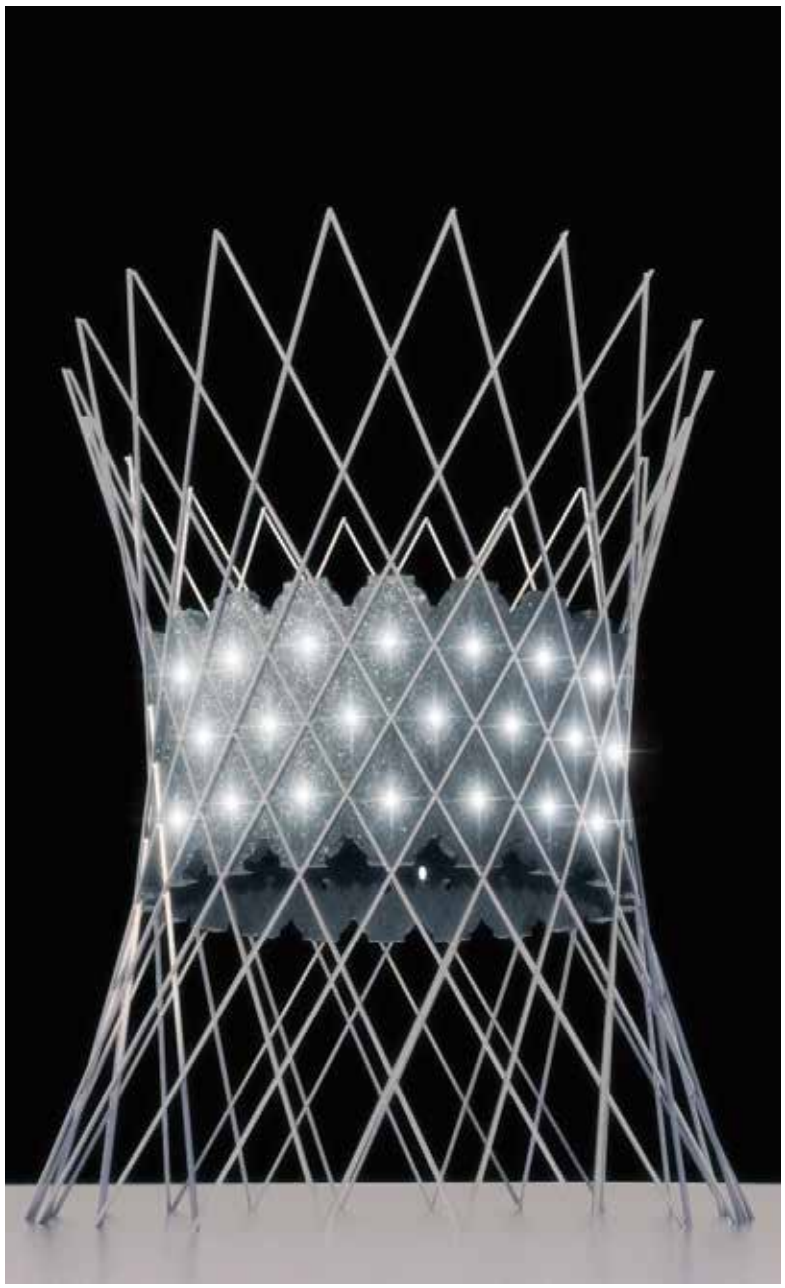
BELLINZONA CROWN

SKIN

MEMORIAL SCULPTURE

OPENING DAY OF THE ALP TRANSIT GALLERY ZURICH - LUGANO BELLINZONA

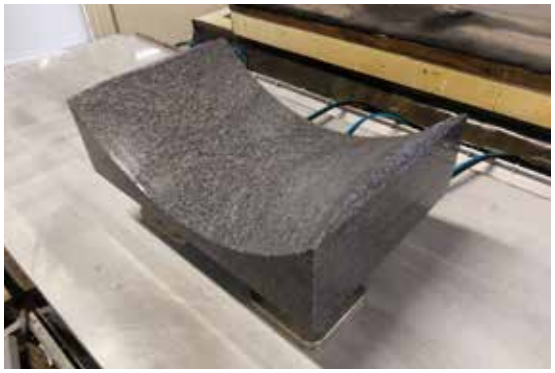
design	Giuseppe Fallacara
collaborators	M. Generelli (Fabrication)
materials	Ticino granite, Swarovski crystals, stainless steel
year	2016

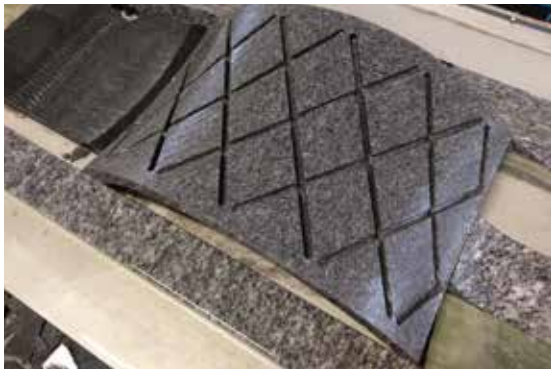


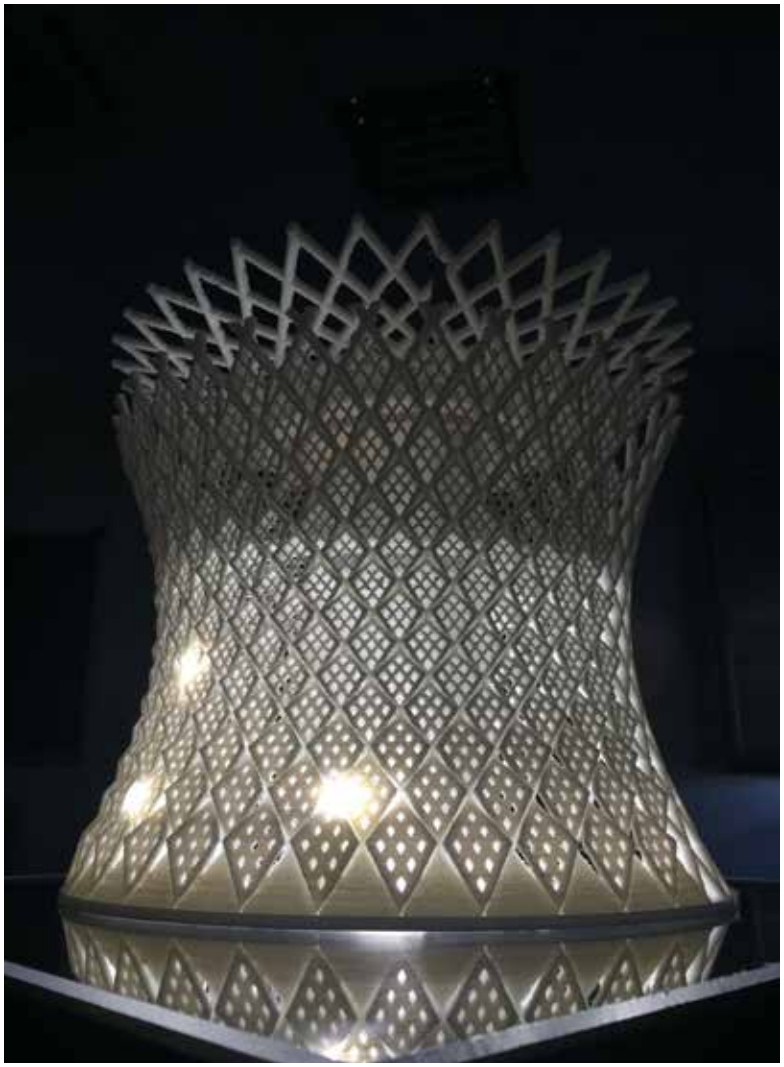
The sculpture has the form of a crown with crenelated rims, embellished with precious stones and wrapped by a network of stainless steel metal bars. The geometry of the crown is a horizontal section of a hyperboloid of revolution obtained by the polar repetition of forty rectilinear segments around a centre. The overall geometry is identified by the metal bars and the crown itself is made of Ticino Granite embellished thanks to the inclusion of sixty Swarovski crystals embedded in the granite. the most innovative CAD-CAM systems of three-dimensional modeling and robotic processing were used To succeed in the particular geometric shape of the crown.

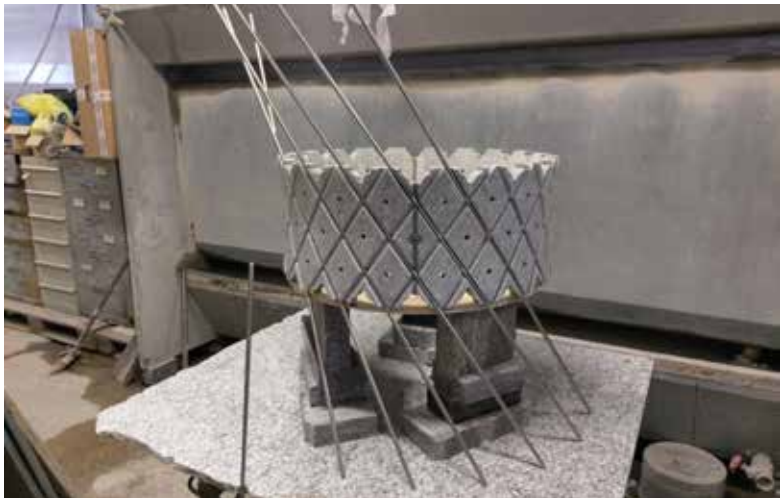
manufacturing company
GENERELLI sa
www.generelli.ch

GENERELLI SA
Marmi e graniti La pietra per passione



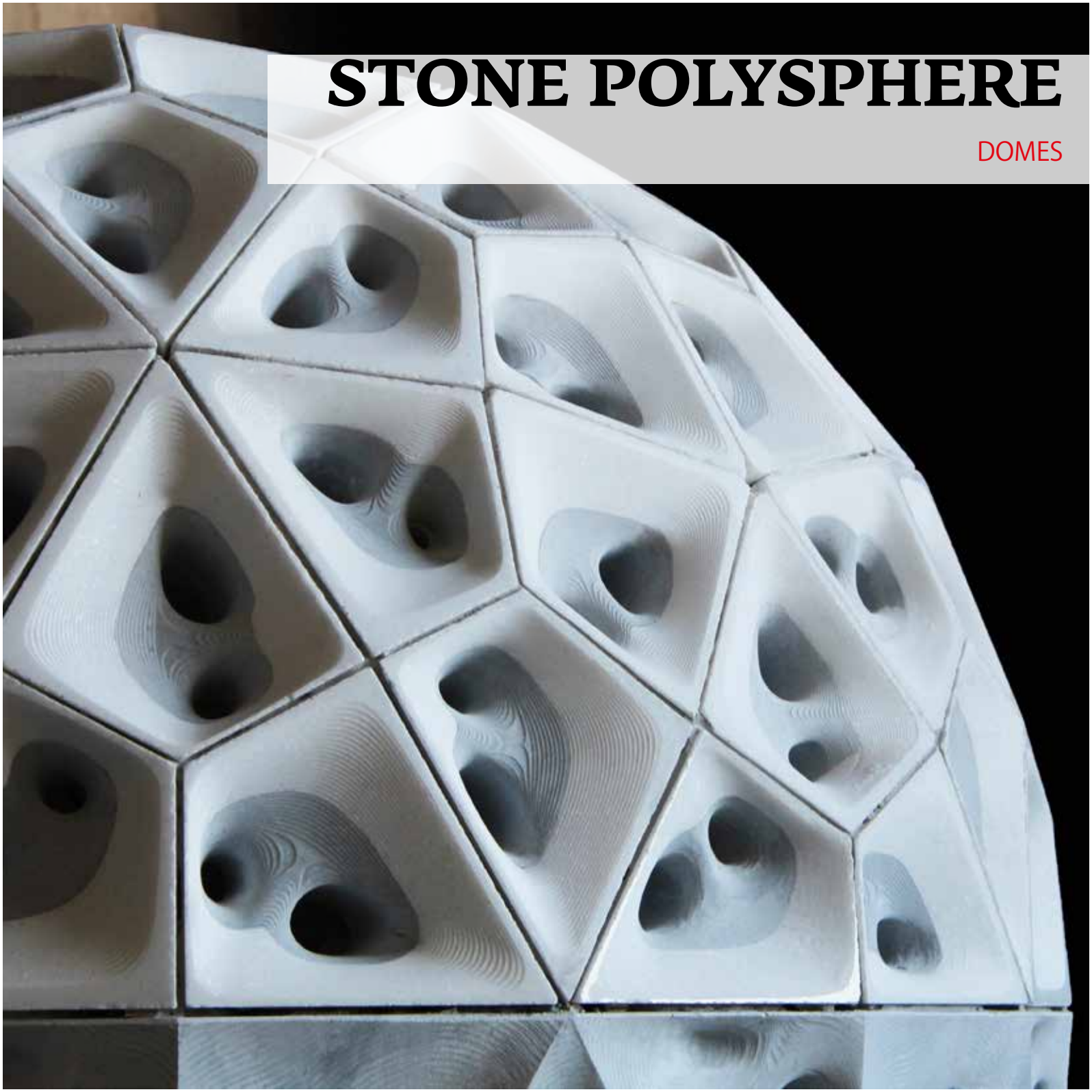






STONE POLYSPHERE

DOMES



MARMOMACC TRADE FAIR

THIBAUT sas STAND
VERONA

design — Giuseppe Fallacara, Maurizio Barberio

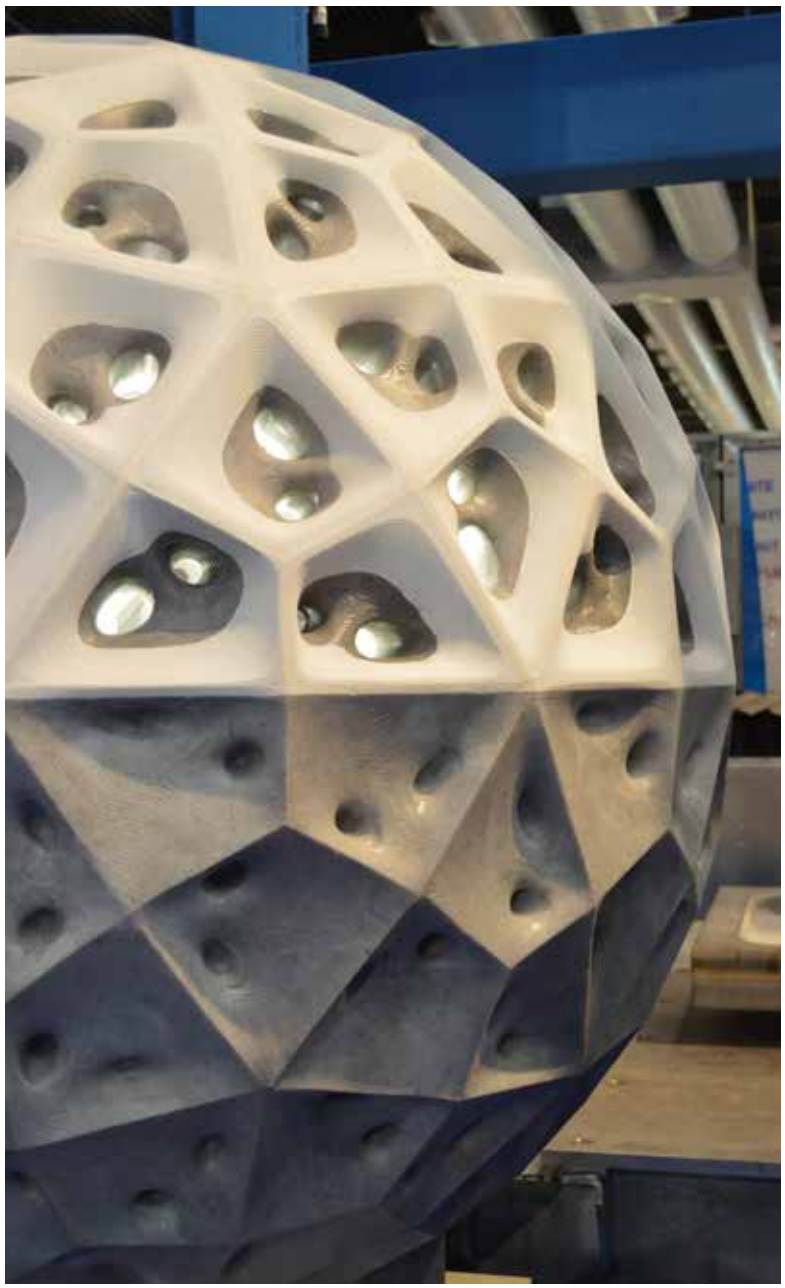
collaborators — Alain Calas (CNC Programming), Bruno Combernoux (Fabrication)

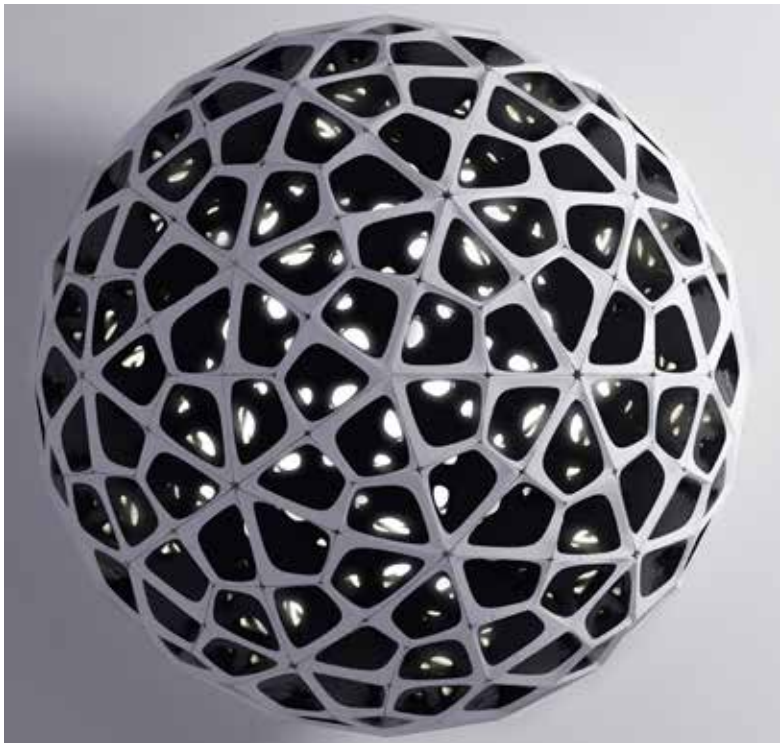
materials — Pierre Bleue de Savoie, Blanc d'Angole (Yelmini, France)

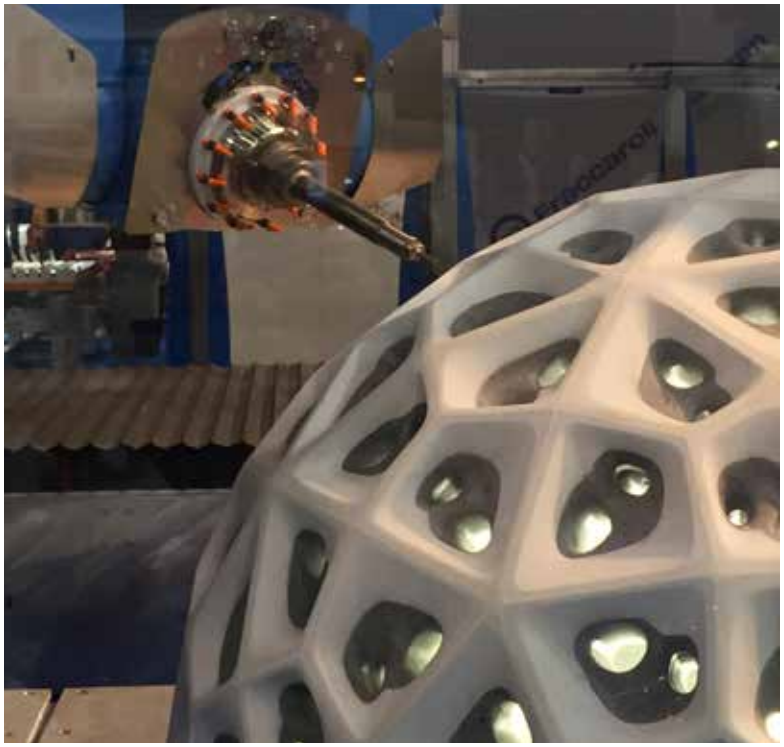
year — 2016

StonePolySphere is an installation that investigates the potential of digital fabrication applied to the stone industry. It is a lithic sphere with a diameter of 1.4 meters, composed by a massive hemisphere below and a stereotomic hemisphere above. The blocks are constituted by two glued layers of stone, returning a two-colour effect variety, depending on the morphology of the block itself. The vaulted domed space has always represented the ideal field for more sophisticated and complex study about the construction of architecture. This is particularly true for the stereotomic architecture. The intrinsic quality of the dome architecture resides in the immediate ability to define measurable areas, which can serve as the endpoint for the indeterminacy of the outer space. In this case, the curved line that composes the archivolted systems is the geometrical locus establishing concavity and convexity, and consequently the concept of interior and exterior space, unambiguously.

manufacturing company
THIBAUT sas
www.thibaut.fr

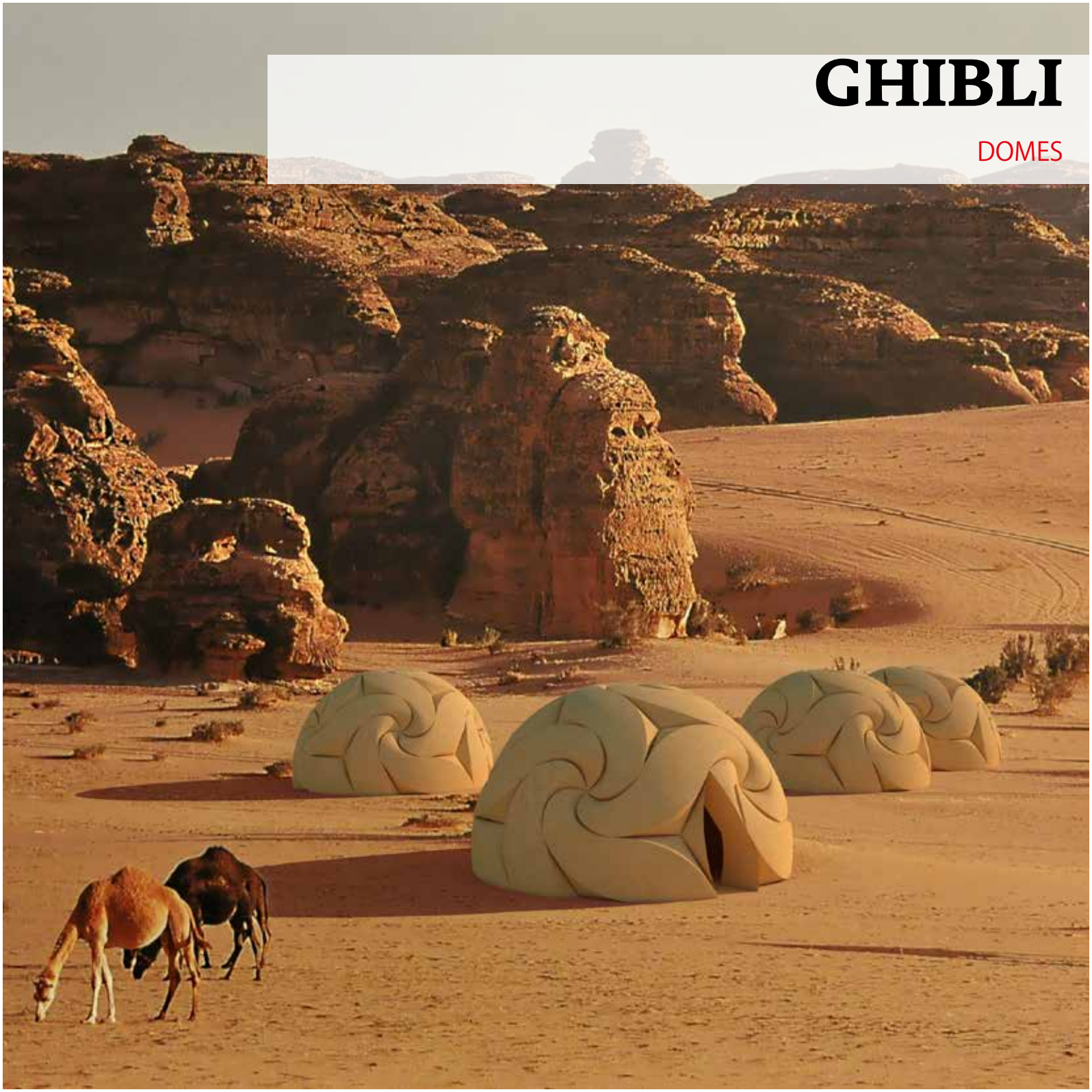






GHIBLI

DOMES



UNIVERSITÀ ROMA TRE

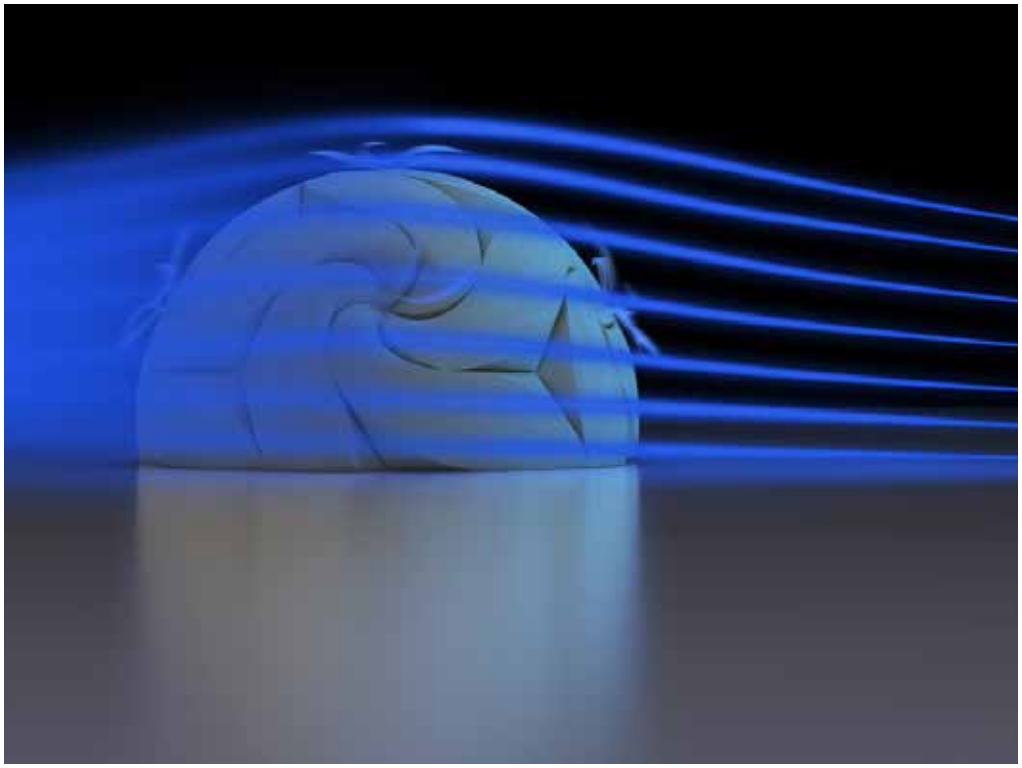
LA PIETRA TRA INNOVAZIONE E TRADIZIONE
ROMA

design	Giuseppe Fallacara, Micaela Colella
collaborators	New Fundamentals Research Group
materials	Pietra leccese - limestone
year	2016

Ghibli is a domed minimal housing unit, aggregable in villages. Its construction is allowed thanks to a stereotomic assembly of two type-block: hexagonal and pentagonal. The intrados of the blocks is optimised using planar faces, thanks to the use of a truncated icosahedral structure. At the centre of the pentagonal blocks is it expected the presence of a micro wind system, which would harness the desert wind energy and transform it into electricity for the main human needs. The spherical shape of the dome and its specific spiral conformation, also, improve the aerodynamics of the construction allowing for a greater uptake of the air currents, and therefore better energy plant performance. A scaled-down prototype of Ghibli has been built (using Lecce's limestone) to test the installation issues in order to optimise the realisation of the full-scale prototype.

manufacturing company
PIMAR s.r.l.
www.pietraleccese.com

PIMAR
ITALIAN LIMESTONE



LAMINA TYPE 1

HELICOIDS

MARMOMACC TRADE FAIR

EXHIBITIONS / EDUCATIONAL
VERONA

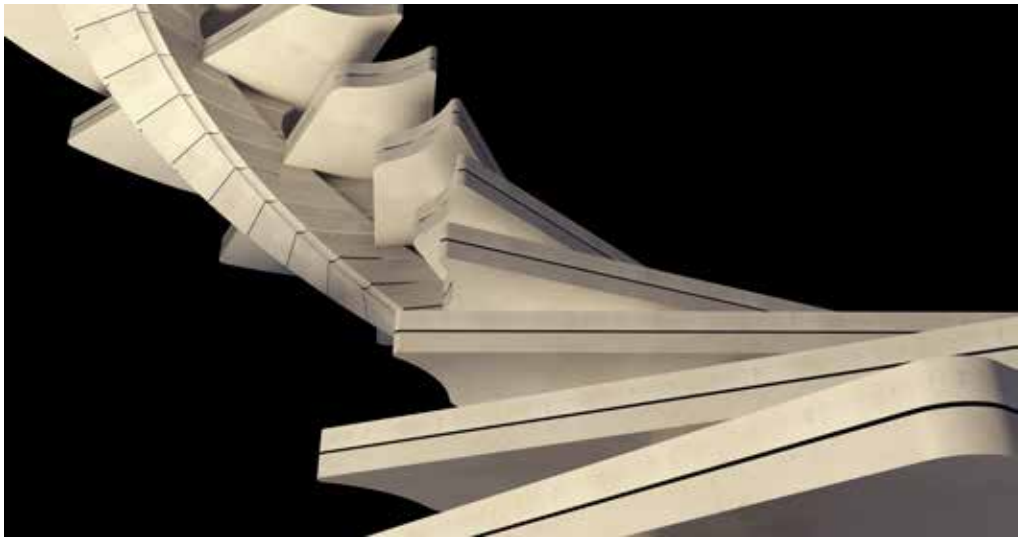
design	Giuseppe Fallacara
collaborators	F. Brunetti (fabrication)
materials	Apricena stone
year	2016
patent	402016000095429

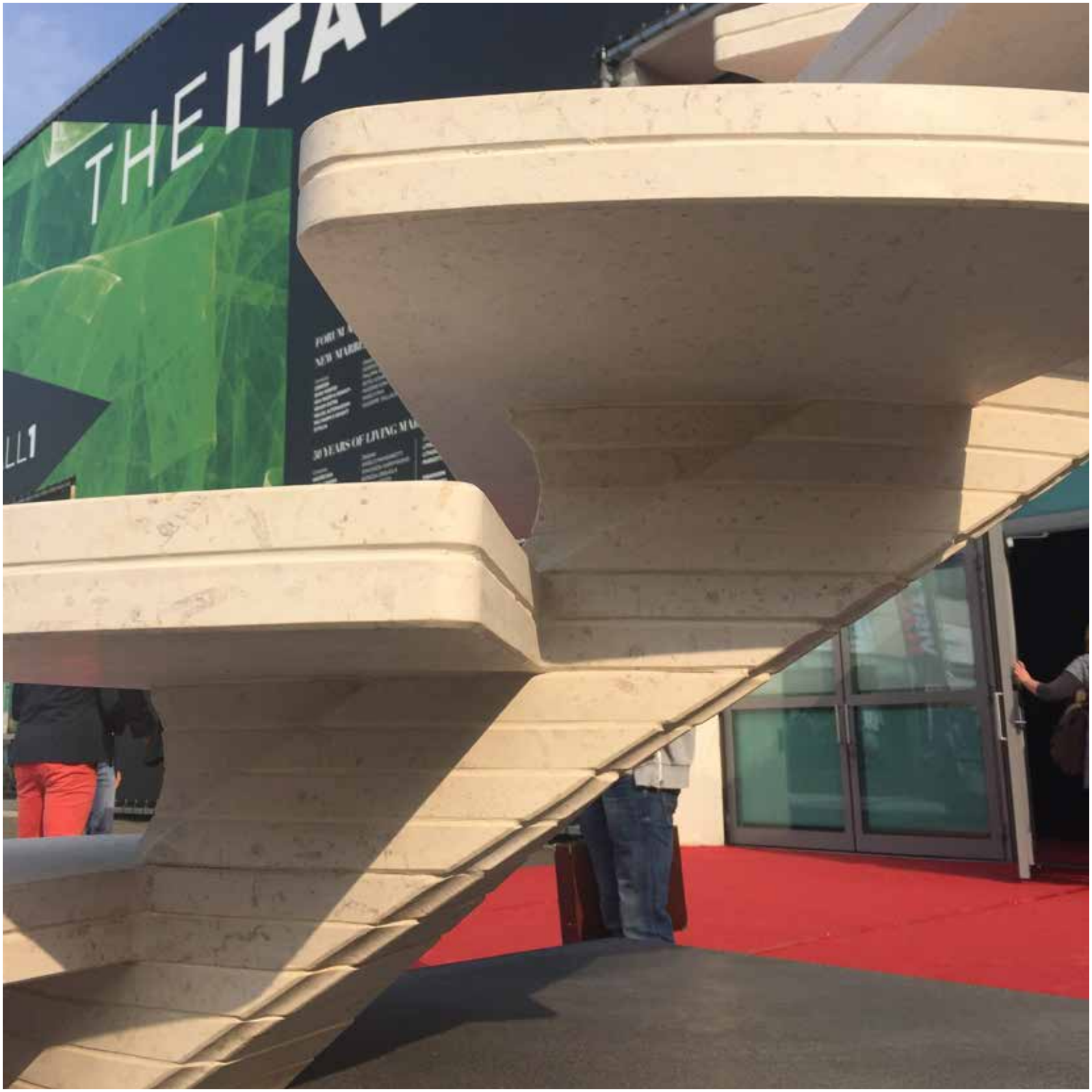
The self-supporting helicoidal staircase Lamina type 1 is made from laminated stone reinforced with metal plates. It was built using Apricena Perlatino marble slabs in three centimeters thickness. Each step of the showcased prototype, consists of six laminated elements obtained by 3D CNC milling. Epoxy resins and epoxy adhesives have been used for gluing; furthermore, a thin layer of basalt fiber has been interposed between the elements constituting the tread of the staircase, in order to improve bending resistance. Each step has a hole that allows the creation of an inner load-bearing helicoidal column made of reinforced concrete.

manufacturing company
CNC Design by Francesco Brunetti
www.cncdesign.it

CNC DESIGN
3D STONE PROCESSING


LAMINA
LAMINA ®




THE ITA
LL1

LAMINA TYPE 2

HELICOIDS

MARMOMACC TRADE FAIR

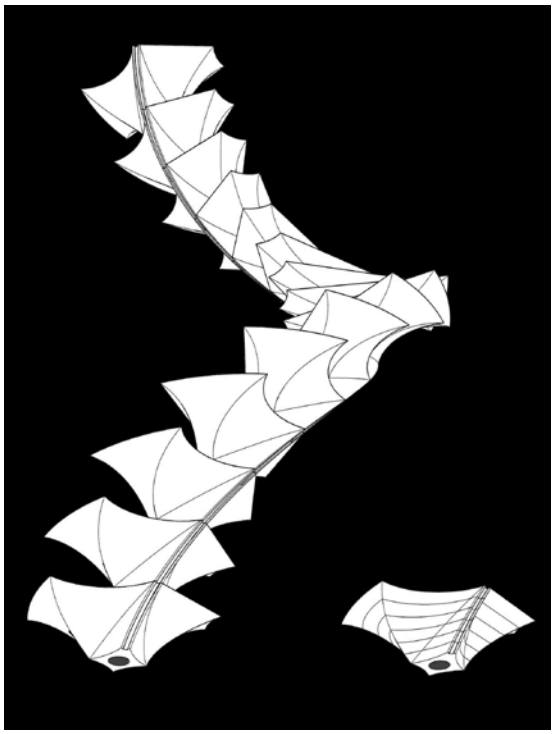
INTERMAC STAND
VERONA

design	Giuseppe Fallacara
collaborators	M. Generelli (Fabrication)
materials	Dekton
year	2016

Lamina type 2 is made from artificial stone. It is a helical prefabricated staircase for interior and exterior spaces. The staircase consists of steps in recomposed layers material (cement, resins and the addition of fine aggregates) and galvanized iron bars. Each step of the staircase has its appropriate central passage hole for the specific reinforcements, which are embedded in the reinforced concrete to assure consolidation to the entire structure.

manufacturing company
GENERELLI sa
www.generelli.ch

GENERELLI SA
Marmi e graniti La pietra per passione



Acknowledgment.

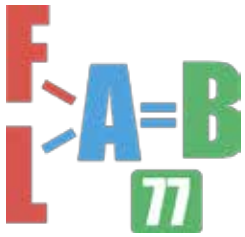
I would like to express a very great appreciation to all the people who are close to me and give me great energy and strength to continue this pioneering research, full of leaps in the dark, about the updating and use of stone in contemporary architecture and design. First and foremost, I would like to thank and dedicate this book to my wife Benedetta. She is my rock and she gives me serenity, which is essential for my creativity. I also thank my friend, Marco Stigliano, who is as a brother to me, for his unconditional help and for providing me with his critical, operational and compelling support, when dealing with my, often neurotic, requests. Thanks to Maurizio Barberio and Micaela Colella, for the same reasons. They are always ready and enthusiastic for news adventures. Certainly, I would like to express my sincere gratitude to Professor Claudio D'Amato. He taught me the way of doing research. Thanks to all the companies and their wonderful employees. I appreciated they believed and still believe in the importance of doing research even if, sometimes, the results are not immediately tangible and useful. In times of crisis, believing in research is a forward thinking which is worthy of my personal admiration. Last, but not least, my sincere thanks also goes to Pongratz - Perbellini Architects I met in 2005 in a joint exhibition at the Marmomacc, curated by Vincenzo Pavan. We presented the results of our researches, my research into stereotomy, and their researches into formal innovations and machine tools for the processing of stone (Hyperwave - 3D stone surfaces). My respect and appreciation towards them has grown over the years. Now, I am honored they accepted to write the introduction of this book. It includes, as I tried to show, my latest research, which, since 2005, has completely shifted the union between tradition-innovation as proposed in the joint exhibition above mentioned.


Atelier
la Pierre d'Angle


PIMAR
ITALIAN LIMESTONE


CNC
DESIGN
3D STONE PROCESSING


Ateliers Romeo


F
L
A=B
77


SNBR


GENERELLI SA
Marmi e graniti La pietra per passione


TARRICONE
Prefabbricati
di Tarricone Francesco


mgi
MARMI E GRANITI D'ITALIA
Sicilmarmi dal 1948


T&D
ROBOTICS


MARMI IANNONE
Corato, Bari


THIBAUT

new fundamentals
RESEARCH GROUP

Giuseppe Fallacara is Associate Professor of Architectural Design at the Department of Civil Engineering and Architecture (DICAR) of the Polytechnic of Bari, where he teaches Architectural Design and Stereotomy. His research focuses on revisiting stone architecture, with particular theoretical and practical attention to Stereotomy. He has published journal articles, built full-size prototypes and held workshops pertaining to the subject.
He is head of New Fundamentals Research Group, a team of Italian architects and academics affiliated to the (DICAR) of the Polytechnic of Bari, and develops research projects which deal with the relationship between innovation and tradition in architecture. Over the years, New Fundamentals has carried out research works on digital stereotomy, the history of construction and sustainable housing in the Mediterranean area, and it keeps its activity alive through teaching/learning activities, publishing textbooks, organizing lectures, workshops, and supervising Master's and Ph.D. theses. He is responsible for the specialized course about stone architecture at CESAR (Poliba).

Other works by the author with editor http://www.presses-des-ponts.fr/