ARS FRUSTUM

Some words on chunks

ALESSANDRO TIEZZI

Énoncé Théorique de Master.

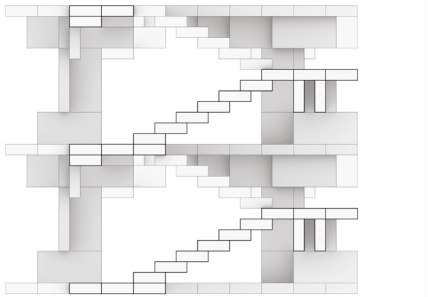
Sous la direction de
Jeffrey Huang, Professeur responsable de l'énoncé & Directeur pédagogique.
Frederick Chando Kim, Maître EPFL.

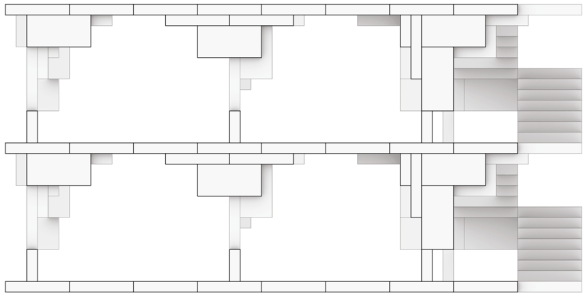
École Polytechnique Fédérale de Lausanne.
Section d'architecture.

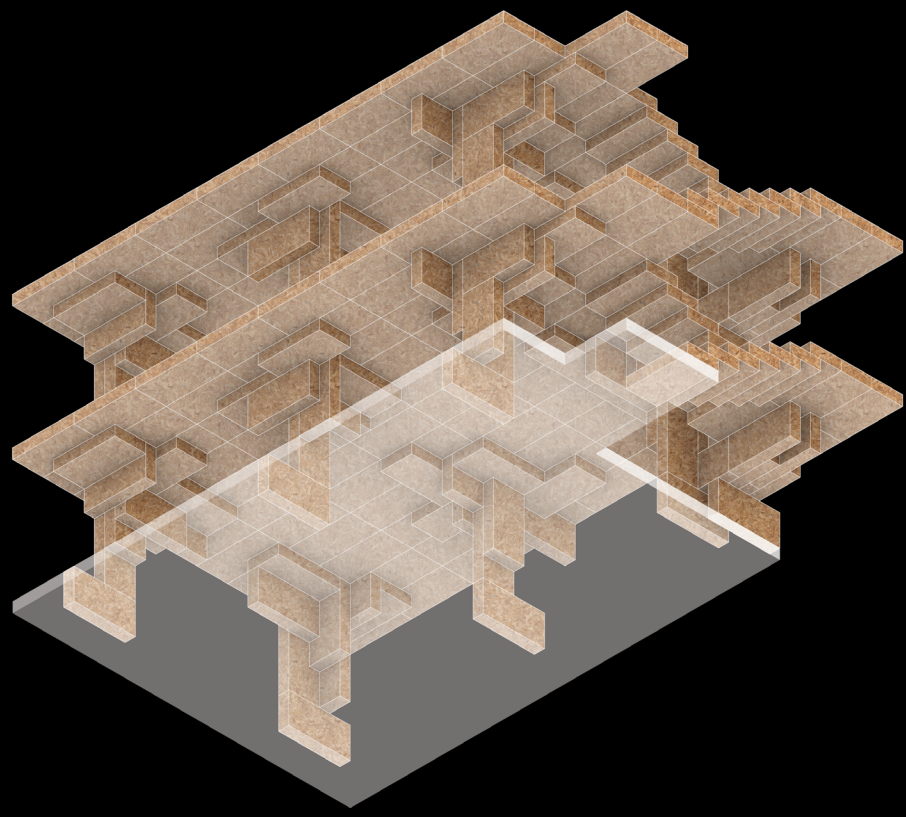
"Formas varias in uno eodemque libello ostendunt, semper prioribus abscedentibus." (Cardano)

Conjurers show changing forms in one and the same book, with the earlier ones always vanishing.

I would like to extend my sincere thanks to Prof. Jeffrey Huang, to Frederick Chando Kim, and to the MxD Lab team, for their insightful comments and suggestions at every stage of the Énoncé.





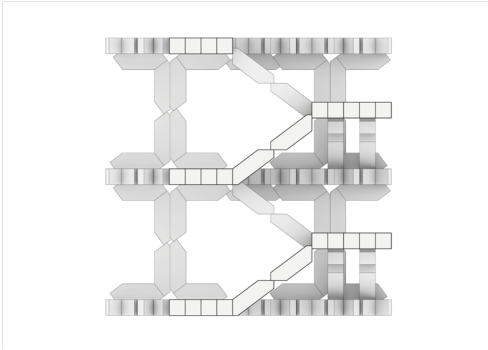


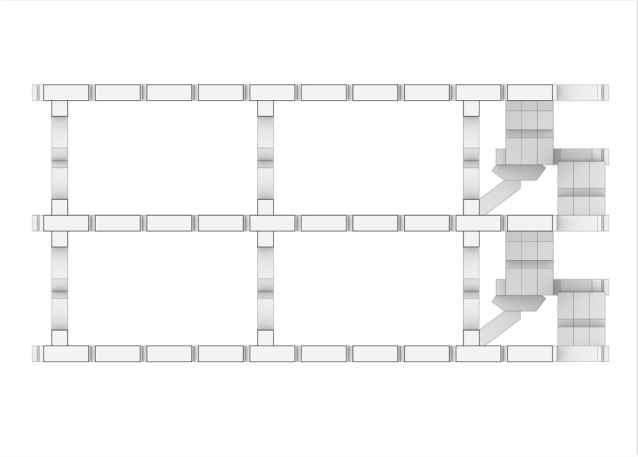
Drawings.
Re-interpretation of the Maison Dom-ino, Le Corbusier.
Used building block designed by AUAR.
Left - Transversal and longitudinal section.
Right - Axonometric projection.

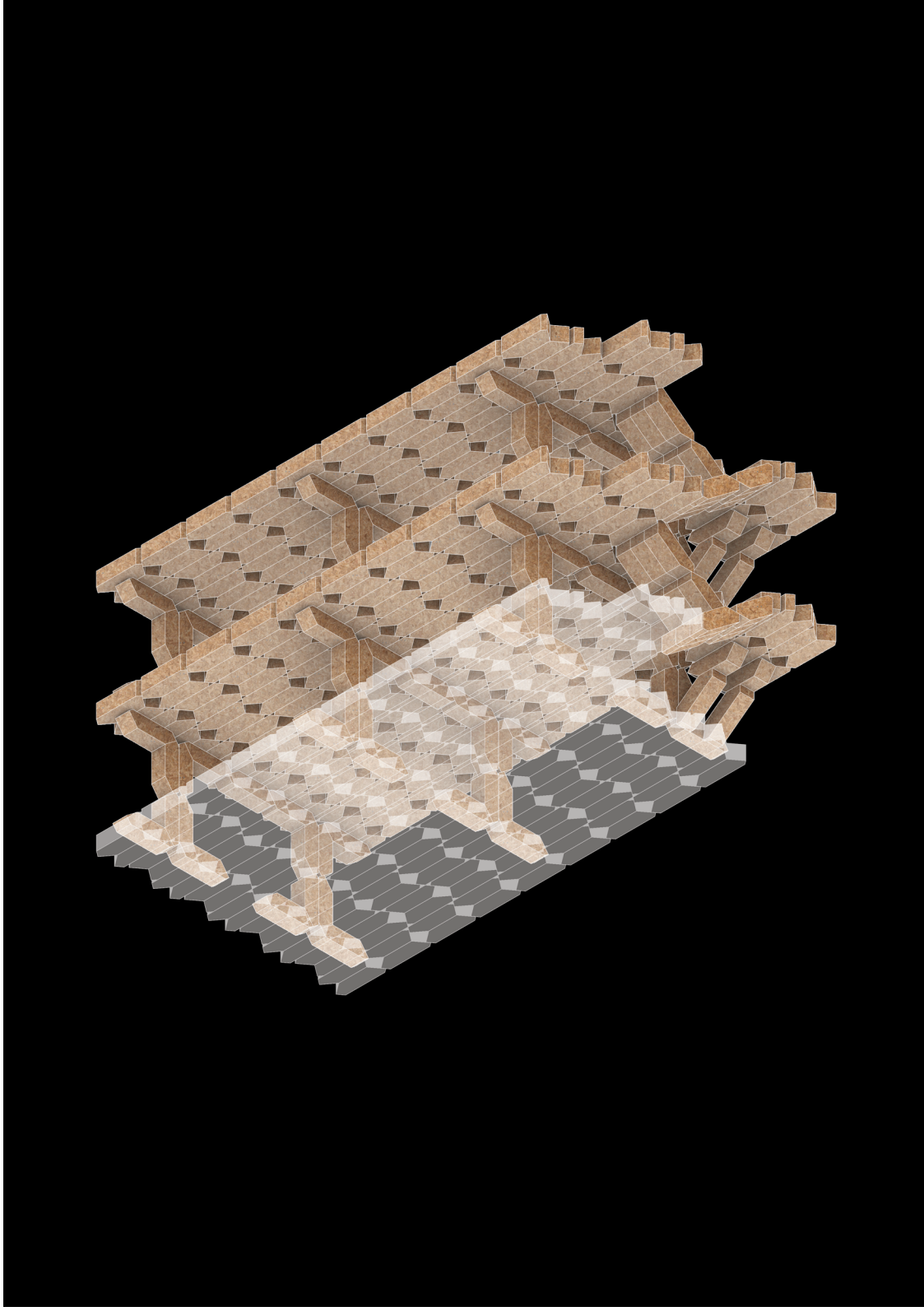
TABLE OF CONTENTS.

ABSTRACT.

Following the brick, and the mass-production, the revolution of the second digital turn allowed the mass-customisation, and a new form of digital design recently emerged in architecture, under the term 'discrete'. Based on the non-standard and versatile assembly of standardised building elements or 'chunks', complex, heterogeneous and functional spaces can be achieved, out of few parts. This 'Énoncé Théorique de Master' focuses then on the study of chunks, their peculiarities and potentialities in architecture, questioning therefore their limits and their ability to answer to diverse architectural characters. This study concludes with a theoretical reconsideration of the discrete thesis in the contemporary architectural debate, encouraging in the end a more collective and interactive use of it.







Drawings.
Re-interpretation of the Maison Dom-ino, Le Corbusier.
Used building block designed by Ivo Tedbury.
Left - Transversal and longitudinal section.
Right - Axonometric projection.

I. ABOUT MODULARITY.

Etymologically, the core concept of modularity is to reduce complexity, dividing a complex system into smaller pieces with varying degrees of interdependence and independence across them. Modules are the basic units, that are structurally independent of one another, but work together, so that determine or proportion the measures of a larger system.

Ars Combinatoria is the phrase with which Gottfried Leibniz (1646-1716) defined what Ramon Llull (1235-1315) had already baptised Ars Magna, that is, a logical methodology by the symbolisation of the various principles in geometric or algebraic signs, such that they could be combined in all possible ways with each other and thus obtain a kind of map or universal cadastre of principles. All concepts are nothing but combinations of a relatively small number of simple concepts, just as words are combinations of letters.

Besides, this game of combination, or permutation, had great applications among artists or writers, like Raymond Queneau, who published in 1961 an unusual book titled *Cent mille milliards de poèmes*. A rhyming sonnet is printed on each page of the book. The separate lines of each page are cut horizontally, one from the other, so that they can be peeled back in any combination, revealing new sonnets with new meanings. Of course, the concept of Ars Combnatoria may be then applied to architecture. Letters become bricks, and words correspond to the architectural language. Humans built complex architectures by the intelligent combination of simple bricks. In fact, architects Filippo Brunelleschi was able to build the radiant cupola of Santa Maria del Fiore of Florence in the 15th century, thanks to the herringbone brick pattern, an ingenious combination of bricks.

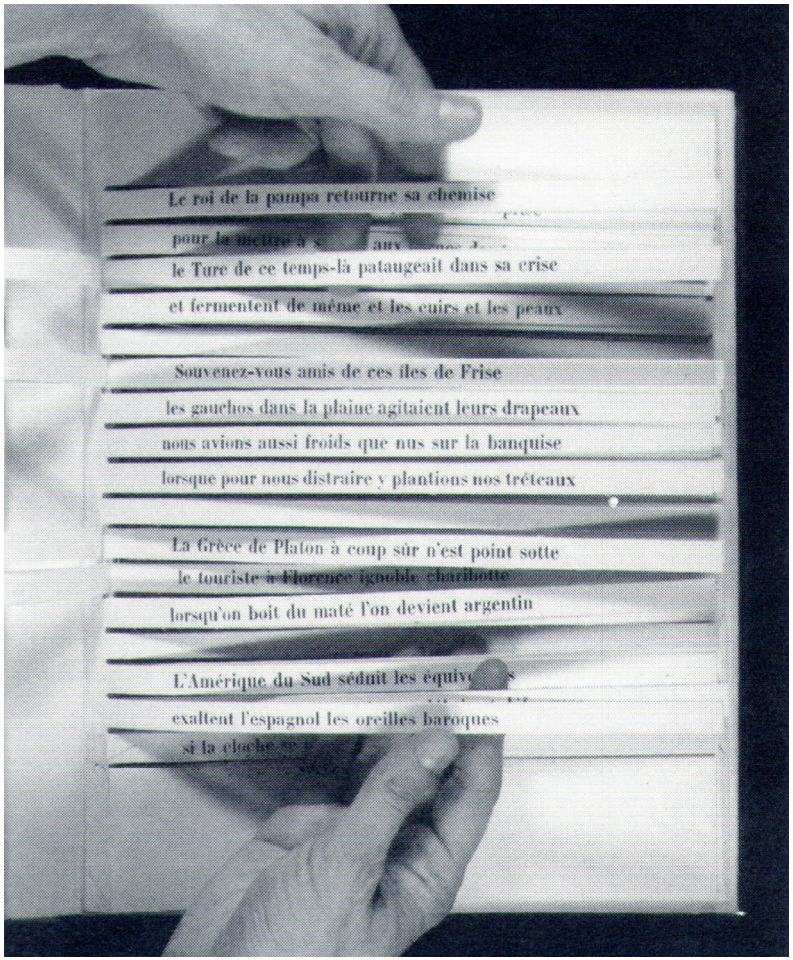


Image.
Raymond Queneau, Cent mille milliards de poèmes (Paris: Editions Gallimard), 1961.

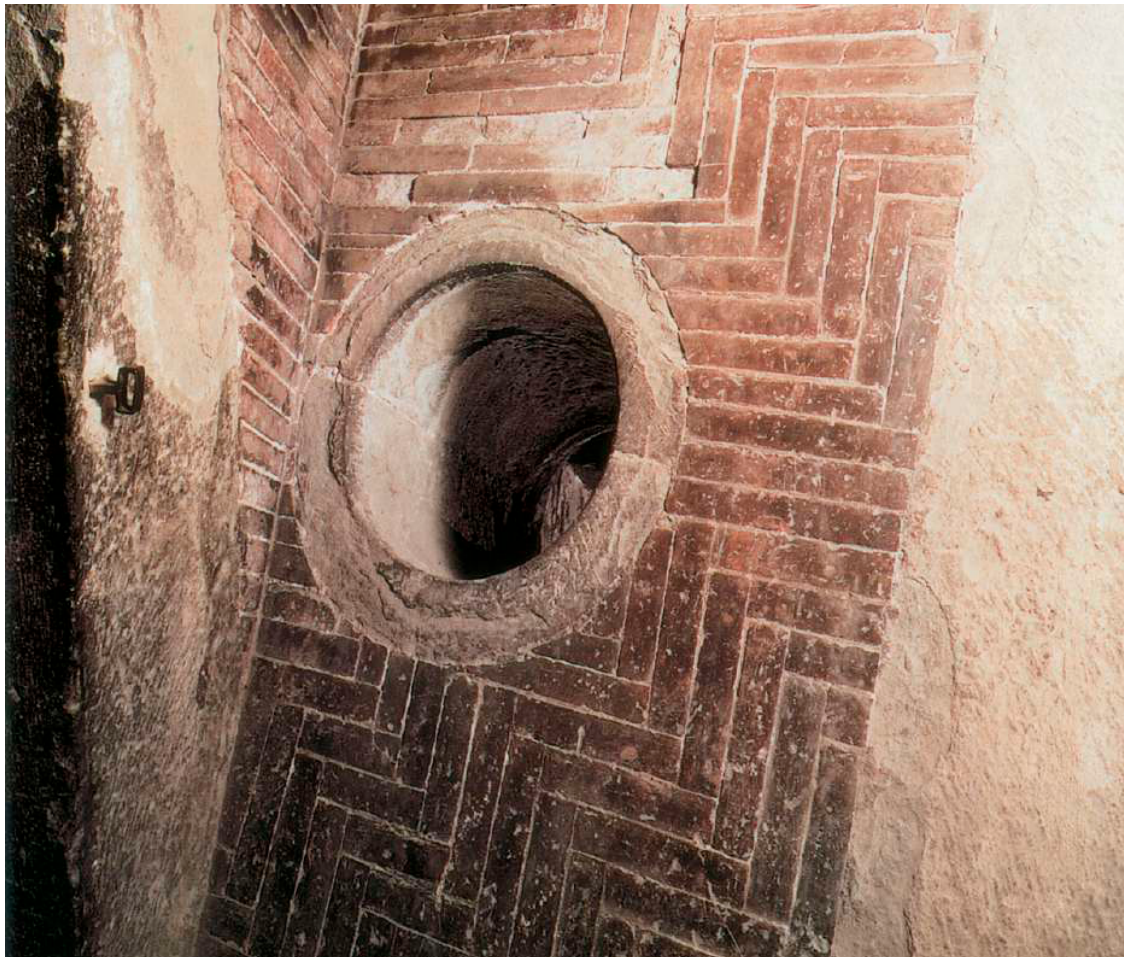
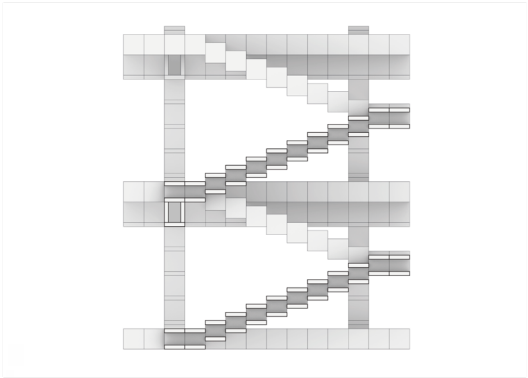
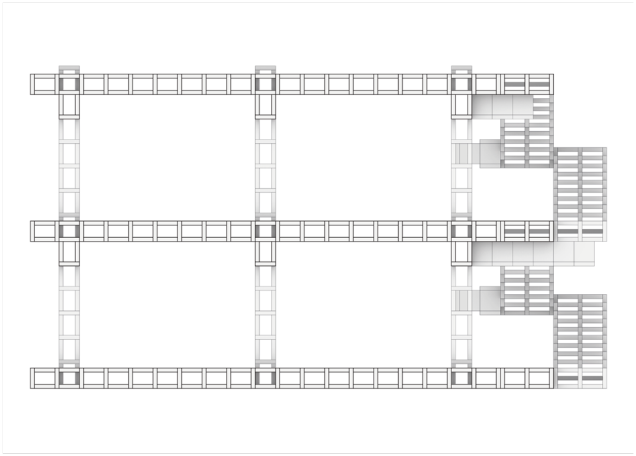
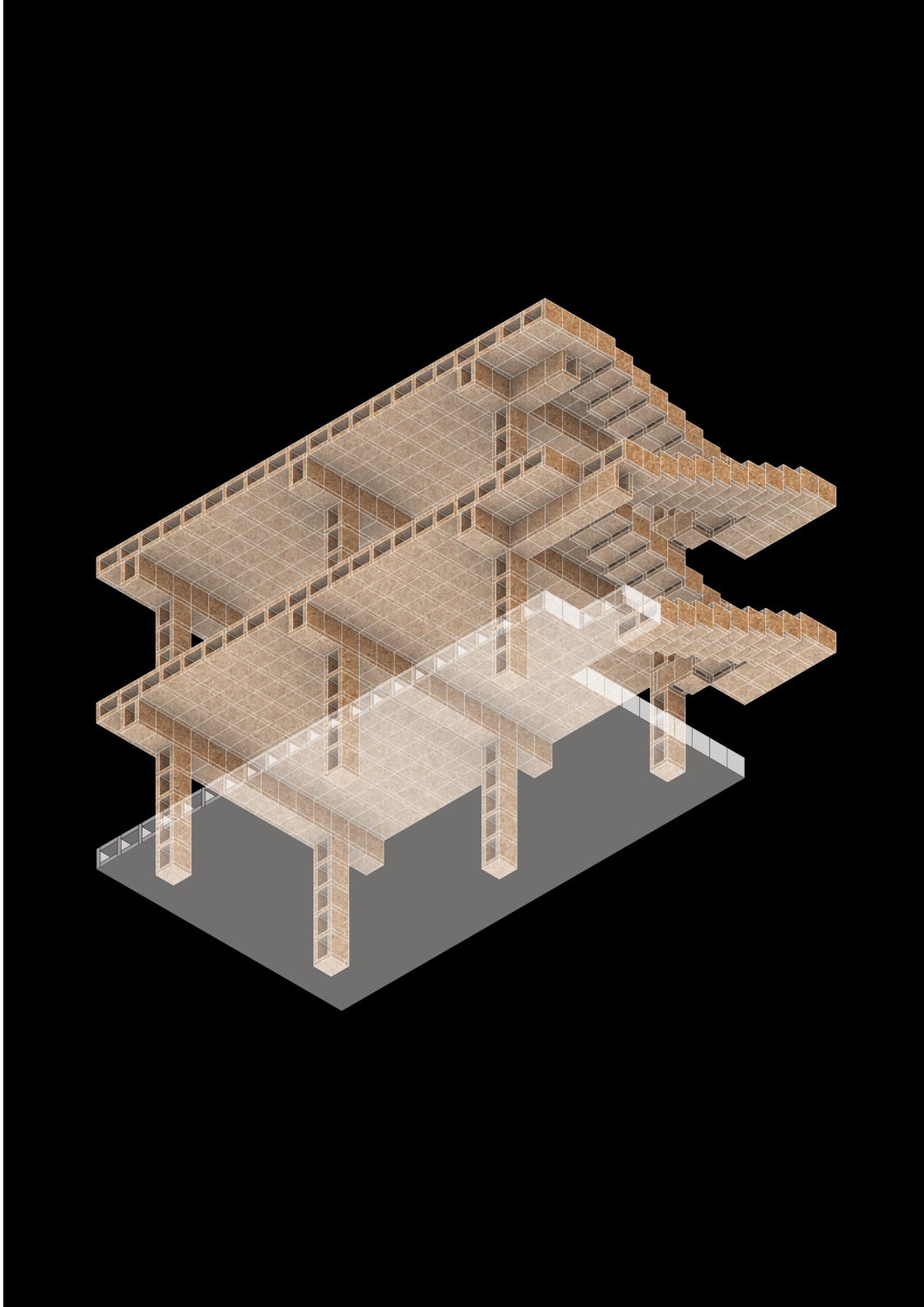


Image.
Filippo Brunelleschi, Cathedral of Santa Maria del Fiore, 1436.
Herringbone brick pattern inside the cupola.







Drawings.
Re-interpretation of the Maison Dom-ino, Le Corbusier.
Used building block designed by the B-Pro Research Cluster 4.
Left - Transversal and longitudinal section.
Right - Axonometric projection.

Bricks.

In architecture, masonry is the building of structures from individual units and bricks have been made to measure for human manipulation since the beginning of time. According to the previous statement, architects reduced the vast complexity of architecture and its language in a single construction rectangular bloc, with well defined proportions, and complexness reappears then by the combination of these bricks. Therefore, by definition, bricks can not be considered as elements of the architectural language like walls, column or arches, but instead as the search for an abstraction, formally and functionally, of the building material. Indeed, the only geometrical shape of the brick doesn't imply any kind of particular function or use, except to facilitate their assembly. On the contrary, the function is given by the architect or the builder, once combined with another to constitute a particular architectural elements that answers for specific needs, structurally or not.

Thus ontologically, the formal abstraction of bricks negates any architectural style and evidently doesn't preconceive any. As bricks have been used for many different types of construction since ancient times, it is the final assembly of them that produces an architectural form, and which is interpreted. As an example, traditional dutch brick houses and Mies van Der Rohe's Brick Country House are made of the same building material, but the spatial organisation of the architectural elements defined their stylistic lexicons.

Besides, the constructive use of brick was born to satisfy the construction needs in areas without other building materials, such as wood or stone. Nevertheless, the large distribution of bricks, geographically and in time, is also due to their ability to be easily reproducible and humans quickly found technics of standardisation. The invention of wooden mould with normalised dimensions strongly generalised its usage because permitting a serialised and relatively massive production of these.

Industrial revolutions.

Brought by the industrial revolution between the XIXth and the XXth century, the arrival of new materials in architecture like steel and concrete drastically changed the way to think construction, and the notion of building material took a complete different scale. Indeed, as the cost of steel was relatively high, it implied an intelligent and rational distribution of the material, which involved therefore the need to optimise the shape of construction elements with the aim of maximise performances. As said before, bricks are made for human manipulation, nevertheless by exploiting at the best the formal performances and capacities of the material and thanks to the help of machines, humans were able to mass-produce bigger functional elements. So an important shift occurred; instead of a standardised versatile construction bloc, it was more accurate to directly standardise architectural elements, by giving them a precise form and function. Thereby, rational dimensions were given to columns, beams, trusses, slabs, etc, based on their constructive roles. The standardisation of these elements allowed consequently their large mass-production, explaining thus also the creation of catalogues at this period, that presented ranges of products.

Built in 1851, Joseph Paxton's Crystal Palace revealed breakthroughs in architecture and construction, by taking dramatically advantage of the new developed technics of pre-fabrication and standardisation of its constructive elements. Paxton's design indeed was based on the size of the largest glass sheet available at the time. However, the concept of industrialised building, i.e. systems of manufacturing buildings components producing similar buildings at various sites, was not developed until the inter-war period, due to the shortage of housing following World War I. This is why, because of its immense reproductive potential, the system of the Maison Domino of Le Corbusier House in 1914 as a rational and standardised solution for housing was so revolutionary.

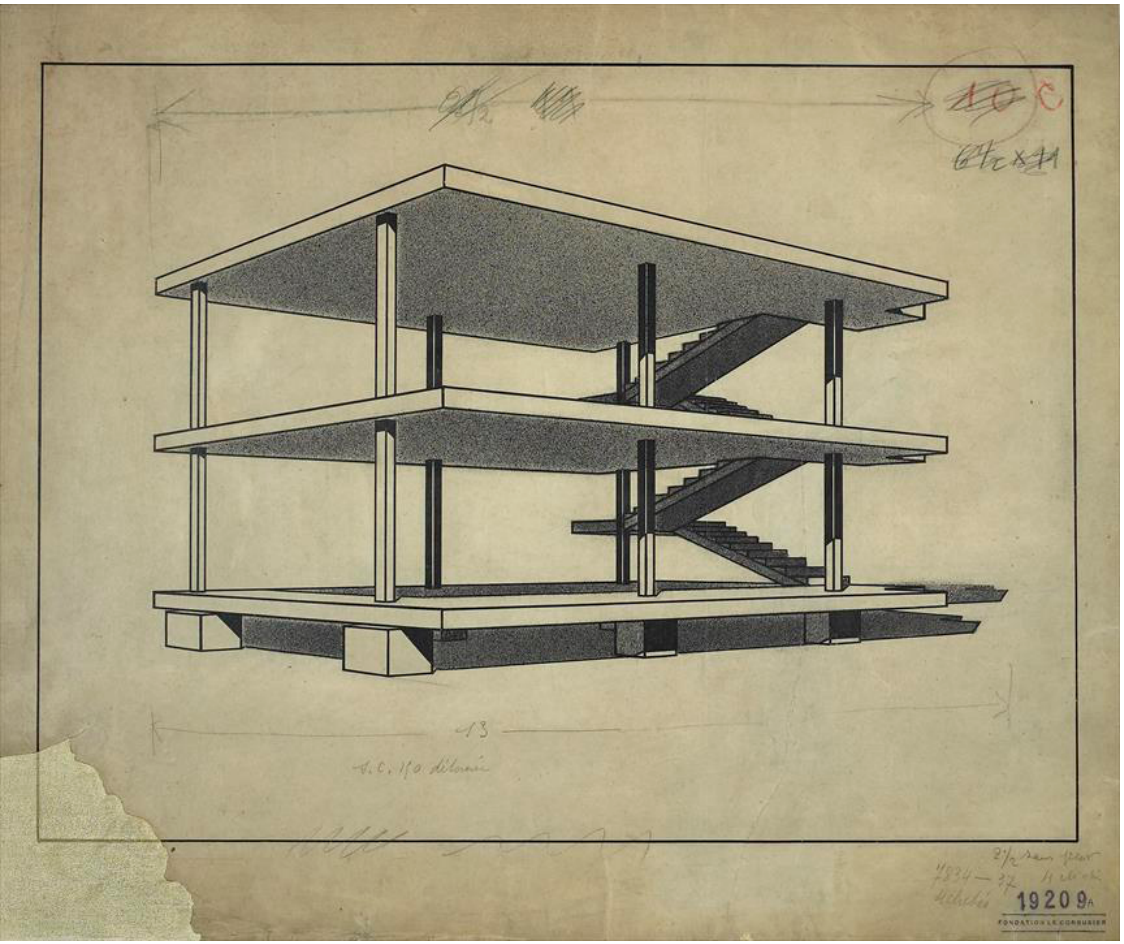
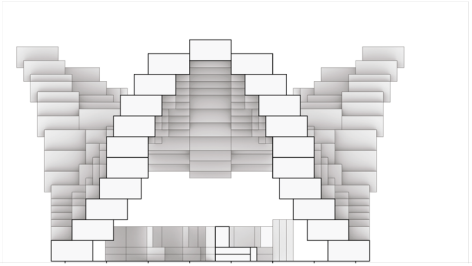


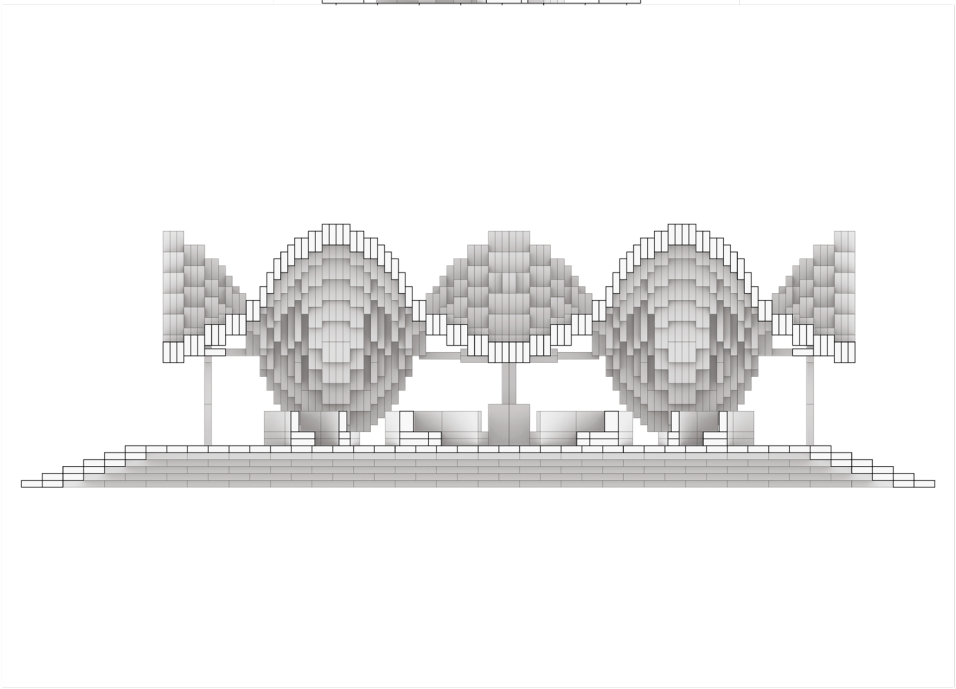
Image.
Le Corbusier, Maison Dom-Ino (not located), 1914.
Conception of a construction system that considered post-war reconstruction problems.

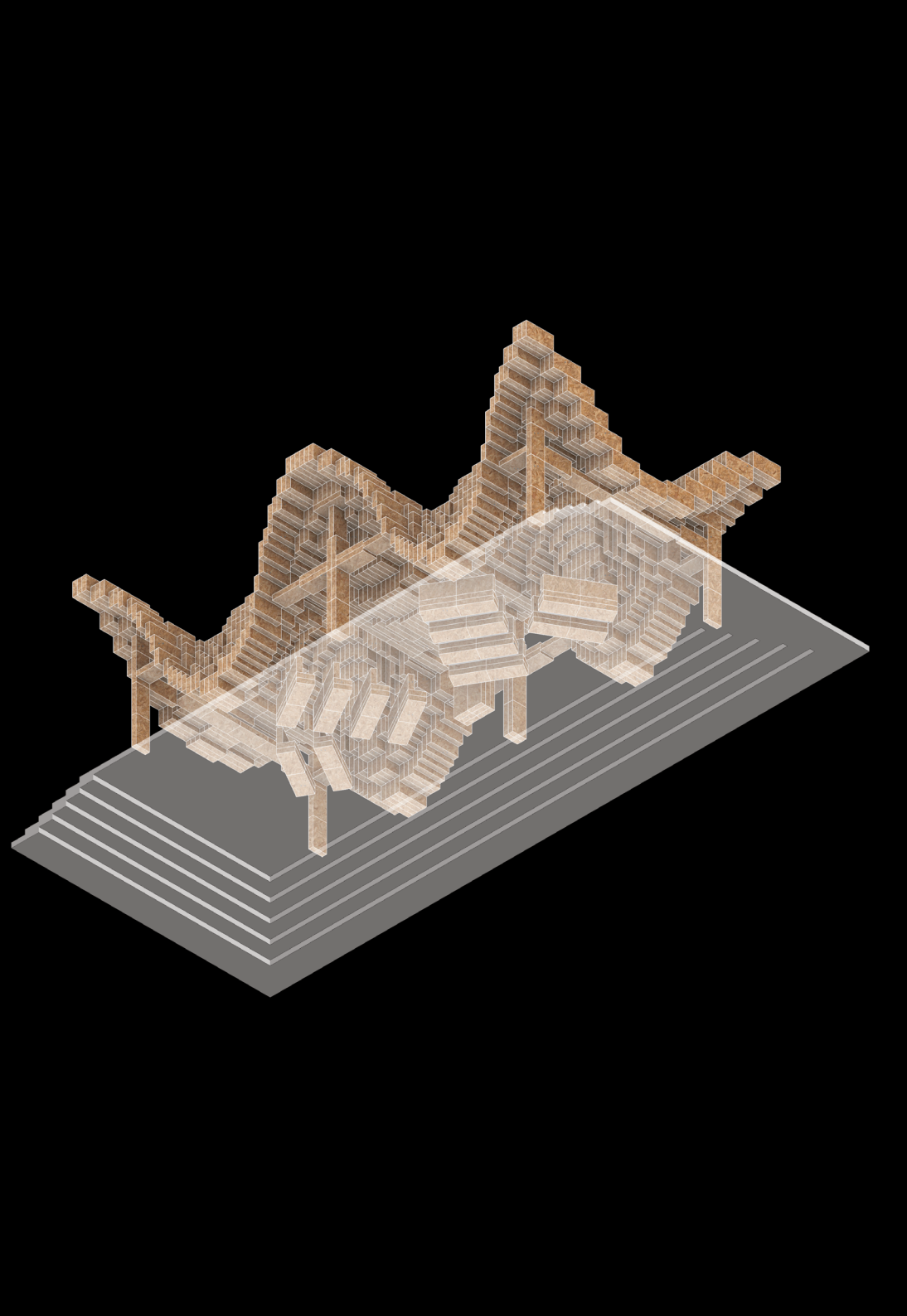
Digital turns.

In his eponymous book, Mario Carpo traced how, in the early 1990s, the technological advances strongly impacted the design process, bringing architecture to a digital age. From the development of new digital tools for Computer Aided Design such as spline modellers, a conspicuous architectural style of smooth and curving lines and surfaces spawned and gave visible form to the first digital turn. However, despite a growing popularity, the complex geometries that characterise this smooth style go completely against the processes of mass-production and standardisation that are at the core of the previous points. Actually, in spite of the potentialities of such softwares to mass-produce, this first digital design took an opposite approach. Indeed, in search of a 'performative' design, each construction element answers to a function but takes also a unique and complex shape, that is not easily reproductive without the aid of advance digital tools. In fact, "*in the turn of the century, non-standard form-making had been proven to work effectively at the small scale of industrial design and fabrication, but did not perform well at the full scale of construction.*" (Carpo)

Nevertheless, new digital intelligence technologies have recently emerged and been adopted. Actually, "*the first digital turn in architecture changed our ways of making; the second changes our ways of thinking*" (Carpo). Now the use of artificial intelligence enables to mass-produce variations at no extra cost and digital mass-customisation has already changed the way the society produces and consumes almost everything. Hence also in the field of architecture, there is now the possibility to mass-produce the non-standard, going then from mass-production to mass-customisation. Therefore, even complex forms can be, theoretically, easily reproduced. Indeed today, numerous studies and examples have demonstrated the skills of adaptive and intelligent robots in the construction and processing of variations, thus getting closer to craft rather than industrial work.







Drawings.
Re-interpretation of the Bosjes Chapel, Steyn Studio.
Used building block designed by AUAR.
Left - Transversal and longitudinal section.
Right - Axonometric projection.

Image.
Gramazio Kohler Research, ETH Zürich, 2006.
Robotic fabrication of an element for Gantenbein Vineyard Façade in Fläsch, Switzerland.

Discrete strategy.

In the field of computational design, architecture called 'discrete' – a term that in science means discontinuous – investigates and emphasises the combinatory and modular features inherent to robotic assembly. As mentioned at the beginning, "*bricks have been made to measure for human manipulation since the beginning of time; but today, more powerful robotic arms can easily deal with bigger and heavier chunks*" (Carpo). In fact, even if the size and scale of the construction unit is not the same, the discrete strategy comes back, maybe surprisingly, to the formal and functional abstraction intrinsic to brick. Today, form-finding coupled with functional performances are at the core of the research in contemporary architecture, but in parallel, discrete architecture negates all of that to focus instead on the non-standard assembly of standardised abstract chunks. In essence, similarly to masonry, the discrete approach develops design strategies for serially repeating, recombinable sets of generic modules that can be assembled and re-assembled into fully functional and complex buildings.

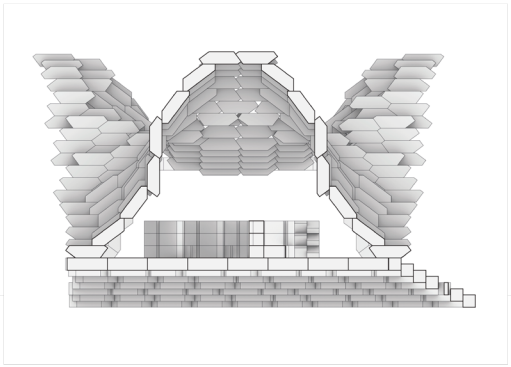
In addition, the discrete design approach seems to be a direct manifestation of how computational design actually works in this contemporary digital world, that gets organised around the so-called big datas, which refer to the capacity of analysing and putting in relation tons of datas to reveal possible interactions. In fact, big data is about processing and organising digital informations, and these informations may absolutely correspond with generic physical units.

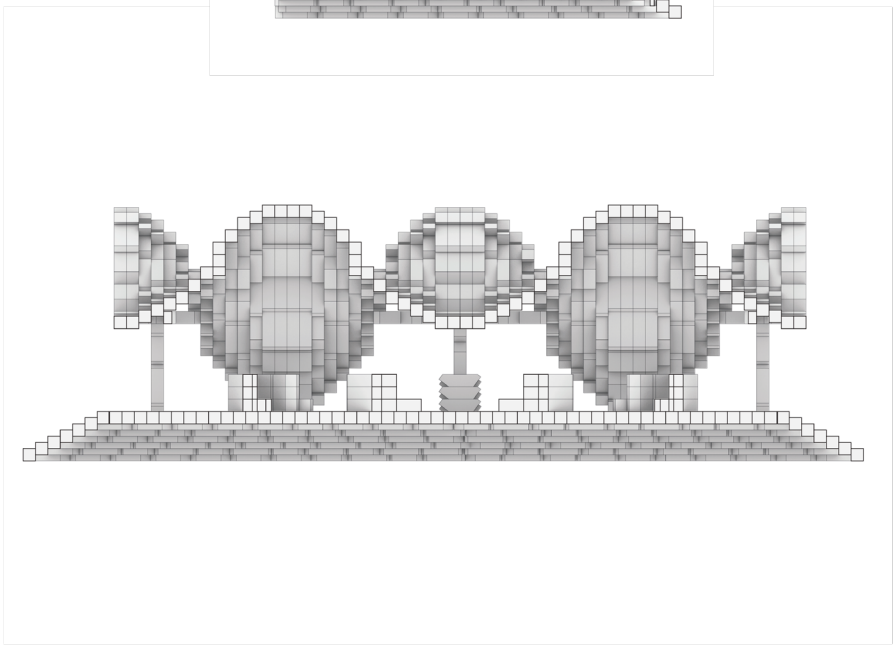
> *When we now compare Henry Ford's assembly line with the Amazon warehouse, we discover that there is at least a certain ambiguity in the difference between the two systems. They are both different and remarkably similar. Both are defined by seriality, repetition and discreteness. However, the big difference,*

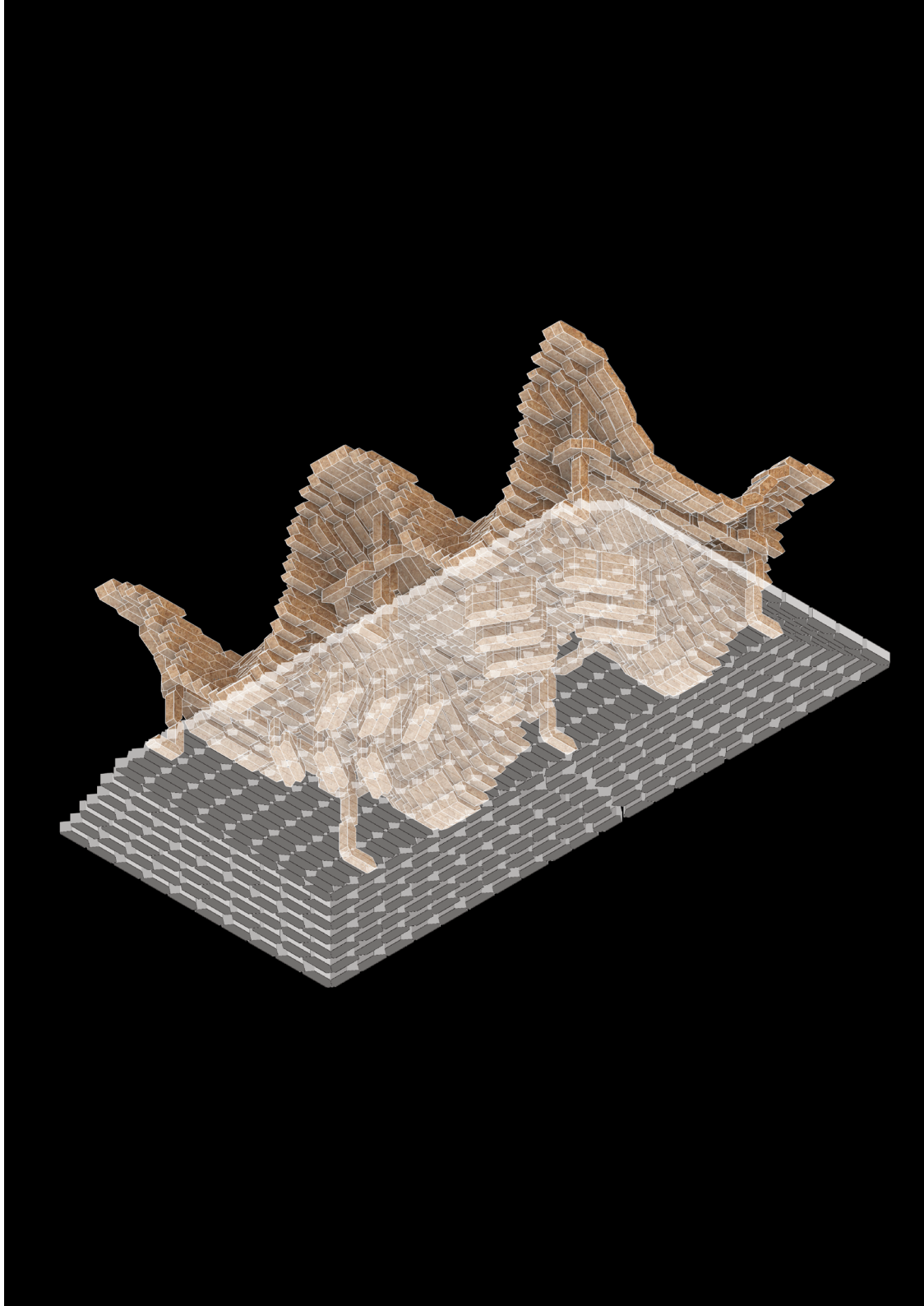
Image.
AUAR, Robotically assembled dwelling, 2021.
Addressing the demand for housing, building blocks made from timber are robotically pre-fabricated and assembled into dwelling units.

> *is not in the formal appearance of the Amazon warehouse, but in the logics behind this strange assembly of piles of cardboard boxes. The Amazon warehouse is about the mass customisation of logistics, not of form. What we see in the warehouse is a global, automated system of distribution based on just-in-time delivery, flexible, efficient and adaptive.* (Retsin)

In other words, to each building element is assigned a specific data and is interpreted as such, and as mentioned above, discrete design is essentially about intelligent organisation and combination of these elements to reveal possible architectures. Finally, as digital datas can be easily used for many different purposes, they are by definition extremely 'versatile', which is maybe the keyword that should be assigned to chunks.







Drawings.
Re-interpretation of the Bosjes Chapel, Steyn Studio.
Used building block designed by Ivo Tedbury.
Left - Transversal and longitudinal section.
Right - Axonometric projection.

II. ABOUT CHUNKS.

Like LEGO bricks or KAPLA planks, generic units don't have any pre-defined functions; they are actually hierarchically equals, without any priorities of assembly either. Because of their versatility, meaning and function become an emerging property of the interaction between parts, which is defined by the coordinator. Therefore in the discrete thesis, this formal abstraction of course questions the shape that these building elements must take, and according to the existing studies and experimentations, four main basic statements have been set to guide the conception and the geometrical design of chunks.

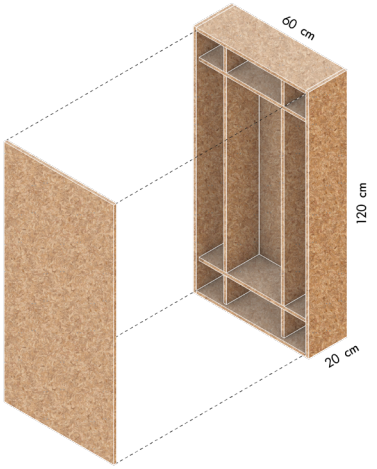
1. Chunks have to be digitally conceived and fabricated, so the elements can be cheaply mass-produced and benefit of the mass-customisation for a non-standard assembly.
2. Due to their versatile character, chunks have the possibility to be disassembled and re-assemble in a different manner, responding through their iterative accumulation and recombination to different conditions.
3. Structurally speaking, geometries of the elements are not optimised to perform in a unique condition, but on contrary, the design enable multi-purposes and multi-performances.
4. Assembly means also connections between the parts. Indeed, the geometry and the connection solution define the growing law that enables possible spatial arrangements, while limiting them too.

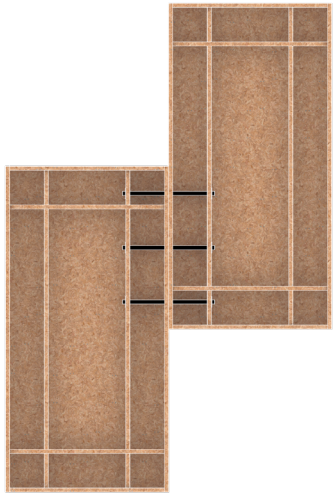
In this chapter, I will present the study of three different existing chunks; their geometry, their connection system, and for each one, a catalogue of possible spatial movements and combinations.

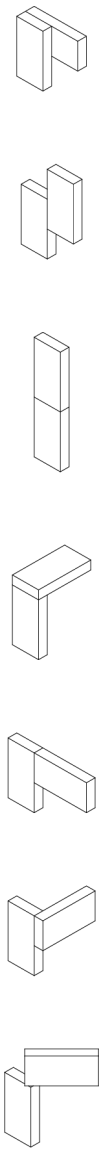
AUAR case study.

Automated Architecture (AUAR) is a London & Bristol-based design and technology consultancy, co-founded by Mollie Claypool, Gilles Retsin and Claire McAndrew, and promoting robotic fabrication and automation in architecture. AUAR uses prefabricated plywood building blocks to build temporary home-offices and customised dwellings.

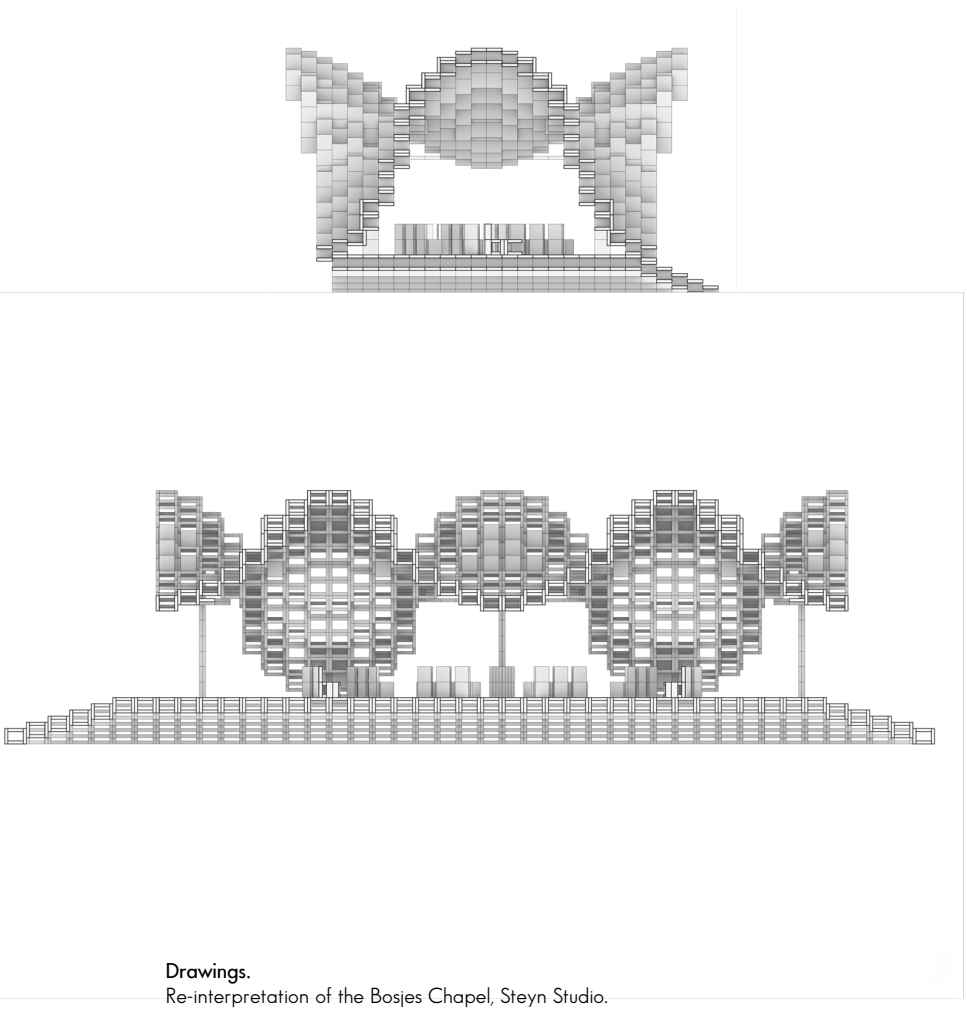
AUAR's chunk geometry is a rectangular prism in proportions one/third for the base and one/half for the height. It is reinforced from the inside and each plank is regularly pierced in order to accommodate the connection system, composed of metallic screwed rods and an ensemble of nuts and bolts. This system enables to switch the blocks between them, multiplying the possibilities of assembly. Each spatial organisation presented here in the catalogue on the right can offer a big variety of different results by shifting and rotating orthogonally the blocs, respecting however the connection openings. It is true that its rectangular geometry allows mainly an orthogonal growing and assembly, but rotations of 360° are still possible if two blocks touch in only one point, meaning therefore connected by one rod.

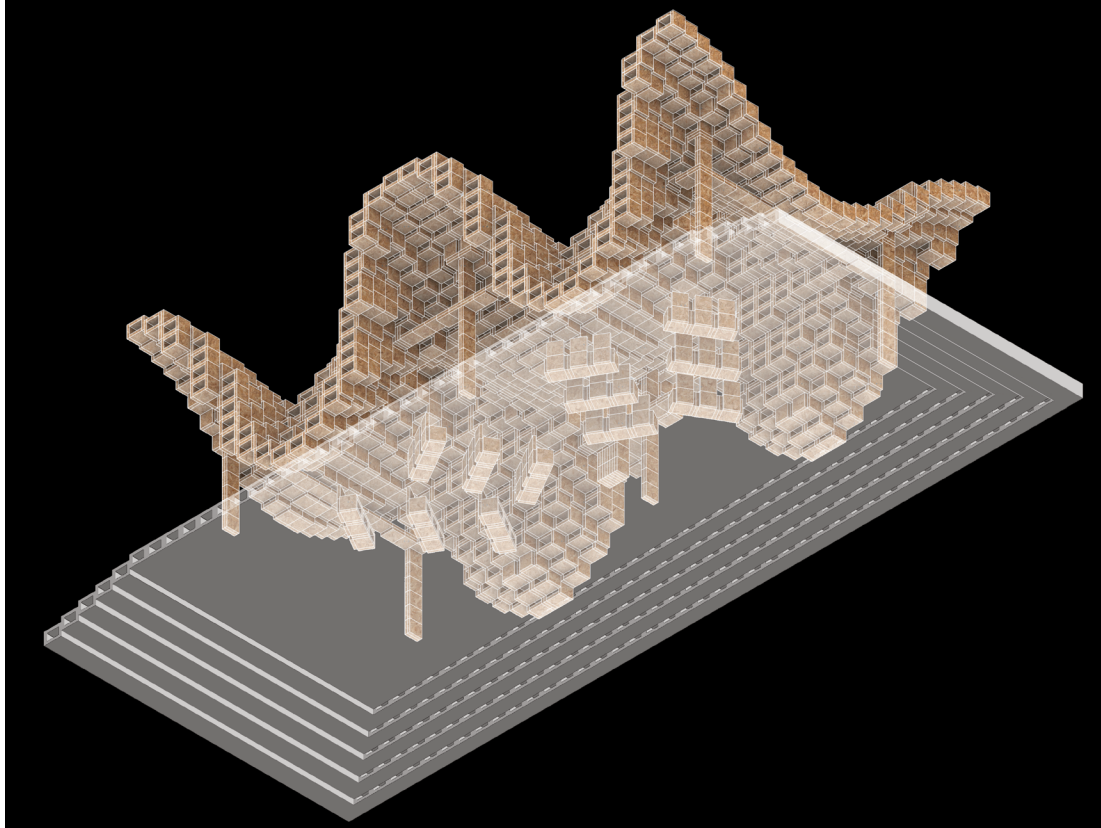






Drawings.
Study of the building block designed by AUAR.
Top - Axonometry of a single element.
Bottom - Connnection system between two elements.
Right - Catalogue of possible arrangements between elements.



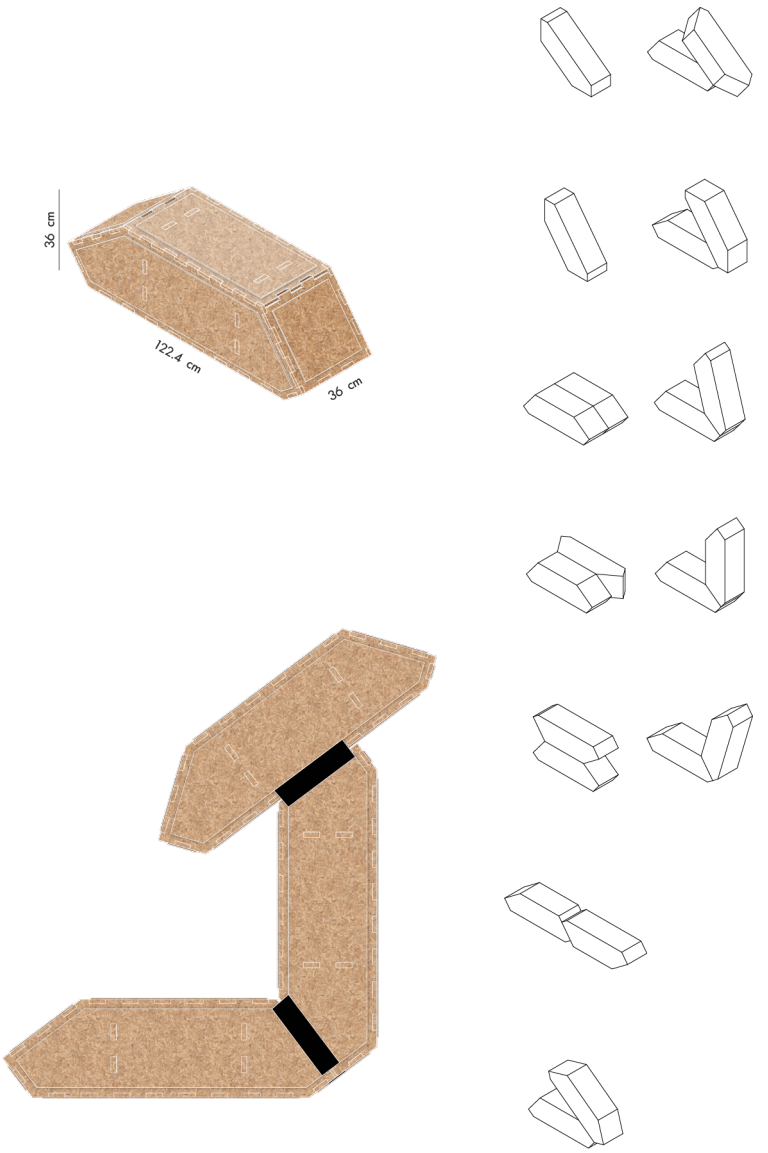


Drawings.
Re-interpretation of the Bosjes Chapel, Steyn Studio.
Used building block designed by the B-Pro Research Cluster 4.
Left - Transversal and longitudinal section.
Right - Axonometric projection.

semblr case study.

semblr is a construction platform to enable automated construction of housing developed by Ivo Tedbury and using also prefabricated timber bricks.

Contrary to the previous chunk, this one has a particular shape and the geometry of the longitudinal face is more complex, while keeping nevertheless strong and logic proportions. As an example, in order to achieve heterogeneous aggregations, particulars angles have been chosen but still complementary to achieve orthogonal movements. Moreover, as the transversal section of the chunk is a square, it can be rotated on the longitudinal axis to emphasise spatial heterogeneity. Conversely, the connection system stand outside along the edges of the whole geometry. The continuous shallow gap that constitute the perimeter of each faces allows to fit a metallic plate that is then screwed in the numerous openings already presents on the blocks to attach them together. This method of fixation responds well to the researched liberty of aggregation because is independent from the position of each block. Therefore, the geometrical and connective particularities enable a large field of spatial actions and orientations, as the catalogue demonstrates.

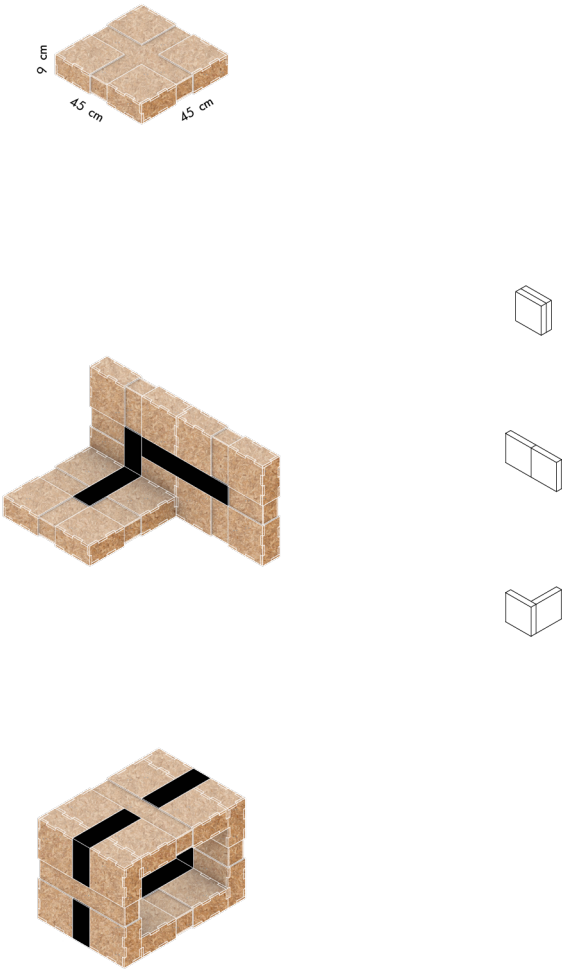


Drawings.
Study of the building block designed by Ivo Tedbury.
Top - Axonometry of a single element.
Bottom - Connnection system between several elements.
Right - Catalogue of possible arrangements between elements.

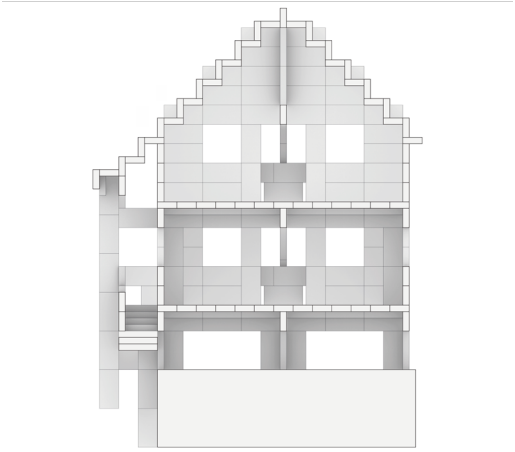
B-Pro Research Cluster 4 case study.

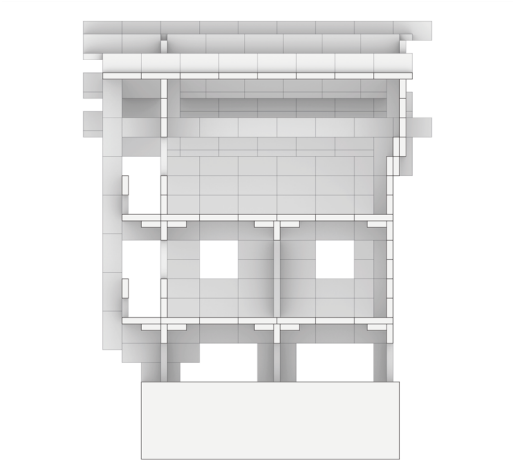
The project *Assembler Assemble* developed by the Research Cluster 4 (RC4), of the B-Pro Design Computation Lab of the Bartlett School of Architecture in London, explore again automation in architecture and construction process by modularising both of the construction timber block, and the robot.

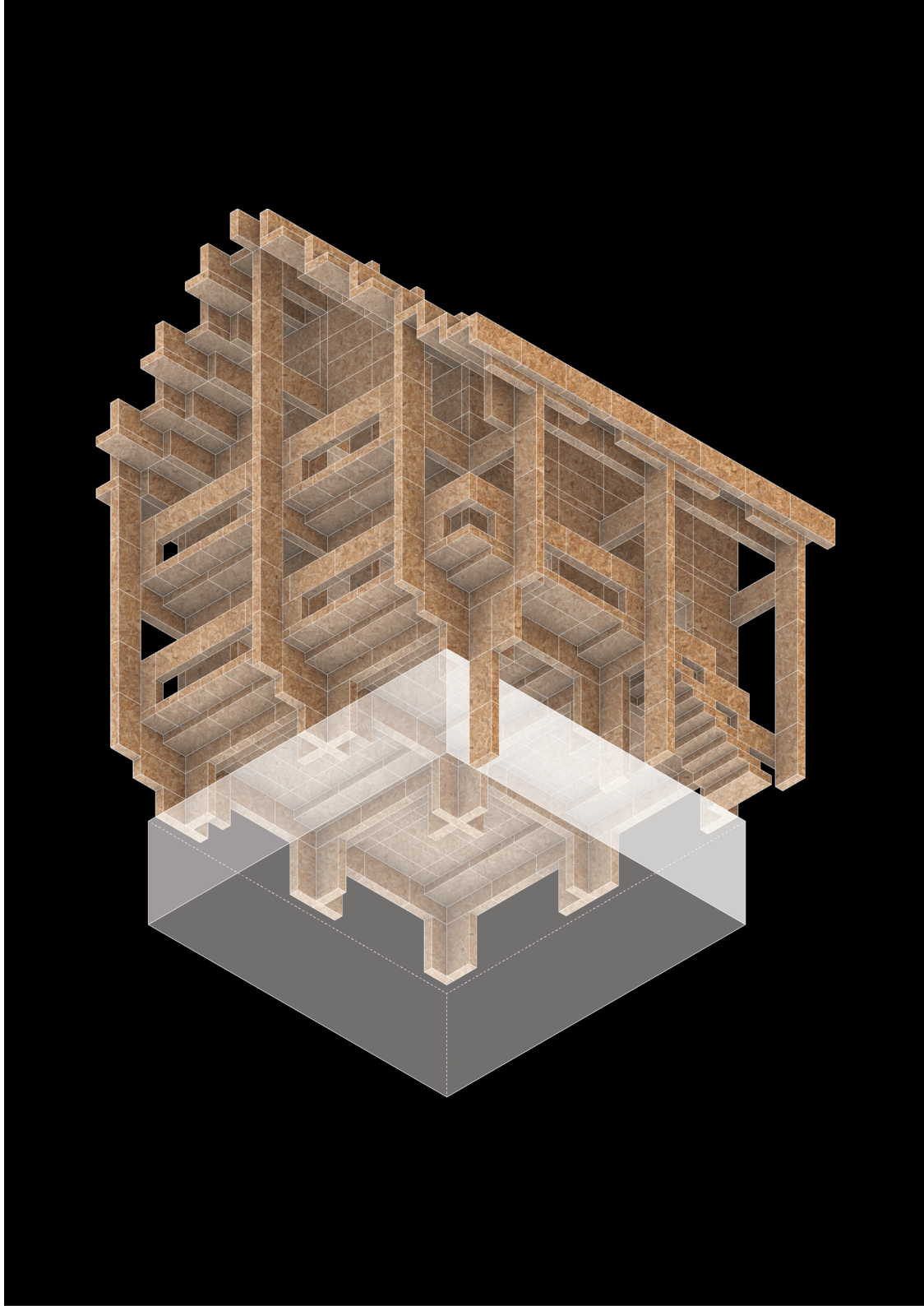
Geometrically speaking, this last chunk is close to the first one, meaning a regular and square-based prism, but on the other hand, the difference in size in comparison is noteworthy. In consequence, the design and the connection system have been conceived so that the aggregation of some blocks creates a bigger and stronger construction brick. According to that, this duality of scales enable to work both the detail and the whole of the construction. The system of connection is whereas similar to the second study case. Indeed, a shallow gap draws a centred cross which creates like a rail that travels all around the chunk and which accommodates again a metallic plate (straight or L shape) of the same length as the side of square face of the block. Then the metallic plates is screwed following a pattern of openings that subdivides the block in five units. Contrary to the previous study case where joins are along the edges, the system of centred cross create a unique junction point on each little faces of the chunk, which limits the possibilities of shifts and tends to encourage the combination of these blocks in bigger bricks.



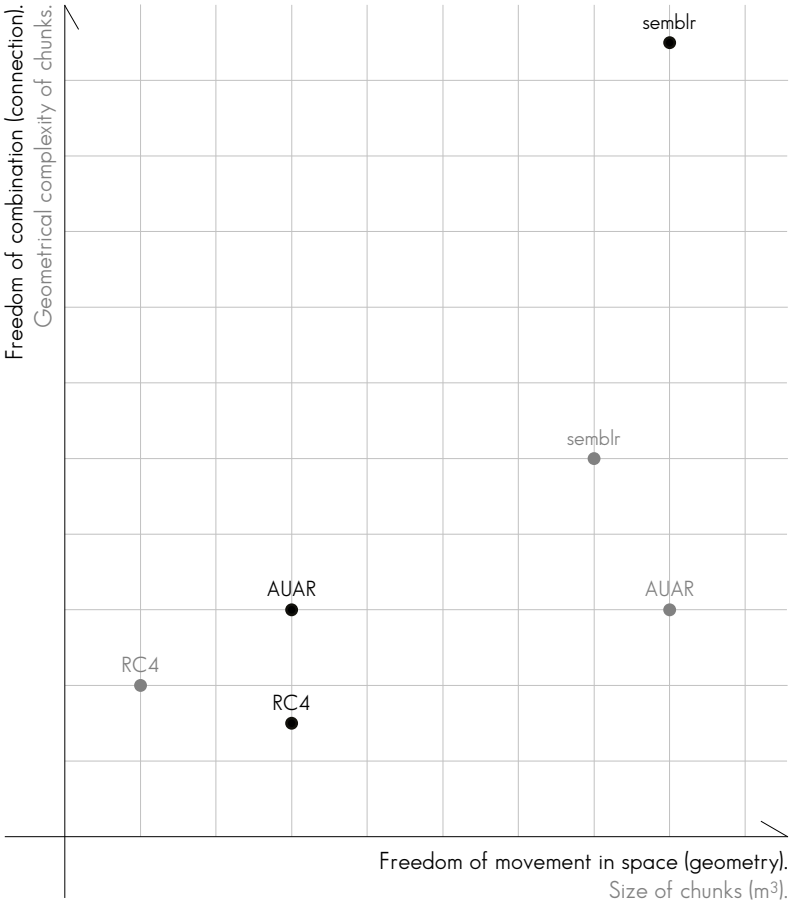
Drawings.
Study of the building block developed by the B-Pro Research Cluster 4.
Top - Axonometry of a single element.
Middle - Connection system between several elements.
Bottom - Bigger unit composed of four elements.
Right - Catalogue of possible arrangements between elements.







Drawings.
Re-interpretation of a vernacular Swiss Chalet.
Used building block designed by AUAR.
Left - Transversal and longitudinal section.
Right - Axonometric projection.



Graph.
Recapitulative graph of the characteristics of the three chunks studied.

III. ABOUT ARCHITECTURE.

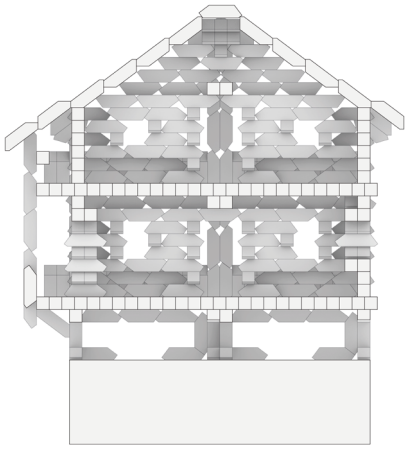
As noticed throughout this reading, the Énoncé théorique is regularly interspersed with study drawings that depict the chunks previously studied by reinterpreting four different architecture projects. As mentioned initially, despite or thanks to the formal and functional abstraction of the bricks, the architectural language has been able to take a multitude of forms throughout the world and through time. Now by considering that the contemporary discrete strategy and chunks as a reinvention of the brick, the purpose of these drawings is to question the discrete thesis in regard to architecture and its complexity of characters. Therefore, each chosen architecture project here presents a particular character to study and test manually, by manipulating the chunks to fit in the best possible way, the expressions of the original construction.

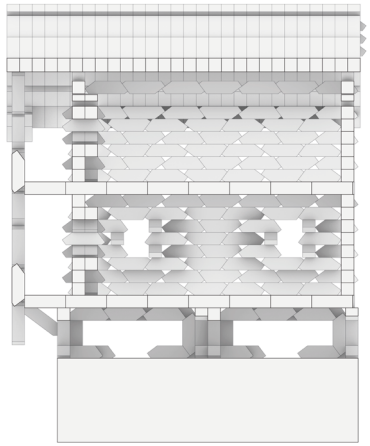
The first architecture project is the Maison Dom-ino conceive by Le Corbusier in 1914. Known for its facility to be massively reproduced thanks to the pilotis system, Dom-ino raises structural issues due to its slabs, questioning the relation of the discrete strategy with the contemporary architecture of slabs.

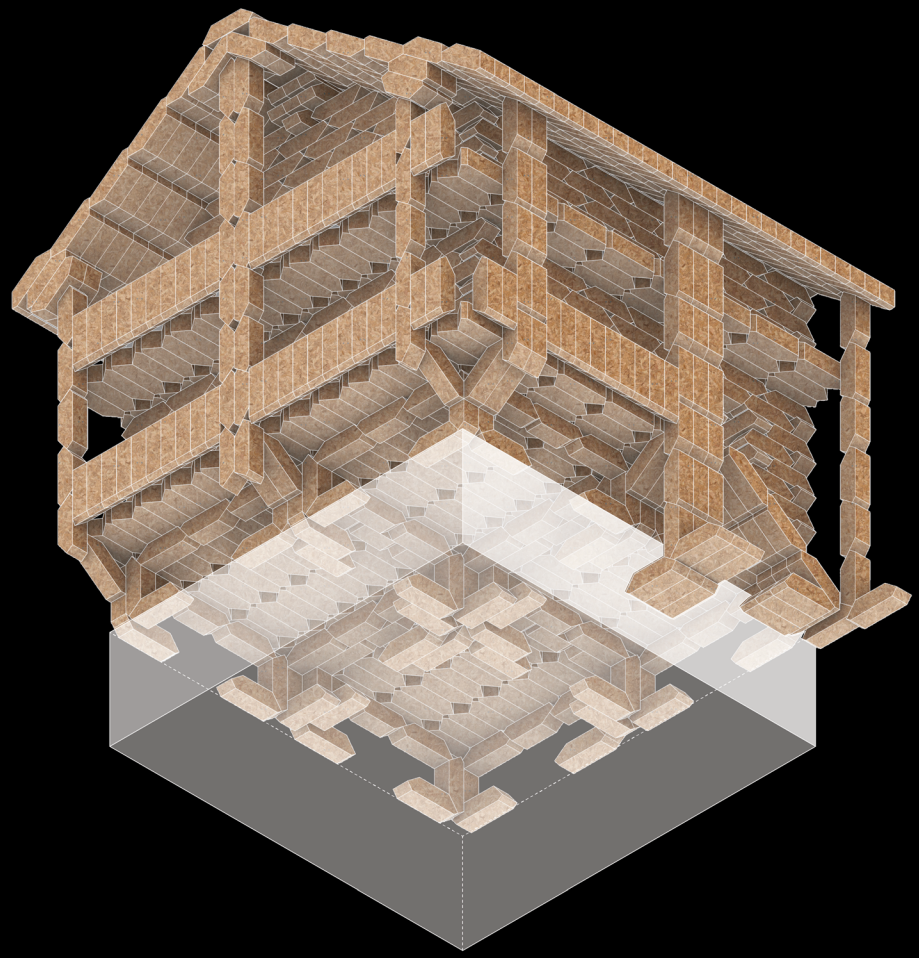
In contrast, the project of a chapel designed by Steyn Studio for the BOSJES estate stands out for its roof with a sculptural aspect and a landscaped character. Then how the discrete strategy can respond to complex topographies in architecture ?

In a different register, after having studied its formal potentialities, the discrete reinterpretation of a typical Swiss chalet analyses its capacity to transcribe a more vernacular and cultural expression.

Lastly, unlike the first 3 examples, can it answer to less tangible problematics but more spiritual characters, that the church San Giovanni Battista of Mogno designed by Mario Botta may have ?

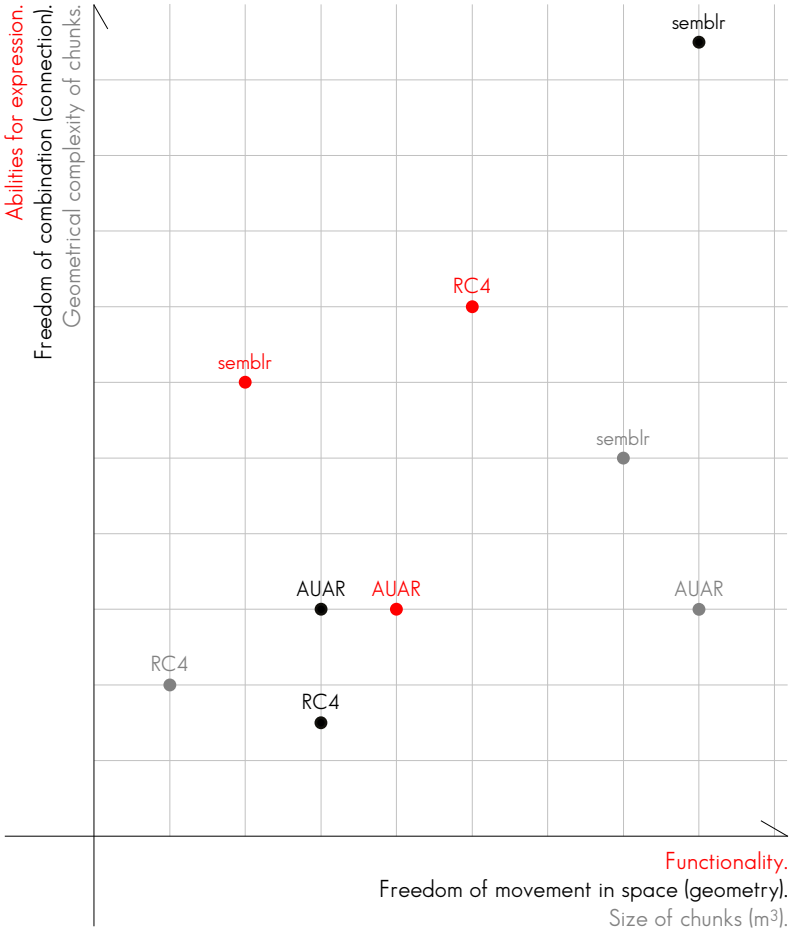






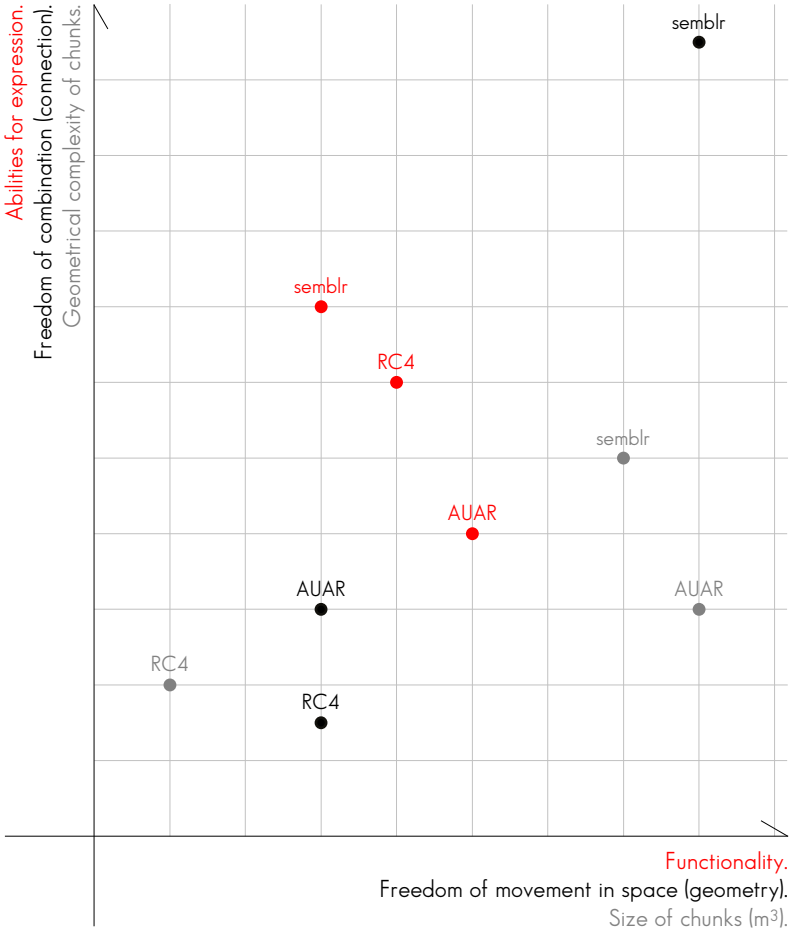
Drawings.
Re-interpretation of a vernacular Swiss Chalet.
Used building block designed by Ivo Tedbury.
Left - Transversal and longitudinal section.
Right - Axonometric projection.

Maison Dom-ino.



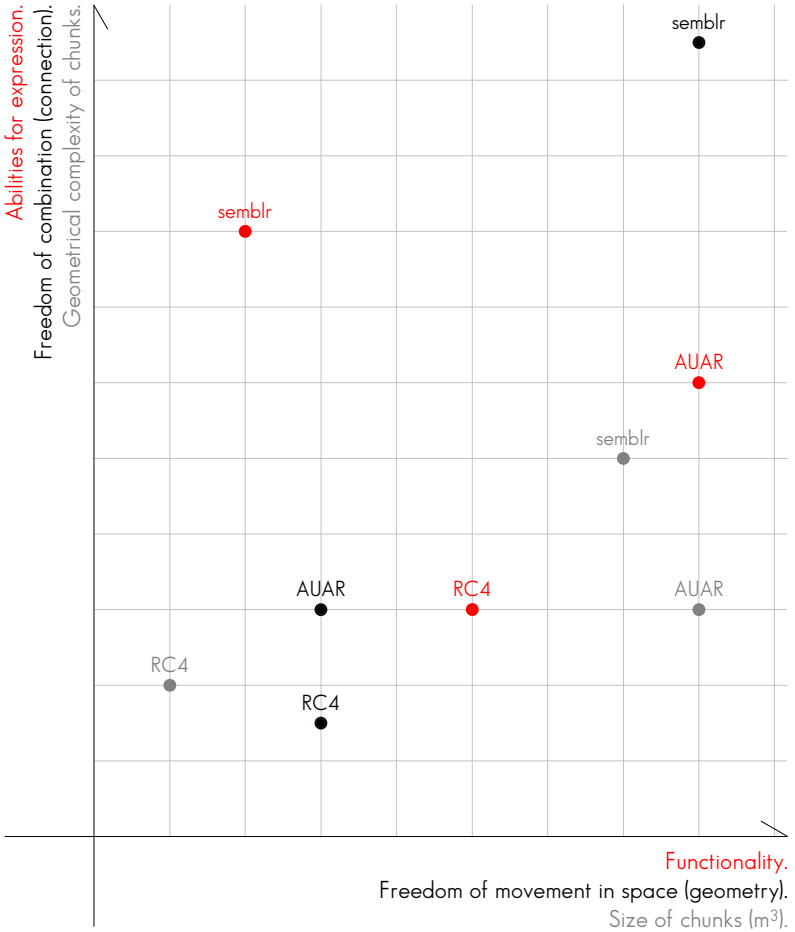
Graph.
Recapitulative graph of the characteristics of the chunks in terms of their expressive and functional abilities.

Bosjes Chapel.



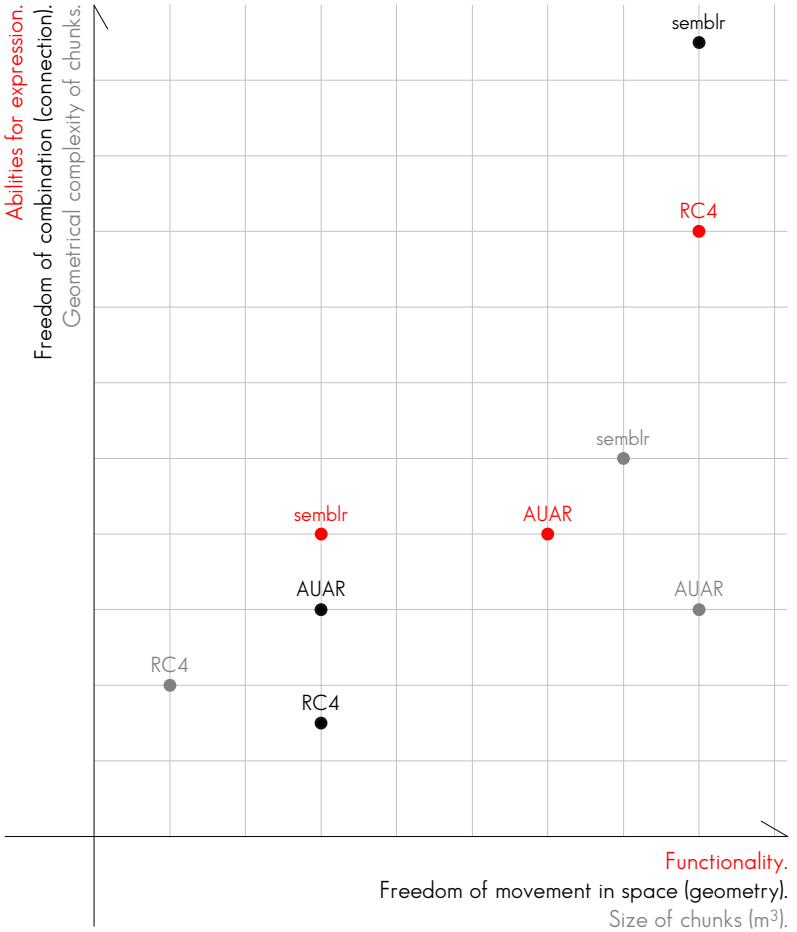
Graph.
Recapitulative graph of the characteristics of the chunks in terms of their expressive and functional abilities.

Swiss chalet.

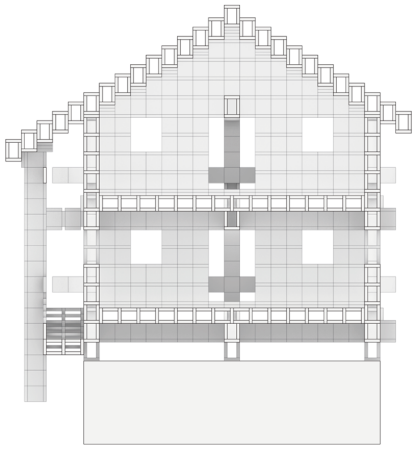


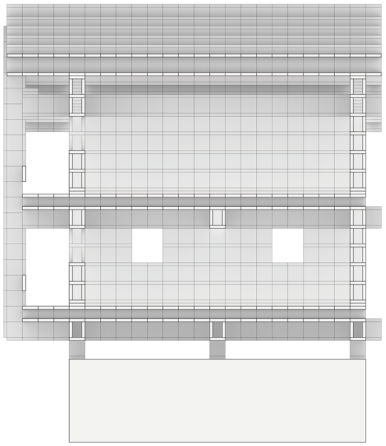
Graph.
Recapitulative graph of the characteristics of the chunks in terms of their expressive and functional abilities.

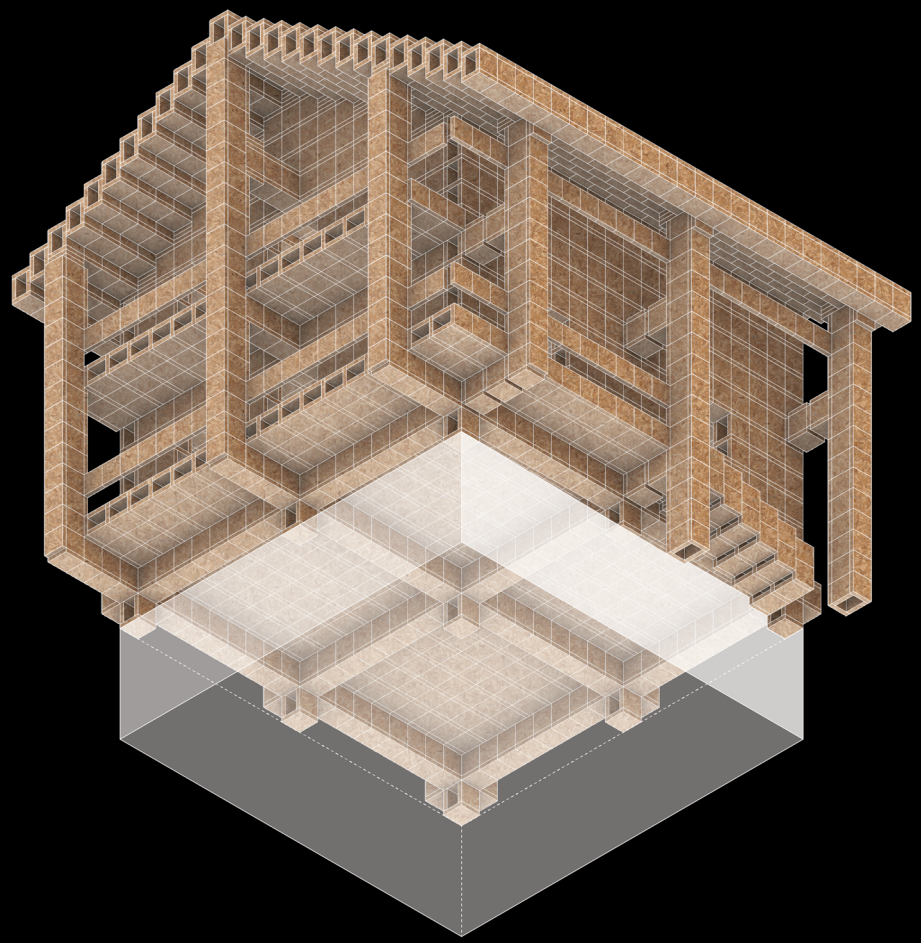
Church of Mogno.



Graph.
Recapitulative graph of the characteristics of the chunks in terms of their expressive and functional abilities.







Drawings.
Re-interpretation of a vernacular Swiss Chalet.
Used building block designed by the B-Pro Research Cluster 4.
Left - Transversal and longitudinal section.
Right - Axonometric projection.

By putting in relation the chunks characteristics with the chunked reinterpretation of each architecture project, this series of graphs brings a first answer to the following questions: could the discrete strategy maintain the architectural characters that have been described above ? But also, are these reinterpretations just as functional architecturally speaking ? Of course, these study drawings are only one example of a construction among the multitude of possible and similar results. Perhaps by repeating the process of progressive combination, the approach of the architectural elements will be different. The overall silhouette of the construction will be then quite the same, however the parameters of functionality and capacity of expression are variable. Therefore, the position of each red point in particular is clearly not absolute, and one should interpret these comparative graphs as a relational grid between each chunk. Nevertheless, they constitute a first personal interpretation of the architectural abilities of these three elementary construction units, this being a preliminary response to the more generic question; could a discrete approach to architecture maintain culture ?

Thus, on the base of this study, the chunk designed by Ivo Tedbury seem to be the one with the most expressive abilities, probably because of its irregular shape and its great combinatorial liberty. Followed then by the one developed by the RC4, probably thanks to its smaller scale in that case. In contrast, Tedbury's chunk has a law ratio of architectural functionality, contrary to AUAR's one, closely followed also by the one of the RC4.

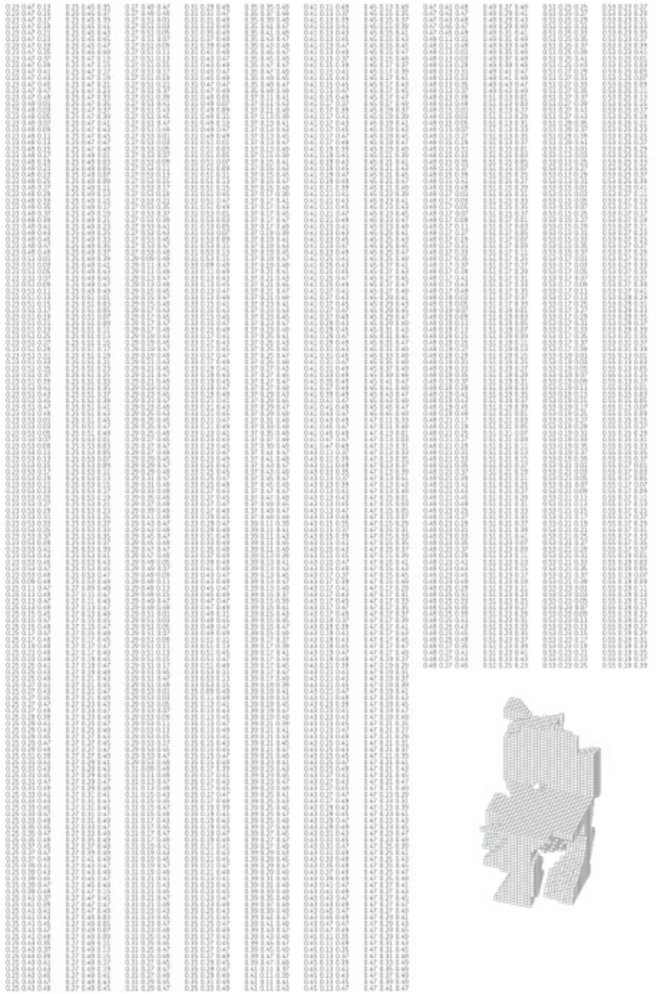


Image.
EZCT Architecture & Design Research, Philippe Morel, Hatem Hamda & Marc Schoenauer, TestBolivar-320 Chair with list of voxel coordinates, 2004.
Studies on optimization: computational chair design using genetic algorithms.

Architectural paradox.

As mentioned initially, the formal and functional abstraction of chunks don't preconceive any architectural expression, but the resultant construction does. By attempting to imitate various architectural characters, inherent in a specific material or construction method, these study drawings aim to demonstrate the possible expressive heterogeneity. Yet, it has also been said that the discrete design approach may and should be think as a physical manifestation of a digital process. As explained, building blocks act as digital datas, meaning that they are versatile and, most importantly, that the approach focuses on the interactions between blocks. Some protagonists of the discrete strategy then speak of a digital syntax, getting rid of geometry and purely emerging from the relations between the elements. Therefore, this syntax may raise an important question; is digital a style, or at least, does it possess its own architectural expression ?

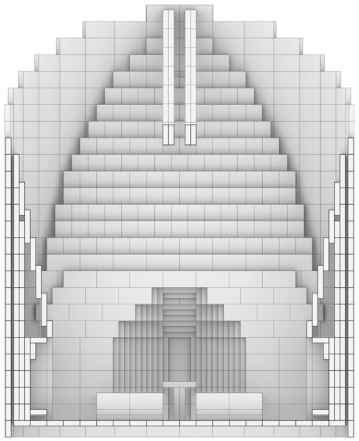
Whereas 'Parametricism' (Schumacher) is composed of continuous, curvilinear forms, 'Discrete architecture', as frequently called by some protagonists, is composed of discontinuous, largely straight forms and positions itself as an architecture of resistance in the contemporary architectural debate. In that case, the search for abstraction lead to an architecture against the surface – whose principles refer to Kengo Kuma's criticism on architecture '*Method called concrete*', which denounces the relations that architects have with materials, considered today as nothing but a texture mapping pattern given to a surface – and against the super-forms that delimit an archetypical geometry, then questioning and inverting the way to give form to architecture. In the discrete thesis, the connstruction seems to follow a super-form but it is in facts only an assembly of hierarchically equal parts. This is the paradox. Ontologically speaking, the discrete approach focus on the study of part-to-part and part-to-whole relations, or, refering to Daniel Koehler, 'mereology', which means in the end to define the laws of composition that will process and put in relation the parts to finally reveal varied forms and possible characters or styles, but not a style in itself.

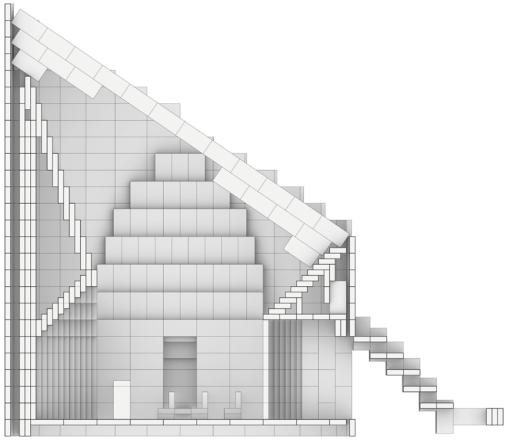
To the question, is digital a style, architect and theorist Neil Leach answers :

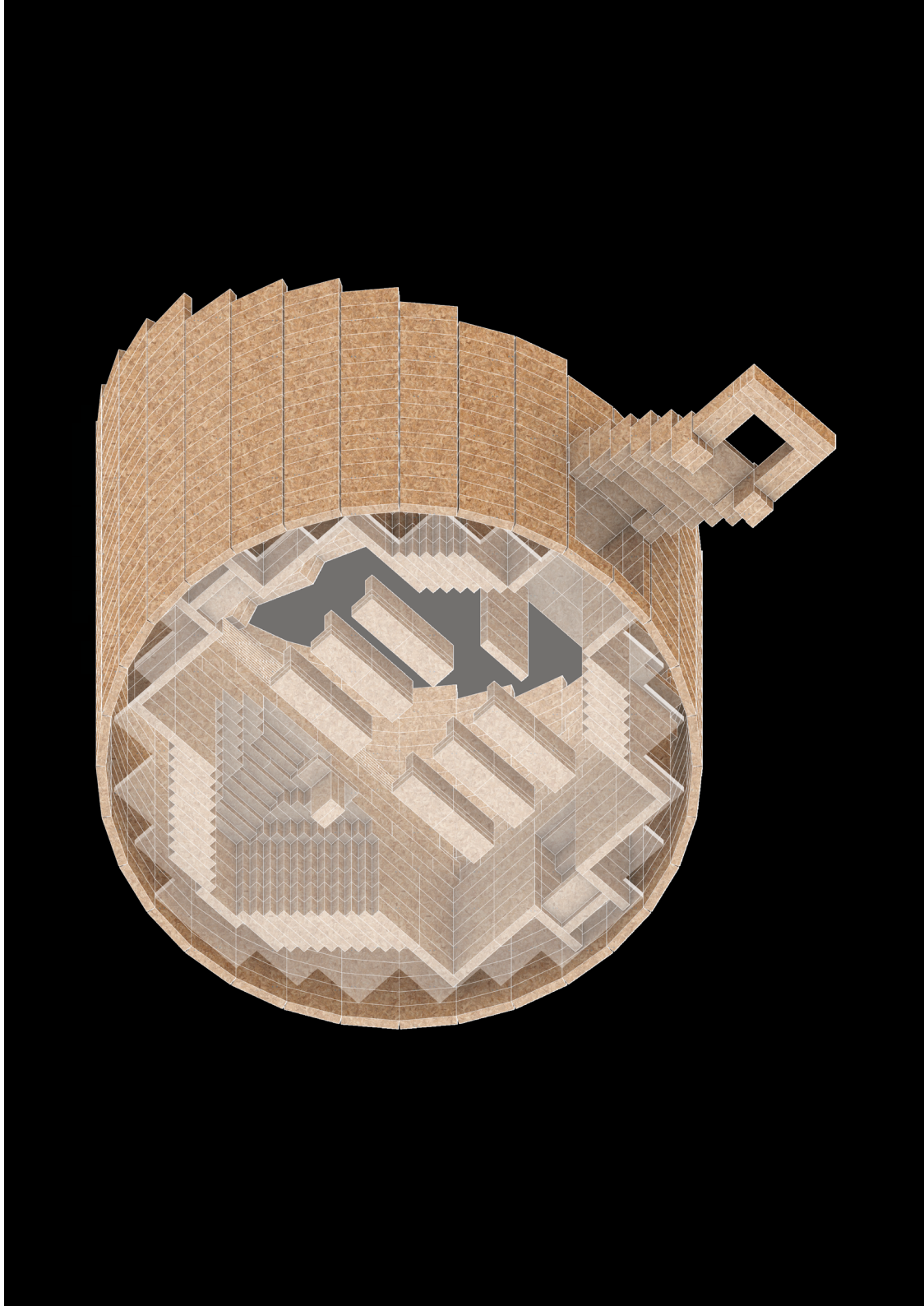
> *What big data has to do with architectural form is unclear. After all, big data is about information, not form. A good example of the intelligent use of big data are Uber cars. Do Uber cars look any different to ordinary cars? No. Because Uber cars are ordinary cars. They just use new techniques to process information. It is patently absurd to claim that there is an architectural style associated with big data.*

Let's use this example to explain my point. Of course, Uber cars are ordinary cars, because they are the basic unit. What is not ordinary is the route these cars will take. Thus, the way to process informations give to each of them a function and this will produce a certain geographic repartition of these Uber cars. Note that the movement of the cars is limited by the super-form that are the roads. Thereby, should the search for super-forms rather result from the existing and/or necessary context ? In conclusion, the 'digital' has indeed no form, or style, unless ruled by relational and organisational laws, like the spatial coordinates which are assigned to the voxels that compose the testBolivar-320 chair.

In architecture then, digital design does not offer formal freedom, but rather a freedom of organisation – given by the formal characteristics of the components, and by the combinatorial tolerances of the connection system that still allow great potential for customisation – which leads to a considerable number of possible forms. In the end, by reinventing the brick, the discrete strategy seeks in my opinion a contemporary method of construction, facing the actual topics or issues, and is thus anchored in a cultural and architectural continuity of construction.





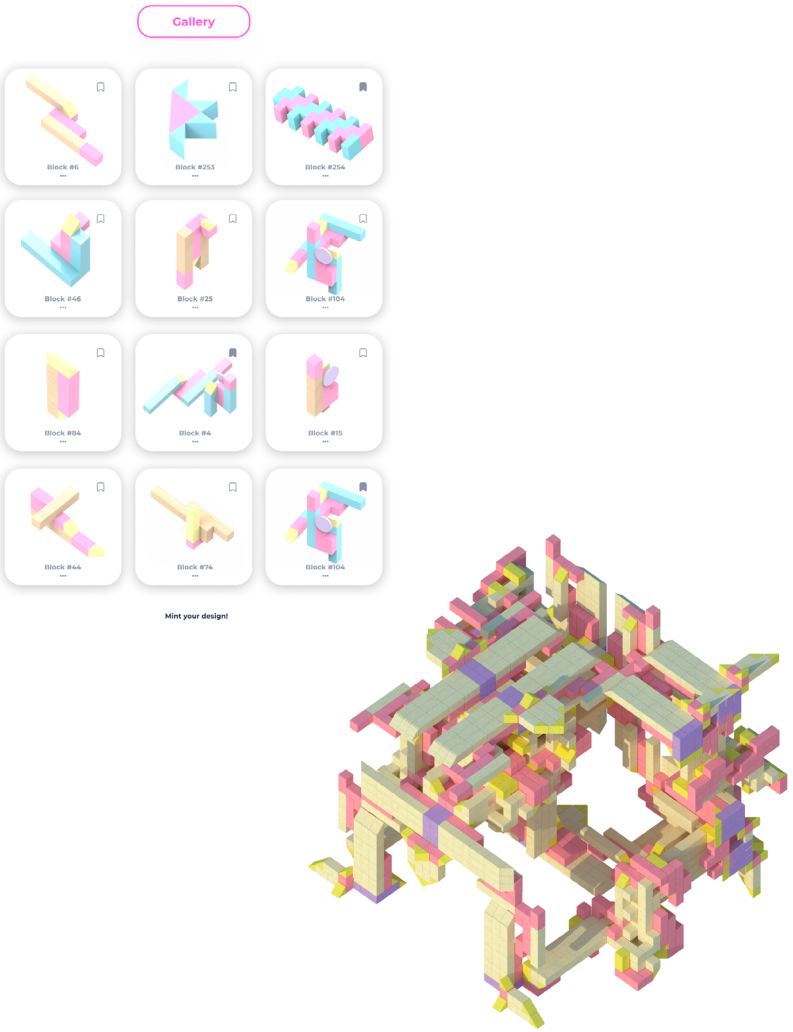


Drawings.
Re-interpretation of the Church of Mogno, Mario Botta.
Used building block designed by AUAR.
Left - Transversal and longitudinal section.
Right - Axonometric projection.

IV. ABOUT COLLECTIVITY.

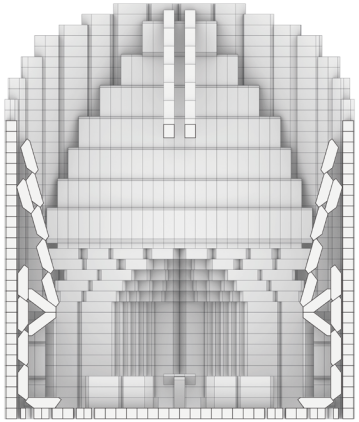
Recently, the architectural design studio IHEARTBLOB presented its pavilion for the Tallinn Architecture Biennale (TAB) of 2022, "*a new decentralised and systematic approach towards architectural design, fabrication and funding in which the community are both the designers and investors leading towards an emergent structure that evolves and grows over time*" (iheartblob). Actually, the project *Fungible / Non-Fungible* proposes an application for mobile phones, built on a NFT – which stands for Not-Fungible Token, a digital asset whose value is relative and which exists completely in the digital universe and which individuals may own – generative tool, in which individuals can design within constraints a piece of the pavilion, and 'mint' – the process of creating and authenticating digital ownership – their own objects. The application will be online for two months and later this summer, the resultant construction will be built and open to the public. In short, "*the result is a pavilion composed of unique parts each with different designers and owners, and ultimately reflective of a broader community demand and aesthetic sentiment*". (TAB)

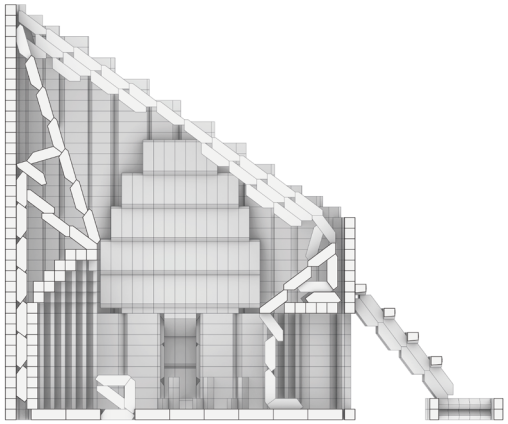
This project is totally in line with the discrete thesis, and furthermore, it approaches also one fundamental thematic for contemporary architecture, which is the participation of an external collectivity somewhere in the process. However, in the majority of discrete architectural experiments, the physical and architectural construction is as if frozen and the versatile character of the chunks is not benefited during its use. Then probably, chunks should not be reserve to digital automation; in fact, in my interpretation, the discrete thesis should first emphasise the connectional agility specific to chunks, the possibilities of disassembly and re-assembly should stimulate the interactivity with the users for a more collective and public use. *Fungible / Non-Fungible* aims to be the symbol of a collective



Images.
IHEARTBLOB, Fungible / Non-Fungible, 2021.
Top - Image gallery of the mobile app showing different pieces.
Bottom - Optional resultant construction.

artwork, digitally fabricated, like a new type of contemporary monument. Yet, it does not refer to a collectivity in the truest sense, but more in a form of self-assertion. On contrary, by reinventing the brick, the chunk must find a collective dimension due to its assembly, for an architecture that speaks to people. In comparison, the LEGO brick, despite all its abstractions, and whose primary function is to be combined, remains a building brick, precisely because it always announces itself as something that can be transformed into a representation of something else. Coming back to words, the LEGO system is best understood as a language, whose bricks are words; and languages are essentially linked to a capacity to construct meaning.





Drawings.
Re-interpretation of the Church of Mogno, Mario Botta.
Used building block designed by Ivo Tedbury.
Left - Transversal and longitudinal section.
Right - Axonometric projection.

BIBLIOGRAPHY.

Literatures.

Baldwin, Carliss Y., and Kim B. Clark. *Design Rules*. Cambridge, Mass: MIT Press, 2000.

Carpo, Mario. *The Second Digital Turn: Design beyond Intelligence*. Writing Architecture. Cambridge, Massachusetts: The MIT Press, 2017.

Köhler, Daniel, and Ludwig Hilberseimer. The Mereological City: A Reading of the Works of Ludwig Hilberseimer. Architecture, volume 36. Bielefeld: transcript, 2016.

Kuma, Kengo. *Kengo Kuma: Materials, Structures, Details*. Basel Berlin Boston: Birkhäuser, publ. for architecture, 2004.

Retsin, Gilles, ed. *Discrete: Reappraising the Digital in Architecture*. Architectural Design Profile, no 258. Oxford: John Wiley & Sons, 2019.

Articles.

Careaga, Mark. "Le Corbusier and the Non-Representation of Technology." *Medium* (blog), December 24, 2017. https://medium.com/@markcareaga/le-corbusier-and-the-non-representation-of-technology-50e35bac62d9.

Carpo, Mario. "Foreword. The Age Of Computational Brutalism" In *Robotic Building: Architecture in the Age of Automation* edited by Gilles Retsin, Manuel Jimenez, Mollie Claypool and Vicente Soler, 8-9. München: DETAIL, 2019. https://doi.org/10.11129/9783955534257-001

Carpo, Mario. "RISE OF THE MACHINES." *Artforum*, March 2020. https://www.artforum.com/print/202003/mario-carpo-on-robotic-construction-82219.

Retsin, Gilles. "Discrete and Digital." *Texas Society of Architects*, 2016, 18. https://www.academia.edu/33411405/Discrete_and_Digital_TxA_2016.

Smith, David Alexander. "Abstracting the LEGO Brick." *BUILDING DEBATES* (blog), June 24, 2017. https://buildingdebates.wordpress.com/2017/06/24/abstracting-the-lego-brick/.

Vongvanij, Anuntachai. "The Digital Turn in Architecture 1992-2012 | Mario Carpo." Postmodernisms: Theories and Analyses of Architecture II, May 2015. https://blogs.cornell.edu/arch5302sp15/2015/05/20/the-digital-turn-in-architecture-1992-2012-mario-carpo/.

Zweig, Janet. "Ars Combinatoria: Mystical Systems, Procedural Art, and the Computer." *Art Journal* 56, no. 3 (1997): 20–29. https://doi.org/10.2307/777833.

Websites.

Barandy, Kat. "AUAR's Robotically Assembled Dwelling Is at Once Beautiful and Affordable." designboom | architecture & design magazine, October 19, 2021. https://www.designboom.com/architecture/automated-architecture-auar-robotically-assembled-dwelling-global-investment-summit-uk-10-19-2021/.

Belitskaja, Aleksandra, Ben James, and Shaun McCallum. "Fungible / Non-Fungible." iheartblob. Accessed January 16, 2022. https://www.iheartblob.com/tab2022/.

Claypool, Mollie. "Discrete Automation." e-flux Architecture, July 2019. https://www.e-flux.com/architecture/becoming-digital/248060/discrete-automation/.

Conjuring Credits. "Blow Book." Accessed January 16, 2022. https://www.conjuringcredits.com/doku.php?id=paper:blow_book.

"De Arte Combinatoria." In *Wikipedia*, June 25, 2021. https://en.wikipedia.org/w/index.php?title=De_Arte_Combinatoria&oldid=1030442631.

Enciclopedia Treccani. "ars combinatoria." Accessed January 16, 2022. https://www.treccani.it/enciclopedia/ars-combinatoria.

Fondation Le Corbusier. "Fondation Le Corbusier - Projects - Maison Dom-Ino." Accessed January 16, 2022. http://www.fondationlecorbusier.fr/corbuweb/morpheus.aspx?sysId=13&IrisObjectId=5972&sysLanguage=en-en&itemPos=4&itemCount=215&sysParentId=65&sysParentName=.

"Installation Competition – TAB 2022." Accessed January 16, 2022. https://2022.tab.ee/installation-programme-competition/."

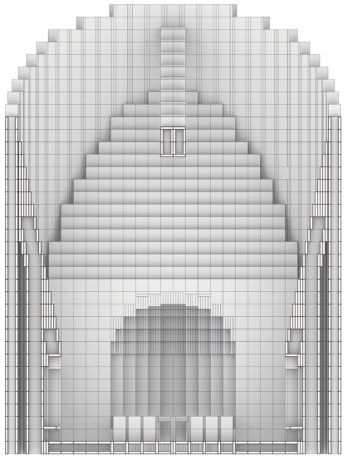
Mattone." In *Wikipedia*, January 13, 2022. https://it.wikipedia.org/w/index.php?title=Mattone&oldid=125041264.

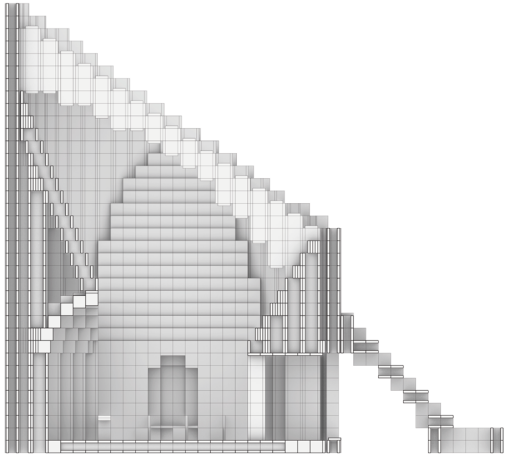
Merin, Gili. "AD Classics: The Crystal Palace / Joseph Paxton." ArchDaily, July 5, 2013. https://www.archdaily.com/397949/ad-classic-the-crystal-palace-joseph-paxton.

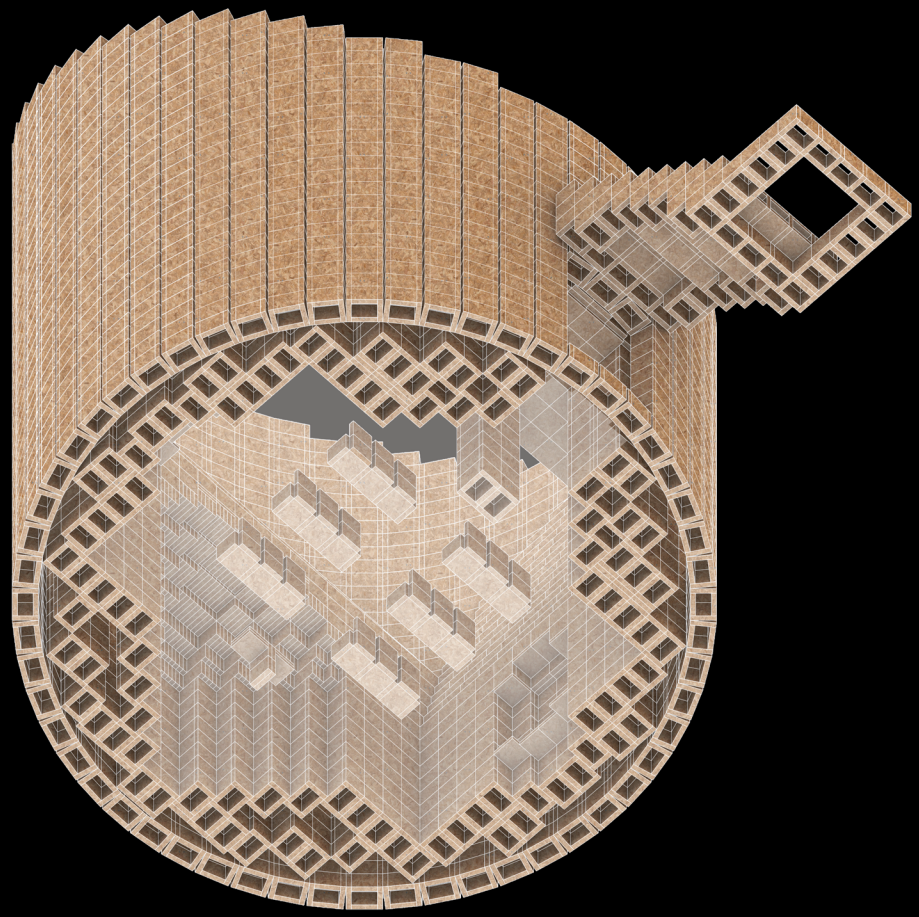
Nguyen, Man. "Assembler Assemble." Issuu, October 23, 2018. https://issuu.com/x.man/docs/final_m4g_potfolio.

TAB 2022. "TAB 2022 Installation Programme Competition to Be Carried on by IHEARTBLOB with the 'Fungible Non-Fungible' Project," December 15, 2021. https://2022.tab.ee/installation-programme-competition/.

Tedbury, Ivo. "Semblr." Ivo Tedbury, 2017. https://www.tedbury.co.uk/semblr.







Drawings.
Re-interpretation of the Church of Mogno, Mario Botta.
Used building block designed by the B-Pro Research Cluster 4.
Left - Transversal and longitudinal section.
Right - Axonometric projection.

The purpose of this Énoncé Théorique de Master was to establish a first study and a theoretical fundament on the discrete thesis, in regard to the realisation of the Project De Master next semester at EPFL. In a few words, based on my observations, I'm going to try to design a piece, make it digitally and use it at the end to build a small public pavilion.

EPFL 2022