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New Geometric Systems

Jekabs Zvilna and Integrative Form-Languages

Edited by Philip Beesley & Bianca Weeko Martin

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Title: New Geometric Systems: Jekabs Zvilna and Integrative Form-Languages

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Cover image: Archival Jekabs Zvilna painted foam geometric tesselation model, detail view, c. 1973-1986. Photograph: Val Rynnimeri and Muhammad Tahir Pervaiz, 2019.
Zvilna Archive, Unversity of Waterloo School of Architecture.

Description: New Geometric Systems: Jekabs Zvilna and Integrative Form-Languages surveys the graphic and three-dimensional work of Waterloo Architecture professor and mid-twentieth-century designer Jekabs Zvilna. Photography of original foam and wood models by Zvilna and new essays by Val Rynnimeri and Muhammad Tahir Pervaiz are followed by studies by undergraduate students working under the supervision of Philip Beesley at the University of Waterloo School of Architecture in 2019.

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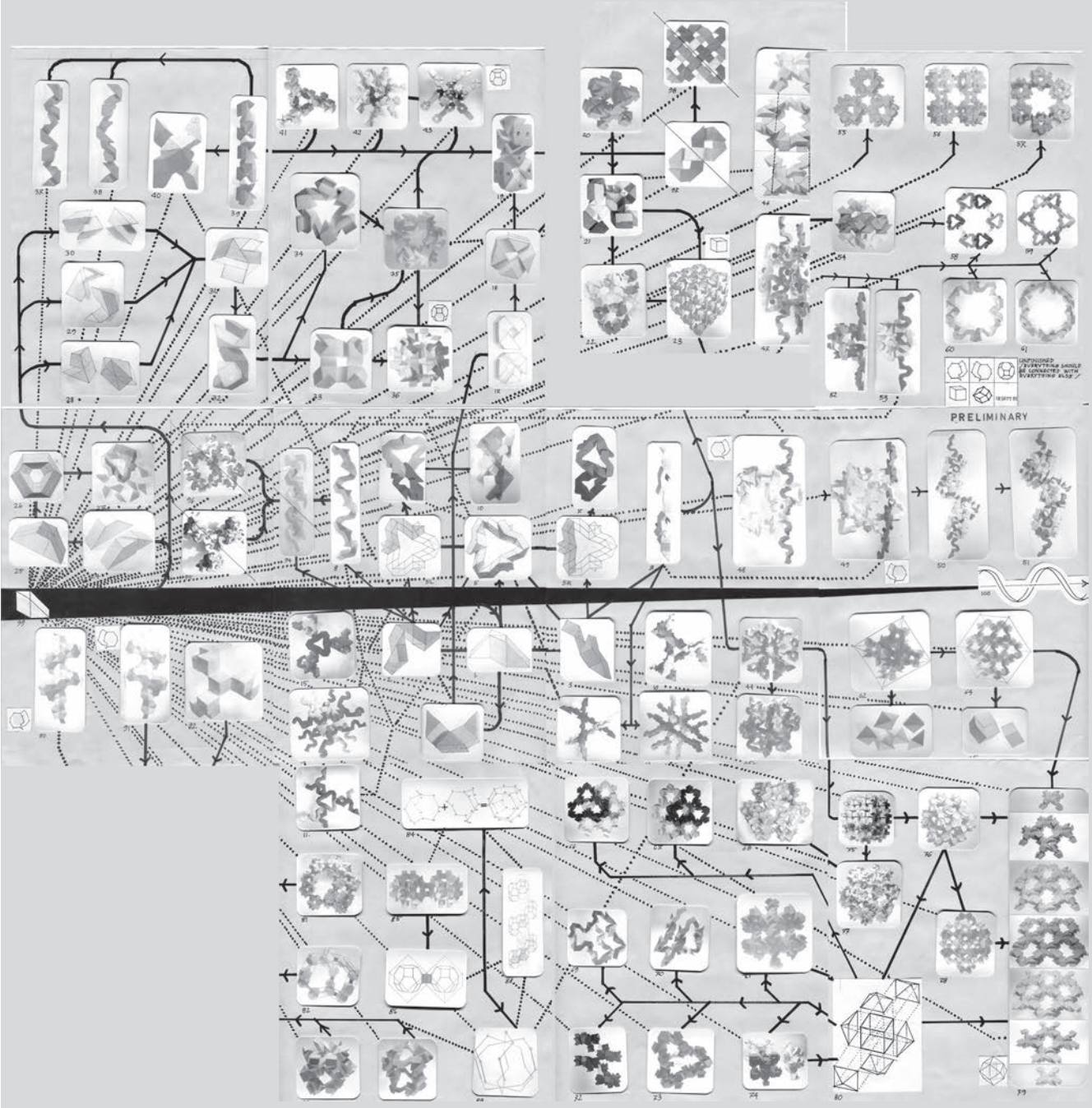
PRELIMINARY

Form from Process

Val Rynnimeri

facing

figure 1 Montage mapping the three-dimensional forms created from "Zvilna blocks"

Jekabs Zvilna was my first year professor at the University of Waterloo School of Architecture in 1974. Teaching and coordinating in the first year design studio with industrial designer Mike Elmitt, and a rotating cast of attached architect faculty, he was an enormous influence on the new students and their picture of what being an architect might be. In addition to his role as a teacher, Zvilna was a very early pioneer in in what we have begun to do as architects and designers today, but a very different kind of pioneer.

Along with that continuing role as a professor, Zvilna was also a researcher. Sixty years ago, beginning in 1960, that meant that he was not undertaking an expected role as an architect, a designer of buildings and cities, but instead was

a solitary person sitting in a room working by hand on complex geometries and processes, and in 1974 when I joined his class as a first year student, with no computers. Over his life (I hesitate to say career in such a personal investigation as his work) Zvilna undertook two large bodies of research and work. One was graphic and two dimensional (Figure 2), the other three dimensional (Figure 3).[1] Both were fundamentally linked in an exploration of the processes of form generation. Much of the material to follow I draw from one of Zvilna's key retrospective articles, *Ad Infinitum*, which he wrote in 1989 and published in the journal "Computers & Mathematics with Applications"[2]. It summarizes most of his research. Also reviewed were other previous works and papers, which largely talk about geometry and about his methodology of "work through processes".

What you have in Zvilna in 1974, in my introduction to him and the middle of the arc of his research, is somebody who was not just a pioneer in a scientific framework of complex systems research. Today, one might find him at a place like the Harvard GSD or MIT (where he exhibited his work in the 1960s[3]). More importantly to him, however, was his place as a spiritual pioneer in the sense of trying to understand what all of this systemic complexity means at a level of personal revelation. In the forms self organized by complexity you will find his search for the opposite, the principle of the one[4]… unity.

Despite the university teaching and research in form generation, what one must see about Zvilna in his biography (and one just doesn't expect it) is that prior to his life in the university he designed toys and games. His was the life of the post-World War II refugee. The displaced person, like my own Estonian father, took the work to start a life for their

1 Jekabs Zvilna, *Rotation and Form* (Waterloo, CA: University of Waterloo, 1974).

2 Jekabs Zvilna, *Ad Infinitum, Computers & Mathematics with Applications*, Volume 17, Issues 4-6, 1989. https://doi.org/10.1016/0898-1221(89)90275-7.(https://www.sciencedirect.com/science/article/pii/0898122189902757) 1041-1066.

3 Jekabs Zvilna Exhibition, 1965 March 5, AC0069_196503_025, Box: 11. Massachusetts Institute of Technology. Libraries. Department of Distinctive Collections. https://archivesspace.mit.edu/repositories/2/archival_objects/140741 Accessed August 20, 2021.

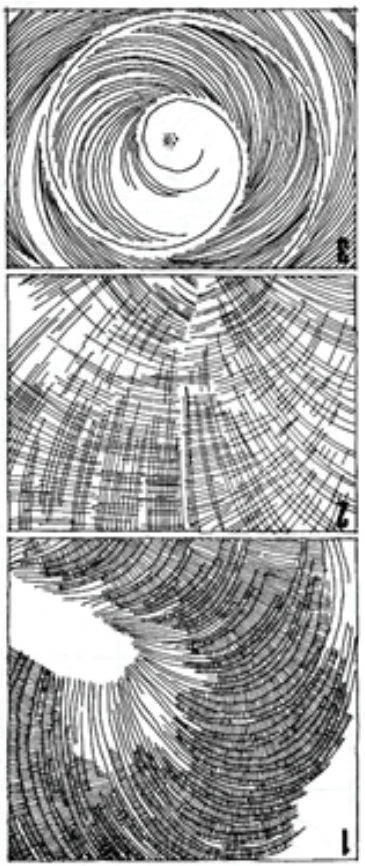

figure 2 Graphic study by Jekabs Zvilna

4 Jekabs Zvilna. 1984. *A doctrine of one: an exercise in twentieth-century synthesis : an exhibition of work by Professor Jekabs Zvilna and his students March 4 to 23, 1984.* (Waterloo, ON): School of Architecture, Faculty of Environmental Studies, University of Waterloo.

figure 3 Foam model study by Jekabs Zvilna. c.1973-1986. Zvilna Archive, University of Waterloo School of Architecture, recorded 2019.

family. Though Zvilna had studied architecture in Latvia, the war and the subsequent occupation of Latvia by the Soviet Union happened. When he came to Canada in the early 1950s, it took almost a decade for his personal research to coalesce. As he puts it, he made a living in designing and making toys and games and it was only later that he went back to architecture – first as a draftsman, then his own time, finally producing the research which in retrospect is a precursor to what all of us are doing in today's sophisticated research in complex systems, self-organization and form generation.

In the early 1970s, he was brought to the nascent Waterloo School of Architecture by founder and cultural historian Lawrence Cummings, a place where he taught for ten to fifteen years. His influence was profound. Most of the students of that generation went through the first year with Zvilna and studied his Interdisciplinary Language course (IDL). Most still hold that first experience of primary form generation in their present making of architecture. The other thing with Zvilna's teaching (and it's interesting given today's rush in architecture schools to teach building design early) was that first-year studio was a place that new students didn't start with designing buildings and instead worked directly with form generation. This design activity was placed in a pedagogy with understanding the creation of form as a process, not as a narrow driven goal to make a building. In such a focus, form-making becomes a kind of process in and of itself, one that hopefully might bring the beginnings of insight. And that habit, with myself and all of my peers, after forty five years, still is deeply, deeply persistent even though at the time some were bewildered at why this was happening in an architecture school.

They would plead, "what happened to the buildings?"

Some of that skepticism was understandable. These were strange concepts forty plus years ago when Waterloo students saw themselves moving forward in a narrow professional working methodology well suited to employment as a coop student in offices. Zvilna's work needed a glossary at the beginning of his Ad Infinitum article (Figure 5) because the language was so strange, and it remains necessary even today despite wider dissemination of such ideas in complexity thinking. Even with its creeping into popular discourse, it's a speech accessible today only by some investigators and creators. Decades ago, Zvilna says about the glossary, this is what I mean by all of these things. In the glossary and article, Zvilna separates nature into themes; nature's order, nature plus man, our connection to nature, but also what he's really interested in is natures that are not natural order, but nature's deeper order, an order that hasn't been decoded as yet. His life's purpose became, to decode it, and to decode it at a very personal level because what he was trying to do was to understand and find truth; to go back to field time or space time to the source and return step by step with memories inscribed in mind matter all the way up to the present. Despite its scientific appearance, in Zvilna's ultimate purpose in the work, there's play with memory as well as material and process.

One of Zvilna's main philosophical outlooks in his working process was the view of the investigator as Homo Ludens. From Huizinga's work[5], this term describes the investigator or creator as the person who plays. This is very important

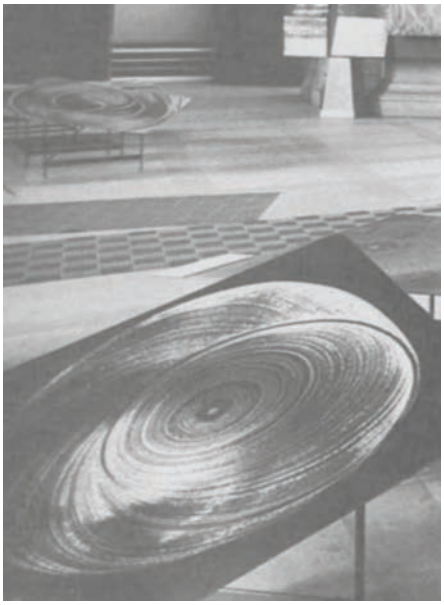

figure 4 Jekabs Zvilna exhibition at MIT, 1965.

facing

figure 5 First page of Zvilna's *Ad Infinitum* article, showing glossary of terms, 1989.

5 Johan Huizinga, *Homo Ludens: A Study of the Play-Element in Culture* (Boston: Beacon Press, 1938.)

Computers Math. Applic. Vol. 17, No. 4–6, pp. 1041–1066, 1989
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AD INFINITUM

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Abstract—In the continuous (and obsessive?) search for an *understanding of the genesis of visual form*, a radical (L. *radix*, a root) form-generating system of relationships, interdisciplinary language, is in the process of being designed.

In this work, the emphasis is on the genesis of form in spacetime: through transformations, growth and abstractions, an infinite number of elements generate an infinite number of forms, all having one and the same intrinsic trihedral structure.

Symmetries emerge as if planned.

GLOSSARY

A doctrine of one. The core of IDL; simultaneous restraint, wonder and surprise.
Element. Intangible, visible emptiness, defined by planes, containing memory and predictable behaviour.
Experience. The way to know; the source of behaviour (applies to the living and non-living).
Form. Shape having an intrinsic structure.
Formative. Communicating development in ft or st.
ft. A world of two spatial dimensions plus time; fieldtime.
hc. Helical configuration.
IDL (I-DE-AL). Interdisciplinary language, a visual all-embracing system of patterns and forms in ft and st; the objective of the IDL—contact with the real, what is, tangible and intangible; the essence of IDL—the potential in emptiness.
Ignorance. A filter over the mind, that allows one to think and dream the impossible, e.g. an interdisciplinary language; cooperation with real time; form, structure and meaning of emptiness, etc.
Memory. The storehouse of experiences.
Natural order. Decoded nature's order; nature plus man.
Nature's order. An order not decoded as yet.
Pattern. The way elements are arranged in ft or st.
Process. The generating of pattern or form.
st. A world of three spatial dimensionsl plus time; space time.
Structure. The intrinsic order of pattern or form.
To understand. To relive; to go back in ft or st to the source and return step by step with memories—inscribed in mind or matter—all the way up to the present.

SCOPE OF THE SEARCH

How do forms in ft and st emerge? This is a question that has haunted me for some time now. Is there a single answer? So far I see a solution unfolding in short essays.

(*1*) "*Rotation and form*" [*1*]

The paper describes a rotational–translational movement as a form-generating process and its application:

> "Many events in nature—the sunset, the migration of birds, the hibernation of animals, the eclipse of the sun, etc. have been found as the result of ROTATION. Without the earth's rotation about its axis and around the sun there would be no day–night, no summer–winter, no consciousness–unconsciousness."

in understanding the relationship between form generation and Zvilna's universe. For Zvilna, in his description of this work, form generation is a personal engagement with play, not an active creation but rather a kind of falling into a world where attention is framed and limited into the universe of the materials and the process. Zvilna writes further as he describes this working process; he works in a 2D graphic space and in what he called field time, which is working with these very, very small graphic plates with carbon black in them, and then inserting thinners and chemicals in them, and then starting to manipulate the plates. (Figure 6) These are small, as he says himself, not worth looking at. But once the self organization of the flow forms of the graphite has been accomplished at the various stages of manipulation and it's judged over enough, Zvilna blows the plates up to very large size and creates enormous graphics that are the size of a door, a room (Figure 7). To us, as students, the giant images were a kind of frozen form of a process, de-contextualized as pure generated form. Zvilna claims that he's not the creator in what is a dance between him and the materials, him and the form, him and the process. In that dance, there is surprise, there is recognition, there are all those factors that, in effect, will reveal this form's truth to him.

In 1965, Zvilna was invited to multiple exhibitions, his Annus Mirabilis. He had one exhibition at MIT, arranged by Gyorgy Kepes, and then another one also by Kepes at Harvard School of Design. After those keystone exhibitions for his work, and still continuing with his 2D graphic work, Zvilna moved his focus more to a 3D form generation research. What he undertook next is what we as students affectionately called Zvilna blocks

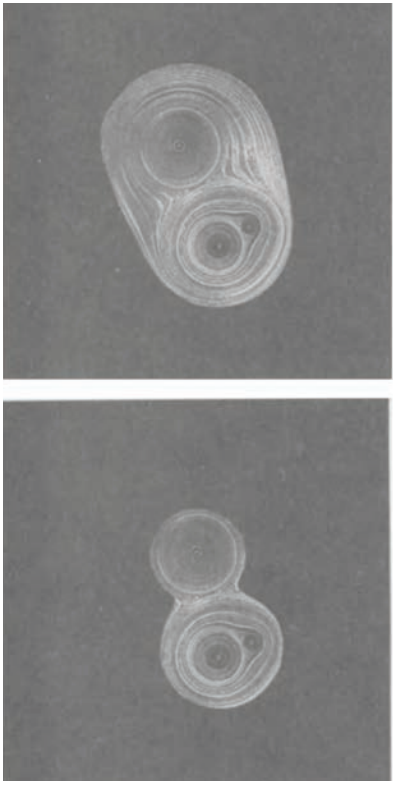
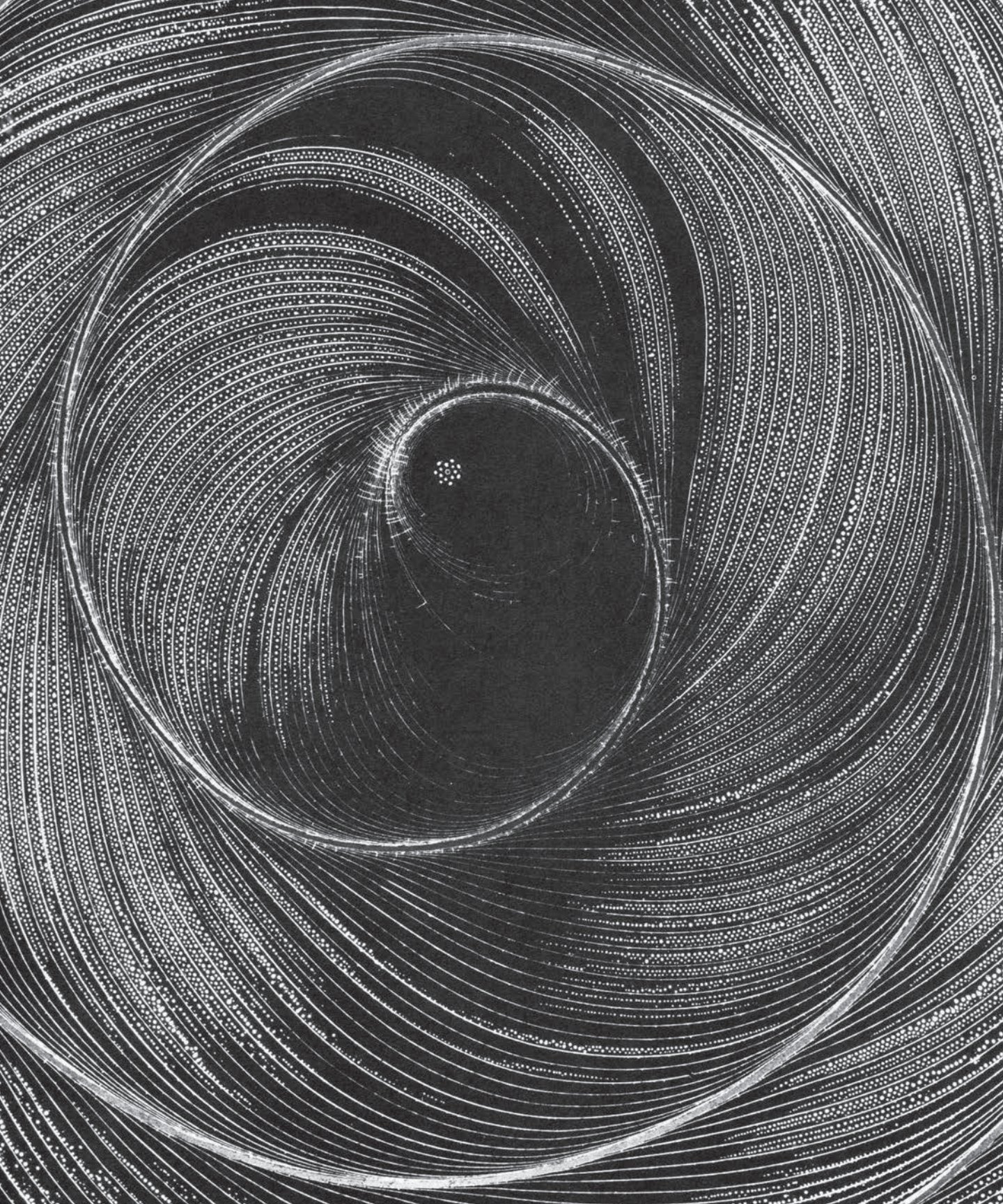


figure 6 Illustration of carbon experiments from Zvilna's *Ad Infinitum* article, originally captioned "Stages of growth on the horizontal plane", 1989.

facing

figure 7 Carbon plate time and motion study by Jekabs Zvilna, showing growth on a sloped plane in a continuous rotation around the centre of the plane



(Figure 7) at the School of Architecture. These were modular 3D blocks the size of one's thumb that he handed to students so they could develop them into hierarchic structures as a culmination project in the IDL course. But this student work was also a personal research activity for him. The blocks, carved out of foam or wood and painted on key sides, were an attempt to create a kind of module that would illustrate his principles, the principles of translation, and rotation in three dimensions, and then become the formulation for a hierarchic system of building bigger and bigger structures. There was a kind of parallel to the work of Buckminster Fuller in Zvilna's 3D experiments, but outside of Fuller's tetrahedral geometric preferences.[6] But there is more and what's truly interesting, and beyond Fuller, is that, like the 2D work, it is all about personal insight and revelation in the process of assembly. Beyond just form generation, it's all about trying to understand what the kind of translations the rotations are telling the student, or Zvilna, about how nature understands itself as it creates itself, and how nature can communicate that process of self awareness, that sensibility.

Zvilna's first year studio was full of the three dimensional student works, some on desks, some hanging from the joists by wires, floating in space. There were big crystalline blocks of hundreds of units repeating, some combinations twisting in spiral rotations, some layered in two dimensional manifolds. The studio was full of the best work of sixty students each year doing these things over ten years. There were creations of solids, creations of spaces. And then there were also two dimensional surfaces and manifolds. And these are the kind of beginnings of

figure 8 Detail view of historic Jekabs Zvilna showing connections between "Zvilna blocks". c.1973-1986. Zvilna Archive, University of Waterloo School of Architecture, recorded 2019.

6 Buckminster Fuller, Applewhite, E. J. *Synergetics 2: Explorations in the Geometry of Thinking.* (United Kingdom: Macmillan, 1983.)

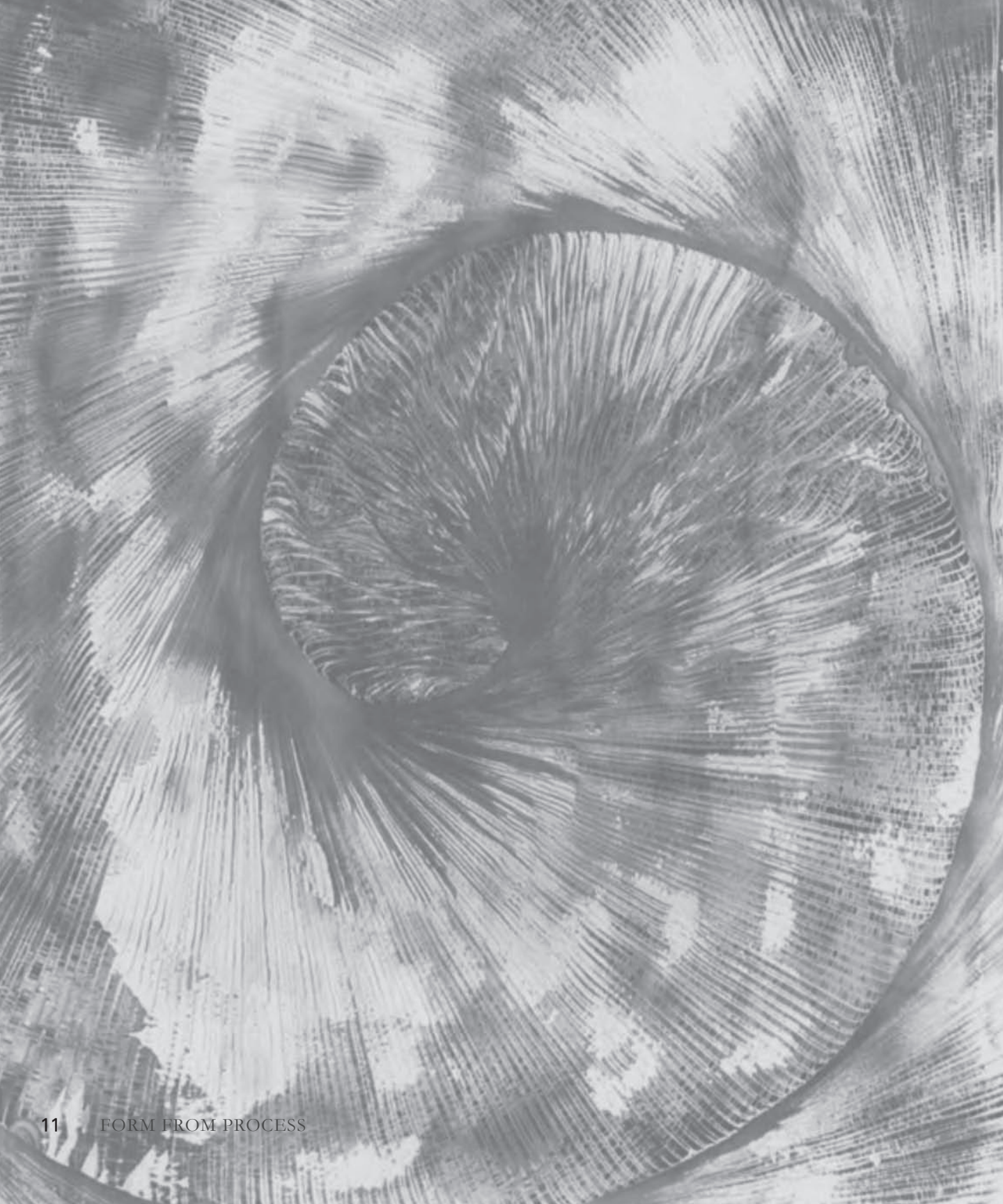
7 Istvan Hargittai, *Symmetry: Unifying Human Understanding.* (Elmsford, NY: Pergamon Press, 1986).

figure 9 Newhall South Chase by Alison Brooks Architects, 2012.

an understanding of structure but it was all done from one module, one module subject to multiple operations and scripts. The personal space of Zvilna at his home, though much smaller, was a similar laboratory of forms, as Darwin would say, most wondrous.

One of Zvilna's research assistants was Alison Brooks. I mention her, because she's probably one of the most illustrious graduates of the Waterloo architecture school and she was his research assistant before her graduation and her departure for a career and life in England.[7] You can see the interest in complex folding geometries in her work, the very careful translations and rotations and motions and subtractions in what is otherwise a very normal housing building topology. (Figure 9) Brooks, however, remains an architect, unapologetically, and she doesn't want to be somebody who's following in Zvilna's direct line of research, but you can see the deep influence in her work, the habits of geometrical thinking.

Zvilna was a polymath. He read widely in mathematics, complexity and philosophy, but also extensive readings in Zen and Sufiism. Besides his research and play with form generating geometries Zvilna's curiosity ranged across faith and philosophy, looking for what was at the heart of creation. I conclude with Zvilna's words, "both developments in field time and space time are self organizing systems, my own role has been that of a midwife, coating the glass sheets, the field with a carbon black in which the patterns are revealed, cutting the various building blocks, not digital, out of Styrofoam, or wood, accepting the emergence by chance of the code ABCD and painting the elements in four different tones, then guided by the ultimate restraint, one structure, only one



method of connection, and one type of element, I let the form emerge. And what's all this for – to be surprised, to be able to wonder."

facing

figure 10 Illustration of graphic experiments from Zvilna's *Ad Infinitum* article, originally captioned "Growth on the vertical plane", 1989.

Lastly, I think what's interesting with Zvilna is that restraint was important for him, because it was his discipline. It was his personal path. To find out this kind of truth, so that he could communicate it to students. I think what he wanted all of us to do was somehow find that similar kind of restraint, to be able to understand what are the boundaries of your form-making, and what the advantage is of having that restraint. But also, I think what's very important – and this is in my own work in ecosystem design – is to really value surprise, and to notice it, to have your ear there to to hear it, to see it and to smell it, and to cautiously say – something is happening here that I didn't expect. And I'm certainly not going to crush it. And so, I think that that's the big lesson all of us learn in art as architects or researchers.

Jekabs Zvilna and Cultural Traditions of Geometry

Muhammad Tahir Pervaiz

facing

figure 1 Wood study model composed of 45-degree "Zvilna blocks". c.1973-1986. Zvilna Archive, University of Waterloo School of Architecture, recorded 2019.

In the following short review, two key parts of Zvilna's investigations are reviewed, placed within a context of the geometry that helped to anchor Western philosophy traditions. Details of the arrayed assembly blocks explored elsewhere within this folio are reviewed first, followed by discussion of patterned images created by Zvilna and also by the author.

Form as a Kit of Parts

Zvilna raised an eternal question: How to generate systems as wholes? Zvilna approached form as both a process and a whole system, expressed within organic tessellations as pictured on the left. To answer Zvilna's question, one has to create parts for the larger wholes and systems, and wholes and systems guiding those parts. What, then, of the rules or combinations of how the parts are linked or joined? Zvilna designed a kit of parts imbued with rules to

allow for a diverse possibility of forms suffused with repetitive patterns. In a playful exploration framed by the organic topography of space-time and energy, Zvilna's experiments culminated in the form of crystalline lattice structures. These complex three-dimensional arrays contained widely varying shapes, volumes, and densities.

To understand Zvilna's methodology for polyhedronic geometric arrays, we can begin to draw an analogy with the 19th century Swiss educator Friedrich Froebel's work. Froebel conceived of building blocks and gift sets to teach children about the spatial relationships in the world around them. (Figure 2) Zvilna's intuitive play with the elementary blocks aligns with Friedrich Froebel who evoked the idea of *organic thinking* in developing a pedagogy called *kindergarten*, encompassing adapting and learning from nature. His approach involved incorporating aspects of play, symbol, and relationship between the macrocosm and the microcosm, and the natural organism as a way of understanding the universe. Froebel used a system of *gifts* (building blocks, sticks, strings) as a way of forming relationships between parts, setting a part-whole dynamic to teach children about nature and its methods of construction. These models, mostly crystalline in their form, provided imagery of simple geometric symmetries to represent the planetary systems or complex concepts. Analogously, Froebel's work becomes particularly relevant to Zvilna, whose work yields a similar form-language of modularity, polyhedron geometries and hierarchical progressions in form-making.

figure 2 Froebel Educational Toy Building Blocks

A Form Generating System

If one deconstructs the fractal lumpiness and the hierarchy of the modular constructions, one comes

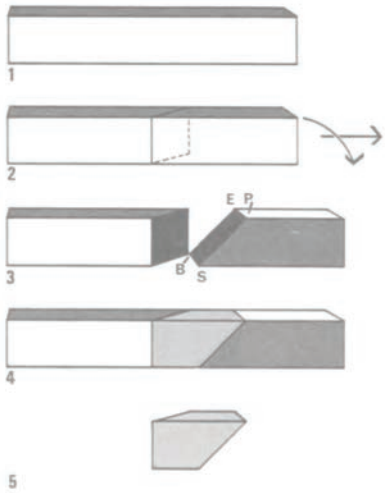


figure 3 Illustration from Zvilna's Ad Infinitum, originally captioned: "Genesis of an element ("building block")", 1989.

to the common denominator, the elementary unit, i.e. the Zvilna Block, a rather simple wedge-shaped unit. (Figure 3) Interestingly, the creation of the Zvilna block is again a repetitive process of inverting or mirroring a square or rectangular block and then cutting it at 45 degrees. Successive mitoses of this shape coupled with the formal system of connections and rules for combination allow for an inexhaustible dynamism. The rules (gravity and rotation) are drawn directly from nature's processes, evident in the organic tessellations created on a two-dimensional plane. (Figure 4) Zvilna deploys rotation in time and space, where the module is rotated on a fixed axis and bonded with another one of its kind. In some forms, a new rotational axis is introduced and the process repeats itself, resulting in varied polyhedron typologies. From this primal module, Zvilna paved the way for students to create infinitely complex form-generating processes that if viewed today would easily be categorized as models of organic growth, and hierarchical successions of visual semantics. Zvilna's work can be described in a neat summation using this phrase, "Develop an infallible technique and then place yourself at the mercy of inspiration."[1]

Form as a Whole: Process and System

The term *system* might imply a rather ambiguous and vast spectrum. *System* comes from Latin *sistema*, meaning an arrangement, an organized whole made of several parts or members, or a whole compounded of parts.[2] In natural systems, minute organic geometries seen when optically enlarged can reveal a whole system of interactions among forces and material *agents* where parts are governed by processes including combustion and vaporization. These system-based forces can causes changes in the orderliness, regularity, shape, and character of a

1 Rapson, Ralph. 1959. "Objectives of Architectural Education." In Journal of Architectural Education (1947-1974) Vol. 14, No. 2, ACSA-AIA Seminar: The Teaching of Architecture (Autumn, 1959), 21-23. Oxfordshire: Taylor & Francis, Ltd.

2 Dictionary, Etymology. n.d. Online Etymology Dictionary . Accessed 07 18, 2021. https://www.etymonline.com/word/system.

form. Experiments by Zvilna often transformed static objects, revealing dynamic qualities. Zvilna sought holistic behaviour of forces that adapt and mutate, leading to evolving changes in the emerging form. Taking the idea of form as a process, and nature as a whole dynamic system of evolving processes, Zvilna proceeded to expound his thesis in the form of organic constructions with mastery. The organic constructions of Zvilna, brought about by creative formative processes, lie at the threshold of art and science. One body of experiments was carried out by coating 2" x 3" glass plates with carbon and gently running an oil solvent over the glass in localized spots. (Figure 4) The plates were then subjected to rhythmic agitation while other factors and agents were controlled and introduced such as surface tension, the volatility and viscosity of the solvent, etc. while being exposed to external factors of gravity and rotation. The technique opened up to the seemingly endless possibilities of forms and explorations inherent to the confluence of carbon wax and oil, acting together to form a holistic system.

Using nature's methods of rotation and material chemistry between graphite and oil, Zvilna was able to manifest cumulative patterns characterized by complex order. In Zvilna's narrative, these organic experiments were the first act – the act to investigate form as a product of transitory formative processes, providing clues to the underlying dynamics of the system. Here the focus was not on the structured order, but on the processes that engendered them. Similarly, it was not about the form itself, but about presenting ways of *looking* at form.

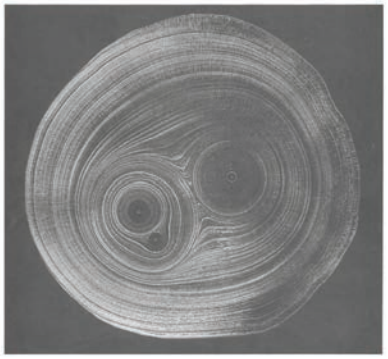


figure 4 Carbon plate illustration from Zvilna's Ad Infinitum, originally captioned: "Growth on the horiozontal plane", 1989.

facing

figure 5 "Chora" by Muhammad Tahir Pervaiz, 2019.

figure 6 Carbon plate exploration by Jekabs Zvilna, c.1973-1989.

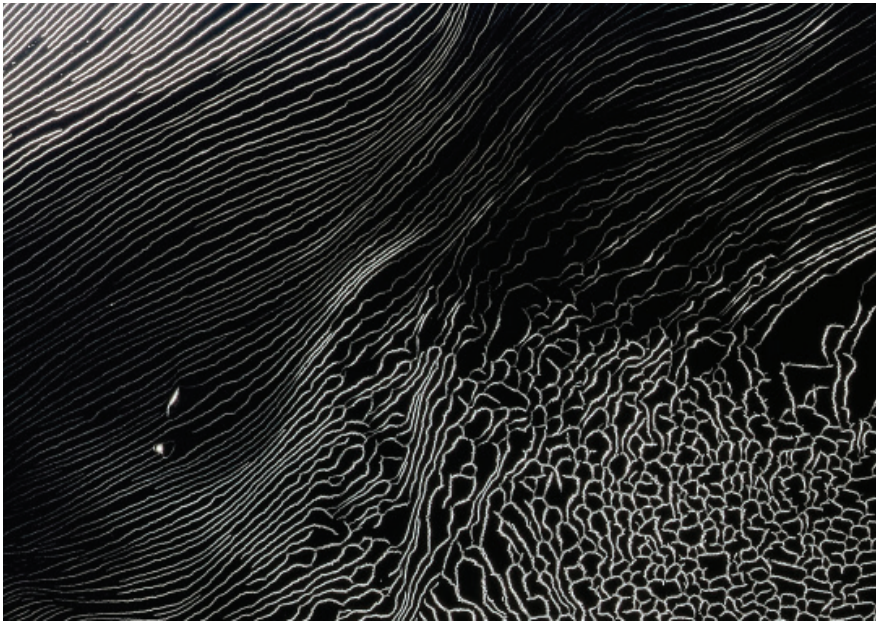


figure 5

figure 6

Geometry

Zvilna's work can be framed within cultural traditions where art and design-based geometry express fundamental relationships where geometry acts as a key. The following writing suggests that the work of Jekabs Zvilna relates closely to fundamental occupations of geometricians, scientists, and philosophers in their observation of matter, seeking descriptions within abstract representations. Historical western philosophy is founded on Greek and Roman traditions in which forms of all kinds are seen as impregnated with geometric principles that permeate all of nature and its institutions.

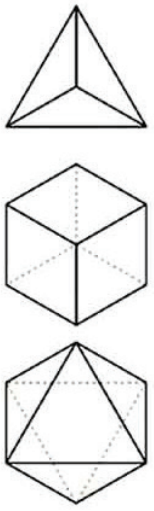


figure 7 Platonic Solids, including tetrahedron, hexahedron, octahedron

The Latin and Greek roots of *geometry* include *ge* meaning earth and *meter*, measurement. The ancient Greek philosopher-mathematician Pythagoras described universal systems of numbers and magnitude. This world was presented as parts related to the whole, introducing the idea of *proportion*. Here numbers were associated with mystical qualities. The number *1* denoted unity. The number *2* presented basic dualities including male and female genders.[3] The Greek philosopher Plato built upon Pythagorean thought by describing a cosmos made up of regular polyhedrons, geometric figures. Triangles were presented as the primary forms within this system. Combinations of triangles created increasingly complex forms, polyhedra, made of many sides.[4] Matter was categorized into elemental geometric forms including pyramid, fire; octahedron, air; icosahedron, water and cube, earth. A fifth form was the dodecahedron, the form nearest to the sphere, which Plato believed God used to embellish the universe with signs.[5] Following shortly after Plato the theorist Euclid wrote the treatise titled *Stoicheia* (Elements) and demonstrated the occurrence of the

3 Stewart, Ian. 2018. "Encyclopedia Britannica." Number symbolism. January 2018. Accessed May 24, 2020. https://www.britannica.com/topic/number-symbolism.

4 Plato. 1888. In The Timaeus of Plato, by R.D Archer-Hind, 190-194. London: Macmillan and Co. and New York.

5 Ibid.

Golden Ratio, forming the basis for the geometrical *elementary* systems based on theorems and axioms defining increasingly complex geometric figures. Within the cultural renewals of the Renaissance, nearly a thousand years following Pythagoras, Plato and Euclid, the manifesto *De re aedificatoria* (On the Art of Building) by Leon Battista Alberti renewed this elemental framing. Alberti built further on the divine ratios and proportions by emphasizing harmonious knitting, which he referred to as *concinnitas*[6]. He wrote:

> "Just as the head, foot, and indeed any member must correspond to each other and to all the rest of the body of an animal, so in a building, and especially in a temple, the parts of the whole body must be so composed that they all correspond one to another, and anyone, taken individually, may provide the dimensions of all the rest."[7]

In the transformations that followed the Renaissance, nineteenth century, the explanation of reality changed with various philosophers searching for a more comprehensive explanation of reality. The landscape of geometry was shaken by Carl Friedrich Gauss, a German mathematician, and Nikolai Lobachevsky, a Russian mathematician, who laid the foundations for non-Euclidean geometry, bringing linearity to a profound crisis. Stable, elemental geometric forms were disrupted by new forms and complex generative processes. Eugenio Beltrami was one of the first to provide an explicit exposition for non-Euclidean Geometry, opening up the realm of hyperbolic geometry and fractal geometry. The world which the Greeks once addressed as absolute and static had now evolved into a geometrical continuous stratum and a manifold of infinite fluctuating expressions. The understanding of reality and nature deviated

6 Concinnitas (Latin) is from 'concinnus' which means 'skillfully put together or joined'. It refers to a harmonious 'fitting' of the parts.

Caroline van Eck, Goethe and Alberti: Organic Unity in Nature and Architecture. Saskatoon: University of Saskatchewan,

7 Padovan, Richard. 1999. "Humanism and architecture." In Proportion: science, philosophy, architecture, by Richard Padovan, 215. London: E & FN Spon.

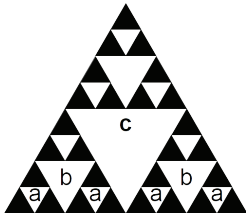


figure 8 Sierpinski triangle, showing the principle of fractal geometry

from the conventional orbit – from a segregated understanding of the world of animate and inanimate reality intertwined into an amalgam of one singular whole. Similarly, Einstein's theory of relativity in 1915 endorsed the idea of dynamism of space; a heterogeneous image rendering the world as a construct of probabilities and not certainties, with time as the fourth dimension. The idea of mass warping space and time and inflicting other bodies in space manifested an infinite network of relations between matter and fields. Relativity further paved the way for permitting various viewpoints at once (an aspect of cubism), leading to forms that broke the rules of unity or compositional unity.[8]

In the context of matter and form; nature and man, the scientific and the philosophical world had come to resonate with one another in a liminal matrix surrounded with greater questions. Was there a segregation between man and nature? What was the role of technology? Man, technology, and nature – could they stay fragmented in the ever-changing landscape? Concurrently, technology's miracle was transforming the outlook on nature itself by providing insight into the detailed phenomena of the nature of things and the understanding of the universe as a whole.

Jekabs Zvilna made quite unique contributions to the long cultural traditions that focus on geometry. He studied nature, form, and order to create a unique study of organic and crystalline geometries. He rendered form and its inner logic as the result of spatial processes, key procedures and rules embedded within primordial and universal influences. His doctrine centered on adapting nature's methods in these form-generating processes. He called for an integration between man and nature to develop

8 Pervaiz, Muhammad Tahir. 2020. Mediation: Resonating between the Organic and Inorganic. Master Thesis, Cambridge: University of Waterloo.

figure 9 Array modeling study, composed of 45-degree "Zvilna blocks". c.1973-1986. Zvilna Archive, University of Waterloo School of Architecture, recorded 2019.

interdisciplinary form-generating systems. Zvilna's thesis was more than simply theoretical: it expressed his untiring conviction to investigate a full range of diverse media, materials and dimensions.

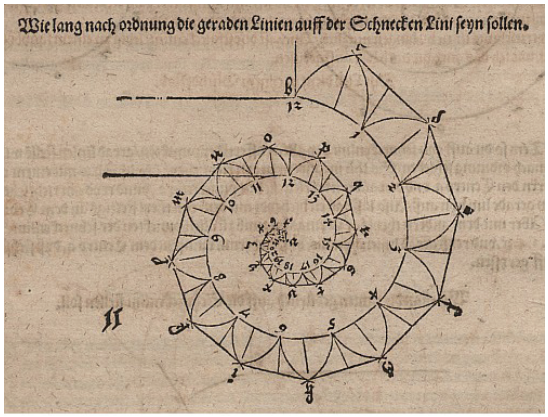


figure 10 Determination of the lengths of attached spikes of a tangent spiral, 1604.

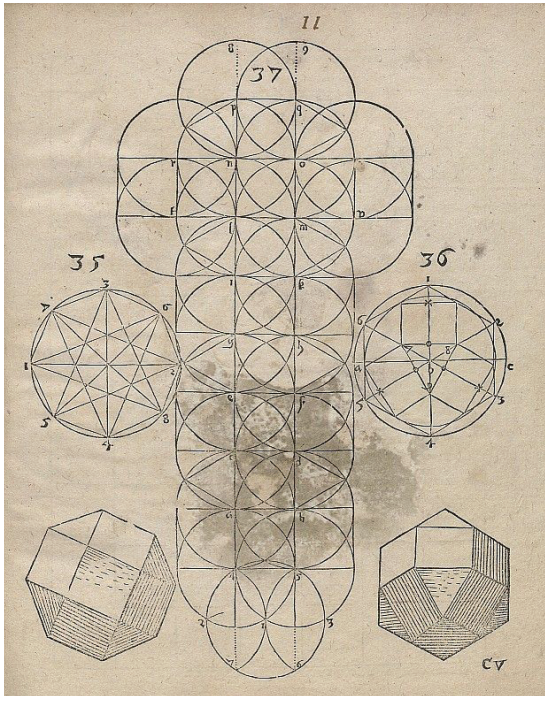
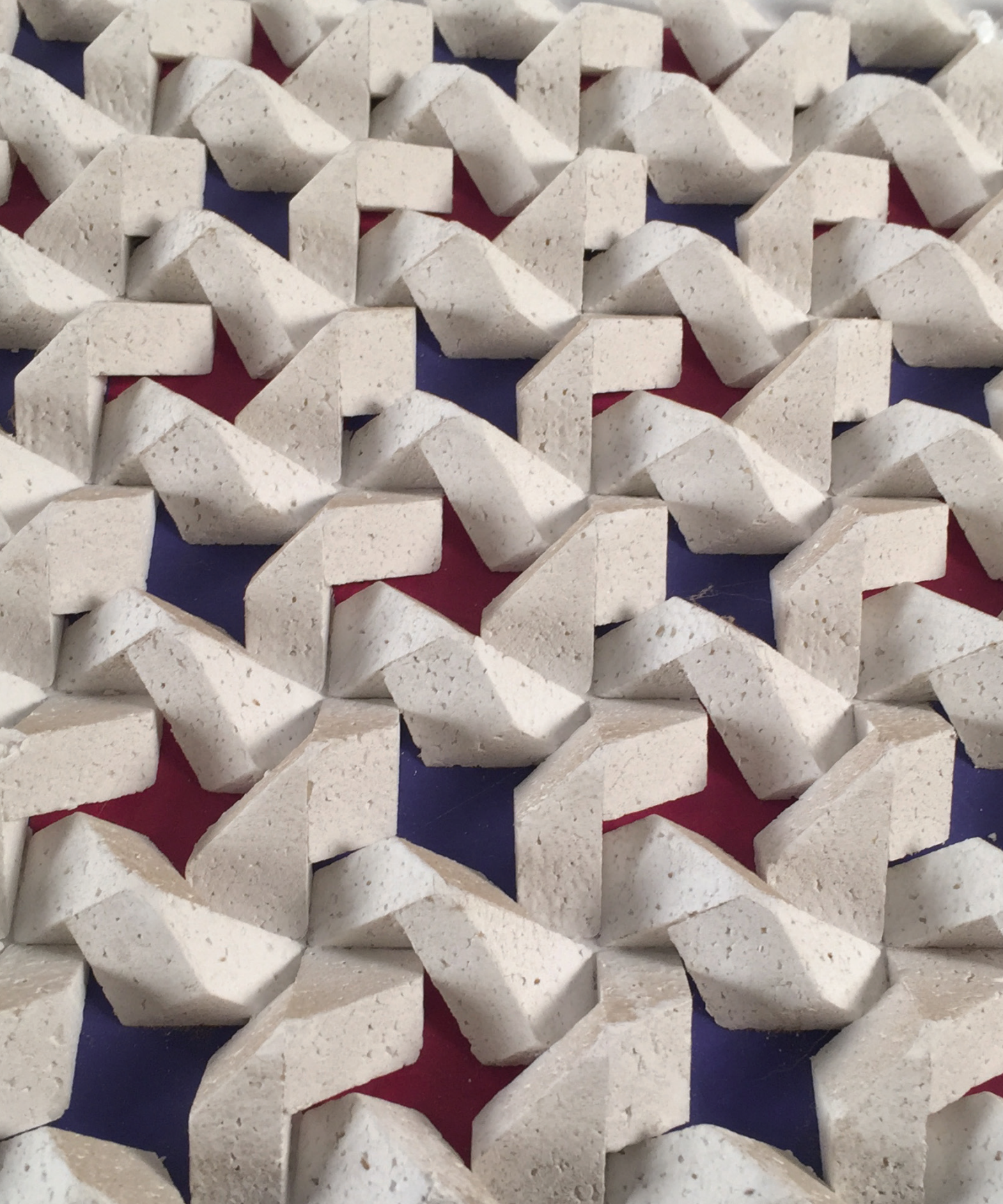


figure 11 Hirschvogel's Geometria, 1543.

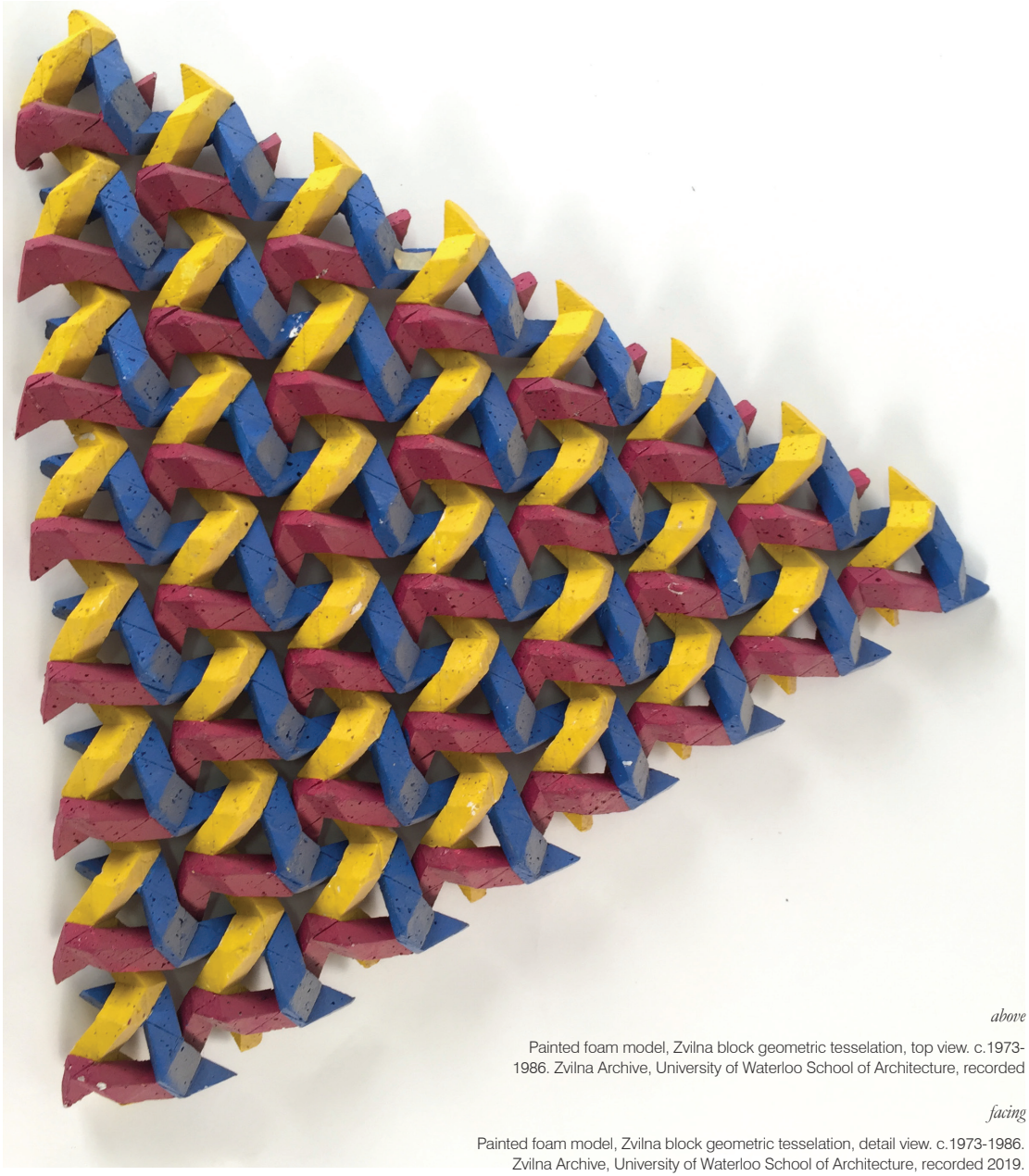


Jekabs Zvilna Archive Models

facing

Foam model, Zvilna block field array, detail view. c.1973-1986. Zvilna Archive, University of Waterloo School of Architecture, recorded 2019.

The following photographs showcase a series of historic models made by Jekabs Zvilna at the University of Waterloo School of Architecture in the late 1900s. These wood and foam models were built with the "Zvilna blocks" discussed in the previous chapters, modular blocks that would illustrate principles of translation, rotation in three dimensions, and eventually a hierarchic system for building larger structures.

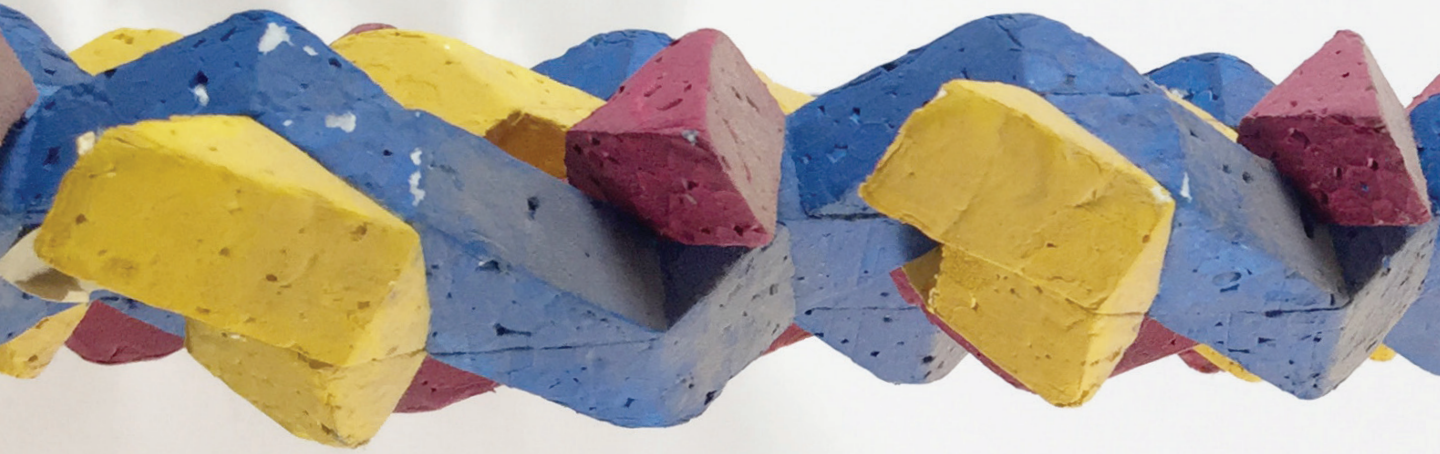


above

Painted foam model, Zvilna block geometric tesselation, top view. c.1973-1986. Zvilna Archive, University of Waterloo School of Architecture, recorded

facing

Painted foam model, Zvilna block geometric tesselation, detail view. c.1973-1986. Zvilna Archive, University of Waterloo School of Architecture, recorded 2019.



Painted foam model, Zvilna block geometric tesselation, side view. c.1973-1986.
Zvilna Archive, University of Waterloo School of Architecture, recorded 2019.

above

Painted wood model, closed Zvilna block loop, top view. c.1973-1986. Zvilna Archive, University of Waterloo School of Architecture, recorded 2019.

facing

Painted wood model, closed Zvilna block loop, perspective view. c.1973-1986. Zvilna Archive, University of Waterloo School of Architecture, recorded 2019.

left

Painted wood model, closed Zvilna block loop, top view. c.1973-1986. Zvilna Archive, University of Waterloo School of Architecture, recorded 2019.

facing

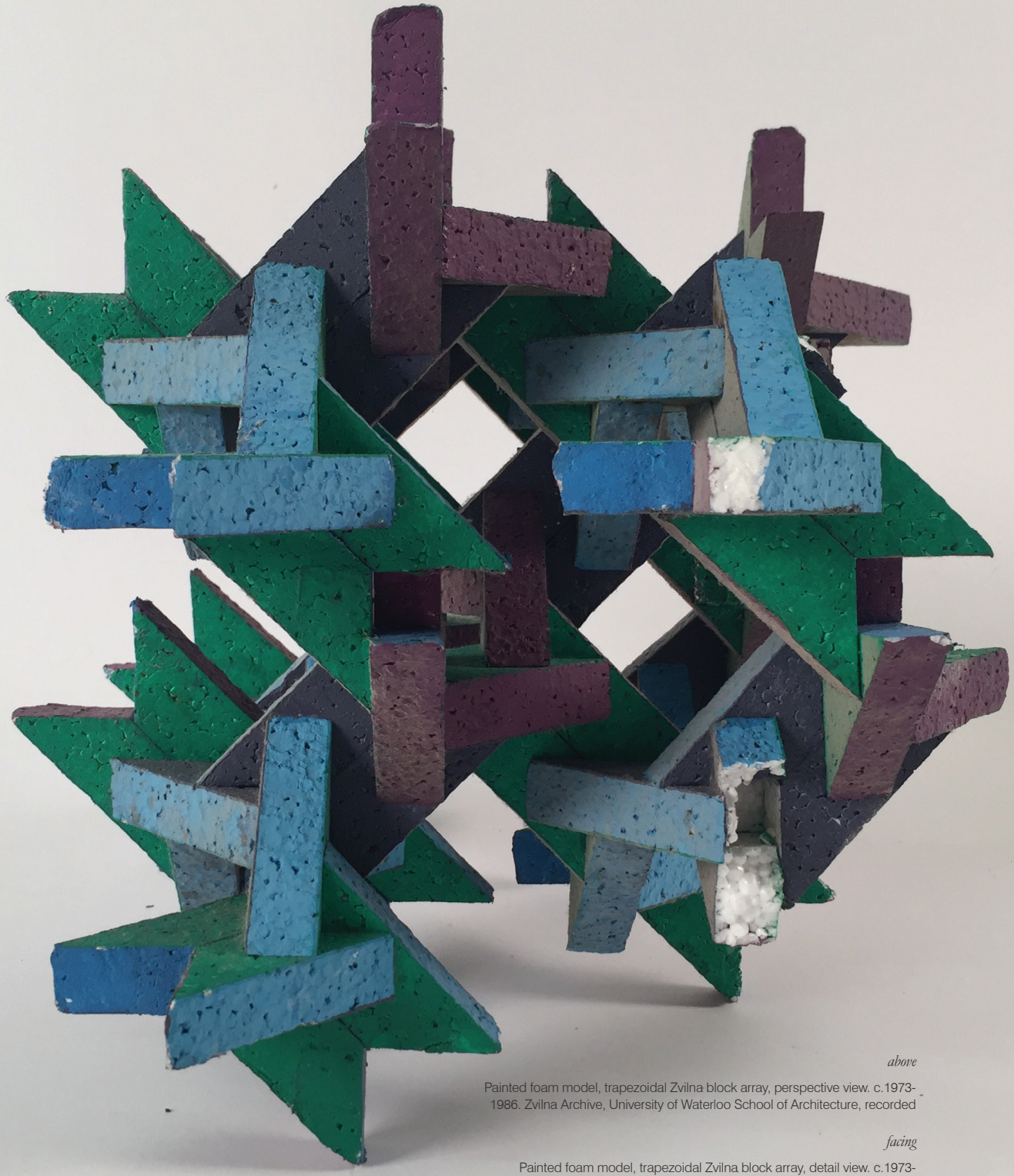
Painted wood model, closed Zvilna block loop, detail view. c.1973-1986. Zvilna Archive, University of Waterloo School of Architecture, recorded 2019.

above

Painted foam model, trapezoidal Zvilna block array, front view. c.1973-1986. Zvilna Archive, University of Waterloo School of Architecture, recorded

facing

Painted foam model, trapezoidal Zvilna block array, detail view. c.1973-1986. Zvilna Archive, University of Waterloo School of Architecture,



above

Painted foam model, trapezoidal Zvilna block array, perspective view. c.1973-1986. Zvilna Archive, University of Waterloo School of Architecture, recorded

facing

Painted foam model, trapezoidal Zvilna block array, detail view. c.1973-1986. Zvilna Archive, University of Waterloo School of Architecture,

above

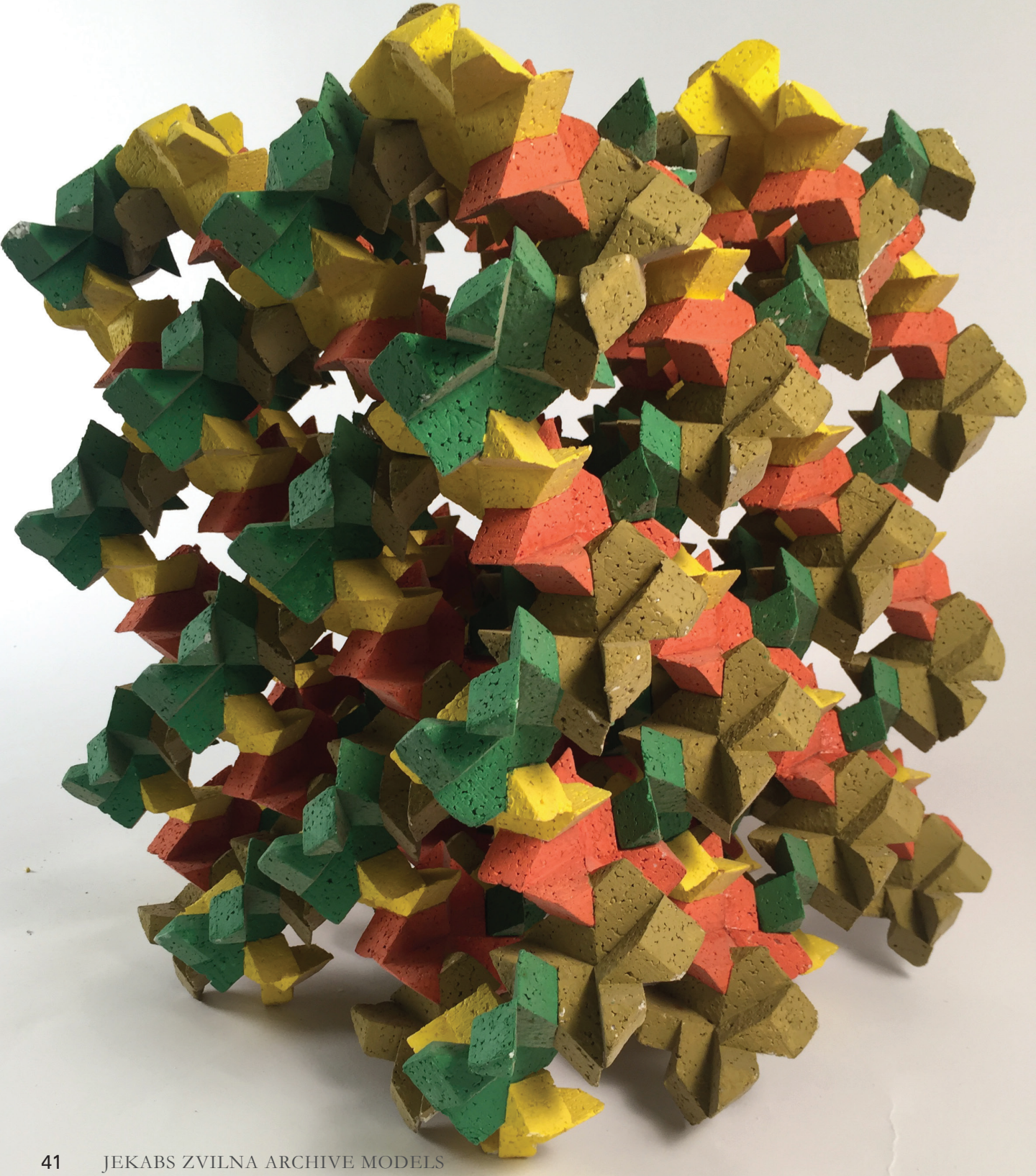
Foam model, interwoven Zvilna block loops, top view. c.1973-1986. Zvilna Archive, University of Waterloo School of Architecture, recorded 2019.

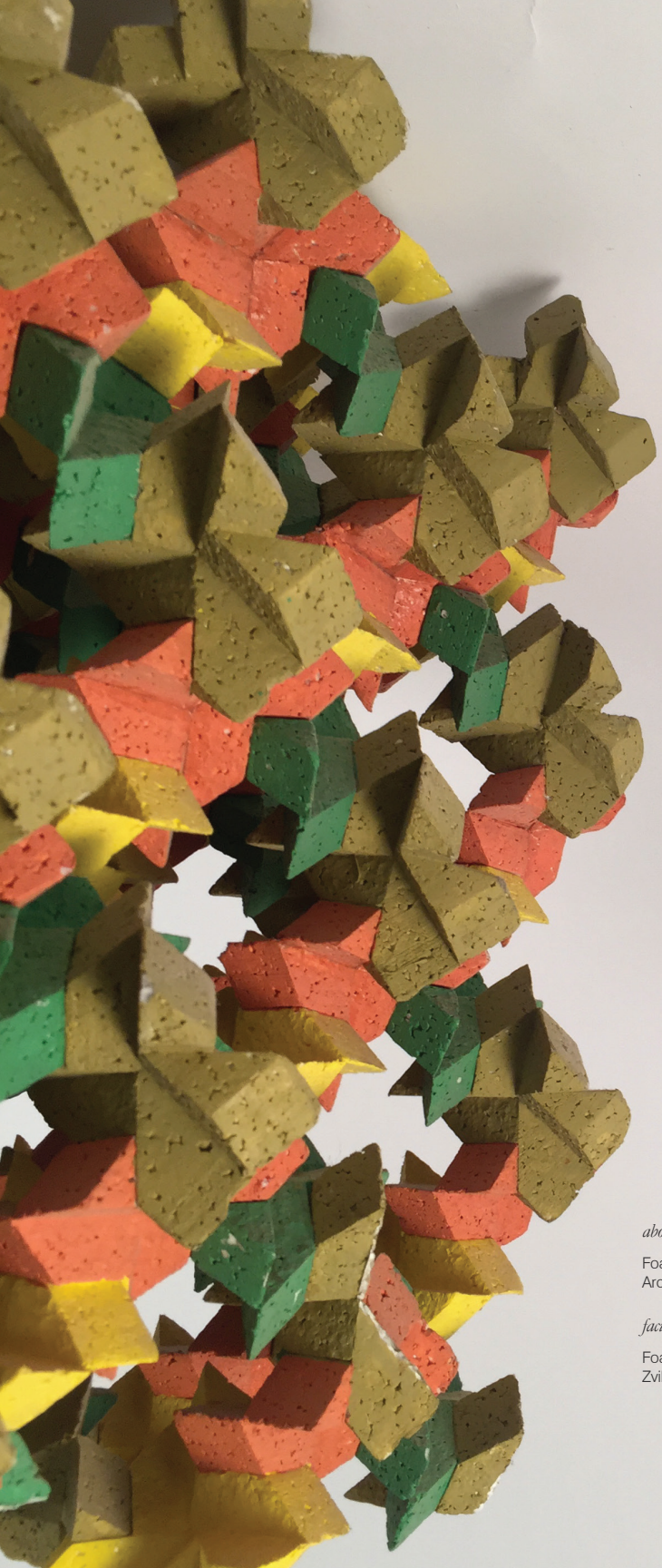
facing

Foam model, interwoven Zvilna block loops, perspective view. c.1973-1986. Zvilna Archive, University of Waterloo School of Architecture, recorded 2019.

Painted foam model, dense Zvilna block aggregation, perspective view. c.1973-1986.
Zvilna Archive, University of Waterloo School of Architecture, recorded 2019.

Painted foam model, dense Zvilna block aggregation, perspective view. c.1973-1986.
Zvilna Archive, University of Waterloo School of Architecture, recorded 2019.



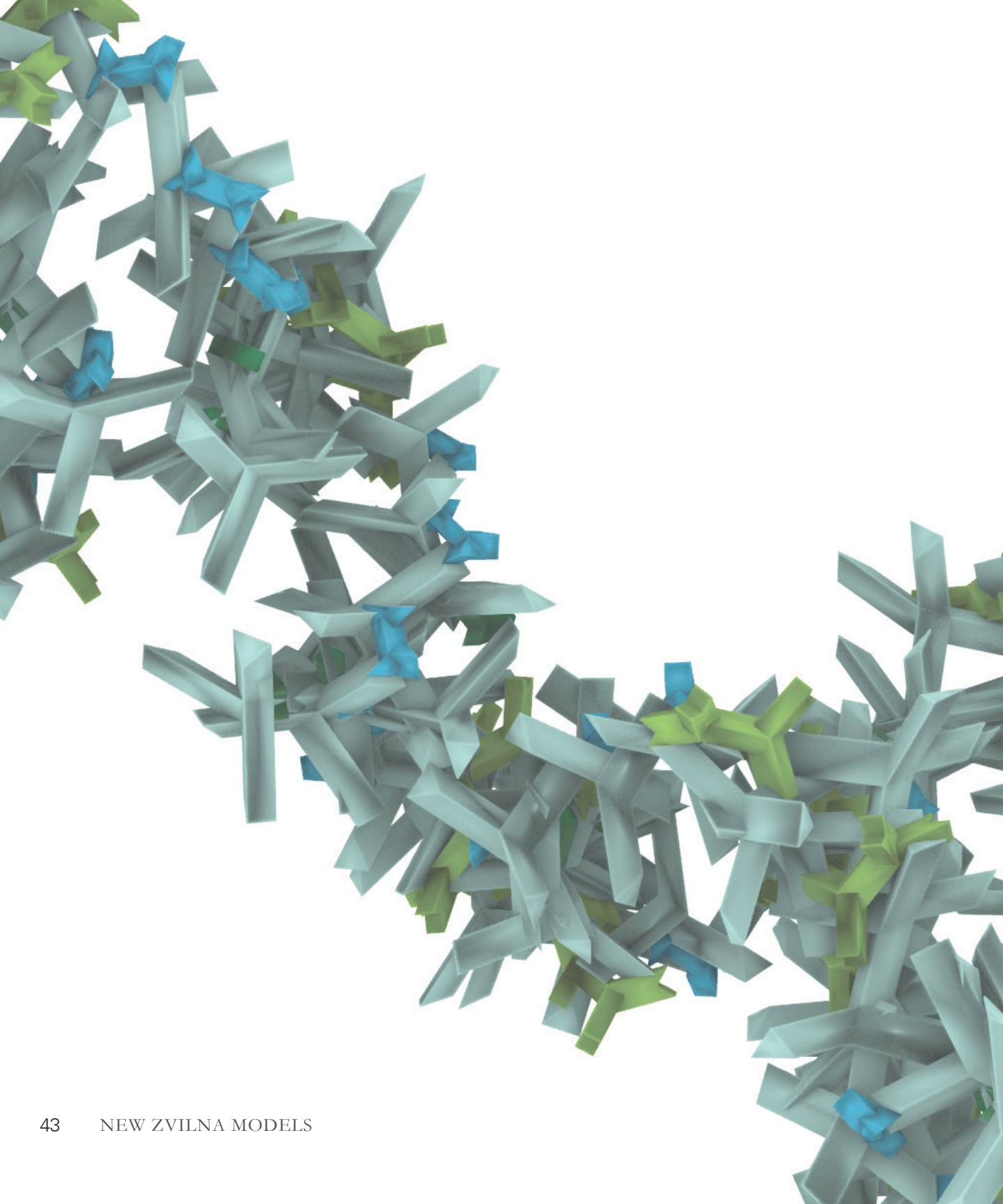


above

Foam model, dense Zvilna block aggregation, detail view. c.1973-1986. Zvilna Archive, University of Waterloo School of Architecture, recorded 2019.

facing

Foam model, dense Zvilna block aggregation, perspective view. c.1973-1986. Zvilna Archive, University of Waterloo School of Architecture, recorded 2019.



New Zvilna Models

The following modelling and graphic studies were undertaken by undergraduate students at the University of Waterloo School of Architecture in 2019, working with Professor Philip Beesley. Explorations in three-dimensional modelling and parametric script-writing were guided by reference to a collection of archival models by Jekabs Zvilna that remain within the archives of Waterloo Architecture. Details of these models are documented in the preceding chapter of this volume.

facing

Digital render of "Abiogenesis of basalt" by Alice Jie Jie Huang

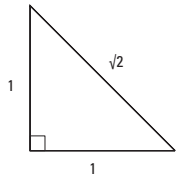
45 Degree Unit Block
Vincent Min and Winston Yew

A Zvilna block based on a base unit with a 45-degree cut.

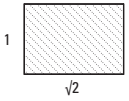
facing

Physical model of geometric exploration, aggregated wood "Zvilna block"

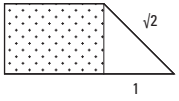
basic unit



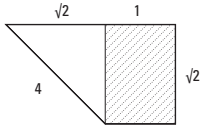
KEY RATIO: 1= √2
(1.41)



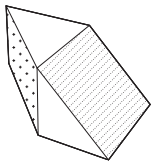
RIGHT



FRONT

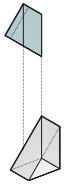


TOP

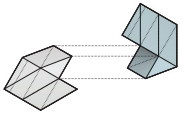


SVBK_45*45

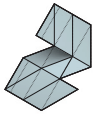
type 1_polar progression



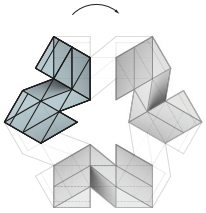
SVBK_45*45

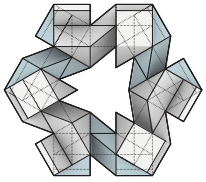


T1_U2



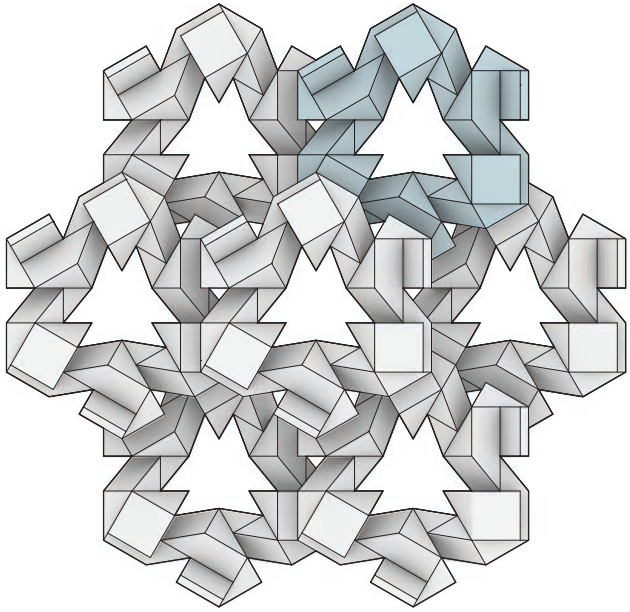
T1_U4



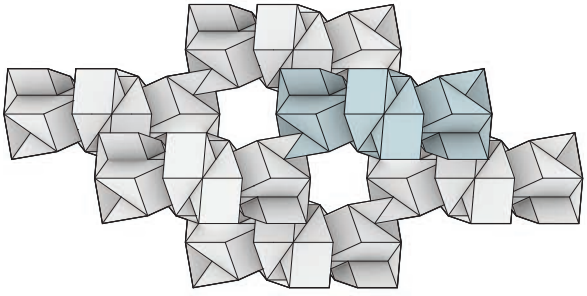


T1_U24

type 1_unit 192

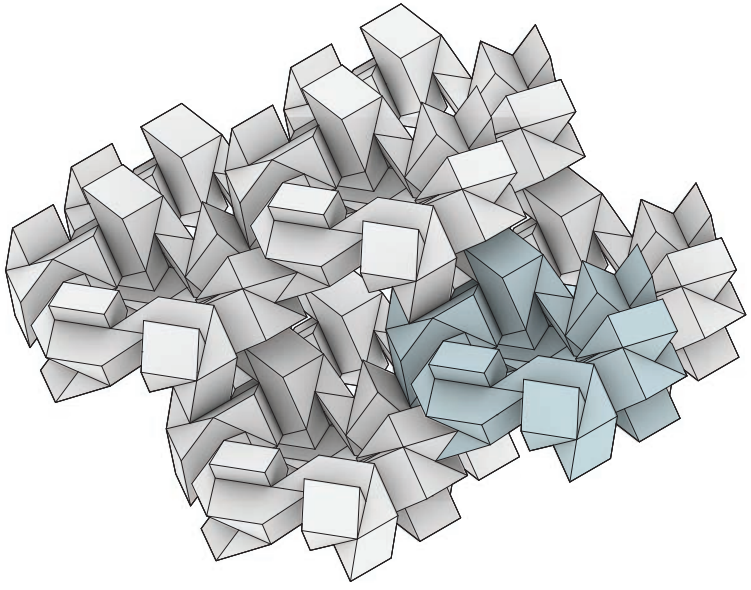


T1_U192 \\ TOP



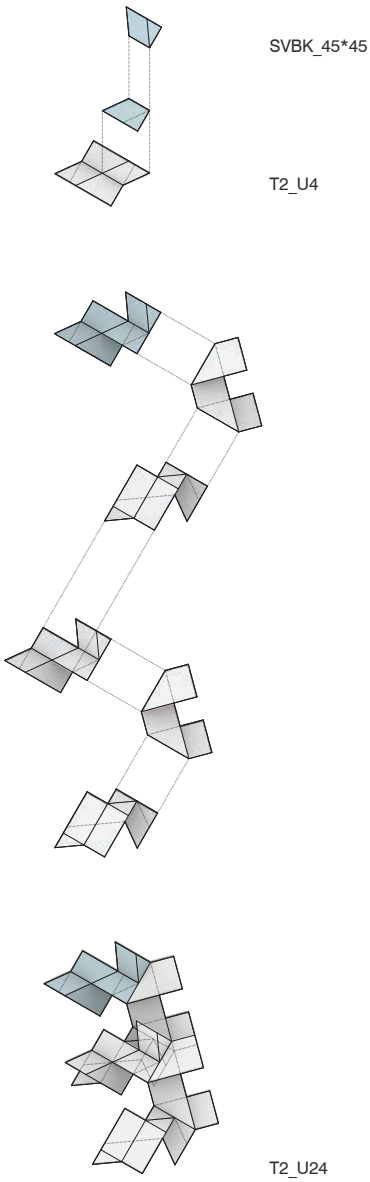
T1_U192 \\ FRONT

type 1_unit 192

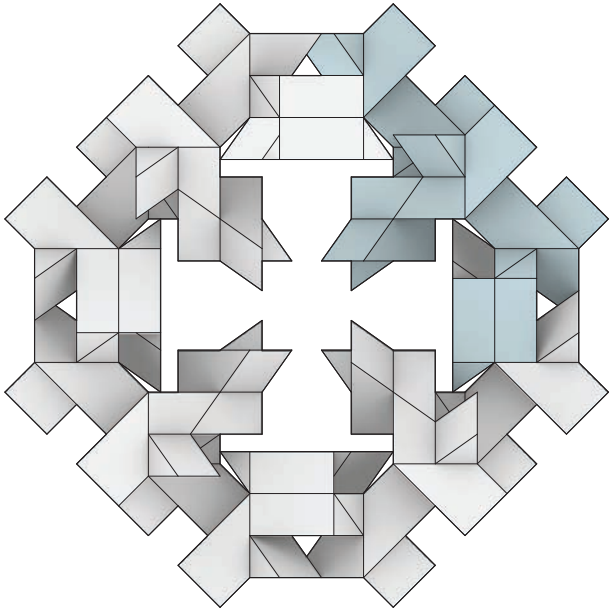


T1_U192 \\ PARALLEL PROJECTION

type 2_helical
progression

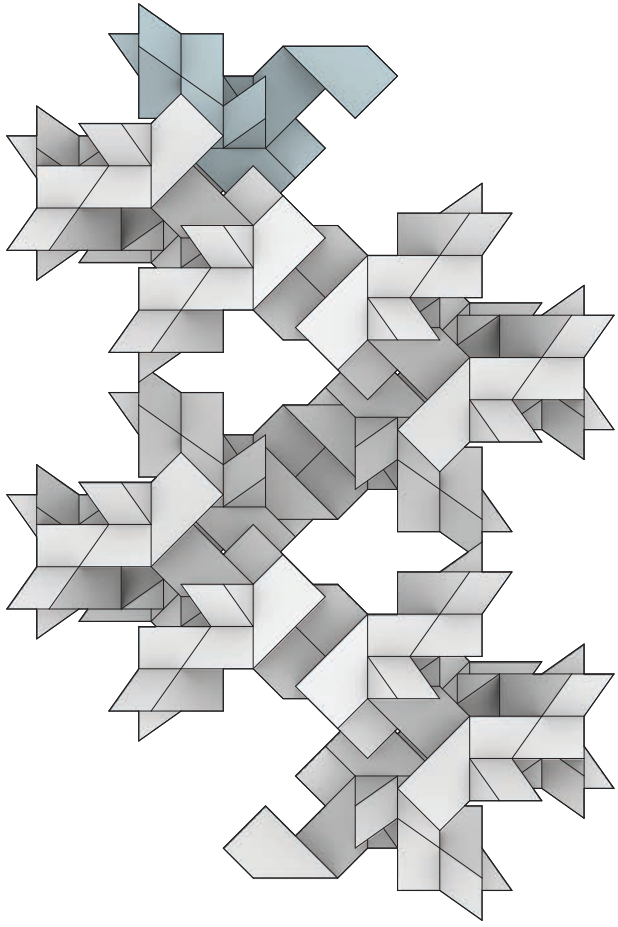


type 2_unit 192



T2_U192 \\ TOP

type 2_unit 192



T2_U192 \\ FRONT

Zvilna Forms
Saadman Ahmed and Kelley Gu

To understand the complexity of the Zvilna assembly, it is necessary to begin with the analysis of its smallest unit. The smallest unit can be constructed either from two triangular prisms, one upright, one on its side; or from two rotated cuts made from a single rectangular prism.

facing

Physical foam model of geometric Zvilna exploration

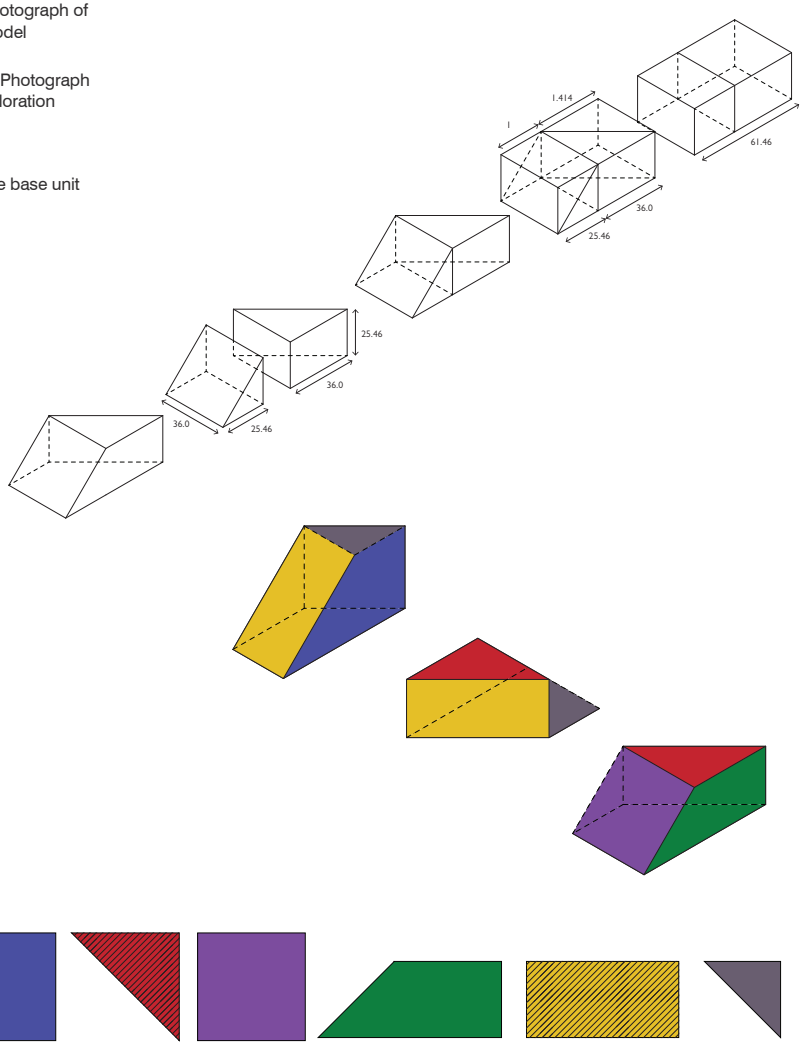
understanding the elemental unit

Note how the ratio is 1 to 1.41.
In other words, 1 to (root)2.

Facing page, top: Photograph of the original Zvilna model

Facing page, below: Photograph of inside of foam exploration model

Below: analysis of the base unit of the assembly



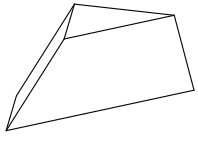
connections between units

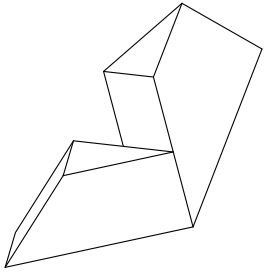
To form the six-unit array, there are two different types of connections: partial face connections of the rectangular faces, and edge connections between the widest faces of two units. For fabrication, it was easiest to glue all the face connections first, then take three of those to make a ‘flower’.

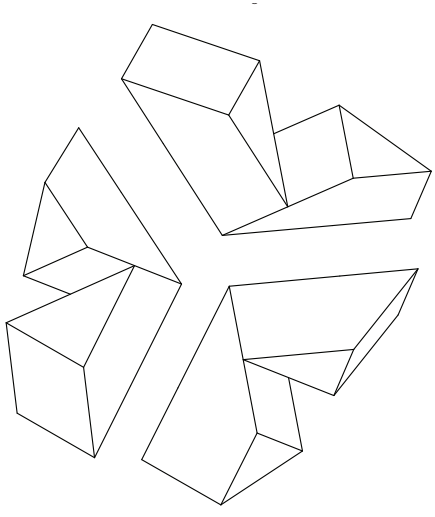
The next page demonstrates the connection between two of these ‘flowers’. With four faces touching (two from each array), they can connect infinitely in any of the three directions to form a lattice.

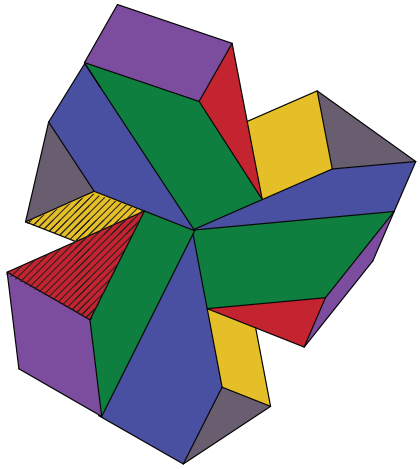
Face connection

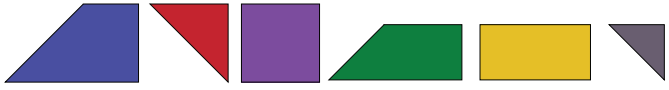
Edge connection

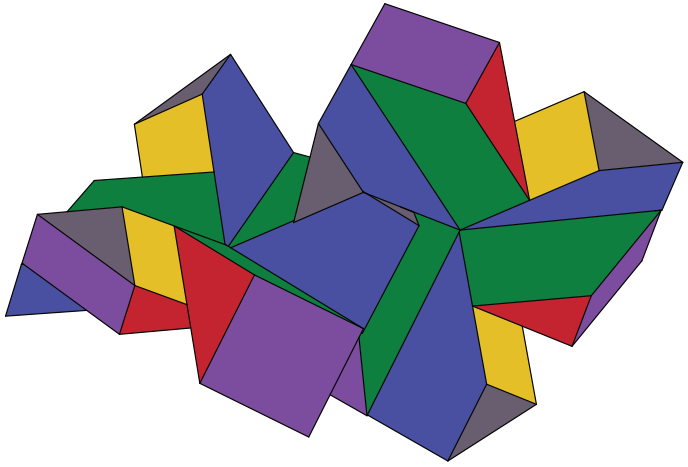








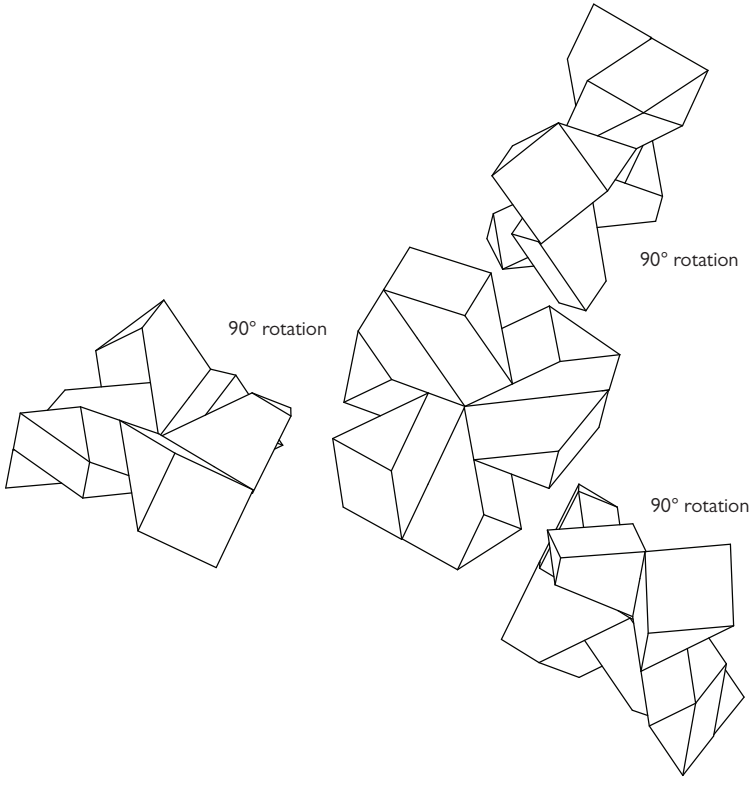


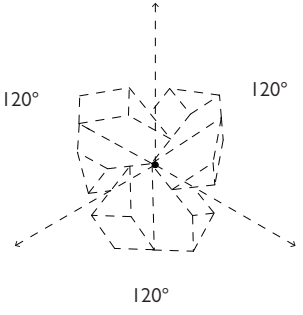


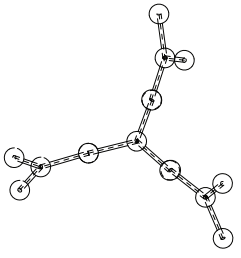
connecting the arrays

Each ‘flower’ array has three attachment points, allowing the lattice to grow hexagonally. However, each attached unit forms a 90 degree twist from the last, producing new and interesting variations on a standard hexagonal lattice.

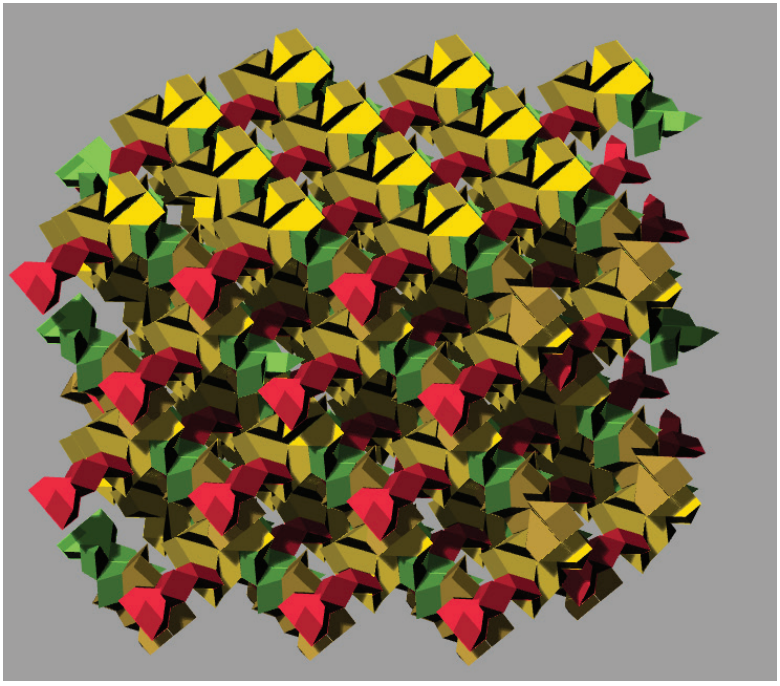
Two units attached together can also be conceptualized as bifurcating branches, that is, each connection produces two more connections.

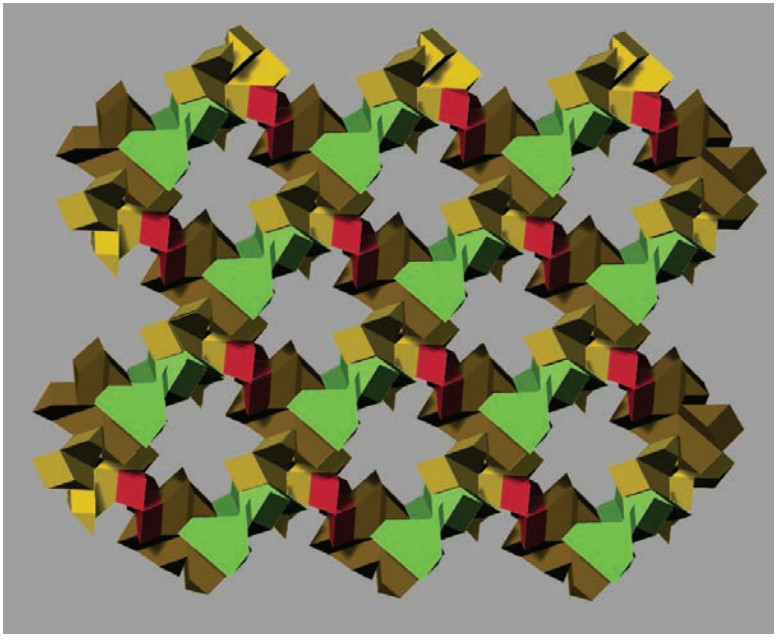






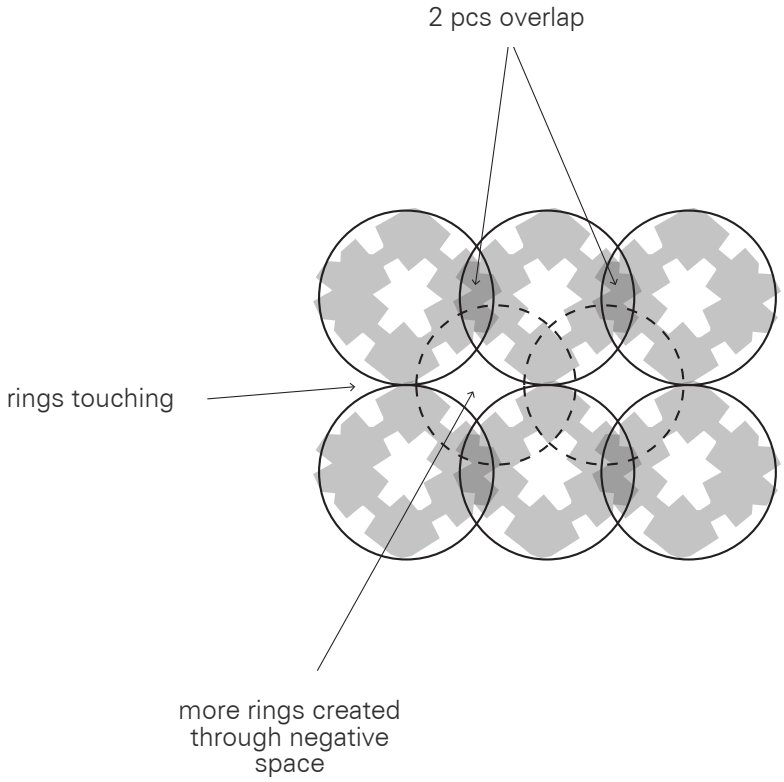
Can be conceptualized as bifurcating branches

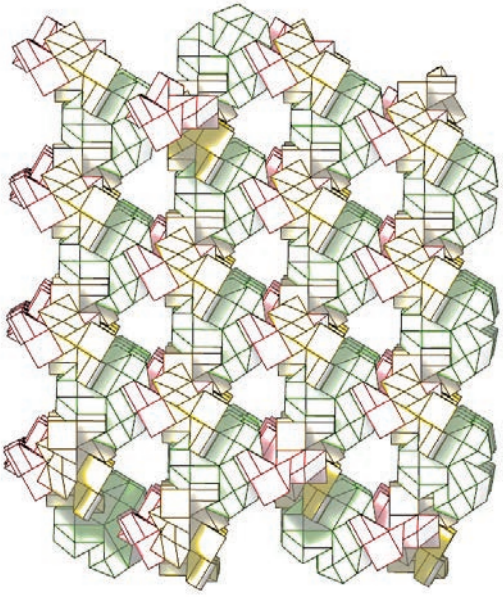


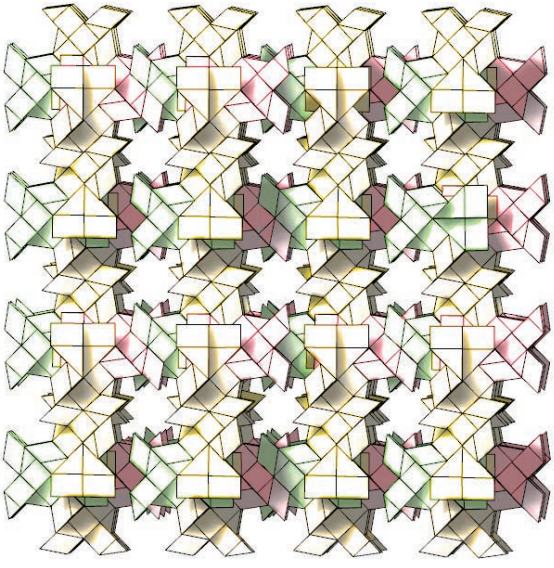


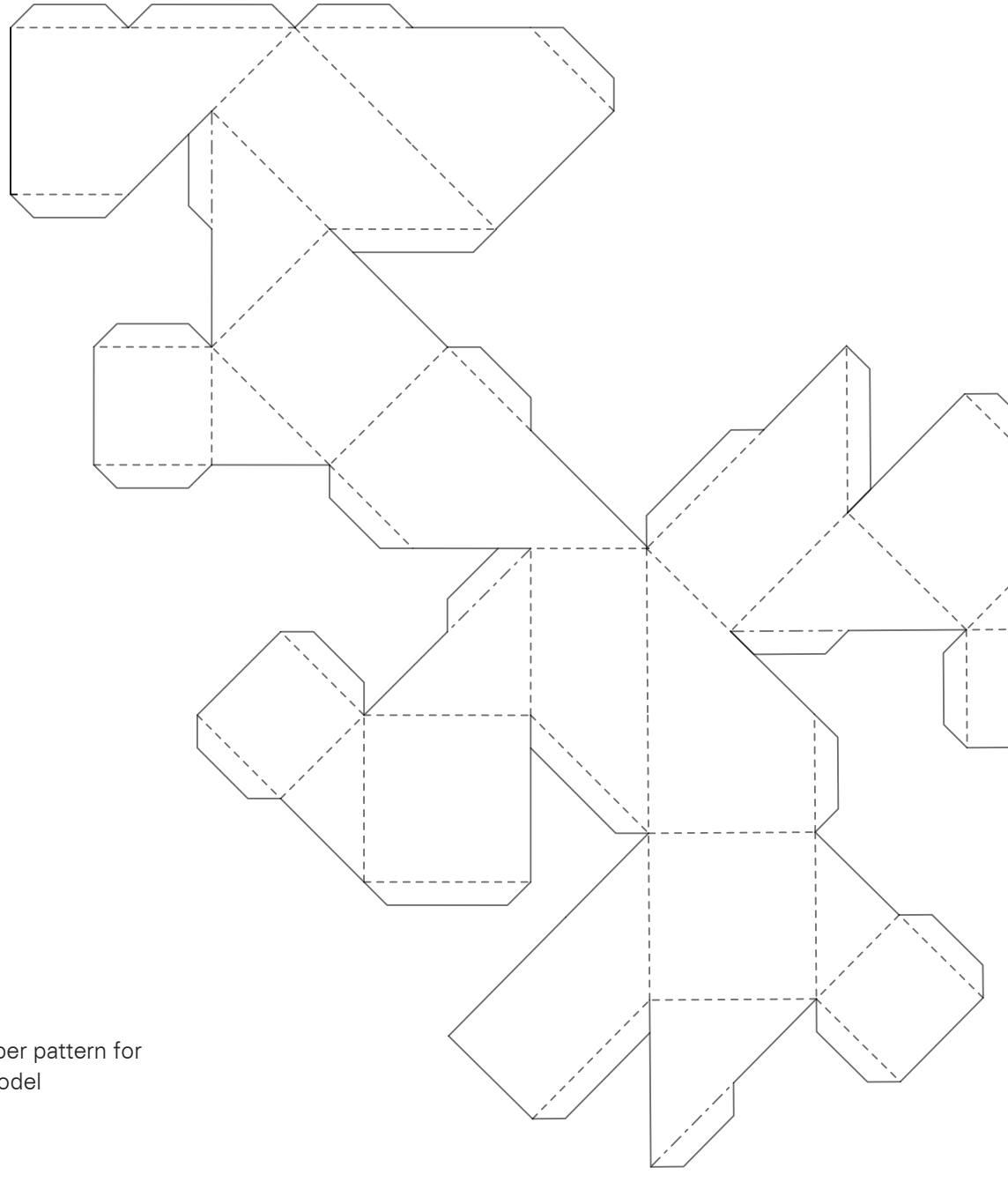
lattice elevations

The lattice looks very different from the front versus the side. From the front it appears to be a series of rings, while from the side it is apparent that it is several layers of the front elevation stacked in front of each other and attached by intermediary pieces, forming a grid.

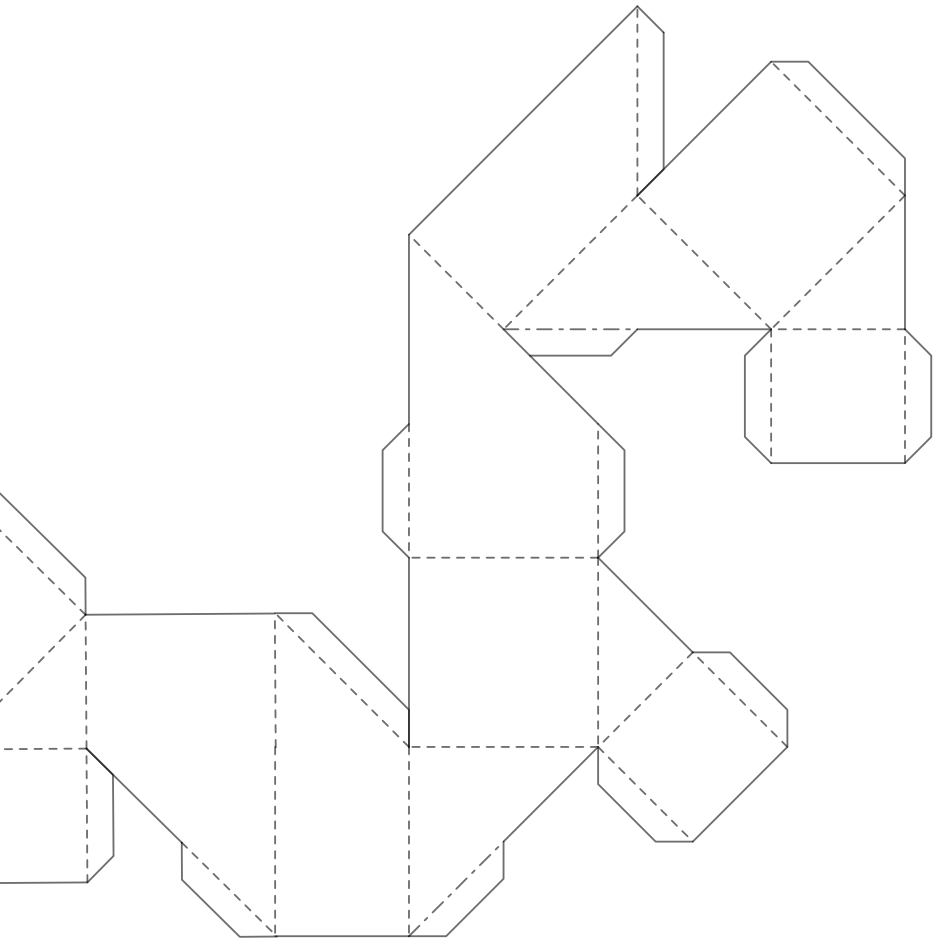


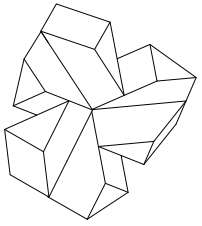






Unfolded paper pattern for
preceding model





Various Experiments
Yun Ru Amy Bao

Experiments with the base Zvilna block
in conjunction with Grasshopper binaries.

facing

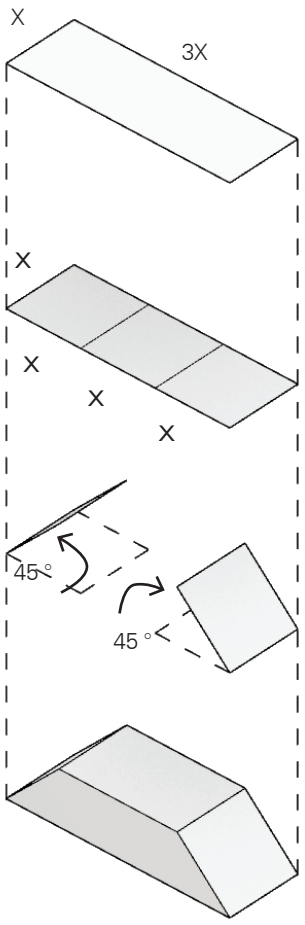
Digital render of geometry
exploration, "Explosion"

original geometry: single

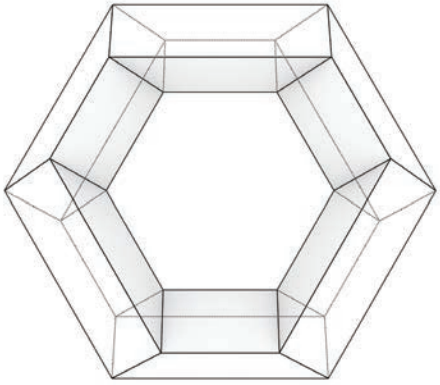
1. Begin with three congruent squares

2. Rotate the outer squares upwards 45 degrees using the outer edges as axes

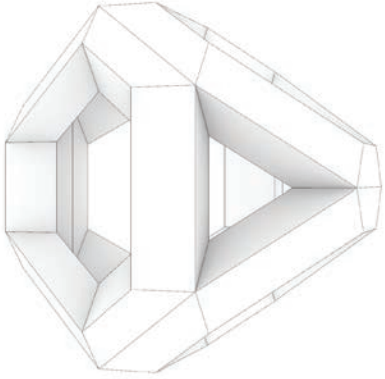
3. Connect all edges to form a solid



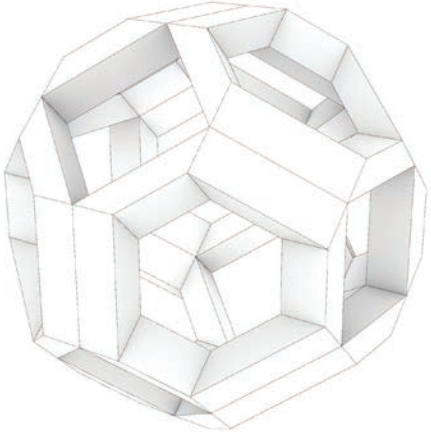
variation 1a:
hexagon



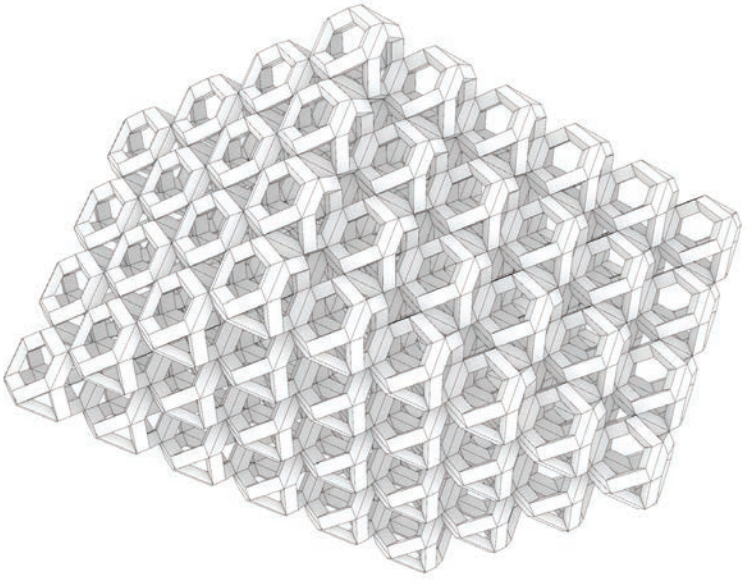
variation 1b:
truncated tetrahedron



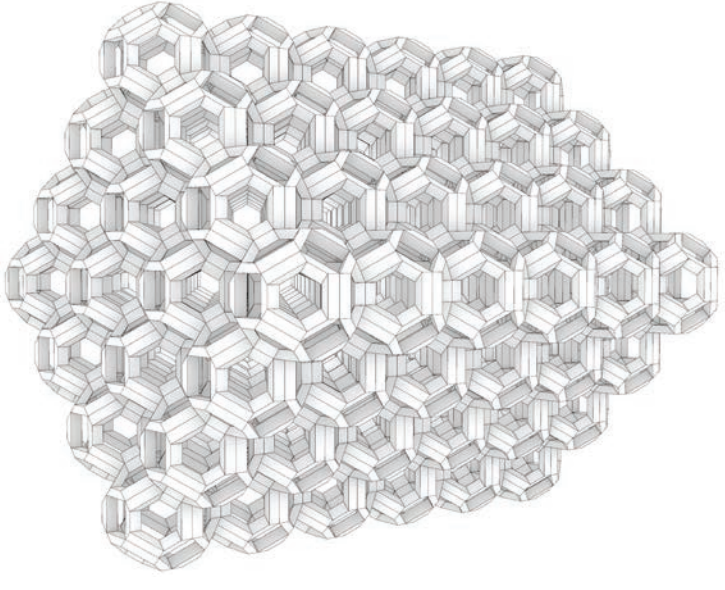
variation 1c:
truncated octahedron

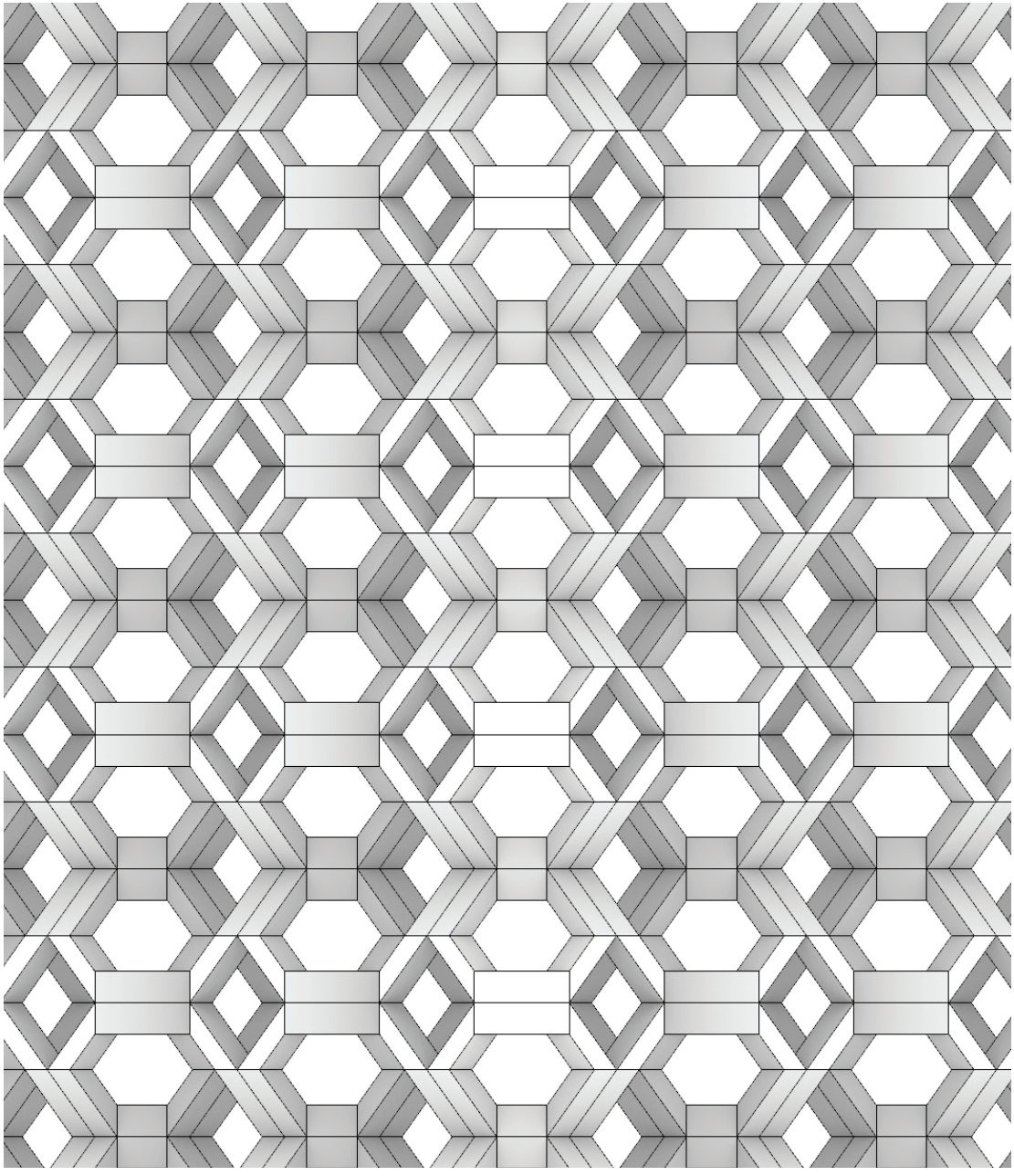


growth 1d: truncated tetrahedron array



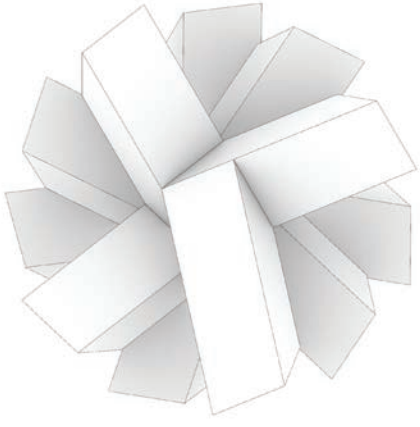
growth 1c: truncated tetrahedron array



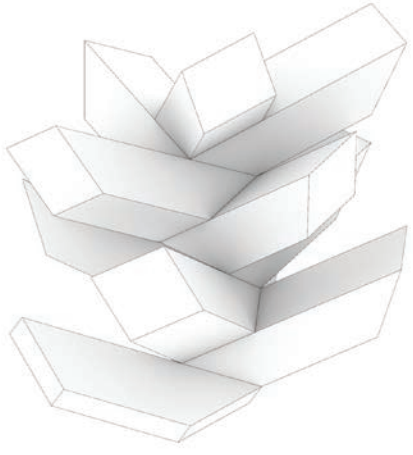


growth 1c: truncated octahedron array, top view

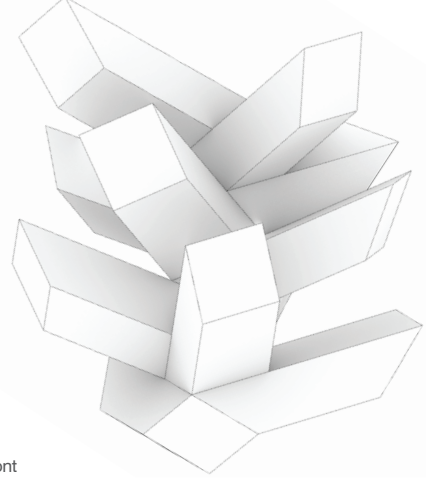
variation 3: pinecone



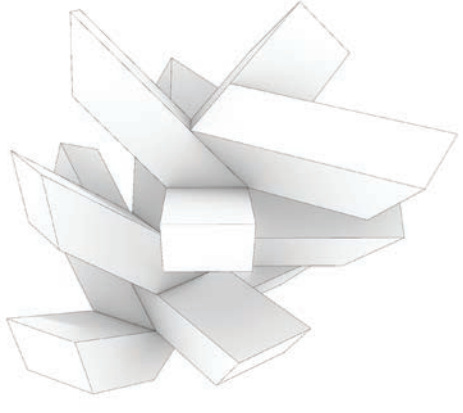
Top



Side

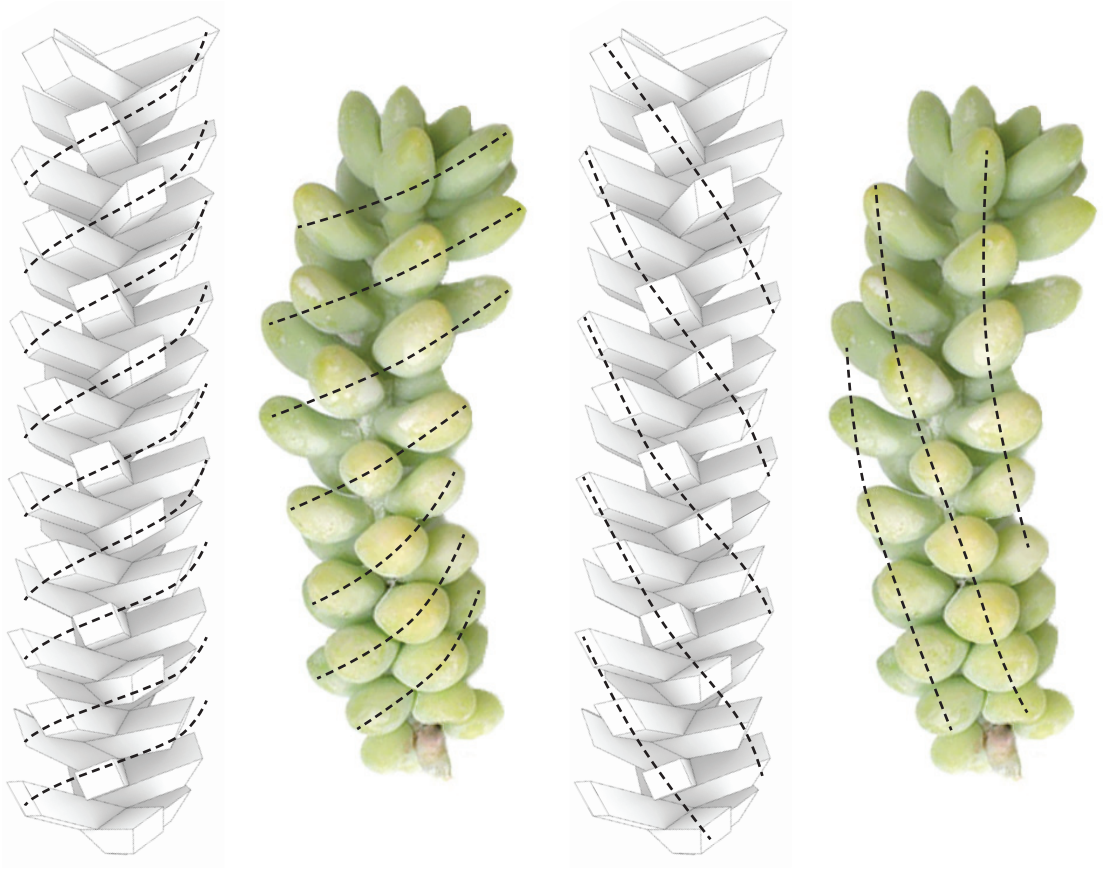


Front



Perspective

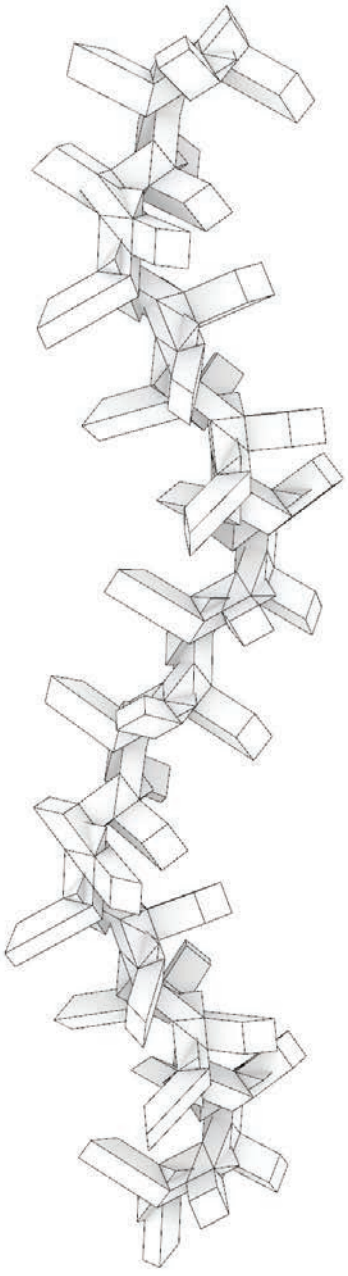
growth 3: burro's tail (sedum morganianum)



Spirals occur frequently in nature, and dual spirals occur frequently in plants. One spiral is steeper than the other. This Zvilna variation captures this characteristic in simplified geometry.

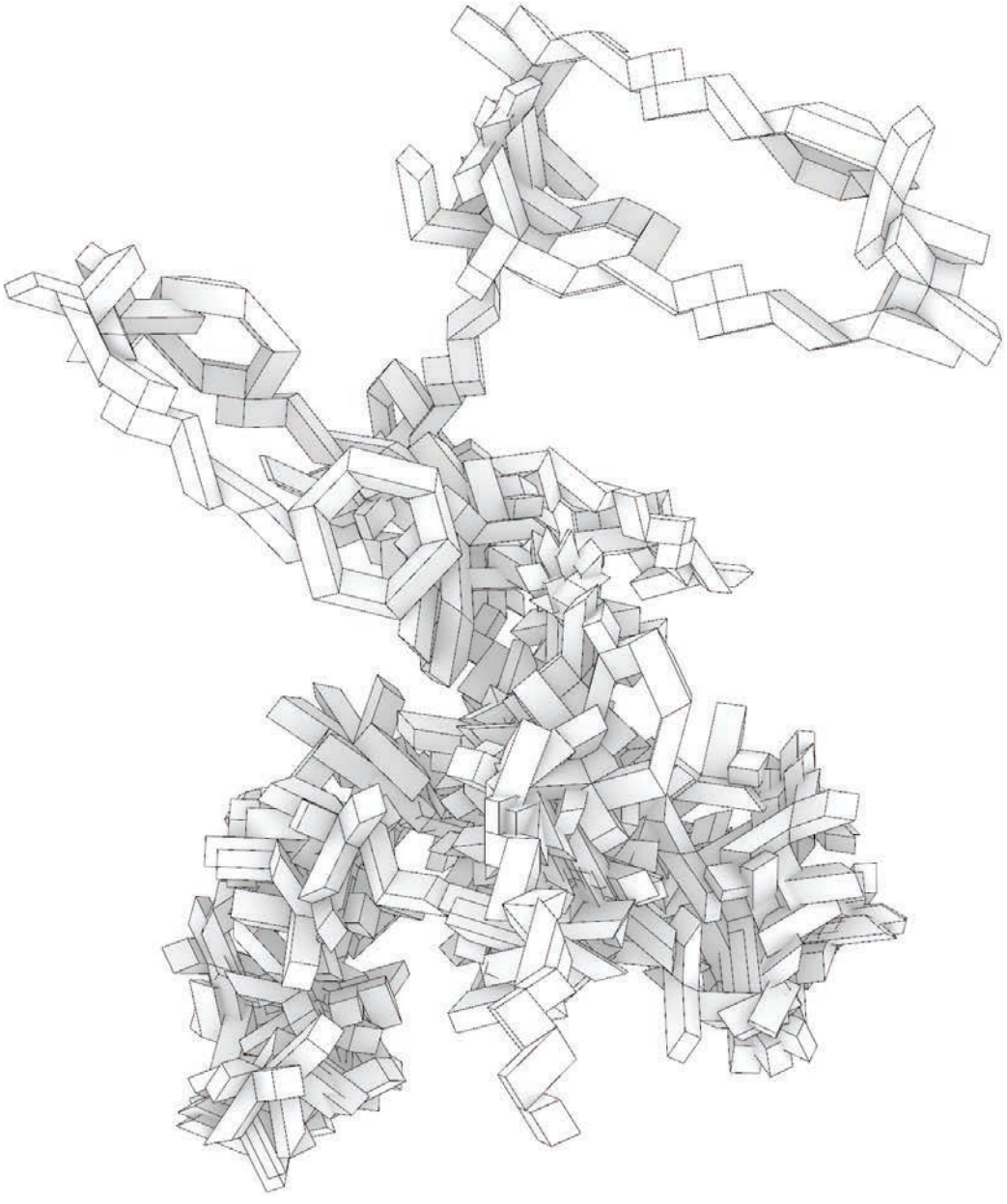
random growth 1: seaweed

Limited touching faces



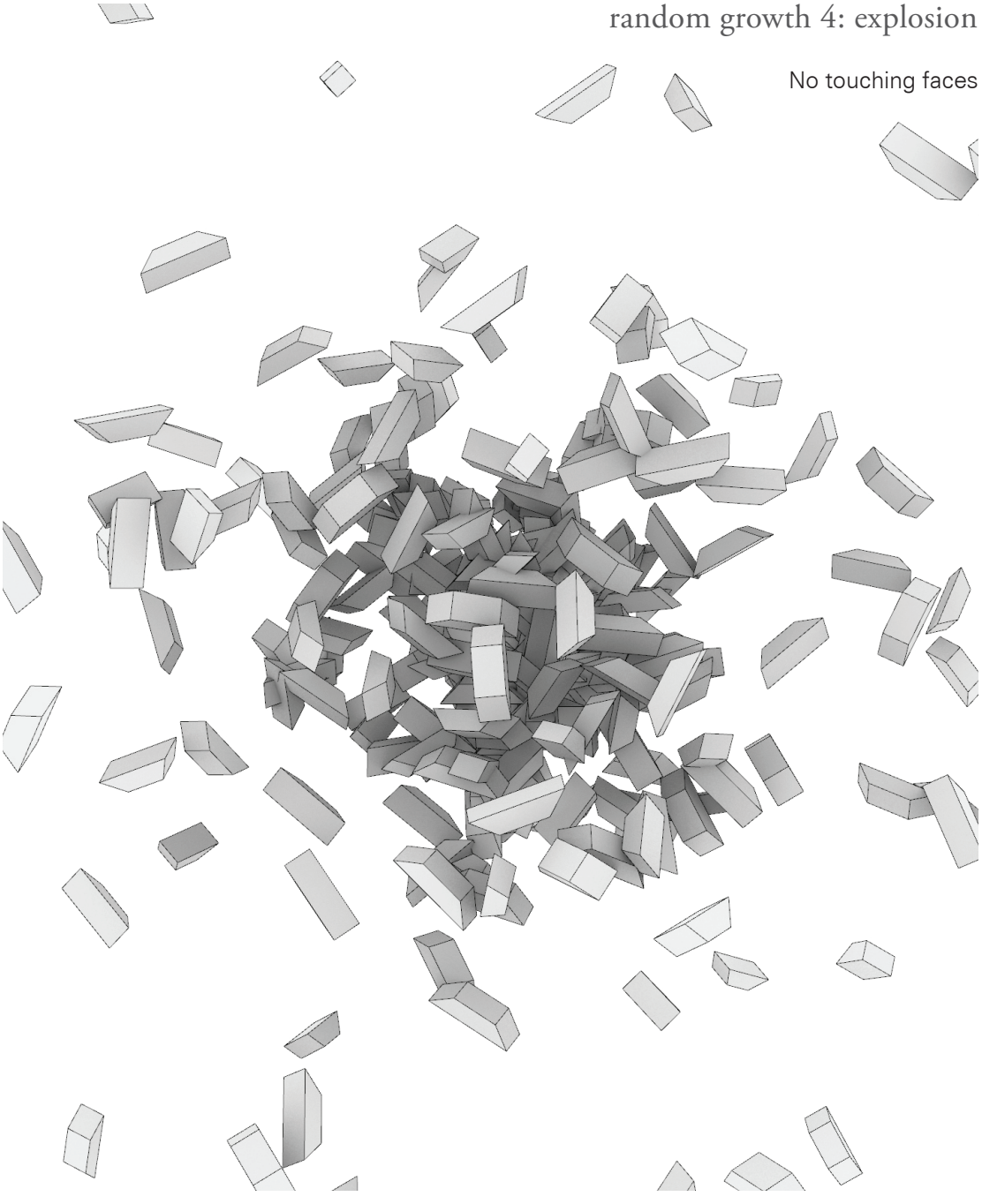
random growth 2: protein

Unlimited touching faces



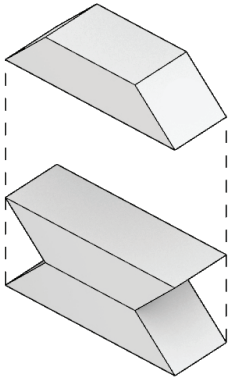
random growth 4: explosion

No touching faces

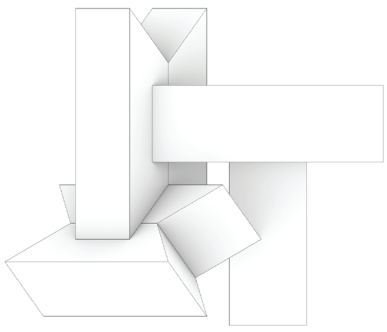


original geometry: double

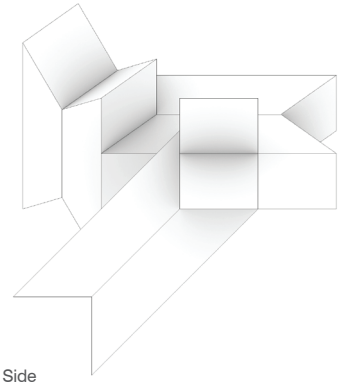
The trapezoidal prism rotates 180 degrees or mirrors vertically to create the facing prism



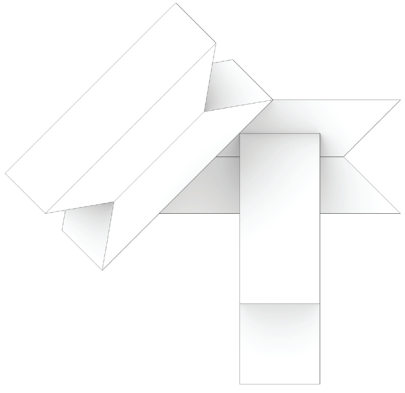
variation 1



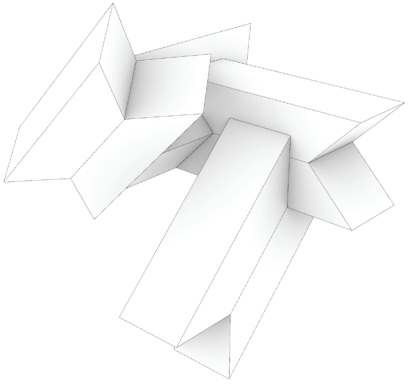
Top



Side

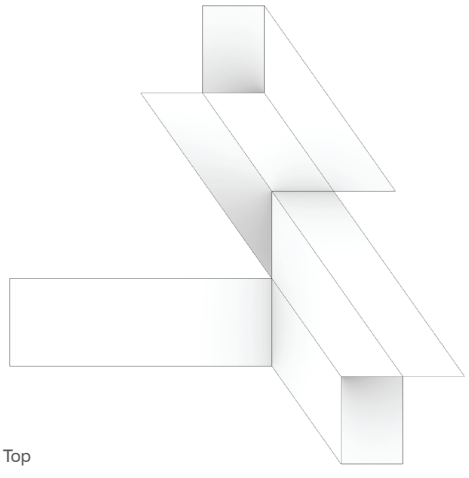


Front

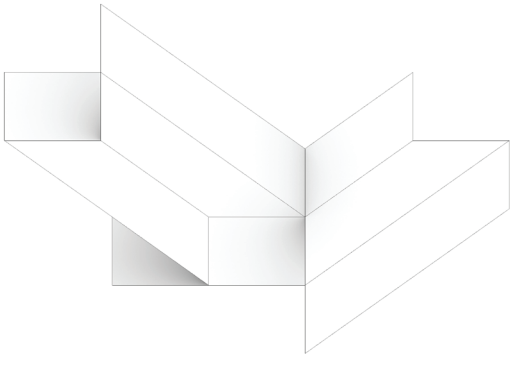


Perspective

variation 2: pinecone

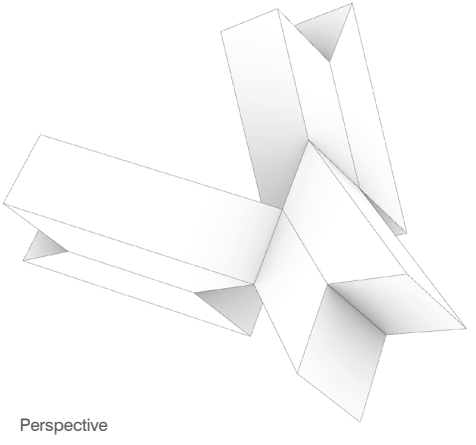


Top



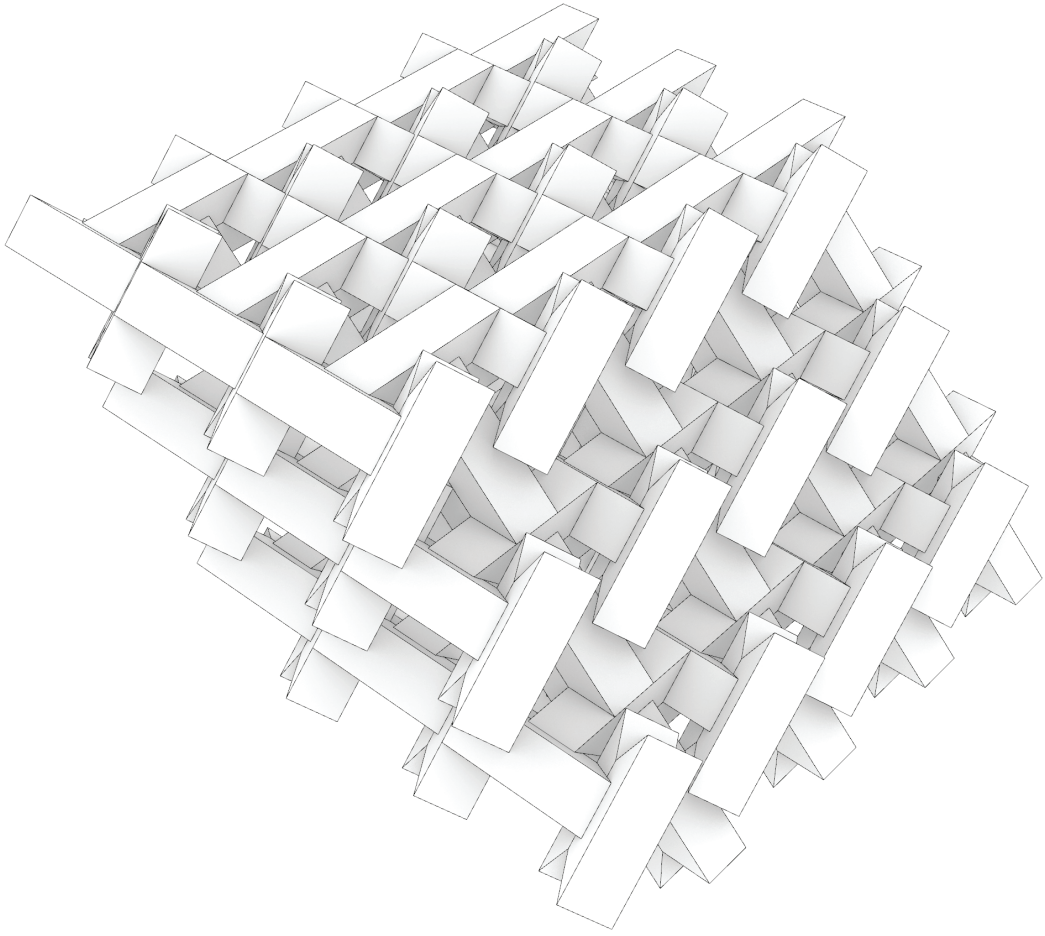
Side

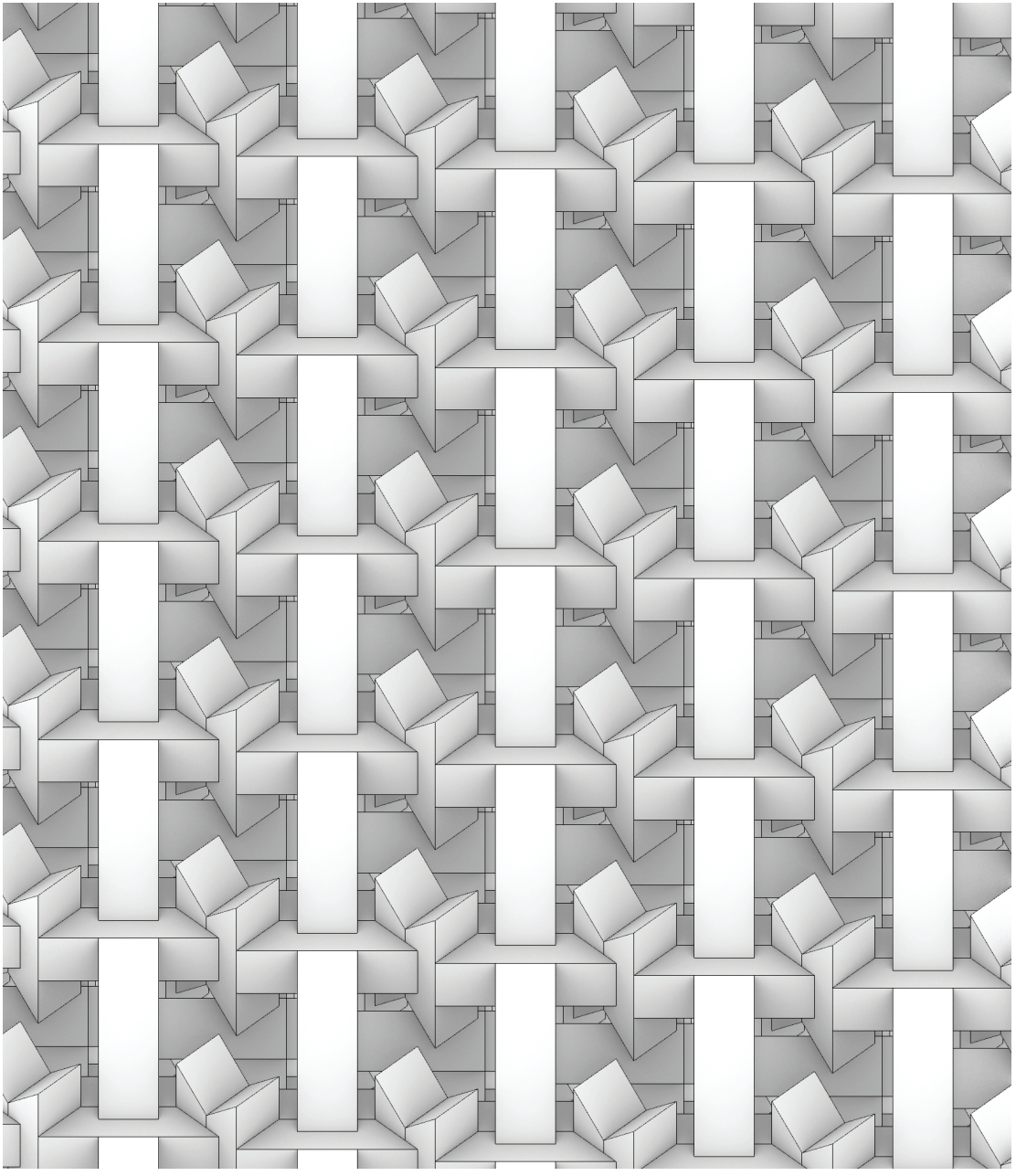
Front



Perspective

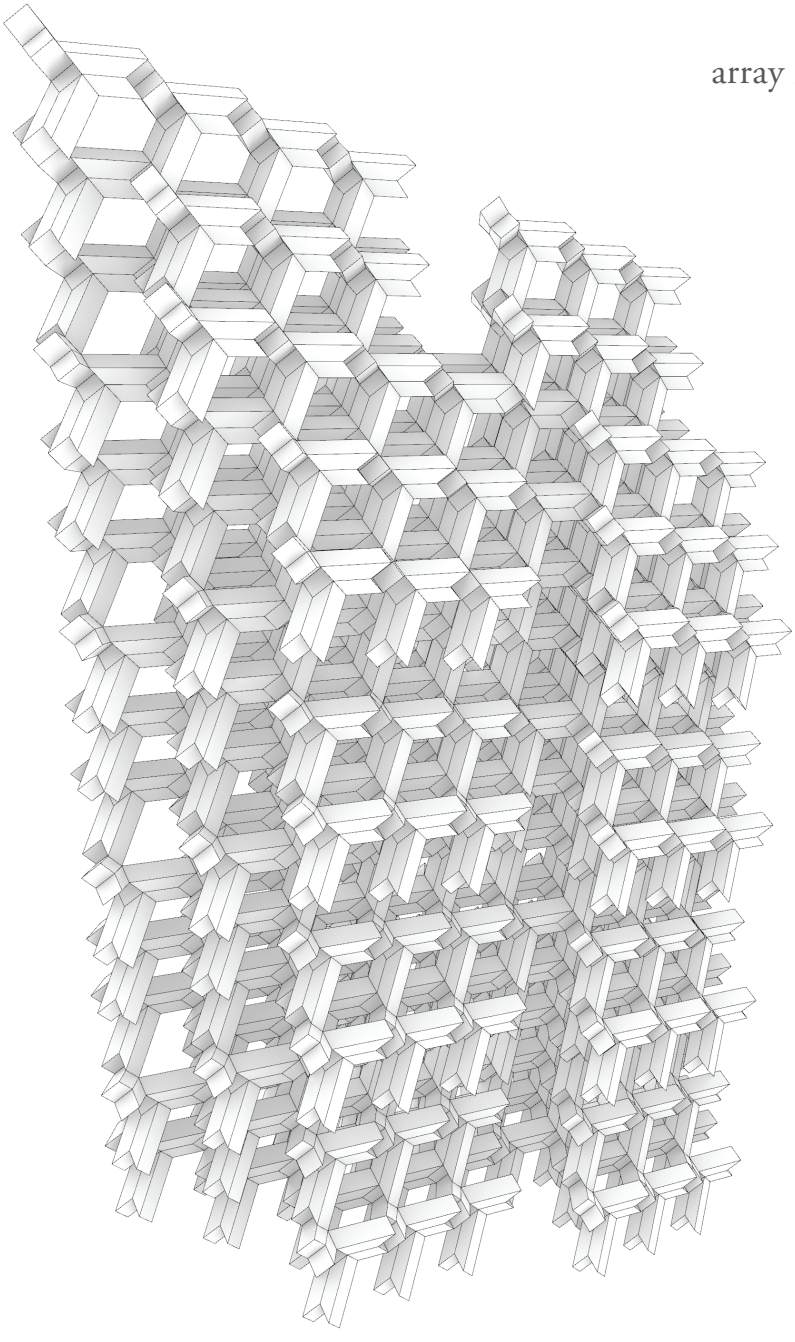
array / growth 1

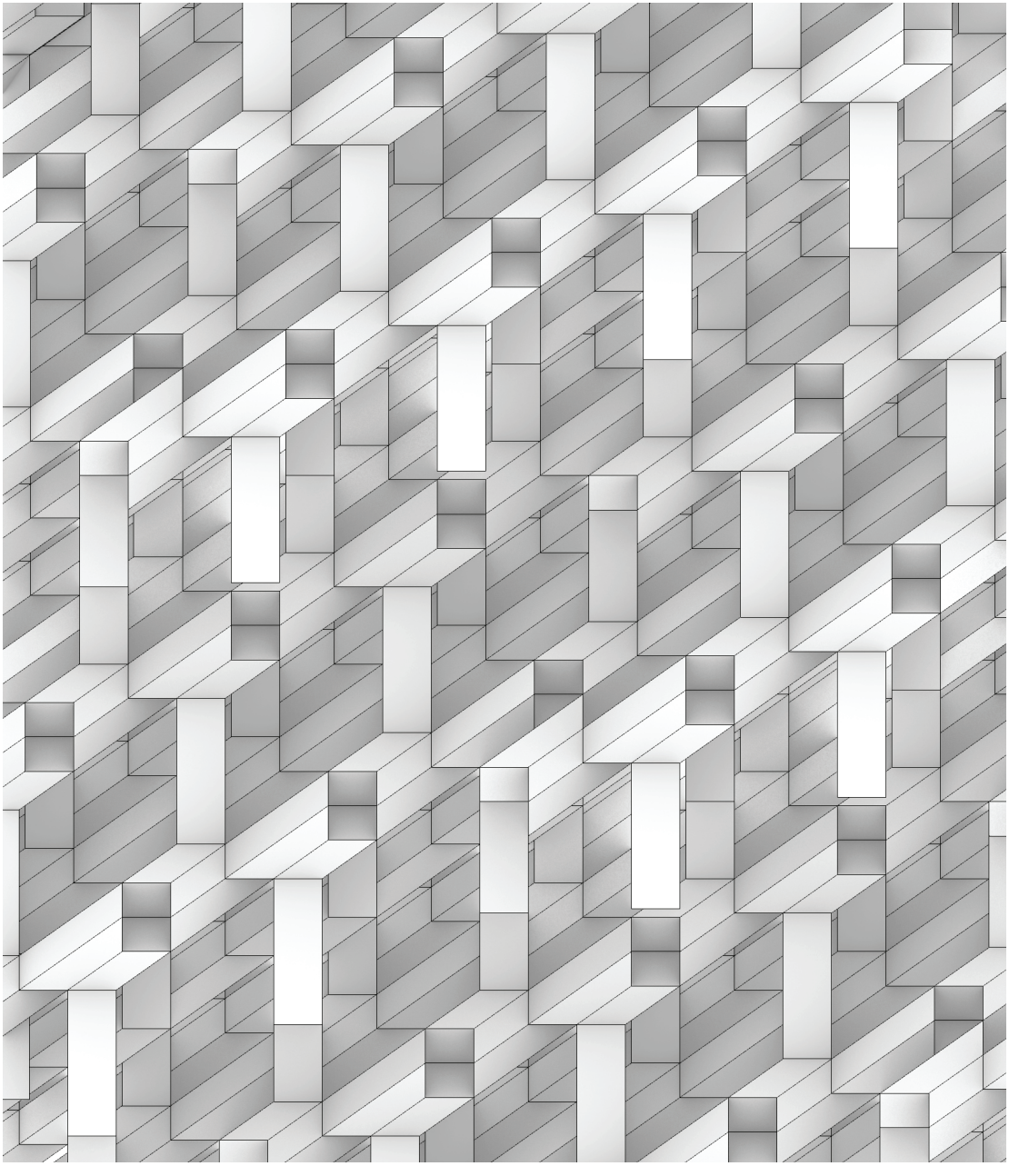




array / growth 1, top view

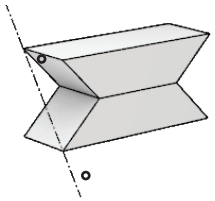
array / growth 2



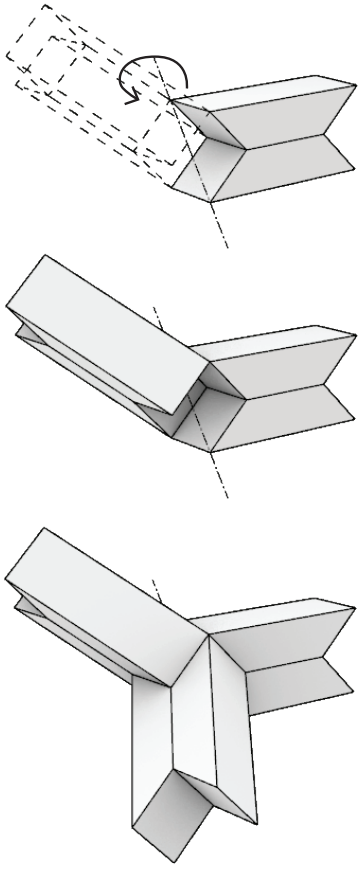


array / growth 2: top view

Axis Definition



Rotate 3D 120 °



original geometry: three-point star

1. Create an axis of rotation diagonal to the neutral axis of the base unit

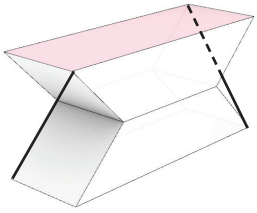
2. Create an axis on the other side of the base unit by rotating it about the centroid, not mirroring it. If mirrored, the resulting three-dimensional array will not form proper connections

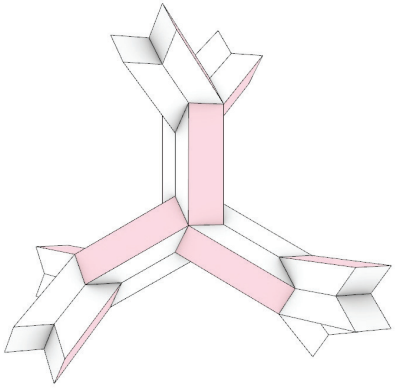
3. Rotate the base unit to create two copies about one axis

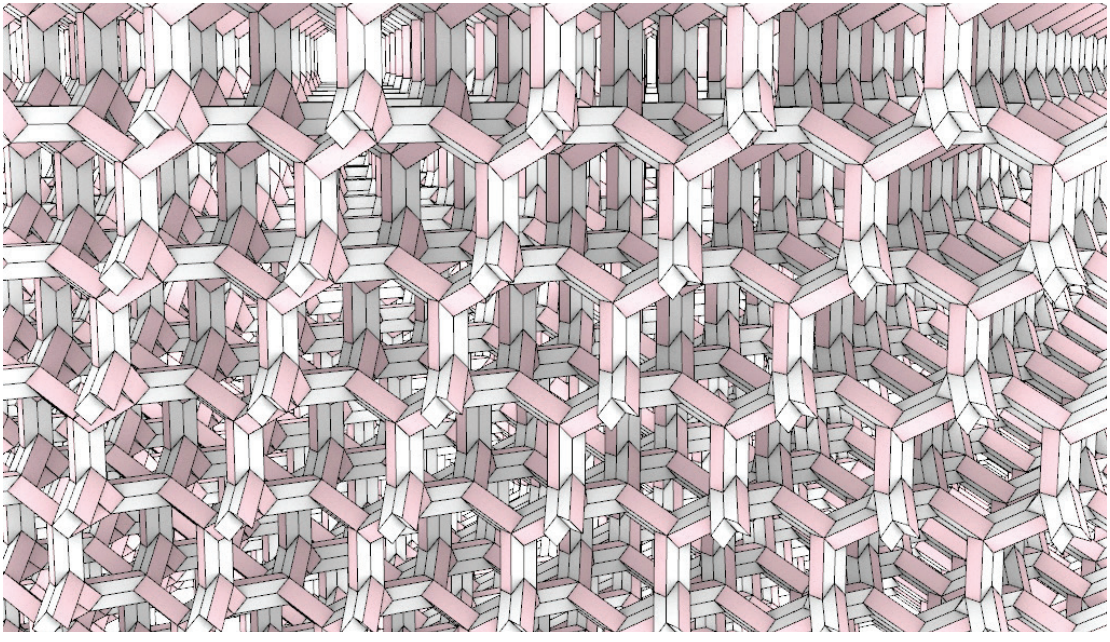
4. The resulting three-pointed star can now be rotated and copied along each outside axis

original crystalline structure

The axes of rotation on each base unit
are rotated about the neutral axis

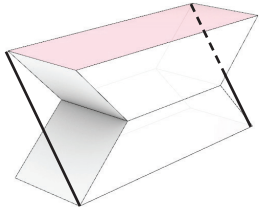


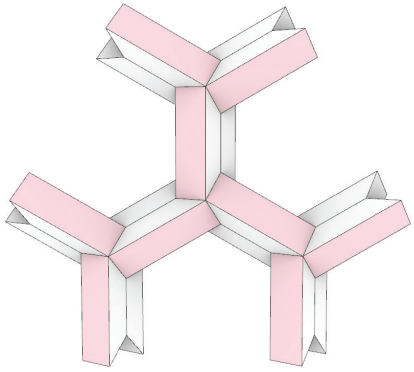


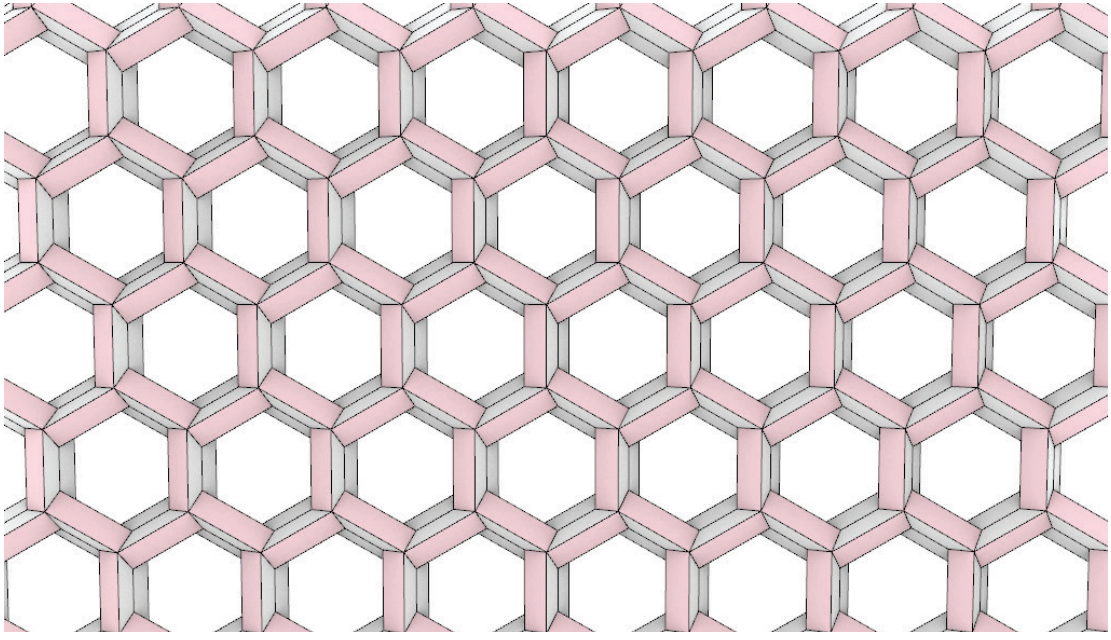


flat-line variant

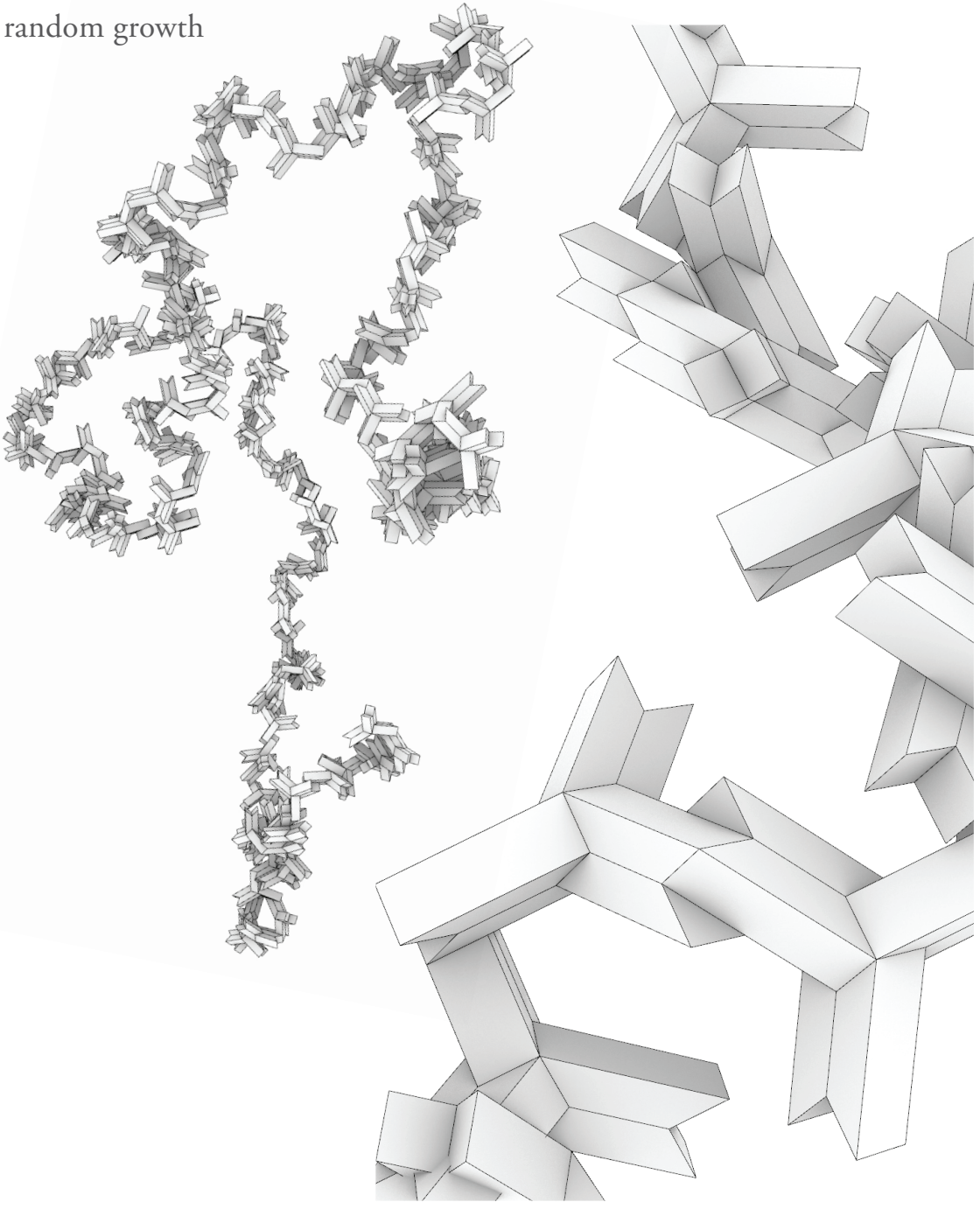
If the axes of rotation on each base unit are mirrored,
a flat mesh of hexagons emerges

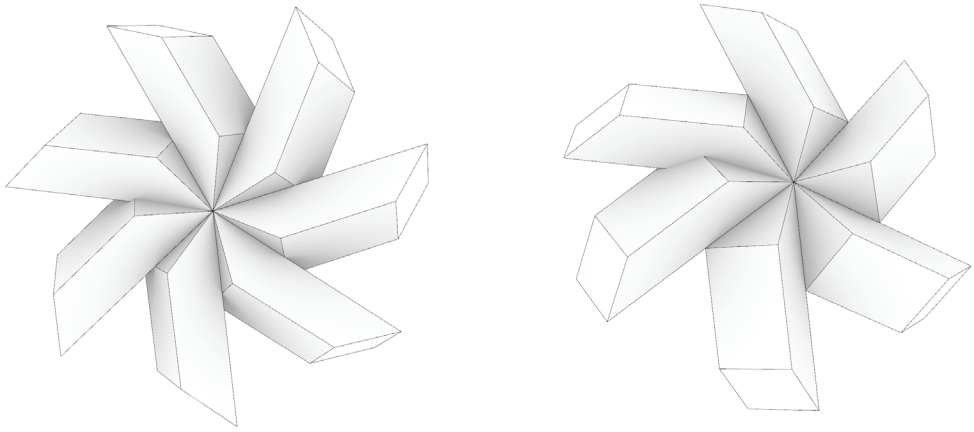




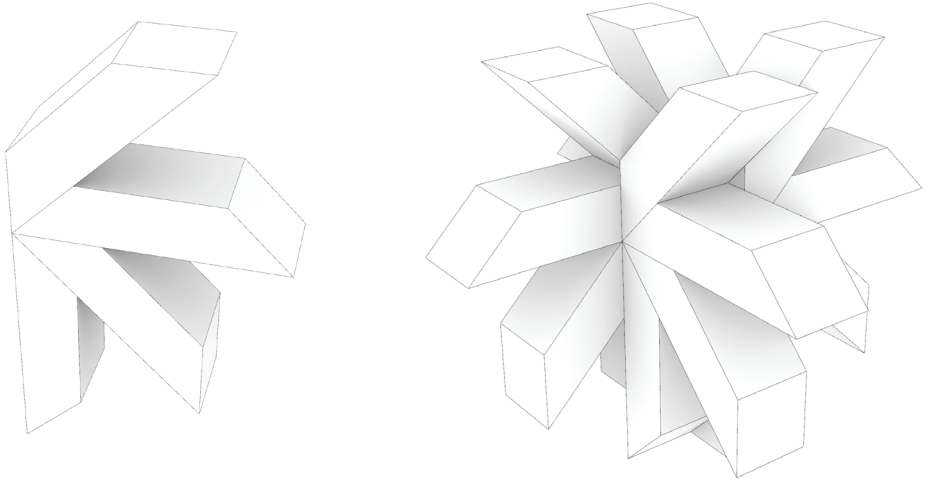


random growth

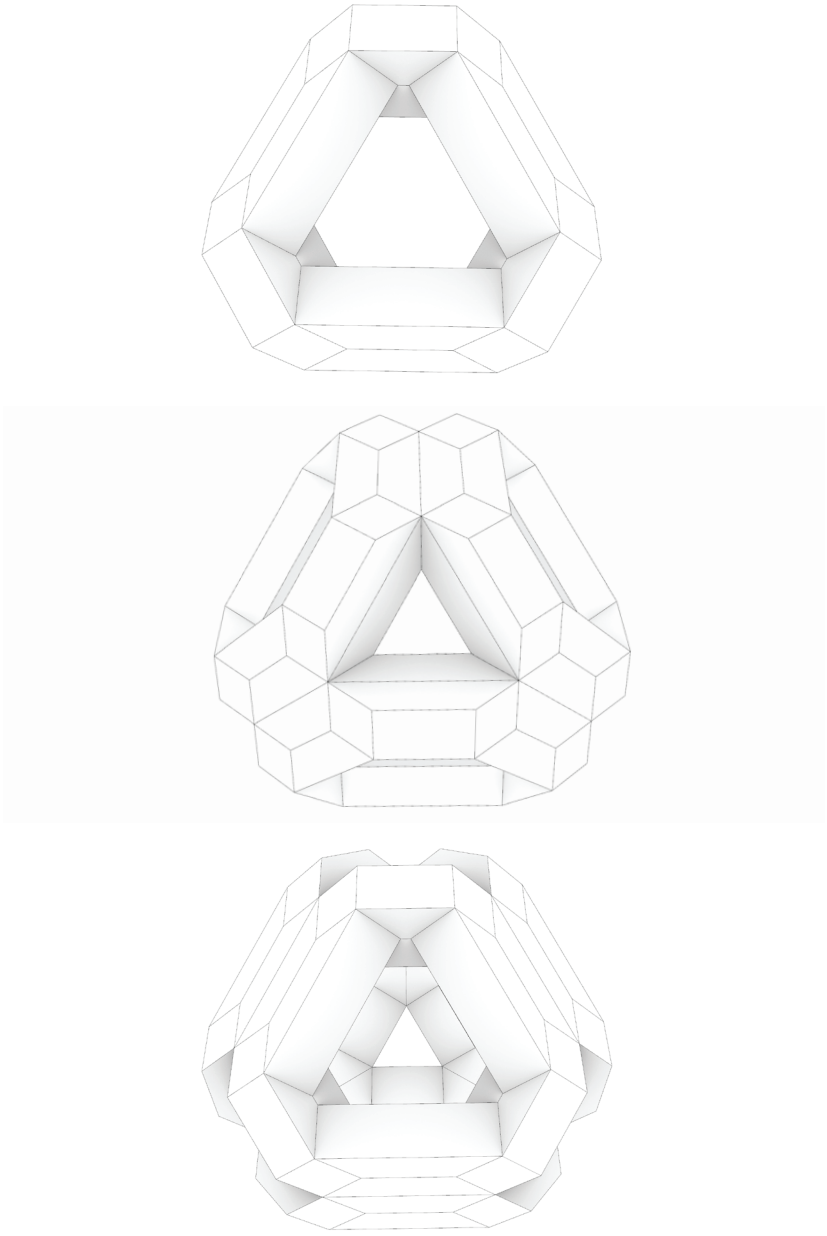




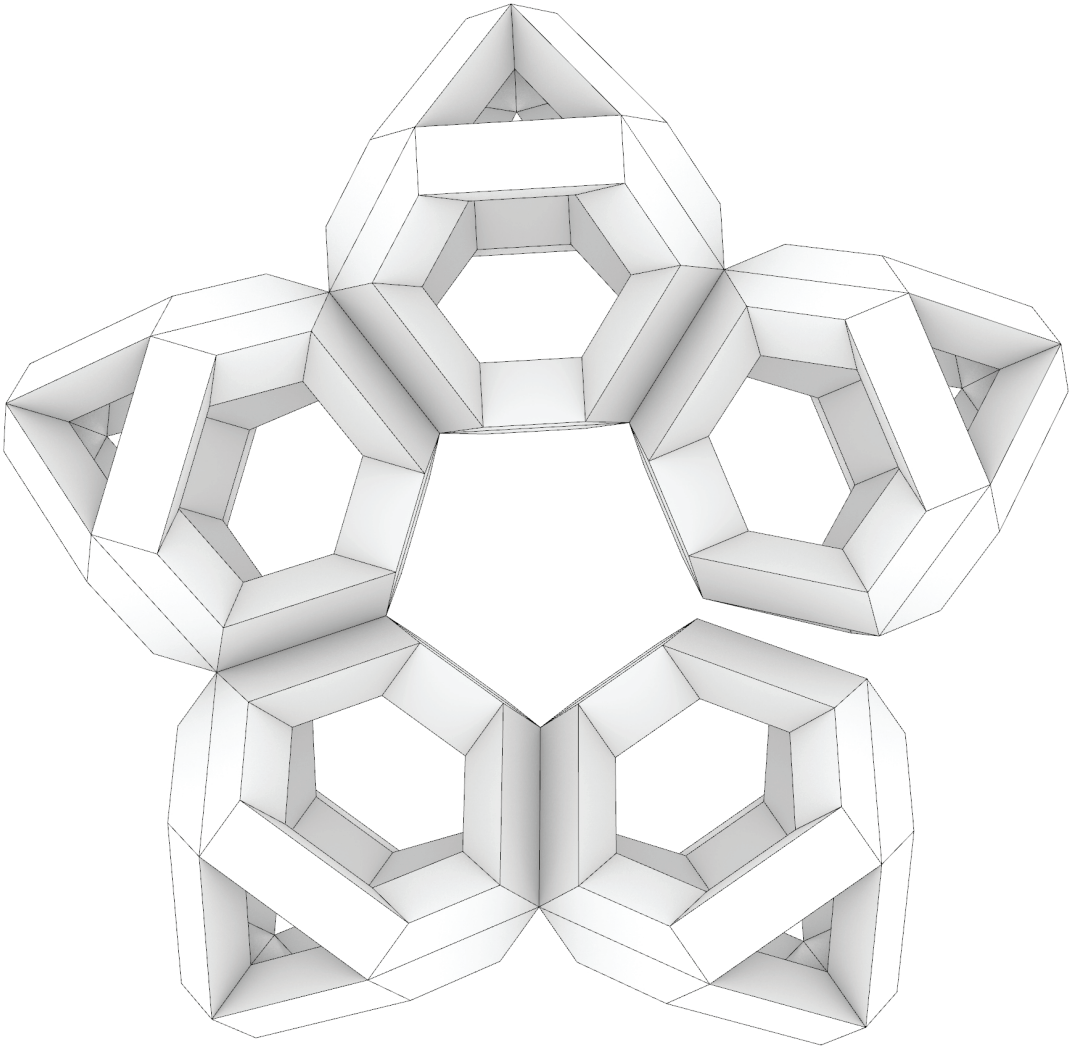
Imperfect pinwheels (overlapped)



Pinwheel “chrysanthemum”



Truncated tetrahedron before simplification



Incomplete pentagram of truncated tetrahedrons

Abiogenesis of Basalt
Alice Jie Jie Huang

Basalt rock interior

facing
Digital render of the exploration

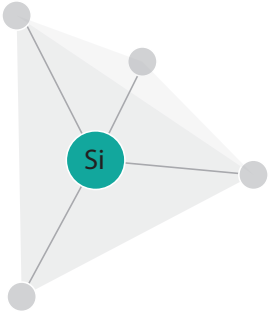
Abiogenesis of basalt by simulating composition and chemical behaviour of basalt, using Zvilna geometry and theory.

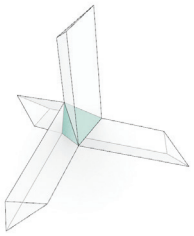
This exploration breaks down the composition of Basalt as sets of Zvilna blocks and some variation of it) that has similar behaviour content as the chemical compound that forms basalt. Carrying the individual characteristics, the parametric model aims to explore the first stage of abiogenesis of basalt where the monomers began to emerge.

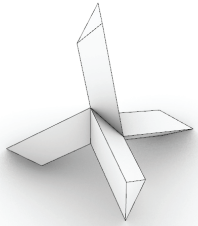
Basalt is a volcanic rock that is formed from the cooling of lava on the surface of earth or other planets such as Moon and Mars.

silicate(SiO_2)

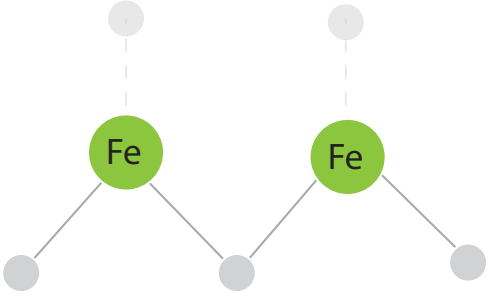
Tetrahedral Crystal

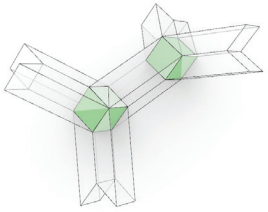


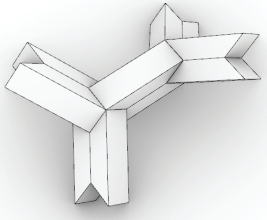




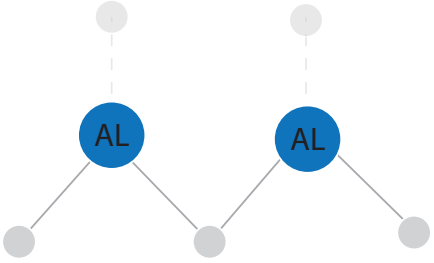
iron
oxide(Fe_2O_3)

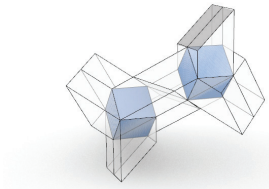


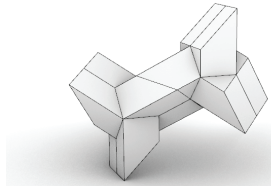




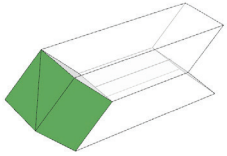
aluminum
oxide(Al_2O_3)

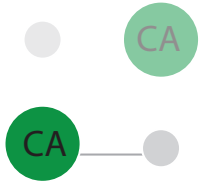


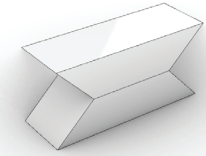




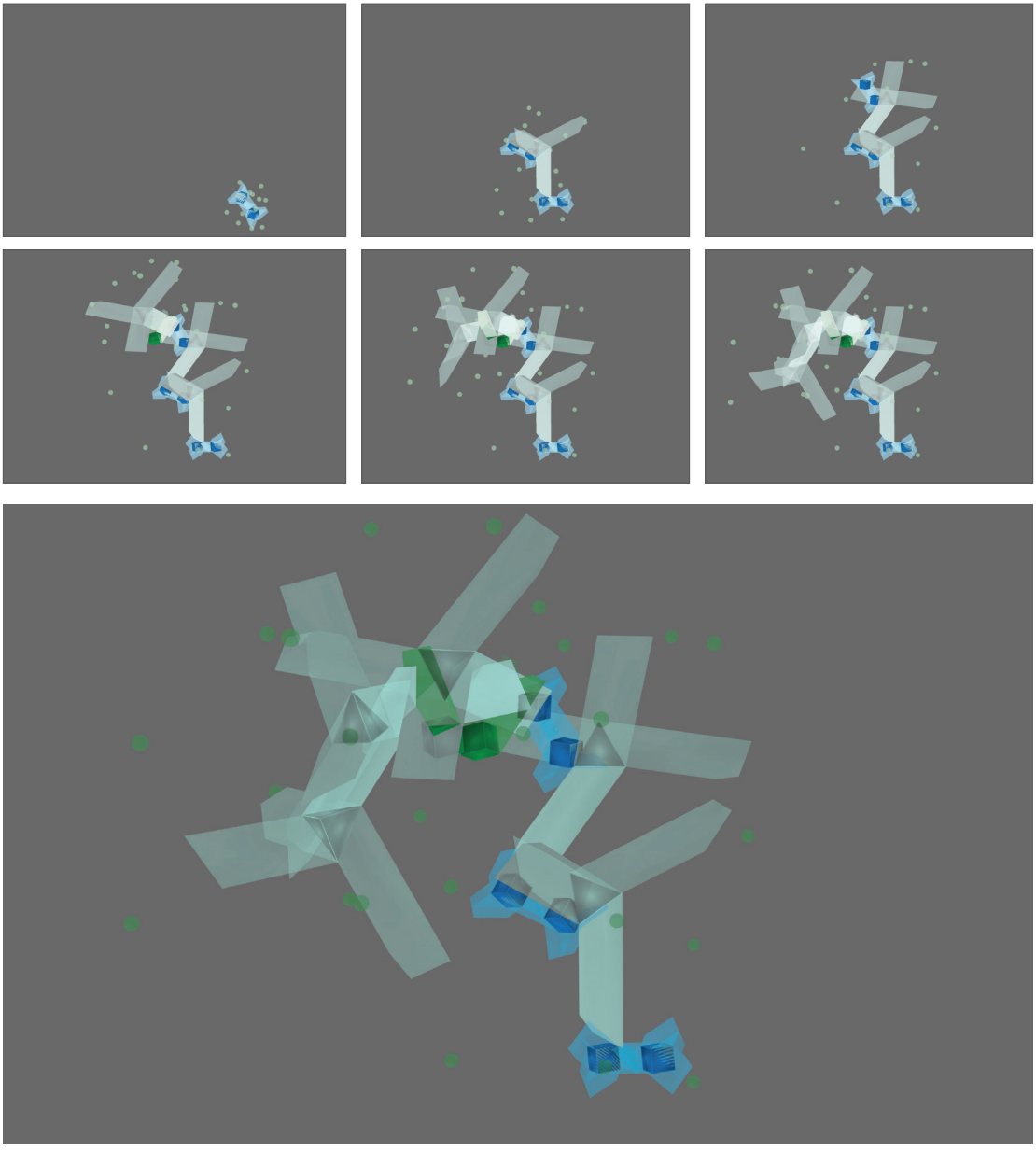
calcium
oxide(CaO)

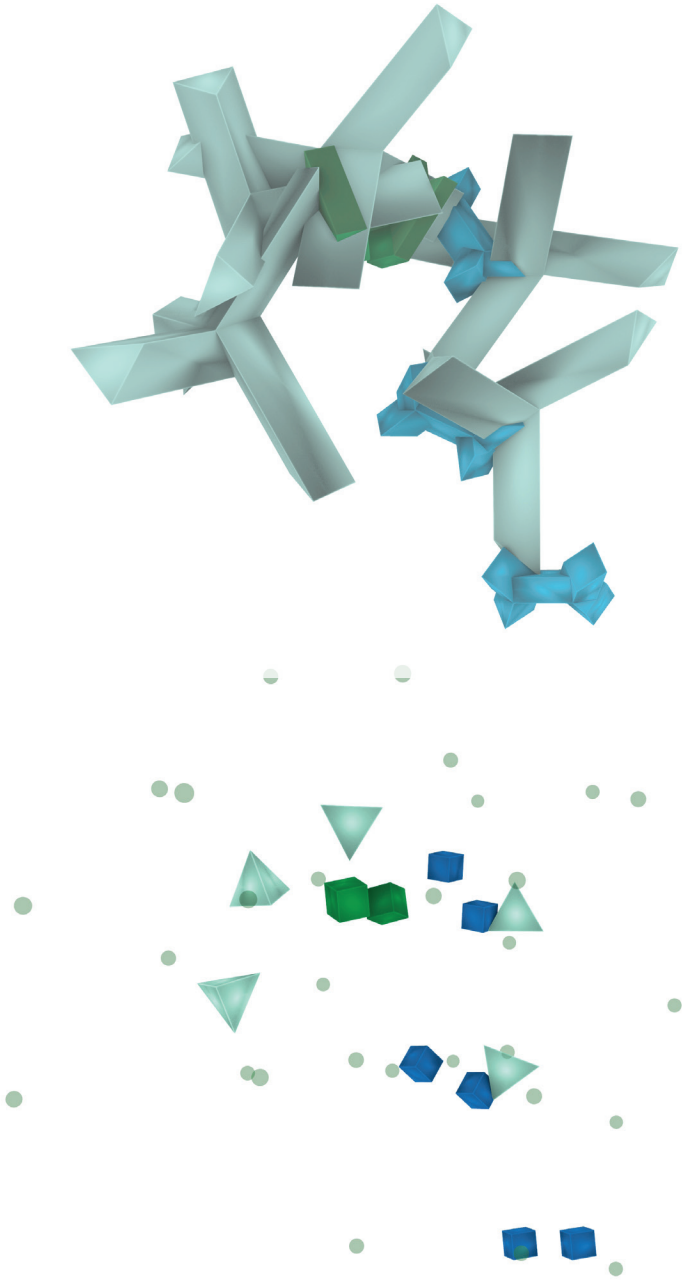


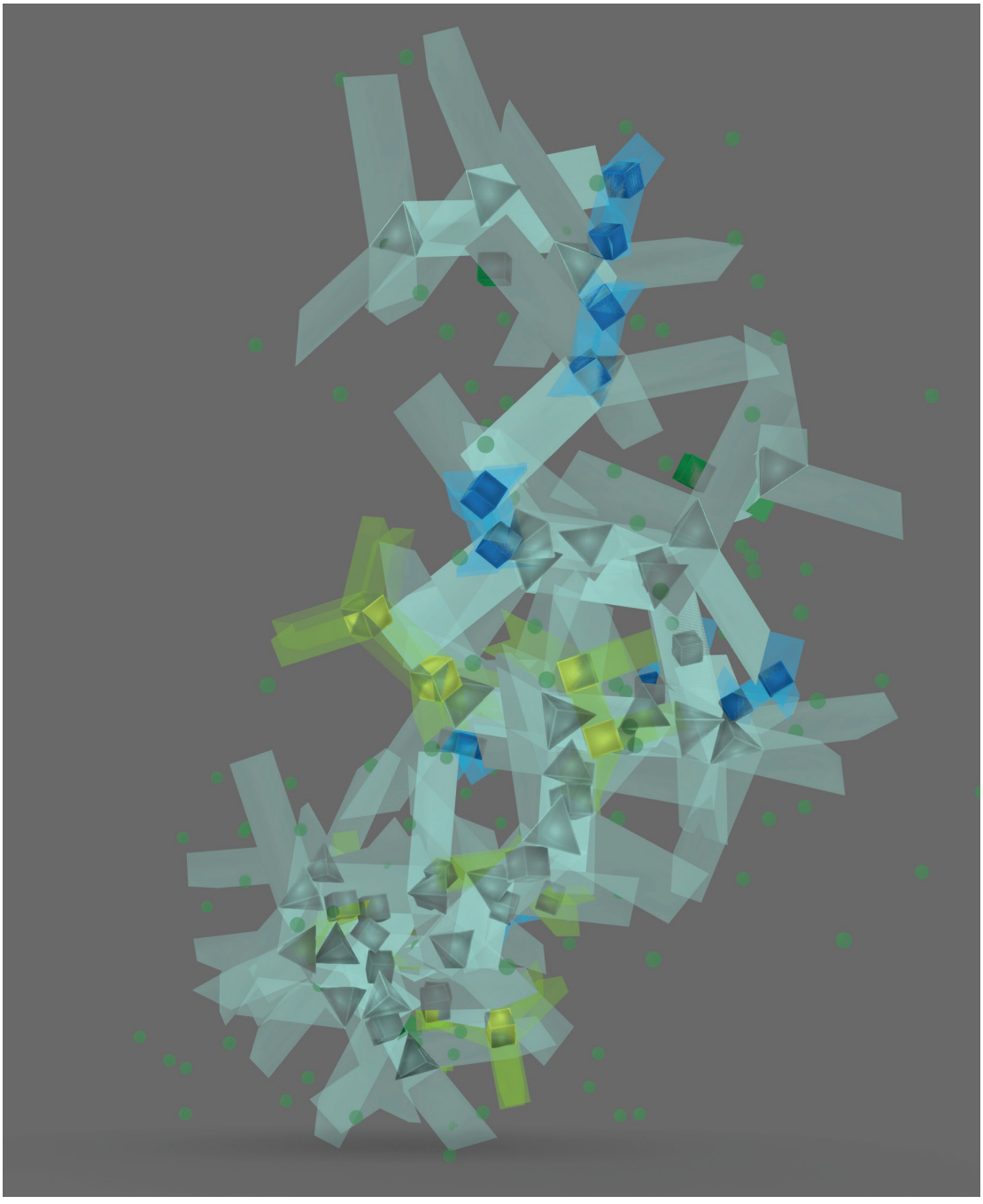




set_10







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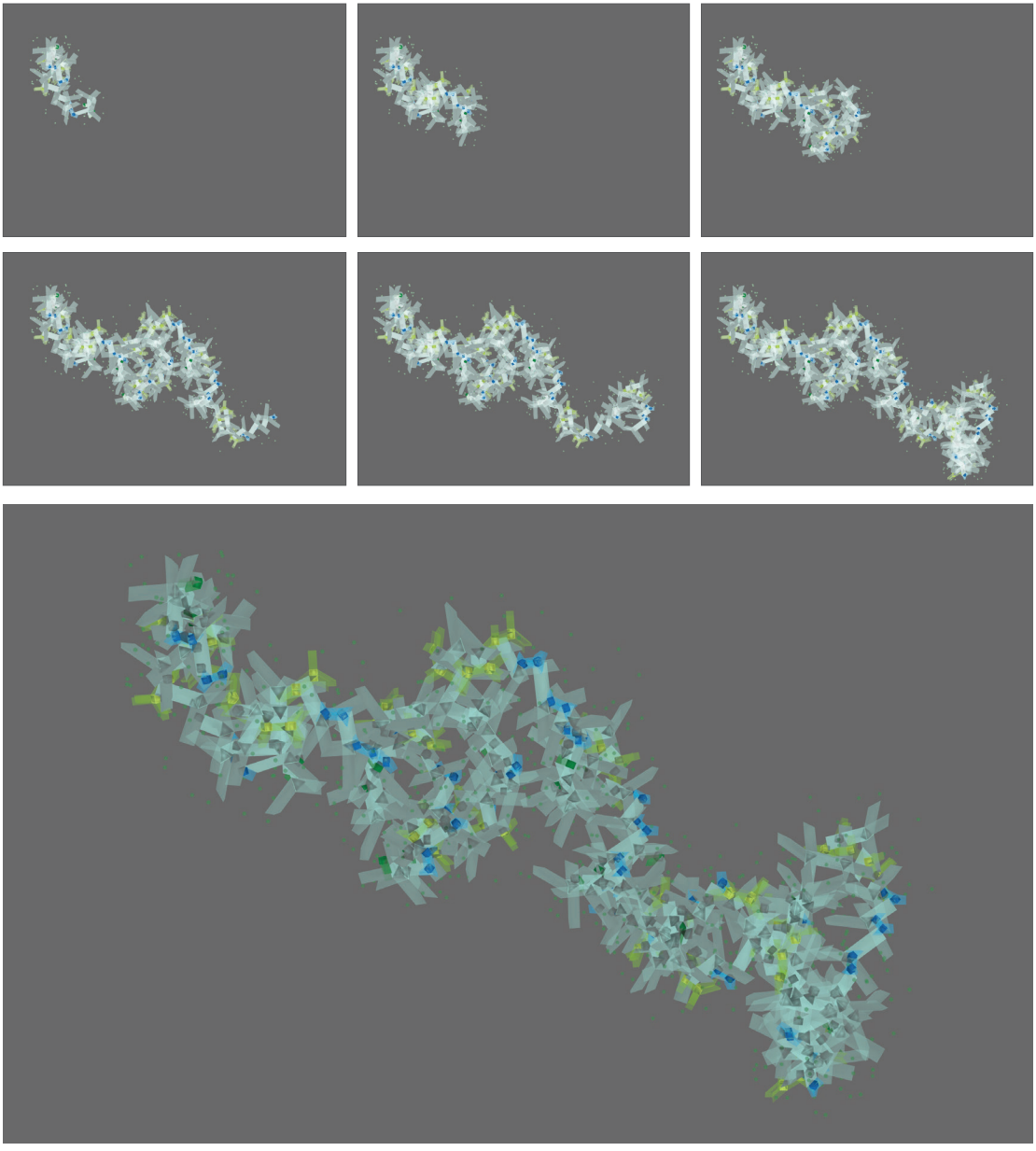
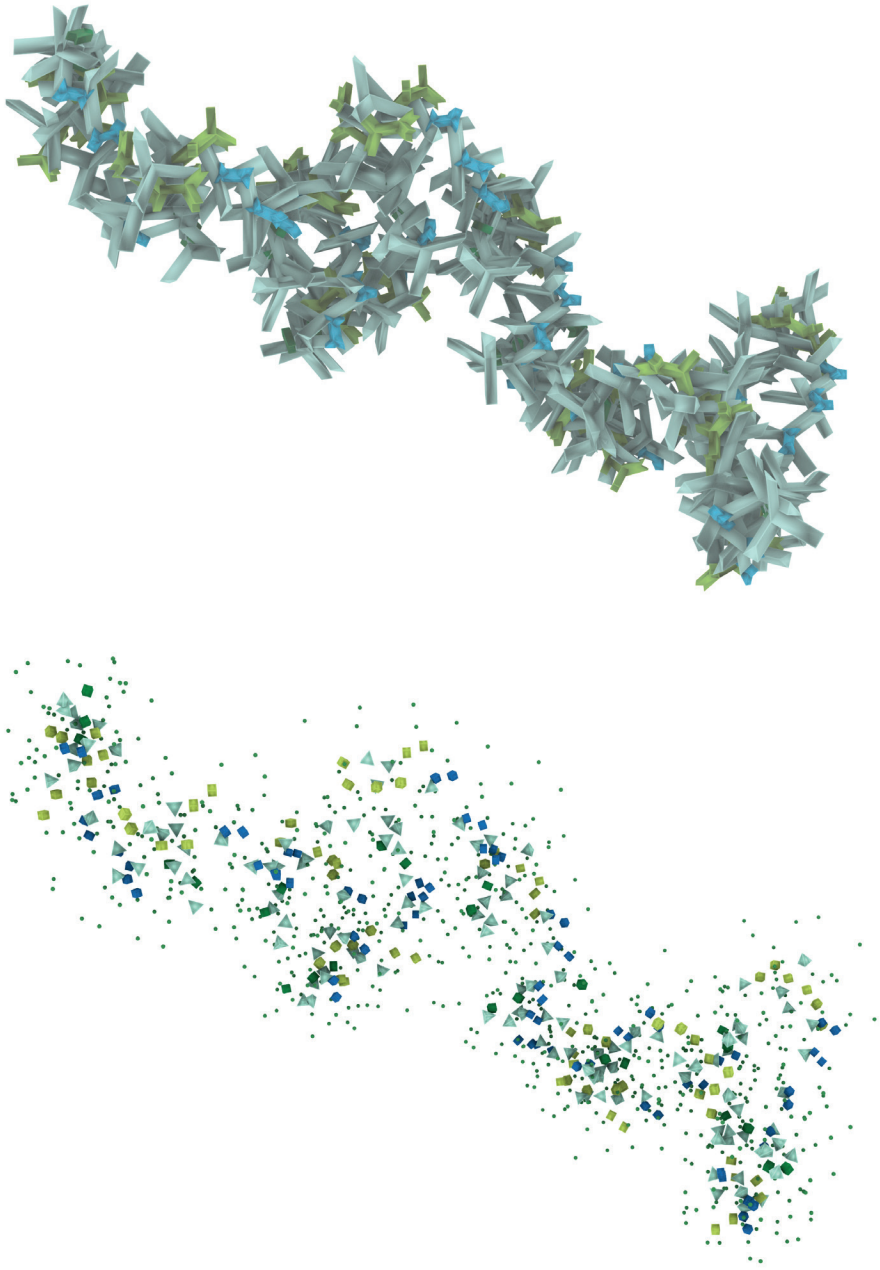
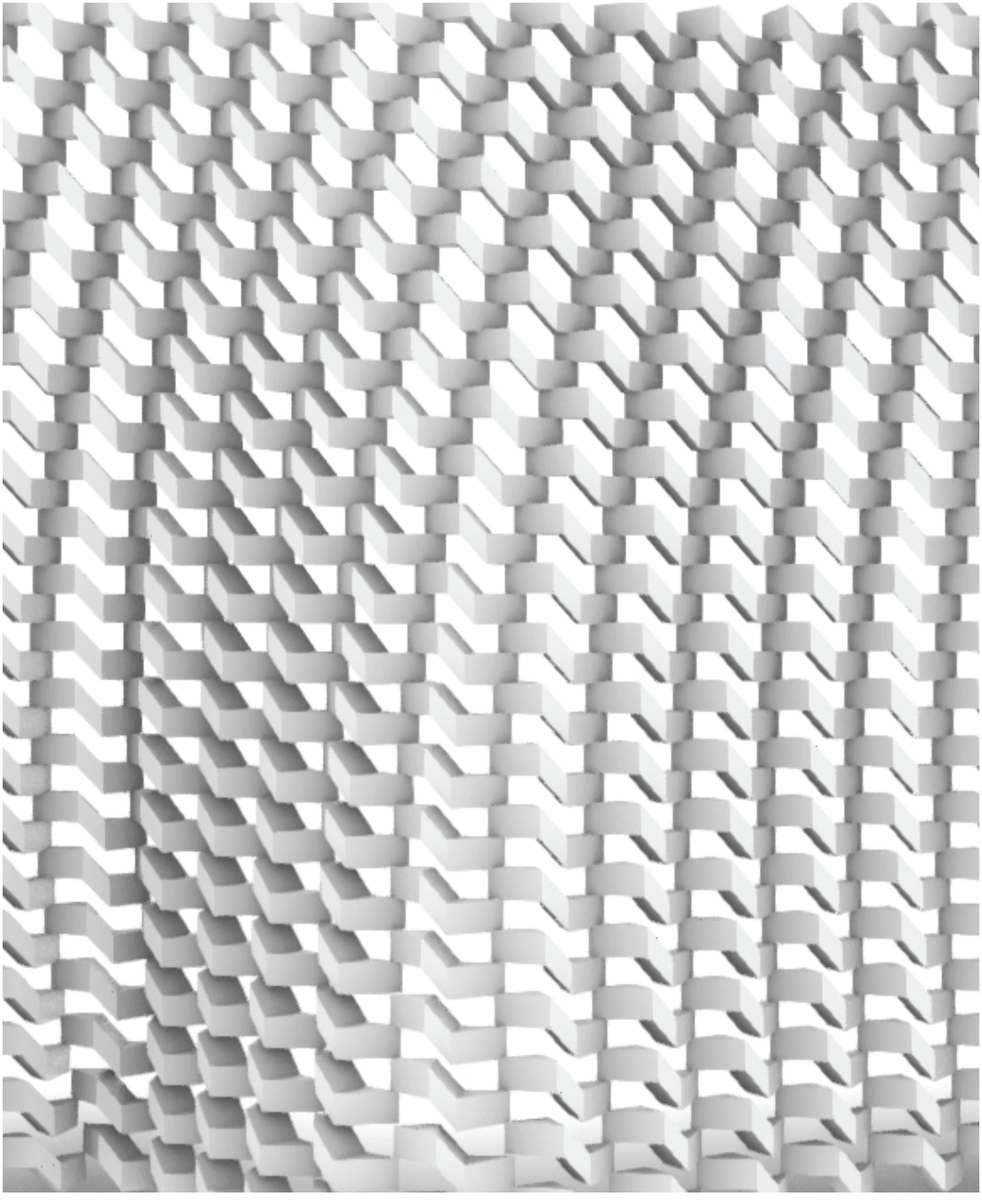






Clay: Imagining a Zvilna Brick

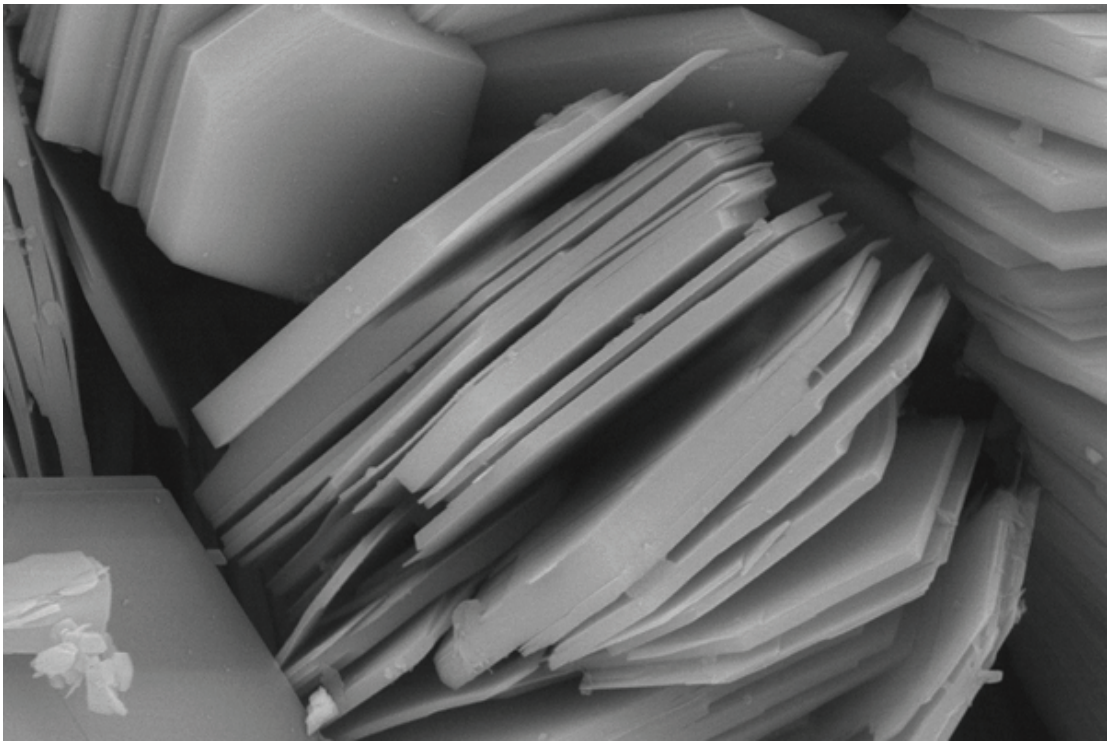
Bianca Weeko Martin

I wanted to explore how the original Zvilna block and Zvilna block array could communicate the quality of flexibility, a key characteristic that clay retains even when bent out of shape. I stacked Zvilna blocks in the path of two lofted, parametric curves. The result bears resemblence to a brick wall and suggests possibilities for facade treatments inspired by the Zvilna block module. Throughout this process, I used Grasshopper binaries to rapidly achieve distinct explorations into array patterns.

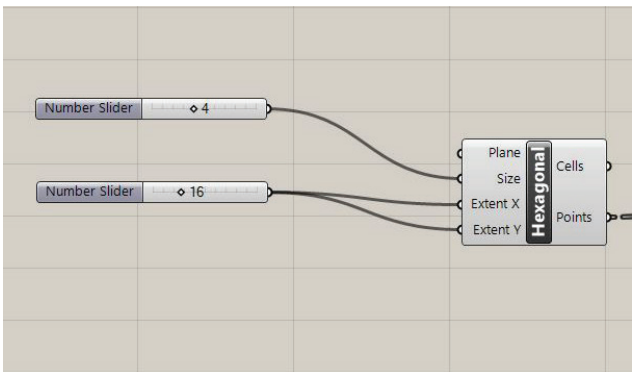
Additionally, I wanted to study the suggested "quality" or "character" of the individual Zvilna block - for example, the difference in appearance of the block standing vertically upright with the triangular arm facing up versus laying flat.

facing

Zvilna 'bricks', overlapping and stacked, inspired by the composition of Montmorillonite clay



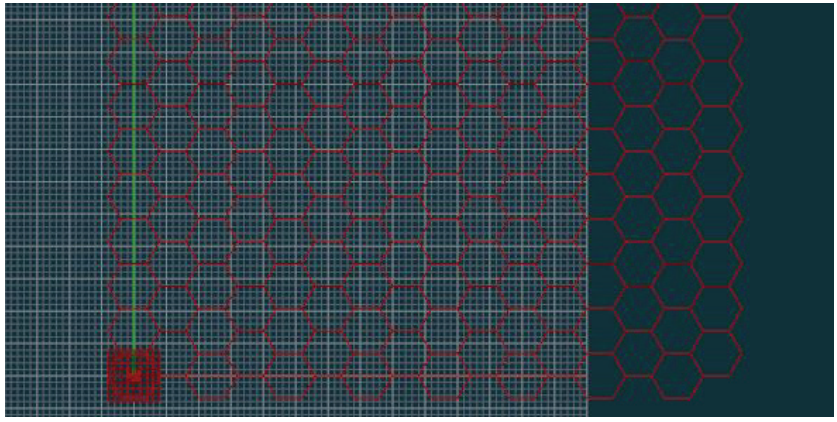
Close up of kaolinite in Jurassic sandstone, UK North Sea, clay type confirmed by X-ray diffraction. Width of image: 20 microns across (50 images side by side would measure 1mm).

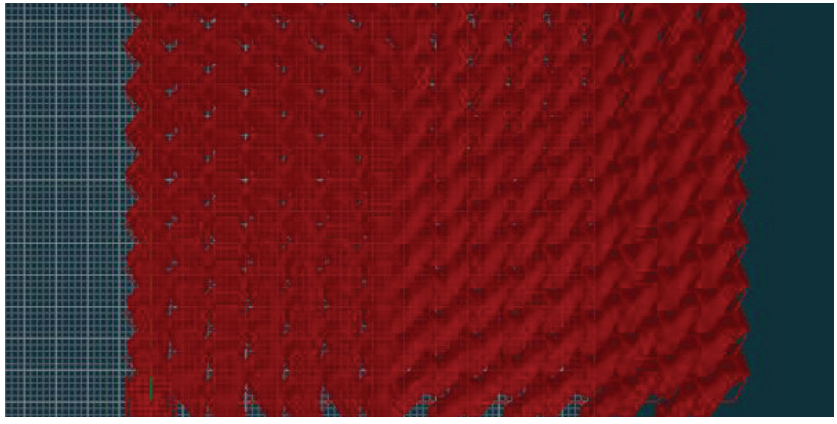


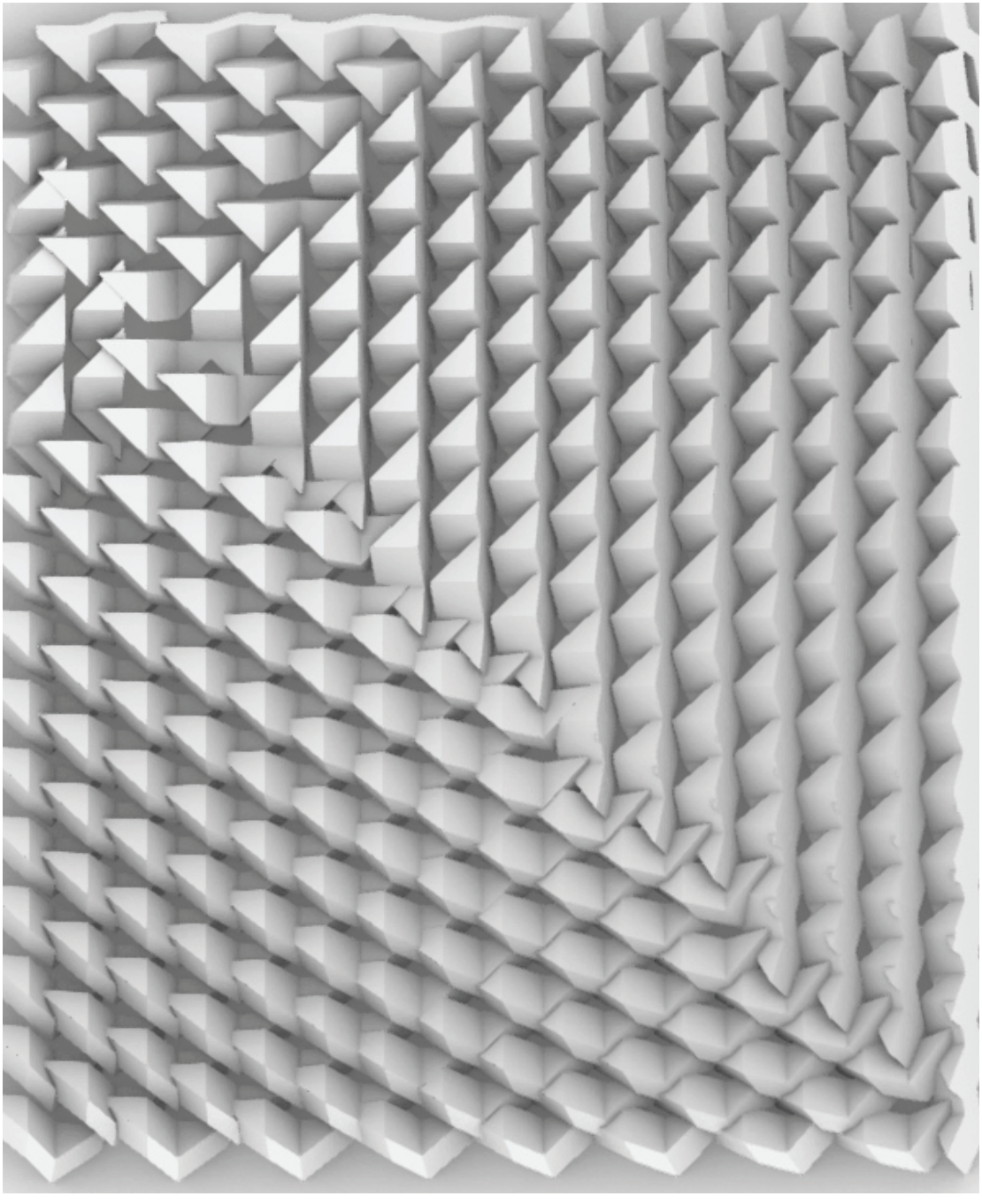
clay as inspiration

Finkelburg, Dave. “Techno File: Geography Matters,” Ceramics Monthly, (August 2018).

“Clay is composed of flat, almost hexagonal plates with water in between.“

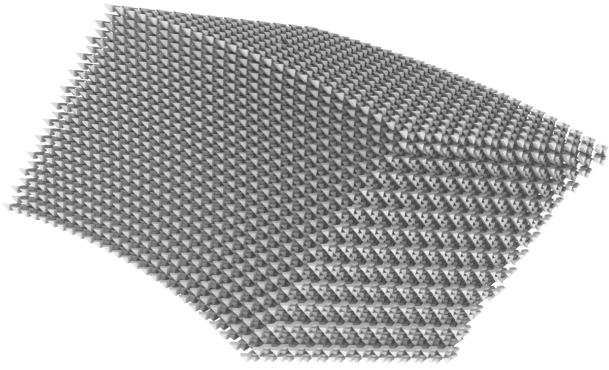


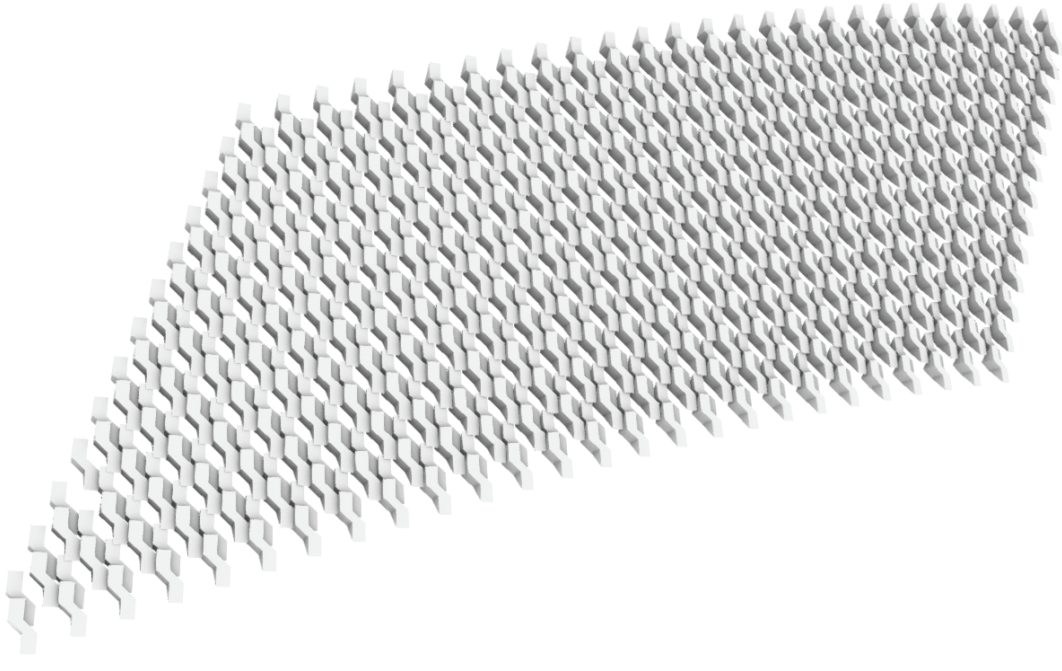


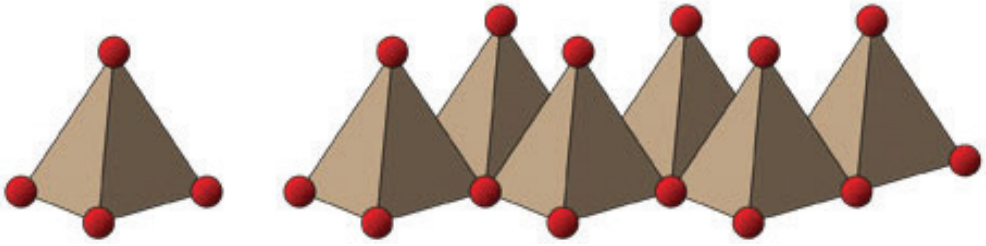


facing

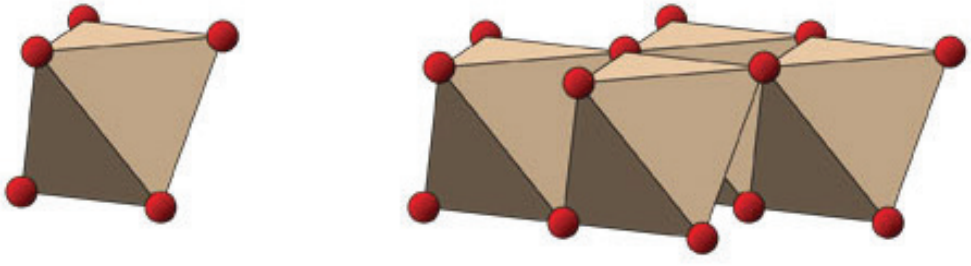
Initial array of zvilna blocks using a “point attractor” system to orient each block on a hexagonal grid system



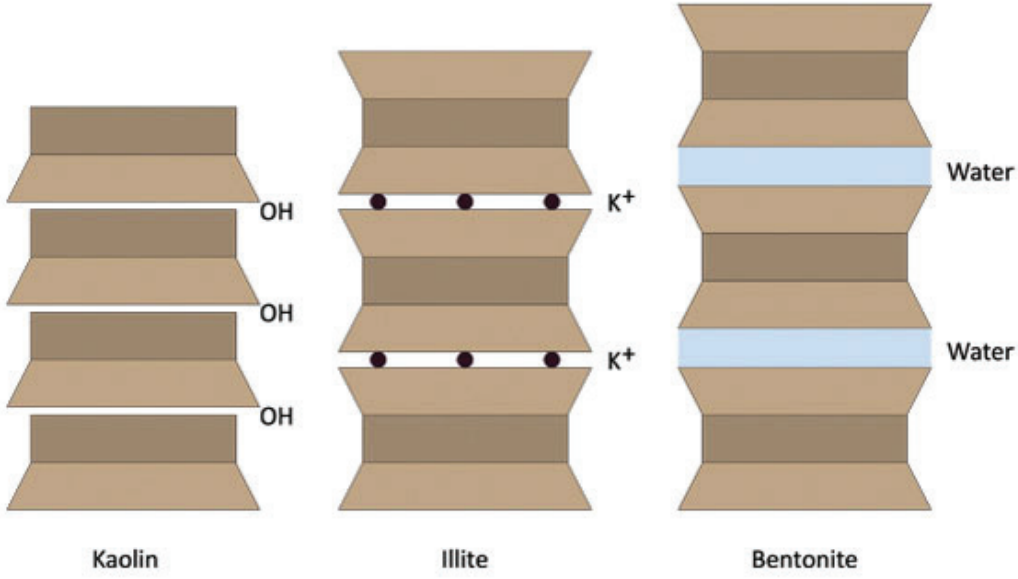




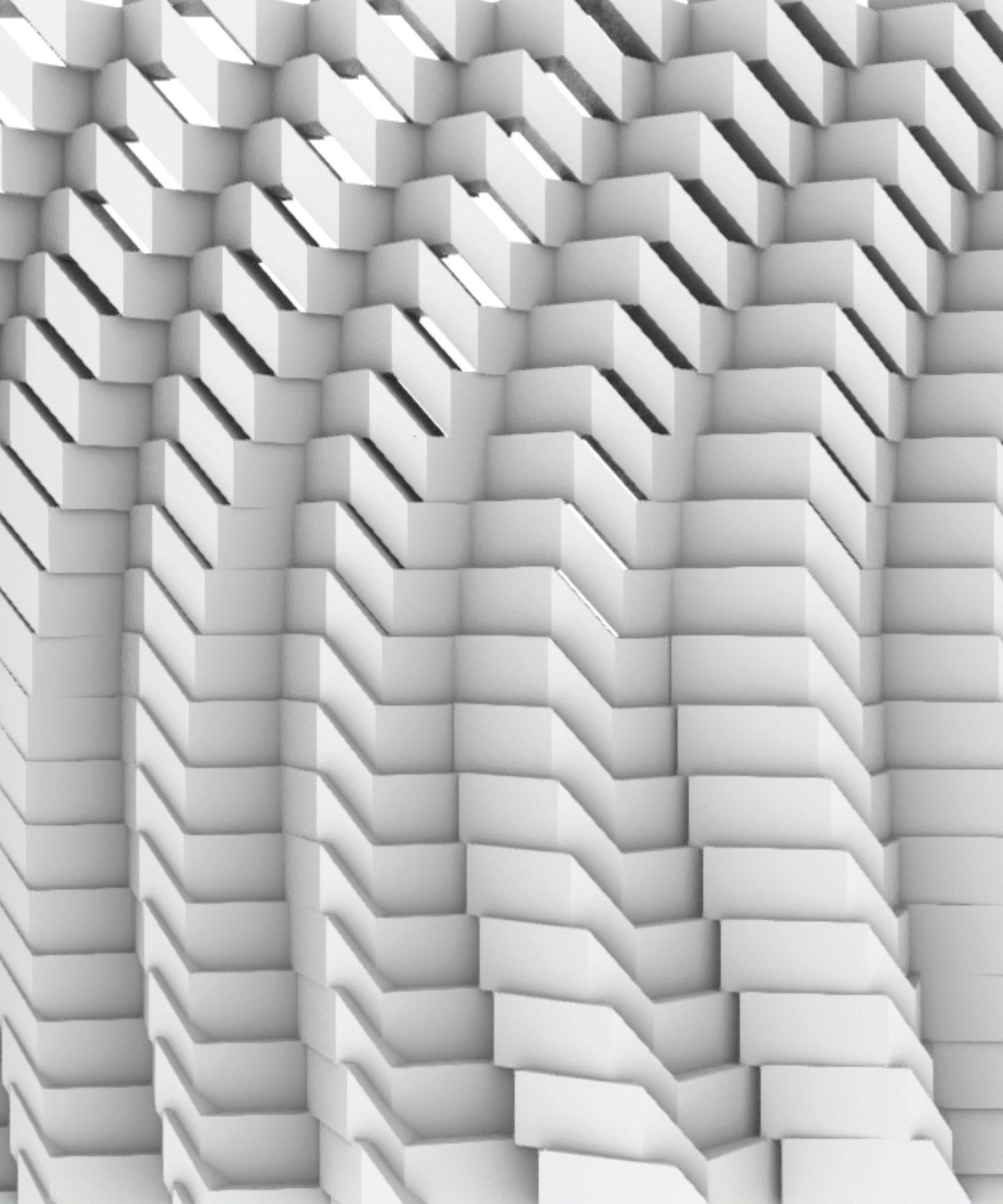
Silica tetrahedra



Alumina octahedra. The red atoms at the corners are oxygen. The silicon atoms are in the centers of the tetrahedra and the aluminium atoms are at the centers of the octahedra. In clay, these build up in alternating layers in a sheet structure.

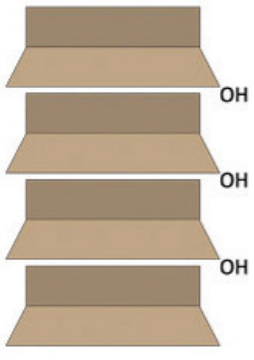


The structures of the three main types of clay; kaolin, illite, and bentonite. The darker rectangular layers represent sheets of alumina octahedra and the layers with triangular ends represent sheets of silica tetrahedra. Kaolin has repeating alumina and silica layers bonded together with weak hydroxyl OH– bonds. Illite has three layers bonded strongly with potassium (K+) ions, while bentonite is similar but the layers are less strongly bonded and can swell by taking in water between each layer.

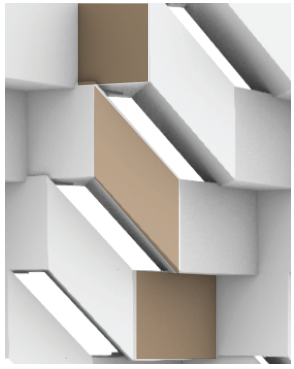


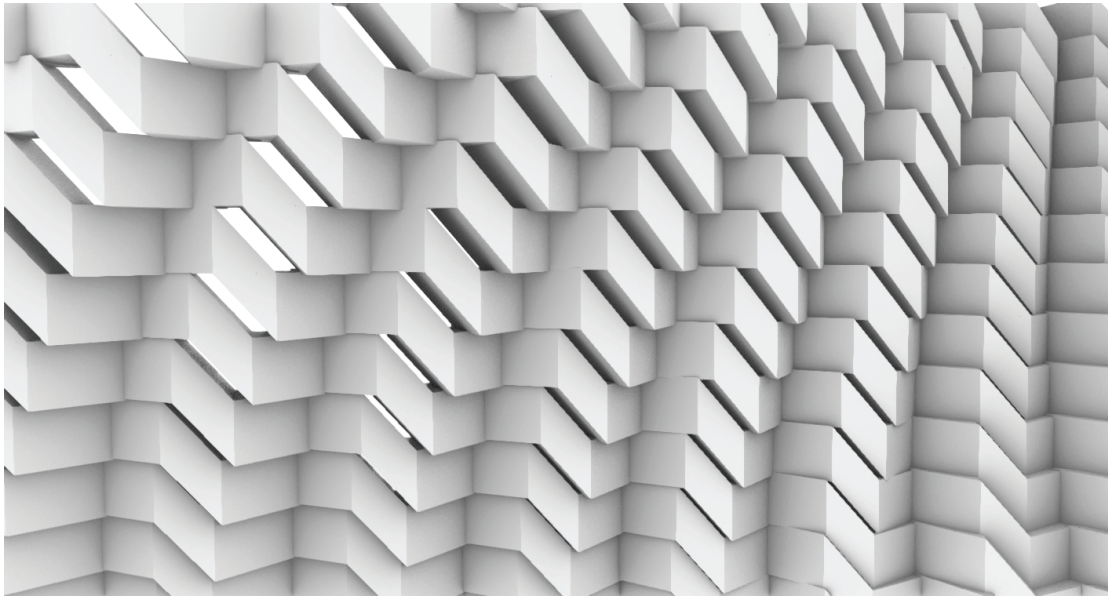
The first transformation applied to the Zvilna block was to stack, one on top of the other.

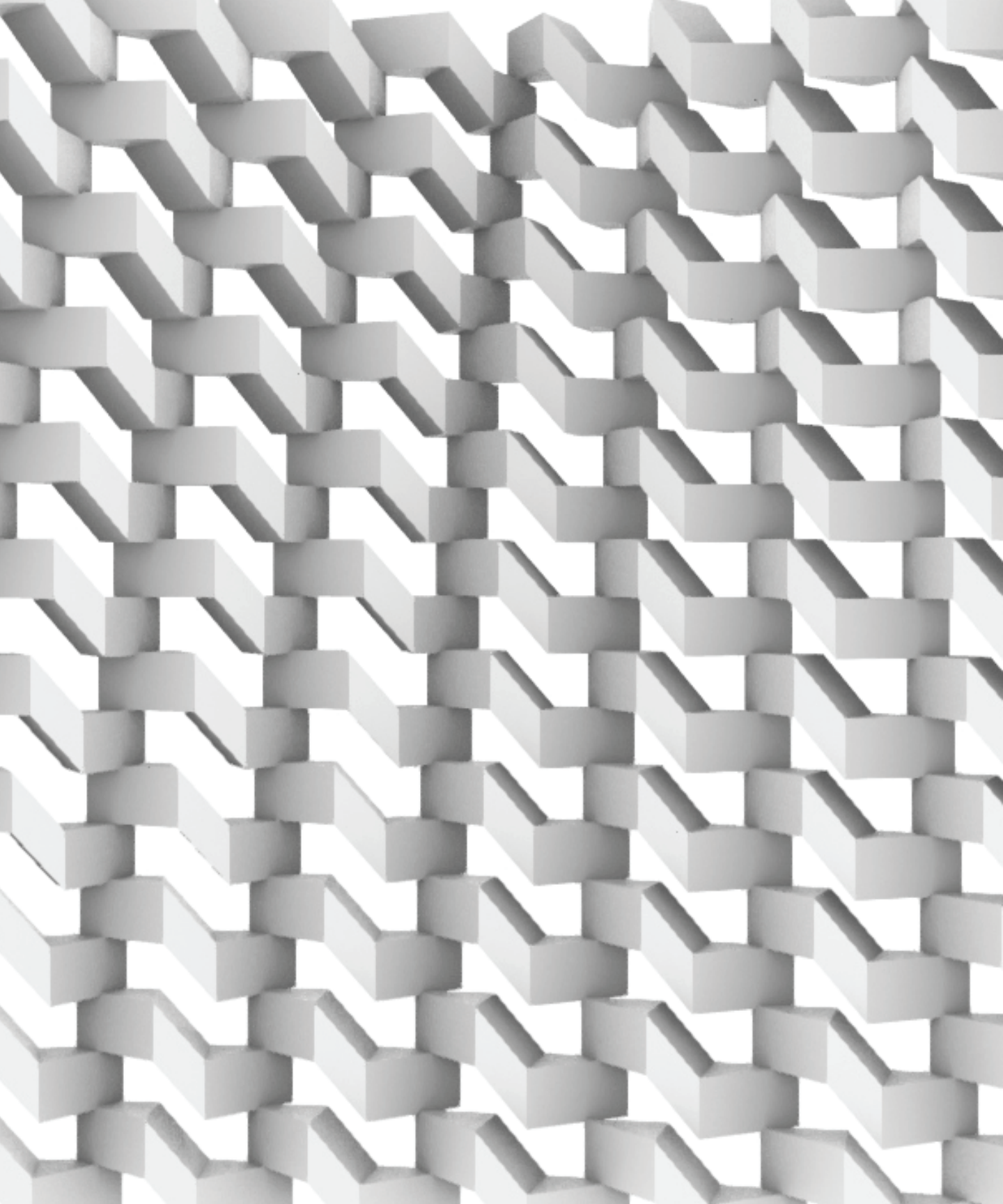
Because I specified the profile of the wall to be a loft between two parametric curves, each Zvilna block rotates slightly as it stacks on top of the one below, eventually forming the contour curve of the wall.



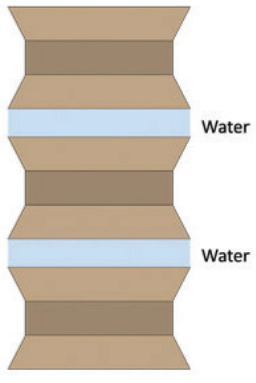
Kaolin

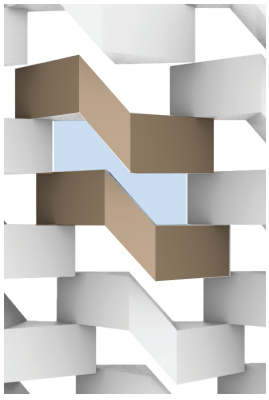


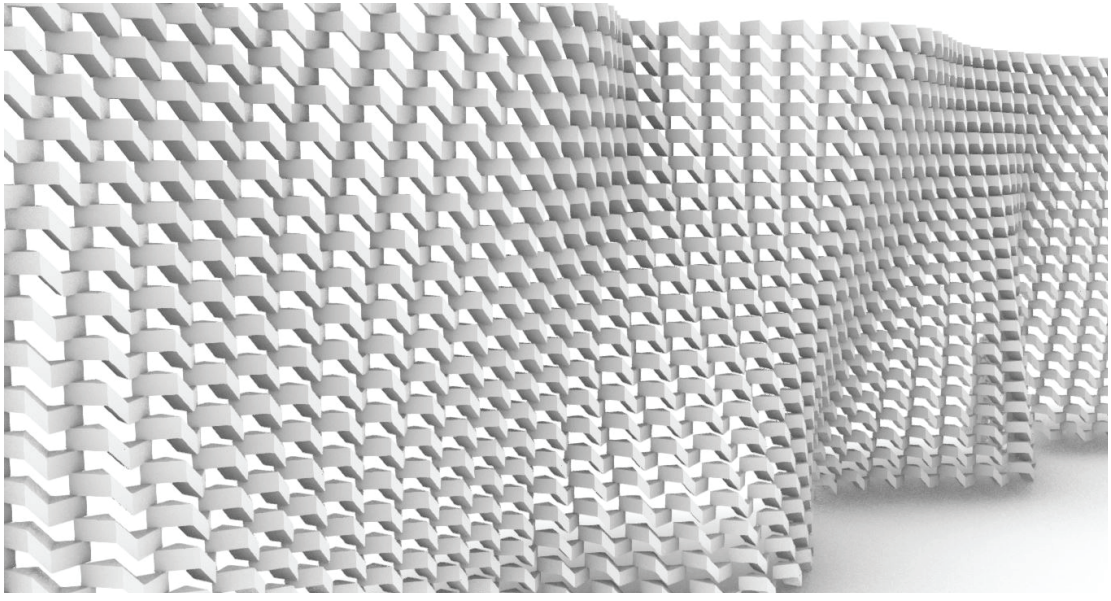


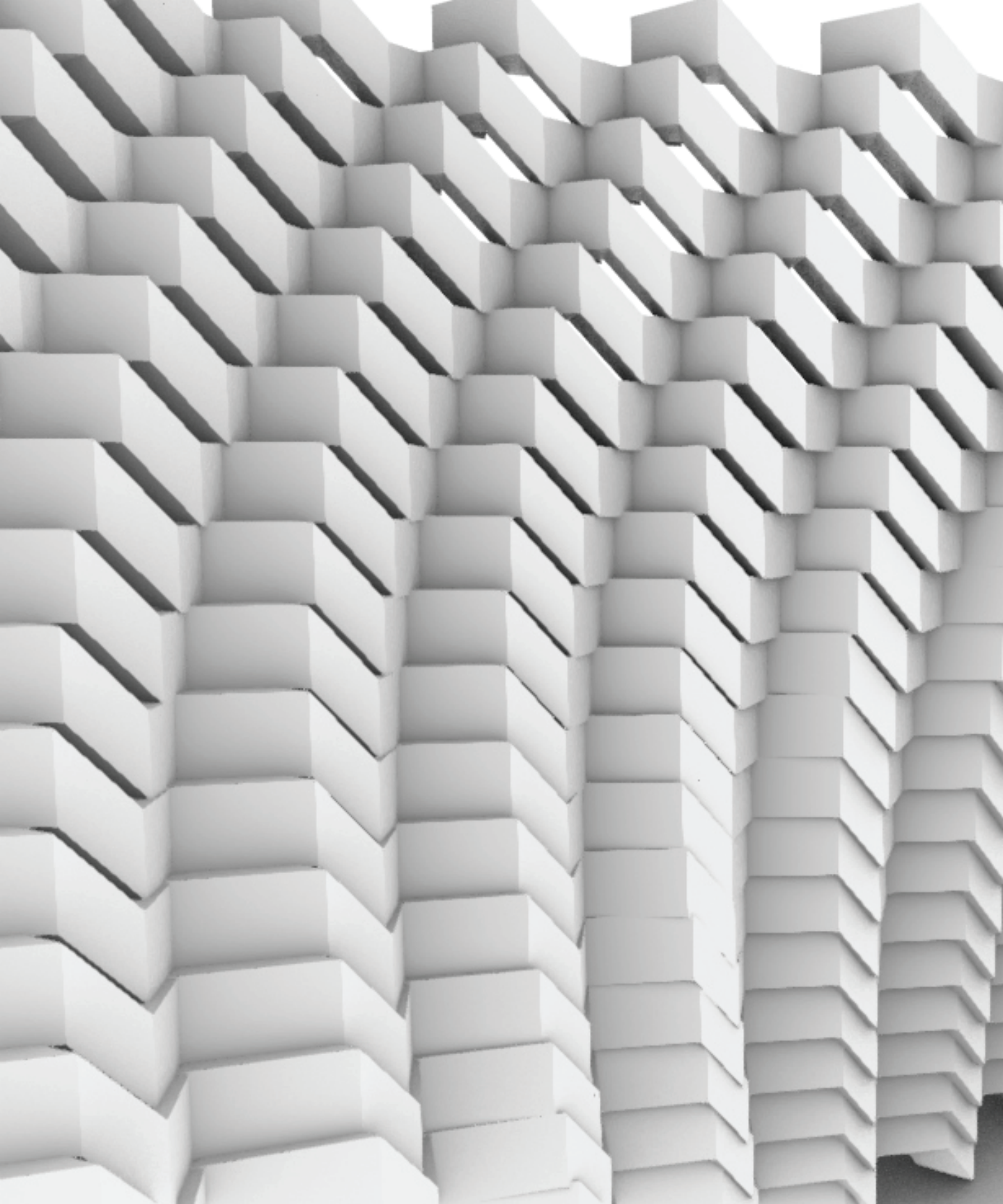


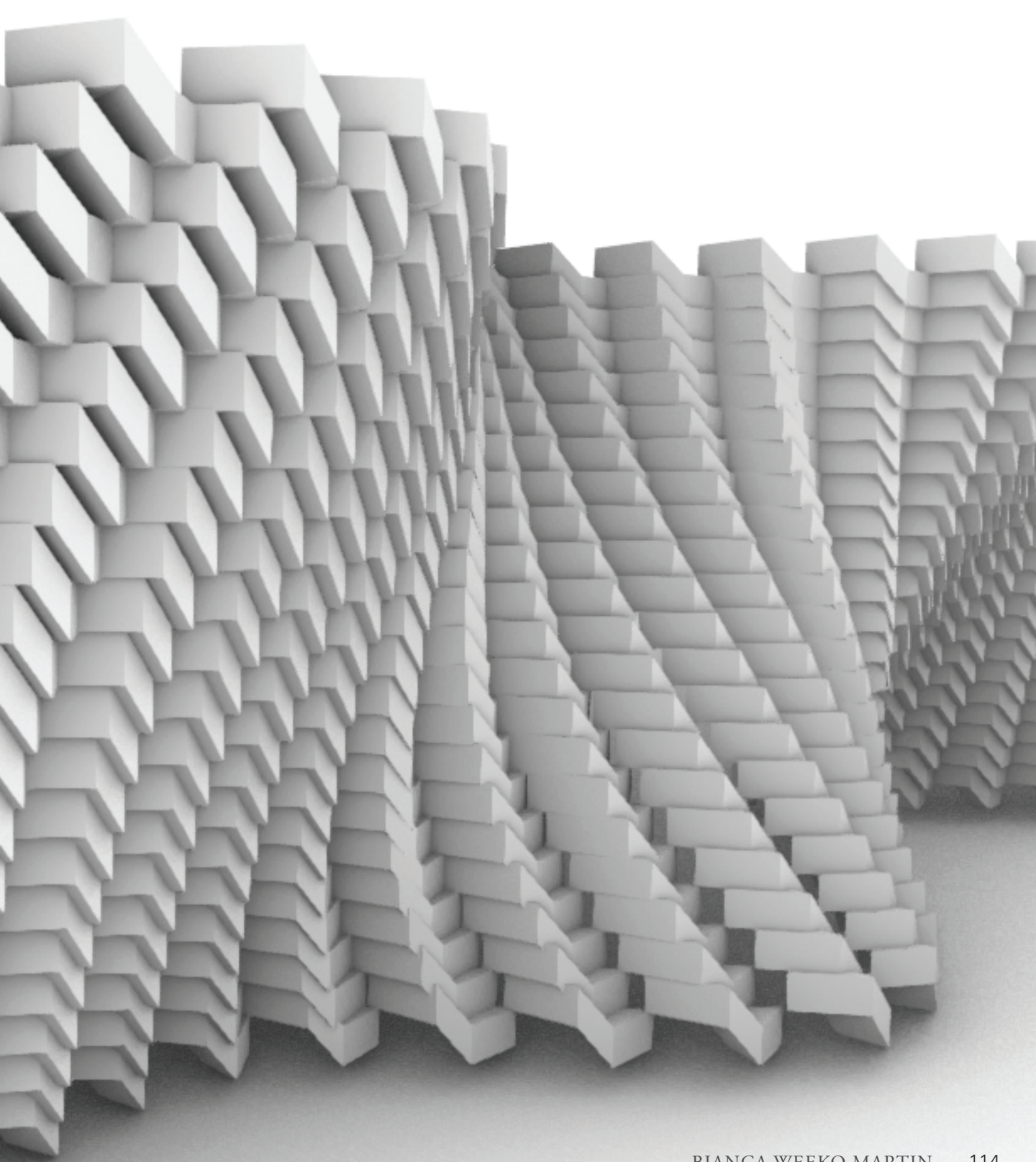
For the second iteration of my array I used the "move" operation, similar to the way in which the repeating layers of alumina octahedra and silica tetrahedra are separated by a layer of water in bentonite clay. In my array I imagine the spaces in between to be like the spaces filled with water. Like the bentonite, this resulting array seems more weakly bonded together.

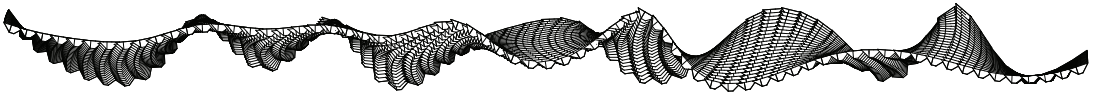












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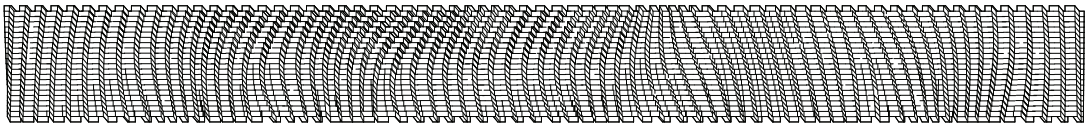
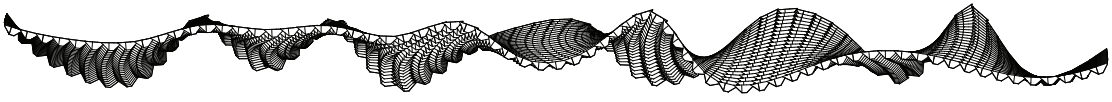


2

1 Kaolin, plan view
2 Kaolin, front elevation
3 Bentonite, plan view
4 Bentonite, front elevation



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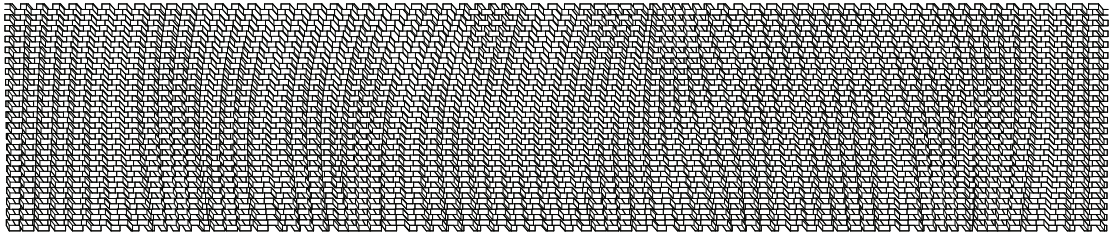

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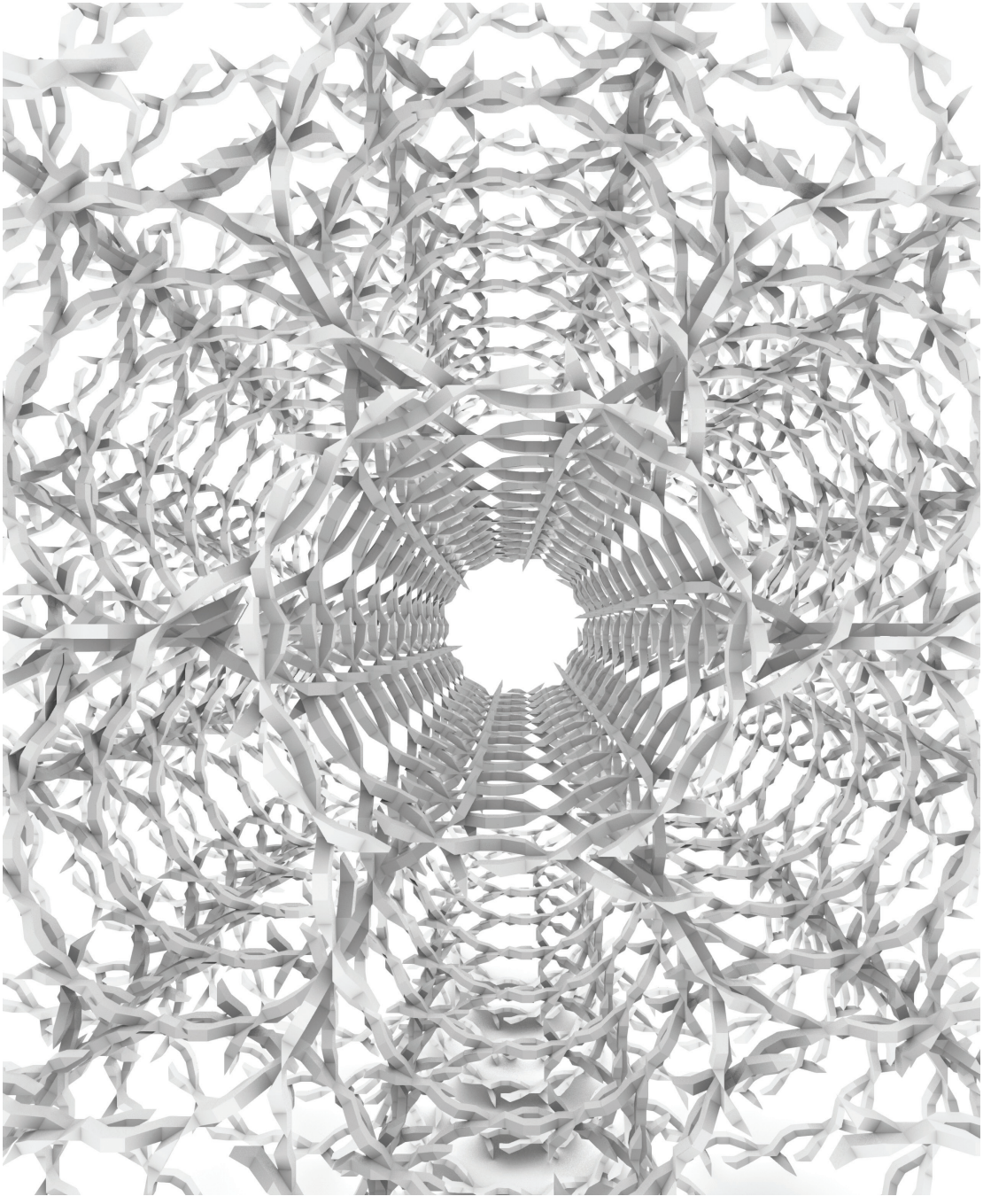


Honeycomb Experiments
Roni Haravon

I experimented with an aggregation process by using the main Zvilna form from the previous chapter. The new module consists of eight Zvilna forms which are connected to each at the edges. The module has four arms and it makes its face to face connection at its 30˚ angled surface.

It continuously grows as a sine graph in the Z Axis. One loop occurs from the aggregation of twelve modules and creates twelve arms to sprawl. It can reproduce itelf six times around the base cell with intersecting modules - like the cells of an honeycomb.

facing

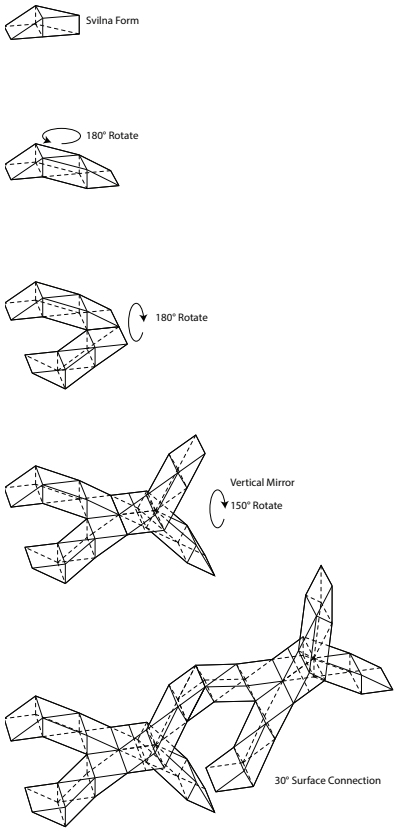
Digital rendering of multiple layers of honeycomb rings

aggregation process

"The most famous of all hexagonal conformations, and one of the most beautiful, is the bee's cell. n this case we have two layers of such cylinders or prisms, one facing one way and one the other, and a new problem arises in connection with their inner ends. We may suppose the original cylinders to have spherical ends, which is their normal and symmetrical way of terminating; then, for closest packing, it is obvious that the end of any one cylinder in the one layer will touch, and fit in between, the ends of three cylinders in the other... Just as it was obvious, then, that by mutual pressure from the sides of six adjacent cells any one cell would be squeezed into a hexagonal prism, and fit in between, the ends of three cylinders in the other..."[1]

Each ring consists of twelve modules and it creates twelve arms for growth. Second layer of rings connect to every other arm and six adjacent rings wrap around the base ring. Each ring is a base cell for six rings.

1 Thompson, D'Arcy, "On Growth and Form." (1917; Cambridge University Press 1942 Edition), p. 525.

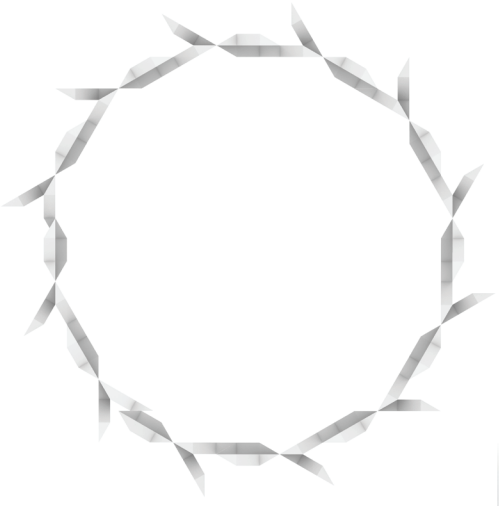


facing

1 Base ring, front view

2 Base ring, perspective

3 Base ring, side view



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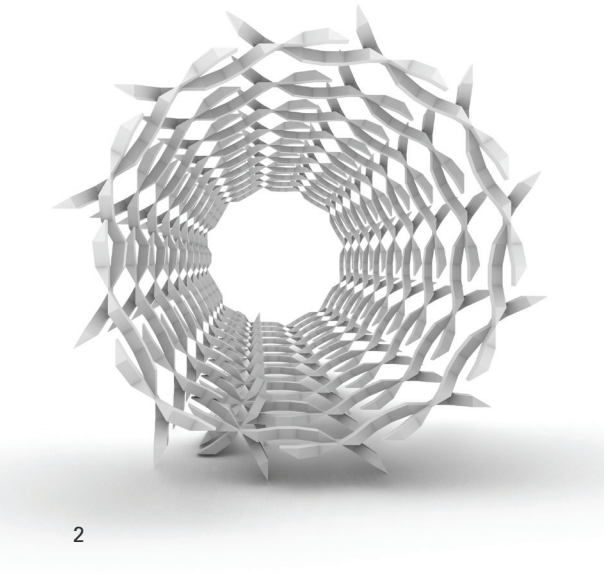

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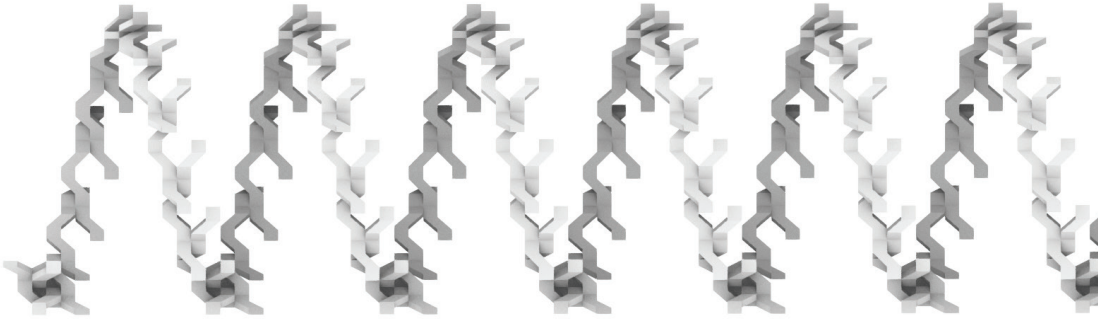

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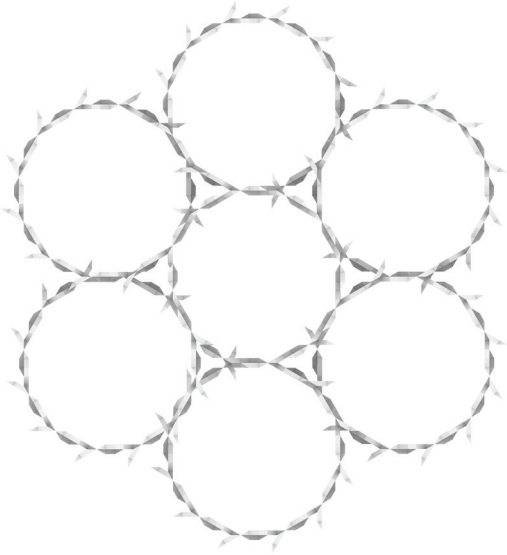

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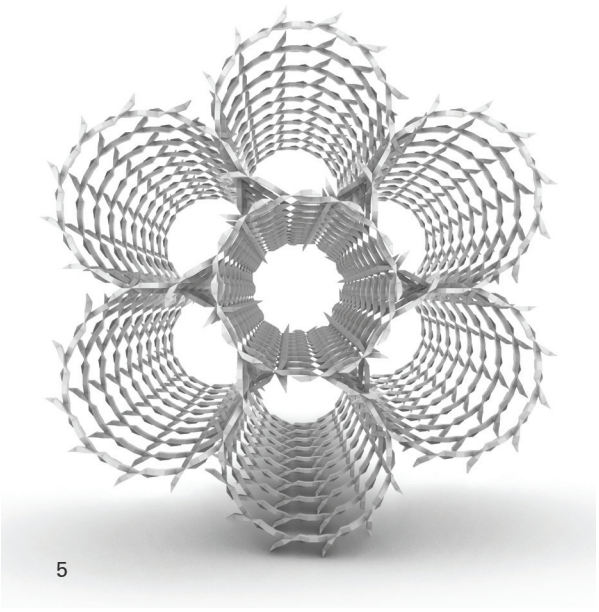

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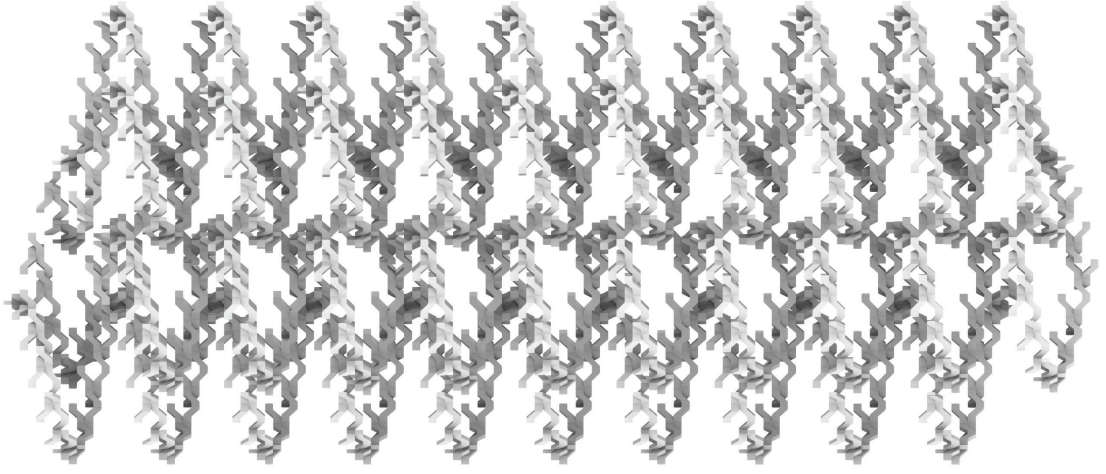

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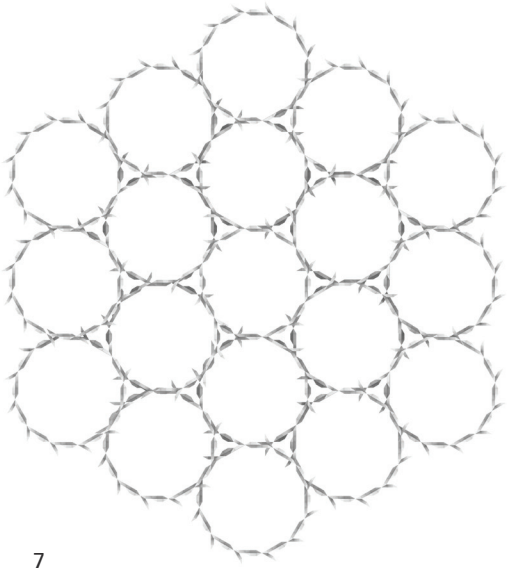

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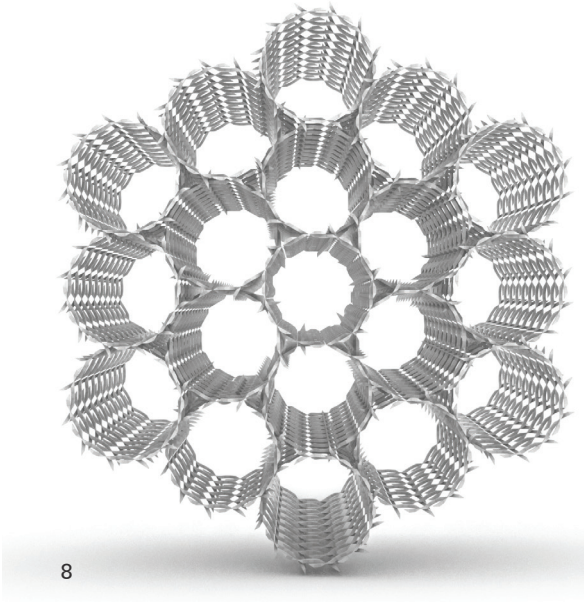


8

facing

4 Two layers of rings, front view

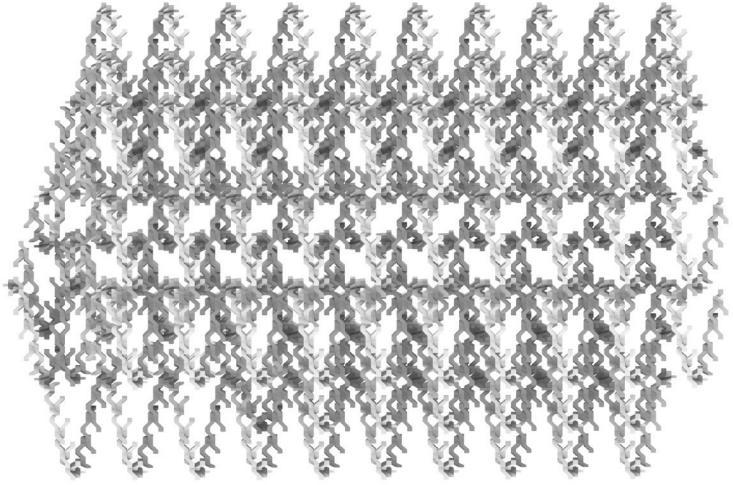
5 Two layers of rings, perspective

6 Two layers of rings, side view

7 Three layers of rings, front view

8 Three layers of rings, perspective

9 Three layers of rings, side view



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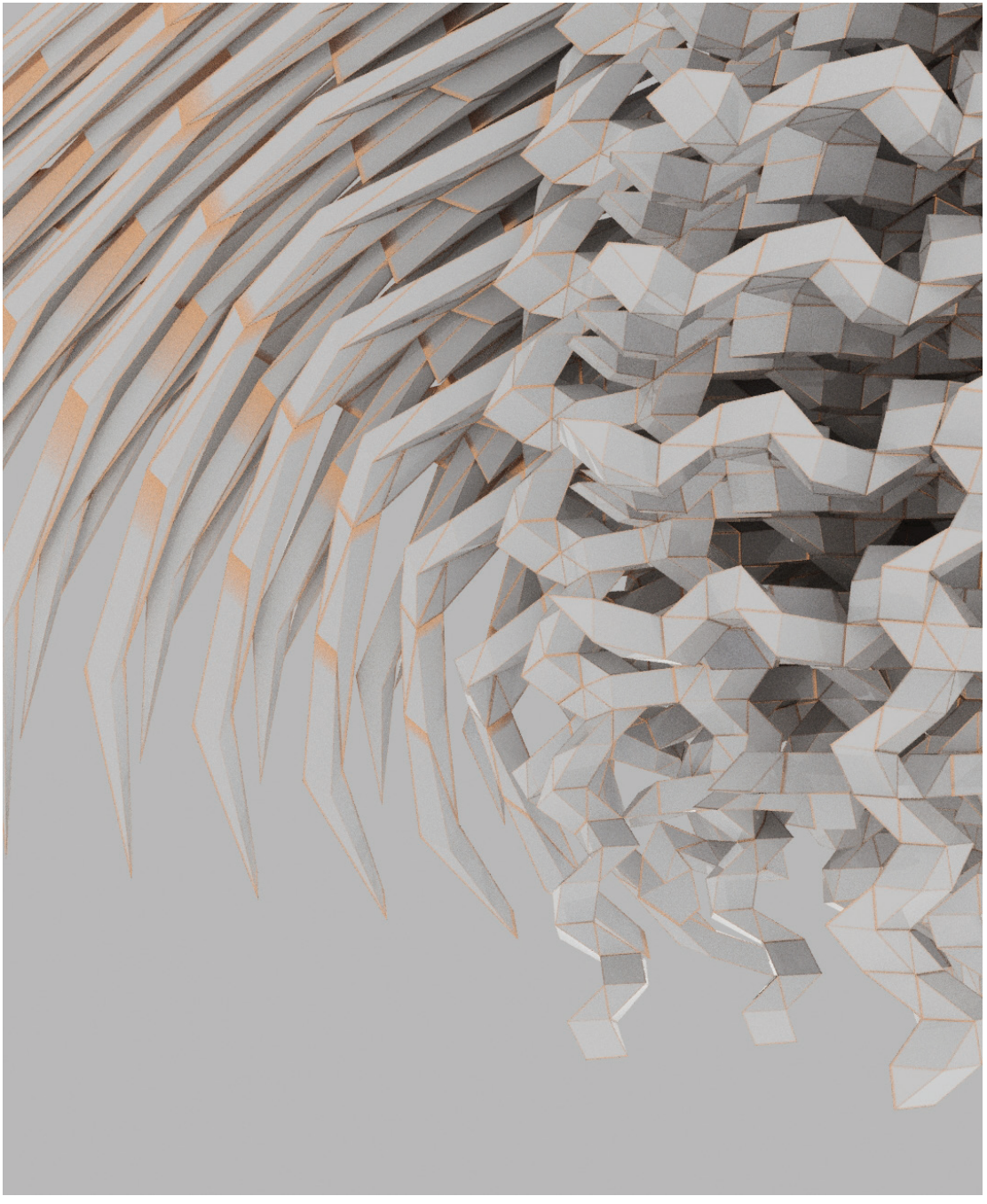


Cloning Zvilna Blocks
Ien Boodan

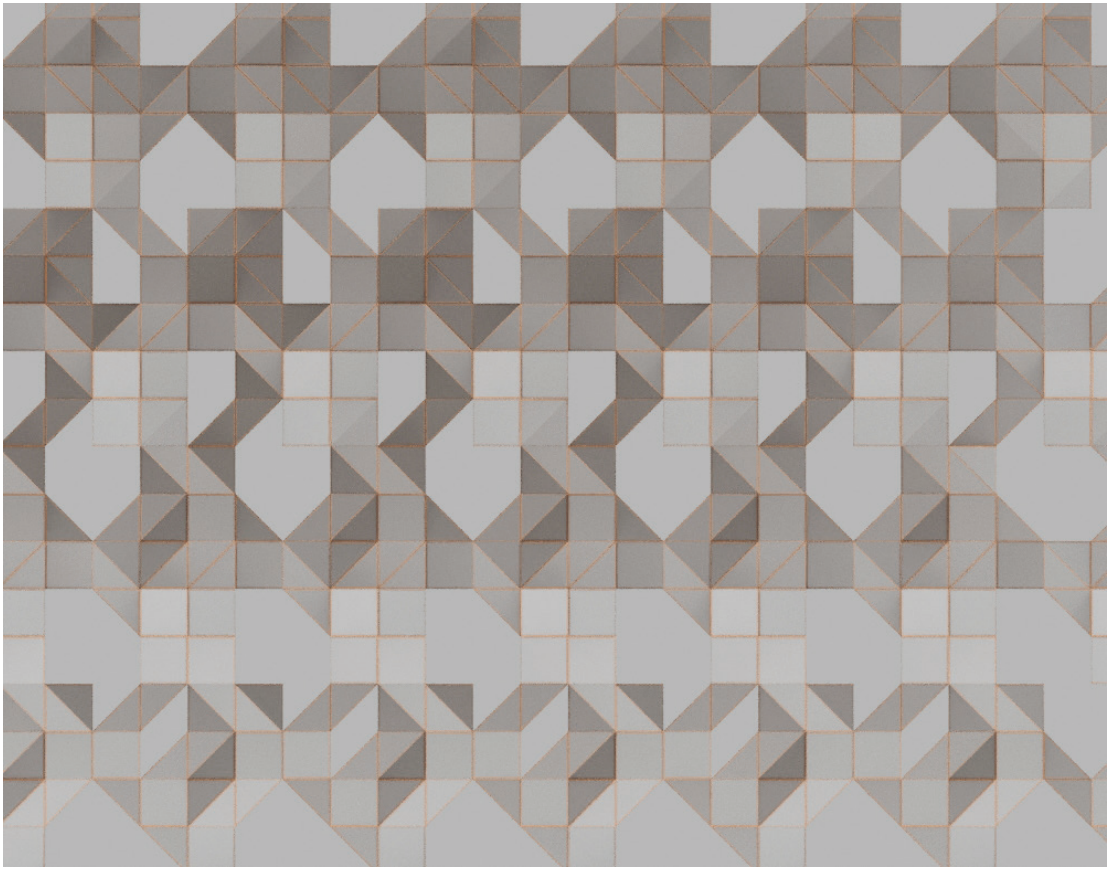
These exercises are the result of a blind exploration using Zvilna blocks and 3DS Max. A lightweight plug-in called "Clone" allows for a translation to be defined and repeated, and then stacked/compounded with another Clone definition, to create complex arrays. Displacement and Rotation were the only parameters used, in whole number and half-integer values, rotations in multiples of 45 degrees about some axis.

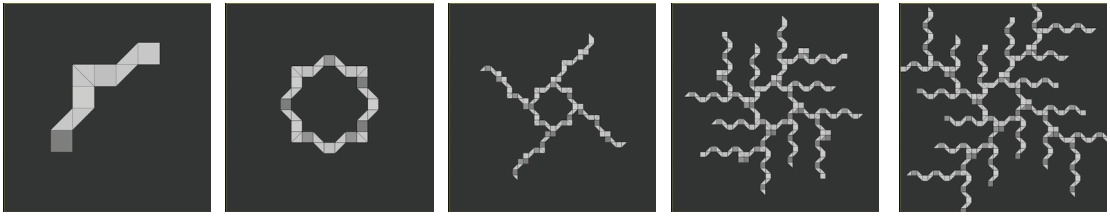
facing

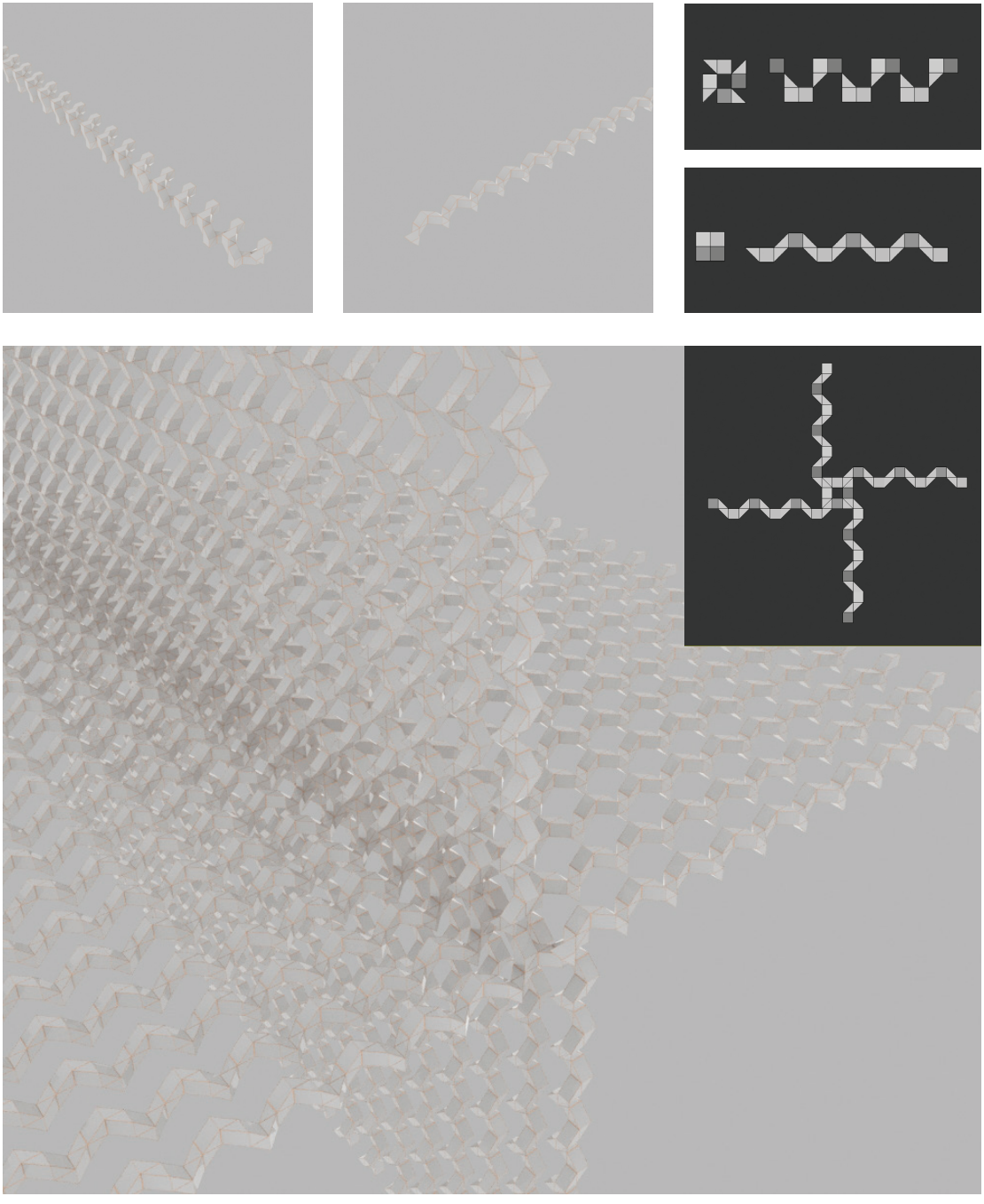
Digital rendering of growth and variation exploration

experiment 1: snowflake (form follows process)

This experiment makes reference to the fractal nature of snowflakes. Here, an eight-sided core is used in lieu of water's regular hexagonal base-geometry.

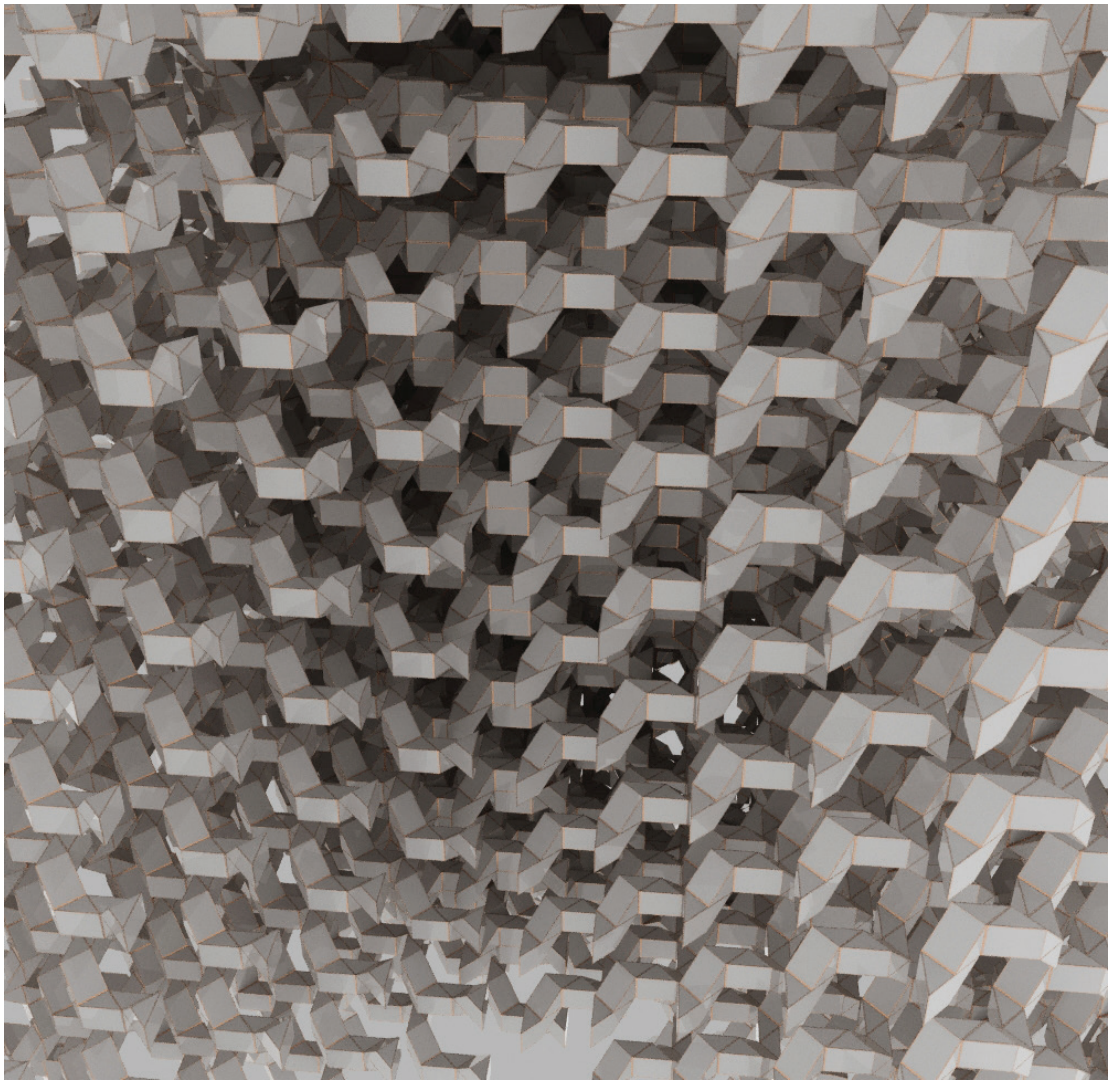


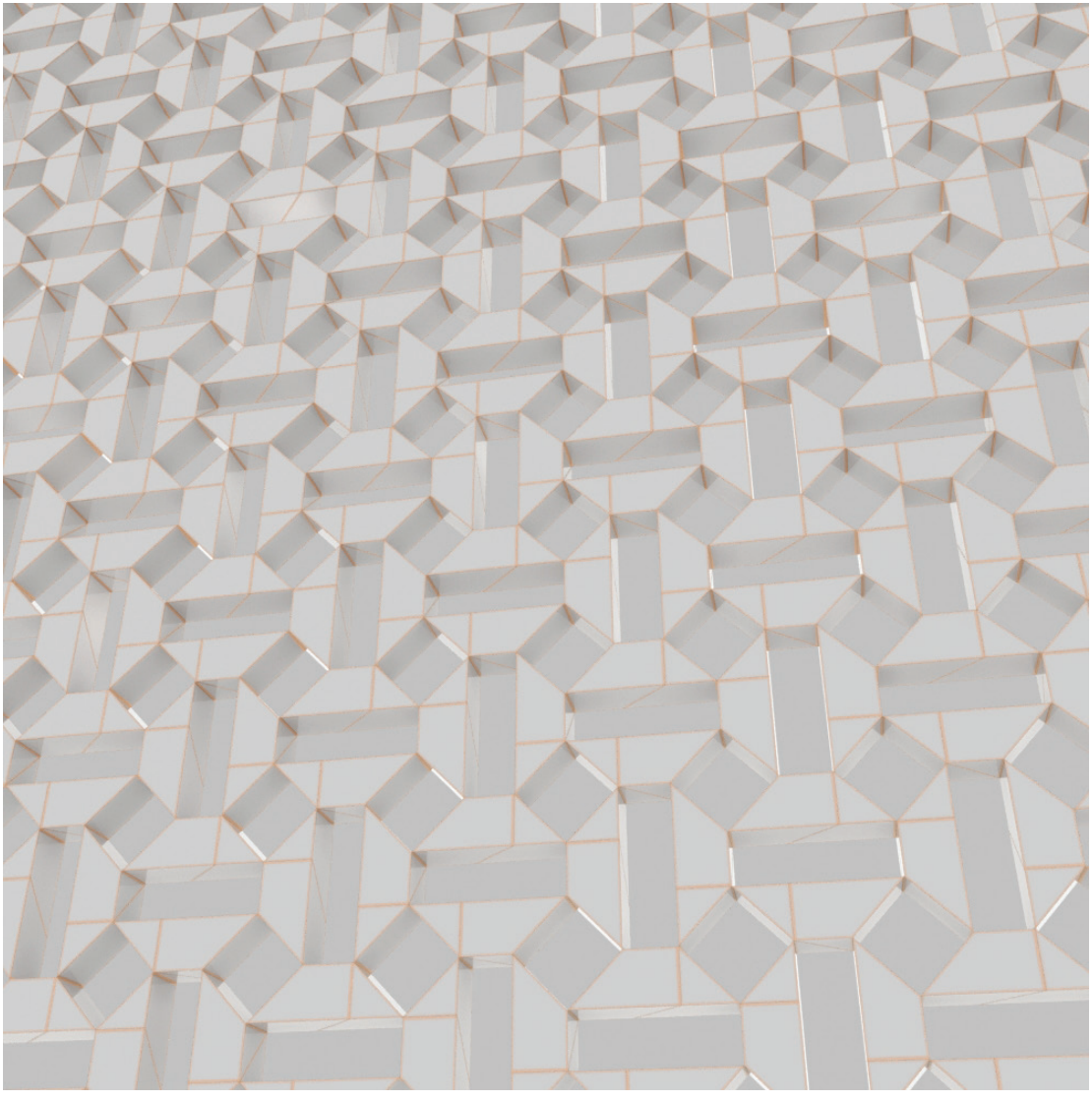


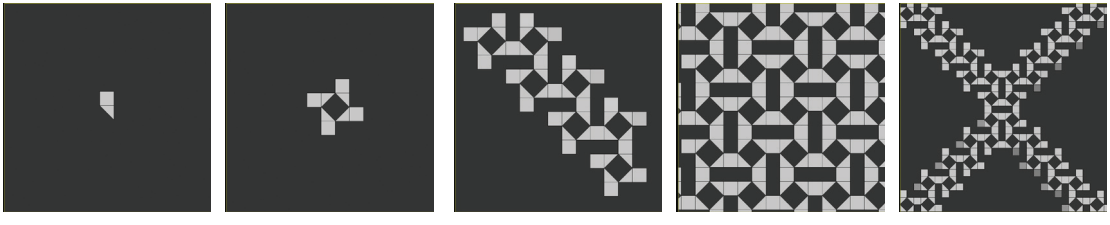


experiment two: braiding rotation

This exercise combines two helical definitions. Helix A is arrayed in the same fashion as Helix B, along Helix A's perpendicular axis.

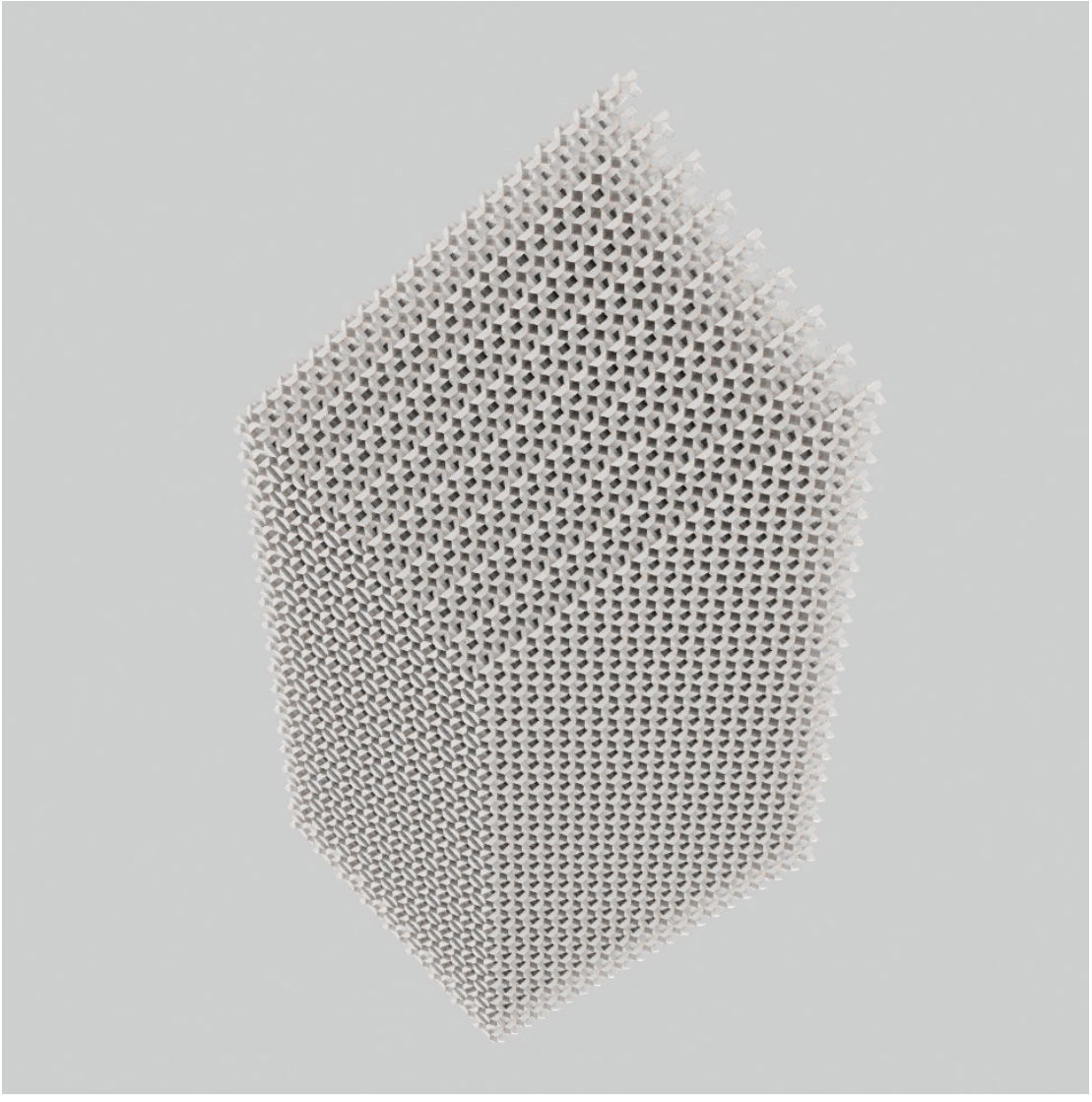


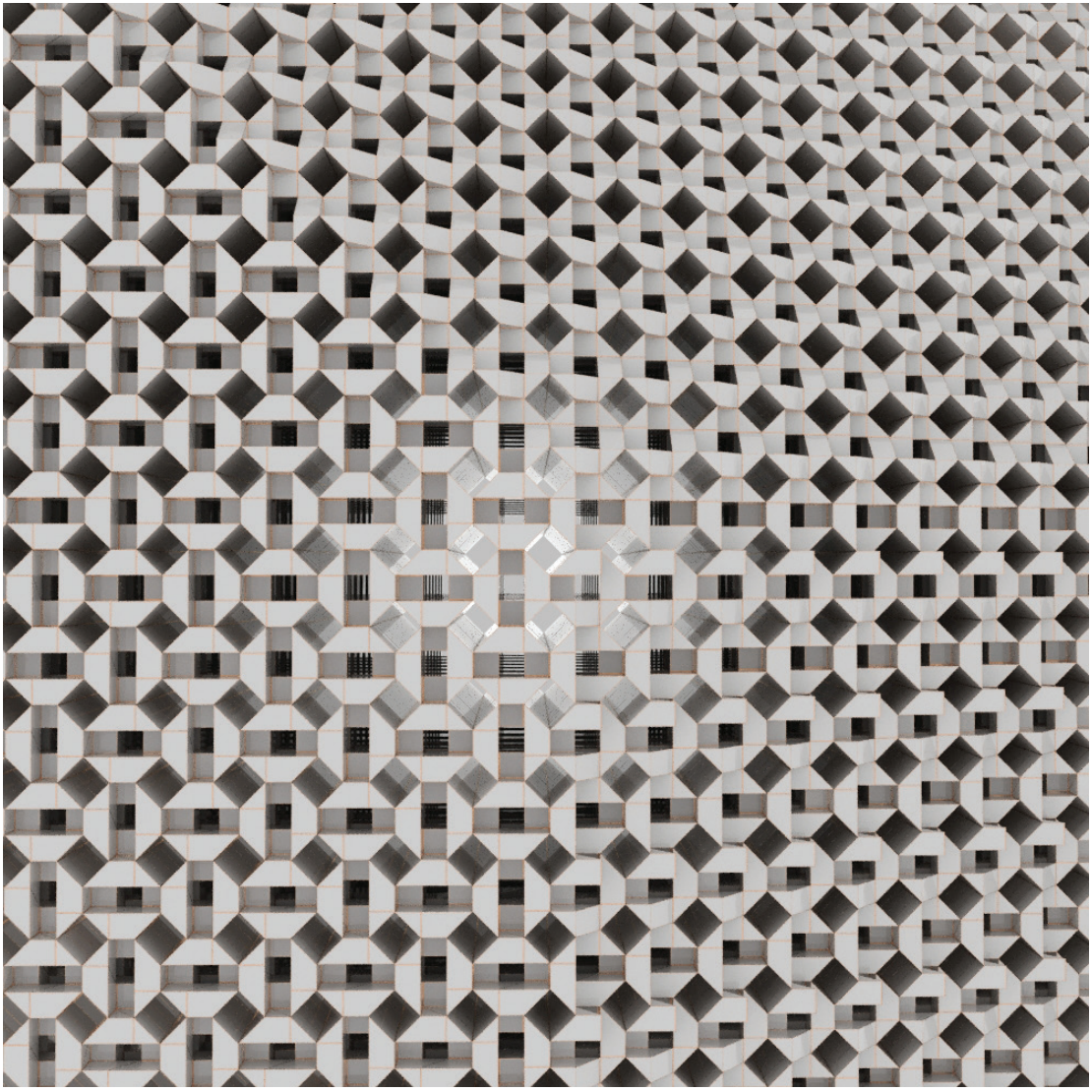




experiment three: stacking dynamic modularity

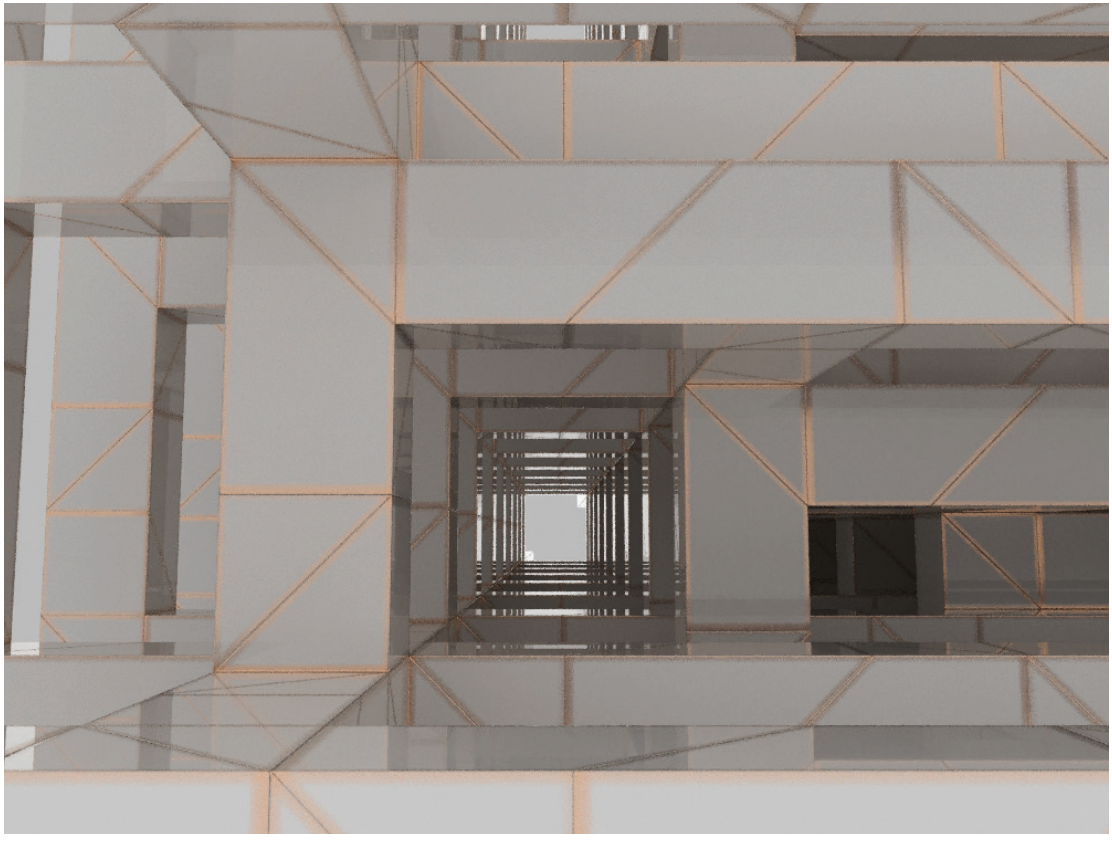
This exercise stacks a "sheet" of Zvilna blocks to create a regular lattice.

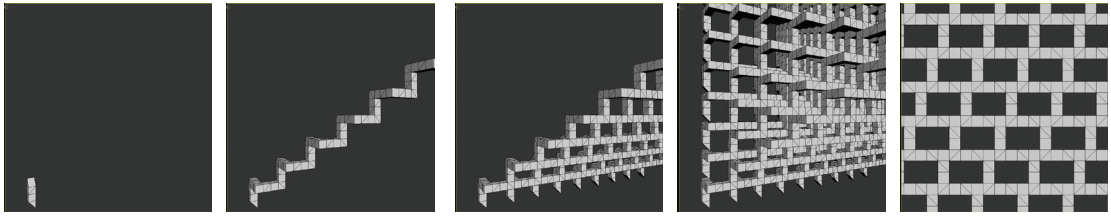


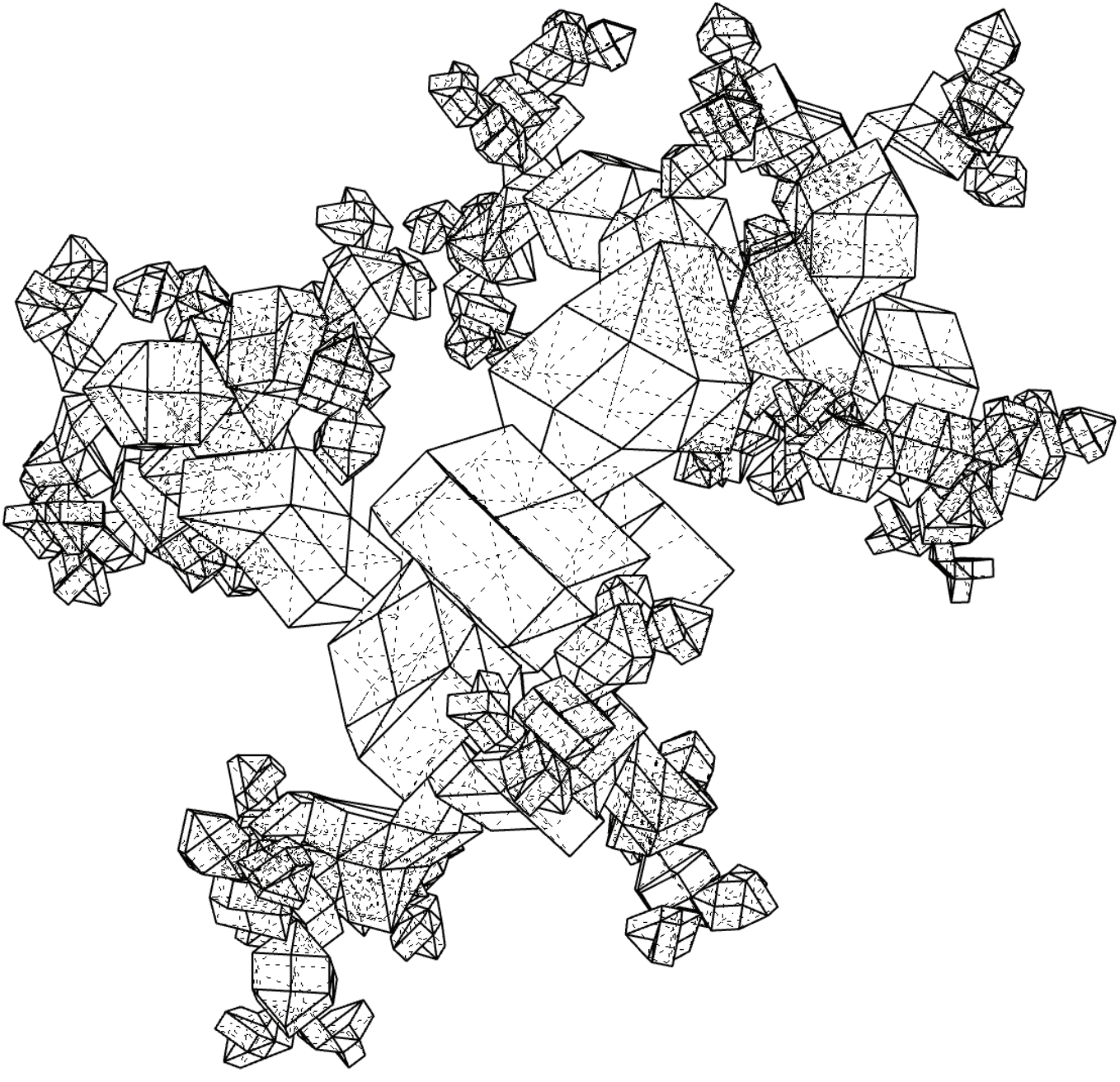


experiment four: combo rotation II

Using a combination of techniques, this crystalline form is generated. An orthogonal helix is arrayed in a porous stack, not unlink a course of bricks. Parent components are tweaked, resulting in a volume that frays at its edges.







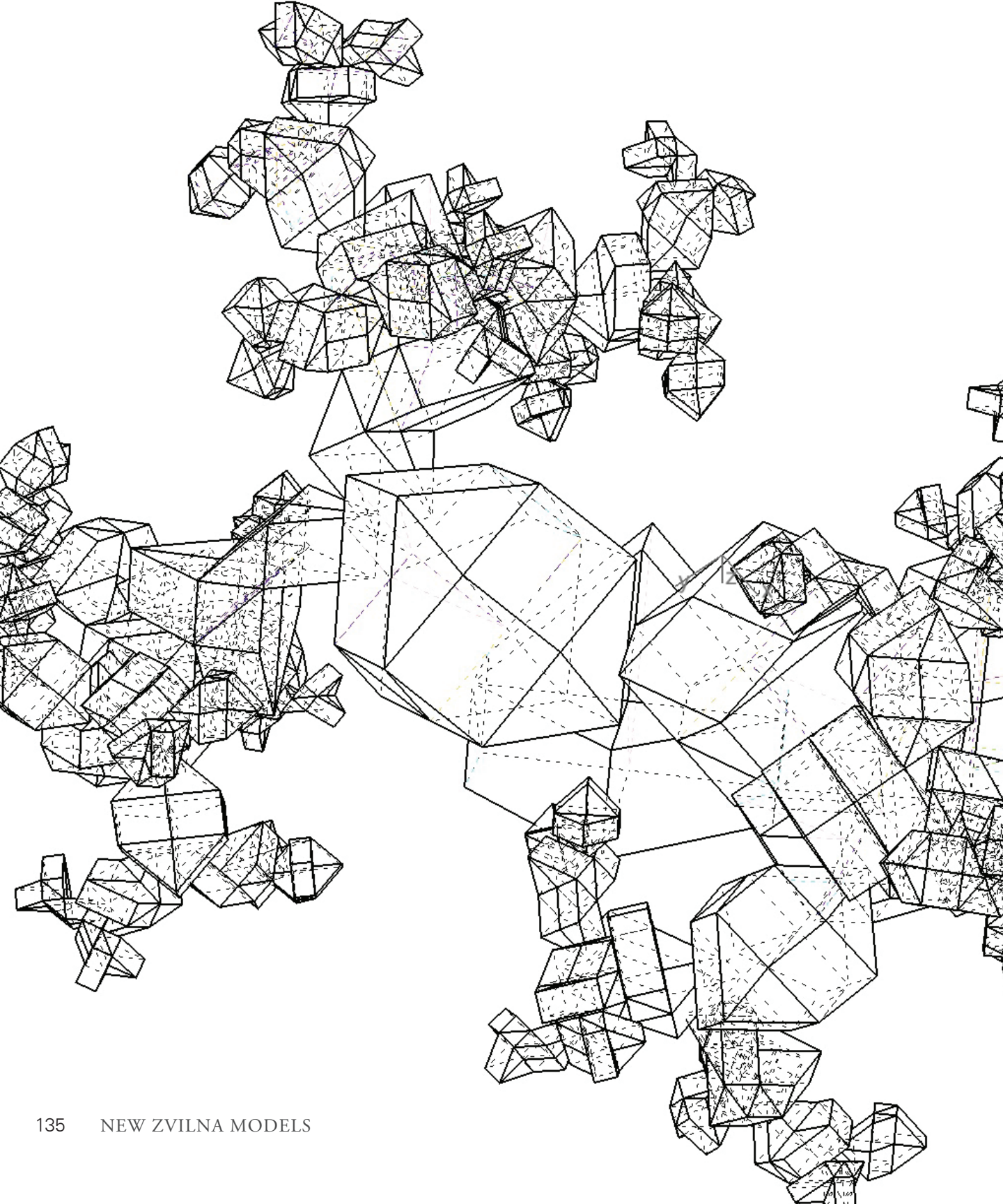
Fractals
Winona Li

facing

Digital rendering of geometry exploration

Through studying the works of Jekabs Zvilna's modular forms and his reading, "Colored Symmetries in Space-Time", we are able to gather insight on his teachings of geometric explorations.

This can be related to the algorithmic patterns that we percieve in nature. Chosen to be examined further is the mathematically generated patterns seen in folliage. These fractal principles can be applied to earlier architecture where patterns are a reflection of the cosmos.



nature exploration

The athyrium filix-femina, or the common lady-fern, is a natural phenomenom in the mathematics realm. The fern is a primary pattern of self similar sets "a mathematically gnerated pattern that can be reproducible at any magnitude or reduction."[1]

The fern shows how structures can be built from repetitive use, similarily to the Serpinski Triangle, where a large equilateral triangle can be subdivided iteritavely into smaller equilateral triangles.

1 "Self-similarity," Wikipedia, http://en.wikipedia.org/wiki/Self-similarity/. Acc. July 10, 2019

fractals everywhere

The contemporary British mathemetician Michael Barnsley states that fractal geometry can be used to make precise models of physical structures from ferns to galaxies. Barnsley's work examines the patterns of the common fern. He proposes that it is an example of an iterated function system (IFS). An IFS is made up of the "union of several copies of itself, each copy being transformed by a function" (reflection, rotation, scaling, translation). He states that the IFS is a model that is used in many plants and leaves, because of the self similarity that occurs in the branching structures in nature.

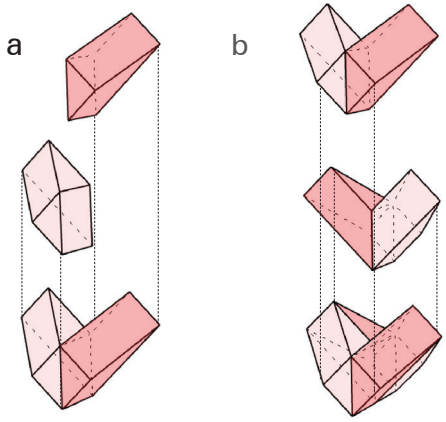
An important observation that he makes is that nature also exhibits randomness. Therefore there are no two ferns that are alike. The random variable allows for versitility, while at the same time "admitting a continous dependence on parameters which facilitates geometric modelling."[2]

Barnsley's Fern

2 Michael Barnsley, "Prime Numbers," Functional Paradigm, http://functional-paradigm.blogspot.com/2013/11/. Acc. July 10, 2019

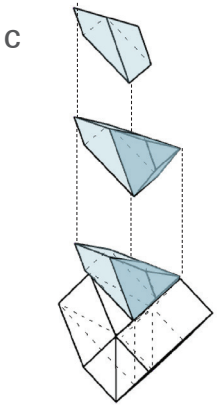
base connection

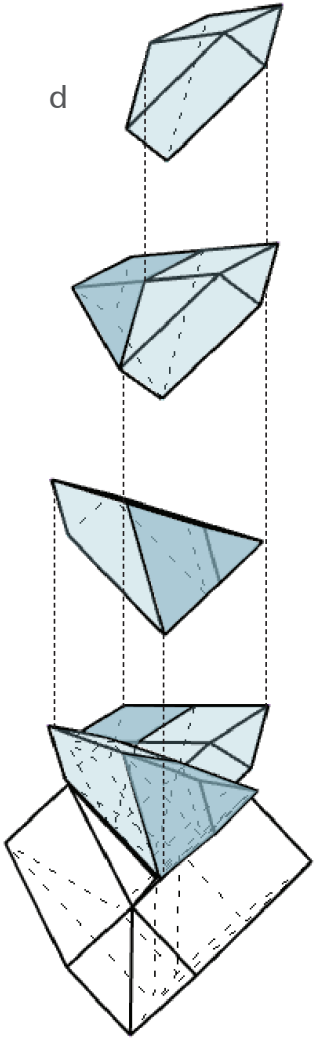
The base connection consists of two modules to create a "v" shape. It is mirrored, making the base four modules.

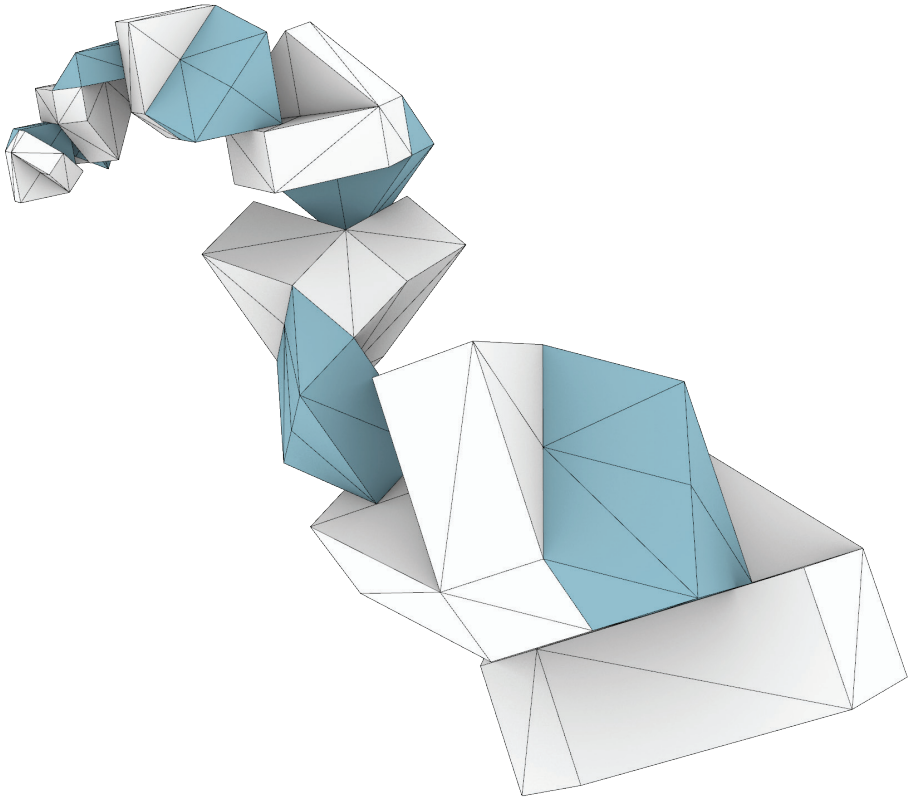


extensions

The extension consists of two modules mirrored against each other. The extension pieces are placed at the midpoint of the base connections.



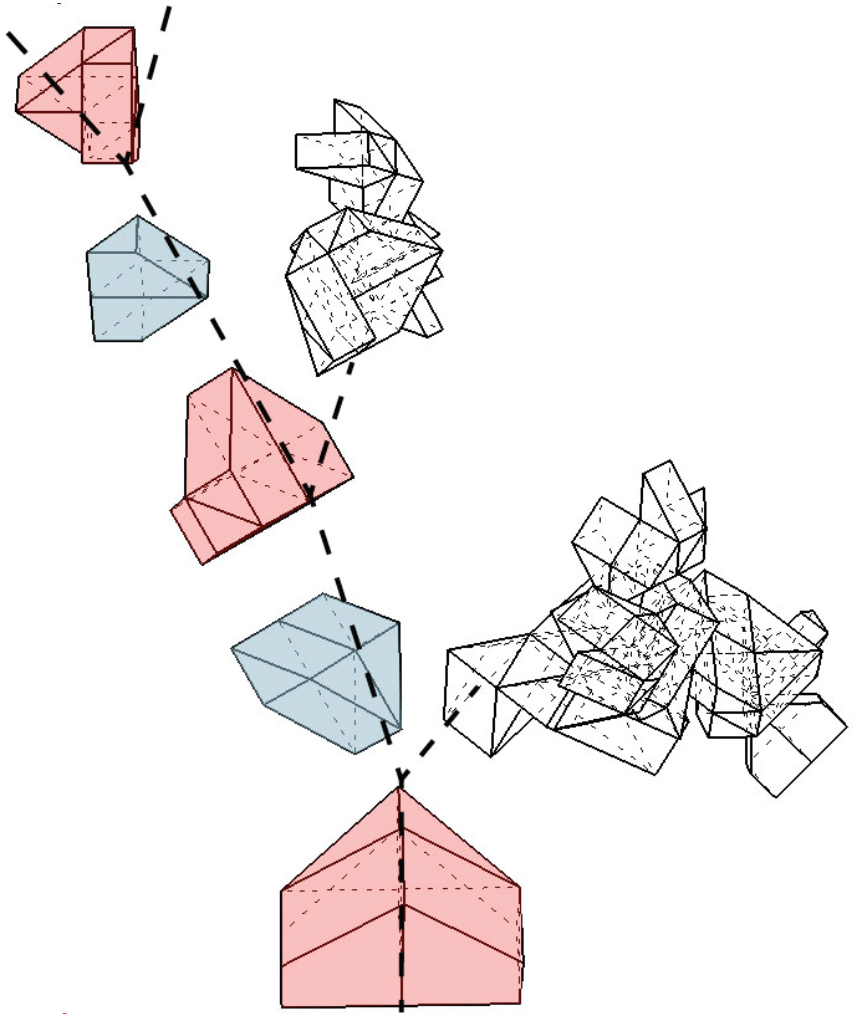




Simplified growth in one dimension

colored symmetries in space-time

Zvilna's writing shows the emergence of symmetries as a universal, archetypal, self organizing phenomenon which originates in an infinite number of forms. From his studies we can gather that his structures use rotational, translational and a combination of both form generating process.



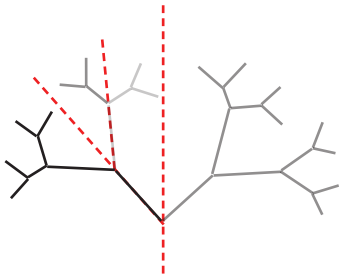
randomness variables

Rotation

Nature uses rotation on many levels to achieve infinite variety. Examples may be seen in the solar systems, the Milky Way, galaxies, day and night

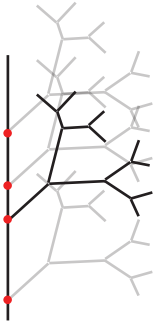
Reflection

A product of bifurcation, may not be perfectly symmetrical as nature is irregular. Mirrored axes may occur anywhere



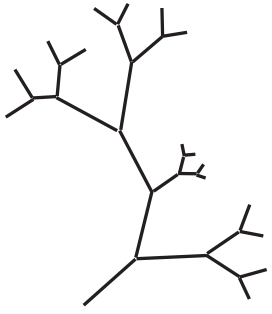
Translational

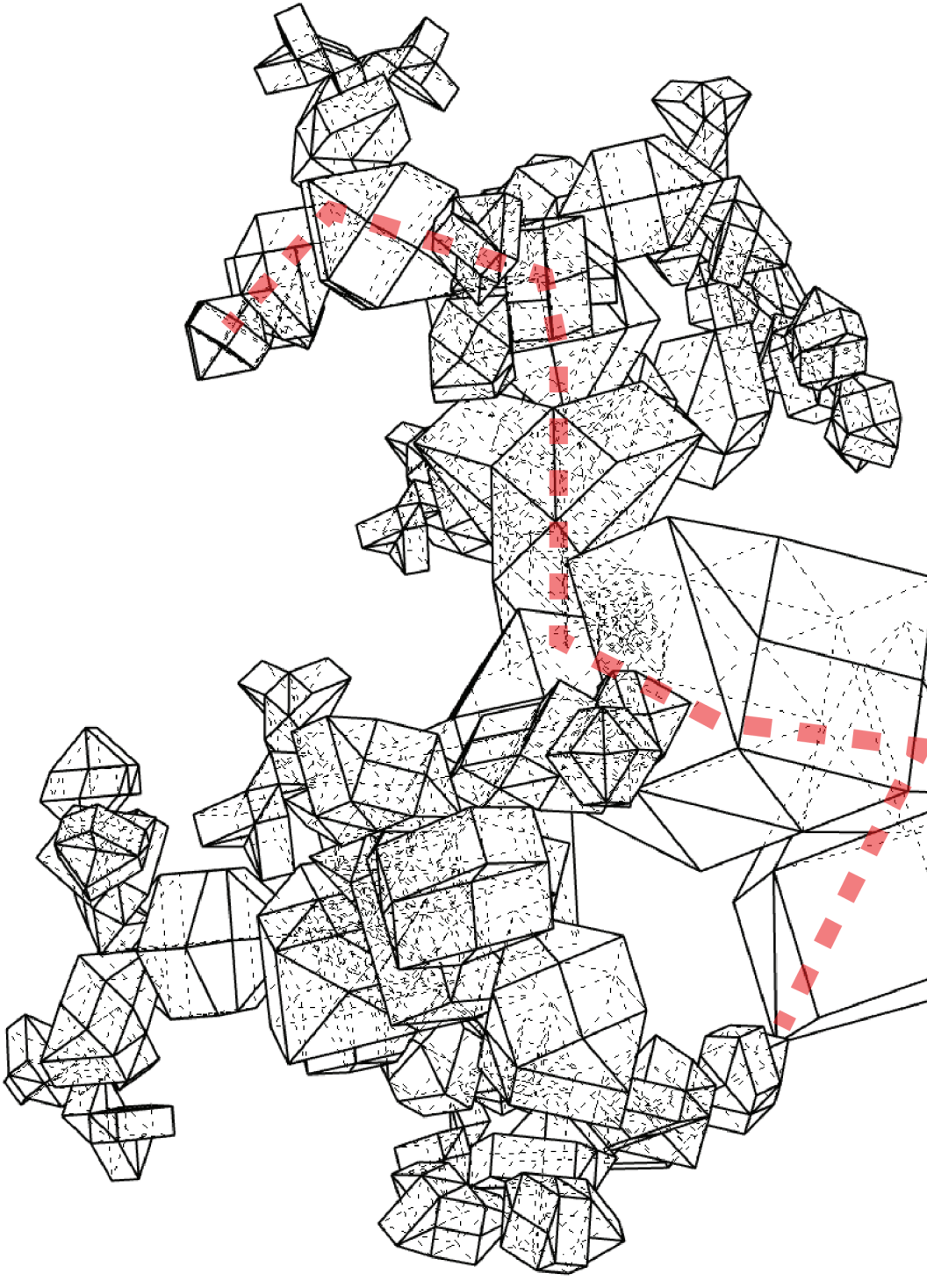
Points of growth may begin anywhere

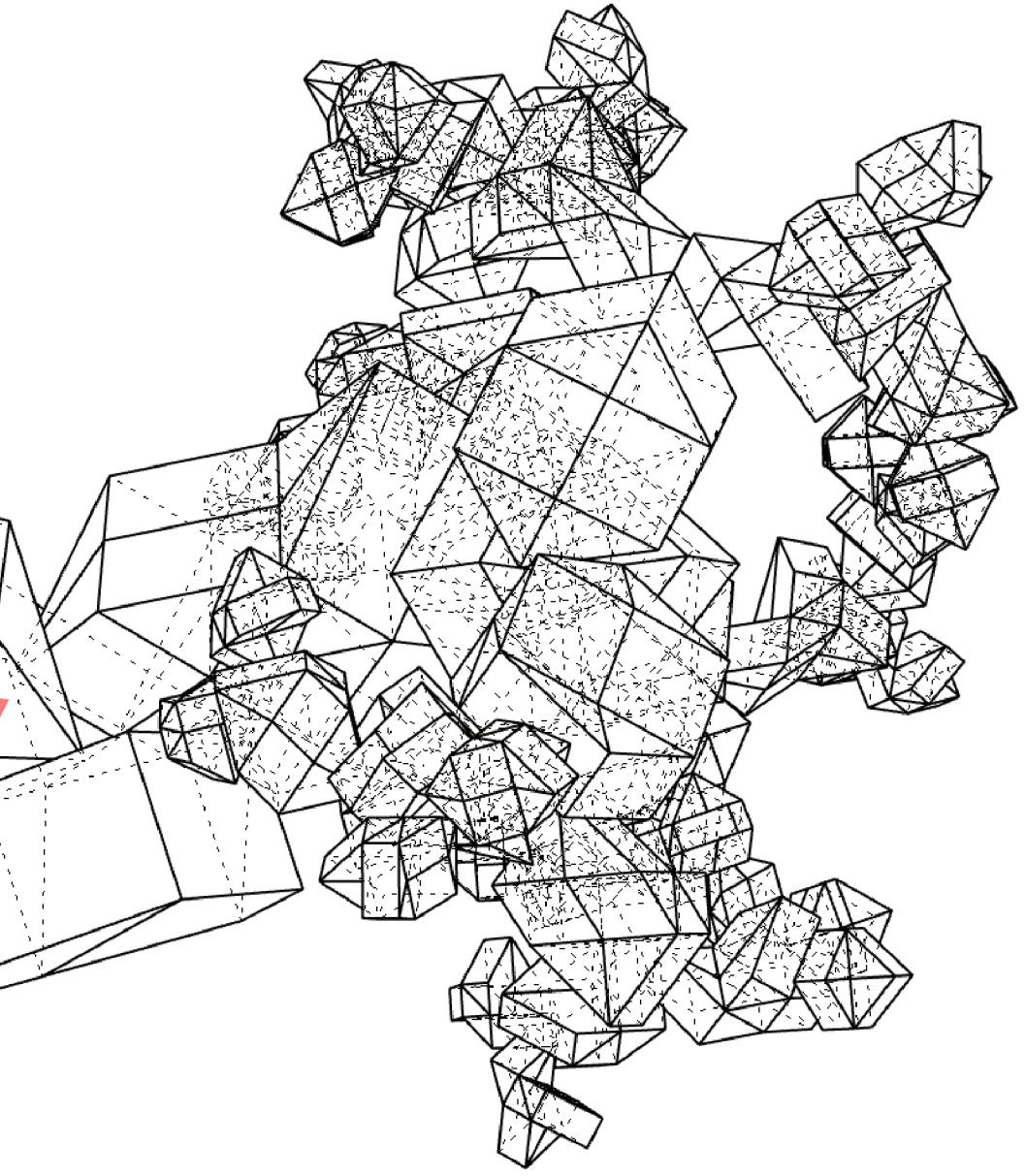


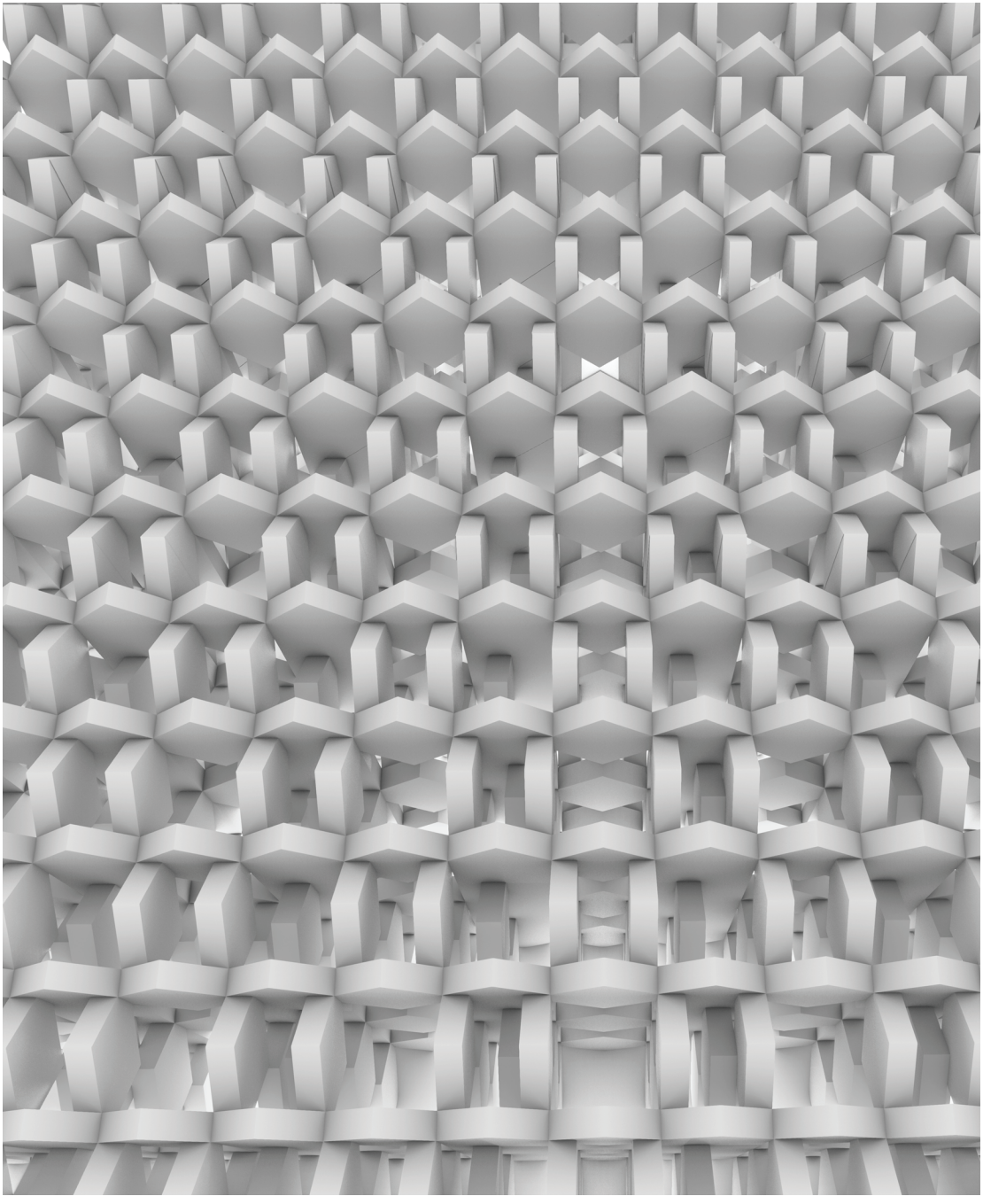
Scale

As growth occurs scale of modules can occur in multiple proportions.









Bamboo Experiments
Hagop Terzian

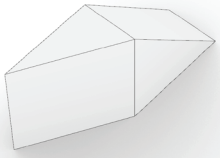
facing

Digital rendering of "bamboo" aggregation, perspective

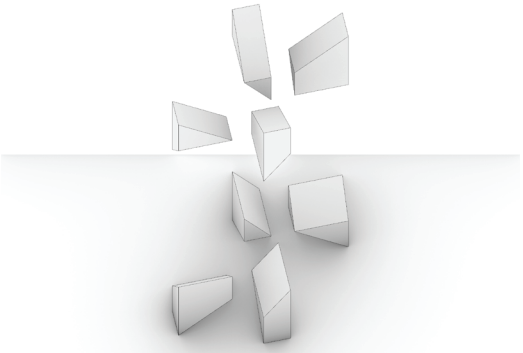
Based on the growth of bamboo forests, this experiment explores the Zvilna geometric shape and attempts to create a complex form that can be configured in different ways to create permeable, semi permeable and impermeable structures.

Zvilna's geometry is joined at the square surfaces. The pair of geometries creates a linear shape with a rectangular surface; the linear shape is then mirrored on that surface. Each shape has an additional pair of geometries connected at the edges.

The edge to surface connection allows the main module to have peaks and valleys in its form. These are treated as the connection surfaces that allow for the modular configuration of the structure.

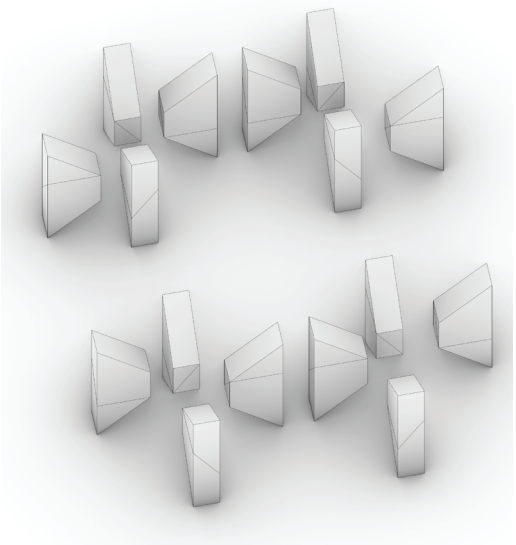


Zvilna's original geometry



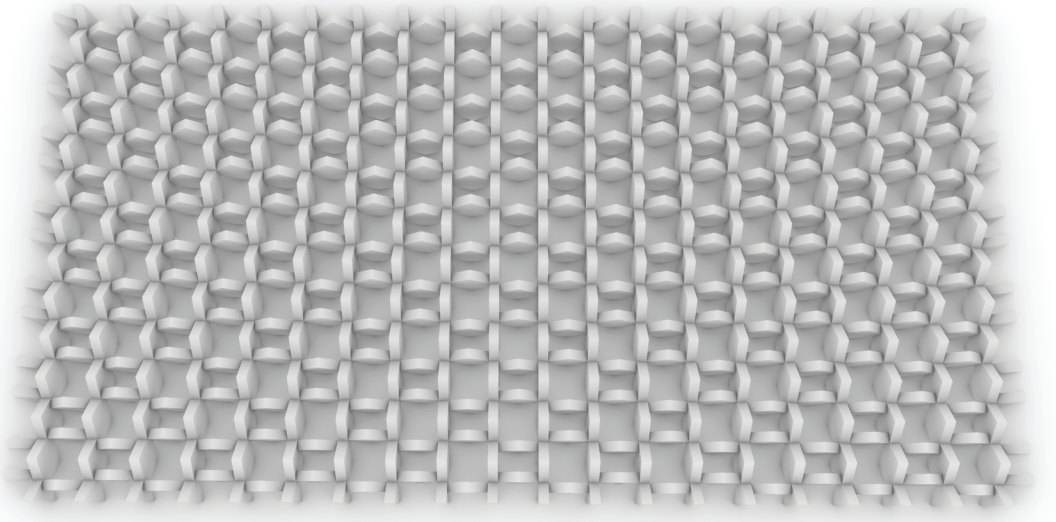
The set of geometries are multiplied and mirrored

Two geometries are joined at the square chamfers



Two sets of modules are joined at their rectangular faces. Each module is then mirrored on its X and Y axis

aggregation process: permeable and semipermeable

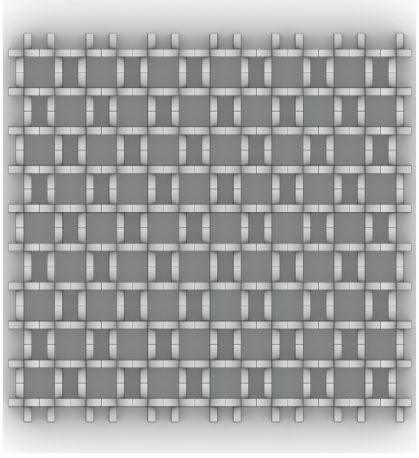


1

2

The repetition of the shapes creates a modular grid- like structure with peaks and valleys that allow for other shapes to attach to its surfaces and joints.

The grid is composed of elements which mirror the original module.

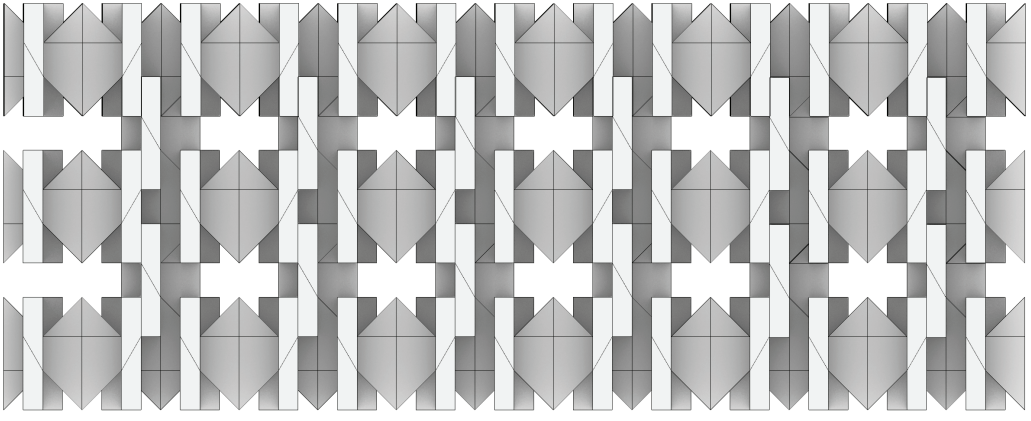


3

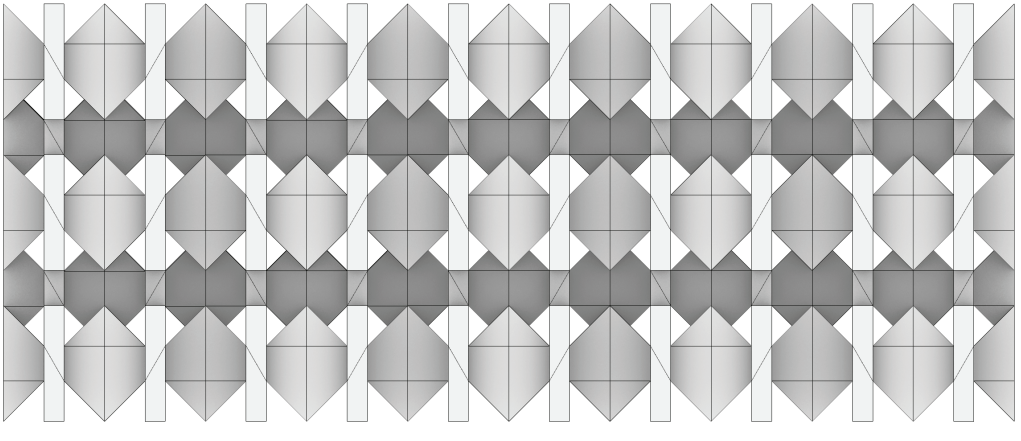
1 Bottom layer, aggregated

2 Side view

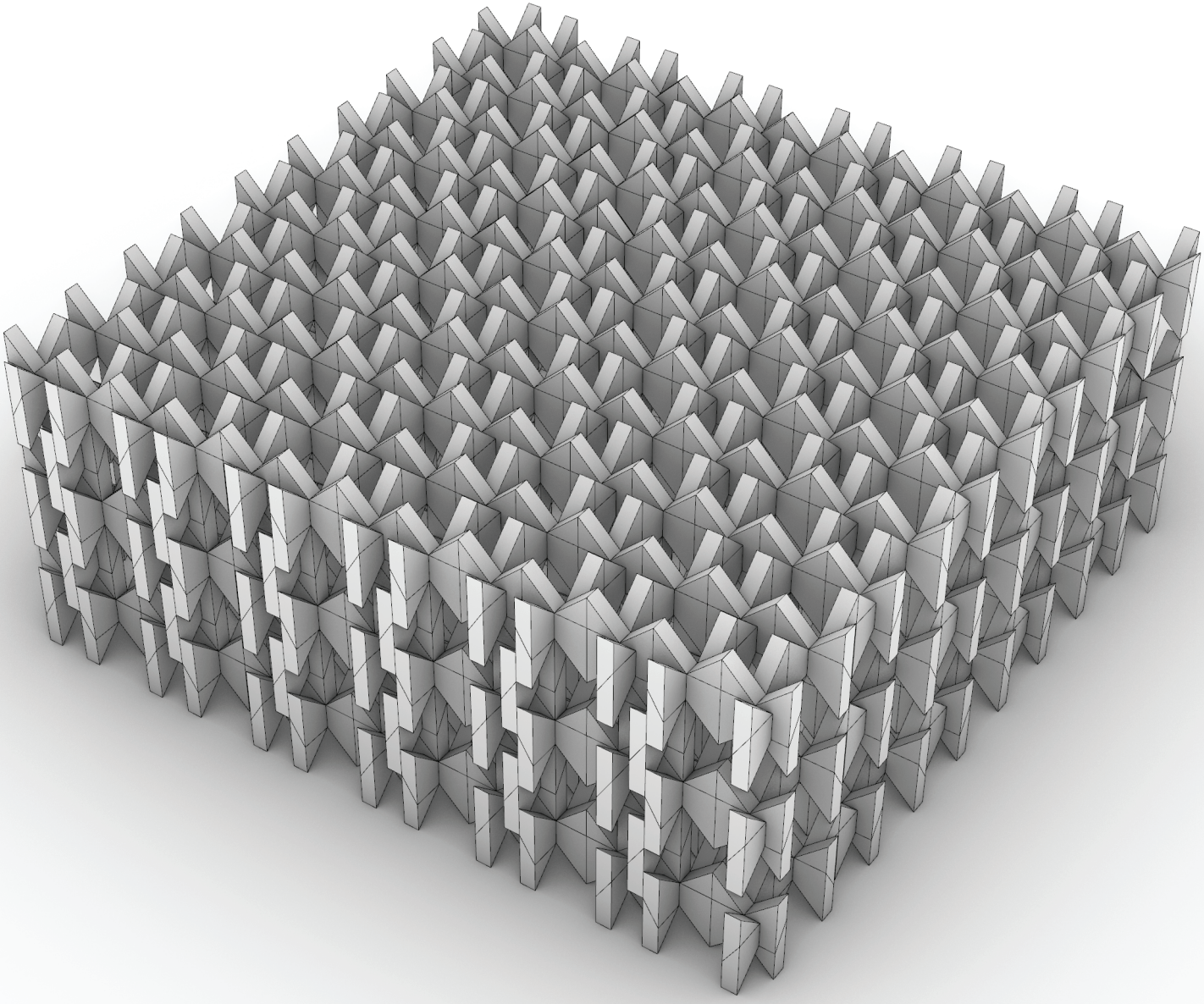
3 Top view of first layer



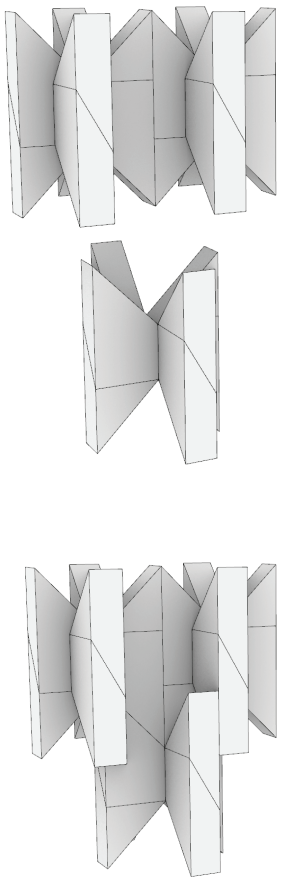
This side of the facade allows for a fully permeable patterned structure

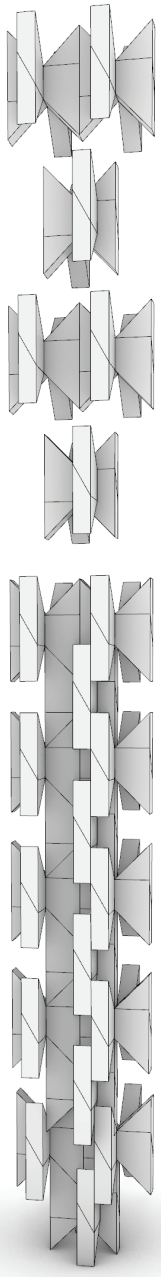


This side of the facade allows for a semi-permeable patterned structure

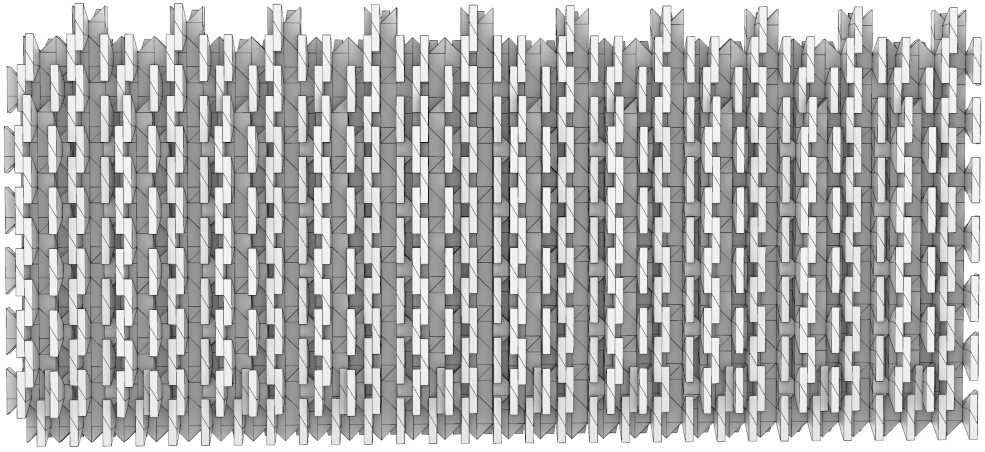


aggregation process: impermeable

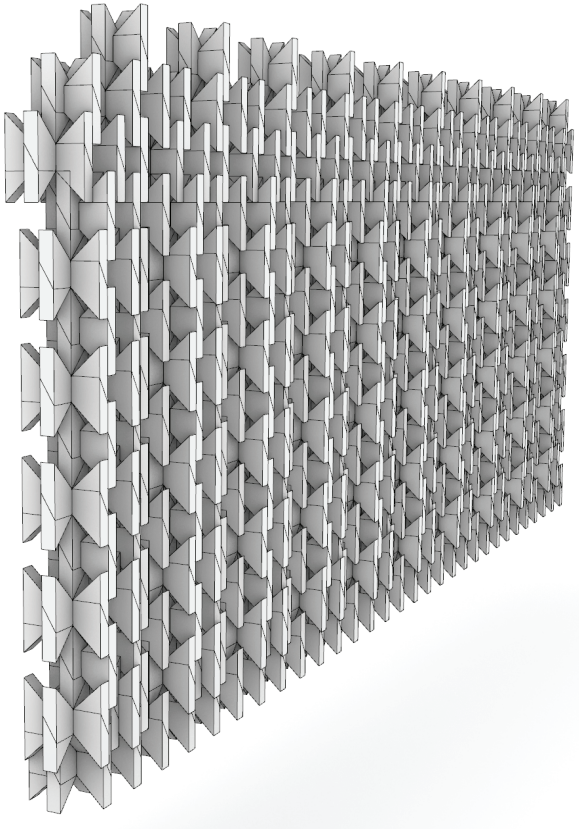




The same module can be explored differently through densified unification. When a single module is mirrored once, it creates an edge condition that allows for an original module to connect to it.



Densely connected facade



Philip Beesley

Philip Beesley is a practicing visual artist, architect, and Professor in Architecture at the University of Waterloo and Professor of Digital Design and Architecture & Urbanism at the European Graduate School. Beesley's work is widely cited in contemporary art and architecture, focused in the rapidly expanding technology and culture of responsive and interactive systems. He serves as the Director for the Living Architecture Systems Group, and as Director for Riverside Architectural Press.

Bianca Weeko Martin

Bianca Weeko Martin is a designer, writer, and researcher who studied architecture at the University of Waterloo. In her role at the Living Architecture Systems Group, she manages publications for Riverside Architectural Press and leads web development, graphic and video editing special projects. She was also involved in the CAST-LASG Workshop at the University of Manitoba and Grove at the 17th Venice Biennale of Architecture.

Val Rynnimeri

Val Rynnimeri is a graduate of the Waterloo School of Architecture and has been an adjunct faculty member since 1981 and a full-time faculty member since 1990. He also has an MA in History from the University of Guelph. His design work has won numerous competitions and awards, and focuses on urban design and land development, the landscape urbanism of the urban periphery, and the ecosystem design of green infrastructure. Val gave a presentation at the 2019 Living Architecture Systems Group Symposium entitled 'Form from Process: Jekabs Zvilna and Integrative Form Languages'.

Muhammad Tahir Pervaiz

Muhammad Tahir Pervaiz served an extended studentship with the LASG during which he produced a thesis that focused on the underlying geometric form-language currently used within studio scaffolds. His thesis 'Mediation: Resonating Between the Organic and Inorganic' at the University of Waterloo School of Architecture includes historical references that expand the context of LASG research-creation. His work included a focus on the visionary mid-twentieth-century designer Jekabs Zvilna.

Image Credits

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Pages 141-148	Photography and new digital models emulating Zvilna design by Hagop Terzian, 2019.

New Geometric Systems
Jekabs Zvilna and Integrative Form-Languages
Edited by Philip Beesley and Bianca Weeko Martin

New Geometric Systems: Jekabs Zvilna and Integrative Form-Languages surveys the graphic and three-dimensional work of Waterloo Architecture professor and mid-twentieth-century designer Jekabs Zvilna. Photography of original foam and wood models by Zvilna and new essays by Val Rynnimeri and Muhammad Tahir Pervaiz are followed by studies by undergraduate students working under the supervision of Philip Beesley at the University of Waterloo School of Architecture in 2019.

Jekabs Zvilna (1913-1997) was a designer, researcher, artist, and professor of architecture at the University of Waterloo. Zvilna studied architecture in Latvia at the University of Riga and immigrated to Canada in the mid-1950s.

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