Earth Printing

Compact Design Studio

Institute of Structural Design
Summer 2024

The Earth Printing compact design course led by Prof. Norman Hack and Noor Khader from the Institute of structural design (ITE), explored the ways in which advanced technology, specifically 3D Ceramic Printing, has transformed the world of design and fabrication nowadays. The use of advanced technologies and parametric modeling has enabled designers and architects to develop intricate and complex designs informed by variable parameters. This has opened up new possibilities for a novel design expression, highly detailed patterns and textures, and visually striking objects that are both functional and beautiful.

The task was to create a column that is segmented into parts and informed by the investigated experimental process such as parametric design, assembly and disassembly, fabrication limitations, interface connection, and functional integration. Through a series of lectures, digital modeling workshops, and hands-on 3D printing sessions, students learned fundamental principles of 3D digital modeling, the technical aspects of 3D ceramic printing, and the creative possibilities and pronounced aesthetics enabled by this technology.

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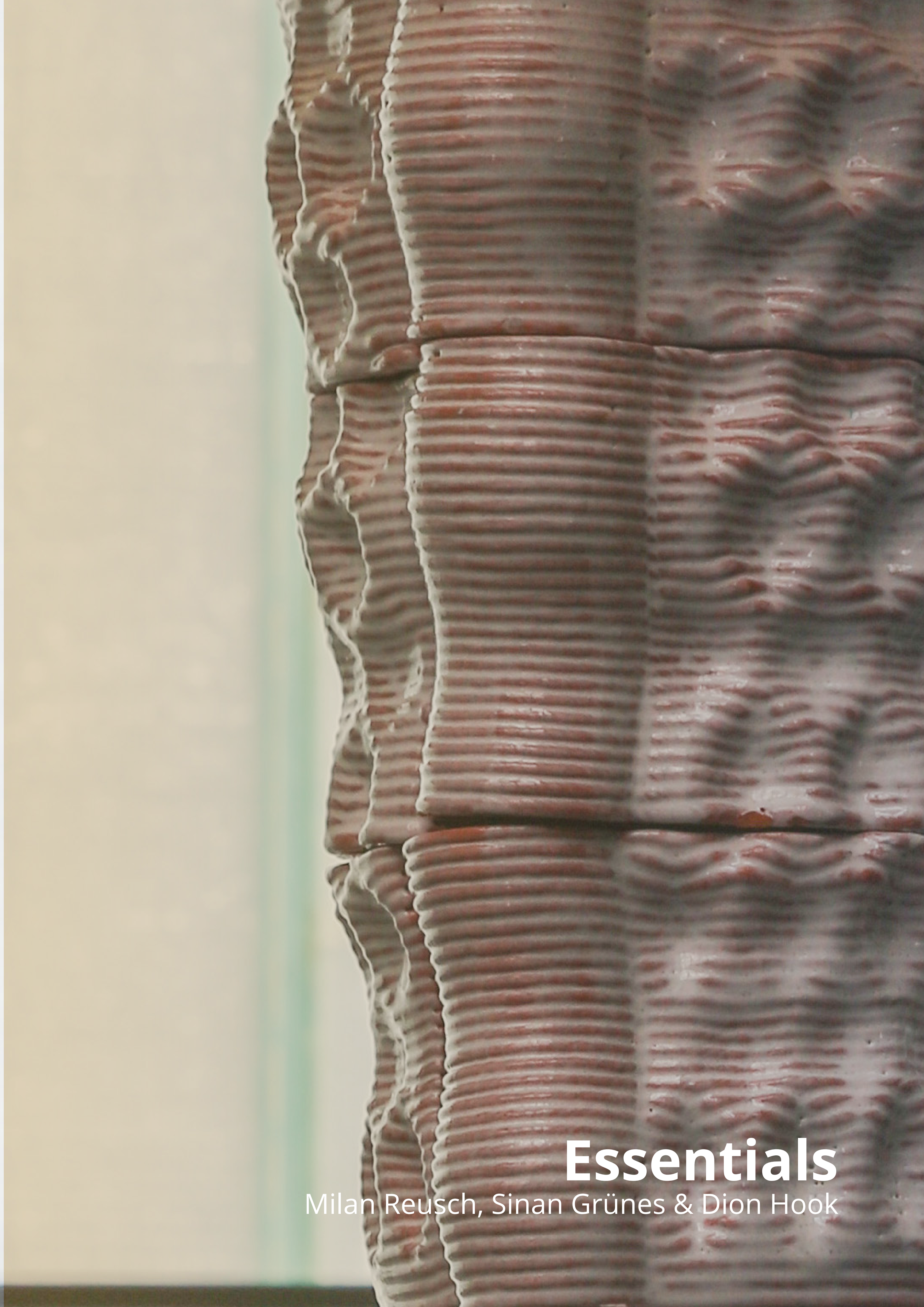
Thank you for your attention!

Printed Explorations



Essentials

Milan Reusch, Sinan Grünes & Dion Hook

An unexpected journey

Grasp the knowledge

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1 Photograph of a middle segment part

Preface

In the beginning there was nothing, which exploded

Our Kompakt Entwurf journey began with an engaging workshop. During the first two weeks, we learned to use Grasshopper for Rhino, a new experience for everyone, which fostered an inclusive and collaborative environment. This foundation was crucial for our design process in the weeks ahead.

After the workshop, each student worked independently on their respective designs. We developed concepts for the appearance of our columns and devised ways to interlock them with a cladding system and infill. We had three weeks for individual exploration, with weekly reviews that guided our progress.

Following this period, we presented our initial designs at the midterm presentation. Many of us also brought our designs to life through our first printing sessions, which was an entirely new experience for all. Communication remained vital throughout the Kompakt Entwurf, and even more so during the printing sessions. We taught and learned from each other, which enhanced our skills collectively.

First individual design

After our initial three and a half weeks, we were instructed to form groups of three. Our task was to either merge our designs or adjust them to fit together in an interesting way. Forming these groups became a crucial step in determining the final 3D-printed model. It was recommended to team up with individuals whose design ideas would complement and enhance our own. After the midterm presentations, we sat down together to discuss which designs would best benefit our own. This allowed everyone to provide input and ensured that the final group design was cohesive and innovative.

Working as a group

After forming groups, everyone began working on their initial designs and scripts. Each group encountered unique challenges, from creating inclusive designs to finding suitable infill and cladding solutions. Ultimately, we decided to use a single cladding system and infill to ensure that each group's segment fitted together seamlessly and allowed for better load transfer.

We were given the next two weeks for designing and test printing. This was followed by the excursion week of the university, during which some students were away. However, we were permitted to continue printing during this time. By this point, most groups had finalized their designs, with only minor adjustments needed for some scripts. At the end of the excursion week, the final printing sessions took place. Once printed and dried, the parts were ready for firing.

During the excursion week and the subsequent ninth week of our journey, we also had time to work on our presentations. We received feedback during the ninth week, which was invaluable for our group.

At the end of the week, the fired parts were ready, and we glazed them to make the final column stand out. We chose white for the glaze, as none of the groups had time to develop a color scheme. In the end, white was a good choice, as it unified the segments, which significantly varied in shape.

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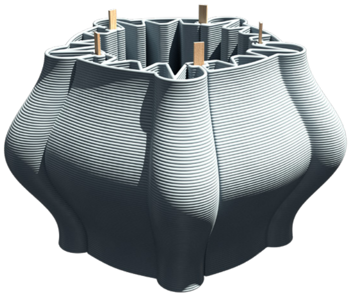
2 The assembly of the segments to the entire design without a lamp pole.

3 Assembly of every groups final design on the lamp pole.



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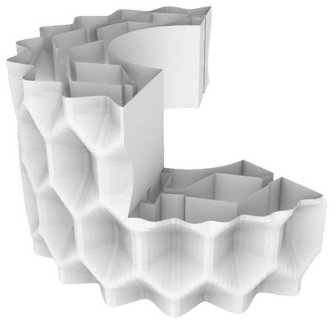

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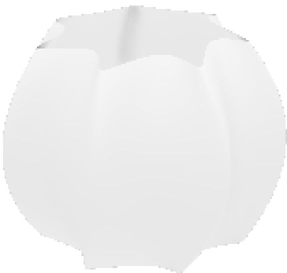

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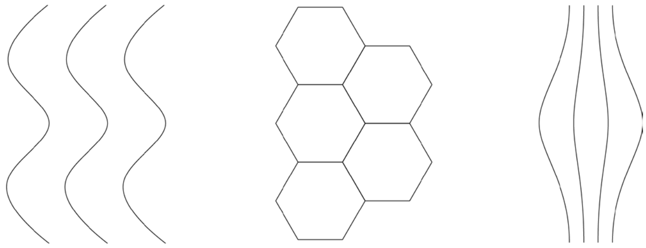

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4 Final design idea for radial segmenting parts that get assembled on a centered pole. - Millan Reusch

5 Final design idea of pearls with a wavy structure and little overhangs. - Sinan Günes

6 Final design idea of a beehive design using a hexagonal grid as an attractor curve to morph a surface. - Dion Hook

7 Pictos of the essential design ideas of each group member.

Pillars

The inspiration for this design came from ancient architectural columns. The idea of using this artifact stemmed from an early design concept. The problem we encountered before was that our prints were limited to a maximum point count. Therefore, the pillars served as reference points where the parts were segmented into smaller, printable pieces. They were conceived as boundaries that framed a surface, which could later be used for different applications. Each part consisted of a wider surface and a pillar. This design remained highly variable in terms of contouring the shape, pillar size, and the number of pillars we wanted to use..

Waves and Pearls

Waves symbolized movement, change, and life's relentless force, reflecting constant evolution. Their flowing shapes also offered a calming, harmonious aesthetic, which we aimed to capture in this design. Pearls represented purity, perfection, and elegance. Combining waves and pearls created a balance between movement and stability, dynamism and tranquility. These elements complemented each other, enhancing the aesthetic and symbolic depth. Additionally, the small overhangs in the design contributed to a sense of flow and continuity, further emphasizing the harmonious blend of these elements.

Beehives

The design "Beehives" drew inspiration from bees, particularly their hives and honeycombs. The initial concept aimed to use the hexagonal structure to interlock multiple parts and provide storage spaces, much like how bees used their honeycombs. However, after two weeks of learning Grasshopper, the original design proved too complex to execute, leading to a simplified shape that was easier to create with the program. Despite this simplification, the honeycomb structures still produced captivating lighting effects when illuminated. The interplay of light and shadow through the hexagonal patterns enhanced the aesthetic appeal of the design and maintained its connection to its natural inspiration.

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Coming together

After everyone knew the key elements of their design, we had to agree on how to integrate them. The base idea involved using the segmentation approach, which allowed precise contouring of the design. However, the next part proved to be quite challenging. Its purpose was to extract the surface between the pillars to apply the beehive contour onto the pre-designed shape. Due to the surface reconstruction, we couldn't reattach the pillars. To solve this, we had to reconstruct the pillars' surface similarly but without applying the beehive pattern, preserving their original shape. Once we managed to get this part working to our satisfaction, we experimented with the entire shape using the graph mapper component to integrate a flowing, wavy texture. Another important aspect of the design was the infill and cladding. The purpose of the infill was to add stiffness to the overall structure and prevent collapse in cases of excessive build height. The cladding, as the name suggested, was used to fix the parts around the lamp pole. Our idea involved small vertical pockets on both sides of the part. By inserting rectangular sticks and jamming the parts using these pockets, the parts were theoretically prevented from sliding apart. To ensure this, an odd number of segments was necessary to avoid creating a splitting axis that could allow the parts to be separated. All groups agreed on this idea to ensure the best fit and easiest application for the entire lamp.

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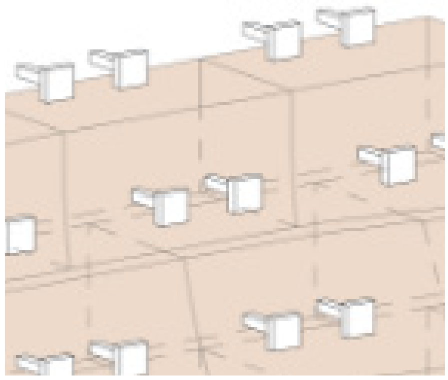
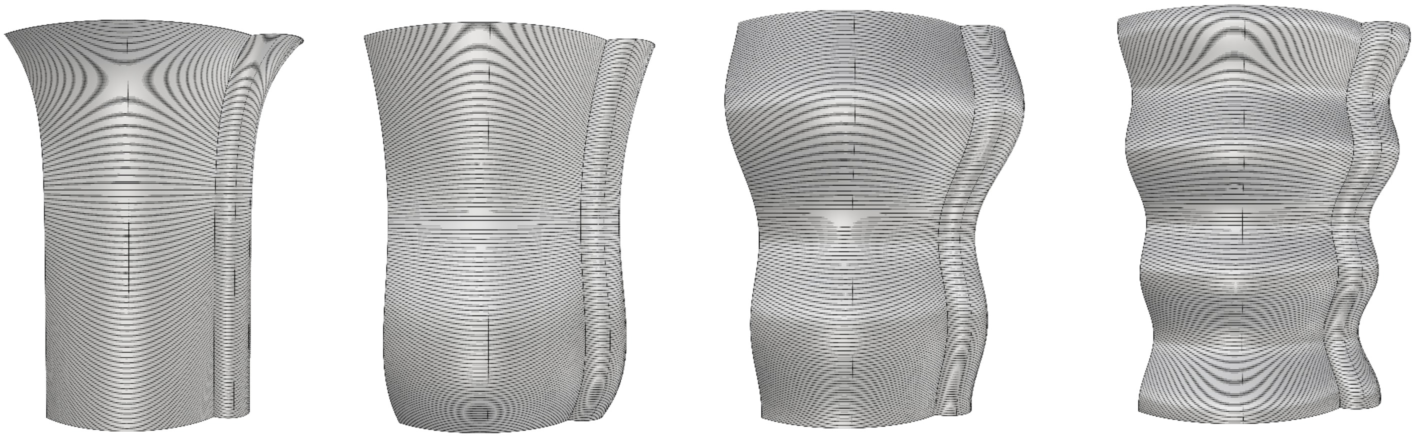
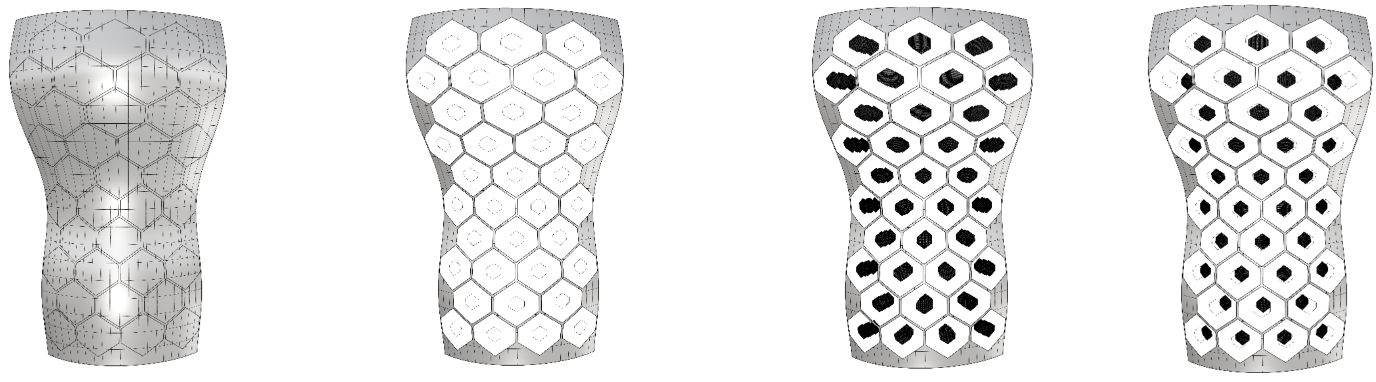
8 Final design: Prints of the lower segments before firing.

9 Before last changes on the spacing between the hexagons were made.

Our workflow began with defining the outer shape through multiple experiments to agree on a single contour. Factors we had to account for included the intricacy of our design, compatibility with the group beneath our group, the shape of the lampshade, and the overall integration of our segment within the larger assembly.

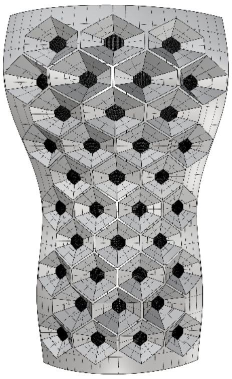
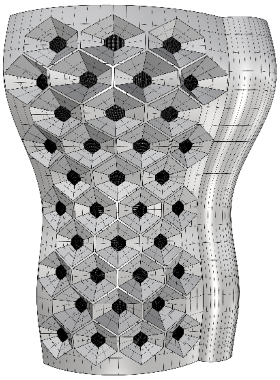
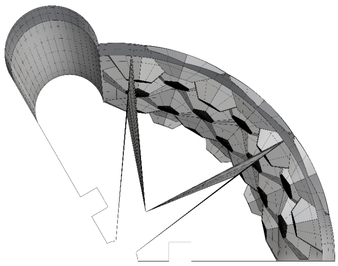
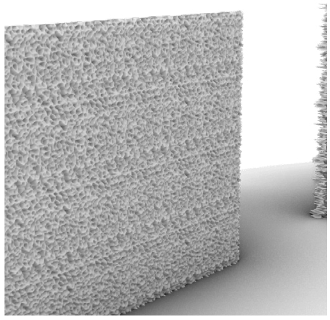




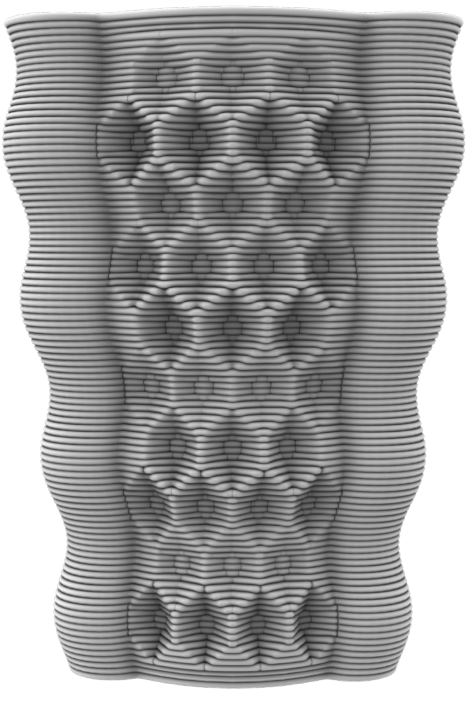
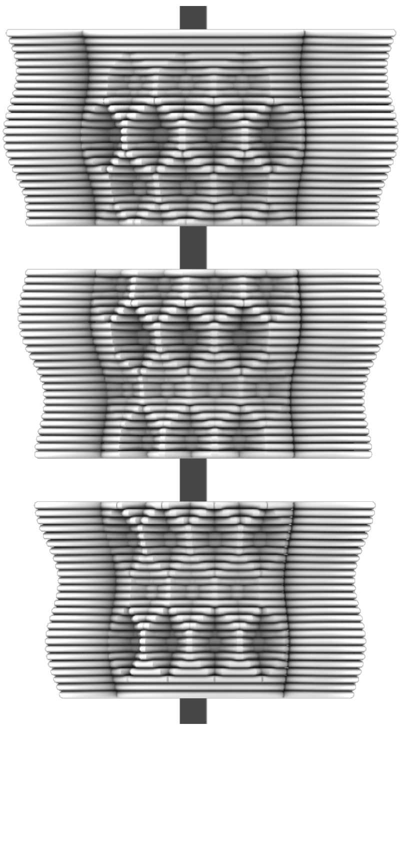


Once we had our shape, we had to remove the pillar on the right side of the surface because of the previously explained problem we faced. This allowed us to apply a hexagonal structure on the remaining singular surface and carve out the hexagonal shapes from the surface.

Subsequently, we duplicated and scaled the hexagonal pattern to achieve the desired dimensions. Using these scaled hexagons, we created inner hexagonal surfaces that we strategically positioned inward. Our approach involved moving certain hexagons deeper inward at points where the outer contour of the design extended outward.

With the positions finalized, we connected the inner hexagonal surfaces with the outer surface. Finally, we incorporated our newly formed surface with the reconstructed pillar.

To complete the design for 3D printing, we integrated the outer surface with the infill and cladding and split the model into three printable segments.

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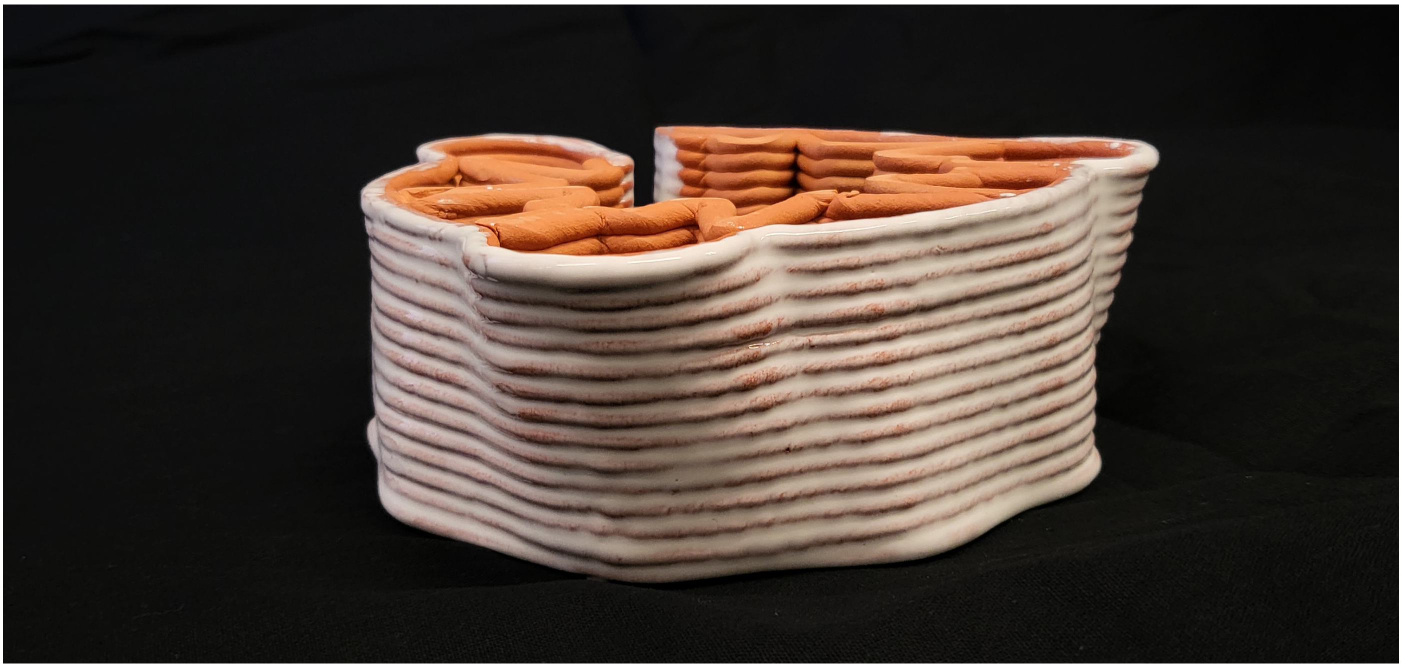
10, 11 & 12	Test print: too narrow pockets for cladding, too high point count for desired resolution due to: build height & too many infill spikes
13 & 14	Test print: not the desired apperance, fixed point count, fixed pocket measurements
15	Final print, fired: warping during drying process



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16 Glazed transition piece: a part to fit the design neatly to the group below, only worked well from one side, shifted too much. (Space in back should be closed)

17 Final Design, Glazed: Assembly test, cladding lacked fixation due to shifting from drying.


arte


Digital Intricacy
Design Journey
Design Variant 1: Components
ITE
Sinan Günes, Milan Reusch, Dion Hook
SoSe 24 I KE - Digital Intricacy
TU Braunschweig

Developmental Lines

Victoria Dang Quoc, Louisa Gehrke & Caroline Zessack

00/Developmental Lines

Each shape requires the next

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Preface

Our initial idea was to create different segments with an endless variety of stacking options. Each of these segments was designed to seamlessly transition into the next. These transitions created a smooth fade between sequences and provided the opportunity to showcase different lighting effects.

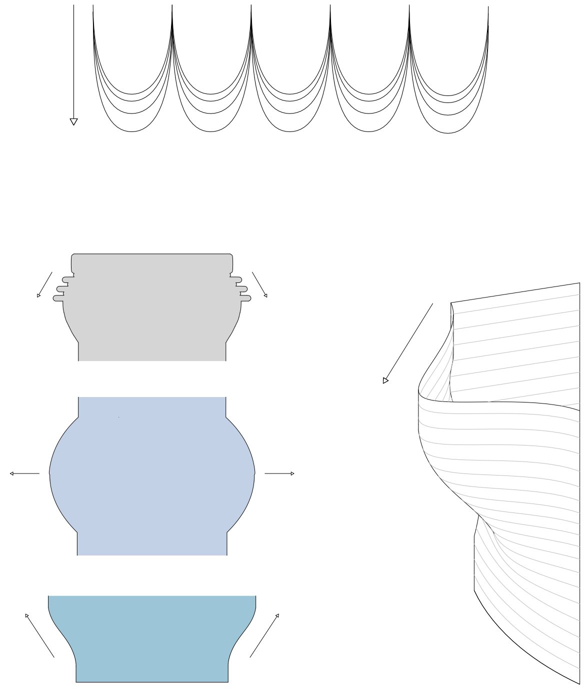
1 Picture Final Cladding

2 Pictogram Initial Ideas

Concept

We came together as a group based on the same design idea of an in- and outgoing curve, with an increasing gradient that created the sling, the pockets, and the shape in general. By using these curves and gradients, each component was harmoniously integrated into the overall structure, with each unit maintaining its own identity and function. The rising and falling curve movement imparted a flowing dynamic to the design, which was not only aesthetically pleasing but also functional.

The segments were designed in a way that they could be combined and stacked in numerous variations, resulting in an almost infinite number of possible configurations. This arrangement created multiple different moods and visual effects and could be adjusted to the user's needs and preferences. Additionally, we wanted to integrate the idea of the interplay between chaos and order. This dynamic interaction generated a fascinating visual experience to engage the attention of the viewer.



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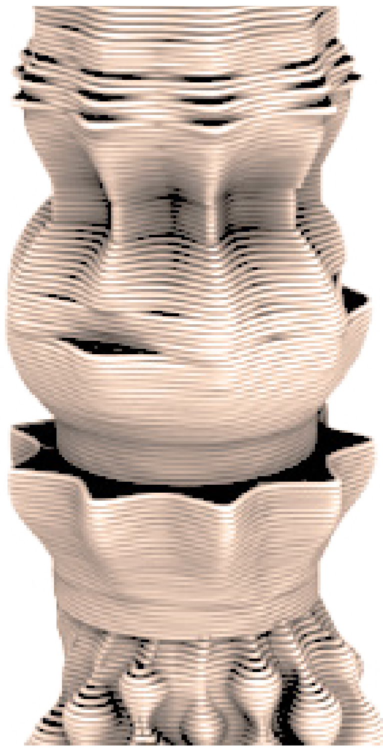
Composition

The final design consisted of three individual but similar singular segments, coming together as one overall design. We divided the parts into Pockets, Slings, and Bottom for better overview and printing efficiency.

The primary concept for the Bottom section was to integrate the pockets with an outrunning shape and make the infill visible. We focused on a horizontal segmentation at three different heights to illustrate the progression of the lines. In the vertical section, it showed that the infill did not follow the outer surface on purpose. The next segment used the Pocket Add-on. Notably, we printed it in two parts due to the effects of gravity.

For the final object, we used the Slings Add-on, which was the culmination of our sling study. We envisioned it as a small crown and aimed to highlight its curvature.



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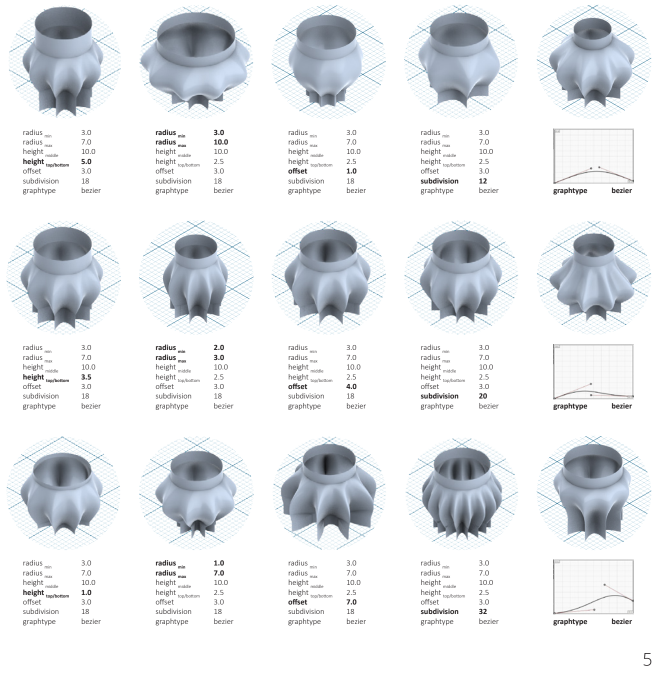
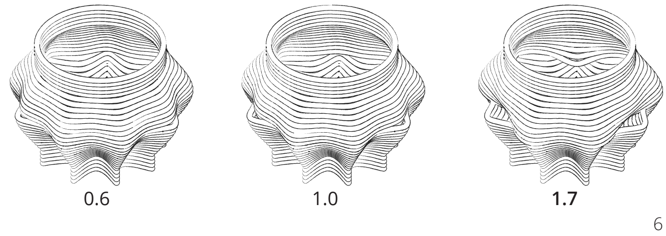
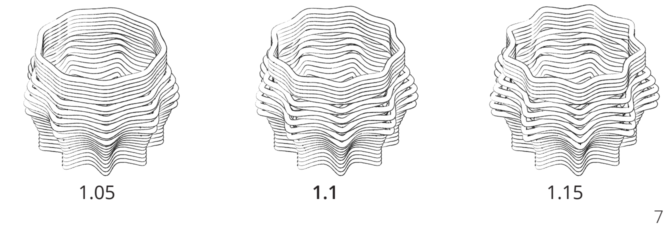
3 Pictogram Concept; Slings dropping down, Stacking system and extruding curve, creating pockets

4 Visualisation Compsition







5 Shape study with variation in height, radius, depth, fragmentation and graph curve (left to right)

6 Design approach Pocket Depth

7 Design approach Pattern Depth Slings

Script

The advantage of parametric design lay in its adjustable parameters. We defined the height using a range of numbers, the width with minimum and maximum radius, the depth through an offset, the fragmentation via subdivision, and the shape using a graph mapper.
In our basic Grasshopper script, we generated the general shape with the mentioned adjustable parameters. We created a series of circles influenced by a graph mapper. The top and bottom parts were treated separately to be adjusted independently. With a mathematical formula, we introduced an increasing offset, which allowed us to dispatch the circle and weave the new points together. This process formed the distinctive shape that transitioned from wavy to round. Because everything was interconnected, each parameter could influence our form. In our shape study, you could observe how the height, radius, depth, fragmentation, and various graph types all impacted the final shape.

One of our key features was the implementation of customizable add-ons.

Add ons

Pockets

Initially, we segmented the edges into inner and outer curves and strategically cut them at a specific height to designate where the pockets would be integrated. The segmentation allowed us to be precise about the placement of each pocket within the column segment. In the following, we dispatched the predefined patterns to ensure that each piece featured a single pocket. To achieve the desired effect, we utilized a graph mapper tool to adjust and manipulate the selected edges by pulling them inward to create distinct pocket formations. We experimented with pocket depths of 0.6, 1.0, and 1.7 to observe the condition of the segment under a piped condition.

Slings

We segmented the surfaces back into curves, utilizing the separation into top, middle, and bottom parts to exert distinct influences and manipulations on each segment. We focused on the manipulation of the outer points of the weaved structure. By extending these outer points outward, we aimed to create an overhang effect during printing.

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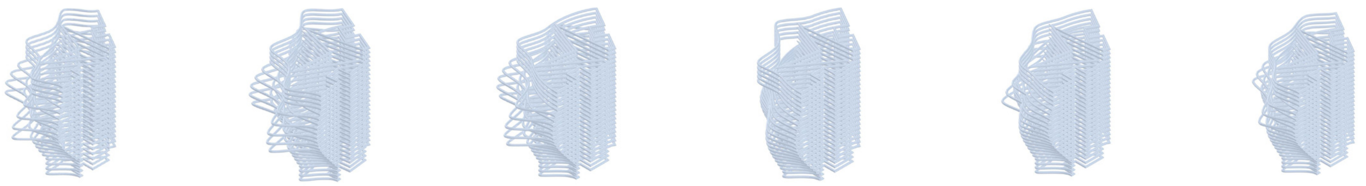

	1	2	3	4	5	6
radius $_{min}$	7.0	**6.5**	6.5	6.5	6.5	6.5
radius $_{max}$	9.0	**7.8**	7.8	7.8	7.8	7.8
height $_{middle}$	8.0	**9.0**	9.0	9.0	9.0	9.0
height $_{top/bottom}$	2.5	2.5	2.5	2.5	2.5	2.5
offset	2.0	2.0	2.0	2.0	2.0	2.0
subdivision	18	18	18	18	18	18
pattern depth	1.2	1.2	1.2	1.2	**1.1**	1.1
start point	8.0	8.0	8.0	**14.0**	**10.0**	10.0

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With this technique, we achieved visual dynamics of the structure but also introduced practical measures, ensuring stability and functionality.

Sling Study

Due to the complexity of the right measurements, we developed a sling study. Our initial attempt failed because the geometry was too stiff. We experimented with more pronounced outgoing curves but were concerned about the fragility during the firing process. Another approach was rotating the slings to drop against the geometry, yet the outcome wasn't what we wanted to achieve.

At the end, we decided to revert to our original design and reduce the depth of the pattern. We gained an aesthetic appeal, addressing both the functional and visual aspects of the concept.

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8 Picture Sling Study

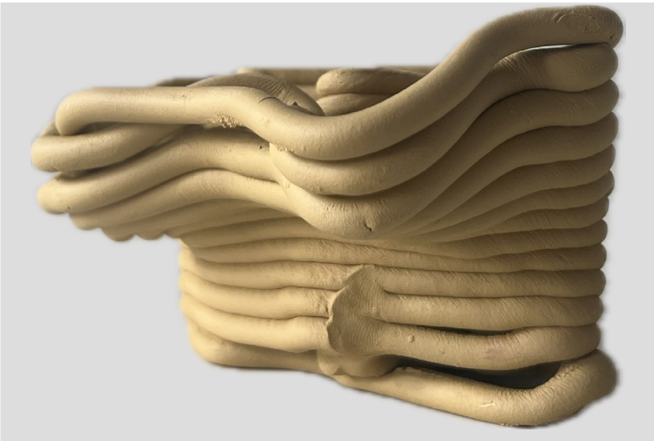
9 Design parameters Slings

10 Final print Slings

Printing Sessions

For our general print setup, we used a 5 mm diameter nozzle, set the layer height to 4 mm, adjusted the speed to 7 mm/s, and worked mostly with a total of points around 1,800.

One major issue was that the curve extended too far outward, causing the print to nearly fall due to its own weight.



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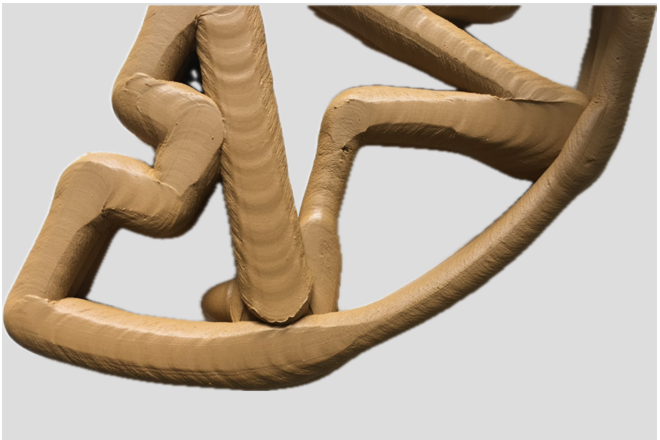
Additionally, while printing, we faced difficulties with the clay being too dry, the cartridge running empty during printing, an uneven table, and the infill touching the exterior surface too much.



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11 Print experiment: Geometry to stiff

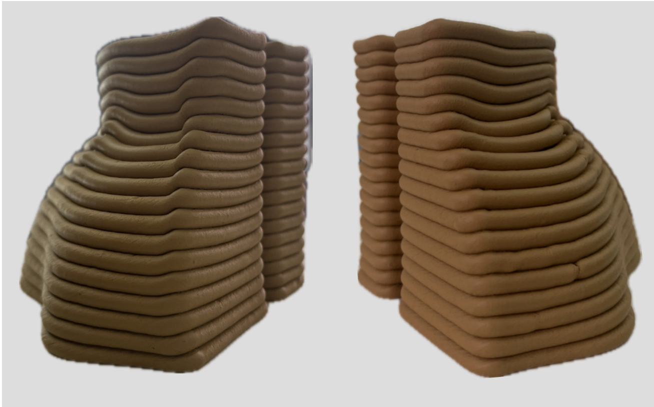
12 Print experiment: Uneven table

13 Print experiment: (left) pushed curve, (right) pulled curve

14 Illustration: Movingdirection of the robot

15 Print experiment: Shrinking process (left) fresh print, (right) print after one day of drying

The positioning of the print was critical; whether the robot pushed or pulled the curve affected the outcome significantly. Pulling the curve tended to create cleaner corners compared to pushing.



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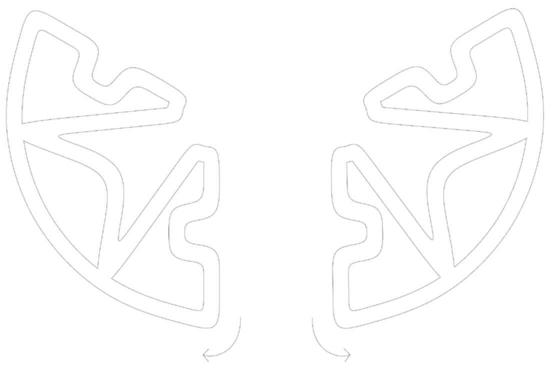

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We documented the shrinking process during drying and observed that the objects shrank by 10–15%, often resulting in uneven drying when it occurred too quickly.

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Firing

We fired our final pieces in the oven at 900 °C, resulting in a color change from natural beige to a terracotta look. After a total of two days, the pieces cooled down completely. Due to challenges encountered during the drying process, we found it necessary to sand some parts for a better assembly of the overall geometry..

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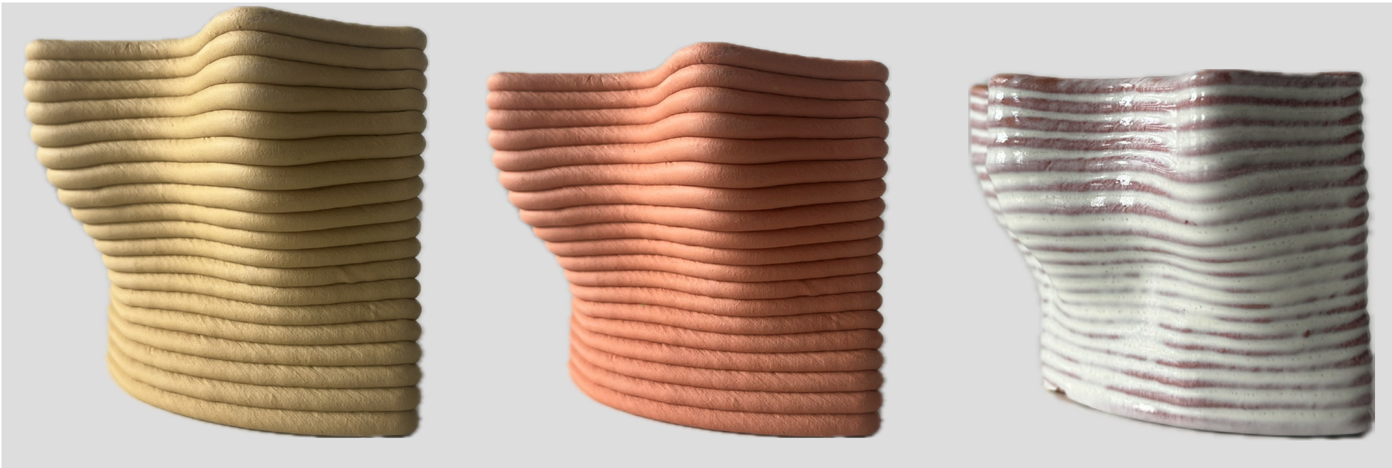

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16 Segments in the oven

17 Development bottom segment printing, firing, glazing

18 Glazing experiment: Spray (left) before firing, (right) after firing

19 Glazing experiment: Brush (left) before firing, (right) after firing

Glazing

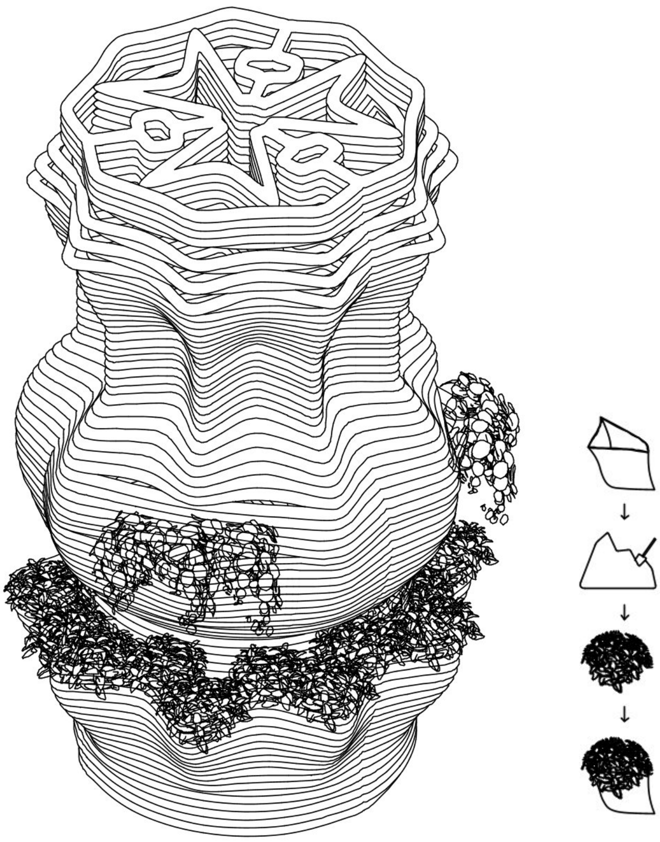
For the final glazing process, we began with experiments to choose the most compatible method.
We experimented with spraying the glaze onto the fired pieces. Unfortunately, this method didn't achieve the desired outcome and applied too heavily on the surface of the geometry.
We later tried painting the glaze onto the surface using a brush. This method proved more effective and gave us better control over the application of the glaze, which was later used on our final pieces.
For the final pieces, we applied two layers of the glaze color "Mother of Pearl" and fired the glaze at a temperature of 1049 °C. Also here, we faced some challenges. For example, an oven leg stood too close to one of our final pieces, causing it to stick and making the removal difficult.

Overall, while we encountered setbacks and challenges throughout the glazing and assembly processes, we ultimately achieved our goal of creating a cohesive and visually appealing final piece.

Future Vision

Originally, Louisa's concept focused on the integration of plants within a column segment. Due to time constraints and a shifted focus on designing the pockets, the idea couldn't be part of our final design. Ultimately, we didn't complete the idea in our minds, leading us to envision a future concept.

In this future vision, we proposed using 3D-printed containers filled with soil to integrate small plants. The next step in our future vision explored the stacking opportunities through parametric design principles and highlighted the flexibility and adaptability of our design. Beyond that, we envisioned our design with an architectural focus. Inspired by historic buildings adorned with intricate details that often clashed with modern additions like simple steel balconies, we conceived a solution. Our idea involved cladding columns to create greener facades. This approach wasn't only for aesthetic reasons but also aimed to improve the microclimate for residents and the urban environment.



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20 Illustration: Plantation

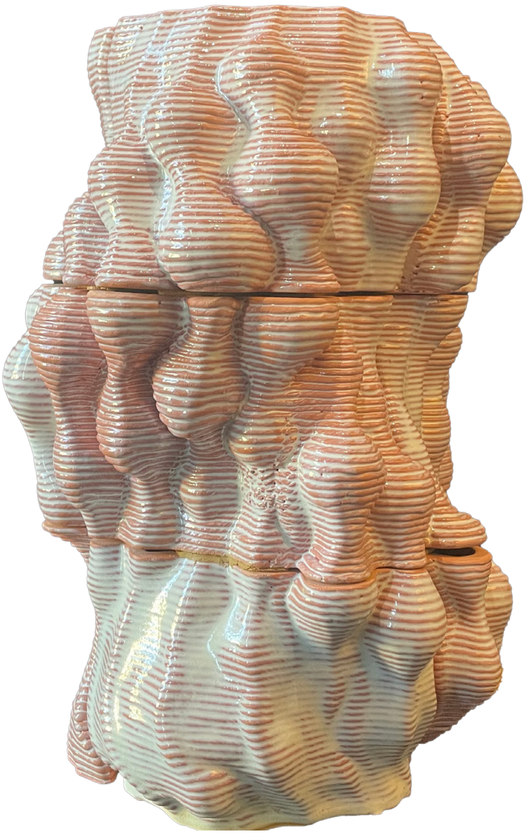
21 Illustration: Balcony cladding

SINE

Konrad Jacobs, Dewid Völk & Katja Heidmann

SINE

An approach to forming and deforming structures



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1 Final glazed and fired object

Preface

So precious, so elegant, it almost seemed to have grown naturally. Shaped by precise parameters yet inspired by nature, this segment evoked the sensation of a gentle breeze passing through. The pearl-like, undulating structure appeared as if it had been formed by the wind itself. Each segment possessed its own unique identity, with varying perspectives revealing intriguing surface formations. Deep crevices between the pearls created additional depth, enhancing the overall texture. Both the top and bottom were reworked to seamlessly transition to neighboring elements, further accentuating the formation of the pearl-like structure in the second segment row.

Behind all those beautiful words were weeks of trial and error. These words merely described the final object, photographed from its best angle. In the following pages, we guided you through the design process. We deconstructed the object into its essential components, revealing the underlying structure and thought behind it. By the end of this chapter, you gained a deeper understanding of the intricacies of the design journey and the concepts of parametric shaping and clay printing.

Pearl Formation

Take a look at Object[1]. Did you notice the correlation between distance and pearl formation? Each pearl was different, right? This uniqueness was made possible by mathematical parameters, so variable that they created many different pearls, each with its own identity. Let's break down the process of pearl formation.

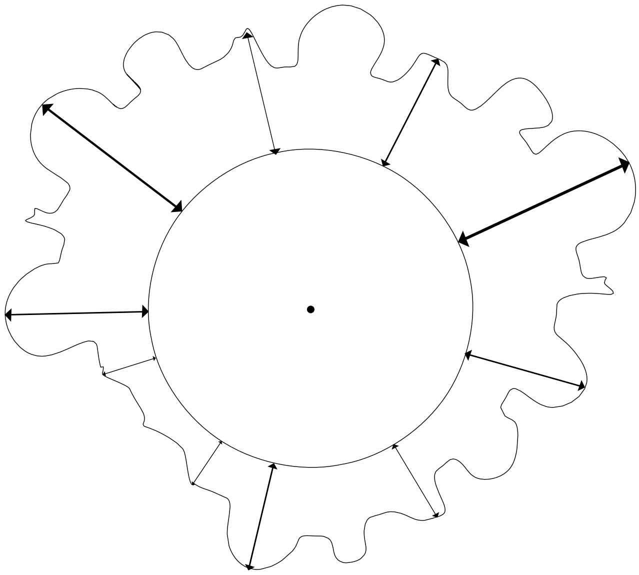
Picture this: Each peak of a pearl was defined by a distance—the distance to an inner cylindrical surface[2]. This distance was a numerical value. By increasing this number, the outer surface point moved further outward. Additionally, this parameter caused the surface to form pearls. At the same time, the size of the pearls was determined by the same distance parameter.

By manipulating these parameters, we achieved a wide range of variations in the pearl formations. The mathematical precision allowed for intricate and organic designs that would have been difficult to replicate manually. With only slight adjustments, we created vastly different outcomes, making each segment unique[3].

Pearl Count

The first described parameter was called amplitude. It defined the size of each pearl. However, the parametric adjustments not only affected size but also the number of pearls created. Increasing the count resulted in more vertical rows and consequently more pearls. As each row became packed tighter, the previously mentioned crevices appeared deeper, adding depth to the object. In our final model, we opted for a balanced approach that harmonized size and quantity.

When these two parameters converged, they not only formed an interesting visual and tactile structure but also created virtually even surface parts. The interplay of these two parameters created a surface where pearls seemingly emerged organically, evoking a sense of natural growth.



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2 Illustration of distance parameter

3 Segment with low pearl count

4 Segment with high pearl count

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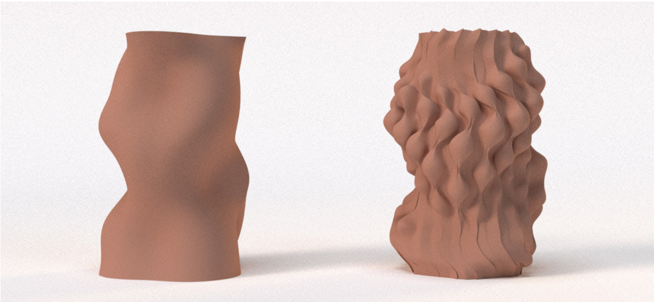

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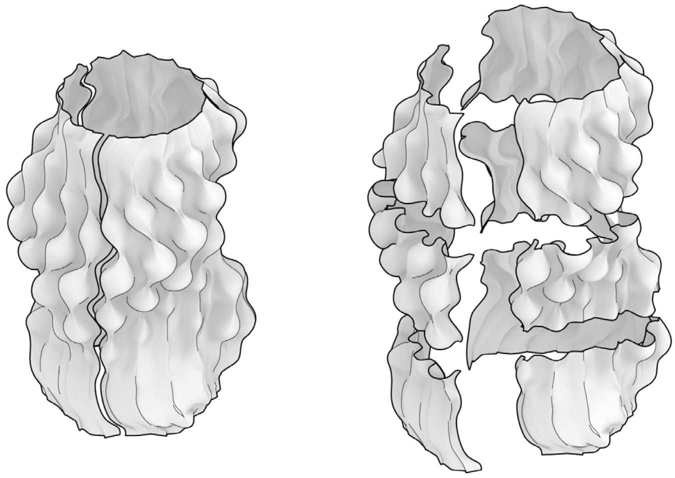

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4 Shape-studie; base-shape on the left, mapped pearl-texture on the right

5 Shape-studie; choosen shape to prepare for printing

6 vertical and horizontal splitted shape

Shaping Process

But first things first. For our Grasshopper design journey, we started with a basic cylinder, which we deformed using the first part of our script. Therefore, we created the desired wavy surface with the help of two different sine graph mappers. In the next step, we took that wavy surface and morphed it into our base cylinder. We were then able to create different silhouettes to work further with.

After creating our winding silhouettes, we began experimenting with fusing the pearl texture into the wavy bodies. For our first attempt, we simply combined the two scripts. The pearly texture was evenly distributed over the body and looked very static.

To aim for a more organic appearance, we started exploring the possibility of manipulating the mapping parameters of the pearly texture, as we had already described. Those mapping parameters gave our design the desired natural appearance, which we then improved until we had our finished product (4, 5, 7).

In the end, we adjusted the top and bottom of our design to fit with the group above and beneath us for a smoother transition in the overall lamp composition.

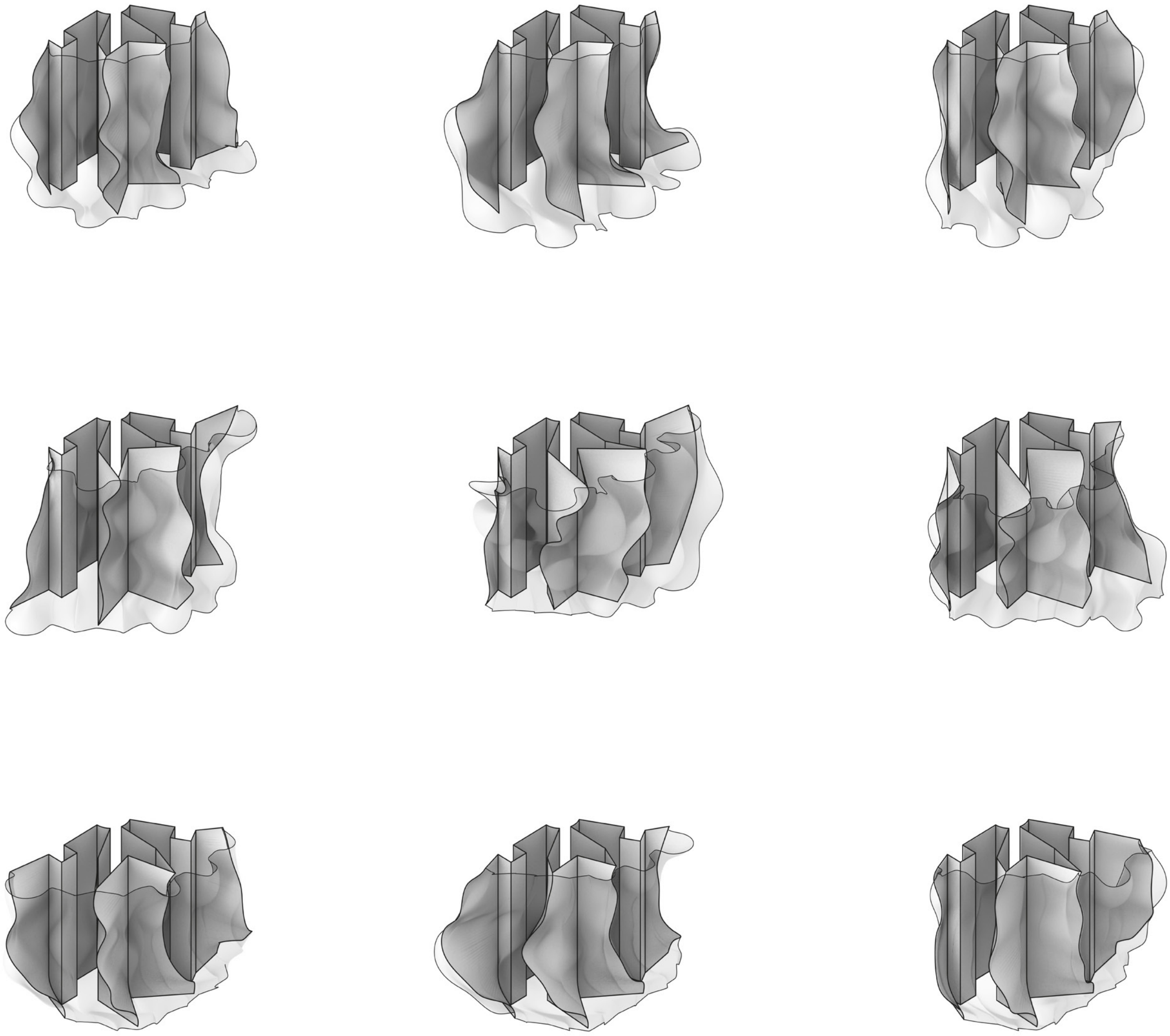
Splitting and Infill

We divided the finished shape into nine parts by cutting it horizontally and vertically three times each (6²). In this partition, the printing dimensions of one element matched the possible clay amount the robot could handle. For the vertical split, we used curves from the loft generation to set the seamlines along three creases. This way, it did not disturb the shape, and the seamline was less visible in the end.

Unfortunately, when it came to splitting the design horizontally, we were only able to cut it straight, slicing through the pearl texture instead of following it. Each part had a height of 10 cm, making a total of 30 cm. Each element was highly individual and had a specific place in the composition. It could not be exchanged with another element.

These shape elements were then inserted into the infill script that all groups in the course had decided on. The infill design aimed to provide structural stability to the outer shape and serve as a connection to the lamp shaft and other elements at the same level.

To use fewer points, the infill incorporated two spikes for structural support. These spikes touched the outer surface along two inner loft curves, allowing the infill to adjust itself to the different elements and integrate with their identities (7).



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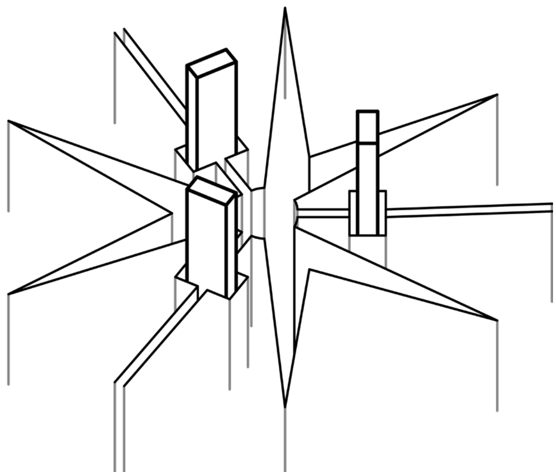
For the connection between stacked elements, the infill had pockets for sticks, which could be placed between two parts. Three sticks (2) prevented the stacked elements from falling apart (8). Despite the promising concept of the infill, we noticed its dysfunctionality during assembly. In other words, this type of connection was not strong enough to support the weight of the stacked designs. Therefore, each layer of elements needed to be tied together from the inside using fishing line.



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7 shape elements in stacked order (3 elemnts in the top are at the top in the arrangement); connecting part between infill and outer surface is pointed out

8 concept of the interlocking-system: sticks prevent the elements from shifting appart

Printing Journey

A significant part of our design-journey were the printing tests. Through those we were able to explore different settings, for example in terms of air pressure or printing speed.

The best setting for our design were:

- average printing time per object: 35 min
- printing speed used: 9 mm/s
- pressure: 5 Bar
- highest point count: 1935
- layer height: 2.7 mm
- first layer height between: -19 to -26 mm
- amount cartridge: 1
-

It took some time to learn, how the different settings affected each other.
For example, the air pressure and the clay softness both had a high impact on the printed clay-amount per time.
The layer height deeply influenced the needed point-count for one element. Though the point-count itself was always around 1900 points, the g-code could either create sharp cuts at the outer surface, or smooth paths. It was up to the path-length, the slicer had to rebuild. A variation of the contour height by 0.2 mm made a visible difference already.

We also played around with the pearl count (the number of horizontal stacked pearls are relevant) to look how it affects the design and the point count (3, 4). Of course, a higher pearl count created more complex contour-paths with more needed points.
So the final combination of pearl-accumulation, their size and spacing is an interplay with the clay-width and contour height.

The major issue in the post-processing was the shrinking of the clay and the resulting deformation. Its intensity depends on a couple of different factors, like the clay softness or an unbalanced clay-accumulation in certain areas of the design.
But also the surroundings like the temperature and available moistness influenced the drying-process.
We decided to use a moister clay than in the packages for a smoother printing process. Due to the higher moisture, the shrinking amount increased to around about 5%.

The printing-process as an experience was very crucial for the task overall. To constantly check the design-process on the object itself and get feedback from it created a back-and-forth that was exemplary for a design-process. To practice this process in a dimension/(task) like this was a very intuitive.

Splitting and Infill

9

10

9 Test print

10 Final element

11

12

11 Glazing process

12 Shape studie


EPSON
Ditgital Intricacy
Prelude | Individual journey
base-line
volumic offset
point control
Monumentalfriedhof "Staglieno",
Nikolaus Walter

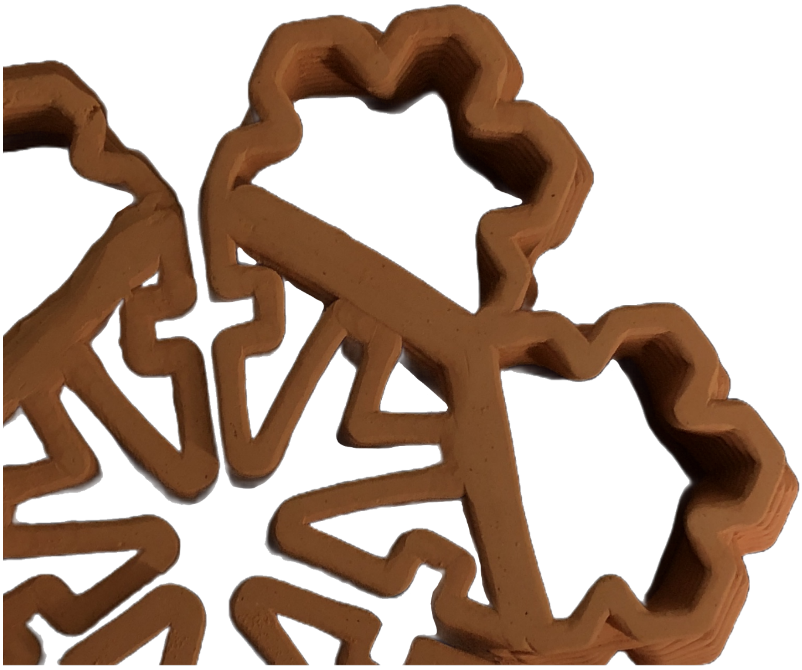
Nature`s Rebellion

Mia Erbguth, Marie-Jeannine Hieke & Deniz Kudu

The Journey of Nature's Rebellion

The story of the importance of Processes

Developed by Mia Erbguth, Marie-Jeannine Hieke & Deniz Kudu



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1 Top view of one final geometry

Preface

The first weeks were about getting in touch with the language of the new program called "Grasshopper." In the workshop, we learned how to loft and manipulate geometries in different ways. This content became the foundation for later design explorations. For us, it was an important realization that there was not always one solution—there were many different ways to achieve the same result.

The Journey is the Destination

In our individual working phase, we developed three different ideas: "A Key to the Universe (3,6,9)," "With a Twist," and "Differential Growth." Our internal systems, including infill and interlocking systems, worked the same way. We created an infill generated through the external structure within one continuous line. The interlocking system functioned like a modified version of a "dovetail" in woodwork. After several attempts with the "Differential Growth" script, we realized that although it produced an interesting and complex structure in the top view, the side view did not reflect the same aesthetic.

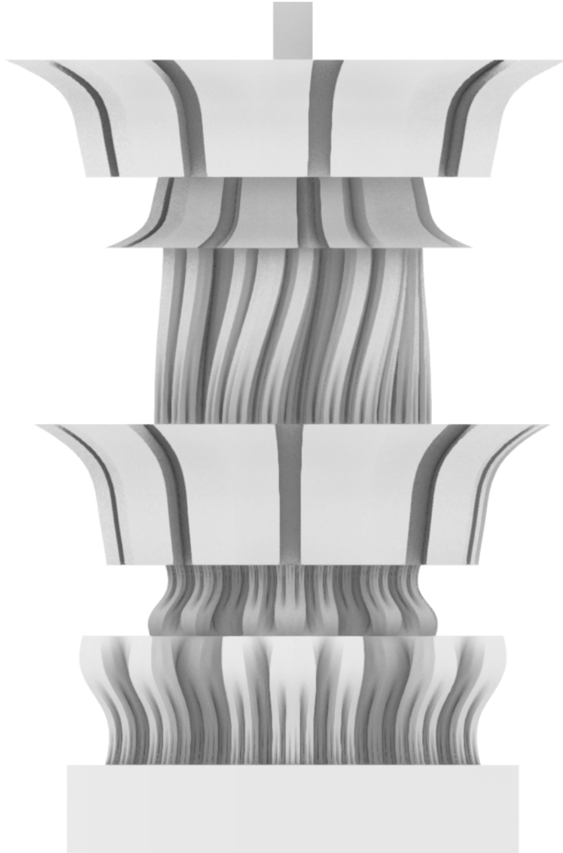
The Free Will

After forming the group, we filtered our themes and reduced them to their essence. Our group chose the expression "Free Will" as our guiding concept. With the topic "3, 6, 9," our goal was not only to integrate these numbers into the "Number Sliders" in Grasshopper but also to reflect the theme in the geometry itself. To break away from conventional forms, we opted for a triangle, dividing it into three parts. While many groups automatically designed a cylinder, as it is the most common column shape, our theme "Free Will" encouraged us to challenge conventions, express individuality, and break out of traditional systems. The theme "With a Twist" embodied both linearity and rotation. We explored how multiple individual linear parts could form a unified sculpture without direct connections. Additionally, "Differential Growth" was characterized by a gradient form: a small diameter with high detail at the bottom, transitioning to a large diameter with less detail at the top. It was essential for us to design a continuous geometry, conveying unity throughout the piece. To visualize our concepts and test the connections, we printed PLA models using a conventional 3D printer.

Given the complexity of our structures, frequent clay printing became essential. While we typically used a 5.0 mm nozzle, we also experimented with a 3.8 mm nozzle, which produced a finer, more detailed layering that we appreciated.Inspired by the increasing diameter and well-defined top view of our design, we envisioned our geometry as the bottom part of the lamp. We also valued the symbolic gesture of creating a "stage" for the next group, fostering continuity within the collective project.

Printing Challenges

When printing the geometries, we ensured that the clay was adequately moistened. Insufficient moisture caused issues such as tearing and low contact pressure. Additionally, an uneven printing plate resulted in inconsistent layer heights. When the printing speed was too high, the layers rolled up, compromising the print quality.



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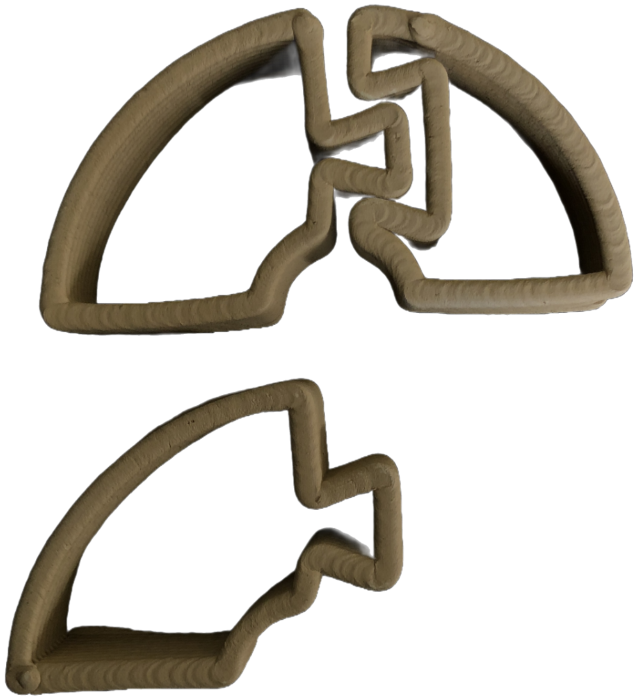
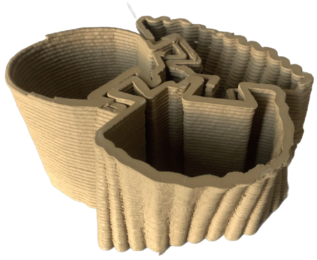


2 Digital prototype of geometries with the topic "Free Will"

3 Testing parameters for our interlocking system



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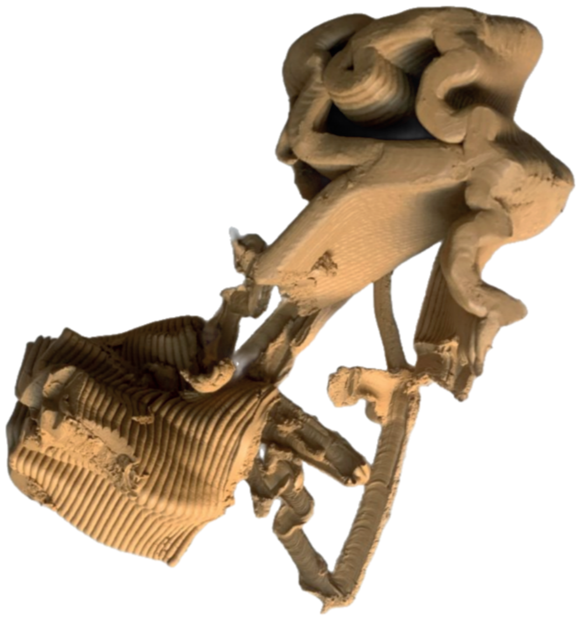

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4 Let our "Free Will" play with the geometry

5 Different layerheights caused by uneven printing plate

6 Failed geometry due to incorrect position of start- and endpoint in the script, robot crashed into final geometry

Challenges

In addition to the typical problems with printing, we also faced challenges with our design. Unfortunately, we had to realise that the geometry combined all of our themes in a simple way but did not represent the full power of our ideas. So we sat down again and let our "Free Will" play with the model. We thought about developing a system in which all the individual parts could be combined with each other in many different ways. After this phase, we developed a design with as many geometries as possible and came up with various combinations. The geometries were created with a "Differential Growth" and a "Fractal" script. It was important to us that the geometries looked as different as possible but still created harmony when combined. This meant we worked with different heights and diameters, combined both scripts, and placed detailed geometries above less detailed ones.We were also faced with further challenges with our final geometry. For instance, our diameter was too small to use the overall agreed infill and interlocking system. It would have collided with our external structure. After solving the first challenge, the next one arose. With the diameter enlarged, the overhangs also increased.

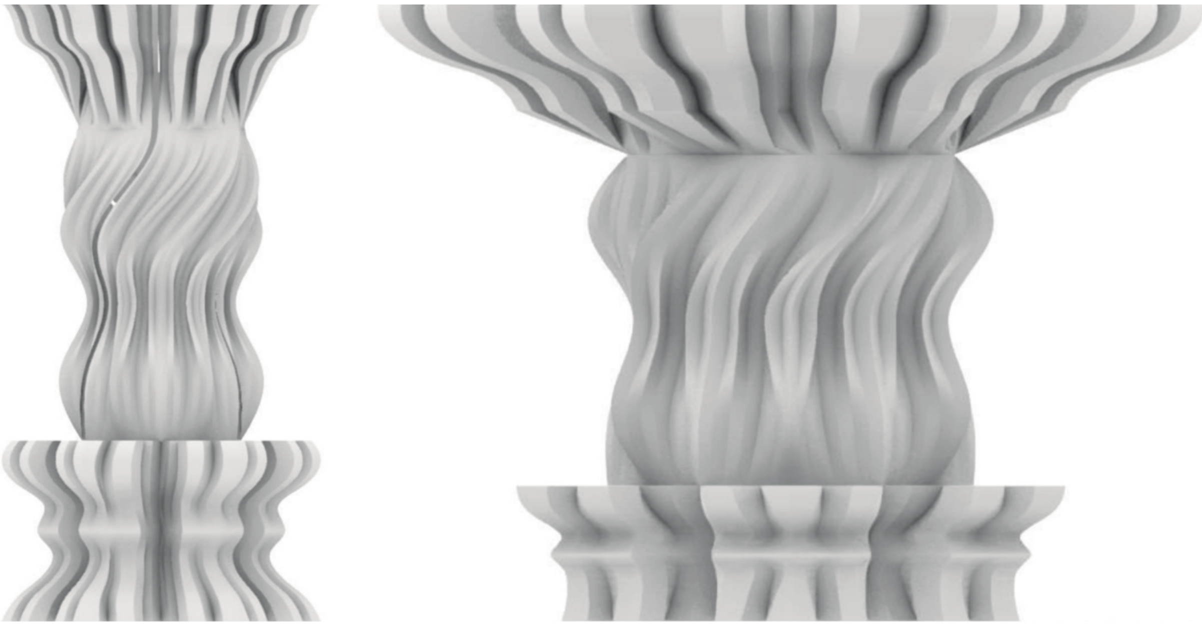
For most of our geometries, we managed to find a solution for a printable version, but the upper geometry had too much overhang. Due to a lack of time, we decided to repeat our lower geometry and replace the upper one.

What is Differential Growth?

Differential Growth was an increasing phenomenon in terms of biology. It was a process in which one form multiplied the same form many times over. It looked like a coral structure from the top. Due to those complex structures, it caused a very high point count.

What is Fractal?

Fractal meant that you had one base geometry, for example, a triangle, and one generator curve. The generator geometry arrayed around the base geometry multiple times. A lot of different levels of detail were generated with the same geometry.



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Glazing

After some glazing tests, the whole group decided to glaze with one overall agreed color. Even though we really liked the baked, unglazed appearance of our model, we agreed to glaze. After some struggles due to a lack of experience with glazing, we optimized the glazed geometries, ran the oven, and finally baked our geometries.

7 Pre-final digital models - before and after enlarging diameter

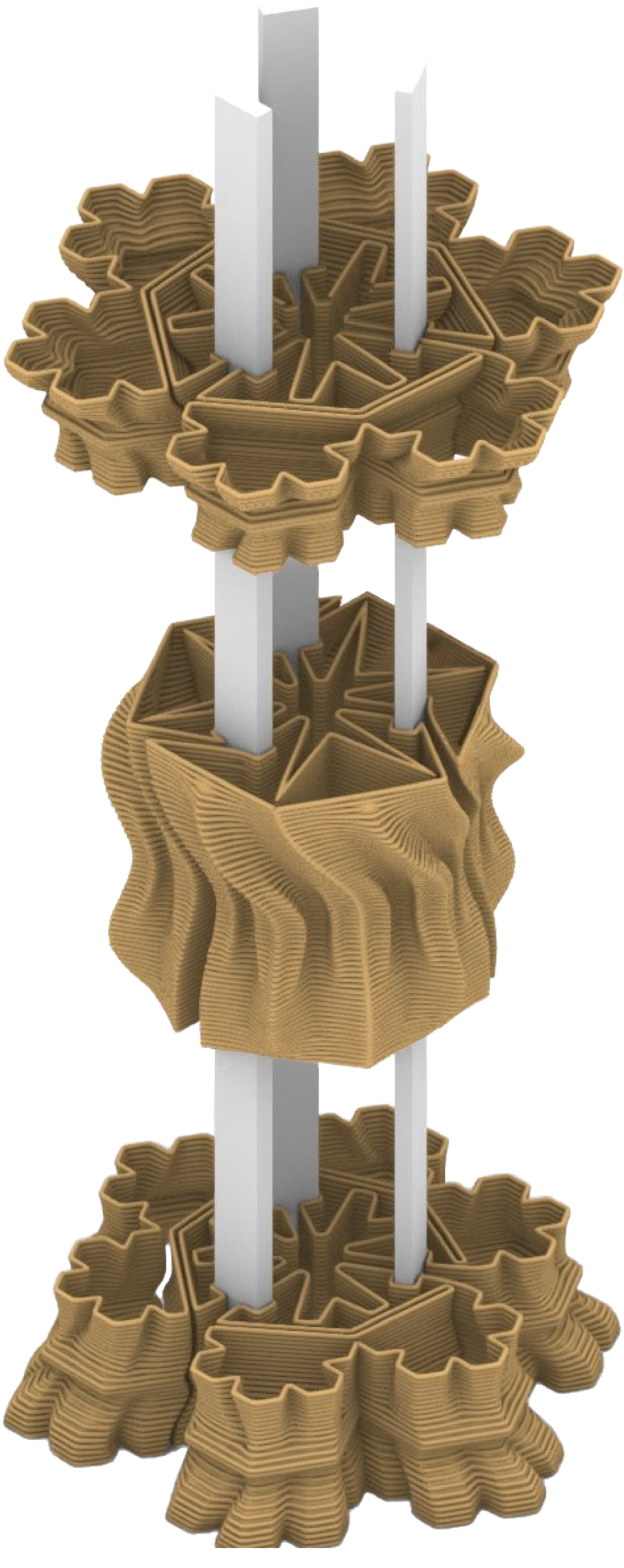
8 Top geometry

9 Bottom geometry

10 Twisted upper geometry

11 Twisted lower geometry

13 Glazing in process



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13 Final digital model with interlocking system

14

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14 Sanding our final geometries

15 Final geometry assembled as bottom part on the lamp


Digital Intricacy
A Key to the universe
Inspirations
ITE

Design Showcase


Beautifying


Digital Intricacy
Background
Ornament in Modern Architecture
Innovate Ornament
Eliminate Ornament
Adolf Loos
Ornament
and
Crime
Technische
Universität
Braunschweig


EPSON

Earth Printing
Compact Design Studio

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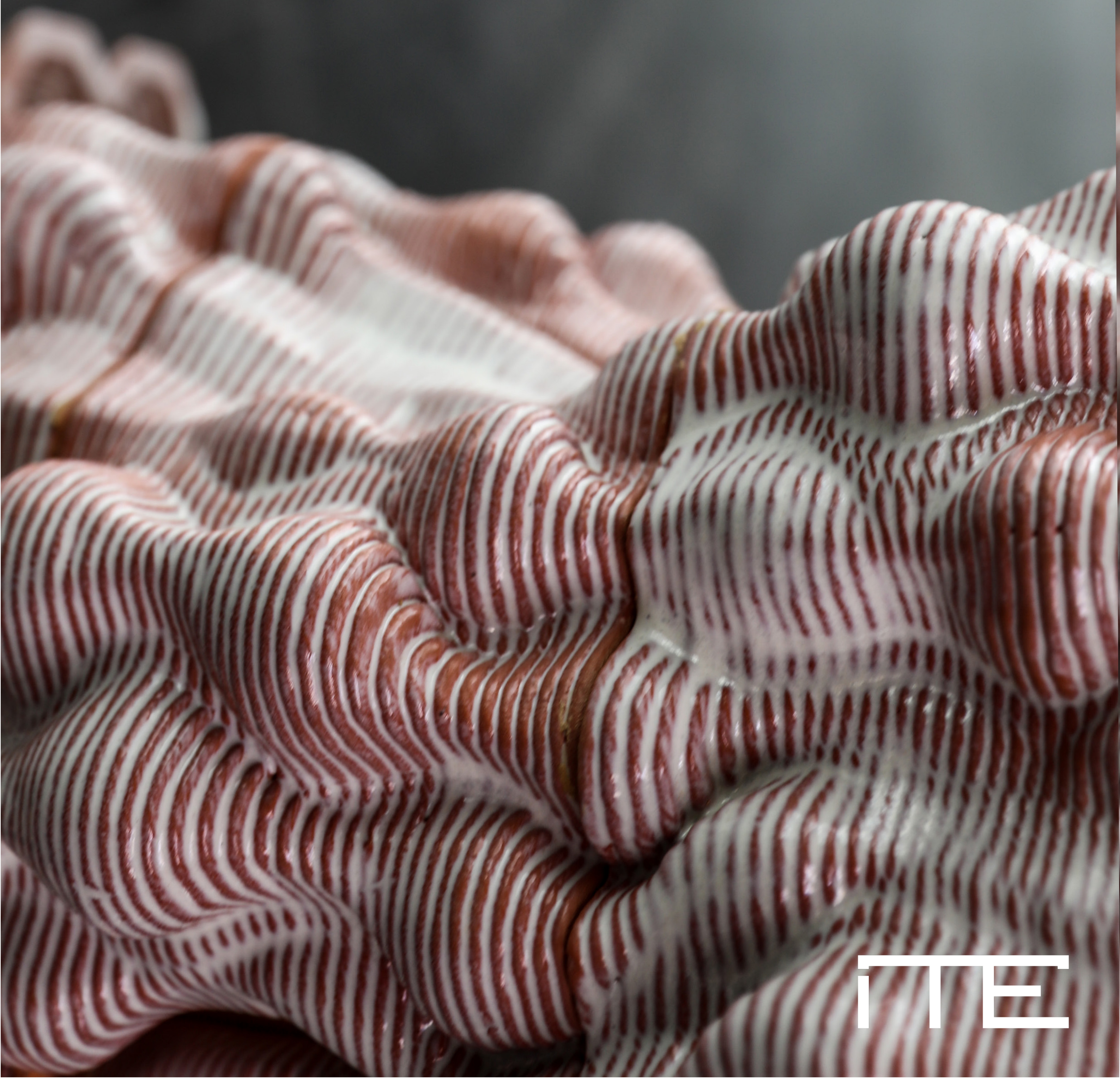
Summer 2023



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