final assignment: Darwinian Evolution-Inspired Growth: A Geometric Vase

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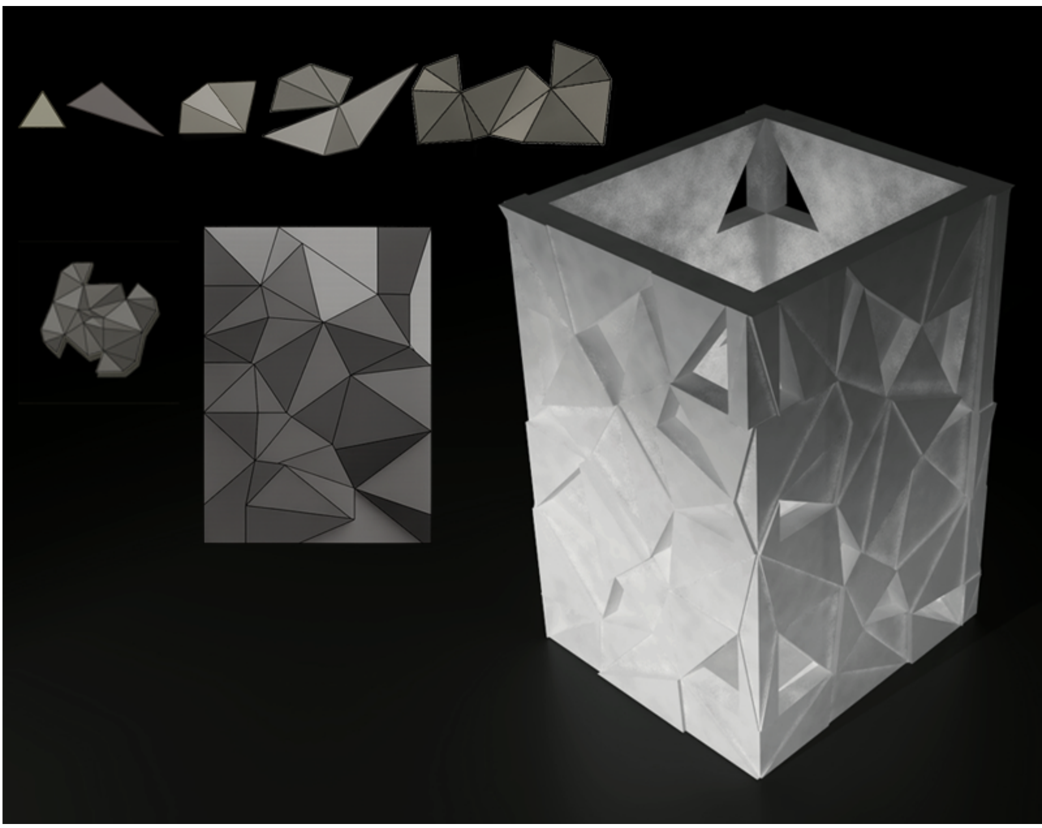

Fig. 1. Darwinian Geometry: Evolving Forms in Space

In this project, based on Darwin's theory of natural selection, I made a vase with some non-symmetrical, irregular, and visually strong triangles. Each vase wall is connected to other walls through these triangular forms. The process starts with a simple triangle, and at each level, some complex forms are selected. The final shape is designed to extend across four walls and create a strong composition on walls. This project aims to

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create and design a vase through geometric transformation inspired by Darwin's theory of natural selection and generate a complex form as a composition that exists within the vase's walls.

CCS Concepts: • **Do Not Use This Code → Generate the Correct Terms for Your Paper**; *Generate the Correct Terms for Your Paper*; Generate the Correct Terms for Your Paper; Generate the Correct Terms for Your Paper.

Additional Key Words and Phrases: Do, Not, Us, This, Code, Put, the, Correct, Terms, for, Your, Paper

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1 Introduction and Related Works

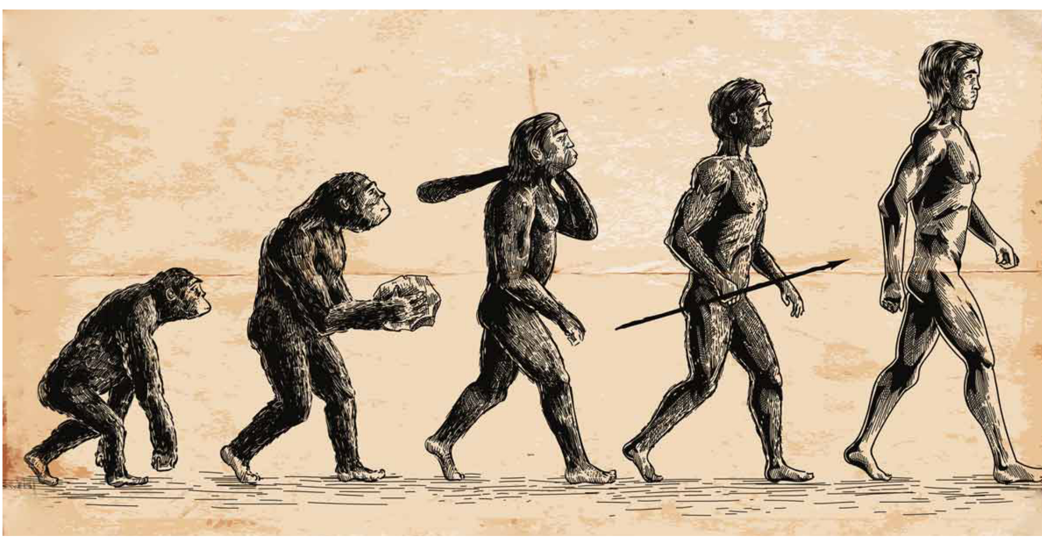

Fig. 2. Biological Evolution: From Survival to Adaptation

$$ {}_1G = \arg\max[F(G'_0)], \quad \text{where } F = w_3V + w_2B + w_1C $$

Fig. 3. formula A :F: Mathematical equation.A1: Asymmetry — how irregular or unbalanced the form is. A2: Complexity — the structural and visual intricacy.A3: Visual Strength — how much the form stands out visually .A4: Structural Stability — how connected, closed, or stable the form looks.w1–w4: Weights assigned to each feature, based on importance G0: A set of generated forms in the current generation G1:The selected form with the highest fitness score to move to the next generation

"As more individuals are produced than can survive, there must in every case be a struggle for existence [1]. Based on Darwin's theory of natural selection, some traits can survive and are complex. [1] "Triangles are the simplest polygon, yet they offer the highest flexibility for constructing complex surfaces" [2]. Most researchers have shown that the human brain responds strongly to complex and unpredictable forms [2]. This theory is my inspiration for this project.

In place of living organisms, I use geometric forms to explore the same principles. I started with a triangle, which can potentially create complex shapes [3]. Also, the angles and the length can be changed, making it many unique triangles, but we have the same angles in other shapes like squares or rectangles. At each stage, I selected the more unpredictable and visually complex form rather than one that was simply symmetrical or orderly. For the production process, I use CAD for sketches, highly precise software for making patterns, and Photoshop to make visual patterns clear. I used SketchUp and 3ds Max to control lighting and textures for modeling, turning scientific theory into visual form. These tools, widely used since the 1980s, helped translate theory into form.

2 Methodology

My process grows step by step, like Darwin's idea. I choose shapes using A and W. I think good design shouldn't feel too predictable, but it should make you think. That's why I started with triangles. Their angles create unexpected, complex forms. Squares are too regular.

Score (A_i)	Feature Name	What It Represents	Example Value	How This Score Is Interpreted
A_1	Asymmetry	How irregular or unbalanced the form appears	0.9	A highly asymmetrical shape with no clear mirror axis
A_2	Complexity	The level of structural and visual intricacy	1.0	A highly detailed, layered form with many internal divisions
A_3	Visual Strength	The form's ability to catch attention and stand out visually	0.8	A bold, directional shape with strong line dynamics
A_4	Structural Stability	How closed, stable, or well-connected the form appears	0.2	A loose or open structure, with minimal visual containment

Fig. 4. feature Score Table(A)

Weight (W_i)	**Feature Name**	**What It Represents**	**Example Value**	**Why This Weight Might Be High or Low**
W_1	Asymmetry	The importance of irregularity and lack of mirroring	0.5	High when visual flexibility and unpredictability are preferred
W_2	Complexity	The importance of visual richness and structural layering	0.3	Medium-high when design focuses on progressive, multi-layered growth
W_3	Visual Strength	How much the form needs to stand out and attract attention	0.2	Lower when boldness is secondary to structural transformation
W_4	Structural Stability	The importance of closed, connected, and static structures	0.1–0.2	Low when openness is desired to allow ongoing visual evolution

Fig. 5. Weight Definition Table

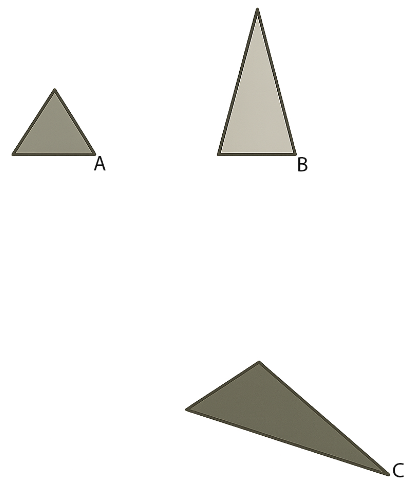

Fig. 6. Figure C: Highly asymmetric (1.0), Complexity (0.5), visually engaging (0.6), and unstable (0.2). Figure B: Asymmetric (A1=0.3), Complexity visually (0.4), weak (A3=0.3), and too stable (A4=0.8). Fitness functions: $F(G) = (w_1 \cdot A_1) + (w_2 \cdot A_2) + (w_3 \cdot A_3) + (w_4 \cdot A_4)$, $F(GB) = (0.5 \times 1.0) + (0.2 \times 0.5) + (0.2 \times 0.6) + (0.1 \times 0.2) = 0.74$, $F(GC) = (0.5 \times 0.3) + (0.2 \times 0.4) + (0.2 \times 0.3) + (0.1 \times 0.8) = 0.37$

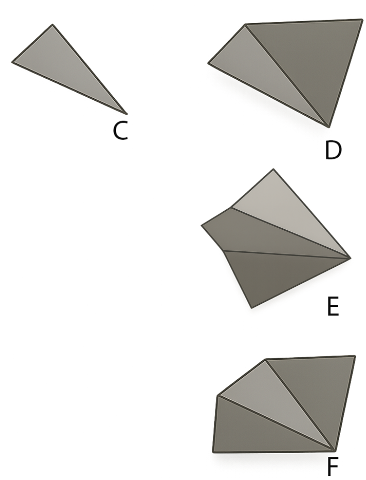

Fig. 7. F(GF) (selected): Irregular (0.7), complex (0.8), strong (0.6), low stability (0.3). F(GE): Symmetric (0.4), simple (0.5), weak (0.4), stable (0.6). There is not enough potential. F(GD): Mild asymmetry (0.5), mid complexity (0.6), average strength (0.5), semi-stable (0.5). Fitness scores: $F(GD) = w_1 \cdot A_1 + w_2 \cdot A_2 + w_3 \cdot A_3 + w_4 \cdot A_4 = (0.3 \times 0.4) + (0.3 \times 0.5) + (0.2 \times 0.4) + (0.2 \times 0.6) = 0.12 + 0.15 + 0.08 + 0.12 = 0.47$, $F(GE) = (0.3 \times 0.5) + (0.3 \times 0.6) + (0.2 \times 0.5) + (0.2 \times 0.5) = 0.15 + 0.18 + 0.10 + 0.10 = 0.53$, $F(GF) = w_1 \cdot A_1 + w_2 \cdot A_2 + w_3 \cdot A_3 + w_4 \cdot A_4 = (0.3 \times 0.7) + (0.3 \times 0.8) + (0.2 \times 0.6) + (0.2 \times 0.3) = 0.21 + 0.24 + 0.12 + 0.06 = 0.63$

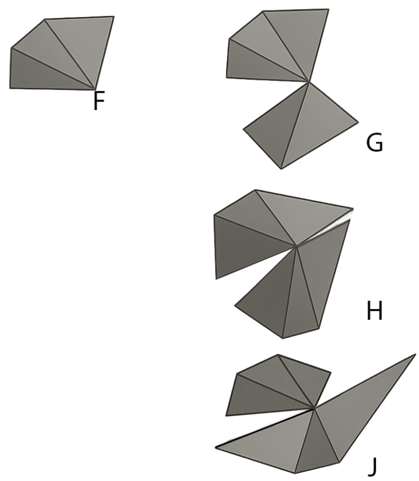

Fig. 8. In Figure 8: F(GJ) (selected shape): Very asymmetric (0.9), highly complex (0.9), visual impact (0.9), and fully open (0.2). F(GG): Slightly asymmetric (0.6), mid complexity (0.6), average strength (0.6), semi-stable (0.5). F(GH): Spread form (0.7), complex (0.8), noticeable (0.7), semi-open (0.4). Fitness scores: $F(GG) = (0.3 \times 0.6) + (0.3 \times 0.6) + (0.2 \times 0.6) + (0.2 \times 0.5) = 0.18 + 0.18 + 0.12 + 0.10 = 0.58$, $F(GH) = (0.3 \times 0.7) + (0.3 \times 0.8) + (0.2 \times 0.7) + (0.2 \times 0.4) = 0.21 + 0.24 + 0.14 + 0.08 = 0.67$, $F(GJ) = w_1 \cdot A_1 + w_2 \cdot A_2 + w_3 \cdot A_3 + w_4 \cdot A_4 = (0.3 \times 0.9) + (0.3 \times 0.9) + (0.2 \times 0.9) + (0.2 \times 0.2) = 0.27 + 0.27 + 0.18 + 0.04 = 0.76$

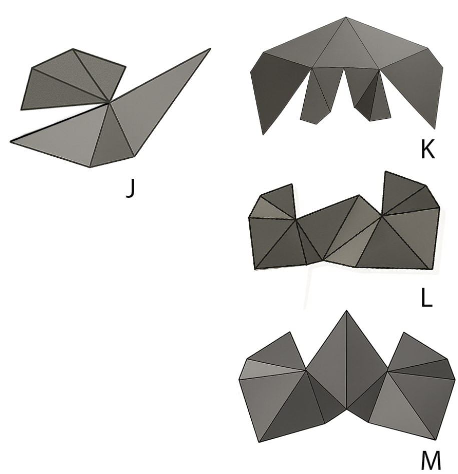

Fig. 9. In Figure 9: F(GK): Some symmetry (0.5), layered (0.7), decent visual (0.6), closed form (0.6). F(GL): Asymmetric (0.7), very complex (0.9), strong visual (0.7), and loosely connected (0.3) (chosen shape). F(GM): Almost mirrored (0.3), balanced complexity (0.6), medium visual strength (0.5), stable (0.5). Fitness scores: $F(GK) = (0.3 \times 0.5) + (0.3 \times 0.7) + (0.2 \times 0.6) + (0.2 \times 0.6) = 0.60$, $F(GL) = w_1 \cdot A_1 + w_2 \cdot A_2 + w_3 \cdot A_3 + w_4 \cdot A_4 = (0.3 \times 0.7) + (0.3 \times 0.9) + (0.2 \times 0.7) + (0.2 \times 0.3) = 0.21 + 0.27 + 0.14 + 0.06 = 0.68$, $F(GM) = (0.3 \times 0.3) + (0.3 \times 0.6) + (0.2 \times 0.5) + (0.2 \times 0.5) = 0.09 + 0.18 + 0.10 + 0.10 = 0.47$

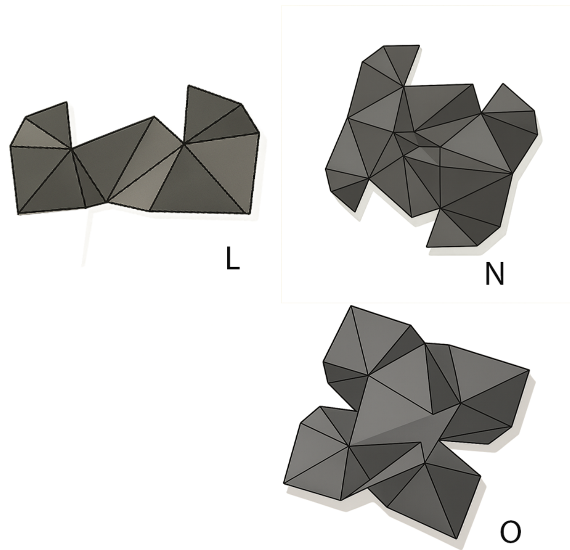

Fig. 10. In Figure 10: F(GN) (selected): Very asymmetric (0.9), highly complex (1.0), strong impact (0.9), and open (0.2). F(GO): Heavy form (0.8), very complex (0.9), dispersed strength (0.8), and rigid (0.4). Fitness scores: $F(GN) = w_1 \cdot A_1 + w_2 \cdot A_2 + w_3 \cdot A_3 + w_4 \cdot A_4 = (0.3 \times 0.9) + (0.3 \times 1.0) + (0.2 \times 0.9) + (0.2 \times 0.2) = 0.27 + 0.30 + 0.18 + 0.04 = 0.79$, $F(GO) = w_1 \cdot A_1 + w_2 \cdot A_2 + w_3 \cdot A_3 + w_4 \cdot A_4 = (0.3 \times 0.8) + (0.3 \times 0.9) + (0.2 \times 0.8) + (0.2 \times 0.4) = 0.24 + 0.27 + 0.16 + 0.08 = 0.75$

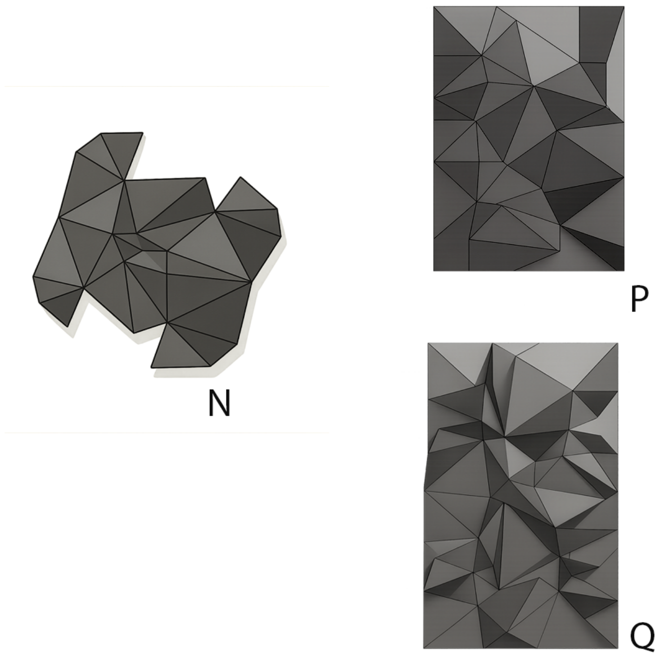

Fig. 11. In Figure 11: F(GP) (selected): Asymmetric (0.8), complex (0.9), strong visual (0.8), and open (0.4). F(GQ): More regular (0.6), less complex (0.7), narrow visual (0.6), and rigid (0.5). Fitness scores: $F(GP) = w_1 \cdot A_1 + w_2 \cdot A_2 + w_3 \cdot A_3 + w_4 \cdot A_4 = (0.3 \times 0.8) + (0.3 \times 0.9) + (0.2 \times 0.8) + (0.2 \times 0.4) = 0.24 + 0.27 + 0.16 + 0.08 = 0.75$, $F(GQ) = (0.3 \times 0.6) + (0.3 \times 0.7) + (0.2 \times 0.6) + (0.2 \times 0.5) = 0.18 + 0.21 + 0.12 + 0.10 = 0.61$.
I mirrored the chosen pattern on all four sides of the vase, creating continuous lines that connect the walls and give the form a unified, flowing appearance.

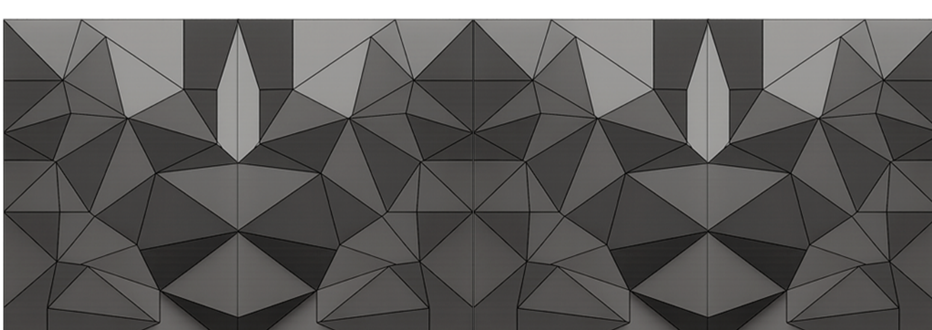

Fig. 12. Unfolded View with solid space

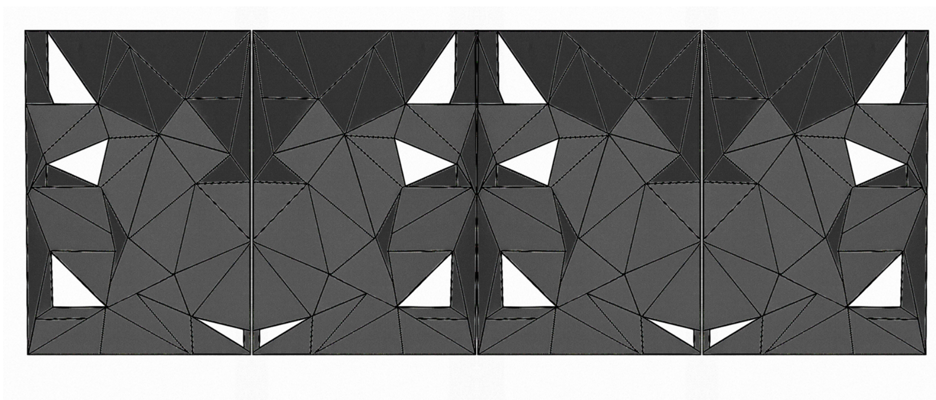

Fig. 13. Unfolded View and add negative space

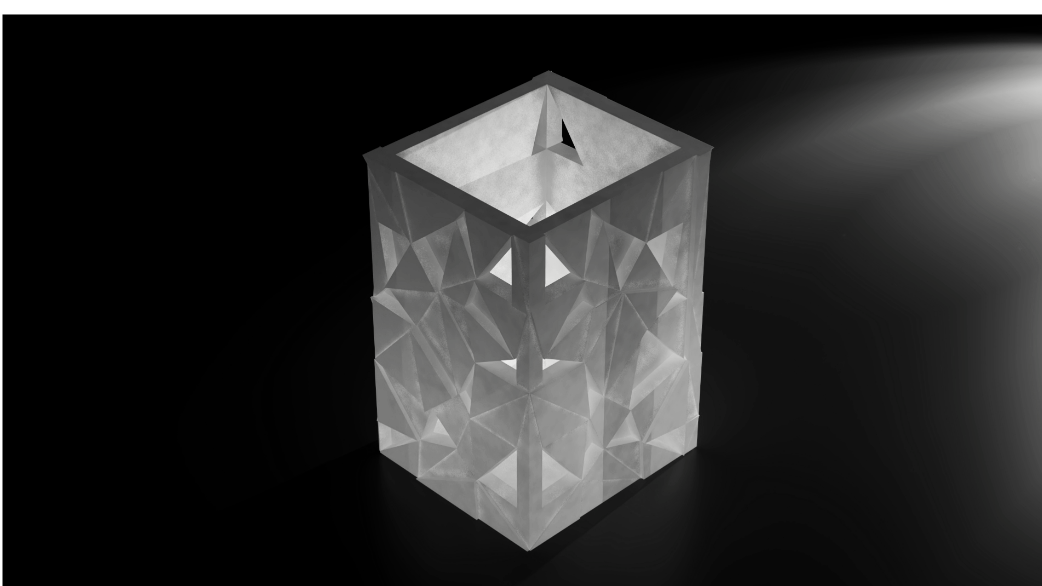

Fig. 14. render 1 of the final vase

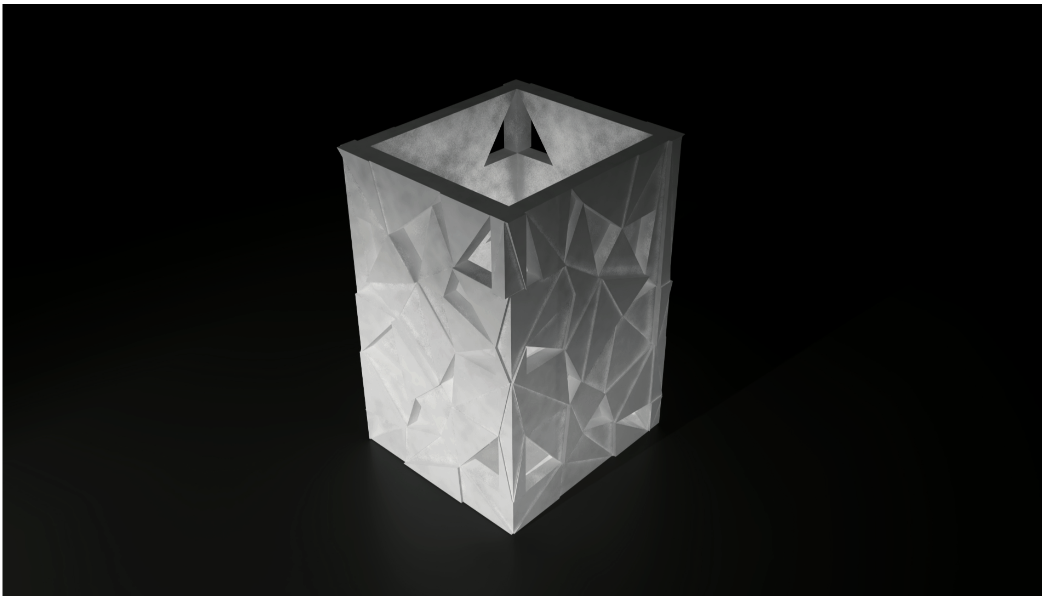

Fig. 15. render 2 of the final vase

3 Result and Future Work

This project reflects my ideas about transforming Darwin's theory of natural selection into a visual design process. I created a process of visual evolution by starting with simple triangular forms and gradually selecting those that seemed more complex and unpredictable in each stage. The shapes were created through small structural changes. Each triangle had different angles, showing forms that looked unique, adapting, and becoming different. Each process of generation was about the logic of natural selection. It was not about being biologically strong but about looking strong and unique. These qualities decided which form could continue to the next level. Selecting the best form was connected to research, not my vision, that I believe the final product is improved; in the future, I plan to use eye-tracking to see how people react to the forms. I will make a small field study where participants look at a series of changing geometric shapes. Then, I can study the eye movement data to understand which forms get more attention and look stronger. It will help me choose shapes based on research and what people see and feel. It also makes the idea closer to natural selection, where survival depends on environmental feedback.

4 Conclusion

This project taught me how to make a complex vase using simple shapes like triangles. The process starts with a simple triangle, and the complex form is chosen for the next step. Based on the research paper, I realized something unpredictable and chaotic is more complicated for the human eye. So, I defined some features of visual chaos and measured the level of chaos at each step. Each form that is high rank is a candidate for going to the next level. A memorable moment was when I made six generations and extended the final form for the vase walls.

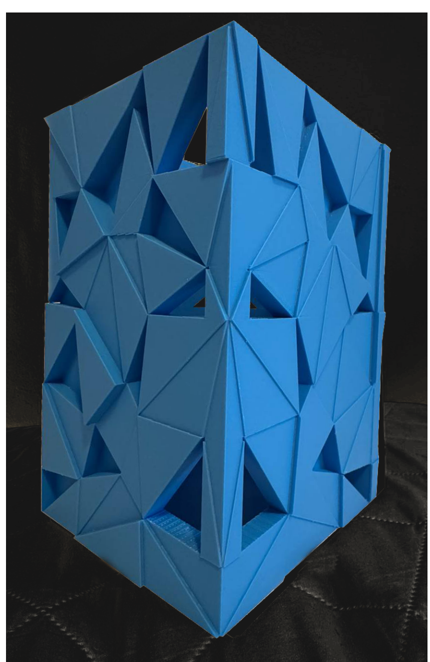

Fig. 16. final 3d print

Acknowledgments

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