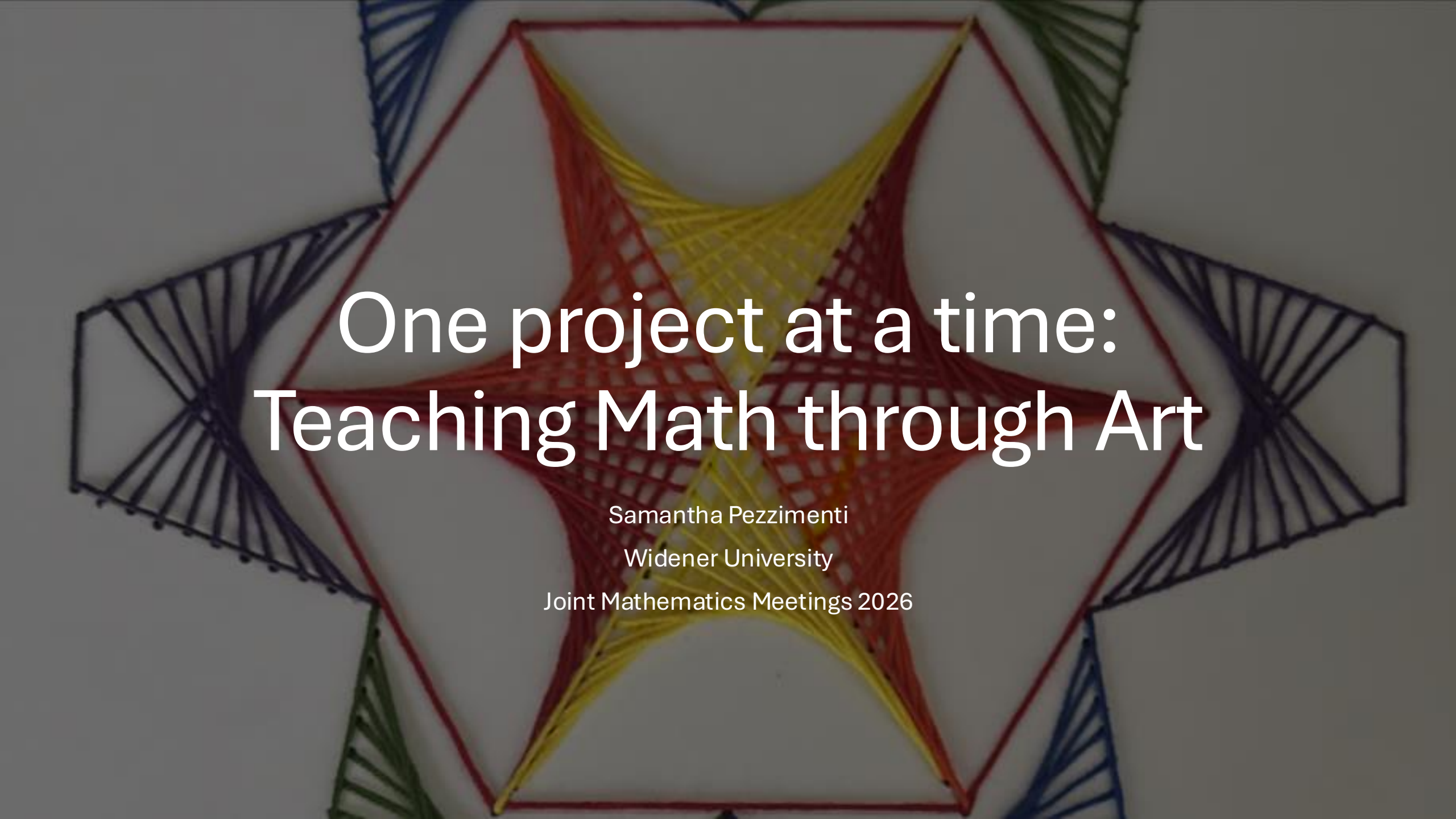


One project at a time: Teaching Math through Art

Samantha Pezzimenti

Widener University

Joint Mathematics Meetings 2026

Art 197N – Special Topics

- Topic: “The Art of Mathematics”
- Interdomain (Arts + Quantification)
- No pre-requisites
- 20 students
- Goal: Math Appreciation
- Project-based
- Mini-grant funded art supplies

PennState
Lehigh Valley

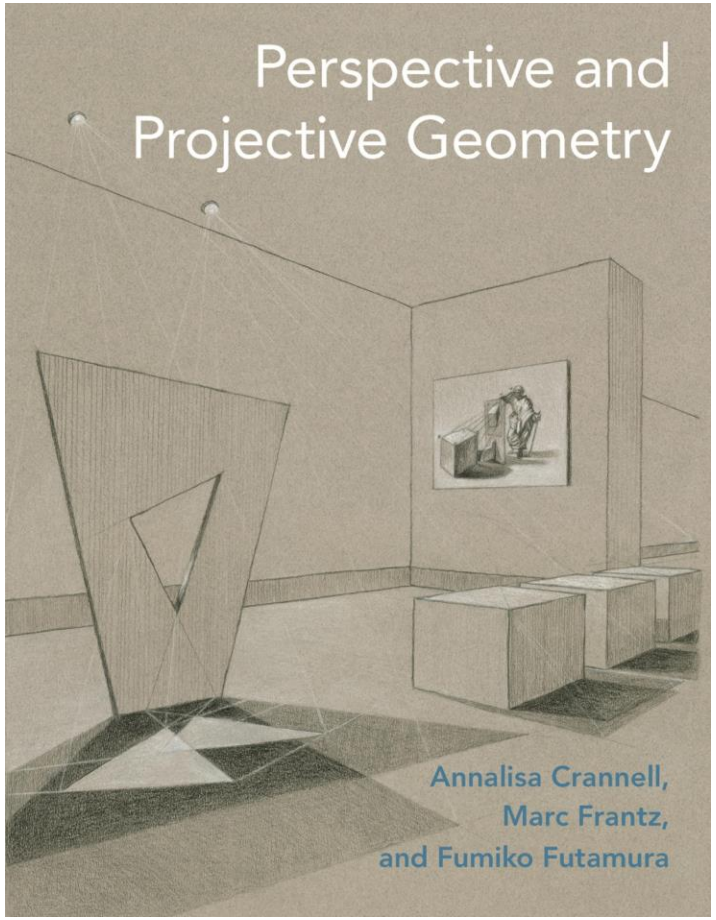
ART197N – Section 001- Spring 2025
Special Topics – Art of Mathematics
(Inter-Domain GenEd Course GA/GQ)

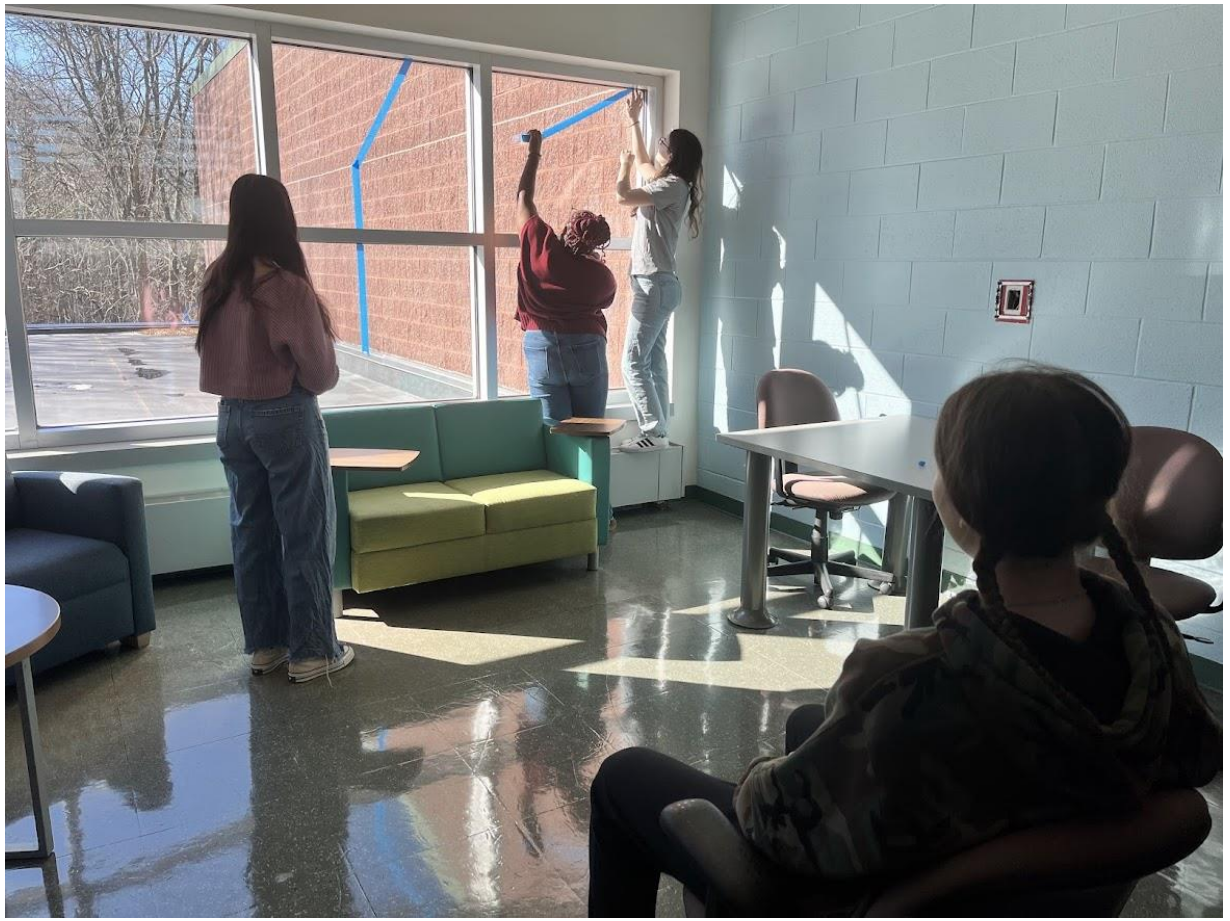
Instructors:	**Larry Musolino - Assistant Teaching Professor** **lsm7@psu.edu Office Phone: 610-217-5843, Office: Room 209B** **Ann Lalik - Gallery Director and Arts Coordinator, Penn State Lehigh Valley** **aal13@psu.edu Office Phone: 610-285-5000, dial 7**

Units

Topic	Weighting
Perspective Drawing	**10%**
Symmetry	**10%**
Tiling and Tessellations	**10%**
String Art	**10%**
Fibonacci Numbers and Golden Ratio	**10%**
Fractals and self-similarity	**10%**
Topology	**10%**
Final Portfolio	**10%**
Final Project and Presentation	**15%**
Participation and attendance	**5%**

Day 1: Window Taping





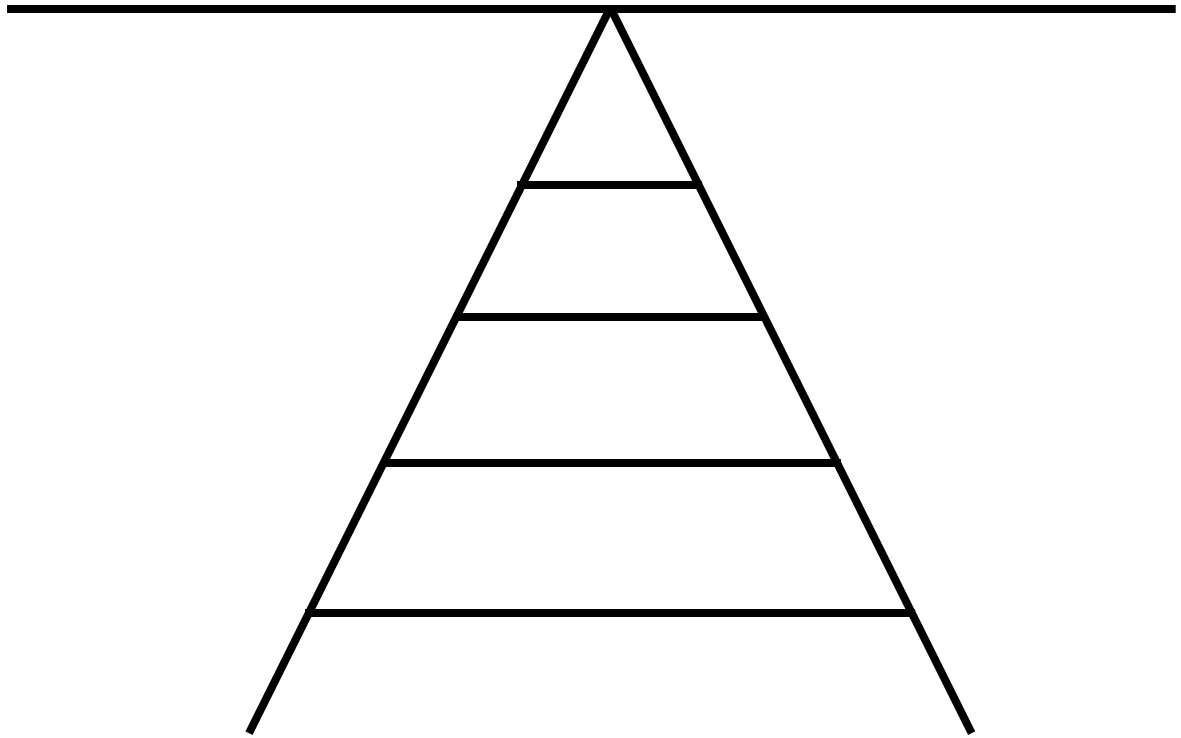
Principles of Perspective

1. The horizon appears as a line.

2. Straight lines in space appear as straight lines in the image.

3. Sets of parallel lines (that are not parallel to the picture plane) meet at a vanishing point.

4. Lines parallel to the picture plane appear parallel and therefore have no vanishing point.



Principles of Perspective

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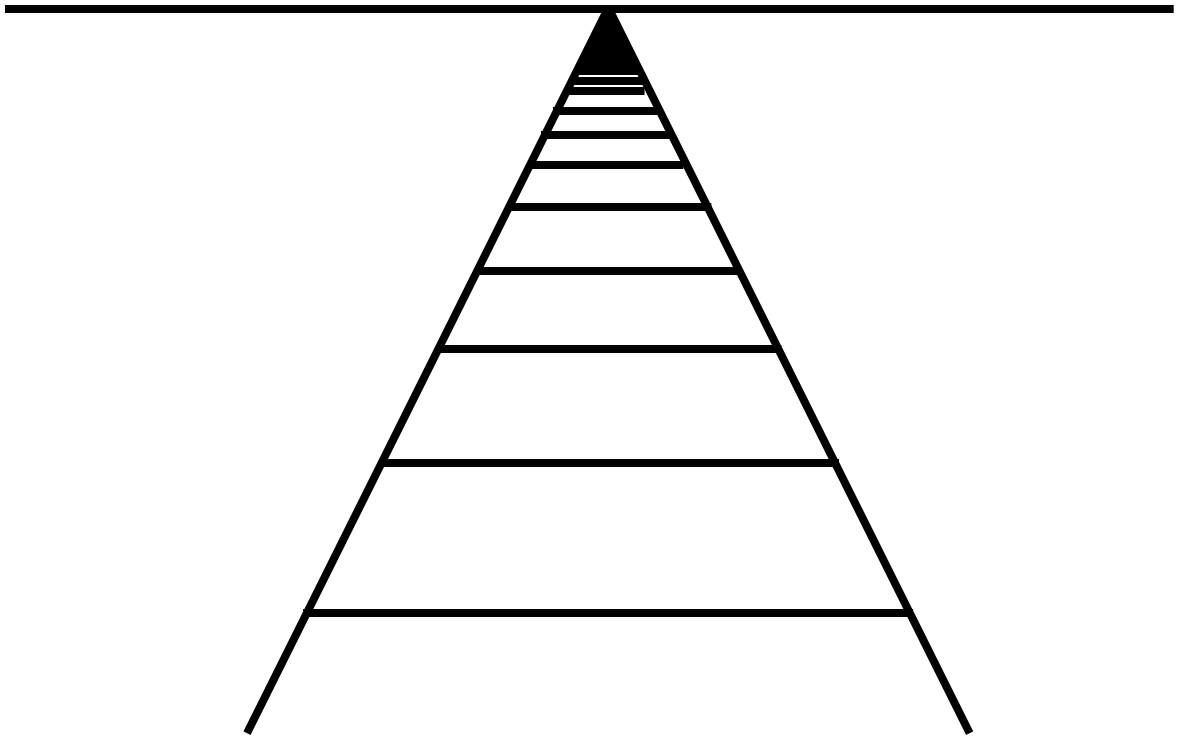
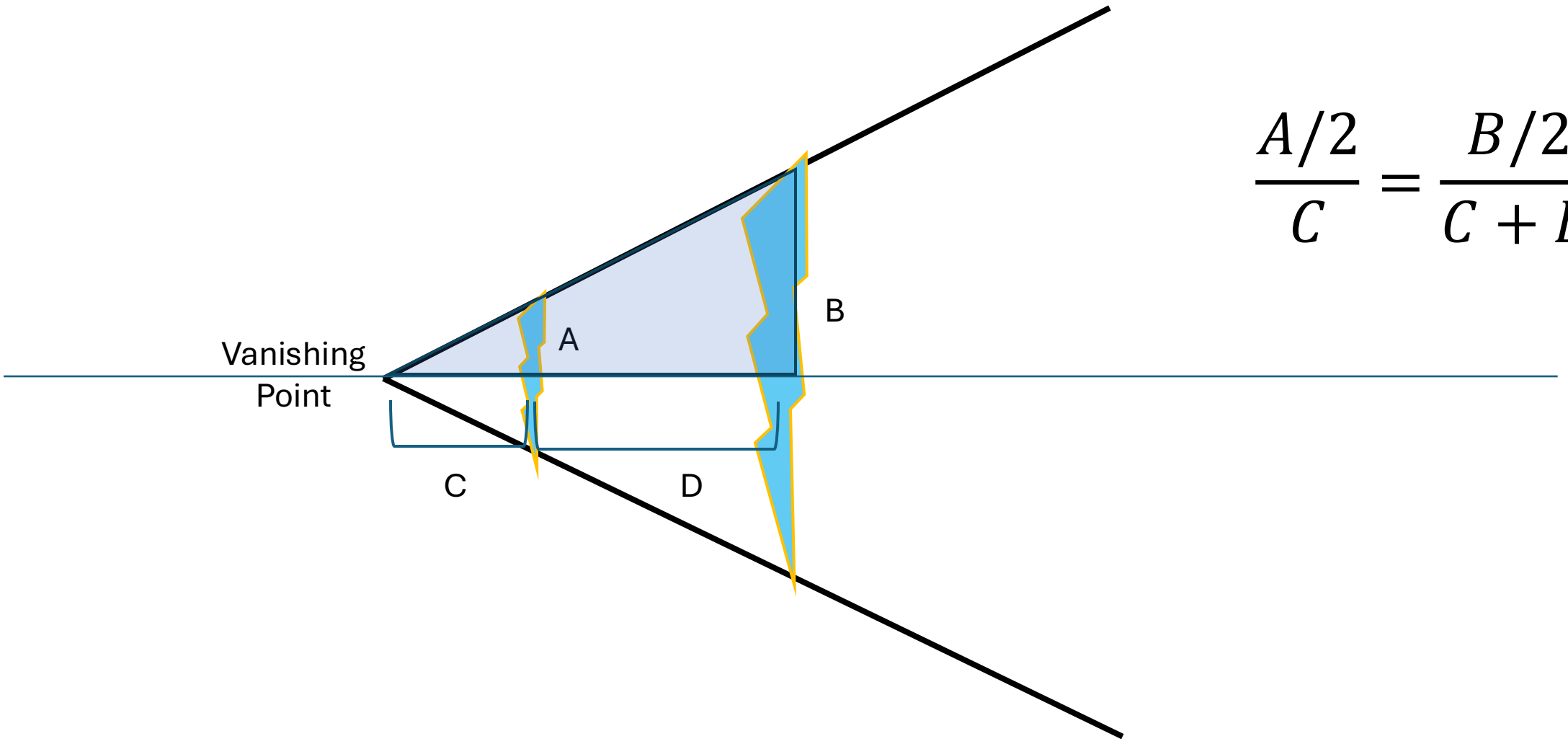
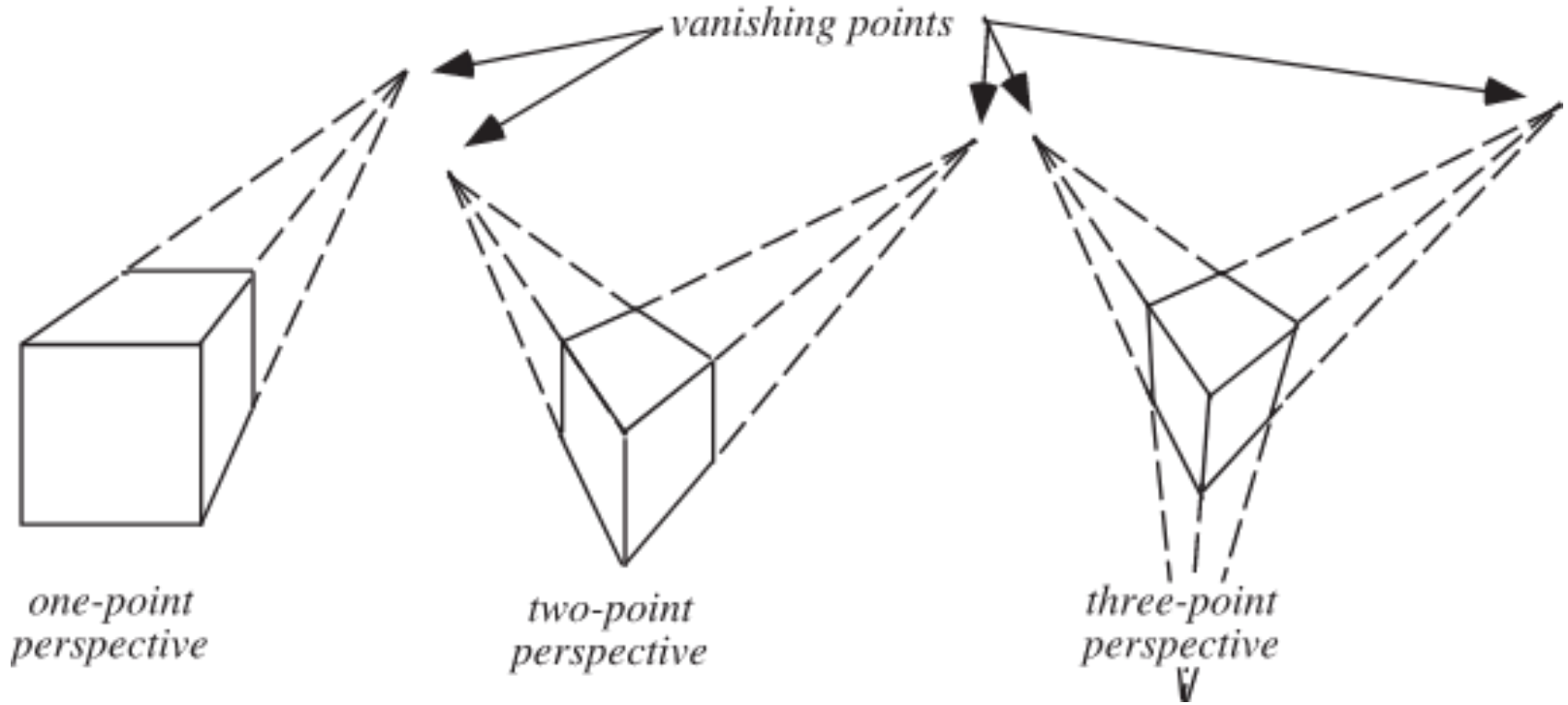
5. Objects father away appear smaller; scale at a rate according to the lines converging to the vanishing point.





$$\frac{A/2}{C} = \frac{B/2}{C+D}$$


vanishing points
one-point perspective
two-point perspective
three-point perspective

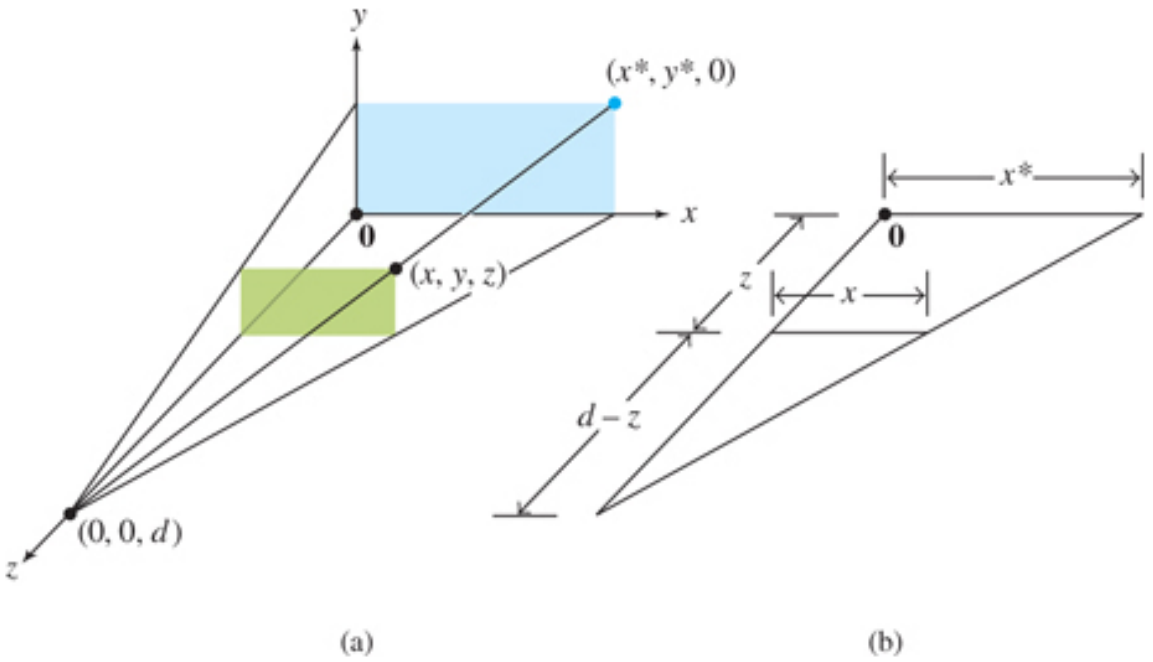


FIGURE 6 Perspective projection of (x, y, z) onto $(x^*, y^*, 0)$.

d

The triangle in the *xz*-plane in Figure 6(a) is redrawn in part (b) showing the lengths of line segments. Similar triangles show that

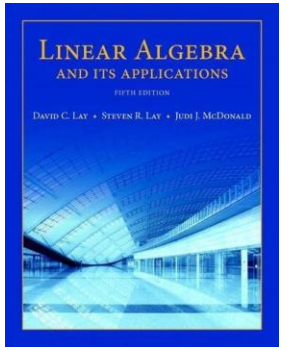
$$\frac{x^*}{d} = \frac{x}{d-z} \quad \text{and} \quad x^* = \frac{dx}{d-z} = \frac{x}{1-z/d}$$

Similarly,

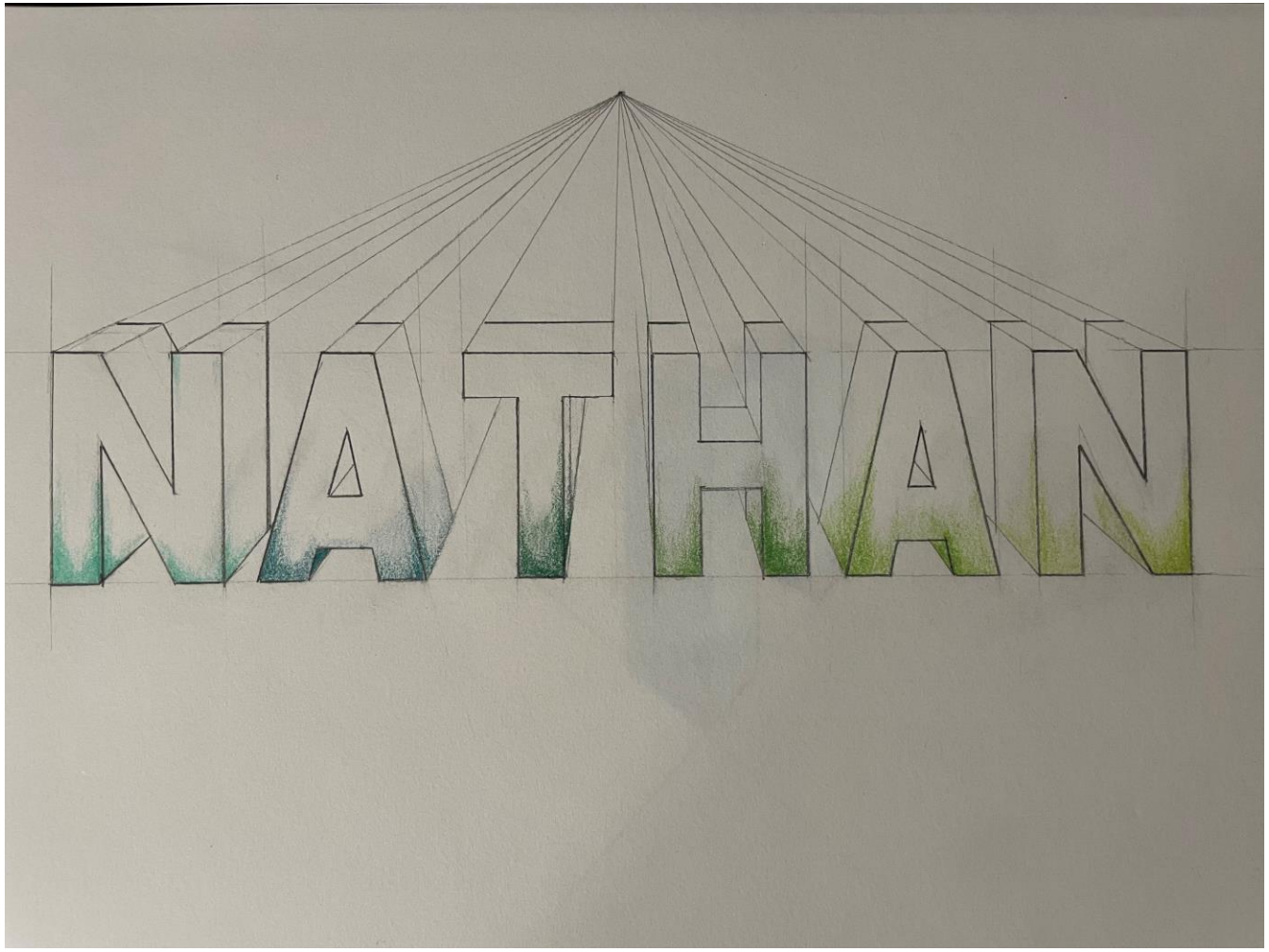
$$y^* = \frac{y}{1-z/d}$$

Using homogeneous coordinates, we can represent the perspective projection by a matrix, say, *P*. We want $(x, y, z, 1)$ to map into $\left(\frac{x}{1-z/d}, \frac{y}{1-z/d}, 0, 1\right)$. Scaling these coordinates by $1 - z/d$, we can also use $(x, y, 0, 1 - z/d)$ as homogeneous coordinates for the image. Now it is easy to display *P*. In fact,

$$P\begin{bmatrix} x \\ y \\ z \\ 1 \end{bmatrix} = \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & 0 \\ 0 & 0 & -1/d & 1 \end{bmatrix}\begin{bmatrix} x \\ y \\ z \\ 1 \end{bmatrix} = \begin{bmatrix} x \\ y \\ 0 \\ 1 - z/d \end{bmatrix}$$



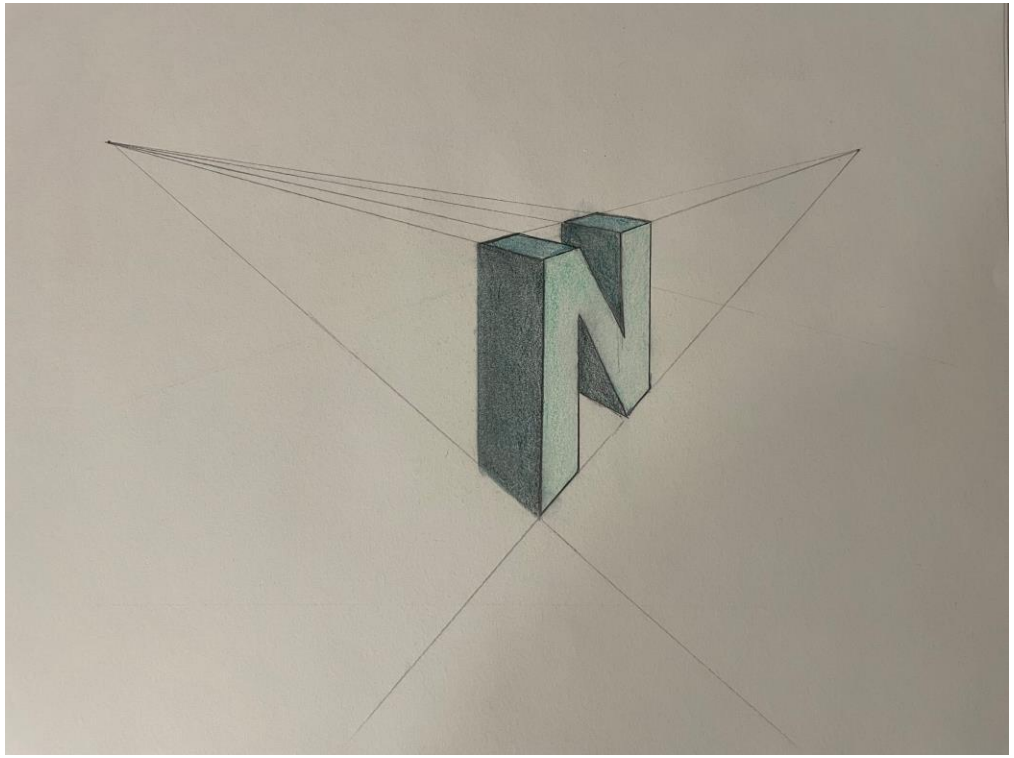
Linear Algebra and Its Applications
Lay, 5th Edition

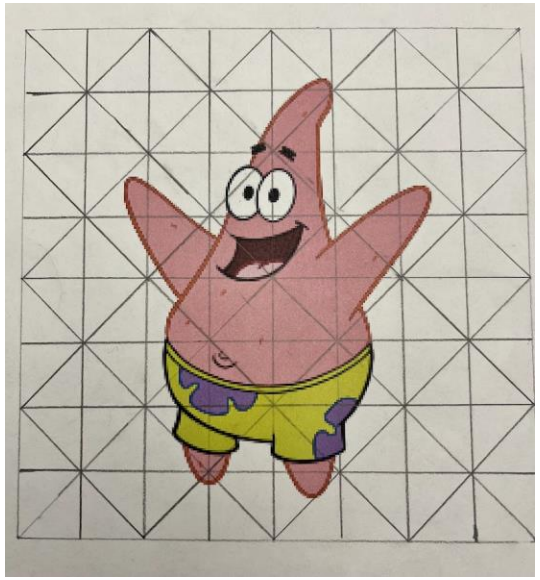


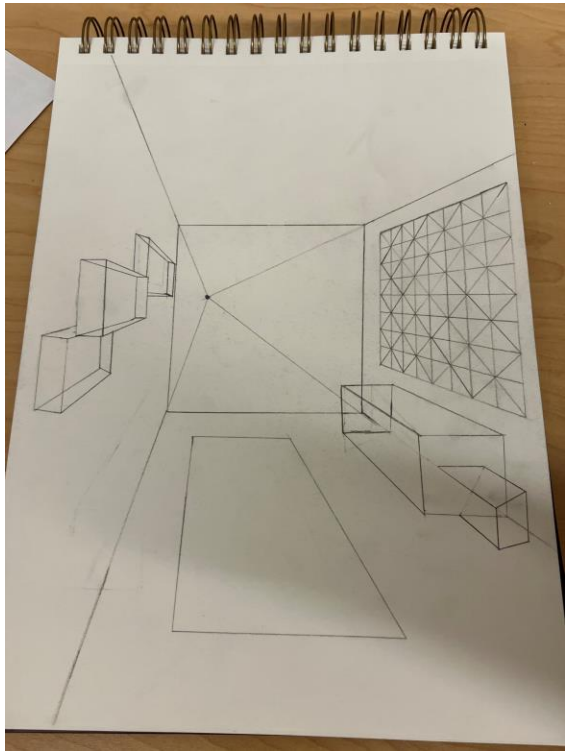
Work by Nathan Gallagher

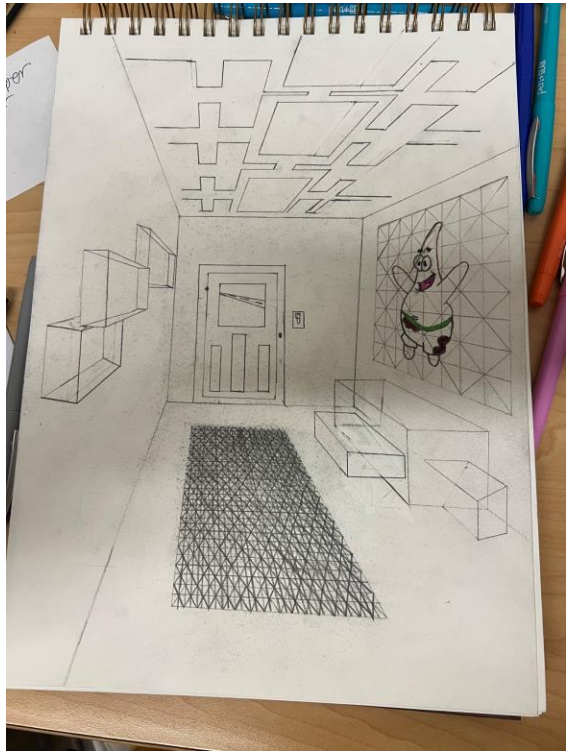
Unit: Perspective Drawing
Assignment:

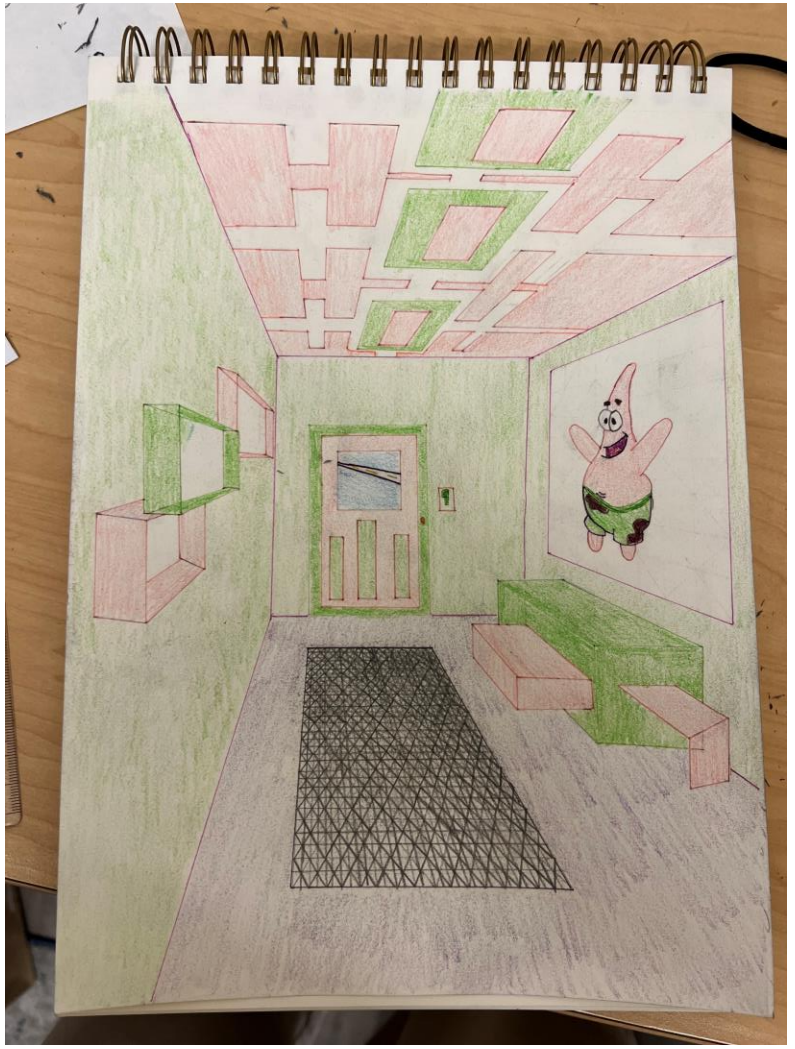
- Draw your name in one-point perspective
- Draw your first initial in two-point perspective





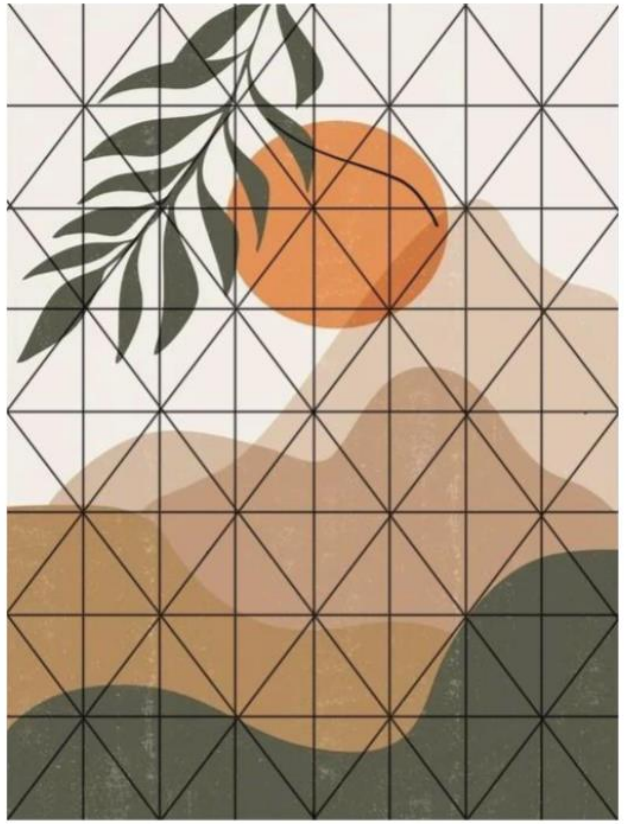




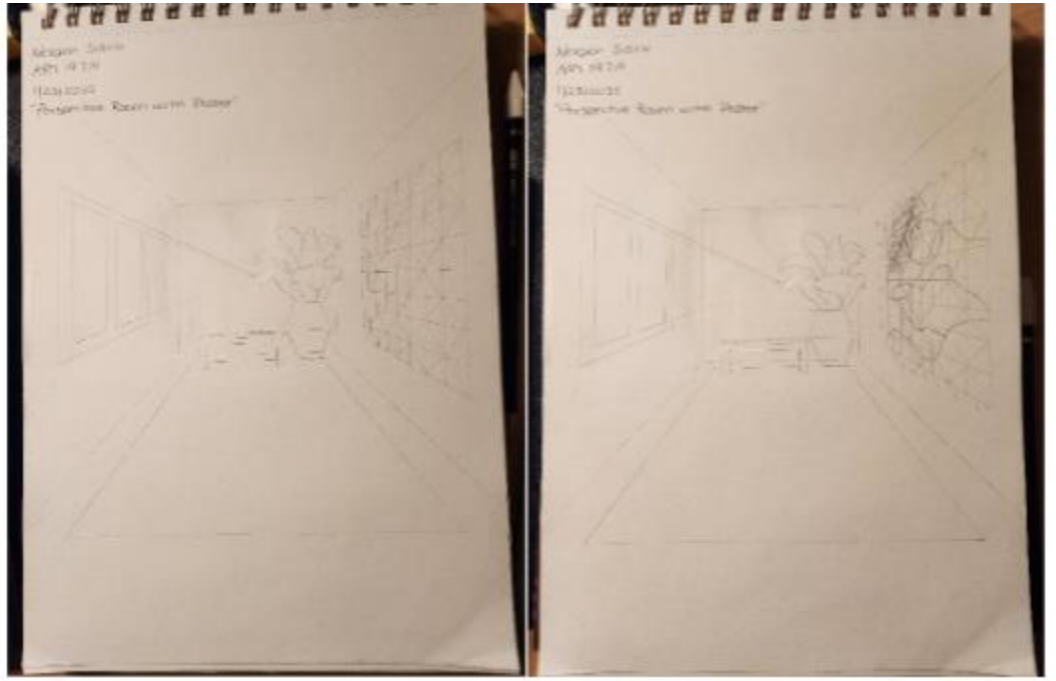


Work by Addison Stanton

Unit: Perspective Drawing
Assignment: Draw a room in perspective containing a poster drawn with a perspective mesh



Work by Nevaeh Sisco



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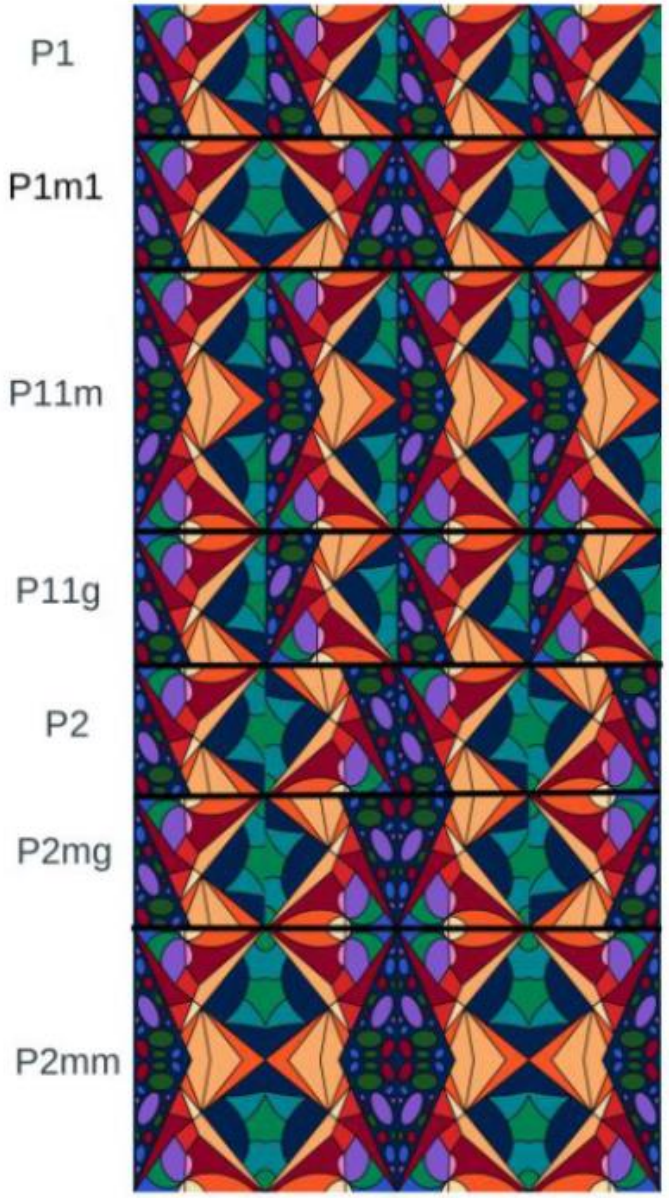
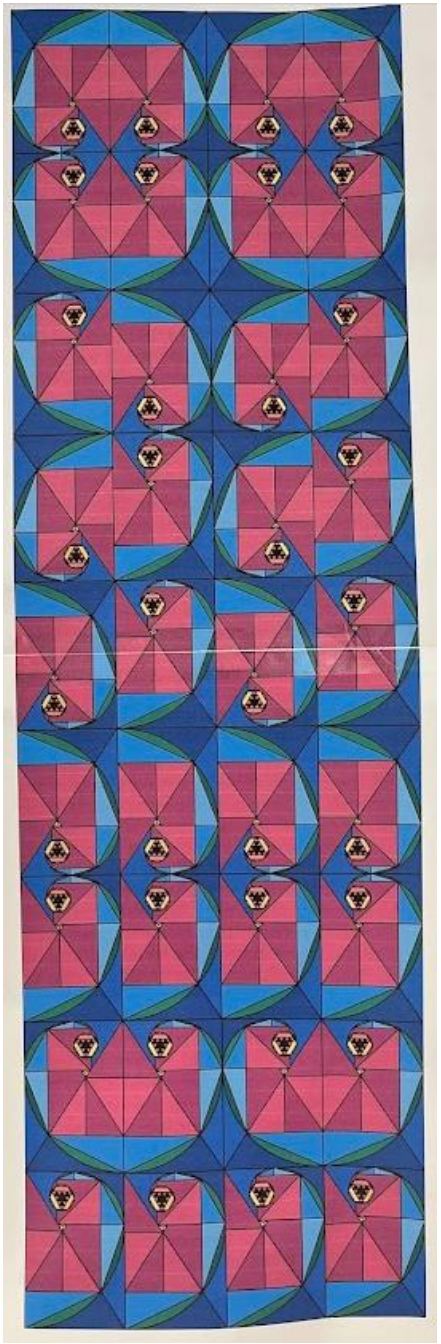


Work by Hideki Shie



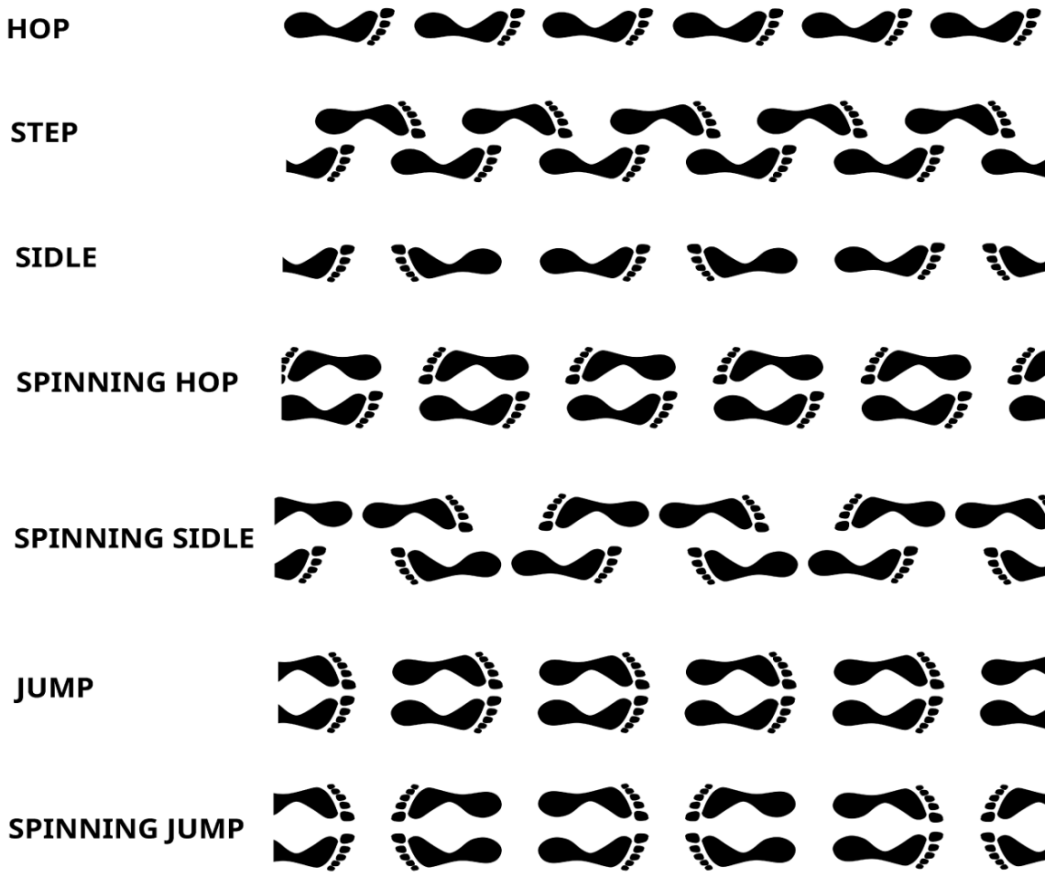
Work by Aiden Waeltz

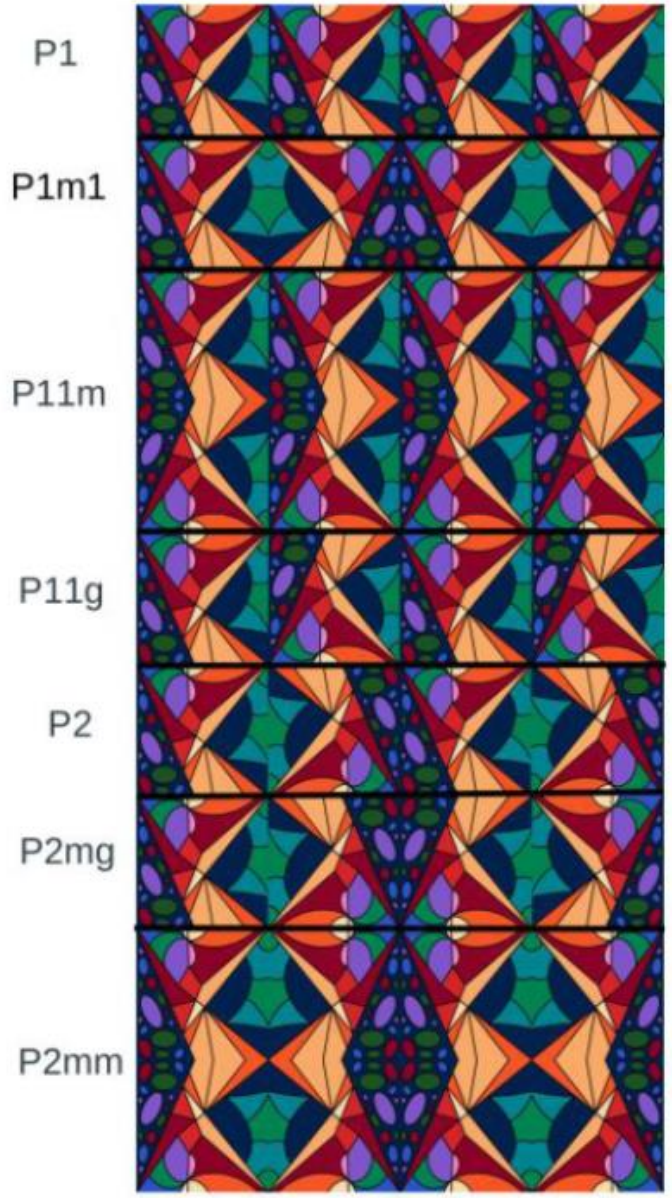
Unit: Symmetry
Assignment:

- Create a “symmetry tile”
- Use it to create a series of portraying all 7 Frieze Groups

Frieze Groups

- **Frieze Pattern**: Two-dimensional design that repeats in one direction
- **Frieze Group**: set of symmetries of a frieze pattern
- Include combinations of: translations, reflections, 180 degree rotations
- There are seven Frieze groups.





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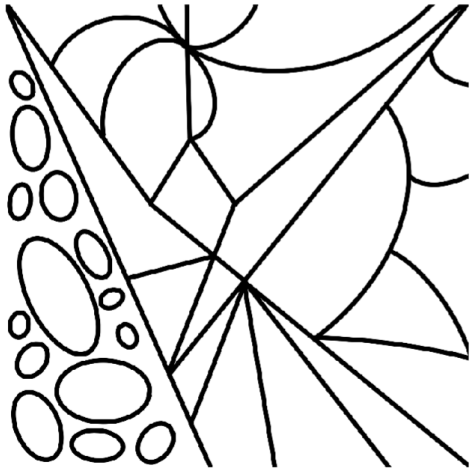


Wallpaper Groups

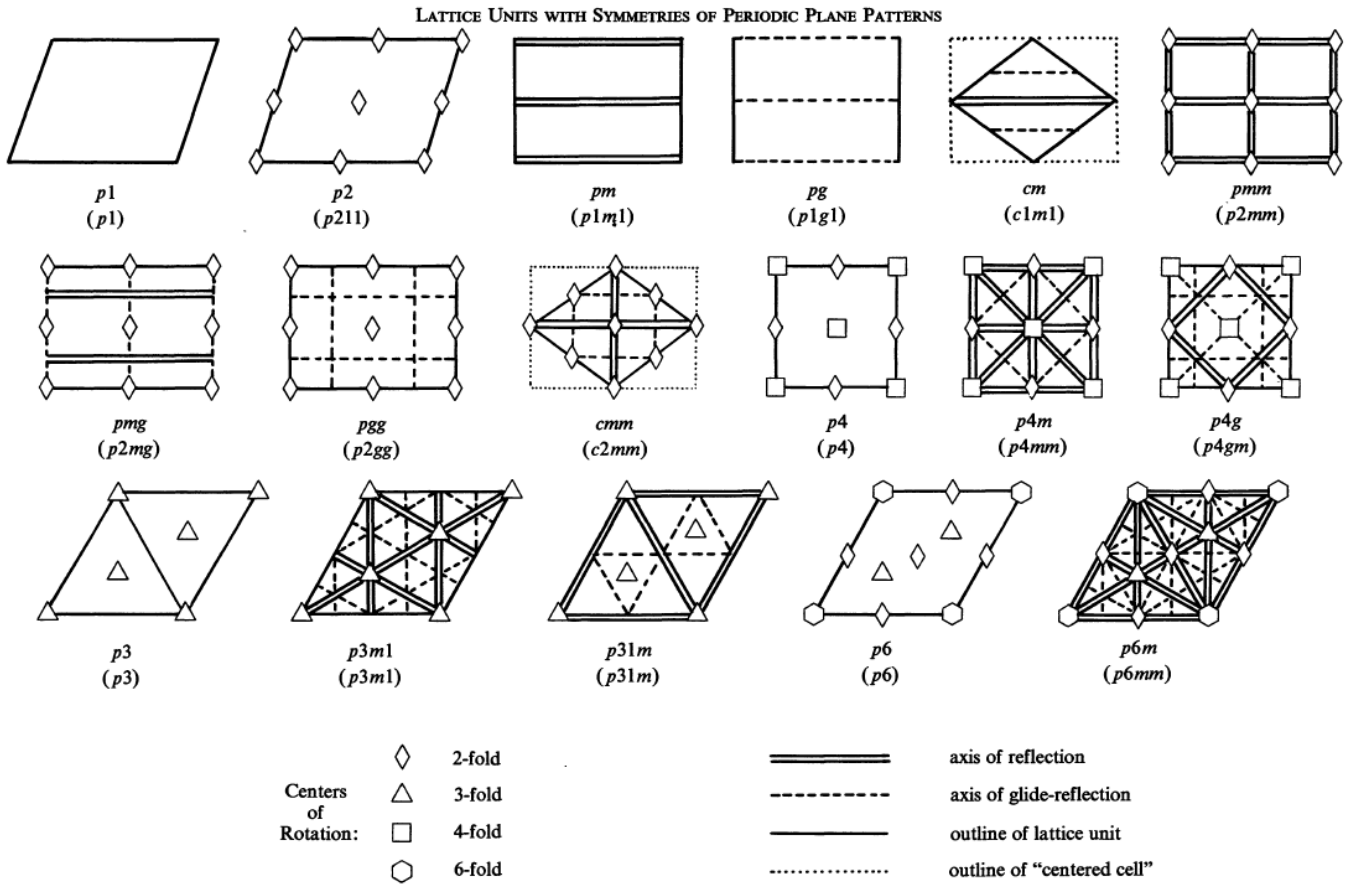
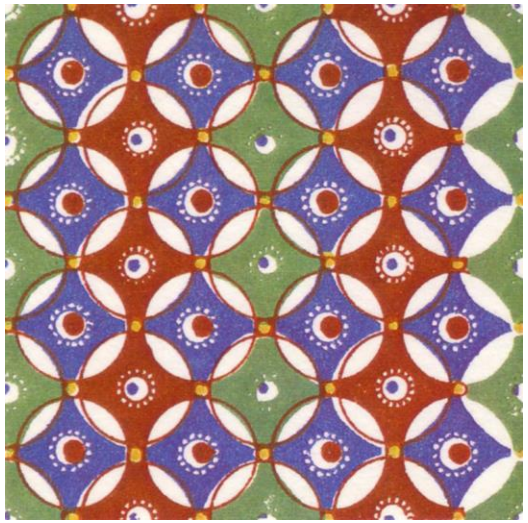
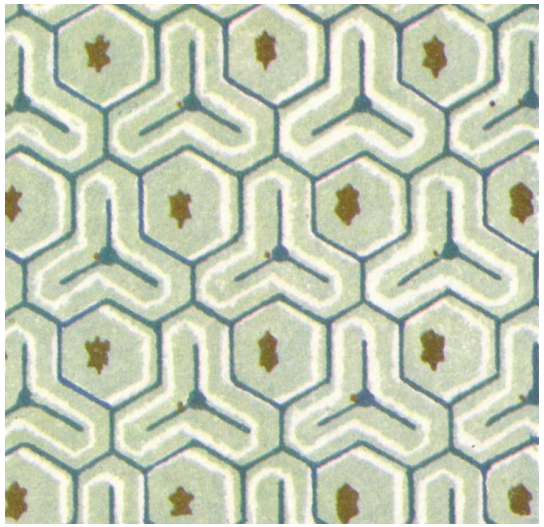
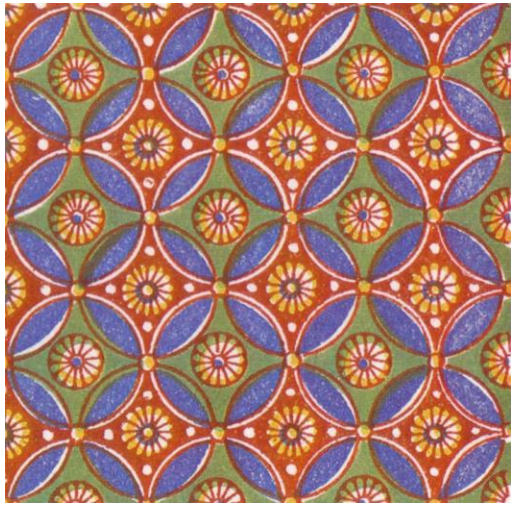


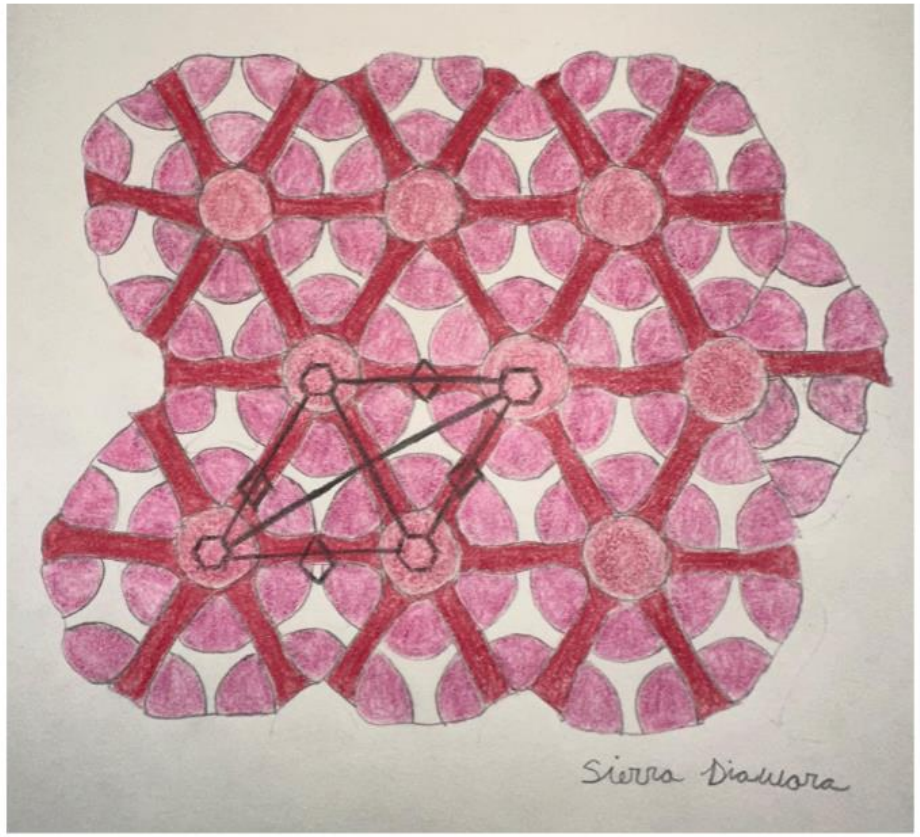
CHART 2. International notation identifies the seventeen two-dimensional crystallographic groups. The short form is given first, with the full notation in parentheses.

Plane Symmetry Groups: Their Recognition and Notation, Doris Schattschneider, AMS Monthly, Volume 85, Issue 6



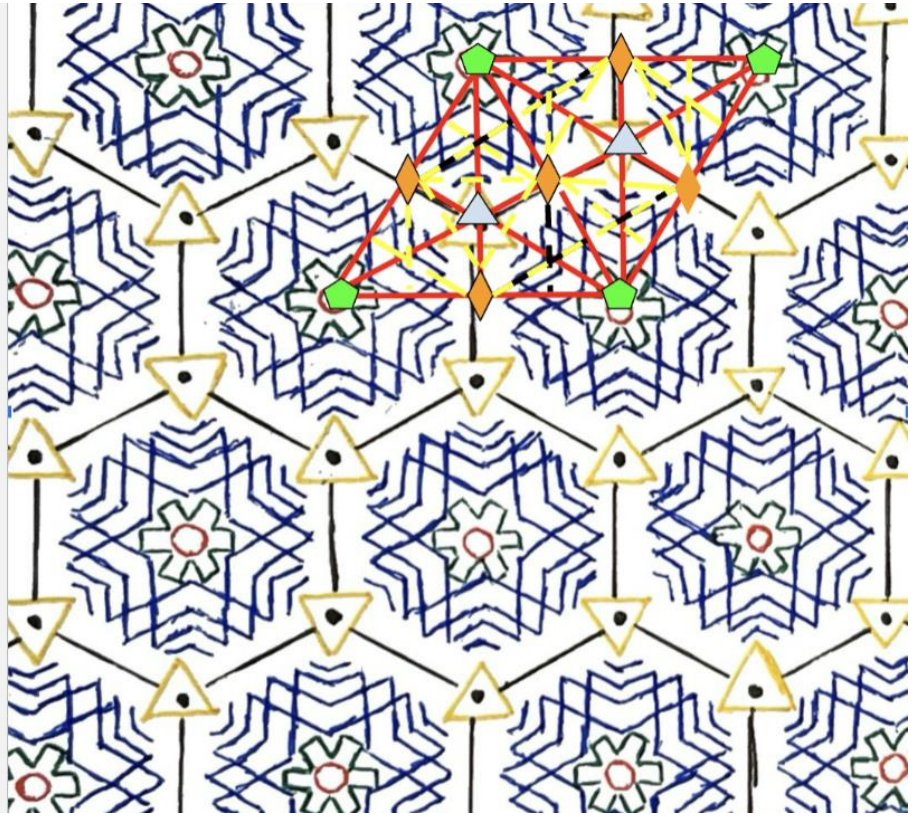





Work by Sierra Diawara

Unit: Tilings of the Plane
Assignment:

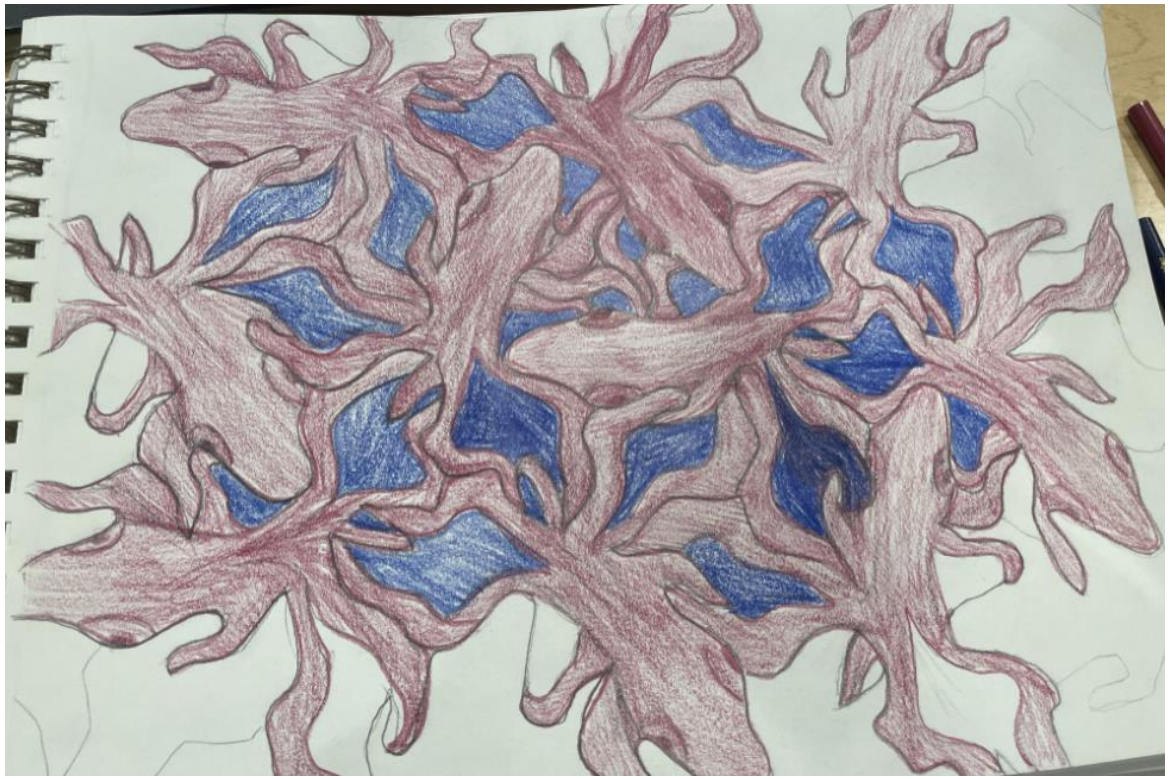
- Design a piece of wallpaper
- Identify the wallpaper group



Work by Addison Stanton

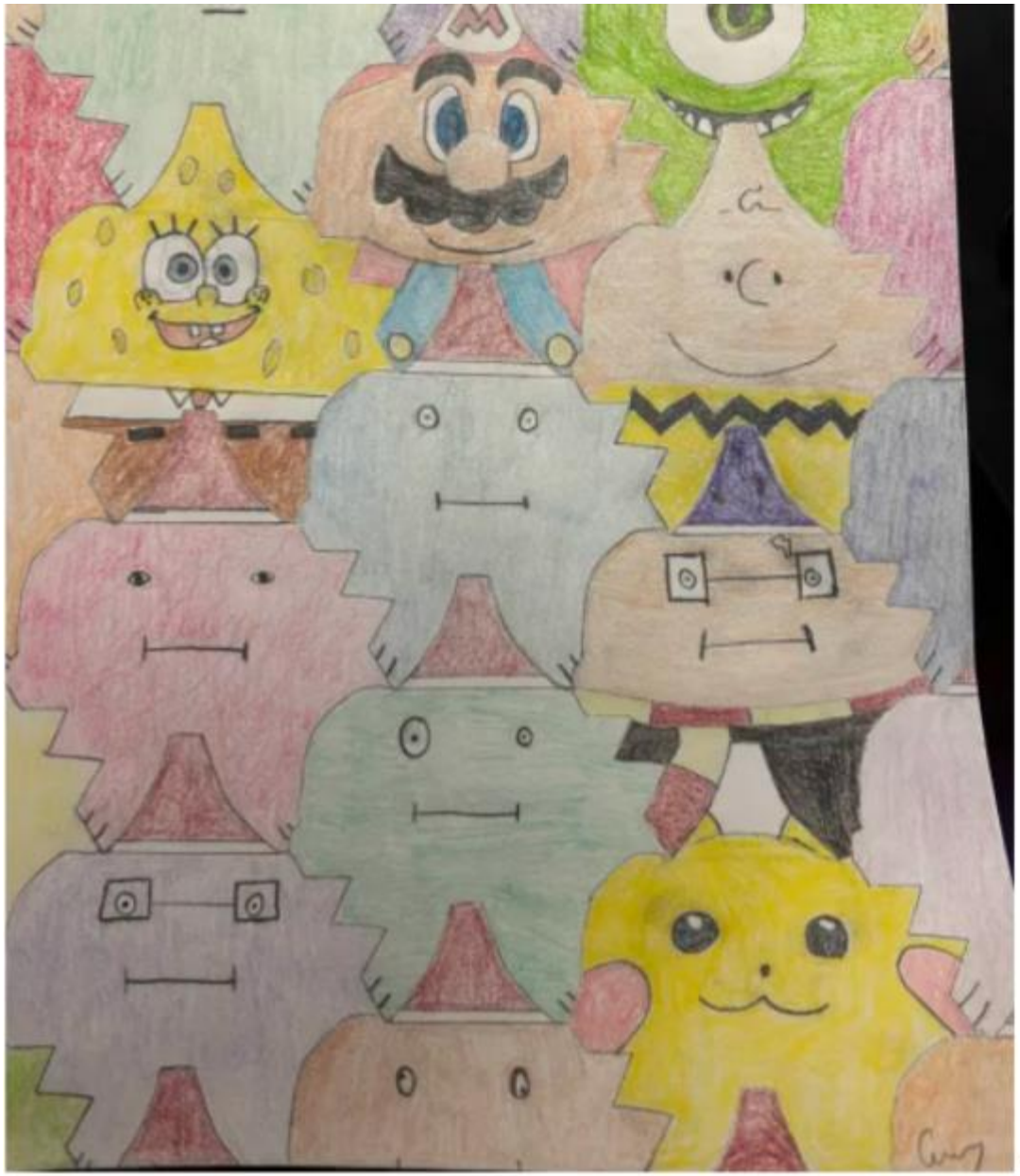
Unit: Tilings of the Plane
Assignment:

- Create an Escher-style tessellation by cutting a pasting sides from a regular polygon that tiles the plane

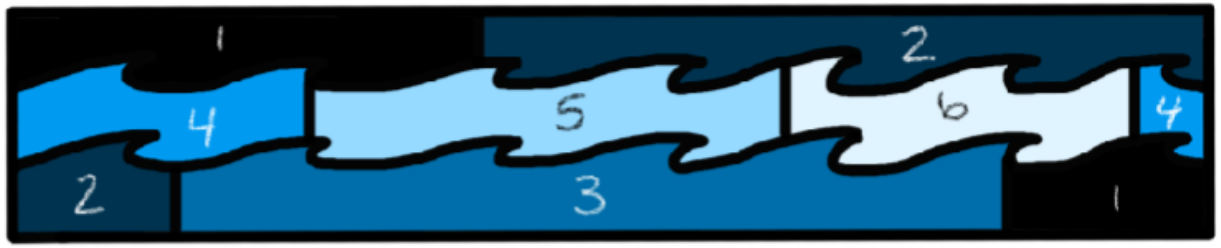


Work by Emma Kaplan

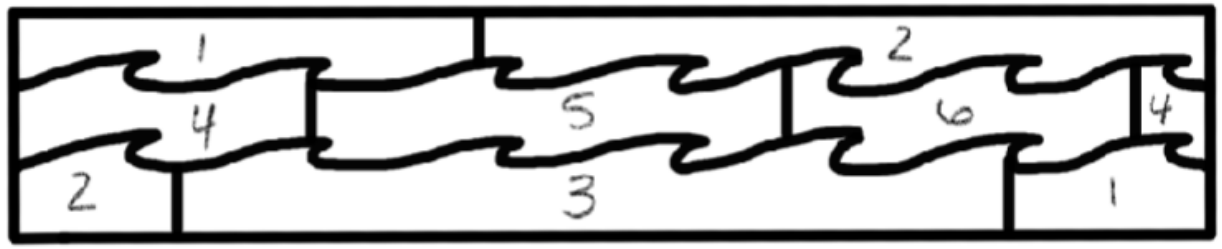
Work by Jack Watson



Colored



Uncolored

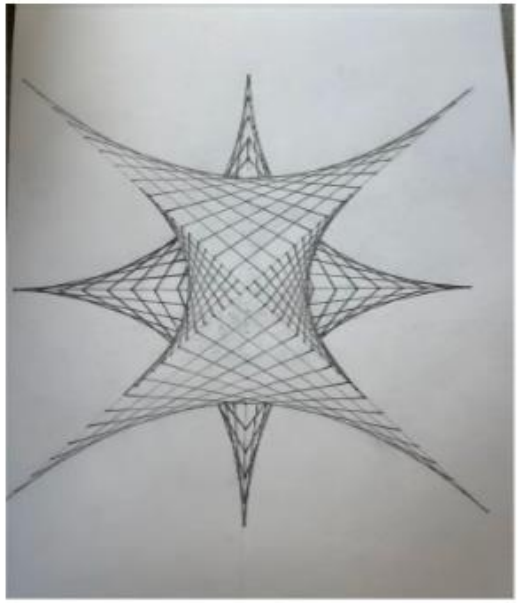


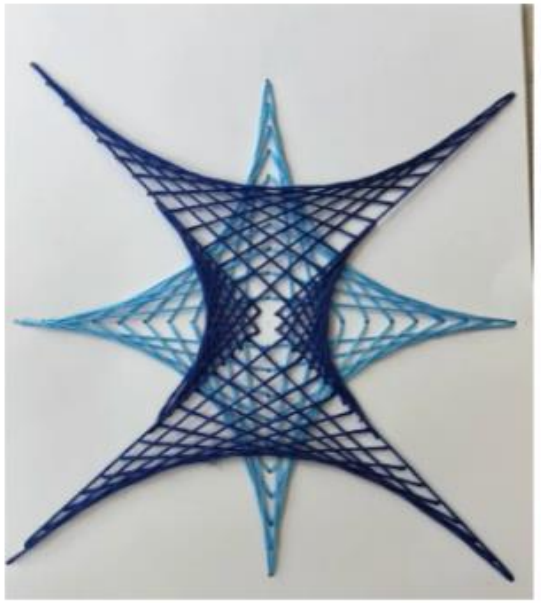
Complete Graph

Work by Nevaeh Sisco

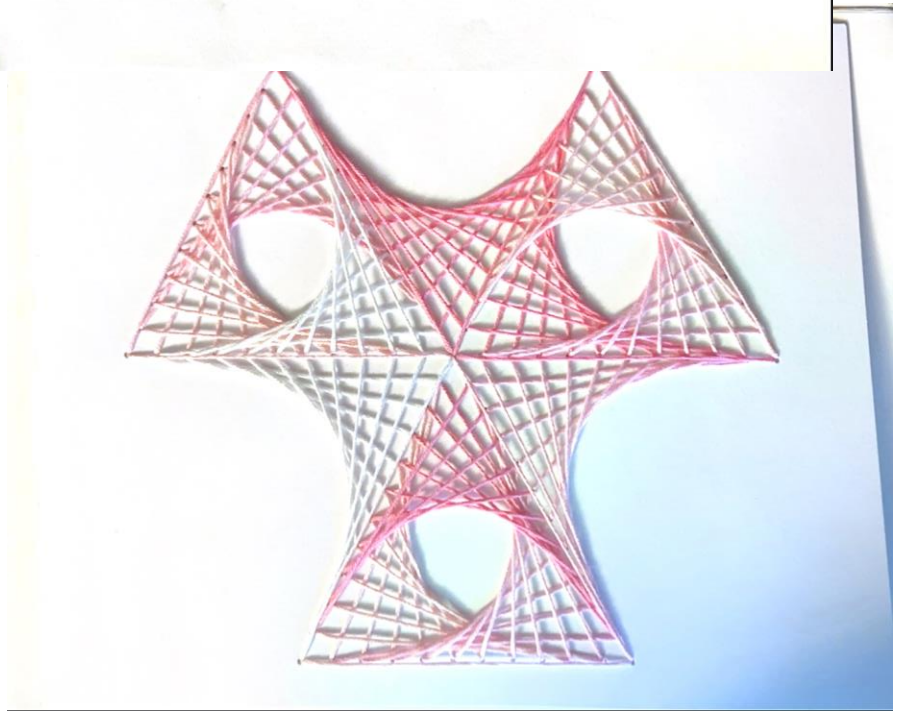
Unit: Topology
Assignment:

- Create a “coloring book page” for the Mobius band





Work by Connor Chauncey

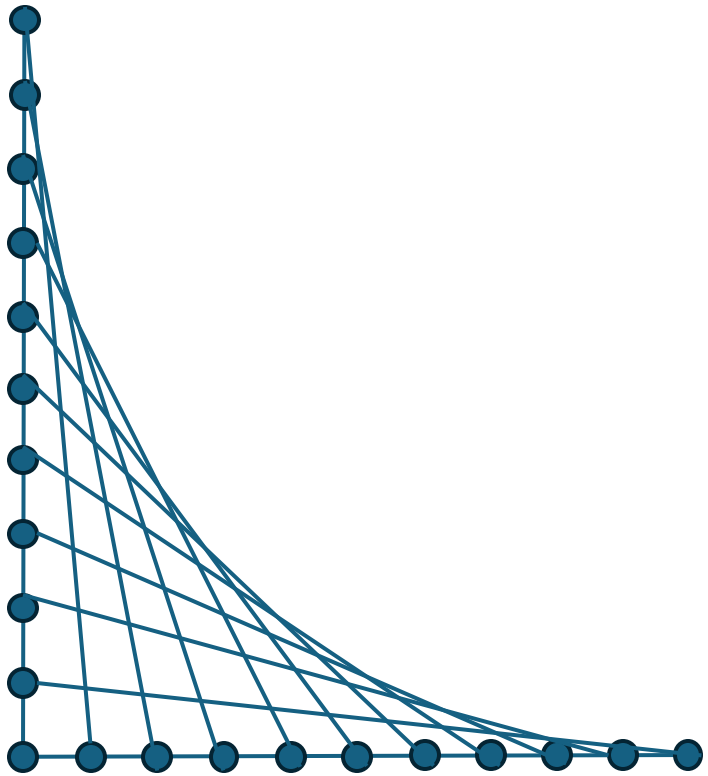


Work by Reina Ramos

Unit: String Art
Assignment:

- Design a piece using only straight lines to approximate parabolic curves
- Create your design with string

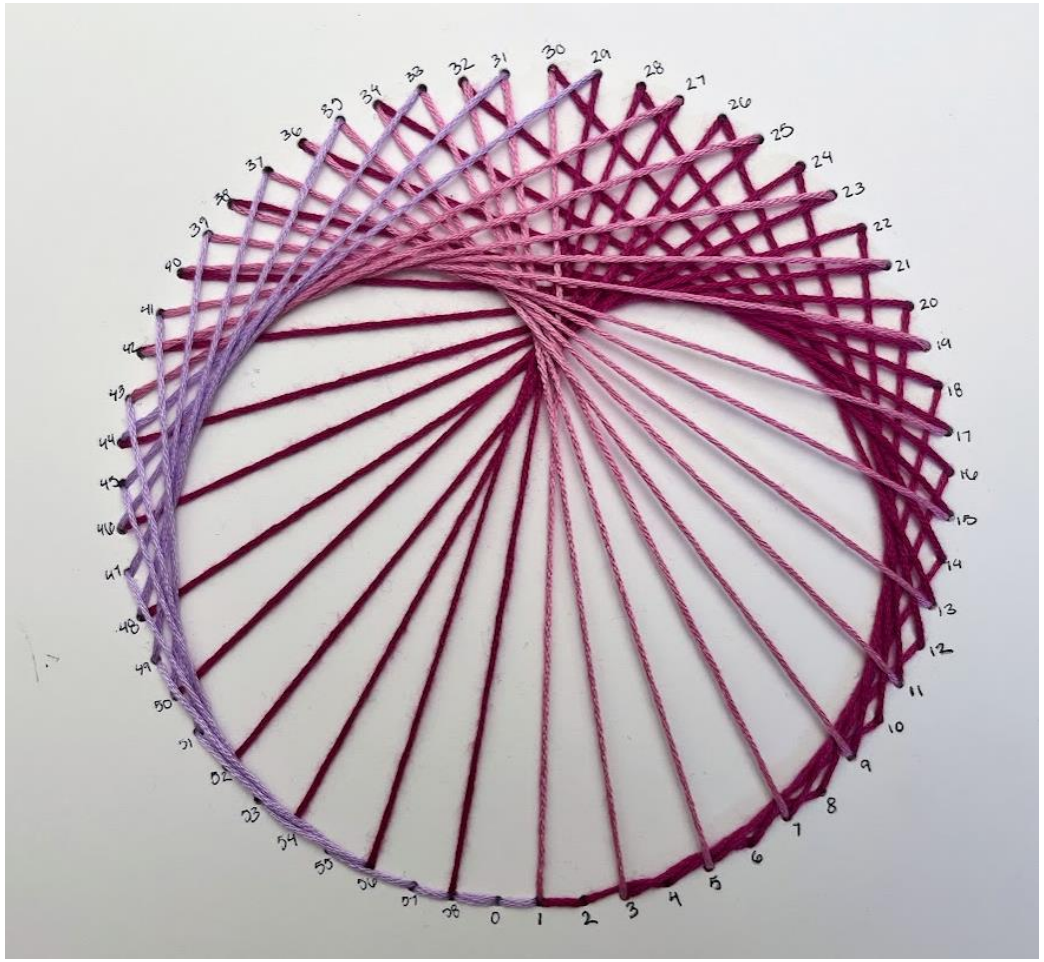
Parabolic curves



Work by Addison Stanton

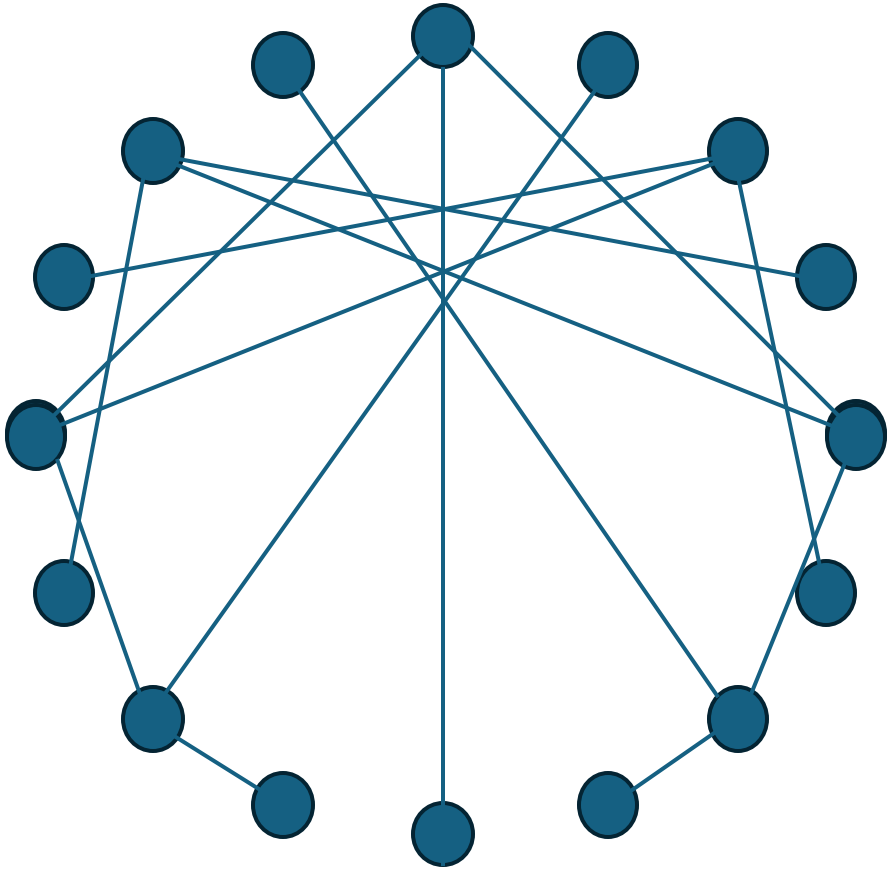
Unit: String Art
Bonus Assignment:

- Create a Residue Design with string



Work by Reina Ramos

Residue Diagrams



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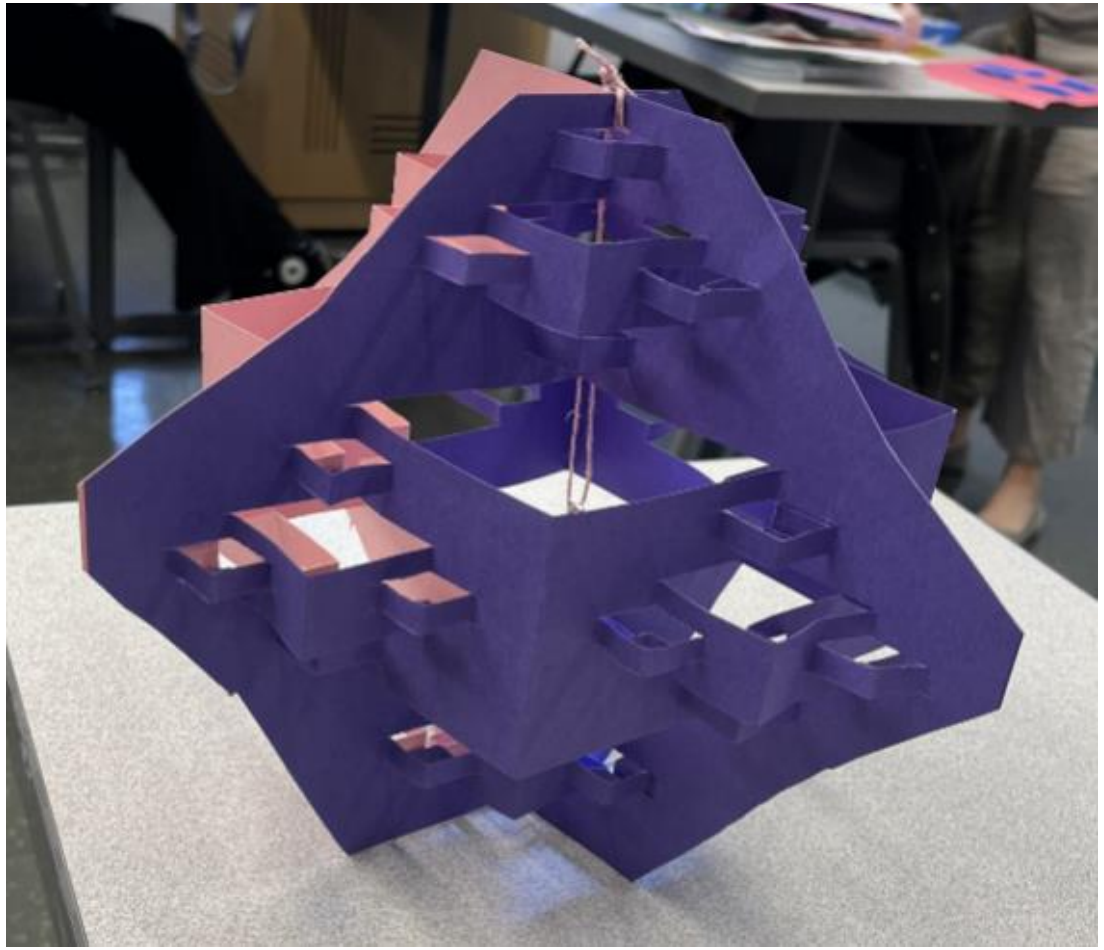
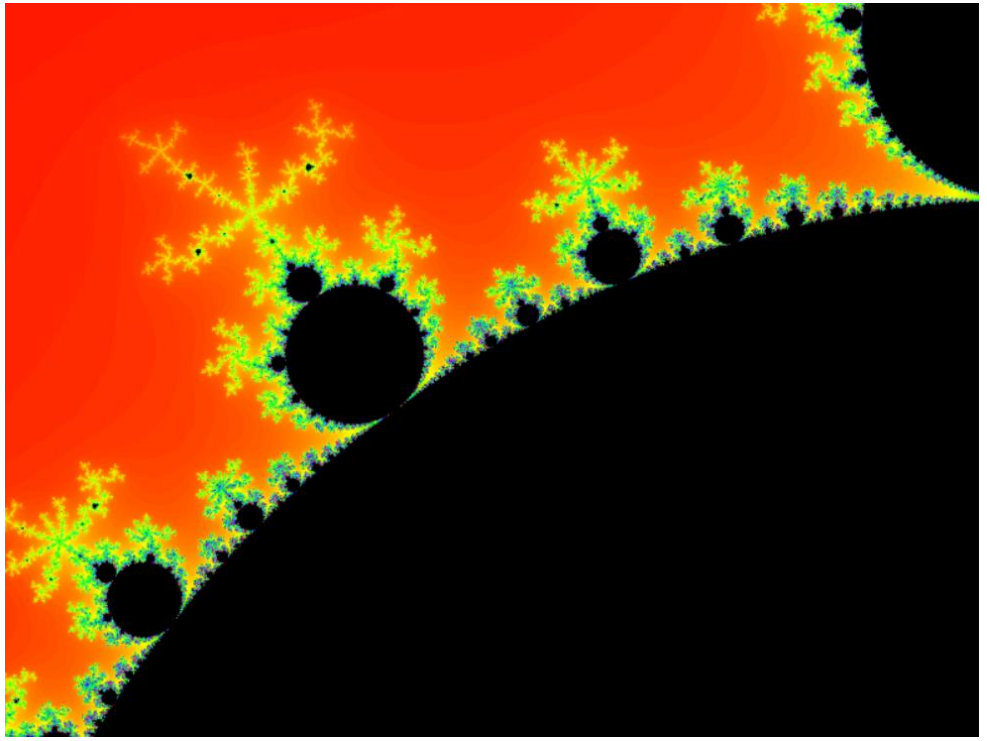
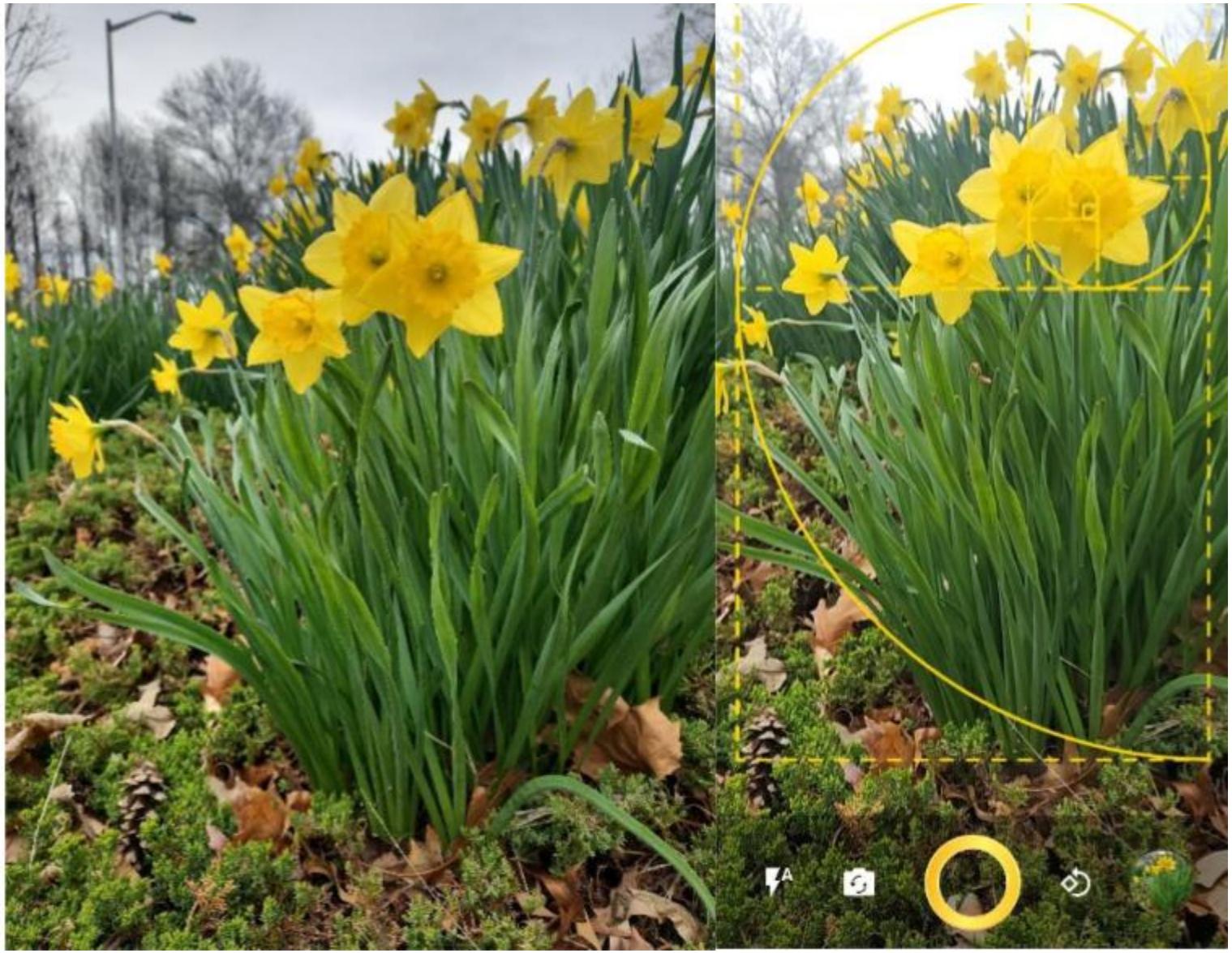
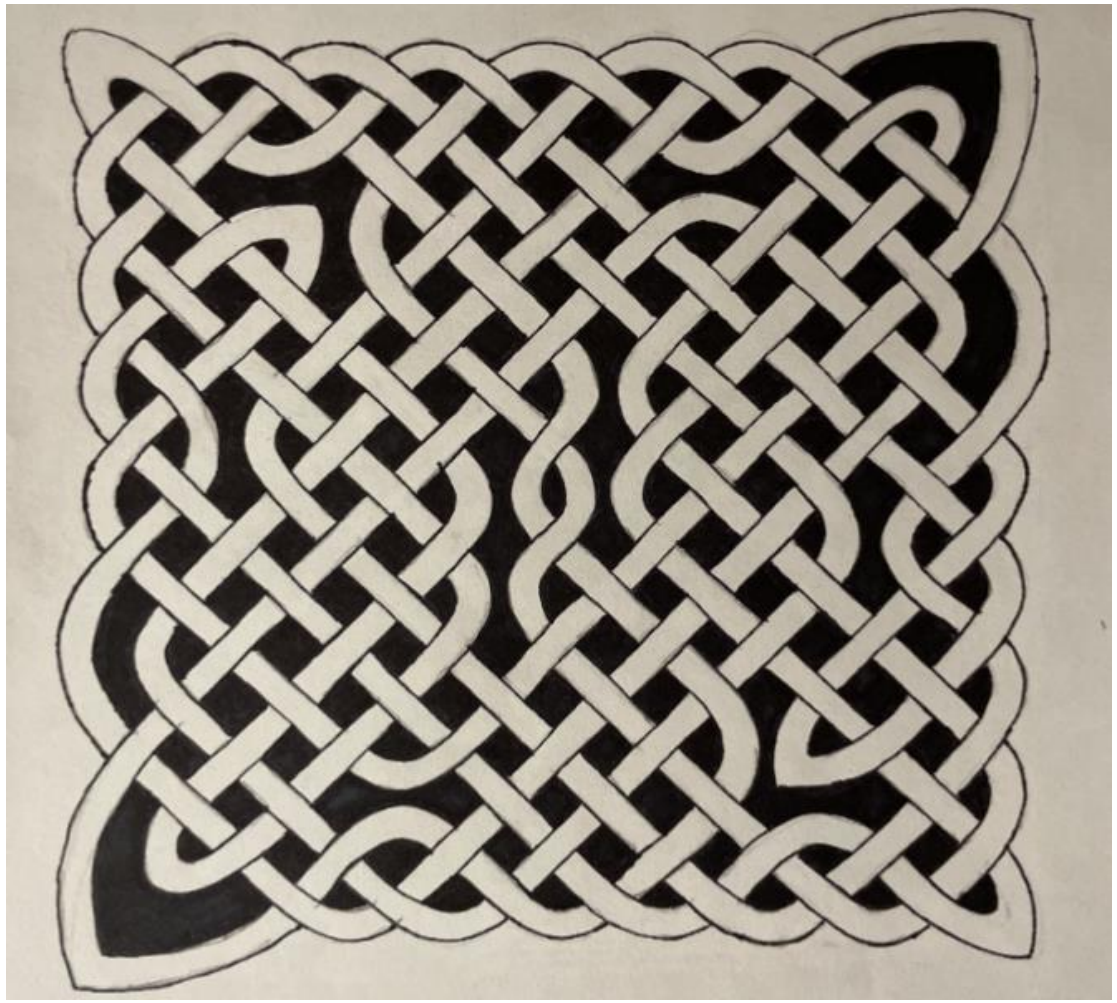
JMM Art Exhibit
Exhibit Hall D

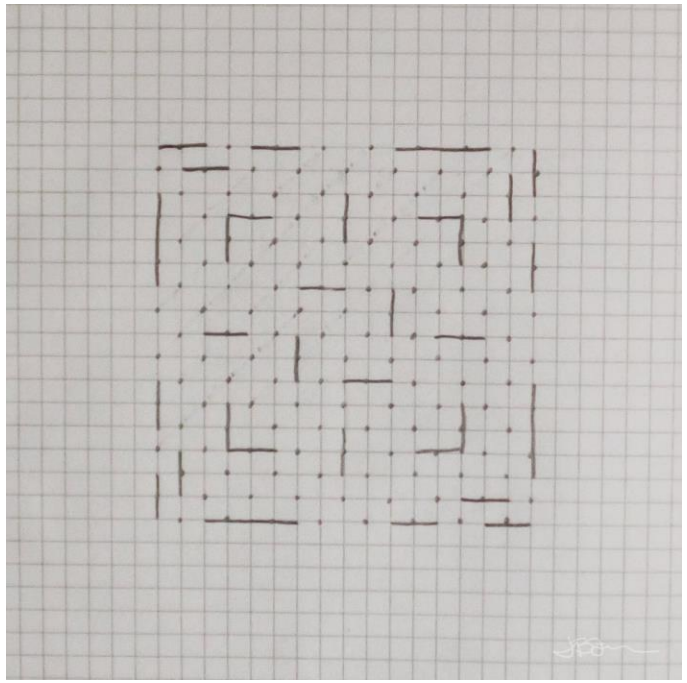
Mod 248 by Addison Stanton

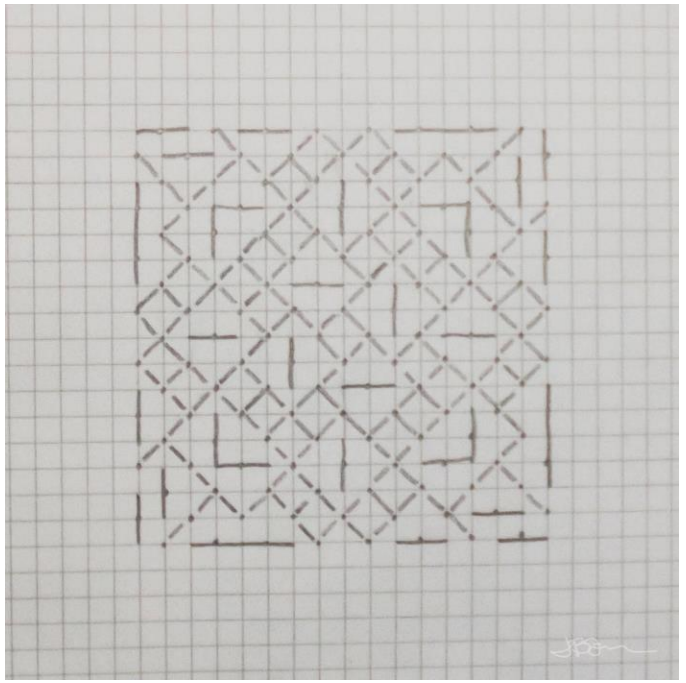


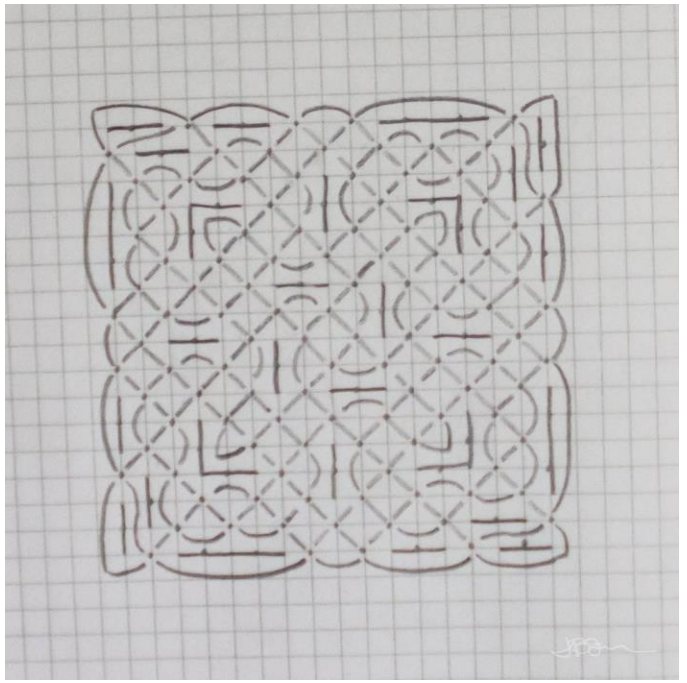












Final Project

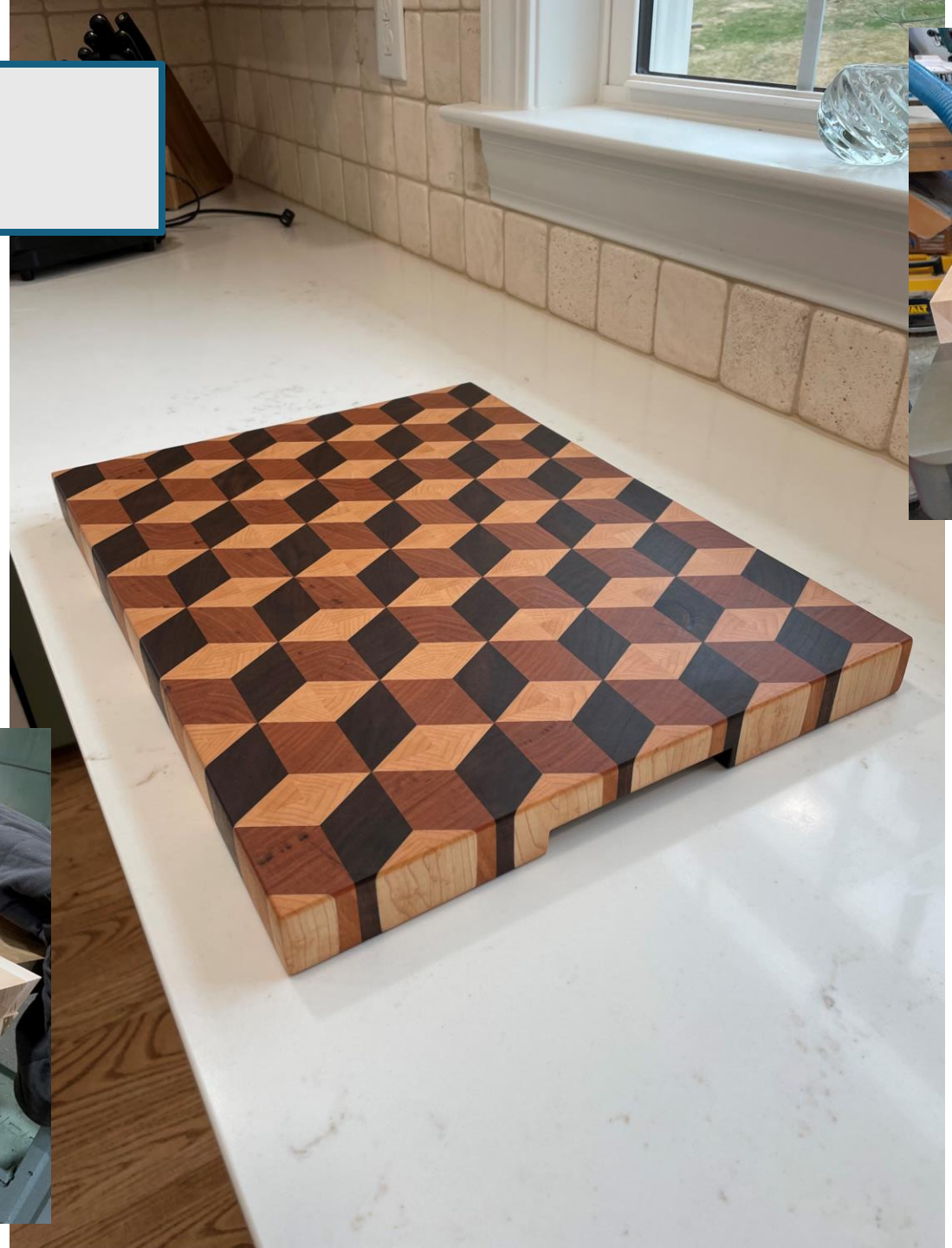
Art 197N- Pezzimenti

Your final project will be the creation of an original piece of artwork using the medium of your choosing and related to the mathematical topic of your choosing. You are encouraged to come up with your own idea, but here are some of my ideas to help you brainstorm:

- Mathematical knitting or crochet: Create an original knitted or crocheted piece that represents an important mathematical object (ex. Mobius band, Klein bottle, hyperbolic plane, ...)
- Geometry and Origami: Create an original origami sculpture and identify the geometric properties represented.
- Mathematics and Dance: Choreograph an original dance that exhibits mathematical properties (For example: https://www.youtube.com/watch?v=Ws2y-cGoWqQ)
- Mathematics and Music: Create an original music recording that exhibits mathematical properties OR perform an existing musical piece, describing the mathematical properties exhibited (For example: https://www.ams.org/publicoutreach/math-and-music)
- 3D Printed art: Create an original design and 3D print the sculpture. (Lots of cool examples here: http://www.3dprintmath.com/)
- Mathematical Knots: Create an original sculpture representing mathematical knot(s) (Lots of possible mediums here including clay, ropes, 3D printing, macrame, etc.)
- Sculpture and Topological shapes: Lots of directions this could take, and lots of mediums you could choose. (Here's an intro on topology: https://en.wikipedia.org/wiki/Topology)
- Geometry and quilting: Create a quilt exhibiting interesting geometry. (Some cool examples: https://www.pinterest.com/shellykuro/math-science-quilts/)
- Artistic representations of Proofs without words (Lots of directions you could go here)
- Mosaics (related to geometry, tessellations, or knot theory): Create an original mosaic that exhibits mathematical properties.
- Create your own idea! Just about anything you are interested in has some underlying math involved. Find it and create something new!

Final Project
Assignment:

- Make something with math!



Work by Nathan Gallagher

“I'm so glad I had the opportunity to make something so cool, it's not something I would have done otherwise.”

Reina Ramos

Time Signatures

A time signature in music indicates how many beats are in one measure and what type of note gets one beat.

Time signatures consist of two numbers and are like a fraction.

These numbers appear at the start of a piece of music to indicate what notes to play on the specified rhythm. The time signature can also change throughout a piece.

The Principal Beat is the rhythmic beat of a piece and is the most important beat to listeners. It is most recognizable in music as the beat of the piece.

Math Involved with Time Signatures

We can use mathematics to solve for the number of notes required to fill a beat based on the given time signature.

Example: How many 8th notes are required to fill a measure in a 3/2 time signature?

Here is what we can calculate based on the problem:

½ note = 4 * 1/8th note – four 8th notes are required to fill one beat.

3 beats are required to fill a measure.

Therefore, 12 eighth notes are required to fill a measure because:

3 * 4 = 12

Top Number/ Bottom Number

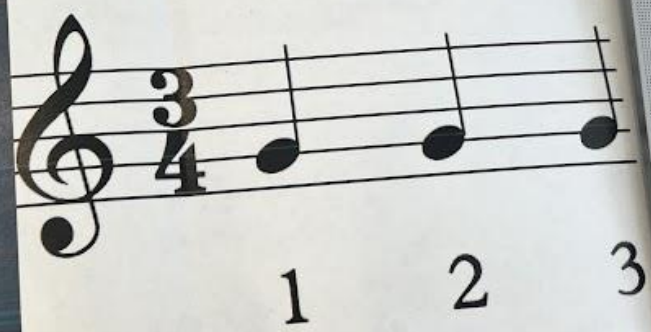
The bottom number of a time signature represents the principal beat.

Examples of the bottom number: 1, 2, 4, 8, 16; The number represents a note; 1 being a whole note, 2 representing a half note, 4 representing a quarternote and so on. (Note: composers use fractions to divide a whole note into fractions)

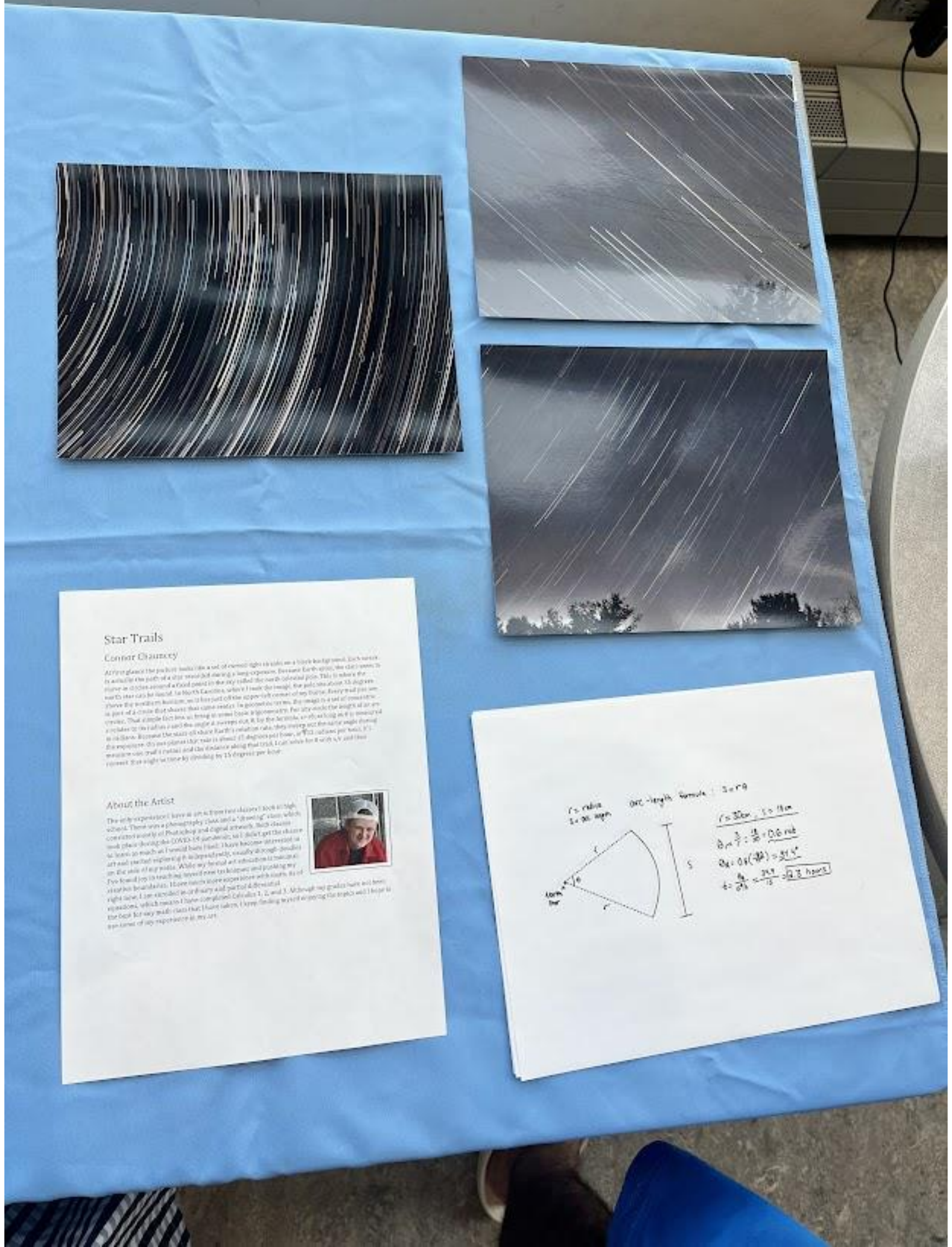
The top number represents how many notes are required to complete a single measure.

A measure is a segment of time within a piece of music which contains the specified number of beats per measure (time signature). Each measure is separated by a bar.

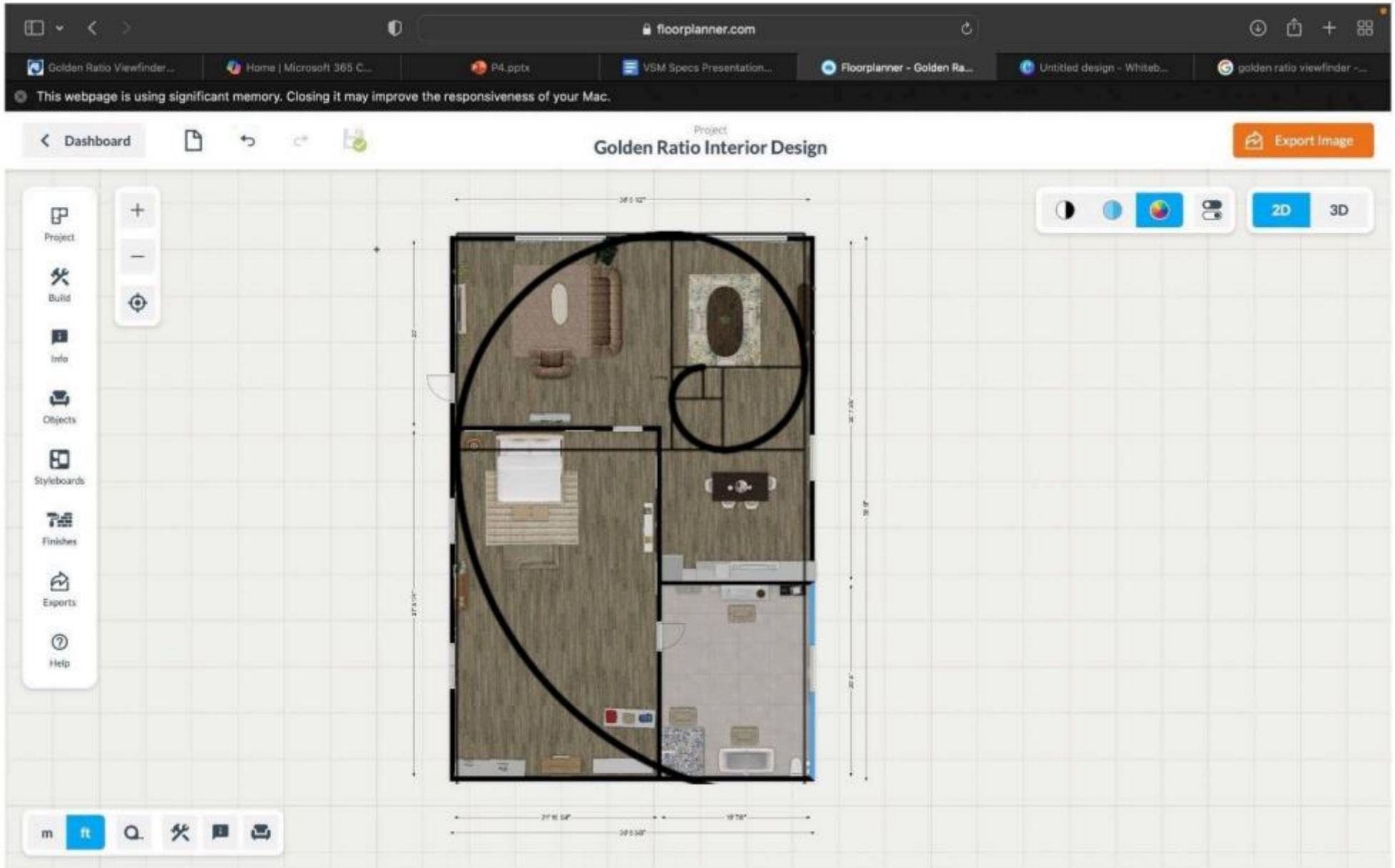
Example Time Signature: ¾, the 3 at the top of the fraction means that exactly 3 notes are needed to fill one measure and the 4 on the bottom lets us know 3 of what note. 4 indicating a quarter note, means that we need 3 quarter notes to fill each measure.




Color Theorems on Different Surfaces


Star Trails
Connor Chauncey
About the Artist


3D Color Space 2D Perspecti
Jack Watson: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Final Portfolio

Art 197N- Pezzimenti

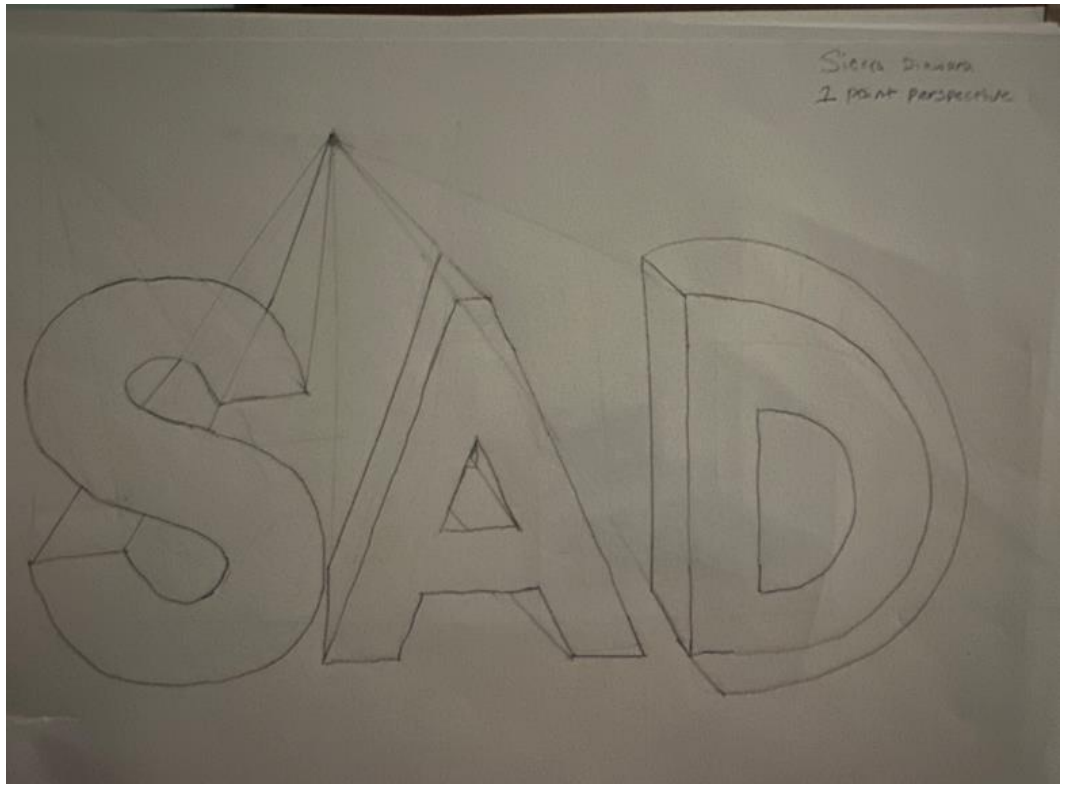
Your final portfolio is a compilation of all projects completed in this class. You can choose to submit either a physical or digital portfolio. In either case your portfolio should include:

- An introduction (~1page) to the portfolio containing a reflection of what you learned from this class. This can also include your general artist's statement.
- Each final piece (or a photograph of the final piece) listed below.
- When relevant (see below), photographs of your work in progress.
- For each piece, include a thorough description of the mathematics involved. This can be identical to the description you submitted with the assignments if you received full points. If you were given feedback, you should edit your description for the final portfolio.

Overall, this class helped me see art through in a new light. I **feel more confident calling myself an artist**, especially because now **I understand the math behind my choices**. I also feel like I've built a good foundation for future creative work

What stood out most to me was that this class focused **less on grades and more on producing thoughtful, high-quality work**.

This commitment to quality work was largely evident at the Student Engagement Expo as well as our final gallery in which the **clear diversity of projects, student perspectives, and personal interests created a beautiful exhibit**. We weren't just impressing others – **we were proud of what we had accomplished ourselves**.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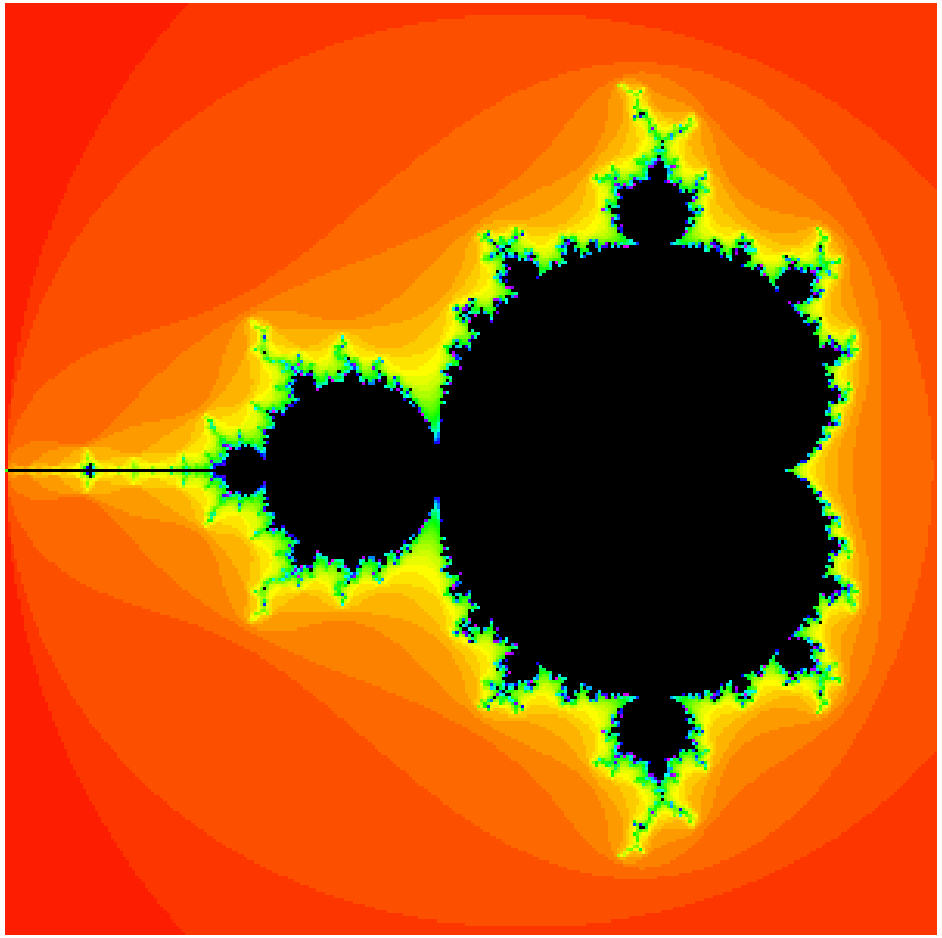
Feedback

- **“I have started to look for the mathematical implications of everyday items** and architecture, which is something this class has opened me up to. In my opinion the broadening of my general viewpoint is a practice that I have adopted that makes it easier to apply math to art.”
- “Having an open mind toward art. I really just thought that I was not good at it and I still have a lot of room to improve, but **actually being like woah art is math kind of made me try a little harder in the art department”**
- “This class is super cool because it **brings people in who prefer math over art and art over math**. It doesn't matter which one a student prefers because you do a really good job at merging the two together.”

Takeaways

- A lot of work, but fun
- Project format allows for segmented planning
- Not every project is a hit
- It’s ok not to be an expert on everything
- Don’t be afraid to get “too mathy”



Future goals

- Deliver a version of this course as a writing intensive course
- Refine technical writing in their piece descriptions
- Peer revisions and rewrites

Thank you!