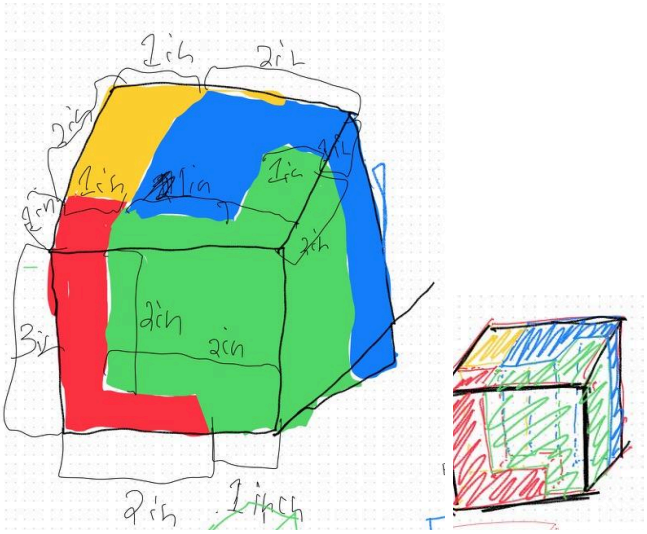
Initial Documentation

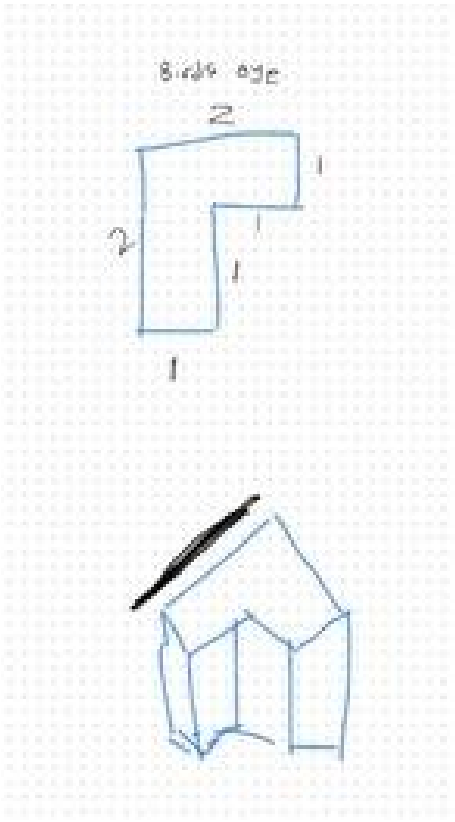
Our team (Shannon, Gigi, myself, and Tia) were challenged to create a 3D puzzle object. We had to first design concept sketches, make a design virtually in CAD, then 3D print the physical parts. Our design had to fit the requirements that the puzzle must contain 4-6 parts, it must fit inside a 27 $inch^3$ volume, and when we 3D print the design each part must be a different color.

We envisioned each puzzle piece as a composition of multiple one-cubic-inch blocks, with the assembly of all these pieces forming a 3”x3”x3” cube. Based on this concept, we generated a straightforward 2D visual representation, illustrating four distinct puzzle components. Each team member was assigned a specific piece to work on: Gigi was responsible for the red block, Tia for the green block, Shannon for the black block, and myself for the blue block. With the concept sketch as our guide, we individually recreated our puzzle pieces using 3D modeling software. For each block, we began by crafting 2D, one-square-inch "sketches" within Fusion 360 and subsequently extruded each square to its required dimensions. Finally, we merged our four separate files into a single file for 3D printing.

Concept Sketches

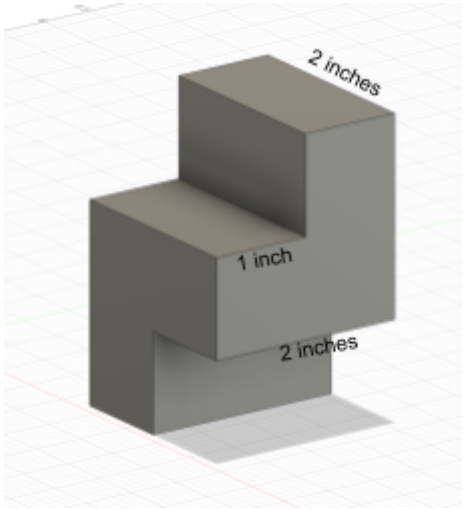


Here is the overall concept sketch we made, it was a rough sketch of how we were going to construct our puzzle. From there we each were designated a piece to resketch on its own and build in CAD.

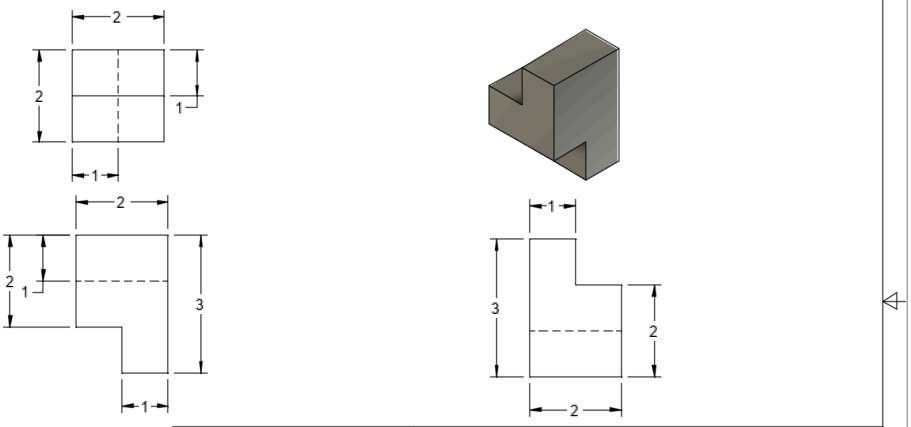


The concept sketch I created resembles a 2x2 block, but with a corner section removed, featuring 1x1 dimensions. Additionally, I incorporated a 2x1 extension to ensure that the block's edge aligned correctly and fits seamlessly between the corners of the other pieces.

3D Model

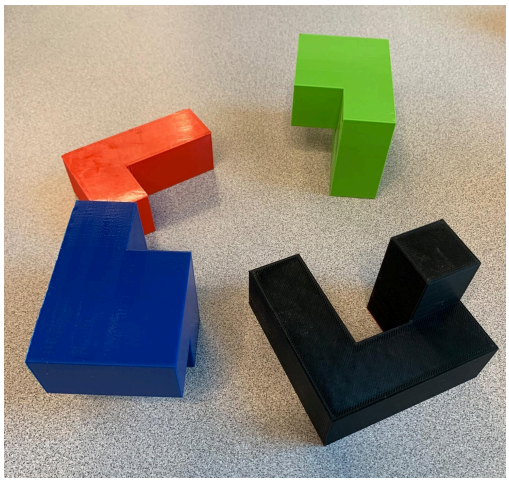
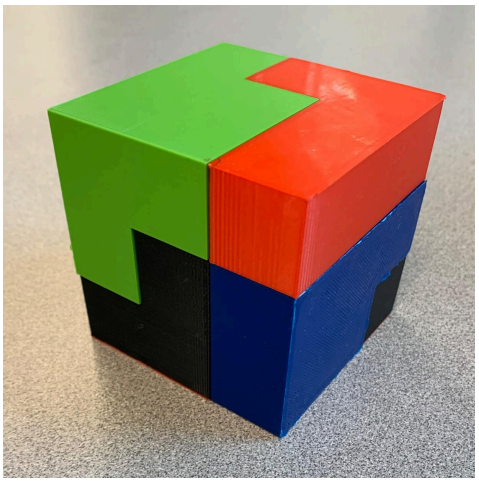


This is my block that I designed, it was printed in blue with PLA filament.



	PROJECT: 3D Puzzle Project
	TITLE: Piece 4
APPROVED	SIZE: A / CODE / DWG NO / REV
CHECKED	
DRAWN Daniella Rosenberger 11/2/23	SCALE 1:2 / WEIGHT / SHEET 1/1

Final 3D Print

Piece 4 (blue):
Print time (t) = 3 hours and 25 minutes = 3.42 hours
Volume (v) = 8 cm^3
Density (d) = 1.25 g/cm^3
Time spent on project (x) = ½ hour

($30/0.5 kg)(1 kg/1000g) = $0.06/g PLA
Total cost = ($30/h)x + ($0.80)t + ($0.06/g)(d)(v)
= (30)(0.5) + (0.80)(3.42) + (0.60)(1.25)(8)
= $23.73

Physics

- Explain the types of fitment that your completed puzzler uses and possible physics that allows this to take place. (you may want to research “types of fits”)

Two of our puzzle pieces are designed with a friction fit, which means they are intentionally slightly oversized. These pieces require a gentle application of force to overcome the friction between their surfaces when assembling them. The friction between the surfaces ensures that they stay connected securely. When disassembling, a similar gentle force must be applied to overcome the friction and separate the pieces. On the other hand, our other two pieces don't rely on a "fit" but are integral to the puzzle thanks to gravitational force and friction. They are positioned securely on top of our two friction-fit blocks to complete the puzzle. This way, our 3x3 block made up of 4 individual puzzle pieces stays together.

- Research and explain how the orientation of the 3D print will affect the strength of the final product. You may want to look into this before 3D printing your parts. A diagram can help explain this, but is not necessary.

The orientation of a 3D print impacts the strength of the final product due to anisotropy, or directional dependence. This means that the physical properties of a material can change depending on which axis it is measured along. For example, in processes like Fused Deposition Modeling (FDM), layer adhesion is weaker between layers, so printing horizontally maximizes strength along the layer lines. The x- and y- axes are typically stronger than the z-axis in FDM. As such, orientation can affect stress distribution and create stress concentration points.