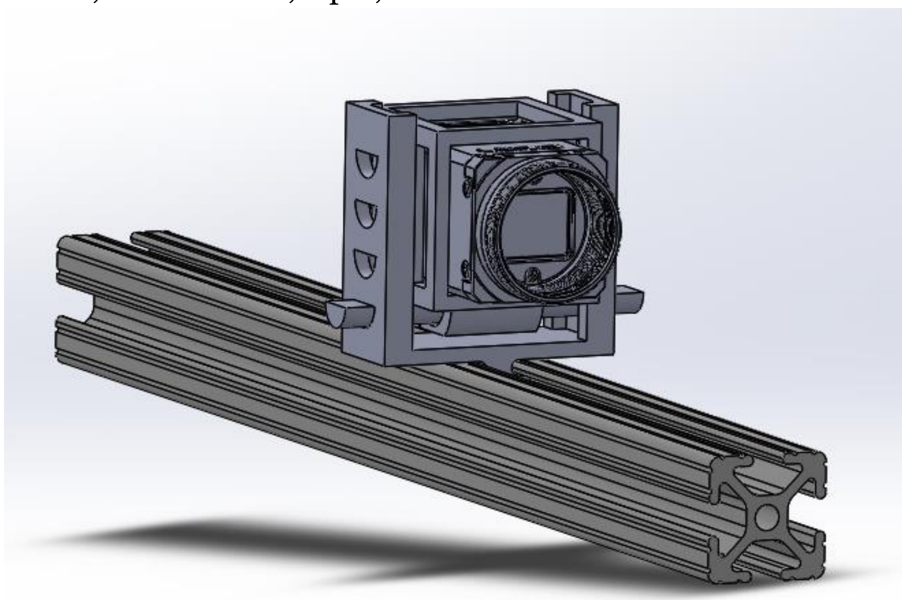
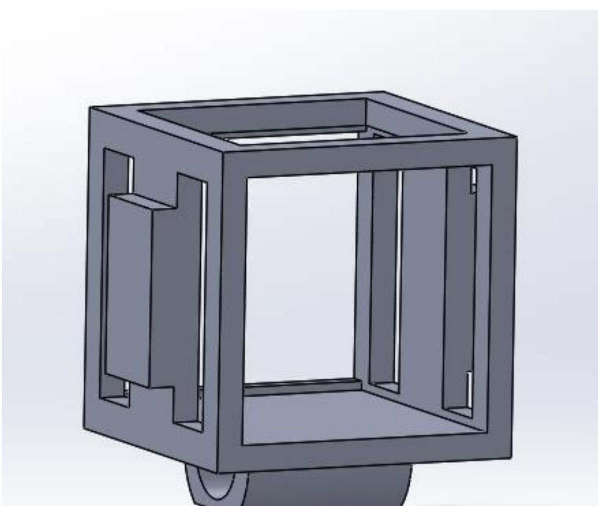
Project 1 Report – Group 3 (Madeline Gershman, Roshan Suhail, Krishi Vishal Panchal, and Sai Thribhuvan Narmeta)

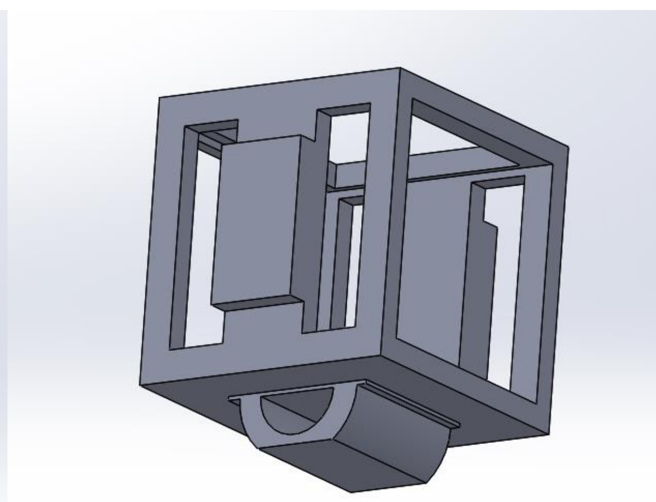
March 03, 2023s

1. CAD- Solidworks
   a. As seen in the image below, the camera mount design consists of 3 components, a camera car, a pin, and an extrusion mount.



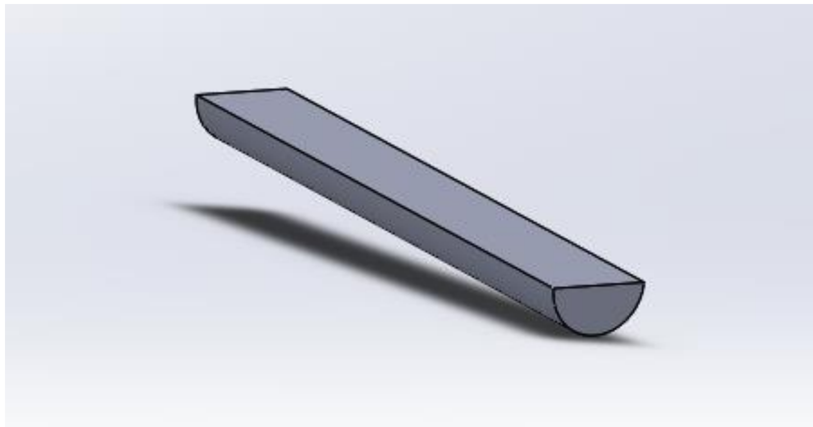
The camera car, which can be seen below, consists of a basic cage shape



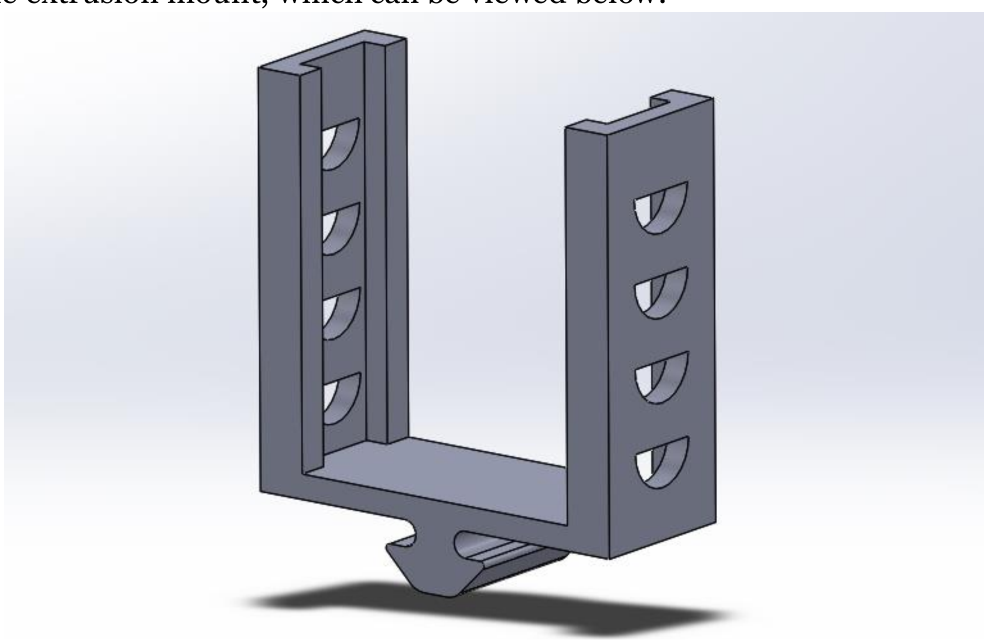


that the camera can slide into, leaving access points for camera connections at the back and the 450mm lens at the front. At the bottom of the part there is a slot meant to hold the pin. On the sides of the car, there is a simple rectangular bump outs to fit into the rail system of the extrusion mount.

The pin, as seen below, is a semicircle shape to prevent any turning or twisting of the pin.



The hole for the pin in the CAD is slightly oversized to ensure the pin will fit through once the part is printed. The final component of the system is the extrusion mount, which can be viewed below.



The bottom portion of the design includes a trapezoidal piece that slides onto the piece of 80/20 from the end, anchoring the camera to the 80/20. There are four positions for the pin to enter the extrusion mount, allowing the height of the camera to be adjusted.

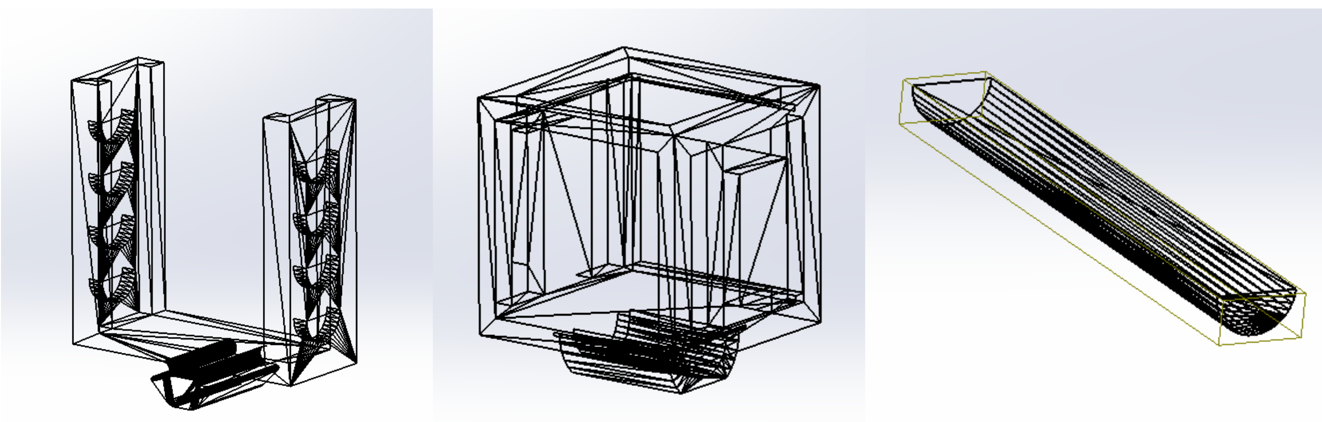
b. Some design decisions were made with the FDM printing process in mind. All of the parts were designed with at least one flat face, aiding in FDM 3D printing orientation and adhesion to the build plate. Material was removed from components where it was not necessary to decrease print time, as supports can print faster. Some of the curved components, including the pin hole in the camera car and the 80/20 slider component of the extrusion mount were designed to print the curved in the x-y plane rather than the z to increase the smoothness of the curves.

2. Conversion to STL
    a. Deviation and Angle Table

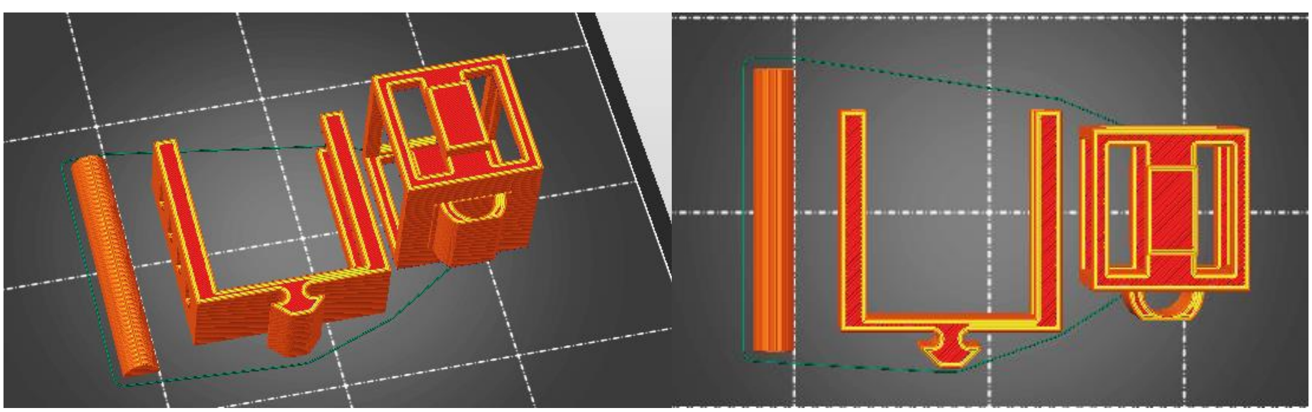
Part	Deviation (mm)	Angle (degrees)
Camera Car	0.04587	10.00
Extrusion Mount	0.04791	10.00
Pin	0.03623	10.00

These tolerances determine the maximum difference between the STL and the CAD model. The deviation and angle determine the size and geometry of the triangles created in the STL file. If the angle and deviation are smaller, there will be more triangles and a higher resolution STL. It also creates a larger file size.

    b.



3. Print Manipulation Slicing Algorithm
    a.



This print orientation was selected for a few reasons. For the pin, the flat side was chosen to avoid the need for supports and to provide a wide enough surface to adhere the part properly to the build plate. For the camera car, the print orientation was selected to decrease the needed support material in the pin hole at the bottom of the car. For the extrusion mount, the part orientation was selected to place the geometry of the 80/20 extrusion slide in the x-y plane. This removed the need for support material and increased the accuracy of the curves as layer height did not impact the curves.

b. These parts did not need a brim, given their flat edges and sufficient print bed contact. The camera car and the extrusion mount did need structural support given the geometry. Both parts include features that do not meet the build plate at any point. The pin requires no support.

c. Print Settings

Print Setting	**Details**
Layer Height	0.2mm This value was selected as the appropriate balance between print resolutions and print time.
Shell Properties	Included for top and bottom layers to suitably encase the infill layers between two shells.
Infill Details	20% dense cubic infill This value was selected to provide adequate structural support for the weight of the camera and lens.
Brim/Raft	None The parts have sufficient print bed interaction and flat sides and do not need the extra support.
Support Material	Support exists for parts on overhangs greater than and angle of 45 degrees. This is a general printing standard for this printing using ABS.
Advanced Parameters	Shell Parameters Wall Thickness = 0.8mm Horizontal Expansion = 0 4 layers These decisions appropriately encase the infill material.

d. Filament Settings

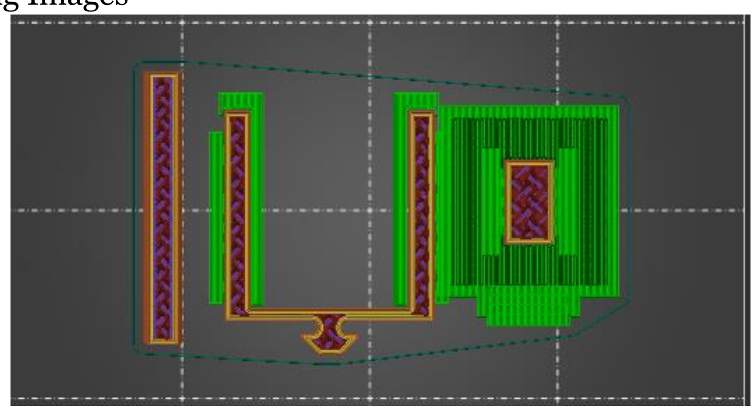
Filament Type	Generic White PLA Low risk of warping with a glossy finish
Temperature	Nozzle Temperature = 200°C Print Bed Temperature = 60°C
Cooling	Auto-Cooling Features

e. Printer Settings

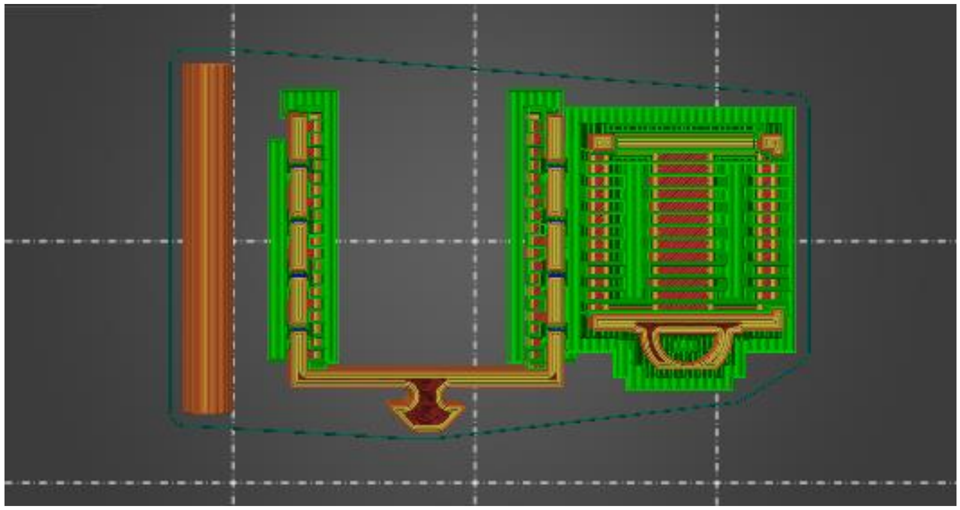
Nozzle Diameter	0.4mm

f. Parameter Effect on Print Time Part Quality and Cost

i. The layer thickness can impact the parameters in the following ways. Increasing the layer thickness will decrease the print time on the part, as less layers are needed to be printed to make the part. Increasing the layer thickness will decrease the print quality as the layers become more visible and less accurate in the printing process. Increasing the layer thickness does not impact the cost of the part very dramatically.
ii. The print speed can impact the parameters in the following ways. Increasing the print speed will decrease the print time on the part, as each layer is printed as a faster rate. Increasing the print speed will decrease the print quality as the accuracy of the nozzle and the evenness of material output is lowered as the machine moves at a faster rate. Increasing the print speed does not impact the cost of the part very dramatically.
iii. The material selection can impact the parameters in the following ways. Changing the material used in the printer can alter the print time depending on the recommended settings for the material, including the layer thickness and print speed. These parameters may increase with something like ABS or need to be decrease with something like nylon. Cost and energy are also impacted by material selection. The cost of the material may increase as the selection becomes higher cost in raw materials or higher in quality.
iv. Slicing Images

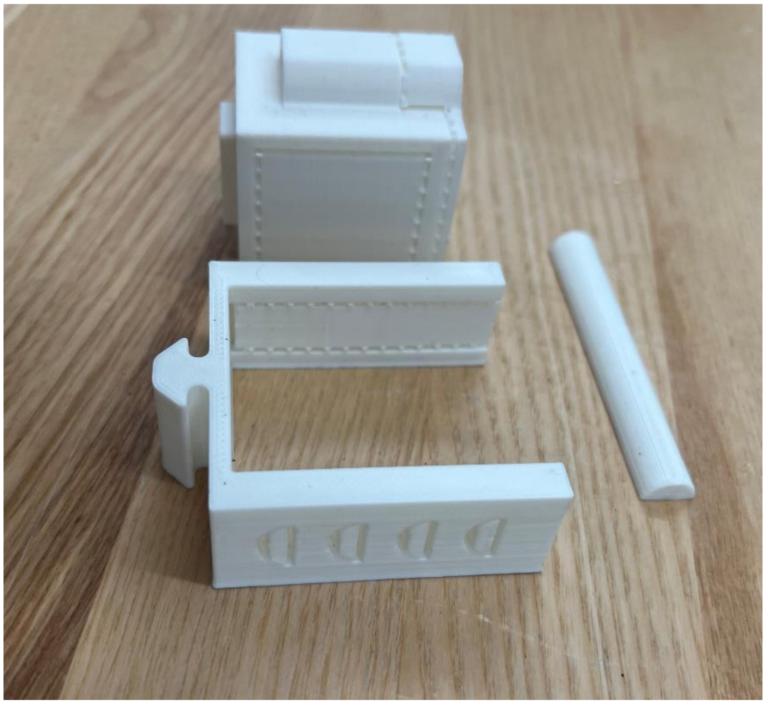


The first image is of the 51st printing layer. The slicing setting can be easily identified through the colors of the extrusion in the image. In tsi particular layer, very early on the printing process, there is a lot of support material being printed (in green) as well as some solid infill (in purple). Every layer in the slicing that isn't entirely support material will include the internal infill (in red) and the perimeter (in yellow) as they are critical to build the part. The skirt can be faintly seen in teal.

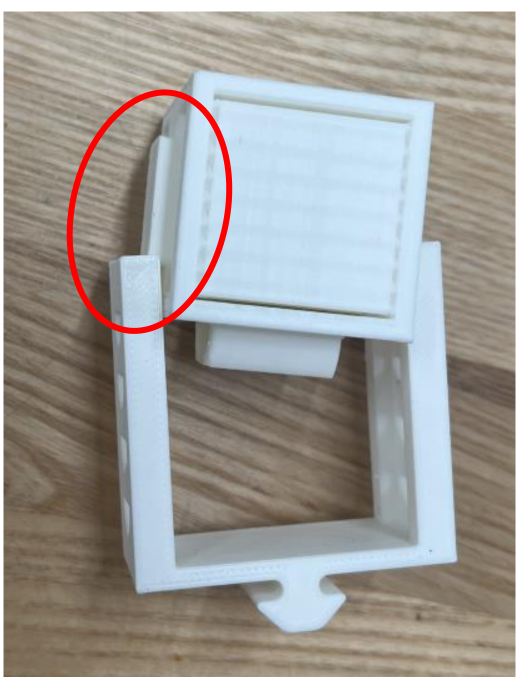


This view is from the 279th layer of the printing process. Where much more perimeter material is bring printed as the pieces' components grow thinner at this part of the print, requiring less infill.

4. Machine Setup
    a. Before the bed and nozzle began heating, a thin layer of glue stick was placed on the surface of the print bed to increase adhesion. The print bed had been leveled previously, and the g-code was uploaded to the printer.
5. Build
    a. There are some defects that occur during most prints. Given the slightly heated print bed, there is usually some spreading with the first few layers of material. This was addressed in the post-processing step below. The layers made by the printer are clearly visible by the human eye, though smaller layer height could have helped this. There is little warping after printing given the material properties of the PLA used to the make the part
6. Part Removal
    a. There is little deformation as the part is removed. Some issues that could occur include scuff damages from the tool used to remove the part from the print bed, part breakage if the parts are rather thin or hard to remove, and curling if the part is thin and tall and the material condenses as it cools.
7. Post-Processing
    a. There was some post-processing needed for this design. Support material needed to be removed from the camera car and the extrusion mount. The before of the support material removal can be seen below.

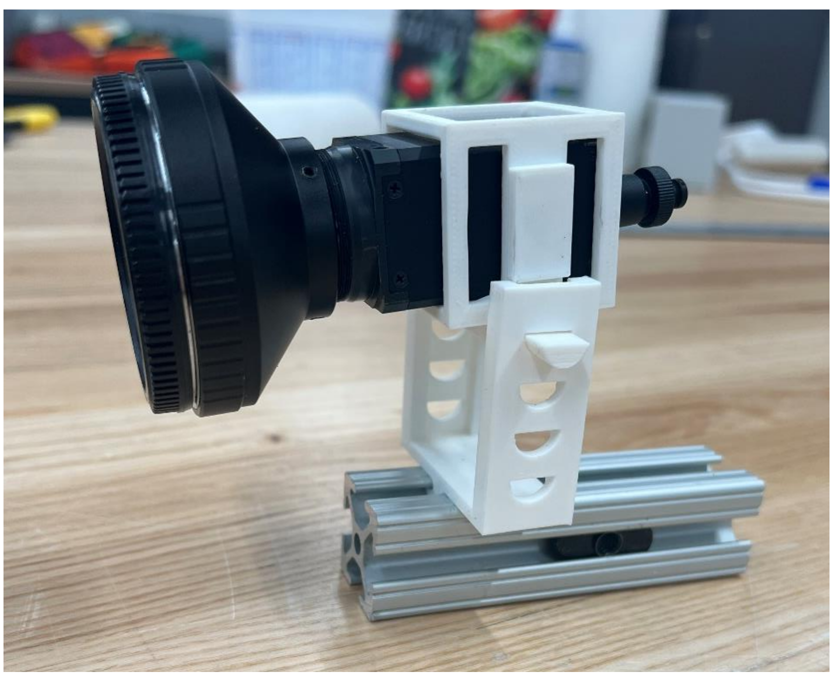


The tools that we used to remove the material were also included in the image. This caused some slight deformation in the material surface but did not impact overall form and function of the completed parts. Sanding of one feature on the camera car was also required. Circled in red below, this slide component printed on the print bed beside a large area of support material.

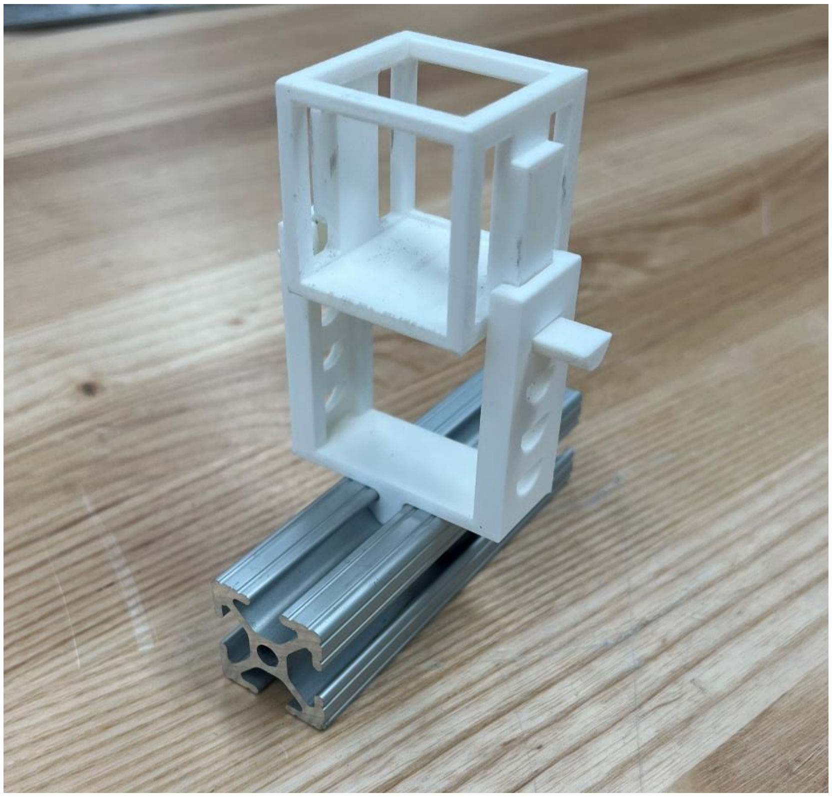


This seemed to have cause some spreading and a few moments of sanding with 120grit paper was able to correct the geometric discrepancy and allow for smooth motion of the camera car.

8. Application and Reflection
   a.



This system relied on slide insertions to fit together all components. After post processing the form and fit on the components worked quite well together as the pin was easily able to travel through the slots in both components. In the design process, the camera car was given a slightly larger hole for the pin to travel through. This worked quite well when trying to manipulate the height of the lens as the pin could be easily removed and replaced. The tighter fit of the pin in the extrusion mount then provided adequate support to prevent any turning in the pin. The part worked quite well slide onto the 80/20 as pictures here.



Though moving forward, this area could benefit from a smaller tolerance. The camera easily slide into the camera car and the connection points on the back of the camera are easily accesses. When put together, the entire system sits well and doesn't fold under the added weight of the lens. The camera can sit on all levels of the pin. This design could be improved with a second latching features to hold the camera in place at a second point.

b. Conventional Manufacturing Methods
    i. Casting – it will take a long period of time to create a cast. The cast created can be used to make the parts in any material which we desire. The strength achieved in this process is the highest. Post processing will also take reduced amount of time.
    ii. Molding - the design created has a lot of enclosed spaces which requires molds to be manufactured and therefore it would be nonsensical economically to create just for this design but once the mold is created it can be used to mass produce products at a very large volume

iii. Machining- if machining is purely used then it would take a lot of time to machine enclosed spaces and create parts. Also, the pin has high aspect ratio and is better to be created using casting process then to be machined
iv. Forming – Forming would be the best conventional method of manufacturing for the designed part. Along with the use of welding we can create the desired part with the required dimensions rather quickly. But the designs that can be manufactured using this technique are limited by complexity and hence cannot be used to manufacture complex geometry

c. Advantages of using additive manufacturing setups are
    i. Entire assemblies can be created in a single step
    ii. Parts can be customized to a degree limited just by the imagination of the user
    iii. Large manufacturing facilities need not be created to print designs
    iv. Designs can be changed even at the last moment of printing which allows design flexibility
    v. It is easier for new users to learn how to 3D print than conventionally produce designs
    vi. Easier to set up the machines and lower cost of maintenance
    vii. The people across the world can collaborate with each other for fit and form which is not possible with conventional manufacturing

d. Multipurpose CNC machines ae the best machines for precision manufacturing. With multi-axis numerical machining, processes can be performed simultaneously leaving less room for human error that may occur during part repositioning. Tasks performed during CNC machining could include milling, turning, drilling, tapping, boring, and more.

   Swiss machining is a specific type of CNC machining which creates parts by bringing the stock to the tool rather than the other way around. They provide a great degree of precision among the various types of CNC machining. Extremely accurate Swiss machining can achieve tolerances within ±0.0001 inches. Hence it would be the best process for this specific setup.