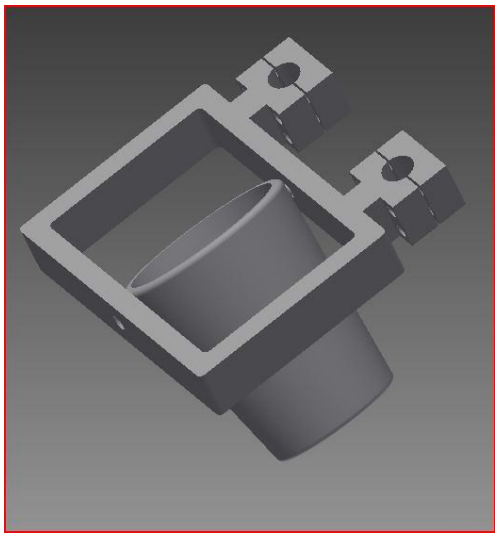
Element G: Construction of a testable prototype

Prototype

When we were building our prototype, we decided to put most of our focus on the frame and hinge system because we feel this is the most important part. We wanted a system that prevented liquid from spilling while a user walks with their crutches. Because of the swinging motion, we knew that this would be a difficult task. The other specifications would be easier and take less time to solve. We wanted to make sure that the pins on the cup holder were up high enough so the center of gravity stays low. We also wanted to make sure that the cup swings freely and maintains an upright position while a user is walking on their crutches. Our most important criteria was to avoid any spills with a full cup.

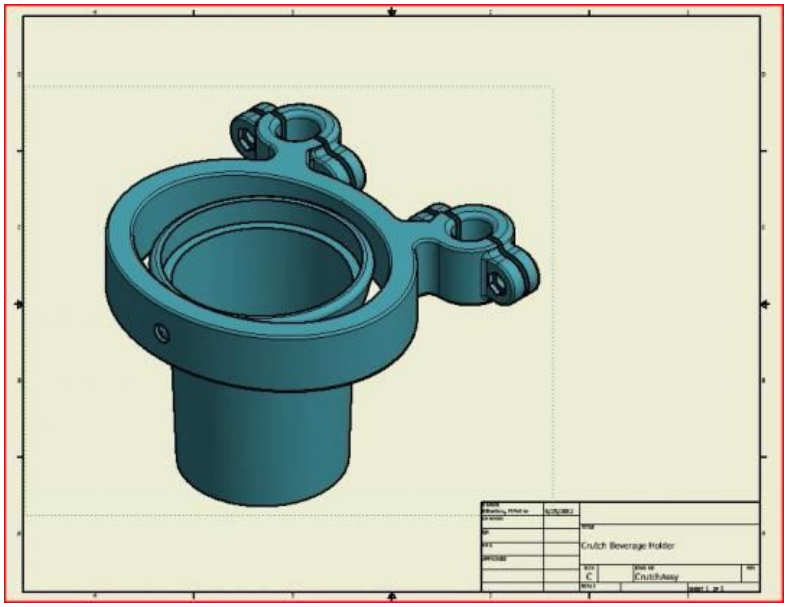
The prototype was constructed with various tools and machines. First, we made a few initial sketches of our design. We made sure our dimensions were correct and would meet our specifications. After that, we built a 3D model of our prototype in Autodesk Inventor. We assembled all of the parts and created an .stl file. These drawings are pictured below:

As we built the prototype, we made some revisions. For example, we made it more aesthetically pleasing by making it more rounded. This got rid of the blocky look. We also cut out the bottom of the cup holder, believing that the mass of the liquid in the user's cup would act as our weight. This did not work because only a portion of the cup would fit below the hole. Therefore, the entire cup holder including the cup was too top-heavy. We decided make that hole larger and replaced it with a standard plastic cup. This plastic cup became our new cup holder. We also tried to slow down the momentum of the cup holder by putting friction tape in the hinges.

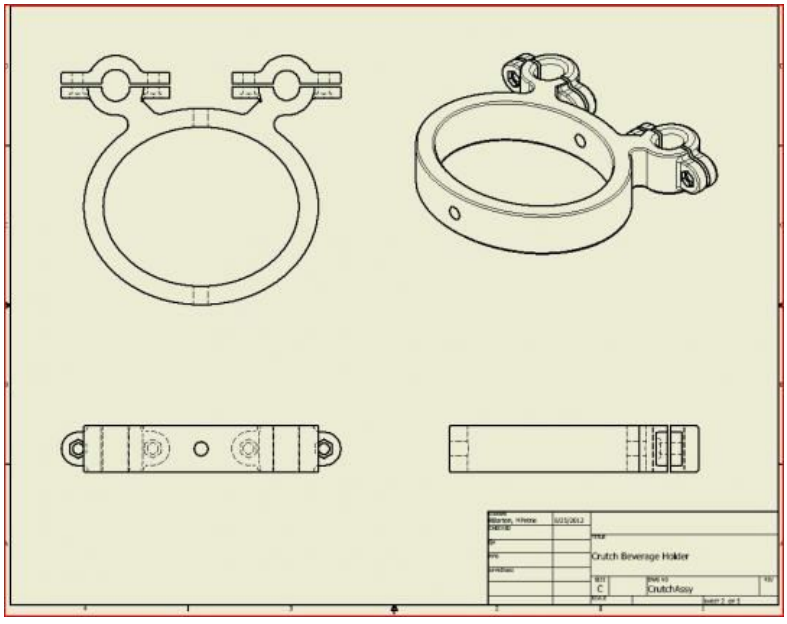


We had planned for our final product to be made out of ABS plastic. The Dimension SST 1200es 3D Printer uses ABS plastic, so our prototype is extremely realistic when it comes to size, shape, and weight. Autodesk Inventor let us know how much our prototype would weigh before we made it. We are still planning on using ABS plastic as our final product material because it is light-weight, durable, and dishwasher-safe.

Below is a pictoral summary of the process described above:

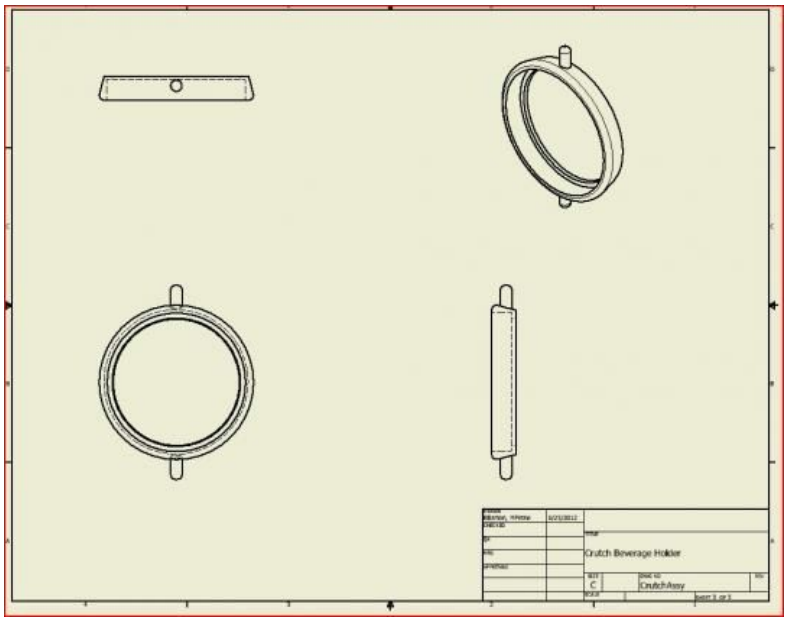


These are the 2 prototype machines at *[school name redacted]* High School. The one on the left is a Dimension SST 1200ES and the one on the right is a Dimension SST. We used the one on the left to make our prototypes. It is newer, faster, and more reliable.

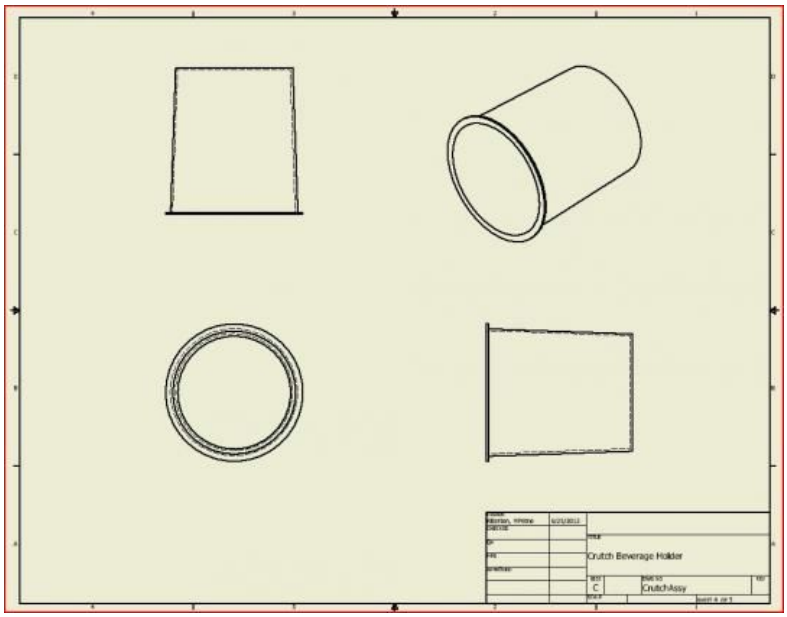


The program that is used to communicate with the Dimension SST 1200 ES is called Catalyst EX4.3. With this program, a user opens their .STL file and orients on the prototyping plate. This program also tells the user how long the process is going to take, how much model material, and how much support material will be required.

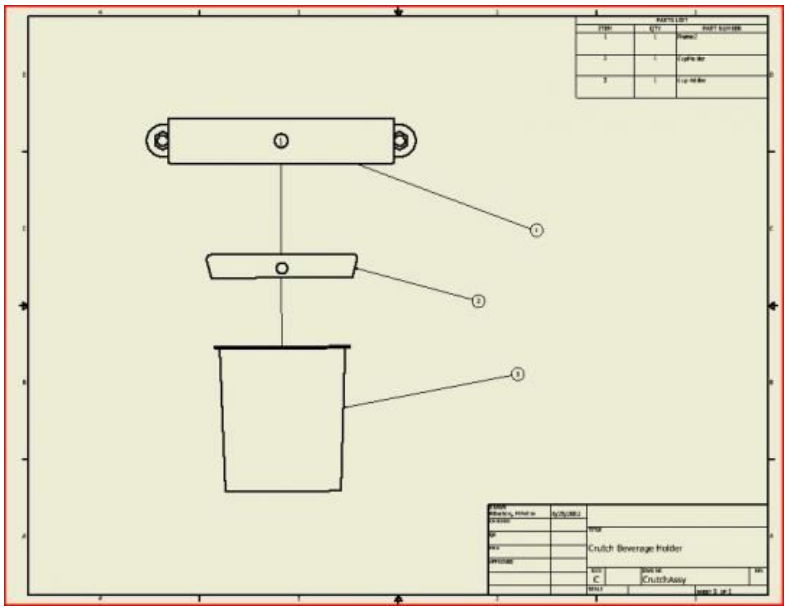
A user can also decide whether or not to create a solid or sparse part.



This is the finished prototype still on the plate. The blue material is used to make the model and the black material is used for support. The support material must be dissolved using the Ecoworks cleaning agent. We built the more aesthetically pleasing part first because it took a considerably shorter amount of time.



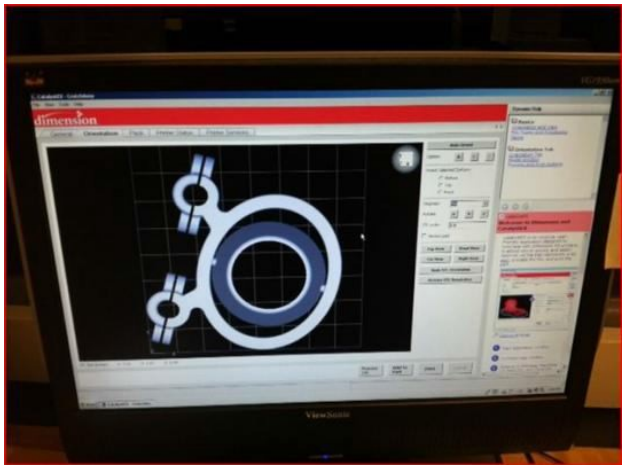
This is the finished prototype in the Ecoworks cleaning solution. It took around one day for all of the support material to dissolve. If the part is taken out too early, you must remove the support material mechanically with screwdrivers and an exacto knife, which can damage the part.



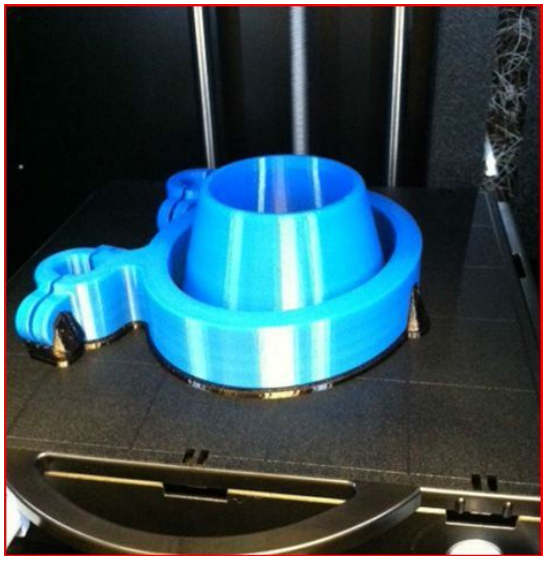
After we put the newly modified design in the cleaning fluid, we started building our original design. This design was to use the full cup rather than the half cup. For this

design, the blue brackets were not fastened correctly. Due to this mishap, our design was skewed and unusable.

This is the original design with all of its flaws. The prototype machine pushed the plate and the part farther away from its original starting point. We tried to fix this prototype by sanding some of the parts, but it was not usable. We decided to use the new sleek design instead even though We had a feeling that the cut out bottom was not going to work.



This is the finished prototype with all of the support materials dissolved. There is no bottom to the cup holder on this prototype. We thought that we could reduce the amount of material by using the weight of the user's liquid filled cup rather than attaching a weight on the bottom of the cup holder. Not only would this not work due to the center of gravity being too high, but most cups would not even fit through the hole.

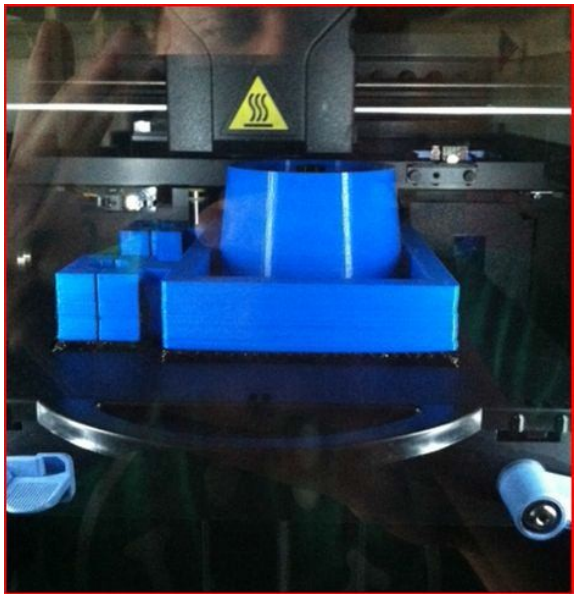


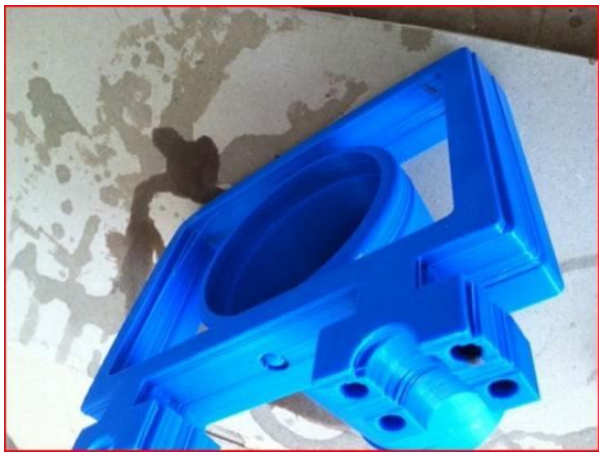
We found an ordinary plastic cup to replace the cup holder. This new cup was necessary because it now looked more like our original design with an updated, more aesthetically-pleasing look. This mistake actually helped us to decide that we wanted the cup holder to be a separate part so users can remove it and put it in the dishwasher when needed.

Adding the weight to the cup allowed the center of gravity to be lower and offset the weight of the liquid in the cup. Without the added weight, most cups would tip and fall over due to the high center of gravity. However, we needed to move the weight closer to the cup in order to decrease the moment occurring when the cup swings back and forth.

Adding the flanges gave smaller cups more support and kept them in the center. This increased the cup holder's stability and decreased the chance of liquid spilling.

Here is the prototype attached to our crutch. There are a few things we would like to improve, but as of right now, we are ready to test.



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