Project 3: Design of a Molded Part

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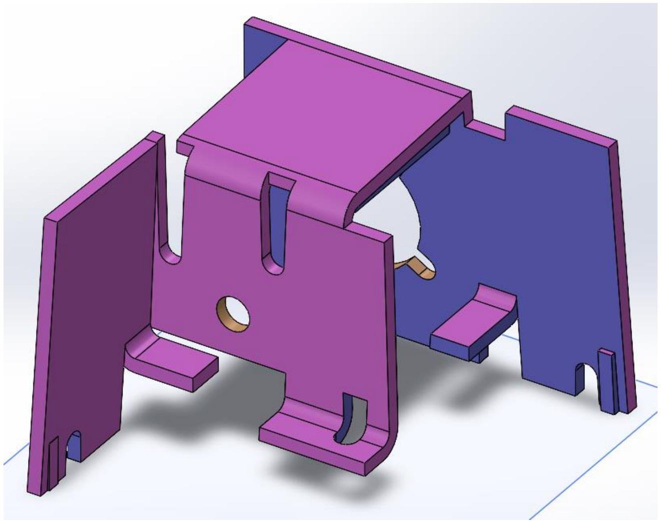

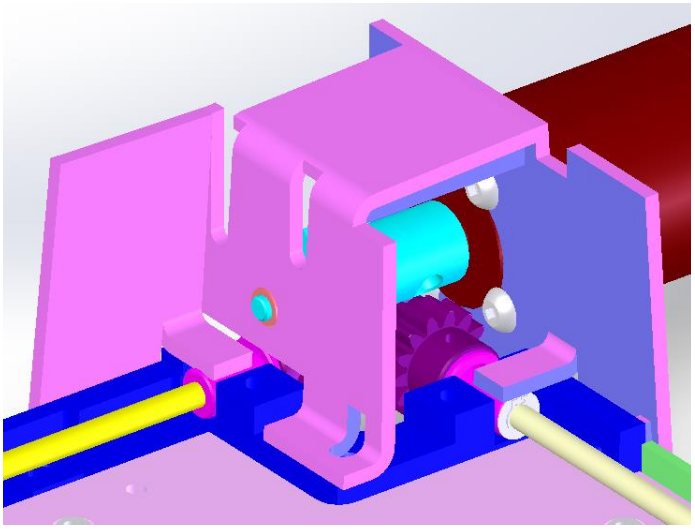

Introduction

The purpose of this injection molded part was for a motor mount for an archive data storage system. The system includes a gear rack, three gears, a motor, and three bearings; the molded part must accommodate all these parts. The molded part would be assembled by mounting to the blue shaft alignment part in three locations: one screw in the bottom left corner through the front plane, one screw in the bottom left corner through the right plane (figure 1), and one screw in the front corner foot through the top plane (figure 2). The three separate alignments ensure security of the connection between the machined part and the rest of the archive data storage system. To assemble into the system in SolidWorks, the molded part has been offset so that it falls directly into place when adding it to the assembly. To design the system, a wall was first created parallel to the right plane, and all material was added on from there. Draft was added to all necessary walls after the wall was created, rather than adding all the draft to the part at the end. The motor is attached to the part using three holes, excluding the hole on the bottom left because it is inaccessible with the design. The pull direction of the mold is perpendicular to the top plane. Moreover, the material to be used is polycarbonate, which is common for small injection molded parts like this one.

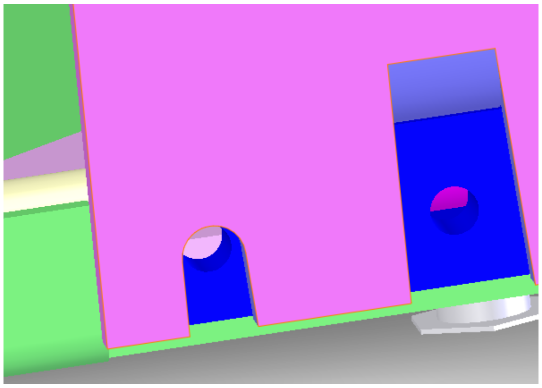

Figure 1: First alignment between the molded part and assembly, using a screw for the left hole.

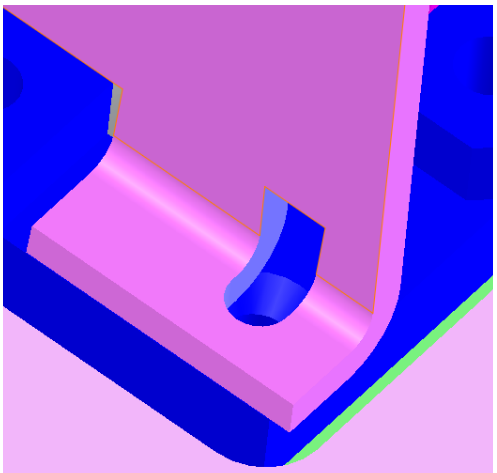

Figure 2: Third alignment between the molded part and assembly, using a screw.

Design Decisions

All design alternatives were a decision. This section will detail each decision and why it was chosen.

The holes are toleranced at .127 mm, which is equivalent to .005 inches, a standard tolerance. Moreover, the sizes of the holes that attach to the blue shaft alignment part in all three locations are 3.175 mm (+ .127 mm), a standard size equivalent to 1/8 inch, and can be seen in figure 1. The size of the hole that secures the flange bearing for the shaft is 4.7625 mm (+ .127 mm), a standard size equivalent to 3/16 inch, which fits the size of the bearing rigidly and can be seen in figure 3. The tight fit ensures security to limit flexure of the motor shaft, which would cause a misalignment between the gears, and subsequently accelerate gear tooth wear. The slotted holes above this bearing, also seen in figure 3, are the same size as the holes to the blue shaft alignment part, creating consistency. This allows the installer to connect and disconnect the screws that attach the motor with the machined part. The purple set screws can be accessed through the bottom, and the light blue set screw can be accessed through the opening on the right side.

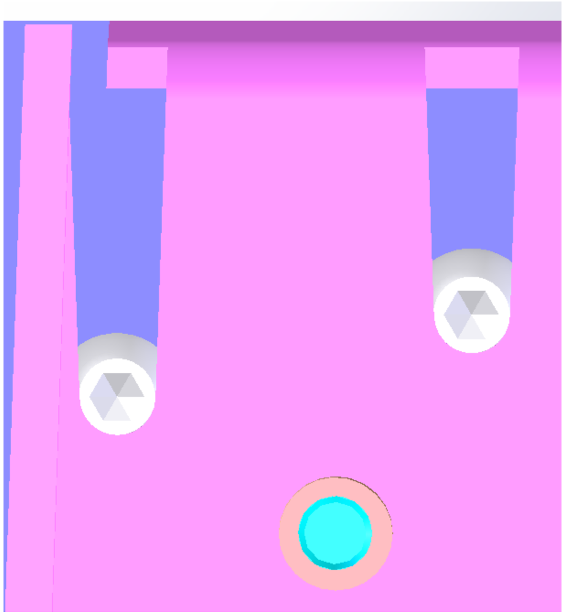

Figure 3: Slotted holes and hole for flange bearing of the shaft.

The diving boards, as seen in figures 4 and 5, have identical geometries to accommodate for ease of manufacturing. The calculations for their deflection are in the *Calculations* section.

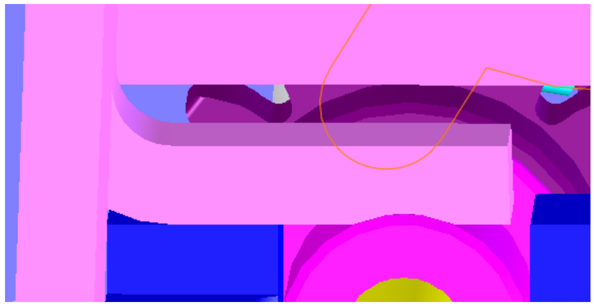

Figure 4: Diving board 1, extruded parallel to the right plane.

Figure 5: Diving board 2, parallel to the front plane.

All walls have a draft of 2 +- .5 degrees. Draft was applied either using the SolidWorks draft feature or applying directly when sketching the extrusion. The surface will be polished, but the draft ensures that the part can be taken from the injection mold without damage, and the extra draft does not diminish the strength of the part significantly. The only two parts that do not have draft are the alignment features, as seen in figures 6 and 7, which are necessary for the part to fit in the assembly and are small enough so that they do not impede the injection molding process. Moreover, all walls are two mm thick, which is equivalent to about .0787 inches, and walls on injection molded parts of this type should range from .06 to .125 inches. This further allows for a seamless injection molding process by providing an even flow path when injecting and having even cooling rates throughout the full part. For the fillets, the inside radii are 1.5 mm, which is 75% of the thickness, and the outside are 3.5 mm, which is the addition of the inside radii and the thickness. This ensures that the rounded edges are the same thickness as the rest of the part.

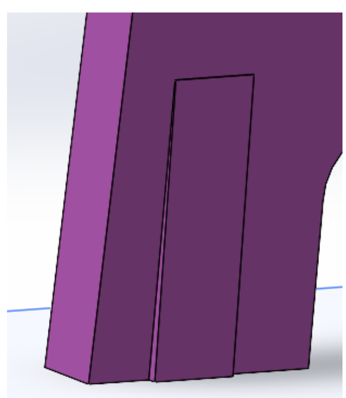

Figure 6: First alignment part.

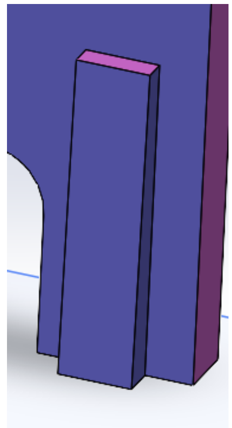

Figure 7: Second alignment part.

The molding consists of a core and a cavity. The surfaces that the core makes are purple, and the surfaces that the cavity makes are pink. The surfaces that are created by slides, which are just two holes, are orange. The first slide is used for the bearing hole in figure 3, and the second slide is used for the cutout for the motor in Figure 8. A good area for a gate where the plastic enters the part is the top roof, where plastic can flow in freely and move to all spots easily. Moreover, good spots for the ejector pins would be the bottom surfaces of the part, next to the hole in figure 1, and on the opposite side.

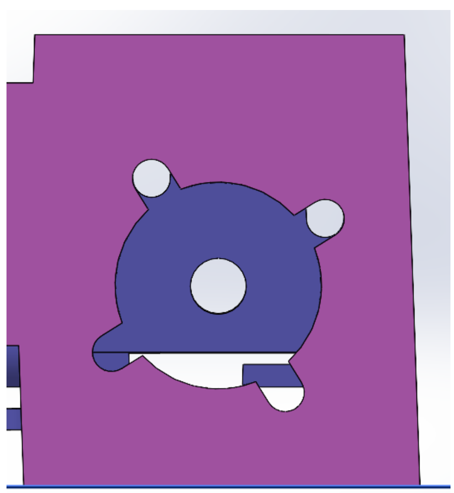

Figure 8: Hole for the motor.

There are multiple quirky design decisions that not only make the part unique but have purposes ranging from manufacturability to strength. One of these decisions is the ribs underneath the roof of the part, as seen in Figure 9. The two ribs add strength, which is vital because the polycarbonate material is not the strongest, especially compared to the materials in the machined and sheet metal parts. Another decision that occurred on multiple areas of the part was removing material either above or below the holes and diving boards. The hole under the diving board can be scene in Figure 10 along with the material removed under the screw hole, which looks the same for the other side. Figure 3 shows the material removed above the holes. These allow for the mold to occur without using a slide. Further, they do not diminish the strength of the part.

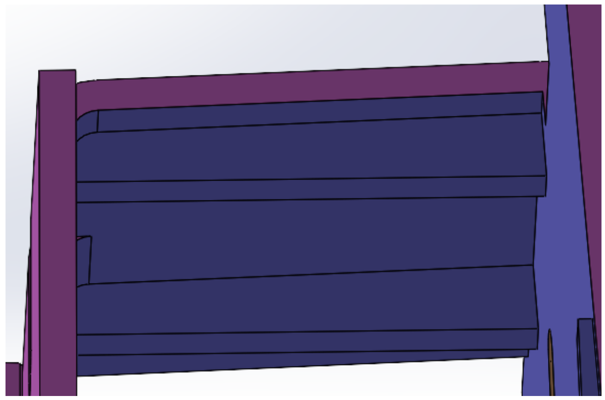

Figure 9: Two ribs underneath the roof of the part.

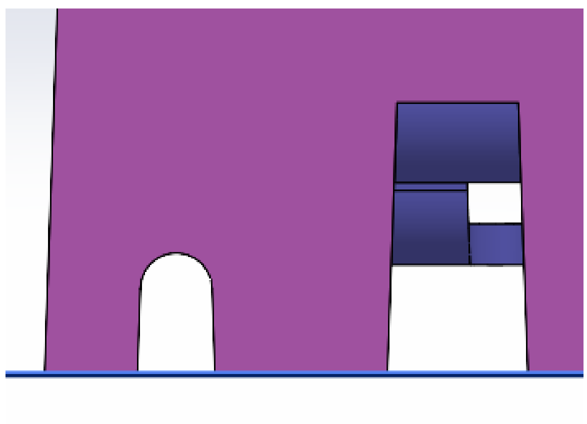

Figure 10: Area taken out under the hole and diving board.

Calculations

The deflection of the diving boards to accommodate for the pink flange bearings and reduce and compression, seen in figures 4 and 5, was calculated using the cantilever beam deflection formula of a point force on a beam:

$$\delta_{max} = \frac{P*a^2*(3*L-a)}{6*E*I} \quad (1)$$

Where δ_{max} is the maximum deflection, P is the force, a is the length from the front of the beam to the force, L is the total length of the beam, E is the elasticity constant, and I is the moment of inertia. For polycarbonate, the elasticity constant is 2310 MPa. The moment of inertia was calculated using the equation for moment of inertia of a rectangular cross-section:

$$I = \frac{b*h^3}{12} \quad (2)$$

Where b is the length of the base and h is the height of the cross section of the diving board. The diving boards had identical sizes and properties for ease of manufacturing, design, and calculations. Table 1 shows the variables and their corresponding values, with units. The maximum deflection for a 15-pound point force was 1.85 mm, and for a 35-pound force it was 4.32 mm.

Table I: The variables and corresponding values used to calculate the deflection of the diving boards.

Variable	Value
Base (mm)	3.75
Height (mm)	2
Length to Force (mm)	7.54
Total Length (mm)	8.15
Elasticity Constant (MPa)	2310