AUTODESK.

Bearing Flat for Fast Prototyping

2022 "Make It Real" CAD Engineering Online Challenge
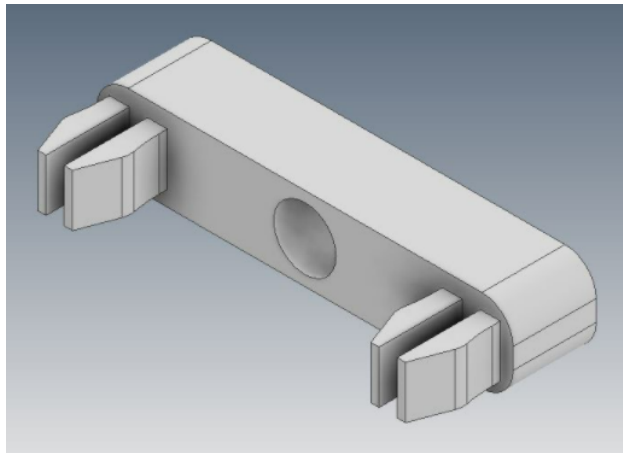
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01 | Problem

While teams competing in the VEX Robotics Competition come to tournaments with a diverse array of robots, when they are building their robots, each team is bound under the same constraint: time. Moving a piece of metal slightly, widening a base, or altering a gear train are all tasks with which most VEX competitors are familiar. In reality, these seemingly small tasks quickly add up.

On our team, one component in particular causes much grief when we are constructing mechanisms: Bearing Flats. During prototyping, the location of a single bearing flat can change several times. Each time, we have to remove its screw and reattach it elsewhere, taking our time and focus away from other pressing issues with the robot.

Our team wanted a simple, all-encompassing solution to this vexing problem – one that didn't require extra components or tools to use. This led us to our design detailed below.

02 | Solution: The Bearing Flat for Fast Prototyping
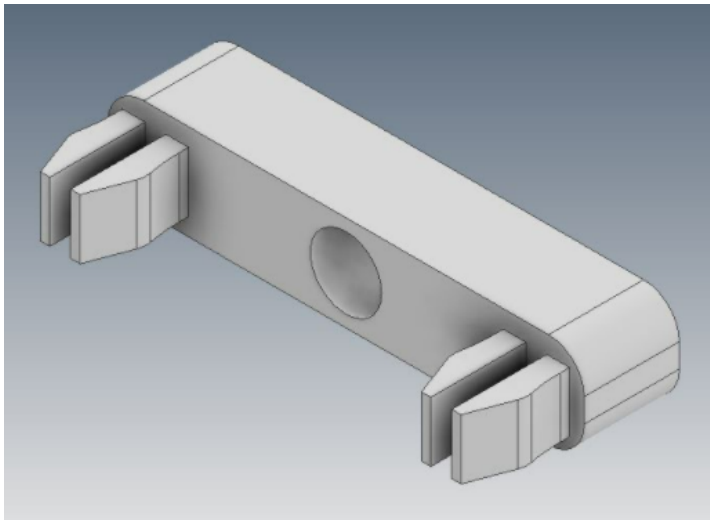
The Bearing Flat for Fast Prototyping (BFFP) is a screw-free bearing flat that is quick to attach and remove. When it is clipped onto a piece of metal, the back prongs expand slightly to prevent the bearing flat from coming loose. In addition to its ease of use, the BFFP can also fit on the inner edges of c-channels, a unique feature in comparison to the traditional bearing flat.

This part is not intended to be used on the final version of a robot, as the stress that Bearing Flats undergo as part of mechanisms is most likely too great for it to be used for a prolonged period of time. Instead, the BFFP is meant to serve as a temporary bearing flat that will save time in teams' prototyping processes.

03 | BFFP Design Process

      While the end product of a design is important, one of the integral parts of engineering is being able to explain how a part is designed. This is so that others are able to replicate it for their own use or further develop the design themselves. Below details the complete process for creating the BFFP in Autodesk Inventor Professional 2022:

1. Creating bearing flat shape
    a. Create a new part, start a sketch on the XY Plane
    b. Starting from origin, draw a `5/4"` by `1/4"` two-point center rectangle
    c. Finish the sketch and extrude the rectangle for `1/4"`
    d. Start another sketch on the front side of the prism
    e. Create a `3/16"` diameter circle
    f. Align its center to the X-axis, but make it `1/2"` away from the origin

    g. Project geometry of the long edge of the prism
    h. Using "Rectangular" tool, copy 2 additional circles in `1/2"` increments in the direction of the edge projected
    i. Finish sketch and cut each hole in a separate extrusion
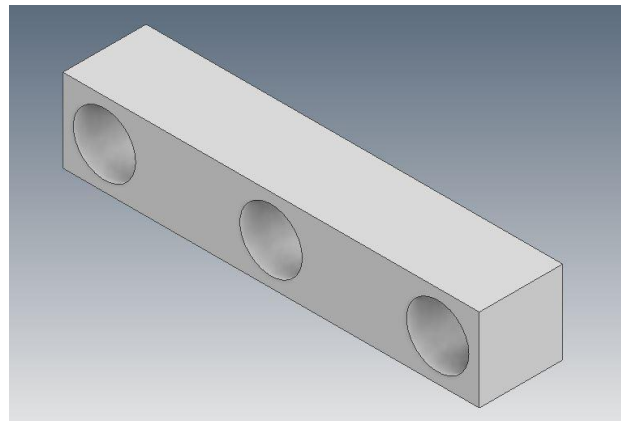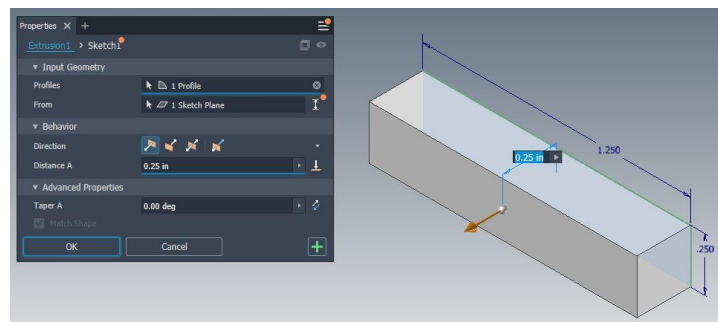
2. Adding pins on top of holes
   a. To prevent confusion, suppress the three holes created previously
   b. Create a third sketch on the same face as the second
   c. Make a `0.182"-1/128"` by `0.182"-1/128"` two-point center rectangle
   d. Align its center to the X-axis, but make it `1/2"` away from the origin
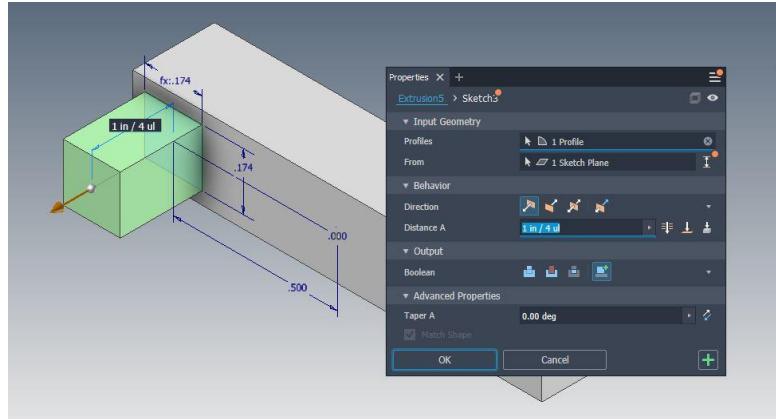
   e. Finish sketch and extrude rectangle by `1/4"`, use "New Solid" instead of "Join"
   f. Create a sketch at the top of the newly extruded prism
   g. Create a `3/64"+1/128"` wide two-point center rectangle that spans the height of the square
   h. Center it by taking the width of the square and dividing it by two
   i. Extrude the thin rectangle inward by `1/4"`
   j. Start the next sketch on the same face as the previous
   k. Project geometry of the two small faces
   l. Create a two-point center rectangle, starting on the X-axis and directly in the projected faces
   m. Dimension rectangle to be `1/4"` wide by `5/32"+1/1024"` tall
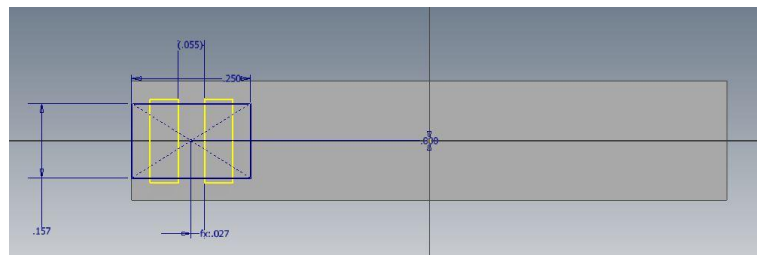
   n. Finish sketch and extrude by `1/4"` to cut out the four smaller rectangles at the ends
   o. Create two equally-sized rectangles, being `3/256"` wide and matching the height of the pin, and place them on the outer edges of the pin
   p. Extrude them downward by `1/8"` using "Join"

3. Adding final touches
   a. Use a two-distance chamfer both of the top corners of the pin, one distance being `3/64"` and the other being `1/8"` or vice-versa
   b. Fillet the inside of the two overhangs by `7/16"`
   c. Fillet the two sharp edges in the middle of the pin by `1/16"`
   d. Use a rectangular pattern, switch to the "Pattern Solids", and select "Create New Bodies"
   e. Pattern the pin bodies exactly the same way the holes were patterned, and click "OK"
   f. Fillet the four short edges of the bearing flat part by `3/32"`
   g. Since the pins and the holes do not rely on each other, you can choose which arrangement works best for you!
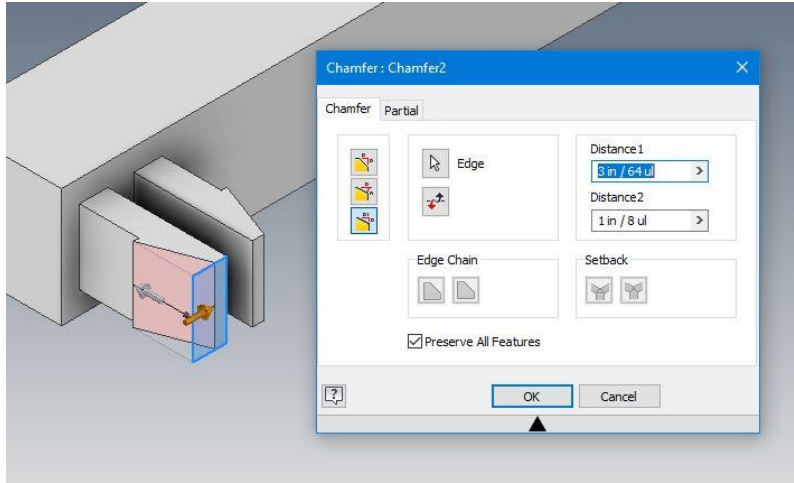
04 | Completed Model
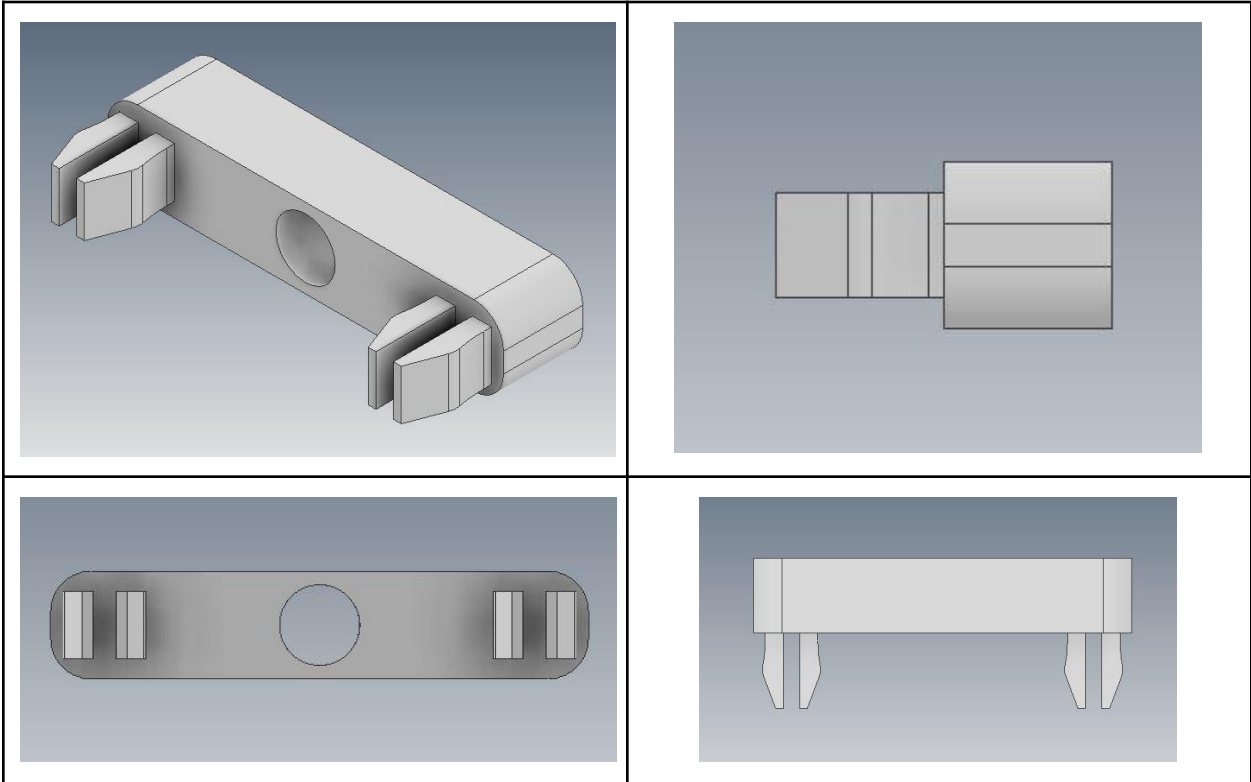

05 | 3D Printed Model
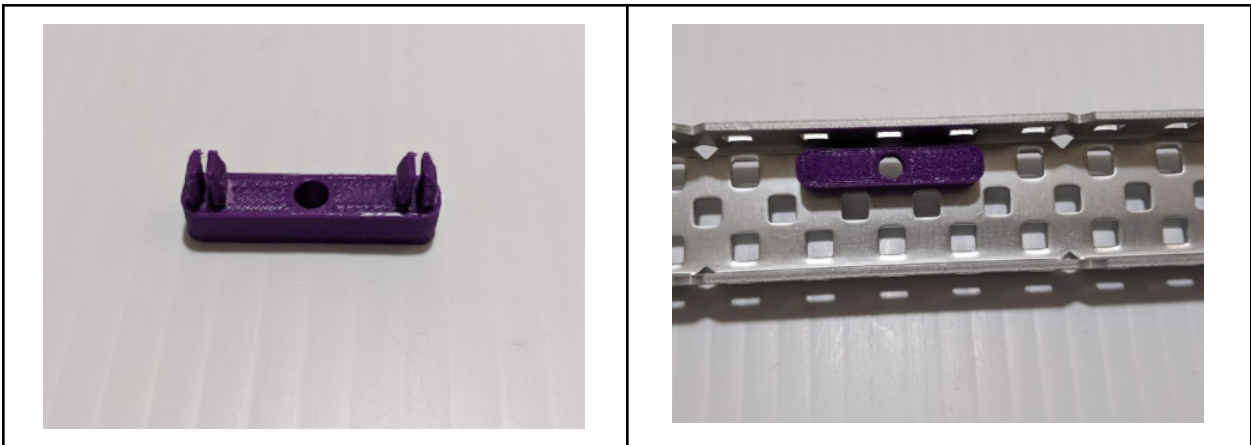
06 | Conclusion and Future Developments

As participants in the VEX Robotics Competition, modeling robotic mechanisms using CAD allows for much quicker prototyping, as we are able to manipulate the view of the model in a variety of ways. A feature of Autodesk Inventor that our team has found particularly useful is the Parameters feature. This feature allows numeric variables to be made in parts and assemblies, so different dimensions can be assigned the same variable to stay consistent. The parameters are also able to be used across files, which is useful when multiple people are working on a project.

In the future, we hope to further develop our skills in Autodesk Inventor. Now that we have some experience designing parts and assemblies, the next step is effectively presenting them. Autodesk Inventor has the Presentation feature, which allows animations to be made of assemblies. This feature is useful in presenting systems of interworking parts to a broader audience, such as an assembly of our robot.

Using Autodesk Inventor to model parts is an incredibly useful skill set not only in the ever-expanding field of STEM careers, but also for personal use. We can only expect that in the future, its prevalence will continue to rise.
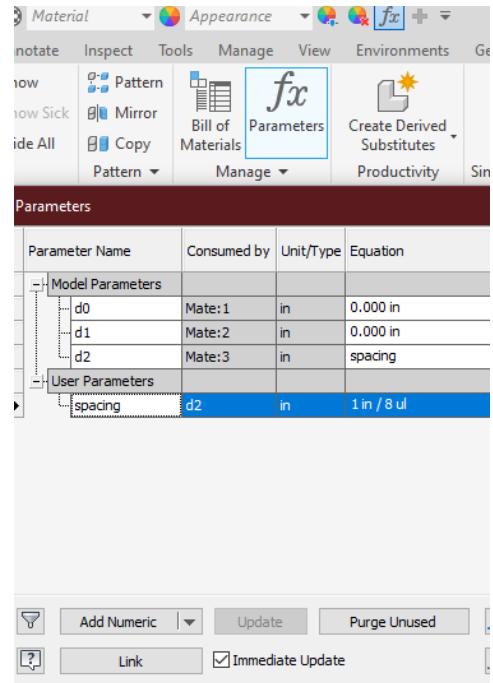
The Autodesk Inventor 2022 Parameters Interface