Goal: Produce a PSU “Paper Weight”

Methodology:
Generate a virtual prototype
Print on the 3-D printer
Create tool paths using Pro/Manufacturing
Verify tool paths using Vericut
Postprocess tool paths for HAAS Minimill
Physically machine part

The finished part should fit in a 3-3/8 x 3-3/8 x approximately 1-3/4 block. Your block will be attached to a sacrificial work holder, allowing you to have a nicely finished paper weight.

Create a sketched datum curve to define the “vertical” edges of the part. Note that the curve encompasses more area at the upper left and lower right corners of the block to allow room for the required text.

Define the upper surface of the block.
Use the overbuild technique to create surface geometry for surface replacement (Chapter 6 of the PTC freeform surface manual). The curves for this surface should be similar to:

Of course the curvature is not critical, the only thing that matters is that the surface that you create fully intersects the original block so you can use the Replace Surface Feature when you offset the surface.

The goal is to generate a surface that is curved in all directions as shown:
Offset another surface from the one you just created. Define this surface to be 1/8" lower than the original. This surface will be used to locate the bottom of the PSU text.

After trimming the square block with the datum curve and doing the replace surface operation, add a 3 degree draft to the side surfaces. Next create the extuded PSU text using the Text tool inside of sketcher. The font should be defined as “font3D” and the text height must be 1.2". This should produce text which will allow a 1/8" diameter end mill to be used to cut the recess.

Extrude the cut down to the second offset surface. Note that this text will have square edges at the bottom of the cut. We will handle that issue later. Keep your text far enough inside the block so there is room for a round on the outside edge.

It is possible to put a .040" round on the inside bottom edges. A .0625" round will not work as the feature will fail on the upper corner of the S.

The reason for the rounds is so that the printed prototype will match that of the machined part. The rounds will be suppressed at a later time.

An easy way to produce these rounds is to use a hidden config.pro option called allow_round_all. Setting this option to yes will then enable the All Convex/All Concave check mark boxes under the Sets option in the Round feature.

Your initials will eventually be machined into the part using the Groove option. In order to do this, place your initials using the Insert – Cosmetic – Groove feature. This text is of type “leroy”, the height is not significant. This text will not show up when printing your part on the 3-D printer.
2) Printing on the Z-Corp printer. In order to print this part, first shell it, removing the bottom surface. A wall thickness of .25 should be sufficient as the part will be strong enough to handle, yet not waste binder and powder. The entire part will not directly shell to this thickness due to the tight radius curves in the text and around the edge. You may have to offset/merge then use this merged geometry to create a “cut” similar to what you did in METBD 306 if it will not shell.

Pay attention to the model tree to see where the shell should be temporarily placed for stl file creation.

Name your stl file paperweight_lastname.

3) Refer to your METBD 306 notes (or the current ones online) to create tool paths for this part. You will be doing a roughing with a 1/2” flat end mill, surface machining with a 3/8” ball end mill and cutting and grooving the text with a 1/8” ball end mill. The side surfaces will be trajectory milled using a 3 degree tapered end mill with a .24 diameter end.

You can find the fixture (Haas_Vise.prt) on the V: drive in the METBD_410 subdirectory.

Measure your physical ABS stock in order to define your Pro/E workpiece as well as knowing how wide the jaws should be opened. This is easily modified here.

Note that the parallels are already mounted in the vise.

Important: Suppress the .040 rounds on your paperweight so as not to confuse the 1/8” cutting tool.
Assemble your part \( X/X'' \) above the parallels, where \( X/X \) is the thickness of the sacrificial piece that you will be given. You will be drilling and tapping your ABS part to attach it to this piece. After assembling the reference part, the work piece and the fixture, define the Operation with the proper Machine Zero and Retract Surface. Note that the machine zero should be on the corner of the workpiece as shown (to make it easy to touch off) and the retract surface should be \( \frac{1}{4}'' \) above the workpiece surface. See the following figure for an example.

Make doubly sure that the bottom of your part is above the vise jaws as shown above. You will have a thicker part than is shown as I am using some “scrap” ABS which is almost a full \( \frac{1}{2}'' \) thinner than your material for testing purposes.

The above two color images are required for documentation purposes for this project.

Tooling for this project is located on the \( \text{V:/METBD}_410 \) drive.

If you have set access to the \( \text{pro}_e \) drive, you will be able to browse to these tools.

**Instead** of creating tooling as you did in METBD 306, use the following method to generate your tools:

In the Tool Setup dialog box, select File – Open Tool Library. Browse to the METBD_410 subdirectory and Select By Copy. You will be prompted for tool diameter and length.
The following tools will be used for this project:

- **MM_1_2_Flat** (Minimill 1/2 Diameter, flat (square) end) for roughing.
- **MM_3_8_Ball** (Minimill 3/8 Diameter, ball end) for surface machining.
- **MM_1_8_Ball** (Minimill 1/8 Diameter ball end) for all text.
- **MM_3_Deg_Taper** (Minimill 3 degree tapered) for side surfaces.

Note that when adding the ball end mills, you will also have to set the Corner Radius in the Tools Setup dialog box. When adding the tapered end mill set the angle.

Tool lengths (when prompted by Pro/E are as follows):

- ½ Flat – 3-1/2”
- 3/8 Ball – 2-1/2”
- 1/8 Ball – 1”

While this is nominally a 1/8” mill, the problem with the PSU text is that there are areas that a 1/8” mill can not reach. Therefore use a .119 diameter with a .0595 radius to “fake” out the system.

Tapered – 4-1/2”. The cutter diameter should be set to .24” (diameter at the bottom of the tool).

Make sure the pocket numbers are as shown in the tool setup dialog box to the right. We have too many people setting up the machine for me to keep track of what pockets you personally used for your nc sequences. Note: Number 1 will be used by the edge finder.

A color screen capture of this dialog box is required for your documentation.

Hints:

When setting the mill volume, remember that the tool always stays within the volume, so make the volume ½” bigger on all sides than the physical part so plunges will be done in the air and not in the material.

Volume Milling Parameters:

- Note the scan_type and stock allowances!
- Make sure the tool makes at least one pass over the entire top of the part.

A print is required for the documentation:

Remember about having a datum point 2" above the coordinate system so we can home the tool at the start and end of each sequence.

You will screen capture each sequence (both Pro/E and Vericut) with the vise being shaded in Pro/E.

An example of the tool path center is shown here.

An example of the Vericut result is shown here. Remember to set the colors as done in the METBD 306 assignment. Make sure the tool appears in the cropped image.

The view was slightly rotated in Pro/E so that the edges of the vise appear defined in Vericut. This might take a few trials to get it looking right.

Other hints:

Make sure you unhide your workpiece before entering Vericut the first time or you will not see your model!

For the surface milling operation (using Isolines), it is not necessary to mill the side surfaces as this will be cleaned up using the tapered tool. Note the step_over! You want to mill the radius by going around the part, not up and down.

Latest Update:
Vericut version of the surface operation:

To cut in the PSU text, use a Trajectory Mill. To drive the “interactive cut” (Interact Path), select Surface then in the Cut Along box make sure Surface, Direction and Height are checked.

Select your geometry from the model and use the Loop from the Surf/Loop selection. Select the bottom surface (not sides) for the loop surface and then an edge of the loop (pay attention to the prompts). When prompted for a depth, (Ctm Depth) choose Select and pick the bottom surface of the text.

Note that you there will be three different paths created. Two for the P due to the “island” and one for the S/U. Use the Customize under NC Sequence options to add the additional paths (Insert button) to your toolpath. The result should appear as shown.
Due to the initial angle of the model, the Vericut version will not show this cut with any degree of clarity. Run Vericut as you normally would then use the Dynamic X rotation button to tip the model.

Use the Zoom to Box button to select a portion to view.

Use the Redefine Display button to clean up the display.

Even more hints:

**Grooving:**

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<th>Value</th>
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</tbody>
</table>
Trajectory milling using the tapered end mill. Note that this cleans up the side surfaces.

Having completed the required milling operations, you now want to print your route sheet. Use Info – Manufacturing – Route. Total machining time should be in the neighborhood of one hour. Include this document with your output.

5) Postprocess your entire Operation (not NC Sequences) using the HAAS Minimmill No Circ Interp 4/06 post processor.

6) Fasten your ABS work piece to the sacrificial block using 4 drywall screws. Make sure that you will not be machining the screws during the process (cut out a plot of the top view of the part and position it on the ABS). Mounting this block takes the average student about an hour.

7) You should now be ready to execute this on the physical machine. Set up a time with your instructor after having been given an A-OK on your tool path generation. Bring a copy of your documentation with you so you can double check your locations and tools! Plan on a three hour time slot for set-up, running the part and clean up. Be advised that for some reason, the route sheet times do not seem to match up with the actual machining time. Make sure you record the actual times for your writeup.