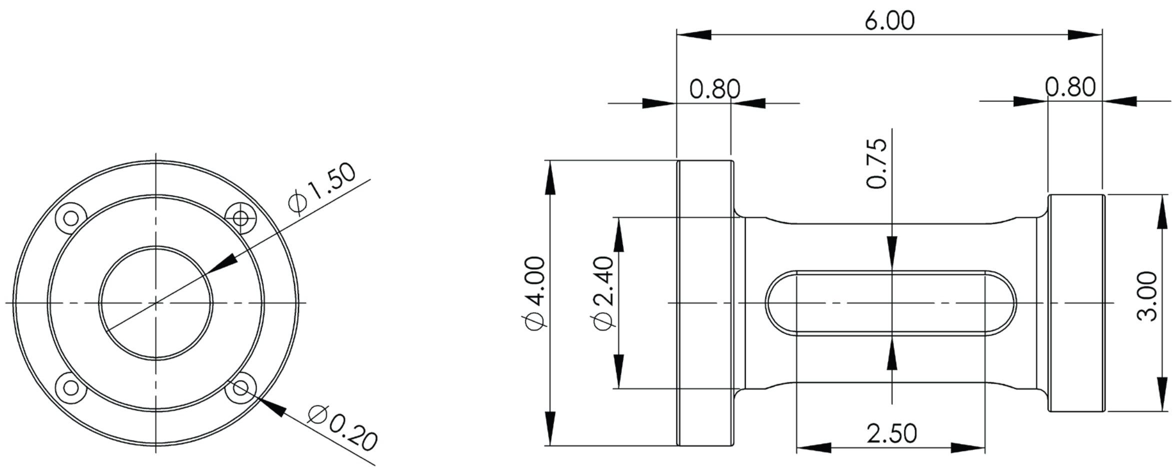
Machining Full Analysis

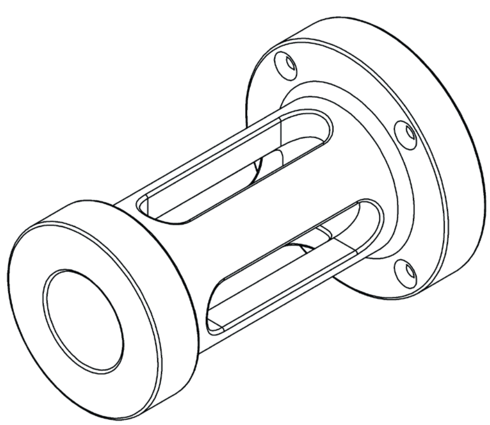
Machining is the process of removing material from a workpiece. This is a common process for creating parts, especially metal parts. Machine tool setups provide a means of holding a cutting tool or abrasive wheel, holding the workpiece, and providing for relative motion between the two in order to produce the desired surface.

In DFM Concurrent Costing, you can model rough and finish machining operations on parts formed by another process. You can also model the machining cost of producing the specified part from a stock material shape. The following tutorial shows such an example.

This tutorial models a hollow cylinder base, which is cut from bar stock, and then various machining operations are performed on a turning center. The complete analysis is contained in the sample file **machined or cast part.dfm** included with your installation of DFM Concurrent Costing (*\data\samples)*, and includes a picture of the cylinder base. A drawing with dimensions appears below. In the completed analysis, we compare cost results where the same part is:

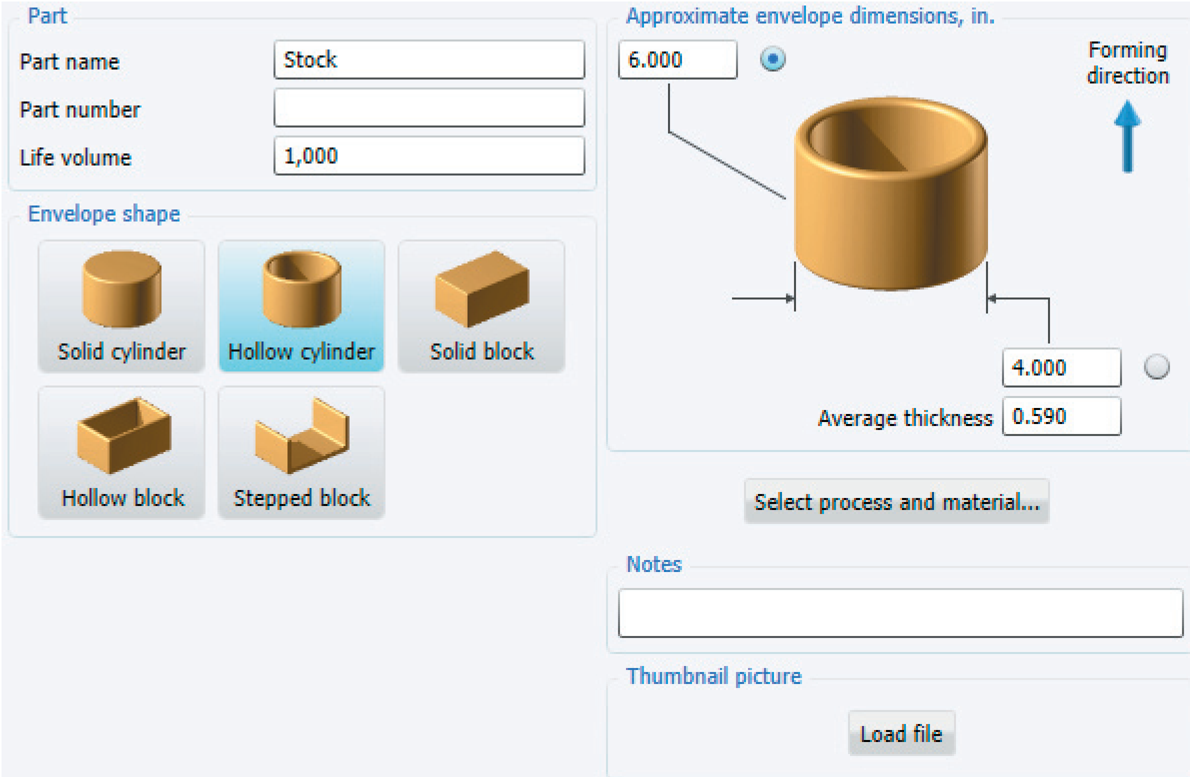
- machined on separate machines for milling, drilling etc.
- machined on a single turning center
- finish machining on a sand cast workpiece



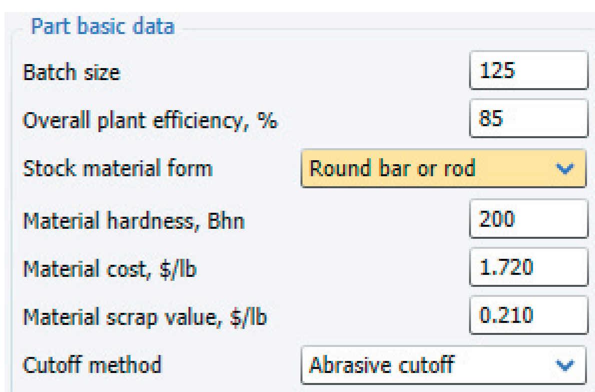


Begin the analysis

1. In a new analysis, complete the part description as shown here:

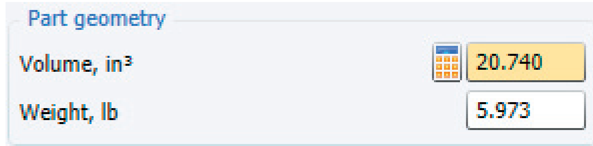


2. Accept the default forming direction shown above because this is the direction the bar stock would have been produced.
3. Highlight the *Original* name on the tab above the Process Chart by double-clicking it. Type **Stock** and press the **Enter** key.
4. To select the process and material, click that button.
5. On the *Process and Material selection* window, open *Machining or cut from stock*, choose *Full analysis* for the process. For the material, open the *Stainless steel* category and choose *Generic stainless steel.*
6. Click the **OK** button to return to the main window with the responses for the stock process on the right panel.
7. Note that the stock material form is defaulted to round tube, because of the envelope shape selection. However, select *Round bar or rod* for the stock material form. Click the **Calculate** button in the *Cost results* box.

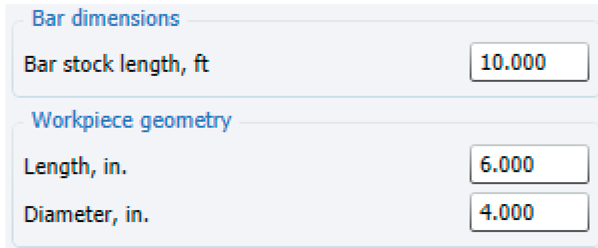


8. We leave the cutoff method as is. The material cost and scrap value are supplied from the Material Library and can be edited for this analysis.

9. Review the *Volume* and *Weight* fields in the Part geometry section. The *Part volume* displayed at this point is set equal to the workpiece volume. As material is removed by machining, this value will change accordingly if you have not entered the final part volume. In this case, we know the finished volume of the cylinder base; change the volume to **20.74**, and click **Calculate** to update the *Weight* field.



10. Review the responses for the *Workpiece*. Here, the fields affecting workpiece cost and volume before any machining operations have been done are recorded.

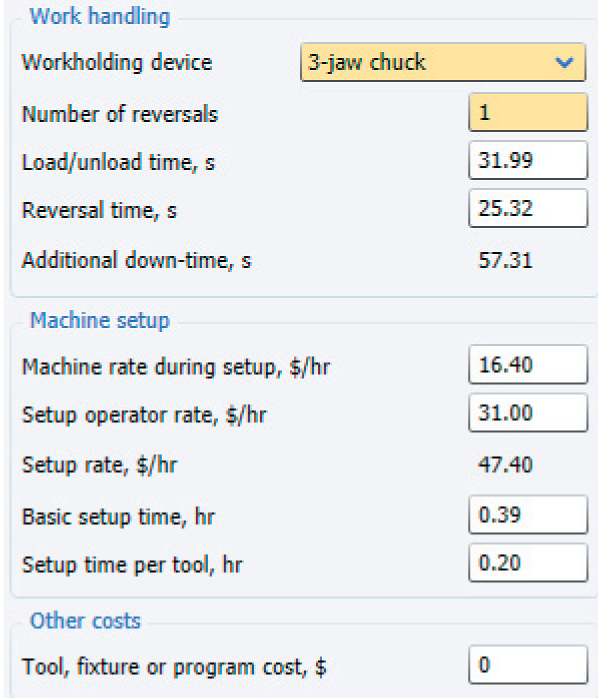


11. Click the *Abrasive cutoff* entry on the Process Chart. The responses for this step are on the right panel. For this analysis we are not adjusting these defaults, which include the labor rate and setup time for the cutoff operation.

Adding a machine tool setup

Now we move the workpiece to the turning center.

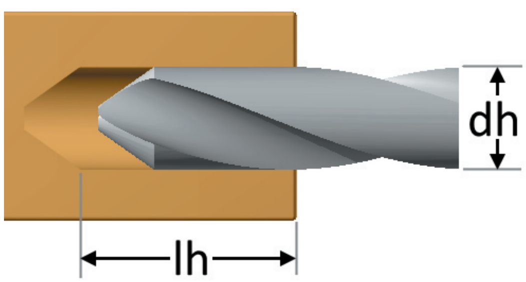
1. First we add a machine tool setup (*Insert* menu→*Machine Tool Setup*.) In the dialog, open the category *Lathes*, if necessary. Click the *Haas ST-10 CNC lathe.*
2. Click the **Insert** button to add the CNC lathe to the Process Chart.
3. Close the Insert machine dialog and view the responses for the lathe.
4. Note that we could change the batch size for this setup as well as the material hardness. For this tutorial we will accept the defaults.
5. Also in the *Basic data* group box is *Rejects, %.* This is the percent rejects following operations in the setup. The cost of rejected parts is shown in the *Cost results* box, under the Process Chart.
6. Note the *Result* box in the Responses Panel where total cycle time and total setup time are displayed for the setup. These will change as machining operations are added.
7. Click the *Setup/load/unload* entry that was automatically added to the Process Chart with the machine to review its responses in the right panel. Here the rates and times for setting up the machine tool, and any fixture and programming costs can be supplied.
8. In the *Work handling* box, choose *3-jaw chuck* from the *Workholding device* dropdown list. Change the *Number of reversals* to **1** because the part must be machined from both ends.
9. Click the **Calculate** button to update the *Cost per part* results.



10. Now we can add machining operations. Choose *Operation* from the *Insert* menu to open the *Library Operations* dialog.

11. In the *Machining* category, open the *Drilling* subcategory. Highlight the *Drill single hole* operation, and click the **Insert** button to add it to the Process Chart. It is added beneath the *Setup/load/unload* operation.

12. The Responses Panel includes a picture of the drilling operation with dimensions labeled, to simplify assigning the correct dimension. The software does not calculate a result until you enter the dimensions and click **Calculate**.



13. Enter **1.5** inches for the diameter (*dh*) and **6** inches for the length (*lh*) of the hole to be drilled.

    Change the tool material selection to *Carbide.* See that the box remains checked to include the tool replacement cost for the drilling operation.

14. Now click the **Calculate** button. Here are the responses after dimensions have been supplied:

Special tooling cost is any cost of special fixtures that are not included elsewhere.

Operation time includes the time to position and change the tool if necessary. Defaults for these times are available in the responses for the Machine tool data.

15. The *Cost results* are as below in the *Current* column. If this is the first time you have clicked the **Calculate** button to update the Results, your *Previous* column will be zeros. Each time you click **Calculate**, the columns lets you compare the change to results from any edits you have made.

Cost results, $		Previous	Current
	Material	0.0000	0.0000
	Setup	0.0000	0.0000
	Process	0.0000	1.9815
	Rejects		
	Piece part	0.0000	1.9815
	Tooling	0.0000	0.0000
	Total	0.0000	1.9815
Tooling investment		0	0

We would continue adding machining operations until all the surfaces of the part have been machined and the holes in the flange have been drilled and tapped.

View the completed analysis

1. To view the completed analysis, choose *Open* from the *File* menu. In the Open dialog, locate the **machined or cast part.dfm** file (installed in *\data\samples*.) There is no need to save the analysis we have started for this tutorial.

2. In **machined or cast part.dfm** there are three analyses. The first, *Stock separate setups*, is where separate machine setups are used for end milling the slots and for drilling and tapping the flange holes.

   The second analysis, *Stock/mill/turn*, corresponds to the analysis you started in the tutorial and uses one setup.

   The third analysis, *Casting*, is where the part is cast and then finish machined.

3. To compare the three analyses, select *Cost vs. Life Volume* from the *Results* menu, and select all three analyses in the Select analyses box.

   Note that for this part it is always less expensive to machine from stock on a single setup rather than multiple setups. Also note that if less than 50 parts are manufactured, machining from stock on a single setup is the most cost effective manufacturing approach. If more than 59 parts are manufactured, it is less expensive to first sand cast the part and then finish machine critical surfaces.