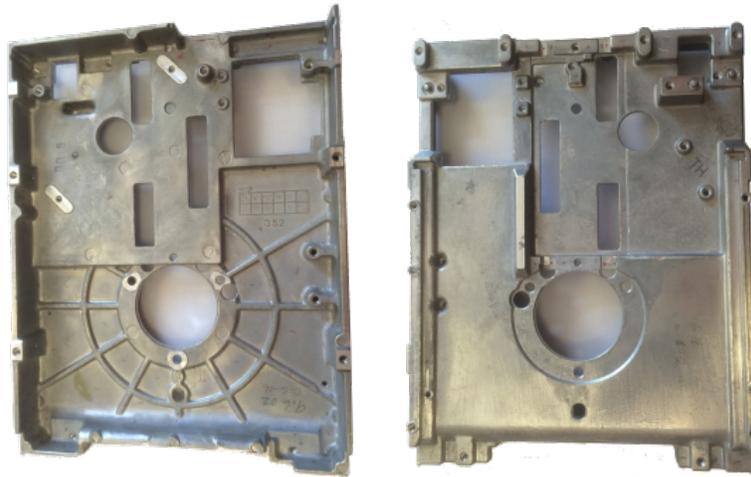


Die Casting Analysis

Start a new analysis

For the purposes of this tutorial we will estimate the cost per part of manufacturing 200,000 of the disk drive casings shown here:

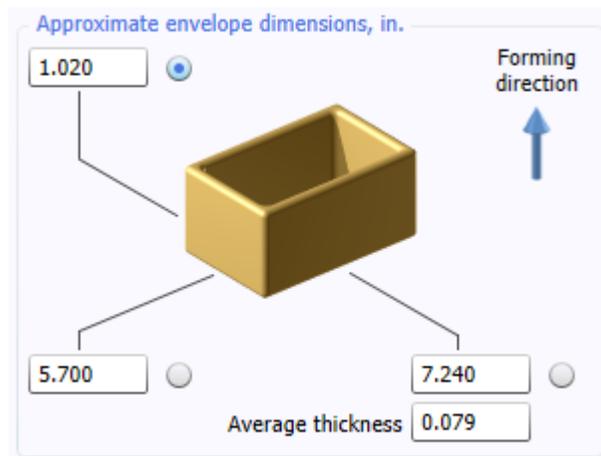


front

back

The material is to be *ZA-8 cast zinc alloy* and the process *Hot-chamber die casting*.

1. Start DFM Concurrent Costing. In the Part box, type **Casing** in the Part name field, **001** for the Part number and **200000** for the Life volume.
2. In the Envelope shape box, click the hollow block envelope shape. Enter the Approximate envelope dimensions in inches as follows: **1.02**, **5.7** and **7.24**. The average thickness is **0.079**.



3. Click the button **Select process and material...**

Basic data

Batch size

Overall plant efficiency, %

Material cost, \$/lb

Material scrap value, \$/lb

Die cast operation

Maximum thickness, in.

9. Supply part geometry data as follows: the Part volume is **5.18** cu in, the Part projected area in the forming direction is **37** sq in, the Outer perimeter is **26.2** in. and the number of Through holes in the part is **12**. Also enter **18.85** in. for the Perimeter of through holes. Note that a Geometry Calculator can be used in determining these values.

Part geometry

Part volume, in³

Part weight, lb

Part projected area, in²

Outer perimeter, in.

Through holes

Perimeter of through holes, in.

10. At any stage you can click the **Calculate** button in the Cost results pane to update the cost estimate. Let's do this now.

Cost results, \$	Previous	Current
Material	1.9482	1.9555
Setup	0.0110	0.0107
Process	0.3235	0.3426
Rejects	0.0189	0.0191
Piece part	2.3015	2.3278
Tooling	0.2168	0.2224
Total	2.5183	2.5502
Tooling investment	43,367	44,476

11. The default for the Surface patches response is based on the volume calculated from the initial dimensions having average complexity. In our example, change the number of surface patches to **445**.

Part complexity

Surface patches

12. Tab to the next section, Non-geometric features. For Tolerance choose most approx. 0.005 in/in; and accept a medium finish for the Appearance field.

Non-geometric features

Tolerance

Appearance

Textured surface, %

13. In the Die data section, we assume a Parting line with two steps; choose 2-4 steps or simple curve from the list box.

14. For holes that are parallel to the forming direction it is not necessary to provide side-pull mechanisms in the die; we can leave the number of side pulls at zero.

Die data

Parting line 2-4 steps or simple curv

Inserts per cavity 0

Side pulls on left 0

Side pulls on right 0

Side pulls on top 0

Side pulls on bottom 0

Automatically select cavities?

Number of cavities 1

15. The optimum number of cavities has been automatically set to a value of 1. This value is estimated from the size of the part, life volume and machine attributes. The automatic selection of the number of cavities considers all of these effects to result in minimization of part cost. By unchecking the Automatic Selection checkbox you can manually enter the number of cavities. For the casing, 1 cavity is optimal. Click the **Calculate** button.

Cost results, \$	Previous	Current
Material	1.9555	1.9555
Setup	0.0107	0.0107
Process	0.3426	0.3446
Rejects	0.0191	0.0191
Piece part	2.3278	2.3299
Tooling	0.2224	0.3329
Total	2.5502	2.6628
Tooling investment	44,476	66,576

16. We have now obtained an accurate cost estimate for our part. However, we can improve on the estimate even further by looking at the machine setup and operations data.

17. Click the 130 Ton Hot Chamber Die Casting Machine entry on the Process Chart to change the Responses Panel to show setup data.

Machine selection	
<input checked="" type="checkbox"/> Automatic selection?	
Machine data	
Clamping force, tons	130.00
Shot capacity, in ³	54.900
Dry cycle time, s	<input type="text" value="2.50"/>
Max. mold opening, in.	9.060
Number of machines per operator	
for automatic operation	<input type="text" value="2"/>
Machine rate, \$/hr	<input type="text" value="42.55"/>
Operator rate, \$/hr	<input type="text" value="27.00"/>
Process rate, \$/hr	56.05
Rejects, %	<input type="text" value="0.05"/>

18. When Automatic selection? is checked in the box above, the software selects the smallest machine by capability to perform the operation. Default machine data are shown for information.
19. Note the Rejects,% response field; the percentage of parts rejected following each operation is user editable. If the operation is within a machine setup, the reject percentage is a response for the setup. The cost of rejects is shown in the Cost results box.
20. On the Process Chart, select Die casting operation. There are group boxes on the Responses panel where you can refine your estimate. Machine setup and Casting process data provide edit fields related to setup and machine operating conditions.

Machine setup	
Machine rate during setup, \$/hr	<input type="text" value="34.00"/>
Setup operator rate, \$/hr	<input type="text" value="31.00"/>
Setup rate, \$/hr	65.00
Setup time, hr	<input type="text" value="3.00"/>
Casting process data	
Cavity life	<input type="text" value="500000"/>
Cost of electricity, \$/kWh	<input type="text" value="0.035"/>
Minimum required melt energy, Btu/lb	<input type="text" value="144.00"/>
Furnace efficiency, %	<input type="text" value="70"/>

21. In Cycle time data, you can edit the machine cycle times for your plant conditions. To update the Die casting cycle time total after editing the cycle time fields, click the **Calculate** button in the Cost results pane.

Cycle time data	
Fill time, s	0.03
Cooling time, s	6.44
Die opening time, s	3.13
Part extraction time, s	2.84
Die lubrication time, s	1.66
Die closing time, s	1.25
Die casting cycle time, s	15.35

22. In the last group box for the die casting operation, you can change the defaults for the tooling estimate.

Die cost data	
Die set purchase cost, \$	4,758
Die set custom work, \$	4,750
Cavity/core manufacture, hrs	1237.62
Die manufacturing rate, \$/hr	42.00

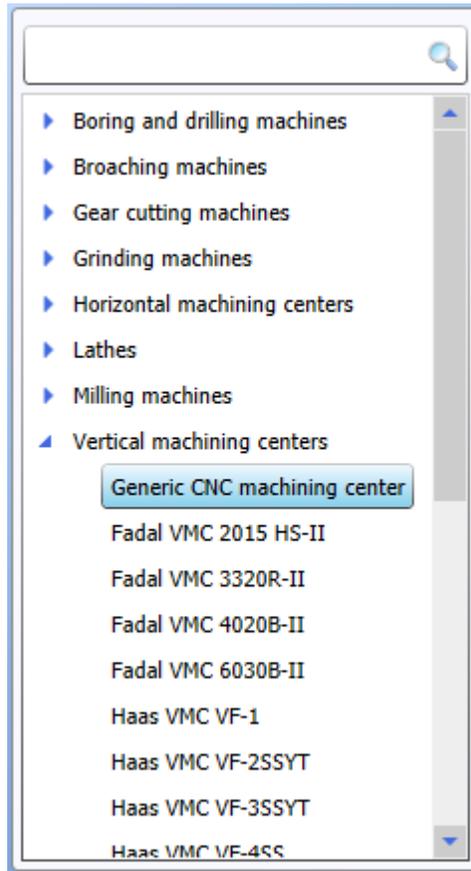
23. Highlight the Trimming operation on the Process Chart, and review the responses. The trimming operation in this model does not use a machine setup. Machine rates associated with trimming are available together with the other trimming operation variables in the responses for the trimming operation.

24. Choose Save As from the File menu and supply the File name **casing**. The file is saved automatically with the extension **.dfmx**. Click the **Save** button.

Add secondary operations

We can add further operations to the process. We want to add a finish slot end milling operation to finish the pads. To add machining steps, you first add a machine tool setup, and then machining operations from the Operation Library.

1. With the Trimming operation still highlighted on the Process Chart, choose Machine Tool Setup from the Insert menu.
2. In the Insert machine dialog, reveal the entries for the Vertical machining centers category by clicking its handle. Highlight Generic CNC machining center. Click the **Insert** button and close the dialog. The machine tool setup and its Setup/load/unload operation is added to the Process Chart.



3. Highlight the Setup/load/unload entry to review its responses.

Work handling

Workholding device: Fixture, horizontal

Number of reversals: 0

Load/unload time, s: 28.28

Additional down-time, s: 28.28

Machine setup

Machine rate during setup, \$/hr: 16.90

Setup operator rate, \$/hr: 31.00

Setup rate, \$/hr: 47.90

Basic setup time, hr: 0.35

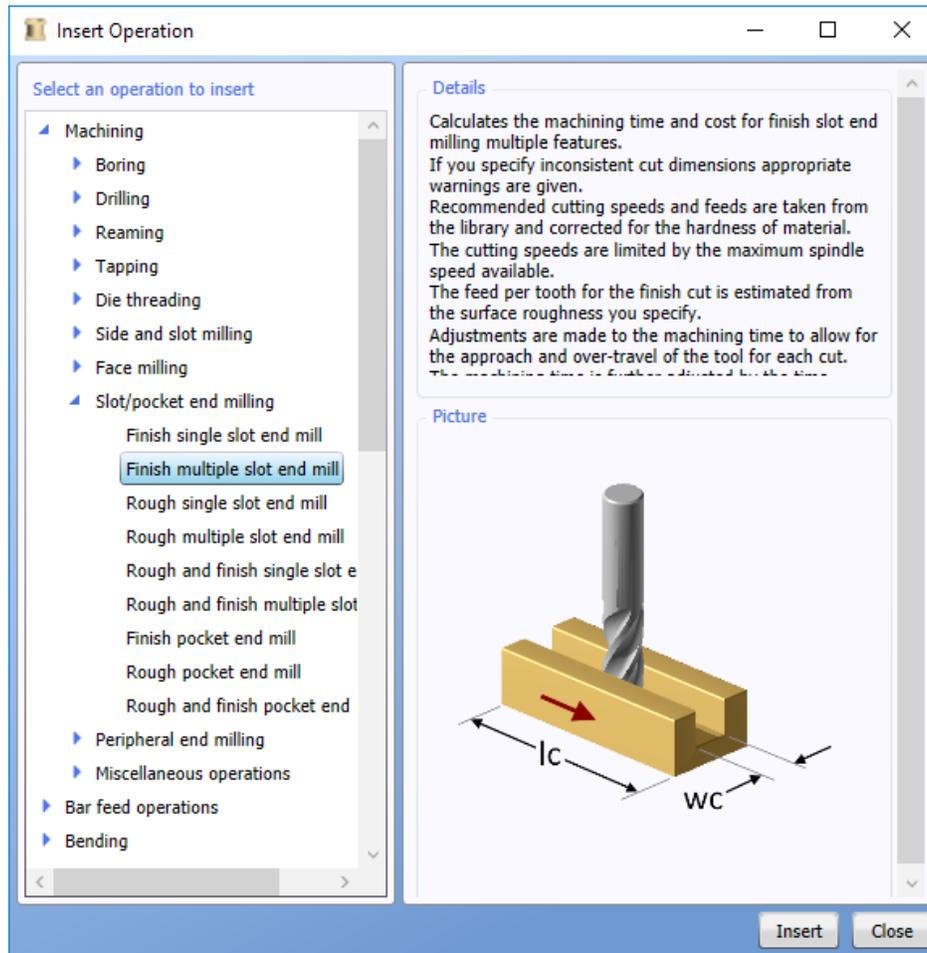
Setup time per tool, hr: 0.15

Other costs

Tool, fixture or program cost, \$: 0

4. Now you can add the finish face mill operation. From the Insert menu, choose Operation.

5. A dialog opens that lists the operations in the Operation Library. Expand the Machining category and then expand the Slot/pocket end milling subcategory. Highlight the Finish multiple slot end mill operation. (We choose multiple because there are 4 identical pads to finish.)



6. Click the **Insert** button and close the dialog. The finish slot end milling operation is added to the Process Chart.
7. A partial set of responses is shown for the end milling operation. To complete the calculation of machining time, we must supply dimensional data.
8. The width of each pad needing machining is **0.25** in. Supply the machined surface length of **0.5** in. Enter **4** for the number of features milled and then select a surface roughness of 63μ in (63 microinches) from the Surface roughness list box. Now click the **Calculate** button to update the results.

Operation inputs	
Tool material	High-speed steel
<input checked="" type="checkbox"/> Include tool replacement cost?	
Width of surface to be milled (wc), in.	0.250
Length of surface to be milled (lc), in.	0.500
Number of features milled	4.000
Surface roughness	63 μ in. 1.6 μ m
Machining data	
Tool diameter, in.	0.250
Number of teeth	4.000
Cutting speed, ft/min	226.100
Feed per tooth, in.	0.002
Feed speed, in/min	26.009
Number of passes	1.000
Width per pass, in.	0.250
Special tooling cost, \$	0.000

Making comparisons

To investigate alternative materials, processes or design changes you can copy an analysis.

1. Click on the tab labeled Original located above the current analysis. From the Edit menu, choose Copy, then Paste. A new tab appears containing a copy of the Original analysis.
2. Double-click the tab to edit the name of the analysis; type **Aluminum** to distinguish it from Original in graphs and reports. Type **Casing-2** in the Part name field.
3. Click the Select process and material button. In the selection dialog, click Die casting, cold-chamber and, in the Aluminum alloy category, A356 Cast aluminum. Click **OK**.
4. The new analysis now shows the cost associated with changing the process and material. Note that the current cost results have updated.

The screenshot shows the software interface for Aluminum analysis. The process tree on the left includes:

- A356 cast aluminum die cast part
 - Cold chamber die casting process
 - 600 Ton Cold Chamber Die Casting Machine
 - Die casting operation
 - Trimming operation
 - Generic CNC machining center
 - Setup/load/unload
 - Finish multiple slot end mill

The 'Dynamic Costing' panel on the right is currently set to 'Off'. It contains several sections of adjustable parameters:

- Basic data:** Batch size (25000), Overall plant efficiency, % (85), Material cost, \$/lb (1.230), Material scrap value, \$/lb (0.500), Die cast operation (Automatic), Maximum thickness, in. (0.180).
- Part geometry:** Part volume, in³ (5.180), Part weight, lb (0.502), Part projected area, in² (37.000), Outer perimeter, in. (26.200), Through holes (12), Perimeter of through holes, in. (18.850).
- Part complexity:** Surface patches (445).
- Non-geometric features:** Tolerance (Most approx. 0.005 in/ir), Appearance (Medium finish), Textured surface, % (0).

The 'Cost results, \$' table at the bottom compares 'Previous' and 'Current' values:

Cost results, \$	Previous	Current
Material	0.0000	1.1391
Setup	0.0000	0.0239
Process	0.0000	0.5350
Rejects		0.0151
Piece part	0.0000	1.7131
Tooling	0.0000	0.5321
Total	0.0000	2.2452
Tooling investment	0	106,421

5. Notice the Cold chamber analysis chooses a much larger machine. This is because the optimal number of cavities under the new conditions is 2 instead of 1.

All of the edited fields have been used in the new analysis, including those for the *Finish multiple slot end mill* operation in the machine tool setup. When the material changed, the software used the new material's machining data to automatically update the operation time. In this case, the aluminum workpiece material in the second analysis is softer and the cutting speed reaches the spindle speed limit.

6. View the totals for each analysis by clicking the first entry on the Process Chart. Click a tab to switch between analyses.

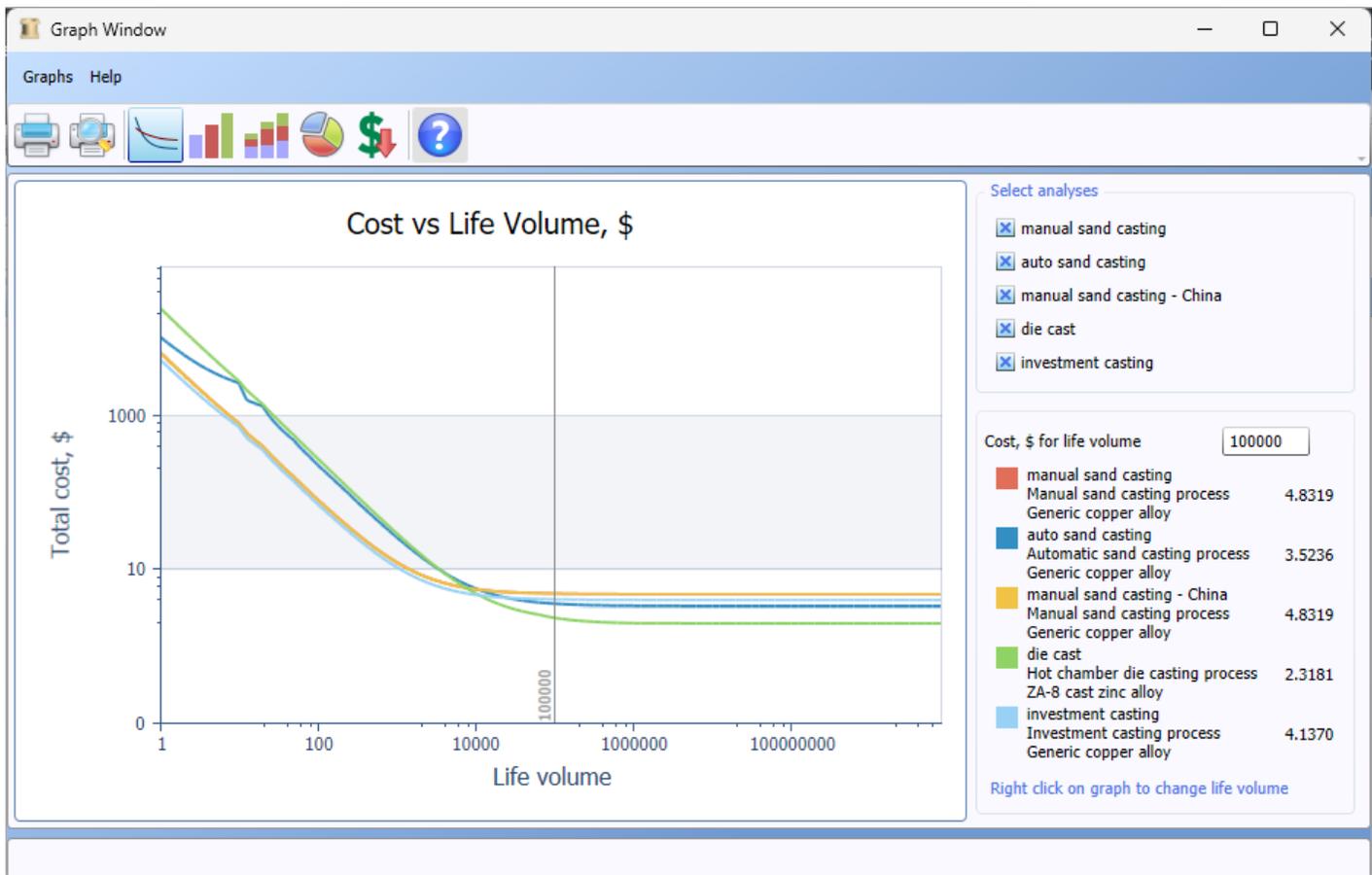
Reviewing results

To compare cost results for several processes, we now open another file that was part of your installation of DFM Concurrent Costing. The file contains five analyses of the same part using several process/material combinations. One of the analyses was carried out using significantly lower labor and machine costs to simulate relatively low-wage manufacturing conditions.

1. Choose Open from the File menu. In the Windows dialog choose **casting comparison.dfm** from the \data\samples folder and click the **Open** button.
2. An image of the part, a faucet body, is included in the Picture box for the top level of the Process Chart.



- From the Results menu, choose Cost vs. Life Volume. Once the graph for the current analysis has finished loading, check the rest of the analyses.



- For each analysis a curve of the total part cost versus the life volume is displayed. Each line is color coded and on the right panel, the costs for a life volume of 100,000 are displayed.
- Type **200000** in the life volume field and observe the change in totals and the repositioning of the slider in the graph.
- Scroll the mouse wheel to zoom in and out of the graph. Press the shift key and outline a rectangle with the mouse to view more detail of that region. Press the Alt key and click to zoom back out.
- Notice that right-clicking the graph will move the slide to give costs for different life volumes.
- Click the toolbar button for Cost Totals bar and observe the cost breakdown for the five analyses.
- Click the toolbar button for Cost Totals stacked to see the total cost for each analysis. Hovering over the bar segments will display more detailed cost information.
- Click the toolbar button Cost Reduction. Choose the investment cast analysis on the right panel.
- The chart shows the contribution of selected cost drivers to the total cost of the part, which is included in the text summary beside the graph. You can view reports for any these graphs by choosing Print Preview from the Graphs menu.