Develop a User Process

Introduction

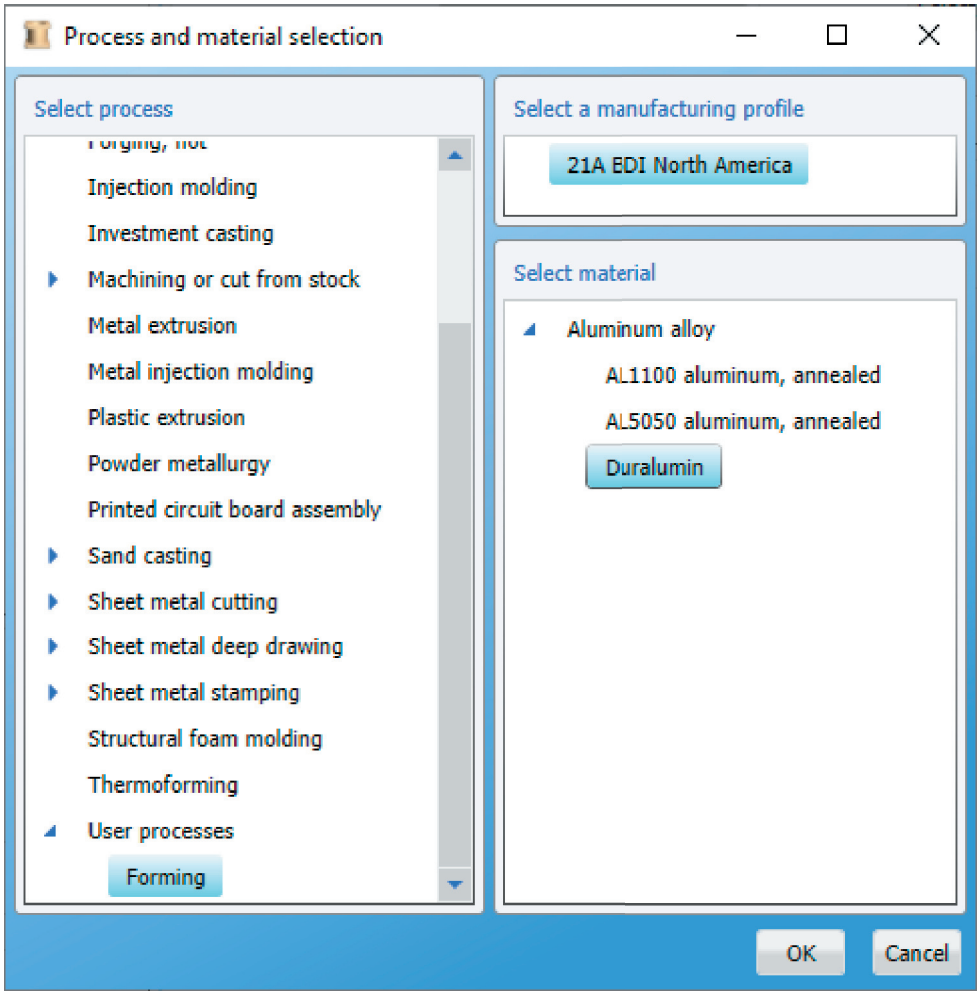
The User process program allows you to install into the DFM Concurrent Costing software your own cost model for a manufacturing process. For this tutorial, an imaginary process named “Forming” will be added which has three operations, namely:

1. Preheating the workpiece.
2. Forming the workpiece to the desired shape.
3. Trimming the workpiece to produce the part.

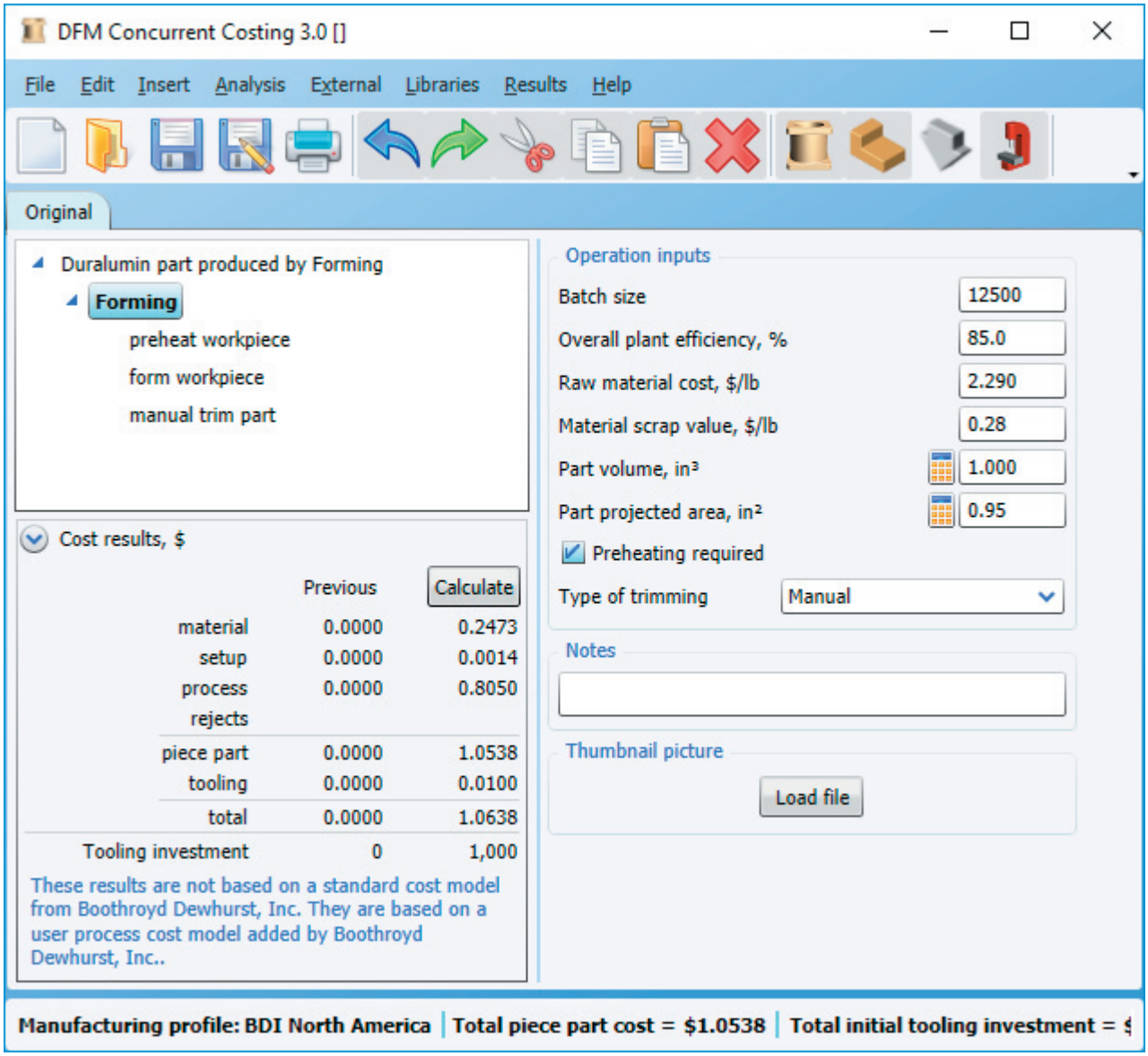
Preheating the workpiece is optional and the user can select automatic or manual trimming of the part.

Appearance and functionality of the completed Forming process

1. When the user starts the Forming analysis, the usual initial responses are made including the life volume, part envelope shape selection, part overall dimensions, and the direction of forming.
2. The user clicks **Select process and material** to display the process and material selection dialog. The User processes category available at the bottom of the process listing is opened and the *Forming* process is selected. The *Aluminum alloy* material category is opened and *Duralumin* is selected.



3. The screen for the Forming process is displayed and a default cost estimate for the described part is generated immediately. The default Process chart appears on the left while the Main response panel for the Forming process appears on the right.



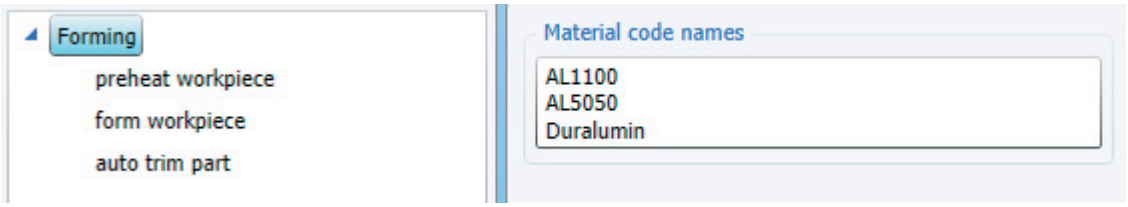
4. The user refines the default cost estimate for the part by adjusting inputs on the Main response panel. The user clicks the button alongside the *Part volume* field to display the Volume geometry calculator, which would be used to define a value for the Part volume field. A similar calculator would also be used to define a value for the Part projected area field.
5. Preheating is not required for this Duralumin material so the **Preheating required** checkbox is unchecked. After **Calculate** is clicked, the Preheat workpiece operation is automatically removed from the Process chart.
6. Automatic trimming will be used for this part so the user changes the *Type of trimming* dropdown to **Auto** and clicks **Calculate**. The trimming operation is automatically changed to an auto trim operation.
7. Analysis of this part is now complete and the results can be presented in the software's reports and graphs.

Add the Forming process and associated operations to the Process library

1. Select *User Process* from the *Libraries* menu.
2. Choose *Process* from the *Insert* menu. A new user process is added to the library with its name in edit mode. Name the process **Forming** and press the **Enter** key to accept the name.
3. Click on the *Items not yet added* entry beneath the Forming process and select *Operation* from the Insert menu. A new operation is added with its name in edit mode. Type **preheat workpiece** and press the **Enter** key.
4. Insert two more operations under the Preheat workpiece operation. Name them **form workpiece** and **auto trim part**

Define materials that are applicable to the Forming process

1. Click on the *Forming* process to display the Material code names box on the right.
2. Into the Material code names box, type **AL1100** and press the **Enter** key to begin a new line. On the new line, type **AL5050** and press the **Enter** key to begin a third line. On the third line, type **Duralumin** and do not press the Enter key.



Define the process level formulas

1. Open the process level Formula window by selecting *Formula* from the *Edit* menu.
2. Before entering formulas, be sure *English* is checked in the *Units* menu.
3. In the top panel of the window, enter the following expressions.

```
Raw_material_cost = 1.25;
Raw_material_cost = Material_code_name == 2 ? 1.58 : Raw_material_cost;
Raw_material_cost = Material_code_name == 3 ? 2.29 : Raw_material_cost;

Material_scrap_value = 0.15;
Material_scrap_value = Material_code_name == 2 ? 0.19 : Material_scrap_value;
Material_scrap_value = Material_code_name == 3 ? 0.28 : Material_scrap_value;

Material_density = 0.097;
Material_density = Material_code_name == 2 ? 0.094 : Material_density;
Material_density = Material_code_name == 3 ? 0.090 : Material_density;

Forming_pressure = 100;
Forming_pressure = Material_code_name == 2 ? 150 : Forming_pressure ;
Forming_pressure = Material_code_name == 3 ? 200 : Forming_pressure ;

Batch_size=Life_volume / 8;
Extra_material_factor;
Overall_plant_efficiency;
Part_weight = Part_volume * Material_density;
Part_projected_area;
Preheating_required;
Type_of_trimming;
```

4. Click **Calculate** to display the list of variables in the bottom panel of the window.

Define the Main response panel

1. Some variables are to be displayed on the Main response panel. These are listed below. Drag and drop these variables within the variables listing so that they are in the order shown and are at the top of the list.

   Batch_size

   Overall_plant_efficiency

   Raw_material_cost

   Material_scrap_value

   Part_volume

   Part_projected_area

   Preheating_required

   Type_of_trimming

2. For all the remaining variables change Always to **Never** in the *Show to user?* column.
3. Make the following change for the *Part_volume* variable.

   Calculator type - change from None to **Volume**

4. Make the following change for the *Part_projected_area* variable.

   Calculator type - change from None to **Projected area**

5. Make the following changes for the *Preheating_required* variable.

   Type - change Number to *Checkbox*.

6. Make the following changes for the *Type_of_trimming* variable.

   Type - change Number to **List**

   Value - click the button to display the *List Contents* dialog. Type **Auto** and press **Enter** to start a new line. On the new line type **Manual** and do not press Enter. Click **OK** to close the dialog.

7. To complete the variables list, enter the values, units, conversion factors and descriptions shown below.

	Variable name	Value	Number of decimals	**English Unit (E)**	Metric Unit (M)	Conversion Factor (F) E*F=M	Description
1	**Batch_size**	0				1	number of parts produced with one set-up; used in sel
2	Overall_plant_efficiency	100.0		%	%	1	average efficiency of all plant operations; equals mach
3	Raw_material_cost	1.250	3	$/lb	$/kg	2.20462	cost per unit weight of raw material
4	Material_scrap_value	0.15		$/lb	$/kg	2.20462	value of material from rejected scrap parts
5	Part_volume	1.000		in^3	cm^3	16.3871	volume of the finished part
6	Part_projected_area	1.00		in^2	cm^2	6.4516	projected area of the part
7	Preheating_required	☑ ☐					checkbox if preheating the workpiece is required
8	Type_of_trimming	☐ 2					type of trim operation
9	Material_code_name	1.00				1	material code name for the selected process
10	Material_density	0.097	3	lb/in^3	kg/cm^3	1	material weight per unit volume
11	Forming_pressure	100.000	3	lb/in^2	MPa	1	pressure required during forming
12	Life_volume	1				1	total number of parts to be produced
13	Extra_material_factor	1.200	3			1	factor to account for the extra material to be trimmed
14	Part_weight	0.097		lb	kg	0.4536	weight of the finished part

8. Click **OK** to exit the process level Formula window and return to the Process library.

Define the operation formula for the preheat workpiece operation

1. Double click the *preheat workpiece* operation to open the Formula window for that operation.
2. In the top panel of the window, enter the following expressions.

   Material_weight = Part_weight * Extra_material_factor ;

   Heating_cost = Material_weight * Heating_cost_per_unit_weight;

Process_cost = (Time_to_load_and_unload * Heating_process_rate / 3600 + Heating_cost) /(Overall_plant_efficiency / 100);

Setup_cost = Setup_rate*Setup_time/Batch_size;

3. Click **Calculate** to display the list of variables in the bottom panel of the window.

Define the operation response panel for the preheat workpiece operation

1. Drag and drop the following variables which will be displayed to the user so that they are in the order shown and are at the top of the variables listing.

   Setup_rate

   Setup_time

   Heating_process_rate

   Time_to_load_and_unload

   Heating_cost_per_unit_weight

2. For all the remaining variables change Always to **Never** in the *Show to user?* column.
3. To complete the variables list, enter the values, units, conversion factors and descriptions shown below.

	Variable name	Value	Number of decimals	**English Unit (E)**	Metric Unit (M)	Conversion Factor (F) E*F=M	Description
1	Setup_rate	36.000	3	$/hr	$/hr	1	cost per unit time to set up for preheating
2	Setup_time	0.500	3	hr	hr	1	time to set up for preheating one batch of workpieces
3	Heating_process_rate	30.000	3	$/hr	$/hr	1	burdened process rate for preheating
4	Time_to_load_and_unload	5.000	3	s	s	1	time to load and unload one workpiece
5	Heating_cost_per_unit_weigh	0.500	3	$/lb	$/kg	2.20462	cost per unit weight to preheat the workpiece
6	Material_weight	0.12		lb	kg	0.4536	weight of material in the workpiece after this operatio
7	Part_weight	0.097		lb	kg	0.4536	weight of the finished part
8	Extra_material_factor	1.200				1	factor to account for the extra material to be trimmed
9	Heating_cost	0.058	3	$	$	1	preheating cost for the workpiece
10	**Process_cost**	0.0999		$	$	1	sum of all processing costs for one part, adjusted for p
11	Overall_plant_efficiency	100.0		%	%	1	average efficiency of all plant operations; equals mach
12	**Setup_cost**	144.0000		$	$	1	sum of set-up times multiplied by set-up rates, divided
13	Batch_size	0				1	number of parts produced with one set-up; used in se

4. Click **OK** to close the Formula window.

Define the operation formula for the form workpiece operation

1. Double click the *form workpiece* operation to open the Formula window for that operation.
2. In the top panel of the window, enter the following expressions.

   Material_weight = Part_weight * Extra_material_factor;

   Material_cost = Material_weight * Raw_material_cost;

   Forming_force = Forming_pressure * Part_projected_area;

Time_per_part_for_forming=Part_depth/Forming_force*Forming_time_constant;

Process_cost = ((Time_to_load_and_unload + Time_per_part_for_forming) * Forming_process_rate)

/ 3600 / (Overall_plant_efficiency / 100);

Tooling_cost_per_part=Initial_tooling_investment/Life_volume;

3. Click **Calculate** to display the list of variables in the bottom panel of the window.

Define the operation response panel for the form workpiece operation

1. Drag and drop the following variables which will be displayed to the user so that they are in the order shown and are at the top of the variables listing.

   Forming_process_rate

   Time_to_load_and_unload

   Time_per_part_for_forming

   Initial_tooling_investment

2. For all the remaining variables change Always to **Never** in the *Show to user?* column.
3. To complete the variables list, enter the values, units, conversion factors and descriptions shown below.

	Variable name	Value	Number of decimals	**English Unit (E)**	Metric Unit (M)	Conversion Factor (F) E*F=M	Description
1	**Forming_process_rate**	60.000	3	$/hr	$/hr	1	burdened process rate for the forming machine and operator
2	Time_to_load_and_unload	6.000	3	s	s	1	time to load and unload workpiece for forming
3	Time_per_part_for_forming	50.000	3	s	s	1	time to form the workpiece
4	**Initial_tooling_investme**	1,000		$	$	1	cost of initial purchase of dies, molds, tools or fixtures; does
5	Material_weight	0.12		lb	kg	0.4536	weight of material in the workpiece after this operation - use
6	Part_weight	0.097		lb	kg	0.4536	weight of the finished part
7	Extra_material_factor	1.200				1	factor to account for the extra material to be trimmed
8	**Material_cost**	0.1455		$	$	1	material cost per part, reduced where appropriate through re
9	Raw_material_cost	1.250		$/lb	$/kg	2.20462	cost per unit weight of raw material
10	Forming_force	100.000	3	lb	N	4.44819	force required for forming
11	Forming_pressure	100.000		lb/in²	MPa	1	pressure required during forming
12	Part_projected_area	1.00		in²	cm²	6.4516	projected area of the part
13	Part_depth	1.000		in.	mm	25.4	depth of the rectangular part envelope measured in the form
14	Forming_time_constant	5,000.000	3	slb/in	sN/mm	0.17513	constant used to calculate forming time
15	**Process_cost**	0.9333		$	$	1	sum of all processing costs for one part, adjusted for plant ef
16	Overall_plant_efficiency	100.0		%	%	1	average efficiency of all plant operations; equals machine run
17	**Tooling_cost_per_part**	1,000.0000		$	$	1	total cost of dies or molds, tools and fixtures divided by life v
18	Life_volume	1				1	total number of parts to be produced

4. Click **OK** to close the Formula window.

Define the operation formula for the auto trim part operation

1. Double click the *auto trim part* operation to open the Formula window for that operation.
2. In the top panel of the window, enter the following expressions.

   Material_weight = Part_weight;

   Process_cost = Trim_time * Trim_process_rate / 3600 / (Overall_plant_efficiency / 100);
3. Click **Calculate** to display the list of variables in the bottom panel of the window.

Define the operation response panel for the auto trim part operation

1. Drag and drop the following variables which will be displayed to the user within the variables listing in the bottom panel of the Formula window so that they are in the order shown at the top of the list.

   Trim_process_rate

   Trim_time
2. For all the remaining variables change Always to **Never** in the *Show to user?* column.
3. To complete the variables list, enter the values, units, conversion factors and descriptions shown below.

	Variable name	Value	Number of decimals	**English Unit (E)**	Metric Unit (M)	Conversion Factor (F) E*F=M	Description
1	**Trim_process_rate**	50.000	3	$/hr	$/hr	1	burdened process rate for machine and operator
2	Trim_time	4.000	3	s	s	1	time for trimming
3	Material_weight	0.10		lb	kg	0.4536	weight of material in the workpiece after this op
4	Part_weight	0.097		lb	kg	0.4536	weight of the finished part
5	**Process_cost**	0.0556		$	$	1	sum of all processing costs for one part, adjuste
6	Overall_plant_efficiency	100.0		%	%	1	average efficiency of all plant operations; equals

4. Click **OK** to close the Formula window.

Define the manual trim part operation

1. Copy the *auto trim part* operation by selecting *Copy* from the *Edit* menu. Paste the operation by selecting *Paste* from the *Edit* menu.
2. Rename the second auto trim operation to **manual trim part** by right clicking the operation and selecting *Rename*.

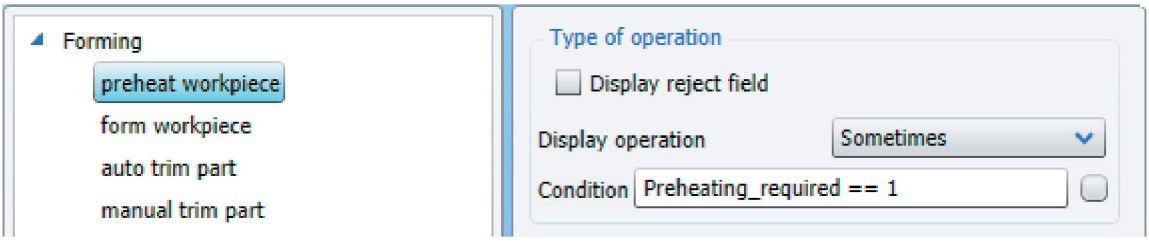
Define the operation formula and response panel for the manual trim part operation

1. Double click the *manual trim part* operation to open the Formula window for that operation.
2. Change the *Value* column for the *Trim_process_rate* variable from 50 to **30**.
3. Change the *Value* column for the *Trim_time* variable from 4 to **6**.
4. Click **OK** to close the Formula window

Define display conditions and reject rate defaults for operations

1. Click on the *preheat workpiece* operation beneath the Forming process and select *Sometimes* from the *Display operation* dropdown.
2. Click the button near the Condition field.

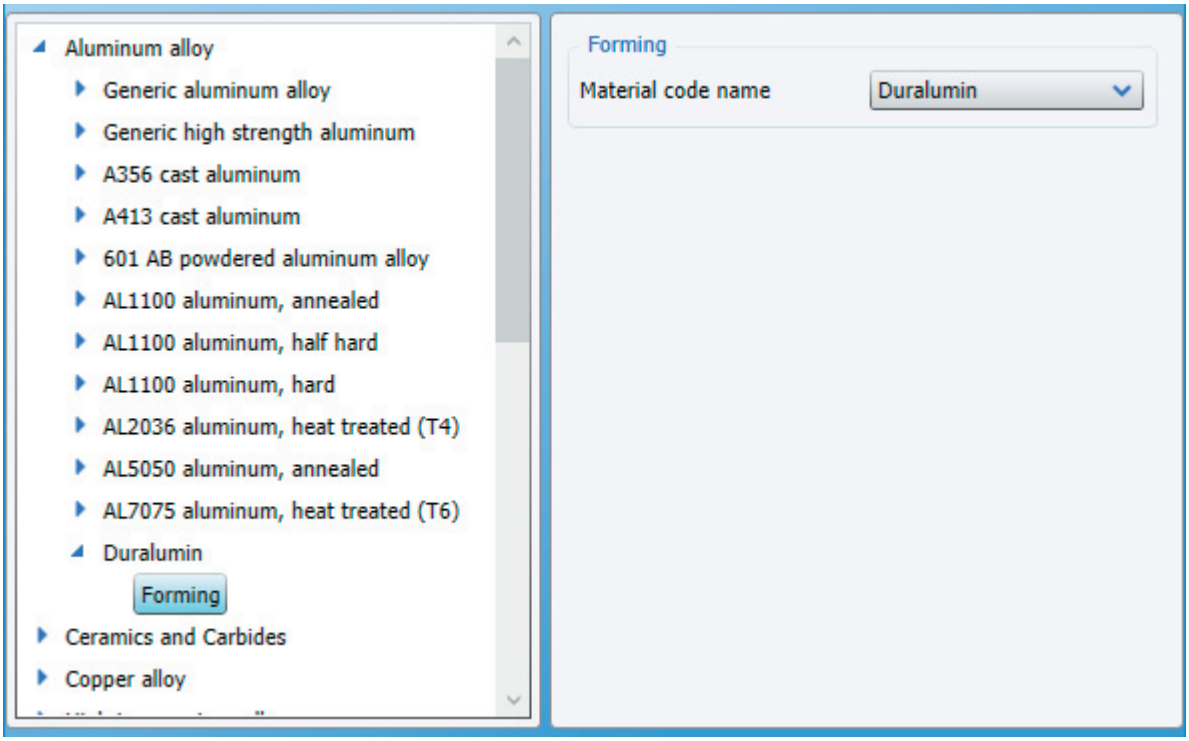
3. During an analysis, the preheat workpiece operation will be displayed on the Process chart whenever the *Preheating_required checkbox* is checked on the Main response panel. For this reason, highlight *Preheating_required* on the left and type **1** into the *Value* field on the right.



4. Click **OK** and highlight the *auto trim part* operation. Click the *Display reject field* checkbox that appears on the right. Enter **0.5** into the *Default value for rejects* field.
5. Select *Sometimes* from the Display operation dropdown and click the button near the Condition field.
6. During an analysis, the *auto trim part* will be displayed on the Process chart whenever *auto* is selected from the *Type_of_trimming* list on the Main response panel. For this reason, highlight *Type_of_trimming* on the left and type **1** into the Value field on the right. Click **OK** to exit the display conditions window.
7. Highlight the *manual trim part* operation and perform the same steps except enter **2** into the *Value* field when defining the display conditions.
8. Close the Process library by choosing *Exit* from the *File* menu.

Link the material library with the Forming process

1. From the main window of DFM Concurrent Costing, choose *Material* from the *Libraries* menu.
2. Expand the *Aluminum alloy* category.
3. Highlight the *AL1100 aluminum, annealed* material and click the *Forming* checkbox that appears on the right.
4. Click the *Forming* entry that appears beneath the *AL1100 aluminum, annealed* material and choose *AL1100* from the *Material code name* dropdown on the right.
5. Highlight the *AL5050 aluminum, annealed* material and click the *Forming* checkbox that appears on the right. Click the *Forming* entry that appears beneath the material and choose *AL5050* from the *Material code name* dropdown on the right.
6. Highlight the *AL7075 aluminum, heat treated (T6)* material. Choose *Material* from the *Insert* menu and a new material is added to the library with its name in edit mode. Name the material **Duralumin** and press the **Enter** key to accept the name.
7. Click the *Forming* checkbox on the right and highlight the *Forming* entry that appears beneath the material. Choose Duralumin from the *Material code name* dropdown on the right.



8. Close the Material library by choosing *Exit* from the *File* menu.

Removing the imaginary Forming process

1. The Forming process added during this tutorial is completely imaginary and should not be used to analyze real formed parts. For this reason, the Forming process should be removed from the Process library after the process is created. Open the User Process library by choosing it from the *Libraries* menu on the main screen of the software.
2. Highlight the *Forming* process and select *Delete* from the *Edit* menu. Click **OK** in the Confirm dialog that appears.
3. Close the User Process library by choosing *Exit* from the *File* menu.
4. Open the Material library by choosing it from the *Libraries* menu.
5. Expand the *Aluminum alloy* material category and highlight the *Duralumin* material. Select *Delete* from the *Edit* menu and click **OK** in the Confirm dialog that appears.
6. Close the Material library by choosing *Exit* from the *File* menu.