FDM BEST PRACTICE: APPLYING CUSTOM TOOLPATHS FOR THIN WALLS AND BOSSES



SOFTWARE/PRODUCT/FINISHING

OVERVIEW

When processing an STL file, smaller or larger toolpath widths are sometimes required to achieve proper fill for certain portions or features of a part. While changing the tip or modifying global toolpath settings for the entire part will generally work, often times it is unnecessary. *Custom Groups* provide a means to specify different toolpath parameters for an individual curve or curves.

Examples include:

- · Features too small to fill using the default toolpath width
- · Features requiring reinforced walls such as bosses and flanges
- Areas that require different fill styles

A common situation requiring custom toolpaths is when the default toolpath cannot fill in the space between two walls, resulting in voids and weak wall strength (Figure 1). This is corrected by modifying the toolpath width parameter (Figure 2).

A similar situation arises with bosses, holes and flanges where the default toolpath results in small gaps between the contour (outer wall) and raster (infill) (Figure 3). This is corrected using additional contours applied with custom toolpath parameters (Figure 4).

1. OPTIONS

1.1 Custom Groups are accessed from the Toolpaths drop-down menu (Figure 5). When creating a new group, all of the options and parameters that can be modified are displayed (Figure 6).

The key parameters that eliminate gaps between contours and reinforce walls around bosses and holes are *Contour width*, *Raster width* and *Contour controls*.

- Modifying contour width Eliminates gaps between single contours by adjusting contour widths so that the contours touch.
- Modifying contour and raster width Eliminates gaps between two contours by adjusting the contour width and raster width such that the gap is raster filled.
- Strengthening features with additional contours Eliminates gaps at the contact point between raster and contour by using multiple contours. Linking the contours joins successive contours, improving seam quality and reducing porosity. This provides additional strength if the hole will be drilled or tapped.

NOTE: Descriptions of all the options in the parameters sheet are available through the Insight[™] software Help Menu. However, many of these settings can have detrimental effects on your parts if not used properly. It is recommended that only experienced or advanced users make changes to these values. To insure the best possible part quality, Stratasys[®] recommends that you always review the toolpaths on your parts and make modifications if necessary, before downloading them to your system.

Companion and reference materials: • Video - Show Me How



Figure 1: Inner and outer toolpaths that do not meet each other which causes a hollow area in between.



Figure 2: Custom toolpaths are applied to achieve proper fill resulting in a stronger feature.



Figure 3: Gaps between the raster fill and contours result in porosity that weakens the boss or hole.

2. PROCESS

2.1. Modifying Contour Widths

- STEP 1: Configure the modeler.
- STEP 2: Open, orient and slice the STL file.
- **STEP 3:** Click () to create toolpaths. View the toolpaths in top-down view.
- **STEP 4:** Identify the area and layer(s) where a void exists between contours. Measure the total width between contours and divide by 2. Make note of this value for use in Step 7.
- STEP 5: From the Toolpaths menu, select Custom groups.
- **STEP 6**: Click **New** to create a new custom group. In the **Toolpath** *parameters* window, give the custom group a name.

NOTE: Give each new custom group a unique name. Reusing a name will result in the toolpath settings for that group being overwritten.

- **STEP 7:** Under the *Contour parameters* section, select a size from the *Contour width* drop-down menu (Figure 7); it should be equal to the value you made note of in Step 4. Alternatively you can type the value into the field. Click
 to confirm your selection.
- **STEP 8:** Select the desired curves using your cursor and click **Add**. All curves that are added to this group will have the toolpath parameters you defined.

TIP: Curves can be added to an already-defined custom group by selecting the **Group name** from the list, selecting the desired toolpaths and clicking **Add**.

- **STEP 9:** Click @ or @ to regenerate the toolpaths for the layer or group.
- STEP 10: From the Toolpaths menu select Shade Toolpaths.
- **STEP 11:** Confirm that the gap between the contours has been eliminated, but the overlap between contours is less than 0.025 mm (0.001 in). If a gap still exists, modify the custom group values and regenerate toolpaths.

NOTE: Custom group settings can be modified by selecting the *Group name* from the list and clicking **Modify** .

STEP 12: Modifying Contour Widths procedure complete.



Figure 4: Adding multiple contours strengthens the boss by eliminating the porosity.



Figure 5: Custom groups are accessed from the Toolpaths menu.

Enter the new group's name	and parameters.				
General information		RA	oter 10 parameters		
Group name	[Concel	- a	Raster vidth	0.0200	1
Description	1	5 F	Algoratiens		
Display color	Can	H 7	Double donse rasters		
Toolpeth material	Please	日に	Parallel offset resters		
Material color	white	3 7	Use alternate sparse fil p	ettern	
T No support generation			Alternate sparse fil stole	Hexagonal	1
Contour parameters			Attempts fil off size	0.2000	
Contour style	Single contour only	2 84	der angle controls		
Contour width	0.0000	3	Start angle	45.000000	
Number of contours	1	3	Delta angle	90.000000	1
Contour controls			Layers between deltas	1	_
F Apply contour style to a	relected feature only	- 50	erse fill controle		
Link contours		1	Include in part sparse fil		
Allow increased contour	averti -		fourse ranks width	0.0220	
C Bypass seam placement	8		Spense raiter air gap	0.0500	
Outer contour location	Inside	3	Portargia	45.0	1
Ar geps between:			Deltaurope	00.0	1
Adjacent racters	0.0000	3 7	Double dance sparse rach	es :	
Contours and rasters	0.0000	3 8	Add a contrary around spa	ne)	
Cantour and contour	0.0000	3 7	Line where the spream fill po	attern	
			Alternate sportse fil store	Hexagonal	
			Alternate fil cell size	0.3000	
		2.00	etophes		
			Open curve width	0.0200	1

Figure 6: Toolpath options and parameters available when making or modifying a custom group.

Contour style	Single contour only	0
Contour width	0.0160	-
Number of contours	1	-,

Figure 7: Contour width can be selected using a drop-down menu found in the Contour parameters options.

2.2. Modifying Contour and Raster Width

- STEP 1: Configure the modeler.
- STEP 2: Open, orient and slice the STL file.
- STEP 3: Click Ø to create toolpaths. View the toolpaths in top-down view.
- **STEP 4:** Identify the area and layer(s) where a void exists between contours.
- STEP 5: From the Toolpaths menu, select Custom groups.
- **STEP 6:** Click **New** to create a new custom group. In the *Toolpath parameters* window, give the custom group a name.

NOTE: Give each new custom group a unique name. Reusing a name will result in the toolpath settings for that group being overwritten.

- **STEP 7:** Under the *Contour parameters* section, select a smaller size from the *Contour width* drop-down menu. Alternatively, you can type the value in this field.
- **STEP 8**: Under the **Raster fill parameters** section, select a size from the **Raster width** drop-down menu (Figure 8). Alternatively, you can type the value in this field. Click ✓ to confirm both selections.
- **STEP 9:** Select the desired curves using your cursor and click **Add**. All curves that are added to this group will have the toolpath parameters you defined.

TIP: Curves can be added to an already defined custom group by selecting the *Group name* from the list, selecting the desired toolpaths and clicking **Add**.

STEP 10: Click \bigotimes or \bigotimes to regenerate the toolpaths for the layer or group.

STEP 11: From the Toolpaths menu select Shade Toolpaths.

STEP 12: Confirm that the gap between the contours has been raster filled. If a gap exists, modify the custom group values and regenerate toolpaths.

NOTE: Custom group settings can be modified by selecting the *Group name* from the list and clicking **Modify**.

STEP 13: Modifying Contour and Raster Width procedure complete.

Ka:	ster nii parameters		
4	Raster width	0.0160	-
Г	Align rasters		
Г	Double dense rasters		
Г	Parallel offset rasters		
Г	Use alternate sparse fill pa	attern	
	Alternate sparse fill style	Hexagonal	*
	Alternate fill cell size	0.2000	

Figure 8: Raster width can be selected using a drop-down menu found in the Raster fill parameters.

General information			. 84	te Ryeanetex		
Group name	Group 1	_		Raster width	0.0200	
Description	-	10	r	Align nasters		
Display color	STORE OF	•	Γ	Double dense rasters		
Toolpath material	Proce	1	$ \Gamma $	Paralel offset resters		
Material color	unte	-	T	Use alternate sparse fil p	attern	
To support generation			0	Abernata sparse R style	Hexagonal	1
Contrue parameters				Alternate fil cell stee	0.2000	-
Contour style	Multiple contours	1	-84	iter engle controls		
Contour width	0.0000	1		Startanje	45.000000	1
Number of contours	3			Delta angle	90.000000	-
Contour contride			11	Layers between deltas	1	
Apply contour style to	selected feature onl	é.	fee	read fill controls		
Erk centours			17	Include in part sparse RI		
Alon monased contour	r over51			Spanan racher width	0.0228	- 2
Dypess seam placement	8			Spanje native all gap	0.0900	_
Outer contour location	Insde			Shetanga	48.0	- 1
Air gape between:				Delta ange	90.0	-
Adjacent rasters	0.0000	-	17	Double diense spierse rish	69 C	
Contours and rasters	0.0000	-1	17	Add a control amount app	14	
Centour and centour	0.0000	•	E	One adversation spectrum RV pr	dan	
				Alternatic sparse Mistole	Hexagonal	-1
				Alternate (N cell sea	0.2000	
			00	in curves		
				Open curve with	0.0200	
				And the second second	and a second	

Figure 9: Multiple contours is enabled and additional contours are specified in the Contour parameters options.

Co	ntour controls
Г	Apply contour style to selected feature only
~	Link contours
Г	Allow increased contour overfill
Г	Bypass seam placement
	Outer contour location Inside



2.3. Strengthening Features with Additional Contours

- **STEP 1:** Configure the modeler.
- **STEP 2:** Open, orient and slice the STL file.
- **STEP 3:** Click () to create toolpaths. View the toolpaths in top-down view.
- **STEP 4:** Identify the area and layer(s) where additional contours are needed.
- STEP 5: From the Toolpaths menu, select Custom groups.
- **STEP 6:** Determine the desired number and width of contours.

TIP: For a hole that will be drilled or tapped, a combination of thicker contours and multiple contours around the feature should be used.

TIP: For a boss, choose a contour width value that is an even divisor of half the wall thickness of the boss. For example, if the boss wall thickness equals 10 mm, choose a contour width that is evenly divided into 5 (half of 10 mm).

STEP 7: Click **New** to create a new custom group. In the **Toolpath parameters** window, give the custom group a name.

NOTE: Give each new custom group a unique name. Reusing a name will result in the toolpath settings for that group being overwritten.

- STEP 8: Under the *Contour parameters* section, select *Multiple contours* from the drop-down menu (Figure 9). You may change the contour width from the default value based on the calculation in Step 6. Select the *Number of contours* from the drop-down menu. This is the number of contours this group of curves will have.
- STEP 9: (Optional) Under the Contour controls, select the checkbox for Link contours (Figure 10).

TIP: Selecting the checkbox to *Apply contour style to selected feature only* (Figure 11) will apply *Contour parameters* only to the selected part curve (feature-based contours) (Figure 12).

- **STEP 10:** Click **√** to confirm your selections.
- **STEP 11:** Select the desired curves using your cursor and click **Add**. All curves that are added to this group will have the toolpath parameters you defined.

TIP: Curves can be added to an already defined custom group by selecting the *Group name* from the list, selecting the desired toolpaths and clicking **Add**.

Link contours Allow increased contour overfill Bypass seam placement	V	Apply contour style to selected feature only
Allow increased contour overfill Bypass seam placement	-	Link contains
Allow increased contour overfil Bypass seam placement	-	
Bypass seam placement	E	Allow increased contour overfill
	Г	Bypass seam placement

Figure 11: The option to apply contours only to selected features is found in the Contour controls.



Figure 12: The Apply contour only to selected feature is enabled when the inside wall is selected.

STEP 12: Click $\textcircled{O}_{\mathbf{C}}$ or $\textcircled{O}_{\mathbf{G}}$ to regenerate the toolpaths for the layer or group.

STEP 13: From the *Toolpaths* menu select *Shade Toolpaths*.

STEP 14: Strengthening Features with Additional Contours procedure complete.

3. TOOLS & SUPPLIES

3.1. Software:

• Insight software (document developed with Insight 9.0)

CONTACT:

To obtain more information on this application, contact:

Stratasys Application Engineering

1-855-693-0073 (U.S. toll-free)

+1 952-294-3888 (international)

ApplicationSupport@Stratasys.com

Stratasys | www.stratasys.com | info@stratasys.com

7665 Commerce Way Eden Prairie, MN 55344 +1 888 480 3548 (US Toll Free) Rehovot 76124, Israel +1 952 937 3000 (Intl) +1 952 937 0070 (Fax)

2 Holtzman St. Science Park, PO Box 2496 +972 74 745-4000 +972 74 745-5000 (Fax)

ISO 9001:2008 Certified

© 2014 Stratasys. All rights reserved. Stratasys, Stratasys logo and FDM are registered trademarks of Stratasys Inc. Insight is a trademark of Stratasys Inc. All other trademarks are the property of their respective owners, and Stratasys assumes no responsibility with regard to the selection, performance or use of these non-Stratasys products. Product specifications subject to change without notice. Printed in the USA. SSYS-BP-CustomToolpaths-10-14

The information contained herein is for general reference purposes only and may not be suitable for your situation. As such, Stratasys does not warranty this information. For assistance concerning your specific application, consult a Stratasys application engineer. To ensure user safety, Stratasys recommends reading, understanding, and adhering to the safety and usage directions for all Stratasys and other manufacturers' equipment and products. In addition, when using products like paints, solvents, epoxies, Stratasys recommends that users perform a product test on a sample part or a non-critical area of the final part to determine product suitability and prevent part damage.

