Understanding CAM in Fusion 360

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About Me

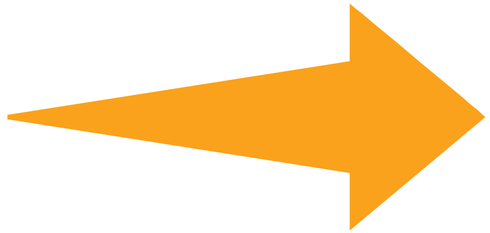
Paul Clauss

- Fusion 360 and Embedded CAM Product Support and Knowledge Domain Expert
- Portland, OR
- Mountain biking and the outdoors
- Making things!

AGENDA

Concepts

- Strategies in Fusion 360
- Toolpath Containment
- Selections
- Smoothing/Tolerance

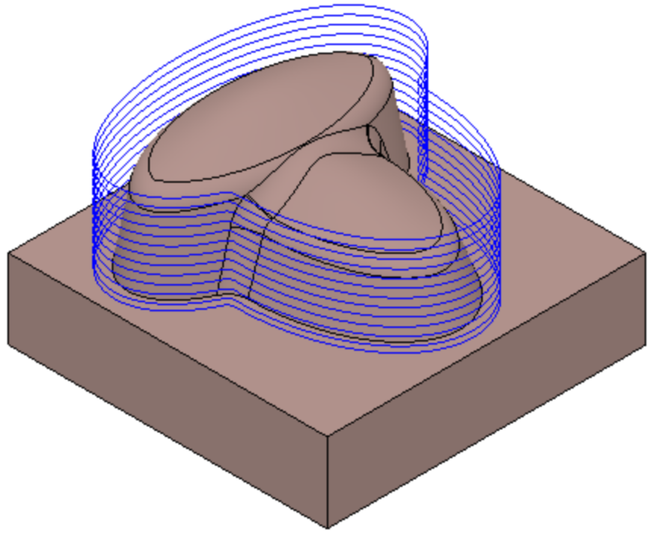


Troubleshooting

- Identify
- Isolate
- Experiment
- Resolve

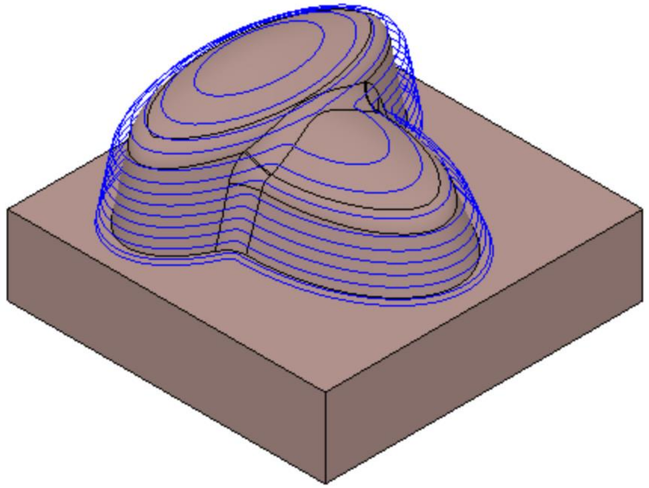
Concepts

CAM Strategies in Fusion 360 - Milling



2D Milling

- Only sees geometry selections
- Fill/Follow Style
- Straightforward or Prismatic Geometry (2.5 axis parts)

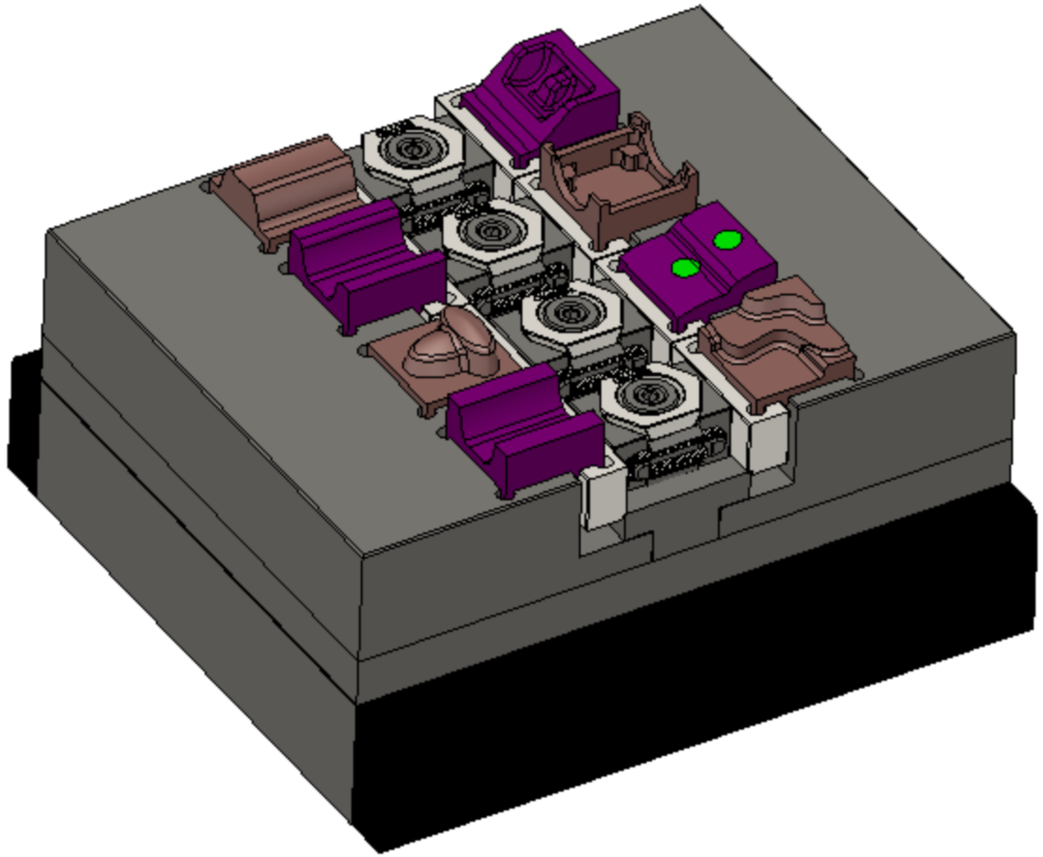


3D Milling

- Sees 3D model
- Projection style
- Control and Automation

Strategy Choice

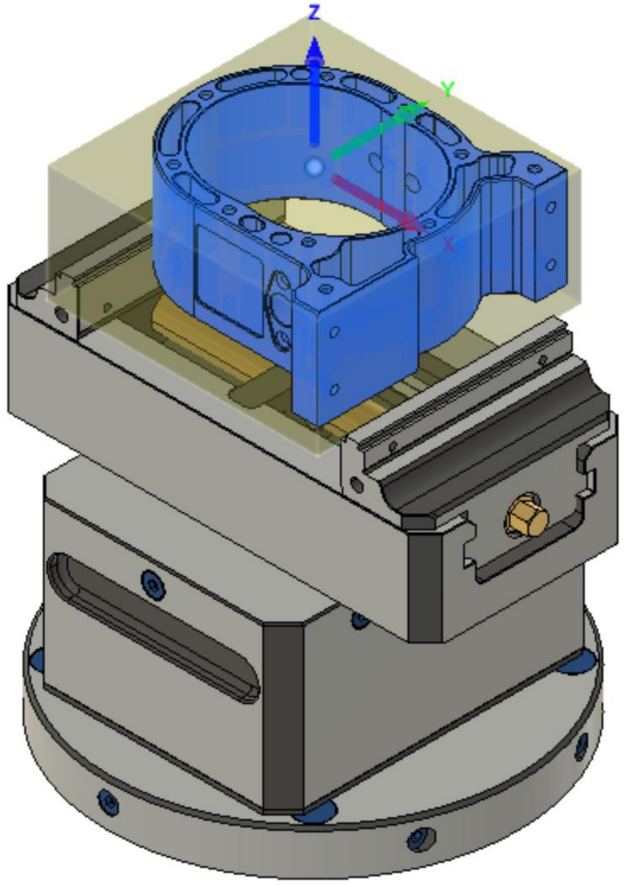
GEOMETRY

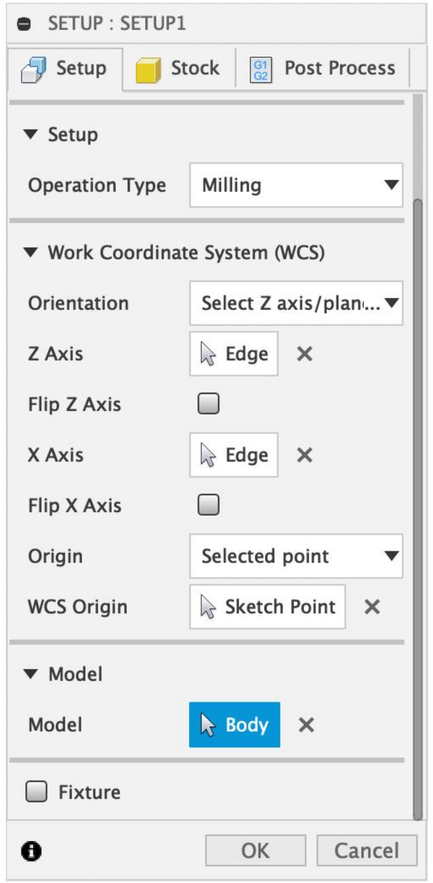


Check out the “CAM Deep Dive” videos and sample parts!

Containment

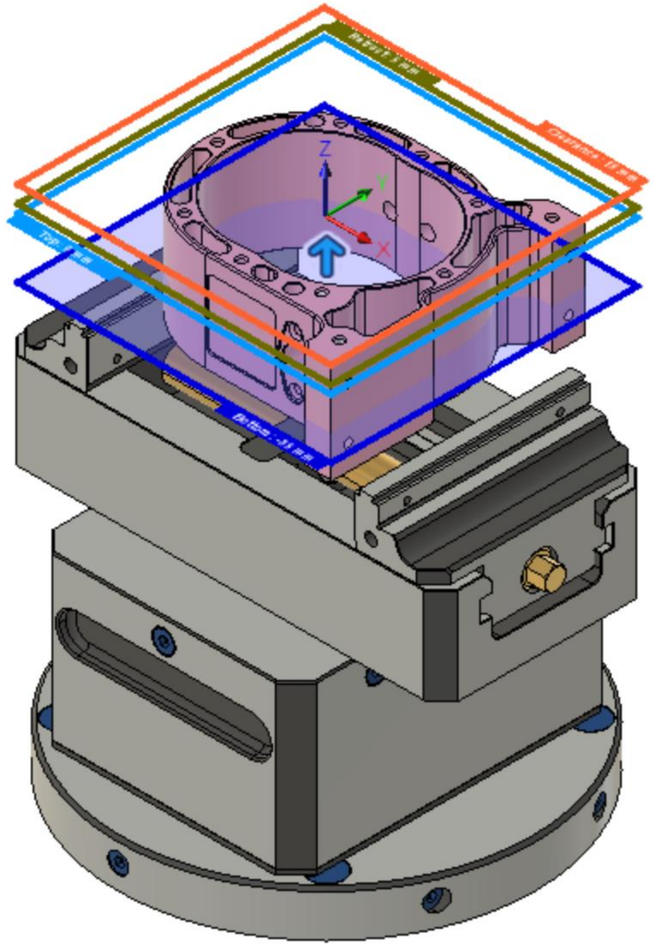
Model Selection in CAM Setup





Containment

Along Z-axis - HEIGHTS



ADAPTIVE : ADAPTIVE5

Clearance Height

From	Retract height
Offset	10 mm

Retract Height

From	Stock top
Offset	5 mm

Top Height

From	Stock top
Offset	0 mm

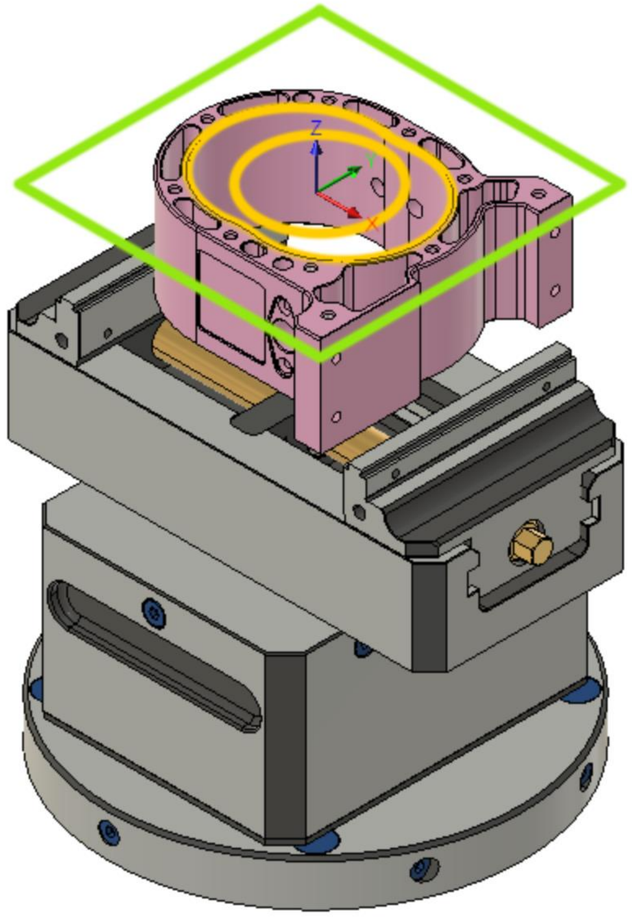
Bottom Height

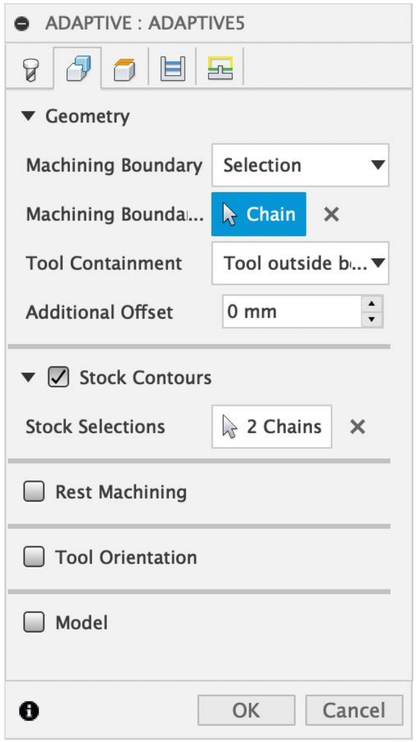
From	Model bottom
Offset	25 mm

OK Cancel

Containment

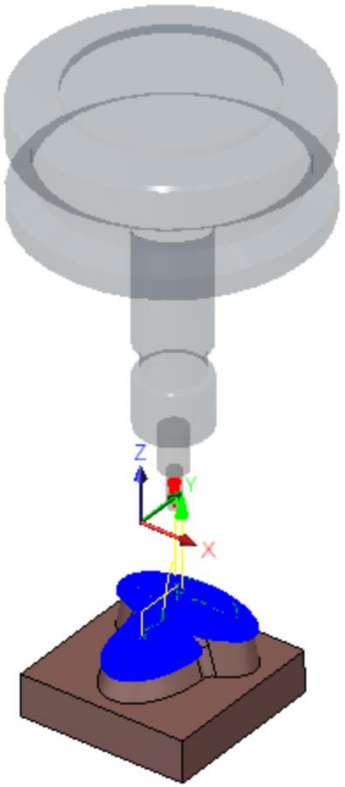
On XY Plane – Machining boundaries, Stock Contours



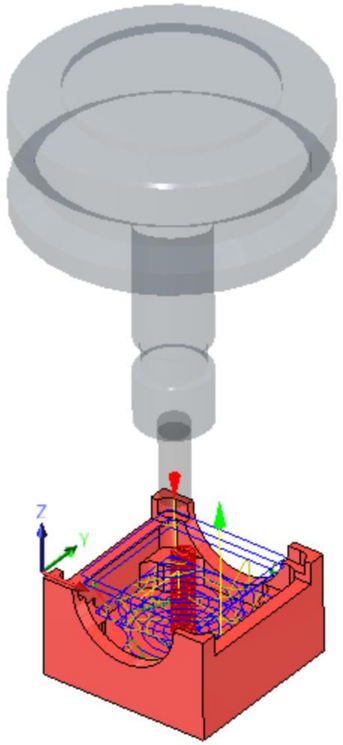


Containment

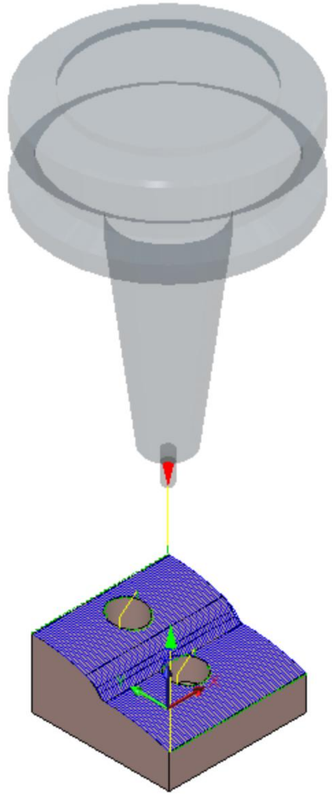
3D Bonuses!



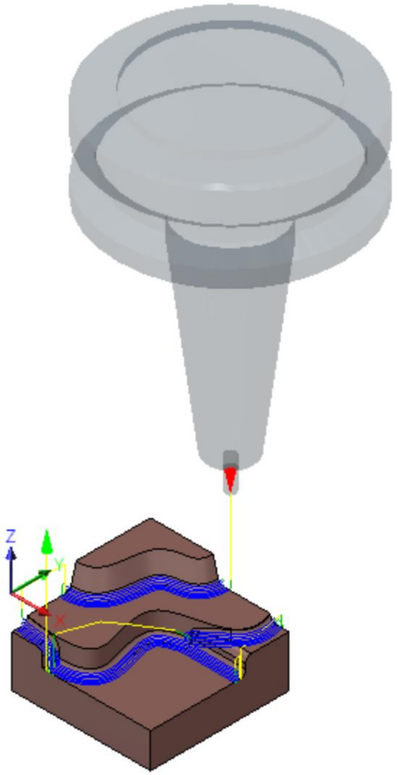
Slope



Model Override

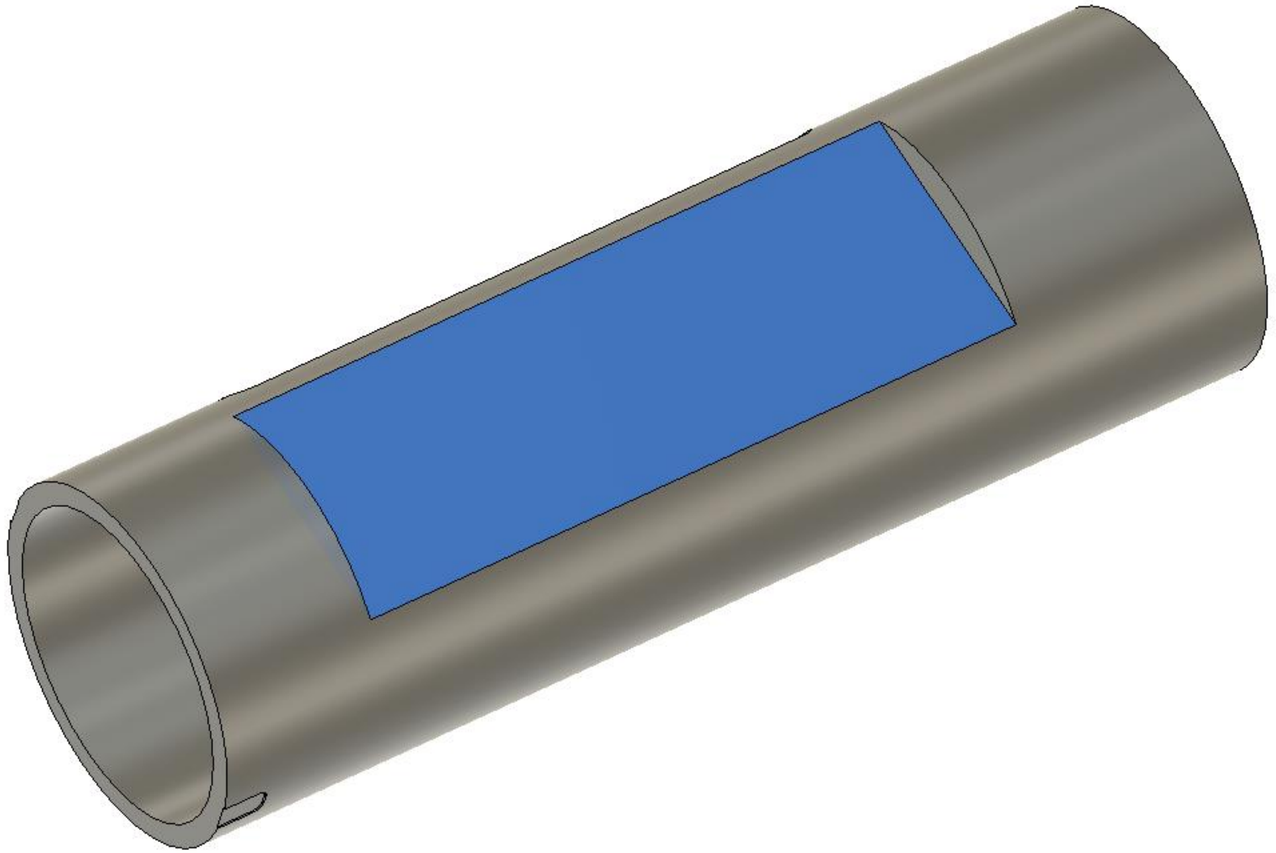


Avoid/Touch Surfaces



Automatic

Containment Example

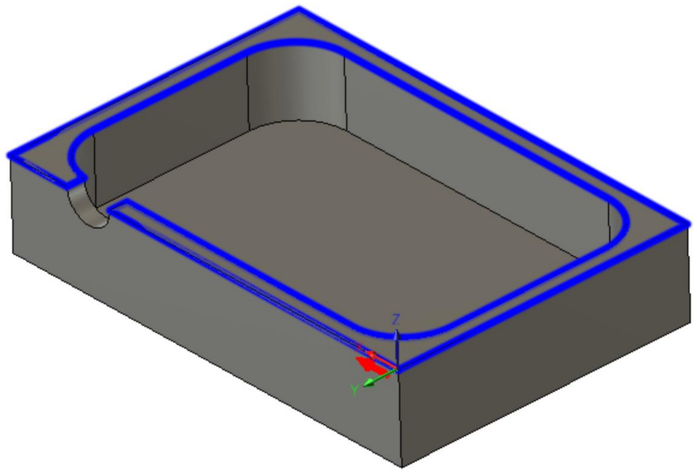


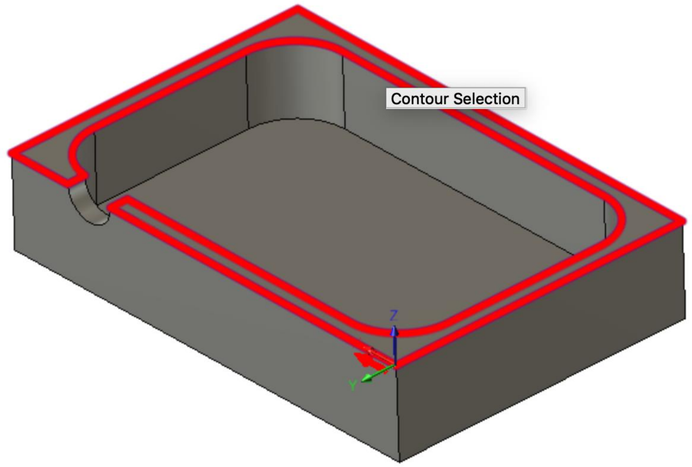
Problem: Boundary conditions are not the same on all sides of boundary

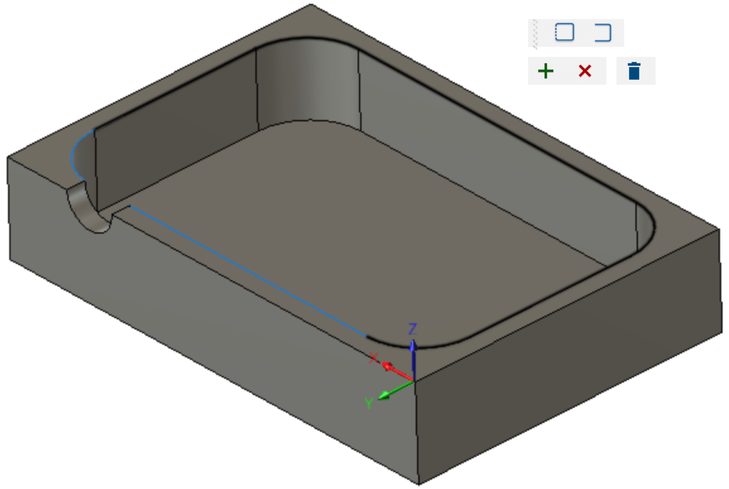
Goals: Side Entry & No Air Cutting (cylindrical stock)

Selections - Editor

Contour Editor Example

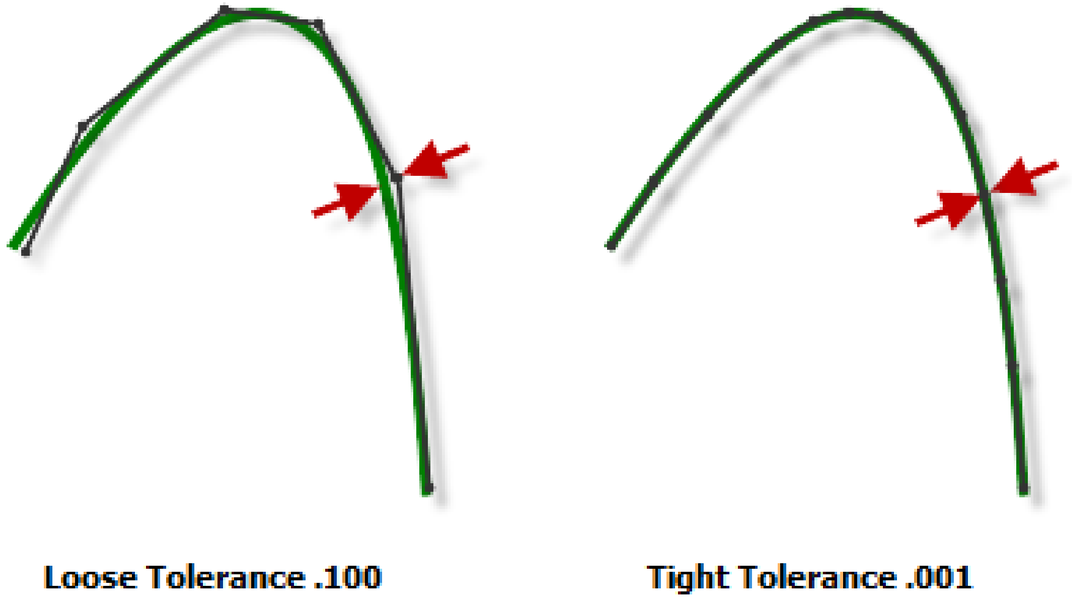






Don’t forget to click the + to confirm the contour!

Toolpath Tolerance



Controls accuracy of “mesh” model driving toolpath generation

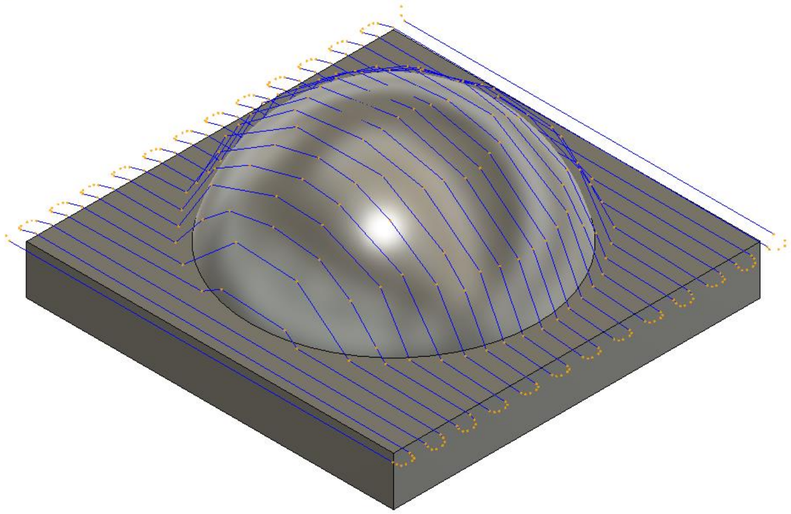
Toolpath Smoothing

Smoothing Off

Smoothing On

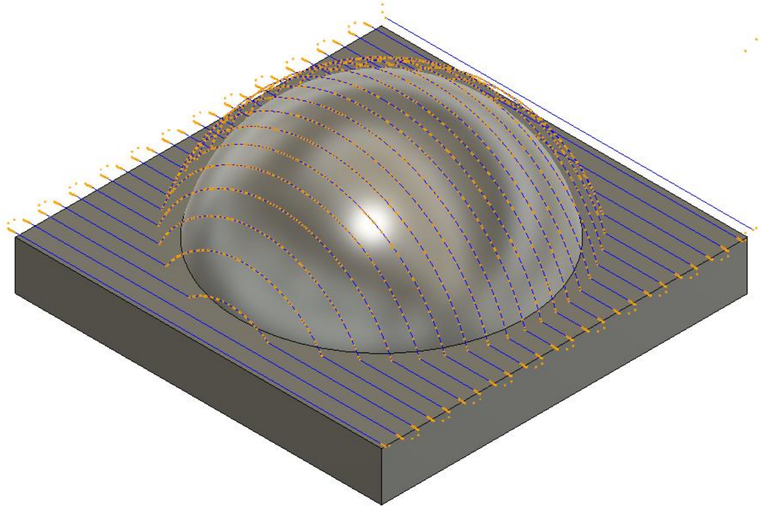
Applies arc moves to reduce excessive linear segments

Toolpath Tolerance & Smoothing



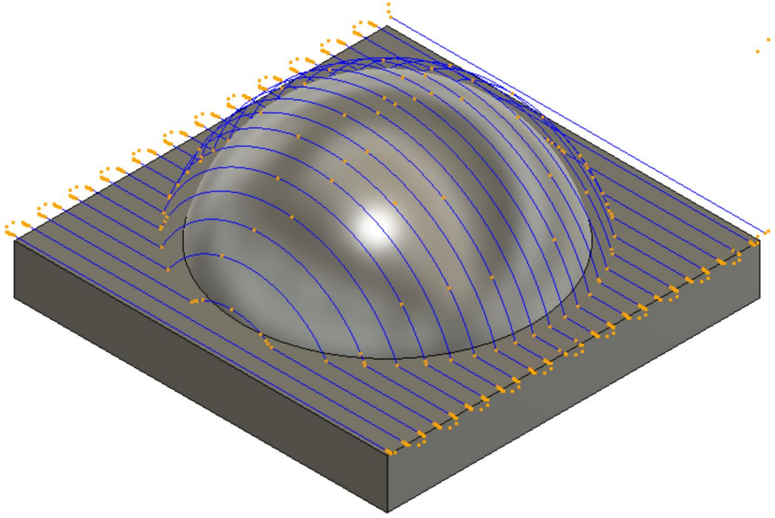
LARGE TOLERANCE

(6.3 KB)



SMALL TOLERANCE

(37.4 KB)



SMALL TOLERANCE

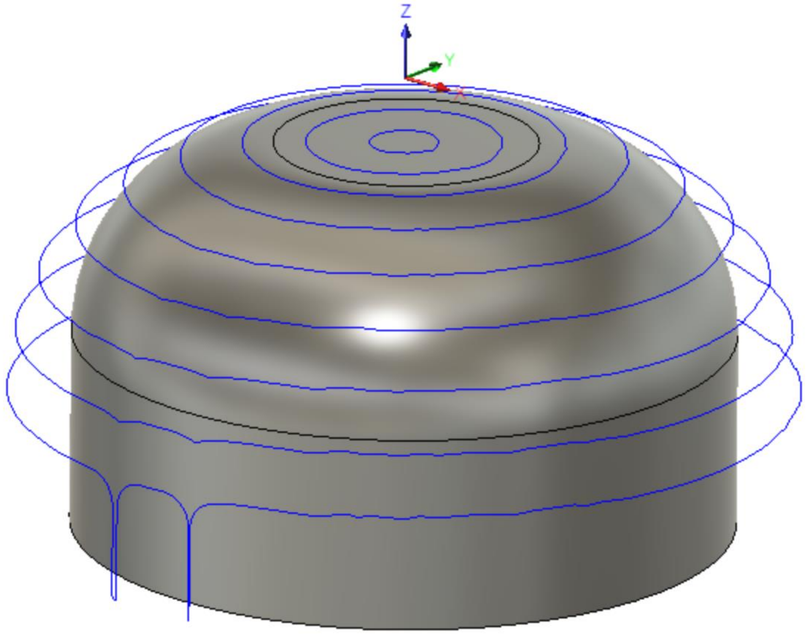
WITH SMOOTHING (1:1 RATIO)

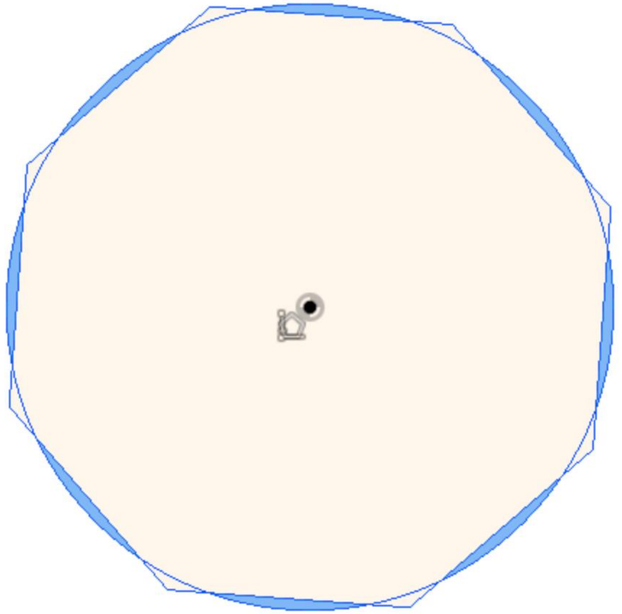
(13.6 KB)

Total Tolerance = (Toolpath Tol. + Smoothing Tol.)

Toolpath Tolerance

SCALLOP EXAMPLE





Troubleshooting

Troubleshooting

IDENTIFY

WHAT IS THE PROBLEM?

Tools:

- *Warnings & Errors*
- *SEARCH! AKN, Learning Materials, Google*

ISOLATE

WHAT IS THE CAUSE?

- Tools
  - *Compare & Edit*

EXPERIMENT

WHAT ALTERNATIVES EXIST?

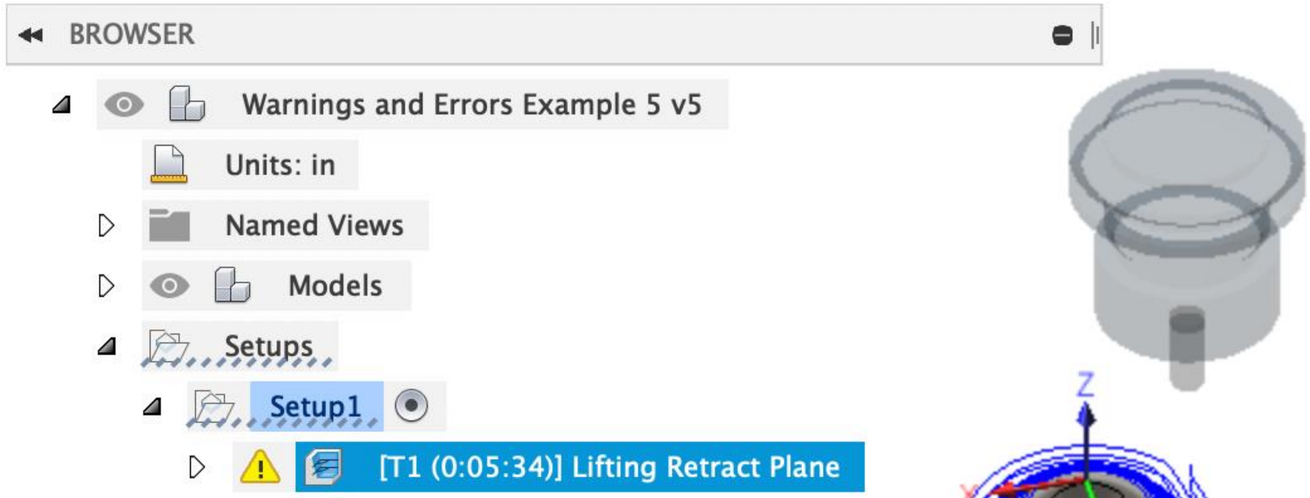
- Tools:
  - *Derived Operations*
  - *Different Parameters & Selections*
  - *Integrated CAD*

RESOLVE

CHOOSE AN ALTERNATIVE

- *Which alternative approaches give an acceptable outcome?*

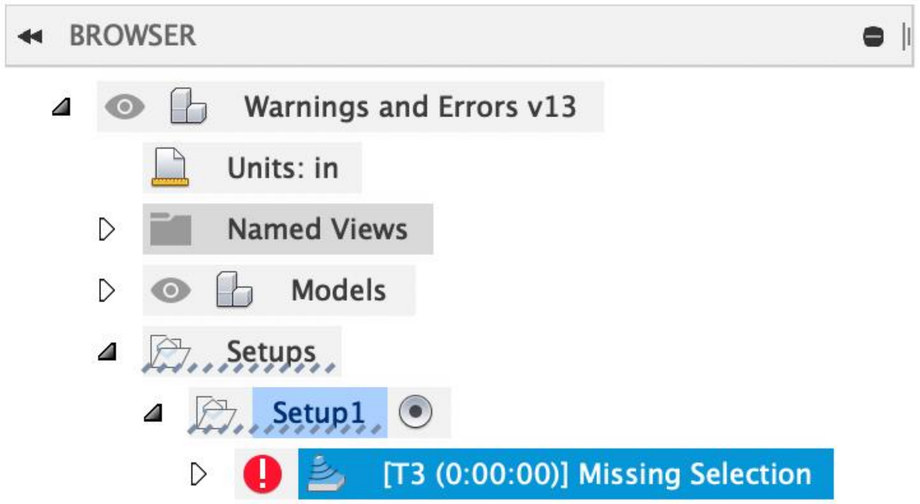
IDENTIFY: WARNINGS

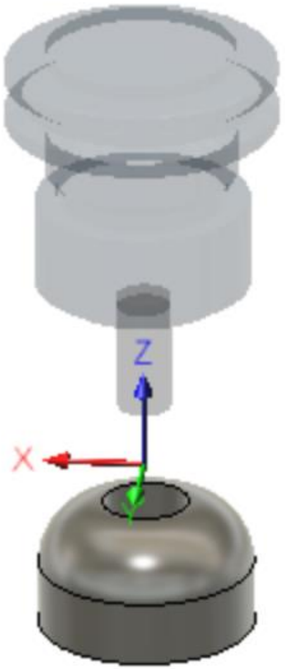


Warnings

Note any ***automatic changes*** made to the toolpath during generation

IDENTIFY: ERRORS

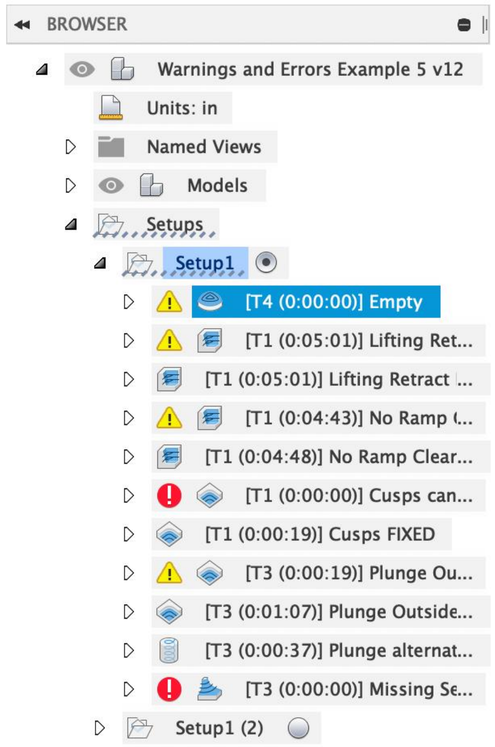


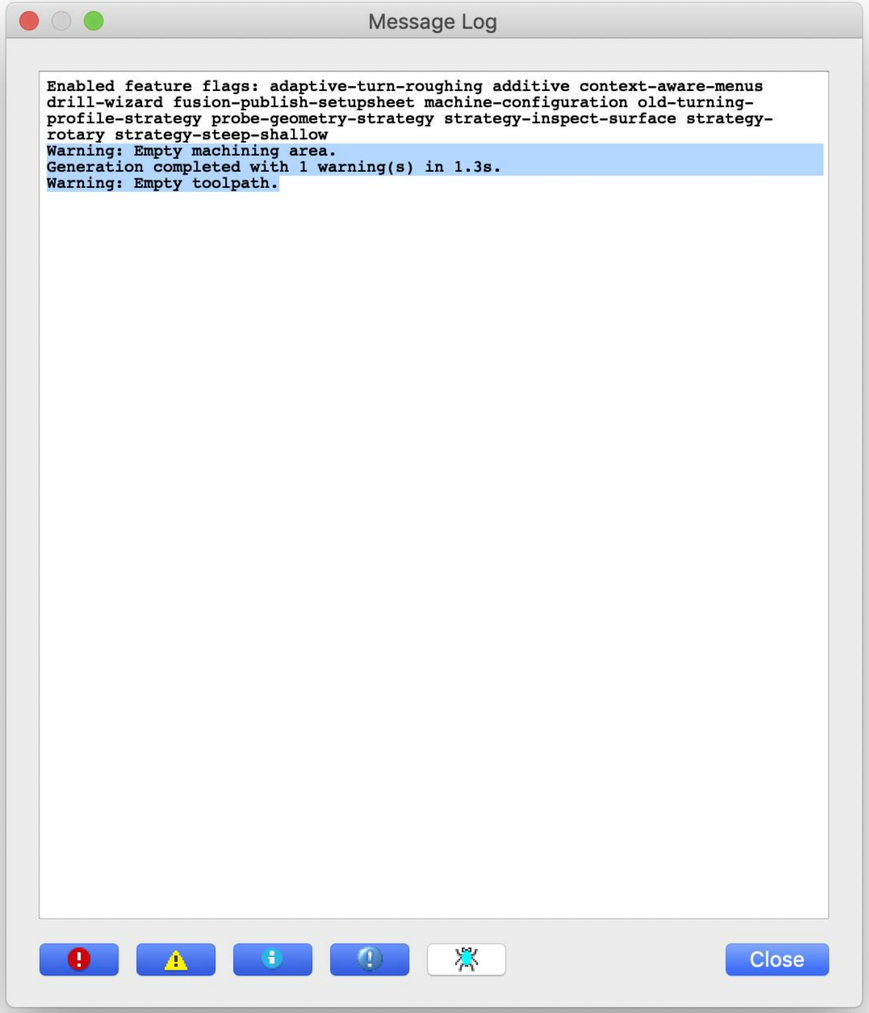


Errors

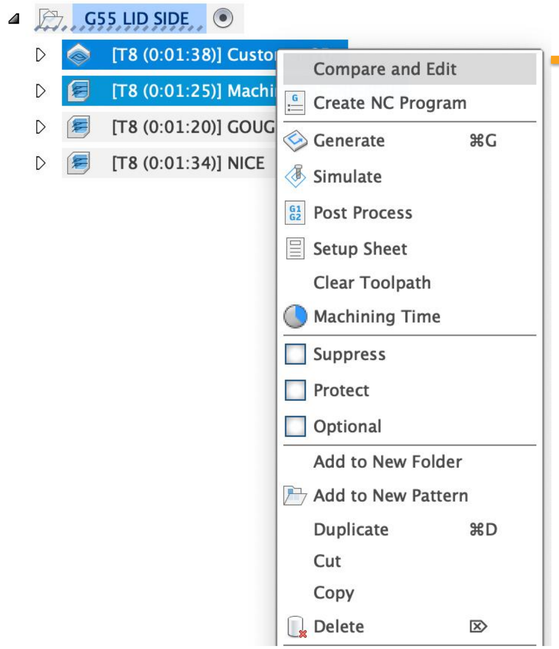
Explain why the toolpath ***cannot be generated***

Warnings & Errors Example





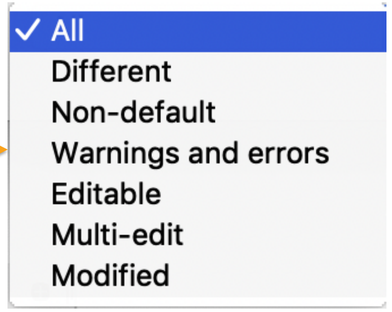
ISOLATE: Compare & Edit



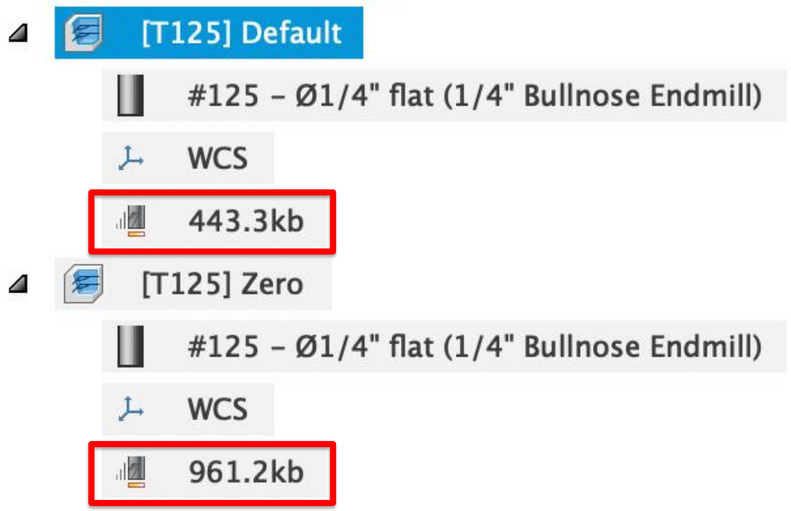
Compare and Edit - Listed parameters: 188

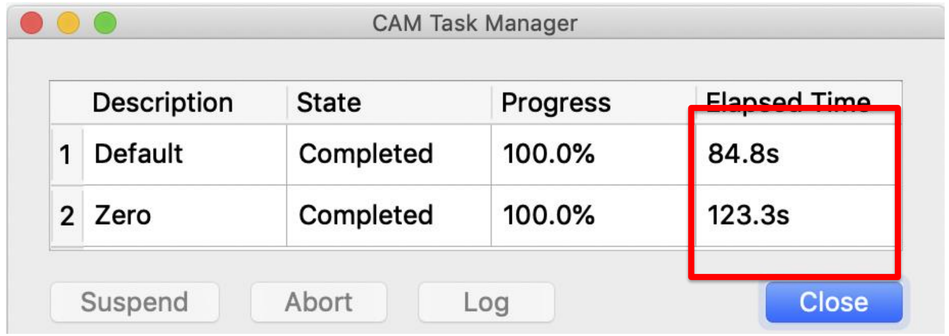
Group	Parameter	Edit All	omer 2D [2D Adaptive Clea	Machining boundary [Adaptive Clearing]
Passes	Link Feedrate	120 in/min	120 in/min	120 in/min
Passes	Measure Feedrate	12 in/min	12 in/min	12 in/min
Passes	Include Setup Model	<not editable>		Yes
Passes	Model Surfaces	<not editable>		Selection
Passes	Model [G]	<not editable>		No
Passes	Orientation	Select Z axis/plane & X a...	Select Z axis/plane & X a...	Select Z axis/plane & X axis
Passes	Origin	Setup WCS origin	Setup WCS origin	Setup WCS origin
Passes	Tolerance	<different>	0.004 in	0.00393701 in
Passes	Tool Orientation [G]	No	No	No
Passes	Unwrap Geometry	<not editable>	No	
Passes	Wrap Cylinder	<not editable>	Selection	
Passes	Wrap Nominal Radius [R]	<not editable>	0 in	
Passes	Wrap Toolpath [G]	<not editable>	No	
Passes	Surface Triangulation Tol...	<not editable>	0.002 in	0.0019685 in
Passes	Chaining Tolerance	<not editable>	0.0004 in	0.000393701 in
Passes	Coordinate System	Selection	Selection	Selection
Passes	Flip Tool Orientation Rot...	No	No	No

All | OK | Cancel



ISOLATE: Compare & Edit

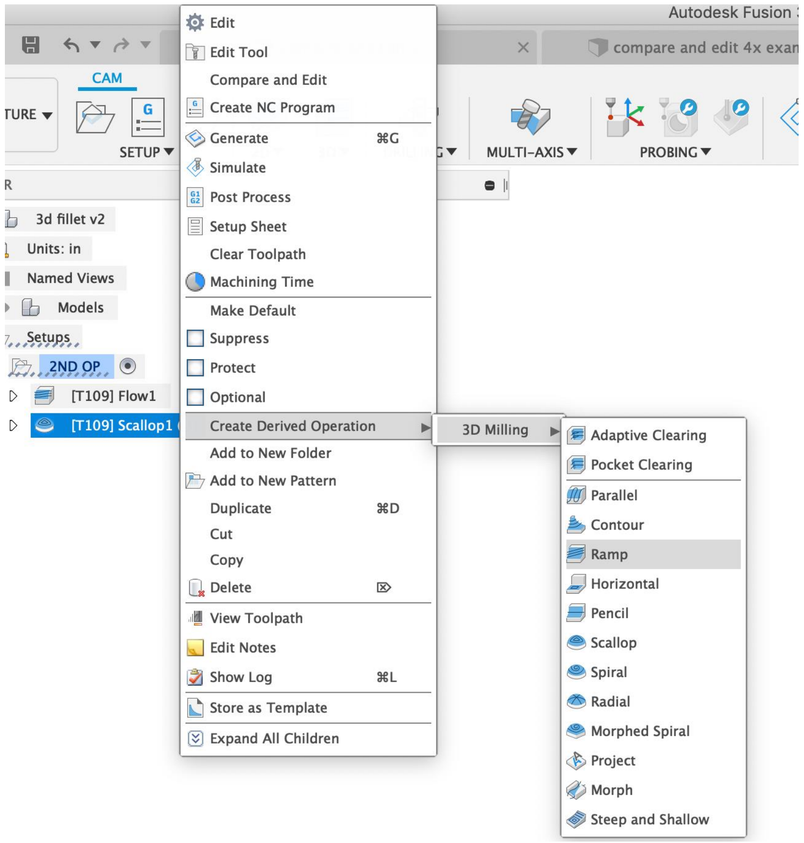




- Why is toolpath twice as large?
- Why is generation time notably slower?

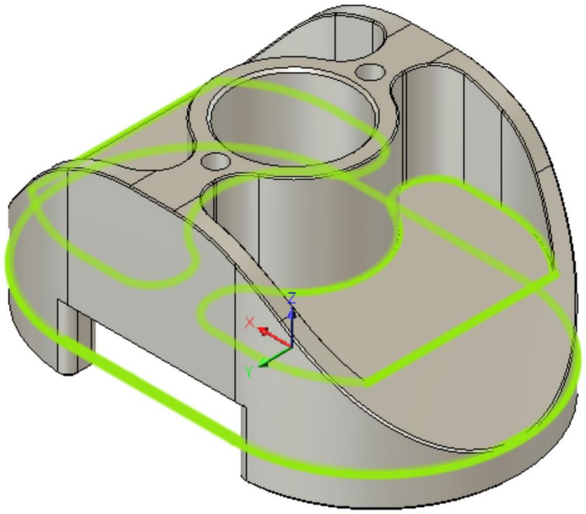
EXPERIMENT – Derived Operations

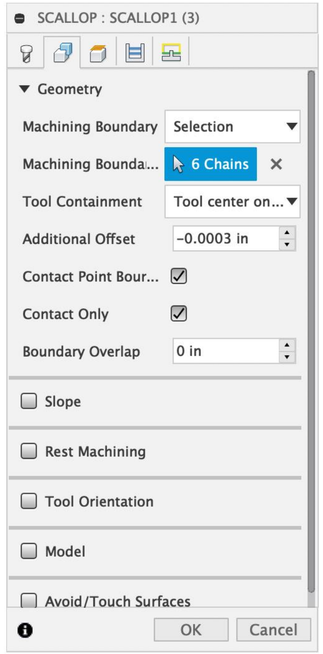
- What alternative strategies may work?
- How can alternatives be generated quickly?

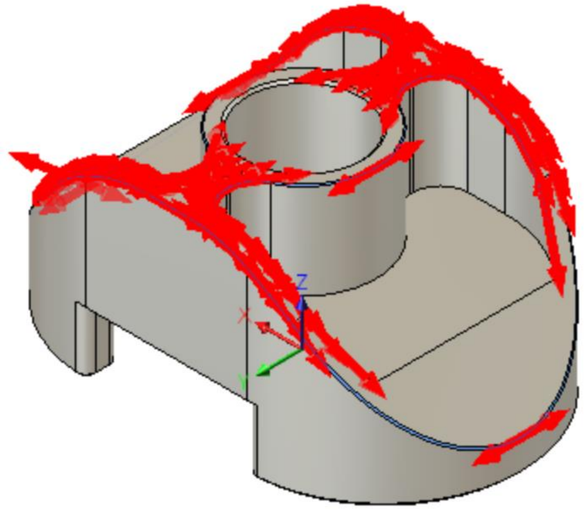


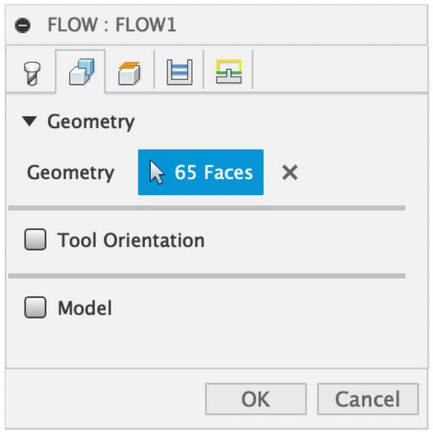
EXPERIMENT – Different Strategies

- More than one strategy may give acceptable motion
  - What will be easiest to set up?

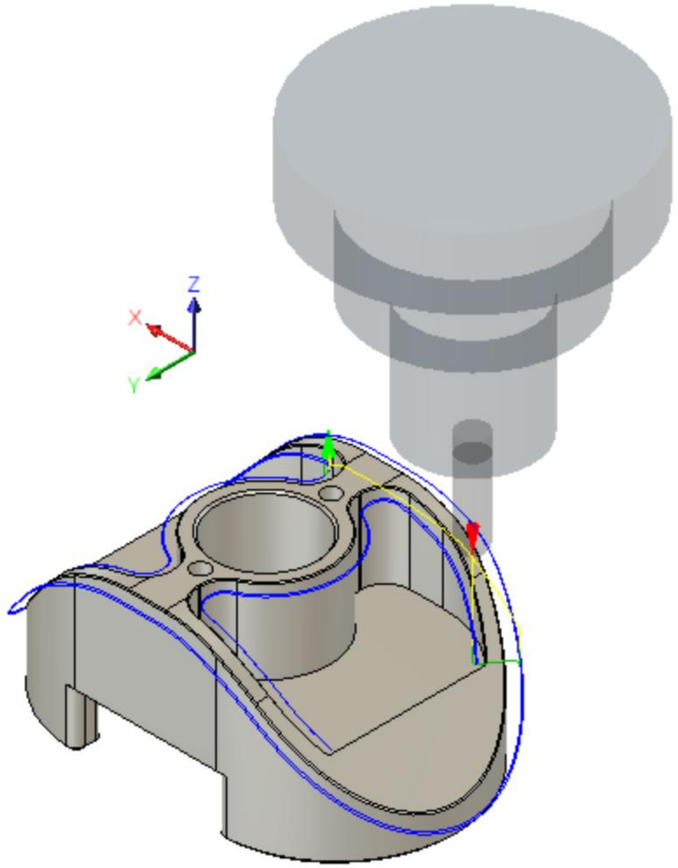




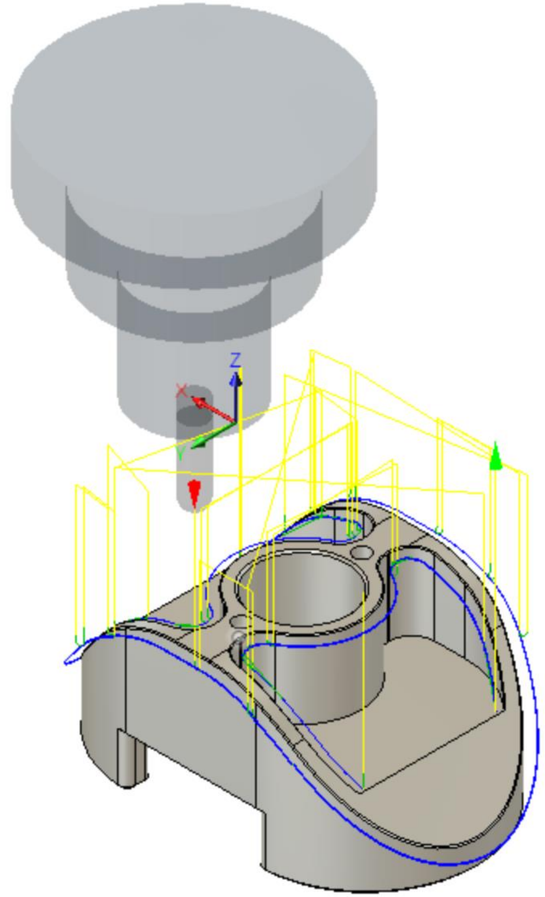




EXPERIMENT – Different Strategies

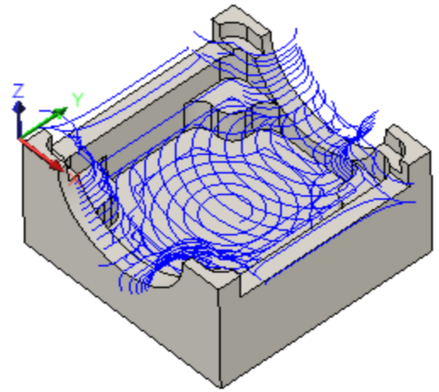


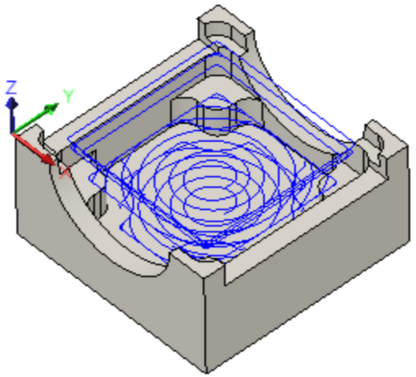
Scallop

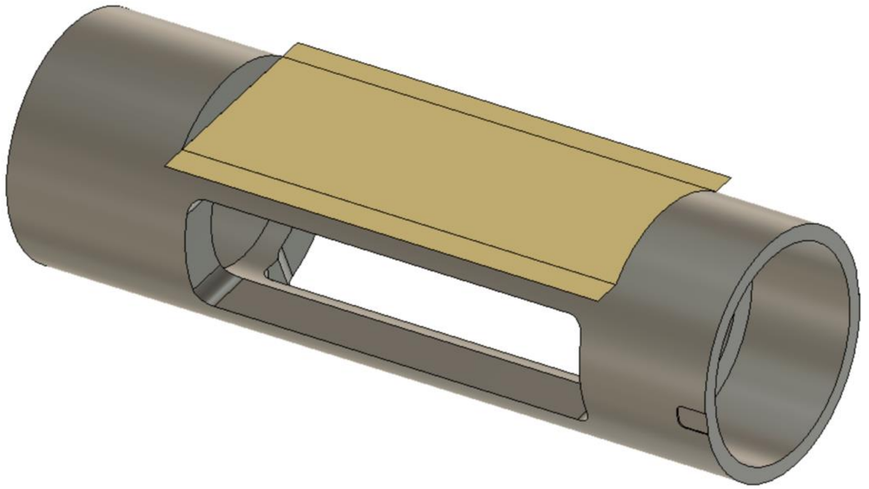


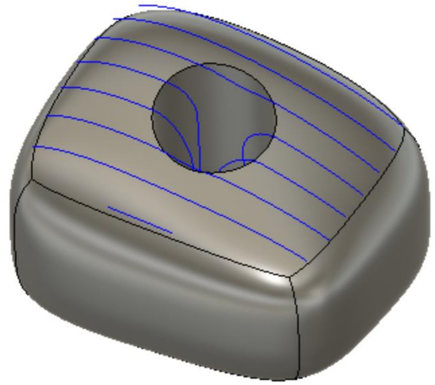
Flow

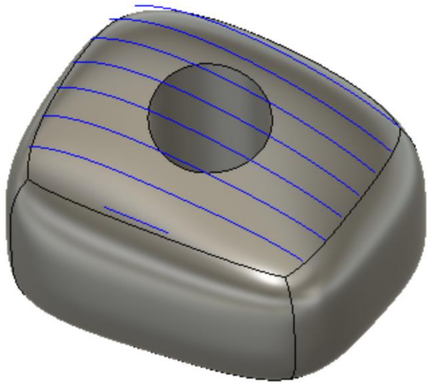
EXPERIMENT – Integrated CAD



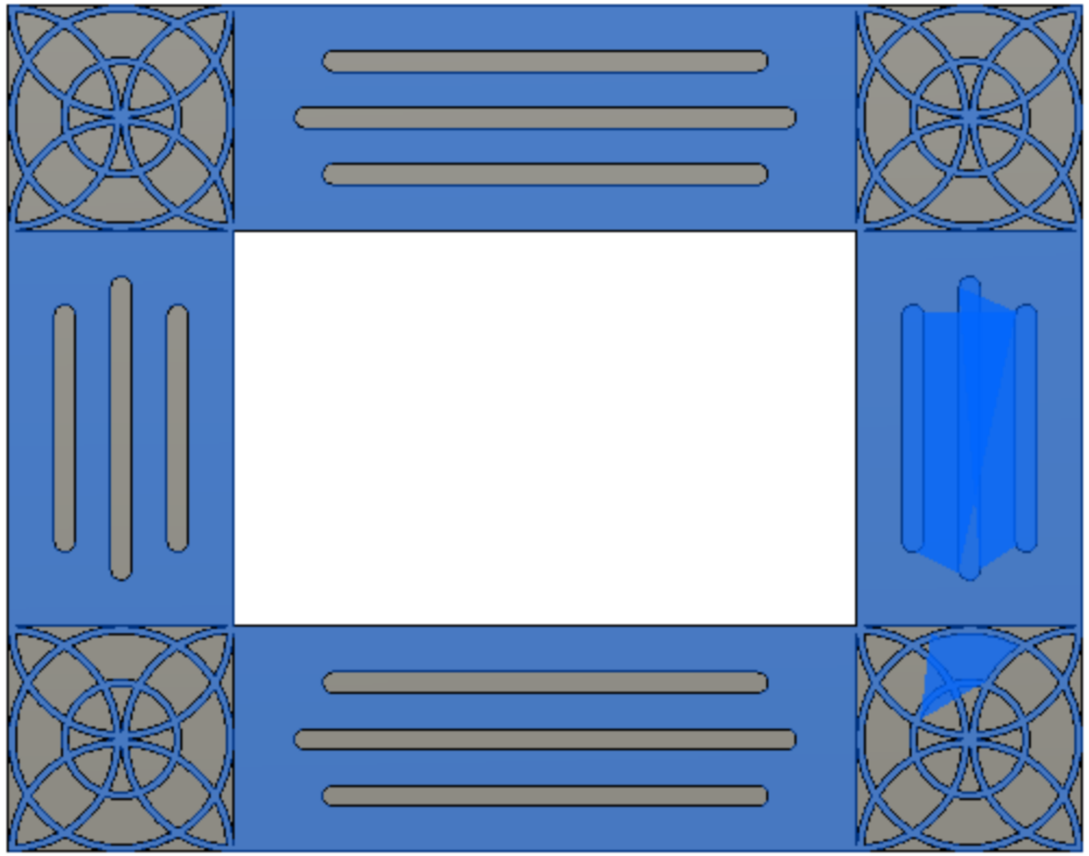






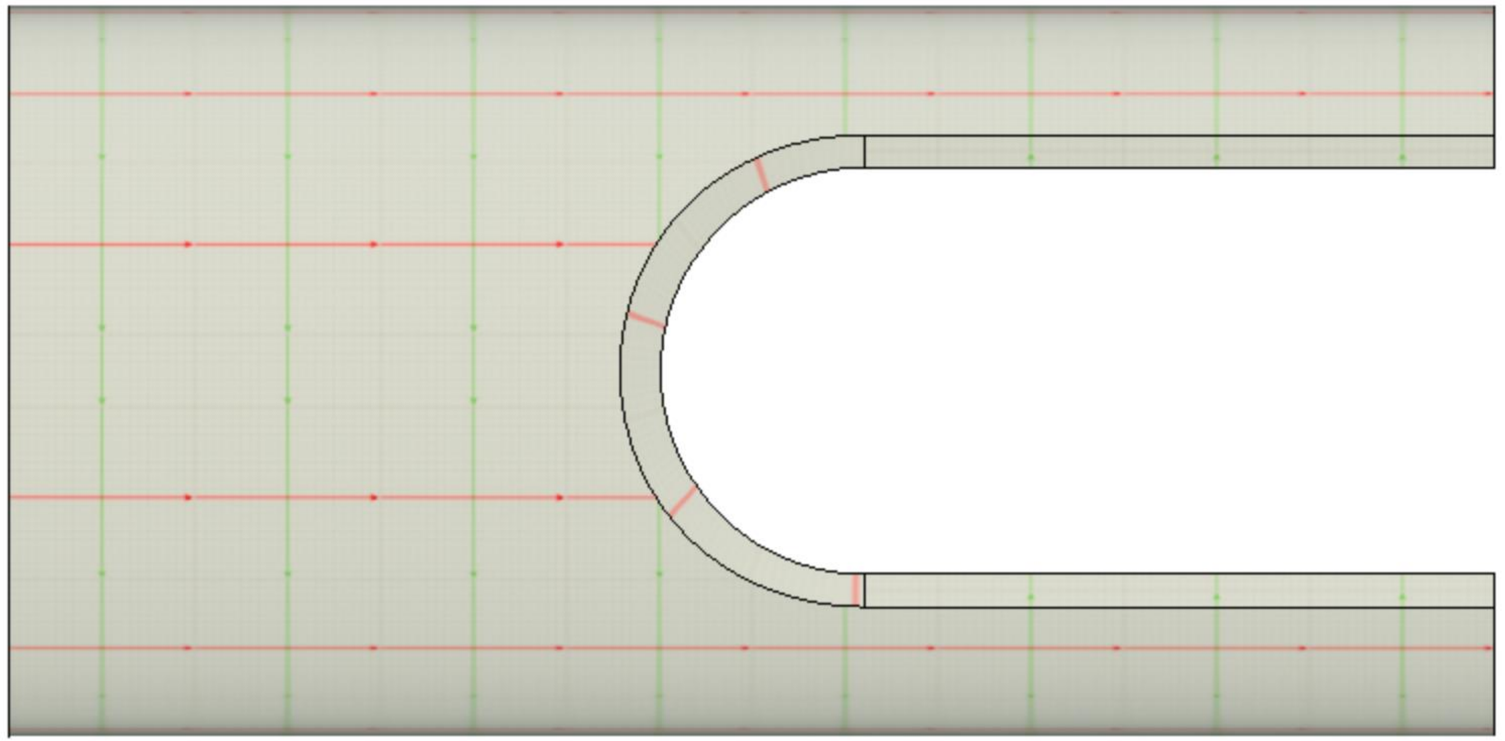


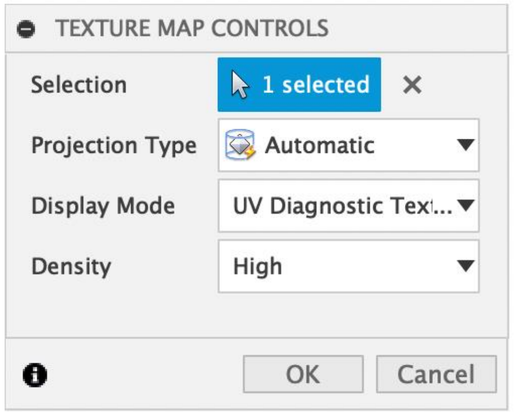
EXPERIMENT: Imported Data



- How can we get around graphics faceting when creating toolpaths?

EXPERIMENT: Surface Quality





How can we remove toolpath chatter in UV toolpaths?

Posts & NC Output

- Posts are .CPS – JavaScript text files
- Program not posting?
  - Check .failed NC output for error messaging!
  - Search CPS file for message to see logic
- Quick Example: Program #

```
...
Warning: Work offset has not been specified. Using G54 as WCS.
Error: Work plane is not supported: A-169.188 B108.
^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^
Error: Failed to invoke function 'onSection'.
Error: Failed to invoke 'onSection' in the post configuration.
Error: Failed to execute configuration.
Stop time: Thu Jun  7 13:57:04 2018
Post processing failed.
```

```
Generated by: Fusion 360 CAM 2.0.4233
...
Error: Turning toolpath is not supported by the post configuration.
^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^
Error: Failed to invoke 'onOpen' in the post configuration.
Error:
Error: Failed to execute configuration.
Stop time: Tuesday, June 12, 2018 9:12:36 PM
Post processing failed.
```

```

################################################################################
Error: Program number is out of range.
Error at line: 414
Failed while processing onOpen().
################################################################################

Error: Failed to invoke 'onOpen' in the post configuration.
Error: Failed to invoke function 'onOpen'.
Error: Failed to execute configuration.
Stop time: Tue Sep 10 22:58:43 2019
Post processing failed.
```

Review

- **Basics/Stepping Stones**
  - Strategies in Fusion 360
    - 2D vs. 3D
  - Toolpath Containment
    - XY Plane, Z
  - Contour Selection
  - Smoothing/Tolerance
    - Effect on toolpaths
    - Effect on NC output

- **Troubleshooting**
  - Identify
    - Warnings & Errors
  - Isolate
    - Compare & Edit
  - Experiment
    - Parameter choices
    - Derived Operations
    - Integrated CAD
  - Resolve!

Questions?

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Make anything™