

Understanding CAM in Fusion 360

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Fusion 360 MFG and Embedded CAM

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About Me

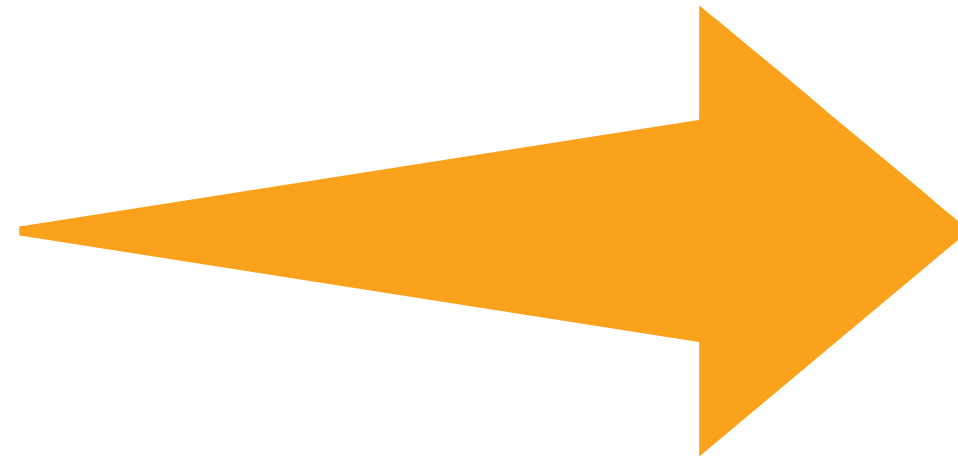
Paul Clauss

- 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



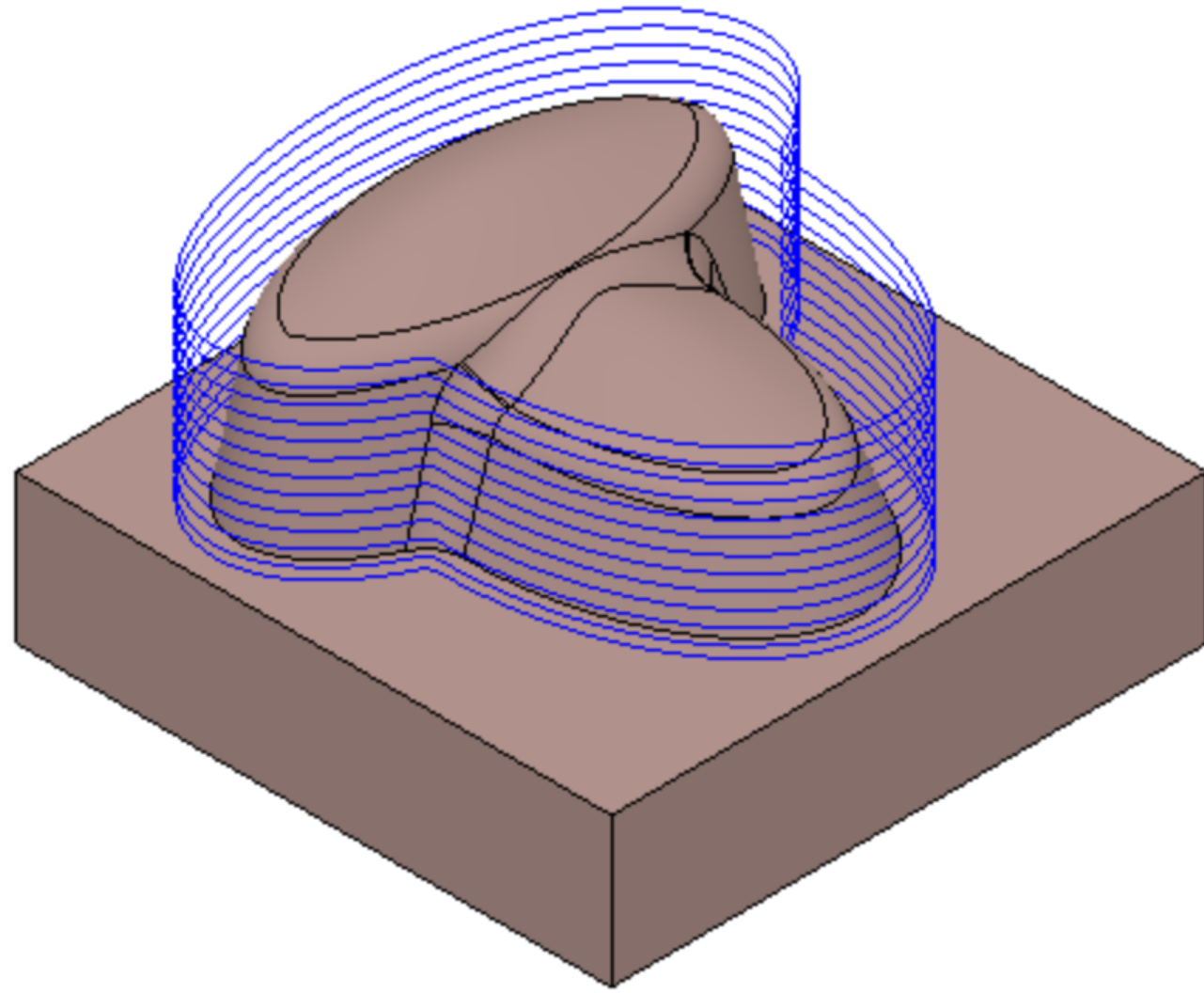
Troubleshooting

- Identify
- Isolate
- Experiment
- Resolve

Concepts

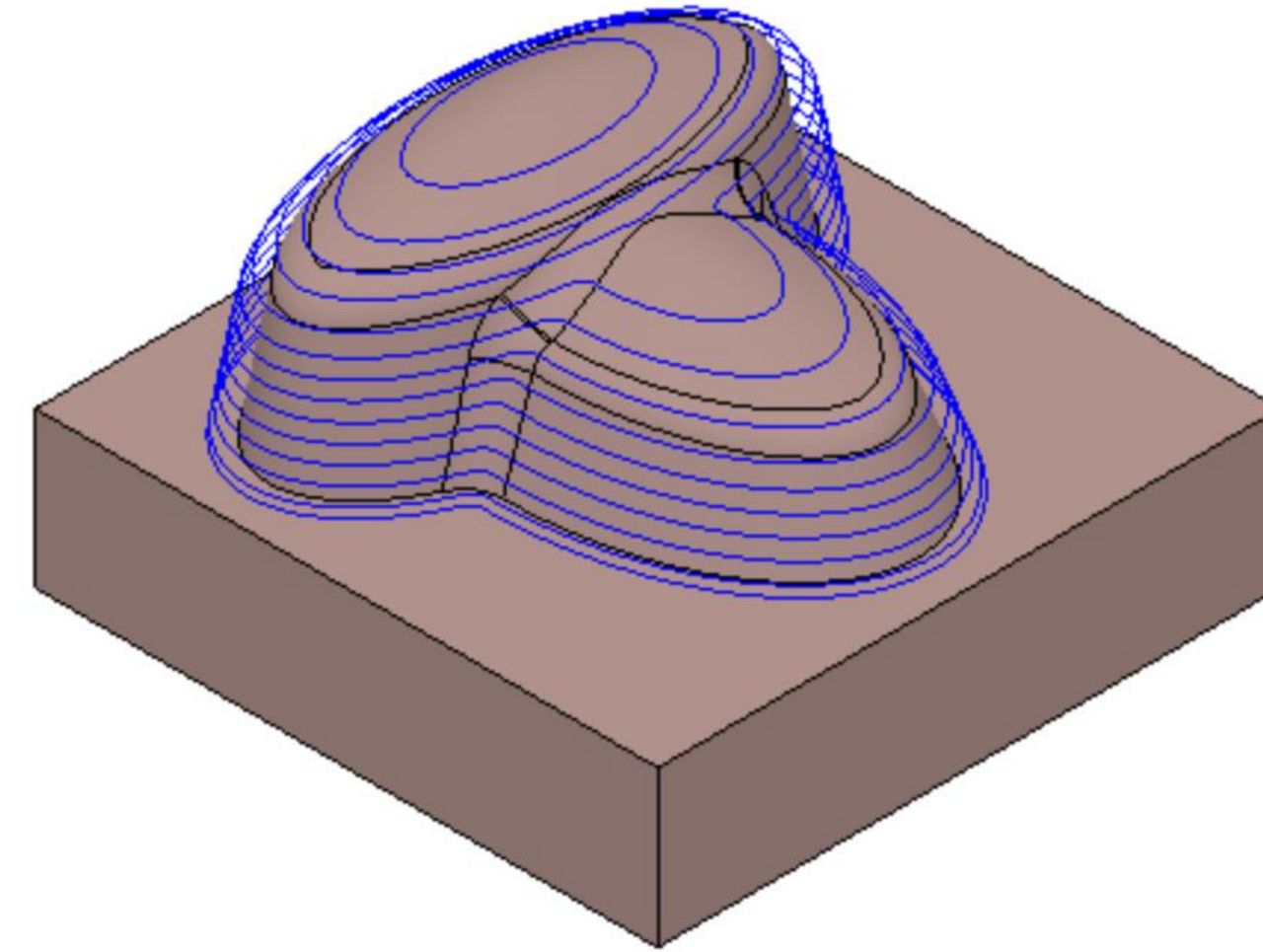


CAM Strategies in Fusion 360 - Milling



2D Milling

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

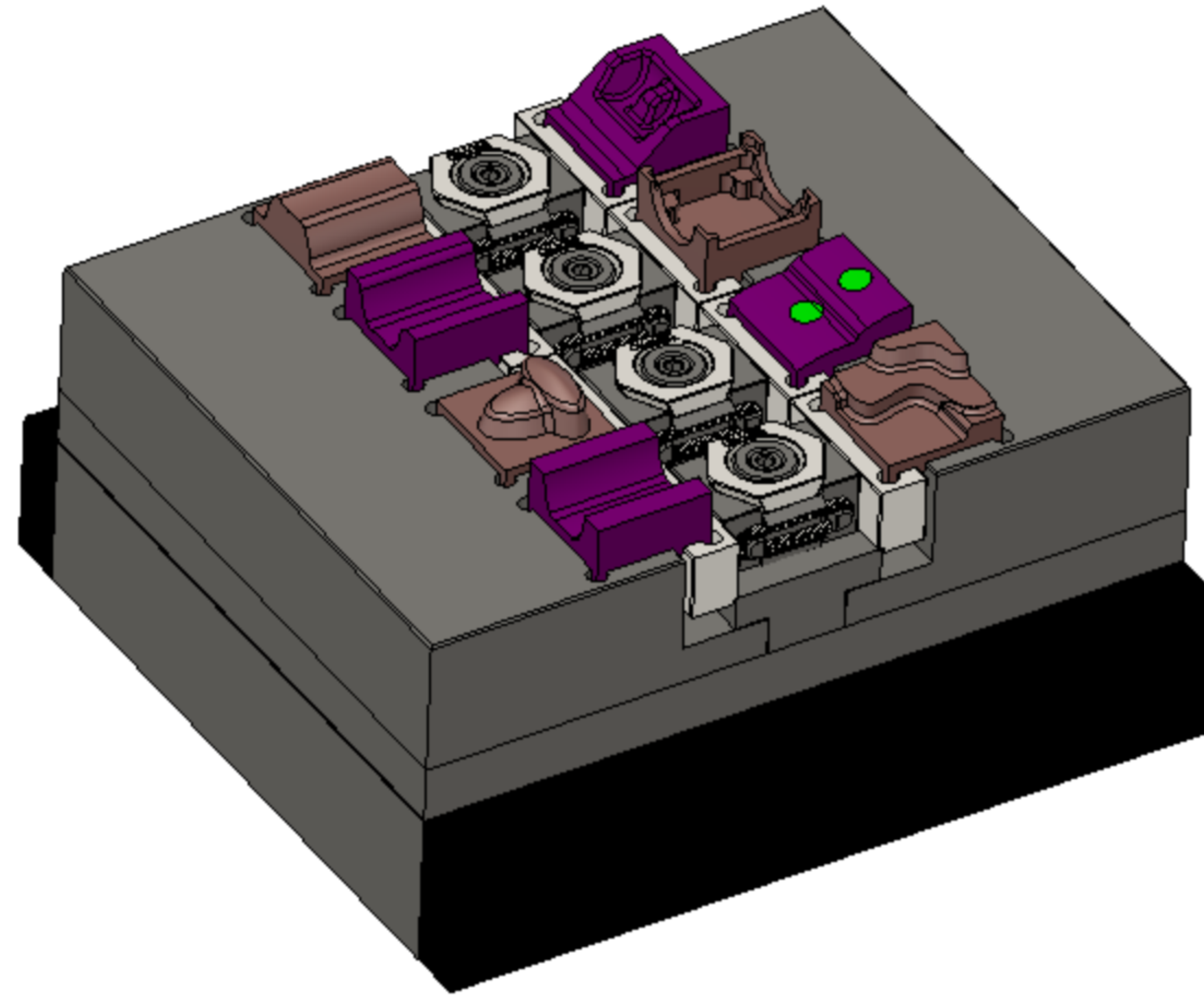


3D Milling

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

Strategy Choice

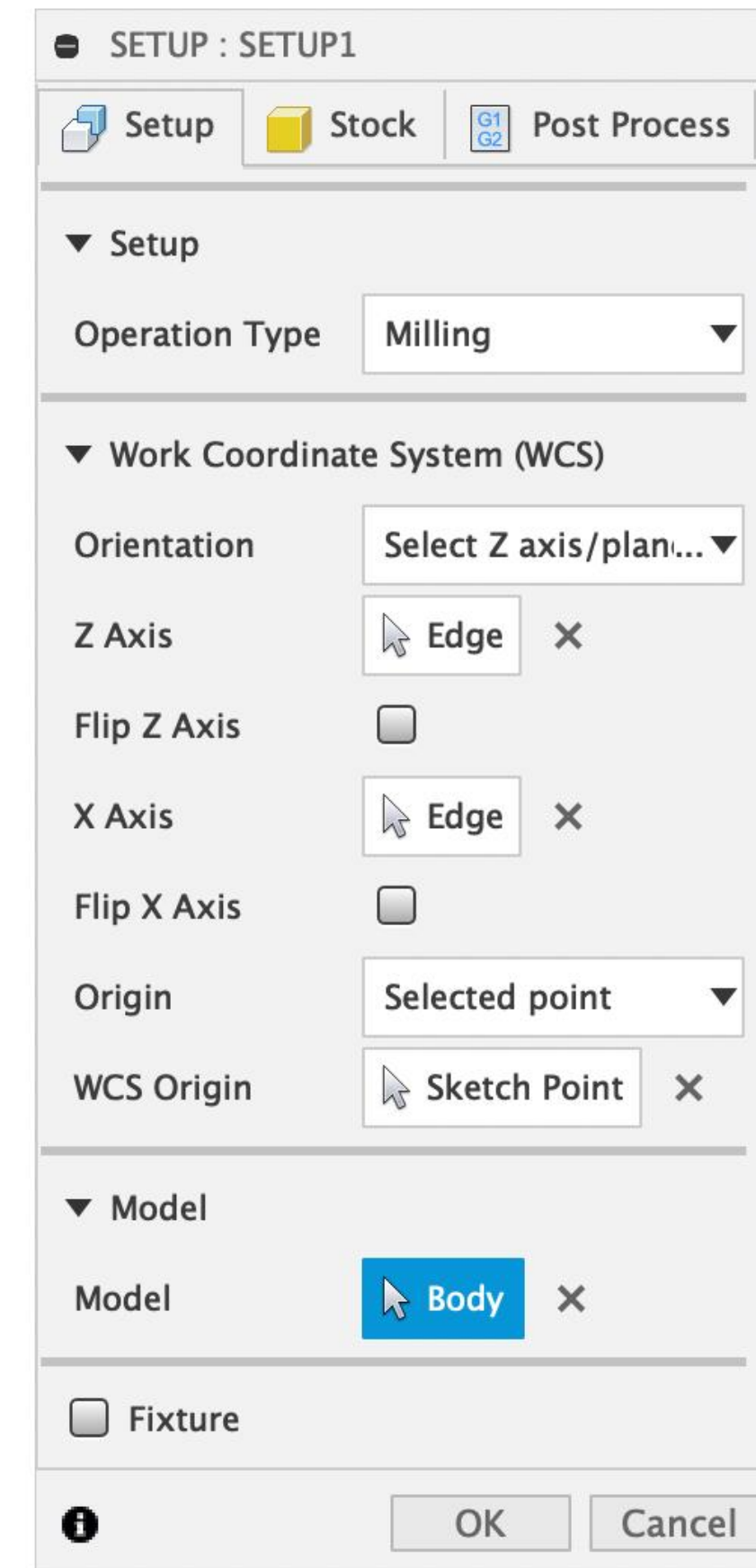
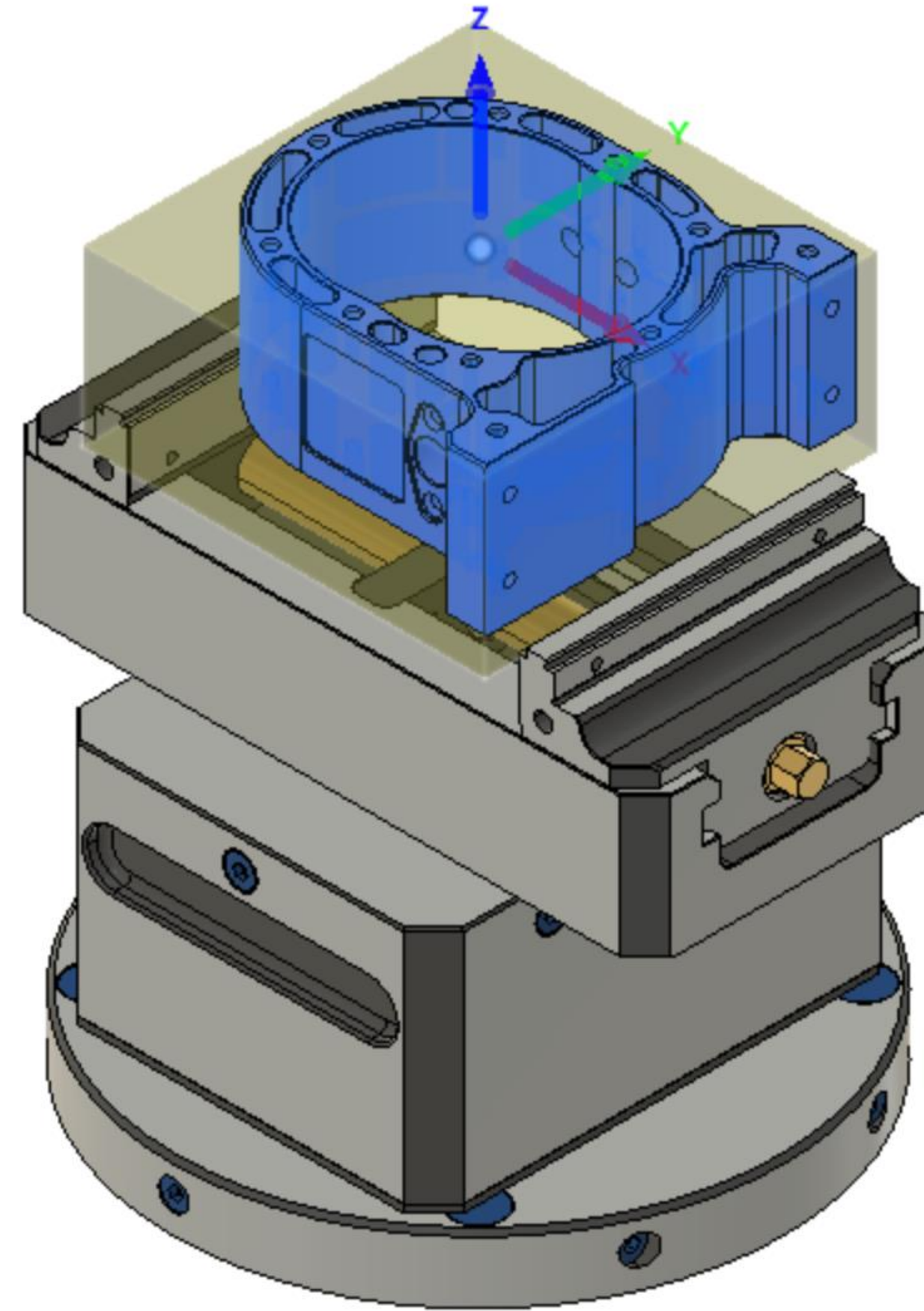
GEOMETRY



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

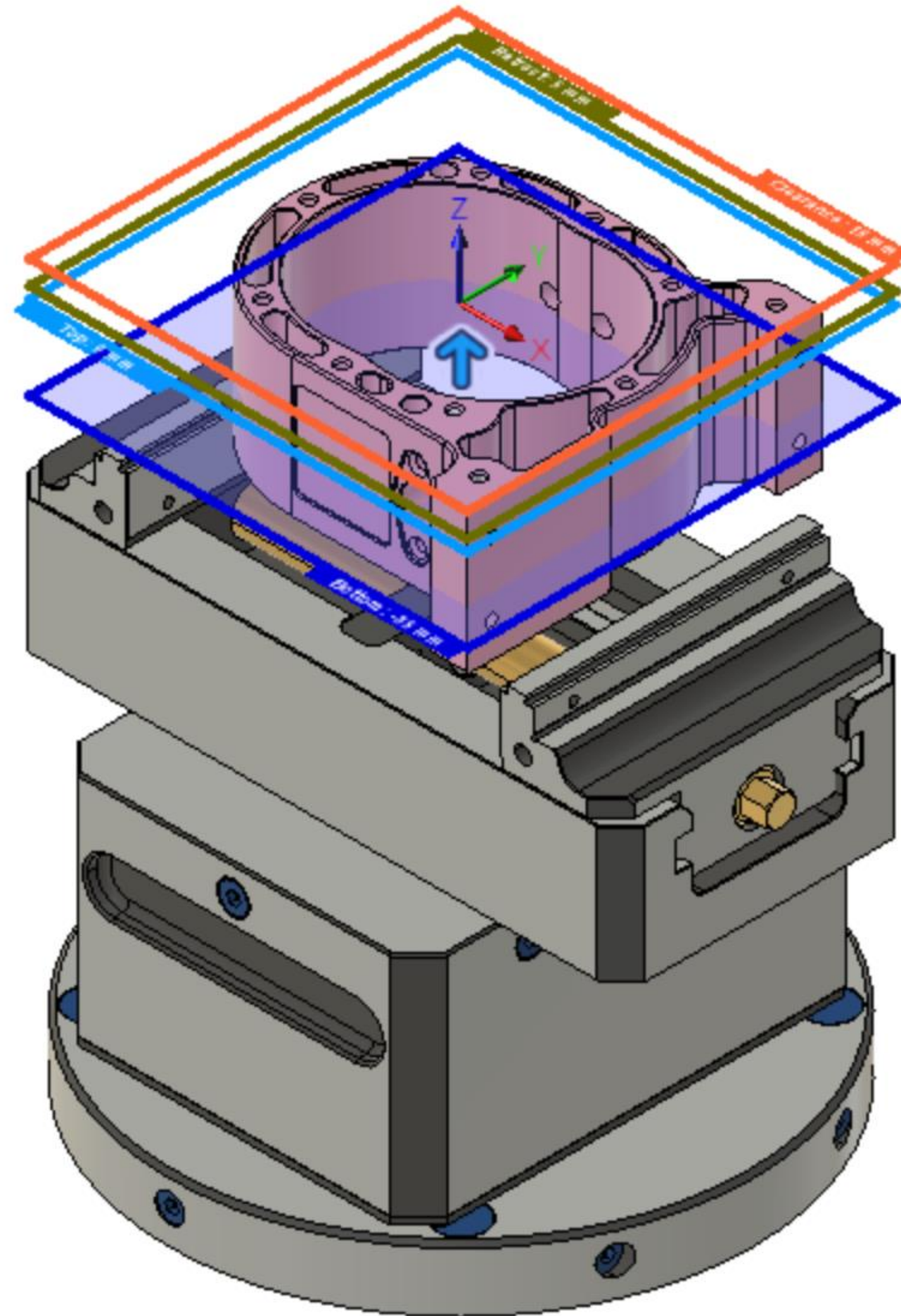
Containment

Model Selection in CAM Setup



Containment

Along Z-axis - HEIGHTS



ADAPTIVE : ADAPTIVES

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

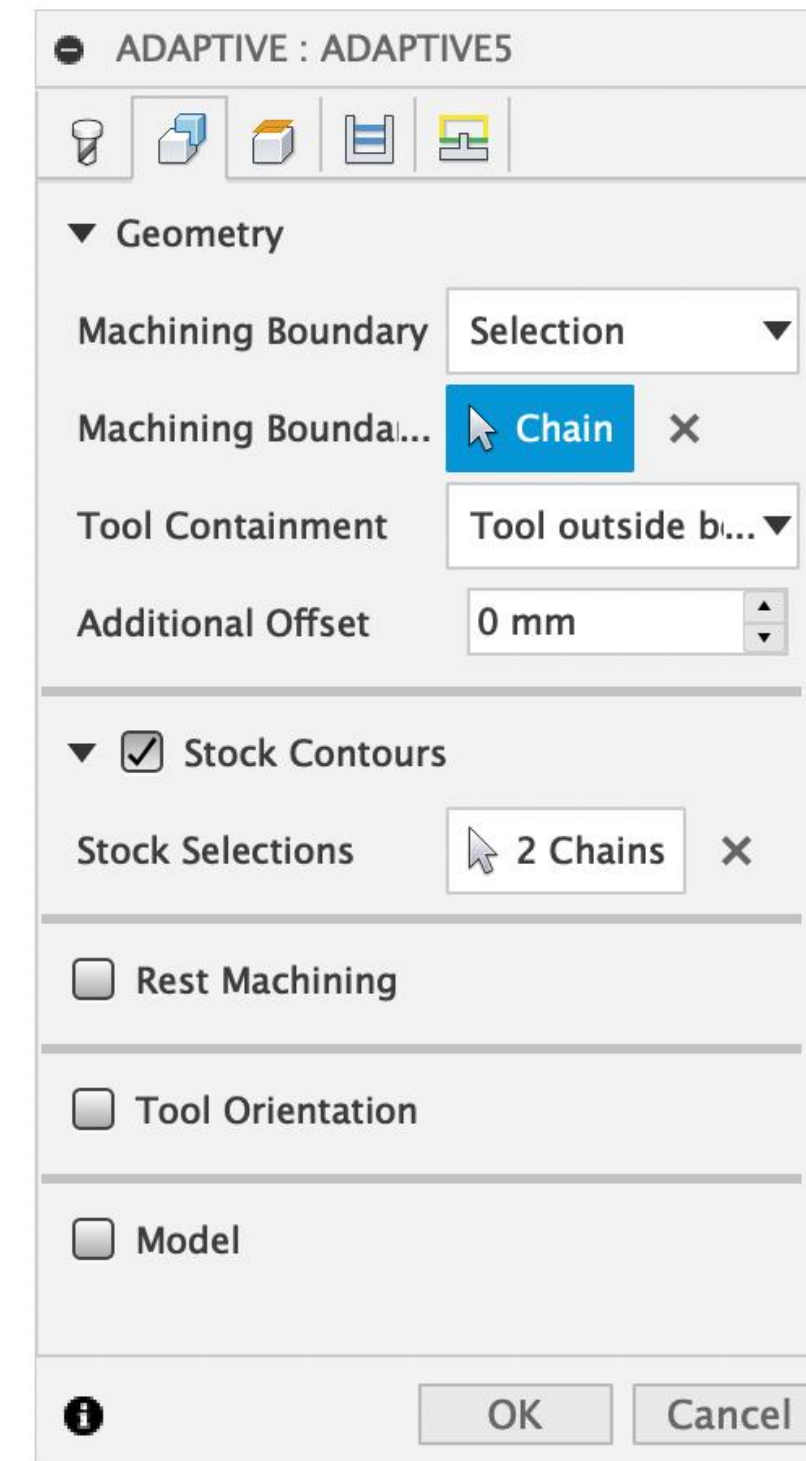
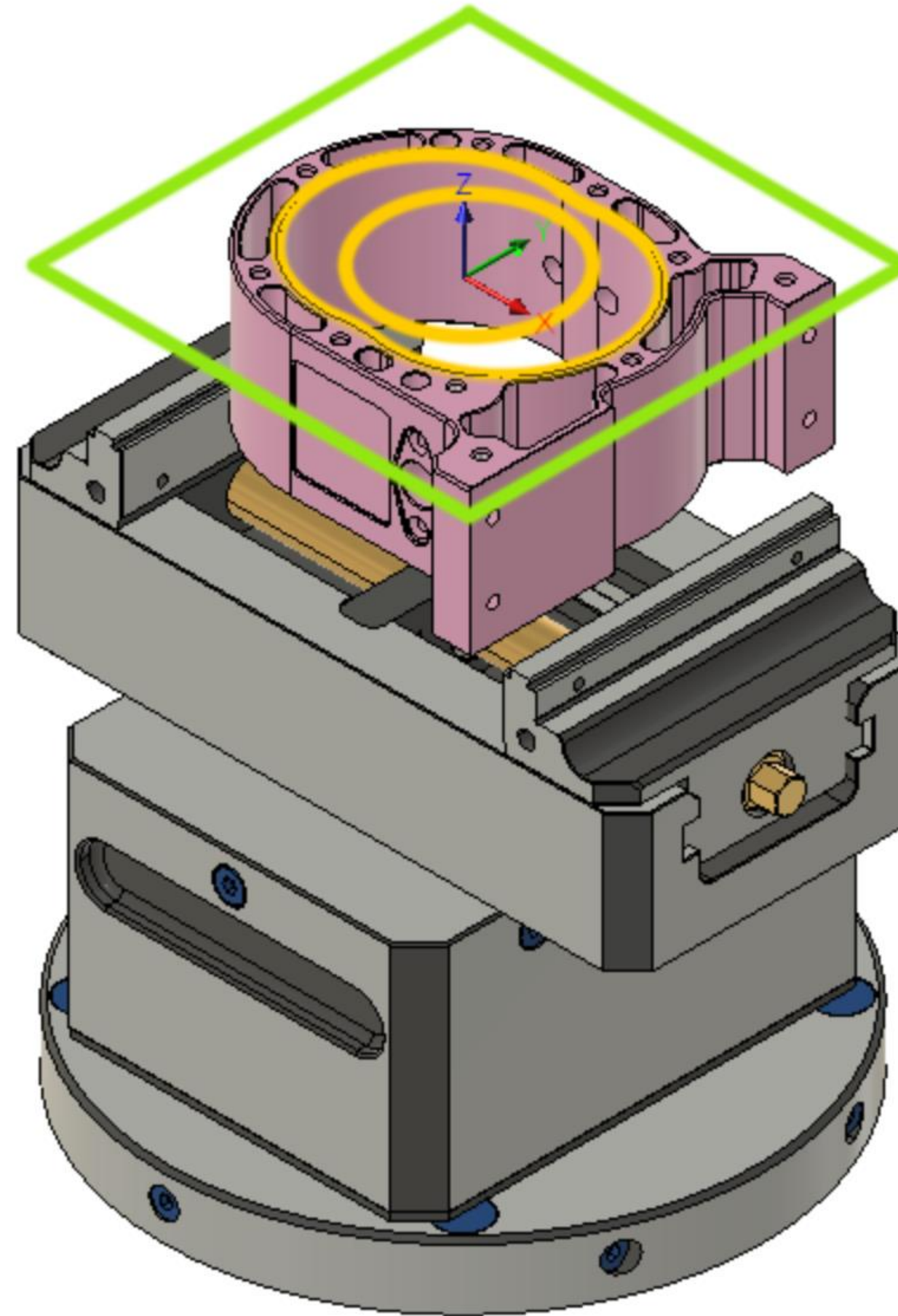
From: Model bottom

Offset: 25 mm

OK Cancel

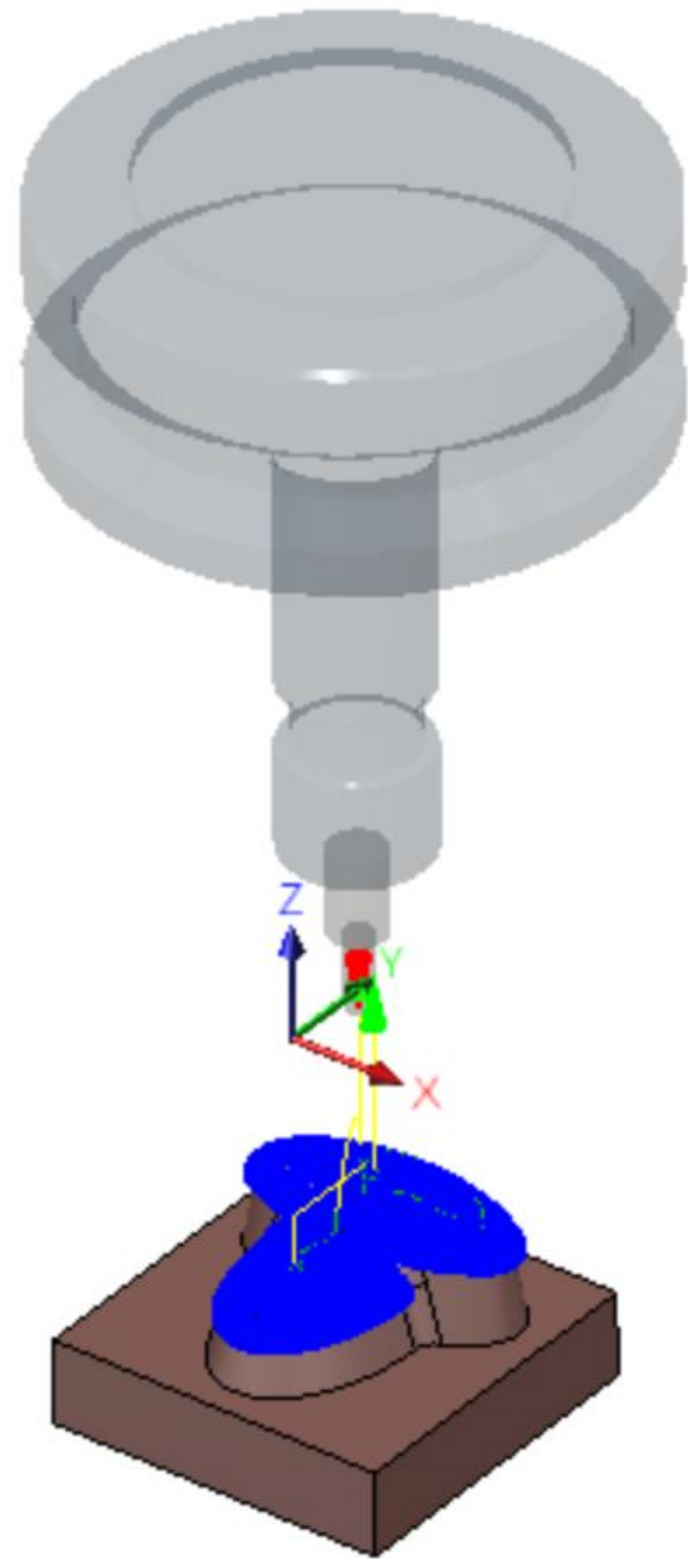
Containment

On XY Plane – Machining boundaries, Stock Contours

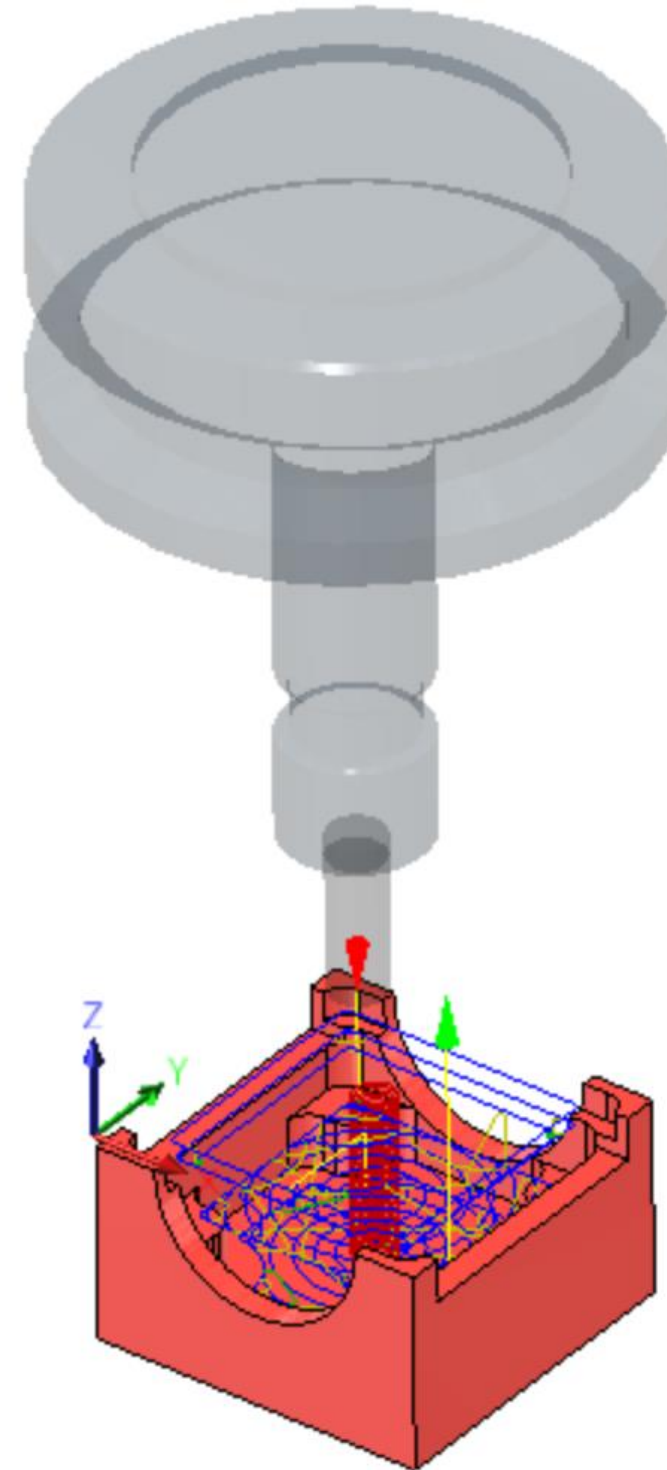


Containment

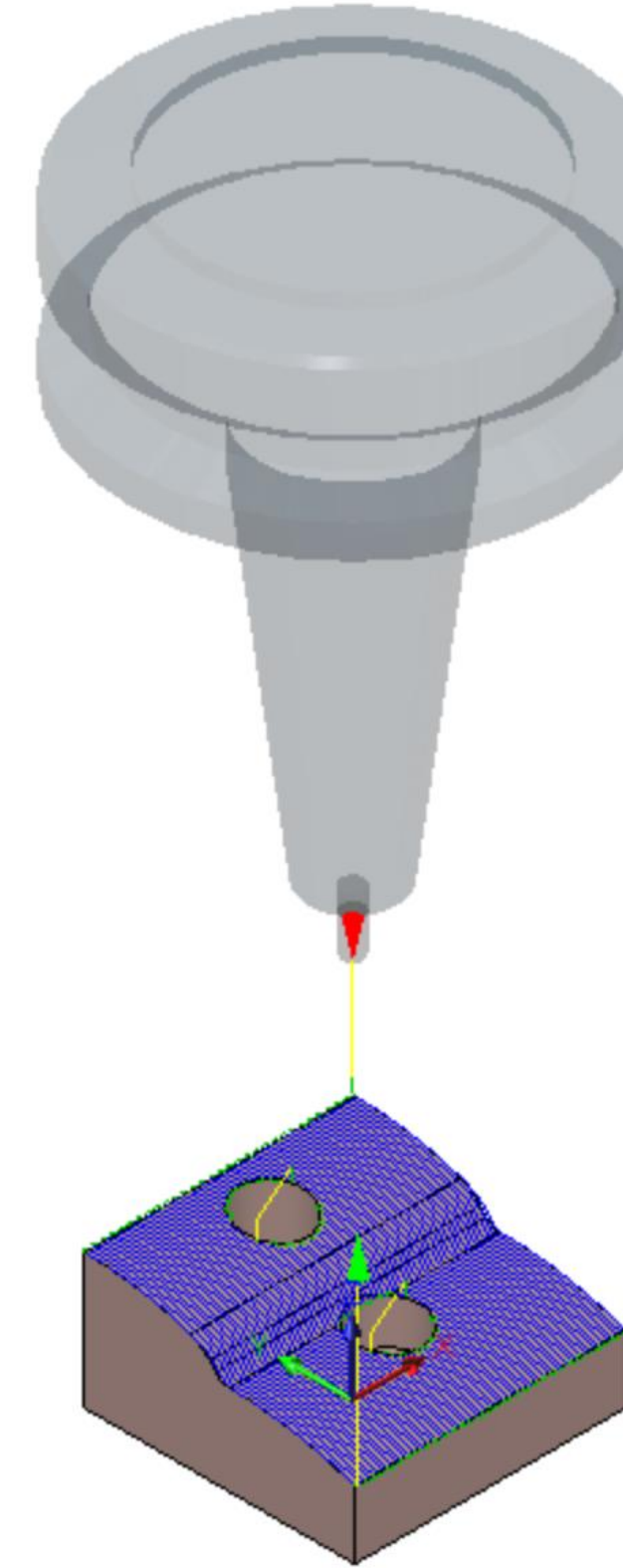
3D Bonuses!



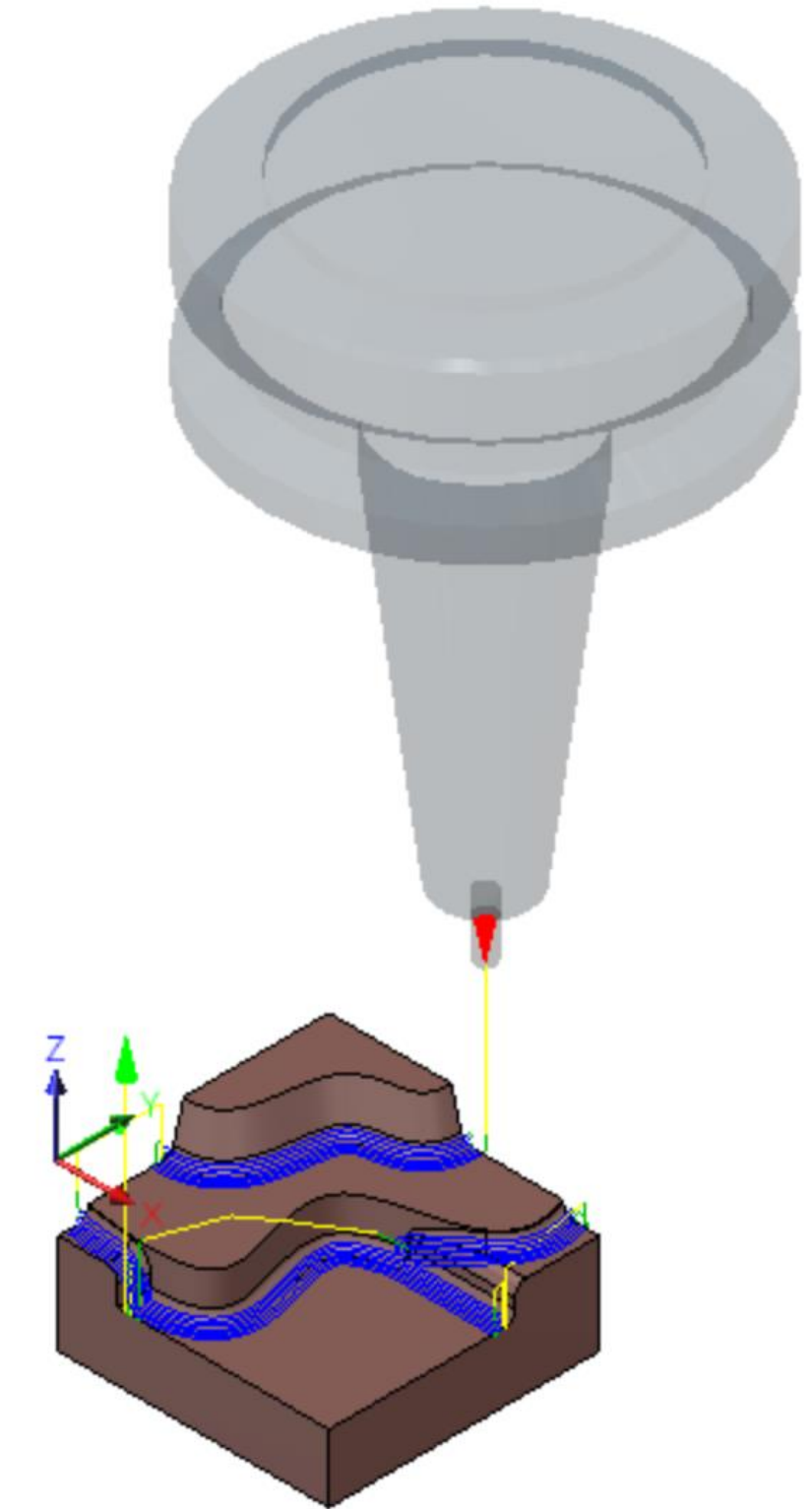
Slope



Model
Override

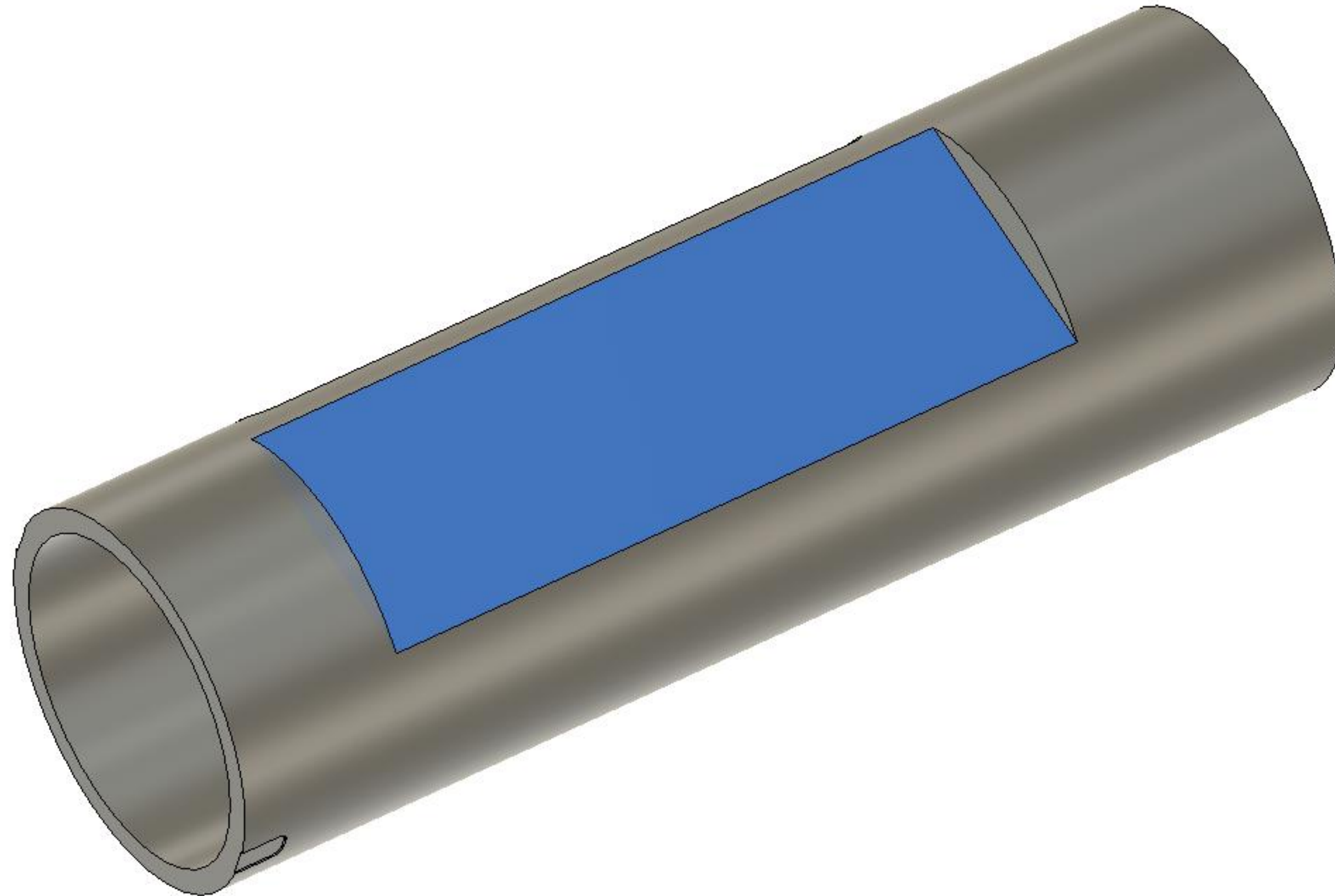


Avoid/Touch
Surfaces



Automatic

Containment Example

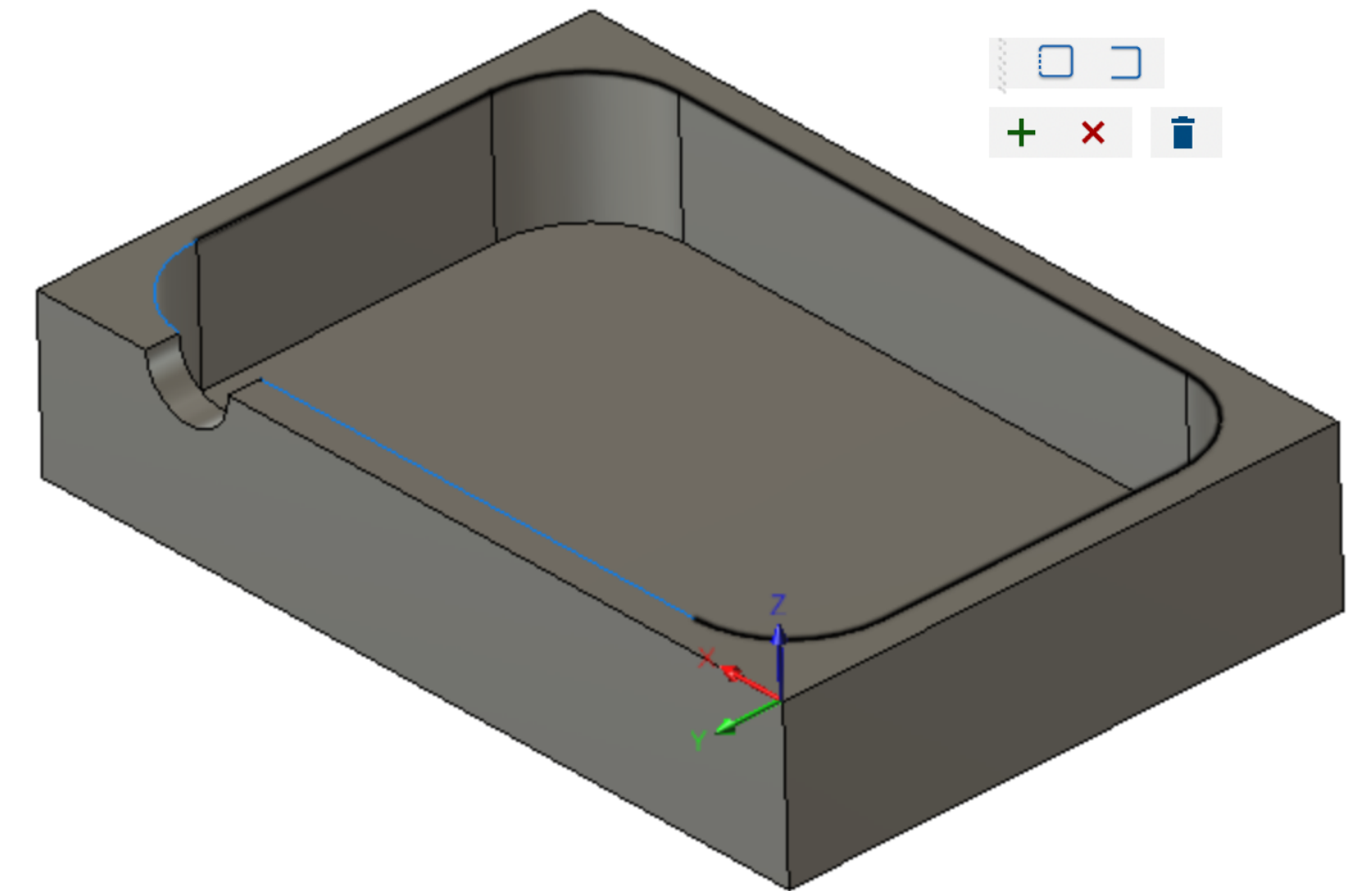
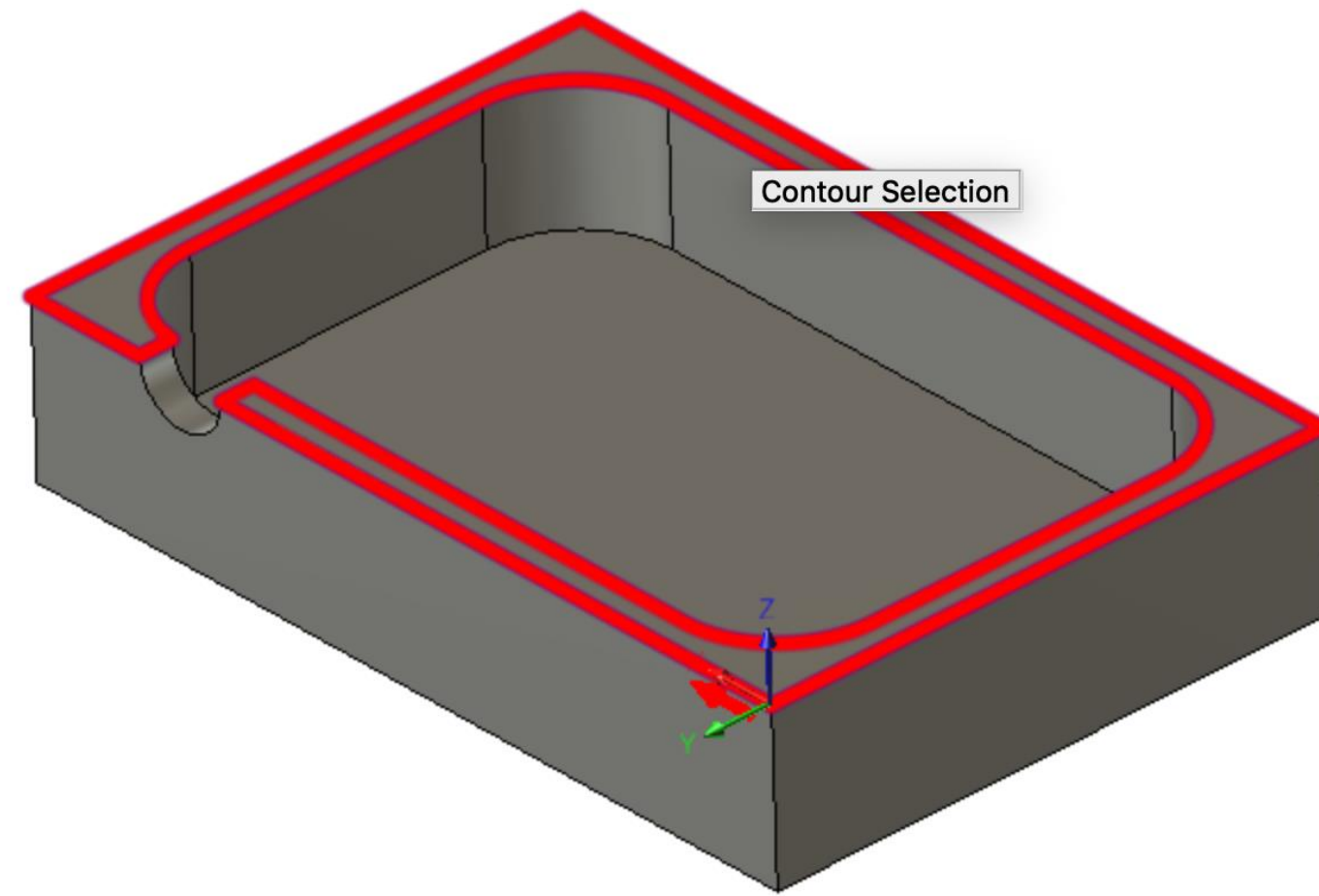
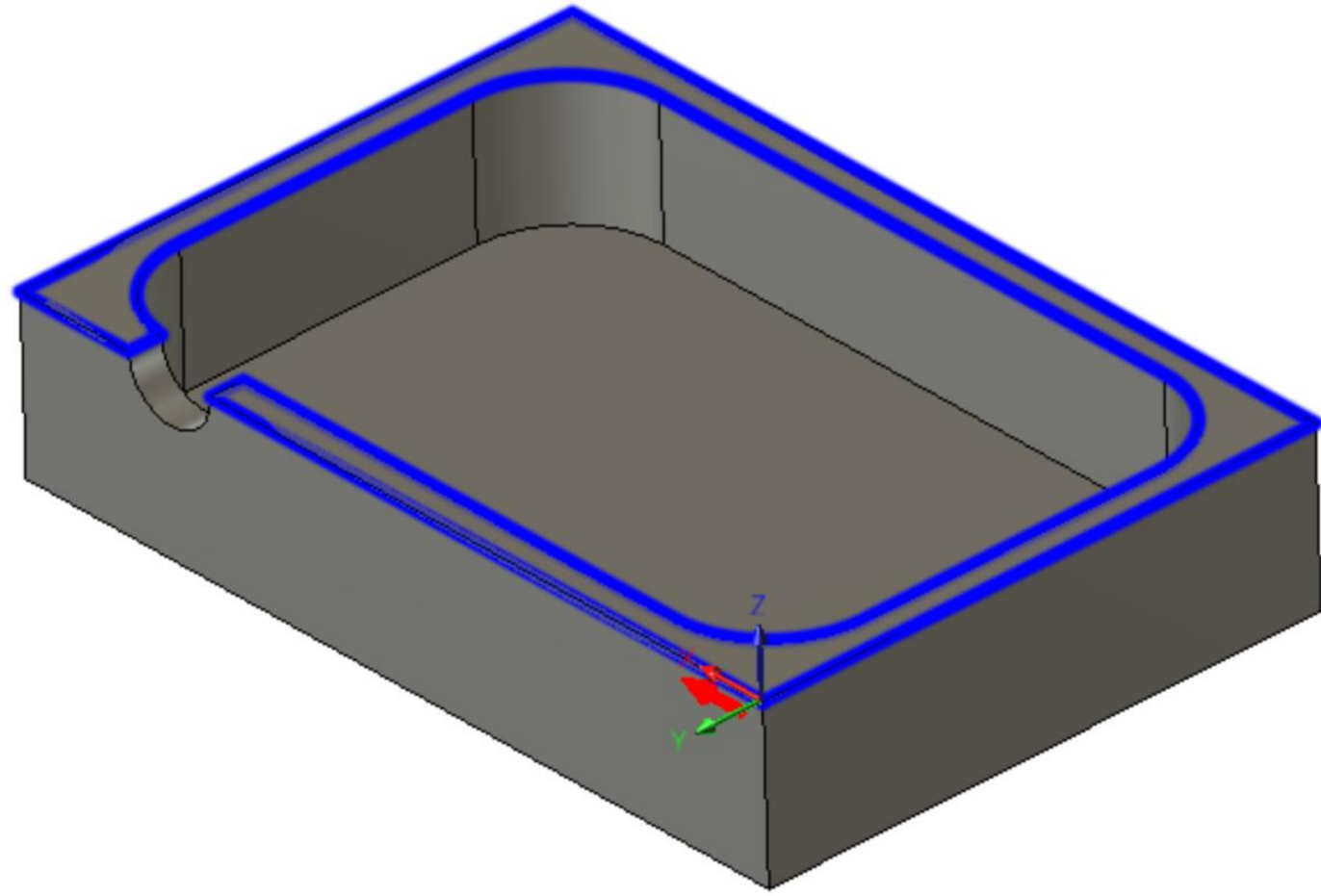


Problem: Boundary conditions are not the same on all sides of boundary

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

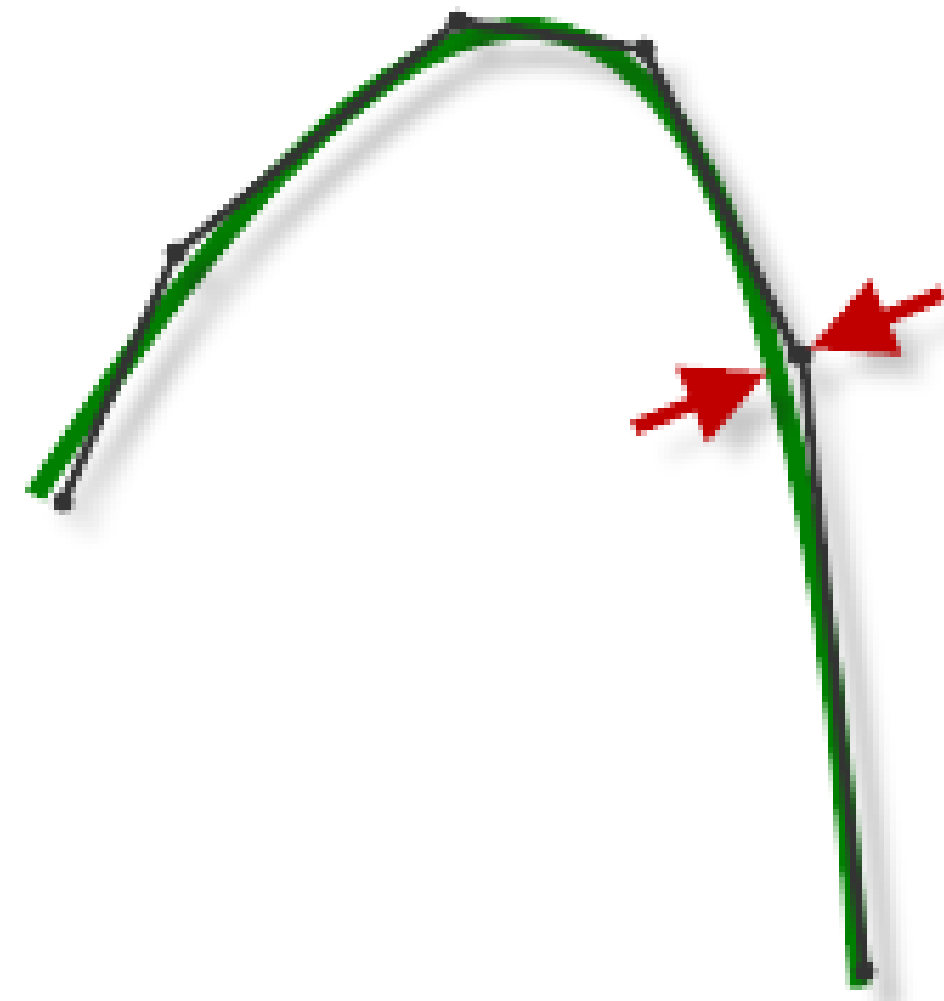
Selections - Editor

Contour Editor Example

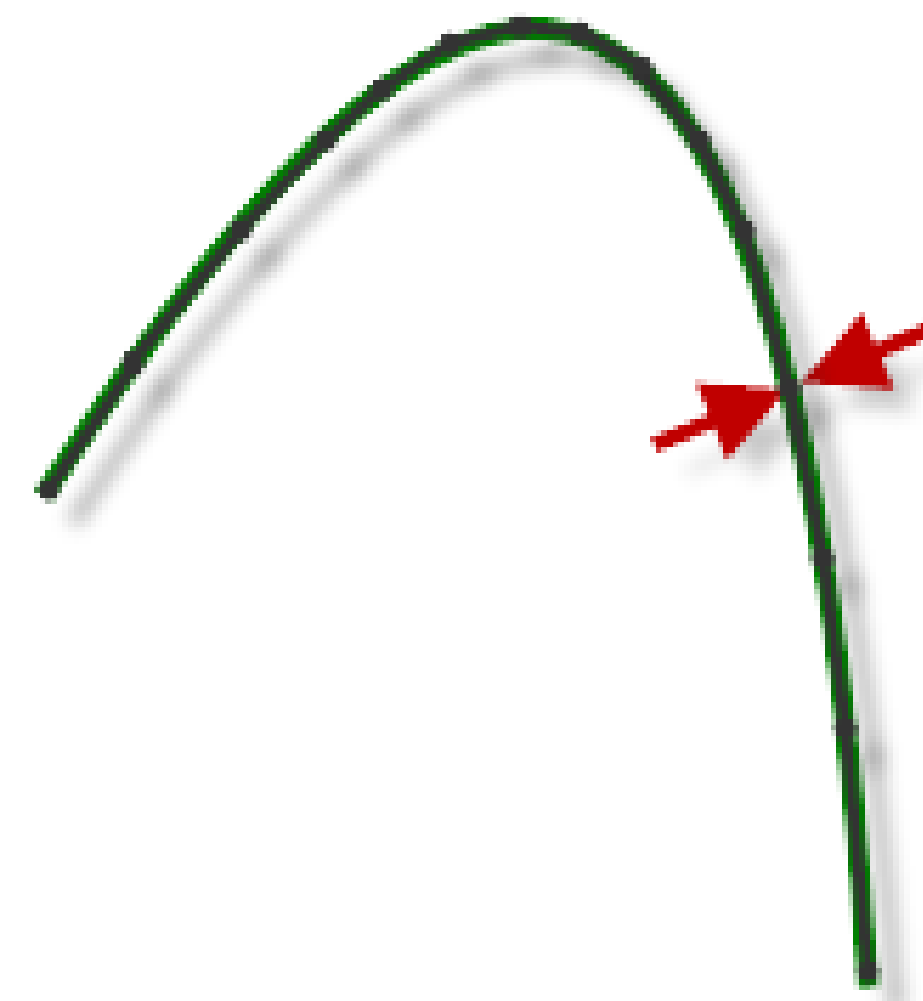


Don't forget to click the **+** to confirm the contour!

Toolpath Tolerance



Loose Tolerance .100



Tight Tolerance .001

Controls accuracy of “mesh” model driving toolpath generation

Toolpath Smoothing



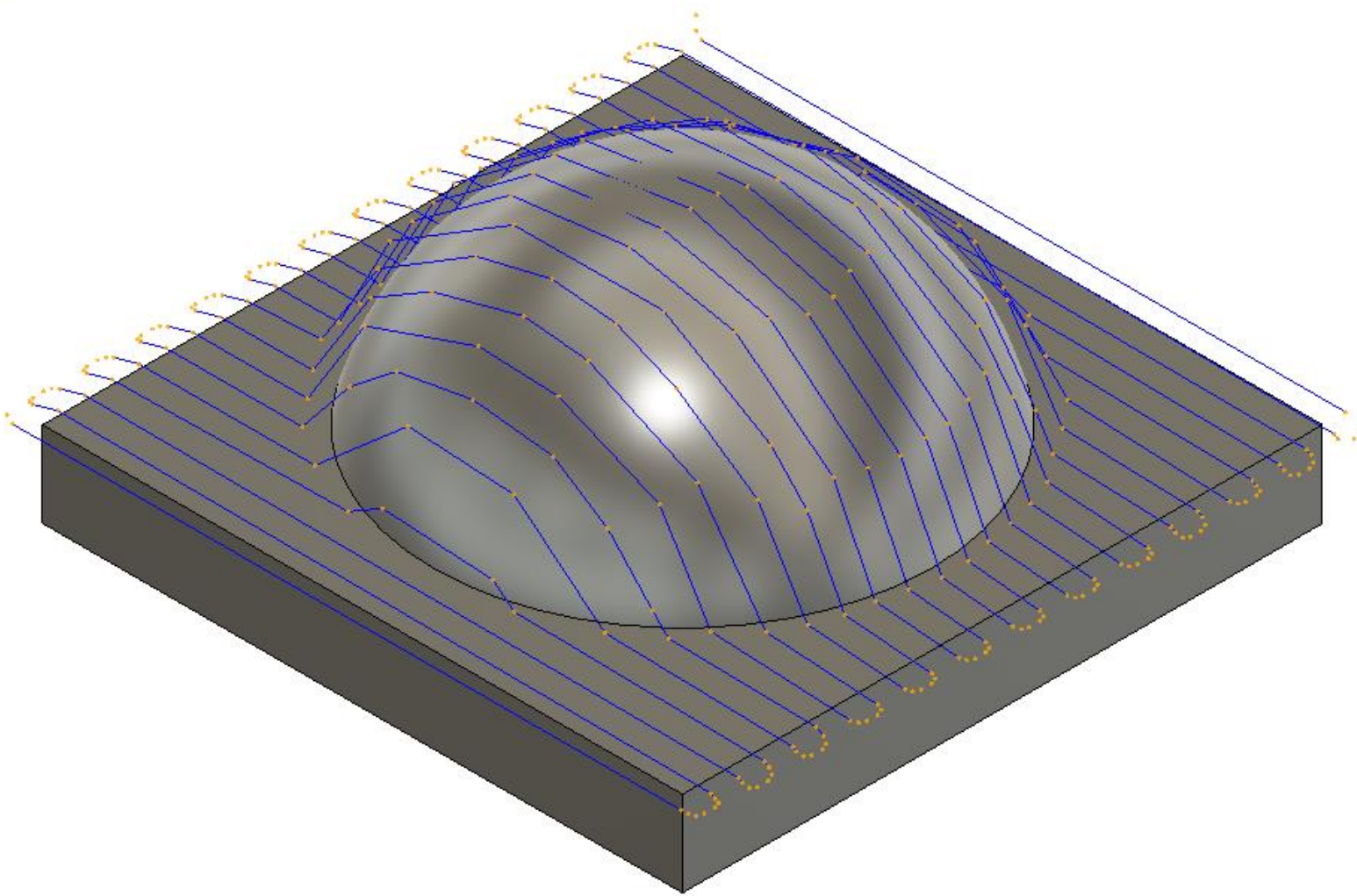
Smoothing Off



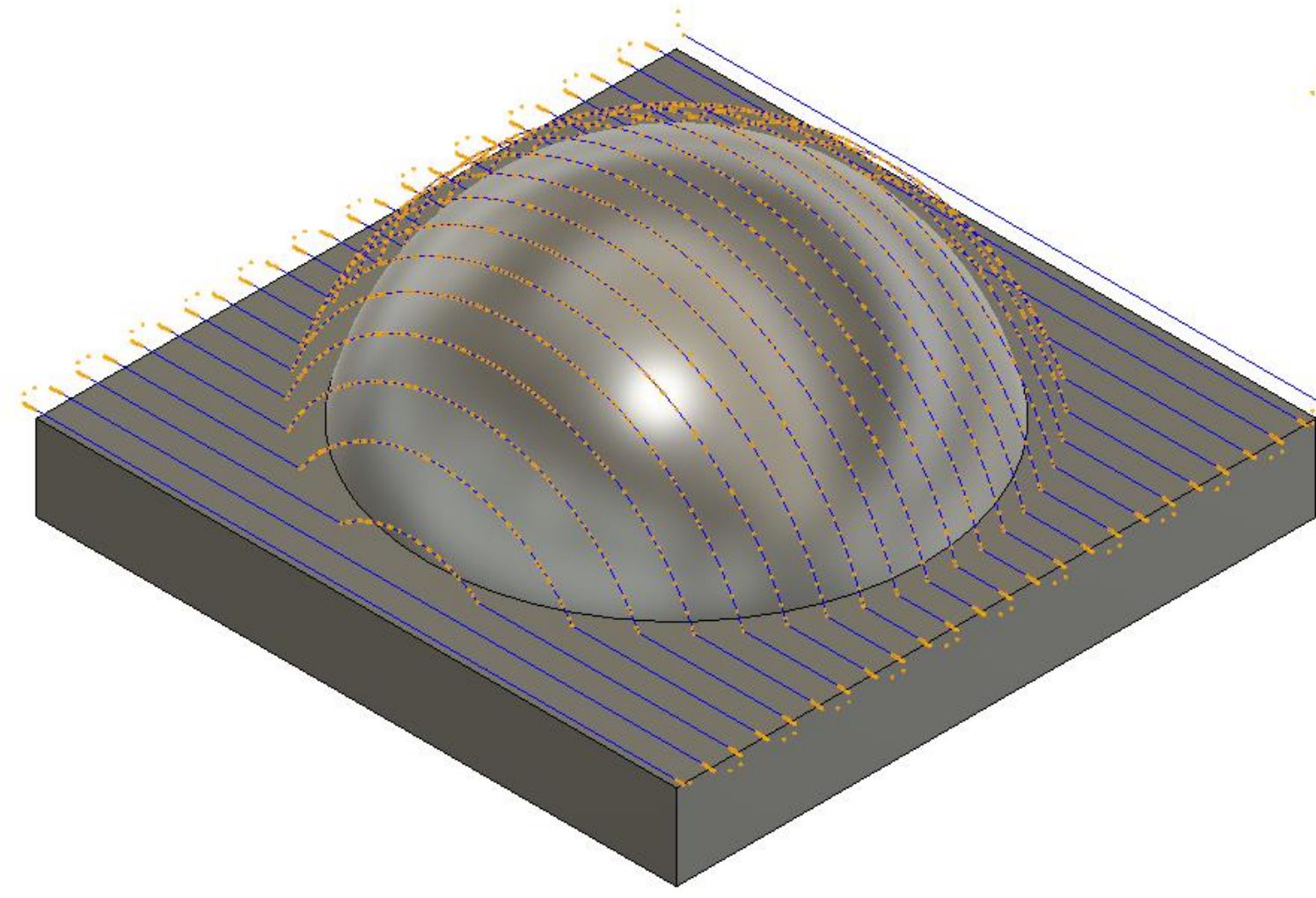
Smoothing On

Applies arc moves to reduce excessive linear segments

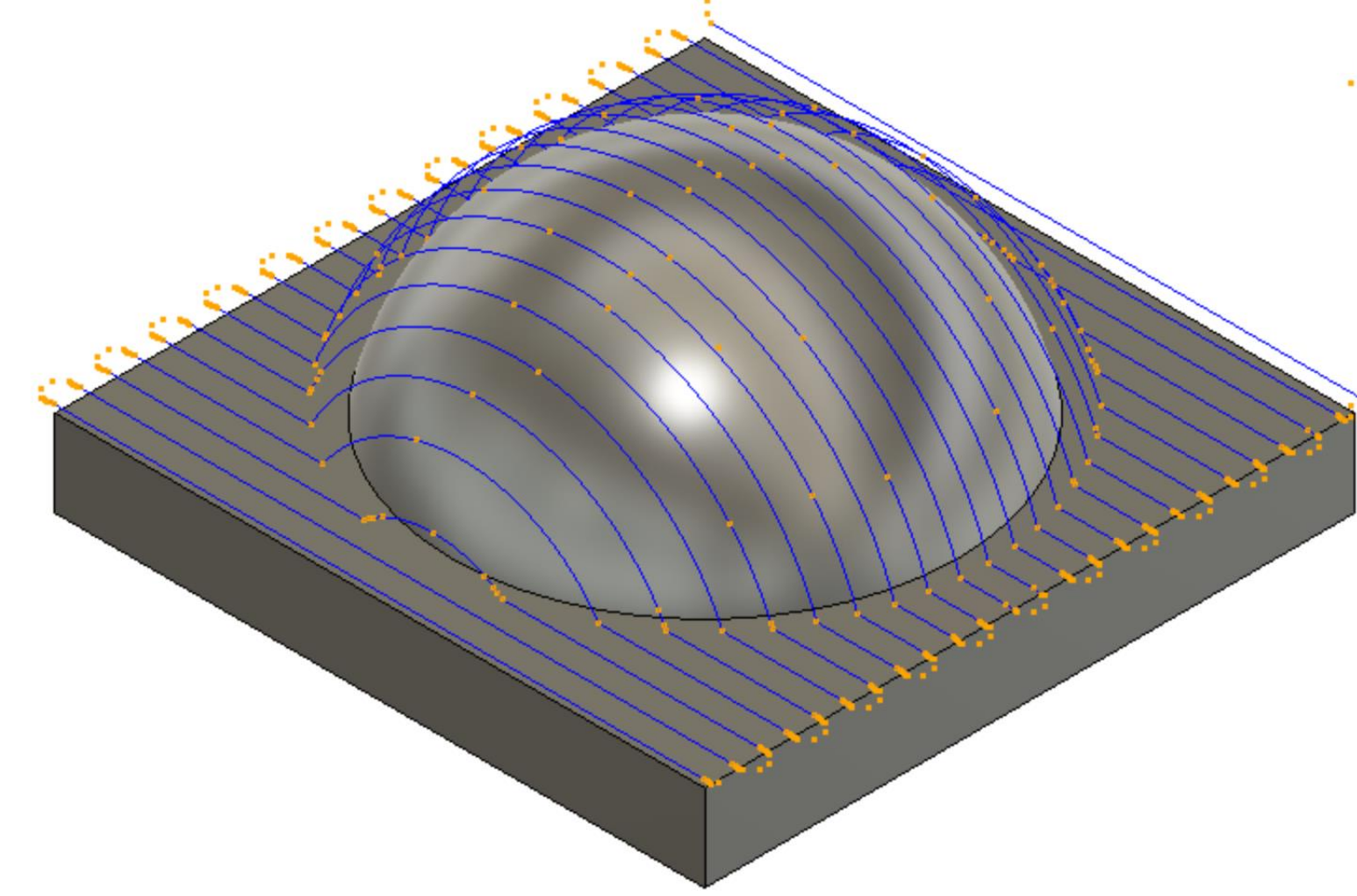
Toolpath Tolerance & Smoothing



LARGE TOLERANCE
(6.3 KB)



SMALL TOLERANCE
(37.4 KB)

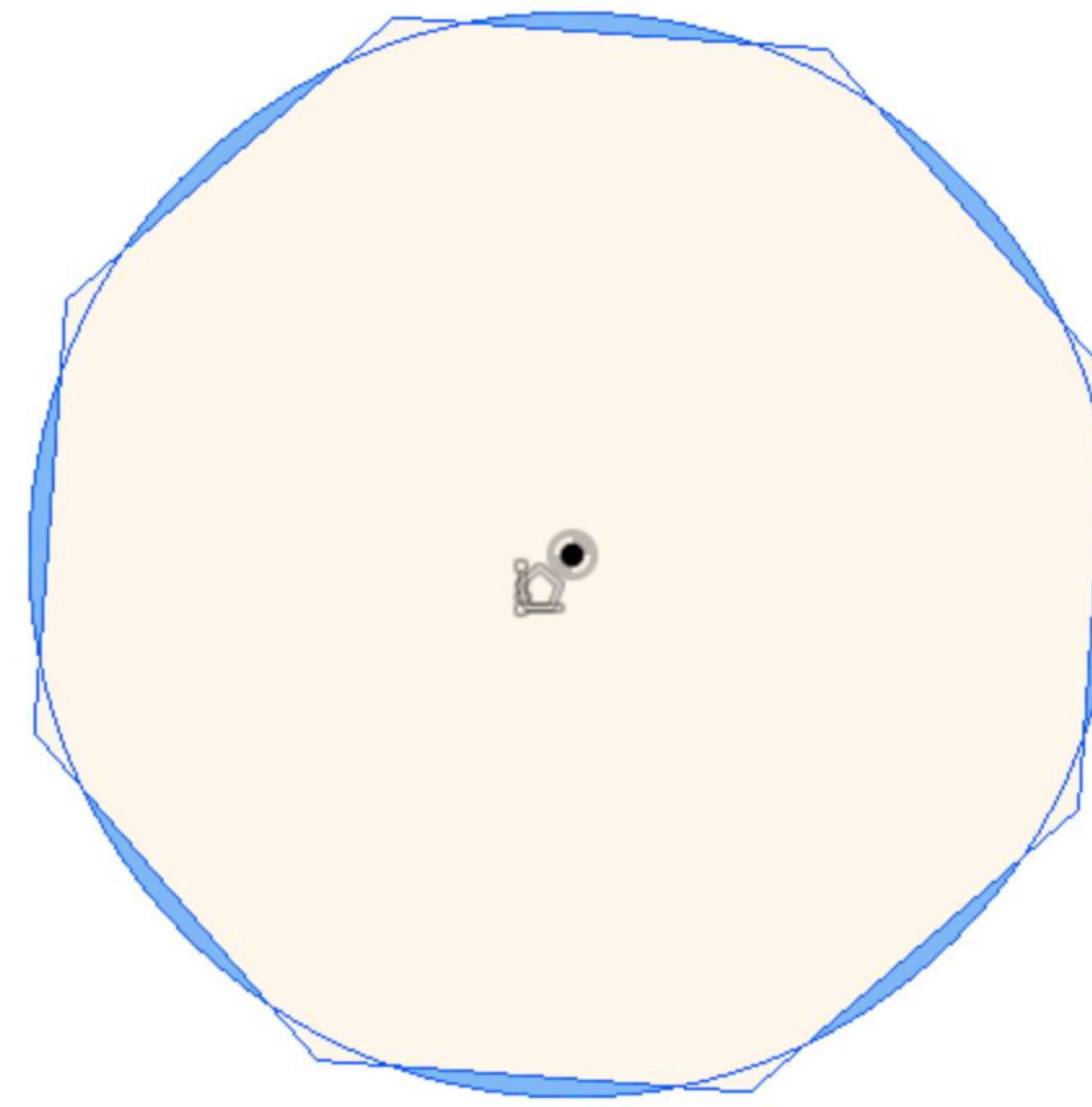
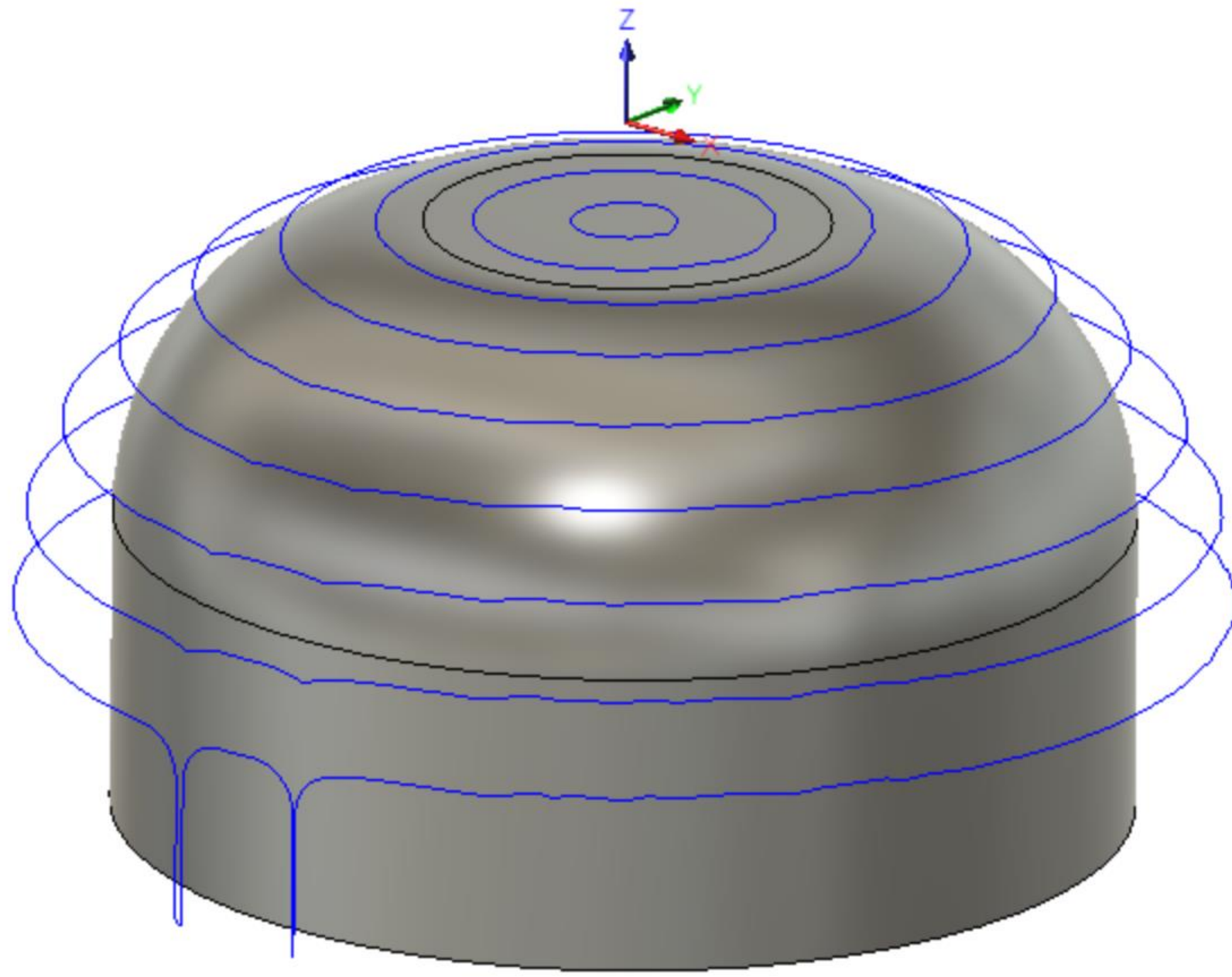


SMALL TOLERANCE
WITH SMOOTHING (1:1 RATIO)
(13.6 KB)

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?

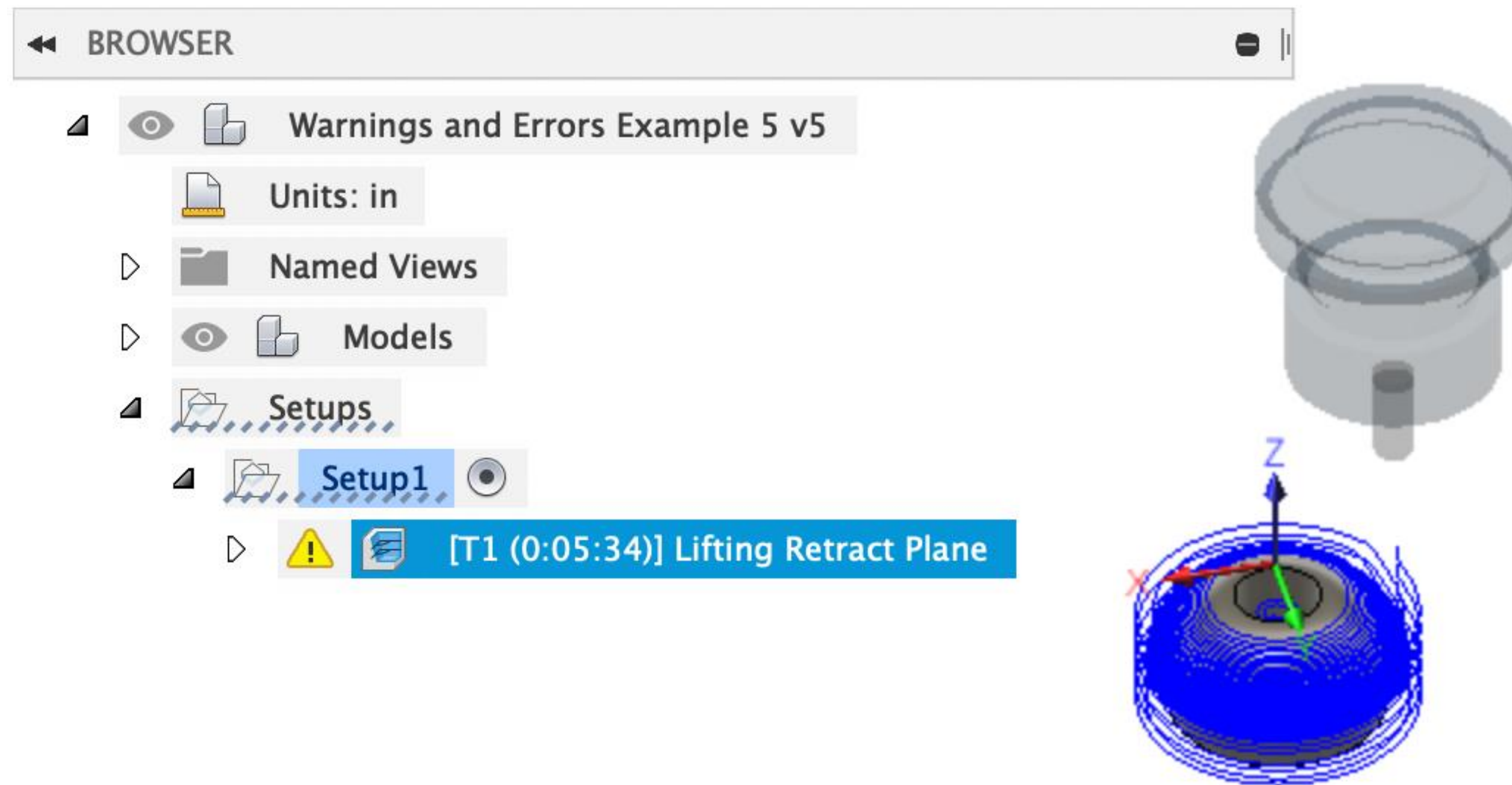
- Tools:
 - *Derived Operations*
 - *Different Parameters & Selections*
 - *Integrated CAD*

RESOLVE

CHOOSE AN ALTERNATIVE

- *Which alternative approaches give an acceptable outcome?*

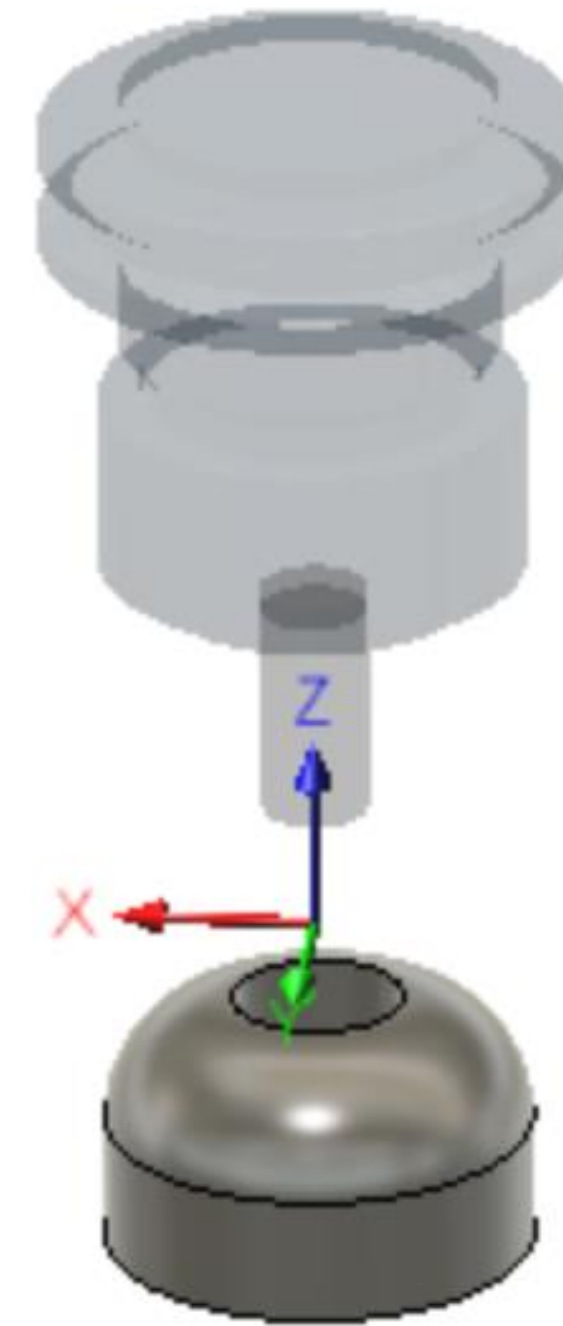
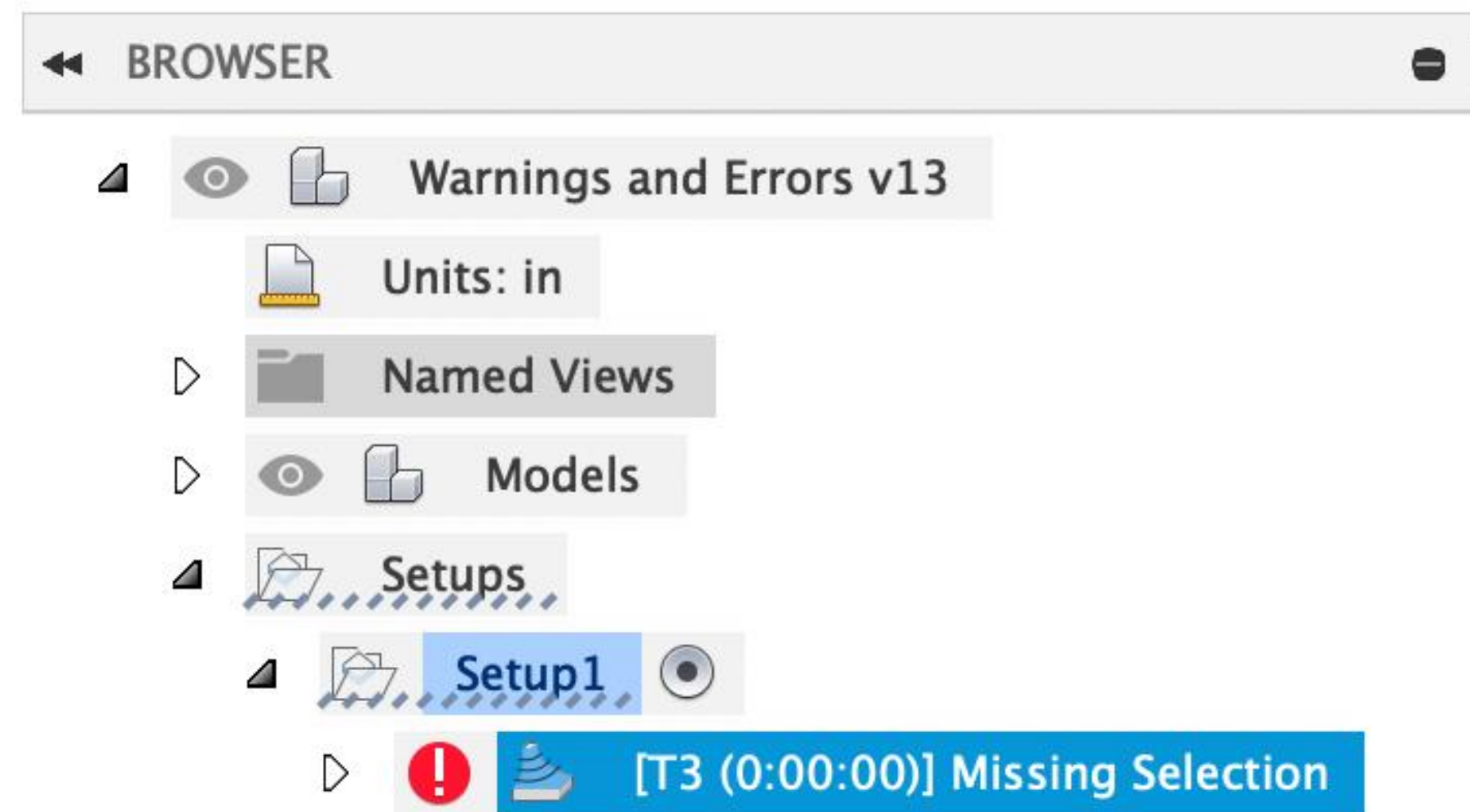
IDENTIFY: WARNINGS



Warnings

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

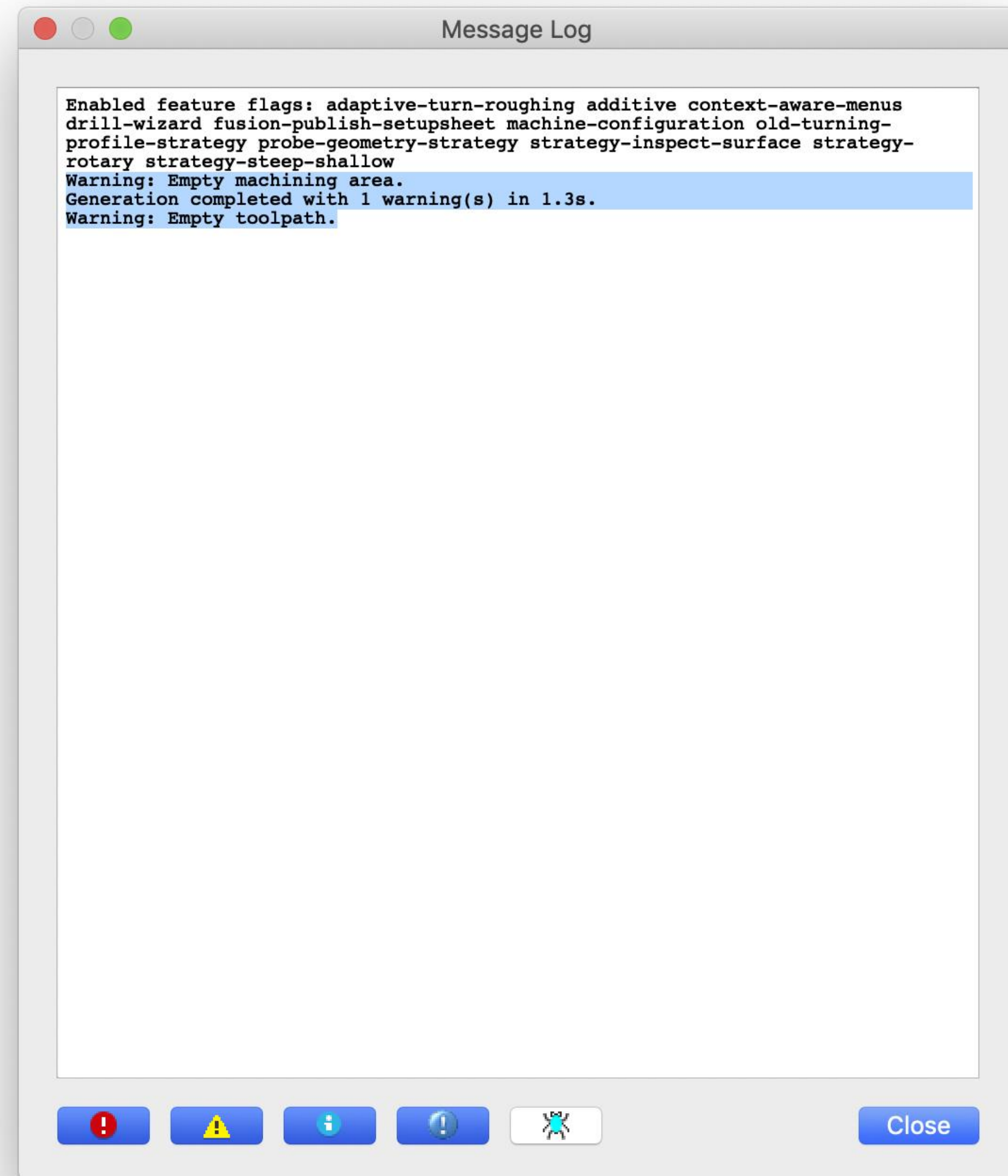
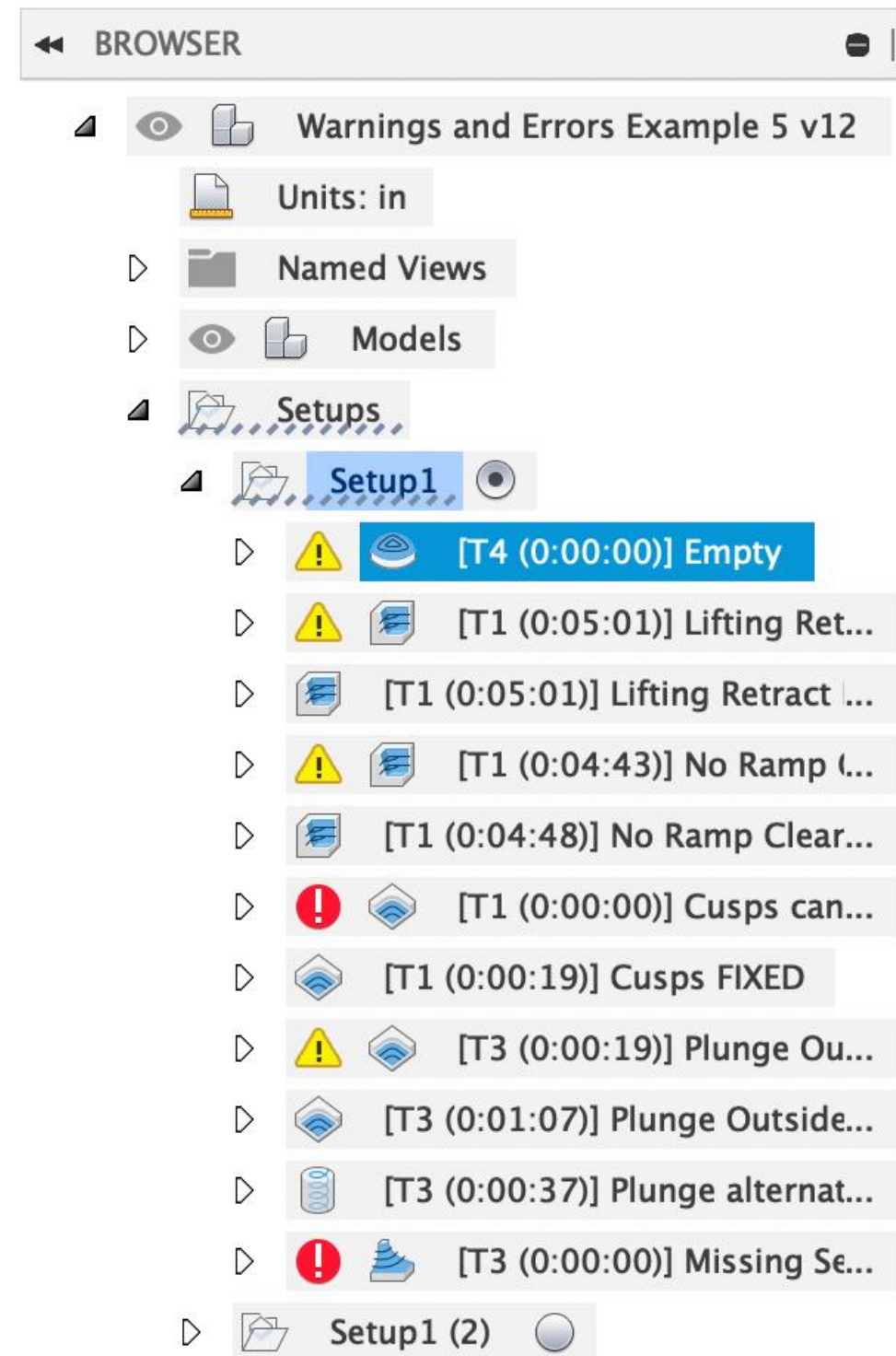
IDENTIFY: ERRORS



Errors

Explain why the toolpath *cannot be generated*

Warnings & Errors Example



ISOLATE: Compare & Edit

G55 LID SIDE

- [T8 (0:01:38)] Custom
- [T8 (0:01:25)] Machi
- [T8 (0:01:20)] GOUG
- [T8 (0:01:34)] NICE

- Compare and Edit
- Create NC Program
- Generate %G
- Simulate
- Post Process
- Setup Sheet
- Clear Toolpath
- Machining Time
- Suppress
- Protect
- Optional
- Add to New Folder
- Add to New Pattern
- Duplicate %D
- Cut
- Copy
- Delete

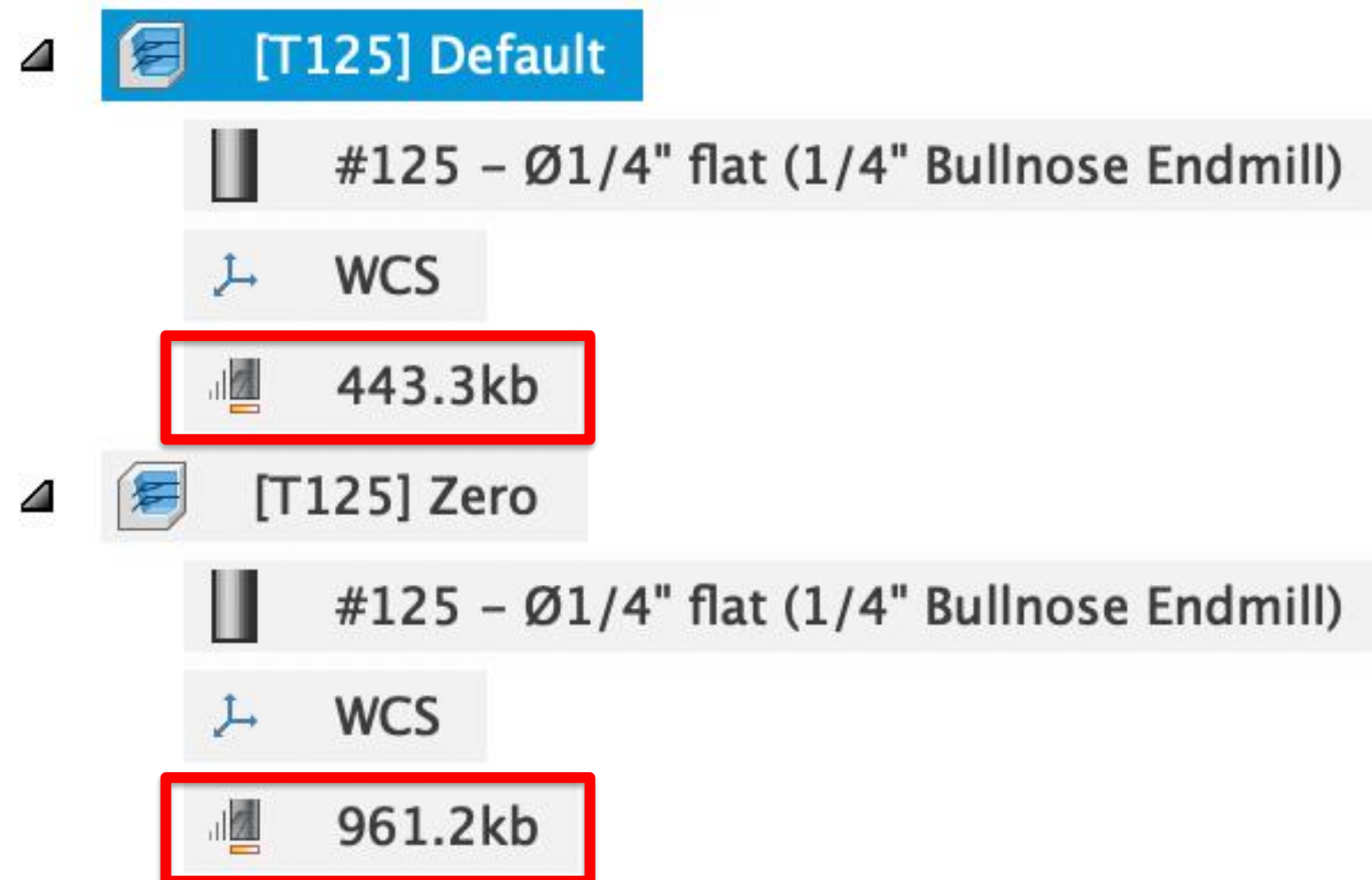
Compare and Edit - Listed parameters: 188

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

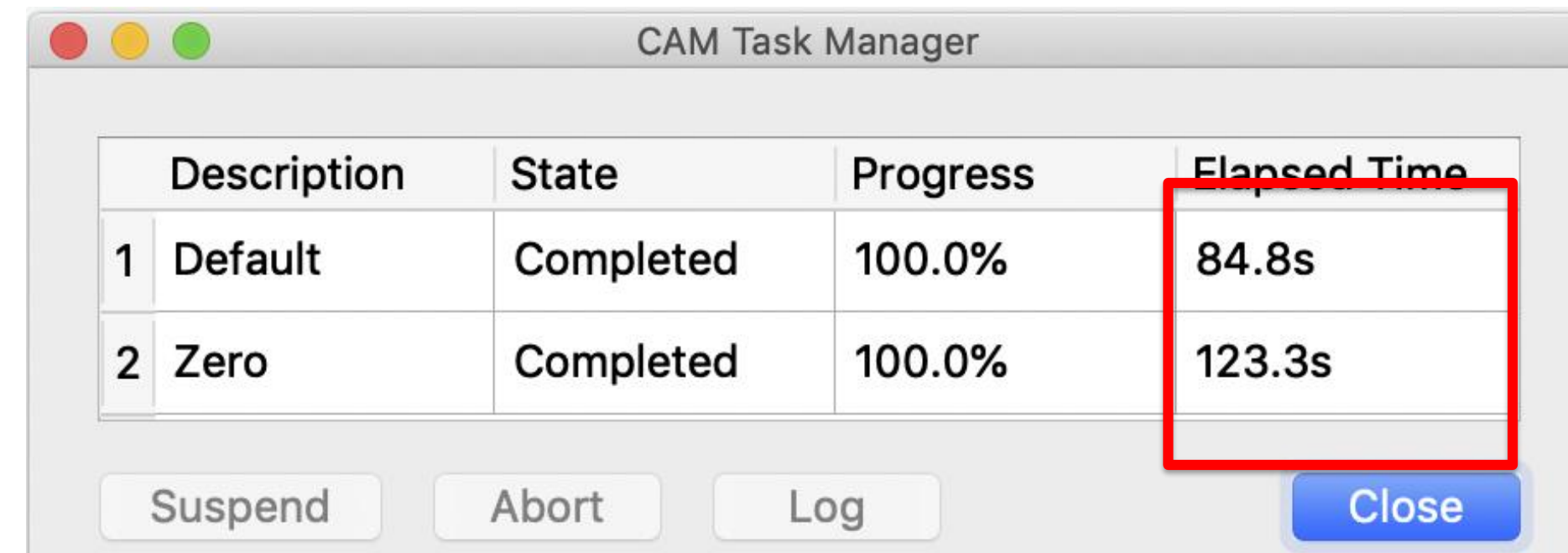
All [dropdown] [X] [OK] [Cancel]

- ✓ All
- Different
- Non-default
- Warnings and errors
- Editable
- Multi-edit
- Modified

ISOLATE: Compare & Edit



The screenshot shows a list of toolpaths in a CAM software interface. The first toolpath is labeled "[T125] Default" and uses a "#125 - Ø1/4" flat (1/4" Bullnose Endmill)" tool. Its WCS is set to "WCS" and its file size is 443.3kb. The second toolpath is labeled "[T125] Zero" and uses the same tool. Its WCS is also "WCS" and its file size is 961.2kb. Red boxes highlight the file size values for both toolpaths.



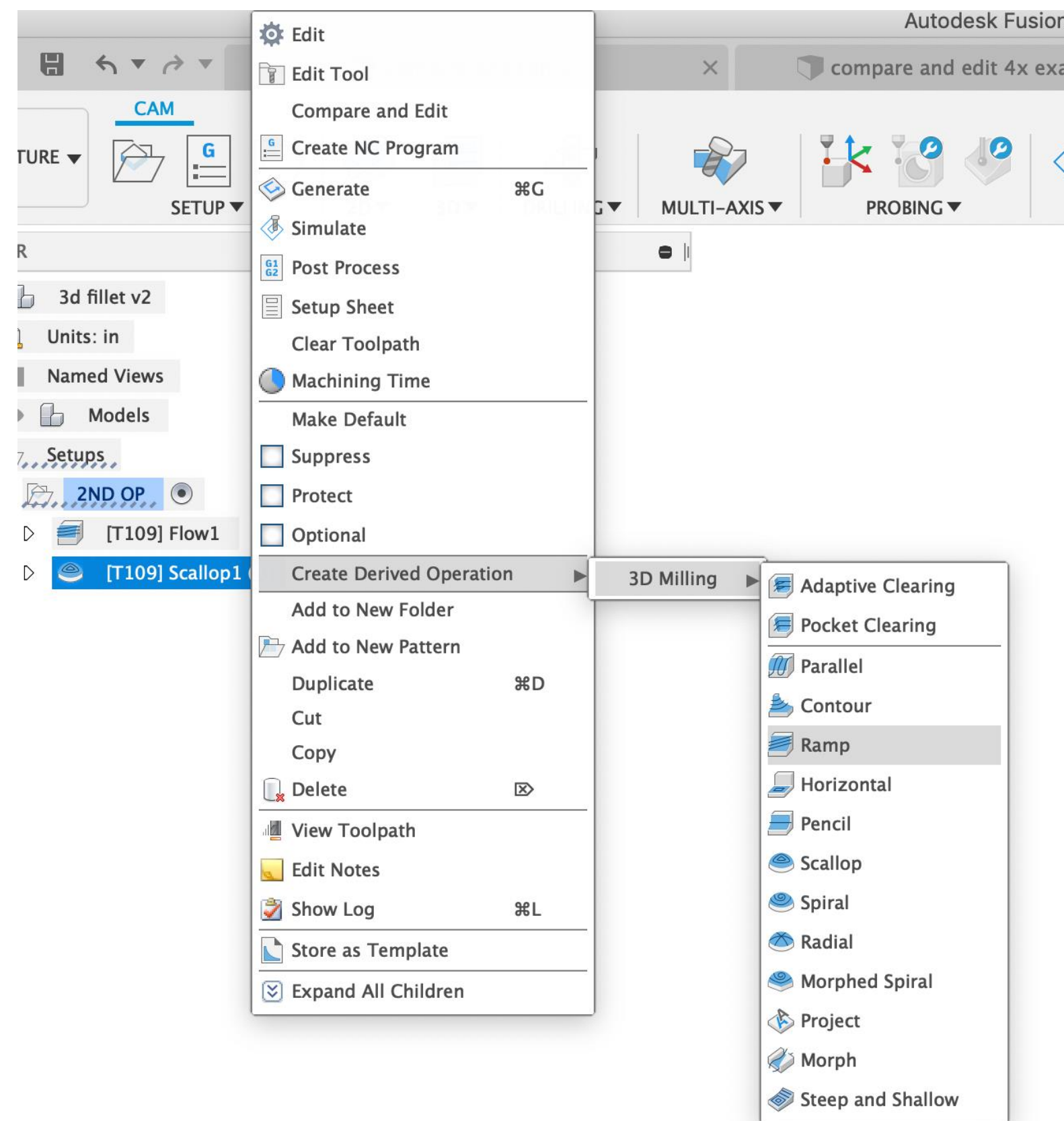
The screenshot shows a "CAM Task Manager" window with a table of task details. The table has four columns: Description, State, Progress, and Elapsed Time. Two tasks are listed: "1 Default" and "2 Zero". Both are in a "Completed" state with 100.0% progress. The elapsed times are 84.8s for the Default task and 123.3s for the Zero task. Red boxes highlight the Elapsed Time column and the values 84.8s and 123.3s. Below the table are buttons for "Suspend", "Abort", "Log", and "Close".

	Description	State	Progress	Elapsed Time
1	Default	Completed	100.0%	84.8s
2	Zero	Completed	100.0%	123.3s

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

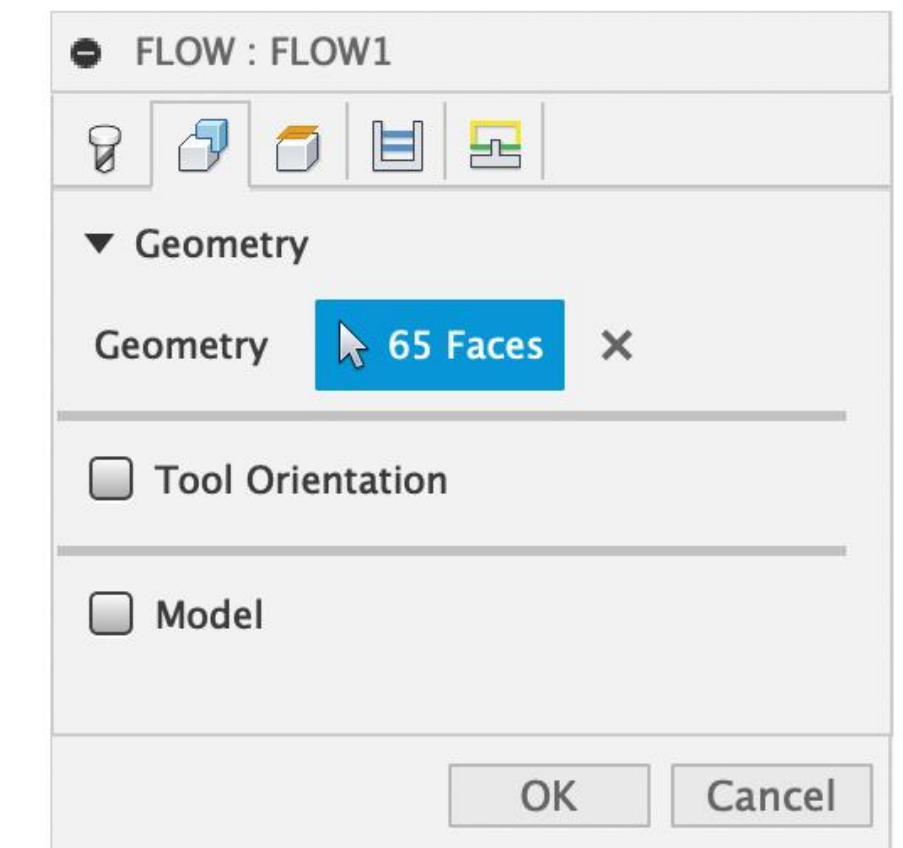
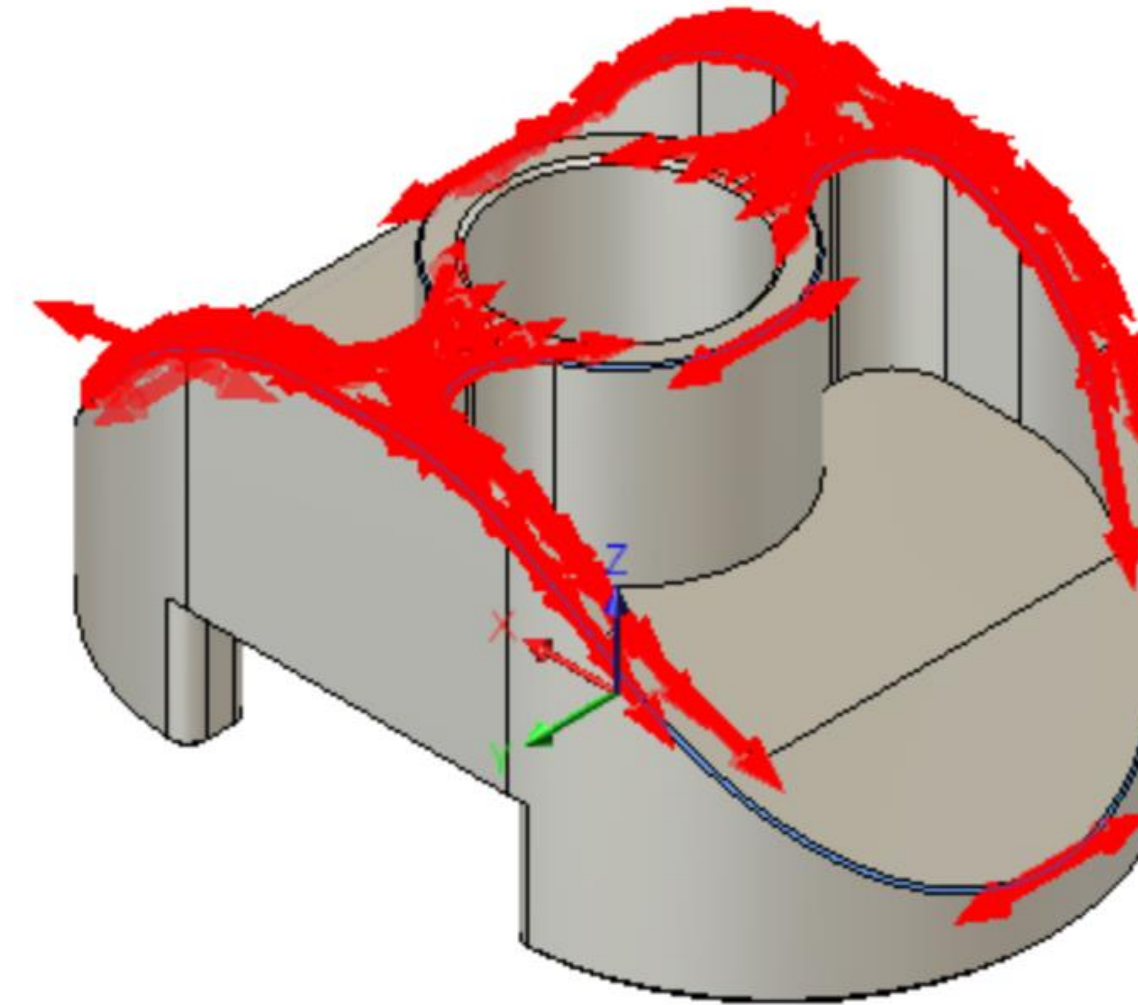
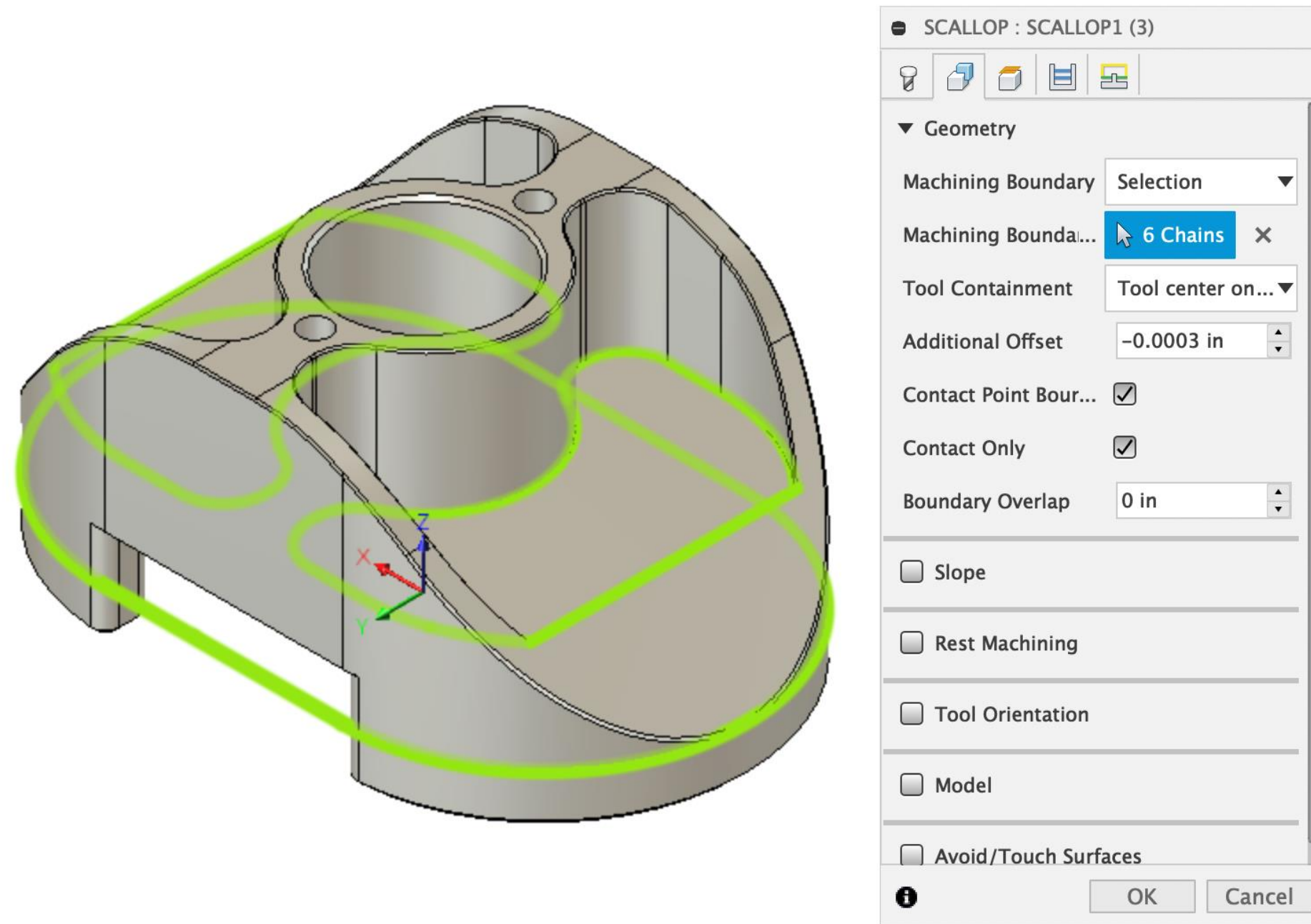
EXPERIMENT – Derived Operations

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

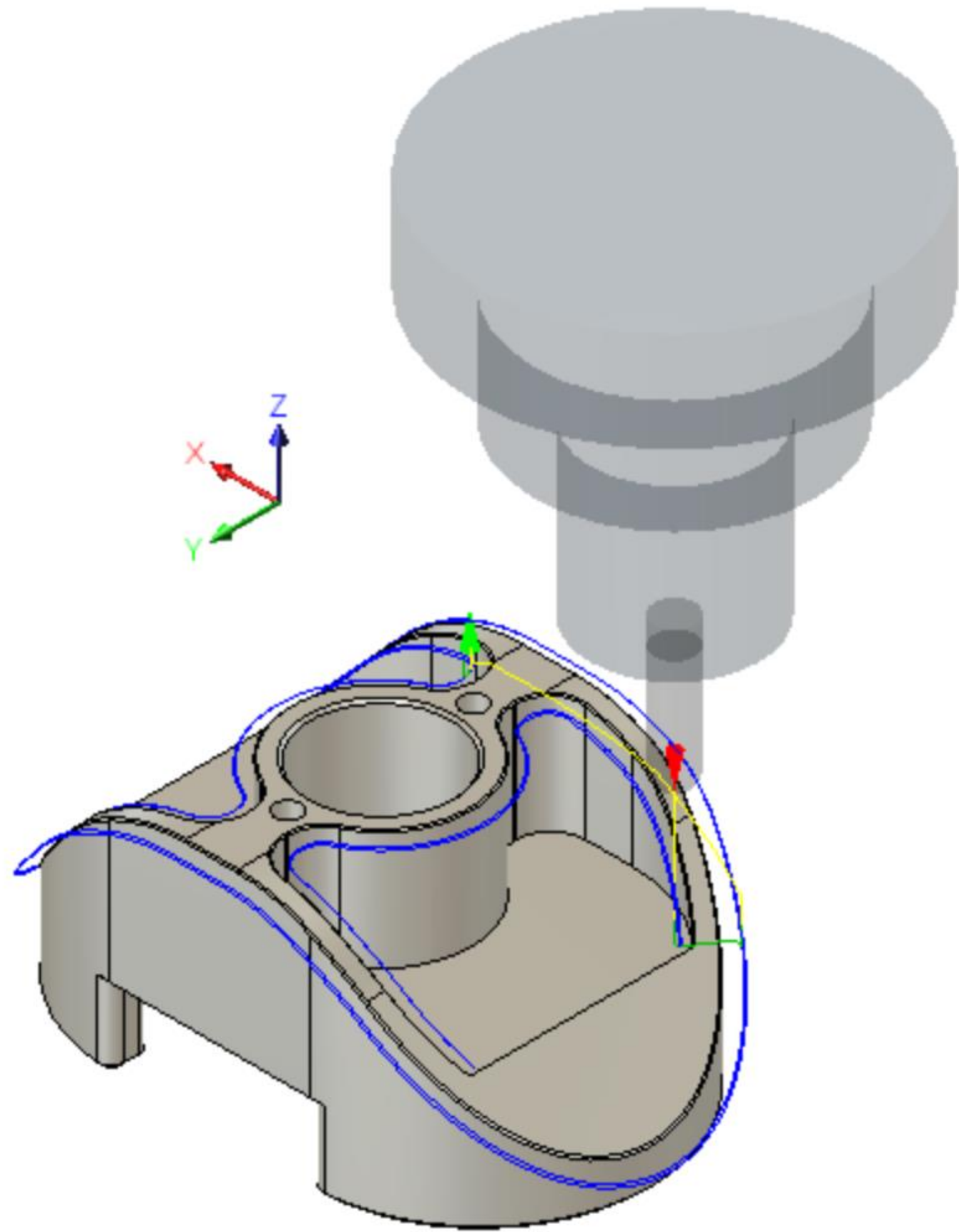


EXPERIMENT – Different Strategies

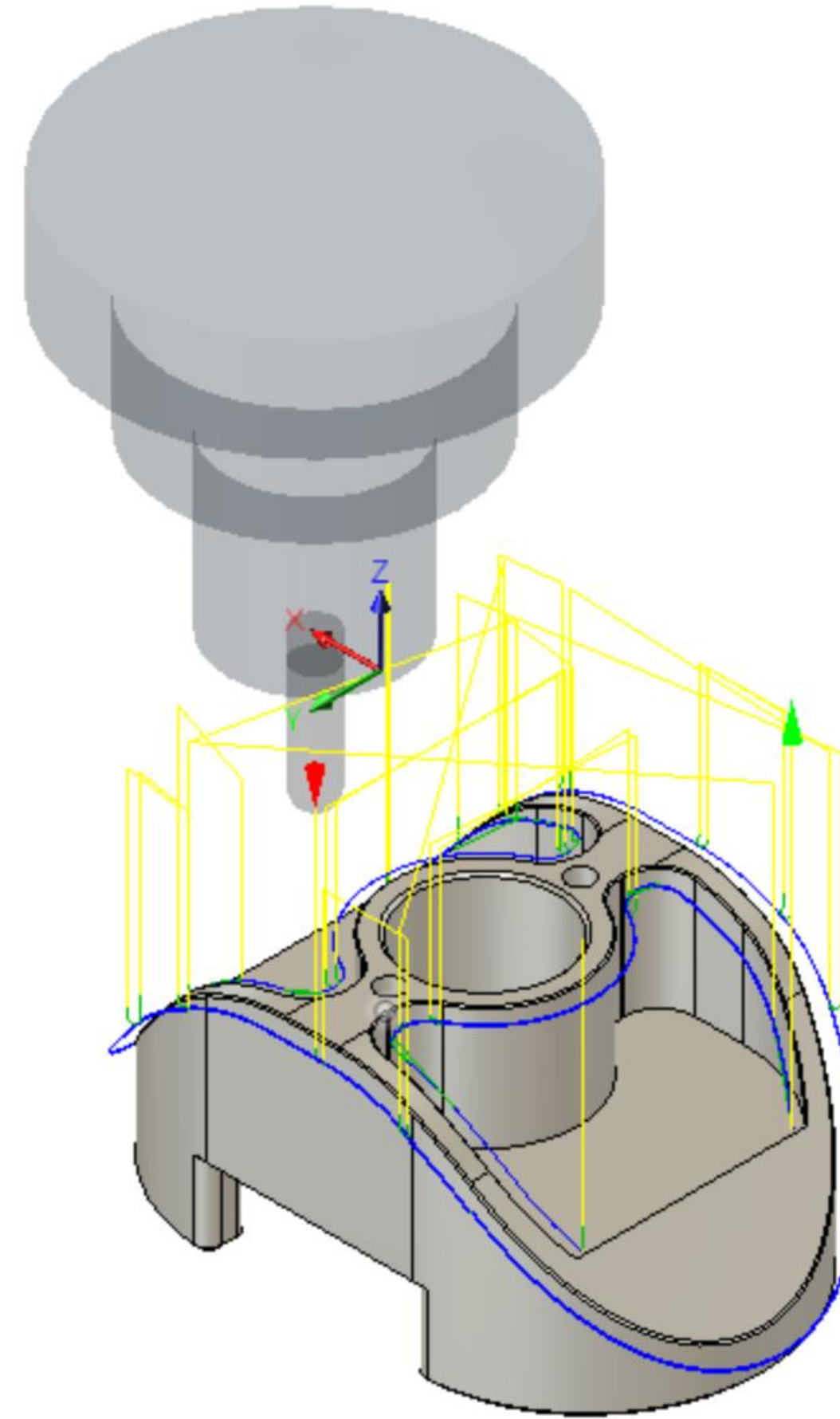
- More than one strategy may give acceptable motion
 - What will be easiest to set up?



EXPERIMENT – Different Strategies

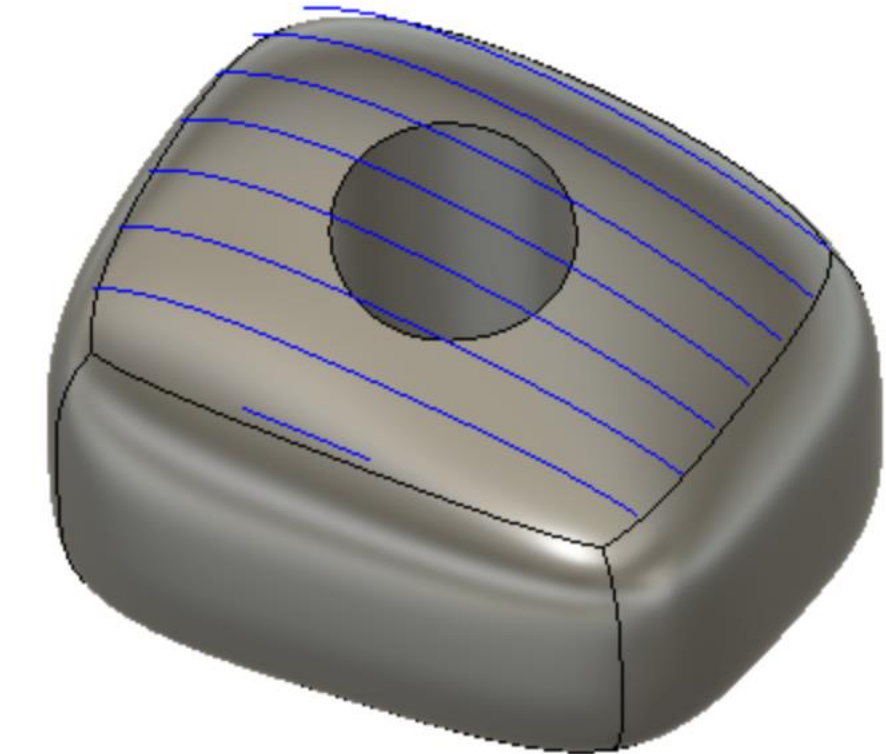
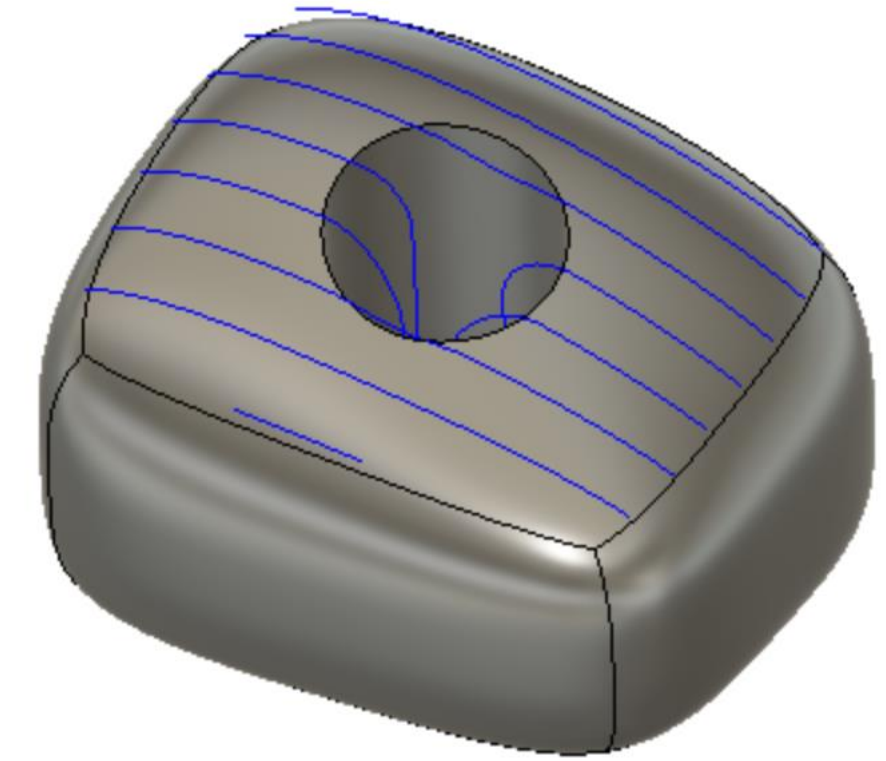
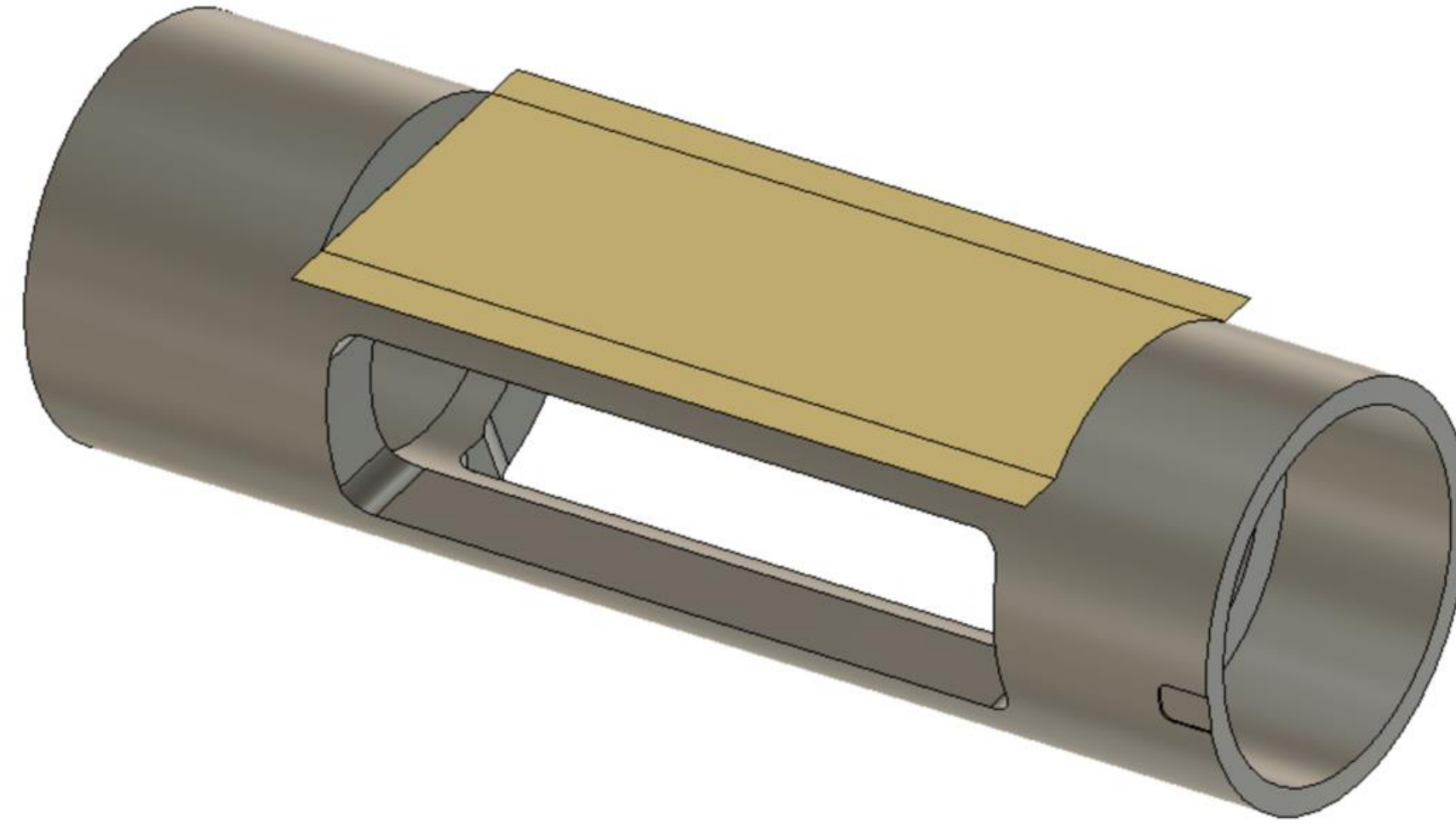
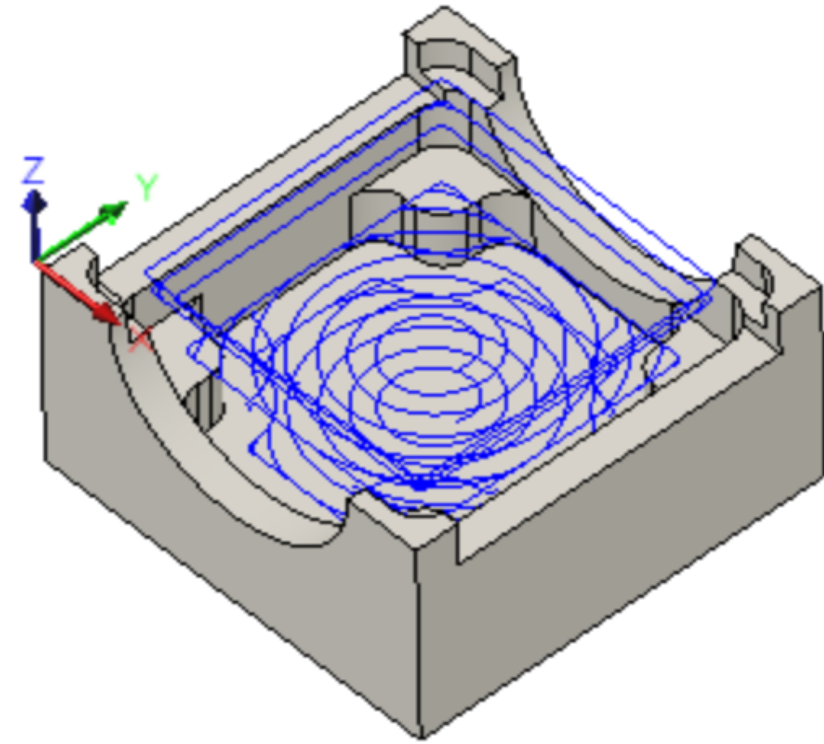
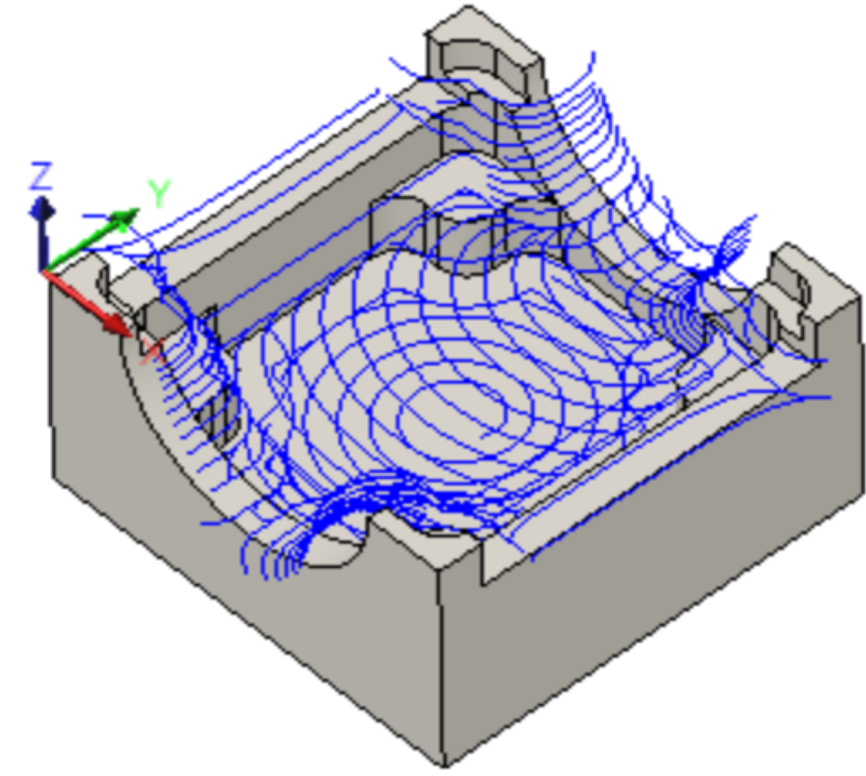


Scallop

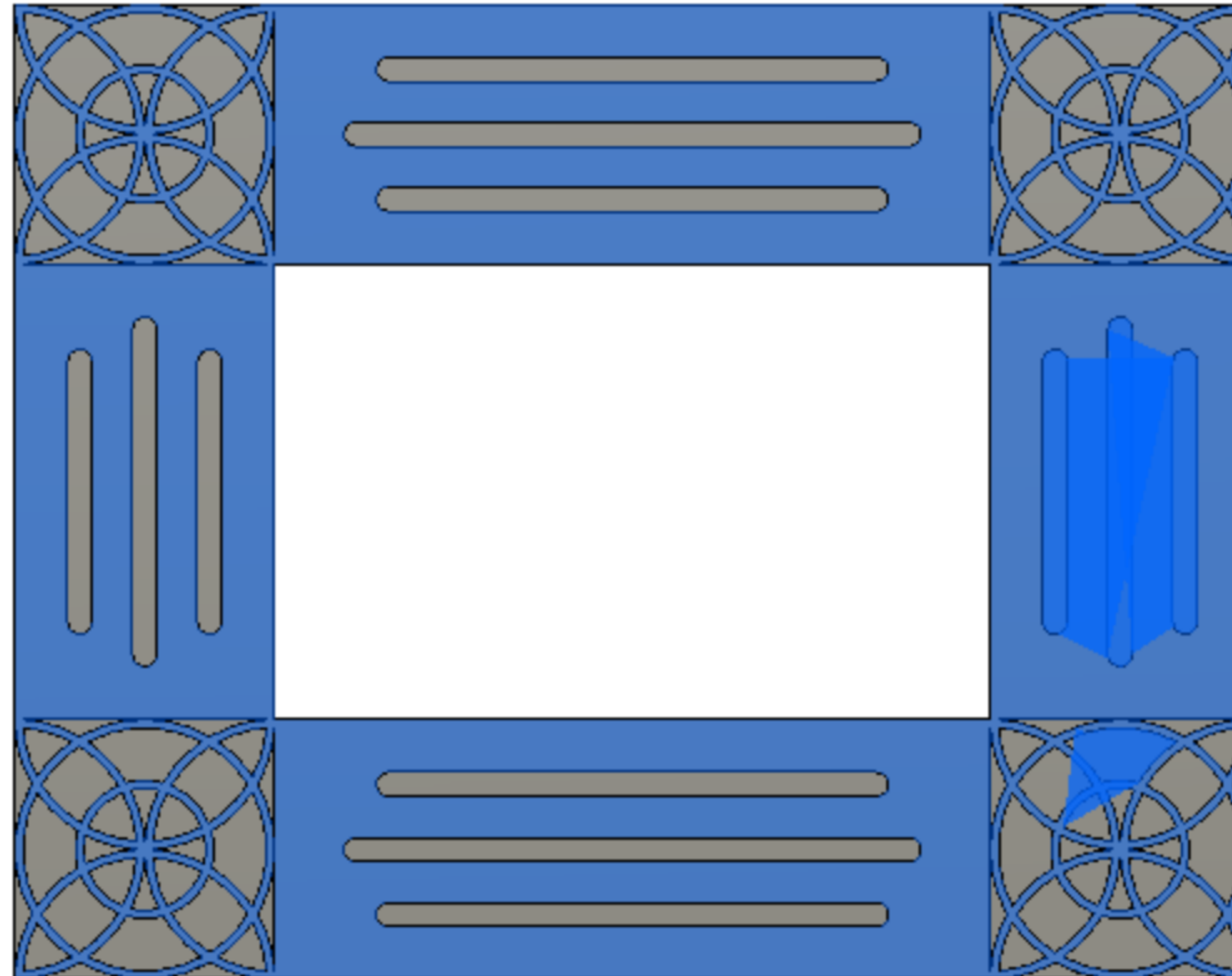


Flow

EXPERIMENT – Integrated CAD

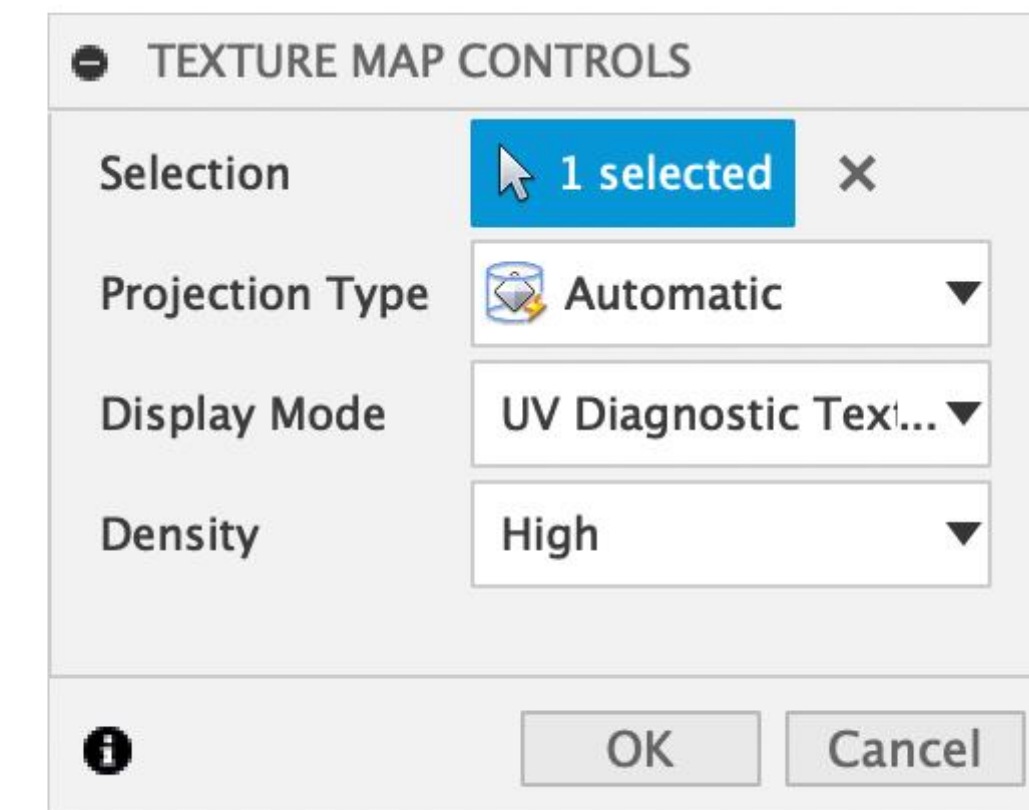
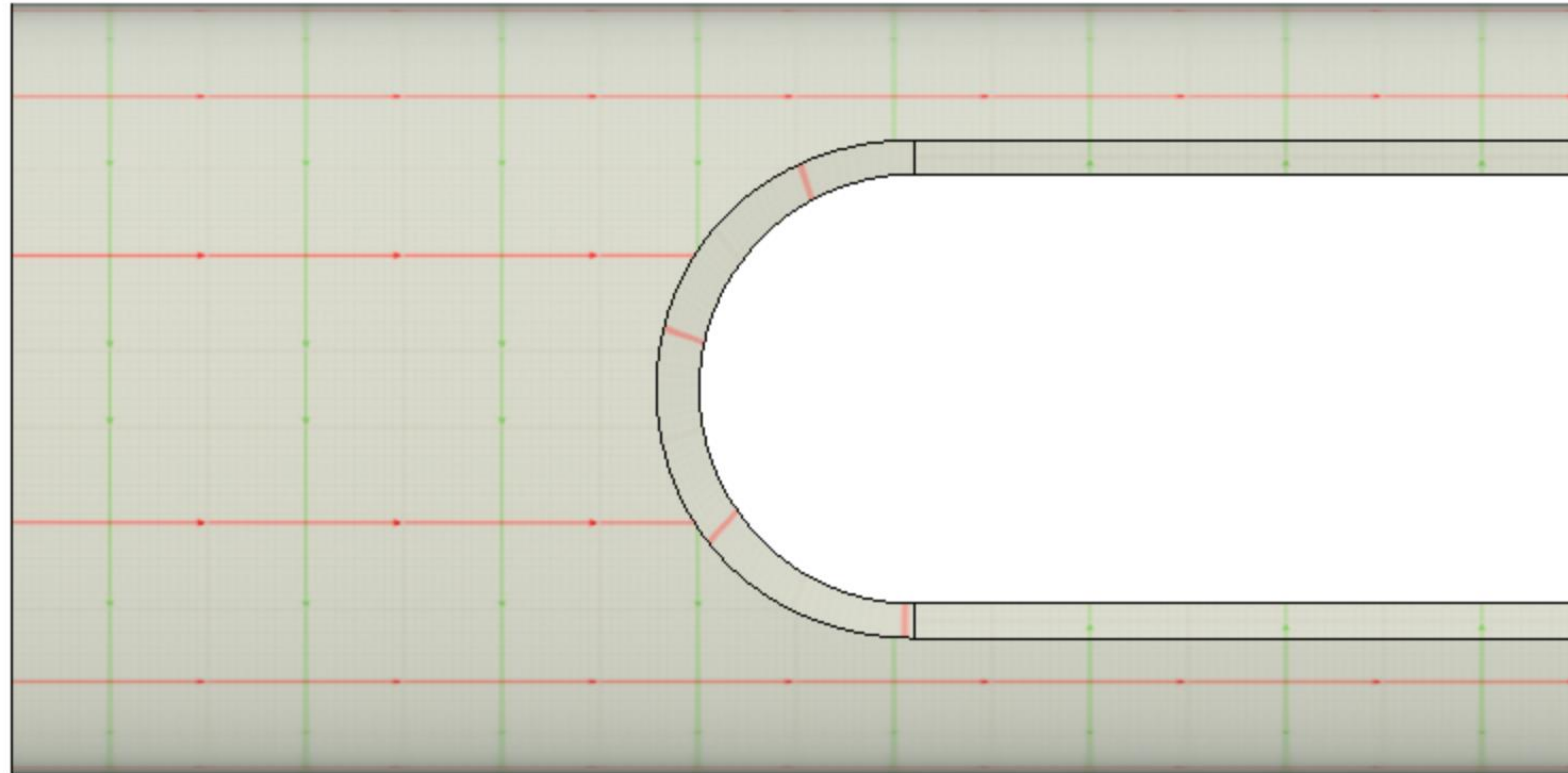


EXPERIMENT: Imported Data



- 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 #

```
19 ...
20 Warning: Work offset has not been specified. Using G54 as WCS.
21 Error: Work plane is not supported: A-169.188 B108.
22 *****
23 Error: Failed to invoke function 'onSection'.
24 Error: Failed to invoke 'onSection' in the post configuration.
25 Error: Failed to execute configuration.
26 Stop time: Thu Jun 7 13:57:04 2018
27 Post processing failed.
28
```

```
18 Generated by: Fusion 360 CAM 2.0.4233
19 ...
20 Error: Turning toolpath is not supported by the post configuration.
21 *****
22 Error: Failed to invoke 'onOpen' in the post configuration.
23 Error:
24 Error: Failed to execute configuration.
25 Stop time: Tuesday, June 12, 2018 9:12:36 PM
26 Post processing failed.
27
```

```
23
24 *****###
25 Error: Program number is out of range.
26 Error at line: 414
27 Failed while processing onOpen().
28 *****
29
30 Error: Failed to invoke 'onOpen' in the post configuration.
31 Error: Failed to invoke function 'onOpen'.
32 Error: Failed to execute configuration.
33 Stop time: Tue Sep 10 22:58:43 2019
34 Post processing failed.
35
```

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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