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Reducing the number of component setups using multi-axis machine tools

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About the speaker

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- **Cadline LTD**
- **Inventor, InventorCAM, Fusion 360, FeatureCam and PowerMill.**
- **Motorsport / Automotive / Cad/Cam / Machine Tools / Fixture Design / Reverse Engineering**
- **Cycling / Dogs / Films / Family**

Overview

In this presentation, we are going to look at how we can reduce the number of operations by using multi-axis CNC machine tools.

We are going to look at a traditional 3 axis VMC to machine a component and compare with machines with more axis.

- **Understand what features we need to machine on a component.**
- **Look at how we would go about machining part, specifically workholding and understanding how many setups would be required.**
- **How installing a 4th axis onto the 3 axis VMC would reduce setups.**
- **How a 4 axis HMC would reduce setups.**
- **How a 5 axis VMC/HMC would reduce setups the best.**

Things to consider?

EXAMINE COMPONENT MODEL/DRAWING?

Get an understanding of the component you're looking to machine, look at the features that need to be created.

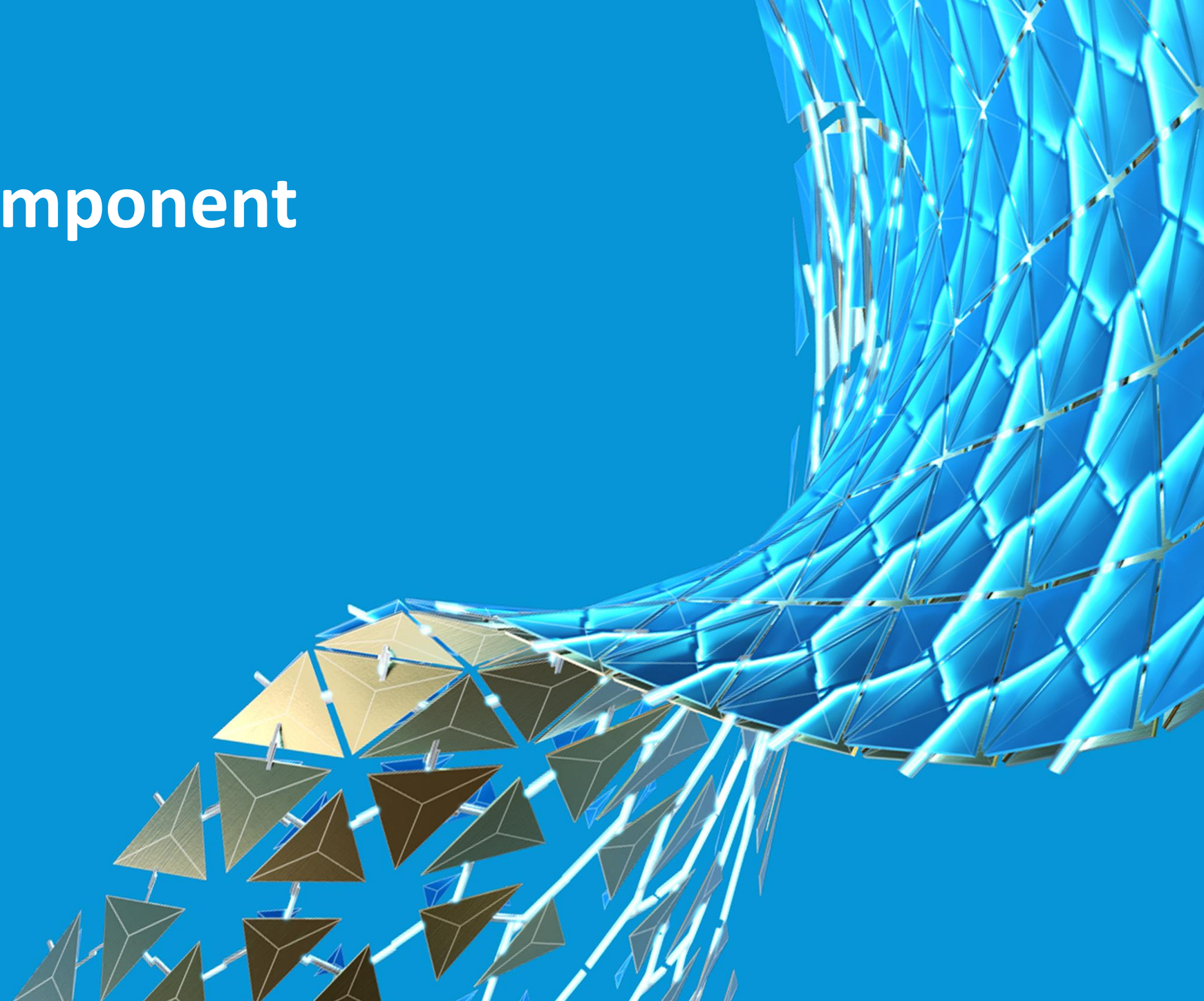
THINK ABOUT WORKHOLDING?

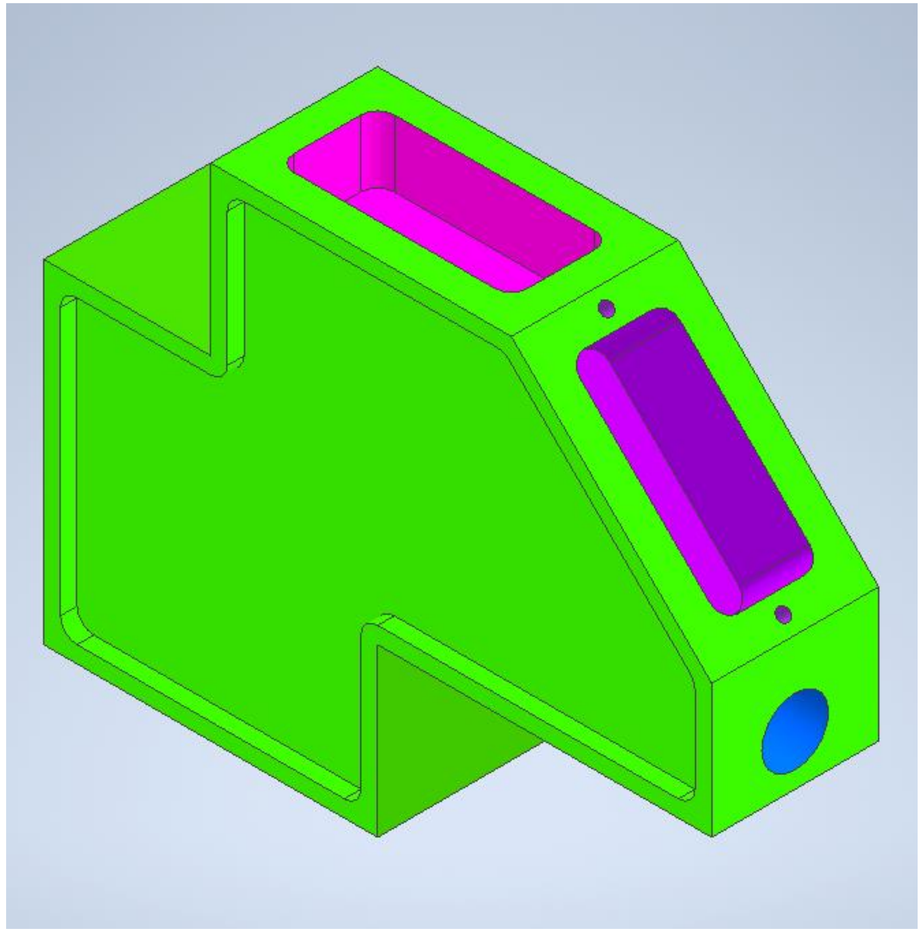
Think about how the component is going to be held in machine and how features are going to be reached for machining.

BEST MACHINE TO USE FOR THE JOB

If we have a choice of CNC machines available, use the one which offers us the most flexibility. Reduce the number of setups if you can.

Examining Component





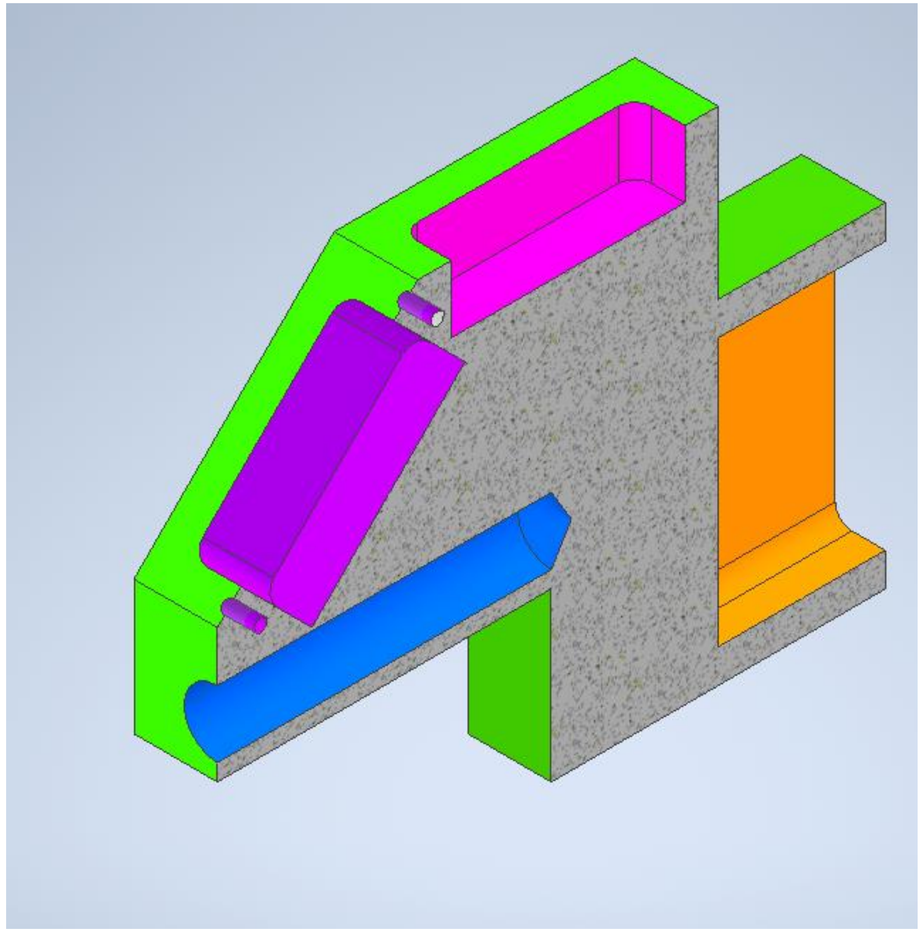
Examining Component

Understanding what's required?

When we are machining components we need to examine the model and drawings to understand what is required to manufacture part.

What to look for?

- Features on different faces, anything which might require special tools to create feature
  - Do you have enough information to be able to manufacture part?

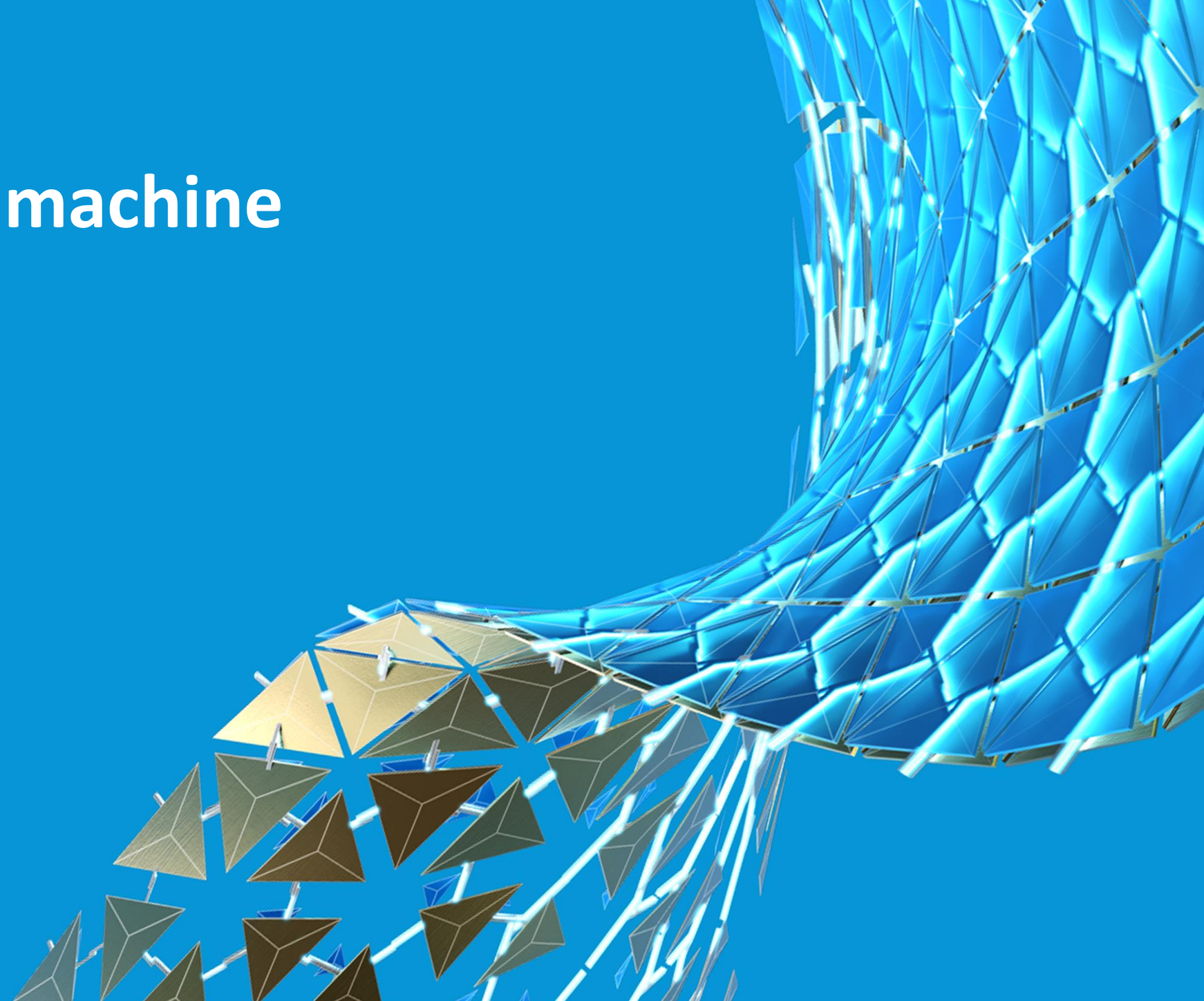


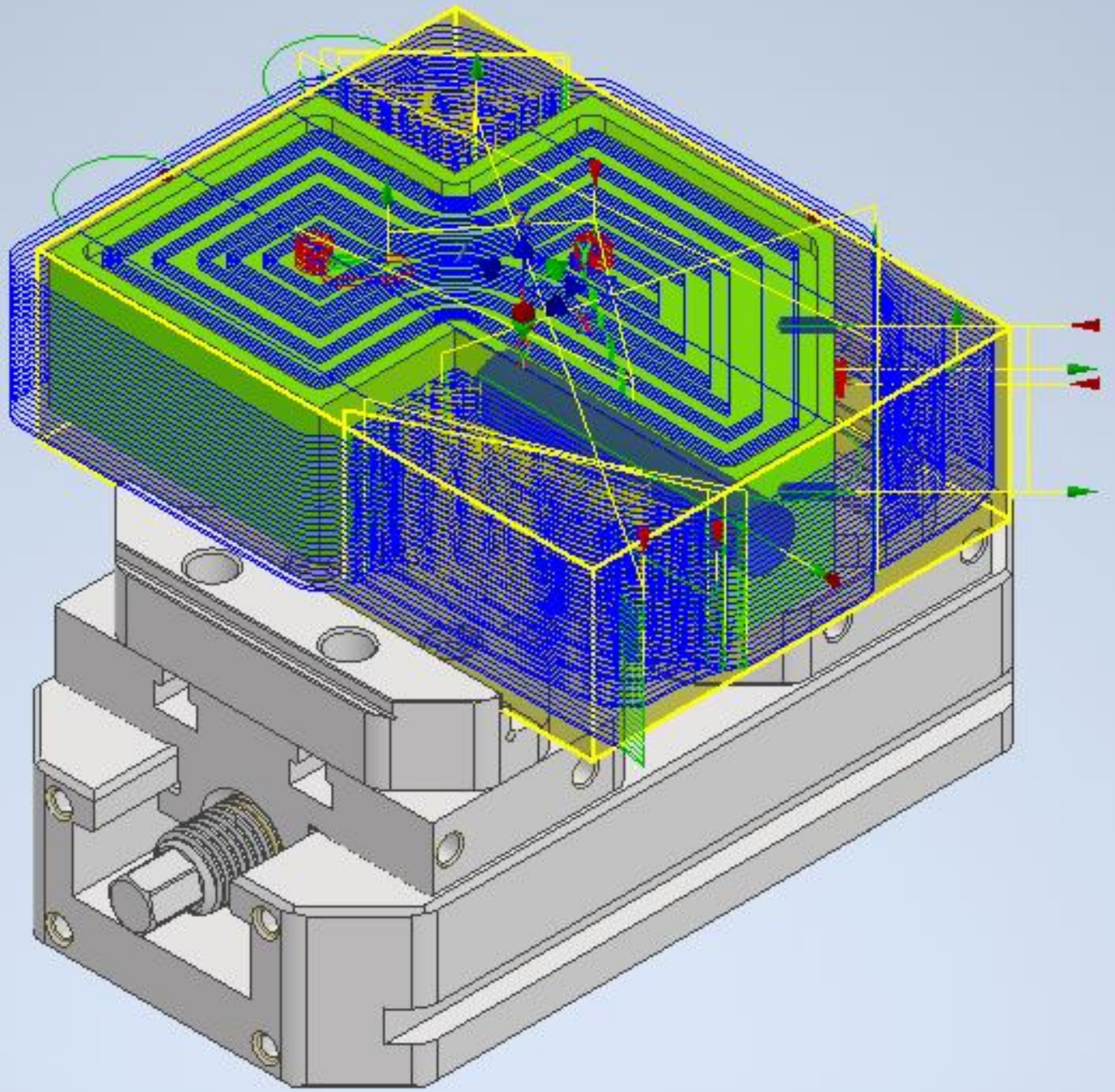
Look at the Features

Look at what can be machined easily

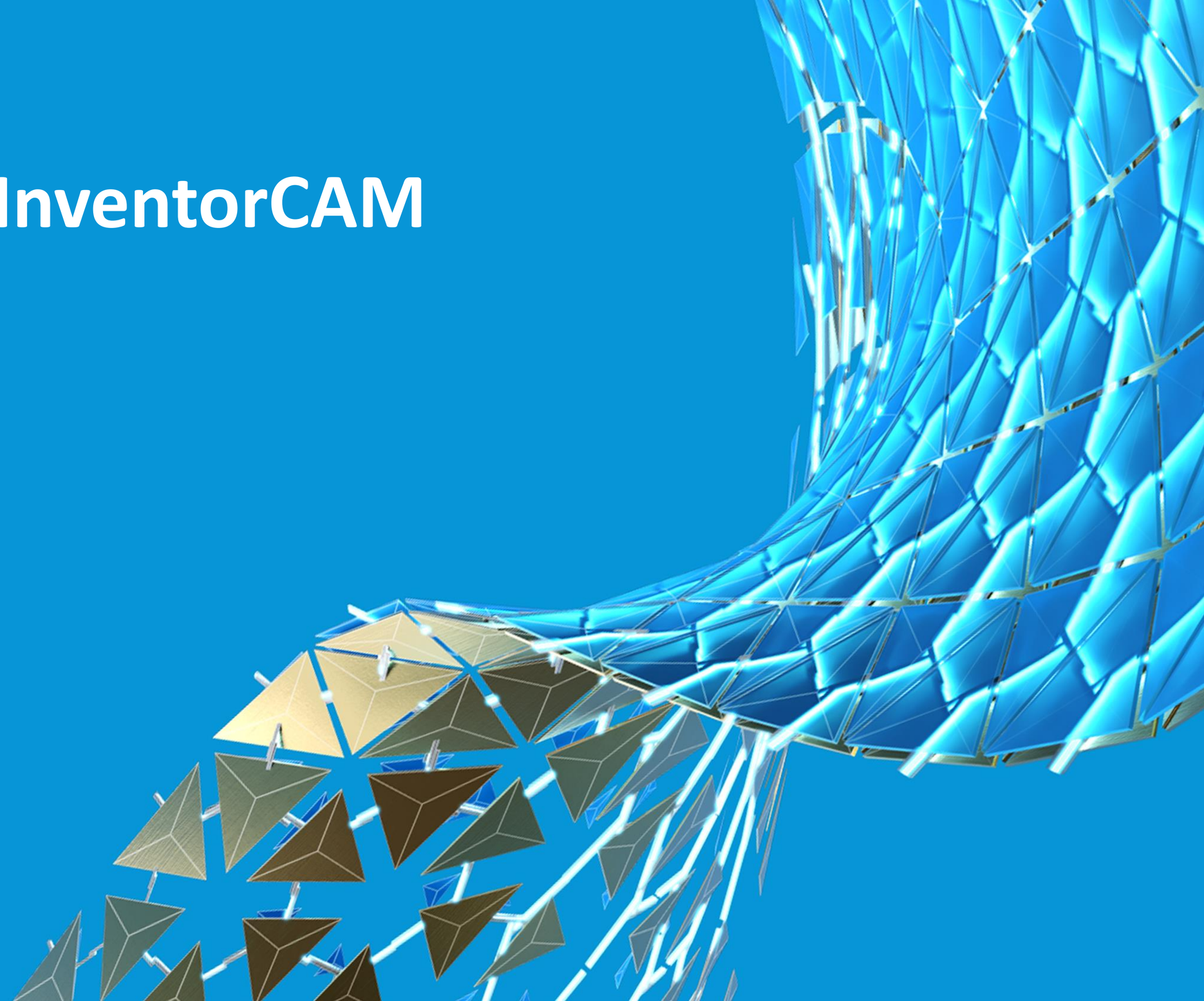
- **Breakdown how each machined feature can be done.**
- **Looking at cutout view we can see we have features that are machined into faces.**
- **Can we machine multiple features of the component within a setup?**

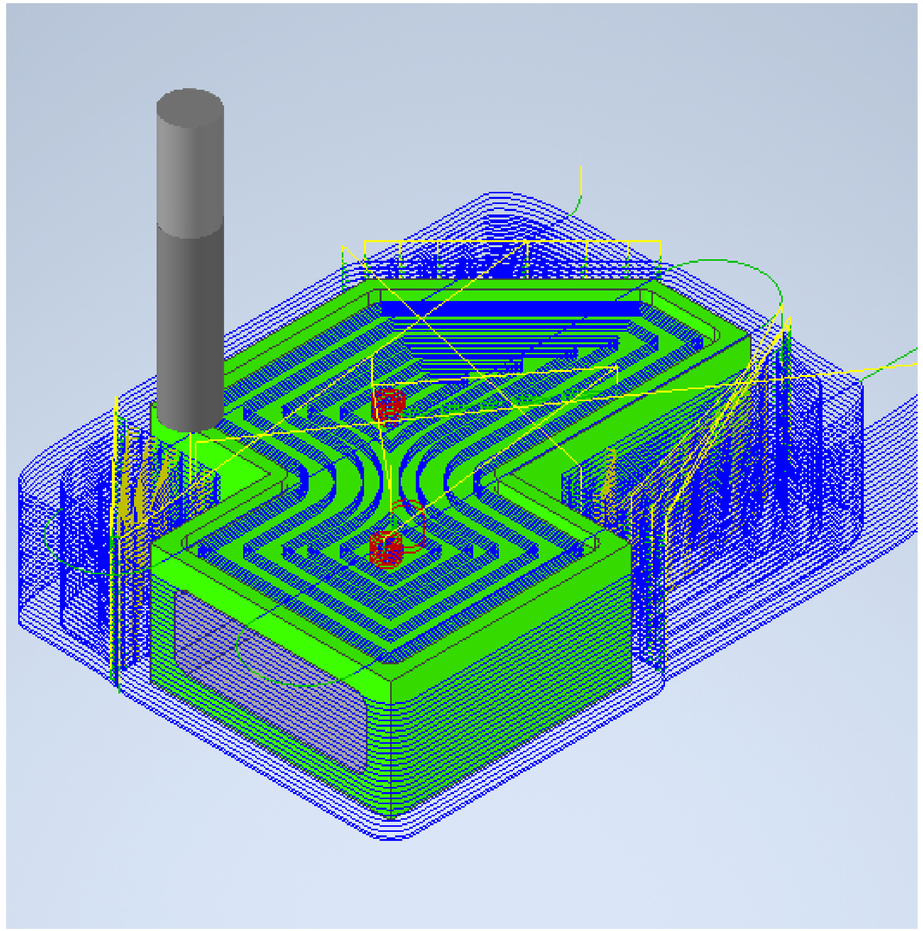
What can we machine





CAM Demo - InventorCAM



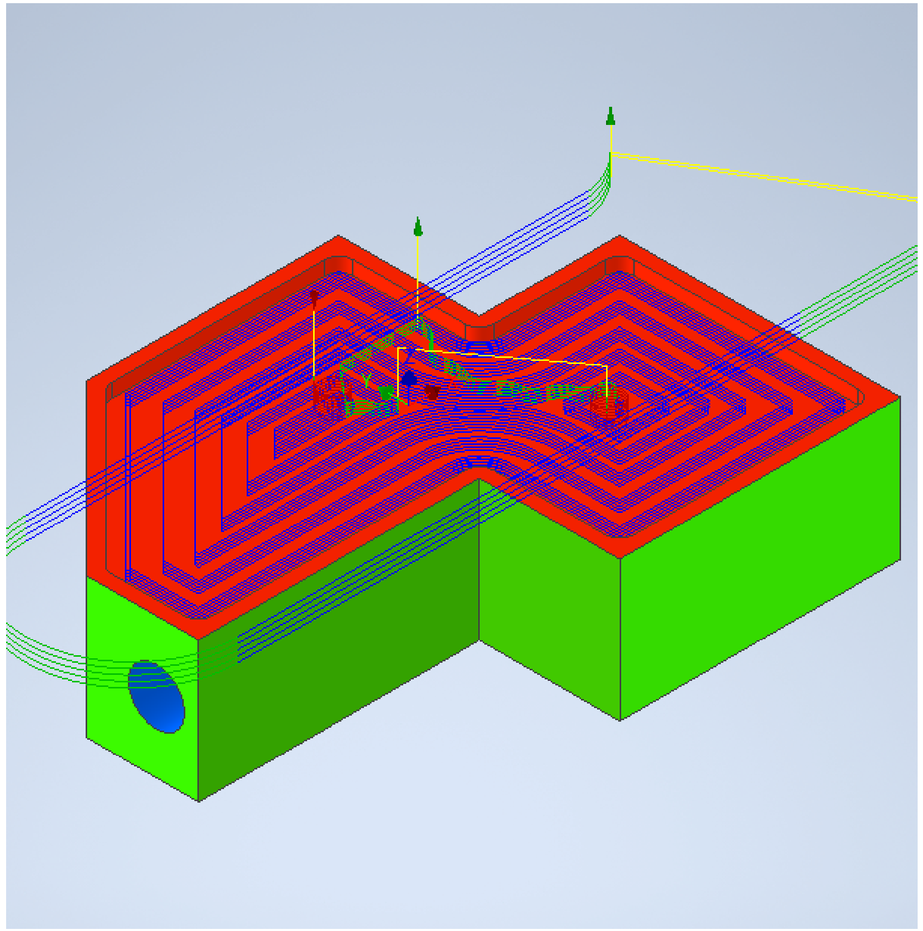


On a 3 Axis Machine

What can we machine in Op 1 setup?

- **Remove material from top of billet, machine pocket and outer profile.**

Note:- Because of the orientation of the cutting tool to the component, this is why we can only machine the faces shown in green.

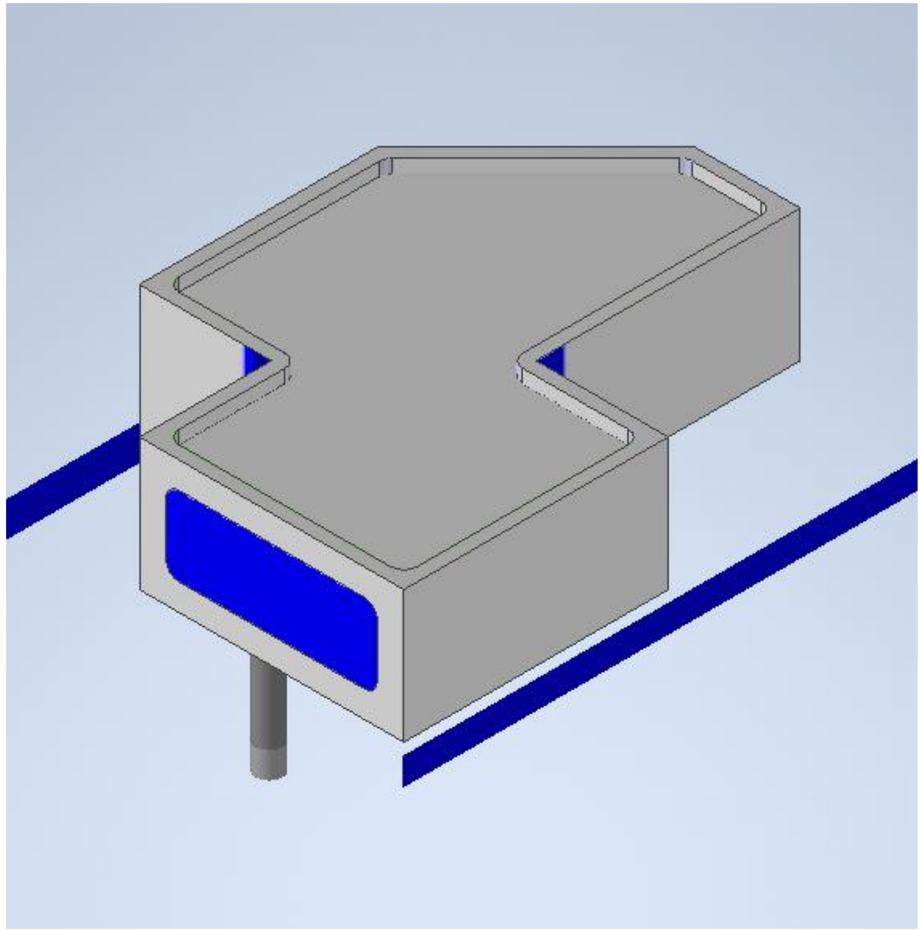


On a 3 Axis Machine

What can we machine in Op 2 setup?

- **Remove material from bottom of billet, machine bottom pocket.**

Note:- Because of the orientation of the cutting tool to the component, therefore we can only machine the faces shown in red.

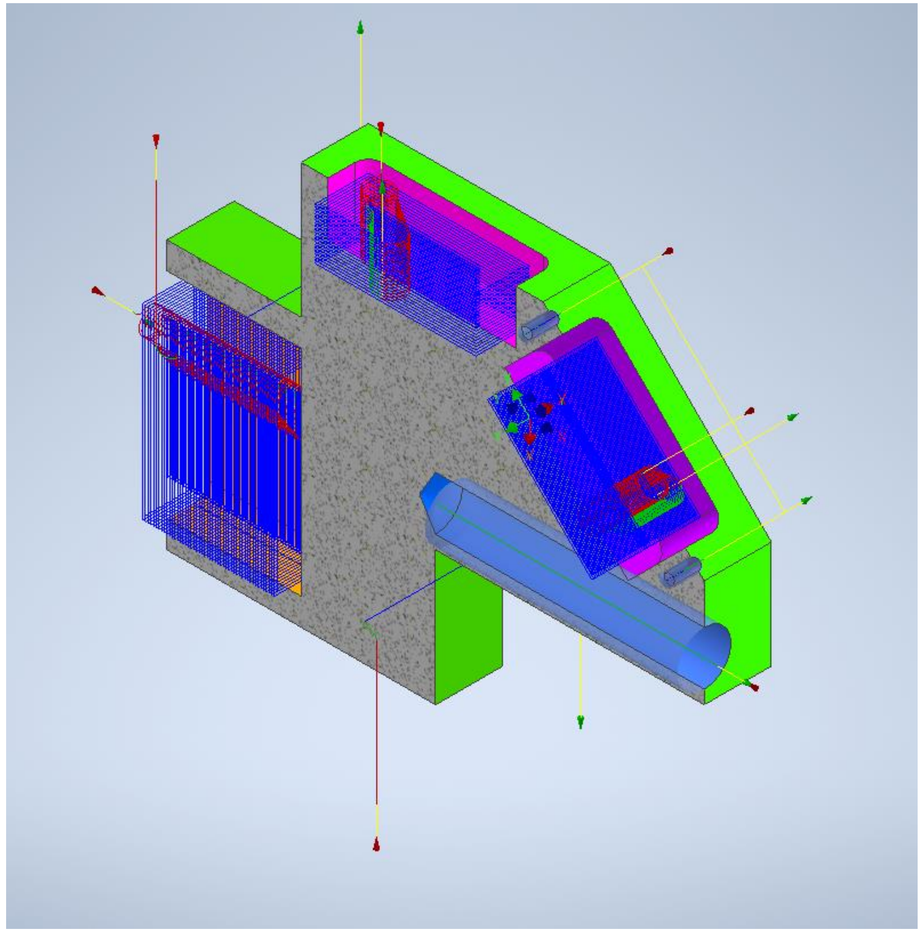


On a 3 Axis Machine

What do we have left to machine?

- **We have 3 pockets, 1 hole 20mm and 2 M5x0.5 tapped holes to machine. If we look at each face which has features to be machined this will tell us how many more setups are required.**

Note:- We also have material left in 2 corners shown in blue, this is where we have excess material left. This will require 2 setups to remove.

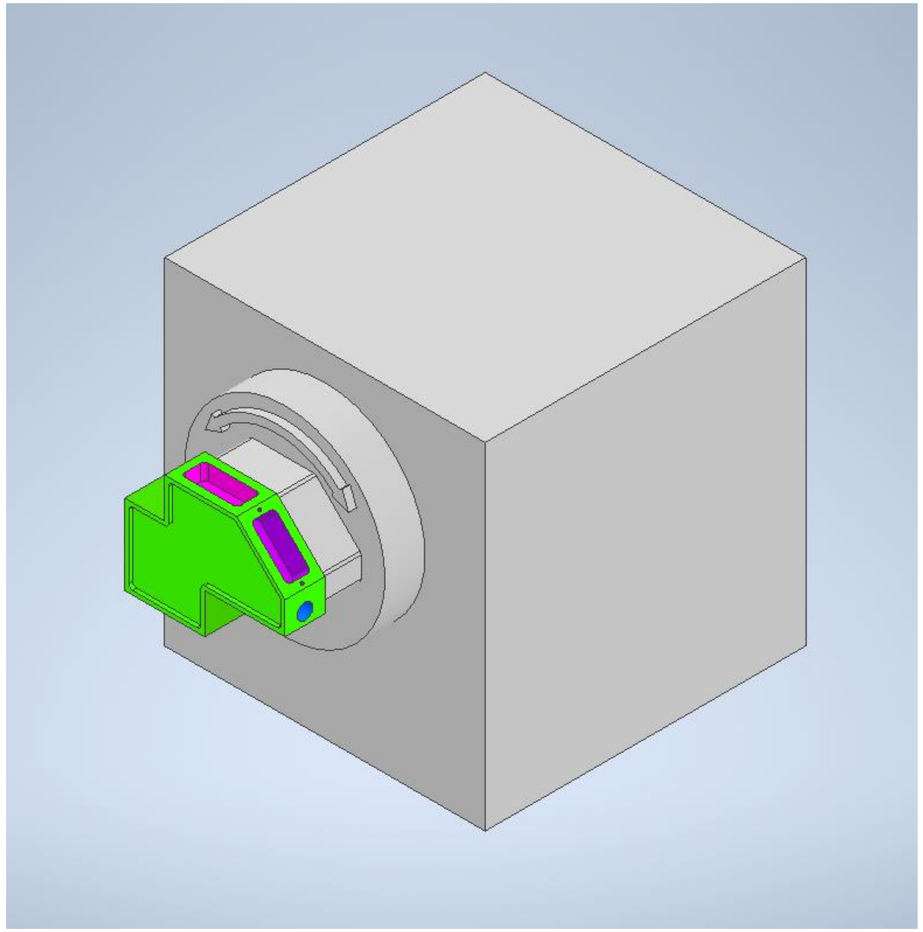


On a 3 Axis Machine

How many more setups needed

- **1 setup for 20mm hole**
- **1 setup for 45 degree pocket and 2 x M5x0.5 tapped holes.**
- **1 setup for top pocket**
- **1 setup for side pocket**
- **2 setups for corner material removal.**

So in total 8 setups would be required to machine this component on a 3 Axis VMC. This is because we must orientate cutting tool to each face which needs to be machined.



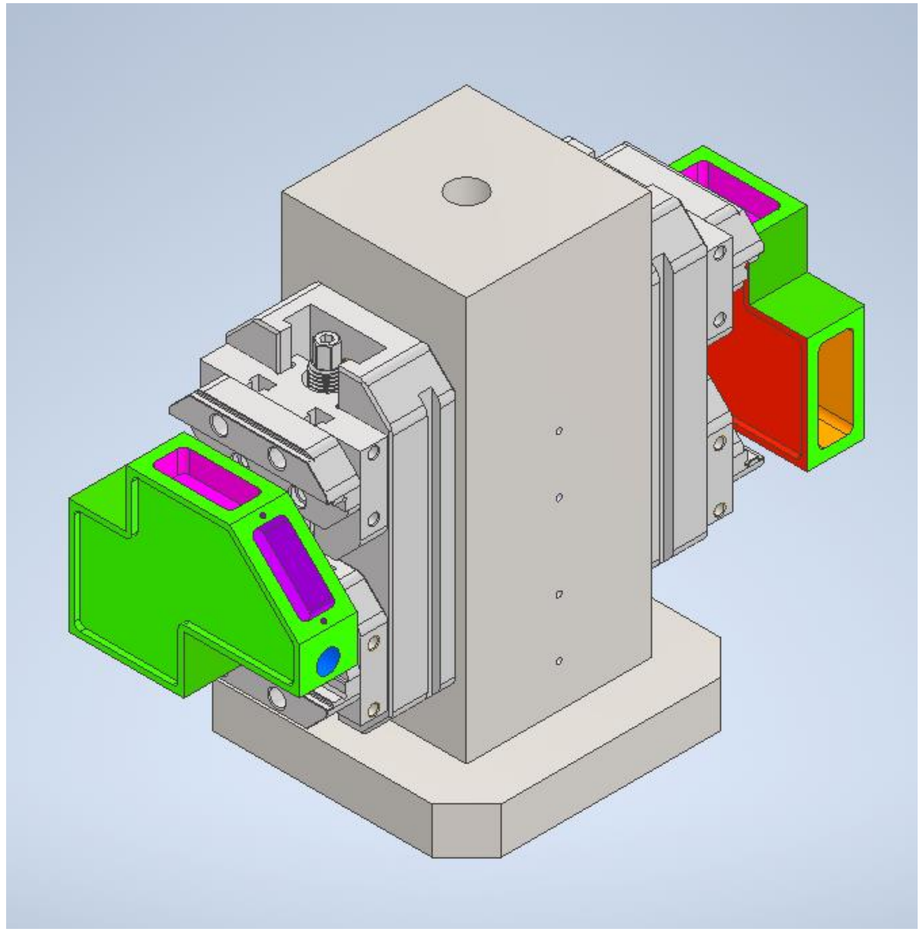
On a 3 Axis Machine with 4th axis

How many more setups needed

- **Op 1 & Op 2 would be exactly the same as previously machined features for a 3 axis machine.**

However in Op 3 part would be fixtured to a 4th axis enabling the part to be indexed to correct positions for remaining 6 features to be machined.

<u>This will reduce number of setups from 8 down to 3</u>.



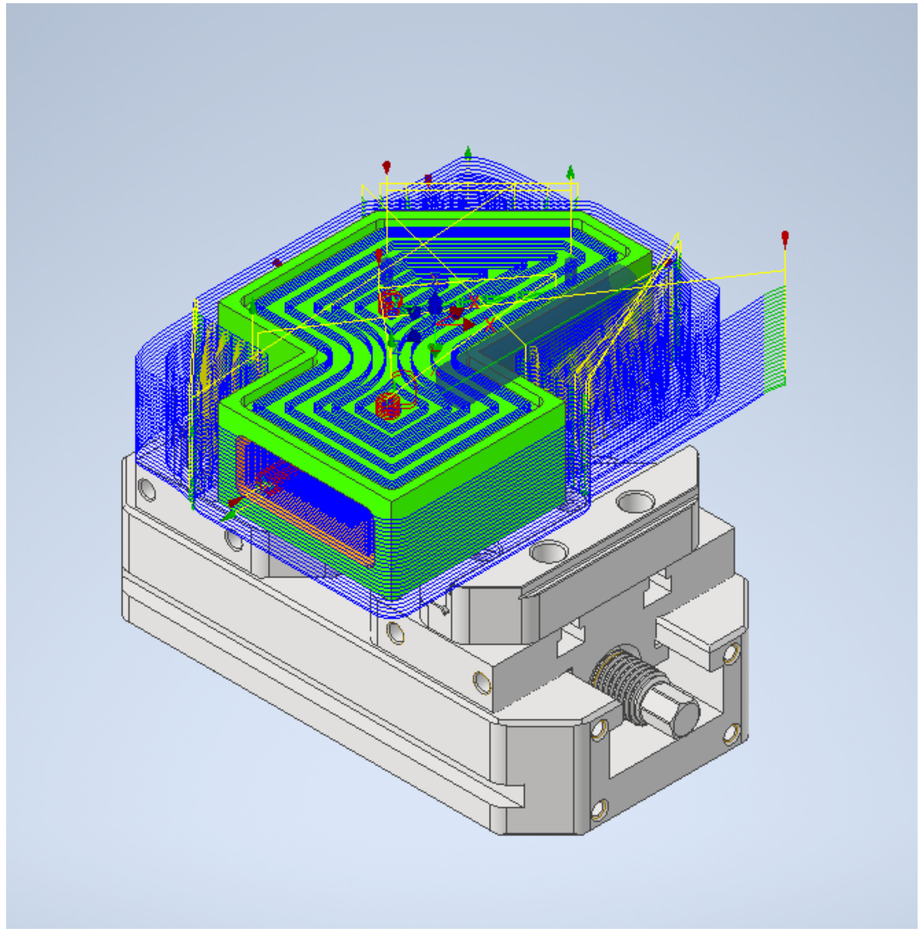
On a 4 Axis Horizontal Machine

How many more setups needed

- **Op 1 & Op 2 would have same features machined as 3 axis machine, but additional features can be machined as component can be rotated around on tombstone, which means end features can also be machined. So Op 1 would also have 20mm hole machined and side pocket. Op 2 part would be rotated 90 degrees in vice and corners and top pocket could also be machined.**

However in Op 3 part would be fixtured at 45 degrees to machine the angled pocket and M5x0.5 tapped holes shown in purple.

This will reduce number of setups from 8 down to 3.



On a 5 Axis Horizontal Machine

How many more setups needed

- **Op 1 & Op 2 would have same features machined as 3 axis machine, but additional features can be machined as component can be rotated by 2 rotary axis. 1 axis can rotate around + or – 110 degrees and the other rotary axis can rotate the table around 360 degrees where the vice is mounted which means end features can also be machined. So Op 1 would also have 20mm hole machined, 45 degree angled pocket, 45 degree M5x0.5 Tapped holes, top pocket and side pocket. Op 2 part would be rotated 90 degrees in vice and corners could also be machined.**

This will reduce number of setups from 8 down to 2.

No of setups required to machine part

8
SETUPS

3 axis VMC would require to machine component.

3
SETUPS

3 axis VMC with a 1 axis rotary axis table would require to machine component

3
SETUPS

4 axis HMC would require to machine component

2
SETUPS

5 axis VMC/HMC would require to machine component

Multi Axis Machine Tool Overview

3 AXIS MACHINING

BENEFITS

- Cheaper to buy

3 AXIS MACHINING WITH A 4TH AXIS

BENEFITS

- Reduction of setups to machine components
- More accurate components due to less setups
- Less fixtures required for setups
- Increased productivity due to less time spent setting up machines

4 AXIS MACHINING HORIZONTAL

BENEFITS

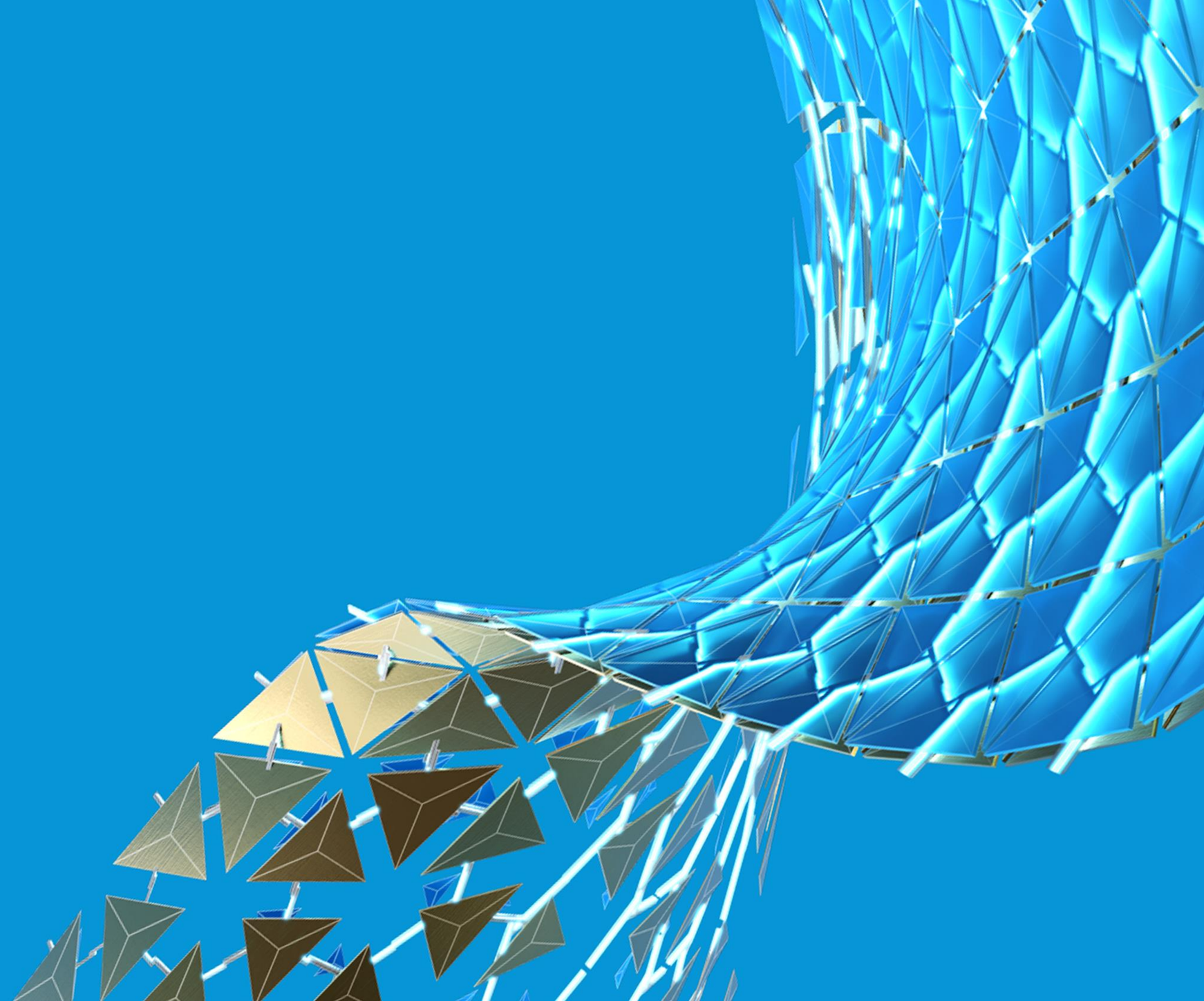
- Reduction of setups to machine components
- More accurate components due to less setups
- Less fixtures required for setups
- Increased productivity due to less time spent setting up machines
- Minimize mistakes with setups
- 2 Pallets as standard, so machine can be constantly machining

5 AXIS MACHINING

BENEFITS

- Optimized reduction of setups to machine components
- More accurate components due to less setups
- Less fixtures required for setups
- Increased productivity due to less time spent setting up machines
- Minimize mistakes with setups
- Can be easily automated to work with pallet systems or can come with pallet systems as standard depending on machine

Conclusion



Conclusion

3 AXIS VERTICAL MACHINING CENTRE

We can see that using a 3 axis VMC is the least efficient method for machining this part.

It took 8 setups to be able to machine component.

5 AXIS VERTICAL/HORIZONTAL MACHINING CENTRE

By using a 5 Axis VMC/HMC we can machine even more sides of a component in 1 setup. By having 1 additional axis enable us to get down to 2 setups to completely machine this component.

3 AXIS + 4TH AXIS OR 4 AXIS HORIZONTAL MACHINING CENTRE

Using a 3 axis + 4th axis VMC or a 4 axis HMC can offer the ability to machine more sides of the component in a fixture.

By changing from 3 to 4 axis machining we could machine the same part with 3 setups instead of 8.

FINAL THOUGHTS

We can see by adding additional axis to a machine how it can significantly reduce the amount of time it takes to setup and machine components. Also because there a less setups and more features are being machined at the same time, parts will be more accurate.

Learning Objectives

- Understand what feature we need to machine on a component.
- Look at how we would go about machining part, specifically workholding and understanding how many setups would be required.
- How installing a 4th axis onto the 3 axis VMC would reduce setups.
- How a 4 axis HMC would reduce setups.
- How a 5 axis VMC/HMC would reduce setups the best.

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