HEXAGON
MANUFACTURING INTELLIGENCE

ALPHACAM 2020.1
WORK PLANES

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Conventions used in this manual

To enable you to use the information in this guide effectively, you need to understand the conventions used in the guide to represent differing types of information.

- Buttons on the screen are represented as the button text in square brackets.
  For example: Click on **[OK].**
- Keys on the keyboard are represented as bold lettering in between **< >** characters.
  For example: Press **<Enter>.**
- Ribbon Tab options are represented as a path with the Ribbon Tab in **UPPER** case with sub menus Capitalised and separated with an arrow
  For example: Select **FILE > Open.**
- Field names are represented as bold text. And the value to be entered will be represented by Bold Text.
  For example: Enter the value **50** in the **Offset** field. Or
  When prompted for the X & Y values type **100,50 <Enter>**

Denotes a **<LClick>** or Primary Mouse Button Click.

Denotes a **<RClick>** or Secondary Mouse Button Click.

This is a note. It contains useful or additional information.

This is a reference. It directs you to another part of the user guide.

This is a thought box. It is generally used in exercises and contains a question for you to consider.

This is a highlighted note to emphasise information

This is a warning; it contains information that you must not ignore.

This is a tip. It is generally used in exercises and offers further advice.

1. This is the first line of a number list item
2. This is the second item of the numbered instructions, which you must
3. Follow in sequence.

- This is a list
- of items, in which
- The order is not important.

Recommended Operating Systems and Hardware for ALPHACAM

Supported Operating Systems

- **Operating System**
- **64bit** operating systems of the following list are supported,
  - Windows 7 (Professional, Enterprise or Ultimate) SP1 required,
  - Windows 8.1 Professional and Enterprise,
  - Windows 10 Professional and Enterprise.
- ALPHACAM will install and run on the 'Home' editions of the above operating systems. However, this is not recommended, and we cannot guarantee to fix any ALPHACAM issues specifically related to these operating systems.
- Nvidia or ATI Open GL Graphics Card with 1Gb dedicated memory

We recommend you keep up to date with the with the latest Software Updates for the supported operating systems and drivers for your hardware base.

Any Windows Operating system (OS) prior to and including Vista, is not a supported operating system.

ALPHACAM Minimum Specifications

The latest minimum specification can be found at http://www.alphacam.com/systemrequirements

This minimum specification is to run any **Alphacam Essential** module, you will need to considerably increase the specification if you are working with solid models and producing the NC code for 3D machining and 3, 4, or 5 axis simultaneous machining strategies.

Your minimum specifications should be the fastest processor with the most memory and the highest specification video card that your budget will allow.

If using Autodesk Inventor Files, please check the current Inventor View requirements at autodesk inventor view

Hexagon Customer Portal

At Hexagon, we strive to provide you and your business with first class technical support and services. The Customer Support Portal allows you the tools you need to receive the best from your software. In addition to generating new and updating existing support cases, the portal allows you:

- Unlimited user logins for your company.
- Access to all your licenses for easy reference.
- Get the latest releases and software update at the touch of a button.
- View what is available on your support and maintenance schedule.
- Reference to the Customer Support Charter at any time.
- View the status of your Technical Support cases.
- View all purchased Professional Services like Training and Consultancy.

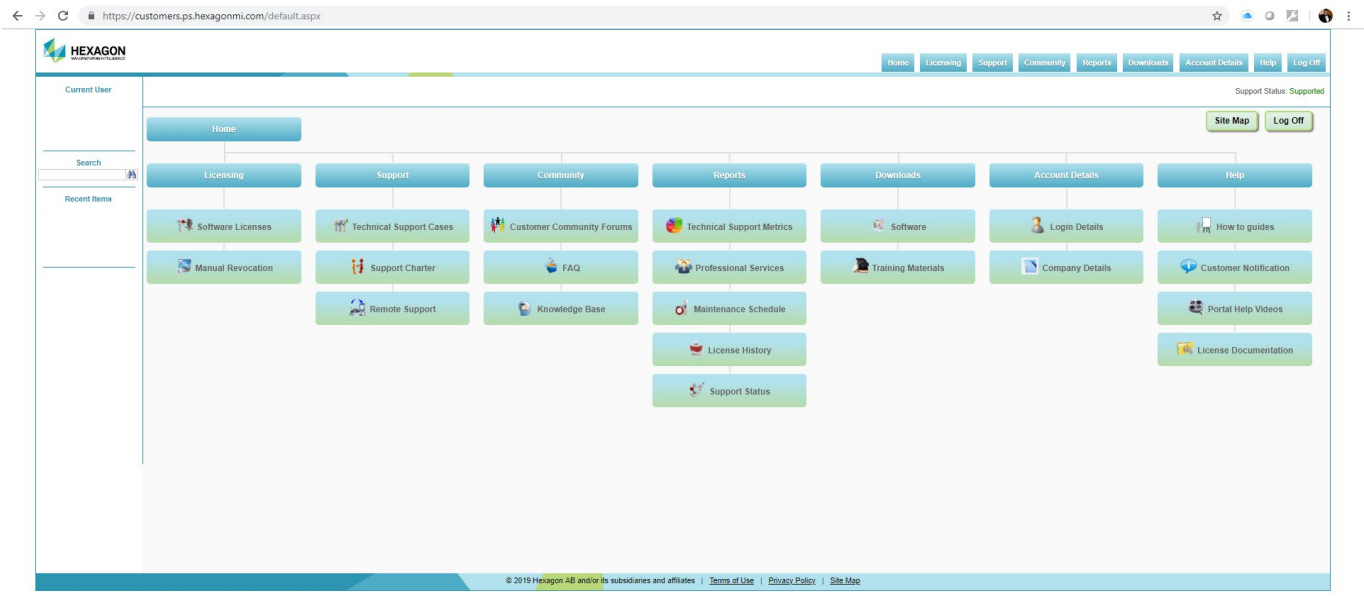


Figure 1 - Customer Support Portal

For the Hexagon Customer Portal visit customers.ps.hexagonmi.com

ALPHACAM esupport

Another location to gain valuable information about using the software or asking other experienced users for assistance are the esupport forums.

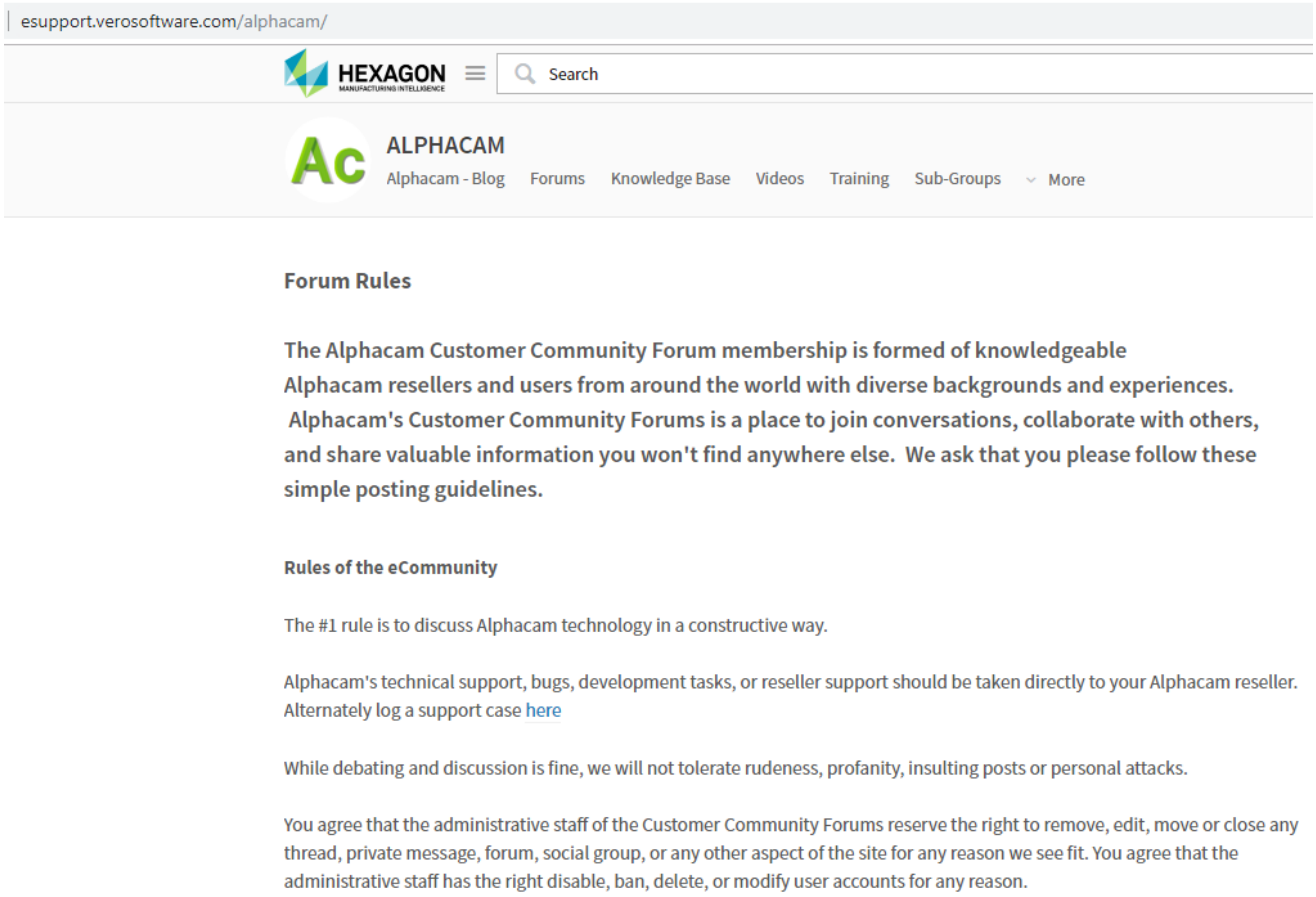


Figure 2 - esupport page

Asking a question of the community, using the knowledge base or other available information links could save you time if you have a problem that someone else may already have supplied a solution for.

Introduction

Objective

The purpose of this training course is to enable you to create Work Planes at any required angle and orientation suitable for geometry creation and machining.
It is the capabilities of the machine tool that places restrictions on the position and orientation of the work plane.

What are Work Planes?

Work planes are 2 Dimensional sections through 3D work space. The 2D section represents the working Z Zero plane.

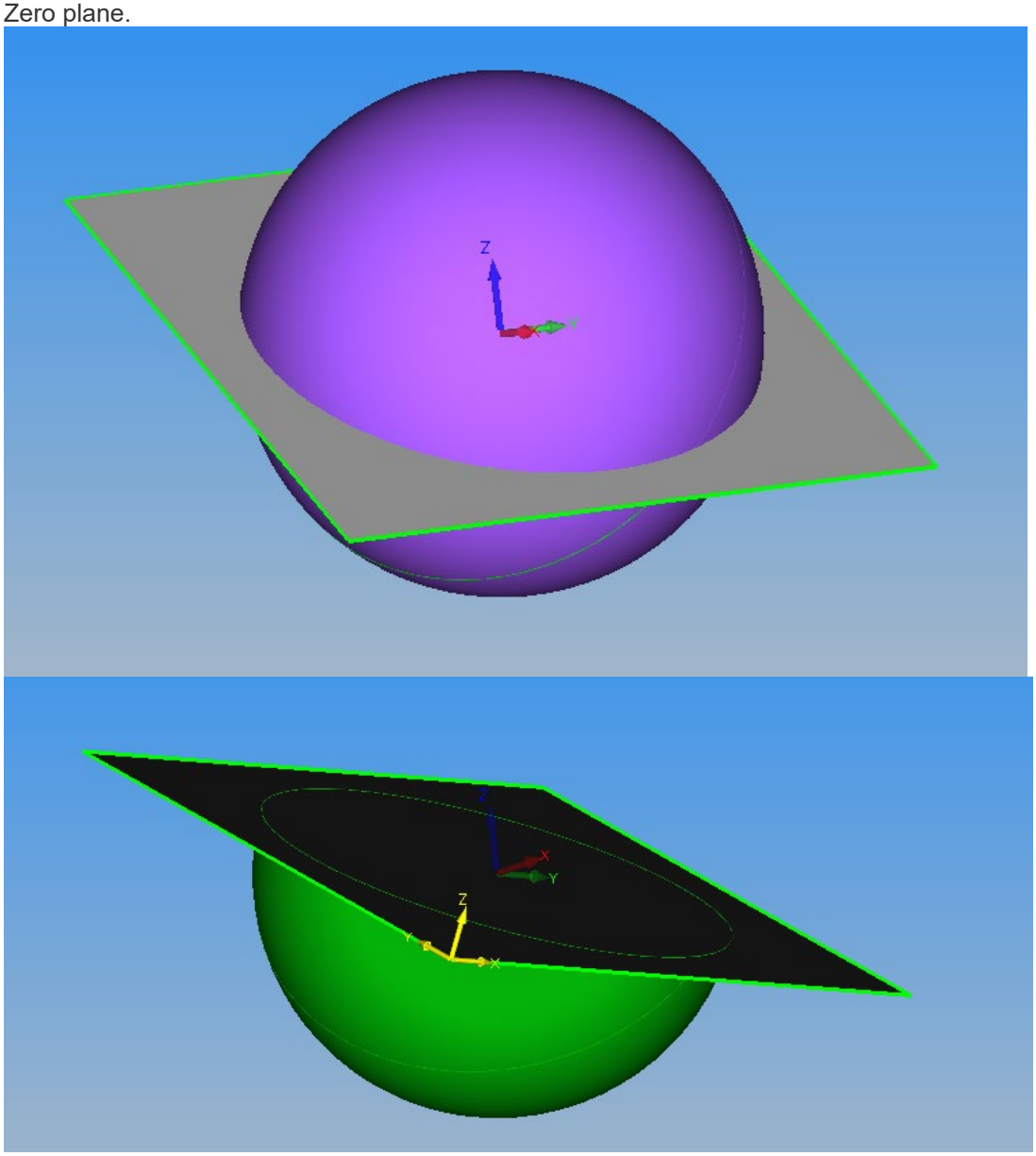


Figure 3 - Visual example in 3D of the concept of Work Planes

Work Plane Terminology

Global Datum

Global X0, Y0, Z0, shown in Red(X), Green(Y) and Blue(Z) also known as the World Coordinate System WCS. This is the equivalent of the main machine datum, for example G92 on a Fanuc based system.

Local Datum

Local X0, Y0, Z0, shown in YELLOW, also known as the User Coordinate System UCS. This is the equivalent of a machine datum shift (G54, G55, G56 or DX, DY, DZ).

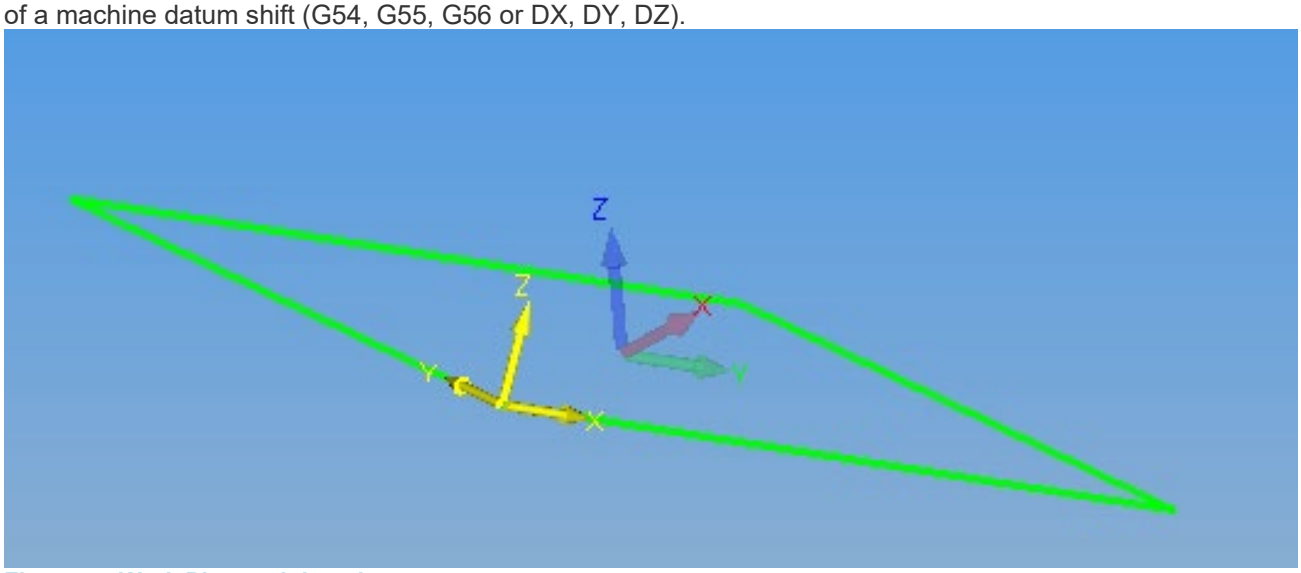
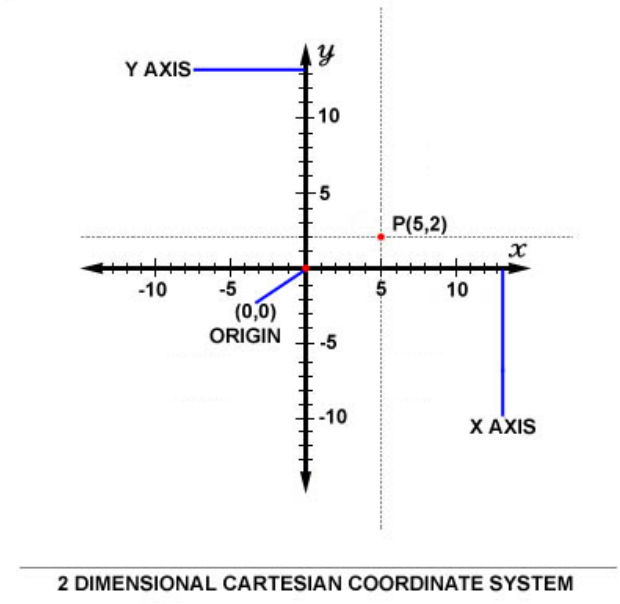
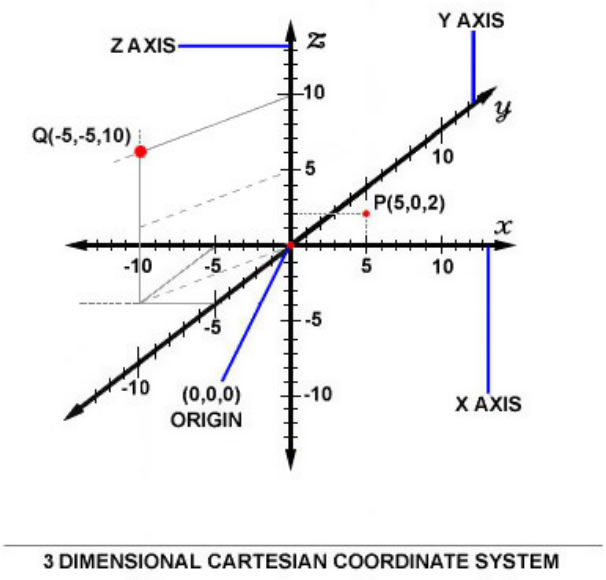


Figure 4 - Work Plane origin colour

ALPHACAM works using the Cartesian coordinate system.



2 DIMENSIONAL CARTESIAN COORDINATE SYSTEM



3 DIMENSIONAL CARTESIAN COORDINATE SYSTEM

Orientation of the Coordinate System obeys the Left hand rule.

This has implications for the use of the Rotate command, where the CW and CCW directions are always set when looking down the axis back towards the origin point around which the rotation will take place.

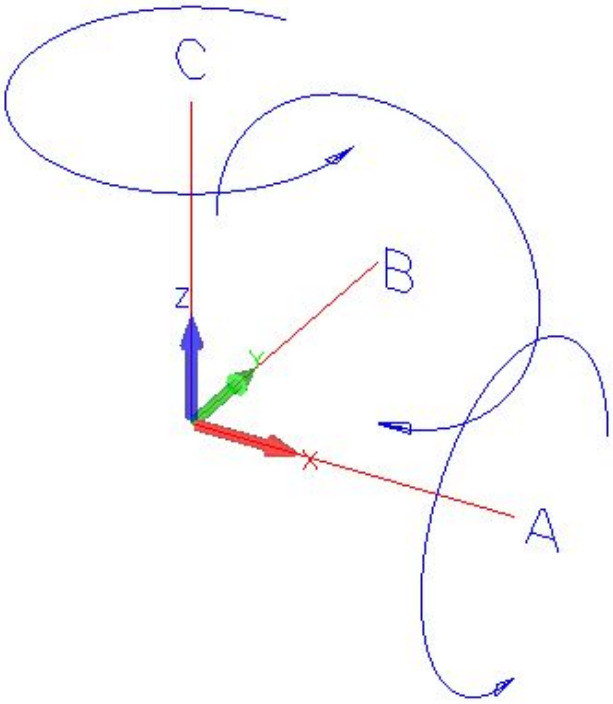


Figure 5 - Left hand rule for axis rotation

Flat Land

The term **Flat-Land** is used to represent the default 2D working environment.
It is like Paper Space, a piece of paper on the ground.
You cannot remove **Flat-Land** it is ALPHACAM's default drawing sheet.
Flat-Land is the default drawing status of ALPHACAM; it is the same as an infinite sheet of paper laid flat on the ground, upon which normal 2D geometry and tool paths are created.
Flat-Land's coordinate dimensions are with respect to the global X0, Y0, Z0 datum WCS.
For most applications geometries and machining can be done in flat land.

Geometries with Z Level Attributes

One area where confusion can arise is with geometry that has the Z level attributes set; this can give the appearance of the geometry being drawn on a different work plane to that which the geometry is associated.
A simple way of showing which geometries are associated to the current work plane is the **Ghost Tool Display**.
Ghost tools are only displayed for the geometries on the active work plane. If there is no active work plane, the ghost tools are only displayed for any geometries in **Flat-Land.**

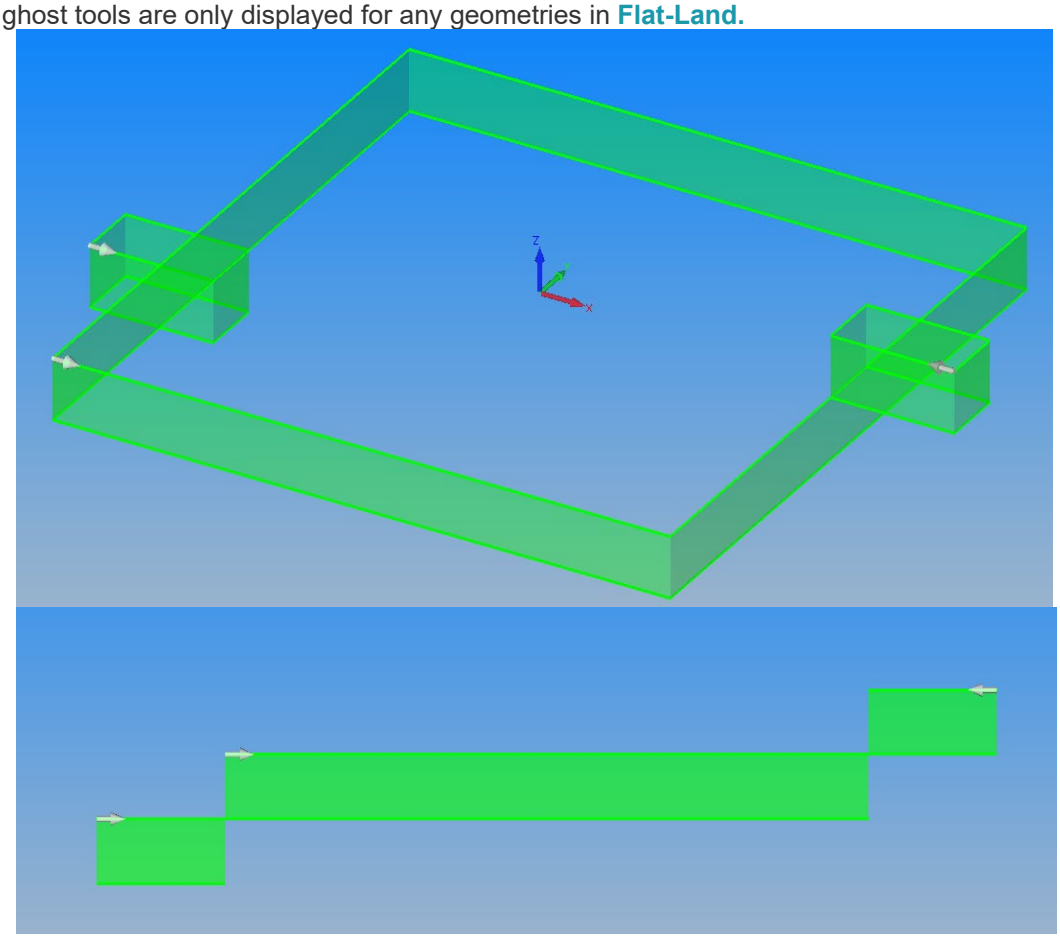


Figure 6 - Ghost Tools on all geometries indicates no work planes

Work Volume

The work volume is a rectangular bounding area enclosing the 3D working envelope. The purpose of the work volume is to give a visual perspective of the bounding area.

The creation of a work volume is not mandatory however it can be beneficial to inexperienced users. (The panel macro used in the Router modules, create a work volume).

Work Volume Creation

The work volume is created by converting a 2D Rectangle into a work volume and adding top and bottom Z values. The work volume is created with respect to global X0, Y0, Z0, datum WCS.

The command **3D > Set Work Volume** converts a 2D rectangle into a work volume.
Create a rectangle from **0, 0** to **200,100.**

Select **3D > Set Work Volume** and pick the rectangle.

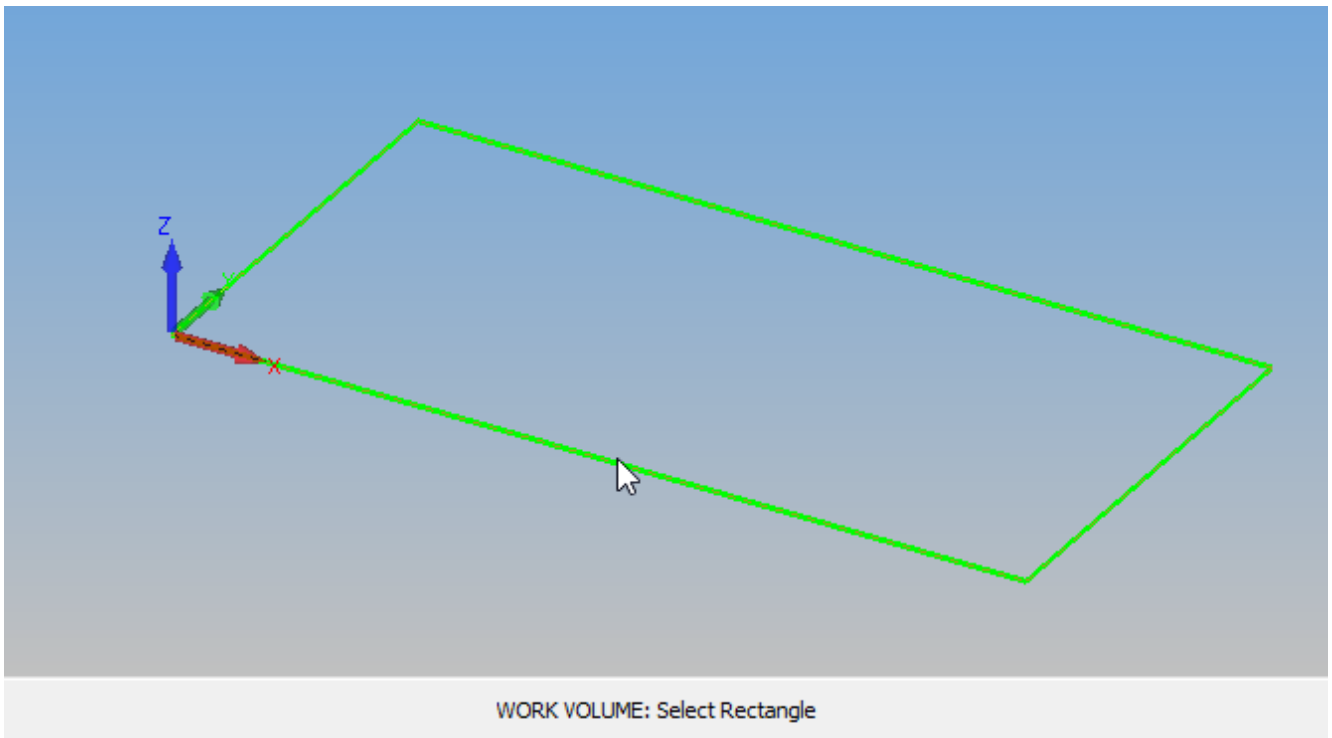


Figure 7 - Selecting the rectangle for a Work Volume

The Define Work Volume dialogue will be displayed set the Top Z to **0** and the Bottom Z to **-100.**

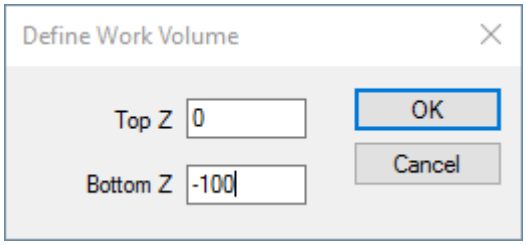


Figure 8 - Work Volume Z values

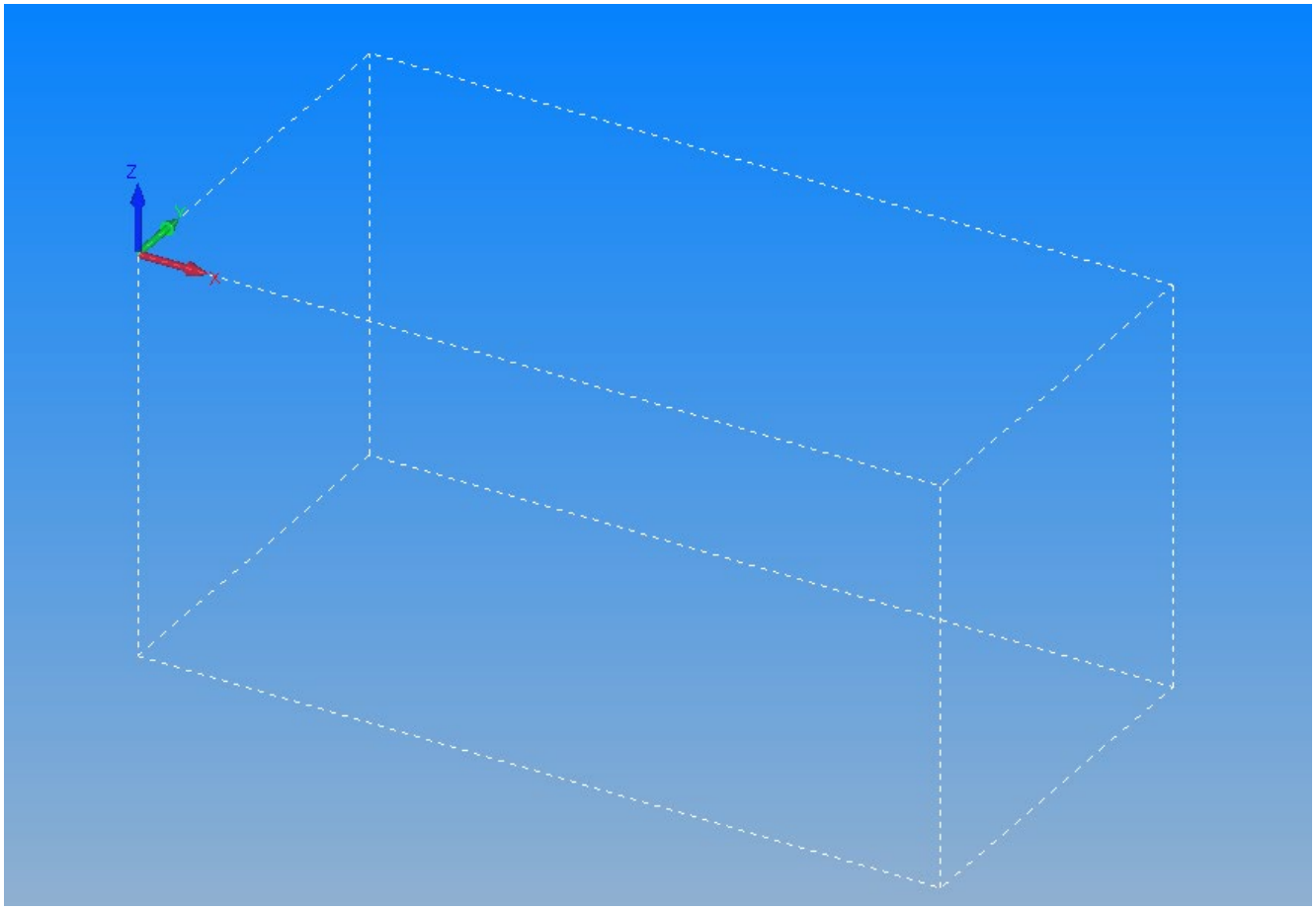


Figure 9 - Created Work volume

Select **WORK PLANES > Slice through Work Volume** pick the X axis top edge of the work volume.

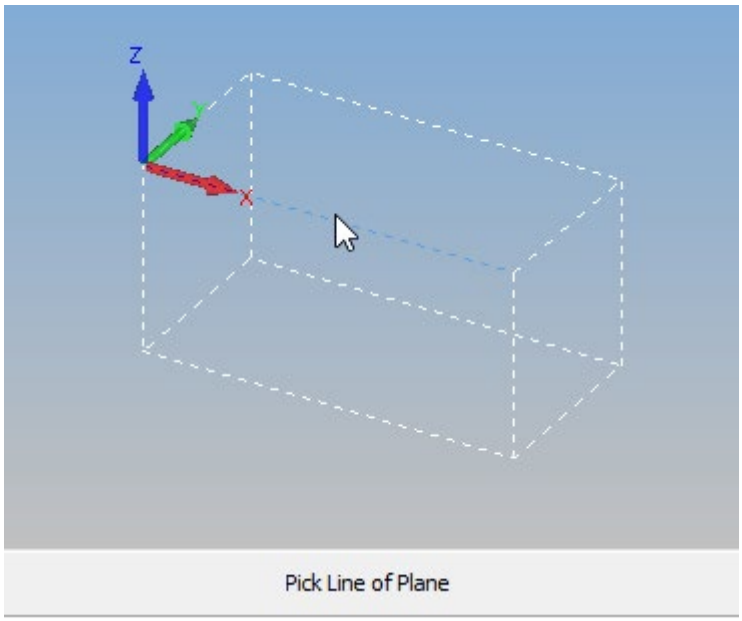


Figure 10 - Selecting a line to Slice Through

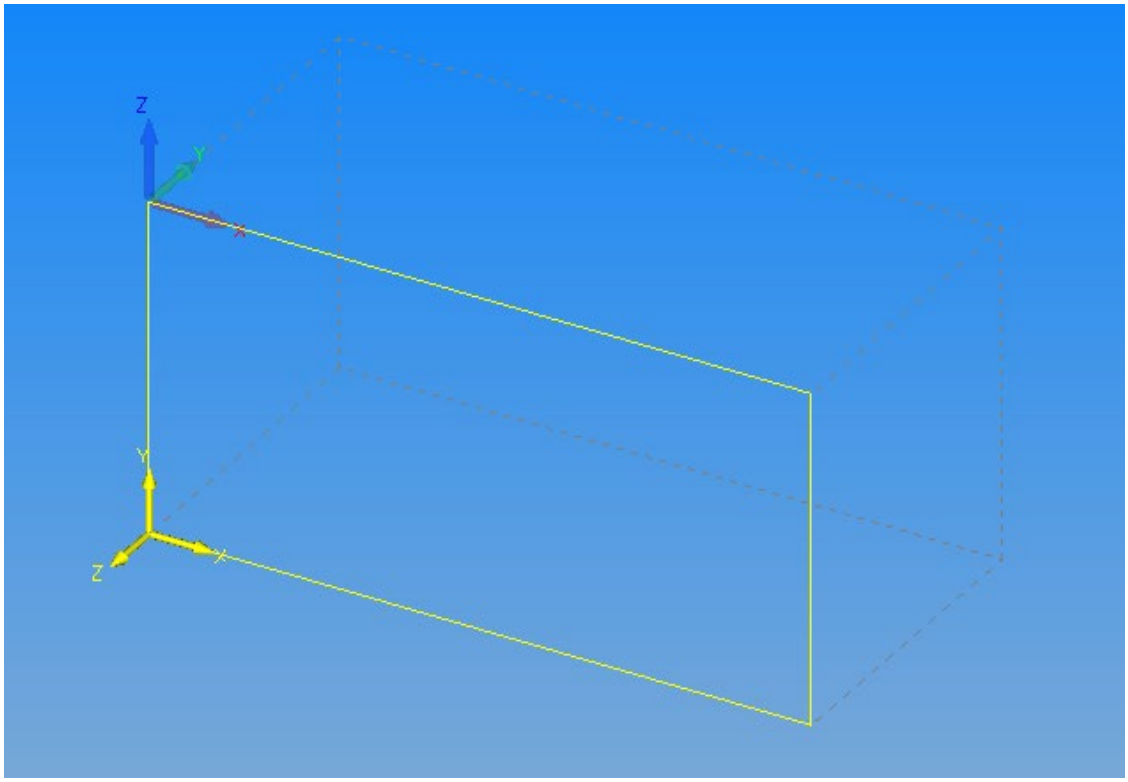


Figure 11 - Generated Work Plane

This example shows how using a **Work Volume** can allow simple side and end face work planes to be created.

Select **VIEW > Work Plane** this changes the view to only show the current work plane.

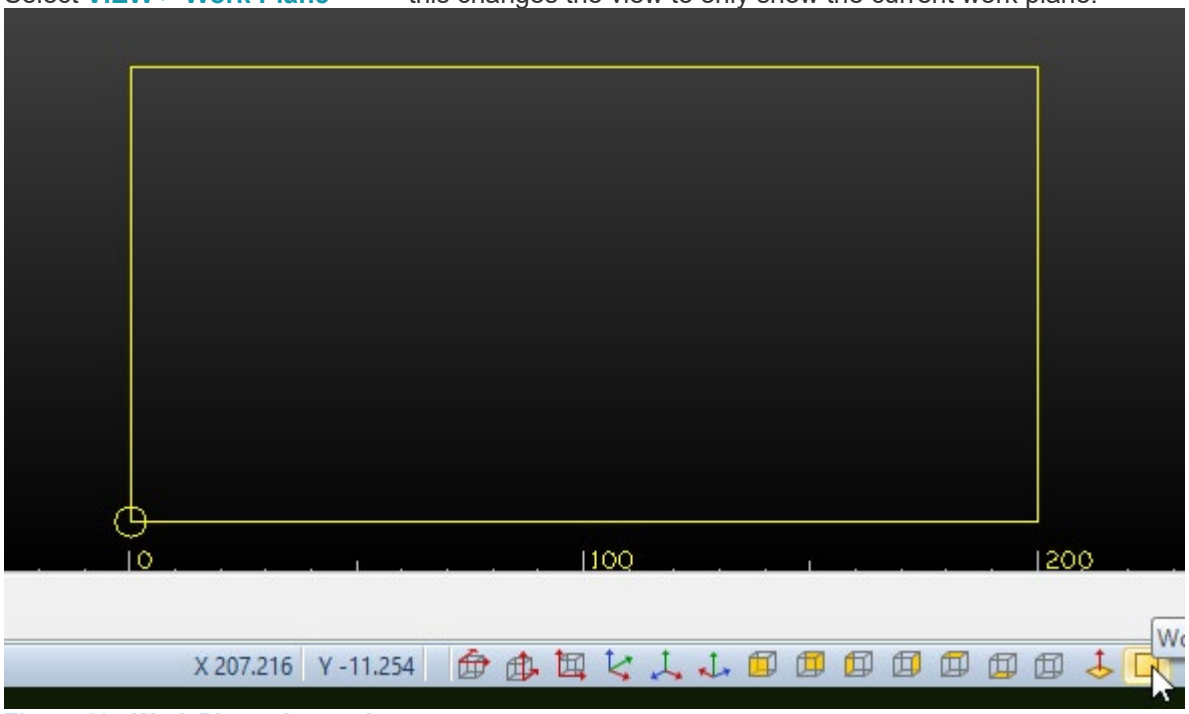


Figure 12 - Work Plane view option

Use the View options to see how they change the display.

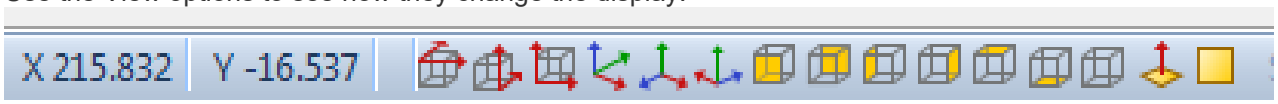


Figure 13 - View options from the prompt bar

Work Plane Specific Views

Set View down Normal

This will create a view looking perpendicular to selected Solid Model Face and include every other visible element in that view. This command is in the **Solid Model Utilities** tab.

Set View Normal to Work Plane

This sets the view to a 3D view looking normal to and through the current work plane. All items which are currently visible will be seen.

Set View Work Plane

This sets the view normal to the current work plane but only displays what is on the current work plane.

Work Plane Geometry Manipulation Commands

3D > 3D Project this allows geometry or tool paths to be projected onto a work plane.

EDIT > Move Copy etc. > Move this activates either a plane to plane or 3D move.

EDIT > Move Copy etc. > Copy this activates either a plane to plane or 3D copy.

EDIT > Move Copy etc. > Rotate this activates a 3D rotation about an axis.

EDIT > Move Copy etc. > Mirror this activates a 3D Mirror through a plane.

Geometries can also be copied and moved between work planes using drag and drop or Copy and Paste in the Project Manager.

Drawing Mode

Selecting one of the following options from the **EDIT > Auto/2D/3D** section of the ribbon will alter the active drawing mode of the current ALPHACAM drawing.
It is used to influence the manipulation commands Move, Copy, Rotate etc. to allow the drawing to be adjusted in basic 2D Flat Land or in a 3D scenario.

Auto

This allows the system to choose between 2D or 3D modes as appropriate.
If 2D items being manipulated are on the active work plane, the manipulation is 2D.
If 2D items being manipulated are NOT on the active work plane, the manipulation is 3D.
If 3D items are being manipulated the manipulation is 3D.

2D

This mode forces 2D manipulation for 3D Polylines and 3D tool paths and is like Auto choosing between 2D or 3D as appropriate for other situations.

3D

Forces all manipulation to work in 3D mode.

After using 3D mode always remember to set the mode back to Auto.

Work Plane Commands

Set Work Volume

This allows you to select an existing rectangle to convert to a work volume by setting the top and bottom Z values as shown.
There are some additional Add-ins that automate the work volume creation.

Auto Set Work Volume

This will automatically create a work volume bounding the extremities of, geometries (3D or with Z levels), or the toolpaths (including rapids).

Auto Set Work Volume on CAD Input

This will automatically create a work volume bounding the extremities of, geometries (3D or with Z levels). Auto set work volume does not work on 2D geometries.

> It is worth considering the orientation of the part when using the Auto Set option. If the part is not aligned to suit manufacture when created, then the created work volume on import will not be correct once the part is aligned for machining.

Set Work Plane Origin

This allows you to change the position of the local plane origin point with respect to the global origin position. The position set MUST lie on the active work plane.

Work Plane Properties

This allows you to set: The reference name/number of the plane as it is displayed in the project manager page. The Offset Number that is used by the post processor to reference the plane in the NC Code.

Order Work Planes

This option allows for the ordering of work planes to suit the shortest movement for toolpaths on differing work planes when using 4 and 5 axis moves.

Cancel Work Plane

This returns the status of ALPHACAM to **Flat-Land. It is** the same as picking **“Flat-Land” name o**n the Work Plane Project Manager Page.

Make Local Axis Horizontal

This command will automatically manipulate existing work planes so that either the X or Y axis is maintained Horizontal with respect to the Global Axis. This allows you to re-orientate planes to suit the machine configuration.

Work Plane ribbon section

This provides access to the commands that allow work planes to be created and activated. A work volume is not required to define work planes.
Activation of work planes can also be done from the **Work Plane** Project Manager page.

Slice through Work Volume

This allows any line geometry to be used as a knife which cuts through 3D space to create the work plane (2D section through 3D space).

The Slice command only works in one of the Ortho Views (XY, XZ, ZY) and any Slice in the ISO view will always be in the global Z direction.

When using the Slice command, you do not have control over the orientation of the local axes, it is important that you ensure the axes directions are suitable for your machine tool.

2 Lines for X and Y axes

This allows you to use two lines whose ends are coincident, that lay in different work planes, to define a work plane. The first line selected defines the new work planes X axis orientation. The second line selected indicates the new work planes Y direction. The lines meeting point is used for the origin position.

Existing Geometry

This allows you to pick geometry on screen and activate the plane on which the geometry is associated. If the command does nothing, then the geometry picked is in “Flat-Land”.
No new work plane is created.

Parallel to Current Plane

This will create a new work plane that is parallel to the currently active plane. The new plane is created the specified distance from the current plane in the Z axis direction. Positive or negative direction is allowed.

Perpendicular to Current Plane

This command will create a new plane that is perpendicular (90°) to the current plane.

Reverse Current Plane

This command will flip the current planes axes through the 4 possible orientations.

As Current Plane, Different Origin

This command will duplicate the current plane and allow you to set a new local origin.

By Name

This will display a dialogue showing the names of all the existing planes. The dialogue allows you to activate a plane from the list, (same as picking the name in the Project Manger page), or Clear, (delete all), Empty work planes. This is very useful if you create a work plane by mistake.

Best Fit Plane through Points.

This will activate a work plane that fits evenly through the points in a 3D spline or polyline the spline or polyline must contain at least 6 points. This option is used primarily when there are no natural 2D options or planar model faces available.

> Polylines and 3D splines exist in 3D space and NOT on work planes.

By Line Element Vector

This will create a work plane perpendicular to one end or the other of a selected 2D geometry line or 3D polyline. The direction and location of the work plane origin is determined by the direction in which the original element has been drawn and the selected answers to the creation dialogue options.

Normal to view

This will create a work plane in the exact direction that the user is viewing the drawing or solid model. This method of creating a work plane can prove very useful when no reference geometry is available, no 2D or 3D items or the solid model does not have a flat face.

From Solid Model Face

This will create a work plane that lies on the flat model face, or perpendicular to a model cylinder hole, selected.

Create 3D Work Plane

This method of work plane creation uses direct input rather than item selection.

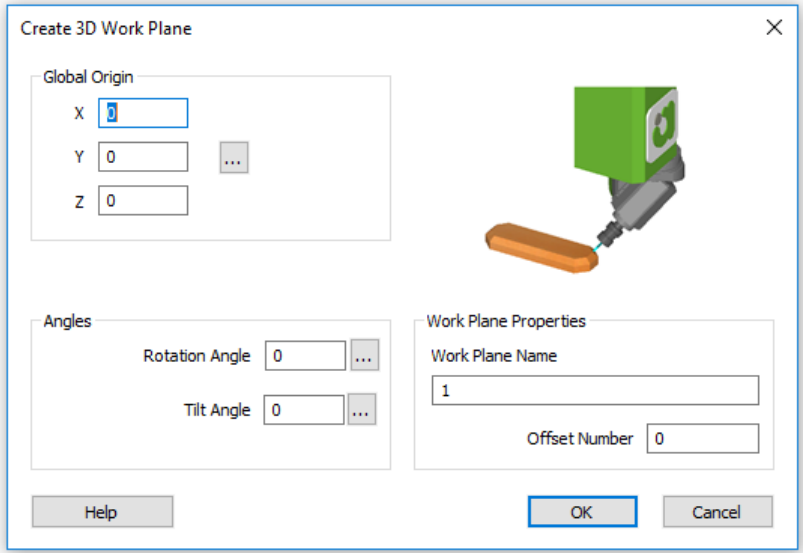


Figure 14 - Create 3D Work Plane dialogue

Using the X, Y & Z options, you can directly state where the work plane origin is to be located.

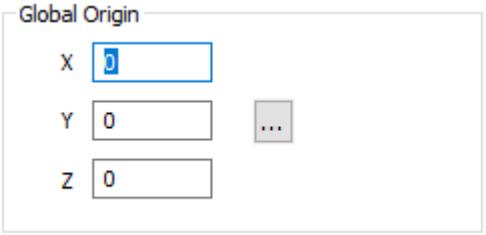


Figure 15 - Origin location

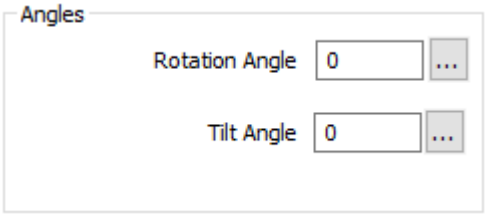


Figure 16 - Angles options

The **Rotation** and **Tilt** angles allow you to specifically set the required values, useful if you have a limited amount of movement on a machine head or table.

Using the browse option will allow you to set any to these options directly from the part.

> In some cases, it proves beneficial to have a tool selected so that you can see which way the Work Plane is created with respect to the machining that me be required.

Work Plane creation methods

There are basically 2 methods of creating a Work Plane:

1. Create the Work Plane using one of these options;

    a. Slice through Work Volume.

    b. 2 Lines for X and Y.

    c. From Solid Model Face.

    Then draw the geometry on the required work plane.

2. Create the Geometry and with the **Edit Mode** set to **3D**, use the manipulation commands Move, Copy, Rotate and Mirror to create and position the geometry, which will then automatically generate the work planes.

> After using 3D mode always remember to set the mode back to Auto, commands such as Array do not work when 3D mode is active.

> Whichever method is used to create a work plane REMEMBER to ensure the working Z axis points **OUT** from the active work plane.

Example of work planes

The following is an example of creating geometry using work planes. This example is based on creating planer geometries on 8 faces of an Octagonal part. The face numbers have no significance and are only there for means of identification.

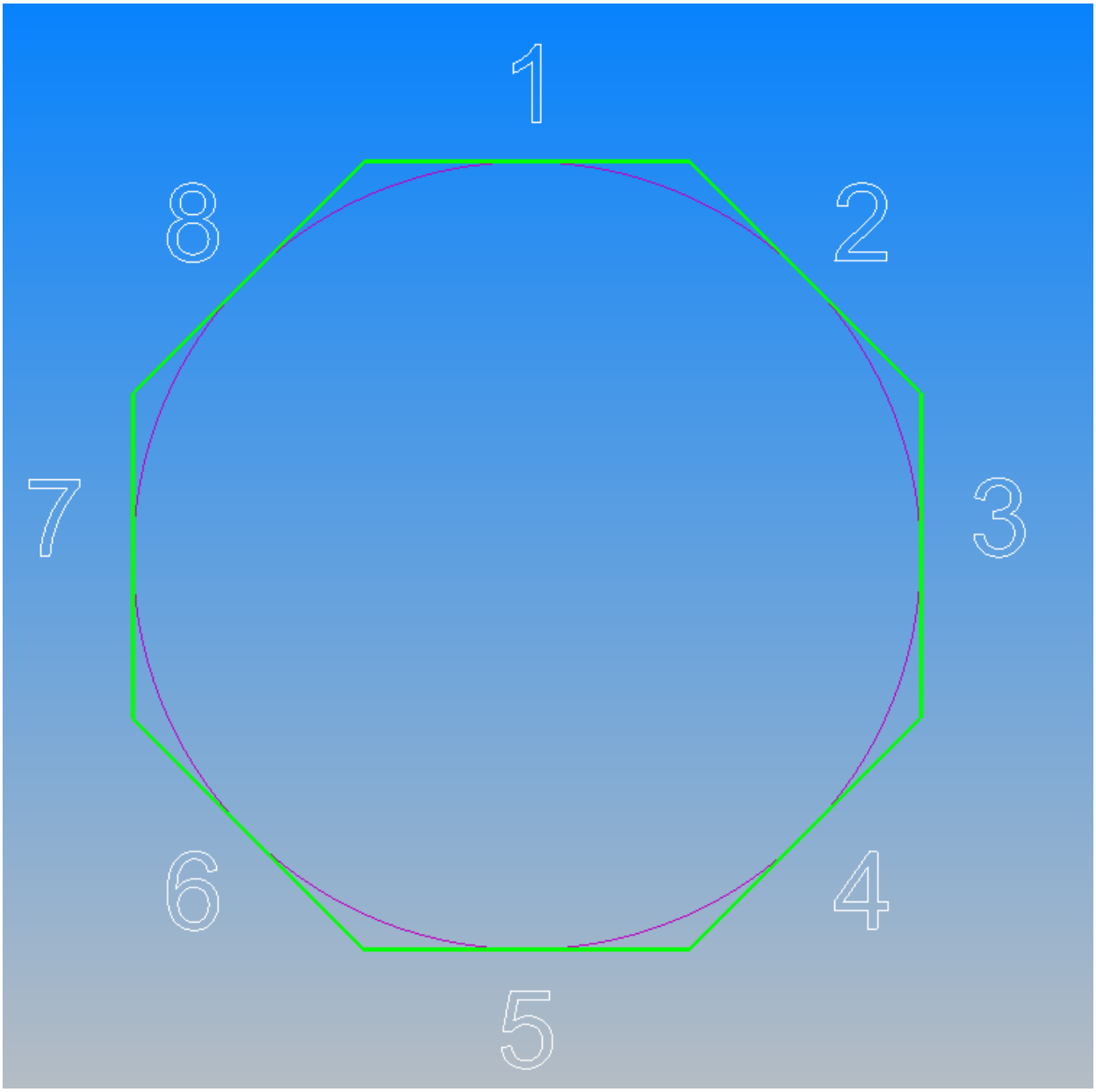


Figure 17 - Work Plane base creation drawing

The Octagon is created around a 500mm diameter circle.
We will create 4, Ø40 Circles in a 2 x 75 array in flat land and rotate them on to Face 1.

A work plane for Face 8 will be set up and 4 triangles based on a Ø40 circle, in a 2 x 75 array will be created.

These geometries will then be manipulated and duplicated on to the other faces.
The geometries are offset to the left of centre on the octagon face to enable you to appreciate the results achieved by each of the different manipulation methods.

- The Circles on Face 1 will be copied on to Face 5 using a **3D COPY.**
- The Circles on Face 1 will be **ROTATED** on to Face 2.
- The Triangles on Face 8 will be **MIRRORED** on to Face 4.
- The Triangles on Face 8 will be copied on to Face 7 using a **PLANE TO PLANE COPY.**
- The Circles on Face 1 or 2 or 5 can be copied to Face 3 using the project manager.
- The Triangles on Face 8 or 7 or 4 can be copied to Face 6 using the project manager.

The Geometry/Machining manipulation method used will depend upon what is required with the resultant Geometry/Machining.

When working on a work plane:
The 2D coordinates entered on the command line are from the local datum.
This can be repositioned using Set Work Plane Origin and its orientation can be altered using Reverse Current Plane.

Create the Octagon Geometry

Select **GEOMETRY > Special Geometries > Polygon** .
The Octagon is based **⊙ Outside** a **500mm** diameter circle positioned at **X0, Y0.**

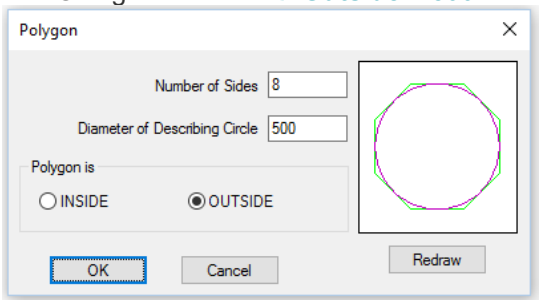


Figure 18 - Polygon dialogue options

Then using **GEOMETRY > Text** **place** the identifying numbers to make picking the correct lines during the course easier.

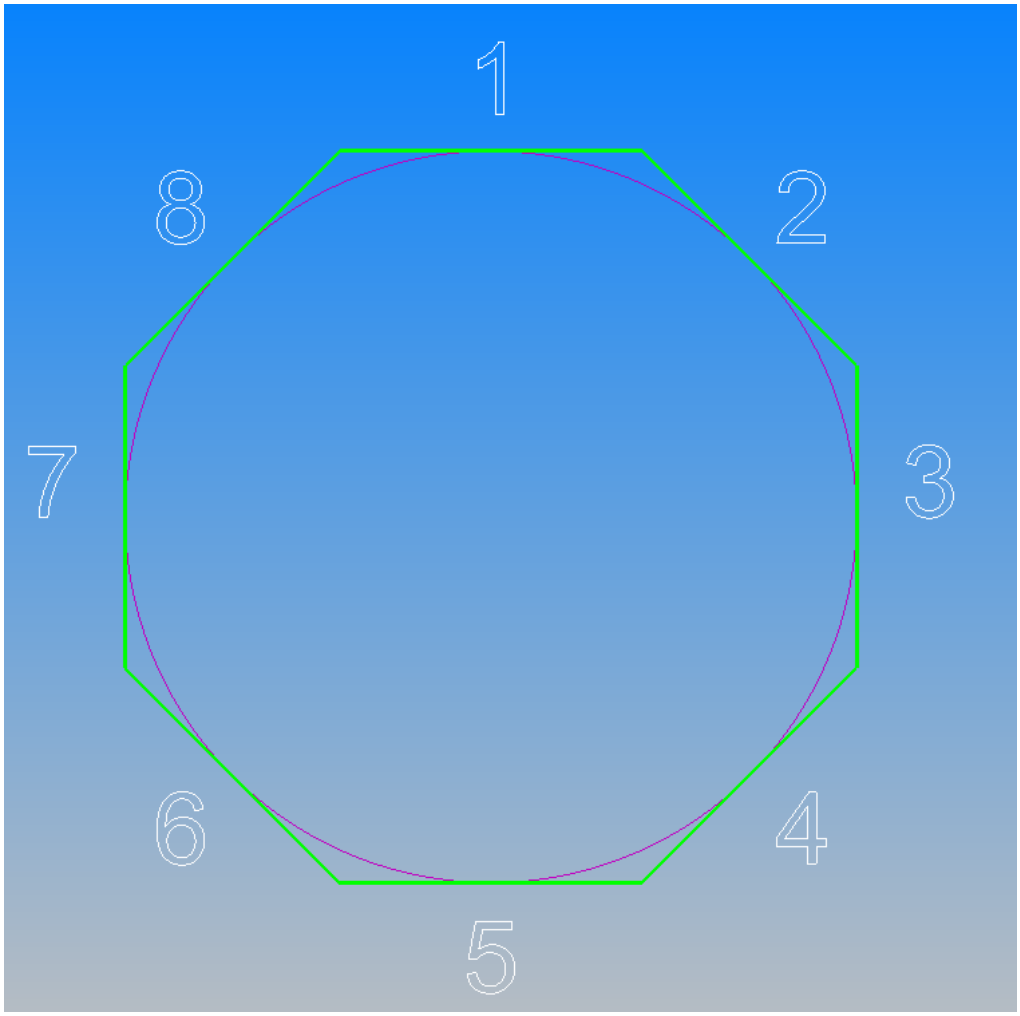


Figure 19 - Base Octagon with identifying numbers

Create the initial Circles for Face 1

Using **GEOMETERY > Circle > Centre + Diameter** .
Draw a Ø40 circle at **X-50, Y50**
<RClick> to finish.

Use the **EDIT > Array** command to produce 4 circles at 75 centres.
When prompted, **<LClick>** to select the previously drawn circle as the item to Array, then **<RClick>** to continue.

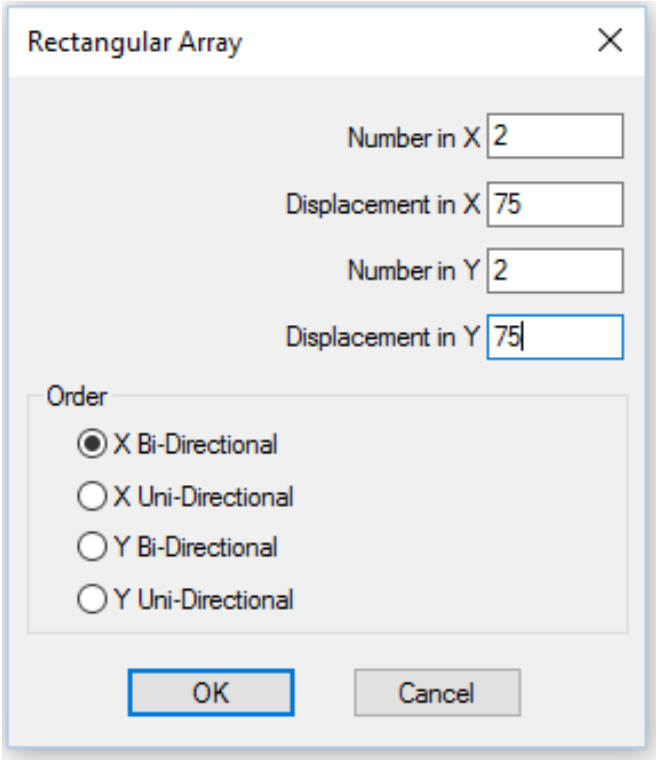


Figure 20 - Array dialogue options

Complete the dialogue with the figures as shown above.

<LClick> [OK] to place the new circles.

<RClick> to finish the command.

Use **EDIT > Move** selecting the four circles from the Array command.
For the **Base Point,** set the values as **X0, Y0.**
For the new location, **<LClick>**the mid-point **<F7>** of Line 1.

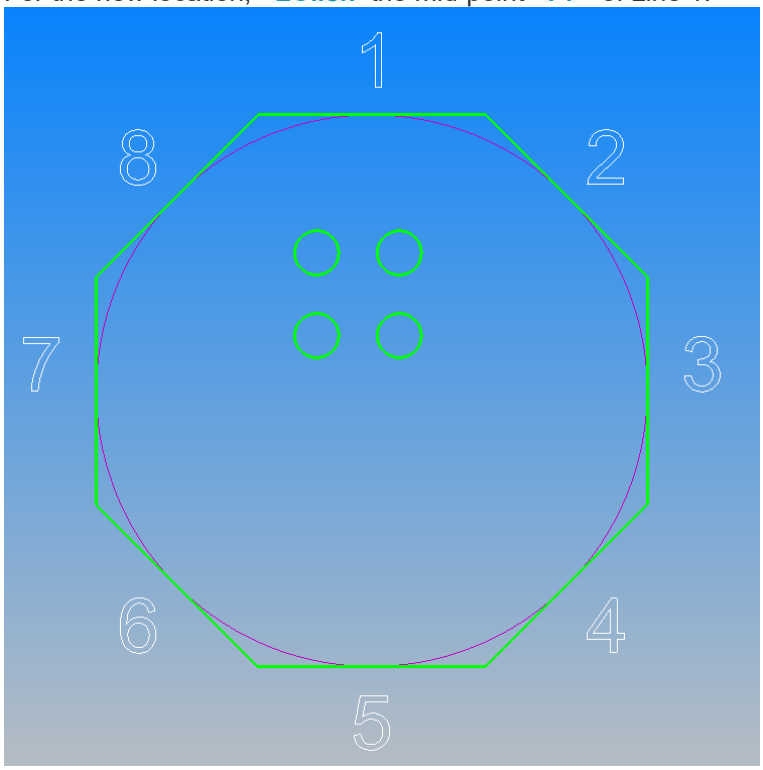


Figure 21 - Original Array

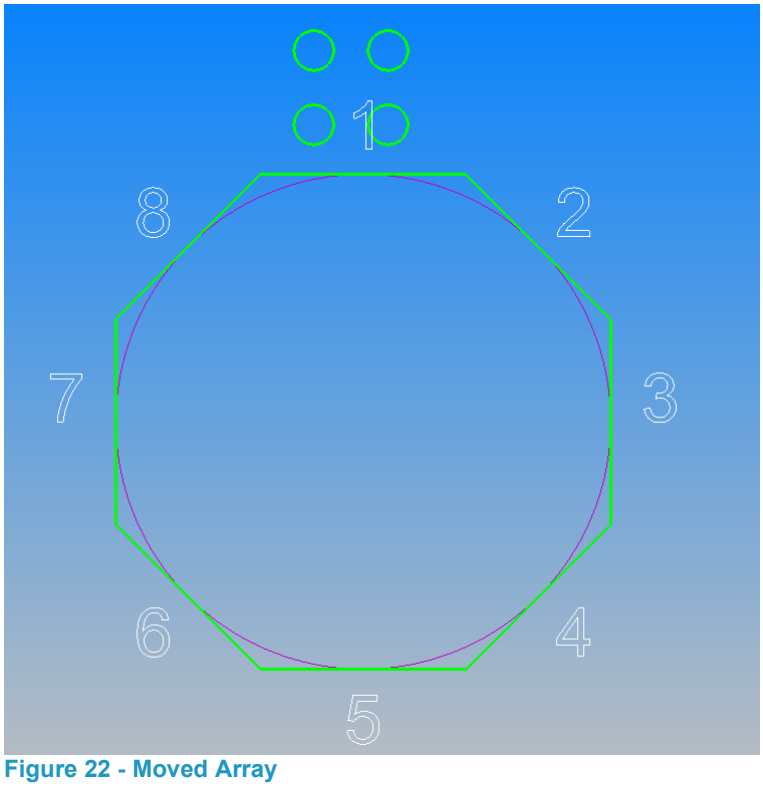


Figure 22 - Moved Array

Rotate the circles to the correct location

Now we will manipulate the four circles from their current **Flat-Land** (no work plane) location, to a vertical work plane.

Set **EDIT > Auto/2D/3D Mode** to **3D**

Set the view to **ISO,** select **VIEW > Iso**
Making the view to the ISO option allows you to visualise the process correctly especially if a positive or negative angle is required.

Select **EDIT > Rotate** and pick the 4 circles as the items to rotate.
<RClick> to continue.
Unlike normal Flat-Land rotation, you are not requested for a **Base Point** for rotation, but you are required to select a **Line of Axis of Revolution** to rotate about.

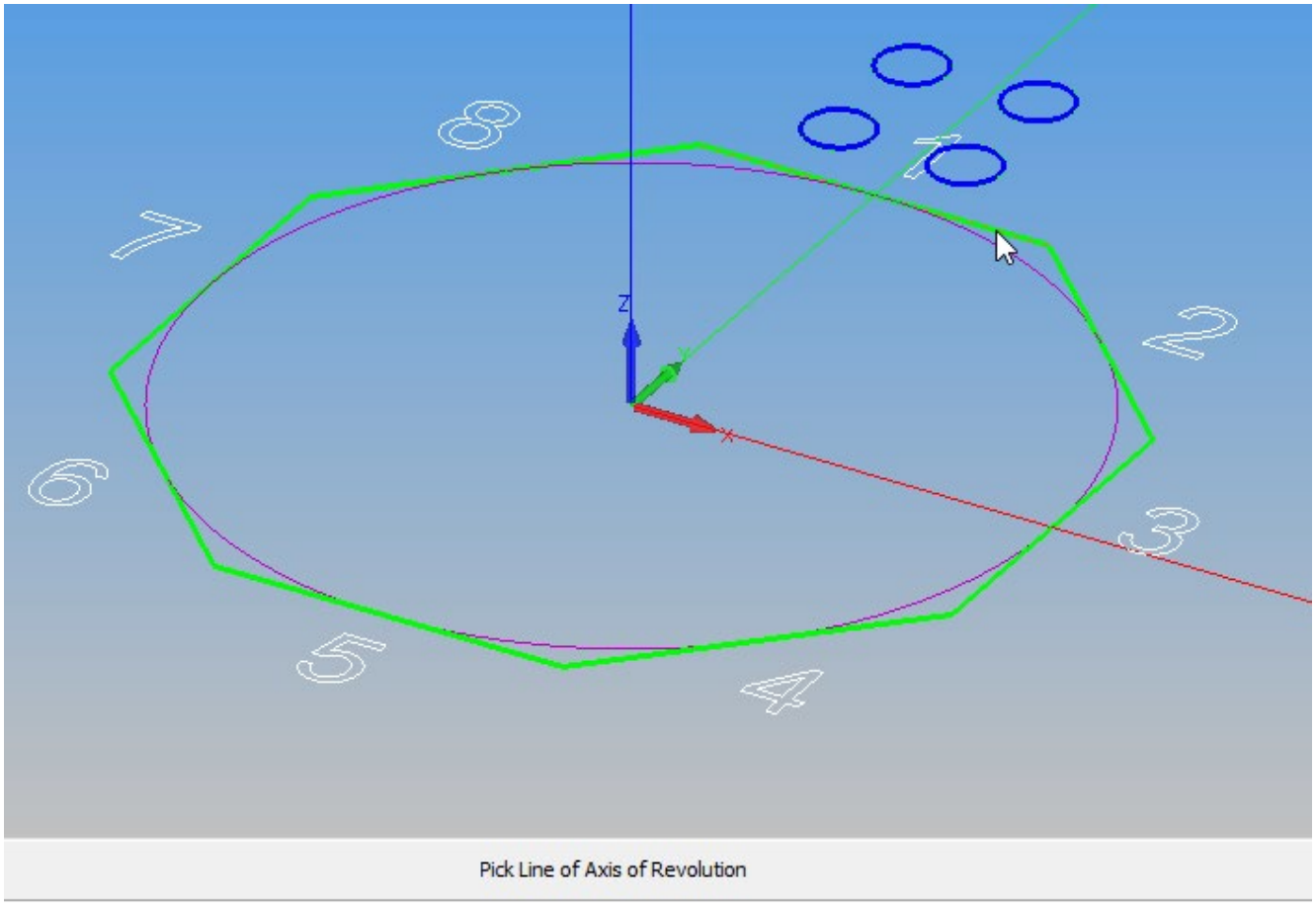


Figure 23 - Selecting the axis of rotation

<LClick> Line 1 as the **Line of Axis of Revolution** and use **90°** for the angle when prompted.

Set the number of rotations as **1**, including the original.

Once the command has been actioned, **<RClick>** to complete.

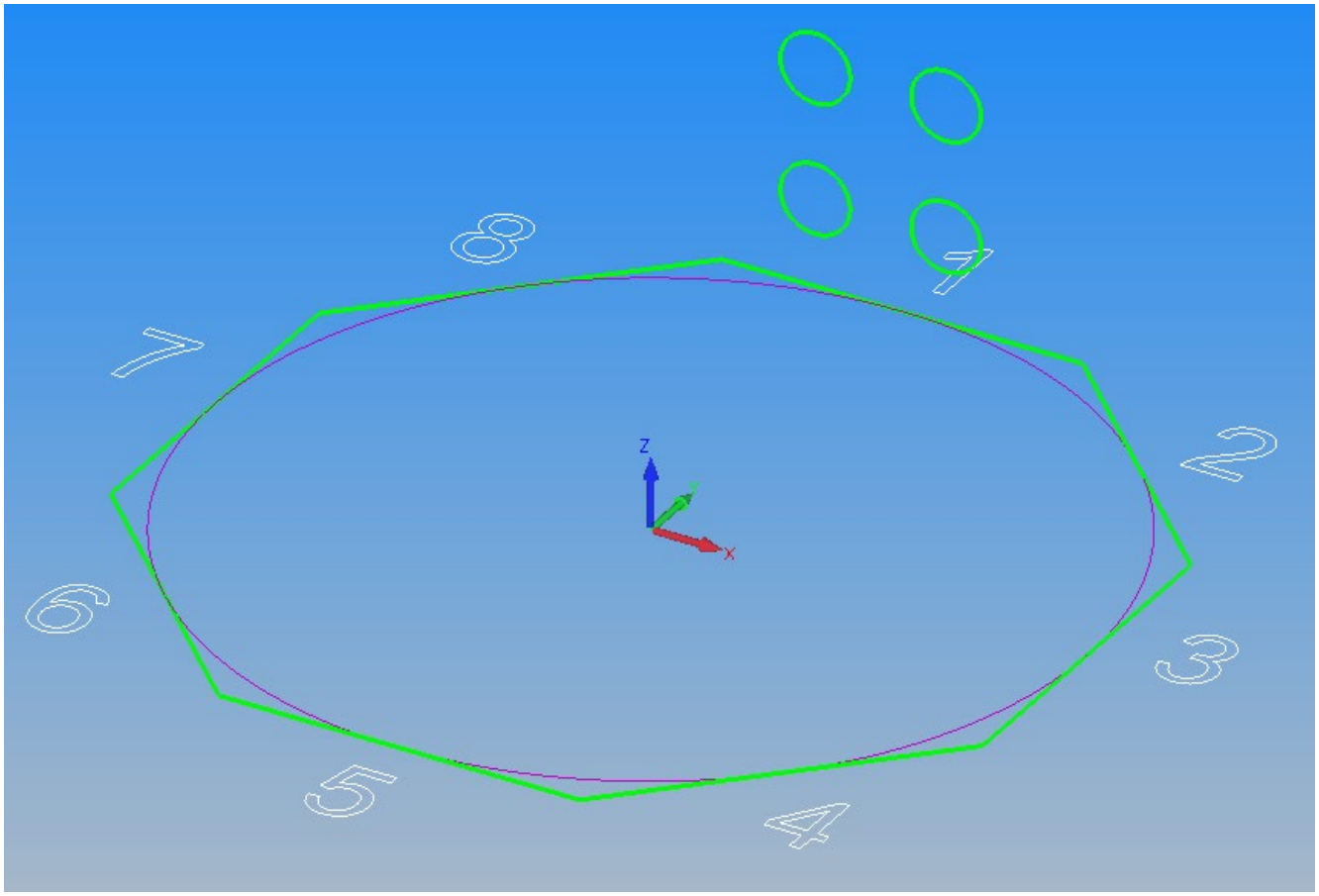


Figure 24 - Rotated original circles

Select the **Work Plane** page of the **Project Manager.**

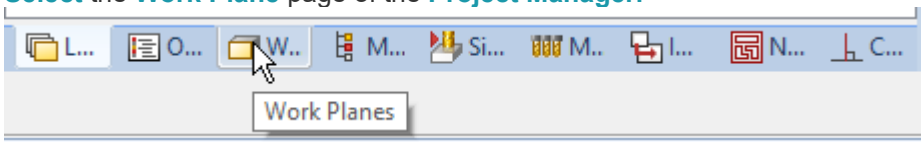


Figure 25 - Project Manager tabs

See how without using any **Work Plane creation** commands from the ribbon section that the process of rotating the four circles has automatically generated the first work plane.

Figure 26 - Automatically created work plane 1

In the Work planes Project Manager Page **<LClick>** on the new work plane to activate it.

Consider the location of the current work plane datum, why is it where it is?

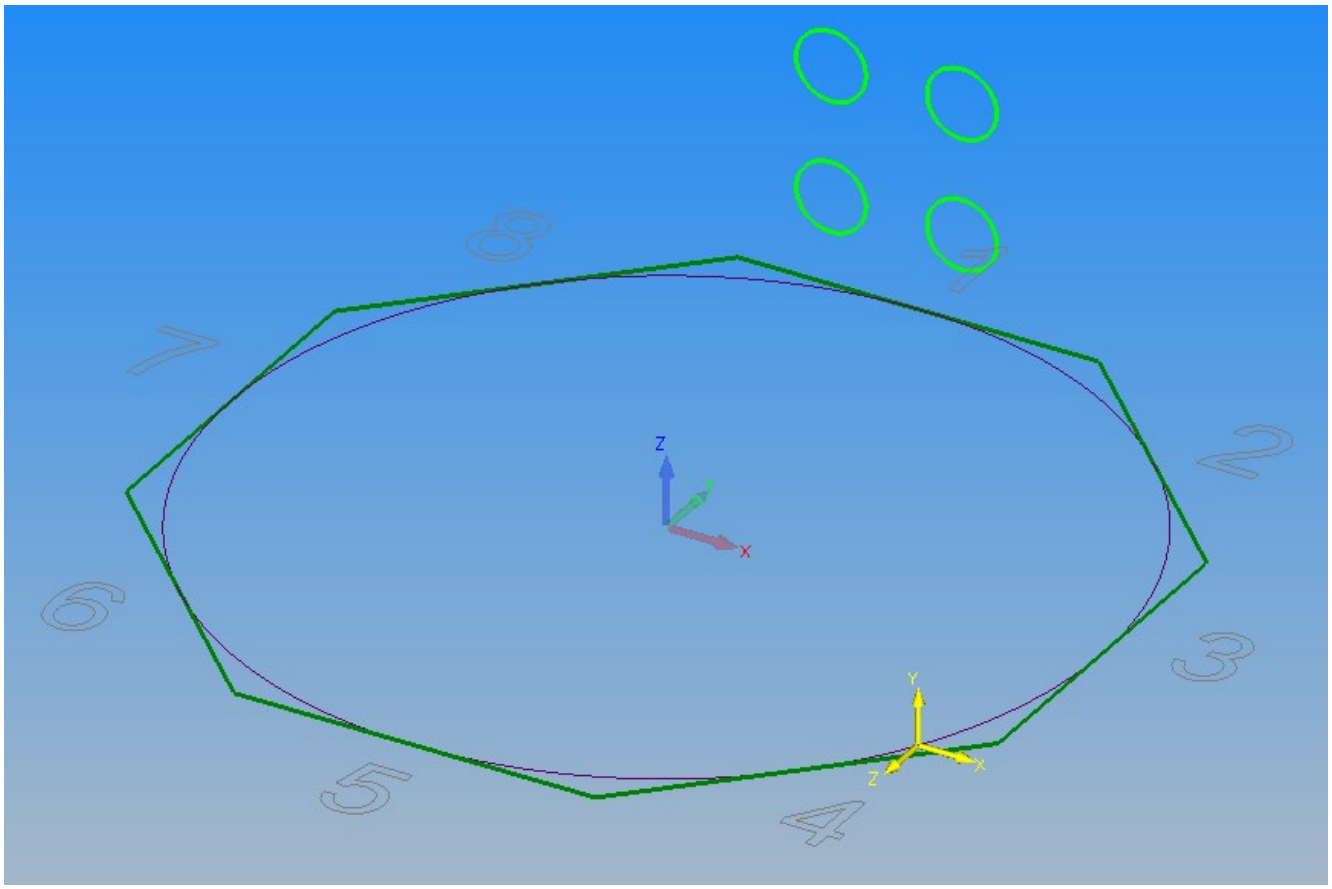


Figure 27 - Work Plane 1 original datum location

Select **WORK PLANES > Set Work Plane Origin** and set it to the mid-point **<F7>** of Line 1.

It is Most Important to ensure the Z axis is pointing **OUT** of the plane towards the direction from which a tool would approach.

Select **WORK PLANES > Reverse Current Plane** to get the axis in the correct orientation.

> Reverse Current Plane only has four options, Z axis up or down and in the corresponding situations the X axis pointing one way or the opposite.
>
> If you cannot gain the correct orientation for your work plane when using this command on real items, you would need to use one of the other methods of Work Plane creation described.

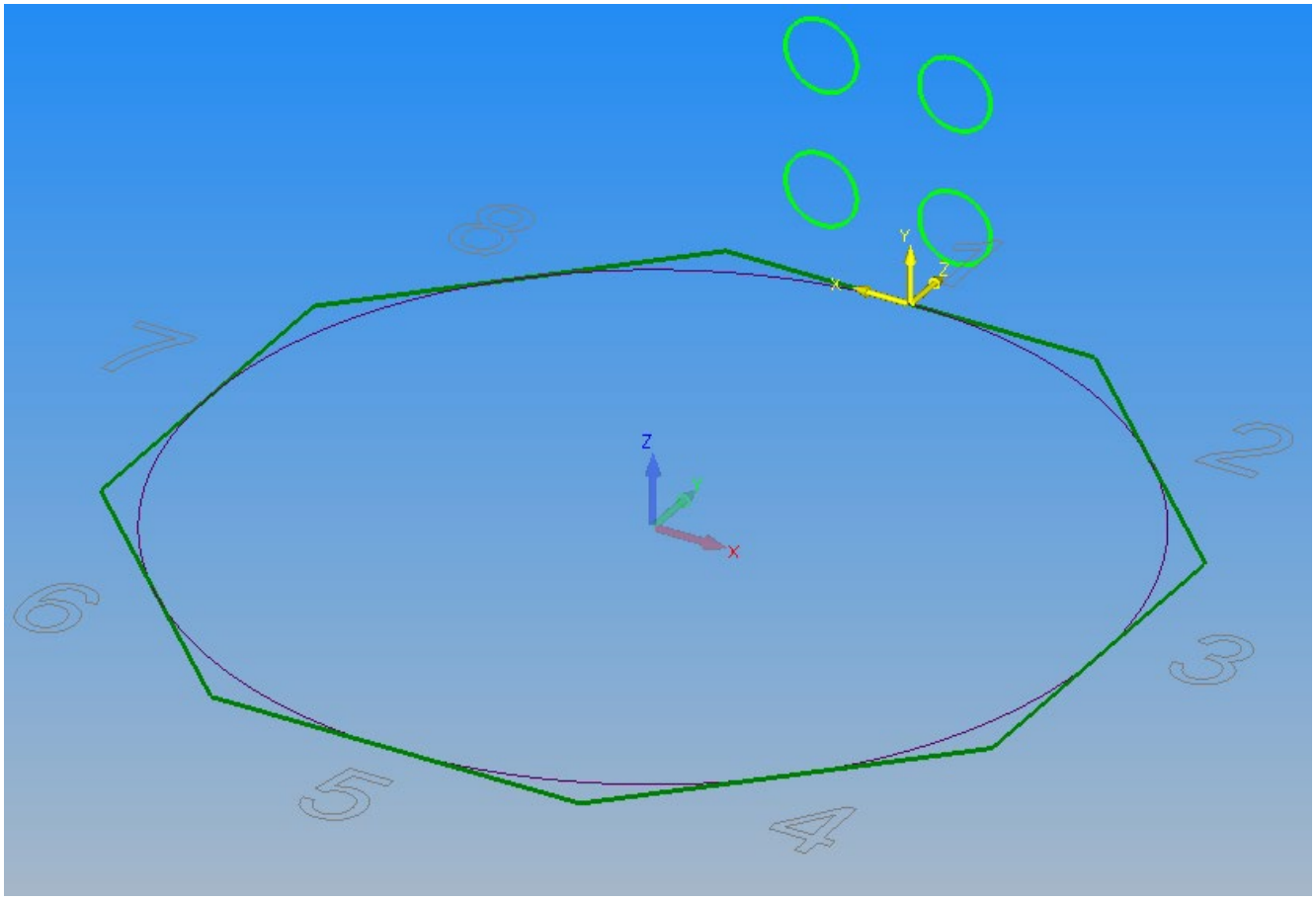


Figure 28 - First work plane created using the Rotate command

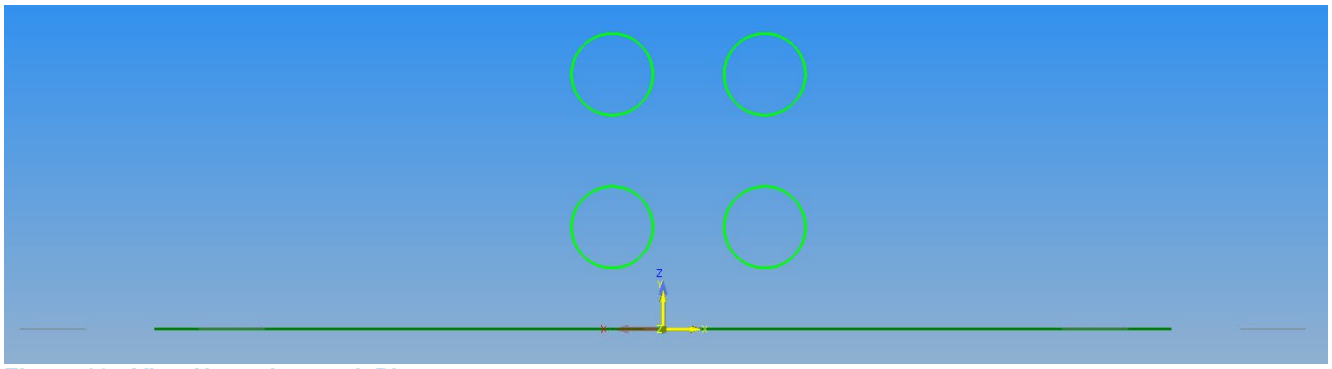


Figure 29 - View Normal to work Plane

Select **EDIT > Group** then select the 4 circles, this will make the picking easier for later manipulations.

When using manipulation techniques to create work planes you **MUST** take into consideration the way in which the items origin orientation will be manipulated.

Create the Triangles on Face 2

Select **WORK PLANES > Slice through work volume**
For the geometry to be used as the line of slice, pick line **EIGHT** as shown in the diagram.

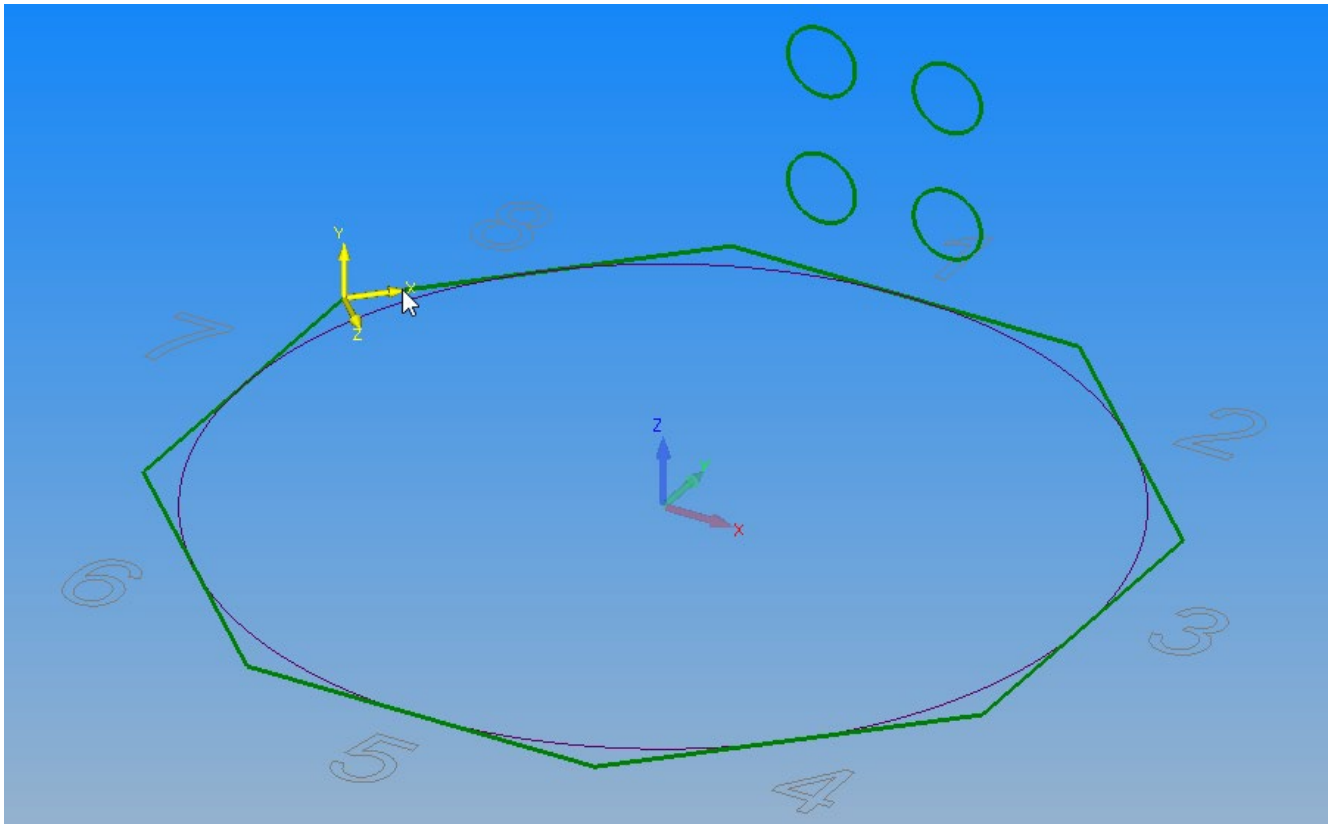


Figure 30 - Creating the new work plane on face 8

It is Most Important to ensure the Z axis is pointing **OUT** of the plane towards the direction from which a tool would approach.

If the Z axis points in the wrong direction use **WORK PLANES > Reverse Current Plane**

In this example, it will be necessary to use the **Reverse Current Plane** option and to reset the work plane origin to a more suitable position to aid in the circle's creation.

Select **WORK PLANES > Set Work Plane Origin**
For the new origin select the mid-point **<F7>** of line 8.

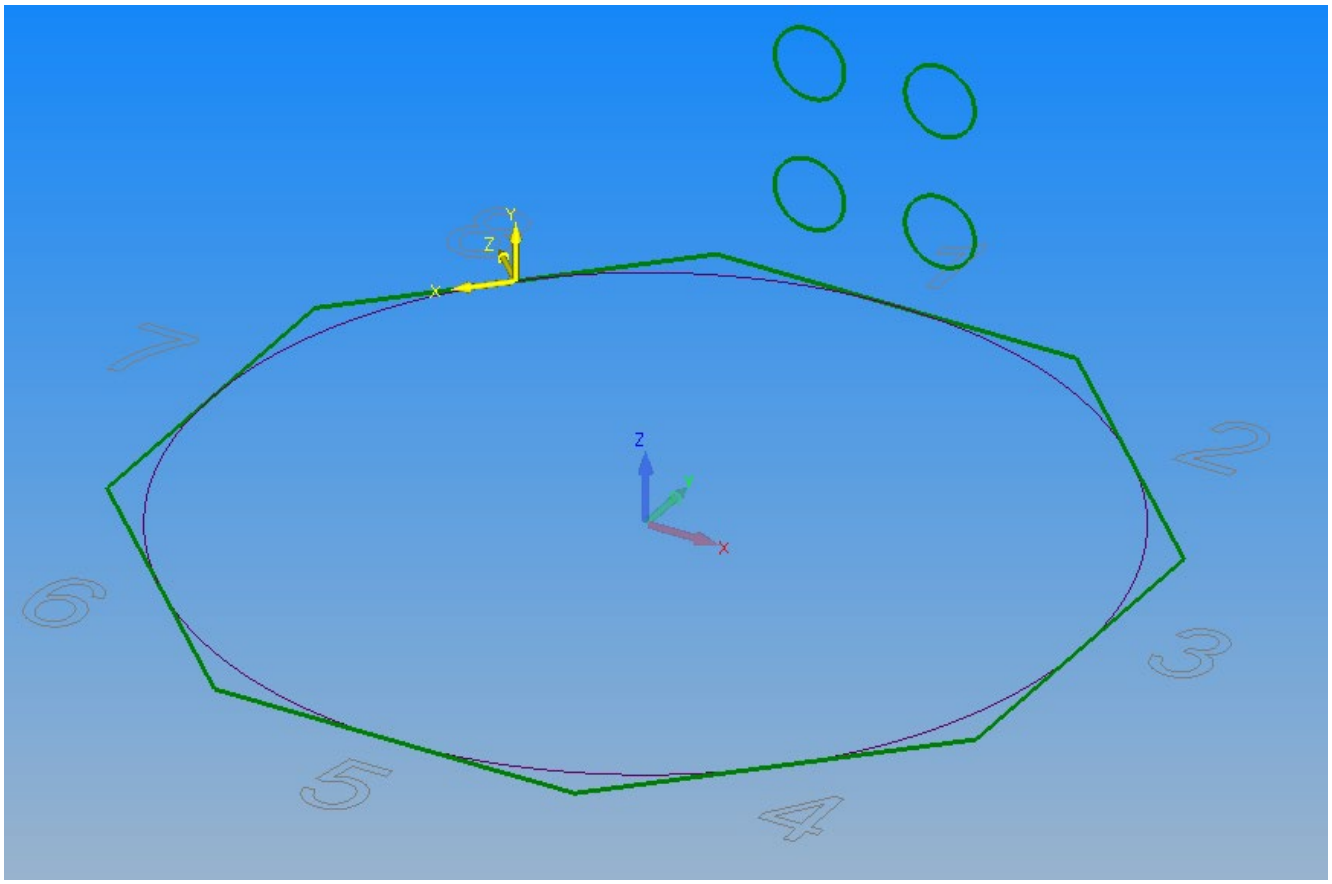


Figure 31 - Correct setting for Work Plane on line 8

Using **GEOMETRY > Special Geometries > Polygon** , draw a triangle based on the inside of a Ø40 circle at **X-50, Y50.**

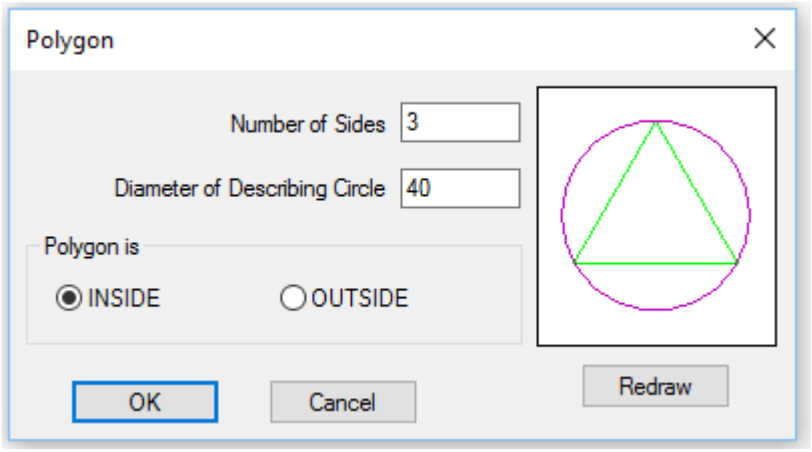


Figure 32 - Triangle creation using the Polygon command

Use the **EDIT > Array** command to produce 4 circles at 75 centres.

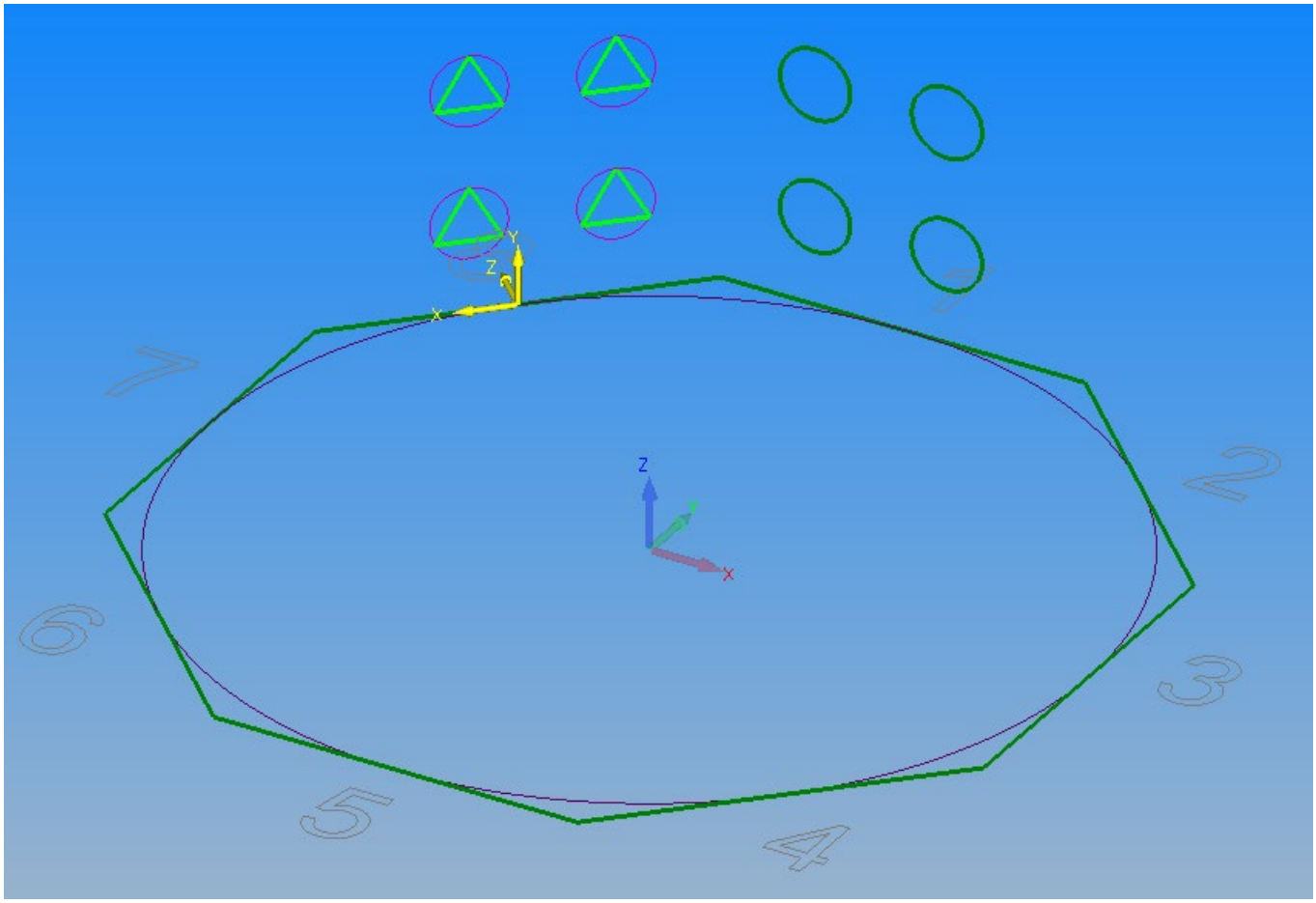


Figure 33 - Triangles created on face 8

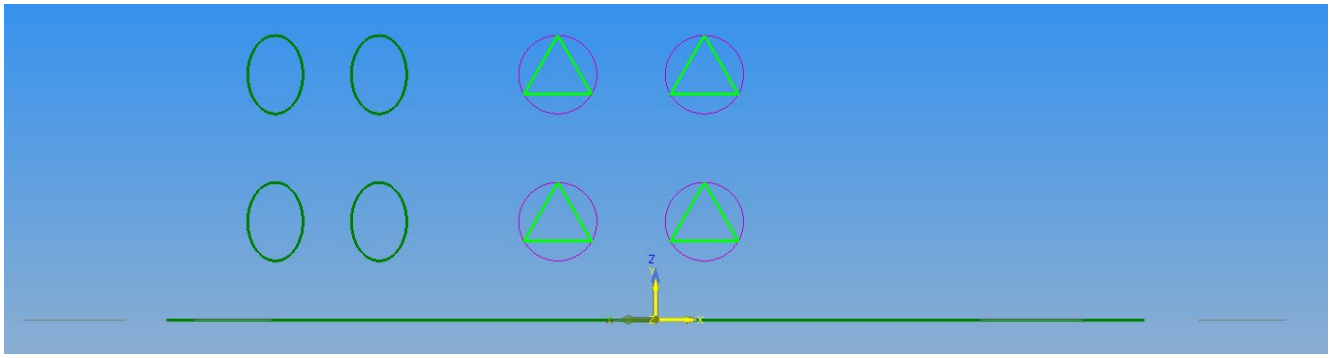


Figure 34 - View Normal to Work Plane

> If Array does not work it is because you have left the Edit Mode in 3D.
>
> Reset the Edit mode to Auto and repeat the array command.

Select **EDIT > Group** then select the 4 triangles and their construction circles, this will make the selection easier during the next sections of the process.

Work Plane Properties

To make identification easier it is possible to rename the work planes in the project manager.
Open the **Work Planes** project manager. **<RClick>** on the first work plane and select **Edit**

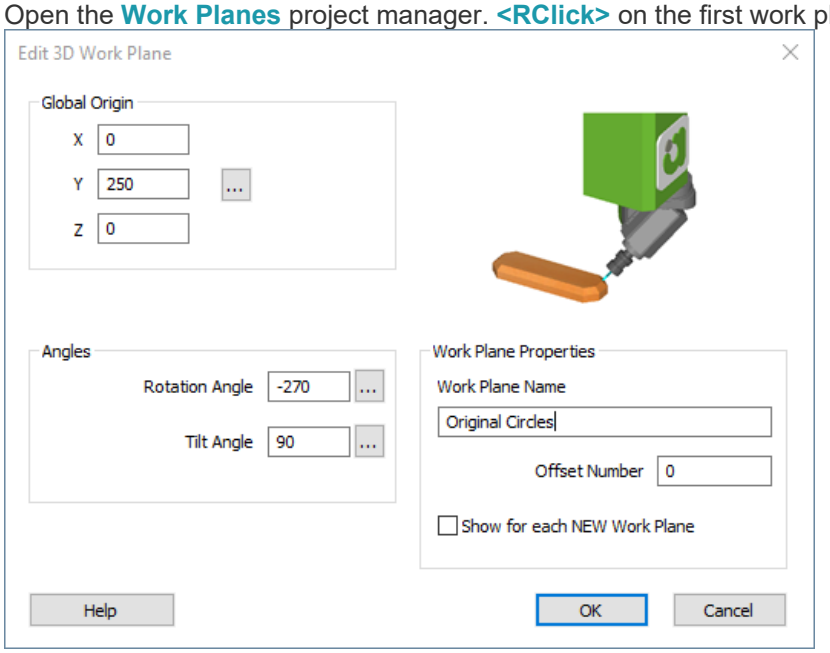


Figure 35 - Work Plane Edit window

The **Edit** window not only allows you to rename your work planes, but also to adjust the angel values if you were to create a differing angle set value from the original Slice Through option.

You can set this dialogue to appear each time you create a new work plane by activating the **☑ Show for each NEW Work Plane option.**

Alter the work plane name to be “Original Circles” then select **[OK]. <RClick>** on the second work plane and select **Edit** and change the work plane name to “Original Triangles” then select **[OK].**

As created

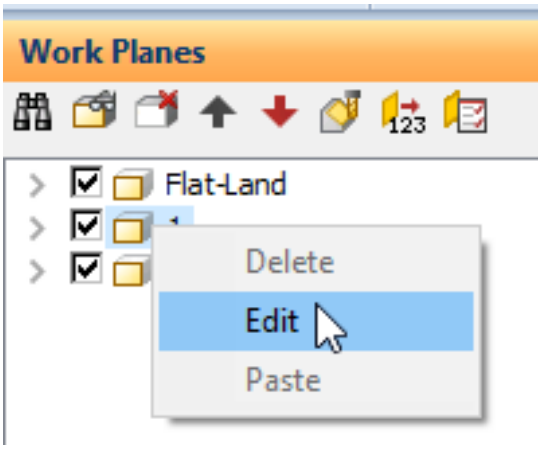


Figure 36 - Original Work Plane names

Renamed

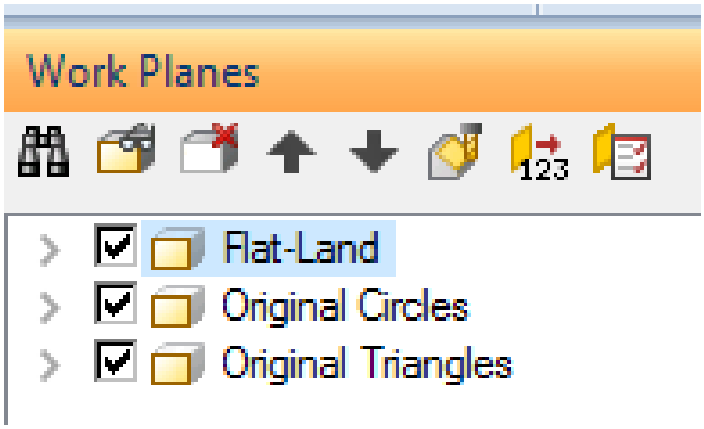


Figure 37 - Edited Work Planes names

If you have more than one Work Plane to edit the properties of, then using the **Work Planes Properties** editor would be a better option.

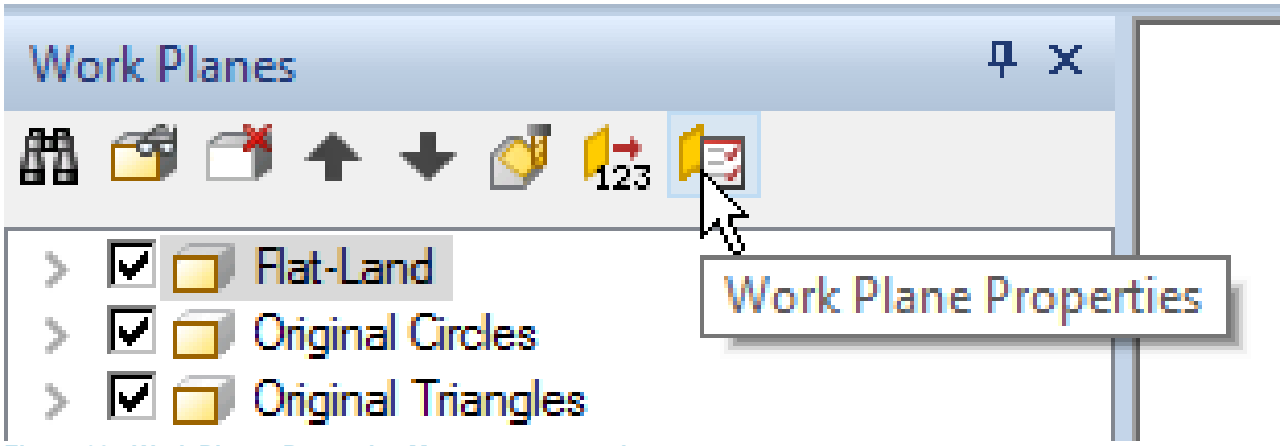


Figure 38 - Work Planes Properties Manager command

The **Work Planes Properties** manager allows the editing of as many Work Planes as you have created regardless of whether they are active and visible or not.

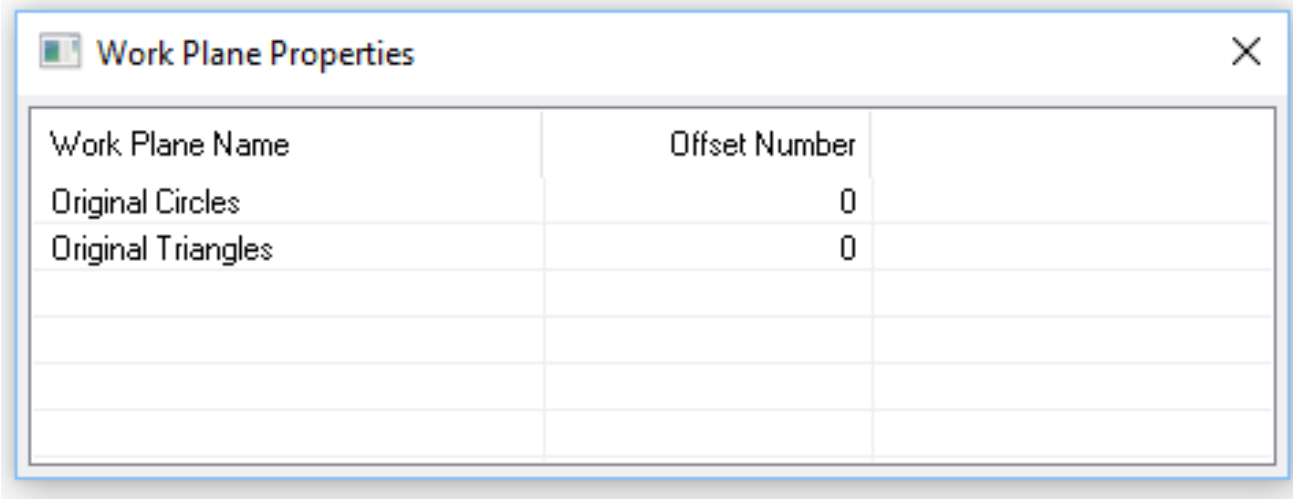


Figure 39 - Work Planes Properties editor

You can activate the work planes by **<LClick>** on their name in the project manager page, **<LClick>** on Flat-Land in the project manager page is the same as **Cancel Current Work Plane.**

3D Copy Circles from Face 1 onto Face 5

Ensure No Work Plane is active using **WORK PLANES > Cancel Work Plane**

Select **EDIT > Move Copy etc.>Copy**
<LClick> one of the circles on face 1, because we Grouped the circles, all are selected.
<RClick> to finish selecting.

For the Base Point, use **End Point of <F6>** and **<LClick>** the right end of line 1.

For the new position use **End Point of <F6>** and **<LClick>** the right end of line 5.

The circles will be copied to face 5.
Using either the **<RClick>** option or the Work Planes Properties command, rename the Work plane to “3D Copy”

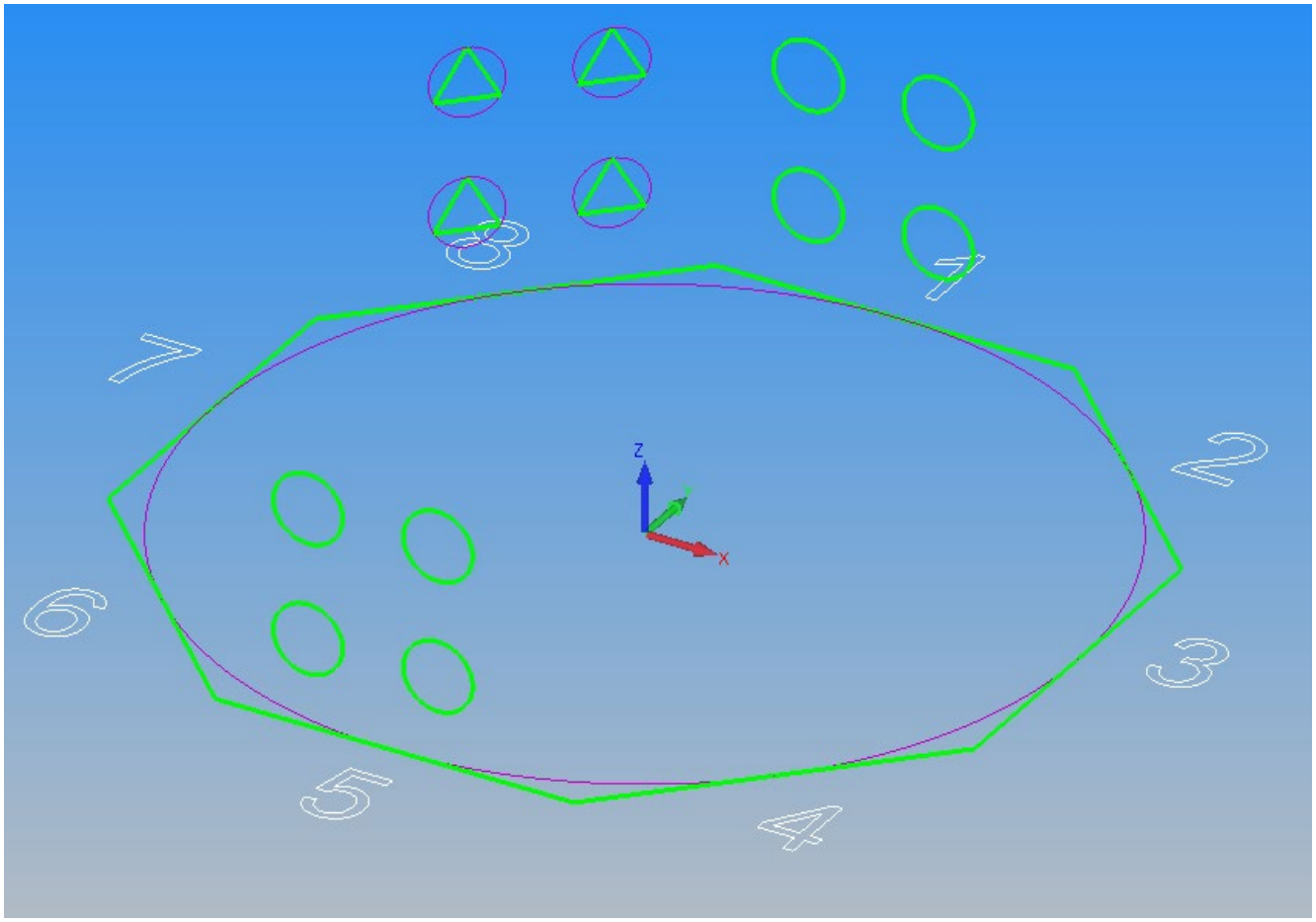


Figure 40 - Work creation using the Copy command

Activate the 3D Copy plane and consider the result of the Copy.
What is the result of this form of copy?
What are the considerations with respect to the application of tool paths?

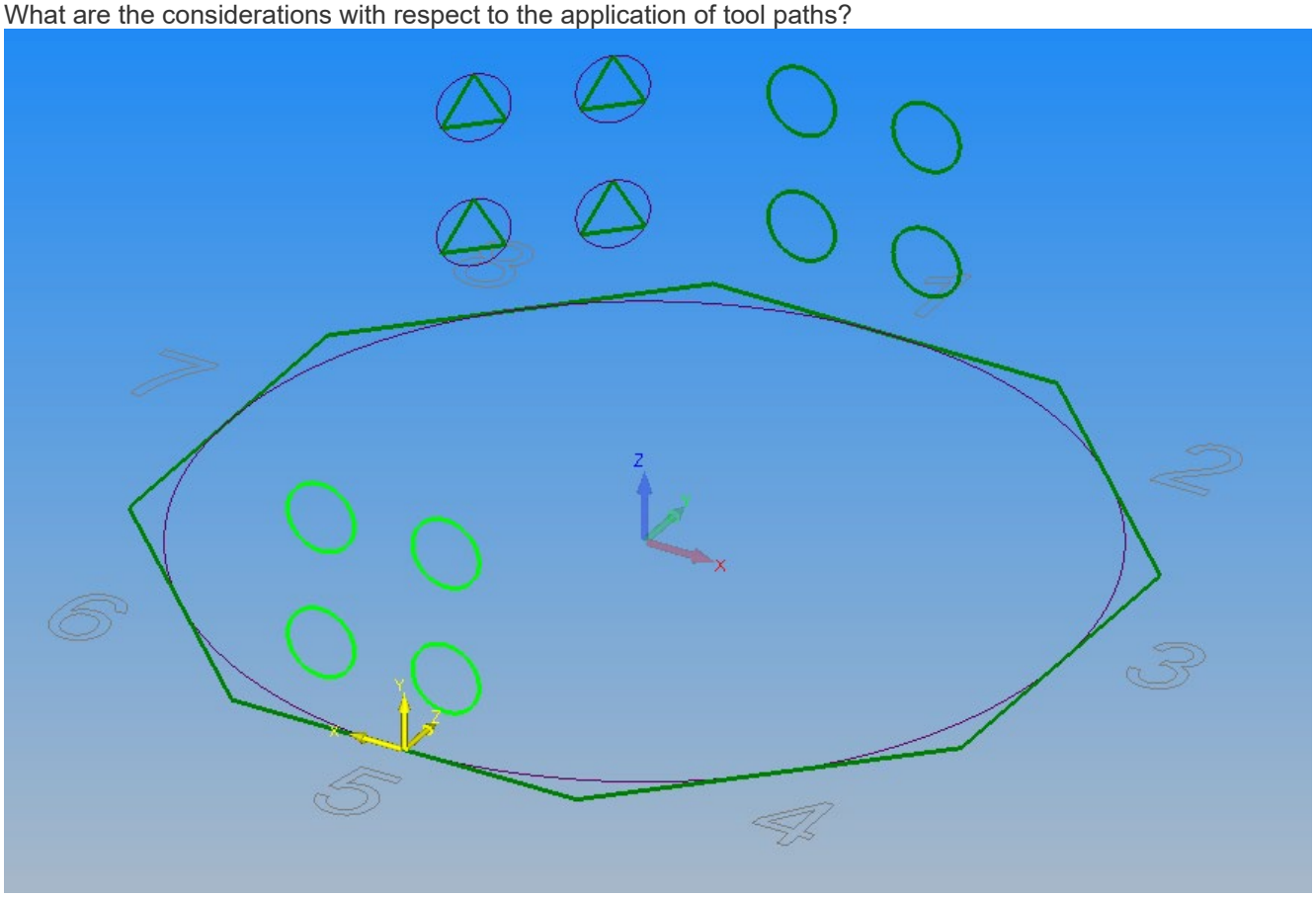


Figure 41 - 3D copied circles in ISO view

It is most important to ensure the Z axis is pointing **OUT** of the plane towards the direction from which a tool would approach.

Use **WORK PLANES > Reverse Current Plane**
In this example, it will be necessary to use the **Reverse Current Plane** option as many times as is required to force the local Z axis to point out of the work plane.

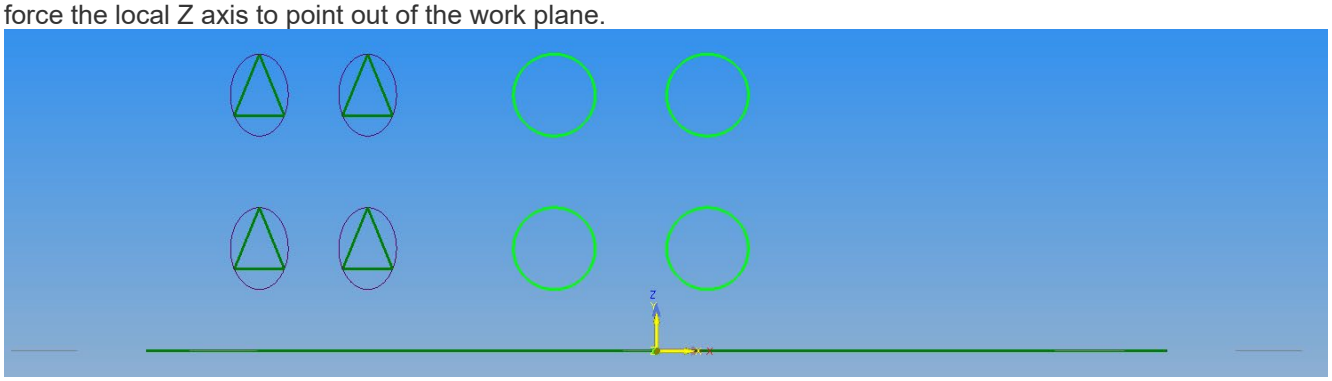


Figure 42 - 3D copied circles on Normal to Work Plane view

3D Rotate the Circles from Face 1 onto Face 2

Ensure No Work Plane is active using **WORK PLANES > Cancel Work Plane**

With a 3D Rotation, it is necessary to have an axis about which to rotate.

> As this part is on the Global origin, there are three supplied axes by default. If you are manipulating from a differing location on real parts, you will need to create the rotation axis before proceeding with the function.

Select **EDIT > Move Copy etc.>Rotate**
Select the circles on face 1 (they can be picked in any view). **<RClick>** to finish selecting.
For the **Axis of Revolution** select the vertical Blue Polyline.

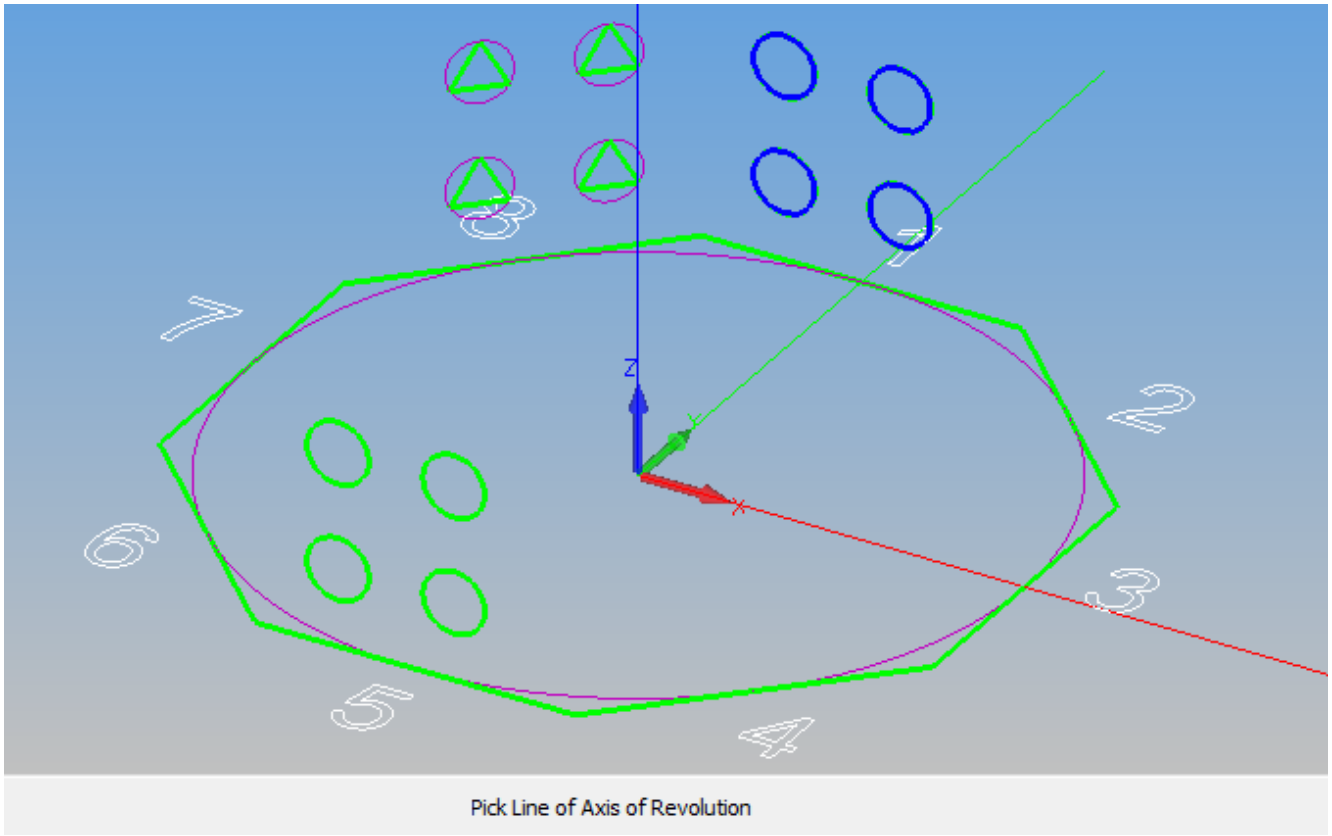


Figure 43 - Rotation axis selection options

For the **Rotation Angle** enter **-45°.**

For the **Number (Including the Original)** enter **2**.

The Circles will be copied to face 2.
At this stage rename the work plane to “3D Rotate”.
Activate the plane for “3D Rotate” and consider the result of the Rotate.

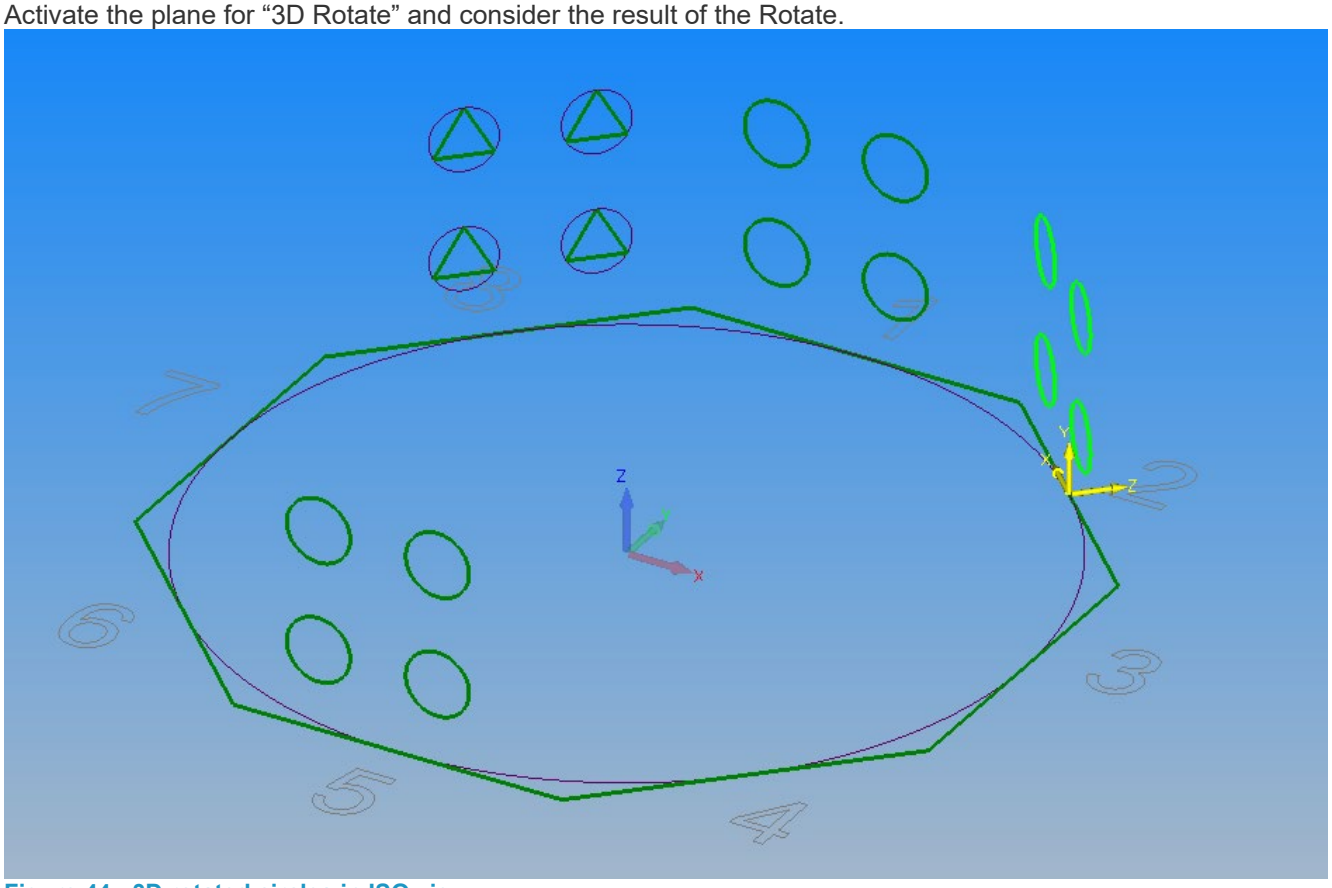


Figure 44 - 3D rotated circles in ISO view

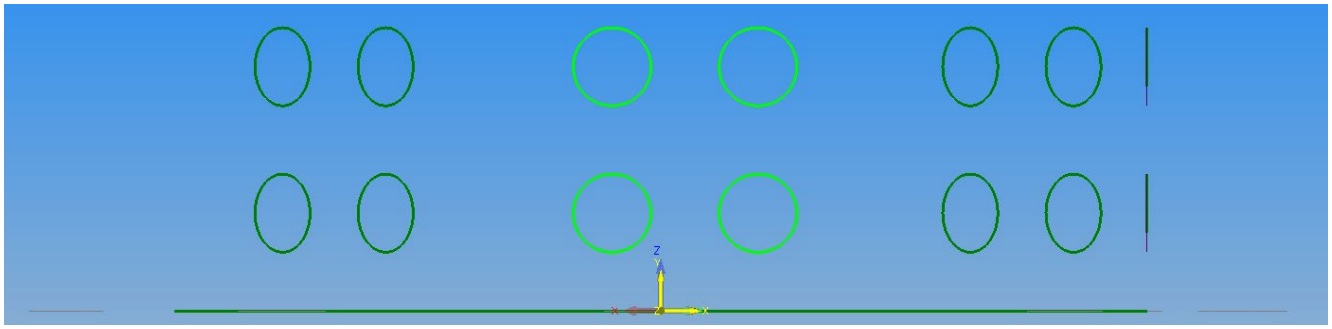


Figure 45 - 3D rotated circles in Normal to Work Plane view

What is the result of this form of copy?
What are the considerations with respect to the application of tool paths?

3D Mirror Triangles from Face 8 to Face 4

Ensure No Work Plane is active using **WORK PLANES > Cancel Work Plane**

With a **3D Mirror** it is necessary to have a work plane through which to mirror. This can be an existing work plane or one created during the command.
For this example, we will need to create a single 2D line that will be used to generate the mirroring plane.

Select **GEOMETRY > Line**
For the Base Point, use Mid-Point **<F7>** and Select line 2.
For the new position, use Mid-Point **<F7>** and Select line 6.

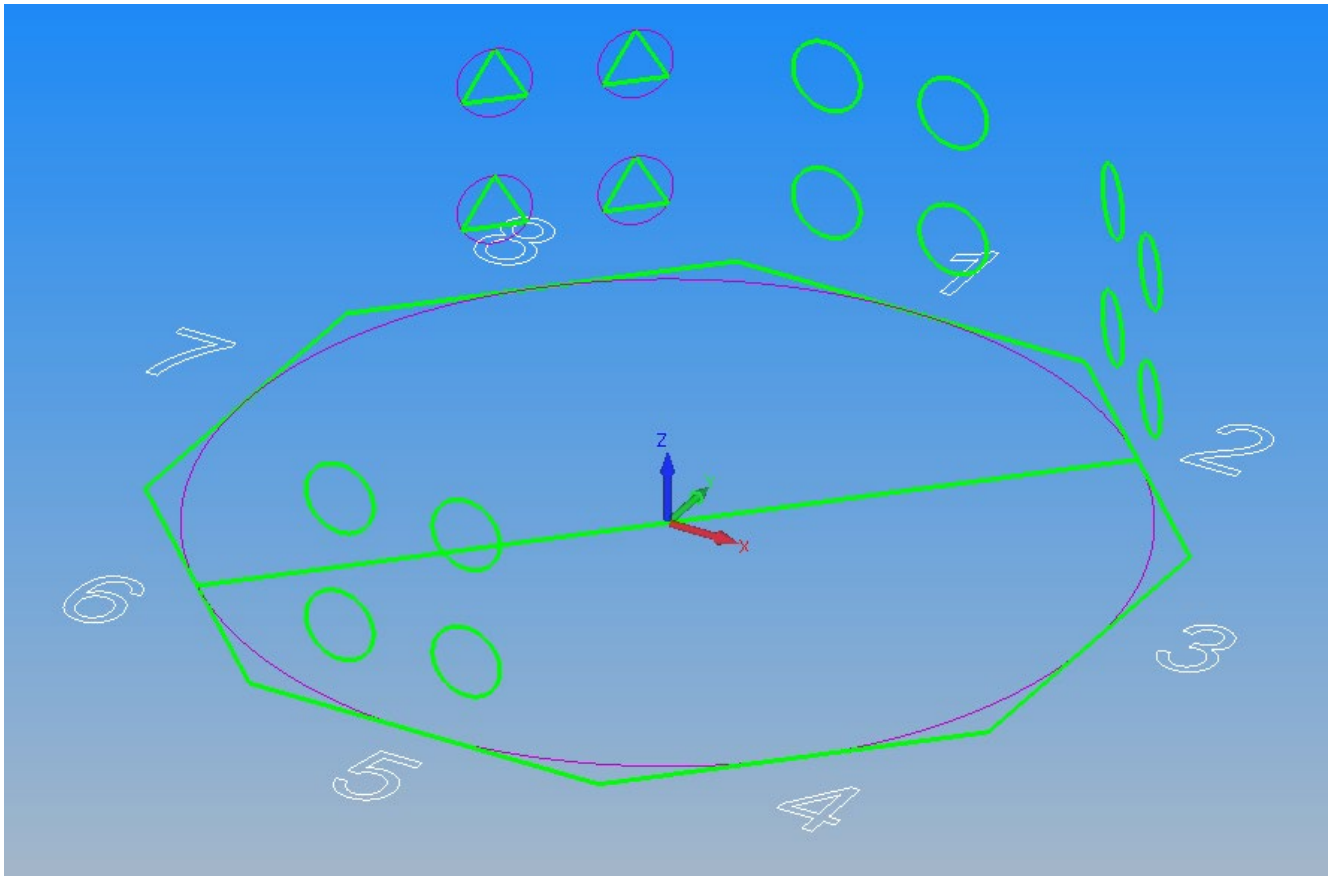


Figure 46 - Reference line created for use in the Mirror options

Select **EDIT > Move Copy etc.>Mirror**
Select the triangles on face 8. **<RClick>** to finish selecting.
Instead of a First point and Second point as is usual when using Mirror in a 2D environment, you need to use the options from the following dialogue box that has appeared.

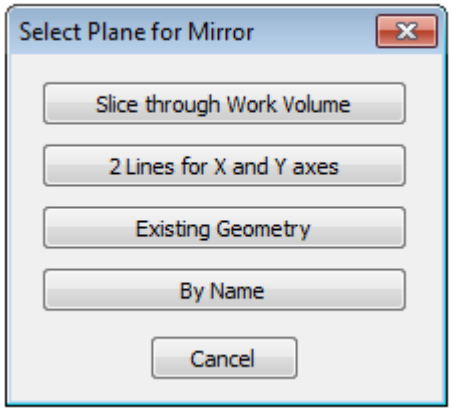


Figure 47 - Options when using Mirror in 3D

For the Plane of Mirror select **[Slice through Work Volume].**
For the Line of Plane pick the previously created line inside the octagon.

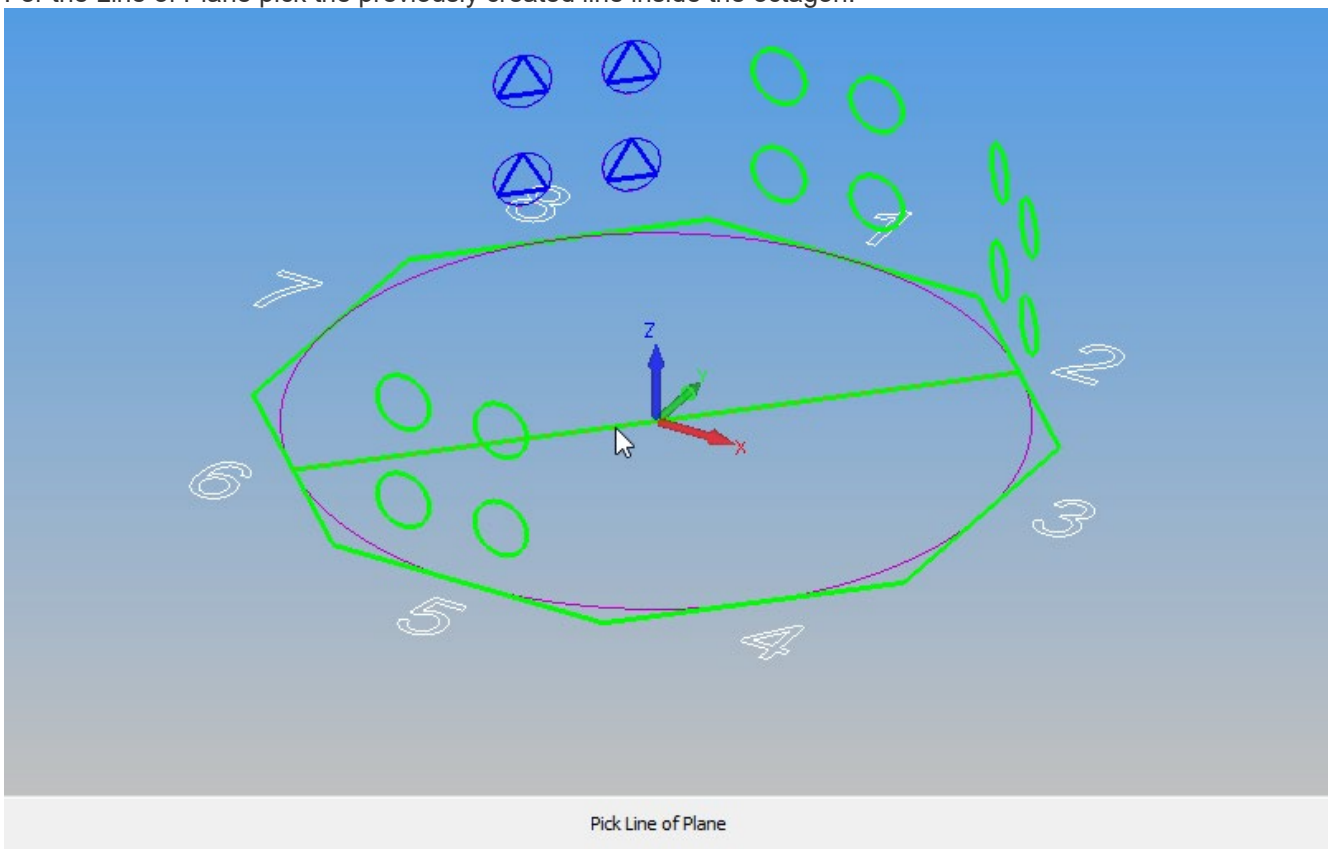


Figure 48 - Selecting the created reference line as the Mirror plane

As with the 2D Mirror command, the **Keep Original** dialogue is displayed select **[Yes].**
The triangles will be mirrored to face 4.
<RClick> to finish.

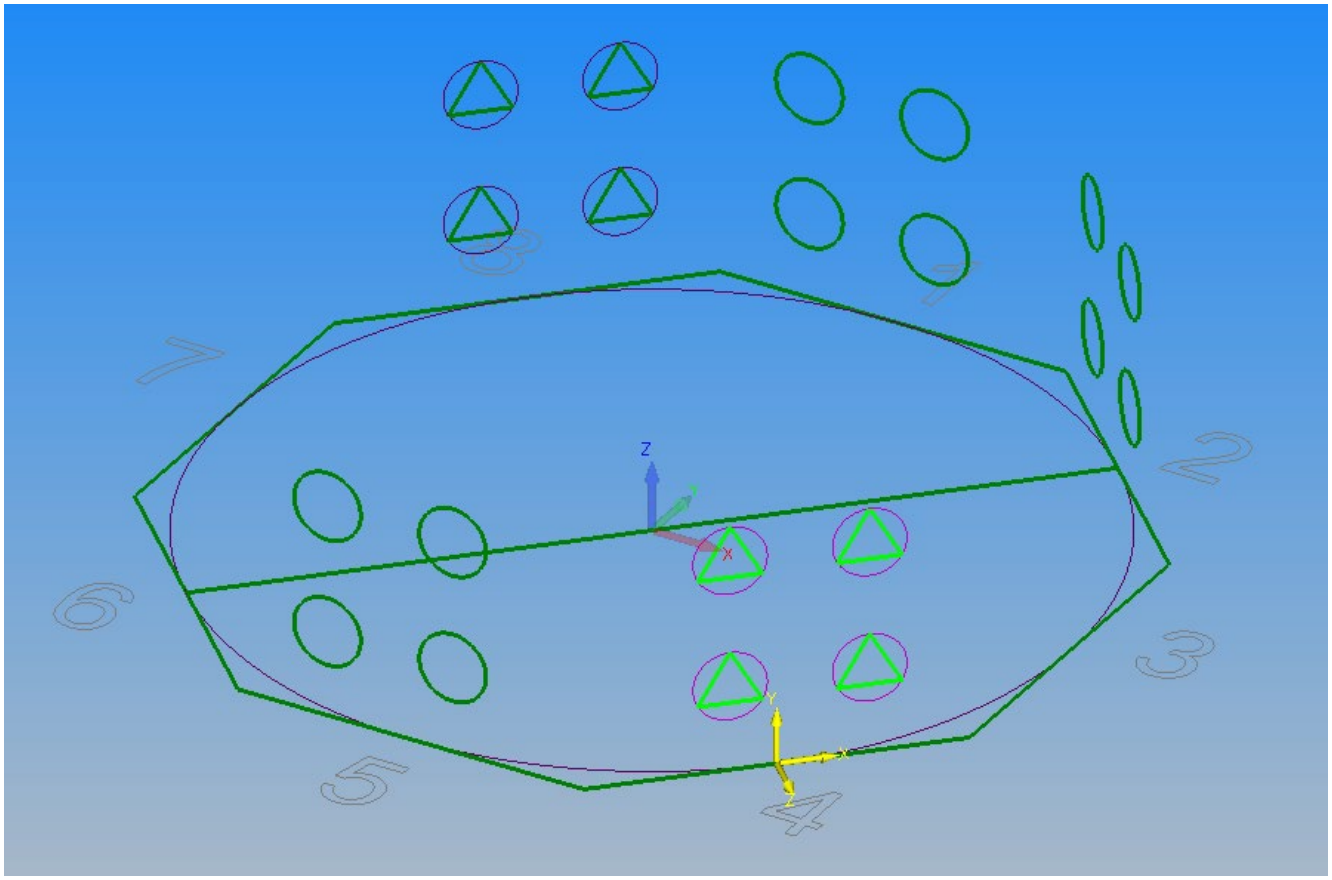


Figure 49 - Work Plane created by mirroring to Face 4

At this stage rename the work plane name to “3D Mirror”.

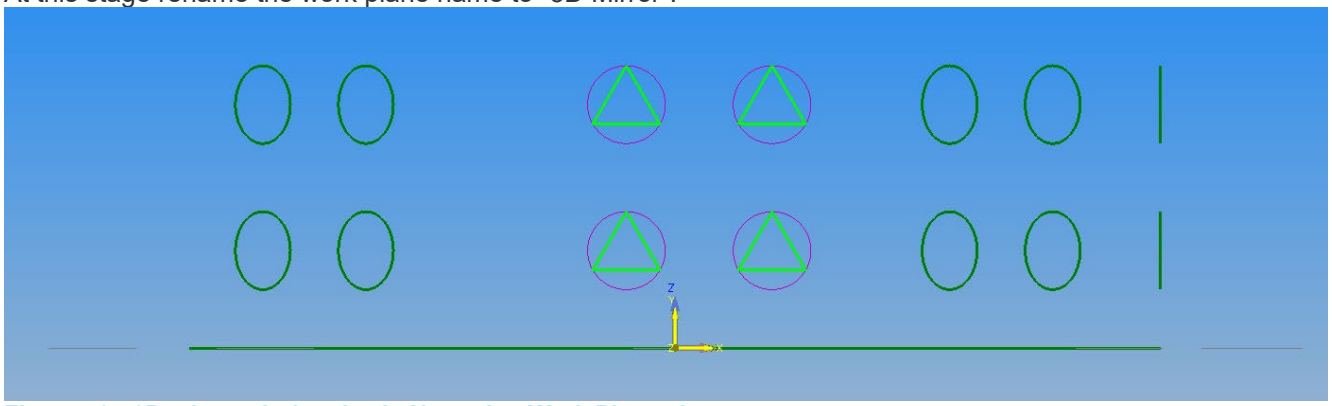


Figure 50 - 3D mirrored triangles in Normal to Work Plane view

Activate the plane for 3D Mirror and consider the result of the Mirror.
What is the result of this form of manipulation?
What are the considerations with respect to the application of tool paths?

Plane to Plane Copy triangles from Face 8 to Face 7

It is possible to create and change work planes in the middle of a command as the creation and activating of work planes are transparent commands, like the Zoom commands.
In this example, we will create the work plane we are copying to, during the command.
Activate the **Original Triangles** Plane using the Project Manager.
Select the **Copy** command and select the triangles and circles **[All]** to be copied. **<RClick>** to finish selecting.

For the Base Point use **X0, Y0**

The base point prompt is only X and Y as this is a 2D copy.

Prior to selecting the new position, it is necessary to change the active plane.

Select **WORK PLANES > Slice through work volume**
For the geometry indicating the line of slice, pick line 7 as shown in the ISO view.

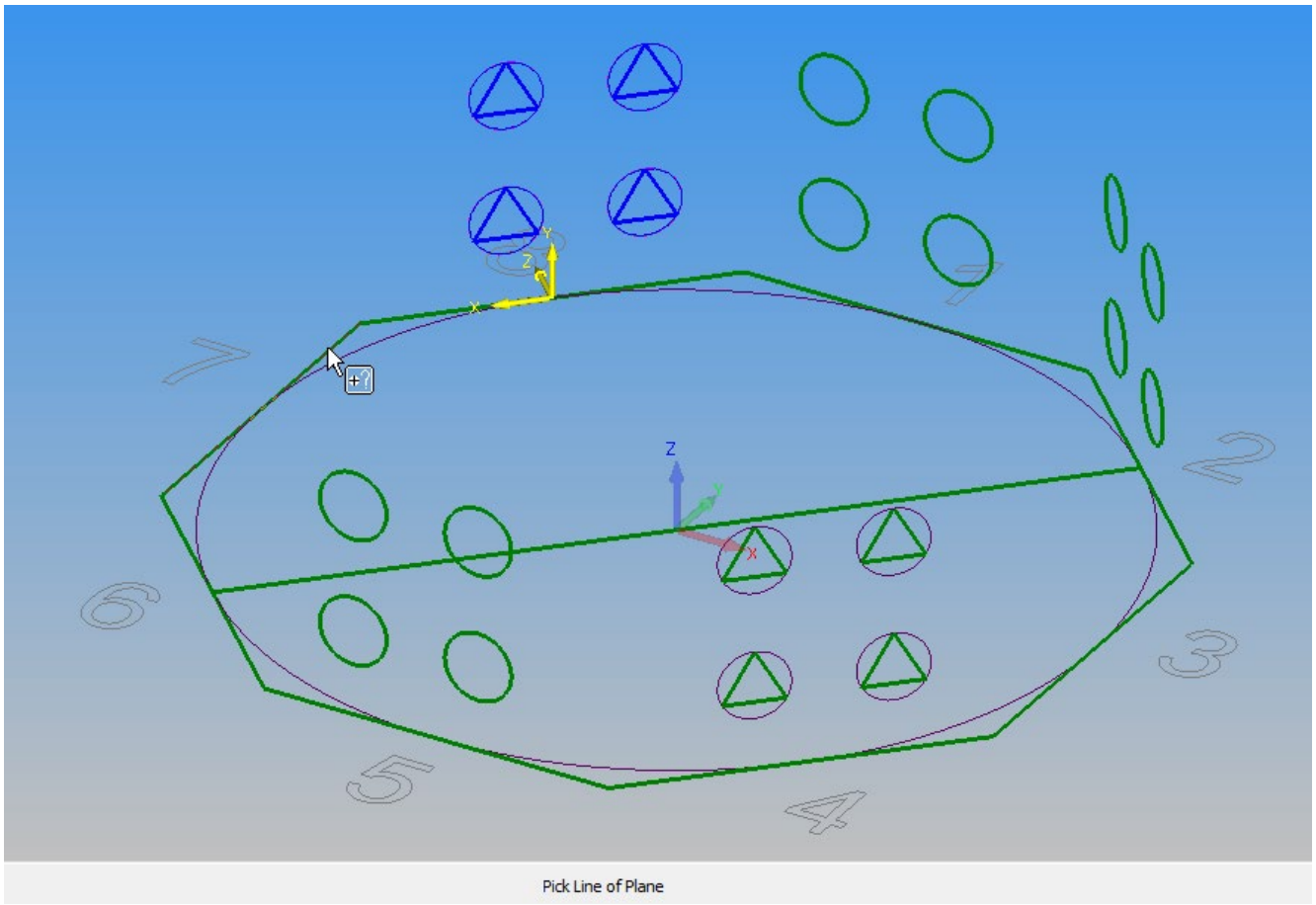


Figure 51 - Creating the new work plane whilst still in the Copy command

It is Most Important to ensure the Z axis is pointing **OUT** of the plane.

If the Z axis points into the plane use **WORK PLANES > Reverse Current Plane**

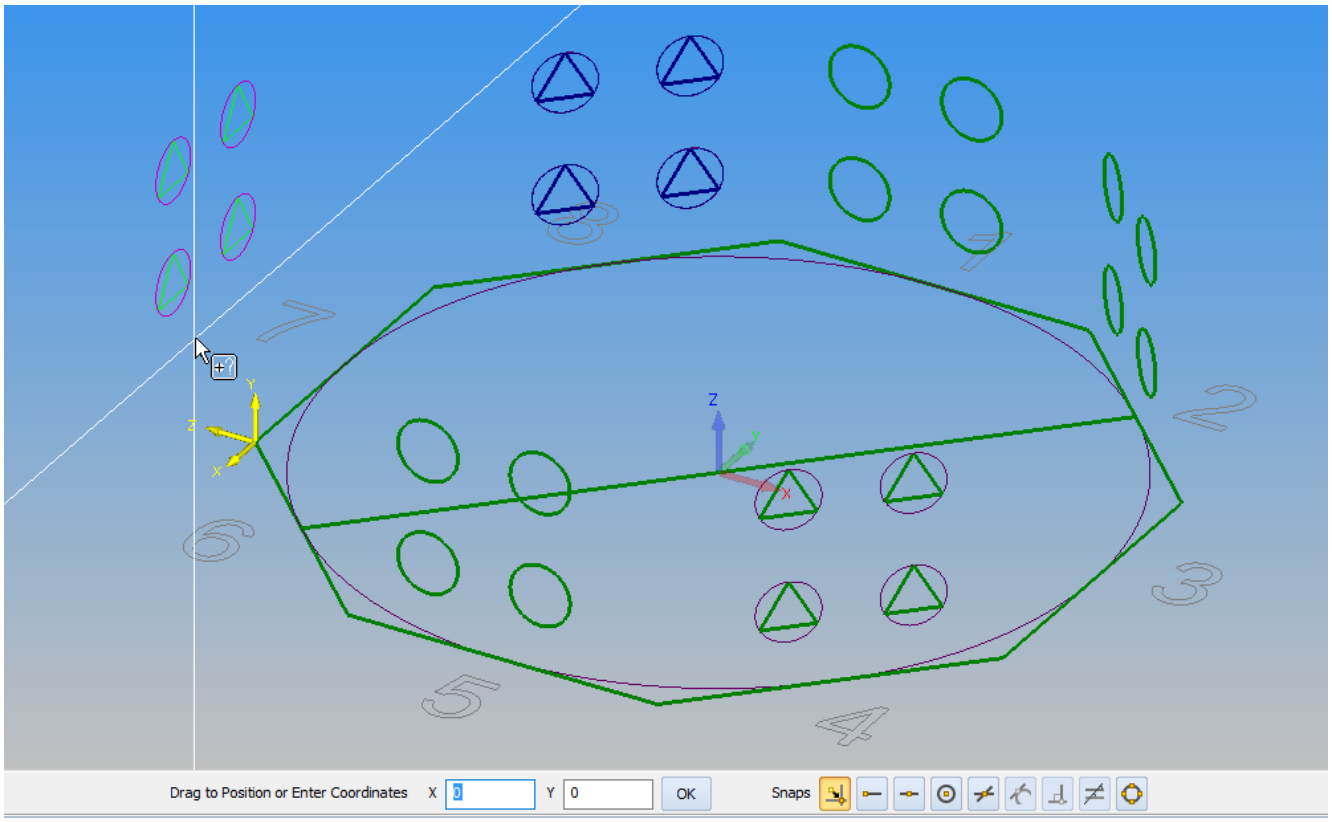


Figure 52 - Work Plane origin manipulated to correct attitude

At this point in the example, it is not possible to reset the work plane origin as this command is not transparent.
For the new position of the copy, use Mid-point **<F7>** and Select Line 7.
<RClick> to finish the copy command.
<RClick> again to complete the process.

You can now reset the work plane origin to the midpoint of line 7 using

WORK PLANES > Set Work Plane Origin ., then rename the work plane to “Plane to Plane Copy”.

Activate the plane for Plane to Plane copy and consider the result of the manipulation.

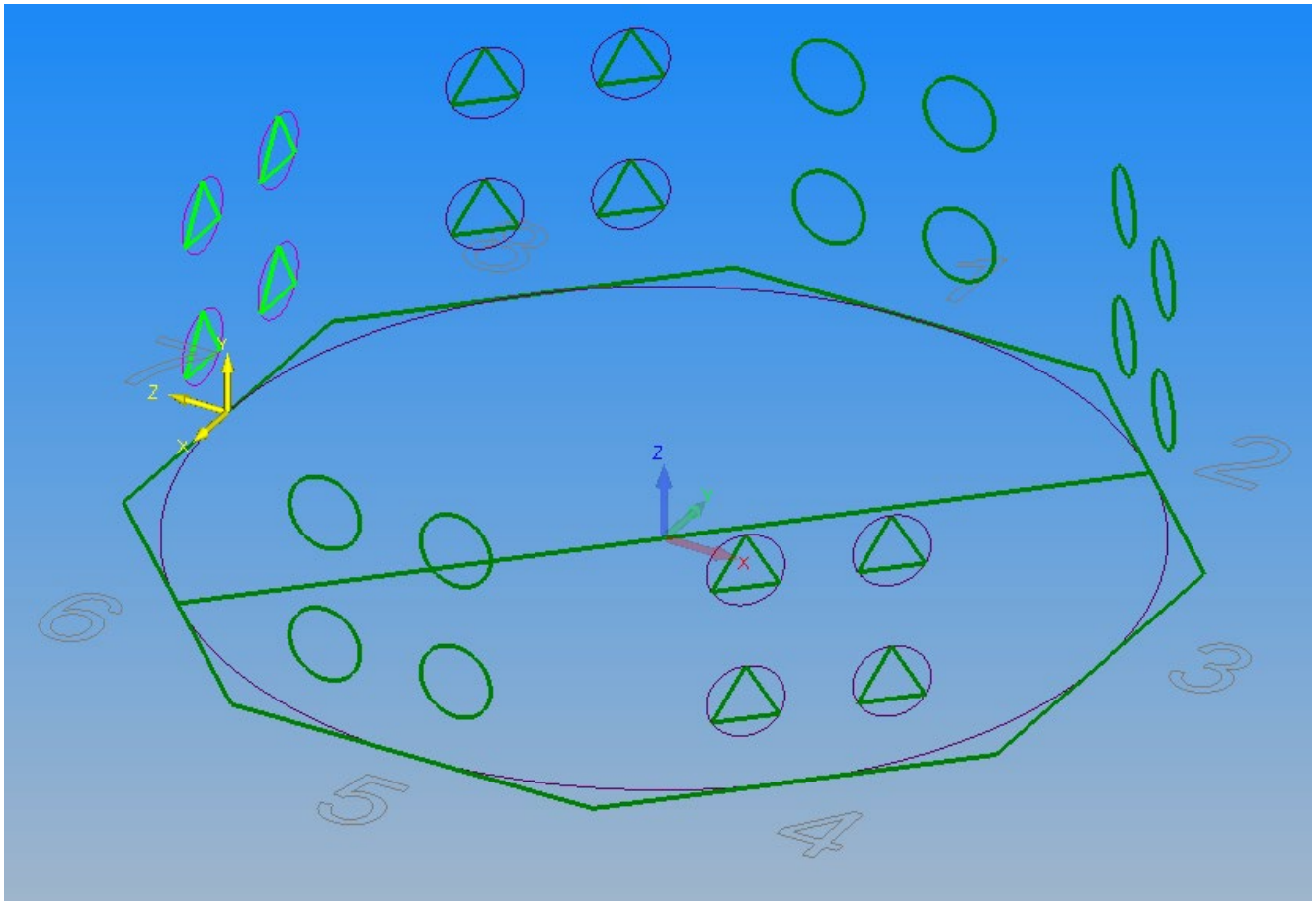


Figure 53 - Triangles copied to Face 7

What is the result of this form of copy?
What are the considerations with respect to the application of tool paths?
If your Machining requires Local Origin numbers you can set these editing the properties of the work plane, (the same as when you renamed the work plane).

Copy Geometries between work planes using the Project Manager

To copy geometries between work planes in the project manager the work planes must exist.

Create the required Work Planes

Create the Work Planes for line 3 using **WORK PLANES > Slice through work volume** and rename to suit.
Set the work plane axes orientation and its position so that the Z axis points out from the examples and the X&Y datum is the centre point of each line.

If the Z axis points into the plane use **WORK PLANES > Reverse Current Plane**

Select **WORK PLANES > Set Work Plane Origin** to adjust the datum of the work plane.

Copy the Original Geometry Circles and Triangles

Expand the tree for the **Original Circles** and **Original Triangles** you will see the geometry groups.

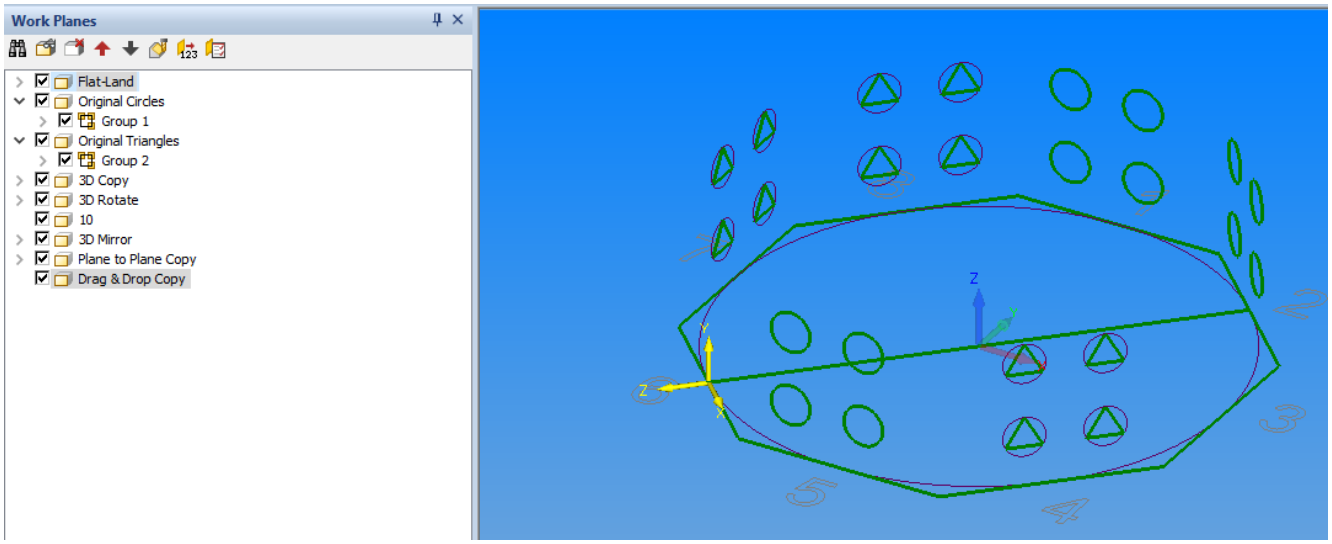


Figure 54 - New Work Plane created prior to working on the drawing

Circles

Drag the group from the Original Circles work plane to the Drag & Drop work plane (Line 6).
<LClick> and hold down the left button, on the Group from the **Original Circles** and move the mouse down until the **Drag & Drop Circles** title highlights.

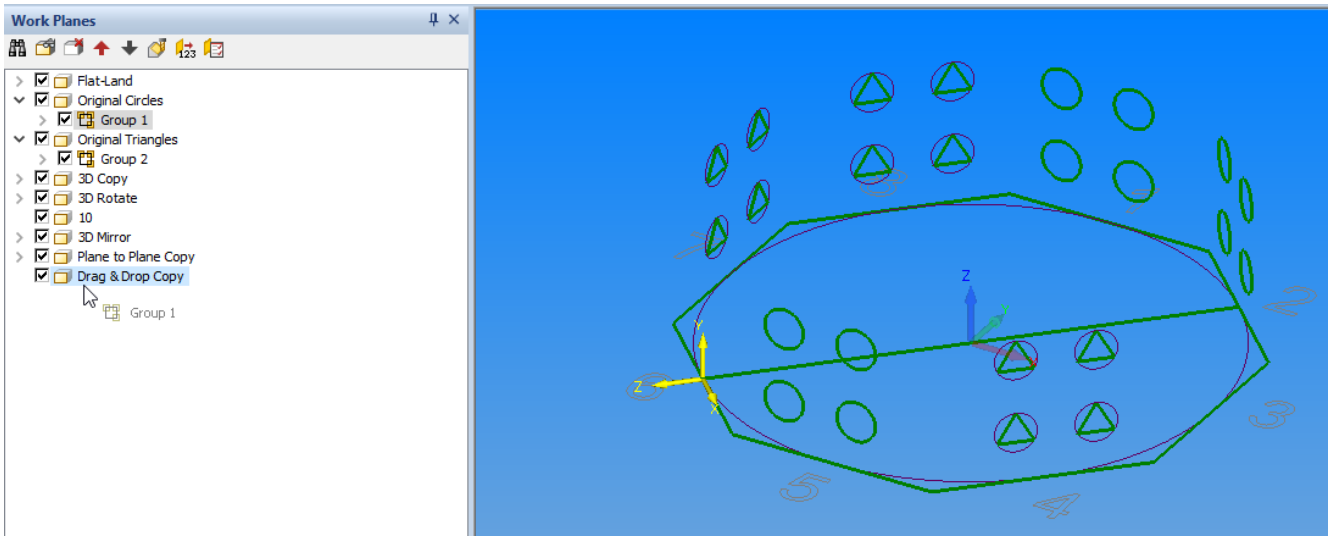


Figure 55 - Using the Drag and Drop method

Still with the left mouse button held down, press and hold **<Ctrl>** on the keyboard, at this point release the left mouse button to copy the group to the new work plane.

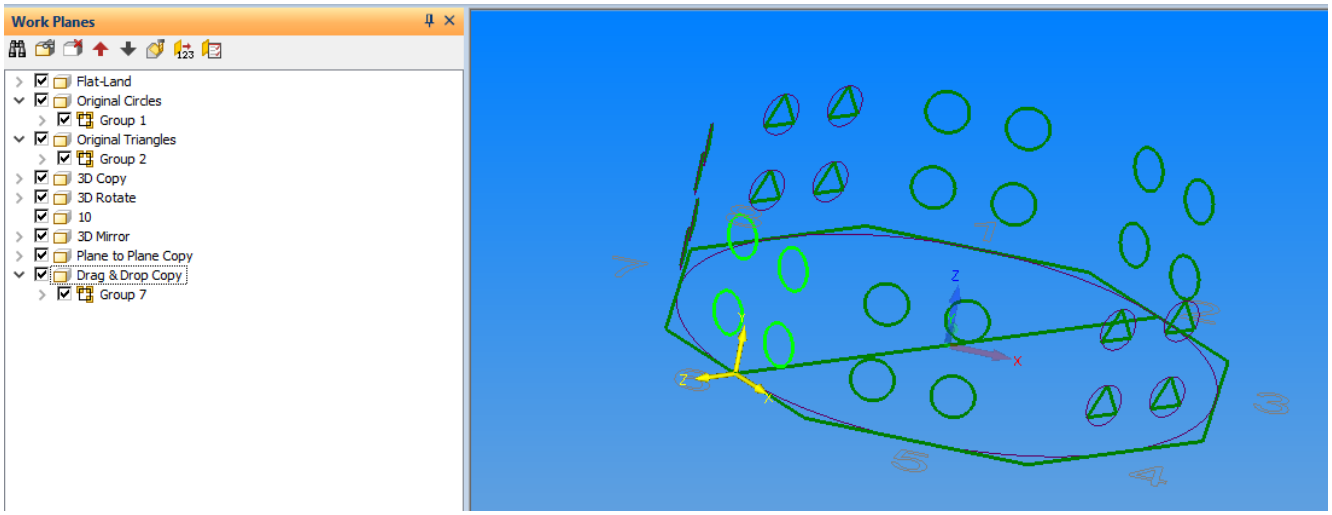


Figure 56 - Circles Dragged to Face 6

Alternatively, **<RClick>** on the items and select **Copy,**

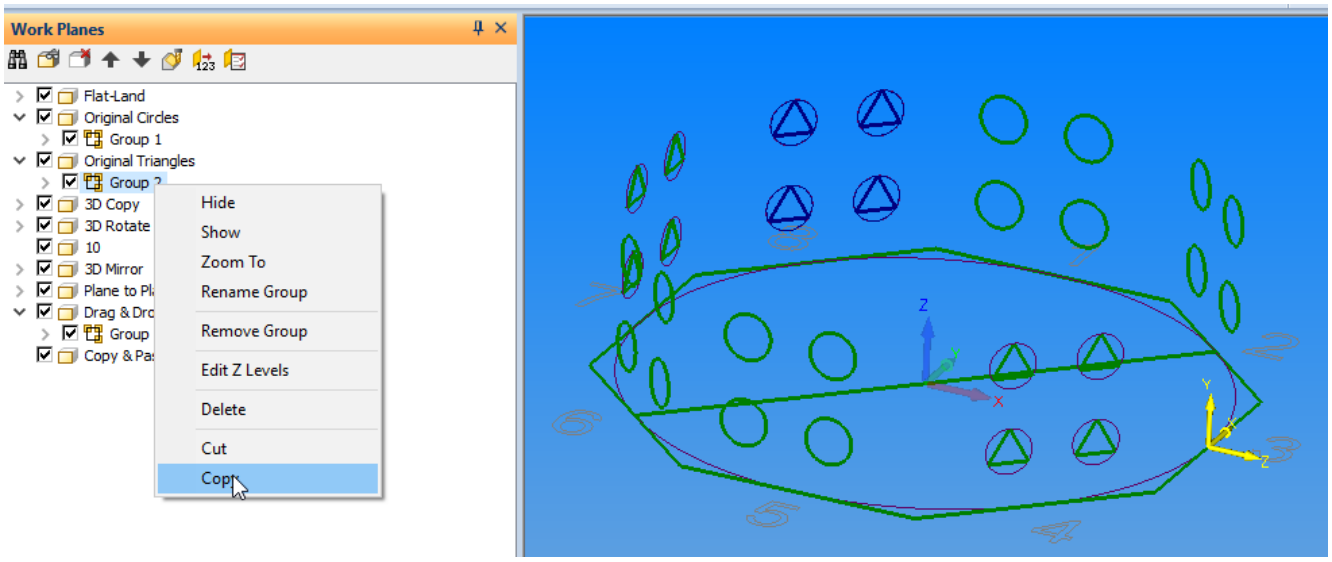


Figure 57 - Using the <RClick> menu Copy option

Then **<RClick>** on the new Work Plane and select **Paste** for the triangles group to Face 3.

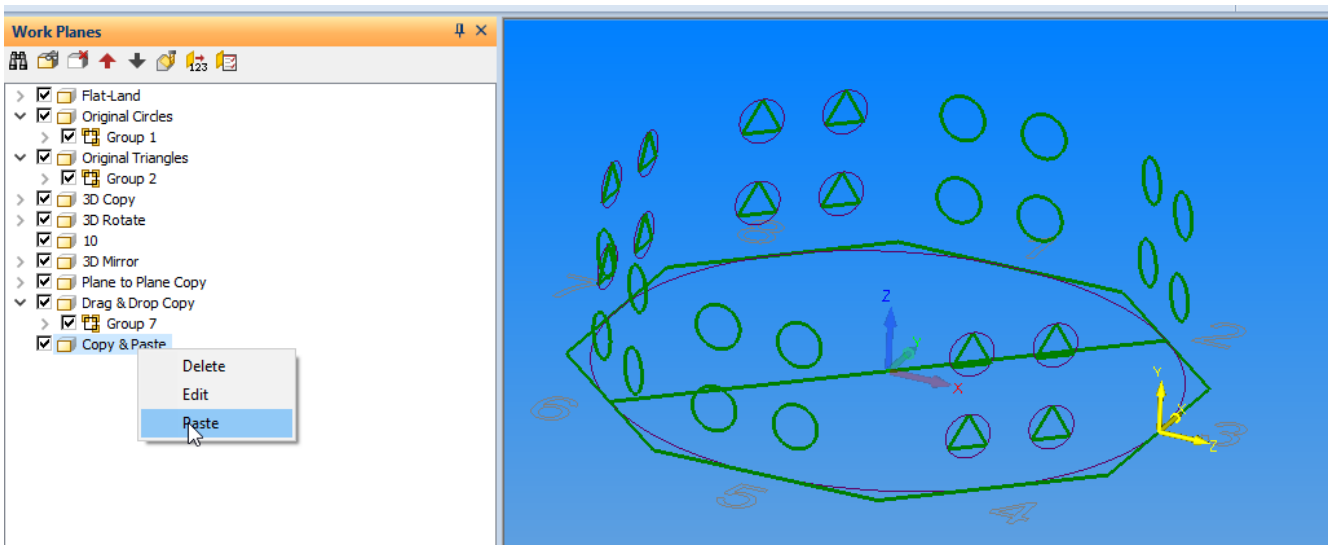


Figure 58 - <RClick> and Paste

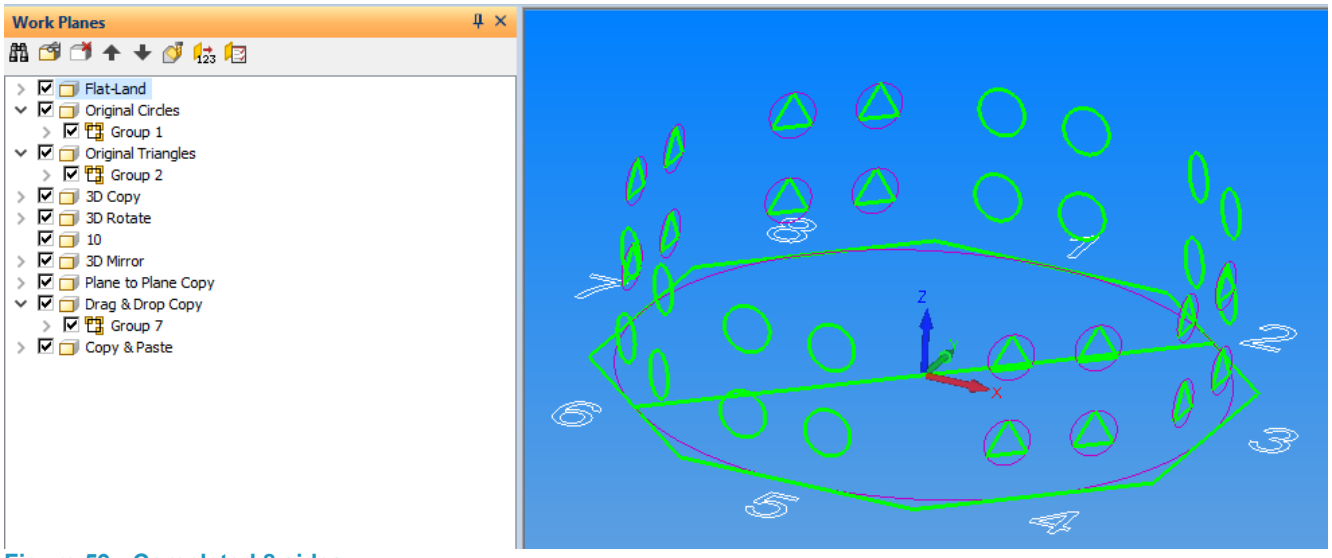


Figure 59 - Completed 8 sides

When copying or moving between work planes in the project manager **REMEMBER** the original relationship between the geometry and work plane origin is maintained.

Note that sometimes creating the two work planes prior to the process can work, in some instances empty work planes will be deleted so it is usually best practice to only create the work planes as and when you need them.

Corner Flats

To create geometry to produce corner flats, first we need to create a plane that is in the correct attitude for the detail to be applied.

Create the top of the part

To generate this correct angle detail, we need to copy the base octagon from Flat-Land to a position 175mm above it, in the global Z axis.

Set the view to ISO Select **VIEW > Iso**

Ensure No Work Plane is active using **WORK PLANES > Cancel Work Plane**

Set **EDIT > Auto/2D/3D Mode** to 3D

Select **EDIT > Move Copy etc.>Copy**

<LClick> on the original octagon as the item to copy.
<RClick> to continue.

For the base point, accept the default **X0, Y0, Z0** and **<LClick> [OK],**
for the new position enter **X0, Y0, Z175, <LClick> [OK].**

<RClick> to finish the placing, **<RClick>** again to finish the command.

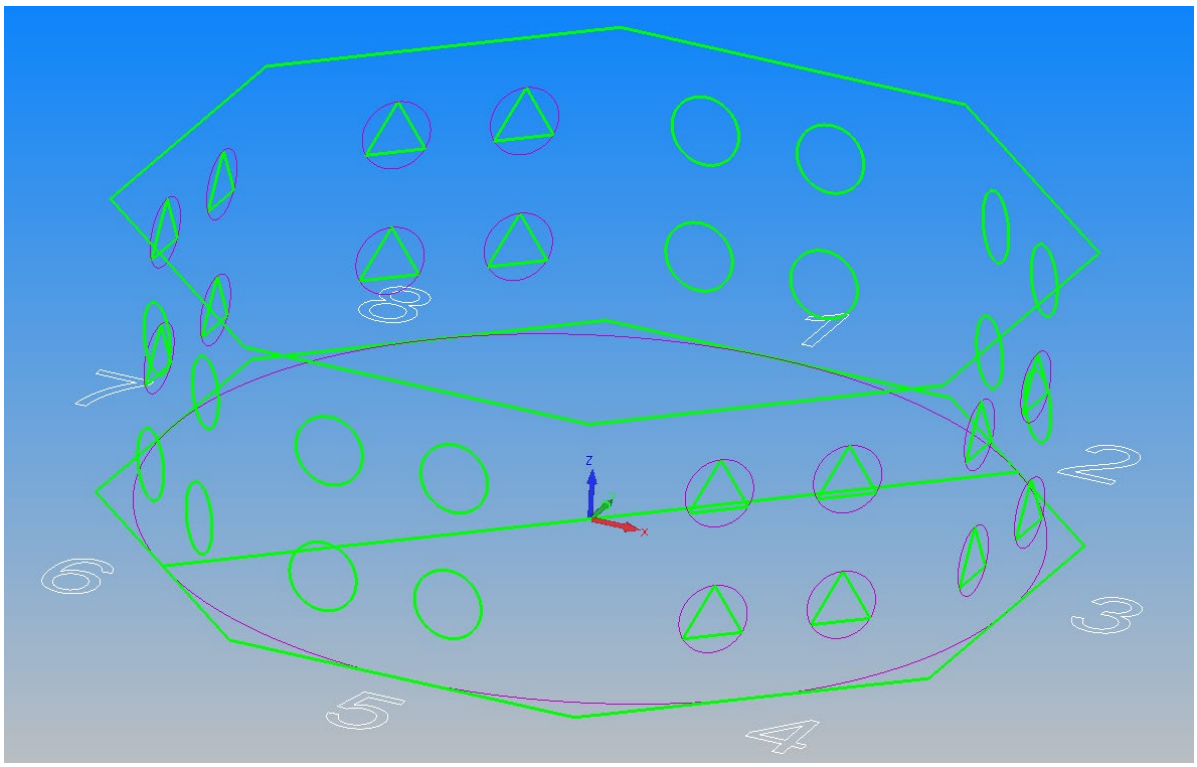


Figure 60 - Copied original octagon to represent the top of the part

Create the reference line for the Plane

Select **GEOMETRY > 3D Polyline**
For the start point use **<F8>** and select the base Circle or **X0, Y0 Z0.**
For the end point use **<F6>** and select the right end of the top line 5.
This will create a polyline from the bottom octagon centre to a corner of the top octagon.

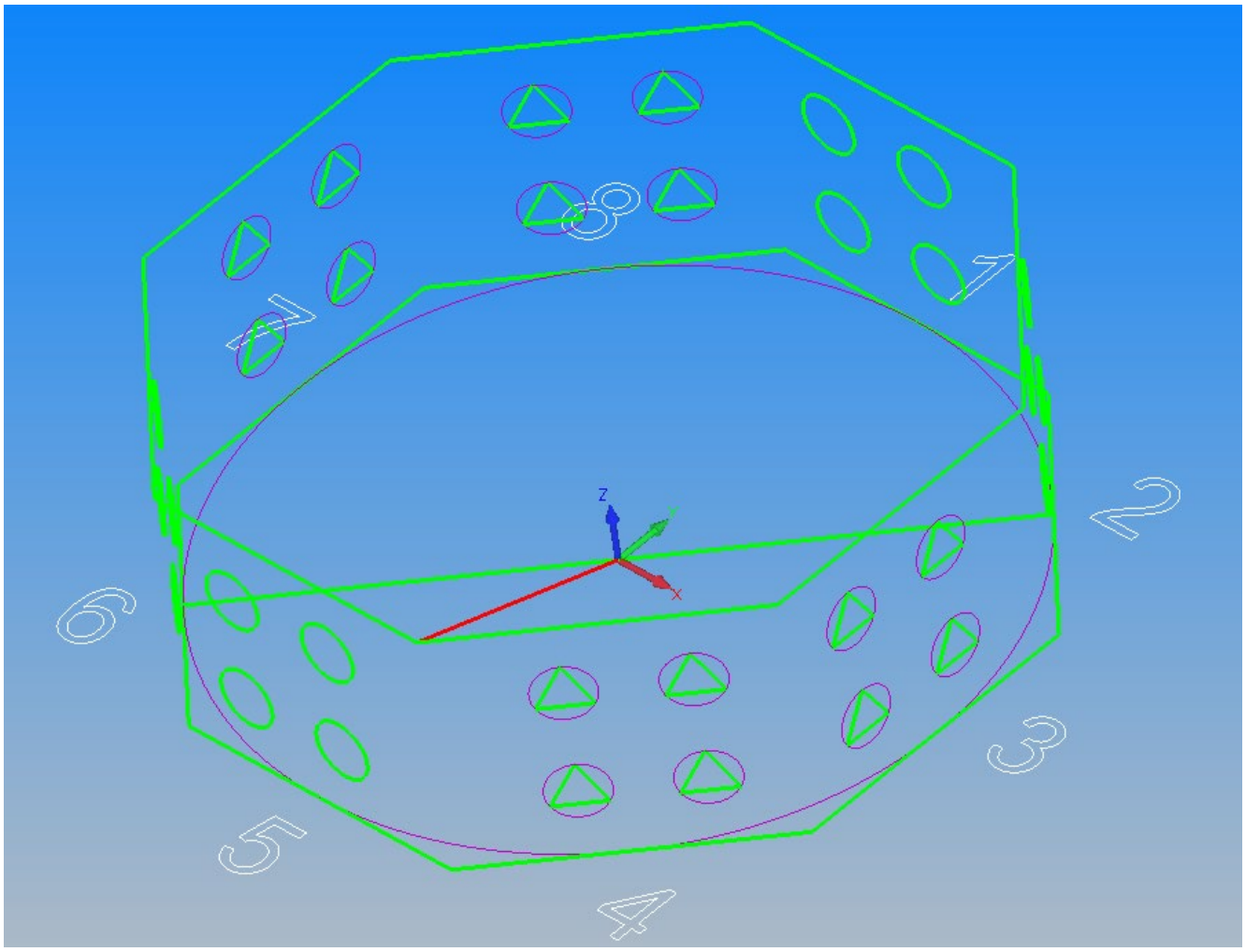


Figure 61 - 3D Polyline created from the Global Origin to an upper corner

Create the Work Plane

Select **WORK PLANES > By Line Element Vector**
<LClick> on the previously created 3D Polyline.

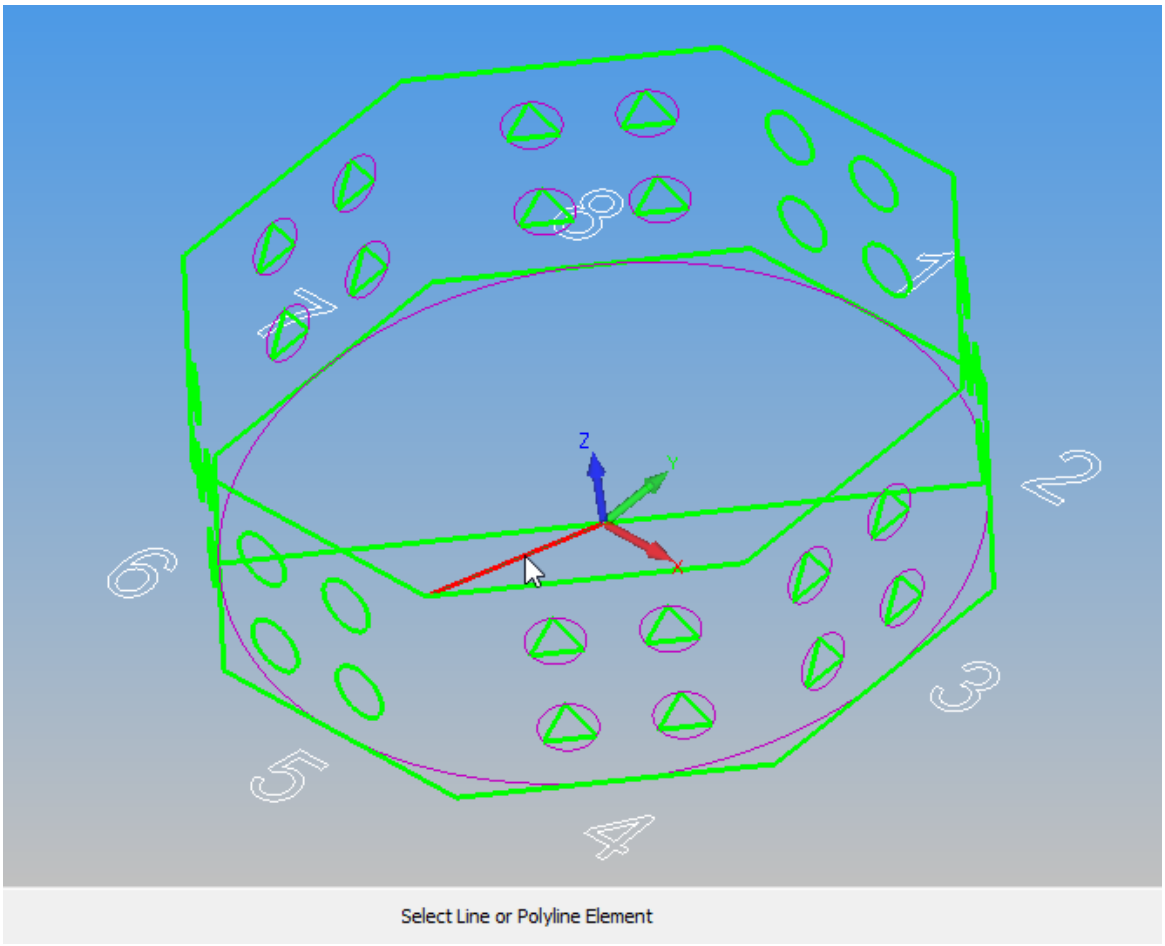


Figure 62 - Line selection for work plane creation options

You are now requested to make choices for the location for the Z level for the new Work Plane.

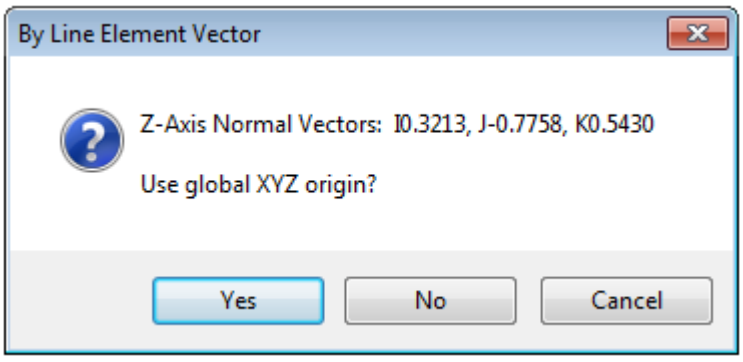


Figure 63 - Options for work plane origin point

In this example the answer to the first dialogue box is **[No]** as we wish to place the work plane in a location of our choosing.

Next you are asked for the location of the new work plane, at one end of the line or the other.

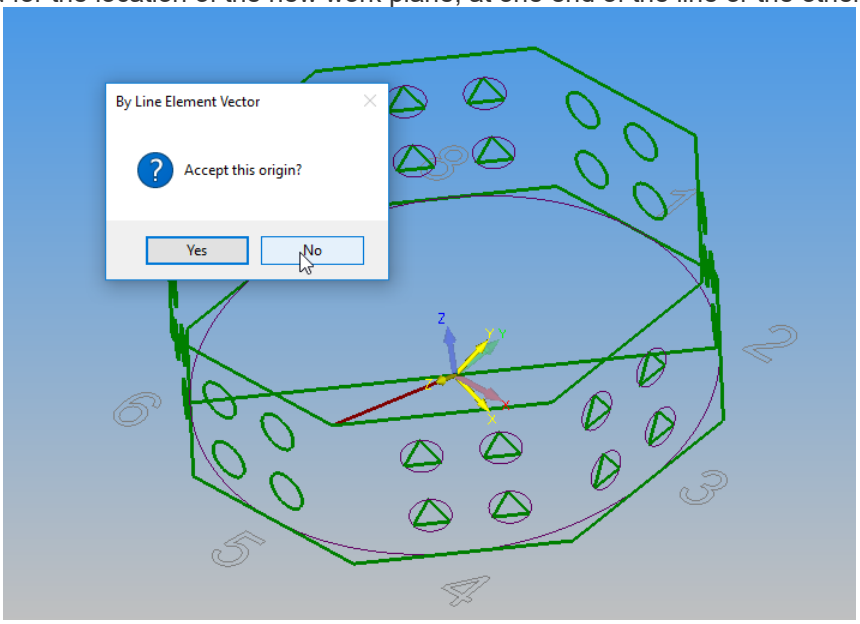


Figure 64 - First origin option

Again, in this example the answer is **[No]** as we wish the Work Plane to be on the top corner of the part. Finally, you are asked to make sure that the Z axis is pointing out from the work plane as we have looked at in all the previous examples. Depending on the way the selected geometry has been created this then dictates the correct response.

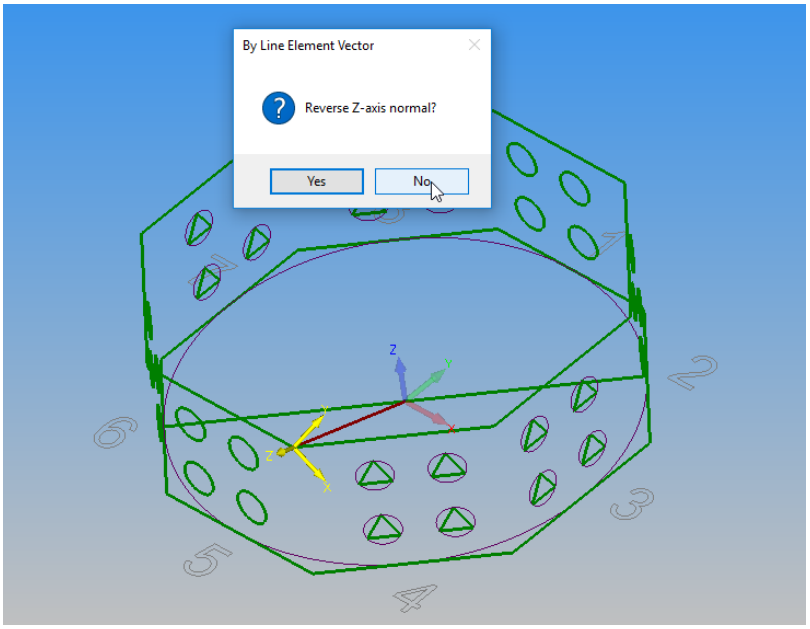


Figure 65 - Second origin option

As we drew this 3D Polyline from the Global Origin to the top of the part, the direction of the line has dictated the Z axis is correct, so the answer for this dialogue is **[No].**

Had we drawn from the upper corner down to the Global Origin, then some of the answers would have been the opposite choices.

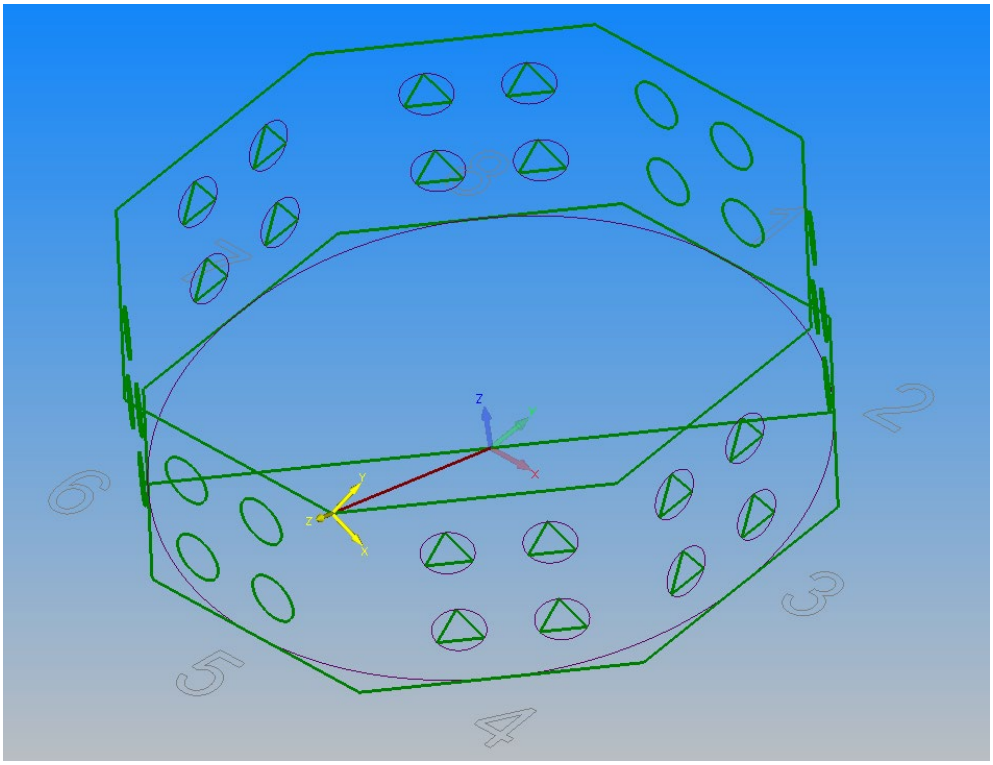


Figure 66 - Created work plane using Normal to Vector

Select **VIEW > Normal to Work Plane**
This will orientate the view so that the X axis is Horizontal you can see the part is skewed at an angle.

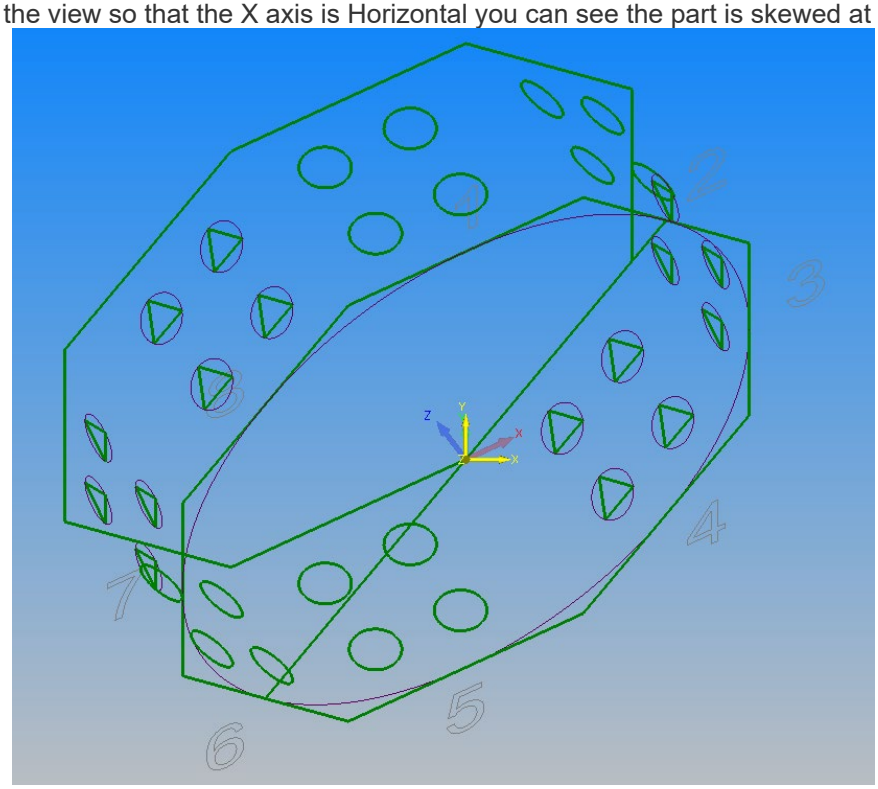


Figure 67 - The alignment of the X axis could be better

Adjust the Work plane for manufacture

This needs to be adjusted so that the work plane is more acceptable for machining,

Select **Work Planes > Make Local Axis Horizontal**

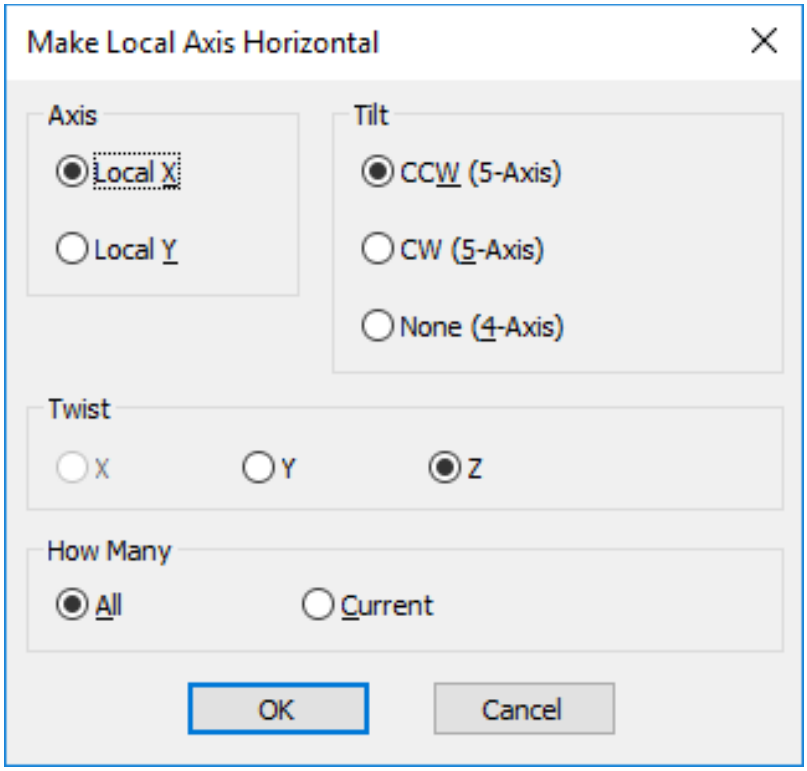


Figure 68 - Make Local Axis Horizontal dialogue options

This dialogue box provides options for;

Axis	⊙ **Local X** ⊙ **Local Y**	Manipulates the work plane so that either the local X or Y axis is horizontal depending on machine and manufacturing requirements.
Tilt	⊙ **CCW (5-Axis)** ⊙ **CW (5-Axis)** ⊙ **None (4-Axis)**	None supplies no Tilt attributes to the work plane for simple 4 Axis rotary machining. If a 5-Axis solution is required, select the one that matches the axis movement of your machine set up.
Twist	⊙ **X** ⊙ **Y** ⊙ **Z**	Sets which local axis the work plane will be rotated to set up the required axis horizontal.
How Many	⊙ **All** ⊙ **Current**	Options as to which work plane is altered.

Set the dialogue options as per the following image

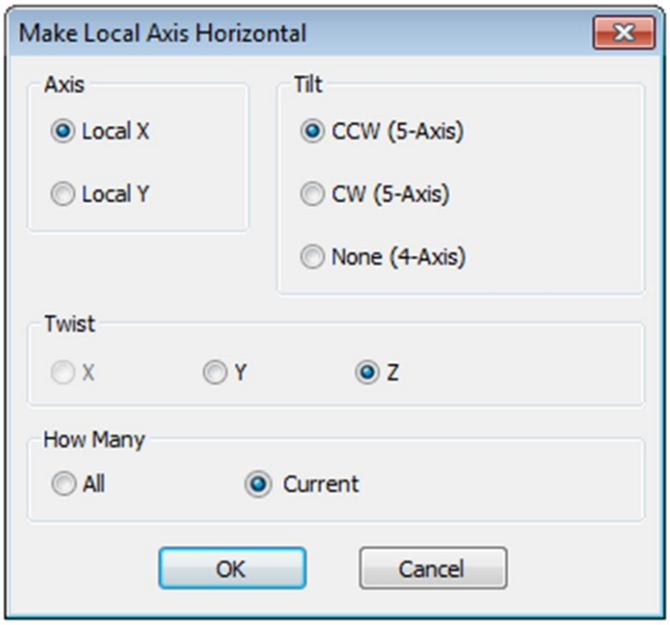


Figure 69 - Options required in this example

> Care should be taken when setting the **How Many** option. Making the option ⊙**All**, may have adverse effects on already applied geometry or tool paths.

<LClick> [OK] to finish.

Then select **VIEW > Normal to Work Plane**

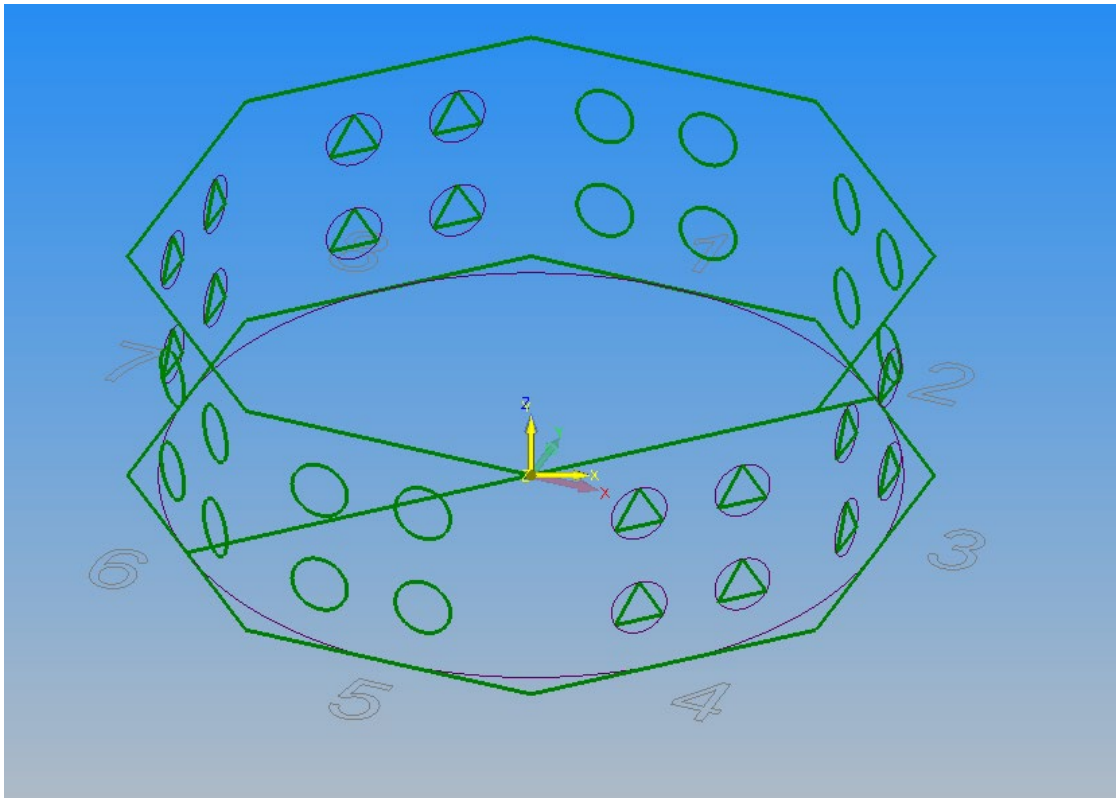


Figure 70 - Work Plane X axis now running parallel to the global X axis

Machine Corners

On the new compound angle work plane, create a rectangle from X-25, Y-25 to X25, Y25.
Pocket the rectangle 12 deep using a Ø12 tool, leave the tool directions on centre.
You will have a warning about soft boundaries, on this example it is perfectly acceptable, in fact it is what we need to create the initial flat.

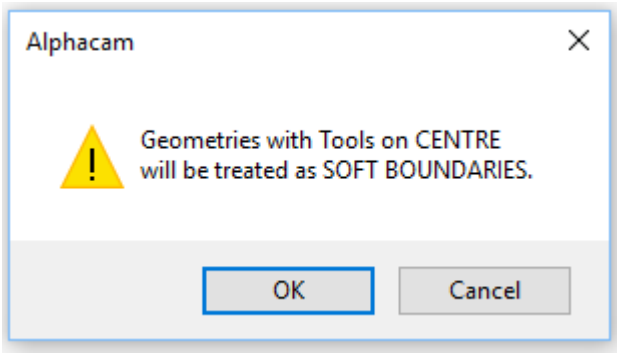


Figure 71 - Soft Boundary warning on corner flats

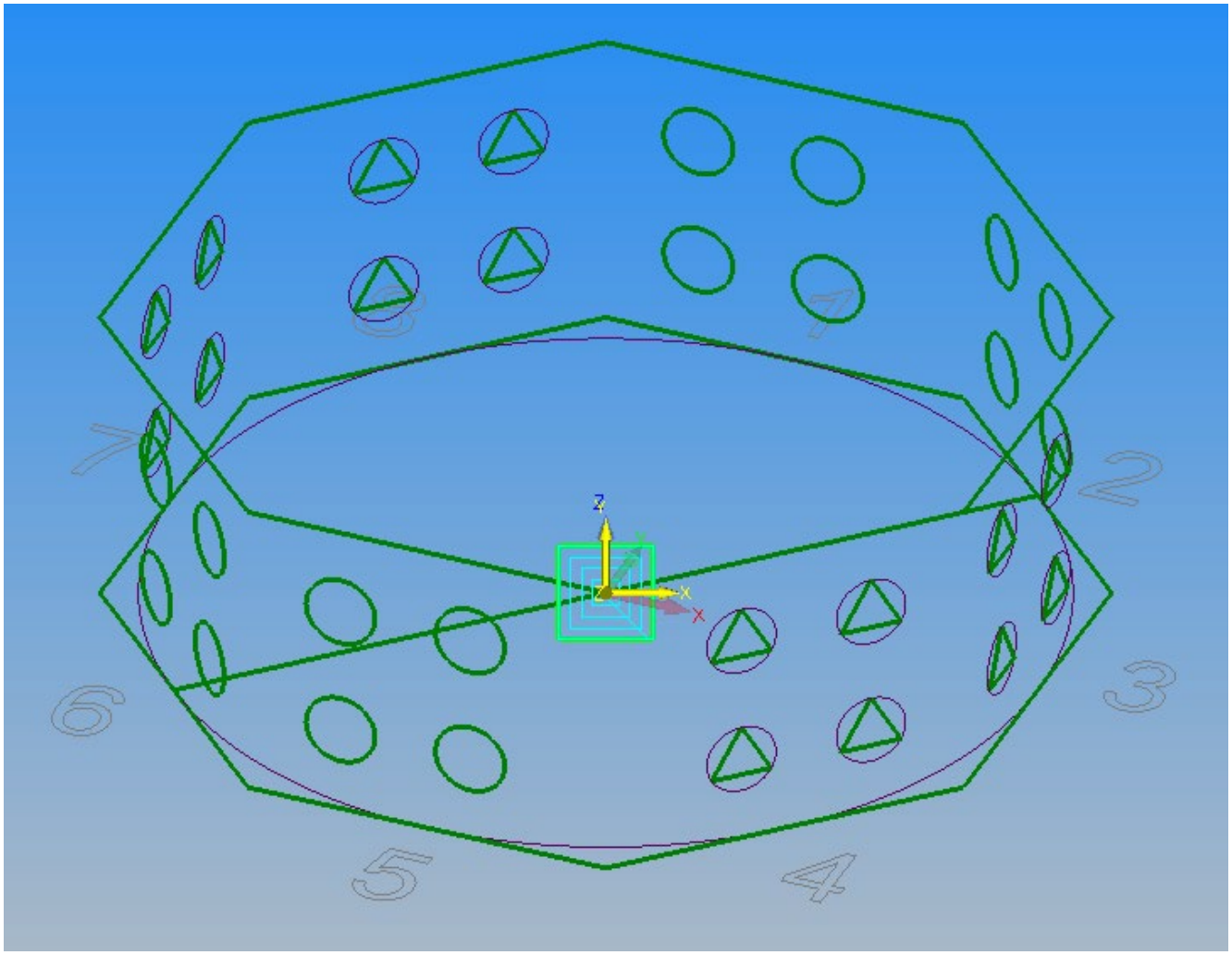


Figure 72 - Initial corner flat machined

Ensure No Work Plane is active using **WORK PLANES > Cancel Work Plane**

Using the Rotate command, select the square geometry and the new toolpath as the items to rotate. When requested, use the Blue Z axis marker as the axis to rotate around, with 8 copies at 45 degrees.

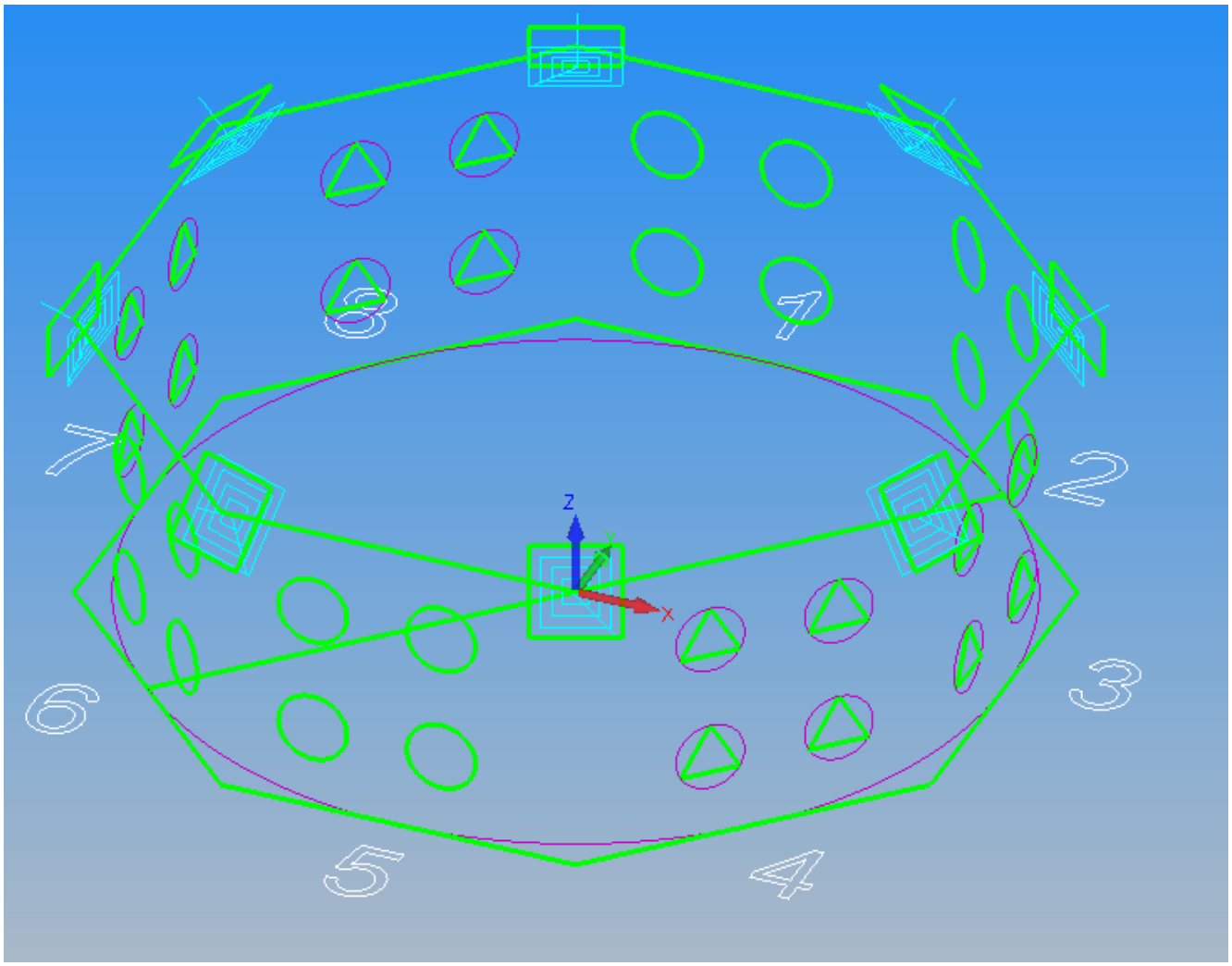


Figure 73 - Rotated corner flats

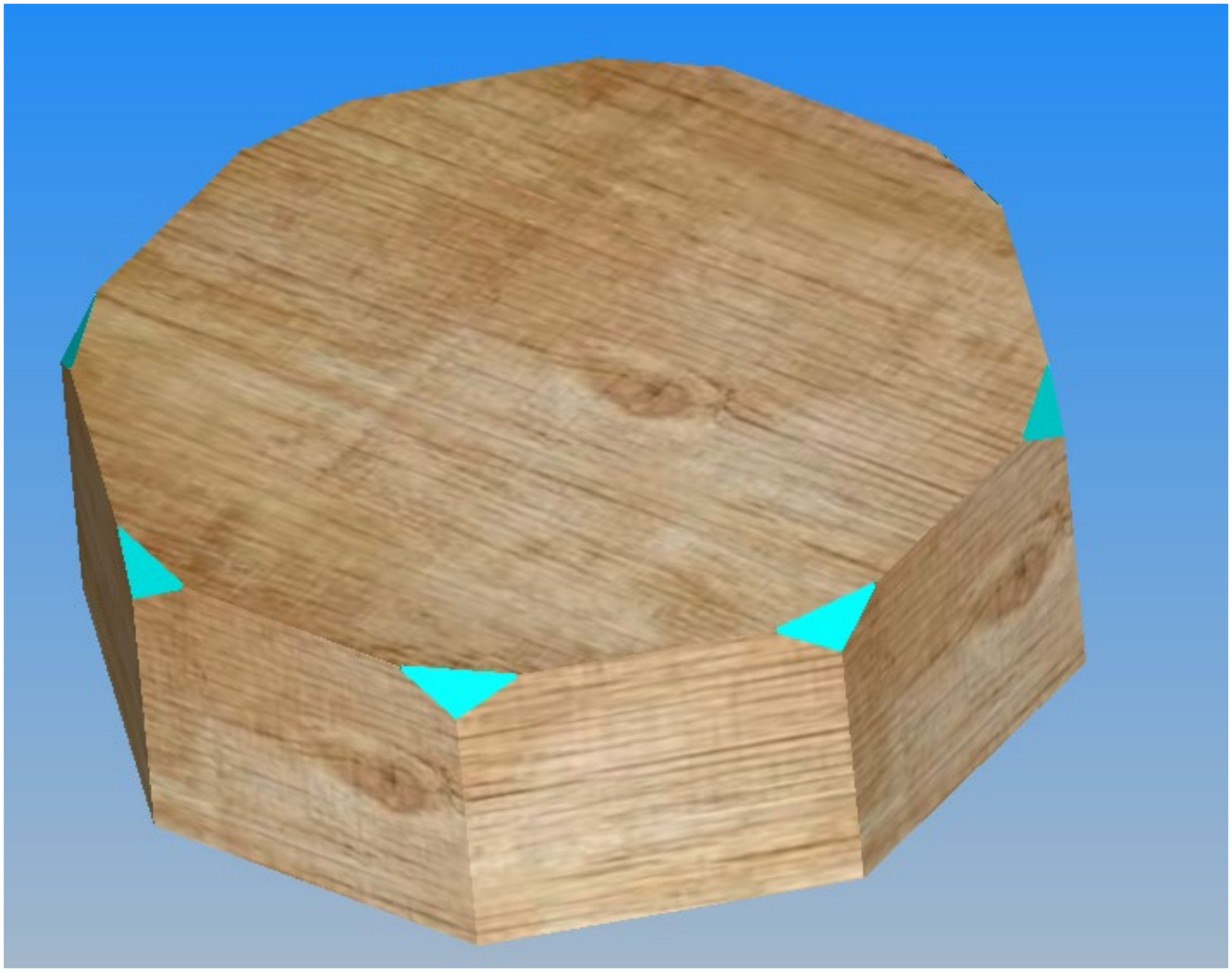


Figure 74 - Compound angle corners machined to the part

Creating Material

When creating main or additional materials for solid simulation or Z Contour Roughing you can use any geometry profile in any work plane.

When extruding materials, the Top and Bottom values will be with respect to the Z axis of the work plane that the geometries are drawn on.

Machining on Work Planes

When generating the machining tool paths, the order in which the tool paths are created is the order in which they are output i.e. these can be manipulated from the Operations project manager page.
All machining can be done on each plane before indexing to the next plane or Machining with one tool can be performed, indexing to each face, before the next tool is selected.
Machining tool paths and geometries can be manipulated and duplicated to different planes. The duplication and manipulation commands Move Copy Rotate Mirror etc. work differently dependent upon the work plane status.

- When a work plane is active commands are 2D as normal.
- When a work plane is NOT active commands are 3D.
- When normal geometry is drawn whilst a work plane is NOT active, it is drawn in Flat-Land that is with NO Z VALUES and has no relationship to the work volume.
- When 2D data is inserted, it is inserted on to the currently active plane. If the data inserted is 3D it is inserted into Flatland 3D space and not on the currently active plane.

Machining geometries, which have been created on work planes, is no different to machining normal geometries. Prior to machining geometries created on work planes it is necessary to make the work plane active using **WORK PLANES >** command.

The output co-ordinates will depend upon the post processor. The program co-ordinates will normally be either local dimensions or global dimensions. When local dimensions are output it is necessary to set the work plane datum to suit the machining required, prior to saving the NC program.

It should be stated here that whilst you can create any number of Work Planes and apply the machining cycle to them, there could be instances during the process where you are advised that you are beyond the limitations of you post processor settings.

You may not be advised until the use of Output NC, at which time you would need to undertake some sever editing of the part.

It is your responsibility to generate and use Work Planes in conjunction with the actual machining limitations of the machine on which you intend to cut the part.

Manipulation of data between Work Planes Procedures.

To move or copy data from FLAT-LAND to a Work Plane

1. Ensure **NO** Work Plane Is Active.
2. Select Move or Copy.
3. Pick the Items to be Moved or Copied.
4. Pick the position the Move or Copy is to be controlled by (Base Point).
5. Activate the Work Plane the items are to be Moved or Copied to.
6. Pick or enter the co-ordinates to position the items being moved or copied.

To move or copy data from Work Plane to Work Plane

1. Ensure the Work Plane containing the items to be manipulated Is Active.
2. Select Move or Copy.
3. Pick the Items to be Moved or Copied.
4. Pick the position the Move or Copy is to be controlled by (Base Point).
5. Activate the Work Plane the items are to be Moved or Copied to.
6. Pick or enter the co-ordinates to position the items being moved or copied.

To Rotate in 3D

Is the same as normal 2D Rotate but instead of picking a point to indicate the rotation axis you must select one of three options,

1. One of the automatic axes created from the Global Datum.
2. A geometric line on a work plane.
3. A 3D Polyline.

To Mirror in 3D

Is the same as normal 2D Mirror, but instead of picking two points, to indicate the Mirror axis you must select a Work Plane to mirror about.

To Move geometries between work planes in the project manager

Drag and Drop the geometry names between the work planes in the project manager.

The geometries are moved but their relationship to the datum is maintained.

To Copy geometries between work planes in the project manager

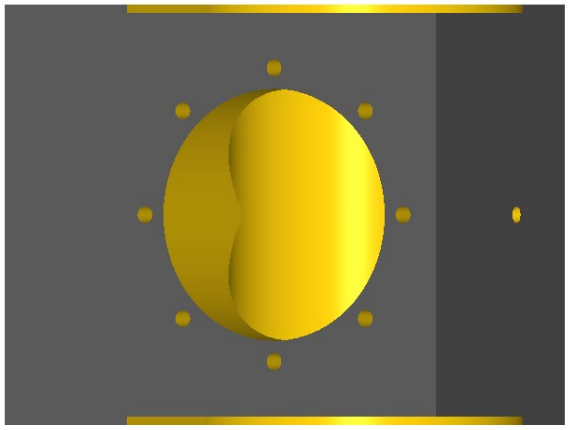
Drag the geometry names between the work planes in the project manager and hold down the **[Ctrl] key when** Dropping.
Or more easily, **<RClick>** on the required item and select **Copy,** then **<RClick>** on the destination work plane and select **Paste.**

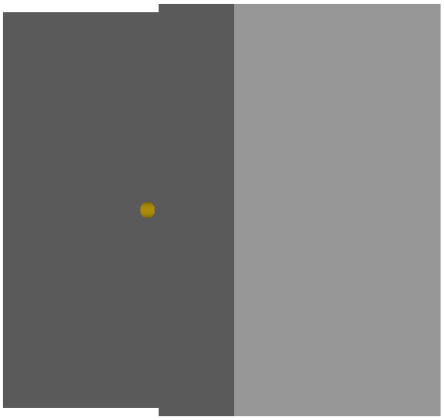
The geometries are copied but their relationship to the datum is maintained.

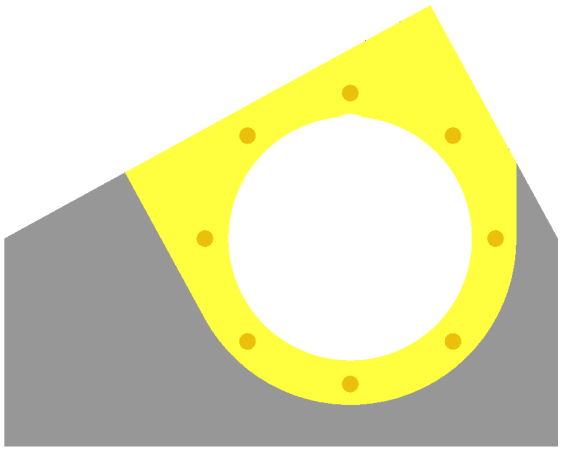
Work Planes Test

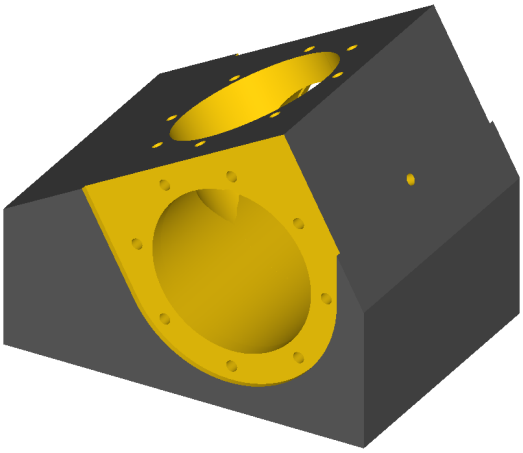
Create the geometries to:

1. Area clear the 3mm recess on either side.
2. Area Clear and Finish profile the 90 diameter holes.
3. Drill or Drill and Tap the M5 holes.
4. Apply the machining and create the material to produce the simulation as shown.









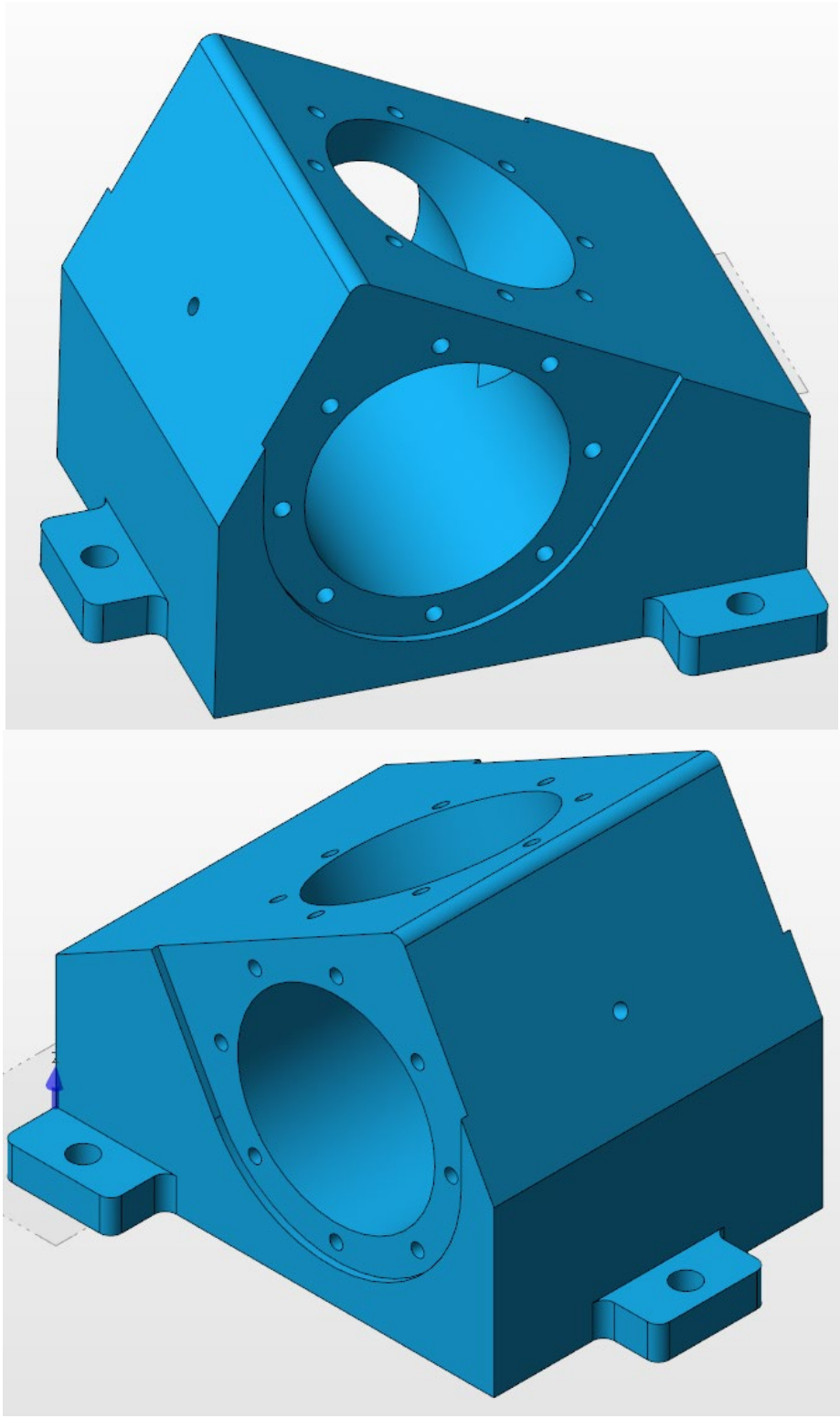


Figure 75 - Work Planes test example

Test Drawing

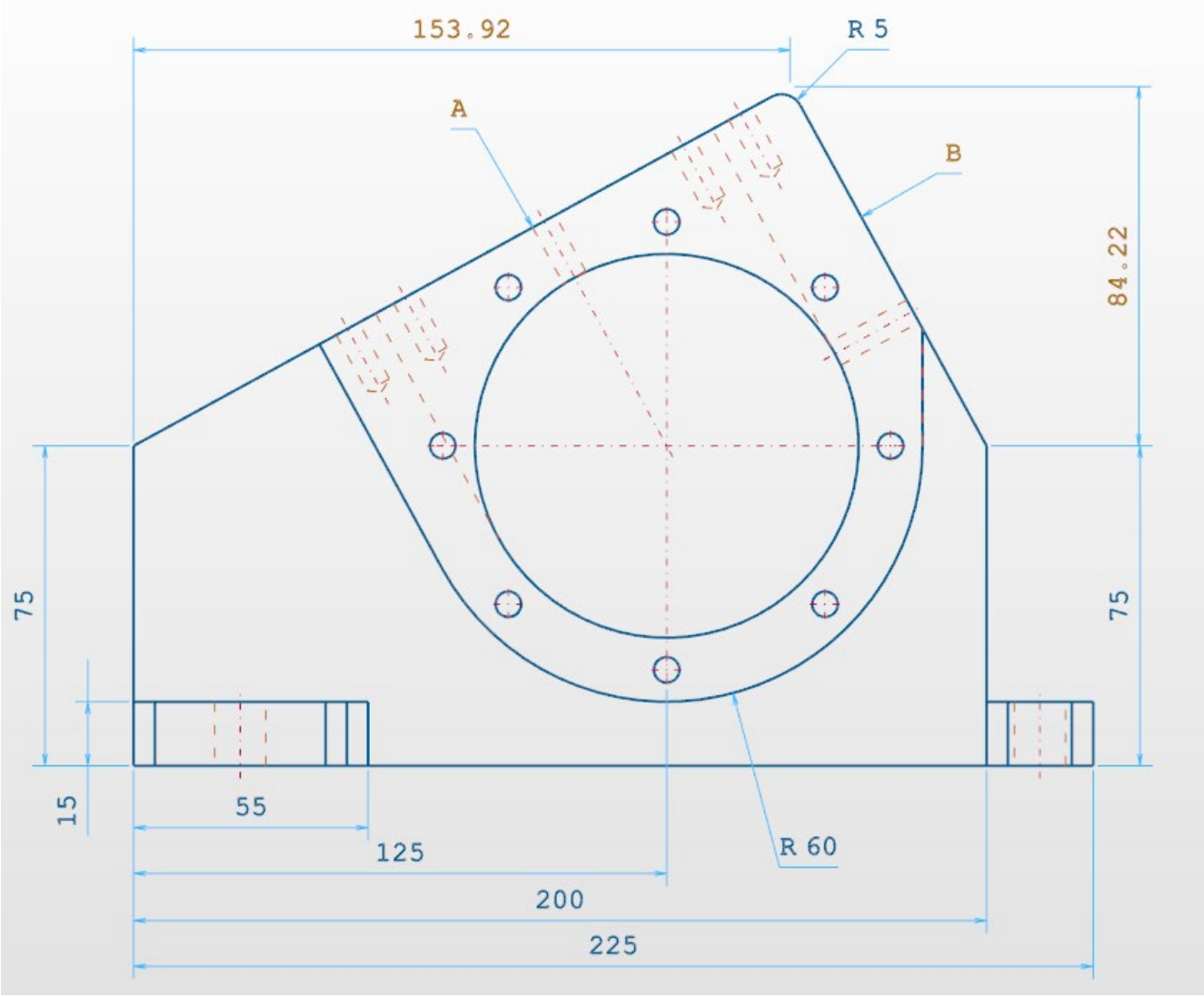


Figure 76 - Test Part Front View

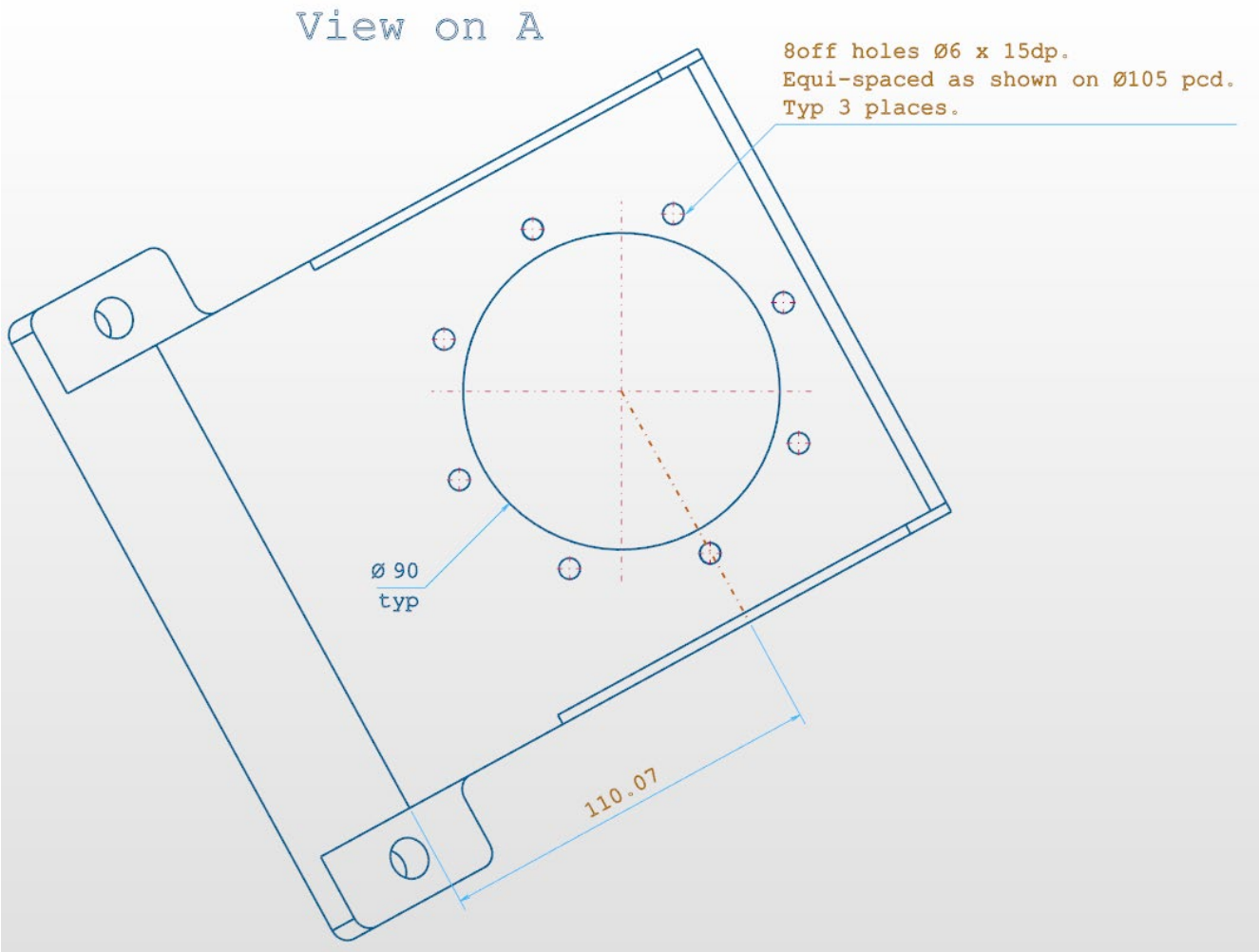


Figure 77 - Test Part View on arrow A

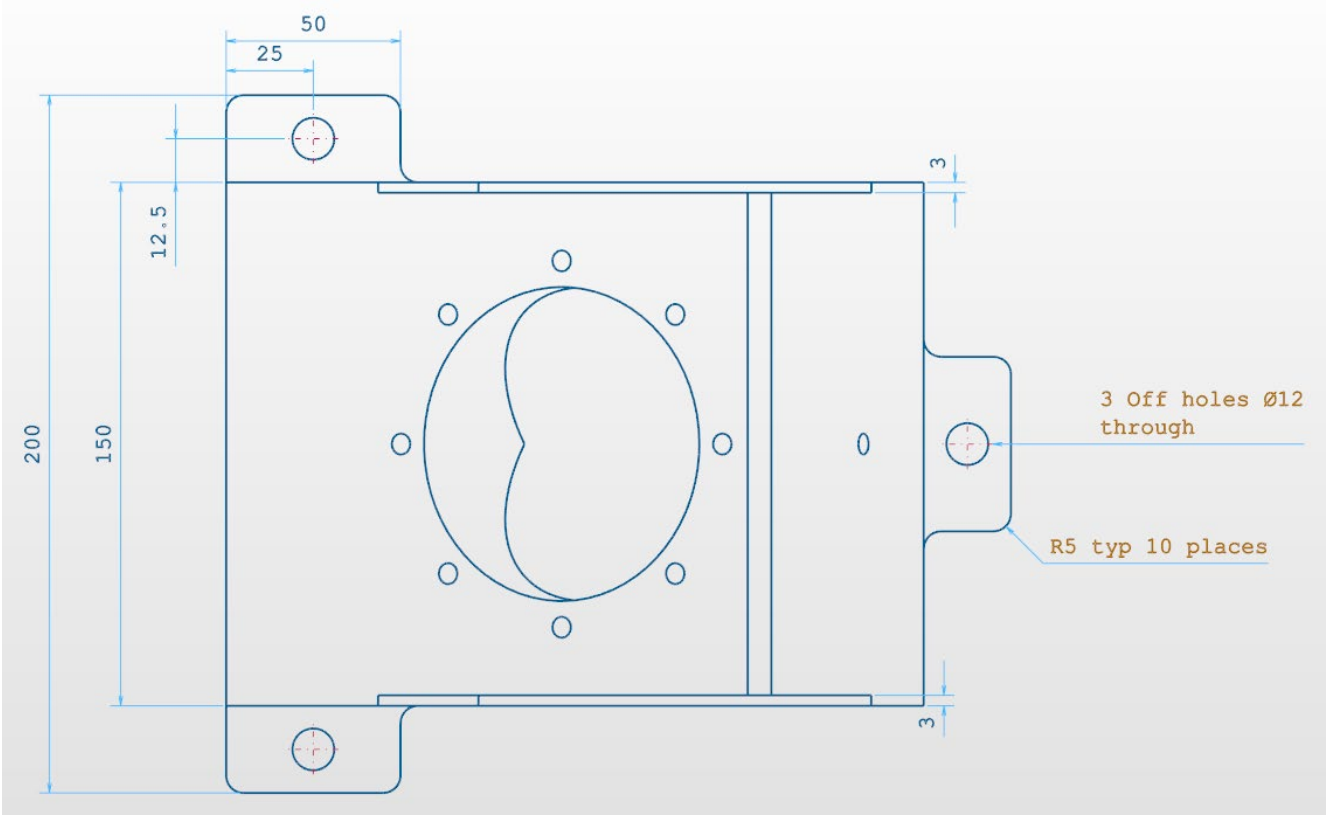


Figure 78 – Test Part Top View

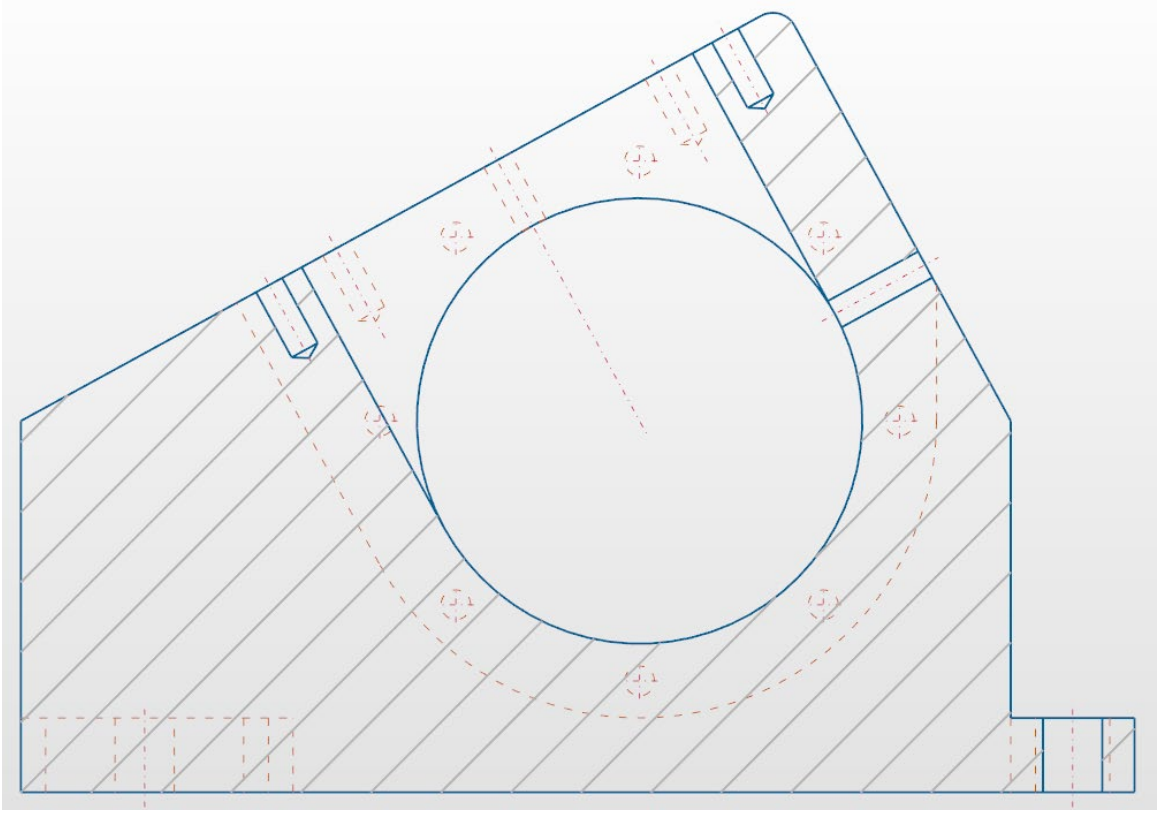


Figure 79 - Centreline cross section

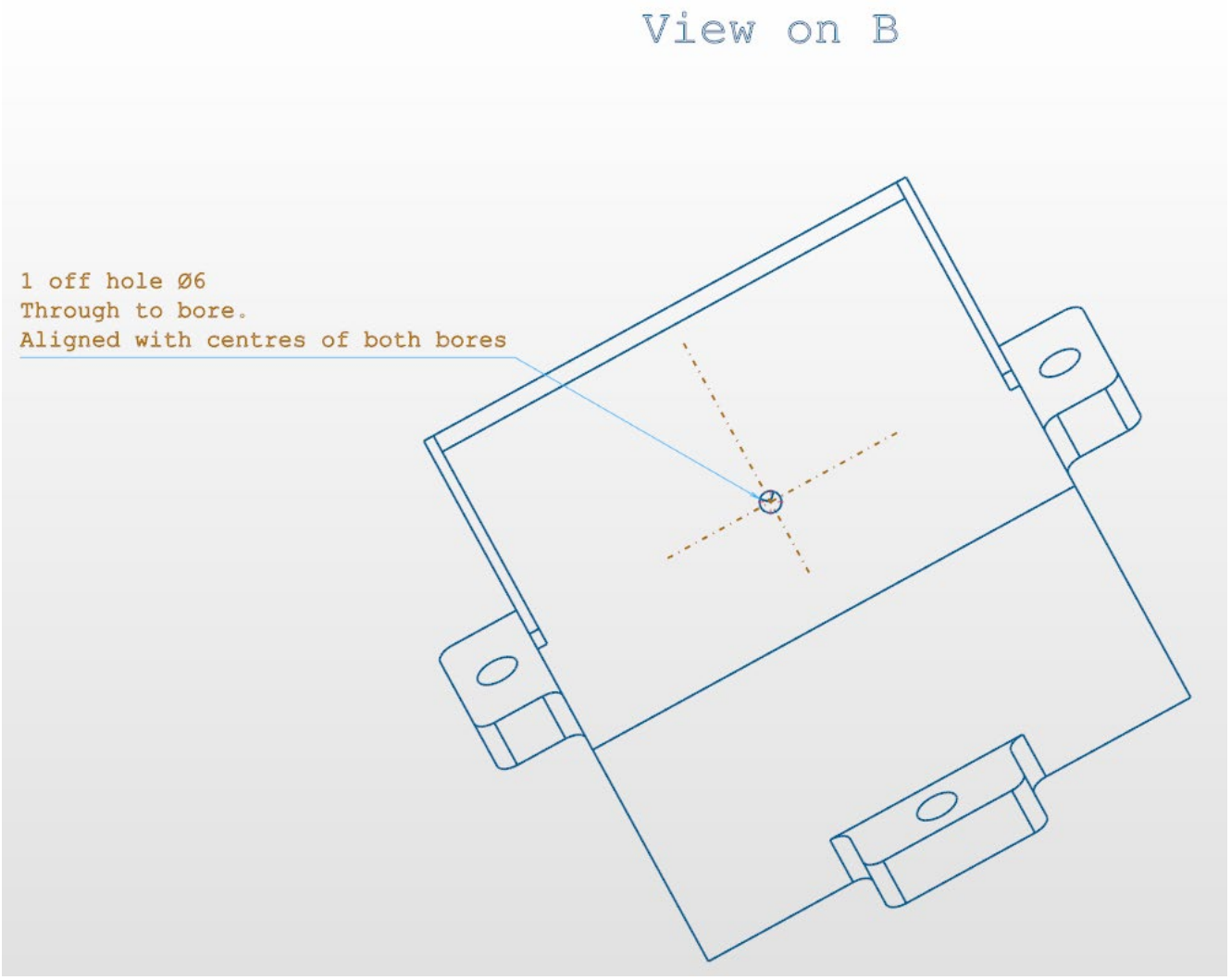


Figure 80 - Test Part view on arrow B

Possibly start with a work volume from a rectangle 0,0 to 200,150
and the Z top 84.22+75 and Z bottom 0

Solid Models and Work Planes

When working with solid models of any description in ALPHACAM, all of the previous reference methods of manipulation are valid for any geometry that you create as new items on a solid model.

The main difference is the method of creating the Work Plane.

Using **Work Planes > From Solid Model Face** becomes the main method of work plane generation, but it must be noted that the command will **ONLY** work on Planar, Cylindrical or Conical faces.

<LClick> on a face to create the required work plane.
<RClick> to complete the command.

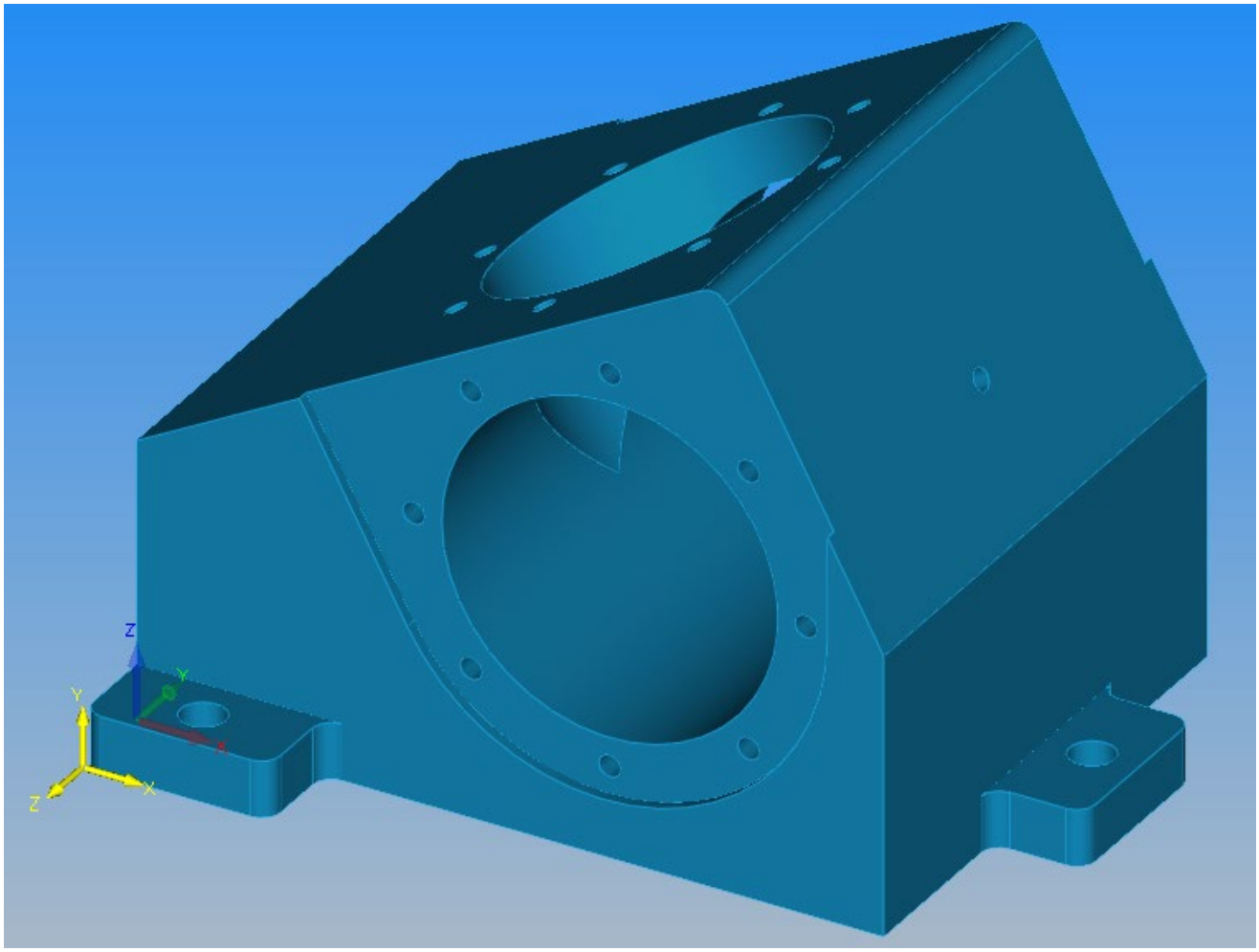


Figure 81 - Work Plane on solid model

The only consideration to make is that the origin for the work plane will be a direct projection of the global origin and from the perspective of the created work plane, the origin may not be in the correct location.

Use of the **Set Work Plane Origin** command is used more often when working with solids.

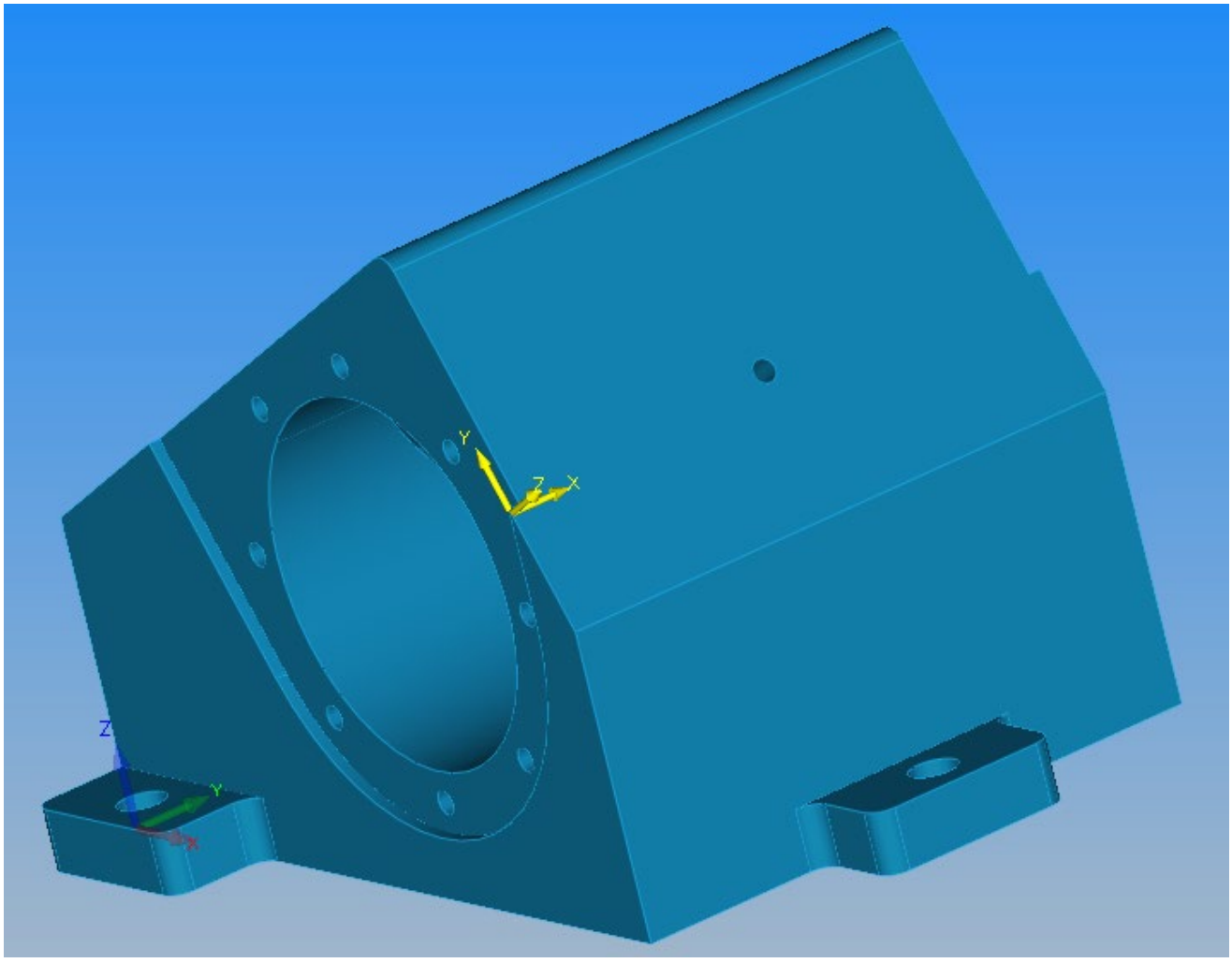


Figure 82 - Work plane on angled face

Note the location of the generated work plane origin is in line with the global origin from that chosen face view.

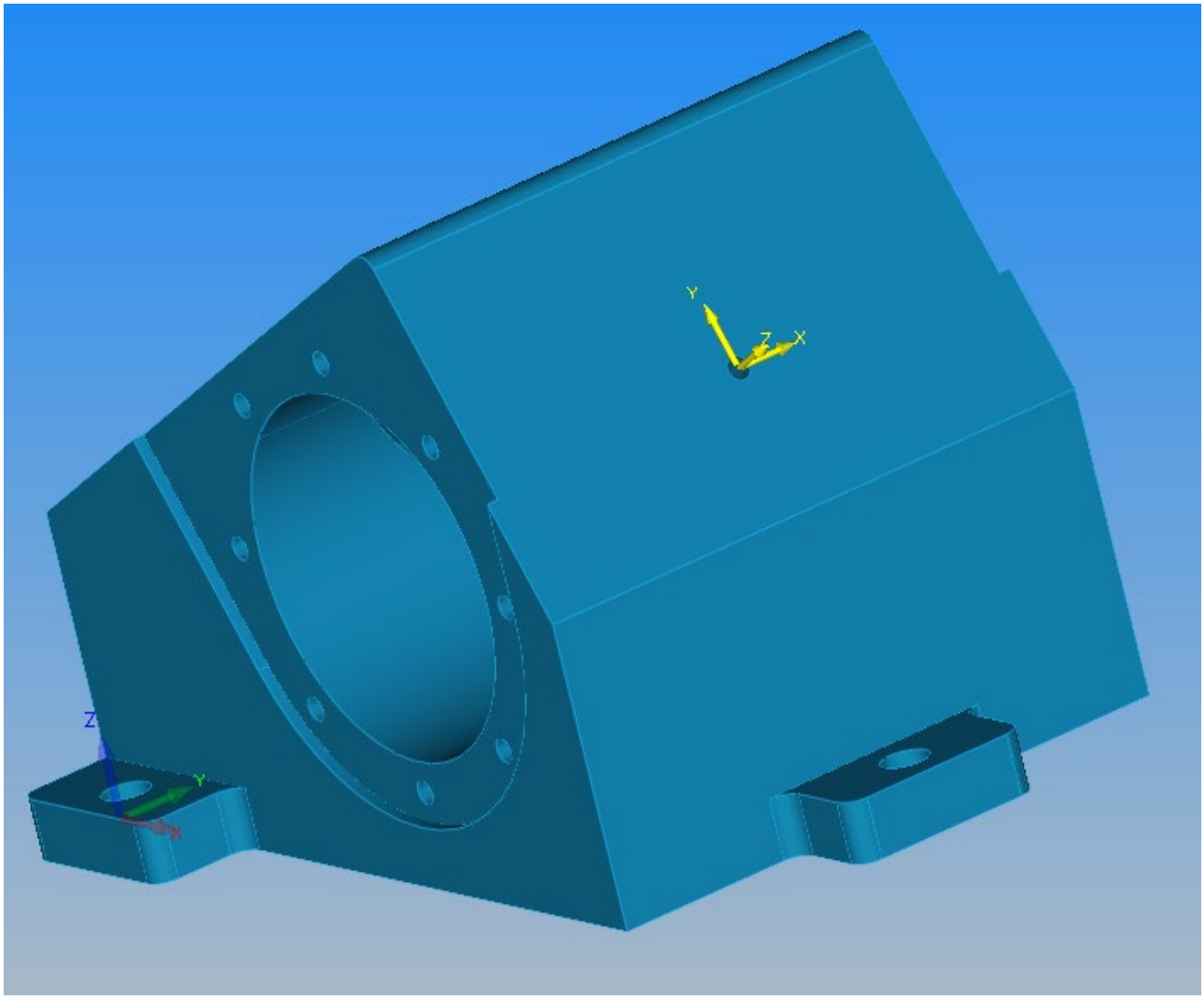


Figure 83 - Work Plane origin relocated

> **Note**
>
> If you are using the **AutoSnap <F2> functio**n, this will not work with Solid Model locations, but the actual Snap function keys will

Version amendments

V	Amendment Description	A	Software Version	Amended Date
12	Minor text formatting alterations.	1	2020.1	10/10/2019/
12	Template altered to Hexagon branding	0	2020.0	15/03/2019

HEXAGON
MANUFACTURING INTELLIGENCE

ALPHACAM 2020.1
Work Planes

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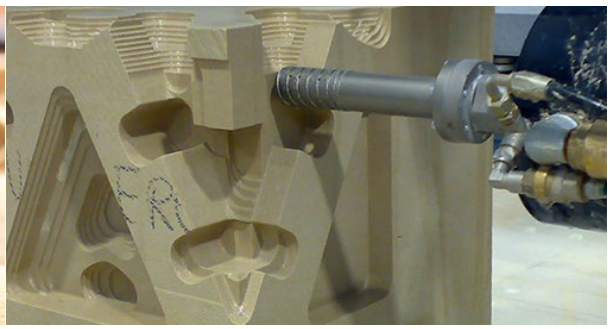
Support. support.alphacam.uk@hexagon.com
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