



# ZW3D CAM

4-5X Machining

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# **4-5X Machining**

#### Key Points:

- ♦ 4X index milling
- ♦ 5X index milling
- ♦ 5X simultaneous movement operations

ZW3D CAM 5X module provides user 4X&5X indexing milling function and simultaneous movement function. With the indexing milling function user can easily mill multiple sides of a complicated part by one-time clamping. With the 4X/5X simultaneous movement operations user can deal with such tough jobs as the titled surface, undercut surface etc.

Notice:

- 1) This tutorial is based on ZW3D 2019 version, some functions or icons may not match the current version.
- 2) All the tutorial models can be found in installation folder: ...training\5X machining model

### 1.1 <u>4X Indexing Milling</u>

Indexing milling function can position the tool axis in any direction by machine. Normally it includes 2 modes: one is for 4X indexing milling called as "3+1" mode. This means 3 linear axis plus 1 rotary axis, while the rotary axis is for positioning ; the other is for 5X indexing milling called "3+2" mode which means 3 linear axis plus 2 rotary axis, also the 2 rotary axis is for posisitioning. Open the practice file "**4X\_Indexing.Z3**" as follows:

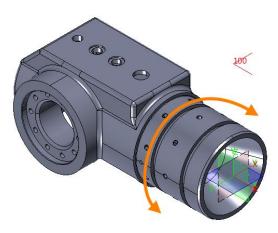


Figure 1 4X\_Indexing milling part



### 

**Analysis**: It is apparent that if we use the 3X milling tool, we are not able to finish all sides by one-time clamping. From the structure of the part it is easy to see that rotating the part around the cylinderical center line(as indicated in Figure1) it is able to mill all sides by one-time clamping. So one rotary positioning axis is enough for this case, here let's suppose that the 4X machine 's rotating axis is A which is rotating around X axis and the part is a casting part. Then let's see how to achieve the 4X indexing milling in ZW3D CAM.

### 1.1.1 Align The Part

In order to make use of the A axis here we will align the part to make the default X axis colinear with the cylindrical center line as follows:

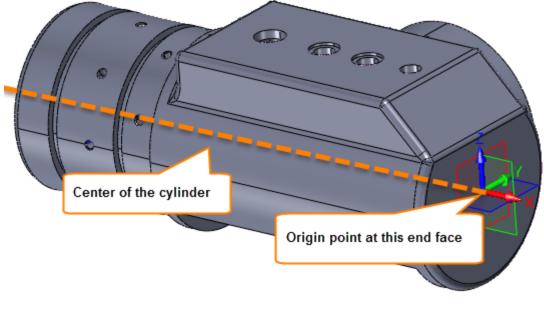


Figure 2 Align the part

### 1.1.2 Create Sub Frame

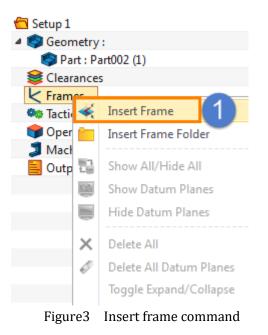
After enter into CAM let'screate the sub frame as follows:

STEP 01 Create Sub frame for right side

I. Right click on Frames tab then we can get the Insert Frame command as follows:

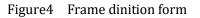






II. Click on Insert Frame command then the definition form for Frame will pop up as follows

🐲 Frame	
Name	Frame 1
Clear Z	100
Head	none
Auto Clear	10
Fixture Offset	
Offset Register	Auto
Write ORIGIN in O	Jutput
Define Frame Datum	n
Create Datum	n Select Datum
Frame Attribute	
Color	
Reset	OK Cancel



III. Then we can click "create datum" to create new frame as follows





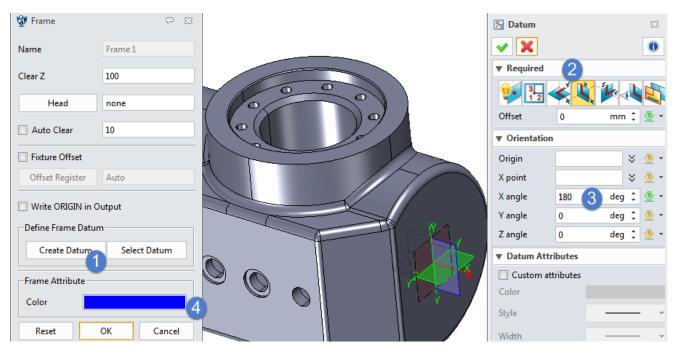


Figure5 Create frame based on XZ plane

#### Note: This process is the same as the process of creating datum in CAD level.

IV. Newly created frame will be as follows:

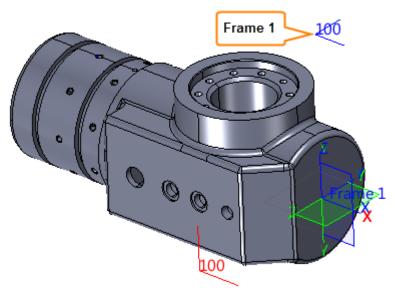


Figure6 Finished Frame 1 for right side

STEP 02 Then create another frame for the bottom side as follow:



### CAM\_5X



😨 Frame			🧏 Datum		23
Name	Frame2		▼ X Required	2	0
Clear Z	100				14 al
Head	none		Offset	0	mm 🗘 🗄 🔻
Auto Clear	10		<ul> <li>Orientation</li> </ul>		
Fixture Offset		100 ]	Origin		🗧 💆 🝷
Offset Register	Auto		X point		🗧 🛬 🔹
			X angle	-180 (3	deg 🗘 垫 🔻
U Write ORIGIN in O	utput	XX	Y angle	0	deg 🗘 垫 👻
Define Frame Datum	n		Z angle	0	deg 🗘 垫 👻
Create Datum	Select Datum		▼ Datum Attr	ibutes	
		- Sel 1	Custom at	tributes	
Frame Attribute	4		Color		
Color			Style		<b>_</b>

Figure7 Create frame on Bottom side

## Tips: In order to distinguish different frame especially in the same position you can choose different color to tell the differences.

Then we can get the following result with 2 newly created frames:

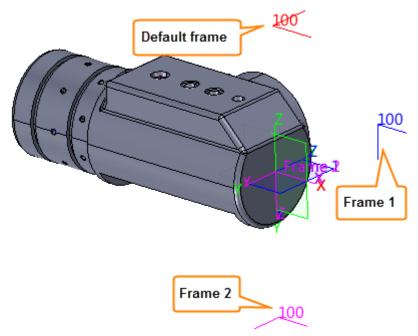
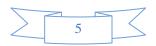


Figure8 Finished local frames and default frame

Next we can create toolpath based on these frames.







#### 1.1.3 Create Toolpath Based On Each Frame

STEP 01 Create toolpath on top side: finish the top face based on default frame.

I. Let's choose 3X Flat Finish operation and choose the whole part as feature as follows. Then choose D10 flat end tool.

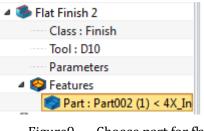


Figure9 Choose part for flat finish

II. Set up frame for it : open the parameter form to set up which frame to be based on as follows:

<ul> <li>Flat Finish 2</li> <li>Type: Flat Finish</li> <li>Frimary</li> </ul>	nk means use the Basic	default one			
Basic	Frame				
<ul> <li>Tolerance and Steps</li> <li>Limiting</li> </ul>	Speeds, Feeds	Flat Finish 2			
🧼 Boundaries	▼ Tolerance and Thick				
Reference Tool					
🔁 Check	Path Tolerance	0.01			
🕺 Filters	Surface Thick	0			
🧶 Path Setting	70 0 7111				
Ink and Lead	Z Surface Thick				
Link	Flatness	0.01			

Figure10 Choose default frame

III. Set up the rest necessary parameters and then calculate the toolpath as follows:

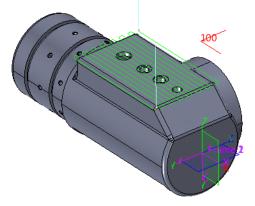


Figure11 Toolpath for top side





Note: since this process is the same as using 3X milling operation so here we will skip the details for creating the toolpath. And here we just use one opeartion to show indexing milling, for the rest necessary operations please finish by yourself.

**Tips:** In order to better manage the operations on each side , it is helpful to create operation folder and name it clearly. For example here we can name the folder for the operations in topside as "topside" and put all of the operations into this folder as follows:

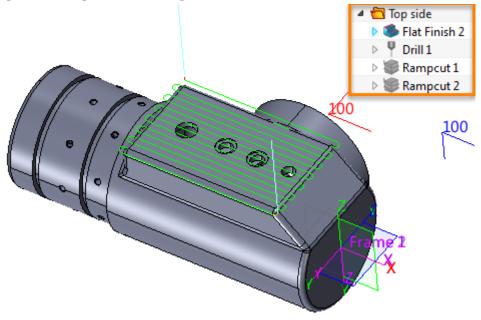


Figure12 Operation folder for top side

STEP 02 Create toolpath based on Frame 1 on right side as follows:

I. In order to get a clear idea about the toolpath on the left side we can firstly rotate the part as follows:

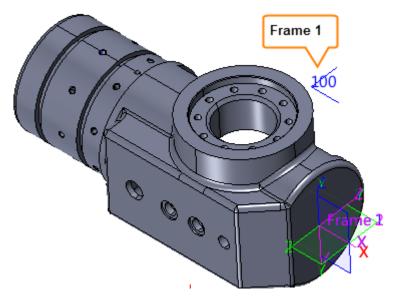


Figure13 Rotated part





CAM\_5X

- II. Create a folder and name it as "Right side" and then go to add operations.
- III. Pick 3X "Flat Finish" operation. Then Open the parameter form to set up the work frame as follows:

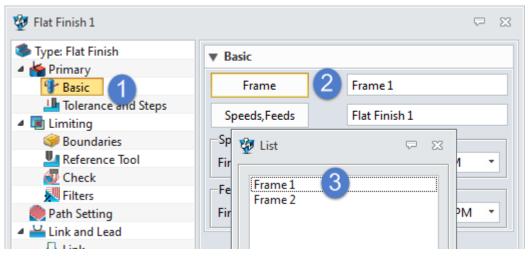


Figure14 Set up work frame for Flat finish operation

IV. Then set up the Boundaries as follows:

🐲 Flat Finish 1		$\bigtriangledown$	23
🌑 Type: Flat Finish 4 🏠 Primary	▼ XY		
Basic	Containment Type	Simple Box	•
Tolerance and Steps	% Offset	0.0	٦
Limiting     Boundaries	3D Offset	No	•
Preference Tool	Limit Lead Moves	No	•
🕖 Check 💹 Filters	▼ Z		
Path Setting	Тор	48	
Link and Lead Link	Bottom	42	
🚢 Lead In			

Figure15 Set up bottom boundary

V. Add the whole part as feature and then calculate (other parameters are default) then we can get the toolpath as follows:



### 

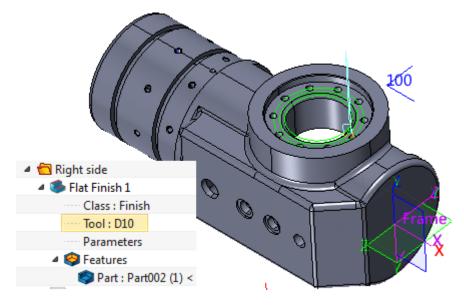


Figure16 Flat finish based on Frame1

Next, use the same process to choose other operations to finish the inner wall as follows:

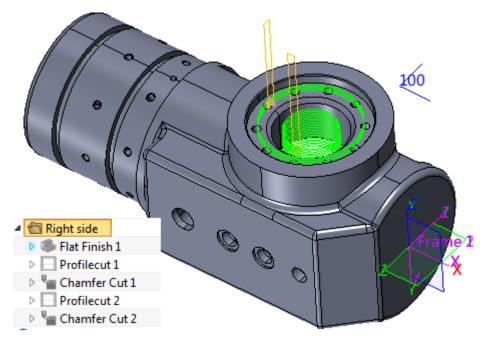


Figure17 Finish toolpath based on frame 1

So far we have created tool path in different frames, next we can go to verify the toolpath in frame1 as follows:



### CAM\_5X

### ZW 3D

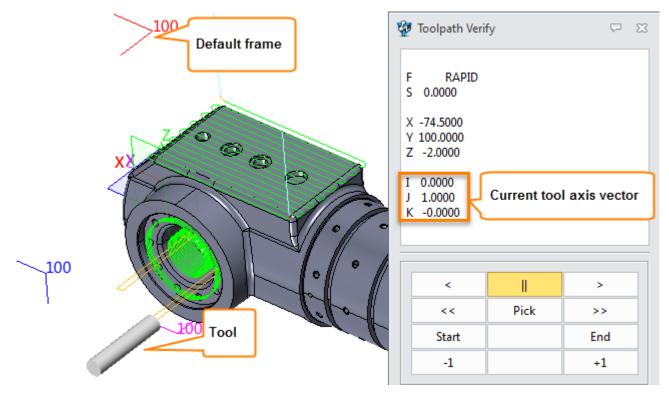


Figure18 Verify the tool and toolpath

From the verified result we can find that now the tool axis has been tranformed. If we check the tool axis's vector we can find it is not (0,0,1) which is default Z axis, butit is (0,1,0), that means the tool has been rotated around X axis 90 degree.

So far the indexing milling from default frame to frame1 is almost finsihed.

But there still is a probem confusing us: How is the tool transformed to this position? And we always want to track this process. Actually the "Inter Path Move" operation can achieve this function. It will connect the end point of the last operation in previous operations and the start point of the first operation in next frame.

STEP 03 Create link toolpath by Interpath operation:

I. Insert Interpath operation between Top side and Right side as follows:

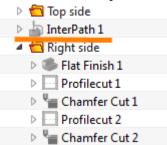
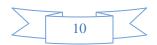


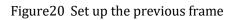
Figure19 Insert Inter Path Move operaion





II. And then set up the interpath operation as follows:

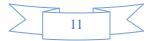
🐲 InterPath 1		$\overline{\nabla}$	23
Type: InterPath Type: InterPath Primary Path Setting Display	▼ Basic     Frame     Speeds, Feeds   InterPath 1		
	m from, can specify. If you leave Frame Il regard the frame applied in previous		



<ul> <li>Type: InterPath</li> <li>Primary</li> <li>Path Setting</li> <li>Display</li> <li>A cutting Control</li> <li>Safety Distance 10</li> <li>Max Rotate Angle 5</li> <li>Home Point 0,0,100</li> <li>Home Axis 0,0,1</li> <li>Home Axis 0,0,1</li> <li>Tool's home point in graphic area</li> <li>Tool's home Z axis in previous frame, can be input manually or by picking direction in graphic area</li> </ul>	💯 InterPath 1		$\overline{\nabla}$	23
Path SettingSafety Distance10Image: DisplayMax Rotate Angle5Home Point0,0,100Home Axis0,0,1The Tool's home point in previous frame. Can input by manually or by picking point in graphic areaTool's home Z axis in previous frame, can be input manually or by picking direction in graphic		▼ Cutting Control		
Home Point       0,0,100         Home Axis       0,0,1         Home Axis       0,0,1         The Tool's home point in previous frame.       Tool's home Z axis in previous frame, can be input manually or by picking direction in graphic	44	Safety Distance 10		
Home Axis 0,0,1 Home Axis 0,0,1 Home Axis 0,0,1 The Tool's home point in graphic area Tool's home Z axis in previous frame, can be input manually or by picking direction in graphic	冒 Display	Max Rotate Angle 5		
The Tool's home point in previous frame. Can input by manually or by picking point in graphic area Tool's home Z axis in previous frame, can be input manually or by picking direction in graphic		Home Point 0,0,100		
in previous frame. Can input by manually or by picking point in graphic area Tool's home Z axis in previous frame, can be input manually or by picking direction in graphic		Home Axis 0,0,1		
	in previous frame. Can input by manually or by picking point in	frame, can be input manually of by picking direction in graphic	r	

Figure21 Set up the Tool's information in previous frame

III. After calculating the InterPath operation we can get the following link toolpath :





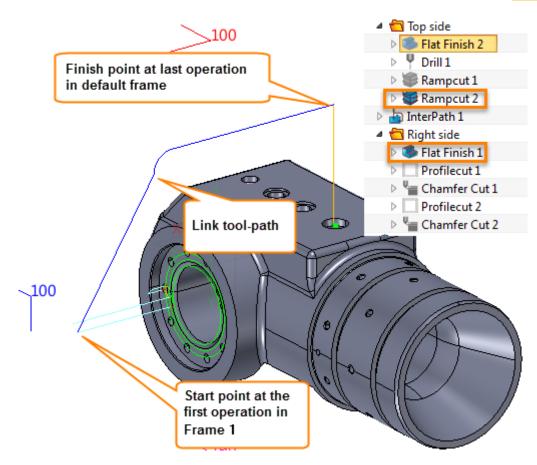


Figure22 Link tool path for transforming

The link toolpath can clearly show how the tool transform from the default frame to Frame 1, so it is helpful to check if it is safe or not.

IV. Verify the InterPath as follows:

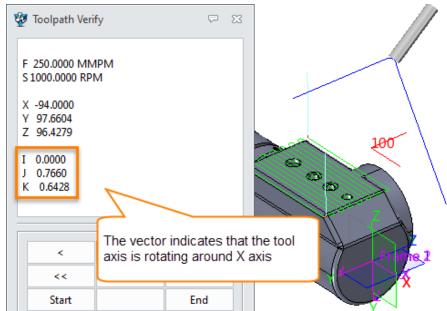
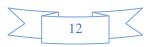
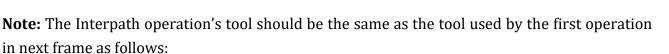


Figure23 Verify link path







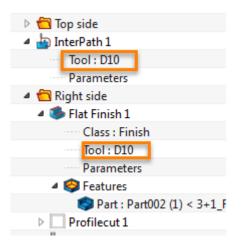


Figure24 Tool for InterPath operation

STEP 04 Create the toolpath on the bottom side as follows:

I. Create toolpath based on the frame 2 as follows:

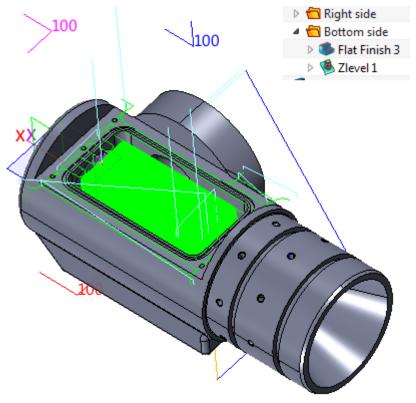
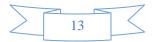


Figure25 Tool path on bottom side

II. Insert Interpath operation and set up as follows:







🐲 InterPath 2	Ģ	23
Type: InterPath Type: InterPath Primary Path Setting Type: Display Ileave it blank : transform from applied in previous operation		

Figure26 Set up Interpah operation

III.Calculate the Interpath operation we can get the link tool-path between right side and bottom side as follows:

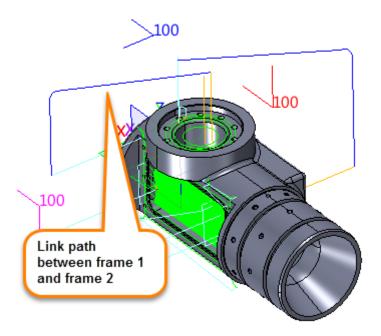
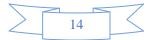


Figure27 Link path beween right side and bottom side

So far we have finished the 4X indexing milling process for this part. Next we need to output the NC code for it. Before we output the NC code, we have to check some necessary setting such as machine type, controller, output space etc.

#### 1.1.4 Set Up The Machine

Double click on the machine tab to activate the Machine Manager and set up as follows:





### CAM\_5X

💯 Machine Manager				₽ %
Definition			Library	
Machine Name	Machine 1		Machine	
Class	5-Axis M.C.	•		
🔲 Туре	Vertical	•		
Subtype	Rotating Head	•		
Post-Processor	ZWPost	•	😼 List 🖙 🛛	
Post Configuration	ZW_FANUC_4X_A		MILL_5AXIS_HeiDH530_ACTT_N 🔺	
XY Arcs	Yes	Ŧ	MILL_5AXIS_SINMS840D_ACTT_ Okuma_3X_Inch	
YZ Arcs	No	Ŧ	TNC426_3X_Heidenhain Turning_KND-2000TC	
ZX Arcs	No	Ŧ	VasnacBasic Vasnac_3000G_Inch	
Check MULTAX	Yes	•	Yasnac_MX3_Inch ZW_Fadal_3X	
MULTAX	Yes 4	•	ZW Fanuc 3X IN ZW_FANUC_4X_A	
Accurate RAPIDs	No	•	ZW_HIYANG_3X ZW_FIYANG_4X_A	
Scale	1		ZW_FIYANG_5X ZW_GSK983M	
#.xxxx	5			
Rewind	Yes	•		
Increment	1			
СИТСОМ	None	•	Delete	
Offset Registers			Options	
NC Extension	.nc		Tool Changer Rotary Axes and Off	sets
Definition File	machine_all.mdf		Parameters Limits	
Open Machine Definit	ion File Legacy Definition Files		Add To Library> Apply Filter>	

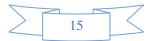
Figure28 Set up machine

Here let's choose the "**ZW\_FUNAC\_4X\_A**" as an example to output.

### 1.1.5 Set Up Output Space

Since here we have already defined different frames, it is necessary for us to specify on which frame to output the NC code.

STEP 01 Insert a new NC file as follows:







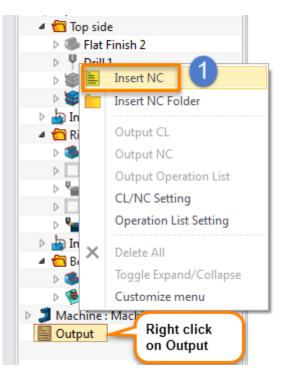


Figure29 Insert new NC file

STEP 02 Add operation for output as follows:

Select Operation for Output	$\sim$	Σ
Select Operations		
😂 Rampcut 1		•
😂 Rampcut 2		
📥 InterPath 1		
🔁 Right side		1
🍮 Flat Finish 1		
Profilecut 1		
Thamfer Cut 1		
Profilecut 2	=	
Thamfer Cut 2		
👆 InterPath 2		
🔁 Bottom side		
🋸 Flat Finish 3		
🖲 Zlevel 1		-

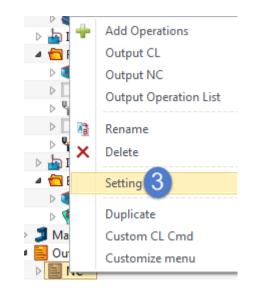
Figure30 Add operations for output

Here we just want to verify if the NC code can correctly output the rotating angle, so we can just pick some connected operation as test.

STEP 03 Set up output space as follows:





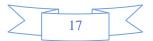


🐲 Output Setting							
Select Machine							
Machine 1							
Cre	ate	Edit					
Cre	ate	Edit					
	NC	Edit					
Setting		Edit					
Setting Part Id	NC	Edit					

Figure31 Set up output space

### **1.1.6 Output NC Code:**

Choose the first Inter-Path operation as an example to show:





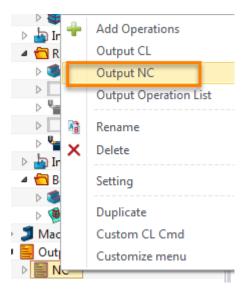


Figure32 Output NC

Output NC code as follows, it shows how the tool rotates around X axis from the default frame to frame1.

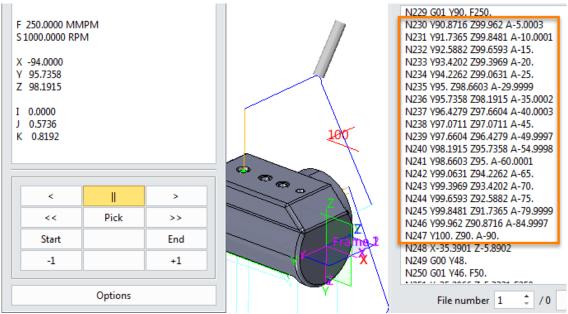


Figure33 Output NC code

If you want to check more, please go through the whole NC code by yourself.

So far, we have finished the sample case for 4X indexing milling. From this process we can find that the key points for the indexing milling are as follows:

- 1. Align the part according to the machine structure
- 2. Create sub frame
- 3. Set up 4&5 X machine type
- 4. Set up the output Space





### 1.2 5X Indexing Milling

Last case we finished the 4X indexing milling. Now we can use the same way to finish the 5X indexing milling case. Following is a 5X indexing milling case we are going to finish:

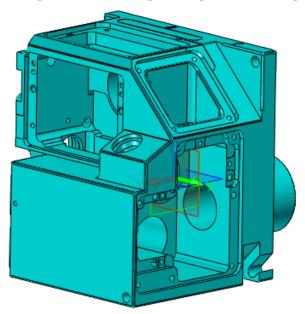


Figure34 5X indexing milling case

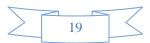
**Analysis:** From this part we can find that if we want to finish all sides by one clamping, the machine needs to rotate the tool axis around different axis. Here let's suppose the 5X machine is AC type, which means rotating around X, Z. Besides here we just take the finished operation as an example to show how to achieve in ZW3D CAM.

### 1.2.1 Align Part

Just as what we mentioned above, in order to make use of the default frame we can align the part in CAD level as follows, here the origin is located at the center of top.

STEL OF Cleate at	The of create a assistive stock for positioning part as follows.										
File Shape	Free Form	Wireframe	Direct Edit	Assembly	Sheet Meta	I FTI W	/eldments				
	<b>3</b>										
Sketch Cylinder Ex	trude Revolve	Sweep Loft	Fillet C	hamfer Draft	Hole Rib	Thread Lip	Stock				
* *		* *	-	*	• •	*					
	Basic Shape				jineering Feat	ure					

STEP 01 Create a assistive stock for positioning part as follows:







Stock     Stock     Stock     Stock	Pick the part as input	
Shapes	1 picked	
Plane		
▼ Dimensio	ns	
Туре	By side	
Length(X)+	0 mm 🗘 💆 🕶 - 0 mm 🗘 ₫	
Width(Y) +	0 mm 🗘 💁 🔹 - 0 mm 🗘 💆	
Height(Z) +	0 mm 🗘 👲 🕶 - 0 mm 🌲 🔮	

Figure35 Create stock in CAD level

STEP 02 Move the part as follows:

Required					
00 11	H 🕅 2	12		Mar:	1
Entity	2 picked	(1) >			
From point	-8.125,-33,60	×	IN THE		
To point	0,0,0	3 -	NINI	100	

Figure36 Move the part and stock to origin point

STEP 03 Result will be as follows:



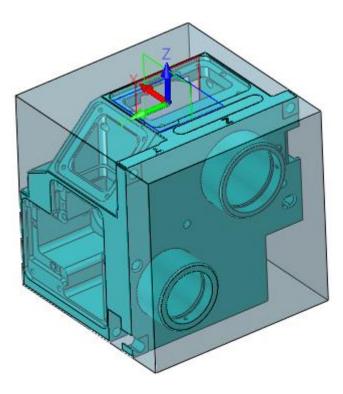


Figure37 Aligned Part

Then we can delete or hide the stock.

### 1.2.2 Create Sub-Frame For Multiple Faces

Here we will choose some faces as examples to show this detailed process which is as follows:

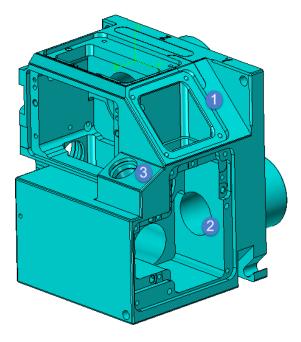


Figure38 Indexing milling area







STEP 01 Create the first frame as follows:

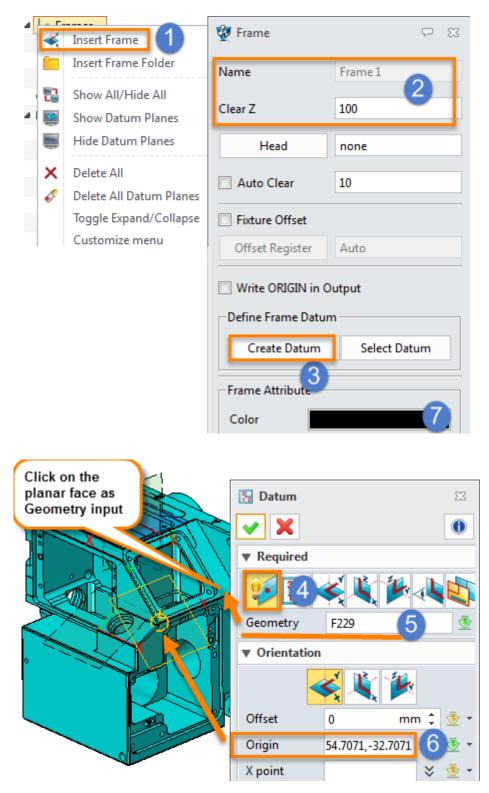
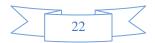


Figure39 Create the first sub frame

Finished result is as follows:





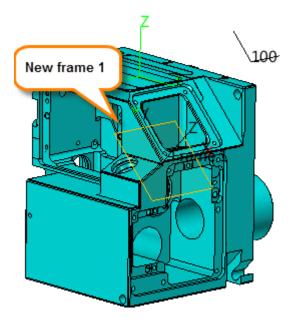


Figure40 Created new frame 1

**Note :** Here the sub frame is only used to define the tool axis's direction, so the sub frame's origin point can be located at any position. In order to show it clearly,here we chose an obvious position mentioned above.

STEP 02 Create other frames on area 2 and area 3 as follows:

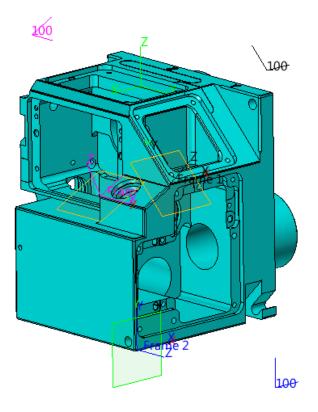
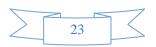


Figure41 Finished frame







### **1.2.3** Create Toolpath Based On Different Frame

The process of creating 2X or 3X toolpath based on different frame is the same as 4X indexing milling , so here we will skip this process of creating toolpath and just show you the result as follows:

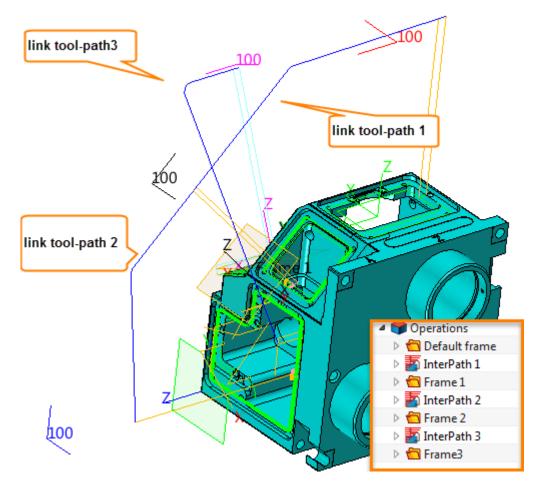
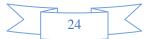


Figure42 Finished toolpath

For your reference you can open the file " **5X\_indexing\_With toolpath.Z3**" directly. But you are strongly recommended to finish it from beginning again by yourself.

### 1.2.4 Set Up Machine and Output Space

STEP 01 Set up the machine and choose the post processor "ZW\_FUNAC\_5X" :





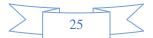
👰 Machine Manager	
Definition	
Machine Name	Machine 1
Class	5-Axis M.C
🔲 Туре	Vertical 🔹
Subtype	Rotating Head 🔹
Post-Processor	ZWPost
Porpnfiguration	ZW_FANUC_5X
XY Arcs	Yes 🔹
YZ Arcs	No 👻
ZX Arcs	No 👻
Check MULTAX	Yes 🔻
MULTAX	Yes 3 ·
Accurate RAPIDs	No 🔻
Scale	1
#.xxxx	5
Rewind	Yes 🔹
Increment	1
СИТСОМ	None 🔻

Figure43 Set up post processor

STEP 02 Set up the machine structure as AC type by the post Processor editor as follows:



Figure44 Open ZW3D Post editor



### 

VW_FANUC_5X.znc - File View Help	Open the Post processor edit page Organize Vew folder	ting	WARE (D:)   Program files   ZWSOFT
<b>Vel C</b> ase click on th Configurati	<ul> <li>Favorites</li> <li>Desktop</li> <li>Recent Places</li> <li>Downloads</li> <li>iCloud Photos</li> <li>Upload_Mega</li> <li>OneDrive</li> </ul>	• E	Name Turning_KND-2000TC.znc Yasnac_3000G_Inch.znc Yasnac_MX3_Inch.znc YasnacBasic.znc ZW_Fadal_3X.znc XW_Fanuc_3X - Copy.znc
Ready	<ul> <li>Libraries</li> <li>Documents</li> <li>Music</li> <li>Pictures</li> </ul>	2	<ul> <li>ZW_Fanuc_3X.znc</li> <li>ZW_Fanuc_3X_IN.znc</li> <li>ZW_FANUC_4X_A.znc</li> <li>ZW_FANUC_5X.znc</li> <li>ZW_FIYANG_3X.znc</li> </ul>

Figure45 Load the related Post Processor

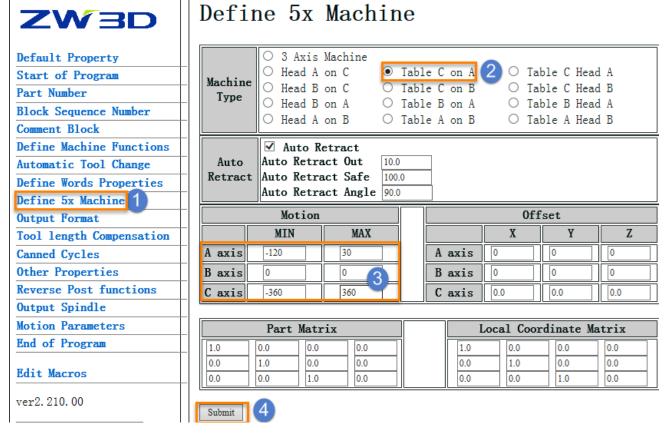


Figure 46 Set up 5X machine type and rotary axis's limitation



### CAM\_5X







Figure47 Save modification

STEP 03 Set up Output space as Machine as follows:

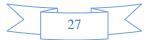
💯 Output Setting				$\overline{\nabla}$	23
-Select Machine -		 		 	
					_
Cre	ate		Edit		
Cre	ate		Edit	 	
	ate NC		Edit		
Setting			Edit		
Setting Part Id	NC win7		Edit		

Figure 48 Set up output space

### 1.2.5 Output NC Code

Here just choose the connected operation to output the NC code and check it as follows:

STEP 01 Choose the connected operation as output:





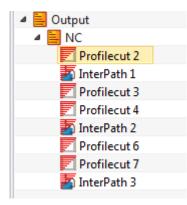


Figure49 Choose operations as output

#### STEP 02 Output NC code and verify

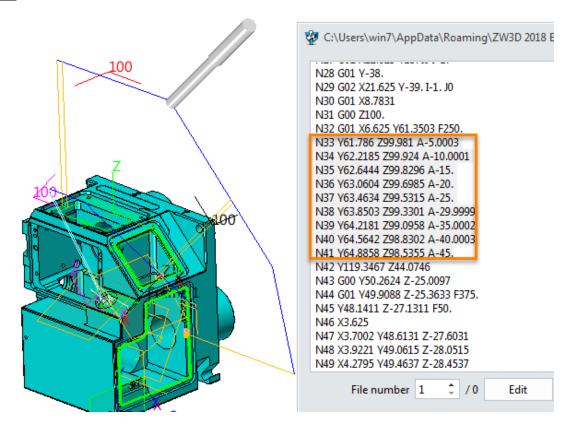
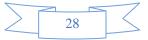


Figure 50 Indexing angle code between default frame and framw1



### CAM\_5X

### 

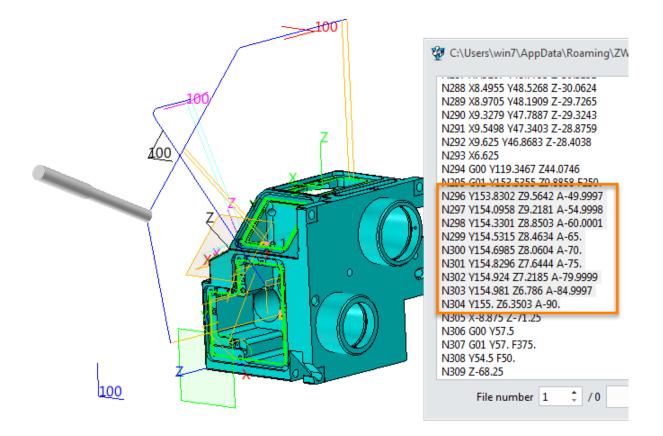


Figure51 Indexing angle code between frame 1 and frame 2

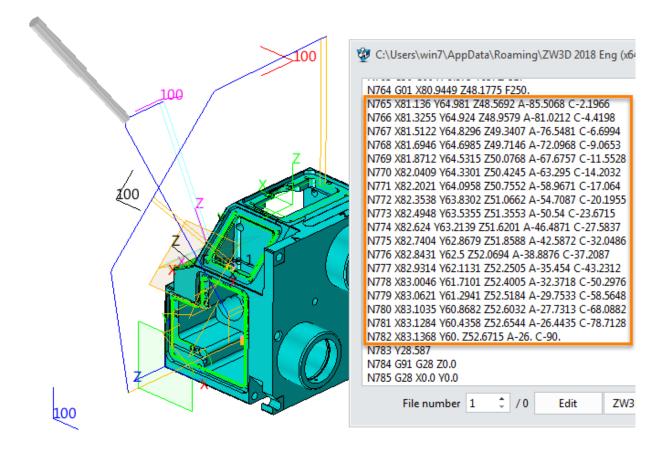


Figure 52 Indexing angle code between frame2 and frame3





### **1.3 <u>5X Silmutaneous Movement Operations</u>**

Next we will learn how to use the 5X operations as follows:

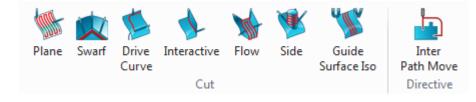


Figure 53 5X Simultaneous Movement Operations

Among those operations we have introduced the InterPath Move operation, so we can skip it. As for the **Interactive** operation, since it is not used very often, it will be not introduced in this chapter, if you are interested in it then you can check the help document.

ZW3D CAM 5X simultaneous movement operations integrate both 4X and 5X functions together. Therefore, it is able to switch the 5X simultaneous operation to 4X simultaneous operation by the tool axis control parameter.

### 1.3.1 5X Plane Cut Operation

**Philosophy:** The 5 axis plane cut creates a cutting pattern based on parallel cuts at a user-specified angle with respect to the frames X axis. This cutting pattern can be used to control the tool tip or the contact location of the tool on the part. It is possible to constrain the tool axis to a plane (for 4 axis milling) or to a specific orientation (for 3 axis milling).

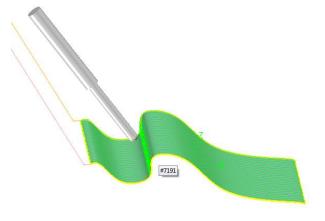


Figure54 5X Plane Cut

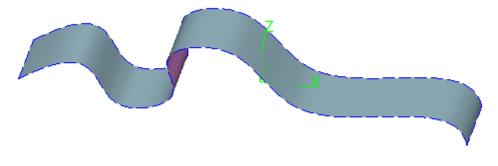
#### 1. How to run 5X plane operation

5X Plane operation works on general surface, so it only requires that the general part surface can create toolpath. Next Let's open the practice file "**5X Plane Cut**.Z3" as follows:









#### Figure 55 5X Plane Cut practice part

Then we shall use this part to show you how to create 5X Plane Cut tool path on it:

I. Define a general surface as follows:

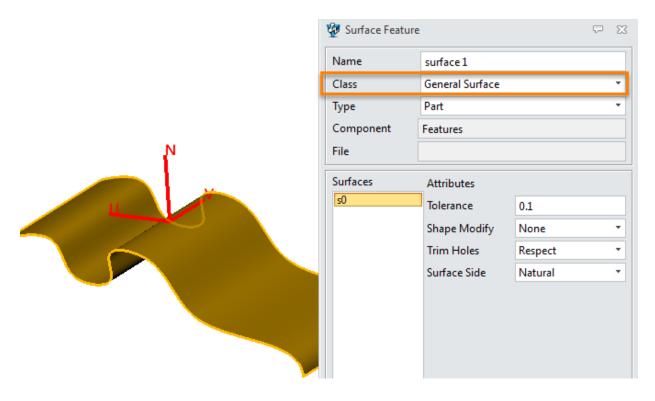
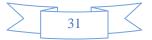
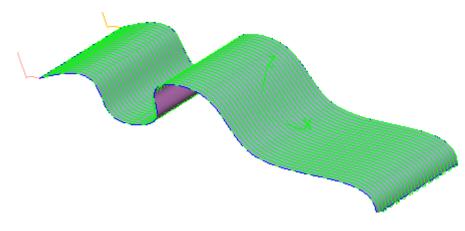


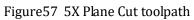
Figure 56 Define general surface for 5X plane cut

II. Calculate operation by default parameter to get toolpath as follows:









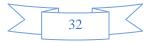
#### 2. Set up 5X Plane Cut parameter:

#### I. Primary parameters:

Planec Basic setting is the other 2-3X operation		Ģ	23
Primary     Basic     Interance and Steps	Path Tolerance Surface Thick	0.1	
Limiting     Path Setting	▼ Cutting Steps	<u>`</u>	ep size in XY direction
Axis Control     Axis Control     Link and Lead     Link	Stepover           The second steps         Image: Steps	% Tool Dia * 60 Step down size	Step down mode:
Link Lead In	Cut Depth Type	Z-Level	Z-level: depth measure along Z axis
Display	Max Cut Depth	Z-Level Along Tool Axis	Along Tool Axis: Depth measure along
Max cut depth for each la then system just create or		blank	tool axis

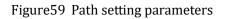
Figure 58 Primary parameters

II. Path setting parameters:





Type: Planecut	▼ Cutting Control		Can specify, by defa
Merimary Basic	Cut Angle	0,0.707107,-0.707107	is the default X axis
Limiting	Path Pattern	Zigzag	direction
Path Setting	Stepover Link	Straight	<ul> <li>Whether or not the</li> </ul>
Axis Control	Trim Holes	Respect _	trimed hole in surfact trimed hole in surfact trimed hole ingored
Link and Lead	Allow Undercutting	No	<u> </u>
崖 Lead In	▼ Point Setting		If cut the undercut reg
Lead Out ■ Display	Tool Home Start		
	Tool Home End		

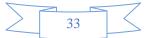


III. Axis control parameters:

💯 Planecut 1		⊽ ⊠
Type: Planecut	▼ Axis Control	
Primary Pasic	Axis Control	Contact Control
Interance and Steps	Lead Angle	Fixed Axis Tip Control
Limiting Path Setting	Roll Angle	Contact Control
Axis Control	Max Tilt Angle	4X Tip Control 4X Contact Control
▲ ≚ Link and Lead	Max Rotate Angle	5
Link		
Lead Out		
冒 Display		

Figure60 Axis control parameters

• **Fixed Axis**: The tool axis will be determined by lead and roll angles along the cutting direction and relative to the Z axis of the frame. Actually, you can think it is the frame's Z axis, since by default the Lead and Roll angle are all 0. As follows:





▼ Axis Control			
Axis Control	Fixed Axis	-	
Lead Angle	0		A
Roll Angle	0		
Max Tilt Angle	60		
Max Rotate Angle	5		Nor
			ENP
Tool axis fixed in fra since the lead and re are 0			

Figure61 Fixed Axis tool.

• **Tip Control**: The local contact data determines the cutter orientation while the cutter tip point is kept within the cutting plane. Actually, when the Tip of Tool is in the cutting plane then the tool axis is the surface's normal way.

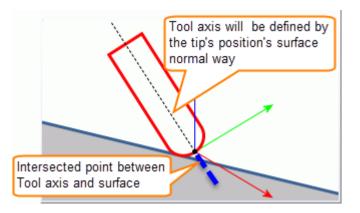


Figure62 Tool tip

• **Contact Control**: The local contact data determines both the cutter orientation and tip point. It uses the local contact point as reference and the normal way of this point together to determine the tool axis's position.





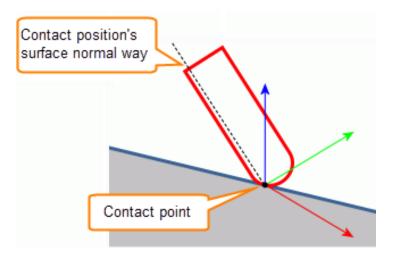


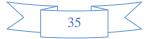
Figure63 Contact control case

• **4X Tip Control:** Tip contol option work in 4X mode, and you need to specify 4X plane as follows:

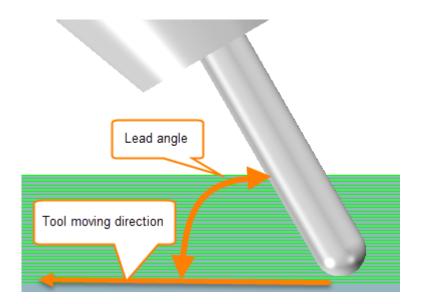
▼ Axis Control			
Axis Control		4X Tip Control	•
Four Axis Plane		0,1,0	
Lead Angle 0			
Roll Angle	Click	this icon to Set	
Max Tilt Angle	up the 4X plane		
Max Rotate Angle			

Figure64 Specify 4X plane

- **4X Contact Control**: Contact control option work in 4X mode, you also need to specify 4X plane.
- Lead angle: The angle of the tool axis will be tilted toward the movement direction









• **Roll angle** : The angle of the tool axis will be tilted to the direction which is perpendicular to the forward motion direction. A positive value will tilt the tool to the right, negative to the left.

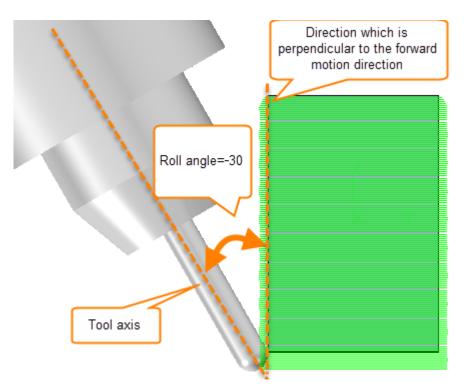
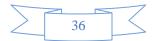


Figure66 Roll Angle



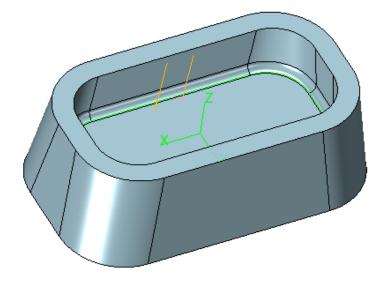


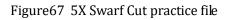


## 1.3.2 5X Swarf Cut

**Philosophy**: The 5 axis Swarf Cut operation uses **Control surfaces** to calculate the tool path. The tool axis is controlled by **Drive surfaces** with which the side of the tool maintains contact. The bottom of the tool (contact point) is controlled by **Part surfaces**.

Open the practice file " **5X\_SwarfCut\_Practice.Z3**" as follows:





From the part structure we can find that it is not able to cut the side wall and radius on the bottom face by 3X tool path since the wall is titled. So here we hope the tool axis can title following side wall and keep tangent to the side wall as follows:

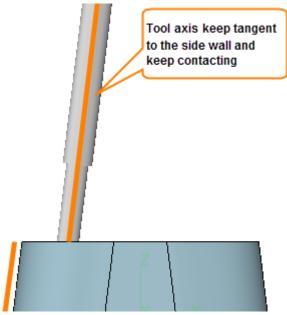


Figure68 Keep tangent to side wall face



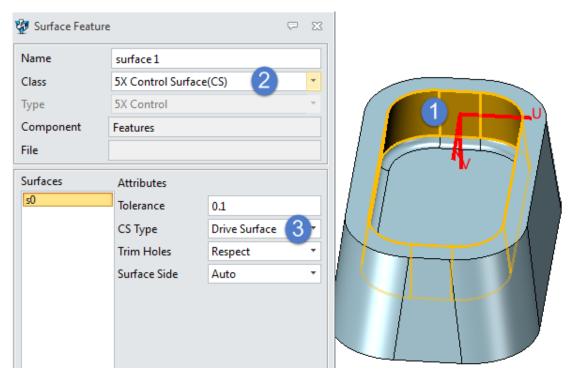
## 

CAM\_5X

Next let's show how to create 5X swarfCut tool path on this part as follows:

#### 1. How to run Swarf Cut operation:

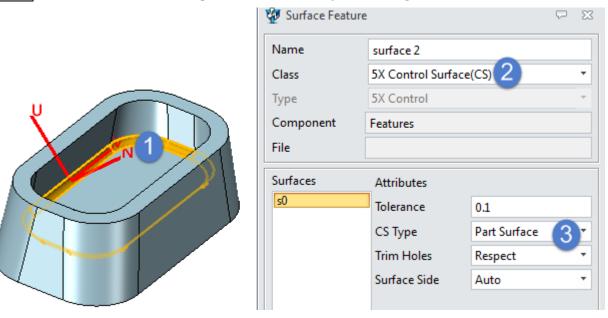
STEP 01 Define drive surface : the drive surface will be used to control the tool axis by



#### maintaining contact with the side of tool

Figure69 Define drive surface

STEP 02 Define Part surface: the part surface actually is the target that will be cut as follows:



#### Figure70 Define Part surface





STEP 03 Choose a ball end tool with diameter of 6 mm, and calculate the operation by default parameter. Then we can get toolpath as follows:

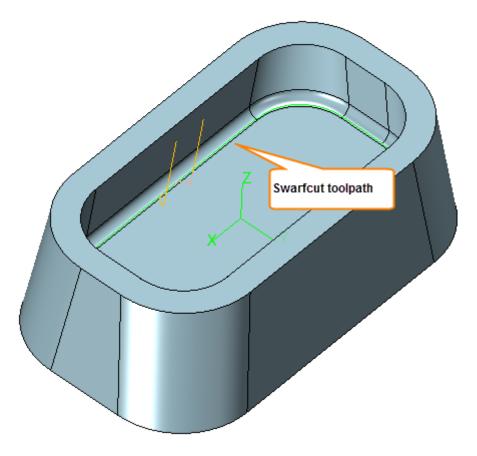


Figure71 Swarfcut toolpath

## 1.3.2.1 Swarf cut parameters

Next let's take a look at the main parameters of Swarfcut operation as follows:

## **1. Primary parameters**





💯 Swarfcut 1		
Type: Swarfcut	▼ Basic	
P Basic	Frame	
Interance and Steps Limiting	Speeds, Feeds	Swarfcut 1
Path Setting <u> </u> Axis Control	▼ Tolerance and Thick	
▲ ≚ Link and Lead	Path Tolerance	0.01
Link	Side Thick	0
🛁 Lead In 🆕 Lead Out	Bottom Thick	0
冒 Display	▼ Bottom Steps	
	Cut Depth Type	Z-Level 🔹
	Max Cut Depth	
	Cutting Height	
	Cutting Position	At Bottom 🔻
	▼ Side Steps	
	Side Cast Offset	
	Side Cut Depth	

CAM\_5X

Figure72 Swarfcut primary parameters

For the Basic and Tolerance related parameter actually, every operation is the same meaning. So here let's skip it. Here are some new parameters we need to explain

- **Cut depth Type**: depth measurement direciton.
- **Z-Level**: means that depth is measured along working frame's Z axis
- Along tool: means that depth is measured along tool axis
- **Max Cut depth**: if we create multiple layers toolpath then this value is the maximum depth for each layer. If we leave it blank then it means only 1 layer toolpath will be created.



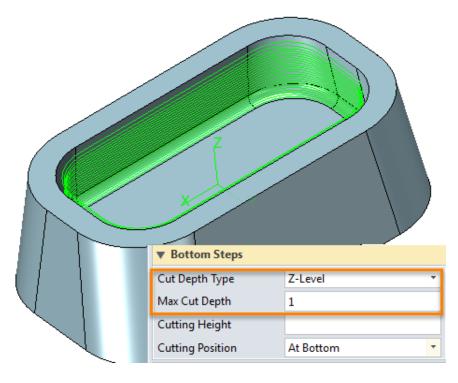


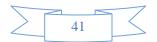
Figure 73 Multiple layers swarf cut toolpath along Z level

• Cutting height : It is a limitation for depth and only work for At Top option as follows

▼ Tolerance and Thio	c <b>k</b>		
Path Tolerance	0.1		
Side Thick	0		
Bottom Thick	0		
▼ Bottom Steps			
Cut Depth Type	Z-Level	•	
Max Cut Depth	0.5		
Cutting Height	3		
Cutting Position	At Top	•	
▼ Side Steps			

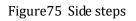
Figure 74 Cutting height of swarf cut

- **Cutting position:** we can regard it as a measurement reference for depth, starting from top or from bottom. If we only create one toolpath then it is used to specify where to cut top or bottom.
- **Side cast offset**: it is used to set up the side thickness of cast part which needs to be removed.
- **Side cut depth**:something like the stepsize in XY.





▼ Tolerance and Thick	k	
Path Tolerance	0.1	
Side Thick	0	Side wall Offset
Bottom Thick	0	value
Bottom Steps		
Cut Depth Type	Z-Level	
Max Cut Depth	0.5	
Cutting Height	3	
Cutting Position	At Top	
▼ Side Steps		
Side Cast Offset	7	Side cut depth
Side Cut Depth	3	

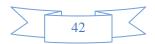


## 2. Path setting parameters

🖗 Swarfcut 2		
🙀 Type: Swarfcut	▼ Cutting Control	
Primary Basic	Path Pattern	Zigzag 🔹
Tolerance and Steps	Cut Order	Side First *
Limiting	Fan In	5
Axis Control	Fan Out	5
a 💾 Link and Lead	Cut Overlap	5
Link	Cut Direction	Climb *
Lead Out	Cutting Order	Automatic 🔹
冒 Display	Corner Radius	Respect 🔹
	▼ Point Setting	
	Start Point	
	Start Axis	
	Tool Home Start	
	Tool Home End	

Figure 76 Path setting parameters

• Path pattern: set up if use one way or Zigzag pattern





- **Cut order**: This determines the depth cut order. This can be applied to both Base Depths and Side Depths. (Normally used under the condition of side cast offset)
  - Bottom First: Cut down to base (part) surfaces first for each side cut.
  - Side First: Cut sides first on each level.
- **Fan In**: A distance from a corner seam (edge) at which the tool will begin to lessen the influence of the drive surfaces on the tool axis so that it can assume the optimal orientation on the corner.
- **Fan Out**: A distance the tool may traverse while transitioning from the optimal orientation in a corner to have the tool axis controlled by a drive surface.
- **Cut Overlap:** This is a re-cut distance to obtain smooth part surface when **cutting closed loops.** This distance is added at the end of the cut (retracting the beginning of the cut) at the "cut" feed rate.
- **Cut Direction**: This determines the direction of cut, which are Clime and Conventional.
- **Corner Radius:** Fillet the cut with this radius.
- 3. Axis control pararmeters:

💯 Swarfcut 1		⊽ ⊠
🙀 Type: Swarfcut 4 🏠 Primary	▼ Axis Control	
Basic	Axis Option	Automatic 🔹
Limiting	Four Axis Plane	Ruled Lines Ruled Line Interp
Path Setting	Max Tilt Angle Min Tilt Angle	Vertical Automatic
Link and Lead	Max Rotate Angle	5
💾 Lead In	Skew Angle	
Lead Out ■ Display		

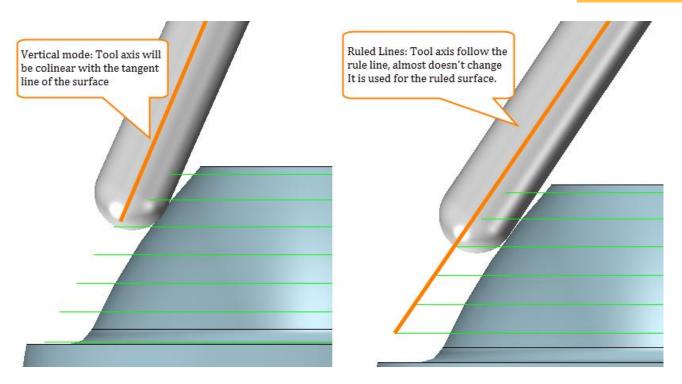
Figure77 Axis control parameters

### **Axis Option:**

- **Ruled lines**: The tool axis always follows the ruling direction of a drive surface for ruled surfaces, it is used for the ruled drive surface.
- **Vertical**: The tool axis is both tangent to the drive surface and vertically tilted.







CAM\_5X

Figure 78 Tool axis options

• Automatic: The tool axis follows "ruled lines" for curved ruled drive surfaces and will be vertical for other types of drive surfaces including flat ones.

## 1.3.2.2 Real case study

Next we will use 2 real cases as examples to show how to apply the swarf cut operation to real work.

## 1. Case 1: "5X\_Impeller.Z3"

Let's open the real case " **5X\_impeller.Z3** " file as follow:

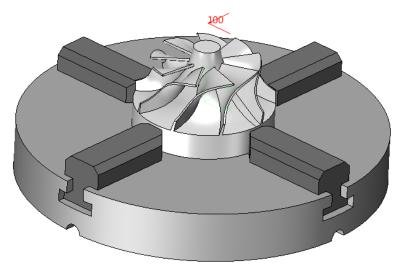


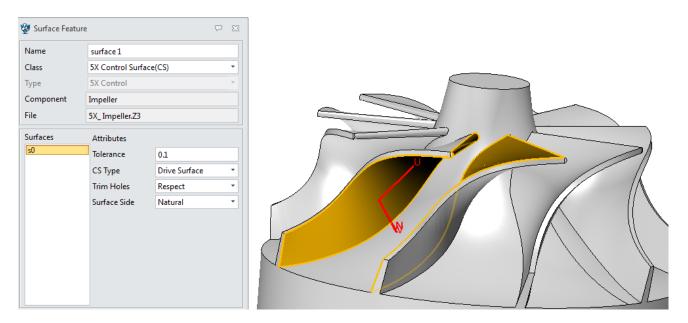
Figure79 5X\_Impeller file





Then we will create swarf cut toolpath to cut the blade as follow:

STEP 01 Define the 5X control surface as follow:



#### Figure80 Define 5X Drive Surface

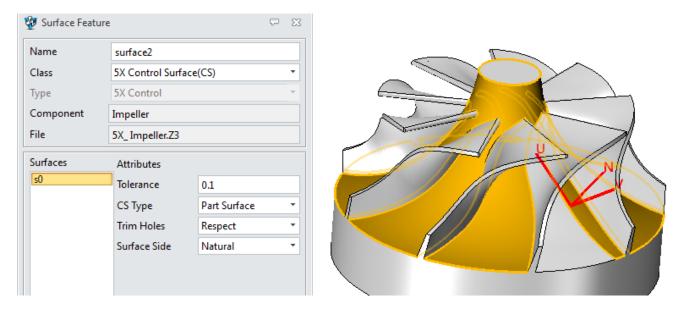


Figure81 Define 5X Part Surface

STEP 02 Set up tool size and operation parameters

Here we assume that the corner radius is 2 mm so that we can choose the ball end mill with the radius of 2 mm. Then set up operation parameters as follows:



## 

Type: Swarfcut	▼ Tolerance and Thick	
Primary Basic	Path Tolerance	0.1
Interance and Steps	Side Thick	0
Limiting Path Setting	Bottom Thick	0
🖉 Axis Control	▼ Bottom Steps	
Link and Lead Link	Cut Depth Type	Along Tool Axis 🔹
Lead In	Max Cut Depth	2
Lead Out	Uniform Depth	Yes 🔹
冒 Display	Cutting Height	
	Cutting Position	At Bottom 🔹
	▼ Side Steps	
	Side Cast Offset	
	Side Cut Depth	

## Figure82 Define Primary parameters

🐲 Swarfcut 2			$\overline{a}$	23
Type: Swarfcut	▼ Cutting Control			
Primary Basic	Path Pattern	Zigzag		•
Tolerance and Steps	Cut Order	Bottom First		-
Limiting	Fan In	5		
Path Setting Axis Control	Fan Out	5		
🖉 💾 Link and Lead	Cut Overlap	5		
Link Lead In	Cut Direction	Climb		•
Lead Out	Cutting Order Automatic			•
冒 Display	Corner Radius	Ignore		•
	▼ Point Setting			
	Start Point			
	Start Axis			
	Tool Home Start			
	Tool Home End			

Figure83 Define Path setting parameters





💯 Swarfcut 1			₽ 33
🙀 Type: Swarfcut	▼ Axis Control		
Primary Pasic	Axis Option	Ruled Lines	•
Tolerance and Steps	Four Axis Plane		
Limiting Path Setting	Max Tilt Angle		
Axis Control	Min Tilt Angle		
Link and Lead Link	Max Rotate Angle	5	
💾 Lead In	Skew Angle		
Lead Out			

### Figure84 Define Axis Control

▼ Lead In		▼ Lead Out	
Lead In Type	Normal 🔻	Lead Out Type	Normal 🔹
Start Angle In		Start Angle Out	
End Angle In	0	End Angle Out	0
Radius In	0	Radius Out	0
Ramp Length In	1.5	Ramp Length Out	1.5
Ramp Angle In	0	Ramp Angle Out	0

Figure85 Lead in and lead out

For the rest parameters keep their default setting.

STEP 03 Calculate toolpath as follows:

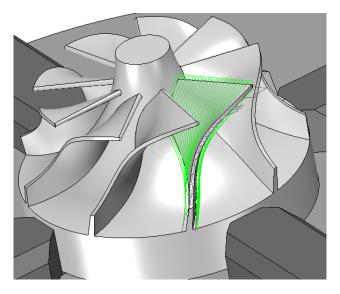


Figure86 Swarf cut toolpath





STEP 04 Pattern the toolpath by transforming function and setting up the pattern parameters as follows:

Type: Transform	▼ Xform Control	
Path Setting	Xform Method	Circular Array 🔹
Link and Lead	▼ Circular	
Tink Display	Origin	0
	Axis	0,0,1
	Angular Spacing 40 Number of Copies 9	
	Create Copy at Orig	ginal

Figure87 Pattern the swarf cut toolpath around Z axis

The finished result is as follows:

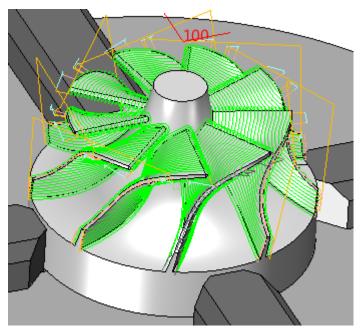
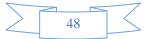


Figure88 Finished swarf cut for impeller blade

Verify the toolpath movement by verifying function as follows:





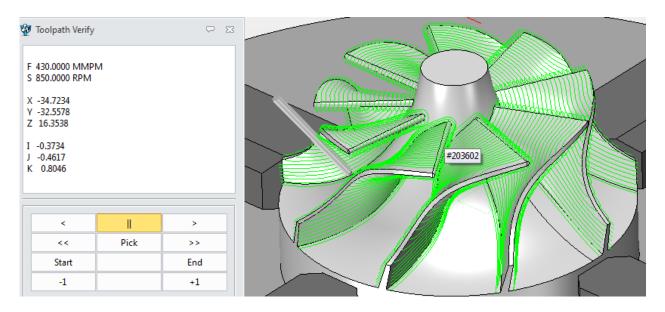


Figure89 Verify swarf cut toolpath

After saving the file. From the result we can find that actually the blade part has been finished. We will keep on creating toolpath on this impeller file by other operations and finally when we finished the tutorial the impeller model also will be finished.

2. Case 2: "SwarfCut\_A.Z3"

Please open the case file "Swarfcut\_A.Z3" as follows:

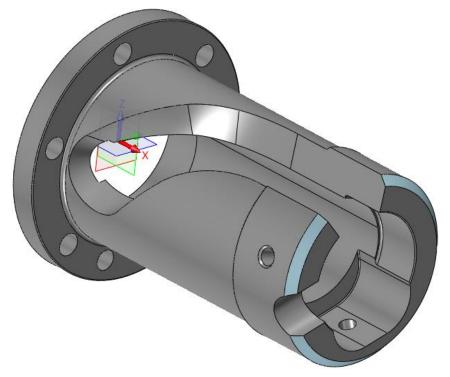
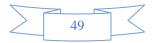


Figure90 Swarfcut\_A file

**Task:** finish the highlighted surface as follows:





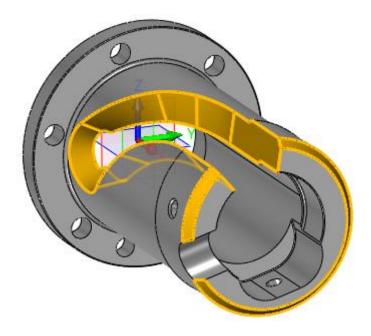


Figure91 cutting required faces

- STEP 01 Heal the highlighted surface: Since this file is an imported file and the swarfcut operation has strictly requirements for geometry quality, so it is better to heal the file first before programming. Details are as follows
  - I. Delete loops

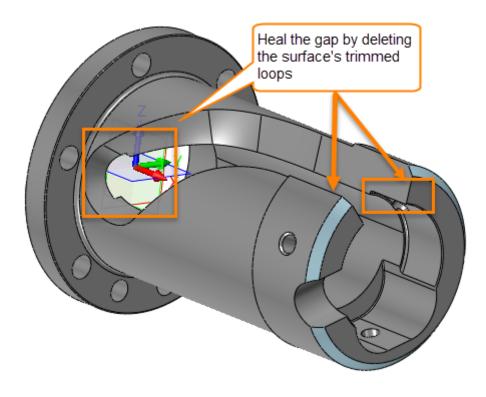
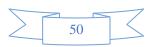


Figure92 Delete surface trimed loops







<ul><li>The provide the second secon</li></ul>	юр	22 •	0
▼ Required			
Face	F360	_ ₫	
Loop	All	•	
▼ Settings			
🗌 Keep trim	nmed face		

#### Figure93 Delete loops operation 1

<ul><li>The provide the second secon</li></ul>		23	
▼ Required			
Face	F358	_ ₹	
Loop	All	-	
▼ Settings			
🔲 Keep trimm	ed face		

#### Figure94 Delete loops operation2

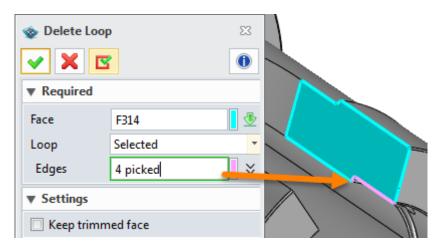
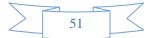


Figure95 Delete loops operation 3







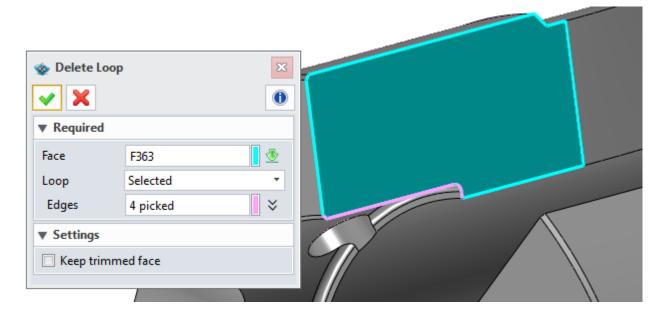


Figure96 Delete loops operation 4

II. After deleting the loops, we can get the following result:

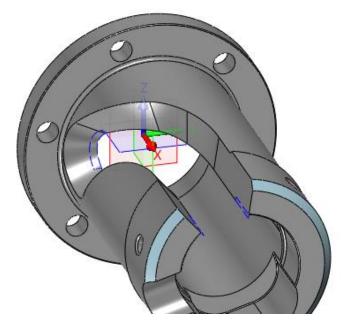
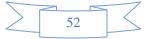
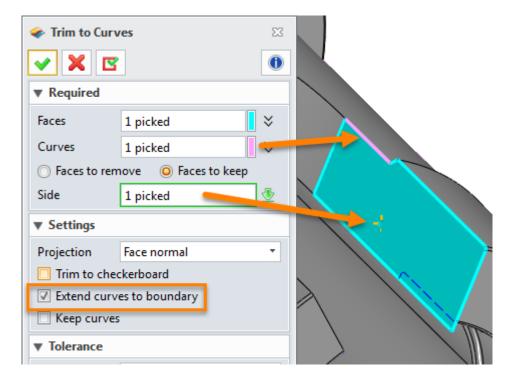


Figure97 Result after deleted loops

STEP 02 Modify surface: Trim the surface to curve as follows:







#### Figure98 Trim surface\_right side

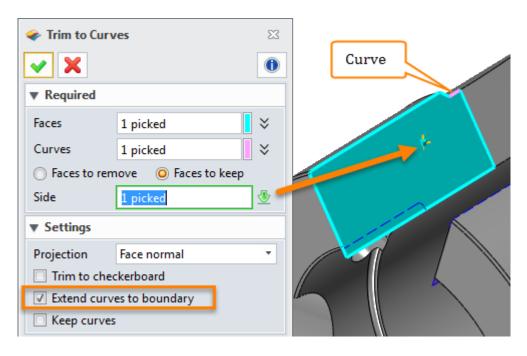


Figure99 Trim surface\_left side

Finally we can get the result as follows:





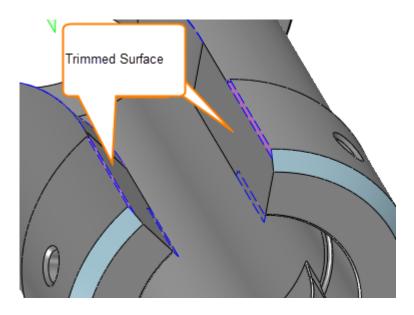
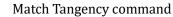


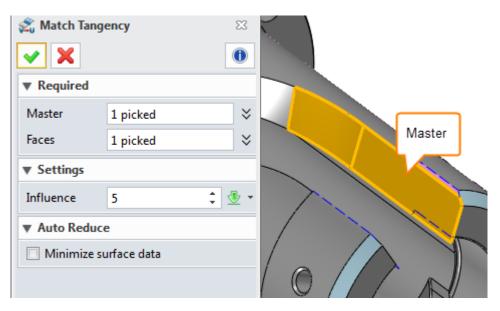
Figure100 Trimmed surface

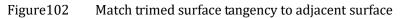
STEP 03 Ensure that the trimmed surface can be tangent to the adjacent surface by **Match Tangency** Tool as follows:

	File	Shap	pe l	Free Form	Wire	frame	Direct Edit	Assem	bly Sh	eet Metal	FTI	Weldmer	nts Point (	Cloud Data	Exchange	Heal	PMI	Tools	Visu	Jalize	Inquire Ele	ectrode
В	lend	Ruled	Curve	Face at Angle	FEM			) Dome				Trim to Curves +	Fillet Open Faces	Modify Isoline Num		Match Tangeno				Explode	Delete Loop →	l Ge
				Ba	isic Face									Edit Face		~	Merge			5	Edit Edge	:
1	<u> </u>	— a	ð - (	) 🗗	All	-	🔇 Entire	Assembly	-		i es 🛃	∃⊳ Nr	Norma		0		werge	Taces				
_	tput															<b></b>	Join Fa	ces				

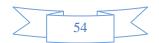
Figure101 Match Ta







Please use the same way to match the trimmed surface tangency on the both right and left side

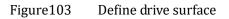




STEP 04 After healing the surface we can go back to CAM and create swarfcut toolpath for the target surface as follows:

🐲 Surface Feat	ure		₽ 33	
Name	surface 1			
Class	5X Control Surfa	ece(CS)	-	
Туре	5X Control		-	
Component	AX			
File	Swarft_A_Withto	olpath.Z3		V
Surfaces	Attributes			
sO	Tolerance	0.1		N
	CS Type	Drive Surface	-	
	Trim Holes	Respect	-	
	Surface Side	Natural	•	- $(2)$

I. Define the drive surface:



Here we will cut the drive surface to define a drive surface as feature input.

- II. Set up tool size : Use 10 mm flat end mill.
- III. Set up parameter as follows:

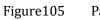
😨 Swarfcut 1		₽ %
鰔 Type: Swarfcut 4 🏠 Primary	▼ Tolerance and Thick	c
Basic	Path Tolerance	0.01
Interance and Steps	Side Thick	0
Limiting Path Setting	Bottom Thick	0
Axis Control	▼ Bottom Steps	
Link and Lead Link	Cut Depth Type	Along Tool Axis 🔹
💾 Lead In	Max Cut Depth	1
Lead Out	Uniform Depth	Yes 🔹
冒 Display	Cutting Height	
	Cutting Position	At Bottom
	▼ Side Steps	
	Side Cast Offset	
	Side Cut Depth	

Figure104 Primary parameters



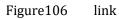


Cutting Control								
Path Pattern	Zigzag							
Cut Order	Bottom First	-						
Fan In	5							
Fan Out	5							
Cut Overlap	5							
Cut Direction	Climb	•						
Cutting Order	Automatic 🔹							
Corner Radius	Ignore	•						
Point Setting								
Start Point								
Start Axis								
Tool Home Start								
Tool Home End								



Path setting parameters

▼ Link									
Short Link Type	Z Lift Up 🔹								
Long Link Type	Automatic 🔹								
% Short Link Limit	300.0								
Max Link Rotate Angle	10								
Safe Distance	5								



▼ Lead In		▼ Lead Out					
Lead In Type	Normal 🔹	Lead Out Type	Normal 🔹				
Start Angle In		Start Angle Out					
End Angle In	45	End Angle Out	45				
Radius In	1	Radius Out	1				
Ramp Length In	0	Ramp Length Out	0				
Ramp Angle In	0	Ramp Angle Out	0				

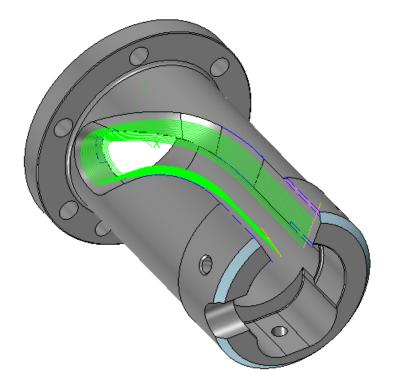
Figure107

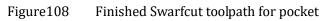
Lead in and out

IV. After calculating the toolpath we can get the following result:



## 





Now we can check the toolpath by verifying as follows:

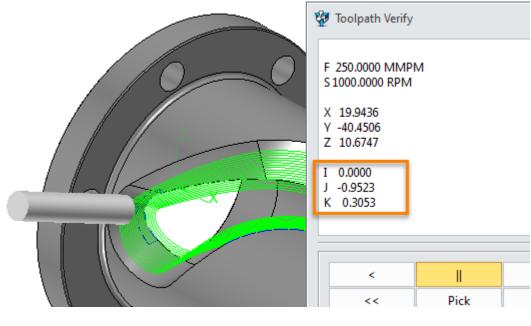
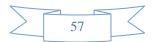


Figure109 Verify toolpath

we can find that actually this is 4X milling simultaneous movement toolpath. So let's look at the Four Axis Plane option as follows:





💯 Swarfcut 1		⊂ 5	23
Type: Swarfcut	▼ Axis Control		
Basic	Axis Option	Automatic 🔹	·
↓↓ Tolerance and Steps	Four Axis Plane		1
Limiting			4
Rath Setting	Max Tilt Angle		
📕 Axis Control	Min Tilt Angle		
Link and Lead	Mary Datata Arrala	5	1
🕂 Link	Max Rotate Angle	3	
📥 Lead In	Skew Angle		
Sead Out			

Figure110 Define 4X plane for swarfcut operation

4X Plane option actually is used to force the toolpath to a 4X Tool path. By default the system will automatically create the toolpath according to the surface's situation. Here the 4X tool path is enough to finish the pocket so even without setting up the Four Axis Plane system can automatically create the 4X toolpath for it. But the end chamfer surface will be different. In order to make a better toolpath here we can modify the part again to the following result:

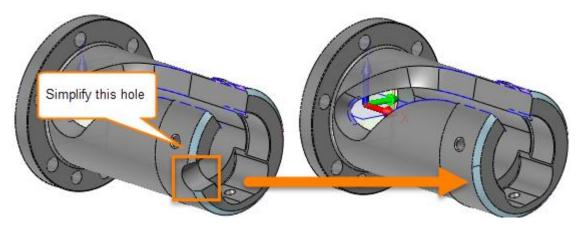


Figure111 Simplify hole in end

Next we will go to create toolpath on the chamfer face by the four axis plane option or without it seperately.

STEP 01 Define the chamfer face as drive surface:





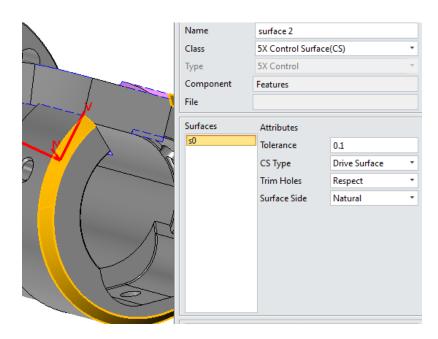


Figure112 Define Define chamfer face as drive surface

STEP 02 Set up parameters and choose the same tool (D10) as follows:

🐲 Swarfcut 2		₽ %			
📩 Type: Swarfcut 4 🏠 Primary	Tolerance and Thick				
Basic	Path Tolerance	0.001			
Tolerance and Steps	Side Thick	0			
Limiting Path Setting	Bottom Thick	0			
Axis Control	▼ Bottom Steps				
Link and Lead Link	Cut Depth Type	Along Tool Axis 🔹			
📥 Lead In	Max Cut Depth	4			
Lead Out	Uniform Depth	No 🔻			
冒 Display	Cutting Height				
	Cutting Position	At Bottom 🔹			

Figure113 Primary cutting parameter for cutting chamfer face

STEP 03 Create toolpath without 4X plane option:





🖗 Swarfcut 1										
📩 Type: Swarfcut 4 🎽 Primary	▼ Axis Control	▼ Axis Control								
Basic	Axis Option	Automatic	+							
Tolerance and Steps	Four Axis Plane									
Limiting	May Tilt Angle									
Path Setting	Max Tilt Angle									
Axis Control	Min Tilt Angle									
Link and Lead	Max Rotate Angle	5								
Link	_									
🛁 Lead In	Skew Angle	Skew Angle								

Figure114 Axis control setting

#### The toolpath is as follows:

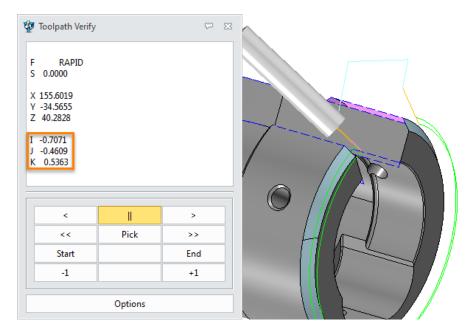
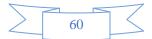


Figure115 Swarf cut toolpath without 4X plane option

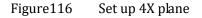
From the result you can find that now actually it is a 5X toolpath not 4X simultaneous toolpath. So it will conflict with your machine. How to solve it? By 4X plane option as follows:

STEP 04 Set up the 4X plane according to real condition (here let's choose A)





🐲 Swarfcut 1		₽ %				
🙀 Type: Swarfcut 4 🏠 Primary	▼ Axis Control					
Basic	Axis Option	Ruled Lines 🔹 🔻				
Limiting	Four Axis Plane	1,0,0				
Path Setting	Max Tilt Angle					
🖉 Axis Control	Min Tilt Angle					
Link and Lead Link	Max Rotate Angle	5				
Lead In	Skew Angle					



STEP 05 After calculation we can get another toolpath as follows:

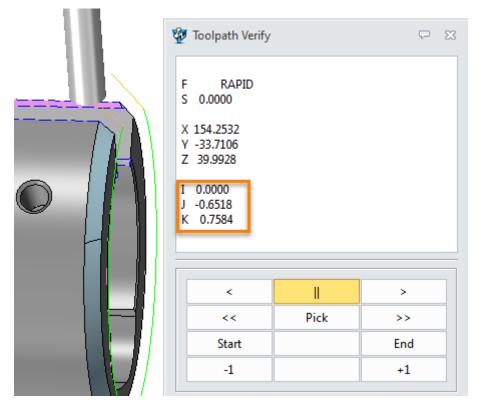


Figure117 4X swarf cut with Flat end mill tool

If we use ball end mill tool and create more toolpath then we can get a better 4X toolpath for finishing this chamfer face as follows:







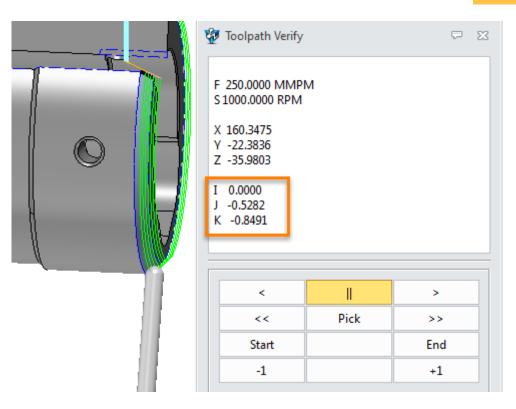


Figure 118 4X Swarf cut toolpath with ball end mill tool

## 1.3.3 5X Drive Curve Cut

**Philosophy:** The 5 axis **Drive Curve Cut** uses 3D driving curves to calculate the tool path. The cutter is driven along these curves and respects the surface geometry to be cut. This operation shares the same Axis Control capability as the 5 Axis Plane Cut operation. The remaining parameters are also similar.

Open the Z3 file "DriveCut\_ISOCut\_HelicalGear.Z3" as follows:

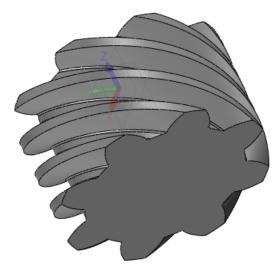


Figure119 DriveCut\_ISOCut\_HelicalGear file





# **ZW** BD

Next, we will use this file to introduce how to run the **Drive Curve** cut operation and Guide Surface ISO operation. First, let's look at drive curve cut operation.

#### 1. How to run Drive Curve Cut operation

STEP 01 Create the drive curve:

I. Choose the 3D medial command from the wireframe module as follows:

File	S	hape	Free Form	n Wi	reframe	Direct Edit	Assembly	Sheet I	Metal I	FTI W	eldments	Point Clo	bud
		Arc •	Rectangle • Drawing			Through Point Curve +	Iso-curve	Blend	3D Medial ▼ Curve	Spiral	<b>V</b> Equation	Planar Section +	Curve List
	Figure120 3D Medial command												

II. Pick the edges on bottom surface of any tooth socket as input as follows:

🐧 3D Medial	23	
🖌 🗙	0	
▼ Required		
1st curve	E121 2	
2nd curve	E118	
▼ Settings		
Method	Equidistant-Middle end	
Tolerance	0.02 mm 🗘 💁 🗸	
Number	1 🗘 🖑 🕶	

Figure 121 Input curves for creating 3D medial curve

After creating the 3D medial curve then enter into CAM let's create Drive curve cut toolpath.

STEP 02 Define dirve curve and part surface



😨 Profile Feature			Ģ	23	
Name	Profile				
Class	general				
Туре	Part			•	
Component	Features				
File					
Profiles	Attributes				
p0	Tolerance	0.001			
	Offset	0			
	Open / Close	Open		•	
	Join Method	Linear		•	
	Reverse Dir	No		•	
	Part Side	Left, Tangent		*	A A

Figure 122 Define profile for Drive curve cut

💯 Surface Featur	re		$\overline{\nabla}$	23	
Name	Part face1				
Class	General Surface			τ.	
Туре	Part			-	
Component	Features				
File					
Surfaces	Attributes				
s0	Tolerance	0.01			
	Shape Modify	None		•	
	Trim Holes	Respect		•	
	Surface Side	Auto		-	

Figure123 Define part surface

STEP 03 Customize a taper tool



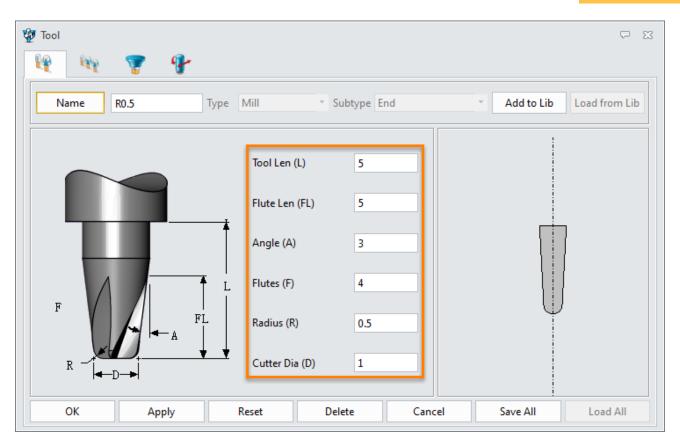


Figure124 Cutomize taper tool

## STEP 04 Set up parameters:

Since most of the parameters are similar to the previous introduced PlaneCut and SwarfCut operations so here we just take some special and different parameter to explain the meaning. For others we just show the setting as follows:

I. Primary parameters:



🐲 5x Drive Curve 1		₽ 🛛		
<ul> <li>Type: 5x Drive Curve</li> <li>Primary</li> <li>Basic</li> <li>Tolerance and Steps</li> </ul>	▼ Basic Frame			
Limiting	Speeds, Feeds	5x Drive Curve 1		
Path Setting	▼ Tolerance and Thick			
Link and Lead	Path Tolerance	0.005		
Link	Surface Thick	0.05		
Lead Out	▼ Bottom Steps			
冒 Display	Cut Depth Type	Along Tool Axis 🔹		
	Max Cut Depth	0.1		
	Number of Cuts	12		



- Number of Cuts: means how many cutting layers in depth way.
  - II. Path setting parameters:

😨 5x Drive Curve 1			$\overline{\nabla}$	23
🕼 Type: 5x Drive Curve 🔺 🏠 Primary	▼ Cutting Control			
Basic	Allow Undercutting	No		•
Tolerance and Steps	Project Direction			
Limiting     Path Setting	Cutting Order	Automatic		-
Axis Control	Tool Side	On		-
Link and Lead	▼ Point Setting			
🛁 Lead In 🖕 Lead Out	Start Point			
Display	Tool Home Start			
	Tool Home End			

Figure 126 Path setting parameters of 5X Drive Curve

• **Tool side**: includes ON, Left/Right/Center of ball as follows:

•On: The curve offset defined in any profile feature will be ignored.

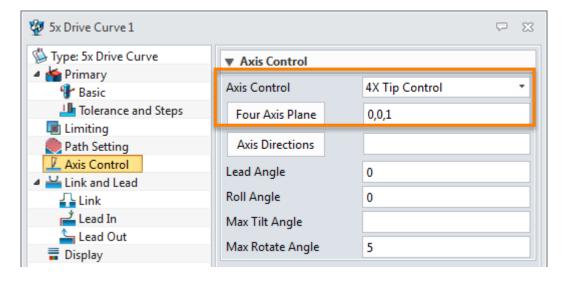
•Left/Right: The cutting tool follows the corresponding left (or right) side of each driving curve when looking down from the z-axis. The left or right offset equals the sum of the curve offset of the profile feature and the tool radius.

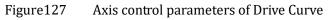




CAM\_5X

III. Axis control parameters:



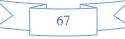


#### IV. Link, lead in and lead out parameters:

🐲 5x Drive Curve 1			Ģ	23
🖄 Type: 5x Drive Curve	▼ Link			
4 🍲 Primary	Short Link Type	Automatic		•
😵 Basic	Long Link Type	Automatic		-
Limiting				-
Path Setting	% Short Link Limit	300.0		
🖉 Axis Control	Safe Distance	20		
Link and Lead	Max Plunge Len			
Link				
📥 Lead In 🆕 Lead Out	▼ Lead In			
Tisplay	Lead In Type	Normal		*
	End Angle In	10		
	Radius In	1		
	Ramp Length In	0		
	▼ Lead Out			
	Lead Out Type	Normal		•
	End Angle Out	10		
	Radius Out	1		
	Ramp Length Out	0		

Figure128

Link,lead in and lead out parameters of 5X Drive Curve







## STEP 04 Calcualte toolpath as follows:

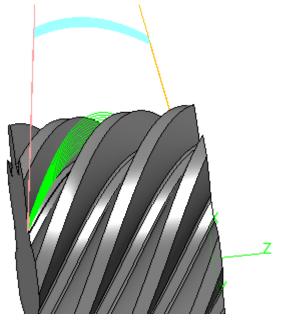


Figure129 5X Drive Curve toolpath

So far we finished the 5X drive curve toolpath for the tooth socket. But as we can see that we had left some material over, so it is necessary to use another operation to finish the whole tooth socket. Then let's take a look at 5X GuideSurface ISO Cut operation as follows:

## 1.3.4 5X Guide Surface ISO Cut

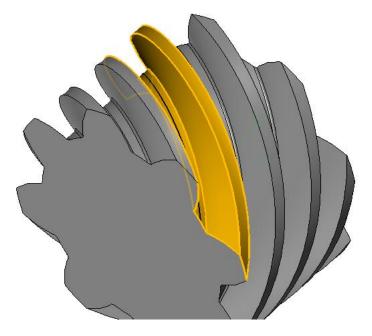
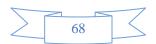


Figure130 Finish required region for the tooth socket





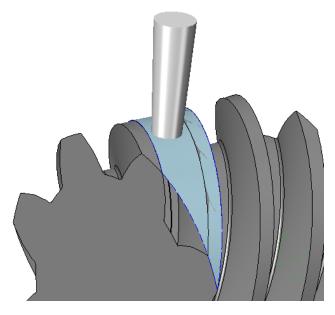
### **Phylosophy**:

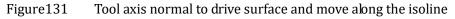
1) Each 5 axis **Guide Surface Iso Cut** operation must have **drive surface(s)** selected in its feature list with general surfaces input as the cutting target.

2) The **guide surface** defined by a drive surface **forces tool axis to follow its normals along the isolines**.

3) If the field "**Cut Drive Surface**" is toggled as "Yes", the drive surfaces will serve as the cutting target in addition to other general surfaces in the feature list. If "No", the drive surfaces will be ignored. The iso direction will be either U-isolines or V-isolines,, conventional or climbing.

Therefore it is easy to know if we want the tool axis to follow a normal way along a special pattern we still need a drive surface as follows:





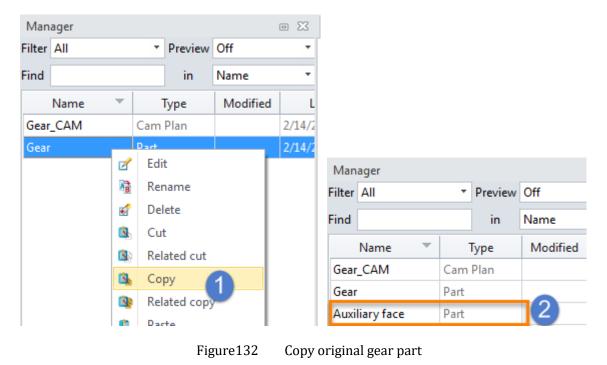
Next let's create the toolpath as follows:

STEP 01 Create drive surface

I. Copy the origial part file and rename it as auxilairy face as follows:







- II. Enter into the new Auxiliary face part file and create surface as follows:
- 1) Create a blend curve at one end as follows:

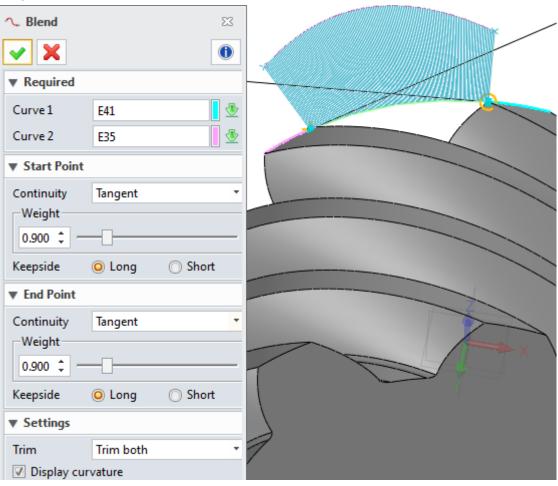


Figure133 Create a blend curve between 2 edges





2) Then make use of the curve to create a surface by "**Bi Rail Loft**" command as follows:

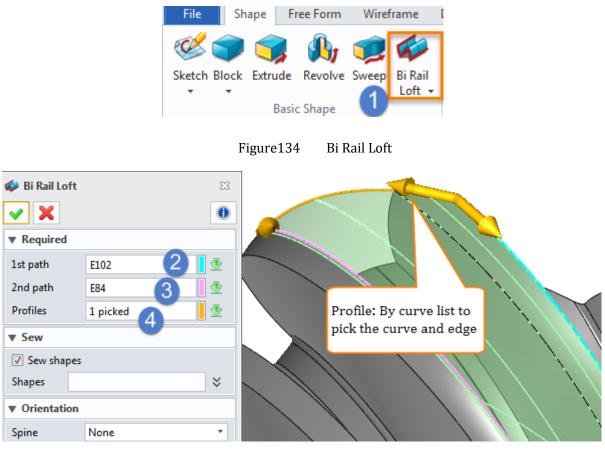


Figure135 Create Surface by Bi Rail Loft command

3) Then delete the gear shape and just leave the surface alone as follows:

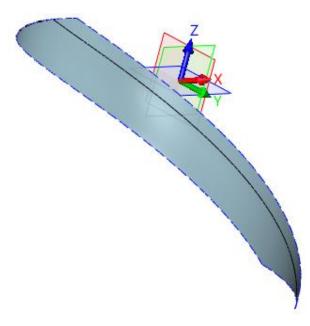


Figure136 Leave the created surface only





4) Merge the surfaces together as follows:

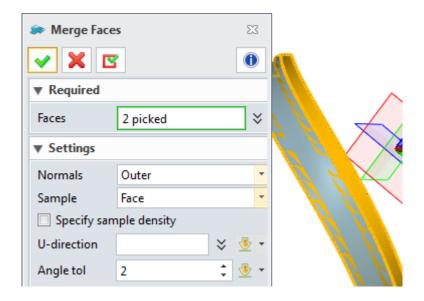
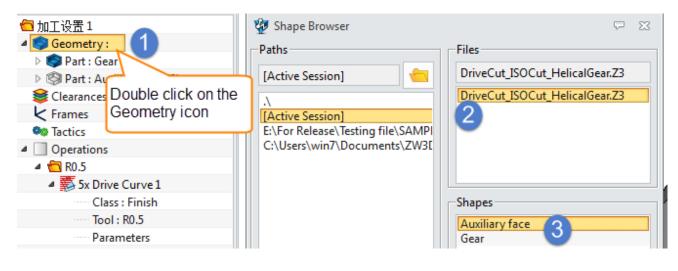
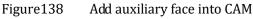


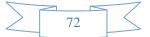
Figure137 Merge the surface together

STEP 02 After finishing the drive surface, go back to CAM and add the auxiliary face into as follows:





STEP 03 After defining the auxiliary face as drive surface, define the cutting region as part surface as follows:





💯 Surface Feature	2			$\overline{\nabla}$	23	
Name	Drive Surfa	ce				
Class	5X Control	Surface(CS	)		-	
Туре	5X Control				-	
Component	Part : Auxilia	ary face (2)	)			
File						
Surfaces	Attributes					X
s0	Tolerance	0.1	L			N
	CS Type	Dr	ive Surface		-	
	Trim Holes	Re	spect		-	
	Surface Sid	le Na	atural		•	
Modify Att	ributes	Ар	oly Attribut	es		
Add Surf	aces	Ren	nove Surfac	es		
	ОК	Cance	ł			

Figure139

Define drive surface

🐲 Surface Featu	ire			23	
Name	Part face1				
Class	General Surfa	ce		-	
Туре	Part			-	
Component	Features				
File					
Surfaces	Attributes				
sO	Tolerance	0.001			
	Shape Modify	y None		•	
	Trim Holes	Respect		•	
	Surface Side	Auto		•	
Modify A	ttributes	Apply Attribute	s		
Add Su	rfaces	Remove Surface	s		

Figure140 Define part surface for 5X Guide Surface ISO Cut





STEP 04 Choose the same tool used in drive curve operation and then set up the parameters as follows:

## I. Primary parameters:

😨 5x Isocut 1		₽ 🛛
Type: 5x Isocut	▼ Basic	
Basic	Frame	
Limiting	Speeds, Feeds	5x Isocut 1
Path Setting	Tolerance and Thick	
4 💾 Link and Lead	Path Tolerance	0.005
Link	Surface Thick	0.05
📥 Lead In 🏠 Lead Out	▼ Cutting Steps	
冒 Display	Stepover	Absolute * 0.05
	▼ Bottom Steps	
	Cut Depth Type	Z-Level *
	Max Cut Depth	

Figure141 Primary parameters of 5X IsoCut

- **Stepover**: can choose differnet type,including Absolute, %Tool Dia, Scallop, Num of Cuts etc.It is the same menaing for the Absolute, %Tool Dia, Scallop,options with what in 3X milling operations.
- **Num of Cuts** means how many toolpath layer you can determine to cretae, which will fill the whole part face.







#### II. Path setting parameters:

🐲 5x Isocut 1			3		
🌿 Type: 5x Isocut 🔺 🍲 Primary	▼ Cutting Control				
Basic	Cut Drive Surface	No 🔻			
Interance and Steps	Path Pattern	Zigzag 🔹			
Limiting Path Setting	Stepover Link	Straight 🔹			
Axis Control	Iso Direction	V-Isoline 🔻			
▲ Link and Lead	Cut Direction	Climb			
Link Lead In	▼ Point Setting				
Lead Out Display	Start Point				
	Tool Home Start				
	Tool Home End				

Figure142 Path setting parameters of 5X IsoCut

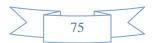
- **Cut Drive Surface**: if we choose yes then the drive surface will serve as milling target at the same time. If No, then it will ignore it, and only use the drive surface to guide the tool axis.
- StepoverLink: Straight or Round
- **ISO direction**: if along the U direction or V direction of drive surface

#### **III. Axis Control parameters**

😨 5x Isocut 1		
🌃 Type: 5x Isocut 4 🍆 Primary	▼ Axis Control	
😗 Basic	Max Tilt Angle	
Interance and Steps	Max Rotate Angle	5
Limiting Path Setting	Four Axis Plane	
🖉 Axis Control		
🔺 🕌 Link and Lead		

Figure143 Axis Control parameters of 5X IsoCut

Here the four axis plane will affect your output, you can set up according to the real machine's structure.





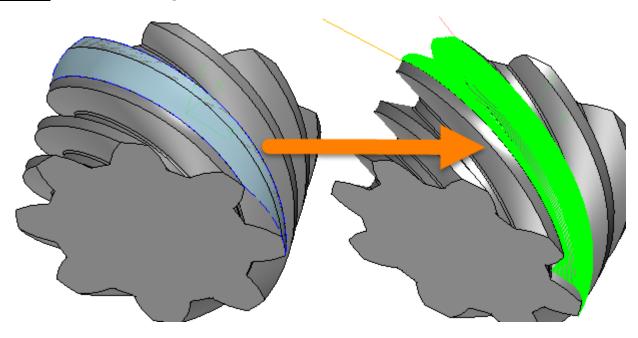
# IV. Leak and lead parameters:

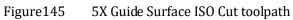
😨 5x Isocut 1		₽ %
Type: 5x Isocut	▼ Link	
▲ Mainter America	Short Link Type	Automatic 🔹
Tolerance and Steps	Long Link Type	Automatic 🔹
Limiting Path Setting	% Short Link Limit	300.0
Axis Control	Safe Distance	5
Link and Lead	Max Plunge Len	
Link Lead In	▼ Lead In	
Lead Out	Lead In Type	Normal 🔹
🖥 Display	End Angle In	10
	Radius In	1
	Ramp Length In	0
	▼ Lead Out	
	Lead Out Type	Normal
	End Angle Out	10
	Radius Out	1
	Ramp Length Out	0



Link and lead parameters

STEP 05 Calculate the toolpath as follows:









## 1.3.5 5X Flow Cut

**Philosophy**: The 5 axis Flow Cut operation requires either a 5 axis Swarfcut or a 5 axis Drive Curve Cut as a reference operation that contains two separated cuts. These two cuts will be used as flowing curves. The Swarf cut or Drive Curve Cut can also have multiple depths. ZW3D CAM will select the two bottom cuts as flowing curves. It is very useful for machining areas between two tilted walls (turbine blades for example).

So let's open the file "**5X\_Impeller.Z3**" again, when introducing the swarf cut operation we have created the swarf cut toolpath to finish the blade as follows:

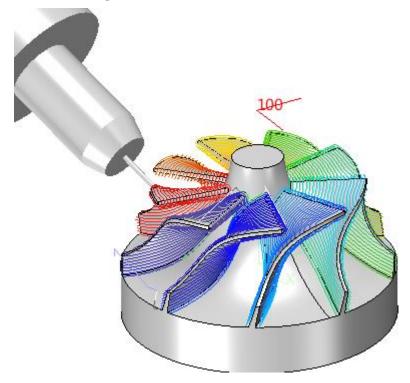
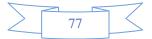


Figure146 5X impeller with Swarf cut toolpath

Here we will make use of the part to introduce 5X Flow Cut operation. Now we need to create toolpath for the areas between blades and the out surface of the blade as follows:







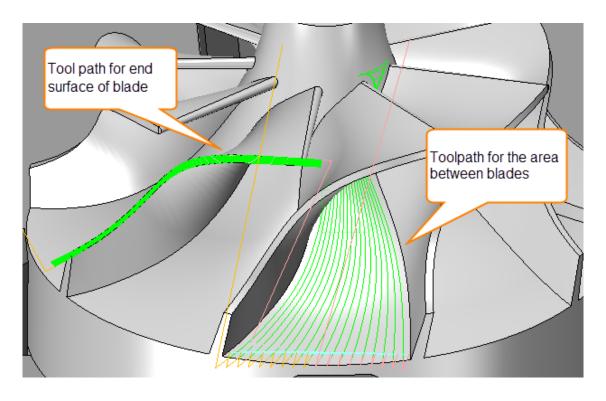


Figure147 Tool path for impeller

Next we will use both introduced swarf cut operation and drive curve operation as reference separately to create the 5X flow toolpath on the desired areas.

## 1. Reference to Swarf Cut operation

STEP 01 Create another swarf cut toolpath on the root of blade as follows:

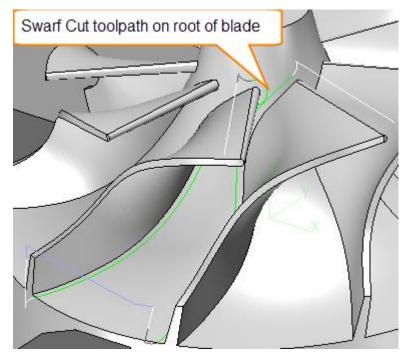
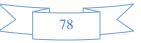


Figure148 Swarf cut toolpath on root of blade





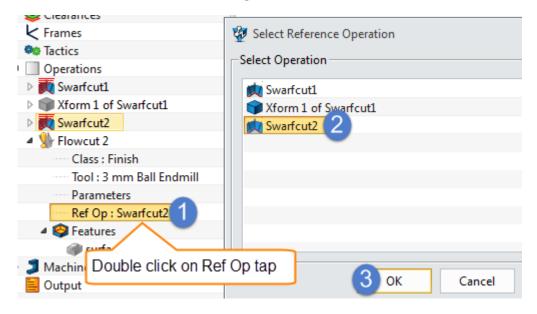
STEP 02 Create 5X flow cut reference to the swarf cut as follows:

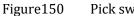
I. Define part surface for 5X flow cut as follows:

💯 Surface Featu	ire	t	- 23	Pick these face as	
Name	surface 3			part surface	
Class	General Surface		-	7 /	
Туре	Part		-		
Component	Features			<u> </u>	
File					
Surfaces	Attributes				
sO	Tolerance	0.1			2 3
	Shape Modify	None	-		
	Trim Holes	Respect	-		
	Surface Side	Auto	-		
					/

Figure149 Define part surface for 5X flow cut

II. Choose swarf cut as reference operation as follows:





Pick swarfcut2 as reference

III. Choose Tool: 3 mm Ball End Mill





## IV. Set up pararmeters

🐲 Flowcut 2		⊽ ⊠
Type: 5x Flowcut	▼ Basic	
P Basic	Frame	
➡ Tolerance and Steps ● Path Setting	Speeds Feeds	Flowcut 2
Axis Control Axis Control Link and Lead	Tolerance and Thick	
Link	Path Tolerance	0.1
📥 Lead In 🍆 Lead Out	Surface Thick	0
Display	▼ Cutting Steps	
	Stepover	Absolute * 2.8



🖗 Flowcut 2			₽ %		
V Type: 5x Flowcut	▼ Cutting Control	▼ Cutting Control			
Basic	Flow Pattern	One Way	•		
	Flow Type	Spiral Outward	-		
Path Setting	Collision Check	Yes	•		
▲ ≚ Link and Lead	▼ Point Setting				
Link	Start Point	PNT#116327			
Lead Out Display	Tool Home Start				
	Tool Home End				

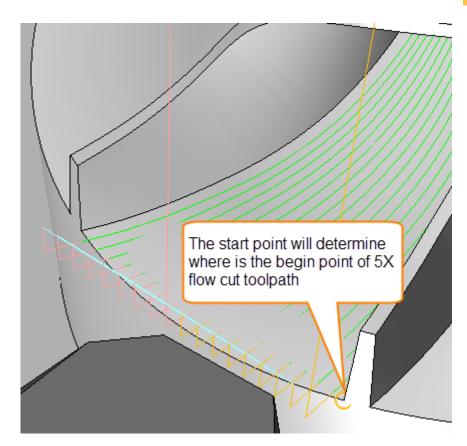
Figure152 Path setting parameters

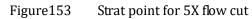
- **Collision check**: choose yes to check if the toolpath will collide with stock
- **Start Point**: it is allowed to set up the start point as follows:





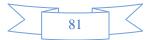






Flowcut 2		₽ %	ζ
Type: 5x Flowcut	▼ Axis Control		
Basic	Max Tilt Angle		
Interance and Steps	Max Rotate Angle	0	
Path Setting Axis Control			

Figure154 Axis control parameters

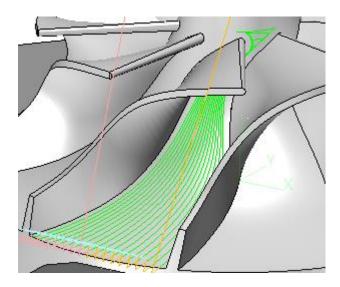


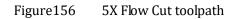


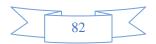
💯 Flowcut 2		₽ %
W Type: 5x Flowcut	▼ Link	
Primary Basic	Short Link Type	Automatic 🔹
Interance and Steps	Long Link Type	Automatic 🔹
Path Setting	% Short Link Limit	300.0
✓ Link and Lead	Safe Distance	5
Link	Max Plunge Len	
📥 Lead In 🆕 Lead Out	▼ Lead In	
冒 Display	Lead In Type	Normal 🔹
	End Angle In	0
	Radius In	0
	Ramp Length In	5
	▼ Lead Out	
	Lead Out Type	Normal 🔹
	End Angle Out	0
	Radius Out	0
	Ramp Length Out	5

Figure155 Link and lead

STEP 03 Calculate the toolpath and we will get the following result:









## 2. Reference to 5X Drive Curve operation

Here we will create 5X flow cut toolpath on the end face of blade as follows:

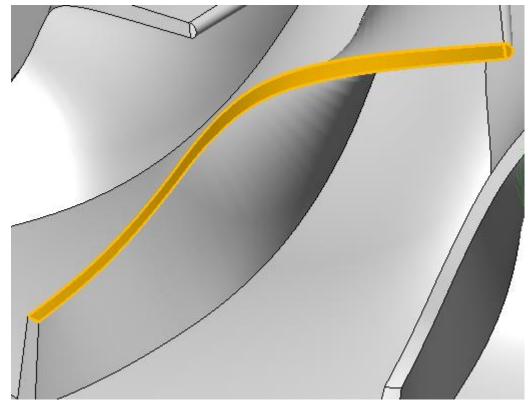


Figure157 End face of blade

In order to make the toolpath that can fully cover the whole end surface, it is necessary to create an auxiliary surface to help create the toolpath. As follows:

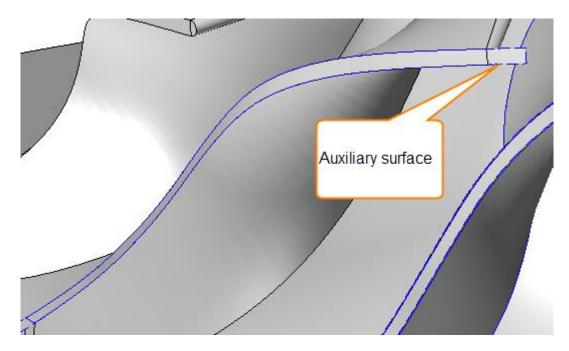
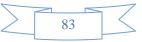


Figure158 Auxiliary surface for 5X flow cut







Here we will not introduce how to create the auxiliary surface again, you can find it in the file of "5X\_impeller" as follows:

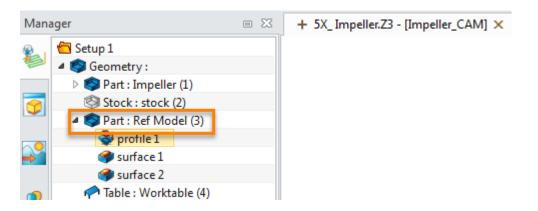


Figure159 Auxiliary surface mode for 5X Impeller

Next let's make use of the existing auxiliary surface to create the toolpath

STEP 01 Define the surface as part surface and choose the profile as drive curve as follows :

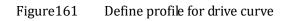
💯 Surface Feature	2		₽ 33		1
Name	surface 1				$> \langle$
Class	General Surface		-		$\sim$
Туре	Part		-		
Component	Features				
File					21/
Surfaces	Attributes			V	
s0	Tolerance	0.1			
	Shape Modify	None	-		
	Trim Holes	Respect	-		
	Surface Side	Auto	-		
					H

Figure 160 Define the auxiliary surface as part surface for drive curve operation





💯 Profile Feature			$\nabla$	Σ3	
Name	profile 1				
Class	general				
Туре	Part			•	
Component	Features				
File					
Profiles	Attributes				5-11
р0 р1	Tolerance	0.1			
ht	Offset	0			
	Open / Close	Open		•	
	Join Method	Linear		•	
	Reverse Dir	No		•	
	Part Side	Left, On		-	
	1				



STEP 02 Choose ball end mill of 3 mm and set up parameters to create toolpath as follows :

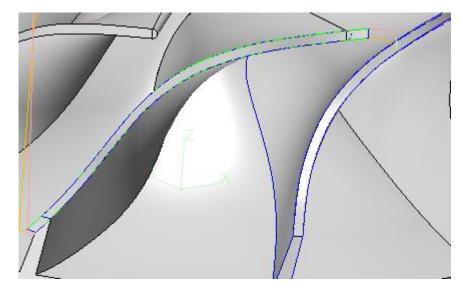
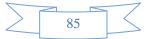


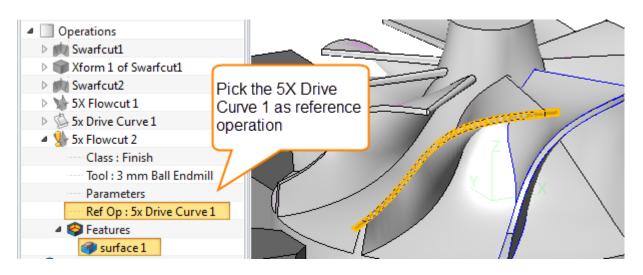
Figure162 5X Drive curve toolpath

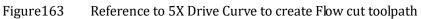
STEP 03 Create 5X flow cut as follows:

I. Set up the feature and reference operation









#### II. Set up parameters

😨 5x Flowcut 2		₽ %
Type: 5x Flowcut	▼ Basic	
😵 Basic	Frame	
Interance and Steps	Speeds Feeds	5x Flowcut 2
<ul> <li>Axis Control</li> <li>Link and Lead</li> </ul>	▼ Tolerance and Thick	
T Link	Path Tolerance	0.1
Lead In	Surface Thick	0
Display	▼ Cutting Steps	
	Stepover	Absolute * 0.2



Primary parameters

🐲 5x Flowcut 2			₽ 23
★ Type: 5x Flowcut ▲ ★ Primary	▼ Cutting Control		
Basic	Flow Pattern	Zigzag	•
Interance and Steps	Flow Type	Along	-
Path Setting	Collision Check	No	-
🖉 Axis Control			
Link and Lead	Point Setting		
Link			
📥 Lead In	Start Point		
🖕 Lead Out	Tool Home Start		
冒 Display	ioor nome start		
	Tool Home End		

Figure165 Path Setting parameters



# **ZW** 3D

💯 5x Flowcut 2		
★ Type: 5x Flowcut ▲ ★ Primary	▼ Link	
Basic	Short Link Type	Automatic 🔹
Interance and Steps	Long Link Type	Automatic 🔹
Path Setting	% Short Link Limit	300.0
▲ Link and Lead	Safe Distance	5
Link	Max Plunge Len	
📥 Lead In 🆕 Lead Out	▼ Lead In	
Display	Lead In Type	Normal 🔻
	End Angle In	90
	Radius In	1
	Ramp Length In	0
	▼ Lead Out	
	Lead Out Type	Normal 🔹
	End Angle Out	90
	Radius Out	1
	Ramp Length Out	0

Figure166 Link and Lead parameters

III. Calculate and get the result as follows:

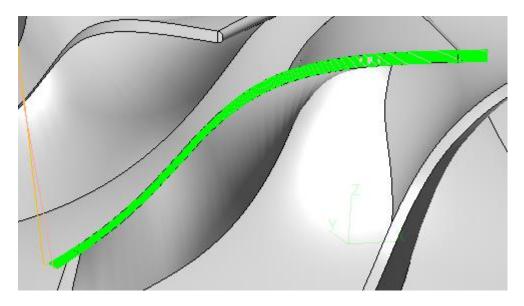


Figure167 5X Flow Cut Toolpath on end face of blade

Then we can use the transform function to pattern the toolpath, finally we can get the following result :





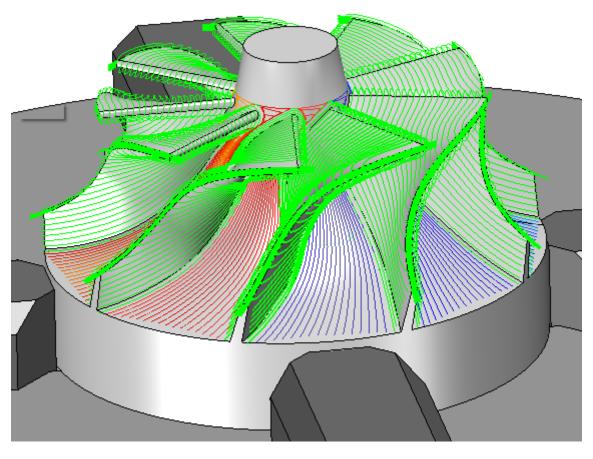
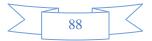


Figure168 Toolpath for the impelle

After finishing these steps please hide the auxiliary part and then save the file. Next let's take a look at the last operation of 5X, side cut.







## 1.3.6 5X Side Cut

**Philosophy:** The **5** axis Side Cut operation accepts parts or general surface features as geometric inputs. Based upon different axis control options, it allows you to position the cutter in various orientations including normal or side tangent to the part with lead, roll and skew angles. This operation is a good choice for turbine top machining or complex pocket finishing with point control.

First we can take the "**5X\_Impeller.Z3**" file as an example again to show how to use the side cut operation. Now we need to cut the top region, the final result will be as follows:

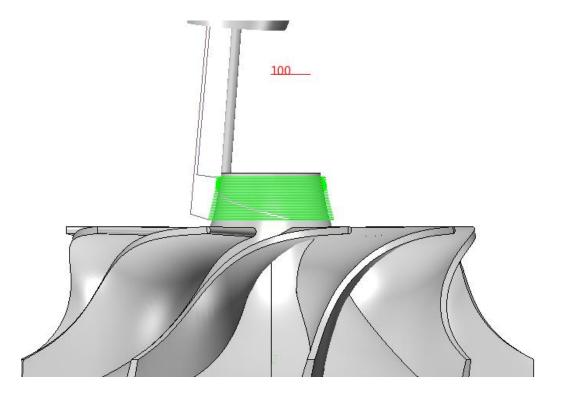


Figure169 5X side cut for the top region of impeller

Next let's create the toolpath step by step as follows:

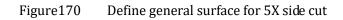
STEP 01 Choose 5X Side Cut operation and define the general surface





# CAM\_5X

Choose the whole	💯 Surface Feature	2		$\bigtriangledown$	23
surface to define as general surface	Name	surface 7			
general carrace	Class	General Surface			•
	Туре	Part			-
	Component	Features			
	File				
	Surfaces	Attributes			
N	s0	Tolerance	0.1		
		Shape Modify	None		-
		Trim Holes	Respect		-
		Surface Side	Auto		•



Normally a general surface is enough to create the toolpath of 5X side cut.

STEP 02 Next let's set up the parameters:

I. Primary parameters:

🐲 5x Sidecut 3		Φ Σ	3
Type: 5x Sidecut	▼ Basic		
😵 Basic	Frame		
Limiting	Speeds, Feeds	5x Sidecut 3	
Path Setting	▼ Tolerance and Thick	:	
🔺 💾 Link and Lead	Path Tolerance	0.01	
Link	Surface Thick	0	
Lead Out	Bottom Steps		
Display	Depth Direction		
	Max Cut Depth	0.5	
	▼ Side Steps		
	Side Cut Offset		
	Side Cut Depth		

Figure171 Primary parameters





### II. Limit parameters:

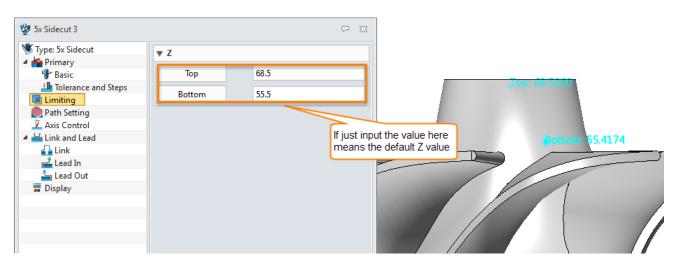


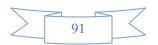
Figure172 Set up the top and bottom point

#### **III. Path setting parameters:**

Type: 5x Sidecut	▼ Cutting Control		
Primary Basic Interance and Steps	Cut Overlap Shift Start Point	0	
Limiting Path Setting	Allow Undercutting	No	•
Axis Control	Path Pattern	Zigzag	-
🛚 ≚ Link and Lead	Cut Direction	Climb	-
Link	Cutting Regions	All Regions	Ŧ
Lead Out	Z Progress	Top to Bottom	-
🖥 Display	Enable Spiral	Yes	
	End Over Mill	Yes	+
	▼ Point Setting		
	Start Point		
	Tool Home Start		
	Tool Home End		

Figure173 Path setting parameters

- Allow Undercutting: If there is undercut need to cut, choose this option to allow tool axis to rotate
- Cutting Regions: Includes All Regions, Pockets Only, Outside Only,





- All regions: means all of the region in the target surface or part will be taken into account
- **Pockets Only**: Just cut the pocket, need to combinate with the option of "**Control Point**" in Axis control.
- **Outside Only**: just cut the outside of surface or part.
- **Enable Spiral**: If we allow the toolpath move as spiral pattern or not.
- **IV. Axis control parameters:**

🐲 5x Sidecut 3		₽ X
🖲 Type: 5x Sidecut 🖌 🏠 Primary	▼ Axis Control	
Basic	Axis Type	Tip Sidecut 🔹
Interance and Steps	Skew Angle	0
Limiting Path Setting	Max Tilt Angle	5
🖉 Axis Control	Control Point	
Link and Lead Link	Max Rotate Angle	5
📥 Lead In	Cutting Height	
Lead Out Display	▼ Axis Guide	
	Guide Type	None 🔹

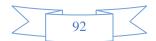
Figure174 Axis control parameters

- **Axis Type**: besides the introduced types in this operation there are 2 more different types :
  - **Tip SideCut**: Tool Tip determine the tool axis's orientation and then cutter side will be tangent to the part tangent plane.
  - **Contact SideCut**: Tool's contact point determine the tool axis's orientation and then cutter side will be tangent to the part tangent plane
- Control Point

This parameter is used to **machine pockets**. If defined, the control point overwrites the Axis Control parameter so that the tool axis passes through the control point.

• Axis Guide

In 5x sidecut, Axis Guide tries to define a few types of primitive surfaces as the guide surface by using the same concept as the guide surface does in 5x isocut. It is used mainly to machine pockets or porting (like driving curve).







For more details about the axis guide function we will use some cases to explain it in details. Here let's skip it first, and choose none.

STEP 03 For the rest parameters please refer to the previous introduction to finish by yourself and then calculate the toolpath as follows:

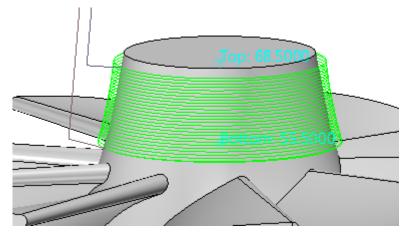
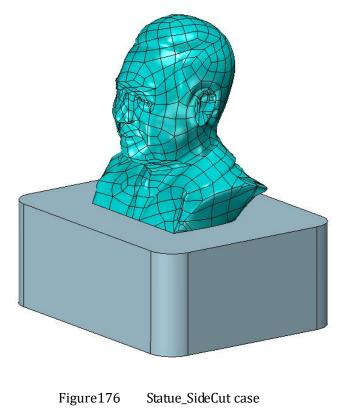


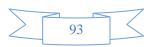
Figure 175 5X side Cut toolpath on the top region of impeller

After saving the file. So far actually we have finished the toolpath for the impeller.

Next, we will take another example to show how to use the axis guide function to solve some problems:

1. Statue Case: Open the Statue Cut case file "Statue\_SideCut.Z3" as follows:







STEP 01 Enter into CAM and create 5X Side Cut operation and then add the general surface as

follows:				
🐲 Surface Featur	e		<b>₽</b> X	
Name	surface 1			
Class	General Surface		-	
Туре	Part		-	
Component	Features			
File				
Surfaces	Attributes			
sO	Tolerance	0.1		
	Shape Modify	None	-	
	Trim Holes	Respect	-	
	Surface Side	Natural	-	

Figure177 define the statue part as general surface

In oder to let the tool stop at the bottom of statue we can define the bottom face as Start check surface as follows:

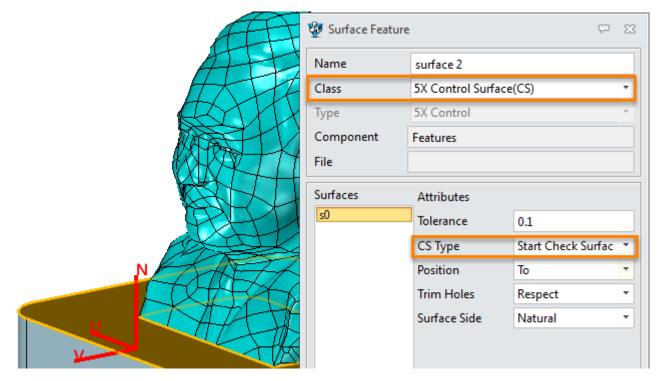


Figure178 Define Start Check Surfac





# STEP 02 Set up the parameter according to the above introduction as follows:

😨 5x Sidecut 1			$\nabla$	ΣS
Type: 5x Sidecut	▼ Basic			
Basic	Frame			
Last Tolerance and Steps	Speeds, Feeds	5x Sidecut 1		
Path Setting	Tolerance and Thick			
Link and Lead	Path Tolerance	0.1		
Link	Surface Thick	0		
📥 Lead In 🆕 Lead Out	▼ Bottom Steps			
Display	Depth Direction			
1	Max Cut Depth	2		
la ander to anno antoriation	▼ Side Steps			
In order to save calculating time set up a big cut depth	Side Cut Offset			
	Side Cut Depth			

Figure179

Primary parameters for statue cut

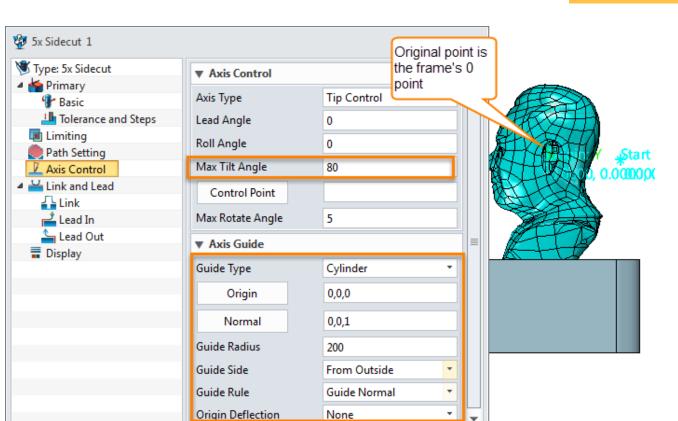
😨 5x Sidecut 1			₽ %	
V Type: 5x Sidecut	▼ Cutting Control	▼ Cutting Control		o start point cool cut
Primary Basic	Cut Overlap	0		his side
Interance and Steps	Shift Start Point			Atra Th
Limiting     Path Setting	Allow Undercutting	No	•	Start Point:
Axis Control	Path Pattern	One Way	-	
Link and Lead	Cut Direction	Climb	-	ALTING .
Link	Cutting Regions	All Regions	•	
Lead Out	Z Progress	Top to Bottom	-	
冒 Display	Enable Spiral	No	•	
	▼ Point Setting			
	Start Point	PNT#50495		
	Tool Home Start			

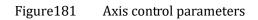


Path setting parameters









Now let's stop here and calculate the toolpath to check what we will get. Following is the result:

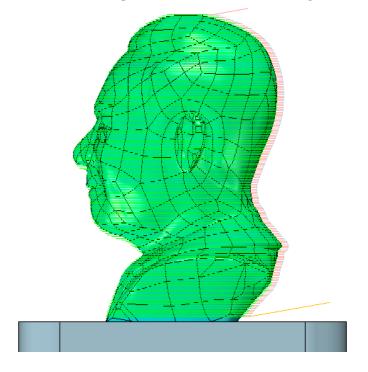
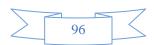


Figure 182 5X Side Cut toolpath for the statue





Next let's make use of the created toolpath to explain axis guide parameters, as follows:

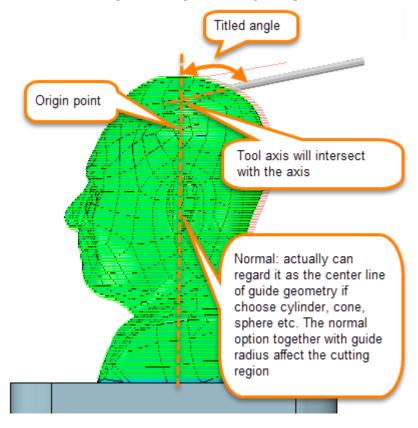


Figure183 Explanation for axis guide parameters

- **Guide type**: normally use the cylinder, cone, sphere and drive curve. For drive curve we will use another case to show how to use it.
- **Origin:** Can be regarded as the center point of section profile in XY as follows, the picked normal way will pass this origin.

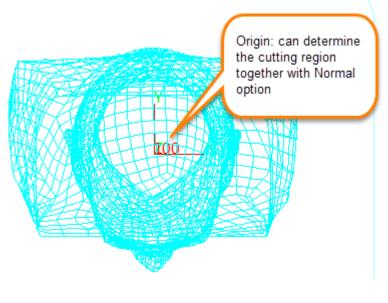
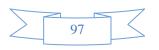


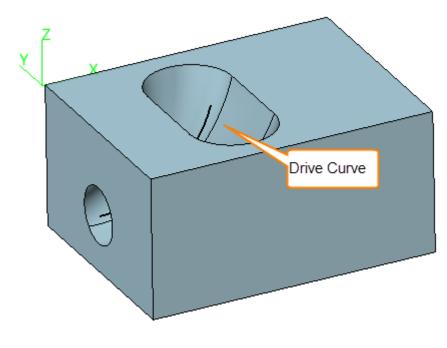
Figure184 Origin option





- **Normal**: if choose Cylinde, Cone, Sphere etc type, regard it as the center line of the guide geometry. which will affect the cutting region together with guide radius.
- **Guide Radius**: It is the section profile's radius of guide geometry which depends on the guide type.
- **Guide Side**: If cut the outside or Pocket.
- **Guide Rule**: if the tool axis guide by guide geometry normal or cutting part's normal.
- **Origin Deflection**: if deflect the origin to allow the tool to engage into the small corner.

Now that most of the pameters are illustrated, let's use another case to explain how to use the drive curve type guide and control point together to do the porting cut.



2. Porting cut Case: Open the file "5X PortingCut.Z3" as follows:

Figure 185 5X porting cut case

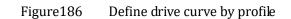
In this file a drive curve had been created for reference. So in this case we will skip the jobs on how to create the drive curve. Next let's create toolpath for the port shape step by step:

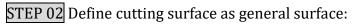
STEP 01 Define profile for drive curve:



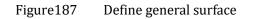


💯 Profile Feature			$\overline{\nabla}$	23	
Name	profile 1				
Class	general				
Туре	Part			-	
Component	Features				
File					
Profiles	Attributes				
p0	Tolerance	0.1			
	Offset	0			
	Open / Close	Open		•	4
	Join Method	Linear		•	
	Reverse Dir	Yes		•	
	Part Side	Left, On		Ŧ	H
	1				

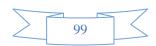




re		$\nabla$	23	
surface 1				
General Surface			-	
Part			-	
Features				
Attributes				
Tolerance	0.1			N
Shape Modify	None		-	
Trim Holes	Respect		-	
Surface Side	Auto		-	
	surface 1 General Surface Part Features Attributes Tolerance Shape Modify Trim Holes	surface 1 General Surface Part Features Attributes Tolerance 0.1 Shape Modify None Trim Holes Respect	surface 1 General Surface Part Features Attributes Tolerance 0.1 Shape Modify None Trim Holes Respect	surface 1 General Surface  Part Features Attributes Tolerance 0.1 Shape Modify None Trim Holes Respect

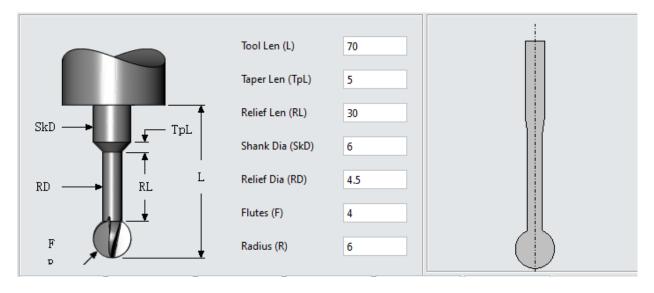


Note: it is important to make sure the surface's direction is positive.





## STEP 03 Define a lollipop tool as follows:





Define lollipop tool

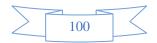
## STEP 04 Set up parameters:

Here we will skip the Primary parameters and Path setting parameter and just focus on axis control parameter as follows:

▼ Axis Control		
Axis Type	Tip Sidecut 🔹	
Skew Angle	0	
Max Tilt Angle		
Control Point	PNT#2076	
Max Rotate Angle	5	
Cutting Height		Control Po
▼ Axis Guide		/1.0005/
Guide Type	Drive Curve 🔹	
Origin		
Guide Radius		
Guide Side	From Inside 🔹 🔻	
Guide Rule	Part Normal 🔹	

Figure189 Set up axis control parameters

Because here used the drive curve as the guide geometry: the tool axis will be guided by the drive curve's tangent way, so the guide radius makes no sense for this situation, just leave it blank.





STEP 05 After finishing setting up parameter, calculate the operation Toolpath as follows.

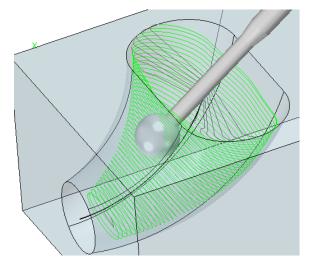


Figure190 Porting cut toolpath by 5X Side Cut operation

#### **Summary:**

We have introduced how to achieve the 5X indexing milling by sub frame and Interpath function. And with the practical examples, we have introduced how to run 5X simultaneous movement operations and apply these operations to the real case.

#### Notice:

This tutorial is based on ZW3D 2019 version, some functions or icons may not match the current version. If you have any suggestions or questions about this tutorial, please contact us at

ZW3D Global Website: <u>https://www.zwsoft.com/zw3d/</u>

ZW3D Forum: https://www.zwsoft.com/forum/forum-18.html

ZW3D Support Team: <u>zw3d@zwsoft.com</u>

