ZW3D

CAM Advanced Training Guide (4-5 Axis)

(Only for 4&5-Axis Machining)

ZW3D™ V2014 CAM Advanced Training Guide

Forward

The full version of the ZW3D documentation is available by selecting **Help Browser** from the ZW3D **Help Menu**. Go to the **"Program Folder\doc"** directory on the ZW3D program directory and open the file **"ZW3D.chm".**

This **CAM Advanced Training Guide** is available as a printed manual and in PDF format. To view or print the PDF version, install the Adobe Acrobat Reader and open the corresponding files in the **"Program Folder\PDF"** folder in the program directory. Refer to the **HELP Manual** for information relating to specific tasks.

NOTES:

1. For best results, view and print the PDF version of the documentation using the Adobe Acrobat Reader.
2. Since the **CAM Advanced Training Guide** is only a portion of the complete documentation, it is highly recommended that you utilize the **HELP Manual**. You will find additional topics, more information on command options, input options, additional command notes, and cross-links to related tasks and topics.
3. It should be noted that the HELP Manual will always be more up-to-date than any printed or PDF material. If you find any discrepancies between the two, always refer to the HELP Manual**.**
4. While you are working with ZW3D, simply press **F1** to view the documentation about the command you select.

To help you customize your CAD/CAM requirements, please contact our Customer Support department on our website http://www.zwsoft.com/ or call at (8620)38289780 ext 565. You can also contact your local sales representative or application engineer to discuss your requirements.

Thanks for being our customer!
Team ZW3D

5 Axis *Milling Operations*

Tool paths created in frames not parallel to the machine coordinate system function like any other tool path within ZW3D CAM. The primary differences will be noted in how ZW3D creates output for these tool paths.

If the machine configuration has “MULTAX" set to "Yes", all points will be written out in the XYZIJK format. If set to "no" then points will be written out as XY or XYZ coordinates as appropriate.

How to Define 5 Axis Milling Operations: Using the CAM Plan Manager (Outline)

1. In the CAM Plan Manager, double click on Operations, select one of the 5 axis milling operation from the form provided. The operation will be added to the manager tree.

2. Select **Parameters** under the operation you just added and set the parameters using the definition form provided. Pick **OK** when you are done. Each 5 axis operation uses a unique definition form. They are shown below under each operation type. See 5 Axis Milling Operation Form Parameters, pages 5-7, for a definition of each parameter.

Notice that (**undefined**) is shown next to **Features,** in the image above, under the 5 axis operation you just added. This means that features are not yet defined for the operation.

3. Your CAM features (once you define them) are listed under the **Geometry** section of the manager tree. Click on **Features** in the operation just created then under **Geometry**, find the CAM component (i.e., **part** : **name**) and expand it (i.e., select + to the left of the part) to list the CAM features currently defined for that component and select one. It will now be listed under **Features** for the 5 axis operation you just created. The (**undefined**) flag will be removed.

To create a new CAM feature: Again, under **Geometry** right-click on the CAM component, select **Add Feature** and follow the forms and prompts. You will be prompted to select geometry from the graphics window.

Control Surfaces

A Control Surface is a CAM Surface Feature whose CS Type is set to **Drive**, **Part**, **Start Check** or **Stop Check**. These properties are automatically recognized by ZW3D CAM when the CAM surface features are applied to operations. For example, the swarf cut operation can use drive surfaces to control the tool axis while the interactive cut operation can use a group of part, check and drive surfaces to create a sequence of tool motions. Refer to each operation type below to find out how to apply control surfaces.

Using the CAM Plan Manager

In the CAM Plan Manager, expand the Geometry section of the tree (i.e., select to the left) and locate the CAM component (i.e., part : name) that contains the surfaces you want to define.
From the manager tree, right-click on the component, select Add Feature and

then select Surface from the popup list.

The component will be displayed in the graphics window. Select the surfaces and then middle-click to display the Surface Feature Form. This form is similar to the Surface Feature Set Manager in the old UI.
Select the Class button and then select from the list of control surface attributes. General, Drive, Part, Start Check and Stop Check surfaces are available. Refer to the Surface Feature Set Manager in the old UI for more information. Complete the form as desired to create the CAM surface feature. The control surface attributes are defined within the CAM feature.
Refer to each operation type below to find out how to apply the control surfaces to individual tool path operations.

Plane Cut Operation (5 Axis) 

The 5 axis plane cut creates a cutting pattern based on parallel cuts at a user specified angle with respect to the frame's 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). Click Plane Cut through the 5x Mill toolbar.

Control surfaces (see above) are not supported in this operation. The Class attribute of any

CAM surface features for this operation should be set to "General surface."

Swarf Cut Operation (5 Axis) 

The swarf cut operation uses control surfaces (see above) 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. Drive and Part surfaces are class attributes applied to CAM surface features. Click Swarf Cut through the 5x Mill toolbar.

How to Apply Control Surfaces to Swarf Cut Operations

The swarf cut operation will automatically recognize any control surfaces that are present within the CAM surface features. See How to define 5 axis milling operations above to find out how CAM surface features are used with all 5 axis operations.

CAM features can contain several surface features with different control surface attributes. See How to define control surfaces above for more information. For example, you can use a CAM surface feature to represent a pocket that is to be machined. The feature can have all the wall surfaces of the pocket as drive surfaces and the bottom surfaces of the pocket as part surfaces.

Note

If the original part from which the control surfaces are selected resides in the CAM assembly, it will be used for gouge-checking during swarf cut operations. Tables and clamps are also automatically considered.

Using the CAM Plan Manager

All of the control surfaces for the swarf cut operation should be contained in one CAM surface feature.

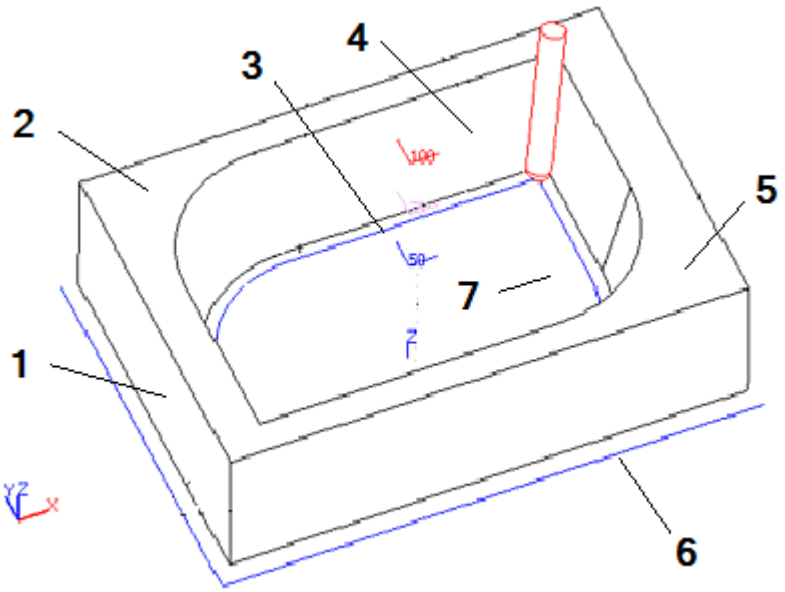
Follow the steps above to define Control Surfaces. Create a 5 axis milling operation per steps described earlier. Select the operation Features in the operation just created then add

each control surface one at a time until all required control surfaces have been added.

Interactive Operation (5 Axis)

The interactive cut operation provides additional flexibility by allowing you to create a sequence of 5 axis swarf cut tool motions by specifying groups of part, check and drive surfaces. You will notice that the definition form shown below is similar to that of the swarf cut shown above. Click Swarf Cut through the 5x Mill toolbar.

How to Apply Control surfaces to Interactive Cut Operations



1: Drive Surfaces (TM2) 2: Start Check Srf (TM2) 3: Tool Motion1 (TM1) 4: Drive Surface1 (TM1)
5: Stop Check Srf (TM2) 6: Tool Motion2 (TM2)

Sample Interactive Cut Operation Containing Multiple Tool Motions using Control Surfaces

Control surfaces are applied on-the-fly using two additional forms when the interactive cut operation is calculated. These forms are the Interactive Path Calculation Form and the Swarf Cut Surface Selection Form. Both are documented below. Using these forms, multiple swarf cut tool motions can be defined each with differing control surfaces.

Interactive Path Calculation Form

When the interactive cut is calculated, this form is displayed first. It allows you to define multiple tool paths within the operation. Continuing cuts will be connected automatically. The **Browse** icons are used to cycle through the tool motions you create. See below for information about each parameter on this form.

- **Class -**Currently only 5-axis is available.
- **Type** - Currently only swarf cut available.
- **New** - This creates a new tool path within the interactive cut operation and displays the Swarf Cut Surface Selection Form (see below). This form is used to apply Control Surfaces and other swarf cut parameters to the tool path.
- **Edit** - This recalculates only the active tool path. When you change any of the interactive cut parameters, use the **Browse** icons to locate a tool path and then press this button to recalculate it.
- **Regen** - This recalculates all tool paths you have currently defined for the interactive cut operation.
- **Delete** - This deletes the active tool path. Use the **Browse** icons to locate a tool path and then press this button to delete it.

Swarf cut Surfaces Selection Form

This form is displayed when the **New** button of the **Interactive Path Calculation Form** (see above) is picked. It is used to apply control surfaces and other swarf cut parameters to a new tool motion within the interactive cut operation. See also **How to define control surfaces** and **How to apply control surfaces to swarf cut operations** above. See below for information about each option on this form.

Drive Loop

The drive surfaces list must be connected. If the whole list you selected forms a closed wall (for example), set this option to closed. The resulting tool path will also be closed. Otherwise, leave this option as open.

Cut Overlap

This is the recut distance to obtain smooth finishing when cutting closed loops. This distance is added at the end of the cut (retracing the beginning of the cut) at the "cut" feed rate. This parameter also appears on the swarf cut operation definition form.

Axis Option

Used to control the tool axis. This parameter also appears on the swarf cut operation definition form. Select from the following:

- Ruled Lines - The tool axis always follows the ruling direction of a drive surface for ruled surfaces.
- Vertical - The tool axis is both tangent to the drive surface and vertically tilted.
- 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.

Control Surfaces

These are properties used to classify surfaces for use with the swarf cut tool motion within the interactive cut operation. Collectively they are referred to as Control Surfaces.

Select a button and then select the part surfaces to apply the attributes to.
Middle-click to complete the selection and a system generated name will appear in the field to the right.

If you select the button again, a form similar to the CAM Surface Feature Form will be displayed allowing you to modify other attributes and add additional surface sets. Select from the following buttons:

- Drive Surfaces - These control the tool axis.
- Part Surfaces - These control the tool height.
- Start Check Surfaces - These determine the starting position of the tool path.
- Stop Check Surfaces - These determine the ending position of the tool path.

Start Point

Used to specify a starting point off of the part from which the tool tip will proceed to on first entry into the material. (Otherwise 0,0, Clear Z is assumed.). This option is only used if Drive Loop (see above) is set to close. You can pick the point from the part or input x,y,z coordinates directly.

Start Axis

In most cases, the drive surface will determine the tool axis clearly so there would be no need to define the starting axis. But, for example, when you want to select a XY plane as drive surface, the starting axis must then be selected. The starting axis is optional to help the system calculate the tool axis correctly.

You can pick the direction from the part or input x,y,z coordinates directly. If not specified, 0, 0,1 (the current Frame's Z axis) is assumed.

Head Attachments for 5 Axis CAM Operations

An alternative to 5 Axis indexing through rotation about table axes is the use of head attachments. Head attachments can allow the machining of tool paths wherein the tool axis is not along the machine Z axis. Instructions for the automatic loading of heads are written in CL output as appropriate.

In order to support the management of Head attachments in output, the following Output Variables have been added:

TAB_AXIS1_NAME TAB_AXIS1_ANGLE TAB_AXIS2_NAME TAB_AXIS2_ANGLE HEAD_NAME HEAD_NUM HEAD_IAXIS HEAD_JAXIS HEAD_KAXIS FIXTURE_OFFSET_REGISTER (not yet in use)

Output variables are located in the file "OutputVariables" located in the "/cam_config" subdirectory of your ZW3D install directory. If you copy this file to your User Directory and then modify the copy, the modified version will be used. ZW3D CAM will first look in your User Directory to locate the file. If it is found there, it will be used.

- Head attachment information is currently not exported to or imported from CAM libraries.

When a Tooling List is requested from the NC Program Output Form, the names and locations of the required Head Attachments are written out as part of the machine definition. Also, the "Toolpath space" field will only allow "machine" as the selection. The "local" option will not be allowed.

In this initial implementation of head attachments, there is no CAM Object Class to manage them. Therefore there is no geometric representation support for head attachments.
In order to use head attachments, the following steps should be taken:

1. The file "HeadAttachments" located in the "/output_def" subdirectory of your ZW3D install directory should be modified or a copy can be made into your User Directory and then modified.
2. The format of the file is the same for each line:
station_id_for_head_attachment:Name_of_head_attachment
As many head attachments as necessary may be loaded in this file.
3. Select Machine Manager > and set the "MULTITAX" field to "yes."
4. Select Setup Manager > Frame Manager and use the "Head" field to select a head attachment defined in step 2 above. Press "Accept" and it will be used during output for all operations created in the frame.
5. (Optional) Select Process Manager > Output > Organize Tab > Sort and set the "Object Type" field to "frame." Set “Object Subtype” to “Frame Name.” Click on “Save Rule” then “Apply Rules.” All operations which share a common head attachment will be output consecutively.

When output is created, each tool path using a given frame will have its coordinates transformed to the correct machine space and the appropriate head for that tool path will be used.

If it is necessary to write out 5 axis motion and there are no table axes or head attachments defined, then the data will be transformed to machine space. In this case it is recommended that you still perform step 3 above.

In the unlikely event that both head attachments and rotational axes are both present, the head attachment will take precedence.

5 Axis Milling Operation Form Parameters

The following tables list all of the parameters located on the 5 axis milling operation definition forms. Many are common to all operations. Others are unique to specific operations. The first table is a matrix of form parameters verses the operation types that support them. The second table lists a description of each form parameter along with their options (if any). Refer to each

5 axis milling operation topic for additional and specific instructions.

5AxisMillingOperationFormParametersversesOperationType							
Form							
Parameter	Plane	Swarf	Interactive	Drive Curve	Flow	Side Cut	Guide Surf Iso
Primary parameters							
Frame	✔	✔	✔	✔	✔	✔	✔
Speeds, Feeds	✔	✔	✔	✔	✔	✔	✔
Bottom Thick		✔	✔				
Side Thick		✔	✔				
Stepover	✔				✔	✔	✔
Stepover Value	✔				✔	✔	✔
Surface Thick	✔			✔	✔	✔	✔
Tolerance	✔	✔	✔	✔	✔	✔	✔
Cut Depth Type	✔	✔	✔	✔	✔		✔
Max Cut Depth	✔	✔		✔	✔	✔	✔
Cutting Height		✔					
Cutting Position		✔					
Depth Direction						✔	
End Over Mill						✔	
Side Case Offset		✔					
Side Cut Depth		✔					
Limiting parameters							
Bottom	✔	✔	✔	✔	✔	✔	✔
Top	✔	✔	✔	✔	✔	✔	✔
Path Setting parameters							
Collision Check			✔		✔		
Corner Radius		✔			✔		
Cut Angle	✔						
Cut Drive Surface							✔
Cut Overlap		✔					
Cut Direction		✔	✔			✔	✔
Cutting Order		✔		✔			
Path Pattern	✔				✔		✔
Cutting Regions						✔	
Fan In		✔	✔				
Fan Out		✔	✔				
Flow Type					✔		
Iso Direction							✔
Project Direction				✔			
Start Axis		✔					
Start Point		✔		✔	✔	✔	✔
Tool Home Start	✔	✔				✔	✔
Tool Home End	✔	✔				✔	✔
Step Over Link	✔						✔
Trim Holes	✔						
Allow Undercutting	✔			✔		✔	
Cut Order		✔					

Axis Control parameters							
Axis Control	✔			✔		✔	
Axis Option		✔					
Control Point						✔	
Four Axis Plane	✔						✔
Lead Angle	✔			✔		✔	
Max Rotate Angle	✔	✔	✔	✔	✔	✔	✔
Max Tilt Angle	✔	✔	✔	✔	✔	✔	✔
Roll Angle	✔			✔		✔	
Skew Angle		✔	✔			✔	
Link and Lead parameters(all operations)							

5 Axis Mill Operations Map

Plane cut： 

Swarf cut： 

drive curve： 

Interactive： 

Flow cut： 

Side cut： 

Guide Surface Iso：