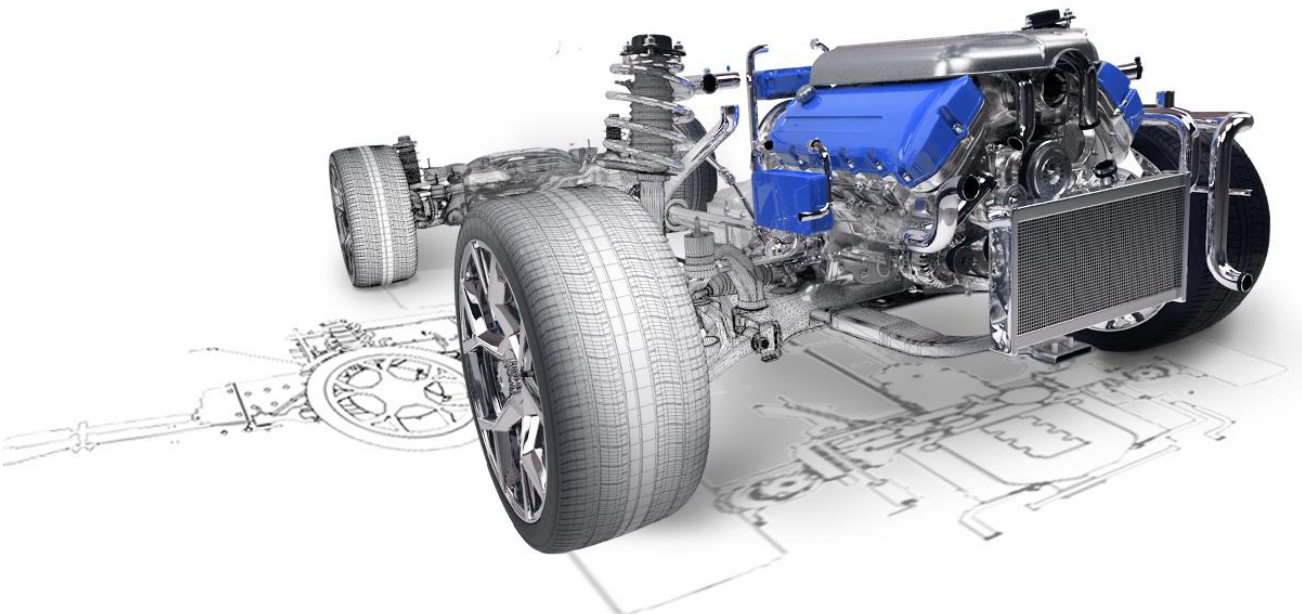


ZW3D From Entry to Master

Point Cloud

Contents

Point Cloud

Point Cloud module provides point cloud/STL model import, point block and STL mesh edit, surface rebuild functions to assist users convert point cloud or STL data to a surface geometry.

Key Points:

- ✧ Data import
- ✧ Point cloud block edit
- ✧ STL mesh edit
- ✧ Surface/Solid rebuild

1.1 Data Import

ZW3D supports to import Point cloud data, STL model, OBJ data into modeling level for the next operating.

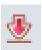
1.1.1 Import Point Cloud Data

Point Cloud Ribbon Toolbar->Import-> 

Using this command, user can import the point cloud data from other systems. The point file will be imported base on the default part unit.

Support format: .txt, .asc, .csv, .dat, .exp, .pts, .xyz

File: Use to specify the point clouds file path. A file browser will pop-up automatically to assist you locate where the point cloud file is. ZW3D also allow user input the file path directly.

Tips: Click  button behind the input box will pop-up a file browser.

Create Point Bolck: Create a point block to store the point data which is a more compact form for storing the point data. And will lead in accelerating the operation speed.

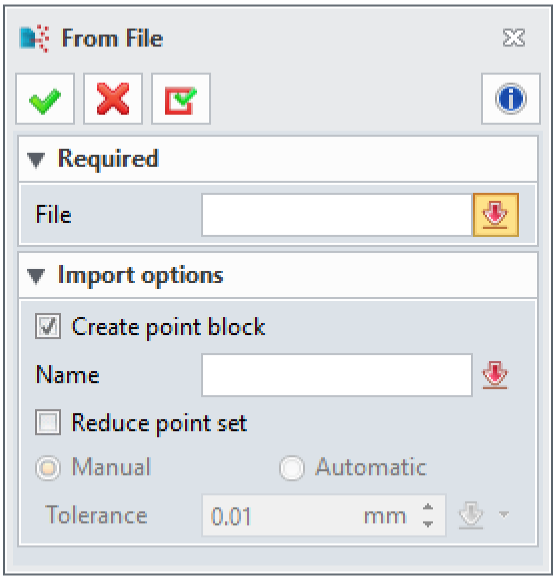


Figure1 Import point cloud data

Name: Specify which group of the points to import. If here specified by the group name, only specified point group will be imported. This option defaults to be empty, thus all the point data in the file will be imported.

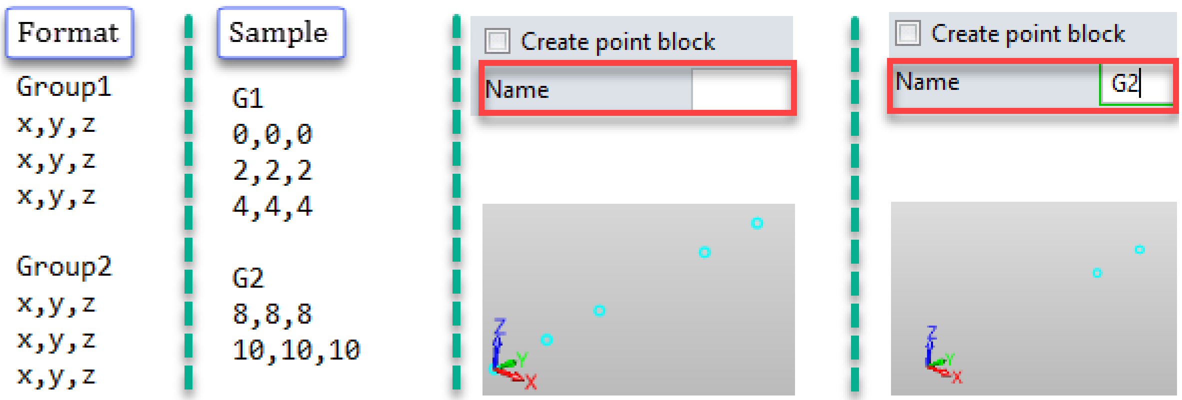


Figure2 Specify group to import

Reduce Point Set: Check this option to reduce the number of points according to the tolerance. The "Manual" method enables you to set the tolerance for removing points. The tolerancee of "Automatic" method is determined by ZW3D.

1.1.2 Import OBJ File

ZW3D supports to import OBJ format which including color and texture. Use import obj command we can control whether import color and texture from the OBJ file.

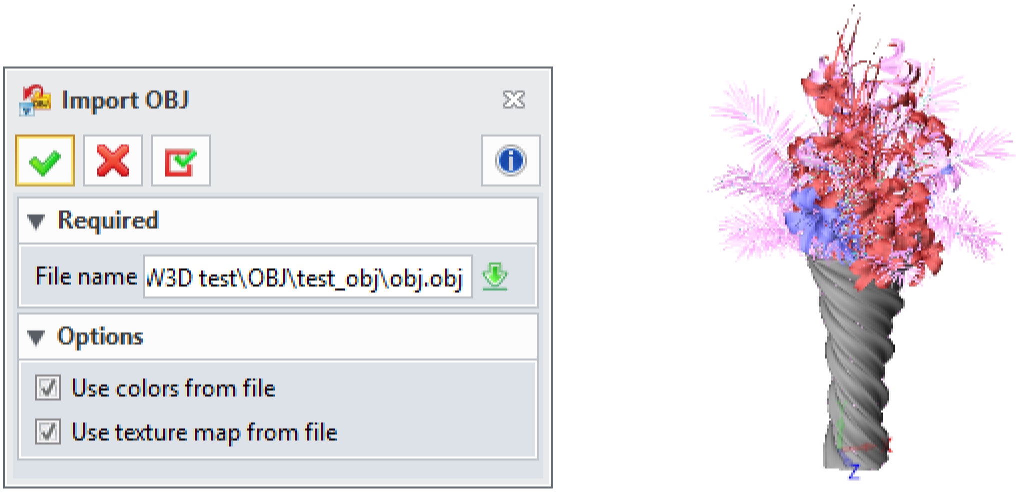


Figure3 Import OBJ file

1.2 Point Cloud Block Edit

1.2.1 Create a 3D Point Cloud Block

Point Cloud Ribbon Toolbar->Edit Block-> 

Use this command to create a point block to store point data which is a more compact form for storing the point data and get a better system performance. We also can use this command to convert a STL model become a point block.

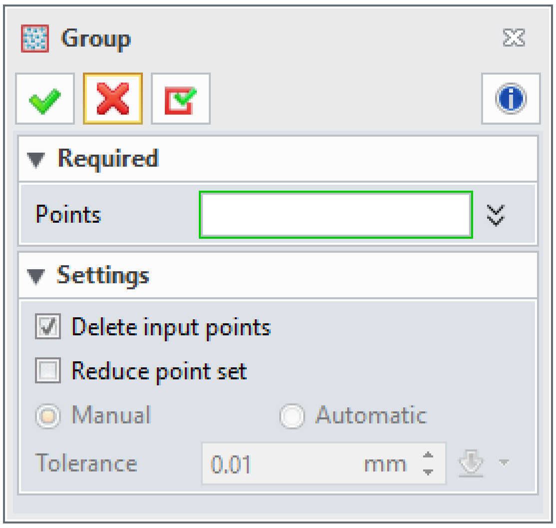


Figure4 Group

Points: Specify the points to be grouped as a point block or specify a STL model to convert to a point block.

Delete Input Points: Check this option to delete the original points.

Reduce Point Set: The same function with "From file" command.

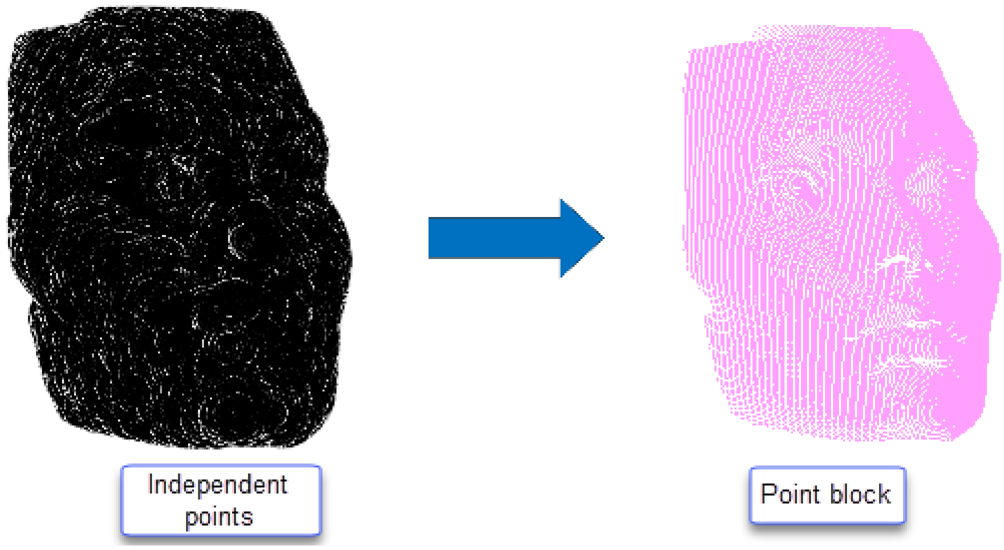


Figure5 Create a point block

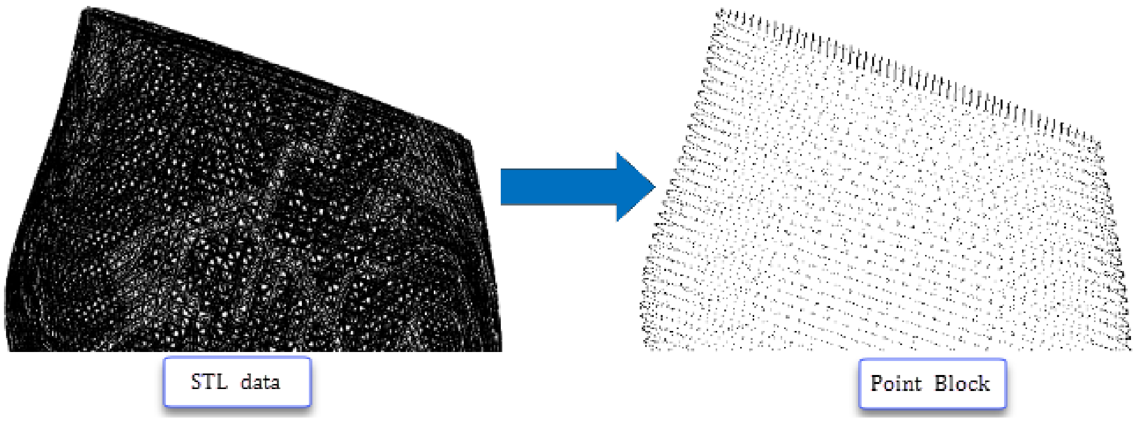


Figure6 Convert STL model to a point block

1.2.2 Explode a 3D Point Cloud Block

Point Cloud Ribbon Toolbar->Edit Block-> 

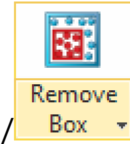
Use this command to explode one or more point blocks to independent points again.

1.2.3 Trim/Split Point Block

ZW3D provides several methods for users to trim or split 3D point block/ STL model. User can utilize sphere, rectangle box, spline and plane to trim or split the 3D point block.

1. Remove Sphere/Box

Point Cloud Ribbon Toolbar->Edit Block-> 

/ 

Use this command to remove or split a set of points from point blocks by a sphere/ box.

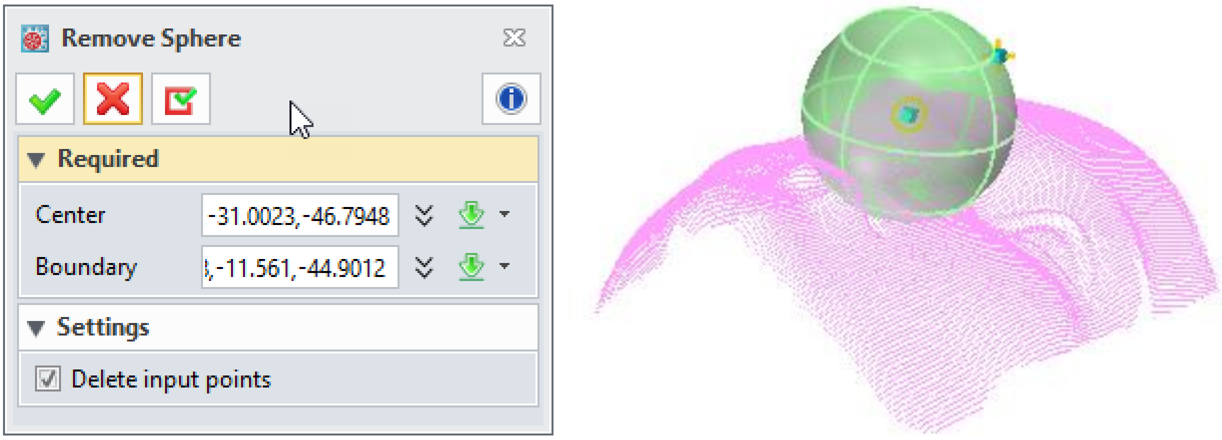


Figure7 Remove Sphere

Center/Boundary/Corner: Specify a point to define the sphere or box.

Delete Input Points: Check this option to delete the original points.

2. Remove Polyline

Point Cloud Ribbon Toolbar->Edit Block-> 

Users can define a closed polyline to remove or split a set of points from point blocks.

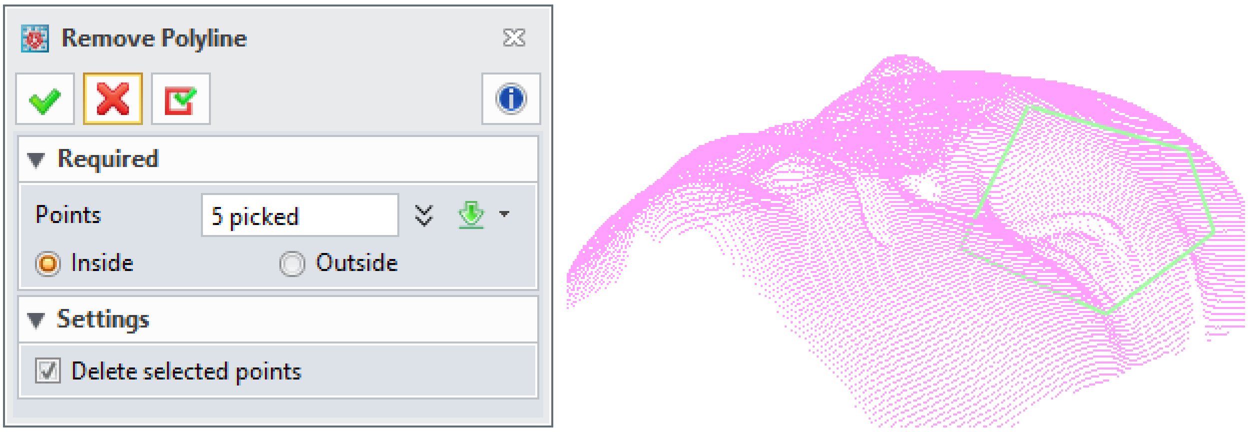


Figure8 Remove Polyline

Points: Select points to define a closed polyline, then trim or split the point block.

The polyline plane will parallel to view plane. Thus the trim or split direction will perpendicular to view plane. We can rotate the view plane to define a different area to be trimmed or splitted.

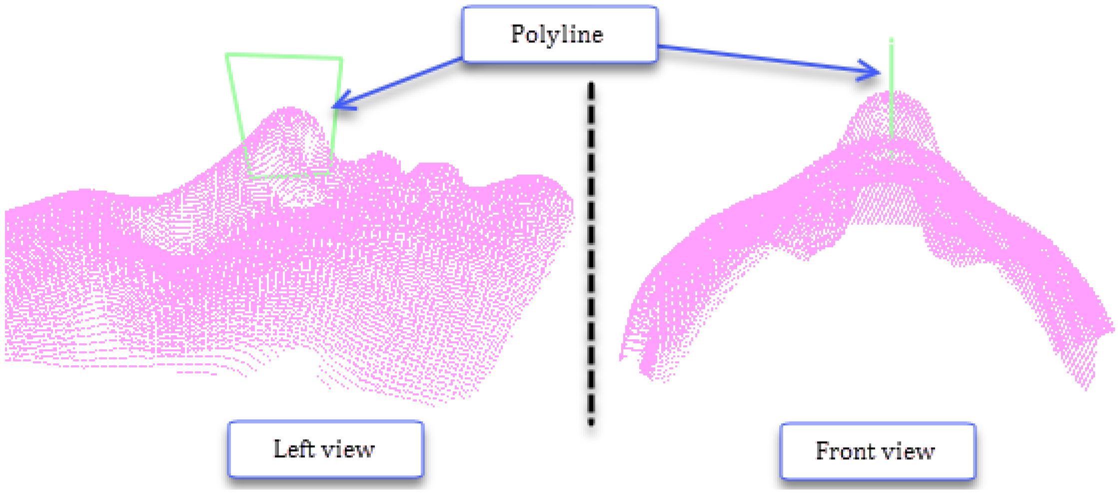


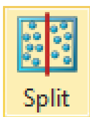
Figure9 Polyline Plane

Delete Selected Points: Check this option to delete the original points.

Inside/Outside: Specify which side points to be deleted when “Delete input points” option is checked.

3. Plane Trim/Split

Point Cloud Ribbon Toolbar->Edit Block-> 

/ 

Use this command to trim/split a point block by a datum plane, planar face or a sketch plane

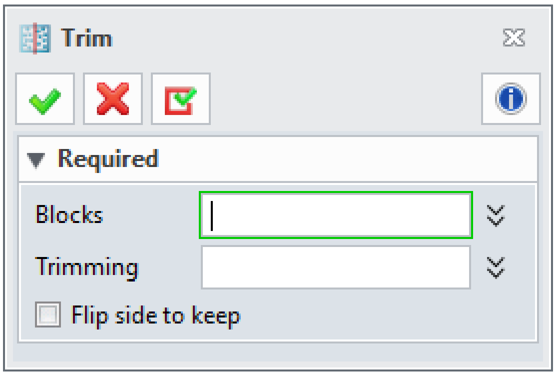


Figure10 Trim

Blocks: Specify point block to be trim

Trimming: Specify more than one datum plane, planar face or sketch plane to trim the point blocks. If multi planes specified, it will use the combined area of planes to trim the point block.

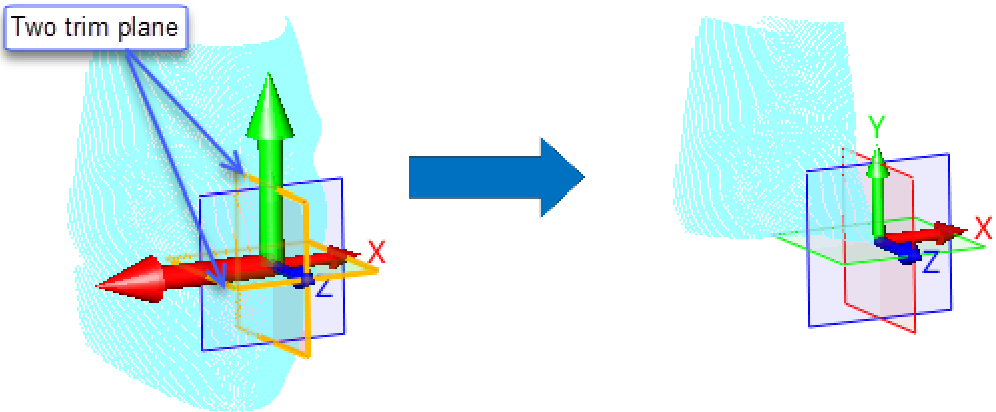
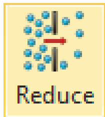


Figure11 Trim by multi-planes

1.2.4 Reduce Number of Points

Point Cloud Ribbon Toolbar->Edit Block-> 

In order to get a better system performance, we can use this command to reduce the total number of points in a point cloud according to specified reduction tolerance. Of course, this operation will cause a lower accuracy result. The same as “Group” function, we can use it to convert a STL model to a point cloud data.

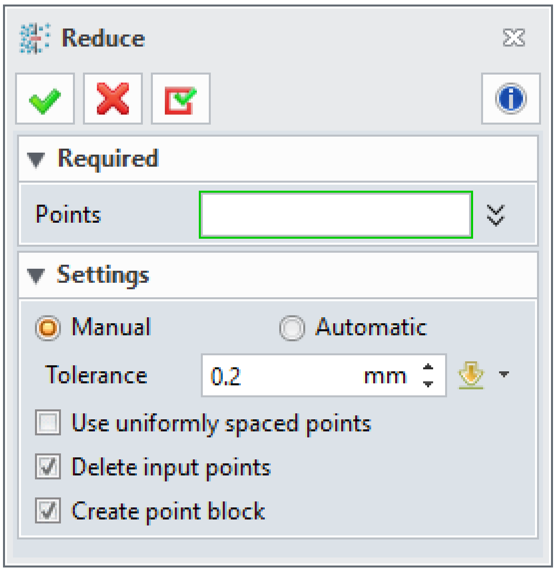


Figure12 Reduce

Points: Specify the points or point blocks to reduce the number. If a STL model is specified, it will convert it to point cloud data firstly then reduce the points number.

- ✓ **Automatic** method to reduce points according to an optimization result.

✓ **Manual** method to reduce the number of points by specified **tolerance** parameter.

In each specified tolerance sized region, only one point will be kept.

Use Uniformly Spaced Points: Keep all remaining points uniformly spaced apart

Delete Input Point: Detele the original points or STL model

Create Point Block: Create a point block for the reduced point cloud

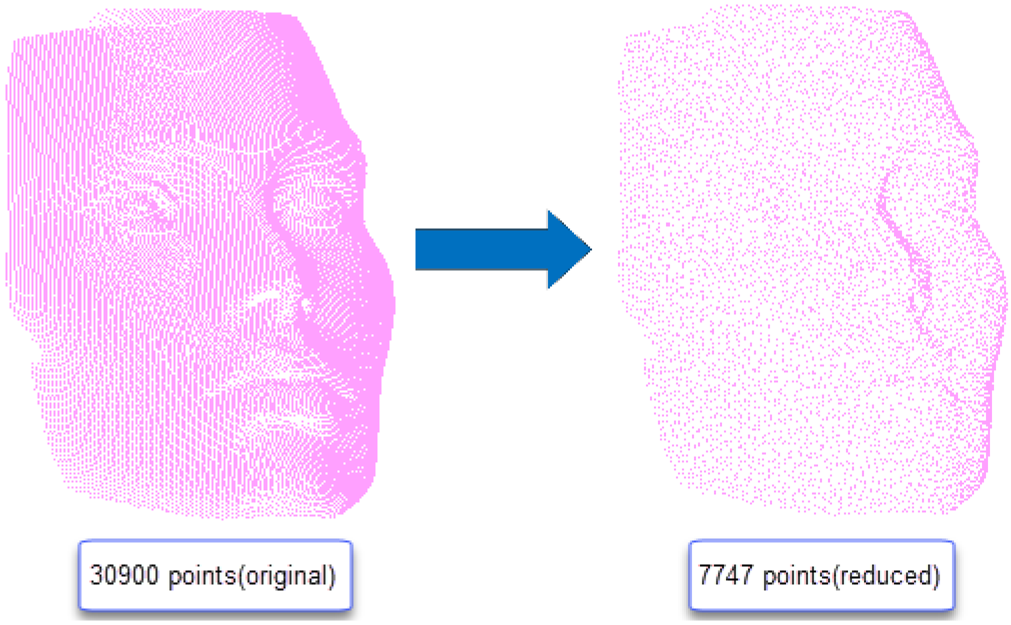


Figure13 Reduce number of point cloud

1.3 STL Mesh Edit

1.3.1 Tessellate

Point Cloud Ribbon Toolbar->Edit Mesh-> 

Use this command to traverse all the vertices of specified point block and inter-connect them to form a series of triangles, then we can convert a point cloud data to a STL model. ZW3D provide two method (Vertex and Uniform Grid) to construct the STL model.

Vertex: This method leaves the input point data intact, inter-connecting them to build the triangulation faces.

Uniform Grid: This method builds a grid of uniform facets to fit the point cloud data in each small region, then constructs a smooth STL model. The resultant vertices of the triangulation do not necessarily pass through the original input points. With dense enough data, the Uniform Grid method will be very close to the original set of points.

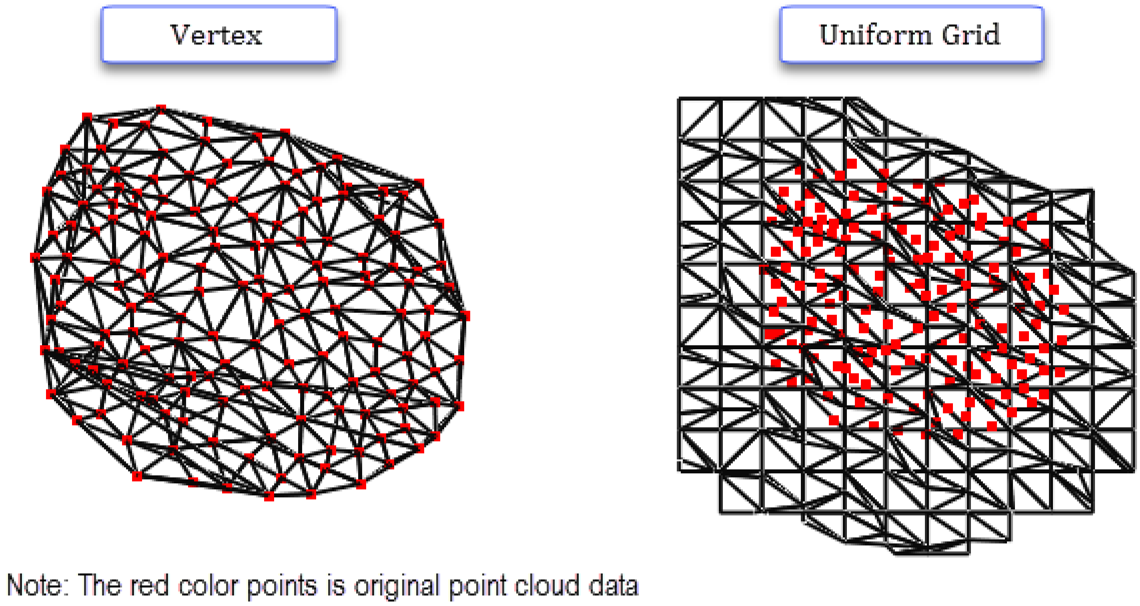


Figure14 Tessellate method

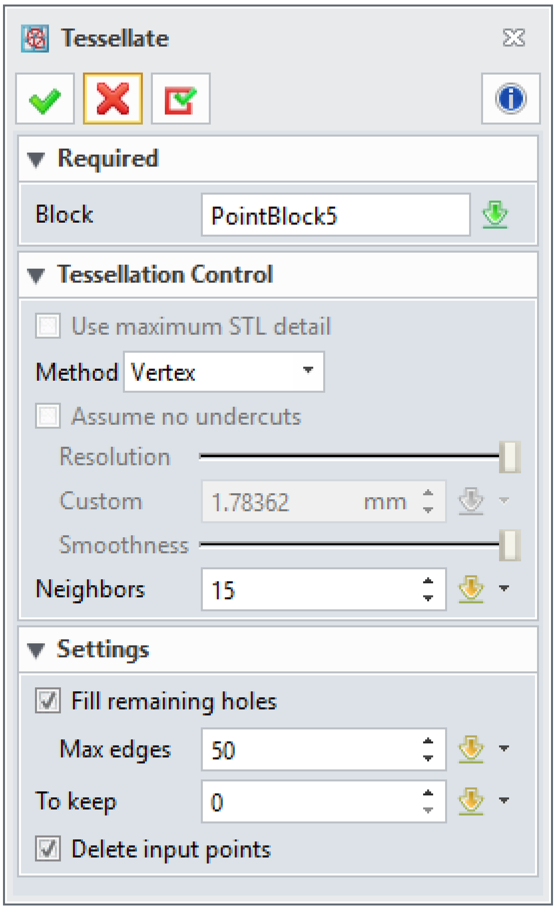


Figure15 Tessellate

Block: Speicfy a point block to construct a STL model. It doesn't support to construct a STL model with a set of individual points, which needs to convert to point block first.

Method: Speicfy use Vertex or Uniform Grid method to build the STL model.

Option "Assume to no undercut", "Resolution", "Custom", "Smoothness" only available for using "Uniform Grid" method to build the STL model:

Assume no undercuts: If the input point data can be projected along one direction without interfering with each other, this option will utilize an optimized "Uniform Grid" method for much faster results.

Resolution: Drag to slider to define the triangular facet size from big to small, lead in the grid becomes coarse to fine.

Custom: When the value of "Resolution" can't fulfill customer's requisition. ZW3D allow the user to input a custom size of triangular facet to build the STL model.

Smooth: Drag the slider to define the connnection of triangular facets from smooth to sharp.

Fill Remaining Holes: When this option is "ON", system will automatically fill the hole according to specified "Max. Edges" number. If the number of hole edge is equal or smaller than specified "Max Edges" number, the hole will be patched. Otherwise the hole will not be patched.

Max. Edges: Specify the number of hole edge utilize to determine the hole to be patched or not.

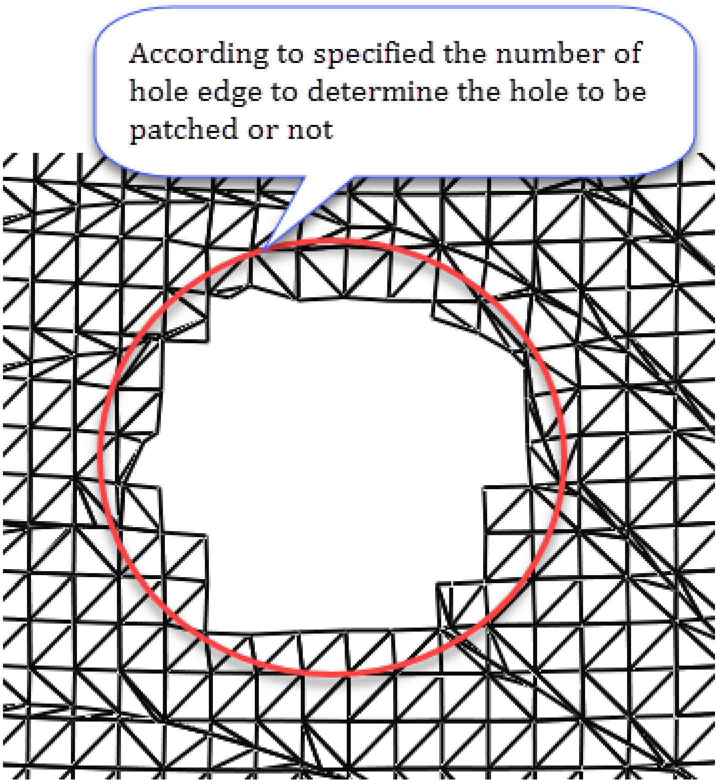


Figure16 Fill remaining holes

To Keep: After tessellation, there maybe some undesirable facets that formed one or more separated bodies. ZW3D can specify a number of STL models to be kept and delete the rest in order to delete undesired facets according to the sizes from big to small.

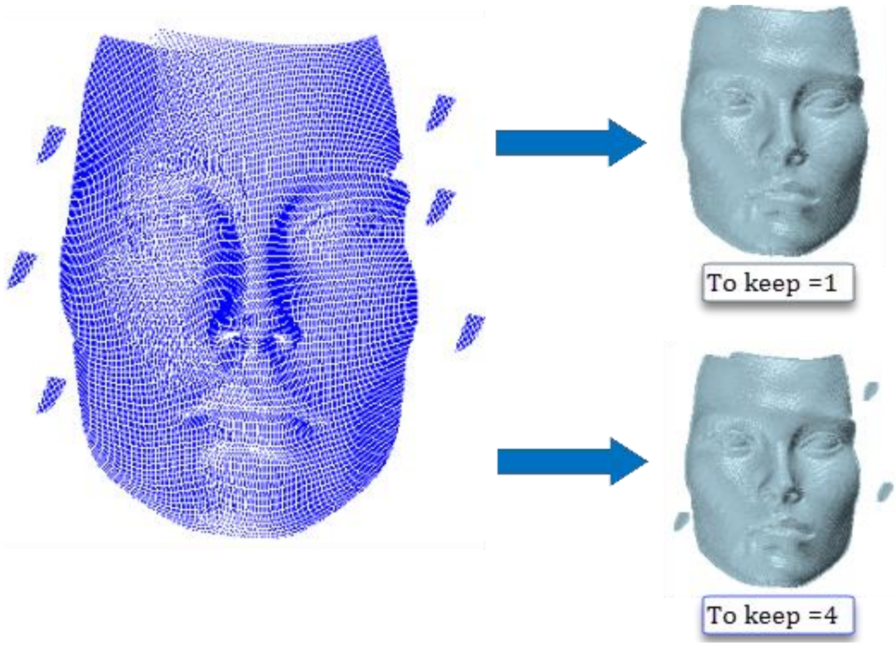


Figure17 To Keep

Delete Input Points: Check on this option will delete the point block which uses to convert to a STL model.

1.3.2 Triangular Facet Edit

ZW3D provides several functions to help users to modify triangular facets for the next process. Such as add/delete/split facet, reverse the direction of facet, change the common edge between two triangular facets.

1. Add Triangle

Point Cloud Ribbon Toolbar->Edit Mesh-> 

Use this command to add a new triangular facet by selecting 3 points at STL model.

2. Fill Hole

Point Cloud Ribbon Toolbar->Edit Mesh-> 

We can use "Add triangle" to fill the hole by creating triangular facets one by one. ZW3D also provides another more efficient method "Fill Hole" to help users patch the holes in STL model. Only need to select an edge of the hole, then the system will create triangular facets to fill all the holes which are adjacent to the selected edge automatically.

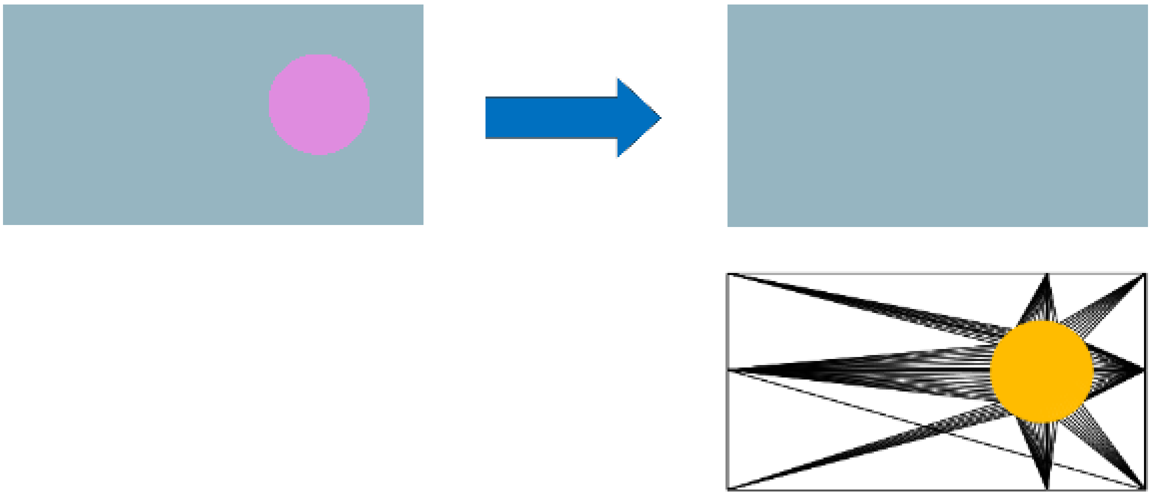
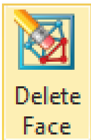


Figure18 Fill hole

3. Delete Face

Point Cloud Ribbon Toolbar->Edit Mesh-> 

Select unnecessary facets then click "OK" button to delete them.

4. Split Edge

Point Cloud Ribbon Toolbar->Edit Mesh-> 

Split one triangular facet to two facets.

Method: Select an edge of the triangular facet, ZW3D will divide the edge equally then creates two facets to divide the original one. If the user selectes a shared edge to split, both triangular facets which have the common edge will be split.

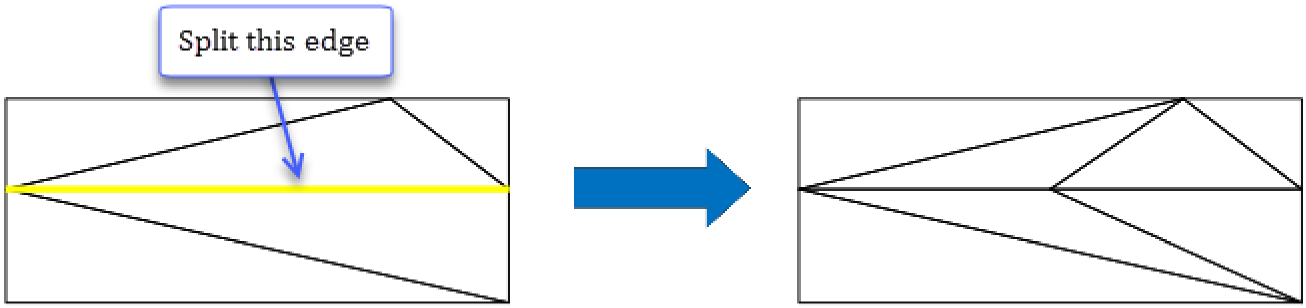


Figure19 Split edge

5. Flip Edge

Point Cloud Ribbon Toolbar->Edit Mesh-> 

Use this command to flip the edge which is the common edge of two adjacent triangular facets.

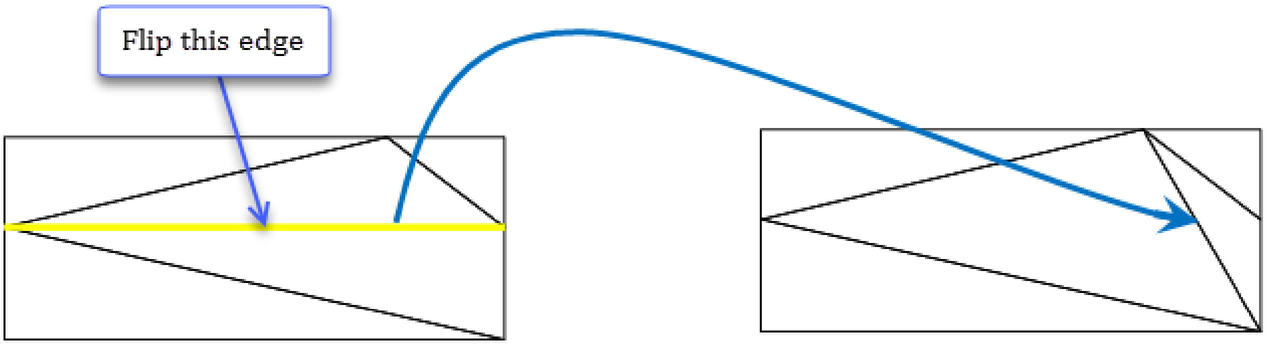
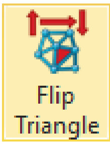


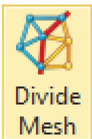
Figure20 Flip edge

6. Flip Triangle

Point Cloud Ribbon Toolbar->Edit Mesh-> 

Sometimes the imported STL will have some facets without correct normal direction. This command can help us to adjust the normal direction of specified facets.

1.3.3 Divide Mesh

Point Cloud Ribbon Toolbar->Edit Mesh-> 

Use this command can divide selected facets into a new STL block or re-assign the selected facets to other STL block.

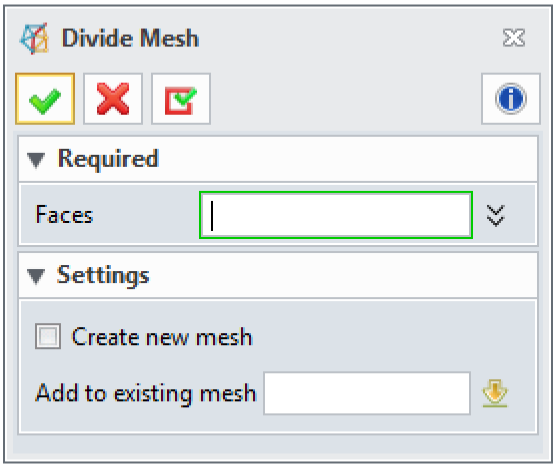


Figure21 Divide Mesh

Faces: Specify the faces to be divided or be reassigned.

Create New Mesh: When this option is "ON", the selected facets will divide from original STL block and create a new STL block.

Add to Existing Mesh: Only when "Create new mesh" option is "OFF", the user can specify selected facets to other STL block.

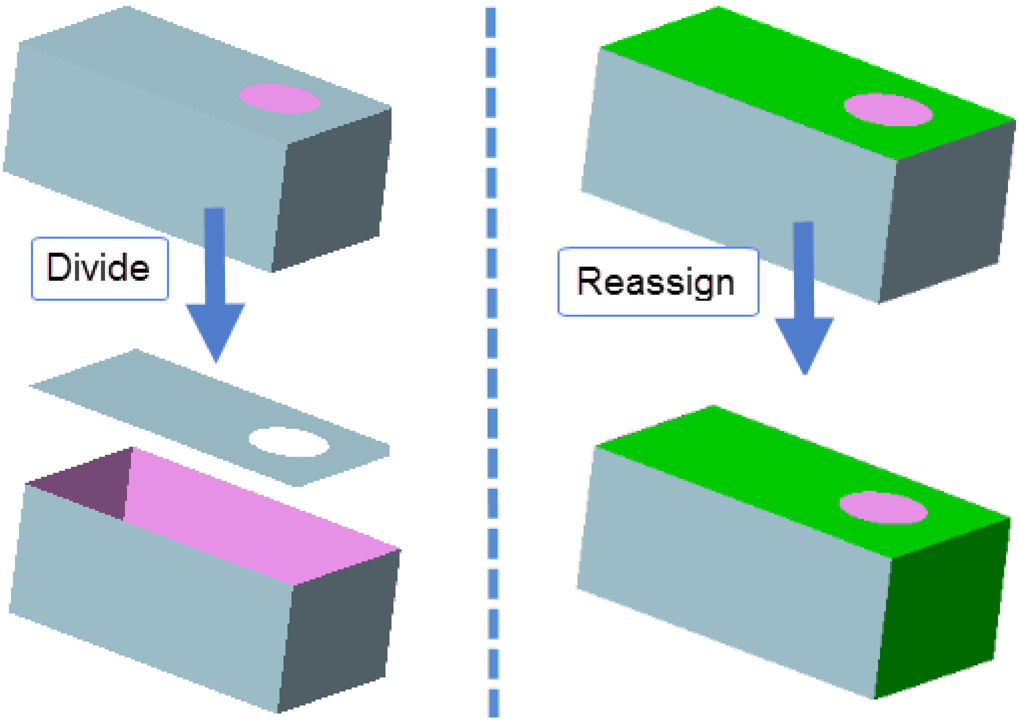


Figure22 Divide & Reassign STL block

Tips: Refer to "Add to existing mesh", we can combine several unconnected STL models as one.

1.3.4 Collect Nodes

Point Cloud Ribbon Toolbar->Edit Mesh-> 

Use this command the user can collect all the nodes of a STL block within a closed boundary and save as a point block.

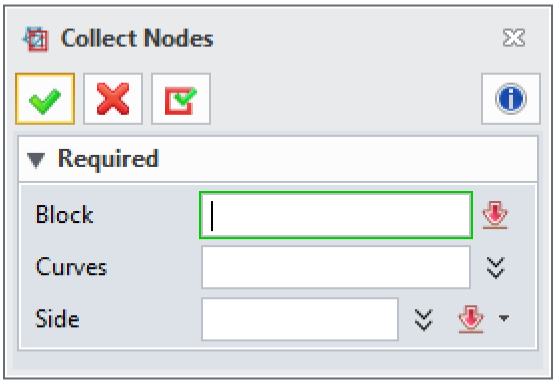


Figure23 Collect Nodes

Block: Specify a STL block to collect nodes (vertices of triangular facets).

Curves: Specify a closed curve as a boundary to collect nodes. The curve should on the STL block and form a closed area of STL block.

Side: Specify which side of the boundary to collect nodes. It should select a node on the STL to define the side. Otherwise the command can't be executed.

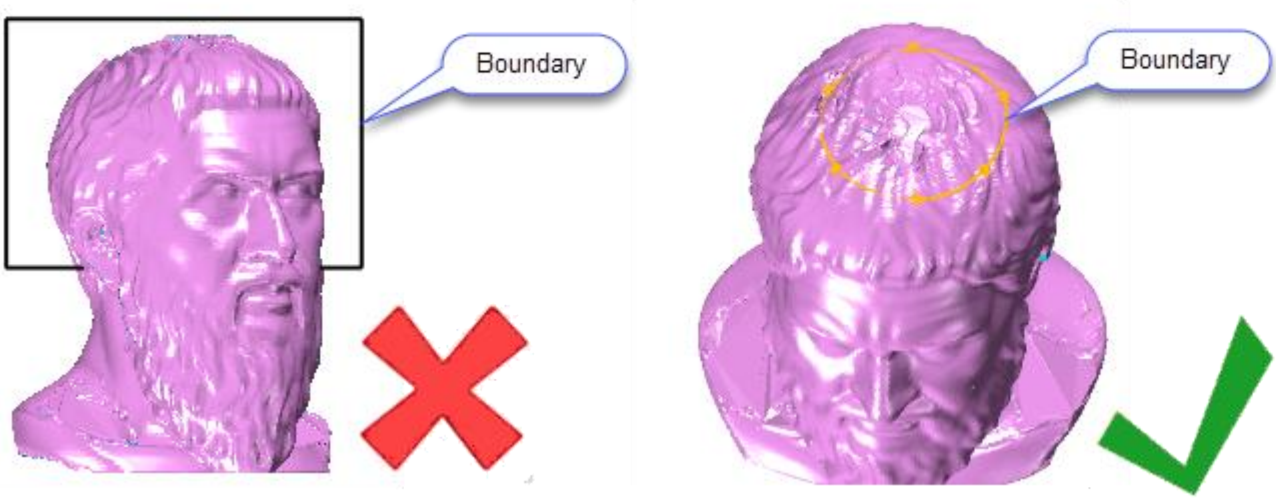


Figure24 Boundary for collecting nodes

1.4 Surface/Solid Rebuild

ZW3D provides two methods to rebuild a surface or solid from point cloud data or STL model. One method is using "fit face" to convert point cloud data to a surface directory. This method suits for complicated shape which is difficult to use modeling method to rebuild. Another method is to create the structure curve firstly according to the STL model, then use the modeling method to rebuild a surface or solid. This method is suitable for a much regular shape.

1.4.1 Automatic Method -Fit Face

Use "Fit Face" to make a trimmed face that passes through a set of points or a point block. With this approach you can divide up an overly complex set of point data into separate sections. Instead of a very large surface, several smaller, tangentially connected patches may be generated. This command also supports to create a surface with a STL model.

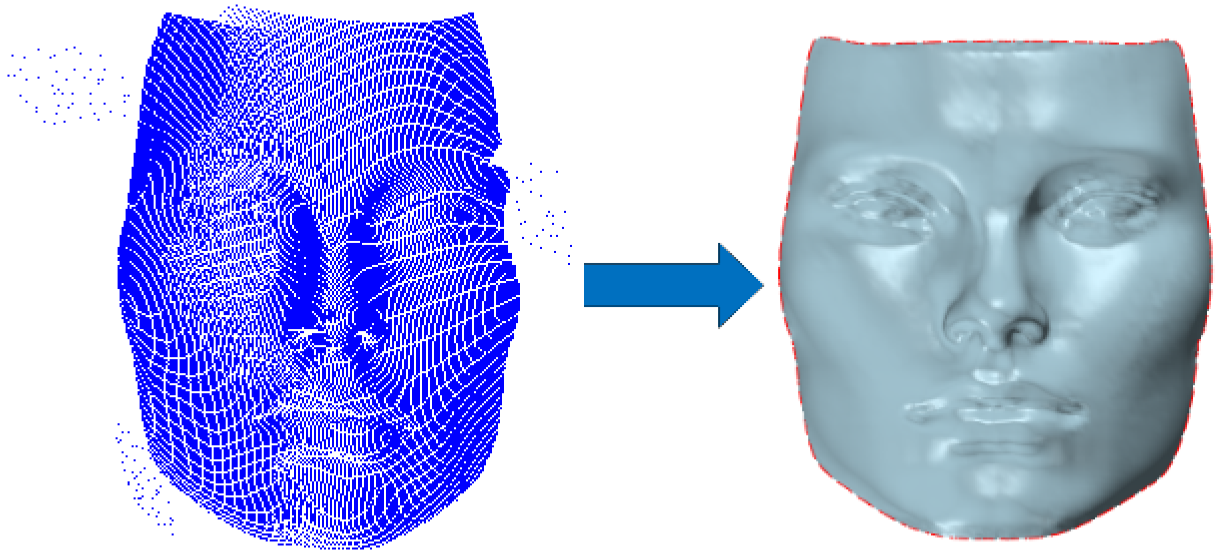


Figure25 Fit face with boundary

Let's use an example to see how to use "Fit Face" to rebuild the surface.

STEP 01 Use the delete tool to remove the noise points as below:

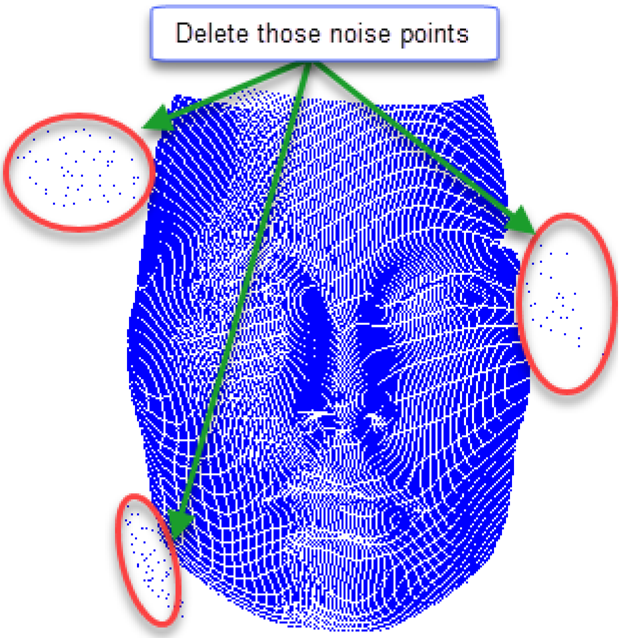


Figure26 Delete noise points

I. Use "Remove Sphere" to remove the noise points in top left side.

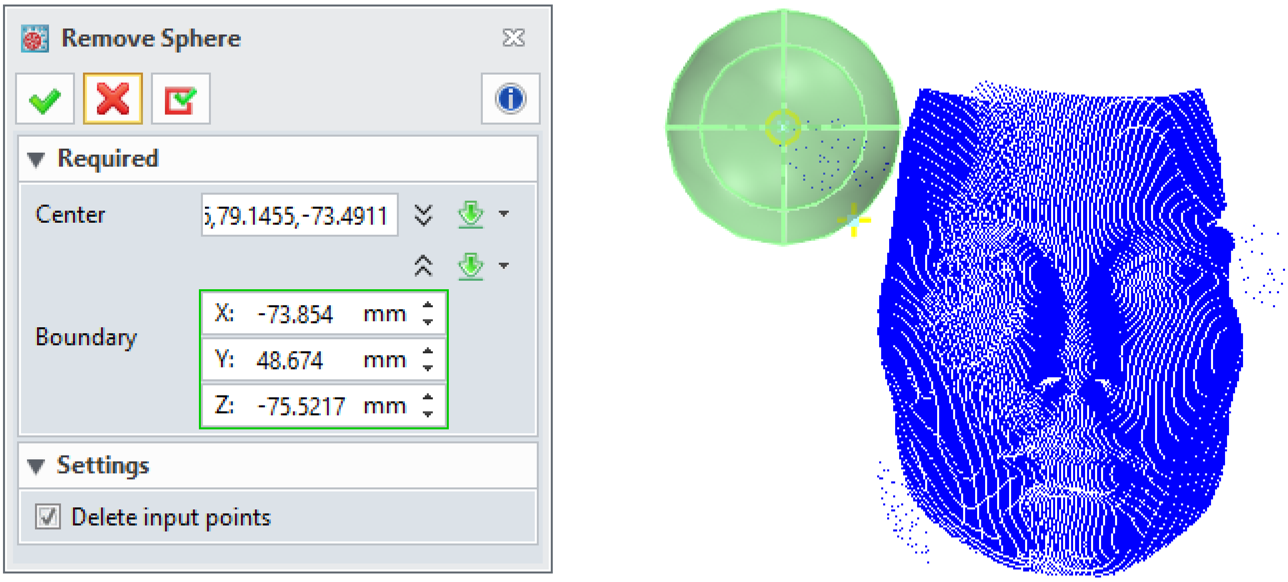


Figure27 Remove noise points with sphere

II. Use "Remove Polyline" to remove the noise points in bottom left side.

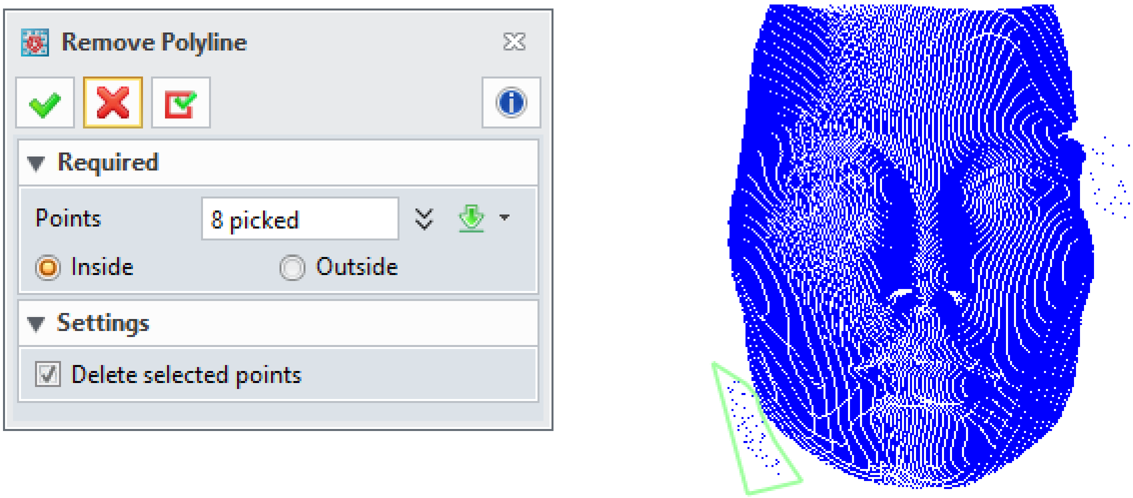


Figure28 Remove noise points with polyline

III. Use “Remove Box” to remove the noise points in middle right side.

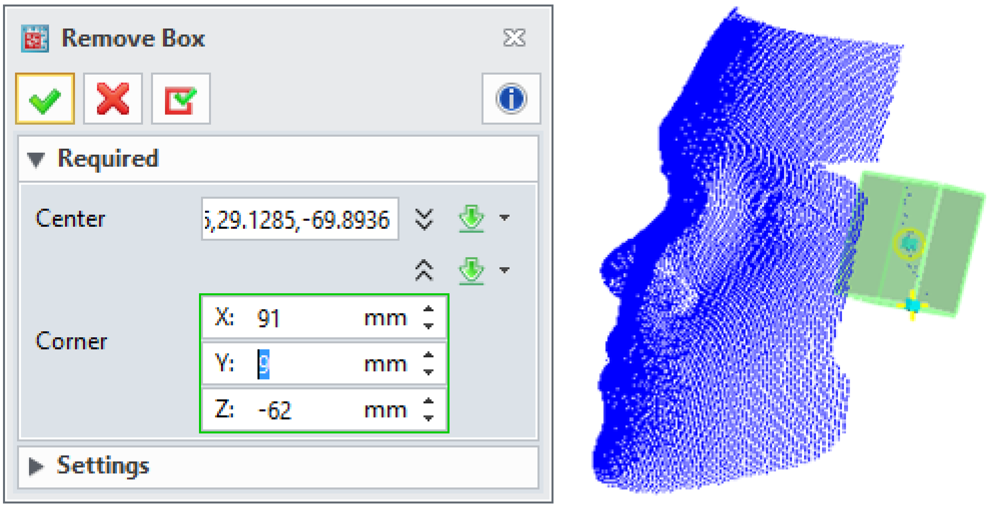


Figure29 Remove noise points with Box

Tips: When the corner point is not easy to pick, we can click the book title mark button to extend the input box to adjust the X, Y, Z value independently.

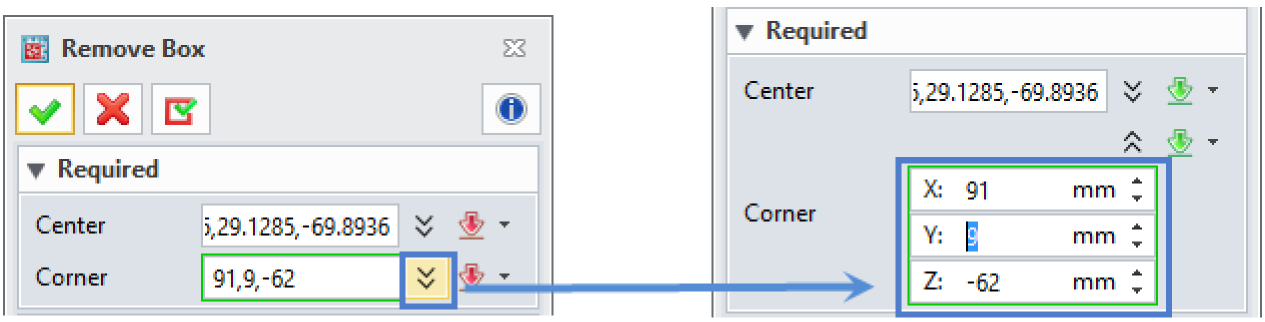


Figure30 Adjust X, Y, Z value independently

STEP 02 Create a plane by offset XZ plane to trim top side of the point block.

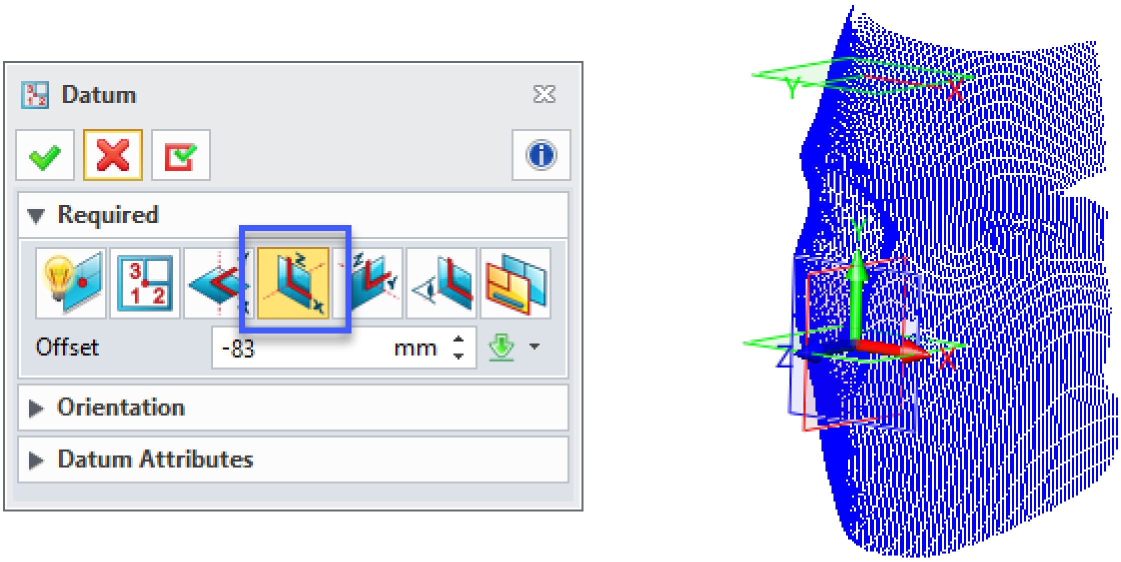


Figure31 Create a plane

STEP 03 Trim the point block with the plane in step2.

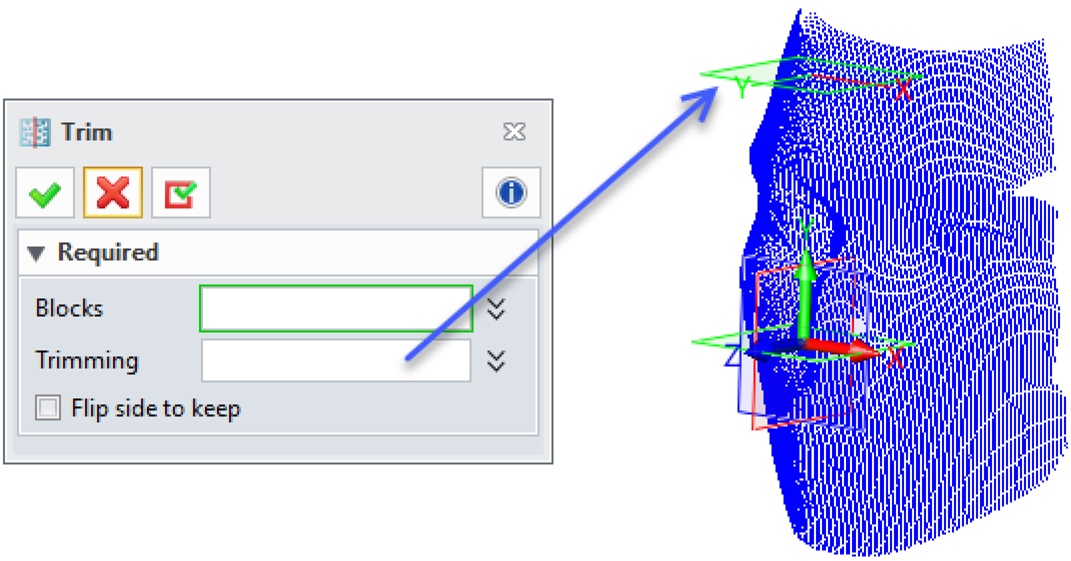


Figure32 Trim with plane

STEP 04 Trim the right side of point block with YZ plane. (Since there are some holes in the right side. We can recover it by mirroring left side of the point block)

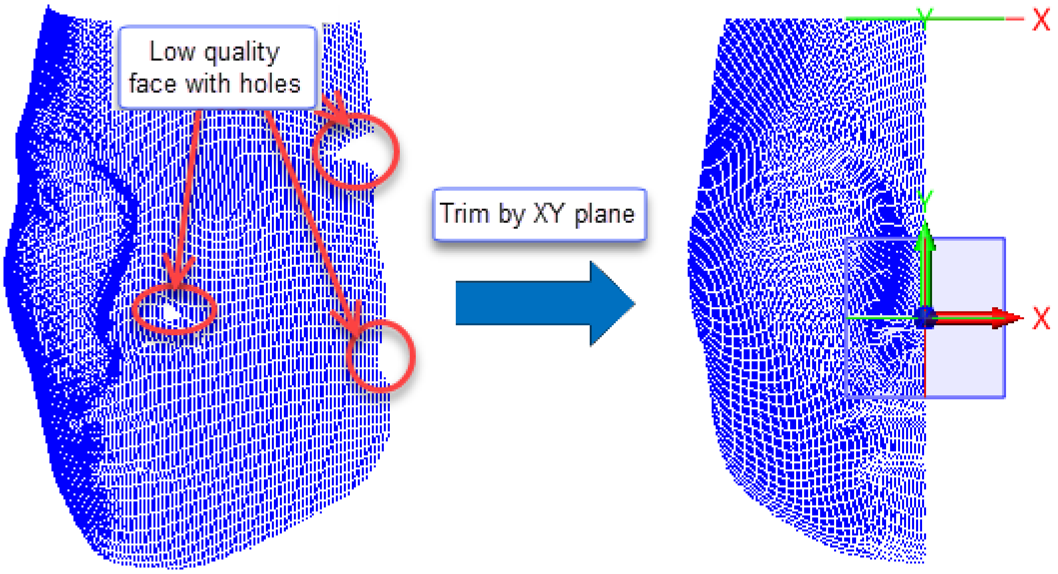


Figure33 Trim by YZ plane

STEP 05 Mirror the point block with YZ plane.

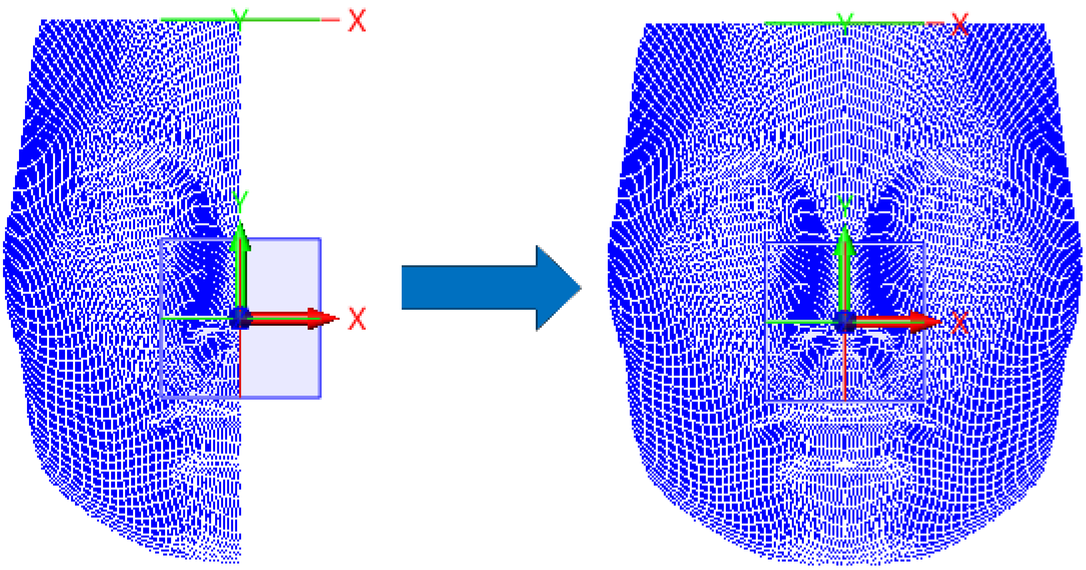


Figure34 Mirror

STEP 06 Use "Group" function to combine two pieces of point blocks to be one.

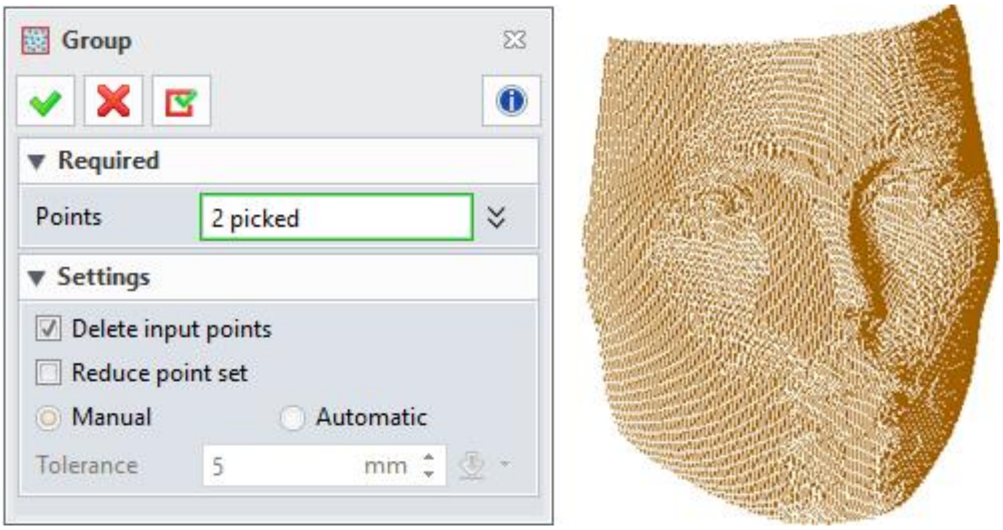


Figure35 Combine point blocks

STEP 07 Reduce the points in point block with 5mm tolerance.

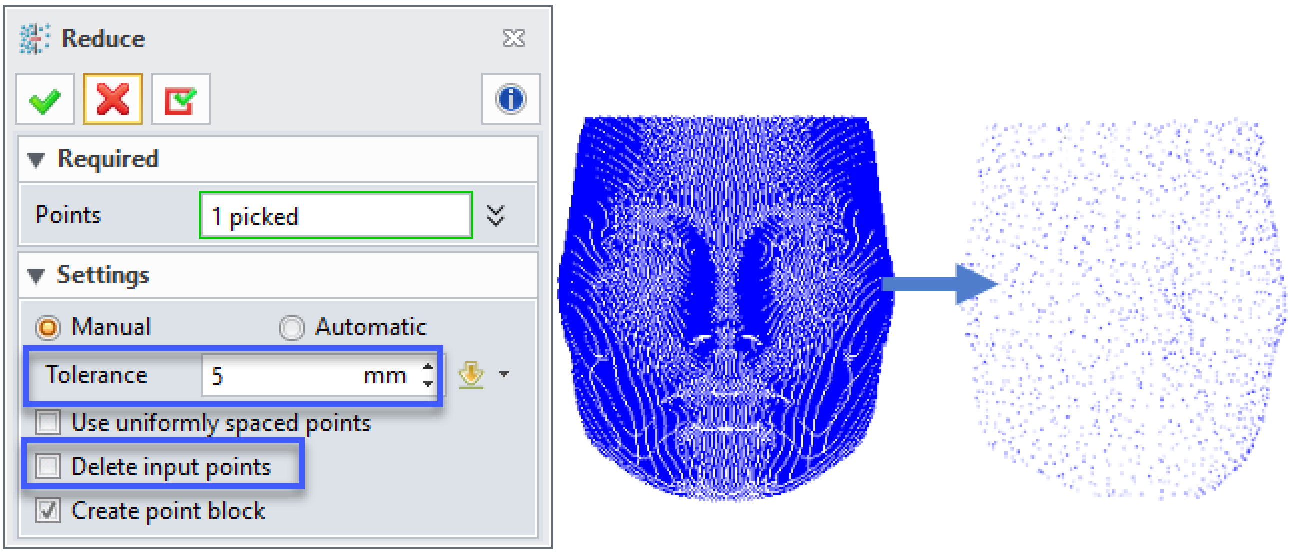


Figure36 Draw outline in XY plane

STEP 08 Use “Fit Face” to create a reference face with the point block create by step 8. (All options use default settings.)

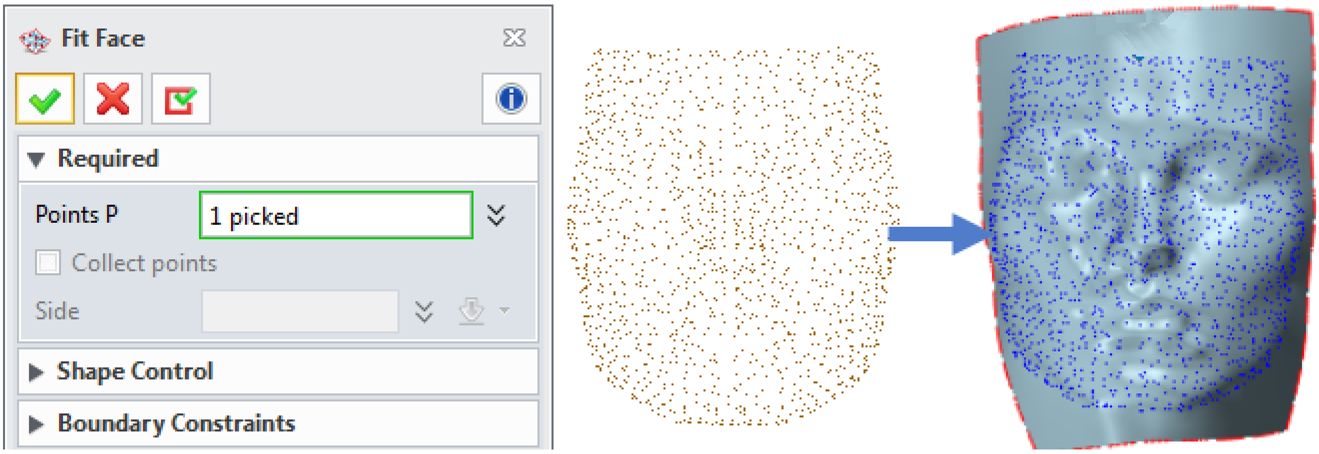


Figure37 Create a reference face

STEP 09 Draw the outline in the original point block by “Through Point curve” in wireframe tab.

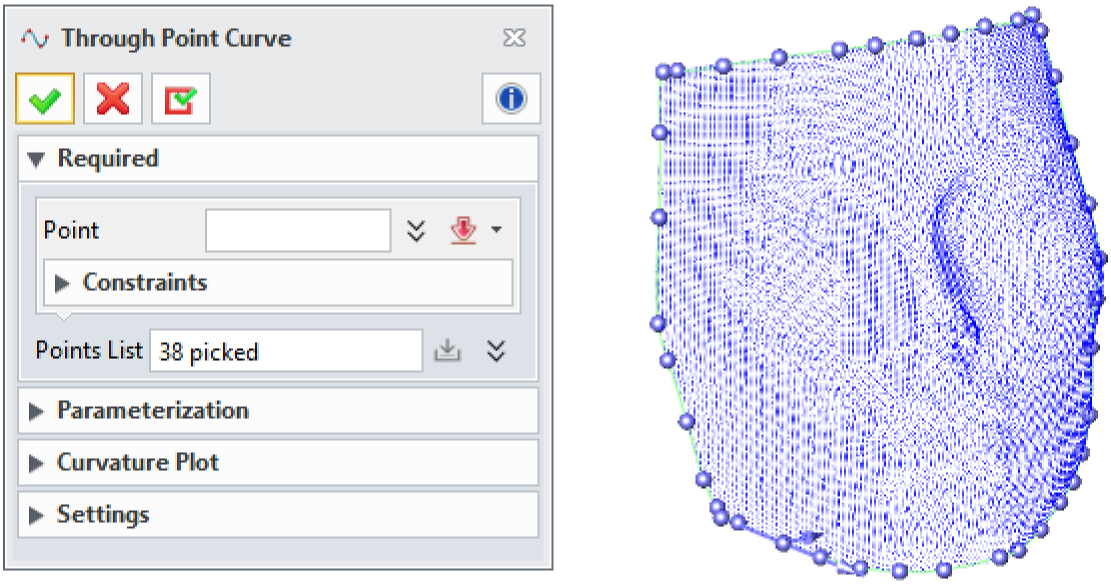


Figure38 Draw the outline of the point block

STEP 10 Rebuild the surface with “Fit Face”. Item “Curve C” selects the outline create in step 9.

Select the face create in step 8 as the reference face . Other settings and selection order are below.

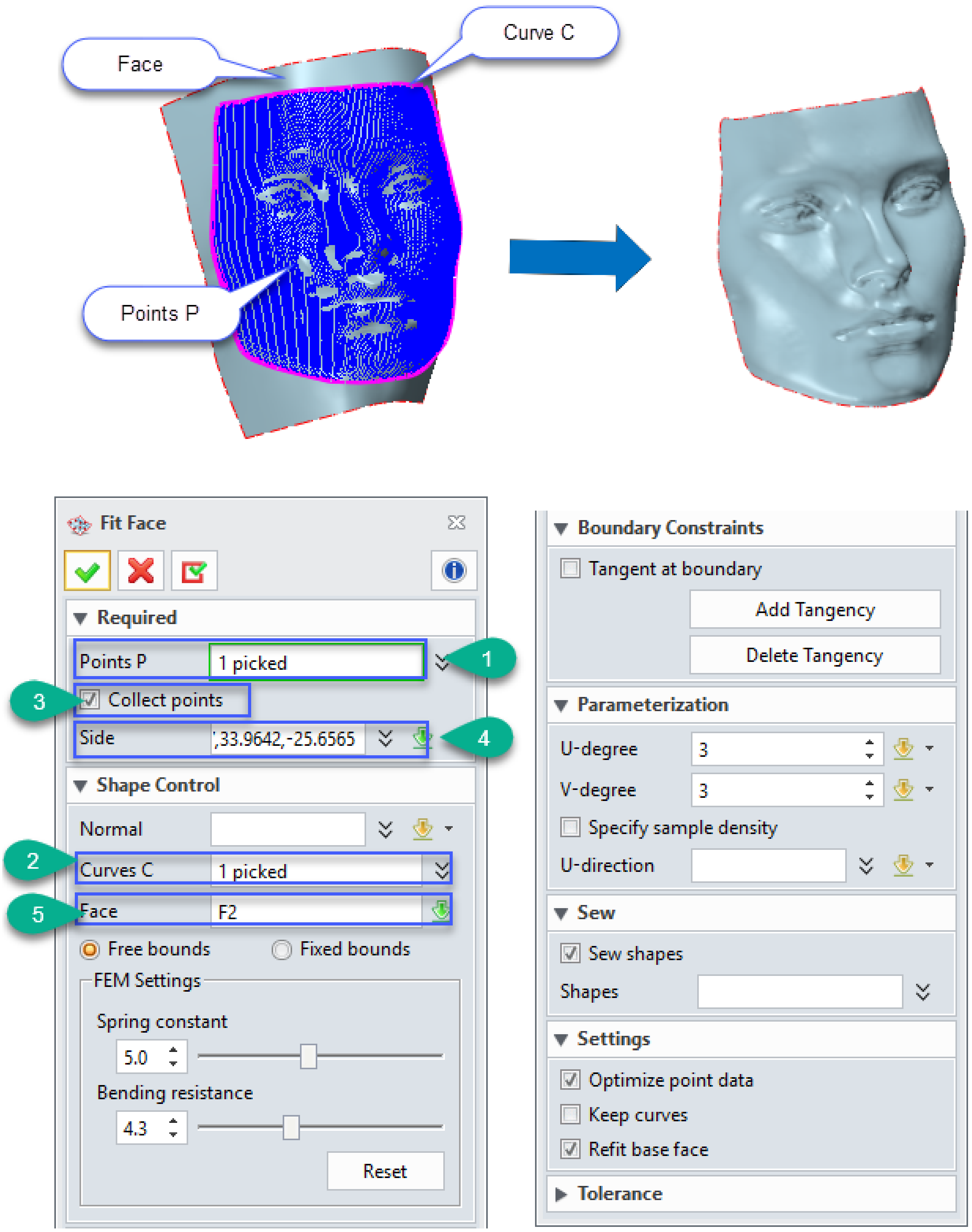


Figure39 Fit face

Detail parameters of Fit Face

Points P: Specify a set of points or a point block to rebuild the surface. The STL model also supports to rebuild the surface. Either point block, points or STL model should be an open shape.

Points Collection: Speicify the point inside a boundary to rebuild a surface. Only when "Curves C" is specified, this option is available.

Side: Speicfy which side of point cloud data to rebuild a surface. Only when "Collect points" checked on and a "Curve C" specified, this option is available.

Normal: Use to redefine the normal of specified "Face".

Curves C: Specify the boundary to rebuild the surface.

Face: Specify a reference face to rebuild the surface. Point cloud data will project to the specified face and according to the face normal, then base on the distance to reference face to rebuild the surface.

FEM Settings: This command bases on energy minimization to rebuild the surface. Changing the spring constant and bending resistance values will affect the rebuilded surface result.

Tanget at Boundary: Enforce rebuilded surface which is tangent to adjacent surface at a speicfied boundary. Only when "Curve C" specified by edges in face, this option is available.

U/V Degree: Specify the degree of rebuilded surface.

Specify Sample Density: When boundary curves are specified, check on this option to specify an averange number of sampling points on each boundary curves.

Sew Shapes: Whether to sew with rebuilded surface.

Shapes: Specify shapes to sew with rebuilded surface. When this option is empty, all the shapes will be sewed.

Keep Curves: Whether to delete the curves specified in "Curves C" option. "ON" to keep, "OFF" to delete.

1.4.2 Manual Method

For some regular or mechanical shapes, using automatic method can't get a proper result. We may need to use the manual method to rebuild the shape. Using manual method to rebuild the shape, firstly we need to get the structure curves, then use the modeling method to rebuild it. ZW3D provides several methods to help users get the structure curves according to the usage scenarios.

Note: Those tools only support to STL model, if there is a point cloud data, you need to convert it to STL model first.

1. Cross Section

Point Cloud Ribbon Toolbar->Create Curve> 

Use this command to create the cross intersection curves between a STL model with a plane.

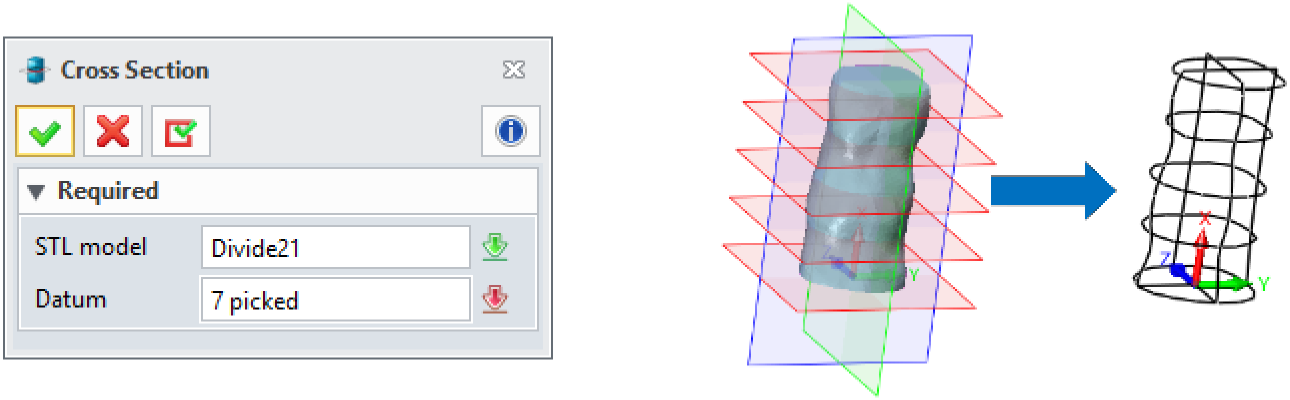


Figure40 Cross Section

STL Model: Specify only one STL model to create intersection curves.

Datum: Specify one or several planes or planar face to create intersection curves.

2. Trace Region

Point Cloud Ribbon Toolbar->Create Curve> 

Use this command to output the bounding curves of a region on the STL model according to a seed facet with limiting angle. After the user specified a seed facet, system will search the facets that the angle of facet normal to the seed facet normal below the limiting angle, then adjacent region will be traced and output a bounding curves.

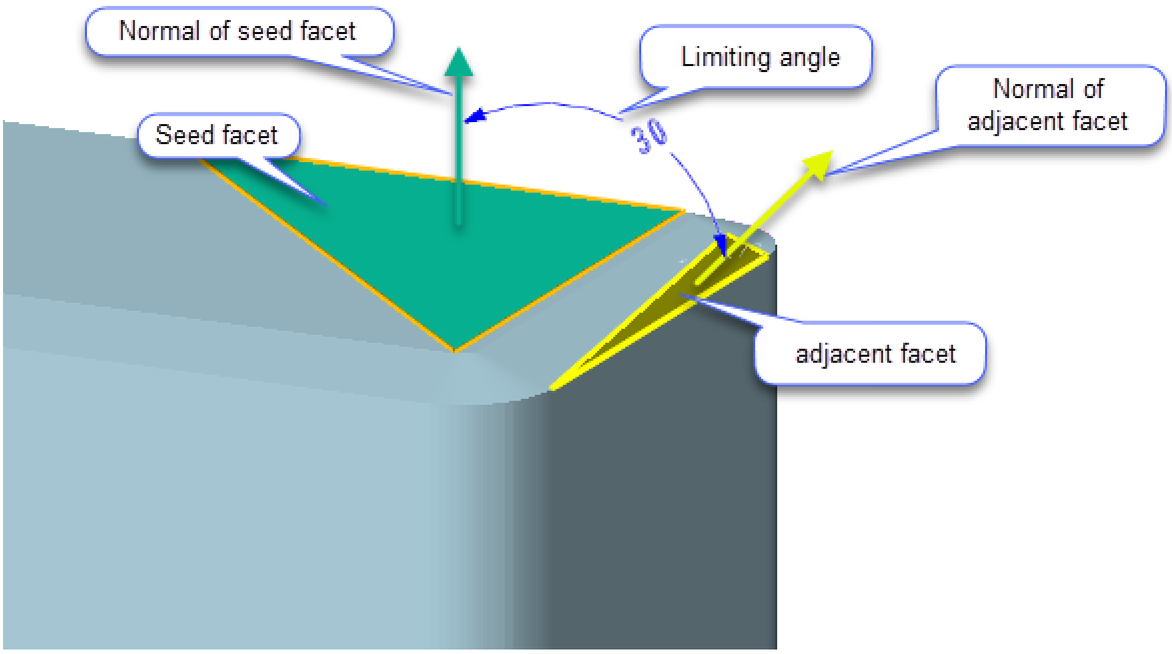


Figure41 Trace region definition

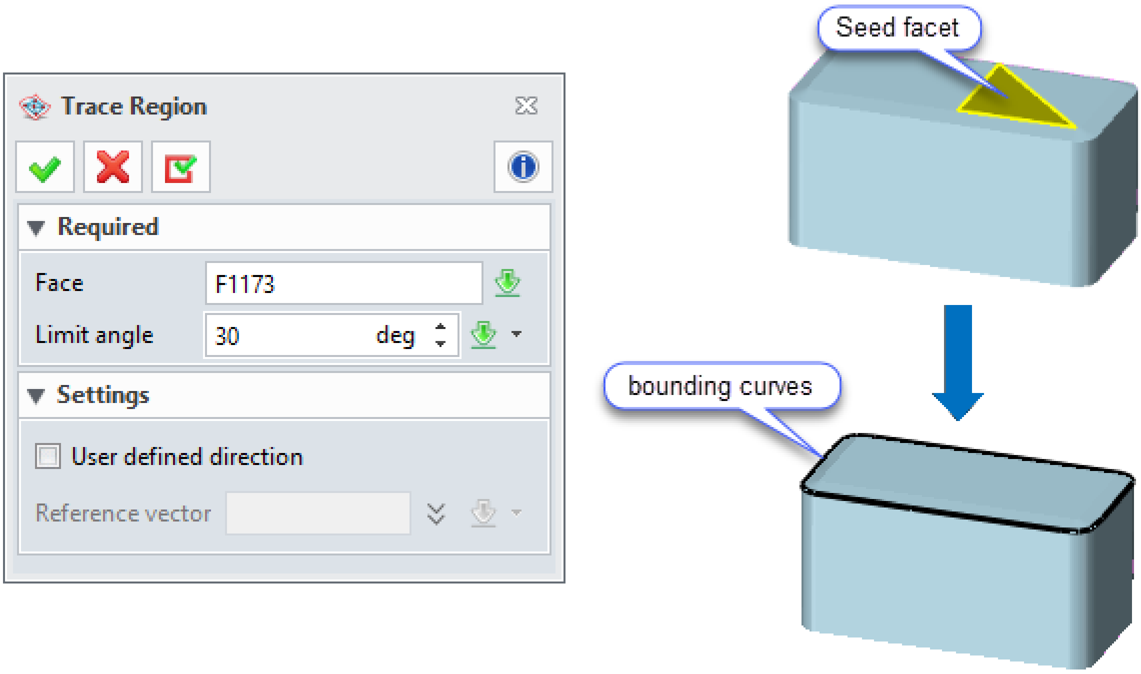


Figure42 Trace region

Face: Specify a seed facet to define the search area and as a reference to determine the limit angle.

Limit Angle: Specify an angle to define the search area.

User Defined Direction: Generally the system will use the normal of seed facet as a reference to define the limit angle. When this option is "ON", user can specify a new "Reference Vector" as a reference instead of facet normal to define the limit angle.

3. Trace Sharp Edge

Point Cloud Ribbon Toolbar->Create Curve> 

This command automatically finds out all the sharp edges in an STL mesh, and joins them into NURBS curves

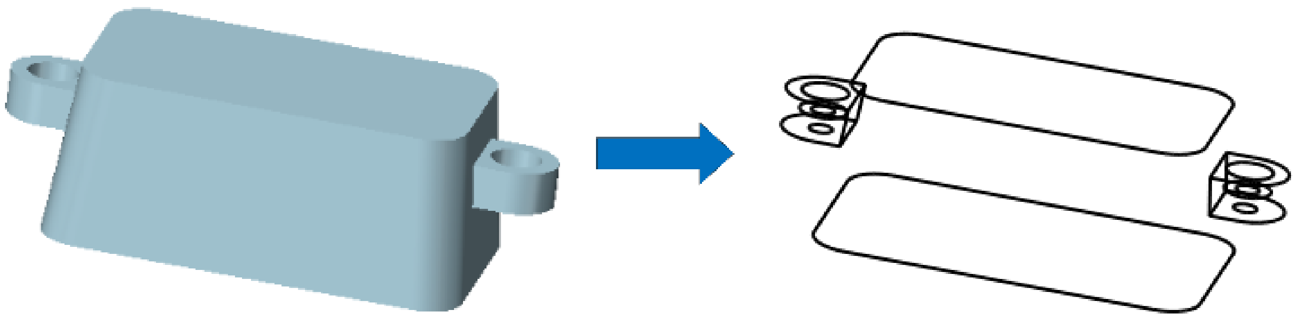
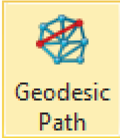


Figure43 Trace sharp edge

4. Geodesic Path

Point Cloud Ribbon Toolbar->Create Curve> 

Use this command to generate the shortest curve between the 2 picked points on a STL model. Refer to this, we can quickly get curves across the STL model.

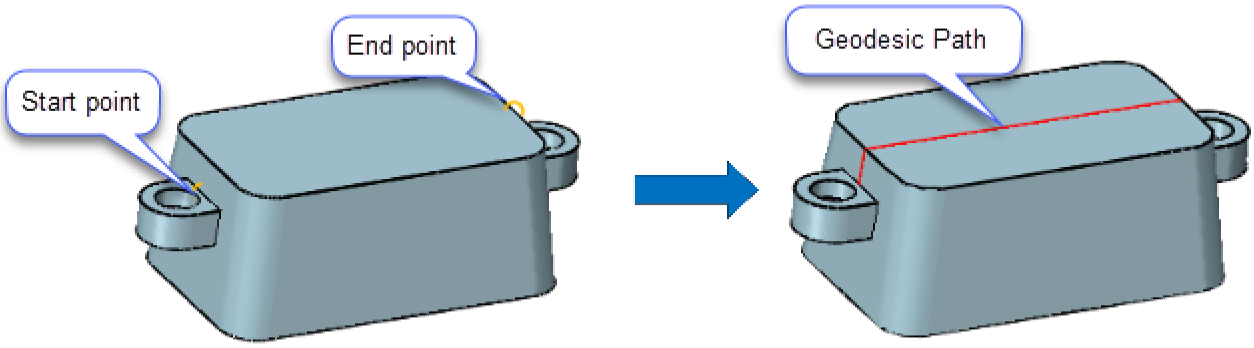


Figure44 Geodesic path

Note:

1) Points selected on different STL model cannot be linked with geodesic path

2) Only the node of STL can be defined as start point or end point.

5. Trace Sillouette

Point Cloud Ribbon Toolbar->Create Curve> 

Use this command to extract the outline of a STL model as 3D silhouette profile according to a specified direction of the datum plane. Then we can project these outline to a plane and use it to rebuild the surface.

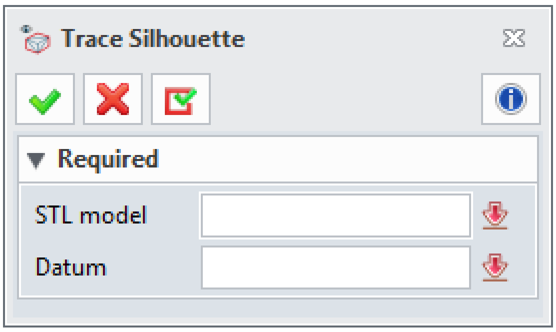


Figure45 Trace silhouette

STL Model: Specify a STL model to extract the outline

Datum: System will extract the outline according to the normal direction of a specified datum plane.

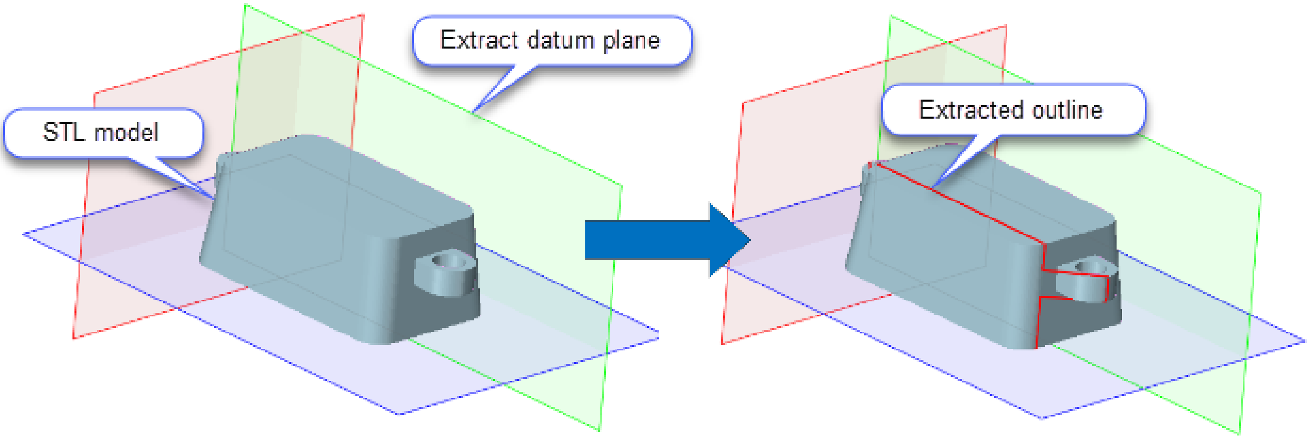


Figure46 Trace silhouette sample

Note: *Then extracted outline will be on the STL model but not on the specified plane. If we want to use the outline to rebuild the solid, we need to project the extracted outline to a datum plane first. There is the workflow below which rebuild the shape by using "Trace Sillhouette".*

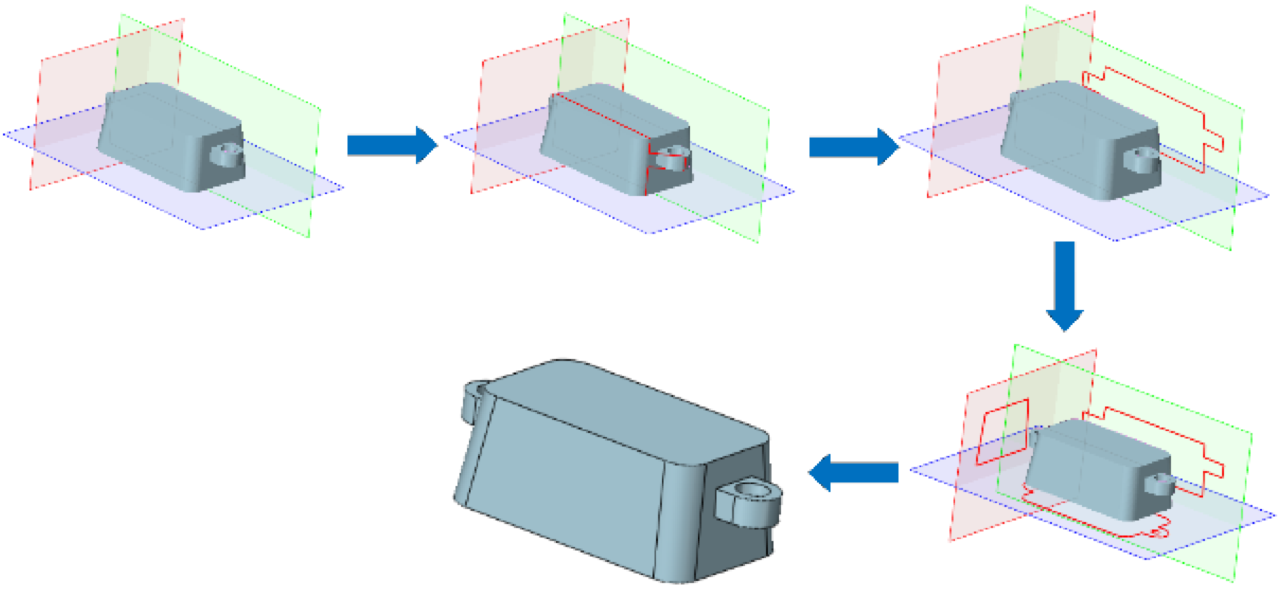


Figure47 Workflow of modeling via trace silhouette sample

1.4.3 Example of Manual Method

Here we have a foot STL model. We will use the manual method to rebuild the surface.

Figure48 Example of the manual method

STEP 01 Import the “Foot.stl” into ZW3D

STEP 02 Pattern XY plane along –Z direction with 50mm pitch to create 7 more planes

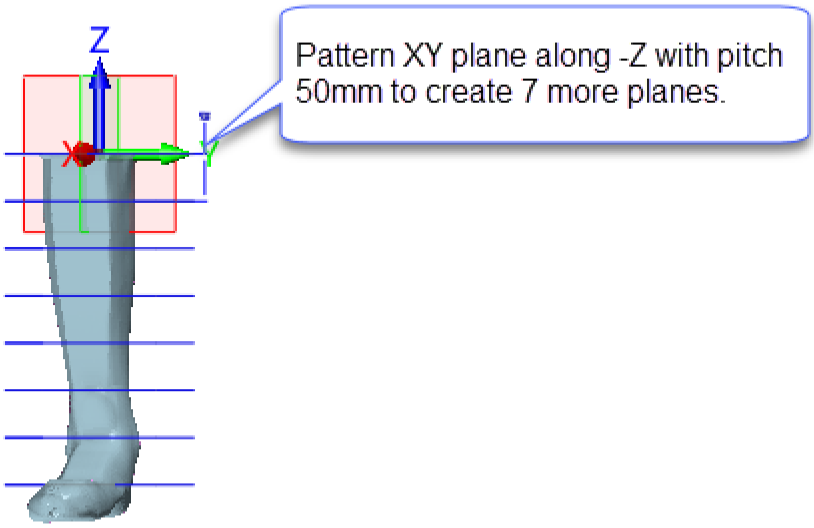


Figure49 Pattern XY plane

STEP 03 Set the bottom plane as a local coordinate system. Then rotate it with 40 degrees along Y axis.

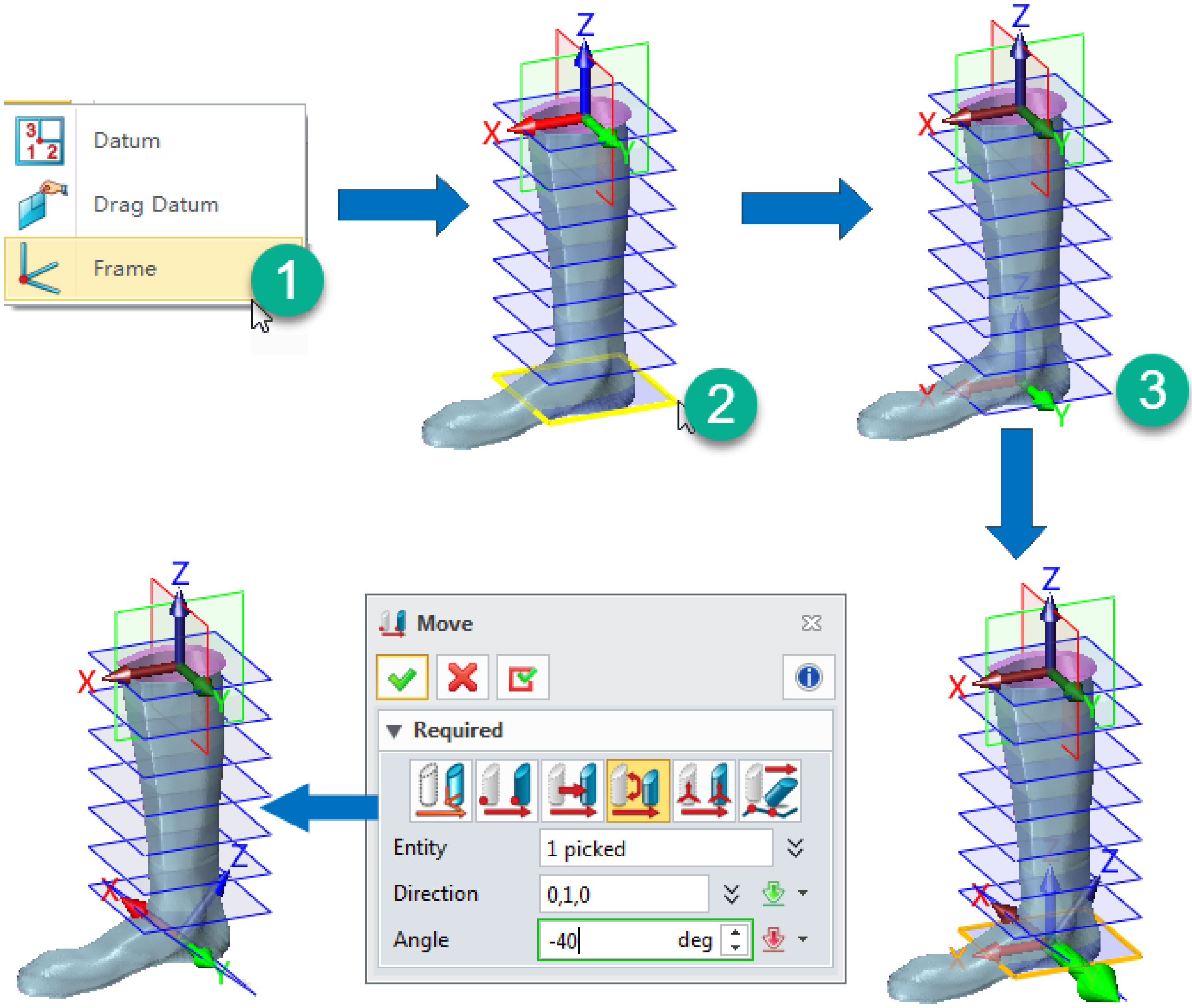


Figure50 Rotate XY plane

STEP 04 Pattern YZ plane along X direction with 50mm pitch to create 5 more planes.

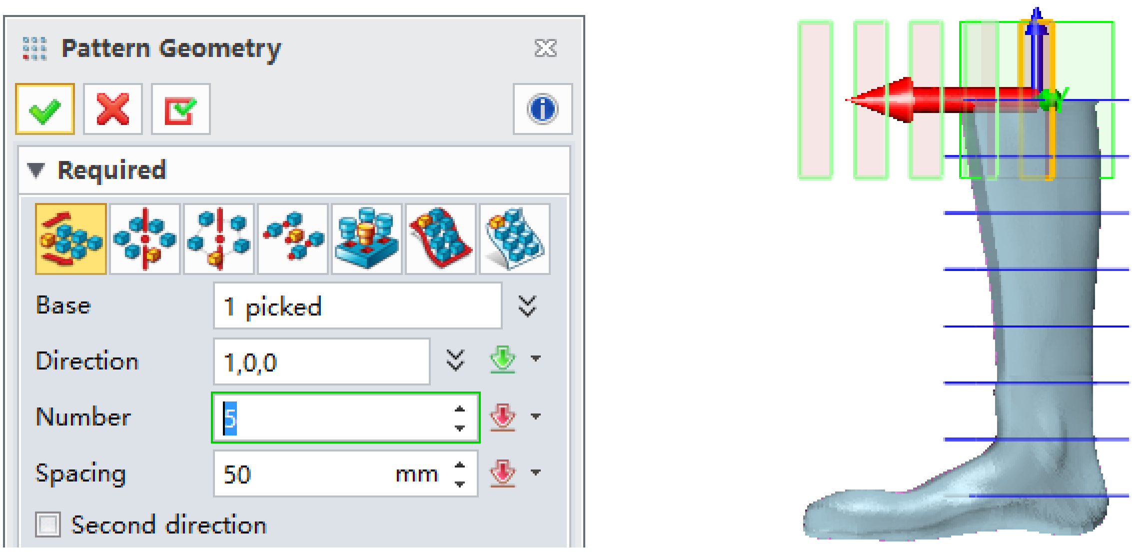


Figure51 Pattern YZ plane

STEP 05 Use "Cross Section" to create section profile with all the planes.

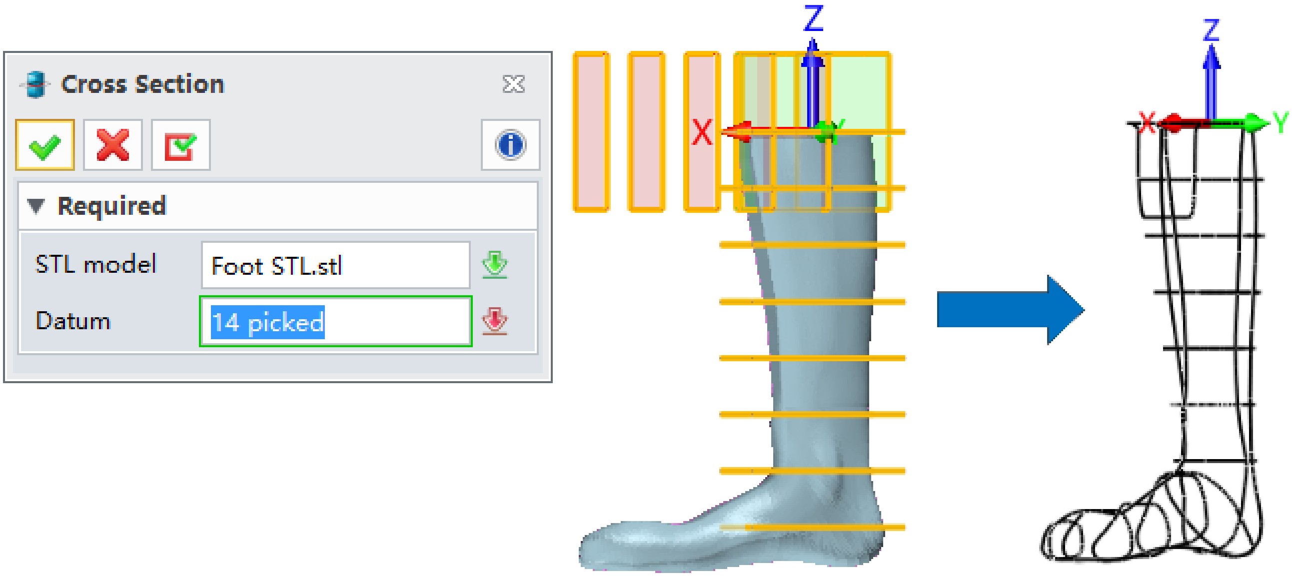


Figure52 Create section profiles

STEP 05 Combine all the wireframe as one and smooth it. Since it has some self-intersection.

I. Select the "Concatenate" function in Wireframe Tab

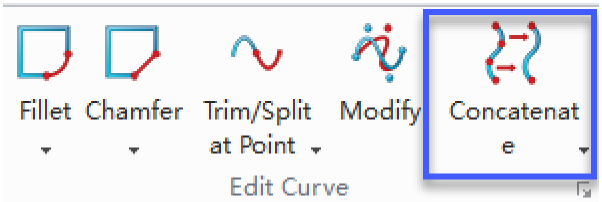


Figure53 Concatenate command

II. Select all the curves in this loop to combine as one

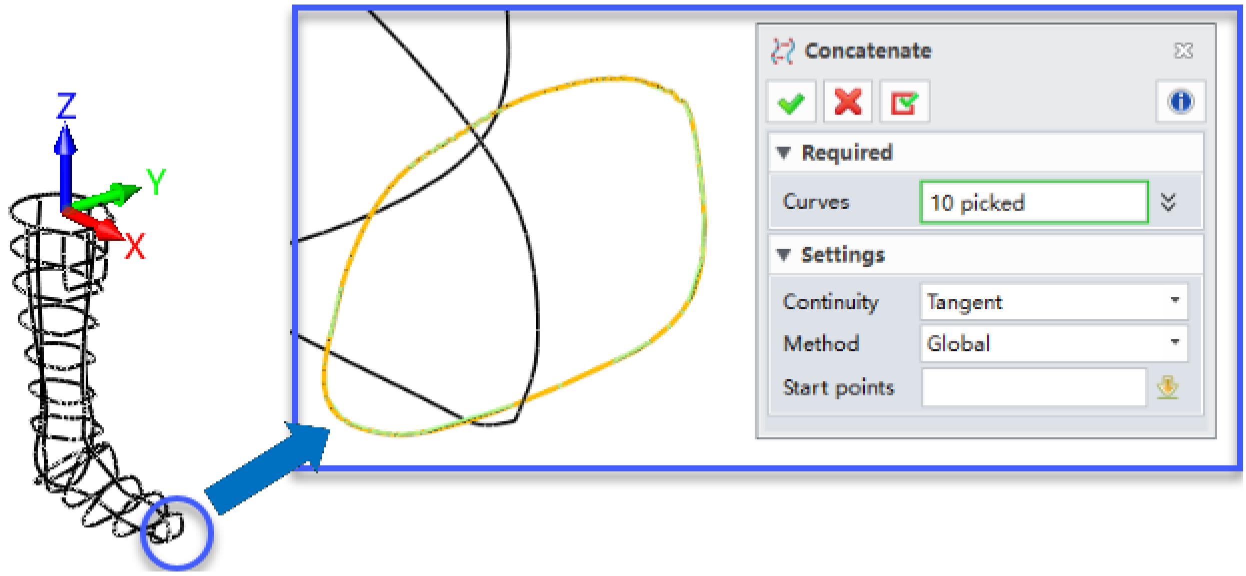


Figure54 Combine the all curves as one

III. Smooth the curve by “FEM Refit” command

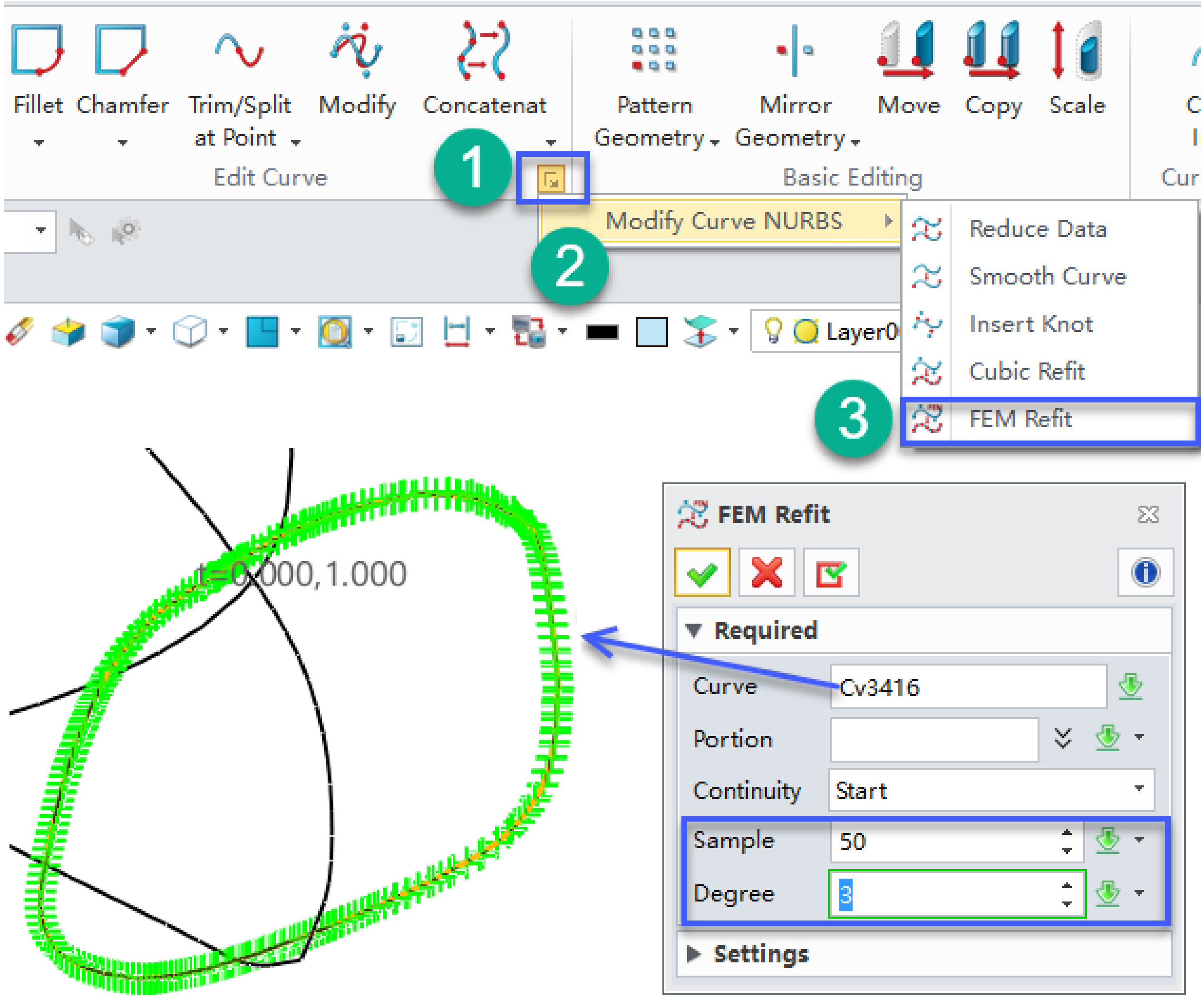


Figure55 Smooth the profile

STEP 06 Split all the profiles at the intersection point with the curve as below.

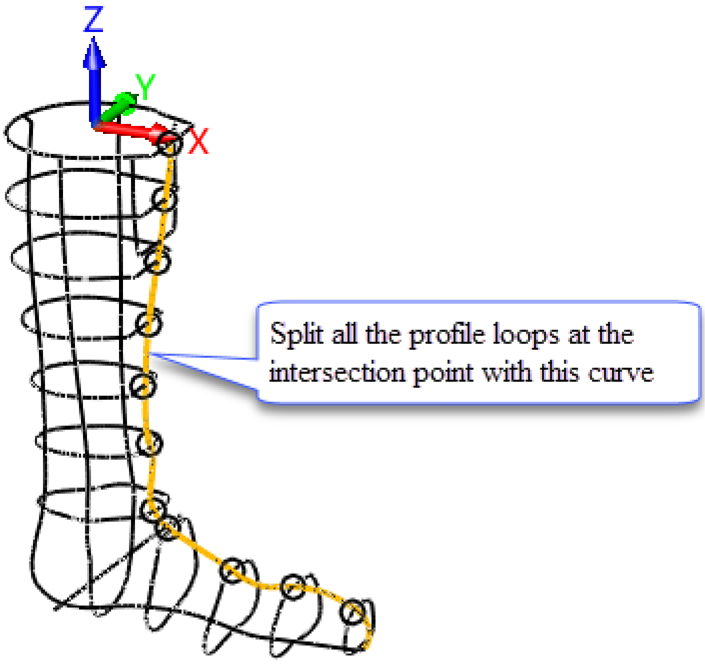


Figure56 Split the profile

STEP 07 Split the blue and green curves as below.

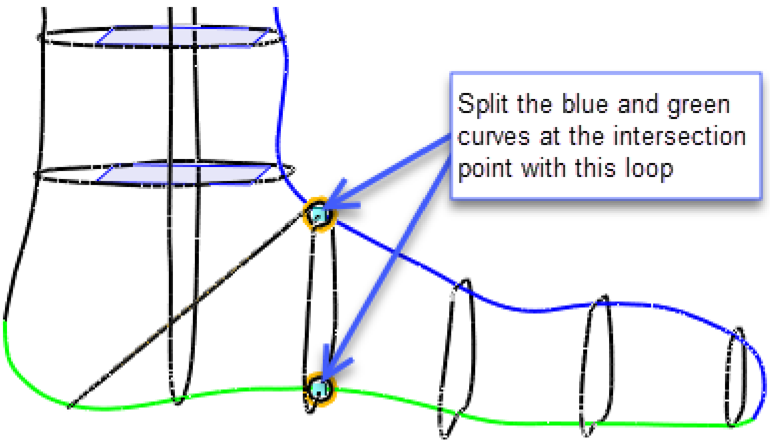


Figure57 Split curve

STEP 08 Create the first surface with "Curve Mesh" in Free Form tab.

I. Select the "Curve Mesh" function

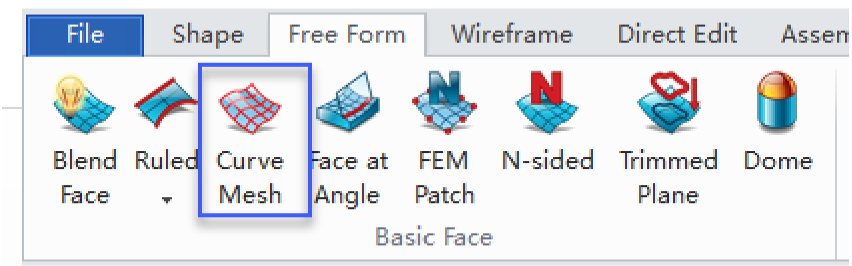


Figure58 Curve Mesh

II. Specify the U curves and V curves as below to create the first surface.

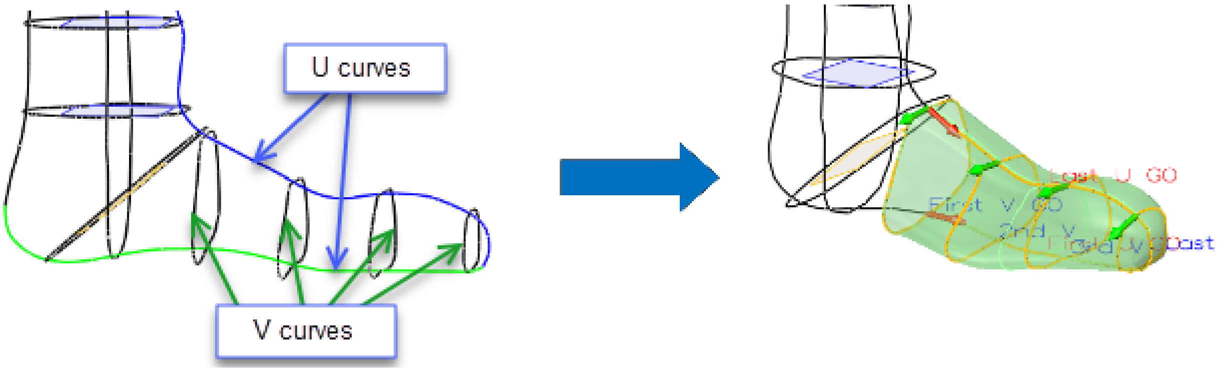


Figure59 Create the first face with Curve Mesh

STEP 09 Split the blue and green curves as below.

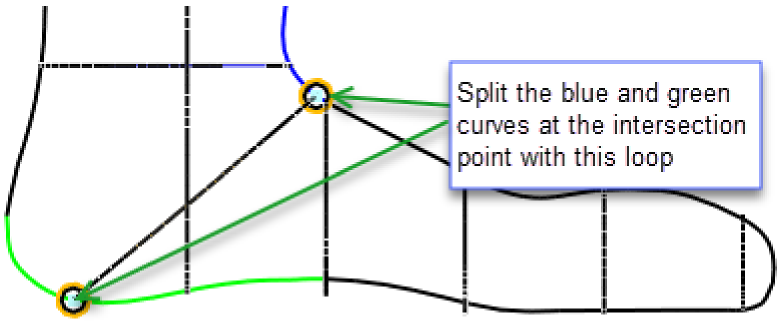


Figure60 Split curves

STEP 10 Create the second surface with “Curve Mesh” in Free From tab. Detailed UV curves settings as below.

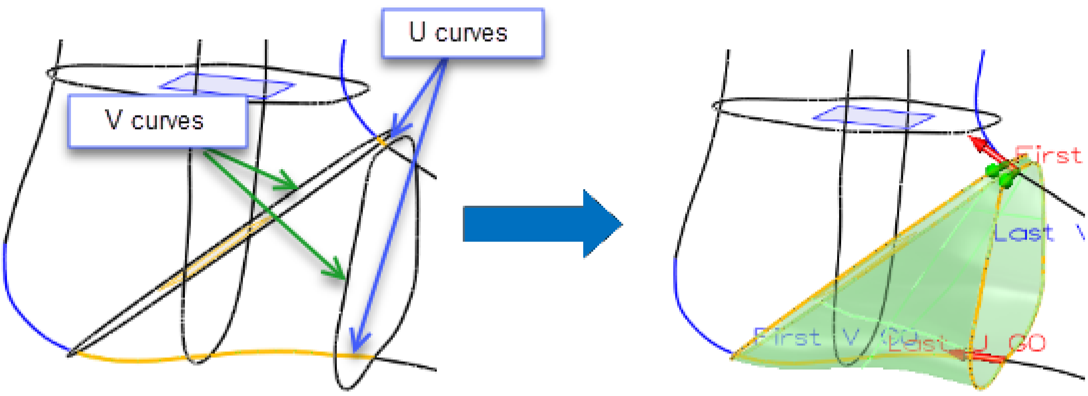


Figure61 Create the second face with Curve Mesh

STEP 11 Use “Concatenate” to combine the bule and green curves.

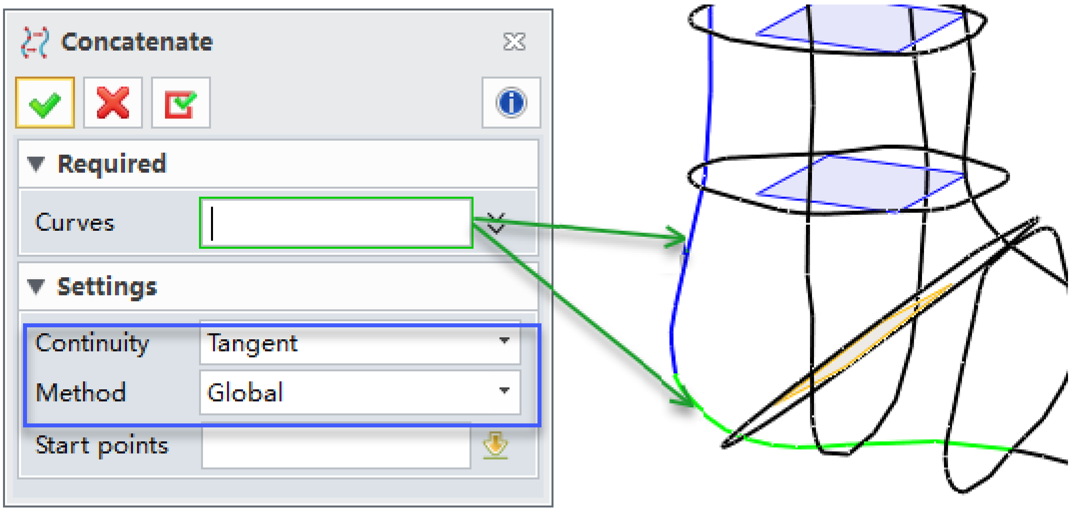


Figure62 Combine specified curves

STEP 12 Split the green curves as below.

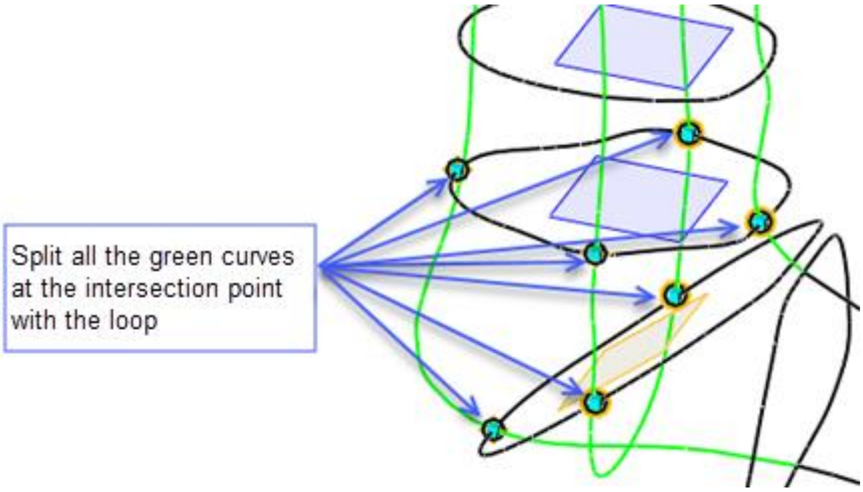


Figure63 Split curves

STEP 13 Create the third surface with "Curve Mesh" command. Detailed UV curves setting as below.

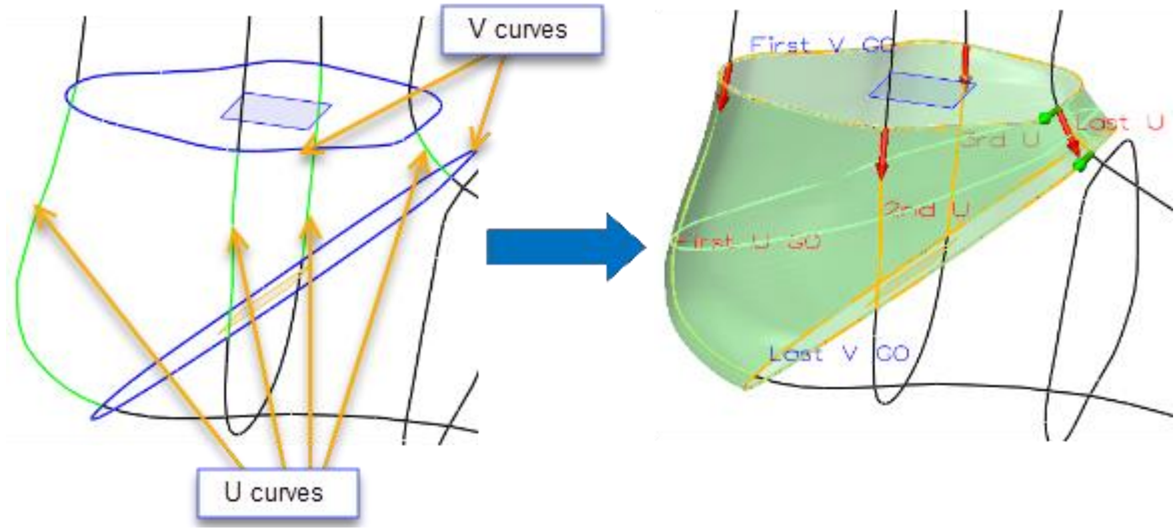


Figure64 Create the third surface

STEP 14 Create the final surface with “Curve Mesh” command. The green curves set to U curves, the blue curves set to V Curves.

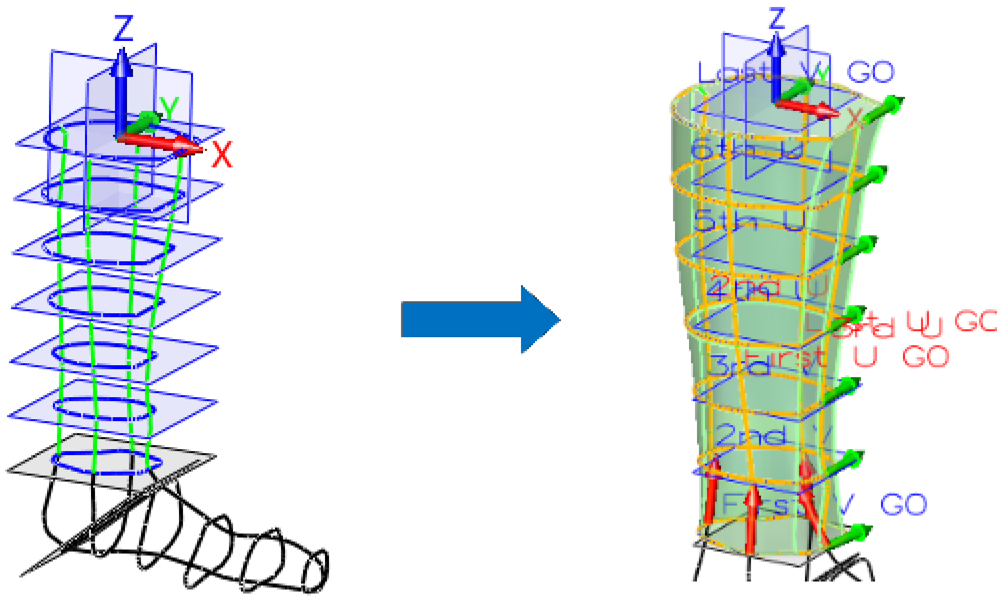


Figure65 Create the final surface

STEP 15 Unblank all the surface, then we can see the result as below.

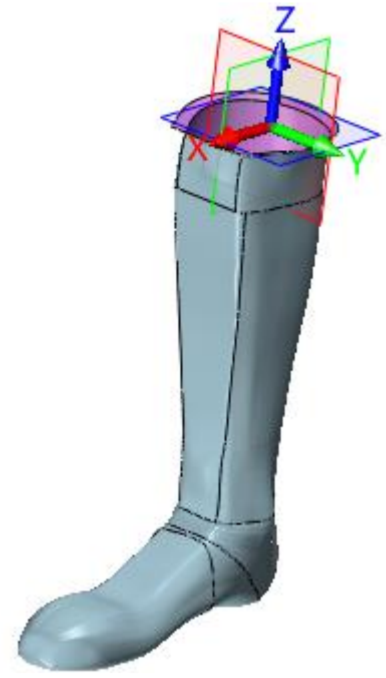


Figure66 Final result

1.4.4 Surface Fit

Use this command to analyze the distance between individual points in a point block and a given surface that was fitted through the point block. The ratio of a given point distance to the surface and the user specified max distance range value determines the color of a point. A "perfect fit" point will display as green. A "1/2 of max range" point will display as yellow, and a distance outside the max. Range point will display as red. Any value in between will be mapped to the standard linear RGB color gradient of green->yellow->red. Customer can have a intuitive image of the rebuilding result with different colors.

Point Cloud Ribbon Toolbar->Create Curve> 

Points: Specify a set of points, a point block or a STL model for analysis.

Face: Specify a face to compare with the points.

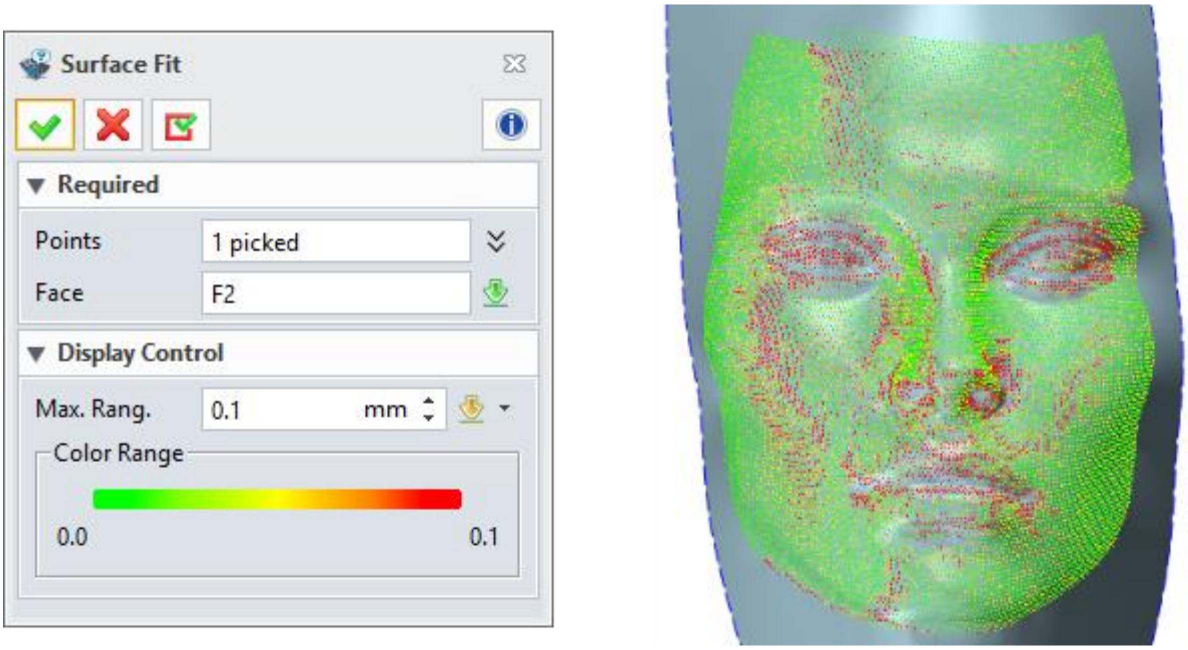


Figure67 Surface fit