

DART-Studio Path Generation Manual

Version 1.0.0.4



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Preface

This User Manual introduces DART-Studio path generation function user operation methods.

The content of this manual refers to the latest product versions at the time of writing, and the product information provided in the manual is subject to change without prior notice to the user.

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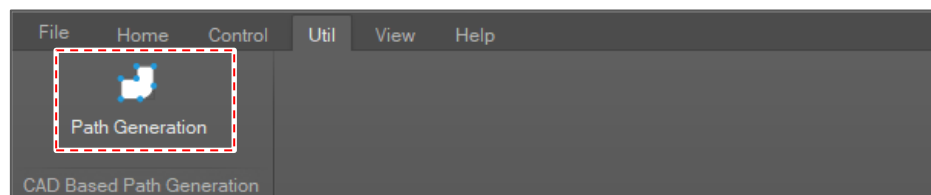
For further information on the revision details, please visit the Doosan Robotics website (www.doosanrobotics.com).

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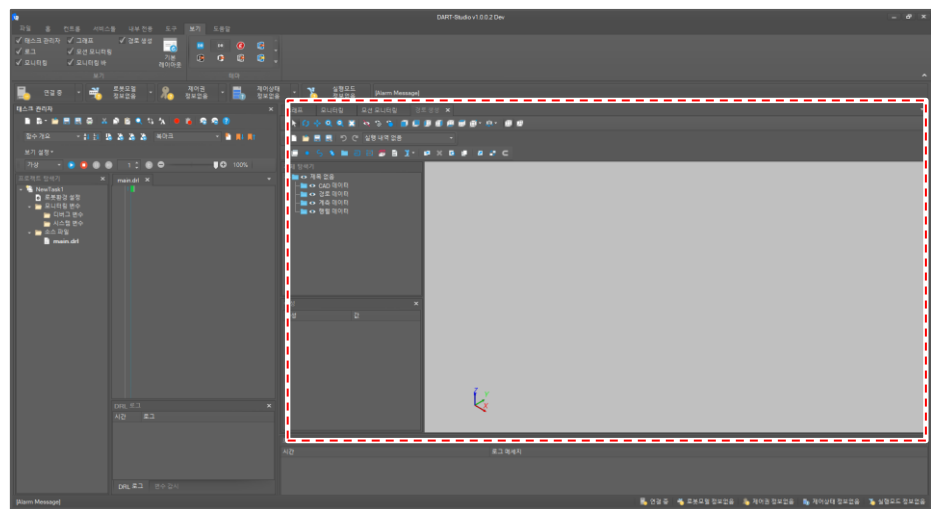
1 CAD-based Path Generation

1.1 Open Cad-based Path Generation Pane

- 1 Select the **Util** tab in the main menu and click the **Path Generation** button.



- 2 Path Generation pane opened and activated.







1.2 3D View Control

1.2.1 View Control



Select objects from scene.

Rotate objects along object center.

	Move the scene direction along mouse position.
	Zoom in the scene at the mouse position.
	Zoom out the scene at the mouse position.
	Initialize the zoom scale so that the whole objects can be fit in the scene.

1.2.2 Object visibility



	Hide objects
	Make objects transparent
	Make objects opaque

1.2.3 Viewpoint



	View from -Y Axis
	View from +Y Axis
	View from -X Axis
	View from +X Axis
	View from -Z Axis
	View from +Z Axis
	View from -X, -Y, +Z Direction
	View from -X, +Y, +Z Direction
	View from +X, +Y, +Z Direction
	View from +X, -Y, +Z Direction
	View from -X, -Y, -Z Direction
	View from -X, +Y, -Z Direction
	View from +X, +Y, -Z Direction



View from +X, -Y, -Z Direction

1.2.1 Projection



Orthogonal projection



Perspective projection

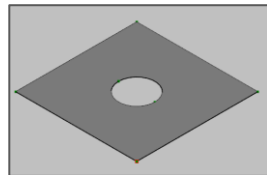
1.3 Object Control

1.3.1 Object selection

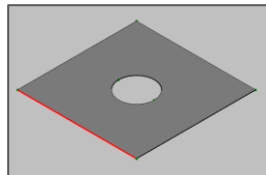
In selection mode, the user can select objects by mouse clicking or dragging.



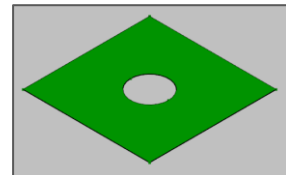
- The selected objects are highlighted.



Point



Line



Plane

- If the user clicks the mouse left button on an object, the object is selected.
- If the user clicks the mouse button while pressing Ctrl key, the user can select multiple objects.
- If the user drags the mouse, all the objects inside the dragging region are selected.

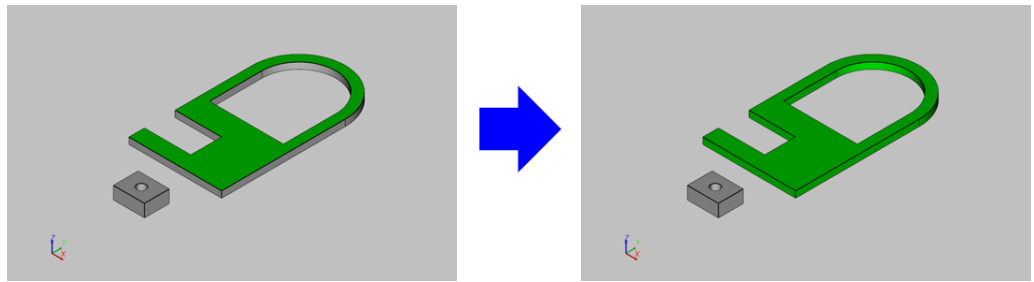
1.3.2 Related objects selection

The program provides functions to select related objects with the currently selected object.



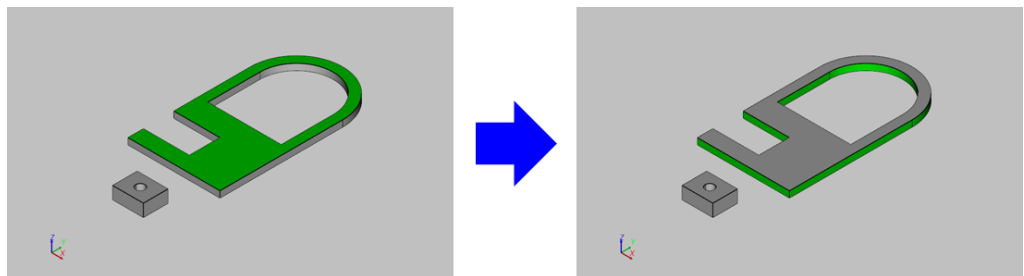
Parent group selection

The function selects all children objects of the parent group of the currently selected object.



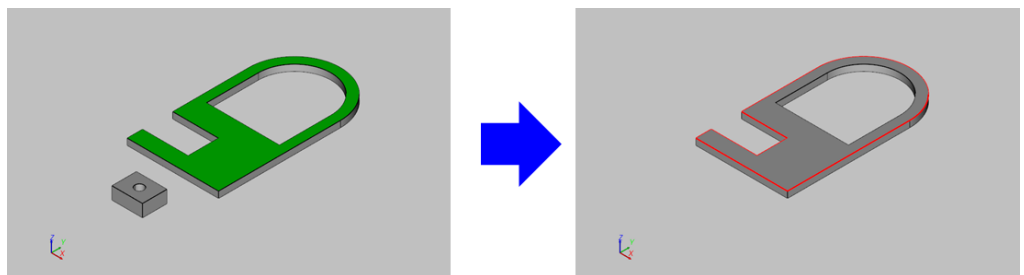
Selection inversion

The function inverts the selection. The objects except the currently selected object in the parent group are selected.



Connected curves selection

The all connected curve objects with the currently selected object are selected.

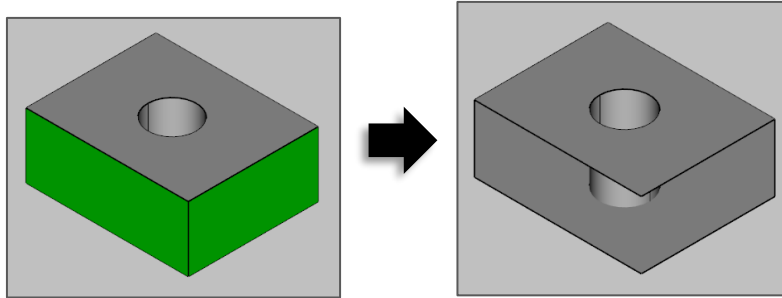


1.3.3 Object deletion

The function deletes all the selected objects.

- 1 Select objects.
- 2 Click **[Delete Object] button** or press the [Delete] key.





1.3.4 Object transformation

The program provides functions to transform the selected objects.

Object translation

The function moves the selected objects by offset.

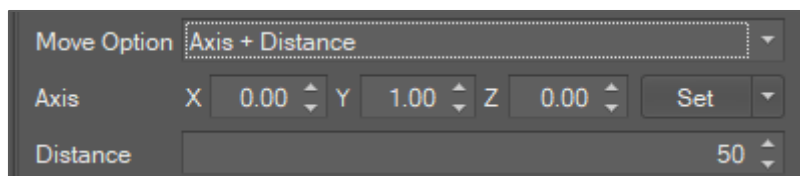
- 1 Click [Transform Object] button.



- 2 Select [Translate Objects] option in the active window.



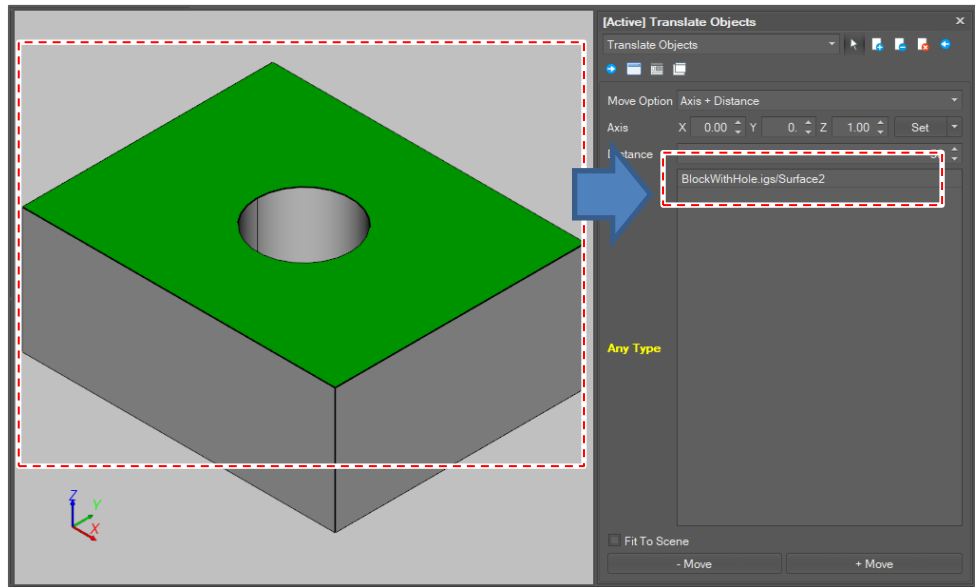
- 3 Select translation options.



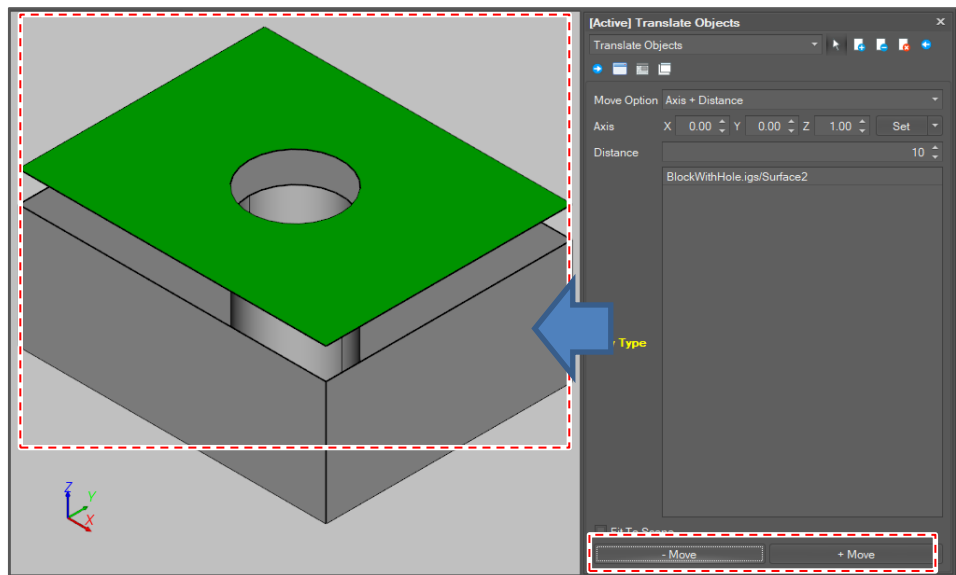
There are two move options.

- Axis + Distance: The function moves the selected objects by the distance along the axis.
- Offset: The function moves the selected objects by offset(X, Y, Z).

- 4 Select objects to move



5 Click [Move] button.



Object rotation

The function rotates the selected objects along an axis.

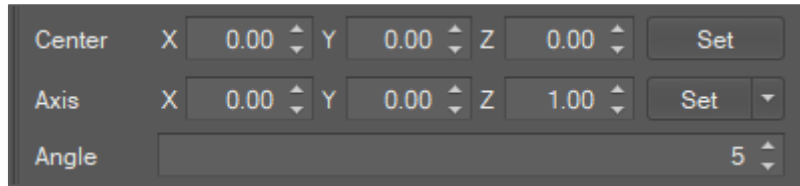
1 Click [Transform Object] button.



2 Select [Rotate Objects] option in the active window.

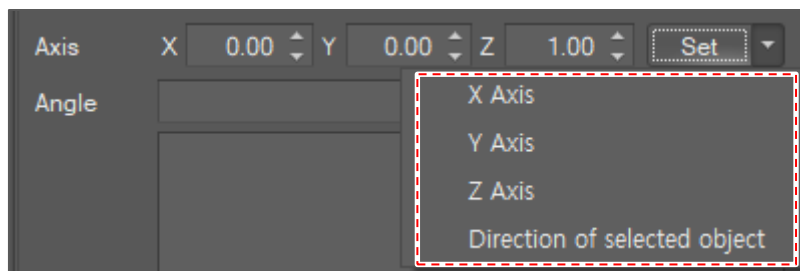


3 Select rotation options.



- Rotation center (X, Y, Z)
- Rotation Axis (X, Y, Z)
- Rotation angle in degree.

There are help function to set rotation axis.



X Axis (1, 0, 0)

Y Axis (0, 1, 0)

Z Axis (0, 0, 1)

If two points selected, the direction from starting point to the end point is set.

If a line or a path segment is selected, the direction of the line is set.

If the direction vector of a path segment is selected, the direction vector is set.

If a plane is selected, the normal vector of the plane is set.

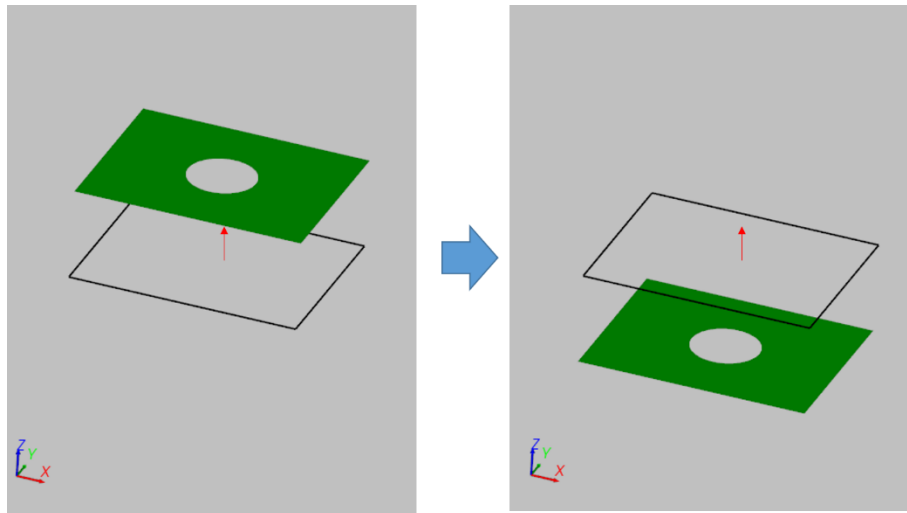
4 Select objects to rotate.

5 Click the [Rotate] button.



Object mirror transformation

The function moves and mirrors the selected object to the opposite side of an axis.



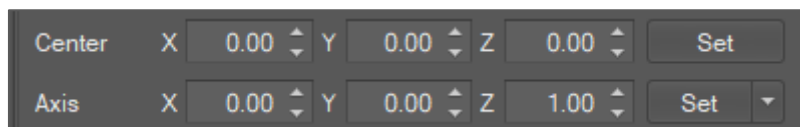
1 Click [Transform Object] button.



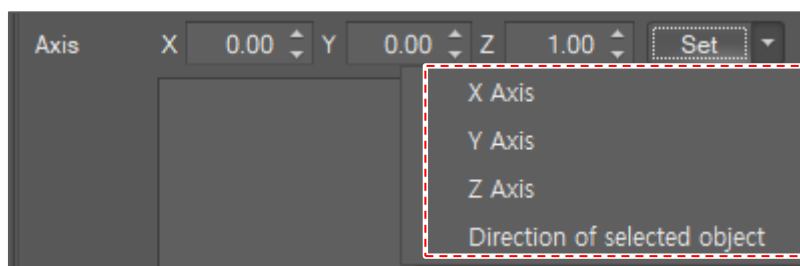
2 Select [Mirror objects] option in the active window.



3 Set mirroring axis.



4 There are help function to set rotation axis.



X Axis (1, 0, 0)

Y Axis (0, 1, 0)

Z Axis (0, 0, 1)

Direction of selected object If two points selected, the direction from starting point to the end point is set.

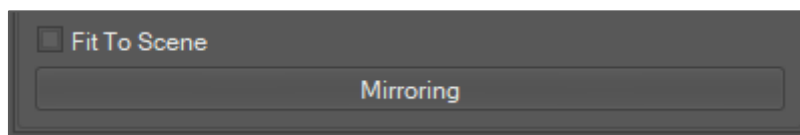
If a line or a path segment is selected, the direction of the line is set.

If the direction vector of a path segment is selected, the direction vector is set.

If a plane is selected, the normal vector of the plane is set.

5 Select objects to mirror.

6 Select the [Mirroring] button.

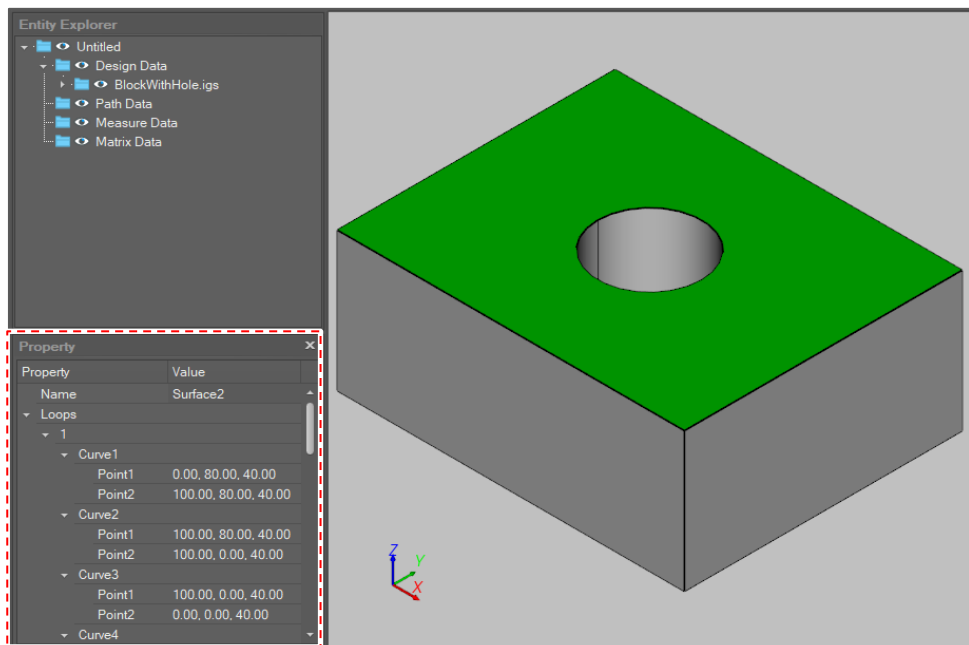


1.3.5 Object property display

The program provides a function to show properties of the selected object.

1 Select an object.

If the user selected an object, the properties of the selected object is displayed in [Property] windows.



1.4 Load CAD files

The program provides to load shapes from CAD files.

■ Supporting CAD Format

3D CAD File	IGES (.igs, .iges), STEP (.stp, .step)
3D Shape File	STL (.stl)
2D CAD File	DXF (.dxf)

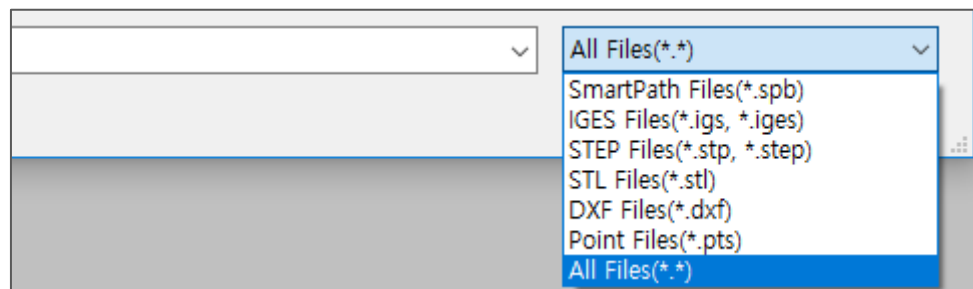
■ For using other 3D formats

IGES, STEP files are standard CAD file formats used widely. If the format of a CAD file is not one of them, translate the cad format by using CAD software.

- 1 Click [Open document] button in the menu bar.



- 2 Select CAD files in the file open dialog.



■ Note

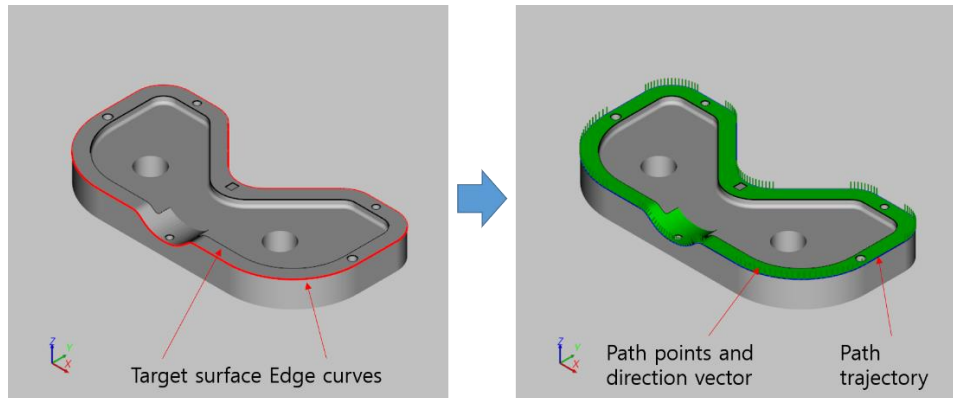
2 or more files can be loaded at once.

.spb file is a path generation document file. So the file cannot be loaded with other file format files.

1.5 Generate Path

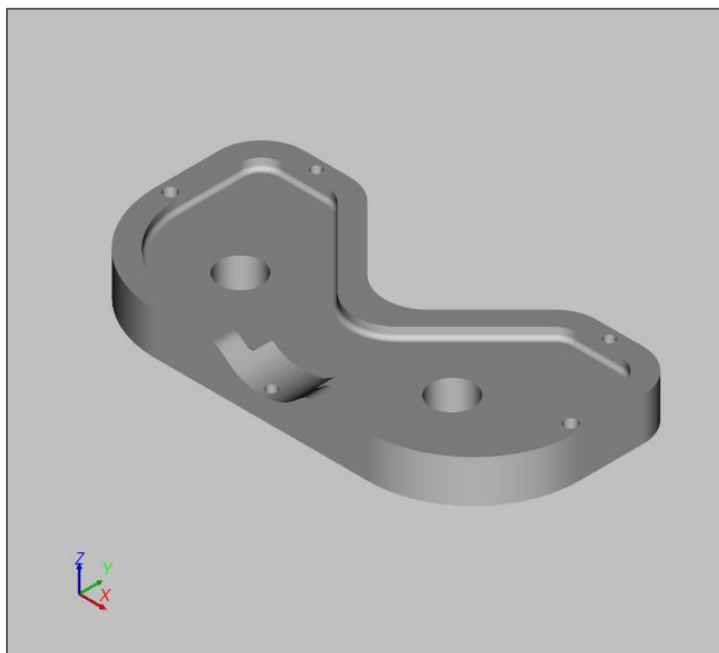
1.5.1 Edge path generation

The program provides a function to generate a path following the edge of a surface. It is also possible to generate a path offset along the surface.

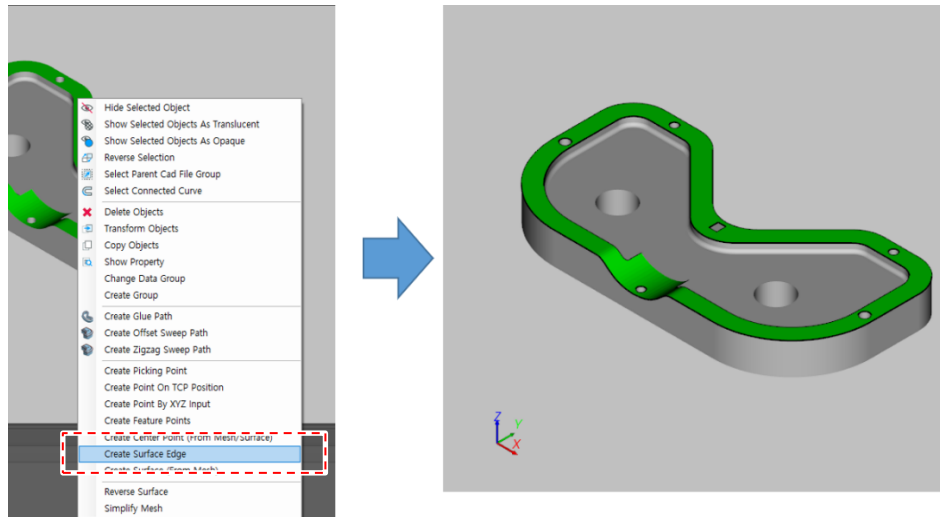


1 Open a CAD file

Initially the edges of surface are not displayed.



2 Create edge of the surface.



■ Create surface edge

Select [Create Surface Edge] menu on the 3D view context menu.

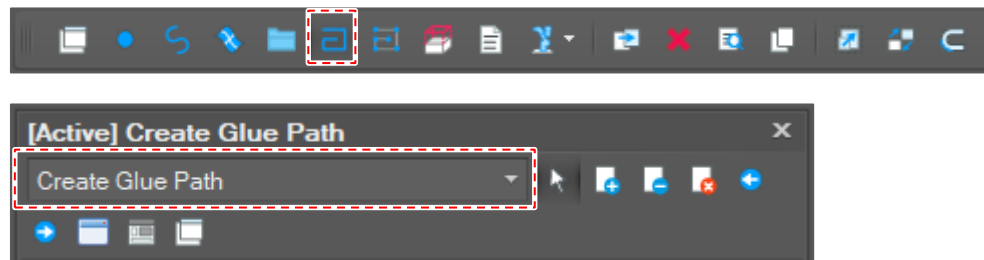
Or Click [Create curve] button in the menu bar and select [Create Surface Edge] option.

■ Create path on more than 2 surfaces

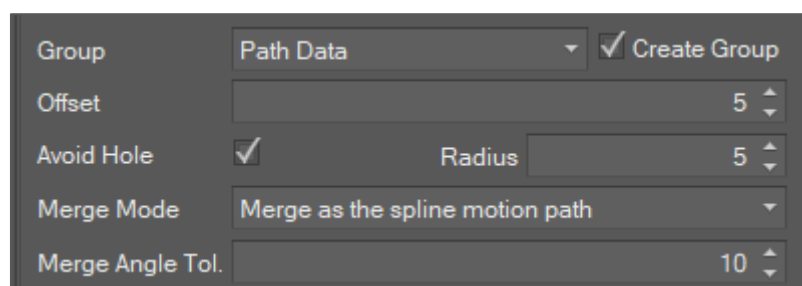
If the user wants to create a path sweeping more than 2 surfaces, first merge the surface in a surface. Please refer to [Create shape >> Plane/Surface creation] chapter.

3 Open the path generation window.

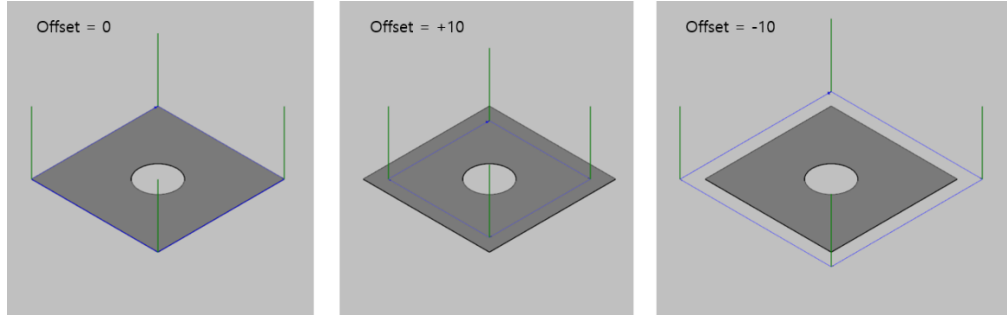
Click [Create Path] button and select the [Create Glue Path] option.



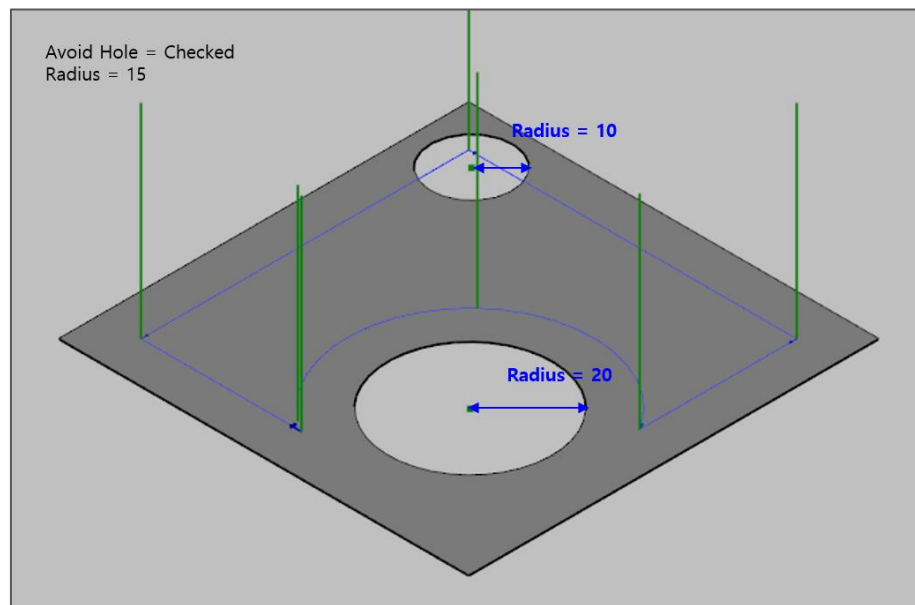
4 Set path generation options.



- **Group:** a group which newly created paths belong. If the [Create Group] check box is checked, a new group named the name of the selected surface is created.
- **Offset:** Offset from the surface edge. If the value is positive, the path is created inside the edge along the surface or the value is negative the path is created outside the edge.



- **Avoid Hole:** When there is a hole inside the surface, the user can decide that the path ignores the hole or not. If the flag is checked, the holes which its radius is less than the Radius value are ignored.



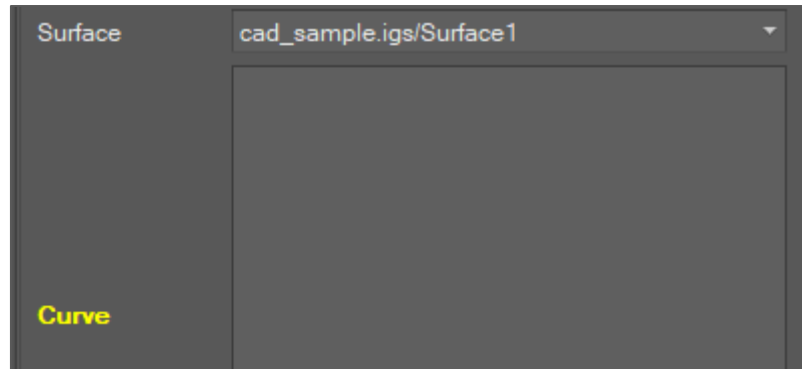
- **Merge mode:** It decides the motion type of the created path.

Preserve original curves	Each original curve becomes a path segment. When creating a script code, a line segment is translated into a MoveL motion and a curve segment is translated into a MoveSX motion. When a curve has edges which its angle is 90 degree, the motion cannot be run. In that case, the user should modify the path before creating a script.
Merge as the spline motion path	Merge whole curves into a curve which can be translated into a spline motion. If the angle between two curves is greater than the merge allowance angle, the path segment is split.
Merge as the blend motion path	Split the curves into lines and arcs so to create a blend motion. The curve is split into arcs based on the arc tolerance.

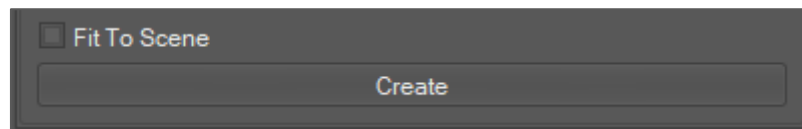
5 Select a surface and edge to create a path.

To create a path, the user should select a surface which the newly created path resides on.

The user can optionally select the surface edge. If the user selects no edge, then a path following whole surface edge is created. If the user selects edges, then a path following the selected edge is created.

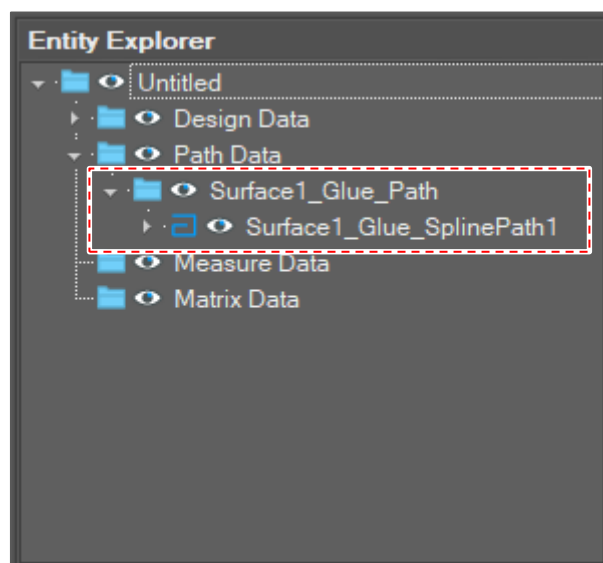


6 Click [Create] button.



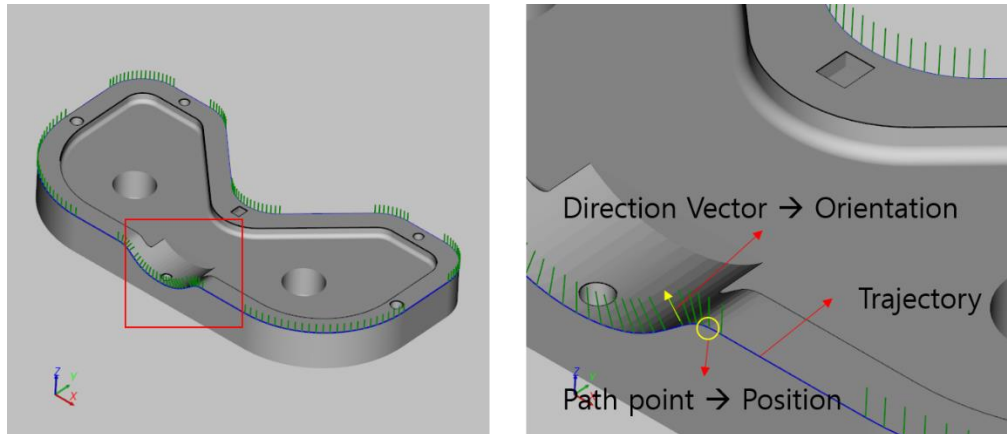
7 Check the result.

A new path is created in the Path data group. If the user checked [Create Group] option, then a path group is created.



A path segment is a list of path points. The robot controller creates motion trajectory based on the points. Each path point defines position and direction vector. The direction vector

means orientation at the position. The direction vector of a path point is initially set as the normal vector of the surface at the position.

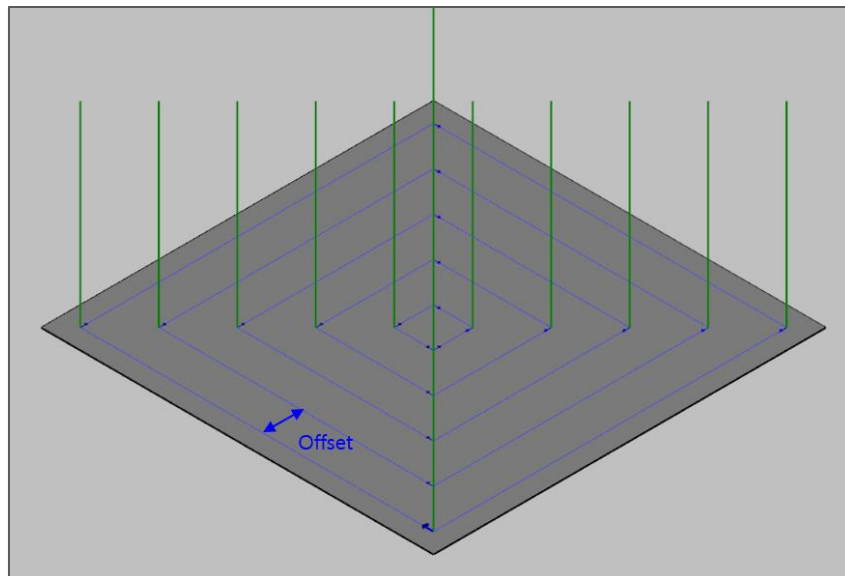


Note

To reverse the whole direction vector, try to create a path again after reversing the surface.

1.5.2 Offset sweep path generation

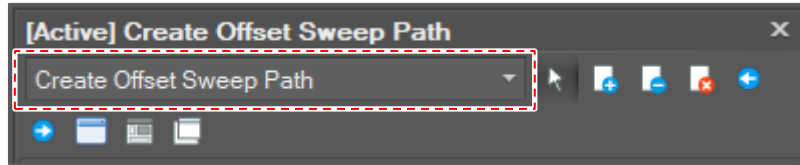
Offset sweep path is a path sweeping a whole surface. Surface edge is repeatedly offset into surface center until there is no space.



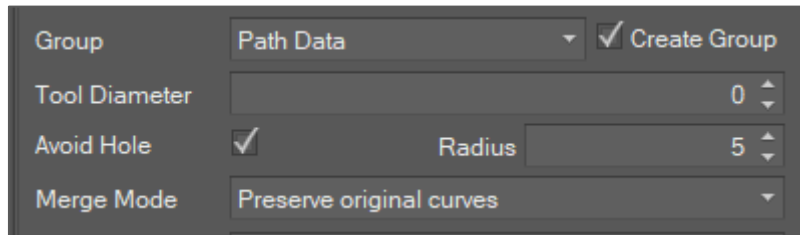
- 1 Open a CAD file
- 2 Create edge of the surface.
- 3 Open the path generation window.

Click [Create Path] button and select the [Create Offset Sweep Path] option.

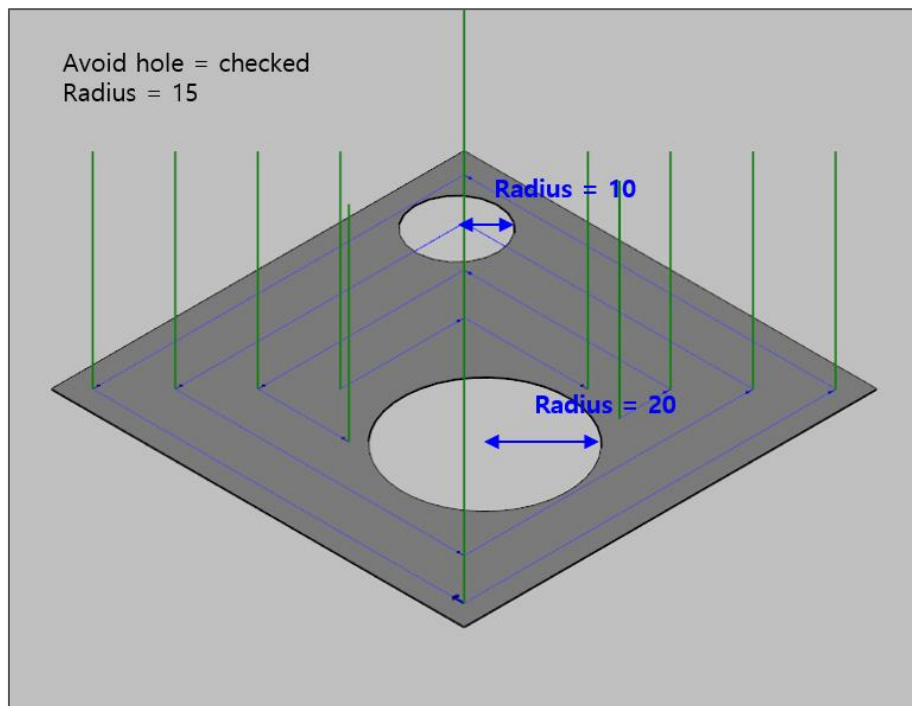




4 Set path generation options.



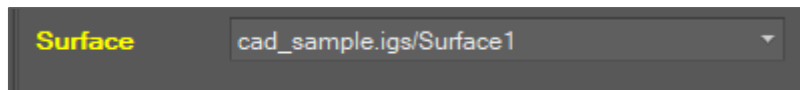
- Group: a group which newly created paths belong. If the [Create Group] check box is checked, a new group named the name of the selected surface is created.
- Tool Diameter: It means offset or distance between pattern. The negative value or zero is not allowed.
- Avoid Hole: When there is a hole inside the surface, the user can decide that the path ignores the hole or not. If the flag is checked, the holes which its radius is less than the Radius value are ignored.



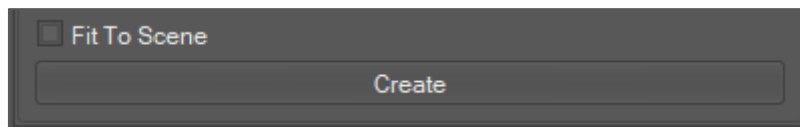
- Merge mode: It decides the motion type of the created path.

Preserve original curves	Each original curve becomes a path segment. When creating a script code, a line segment is translated into a MoveL motion and a curve segment is translated into a MoveSX motion. When a curve has edges which its angle is 90 degree, the motion cannot be run. In that case, the user should modify the path before creating a script.
Merge as the spline motion path	Merge whole curves into a curve which can be translated into a spline motion. If the angle between two curves is greater than the merge allowance angle, the path segment is split.
Merge as the blend motion path	Split the curves into lines and arcs so to create a blend motion. The curve is split into arcs based on the arc tolerance.

5 Select a surface and edge to create a path.

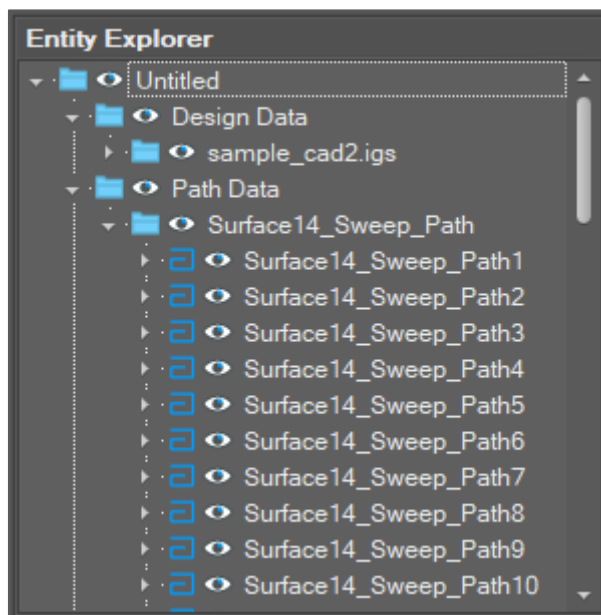


6 Click [Create] button.



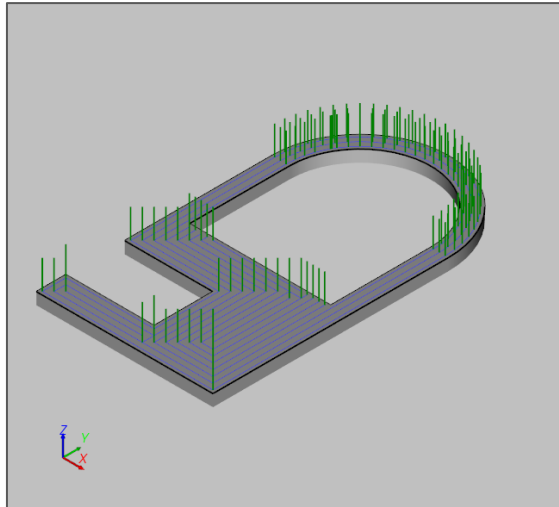
7 Check the result.

A new path is created in the Path data group. If the user checked [Create Group] option, then a path group is created.



A path segment is a list of path points. The robot controller creates motion trajectory based on the points. Each path point defines position and direction vector. The direction vector

means orientation at the position. The direction vector of a path point is initially set as the normal vector of the surface at the position.

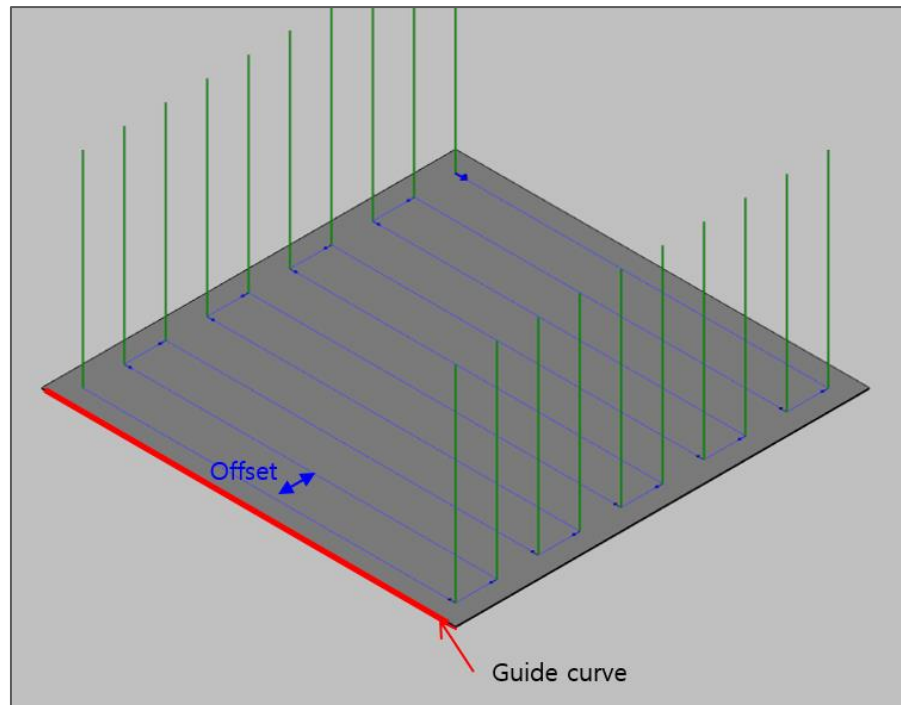


Note

To reverse the whole direction vector, try to create a path again after reversing the surface.

1.5.3 Zigzag sweep path generation

A zigzag sweep path is a path sweeping the surface with zigzag pattern.

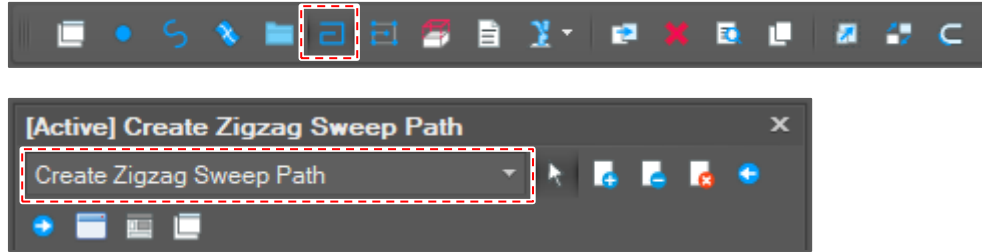


To create a zigzag pattern, A guide curve should be defined. The pattern extends to the normal direction of the guide curve.

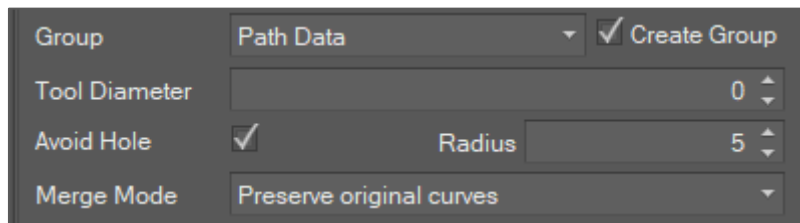
- 1 Open a CAD file

- 2 Create edge of the surface.
- 3 Open the path generation window.

Click [Create Path] button and select the [Create Offset Sweep Path] option.



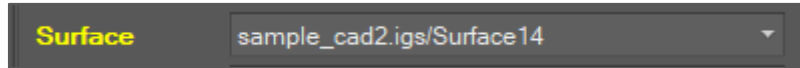
- 4 Set path generation options.



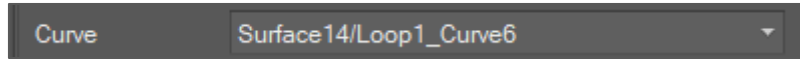
- Group: a group which newly created paths belong. If the [Create Group] check box is checked, a new group named the name of the selected surface is created.
- Tool Diameter: It means offset or distance between pattern. The negative value or zero is not allowed.
- Avoid Hole: When there is a hole inside the surface, the user can decide that the path ignores the hole or not. If the flag is checked, the holes which its radius is less than the Radius value are ignored.
- Merge mode: It decides the motion type of the created path.

Preserve original curves	Each original curve becomes a path segment. When creating a script code, a line segment is translated into a MoveL motion and a curve segment is translated into a MoveSX motion. When a curve has edges which its angle is 90 degree, the motion cannot be run. In that case, the user should modify the path before creating a script.
Merge as the spline motion path	Merge whole curves into a curve which can be translated into a spline motion. If the angle between two curves is greater than the merge allowance angle, the path segment is split.
Merge as the blend motion path	Split the curves into lines and arcs so to create a blend motion. The curve is split into arcs based on the arc tolerance.

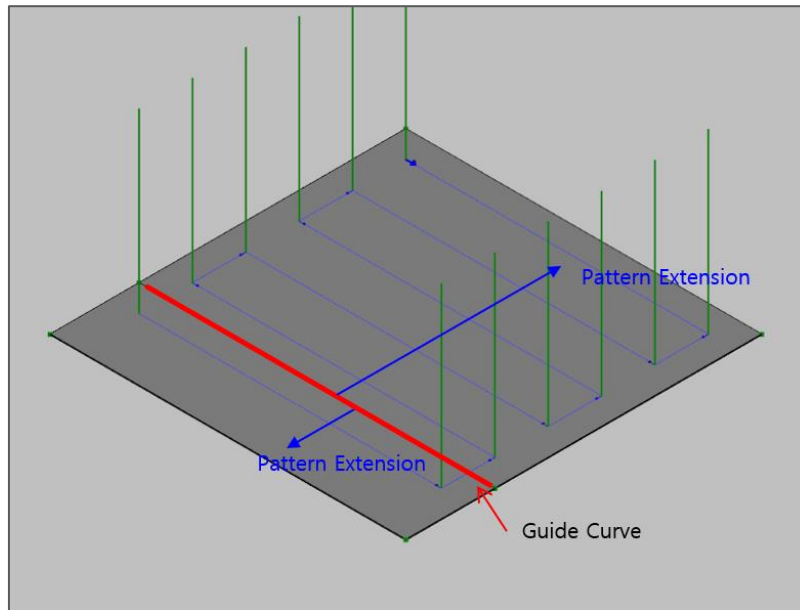
- 5 Select a surface to create a path.



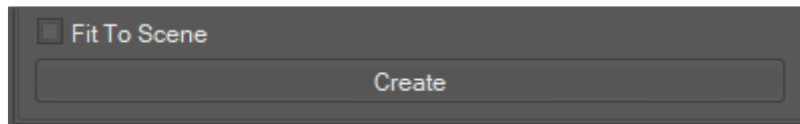
6 Select a guide curve.



The curve is a starting point of the zigzag pattern. The pattern extends to both direction of the normal direction of the curve.

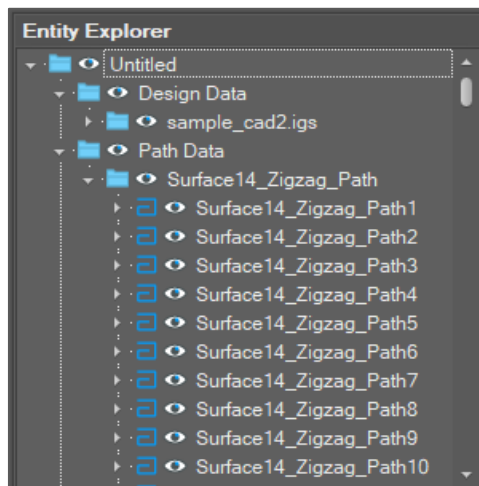


7 Click [Create] button.

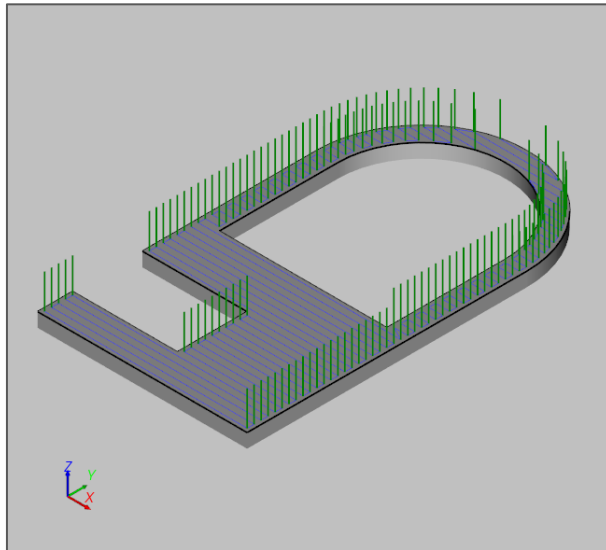


8 Check the result.

A new path is created in the Path data group. If the user checked [Create Group] option, then a path group is created.



A path segment is a list of path points. The robot controller creates motion trajectory based on the points. Each path point defines position and direction vector. The direction vector means orientation at the position. The direction vector of a path point is initially set as the normal vector of the surface at the position.



Note

To reverse the whole direction vector, try to create a path again after reversing the surface.

1.6 Edit Path

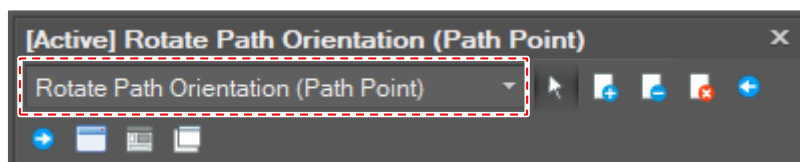
1.6.1 Change path orientation

The program provides a function to change the orientation of a path.

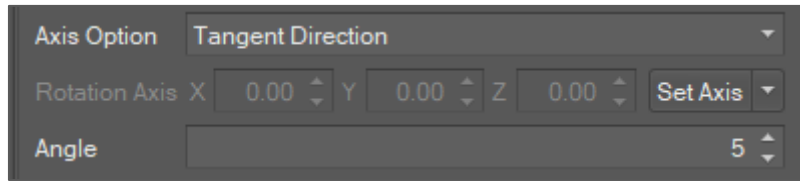
Path orientation rotation

1 Open [Rotate Path Orientation] window.

After clicking the [Edit Path] button in the menu bar, select [Rotate Path Orientation (Path Point)] option.



2 Set rotation options.



- Axis option: There are options as below.

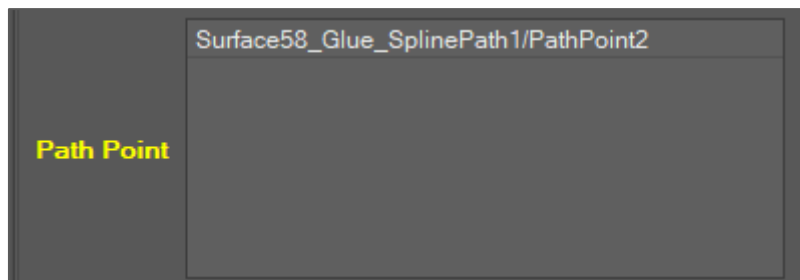
Tangent Direction The tangent direction at the path point.

Perpendicular to the Tangent direction The direction perpendicular to both the tangent direction and the head-up direction.

User Setting The user can set direction directly.

- Rotation Axis: The direction when [Axis Option] is selected as [User Setting]
- Rotation angle: Angle in degree

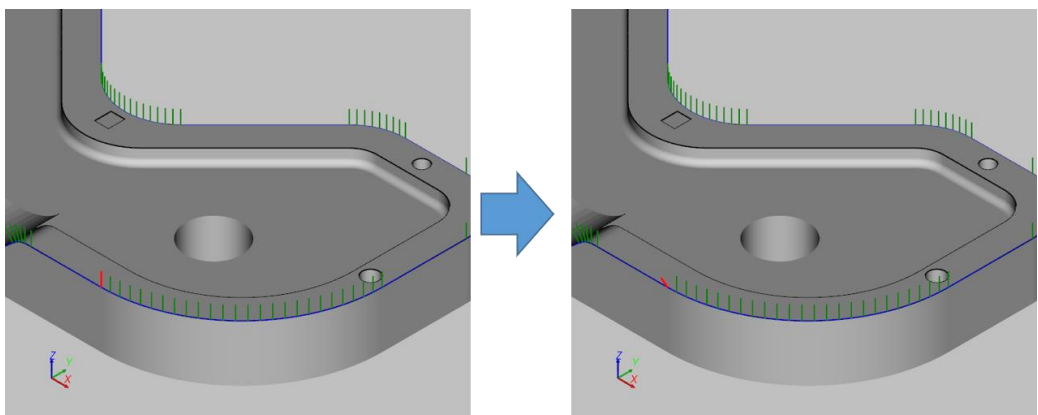
3 Select path point objects to rotate.



4 Click the [Rotate] button.



5 Check the result.

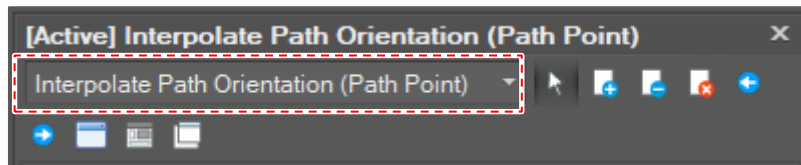


Path orientation interpolation

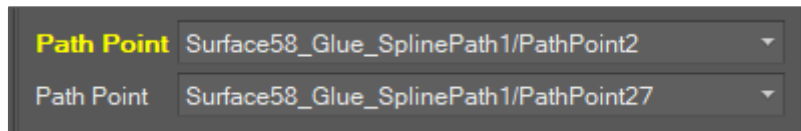
The function interpolates the orientation of all path points between two pivot path points evenly.

- 1 Open [Interpolate Path Orientation] window.

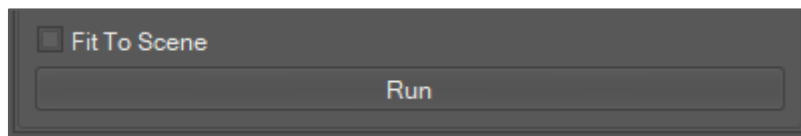
After clicking [Path Edit] button, select the [Interpolate Path Orientation(Path Point)] option.



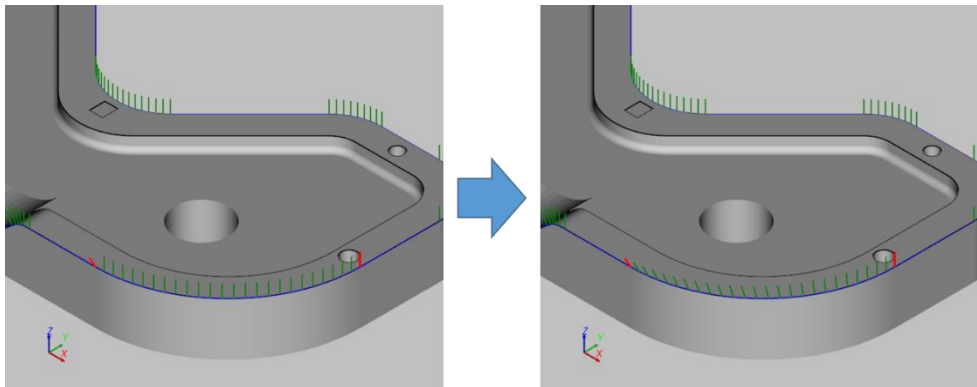
- 2 Select two path point objects.



- 3 Click the [Run] button.



- 4 Check the result.



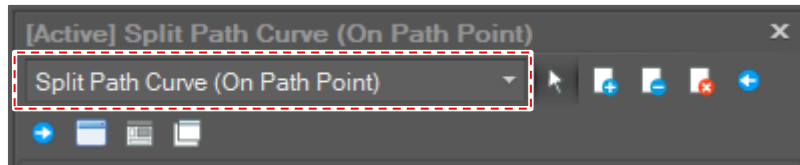
1.6.2 Split path segment

The function splits a path segment into two segments on a path point or on a point on the curve.

- 1 Open the [Split Path Curve] window.

After clicking the [Edit Path] button, select [Split Path Curve (On Path Point)] option.

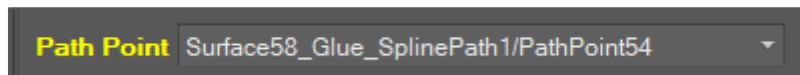




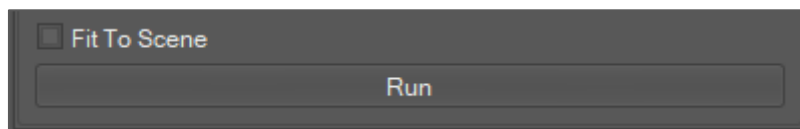
1.6.2 Split path curve on a point

To split the path curve on a point, select [Split Path Curve (On Point)] option.

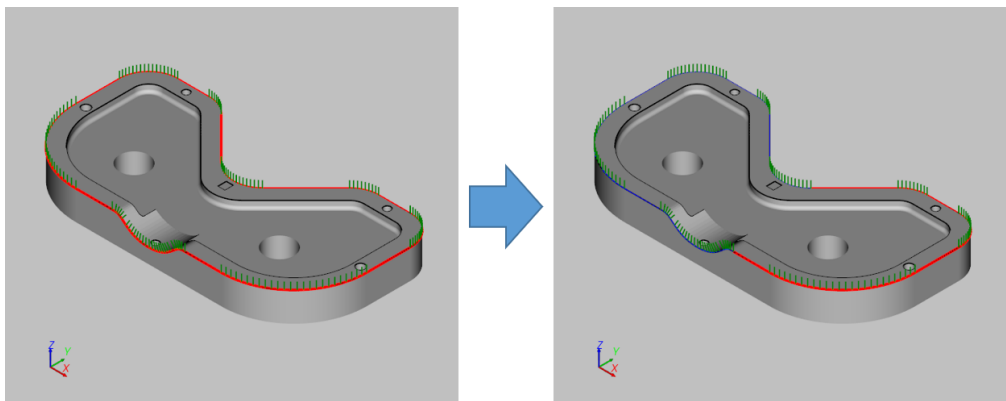
- 2 Select a path point object.



- 3 Click the [Run] button.



- 4 Check the result.



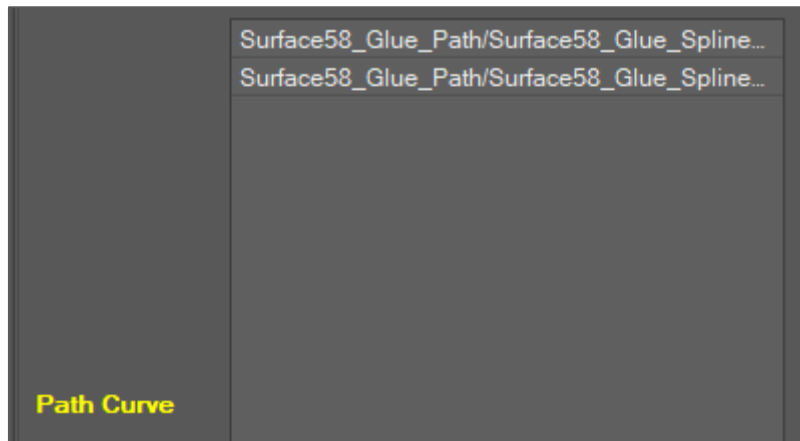
1.6.3 Merge path segment

The function merges path segments into a segment.

- 1 Open [Merge Path Curves] window.
- 2 After clicking the [Edit Path] button, select [Merges Path Curves] option.



- 3 Select path segments to merge.

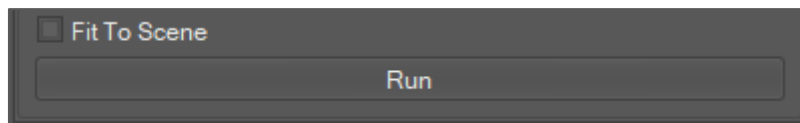


- 4 Set the merge angle tolerance.

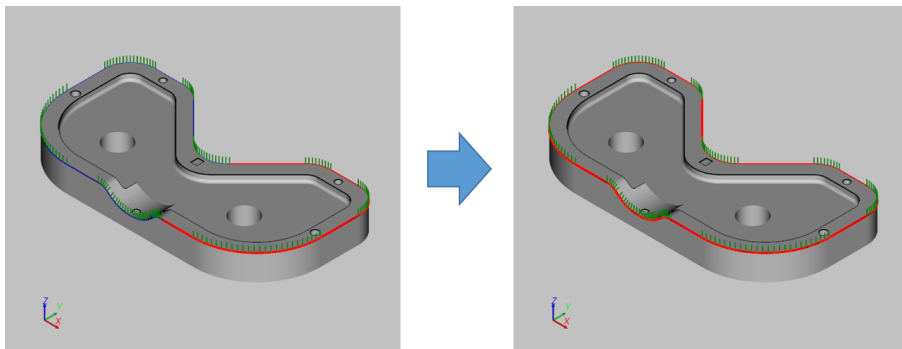


If the angle between two segments is greater than the tolerance, the merge failed.

- 5 Click the [Run] button.



- 6 Check the result.



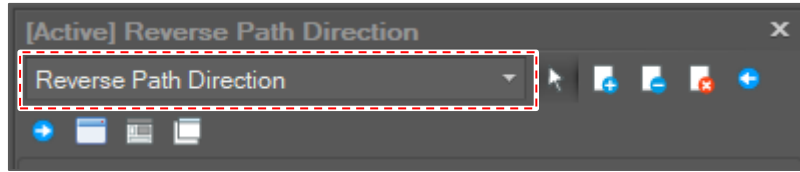
1.6.4 Change path direction

The function reverses the direction of a path.

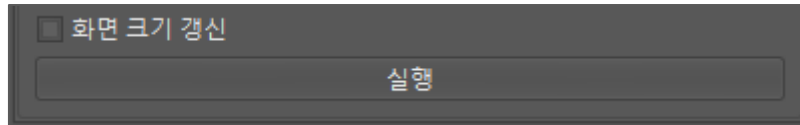
- 1 Open [Reverse Path Direction] window.

After clicking [Edit Path] button, select the [Reverse Path Direction] option.



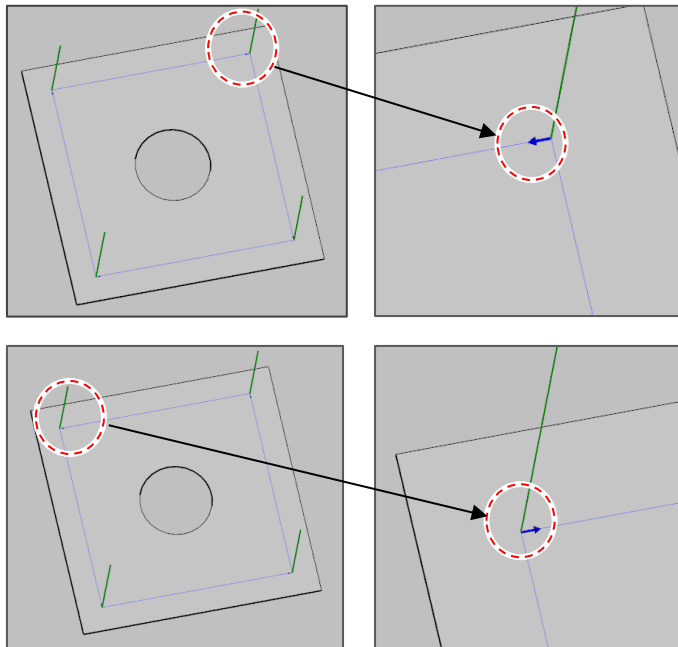


- 2 Select path segments to reverse.
- 3 Click the [Run] button.



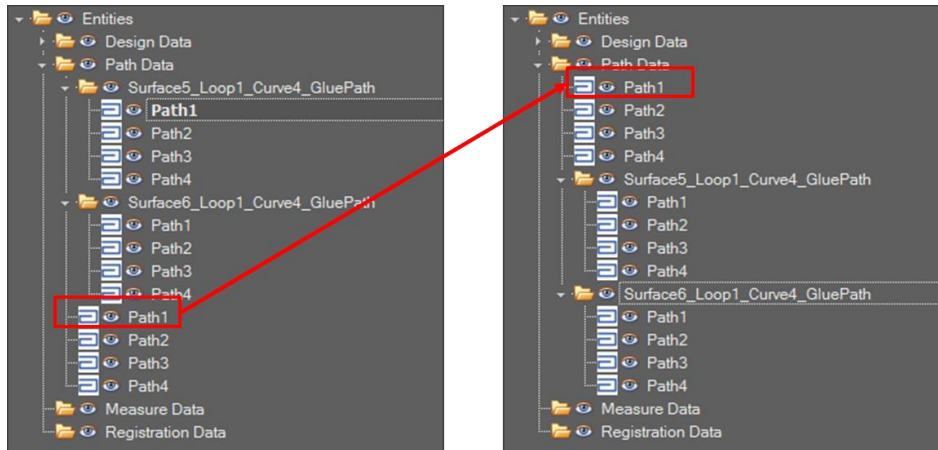
4 Check the result.

The arrow in blue color means the direction of the path.



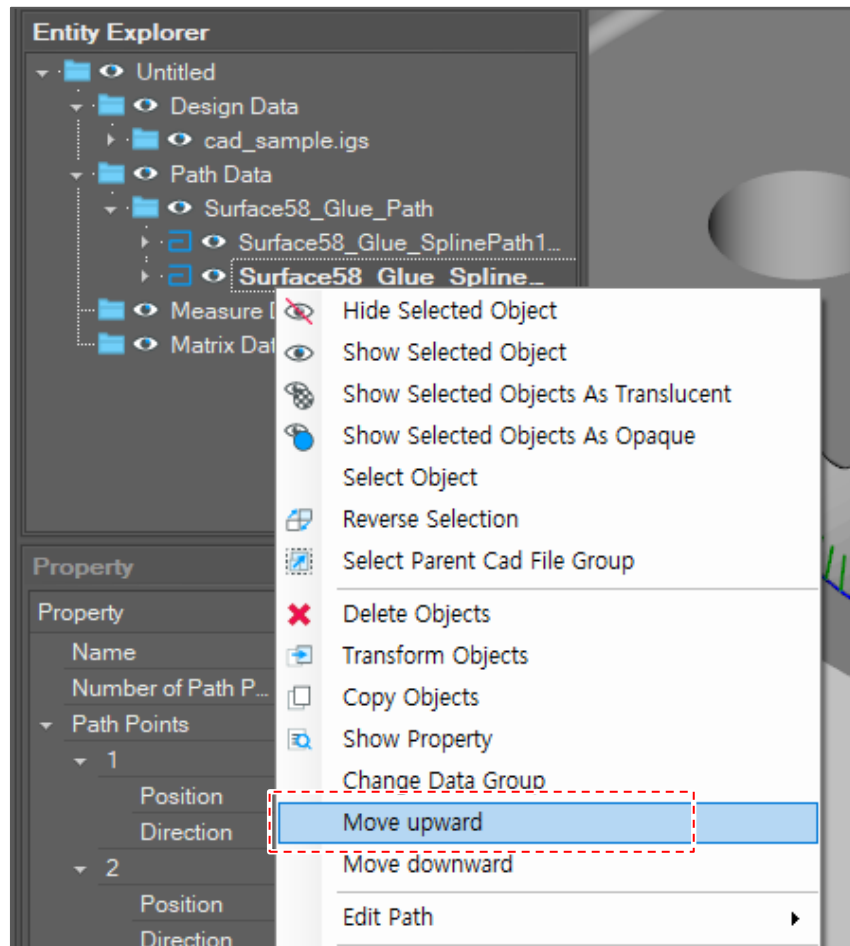
1.6.5 Change path sequence

The sequence on the explorer tree is the sequence of the path. To change path sequences means to change the object sequence on the tree.

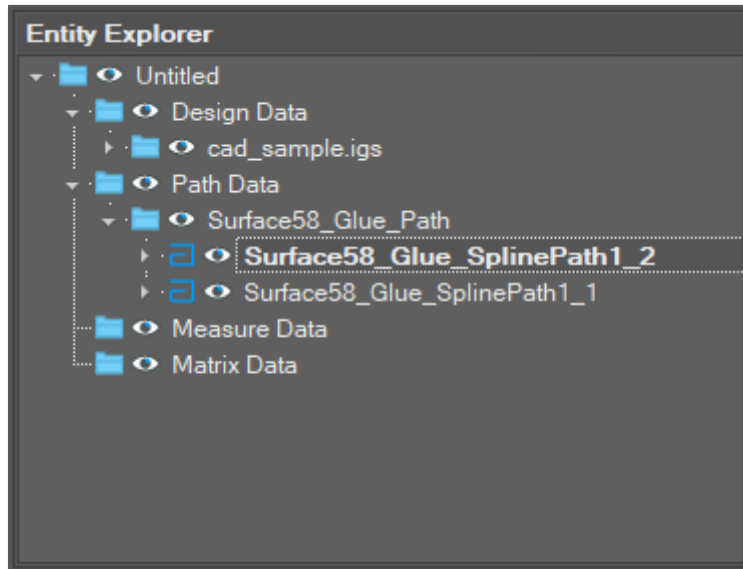


Change Path Sequence

- 1 After selecting a tree node, click [Move upward] or [Move downward] menu.



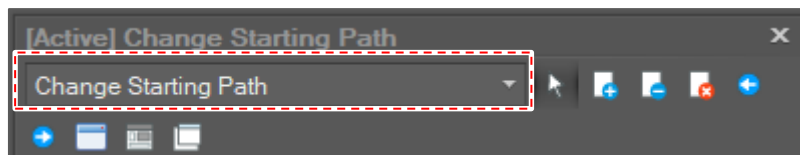
- 2 Check the result.



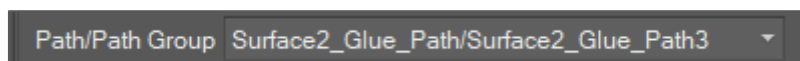
Change the starting path

1 Open [Change Starting Path] window.

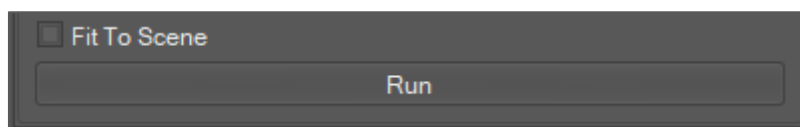
After clicking [Edit Path] button, select [Change Starting Path] option.



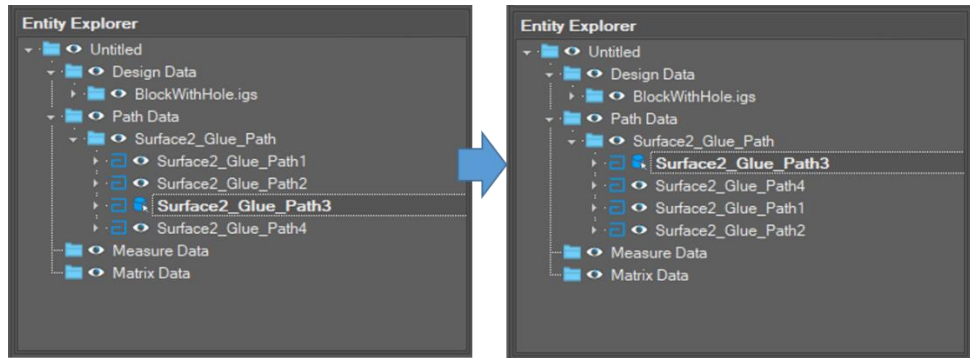
2 Select a path segment or a path group.



3 Click the [Run] button.



4 Check the result.



1.7 Create Shape

It is sometimes needed to edit shapes from CAD file or to create point, curve and surface. The program provides functions to create and edit shapes.

1.7.1 Create point

Crate point at picking position

The function creates a point object at picking position.

- 1 Click [Create Point] button in the menu bar.

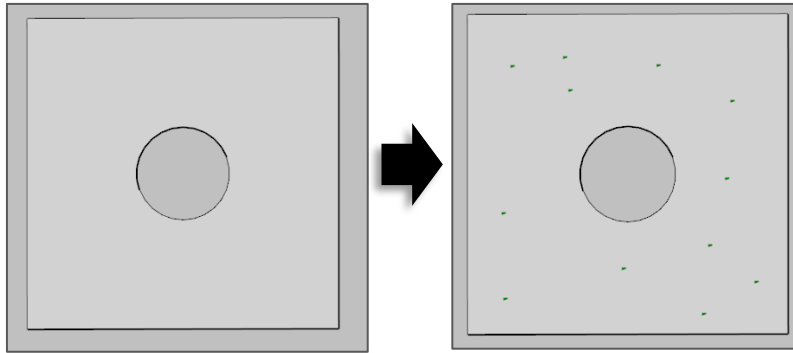


- 2 Select [Create picking point] option in the active window.
- 3 Set creation option.
 - Group: A group to which newly created object belongs.
- 4 Select [Enable] button. The [Enable] button is initially selected.



- 5 Pick object at the 3D view.

If the user clicks an object, a point object is created at that position.



6 If the creation job is done, select the [Disable] button or close the window.

Create feature points

The function creates point objects at the feature position of the selected object. The feature position is as below.

Surface	The Start point and the end point of all curves which belong to the surface.
Curve	The Start point and the end point of curve.
Path segment	The path point of the path segment.

1 Click [Create Point] button in the menu bar.

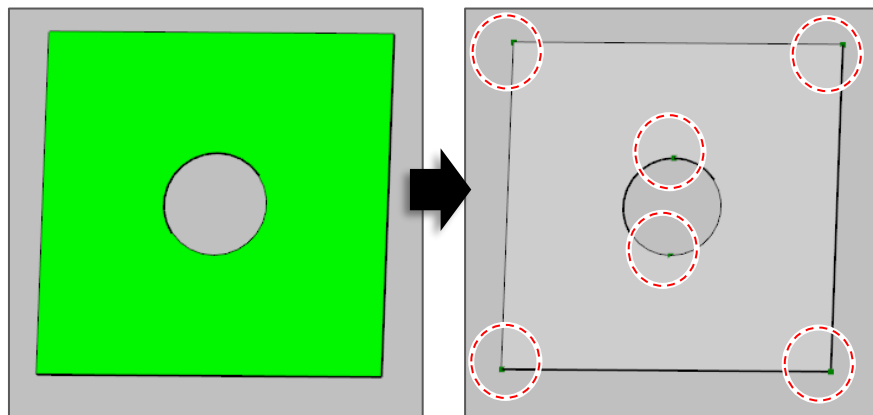


2 Select [Create Feature Points] option in the active window.

3 Set creation option.

- Group: A group to which newly created object belongs.

4 Select the [Create] button.



Create Point By XYZ Input

The function create a point object at the position input by the user.

- 1 Click [Create Point] button in the menu bar.

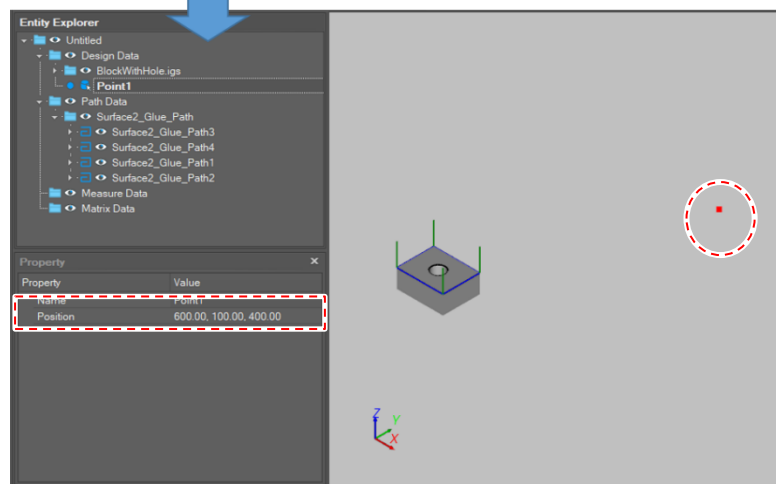


- 2 Select [Create Point By XYZ Input] option in the active window.

- 3 Set creation option.

- Group: A group to which newly created object belongs.
- Position(X, Y, Z)

- 4 Select the [Create] button.



Create Point On TCP Position

The function creates a point at the current robot position.

Note

Before creating a point, the user needs to check the TCP and coordination configuration.

- 1 Click [Create Point] button in the menu bar.



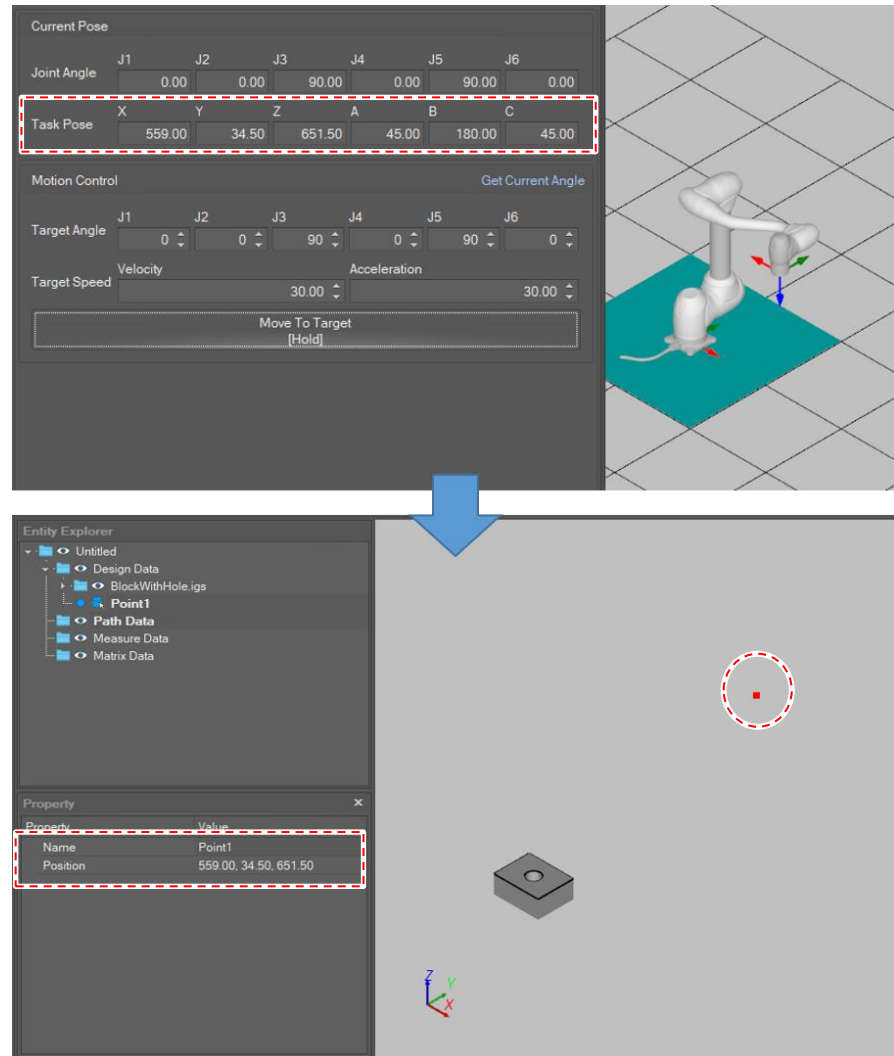
- 2 Select [Create Point On TCP Position] option in the active window.

- 3 Set creation option.

- Group: A group to which newly created object belongs.

- Coordinate: The base or world coordinate type.

4 Select the [Create] button.



Create Center Point

The function create a point at the center of the selected object.

1 Click [Create Point] button in the menu bar.



2 Select [Create Center Point(From Points)], [Create Center Point(From Curve)] or [Create Center Point(From Mesh/Surface)] option in the active window.

3 Set creation option.

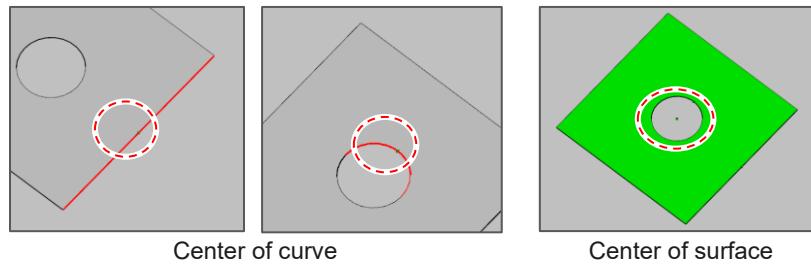
- Group: A group to which newly created object belongs.

4 Select target objects.

The input condition is as below according to the selected function.

From Points	More than 1 point object.
From Curve	A curve (or path segment) object
From Mesh/Surface	A surface (or mesh) object.

5 Select the [Create] button.



Create Circle Center Point

The function creates a point at the circular center of the selected object.

1 Click [Create Point] button in the menu bar.



2 Select [Create Circle Center Point(From Points)] or [Create Center Point(From Curve)] option in the active window.

3 Set creation option.

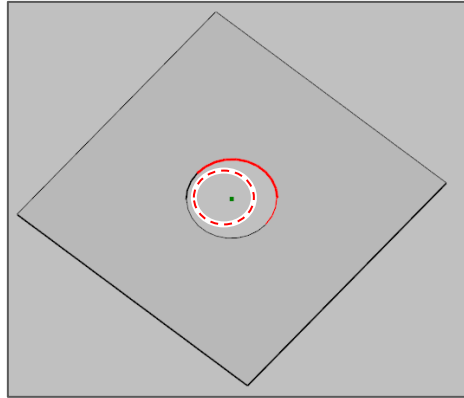
- Group: A group to which newly created object belongs.

4 Select target objects.

The input condition is as below according to the selected function.

From Points	Equal or more than 3 point objects
From Curve	A curve (or path segment) object

5 Select the [Create] button.



Create Intersection Point

The functions creates a point at the intersection position of the selected objects.

- 1 Click [Create Point] button in the menu bar.



- 2 Select [Create Intersection Point(From Line-Line)], [Create Intersection Point(From Line-Plane)] or [Create Intersection Point(From 3 Planes)] option in the active window.

- 3 Set creation option.

- Group: A group to which newly created object belongs.

- 4 Select target objects.

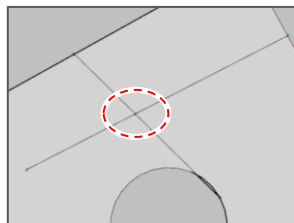
The input condition is as below according to the selected function.

From Line-Line 2 line (or path segment) objects.

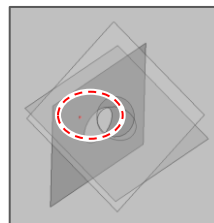
From Line-Plane A plane object and a line object.

From 3 Planes 3 plane (or mesh) object.

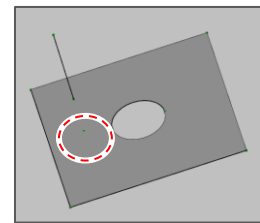
- 5 Select the [Create] button.



Intersection of lines



Intersection of line and plane



Intersection of planes

Create Projection Point

The function creates a point at the projection position of a point to the selected curve or surface.

- 1 Click [Create Point] button in the menu bar.



- 2 Select [Create Projection Point(From Curve)] or [Create Projection Point(From Mesh/Surface)] option in the active window.

- 3 Set creation option.

- Group: A group to which newly created object belongs.

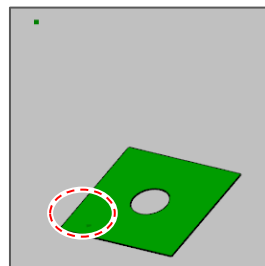
- 4 Select target objects.

The input condition is as below according to the selected function.

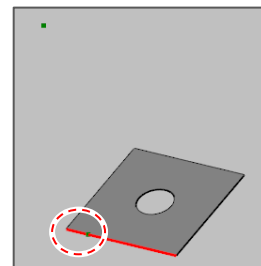
From Curve A point object and a curve (or path segment) object.

From Mesh/Surface A point object and a surface (or mesh) object.

- 5 Select the [Create] button.



Projection to surface



Projection to curve

Note

If the point is located outside the curve and surface so that the projection is impossible, a new point is created at the nearest position from the point to the target object.

Create N Points on Curve

The function creates N even points on the selected curve.

- 1 Click [Create Point] button in the menu bar.

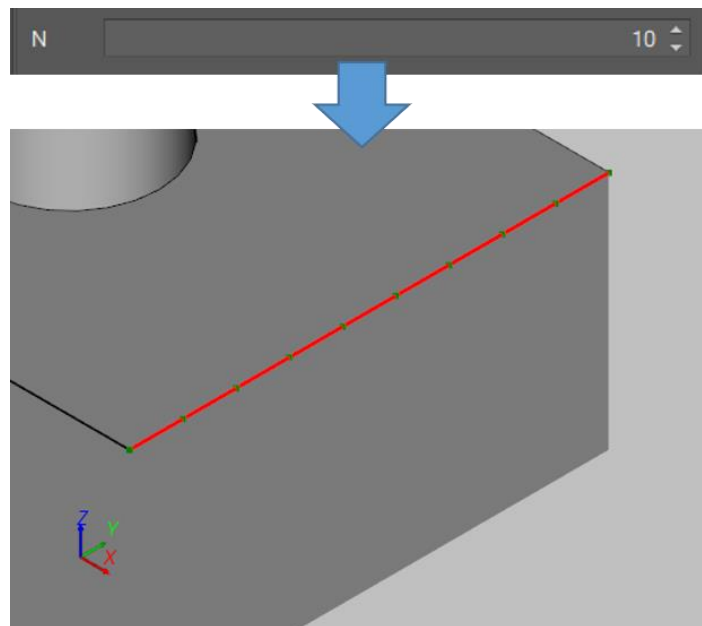


- 2 Select [Create N Points on Curve] option in the active window.

- 3 Set creation option.

- Group: A group to which newly created object belongs.
- N: Number of points to create. The number should be greater or equal to 2.

- 4 Select a curve object.
- 5 Select the [Create] button.



1.7.2 Create line/curve

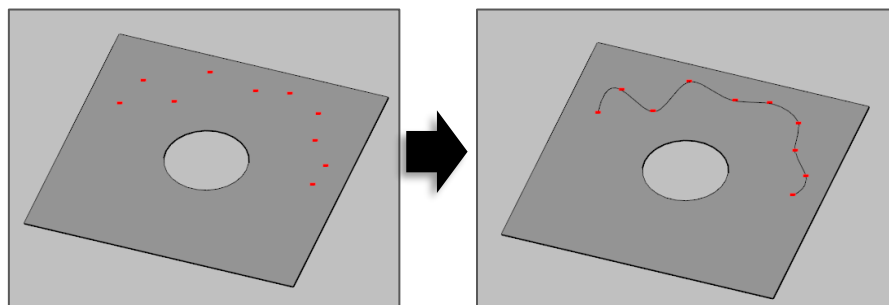
Create spline curve

The function creates a spline curve connecting all the selected point objects.

- 1 Click [Create Curve] button in the menu bar.



- 2 Select [Create Curve] option in the active window.
- 3 Set creation option.
 - Group: A group to which newly created object belongs.
- 4 Select 2 or more point objects.
- 5 Select the [Create] button.



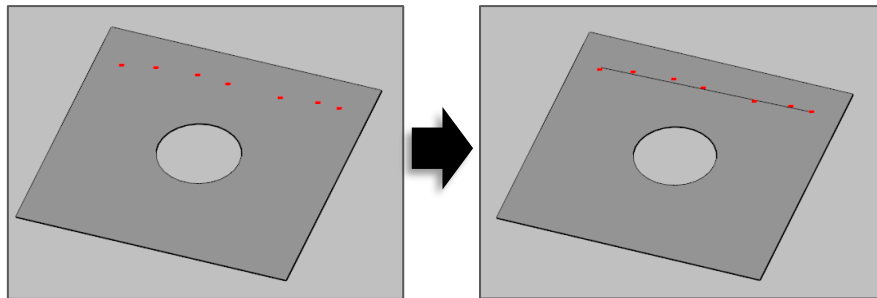
Create Estimated Line

The function creates a line object which minimizes the sum of distance from the point to the line.

- 1 Click [Create Curve] button in the menu bar.



- 2 Select [Create Estimated Line] option in the active window.
- 3 Set creation option.
 - Group: A group to which newly created object belongs.
- 4 Select 2 or more point objects.
- 5 Select the [Create] button.



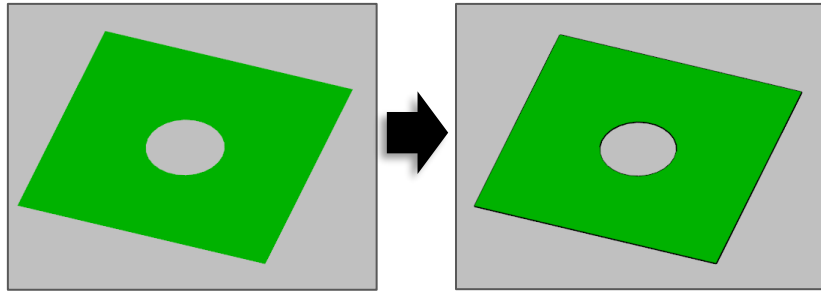
Create Surface Edge

The function creates curve object of surface edges.

- 1 Click [Create Curve] button in the menu bar.



- 2 Select [Create Surface Edge] option in the active window.
- 3 Set creation option.
 - Group: A group to which newly created object belongs.
- 4 Select 1 or more surface object.
- 5 Select the [Create] button.



1.7.3 Edit line/curve

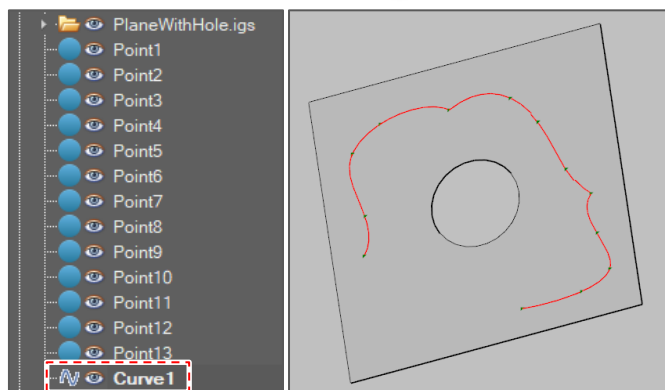
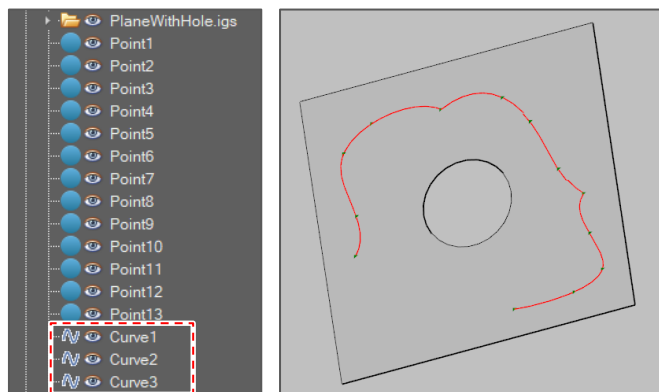
Merge Curves

The function merges 2 or more selected curves into a curve.

- 1 Click [Create Curve] button in the menu bar.



- 2 Select [Merge Curves] option in the active window.
- 3 Select 2 or more curve objects.
- 4 Click the [Run] button.



Split Curve Evenly

The function splits a curve into 2 or more curves which has same length.

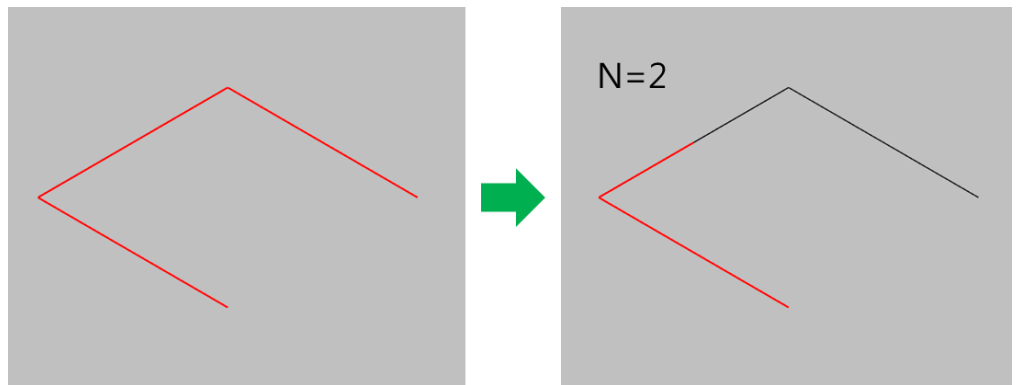
- 1 Click [Create Curve] button in the menu bar.



- 2 Select [Split Curve Evenly] option in the active window
- 3 Select a curve object.
- 4 Select the number of curves to split.



- 5 Click the [Run] button.



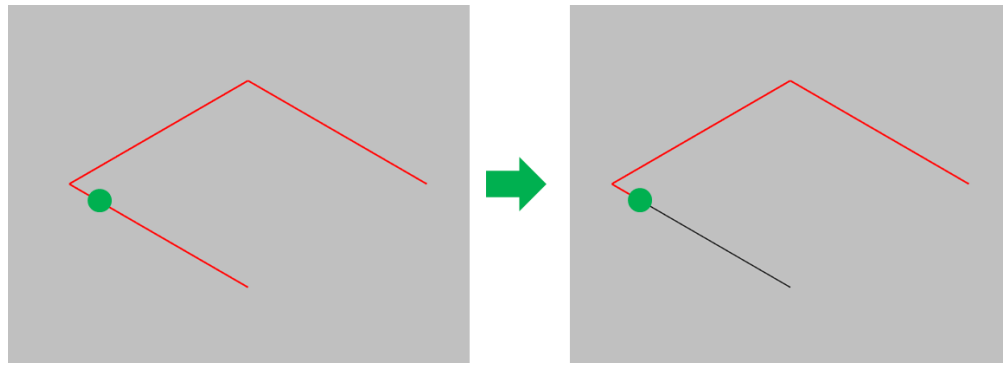
Split Curve On Selected Point

The function split the selected curve into 2 curves on the point on the curve.

- 1 Click [Create Curve] button in the menu bar.



- 2 Select [Split Curve On Selected Point] option in the active window.
- 3 Select a curve object.
- 4 Select a point object on the curve object.
- 5 Click the [Run] button.



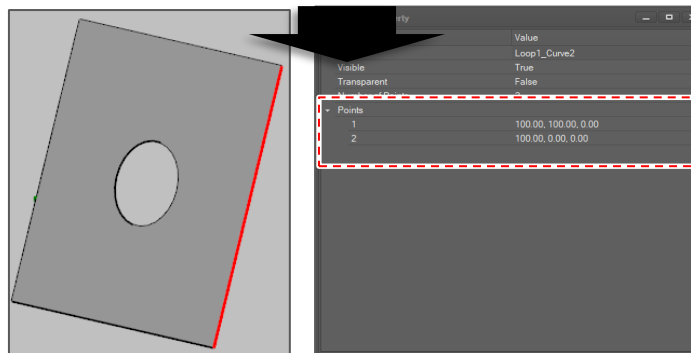
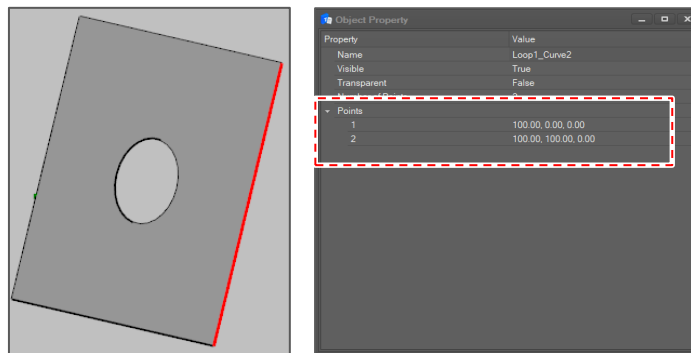
Reverse Curve

The function reversed the direction of the selected curves.

- 1 Click [Create Curve] button in the menu bar.



- 2 Select [Reverse Curve] option in the active window.
- 3 Select 1 or more curve objects.
- 4 Click the [Run] button.



1.7.4 Create Plane/Surface

Create Plane

The function creates a plane from the selected points or curves.

- 1 Click [Create Surface] button in the menu bar.

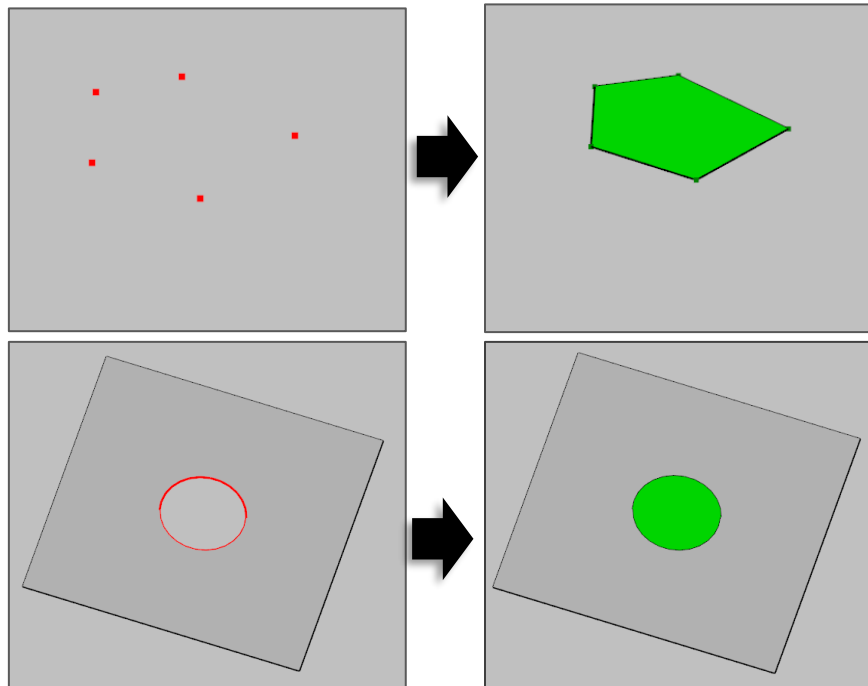


- 2 Select [Create Plane (From Points)] or [Create Plane (From Curves)] option in the active window.
- 3 Set creation option.
 - Group: A group to which newly created object belongs.
- 4 Select target objects.

The input condition is as below according to the selected function.

From Points	3 or more point objects.
From Curves	1 or more curve (or path segment) objects. The curves should be on the same plane and compose a loop.

- 5 Select the [Create] button.



Create Surface From Mesh

The function creates surfaces from the selected mesh object. A mesh object contains triangular mesh information to display the model in 3D view. The function restores geometric surface and curve information from the mesh.

The function can be used when .STL file is used to create a path.

- 1 Click [Create Surface] button in the menu bar.



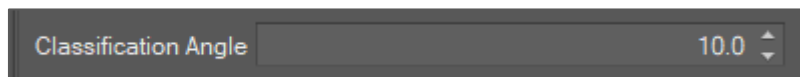
- 2 Select [Create Surface (From Mesh)] option in the active window.
- 3 Set creation option.

- Group: A group to which newly created object belongs.

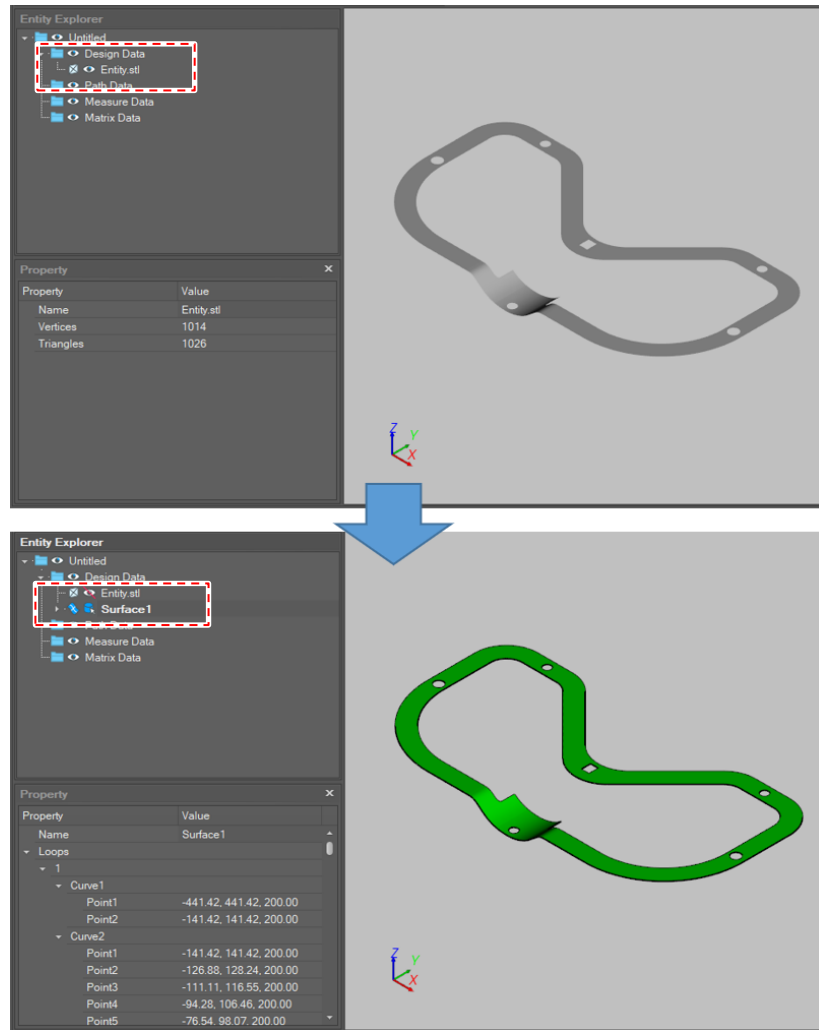
- 4 Select a mesh or surface objects.

Surface object also has mesh information.

- 5 Set the classification angle in degree. If the angle between two neighboring triangles is less than the classification angle, then those triangles belong to the same surface. Or they are split into different surfaces



- 6 Select the [Create] button.



1.7.5 Edit Plane/Surface

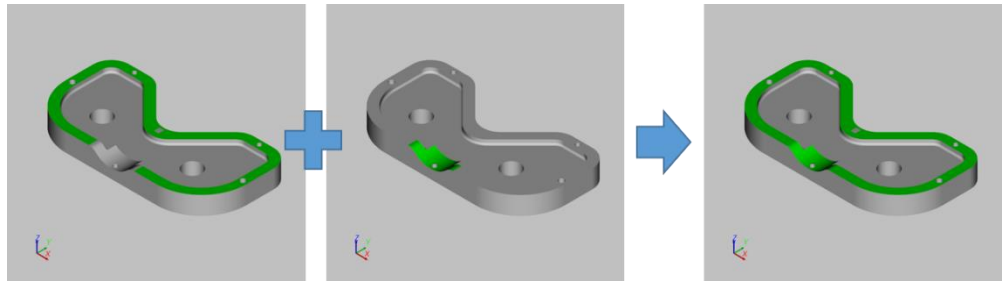
Merge Surface

The function merges surfaces into a surface.

- 1 Click [Create Surface] button in the menu bar.



- 2 Select [Merge Surface] option in the active window.
- 3 Select 2 or more surface objects.
- 4 Click the [Run] button.



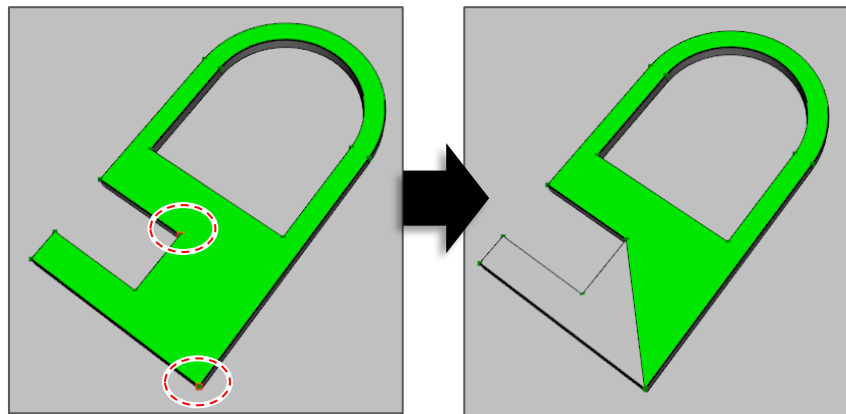
Split Surface

The function splits a surface into 2 surfaces.

- 1 Click [Create Surface] button in the menu bar.



- 2 Select [Split Surface] option in the active window.
- 3 Select a surface object to split.
- 4 Select 2 points on the surface edge to decide the segmentation direction.
- 5 Click the [Run] button.



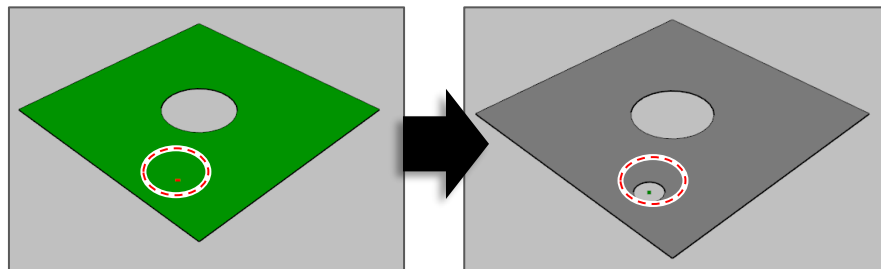
Create Circular Hole On Surface

The function makes a circle-shaped hole inside a surface. The hole can be treated as an obstacle when generating a path.

- 1 Click [Create Surface] button in the menu bar.



- 2 Select [Create Circular Hole On Surface] option in the active window.
- 3 Select a surface object to make a hold.
- 4 Select a point on the surface. The point decides the hole center.
- 5 Set the radius of the hole.
- 6 Click the [Run] button.



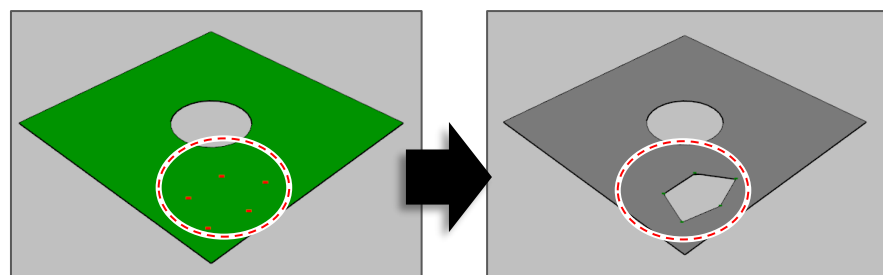
Create Polygon-shape Hole On Surface

The function makes a polygon-shaped hole inside a surface.

- 1 Click [Create Surface] button in the menu bar.



- 2 Select [Create Polygon-shape Hole On Surface] option in the active window.
- 3 Select a surface to make a hole.
- 4 Select 3 or more points on the surface.
Selection sequence decides the polygon shape.
- 5 Click the [Run] button.



Create Curved-shape Hole On Surface

The function makes a curve-shaped hole inside a surface.

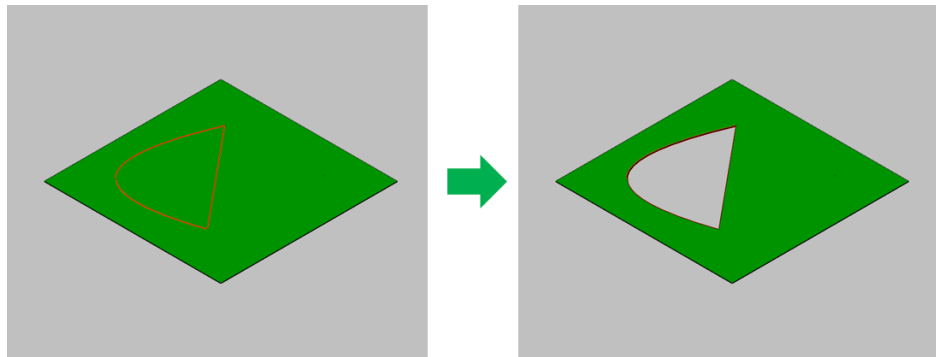
- 1 Click [Create Surface] button in the menu bar.



- 2 Select [Create Curved-shape Hole On Surface] option in the active window.
- 3 Select a surface to make a hole.
- 4 Select curves on the surface.

The selected curves should compose a loop.

- 5 Click the [Run] button.



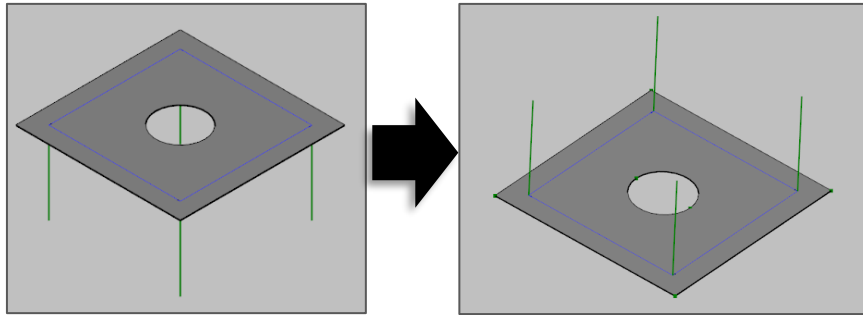
Reverse Surface

The function reverses the direction of loops which composed the surface. The direction of the loop decides the direction of normal vector of the surface. So the function can be used to reverse the initial path orientation when creating a path.

- 1 Click [Create Surface] button in the menu bar.



- 2 Select [Reverse Surface] option in the active window.
- 3 Select 1 or more surface objects.
- 4 Click the [Run] button.



1.7.6 Create Group

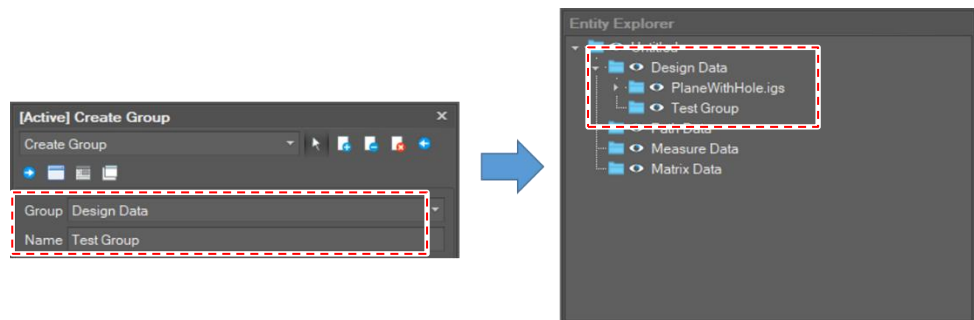
Create Group

The function creates a group object.

- 1 Click [Create Group] button in the menu bar.



- 2 Select [Create Group] option in the active window.
- 3 Select the owner group of the new object.
- 4 Set the name of the new object.
- 5 Select the [Create] button.



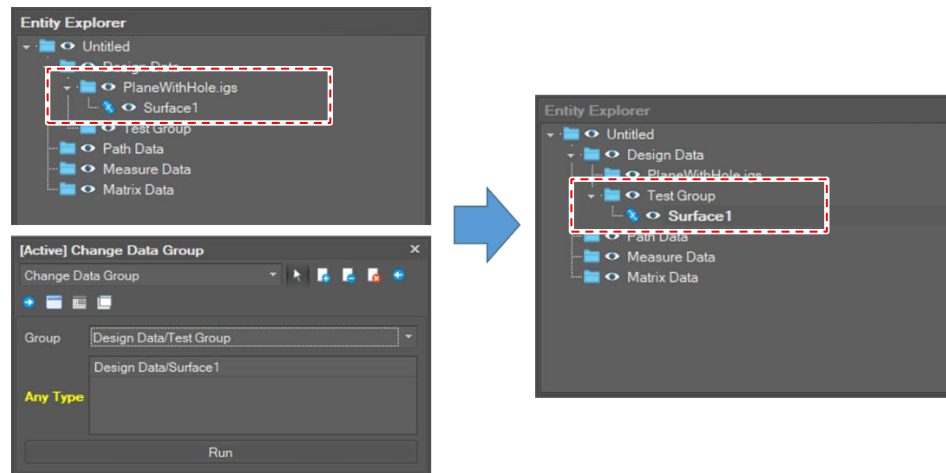
Change Group

The function changes the owner group of the selected objects. In other words, the selected objects move into the selected group.

- 1 Click [Create Group] button in the menu bar.



- 2 Select [Change Data Group] option in the active window.
- 3 Select a group to which the selected object will belong.
- 4 Select objects to move.
- 5 Click the [Run] button.



1.8 Transform Objects Into Robot Space

To apply the created path to the real robot, the object in CAD space should be transformed into the robot space. Or the user can create a path after transforming the CAD model into the robot space.

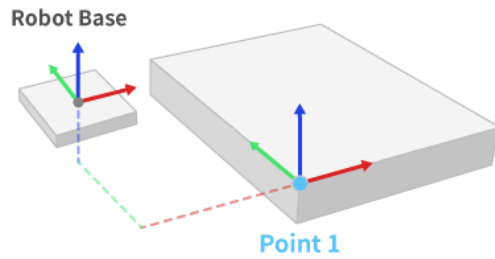
To transform the object in CAD space into the robot space,

- 1 The user should find common points both in CAD model and the real model in the robot space.
- 2 The user should measure the coordinates of the common points in the robot coordinates.
- 3 The program calculates the transformation matrix from the source points in CAD space to the target points in robot space.
- 4 If the user applies the transformation matrix to the CAD model, the model is transformed into the robot space.

The procedure to calculate the transformation from source points to target points is called registration. The program provides several functions for registration.

Point To Point Transformation

The function creates a transformation matrix which moves the source point to the target point. The function assumes that the coordinates of the model is aligned along all direction both in CAD space and in robot space.

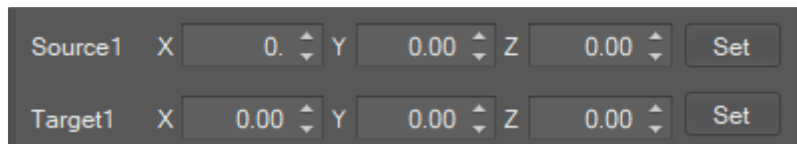


1 Click [Match Objects] button in the menu bar.



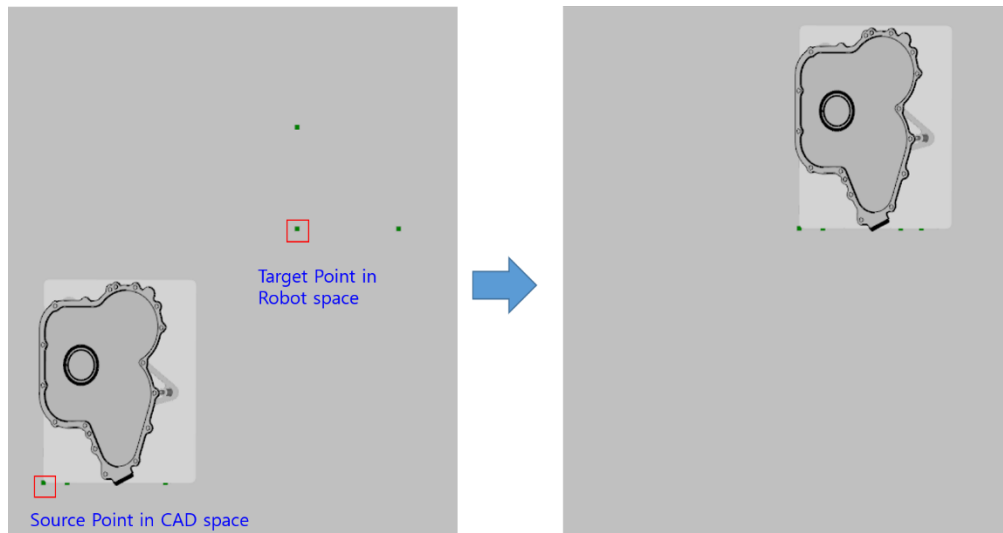
2 Select [Point To Point Registration] option in the active window.

3 Set source and target points.



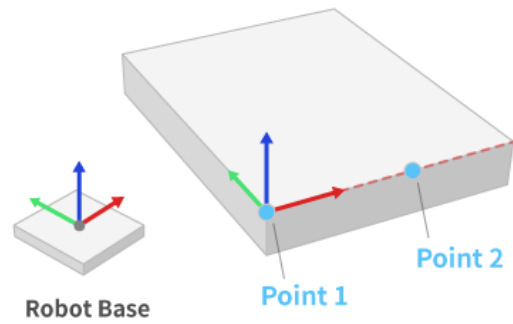
4 Select objects to transform.

5 Click the [Transform] button.



Line To Line Registration

The function creates a transformation matrix which matches the start point and the direction of the source line to the target line. The function assumes that the coordinates of the model is aligned in Z-Axis both in CAD space and in robot space.



Front View



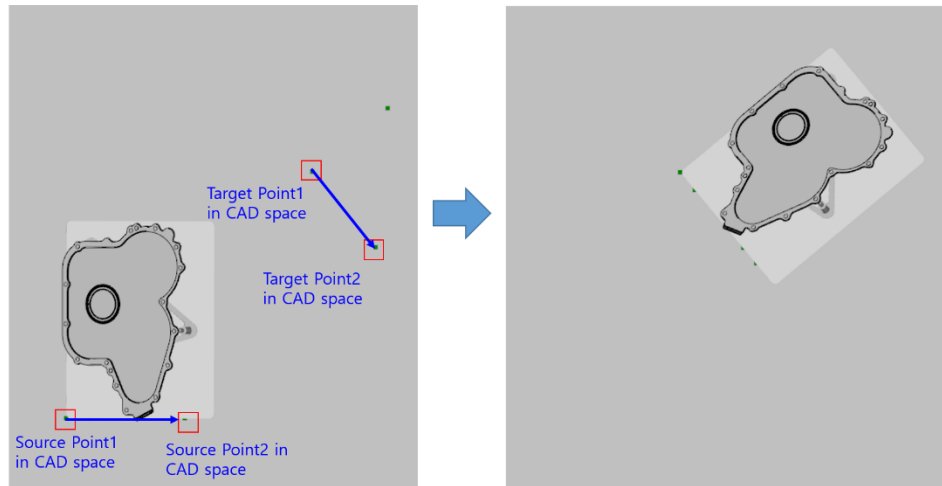
- 1 Click [Match Objects] button in the menu bar.



- 2 Select [Line To Line Registration] option in the active window.
- 3 Set source and target points.

Source1	X	0.00	Y	0.00	Z	0.00	Set
Source2	X	0.00	Y	0.00	Z	0.00	Set
Target1	X	0.00	Y	0.00	Z	0.00	Set
Target2	X	0.00	Y	0.00	Z	0.00	Set

- 4 Select objects to transform.
- 5 Click the [Transform] button.



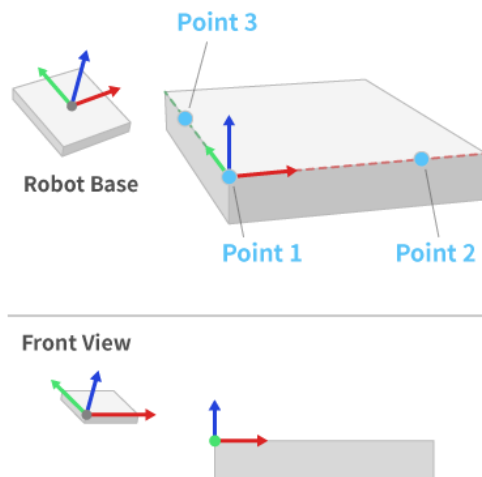
Plane To Plane Registration

The function creates a transformation matrix which matches the source plane to the target plane.

The function assumes that 3 points compose the plane.

- The first point decides the origin point of the plane.
- The second point decides the main axis on the plane.
- The third point decides the normal direction of the plane.

The transformation first coordinates the origin point and the main axis on the plane and the normal direction of the plane.



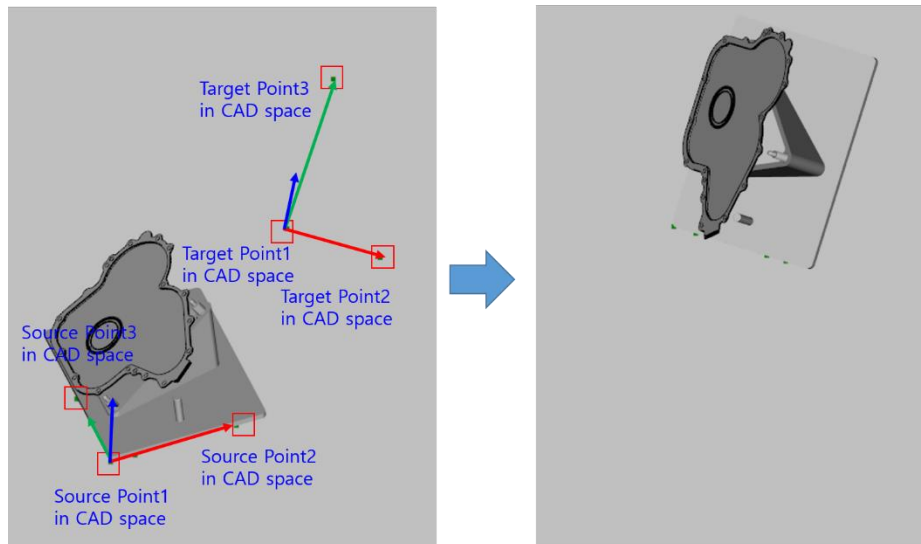
- 1 Click [Match Objects] button in the menu bar.



- 2 Select [Plane To Plane Registration] option in the active window.
- 3 Set source and target points.

Source1	X	0.00	Y	0.00	Z	0.00	Set
Source2	X	0.00	Y	0.00	Z	0.00	Set
Source3	X	0.00	Y	0.00	Z	0.00	Set
Target1	X	0.00	Y	0.00	Z	0.00	Set
Target2	X	0.00	Y	0.00	Z	0.00	Set
Target3	X	0.00	Y	0.00	Z	0.00	Set

- 4 Select objects to transform.
- 5 Click the [Transform] button.



Plane To Plane Registration (2 Lines)

The function provides the same function with [Plane To Plane Registration] except that the function assumes that 4 points compose the plane.

- The first point and the second point compose a line (line 1).
- The third point and the fourth point compose a line (line 2).
- The line 1 decides the main axis on the plane.
- The product of the line 1 and line 2 decides the normal direction of the plane.
- The intersection of the line 1 and the line 2 decides the origin point of the plane.

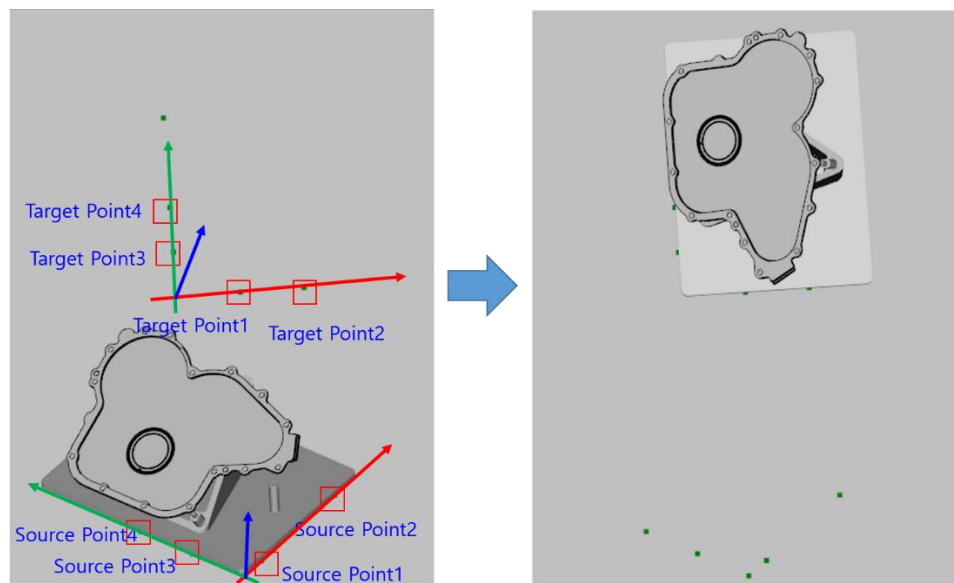
- 1 Click [Match Objects] button in the menu bar.



- 2 Select [Plane To Plane Registration (2 Lines)] option in the active window.
- 3 Set source and target points.

Source1	X	0.00	Y	0.00	Z	0.00	Set
Source2	X	0.00	Y	0.00	Z	0.00	Set
Source3	X	0.00	Y	0.00	Z	0.00	Set
Source4	X	0.00	Y	0.00	Z	0.00	Set
Target1	X	0.00	Y	0.00	Z	0.00	Set
Target2	X	0.00	Y	0.00	Z	0.00	Set
Target3	X	0.00	Y	0.00	Z	0.00	Set
Target4	X	0.00	Y	0.00	Z	0.00	Set

- 4 Select objects to transform.
- 5 Click the [Transform] button.



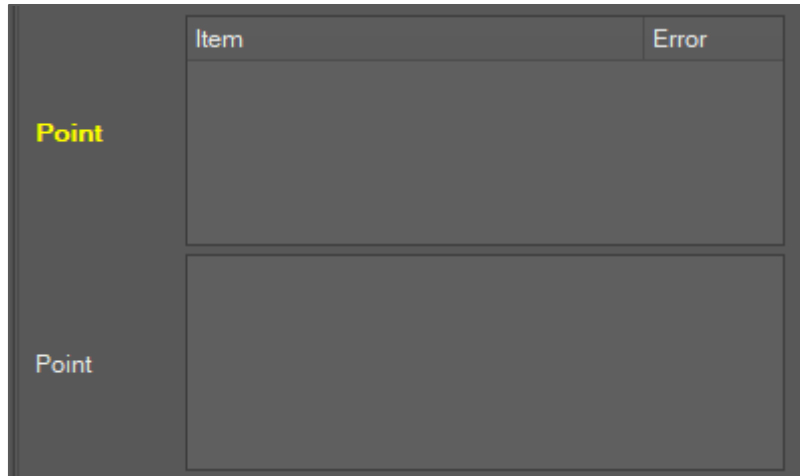
Points To Points Registration

The function creates a transformation matrix which minimize the error between the transformed source points and the target points.

- 1 Click [Match Objects] button in the menu bar.



- 2 Select [Points To Points Registration] option in the active window.
- 3 Set source and target points.



Note

The number of source points and the number of target points should be greater or equal than 3 but may be different.

- 4 Set error tolerance.

The error means the distance between corresponding matching points. The tolerance means the maximum error allowed and decides when the matching iteration stops.



- 5 생성되는 행렬 관련 옵션을 설정합니다.

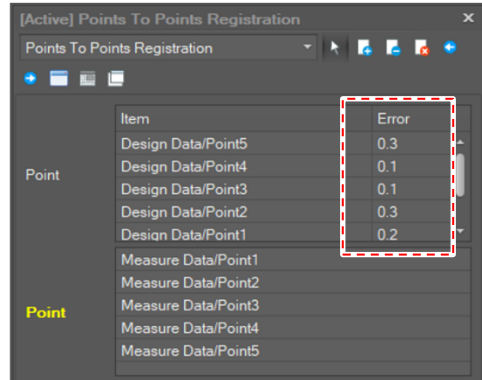
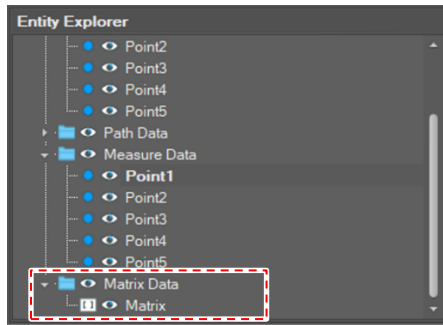
The function calculates a matrix from the source points to the target points. The [Also Create Inverse Matrix] flag allows to create additional inverse transformation matrix from the target points to the source points. The inverse matrix is named "MatrixName_Inverse".



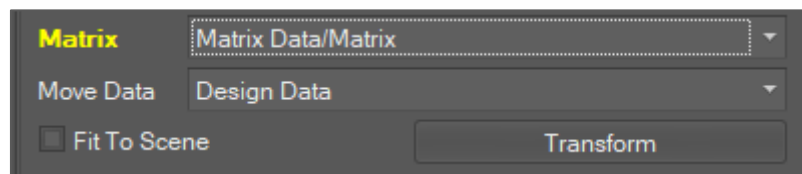
- 6 Set the matrix name and click the [Create Matrix] button.



If the matrix is created, the error between the source point and the target point is displayed. The user should evaluate the error to decide whether to use the matrix or not. If the error is beyond the allowance error, add more points or delete outlier points.



■ Apply Matrix



- 1 Select the matrix to apply.
- 2 Select a group to move.

If the transformation matrix is applied, the whole child objects in the group are transformed.

- 3 Click the [Transform] button.

Points To Curves Registration

The function creates a transformation matrix which minimize the error between the transformed source points and the projected points to the curves.

The usage of the function is same as the [Points To Points Registraton]. Please refer to the [Points To Curves Registration] section above.

Point To Surfaces Registration

The function creates a transformation matrix which minimize the error between the transformed source points and the projected points to the surfaces.

The usage of the function is same as the [Points To Points Registraton]. Please refer to the [Points To Curves Registration] section above.

1.9 Create Script

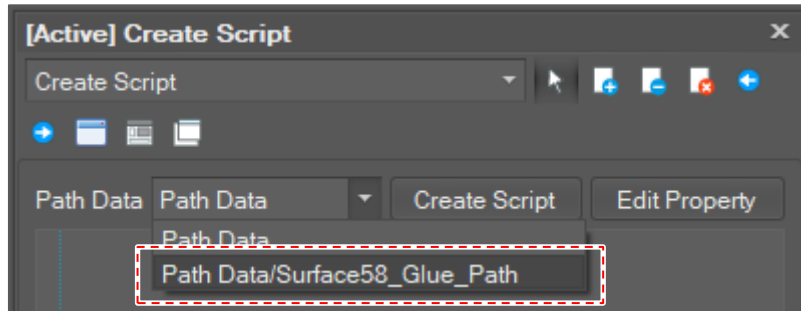
Create Script

The function create a DRL script from the path objects.

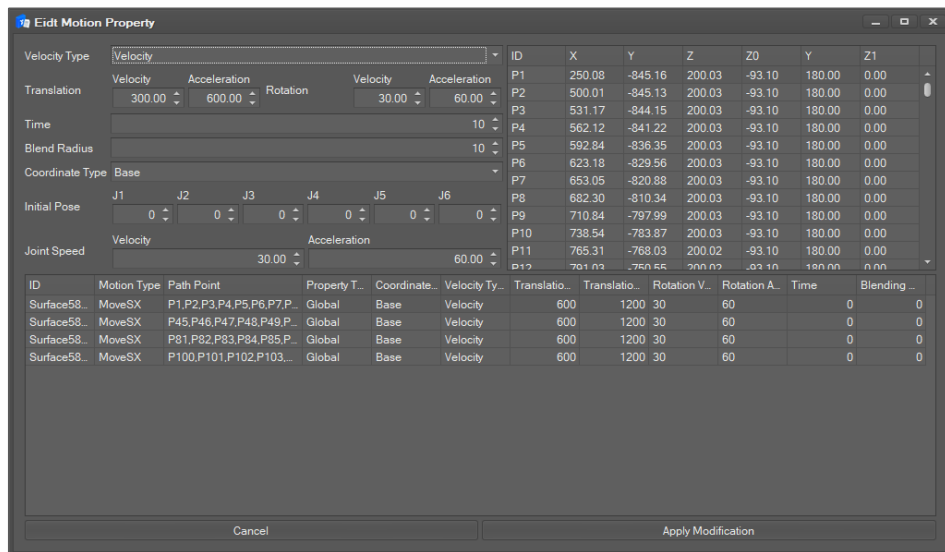
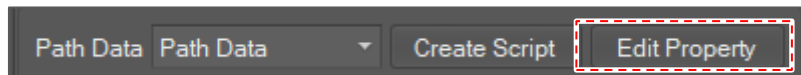
1 Click [Create Script] button in the menu bar.



2 Select a path data group to create a script.



3 Click [Edit Property] to edit motion property.



A motion has properties as below.

Velocity Type There are two options: Velocity and Time.
 Velocity: velocity and acceleration value decide the speed of motion.
 Time: motion complete time decides the speed.

Translation Speed/Acceleration Speed Applied in case that velocity type is 'Velocity'.

Time Applied in case that velocity type is 'Time'. The unit of time is second.

Coordinate Type The coordinate type of motion points: Base or World.

Blending Radius If the value is greater than 0, the current motion will be blended when the TCP reaches the point where the distance from the next motion's starting position is less than the radius.

If the value is 0, no blending occurs.

A path segment is translated into a motion script. Initially all motion script follows the global property.

Velocity Type: Velocity

Translation: Velocity (300.00), Acceleration (600.00), Rotation Velocity (30.00), Rotation Acceleration (60.00)

Time: 10

Blend Radius: 10

Coordinate Type: Base

If the user changes the property type to 'Local', the motion follows the local property.

Property T...	Coordinate...	Velocity Ty...	Translati...	Translati...	Rotation V...	Rotation A...	Time	Blending ...
Local	Base	Velocity	600	1200	30	60	0	0
Global	Base	Velocity	600	1200	30	60	0	0
Global	Base	Velocity	600	1200	30	60	0	0
Global	Base	Velocity	600	1200	30	60	0	0

The user can define initial joint pose and joint motion speed.

Initial Pose: J1 (0), J2 (0), J3 (0), J4 (0), J5 (0), J6 (0)

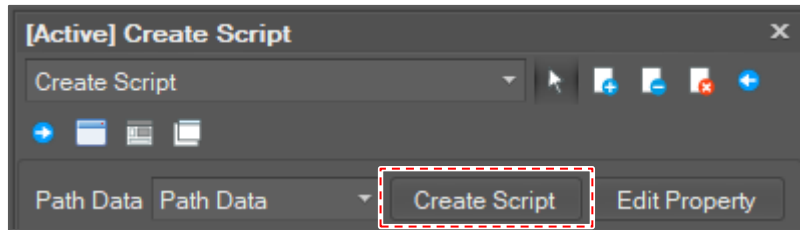
Joint Speed: Velocity (30.00), Acceleration (60.00)

수정이 완료되면 속성 반영 버튼을 클릭합니다. 속성 반영을 해야 수정 내용이 스크립트에 반영됩니다.

ID	Motion Type	Path Point	Property T...	Coordinate...	Velocity Ty...	Translati...	Translati...	Rotation V...	Rotation A...	Time	Blending ...
Surface58...	MoveSX	P1,P2,P3,P4,P5,P6,P7,P...	Local	Base	Velocity	600	1200	30	60	0	0
Surface58...	MoveSX	P45,P46,P47,P48,P49,P...	Global	Base	Velocity	600	1200	30	60	0	0
Surface58...	MoveSX	P81,P82,P83,P84,P85,P...	Global	Base	Velocity	600	1200	30	60	0	0
Surface58...	MoveSX	P100,P101,P102,P103...	Global	Base	Velocity	600	1200	30	60	0	0

Buttons: Cancel, Apply Modification

4 Click the [Create Script] button to Create Script.



5 Check the result script.

```
1 #define global variable/acceration speed
2 gTransVel = 300
3 gTransAcc = 600
4 gRotVel = 30
5 gRotAcc = 60
6 gTime = 10
7 gBlendRadius = 10
8 gCoordinate = DR_BASE
9 gJointVel = 30
10 gJoiintAcc = 60
11
12 #define global point variables
13 P1 = posx(250, -500, 200, -180, 180, 0)
14 P2 = posx(500, -500, 200, -180, 180, 0)
15 P3 = posx(531.4, -499.0, 200, -180, 180, 0)
16 P4 = posx(562.7, -496.1, 200, -180, 180, 0)
17 P5 = posx(593.7, -491.1, 200, -180, 180, 0)
18 P6 = posx(624.3, -484.3, 200, -180, 180, 0)
19 P7 = posx(654.5, -475.5, 200, -180, 180, 0)
20 P8 = posx(684.1, -464.9, 200, -180, 180, 0)
21 P9 = posx(712.9, -452.4, 200, -180, 180, 0)
22 P10 = posx(740.9, -438.2, 200, -180, 180, 0)
23 P11 = posx(767.9, -422.2, 200, -180, 180, 0)
24 P12 = posx(793.9, -404.5, 200, -180, 180, 0)
25 P13 = posx(818.7, -385.3, 200, -180, 180, 0)
26 P14 = posx(842.3, -364.5, 200, -180, 180, 0)
27 P15 = posx(864.5, -342.3, 200, -180, 180, 0)
28 P16 = posx(885.3, -318.7, 200, -180, 180, 0)
```

6 Copy and paste the script to the DRL project source editor.

Note

The script generation could fail in cases as below.

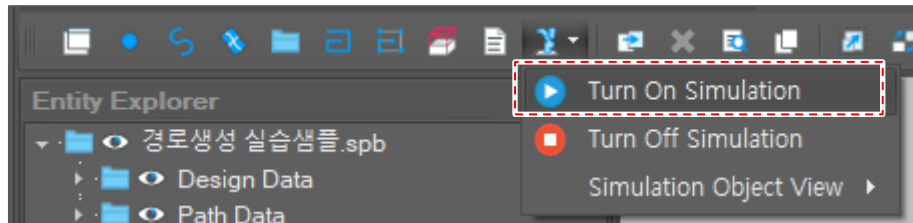
- Spline motion restricts the path points to 100. If a path segment has more than 100 path points, the script generation fails. In that case, the user split the path segment so that the number of path points is less than 100.
- Blend motion restricts the segment motions to 100. If a blend path segment has more than 100 child segments, the script generation fails. In that case, the user split the path segment so that the number of child segment is less than 100.

- The child segment of blend path segment should be line or arc. If the type of curve of the child segment is not one of them, the script generation fails. In that case, the user should modify the curve type of the child segment.

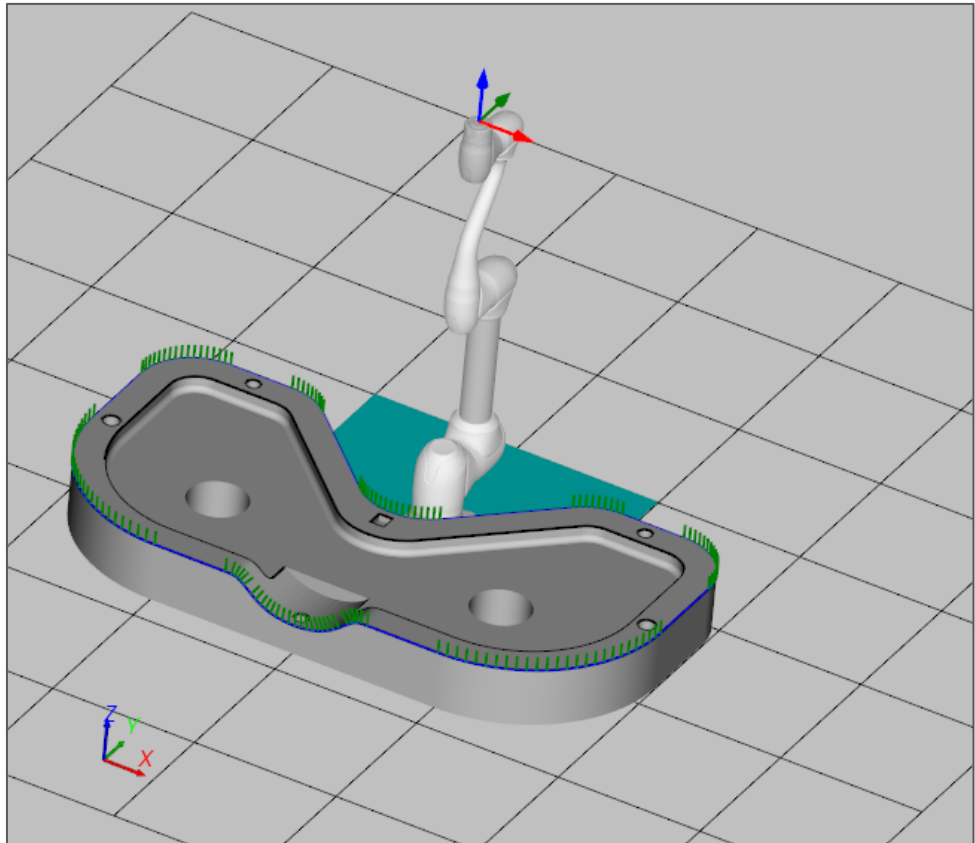
Run Script

The program provides functions to verify the motion and the trajectory of the generated script.

- 1 Connect to the controller.
- 2 Copy and paste the generated code to the script editor of the [Task manager].
- 3 Click the [Turn On Simulation] button in the menu bar.

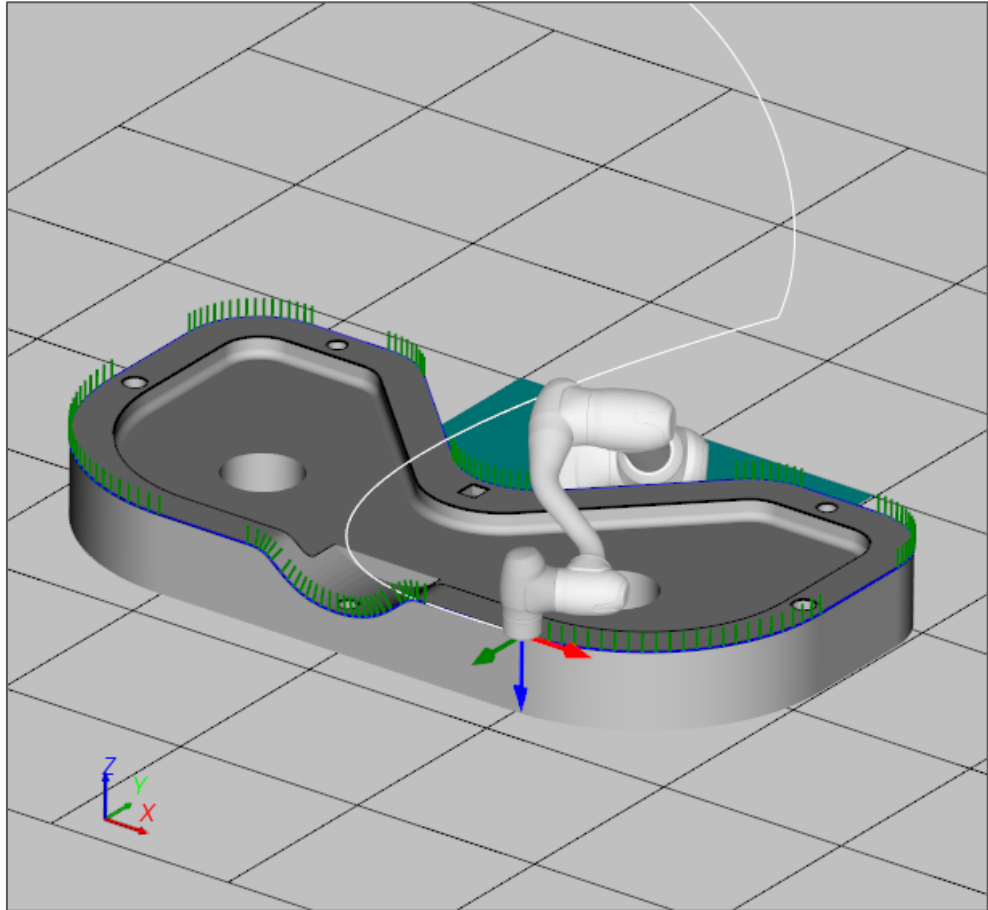


If the program is connected to the controller, the shape of currently connected robot model is display.

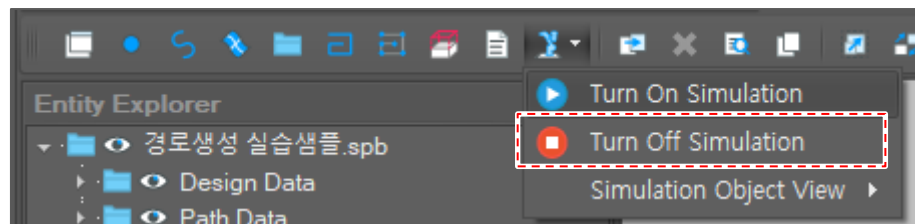


4 Run the program in the [Task manager].

If program starts, the trajectory of the TCP is drawn in the 3D view. Check the trajectory of the motion.

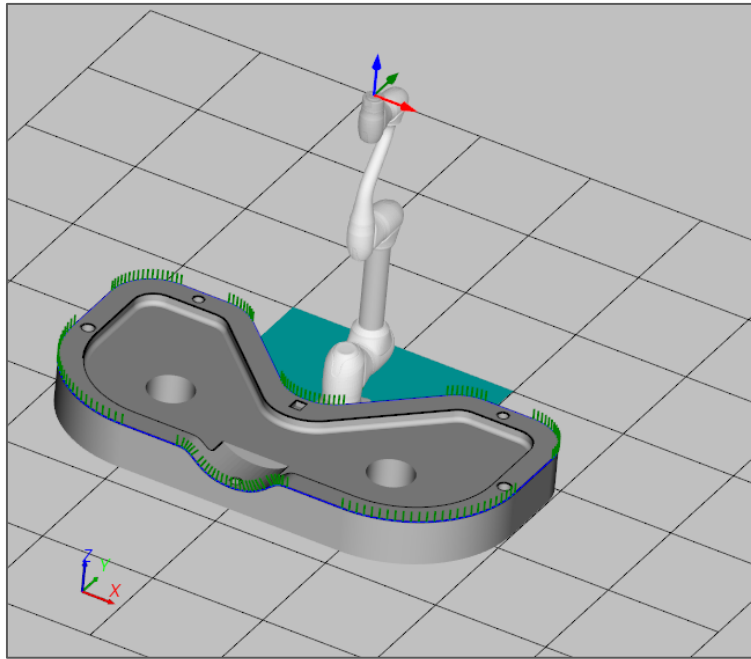


5 If the simulation is done, click the [Turn Off Simulation] button in the menu bar.

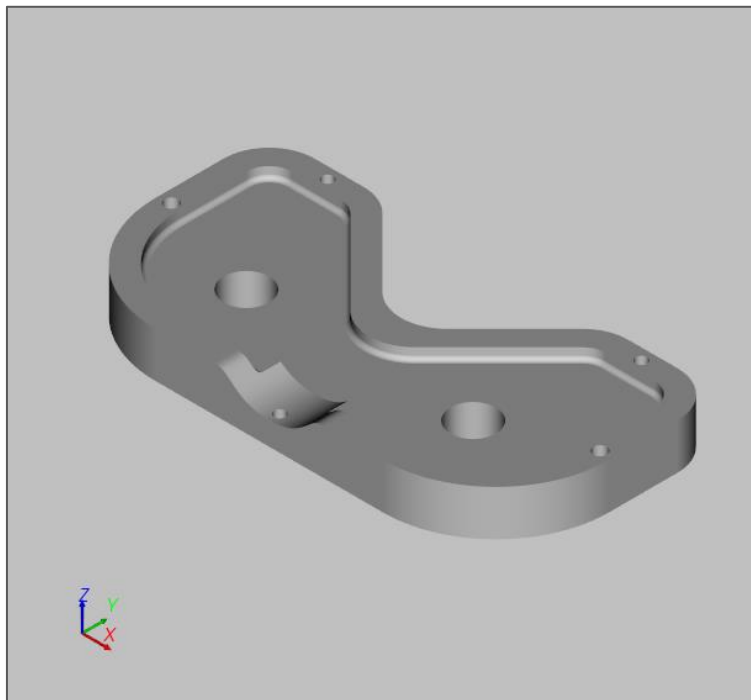


1.10 Overall Practice

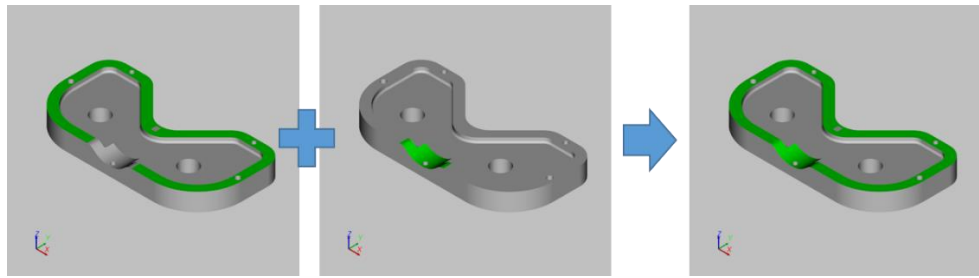
This chapter guides overall procedures from loading a cad file to the simulation of the generated script.



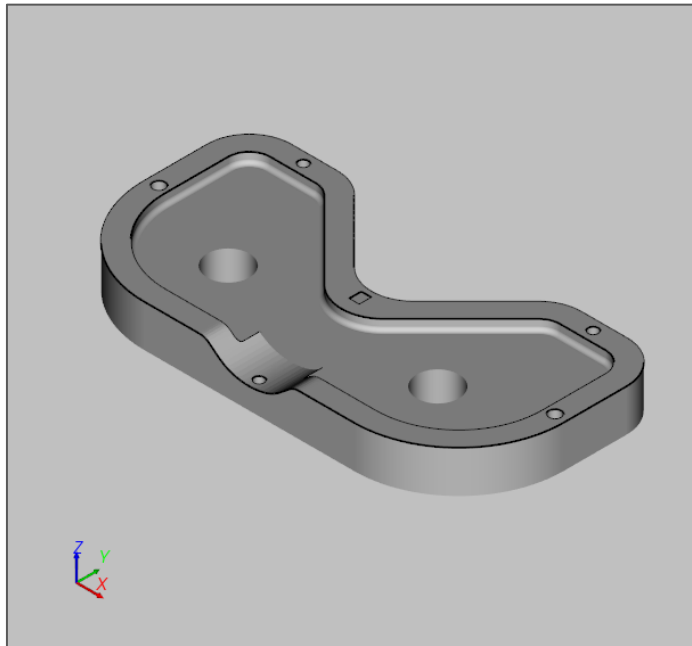
1 Load a CAD file.



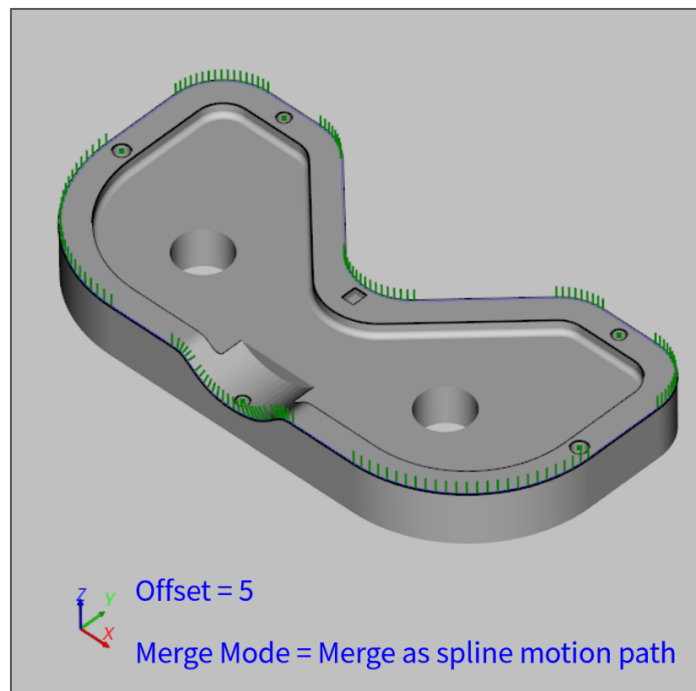
2 Merge surfaces. User 'Merge Surface' function.



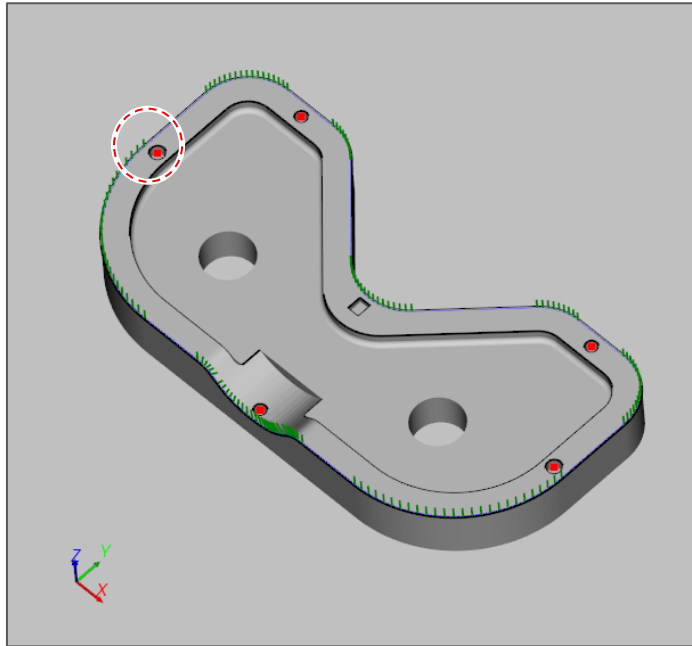
3 Create edge of the surface. User 'Create Surface Edge' function.



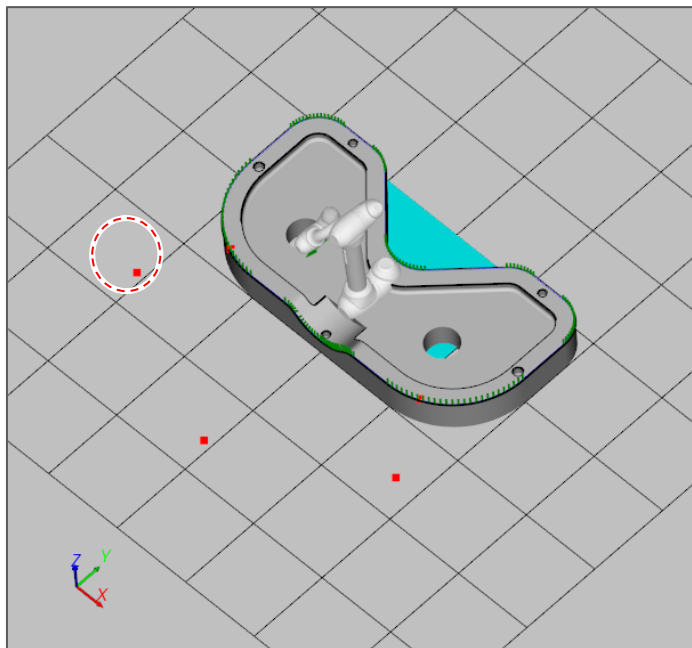
4 Create a surface edge path. Use 'Create Glue Path' function.



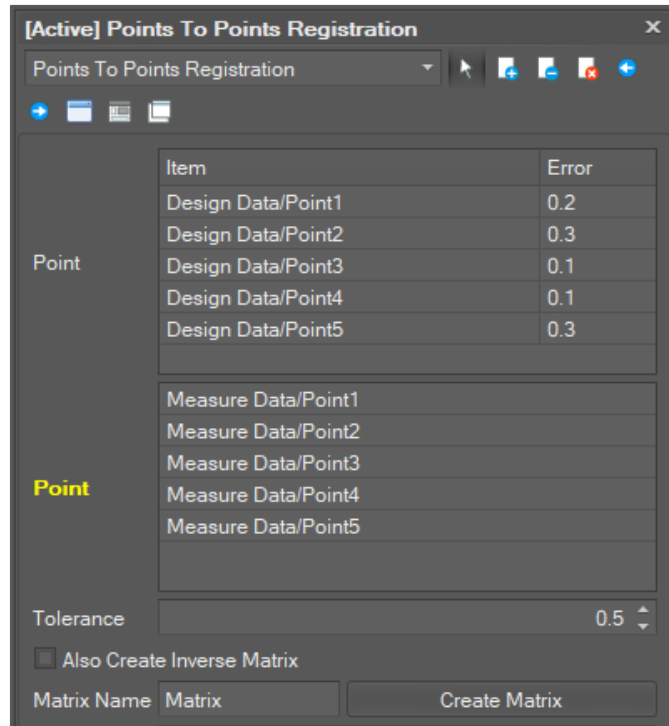
- 5 Create source points for registration. User 'Create Circular Center Point' function.



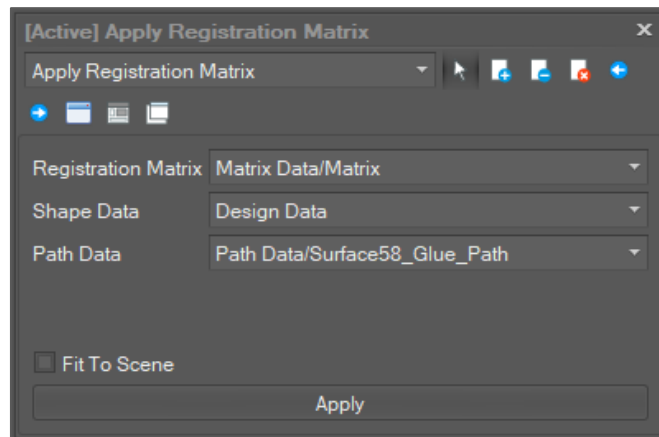
- 6 Measure the target points in the robot space. User the 'Create Point On TCP Position'.

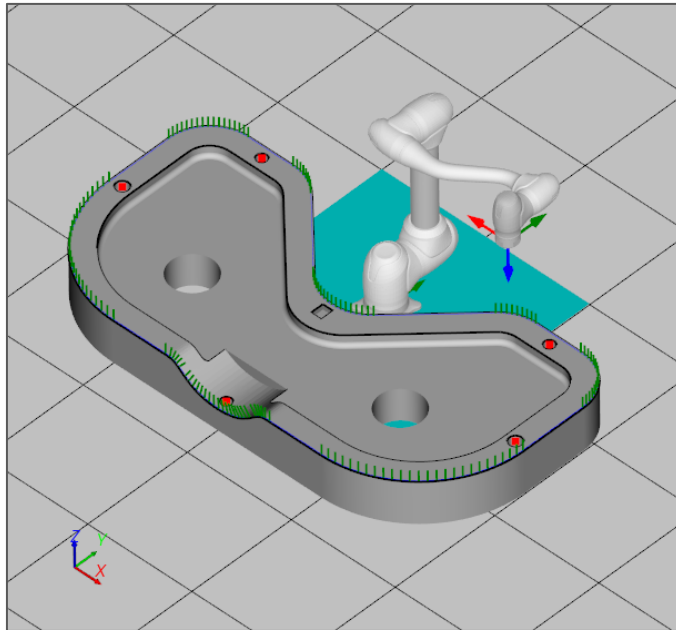


- 7 Create a transformation matrix from the source points in CAD space to the target points in the robot space. Use the 'Points To Points Registration' function.



- 8 Move the path data and the shape data into the robot space. Use the 'Apply Registration Matrix' function.





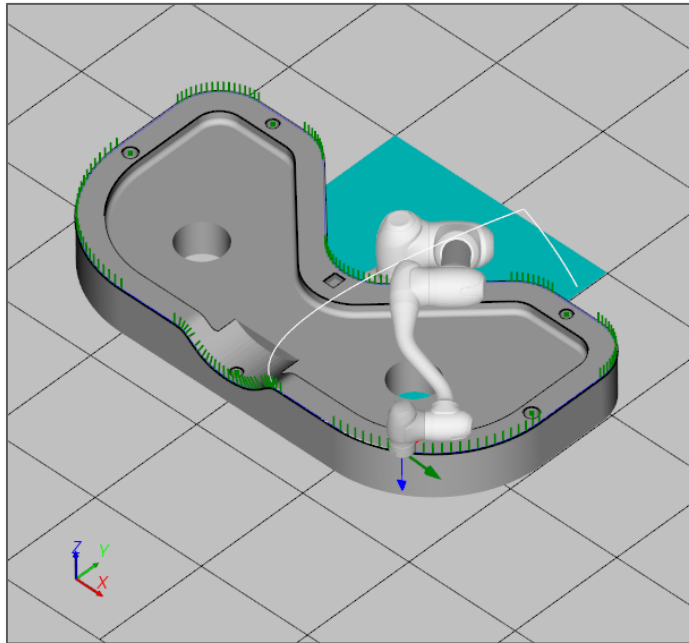
9 Create a script. User 'Create Script' function.

```

[Active] Create Script
Create Script
Path Data Path Data Create Script Edit Property
1 #define global variable/acceleration speed
2 gTransVel = 300
3 gTransAcc = 600
4 gRotVel = 30
5 gRotAcc = 60
6 gTime = 10
7 gBlendRadius = 10
8 gCoordinate = DR_BASE
9 gJointVel = 30
10 gJointAcc = 60
11
12 #define global point variables
13 P1 = posx(250.1, -845.2, 200.0, -93.1, 180.0, 0)
14 P2 = posx(500.0, -845.1, 200.0, -93.1, 180.0, 0)
15 P3 = posx(531.2, -844.1, 200.0, -93.1, 180.0, 0)
16 P4 = posx(562.1, -841.2, 200.0, -93.1, 180.0, 0)
17 P5 = posx(592.8, -836.3, 200.0, -93.1, 180.0, 0)
18 P6 = posx(623.2, -829.6, 200.0, -93.1, 180.0, 0)
19 P7 = posx(653.0, -820.9, 200.0, -93.1, 180.0, 0)
20 P8 = posx(682.3, -810.3, 200.0, -93.1, 180.0, 0)
21 P9 = posx(710.8, -798.0, 200.0, -93.1, 180.0, 0)
22 P10 = posx(738.5, -783.9, 200.0, -93.1, 180.0, 0)
23 P11 = posx(765.3, -768.0, 200.0, -93.1, 180.0, 0)
24 P12 = posx(791.0, -750.6, 200.0, -93.1, 180.0, 0)
25 P13 = posx(815.6, -731.5, 200.0, -93.1, 180.0, 0)
26 P14 = posx(838.9, -710.9, 200.0, -93.1, 180.0, 0)
27 P15 = posx(860.9, -688.9, 200.0, -93.1, 180.0, 0)
28 P16 = posx(881.5, -665.6, 200.0, -93.1, 180.0, 0)
29 P17 = posx(900.5, -641.0, 200.0, -93.1, 180.0, 0)

```

10 Turn on simulation.



1.11 Other Usage Tips

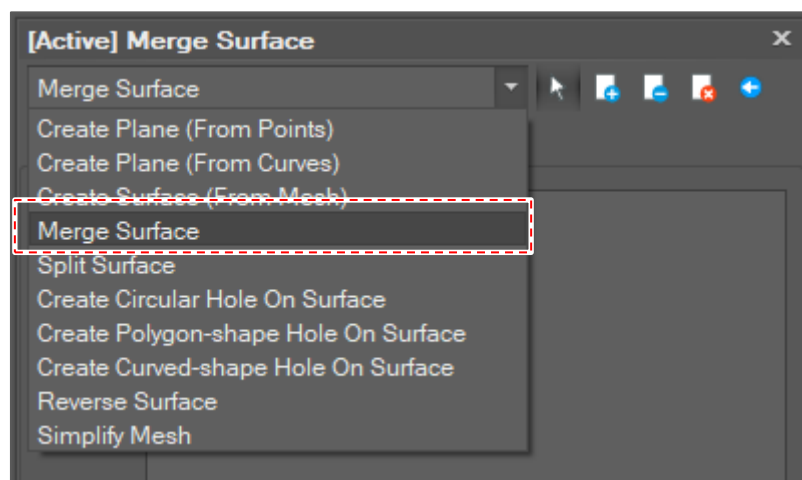
1.11.1 Various methods to open the operation window

Open operation window from main menu bar

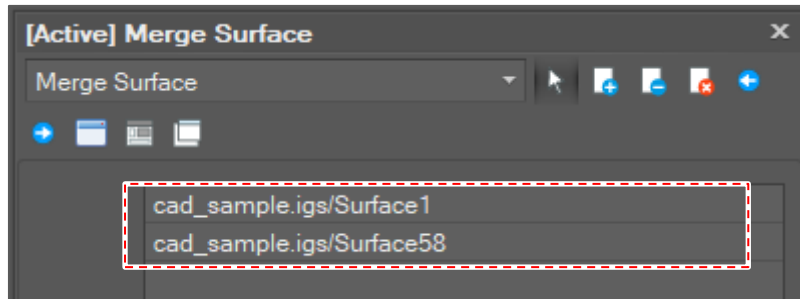
- 1 Click a menu button in the main menu bar.



- 2 Select an option in the active window.

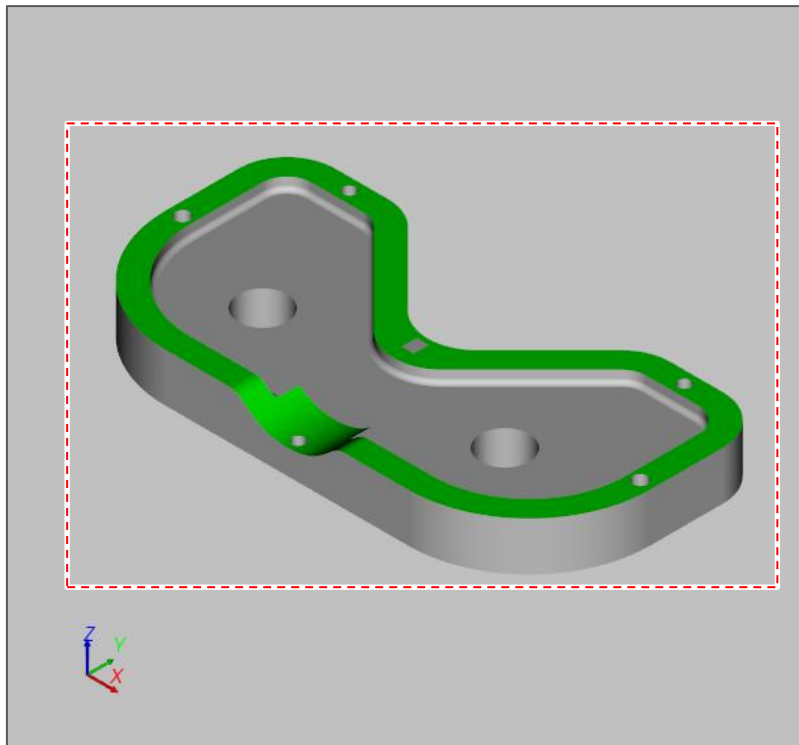


- 3 Select the target objects.

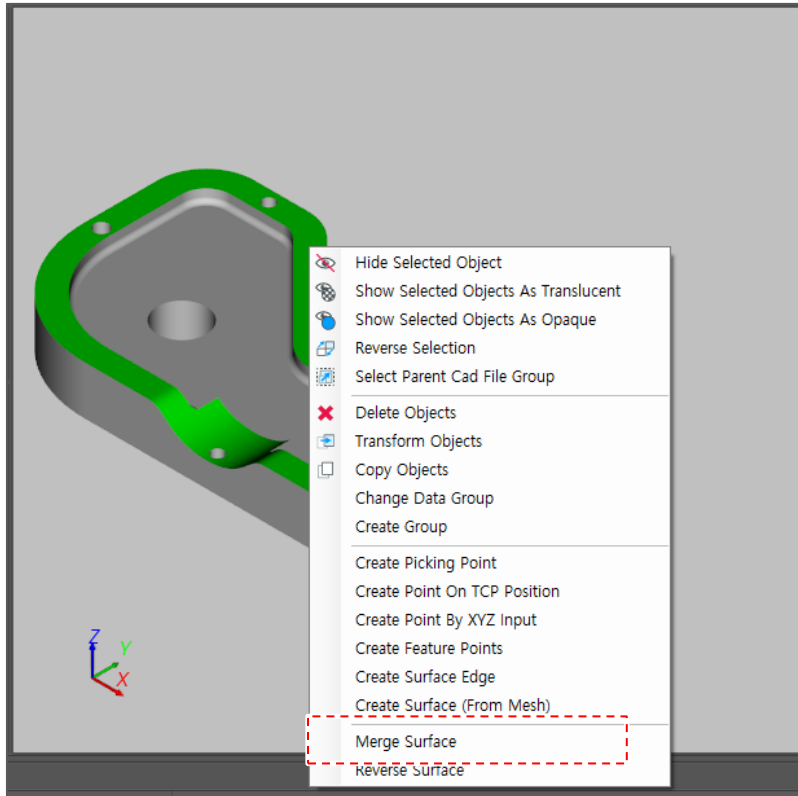


Open operation window from 3D view

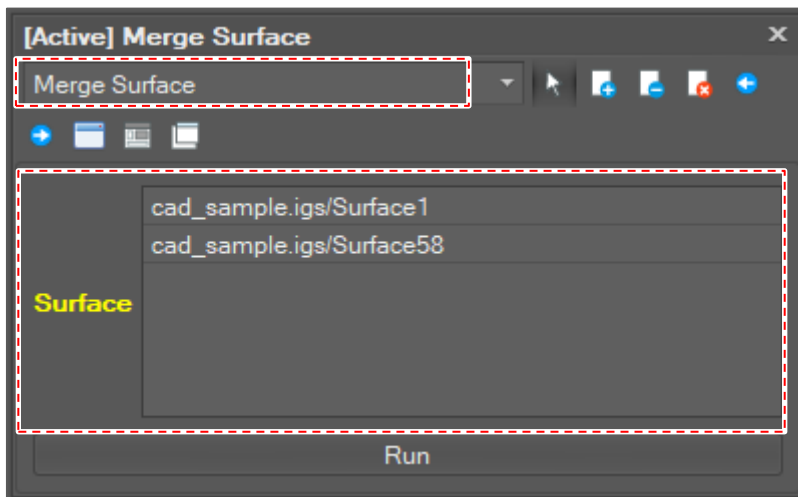
- 1 Select the target objects in the 3D view.



- 2 Select a menu in the context menu.

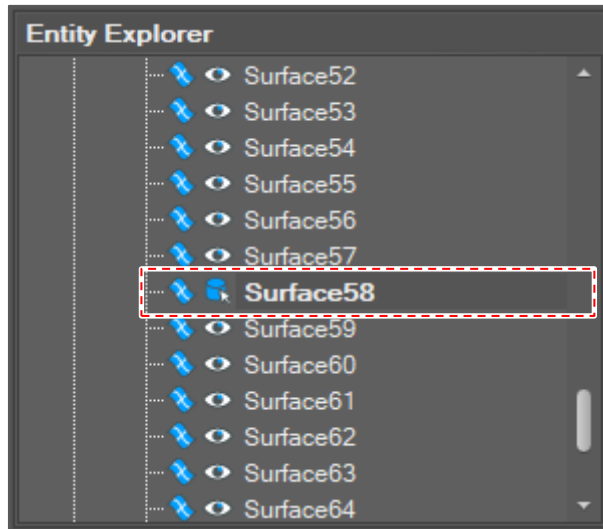


If the user selects a menu, the corresponding operation windows is activated and the control for the target objects are filled.

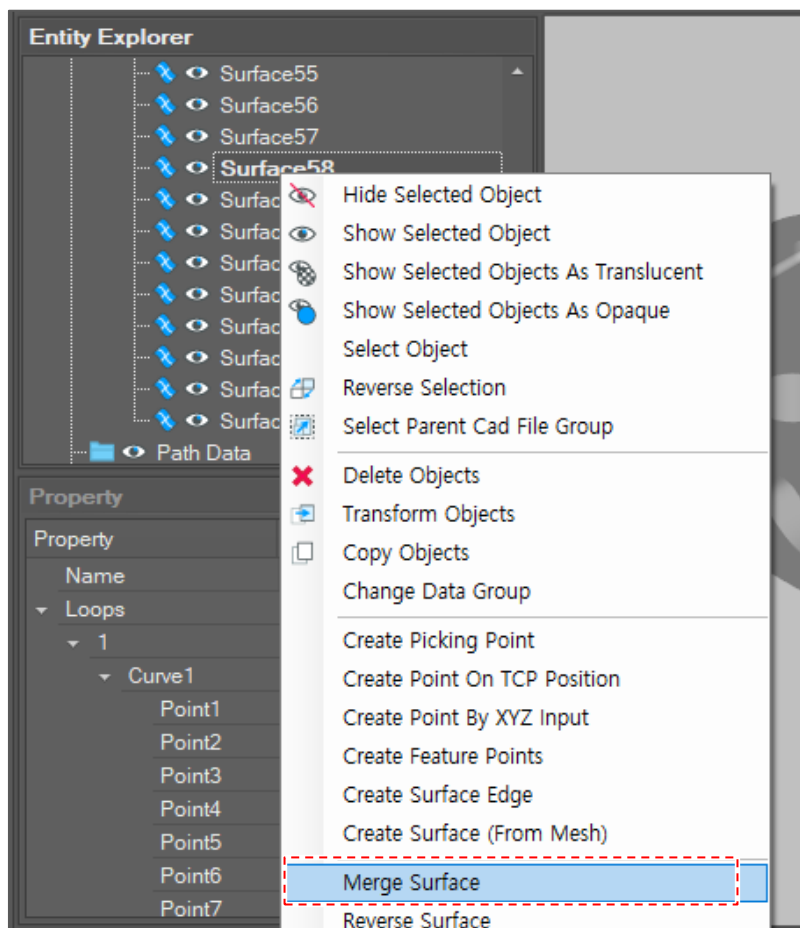


Open operation window from Entity tree

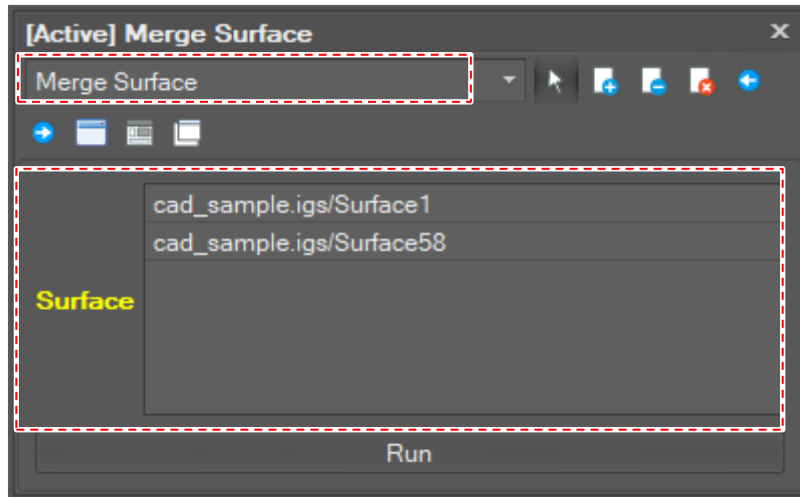
- 1 Select target object in the entity tree.



2 Select a menu in the context menu.



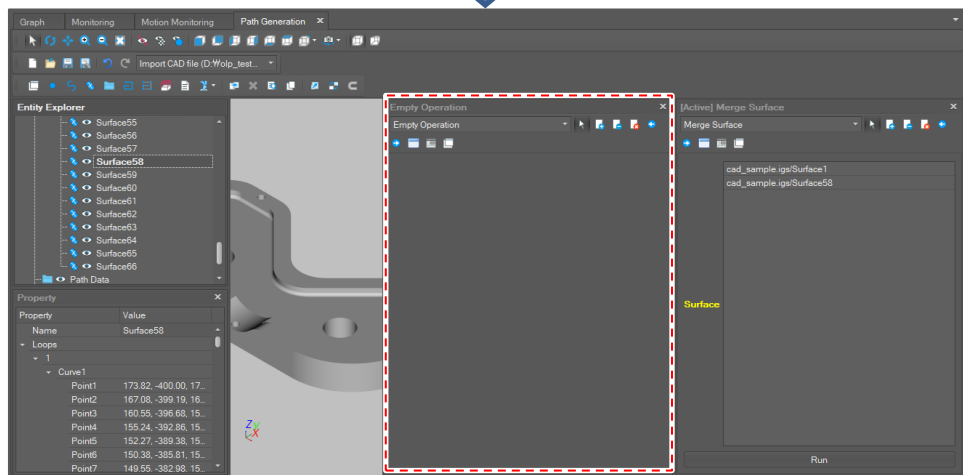
If the user selects a menu, the corresponding operation windows is activated and the control for the target objects are filled.



1.1.2 Open multiple operation windows

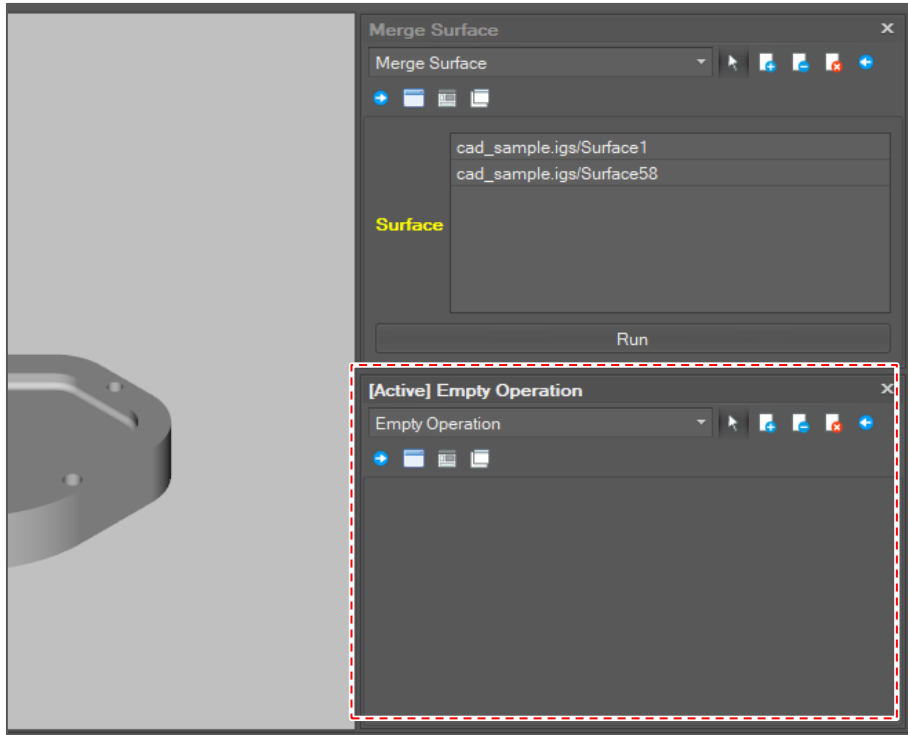
If the user runs a menu, an operation window opens. If the user runs a menu when an operation window is already shown, the window is switched to the corresponding user interface.

The program provides a function to open another operation window. To open another operation window, click [Open a New Work Pane] menu in the menu bar. Then a new empty operation is shown.

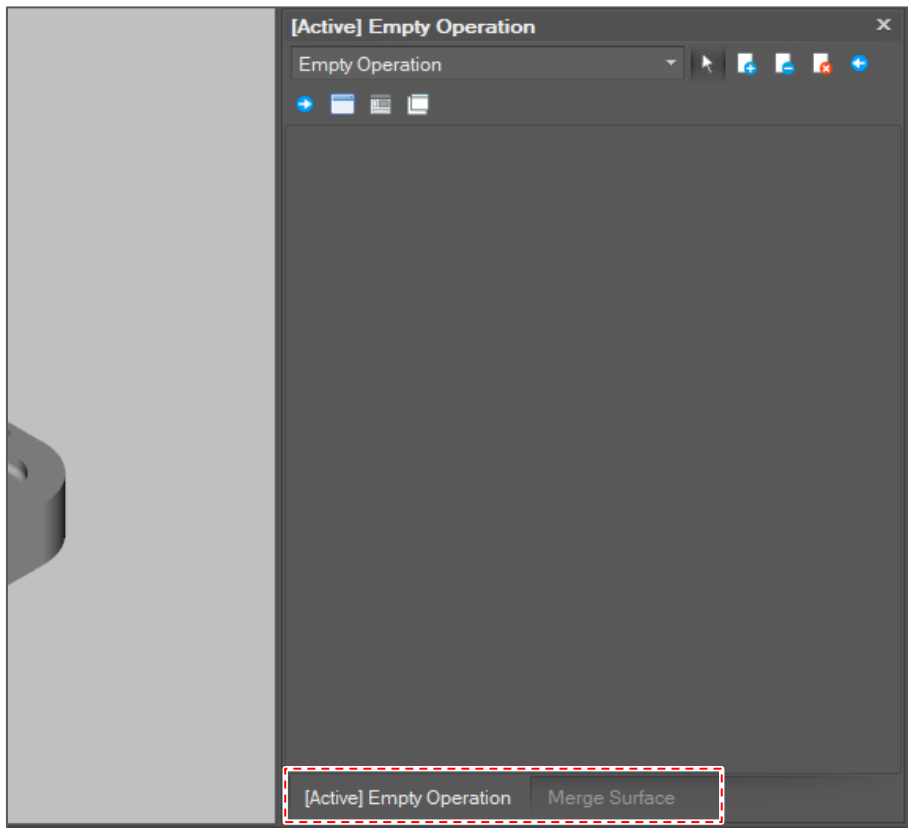


If there are more than 1 operation window, the Active operation is updated when the user clicks an operation menu.

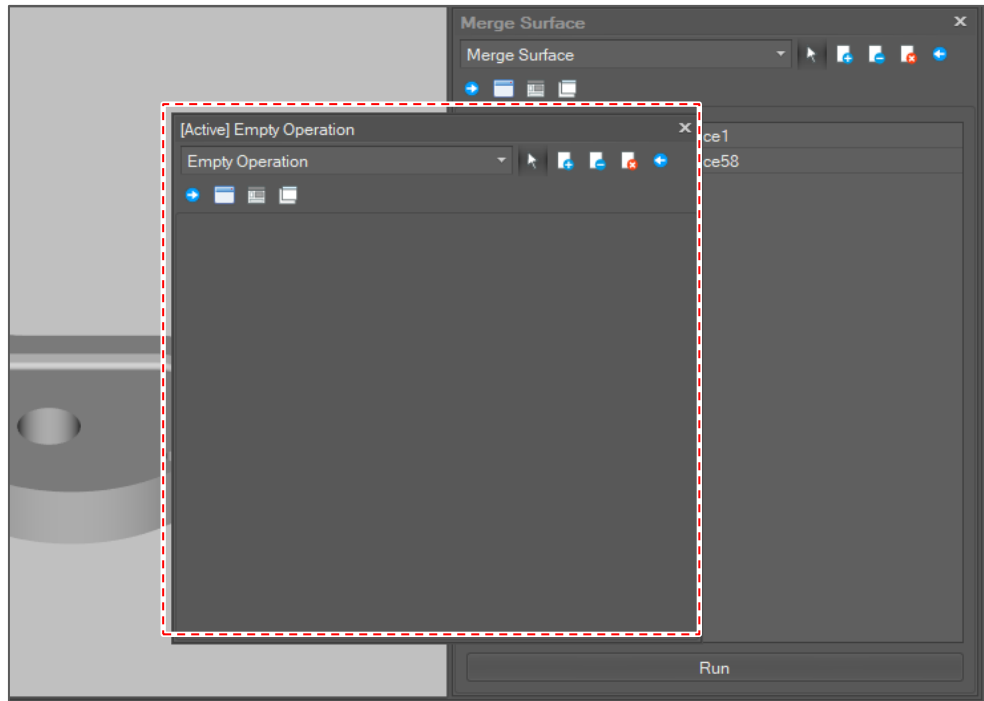
The operation window can be docked to anywhere.



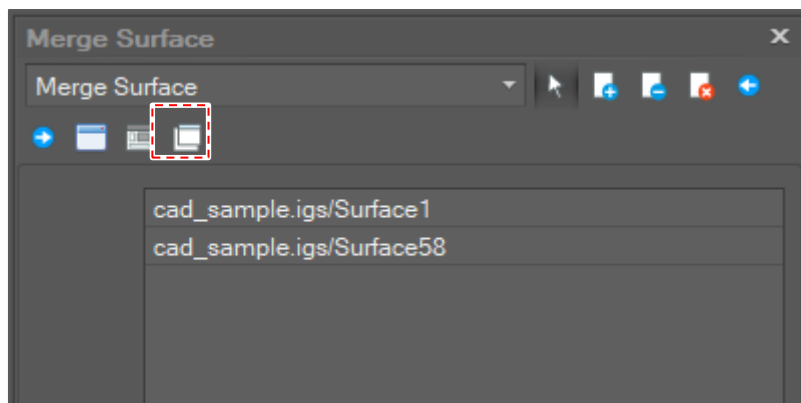
The operation window can be overlapped with another operation window. In other word the user can compose a tab window.

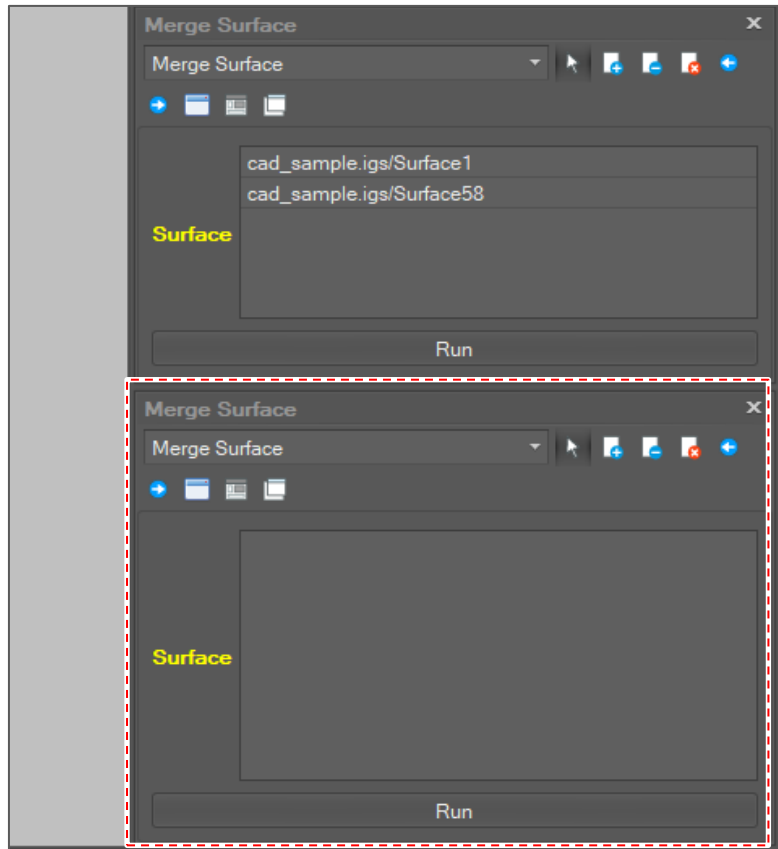


The operation window can be popped up as well.



The operation window can be cloned. If the user clicks [Open A Cloned Panel] button, a clone panel is shown up.

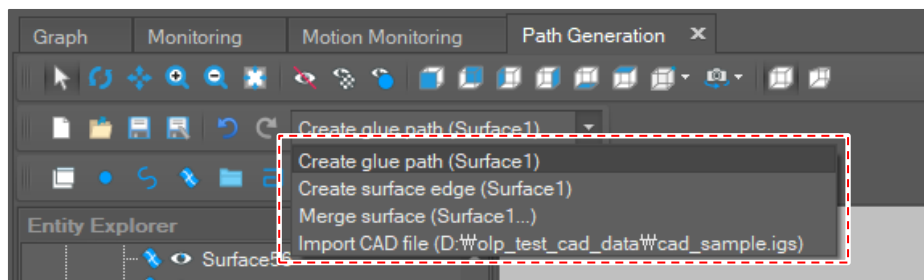




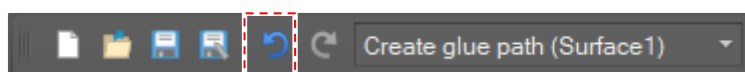
1.11.3 Undo and Redo

The program provides undo and redo function for all operation.

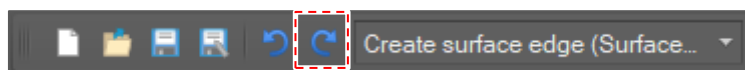
At most 30 operations are stored and can be canceled (Undo) or restored (Redo) again.



The user can undo the last operation by clicking the [Undo] button in the menu bar or by pressing [Ctrl + Z] key.

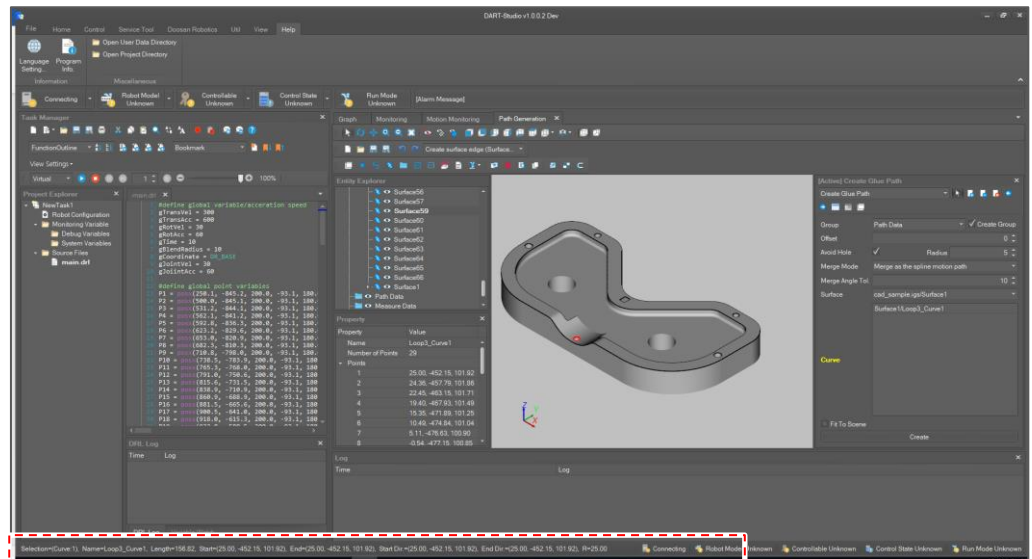


The user can redo the canceled operation by clicking the [Redo] button in the menu bar or by pressing [Ctrl + Y] key.



1.11.4 Status bar information

The status bar displays summary information for the selected object.



Selection=(Curve:1), Name=Loop3_Curve1, Length=156.82, Start=(25.00, -452.15)

The displayed information depends on the type and the number of the selected items. The type and the number of the selected items and displayed information are as below.

1 point	Coordinates.
2 points	Coordinates, Distance between two points.
3 points	Coordinates, Angle between (Point2-Point1) and (Point2-Point3).
3 or more points	Radius of fitting circle.
1 curve	Coordinates of start and end point. Length of Curve, Tangent direction of start and end point.
2 lines	Angle between two lines.
1 arc	Radius of fitting circle.