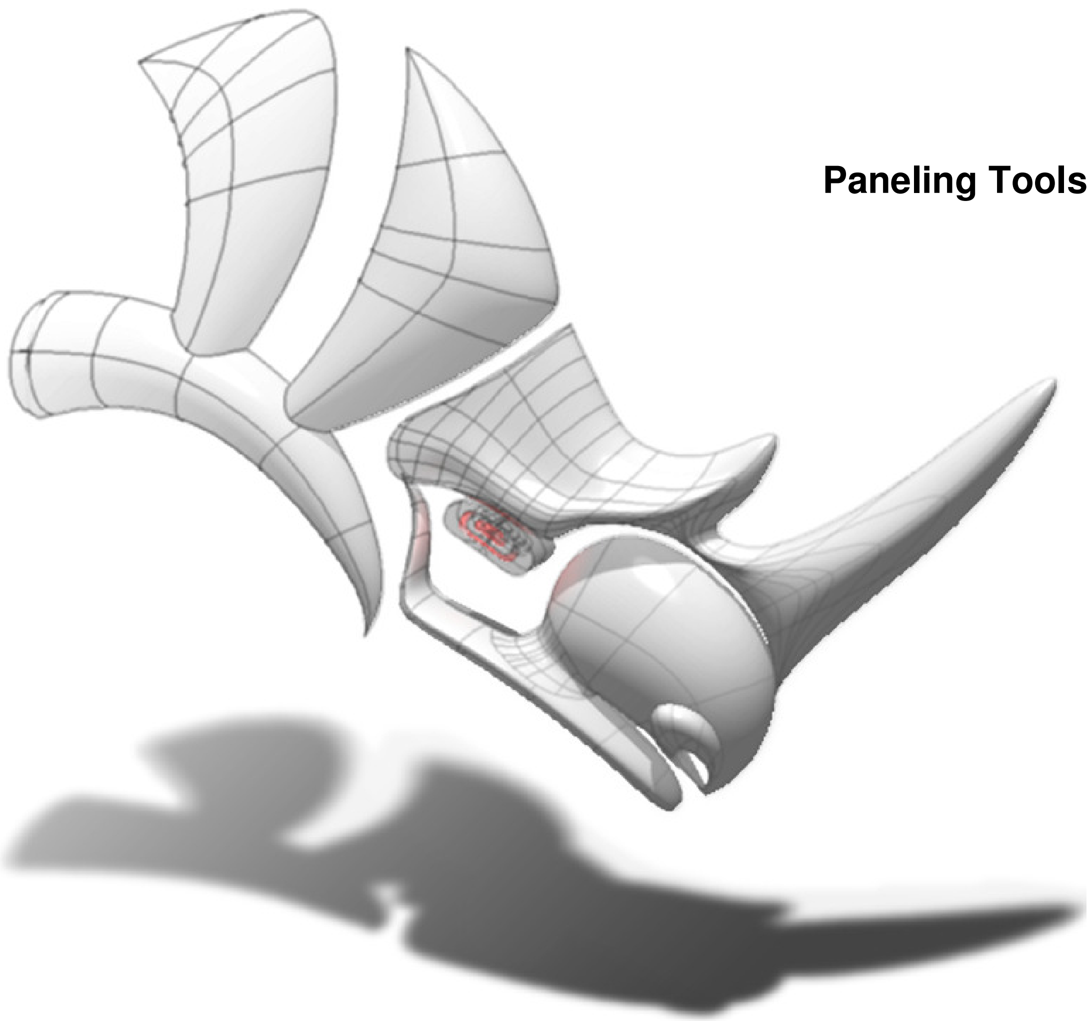
Rhinoceros®

NURBS modeling for Windows

Paneling Tools



Note from the Author

Development on PanelingTools plug-in for Rhino 4.0 started in 2008. Some of its functionality was included in SectionTools plug-in (previously called ArchCut). The plug-in facilitates conceptual and detailed design of paneling patterns using NURBS geometry. PanelingTools is closely integrated with Rhino environment using standard Rhino geometry. PanelingTools also extends RhinoScript for completely customized paneling.

This manual describes the two-step process of generating panels. The first is to represent base geometry in terms of a two-dimensional point grid, and the second step is to define and apply patterns to that grid. This manual has detailed description of all commands with examples and options.

PanelingTools is under rapid development. New functionality is added frequently and like any other McNeel products, your feedback continuously shapes and steers its development.

I hope using the plug-in will be a fun and useful experience. I am always happy to hear from you and learn how you are using the plug-in. If you have any questions or suggestions to further its development, feel free to contact me.

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Table of Contents

1 Getting Started

PanelingTools is a plug-in for Rhino 4.0 that supports designing and modeling paneling patterns. It also rationalizes NURBS surfaces and polysurfaces. Many of the commands in the plug-in are history based.

To load the PanelingTools plug-in:

1. Save **PanelingTools.rhp** in any location.

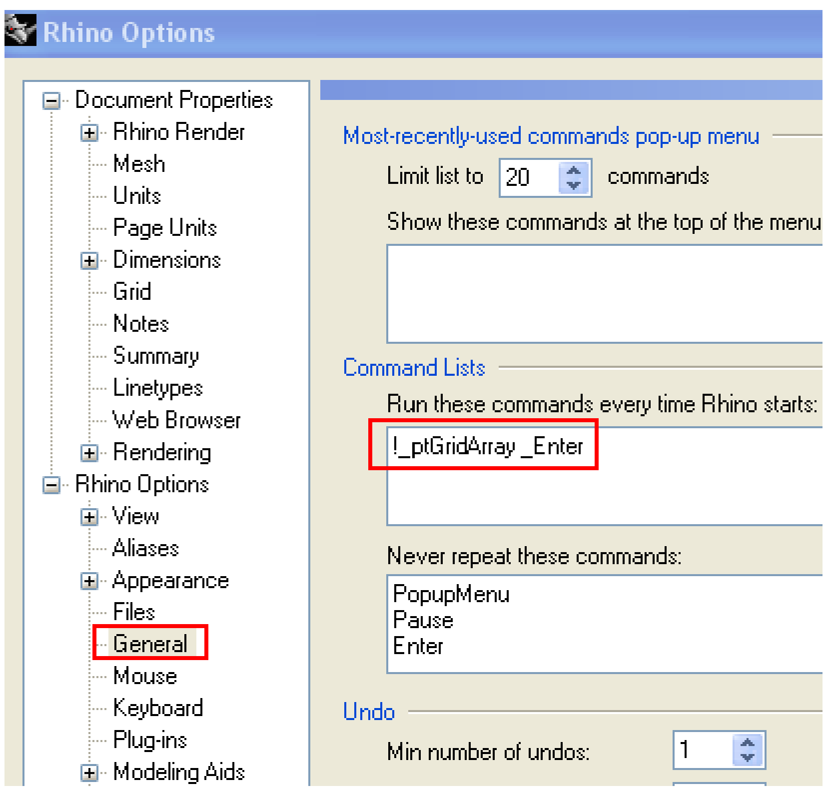
   Normally this is **C:\Program Files\Rhinoceros 4.0\Plug-ins**.

2. Use the Rhino **PluginManager** command (*Tools menu* > *Options* > *Plug-ins*) to install **PanelingTools.rhp**.

   Or,

   Drag-and-drop the PanelingTools.rhp file into Rhino.

   Note: Load the plug-in only once using either of the above methods. After that, with every new Rhino session, PanelingTools and its menu loads when you call a plug-in command for the first time in that session. If you like to have the menu loaded at startup, you need to type an empty command such as "!_ptGridArray _Enter"" in the "General" section of "Rhino Options" as follows:

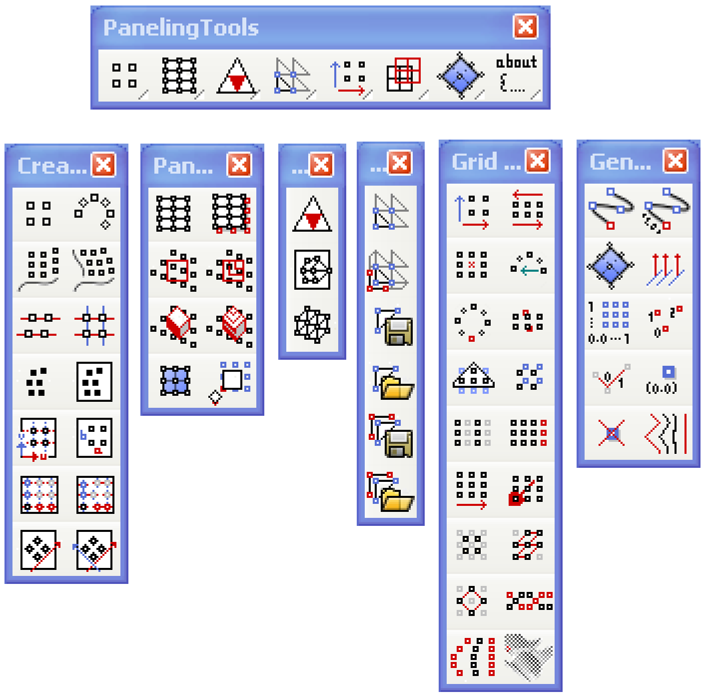


Toolbars and Menu

The PanelingTools toolbar file (**PanelingTools.tb**) includes all plug-in commands.

To load toolbars:

1. Start the **Toolbar** command (*Tools >Toolbar Layout*).
2. From the **File** menu, click **Open**, and browse to **PanelingTools.tb**.



The PanelingTools plug-in also adds the **PanelingTools** menu when it is loaded.

Check for Updates

PanelingTools is under active development. For new versions and up-to-date documentation go to http://en.wiki.mcneel.com/default.aspx/McNeel/PanelingTools.html.

Suggestions, bug reports and comments are welcome. Please share your stories, examples, and experiences with us. Post questions to our newsgroup or email us directly. Visit http://www.rhino3d.com/support.htm for more details, or contact the developer, Rajaa Issa.

Help and Support

The PanelingTools Wiki page contains the latest download, documentation, and links to tutorials and short videos: http://en.wiki.mcneel.com/default.aspx/McNeel/PanelingTools.html

For tutorial examples and video clips go to: http://en.wiki.mcneel.com/default.aspx/McNeel/PanelingExamples.html

Post your questions to the Rhino newsgroup: news://news.rhino3d.com/rhino

Email support is also available: tech@mcneel.com

History Support

Most PanelingTools commands support history. However, history can be expensive to use. It works great for smaller grids, but can be very time consuming for larger ones.

Here are few useful things to keep in mind when using history:

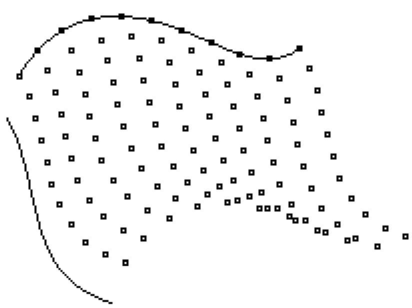
Although history is very useful in some cases, it can be slow and counter-intuitive when dealing with a large set of data.

History in the Rhino SDK is not designed to handle problems typical to paneling where there is a lot of input (grid of hundreds of points) and even more output data (all those panels) that typically expands and shrinks with each update. The PanelingTools history implementation affects speed.

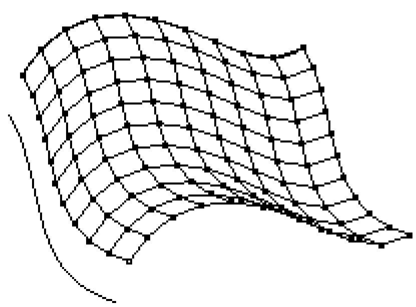
There is the possibility to cancel calculation in most cases.

How does history work

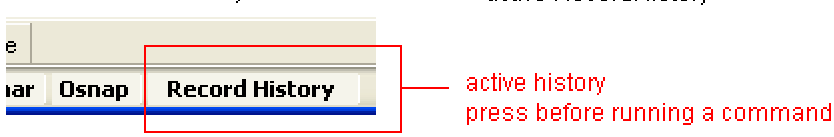
Just like other Rhino commands, you need to activate history recording before running the command you intend to record history for. When referenced input geometry changes, the command will be replayed to update output. Here is an example that generate paneling grid with history.



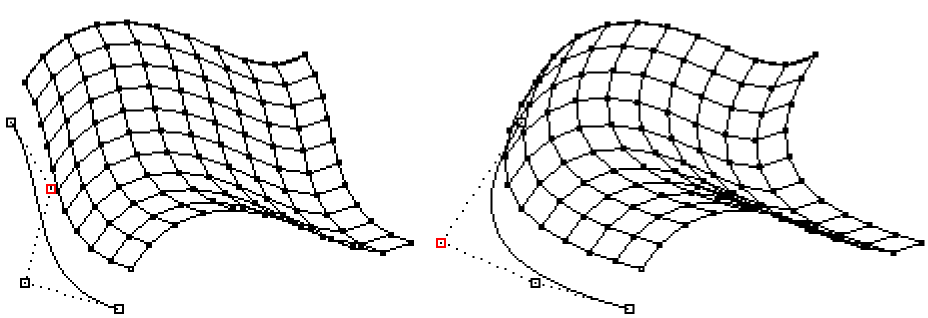
ptGridExtrude2 with
active RecordHistory



ptPanelGrid with
active RecordHistory



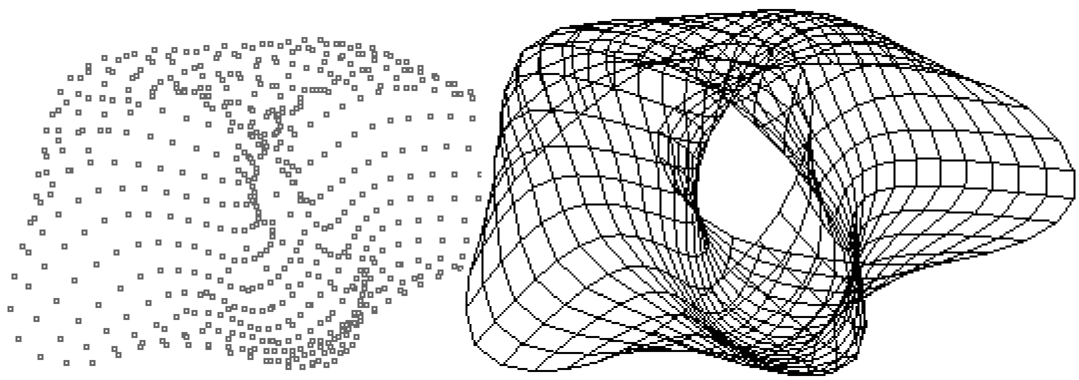
Modifying input curves update grid points which in tern updates paneling triggering a chain update effect.



2 Introduction

The PanelingTools plug-in supports conceptualizing with 2-D and 3-D design patterns and helps rationalize NURBS surfaces and polysurfaces for analysis and fabrication.

Forms that can be paneled with PanelingTools can be represented with a 2-dimensional point grid. PanelingTools provides many functions to turn base geometry of points, curves, surfaces, and polysurfaces into an ordered 2-dimensional grid. The grid is then used as basis to apply 2-D and 3-D patterns.

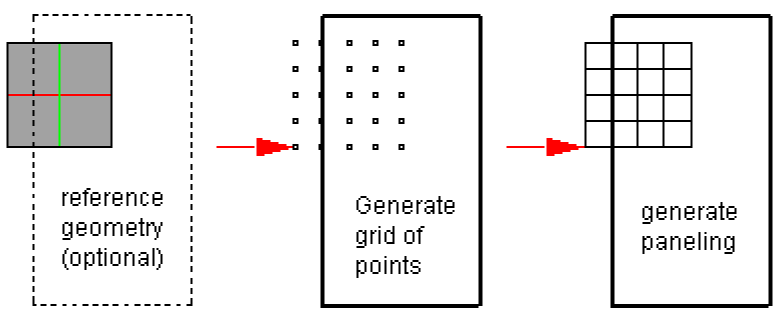


Paneling Process

Paneling is done in two steps: first, create a paneling grid, and then generate the paneling geometry of curves, surfaces and polysurfaces.

Creating a paneling grid results in points that can be manipulated with any Rhino command or PanelingTools grid utility commands.

Generating the paneling creates patterns and applies the patterns to a valid paneling grid of points. The resulting paneling is standard Rhino geometry in the form of curves, surfaces, or a mesh. To further process panels (with the Unroll, Offset, Pipe, or Fin commands, for instance) use paneling utility functions and other Rhino commands.



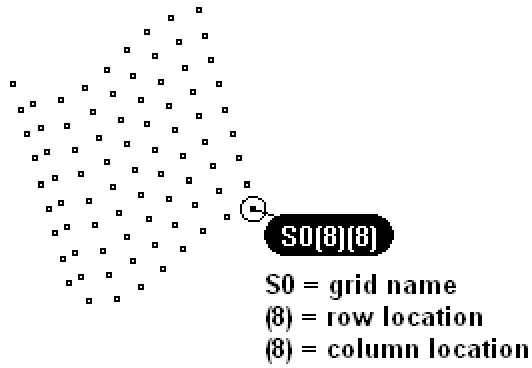
The two-step process gives more flexibility and better control over the result. Normally, the initial grid is generated interactively and is a good indicator of scale. The grid can be generated using the many grid-generating commands or with scripting. The grid can be directly edited and refined before any paneling is applied. Panels can be created using built-in patterns or user-defined free-form patterns.

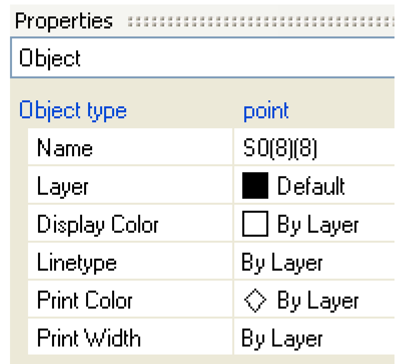
The following sections illustrate various methods for generating a base grid of points and how paneling is applied using that base grid.

3 Create a Paneling Grid

A paneling grid is a group of Rhino point objects. Each paneling point has a name consisting of its row and column location in the grid.

For example:





Points have name tags S0(0)(0), S0(0)(1), …. These names are object properties. The naming convention is as follows:

S0 = paneling grid name

(first number) = row location

(second number) = column location

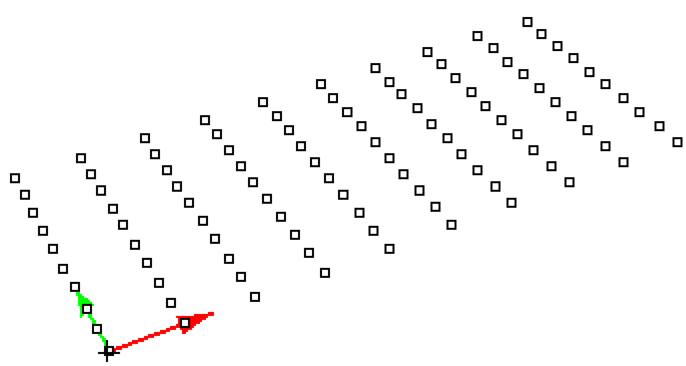
Since the names can be edited directly using the Rhino **Properties** command, points that are valid input for paneling can also be created using the Rhino **Points** command, and names can be assigned to reflect their locations with the **Properties** command. PanelingTools grid creation commands do the naming automatically.

Create Paneling Grid Directly

The **ptGridArray** and **ptGridArrayPolar** commands create a two-dimensional array of points.

ptGridArray

The **ptGridArray** command creates an array of parallel points.



Command flow

1 Start the **ptGridArray** command.

2 Pick a base point.

3 Press **Enter** to accept options.

Options

U_Number
Number of points in the u-direction.

U_Spacing
Distance between points in the u-direction.

U_direction
Pick two points to set the u-direction.

V_Number
Number of points in the v-direction.

V_Spacing
Distance between points in the v-direction.

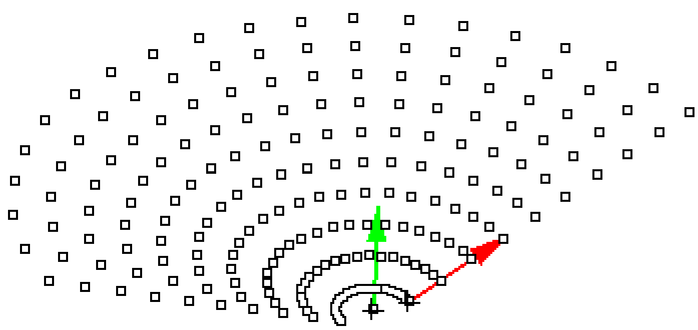
V_Direction
Pick two points to set the v-direction.

Group
If **Yes**, group the resulting points.

NameOfGrid
Grid name prefix attached to each point. The row and column location complete the point name.

ptGridArrayPolar

The **ptGridArrayPolar** command creates a polar array of points.



Command flow

1 Start the **ptGridArrayPolar** command.

2 Pick a center and first point of the rotation axis.

3 Pick a second point of the rotation axis.

Press **Enter** to rotate normal to active construction plane.

4 Pick the base and first point of the grid direction.

5 Pick the second direction point.

Press **Enter** if parallel to rotation axis.

6 Press **Enter** to accept options.

Options

U_Number
Number of points in the u-direction.

U_Spacing
Distance between points in the u-direction.

U_Direction
Pick two points to specify a u-direction.

V_Number
Number of points in the v-direction (polar direction).

V_Angle
Angle between points in v direction.

Group
If **Yes**, group the resulting points.

NameOfGrid
Grid name prefix attached to each point. The row and column location complete the point name.

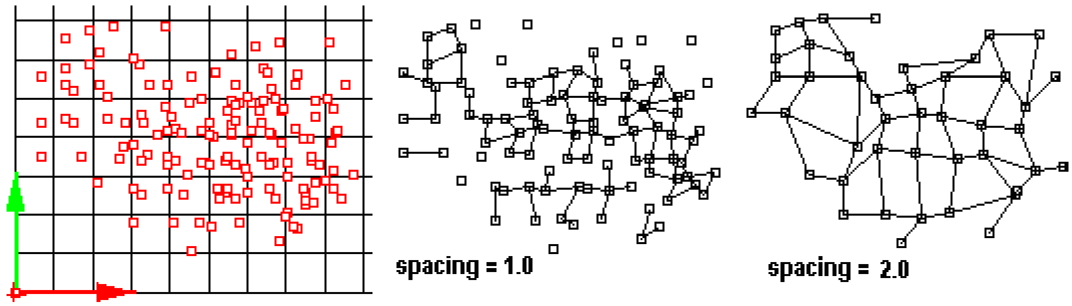
Grid from Predefined Points

The **ptGridPoints** and **ptGridPointsOnSurface** commands use a pre-defined set of points to create a paneling grid or to order these points into rows and columns.

These commands define a distance tolerance to identify points that belong to one row or one column. The result may not always be desirable. It is best to define the paneling grid points using plug-in commands whenever possible.

ptGridPoints

The **ptGridPoints** command uses u- and v-values from a base surface as a parallel reference grid. Input points take the row/column location from the closest reference grid point. The result might have fewer points than the input since more than one point could be rounded to same index. Reference spacing is critical to the result as illustrated in the image:



Command flow

1 Start the **ptGridPoints** command.

2 Pick the base point.

3 Press **Enter** to accept options.

Options

U_Spacing
Reference grid spacing in the u-direction.

V_Spacing
Reference grid spacing in the v-direction.

U_Direction
Pick two points to specify a u-direction.

V_Direction
Pick two points to specify a v-direction.

Group
If **Yes**, group the resulting points.

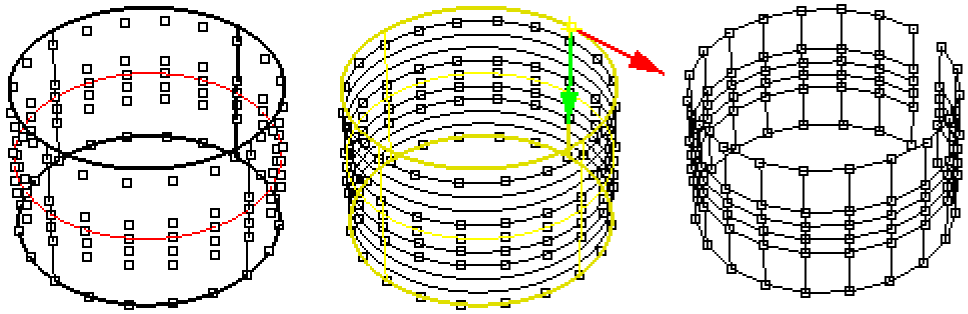
DeleteInput
If **Yes**, delete the input points.

AlignPoints
If **Yes**, shift the points to align with reference grid.

NameOfGrid
Grid name prefix attached to each point. The row and column location complete the point name.

ptGridPointsOnSurface

The **ptGridPointsOnSurface** command turns points existing on a surface into a valid grid of paneling points. The algorithm creates isocurves using (2***Tolerance**). Points within tolerance of any one curve are added to the grid as one row of points. Points in one row are ordered relative to their parametric location on the curve.



Command flow

1. Start the **ptGridPointsOnSurface** command.
2. Select the points.
3. Select the surface.
4. Press **Enter** to accept options.

Options

Tolerance
Spacing between isocurves is equal to double the tolerance value. Points should be within tolerance from a particular row base line to be included in that row.

Group
If **Yes**, group the resulting points.

DeleteInput
If **Yes**, delete input points.

AlignPoints
If **Yes**, shift the points to align with reference grid.

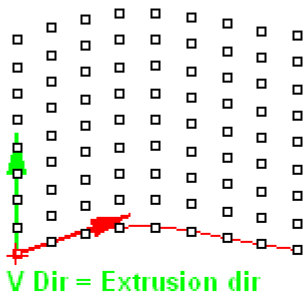
NameOfGrid
Grid name prefix attached to each point. The row and column location complete the point name.

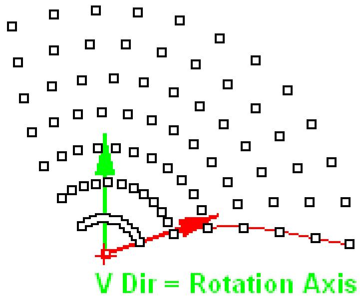
Grid from Curves

The **ptGridExtrude1**, **ptGridExtrude2**, **ptGridUCurves**, and **ptGridUVCurves** commands use input curves to create a paneling grid.

ptGridExtrude1

The **ptGridExtrude1** command uses one curve and extrudes division points in parallel or polar directions.





Command flow

1. Start the **ptGridExtrude1** command.
2. Select the base curve.
3. Press **Enter** to accept options.

Options

U_Method
Base curve division method.

Number — **U_NumberOfSpans**
Number of spaces between points.

ArcLength — **U_Length**
Along-curve distance between points.
U_Round
If **Yes**, round the distance up or down to fill the whole curve.
U_RoundingMethod
Up
Down

ChordLength — **U_ChordLength**
Straight-line distance between points.
U_AddEndPoint
If **Yes**, add a point at the end.

V_Number
Number of points in the extrusion v-direction.

V_Method
Array curve divide points in parallel or polar direction.

Parallel — **V_Distance**
Distance between points.
V_Direction
Pick two points to specify a v-direction.

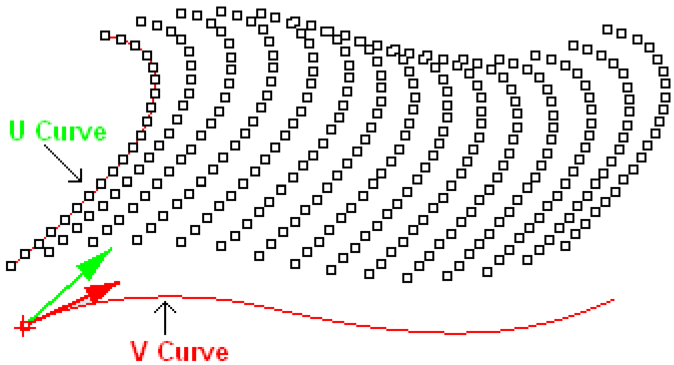
Polar — **V_Angle**
Angle between rows of points.
V_RotationAxis
Pick two points to specify a rotation axis.

Group
If **Yes**, group the resulting points.

NameOfGrid
Grid name prefix attached to each point. The row and column location complete the point name.

ptGridExtrude2

The **ptGridExtrude2** command extrudes points of a base curve along a path curve.



Command flow

1. Start the **ptGridExtrude2** command.
2. Select the first curve.
3. Select the second curve.
4. Press **Enter** to accept options.

Options

U_Method
First curve division method.

Number	**U_NumberOfSpans**	Number of spaces between points.
ArcLength	**U_ArcLength**	Along-curve distance between points.
	U_Round	If **Yes**, round the distance up or down to fill the whole curve.
	U_RoundingMethod	**Up** **Down**
ChordLength	**U_ChordLength**	Straight-line distance between points.
	U_AddEndPoint	If **Yes**, add a point at the end.

V_Method
Second curve division method.

Number	**V_NumberOfSpans**	Number of spaces between points.

ArcLength	**V_ArcLength** Along-curve distance between points. **V_Round** If **Yes**, round the distance up or down to fill the whole curve. **V_RoundingMethod** **Up** **Down**
ChordLength	**V_ChordLength** Straight-line distance between points. **V_AddEndPoint** If **Yes**, add a point at the end.

Group

If **Yes**, group the resulting points.

NameOfGrid

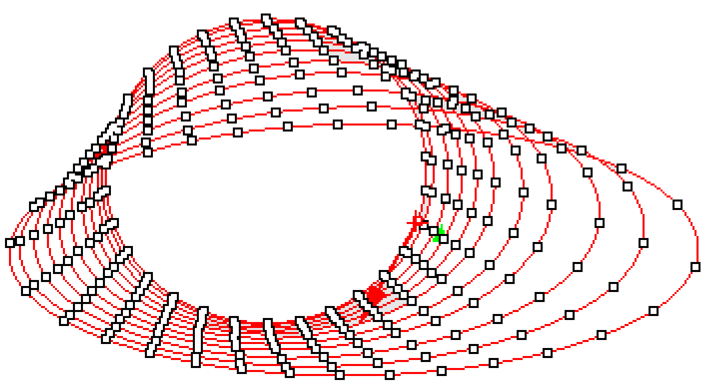
Grid name prefix attached to each point. The row and column location complete the point name.

SwitchCurves

Change which of the two curves to copy along the other curve points.

ptGridUCurves

The **ptGridUCurves** command uses an existing array of curves to create a paneling grid. It divide the curves, that are usually parallel or non-intersecting, by number or distance. It is best to select curves in the order of desired rows (first selected curve become row0, etc). The option to automatically order curves and unify their direction might not yield desired result in all cases.



Command flow

1. Start the **ptGridUCurves** command.
2. Select curves in order or group select curves and have the command order curves internally using each curves midpoint.
3. Press **Enter** to accept options.

Options

SortCurvesOrder

If **Yes**, the following option appears:

SortMethod

StartPoint	Curves start point
MidPoint	Curves mid point
Centroid	Curves centroid

Method

Division method.

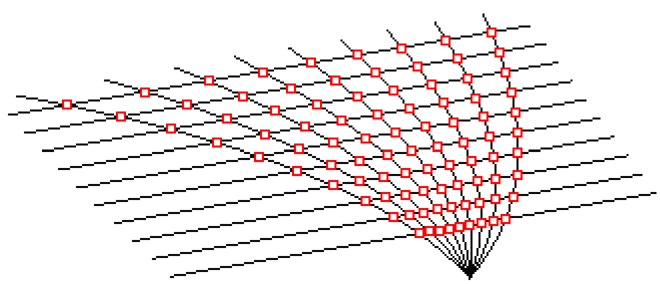
Number	**NumberOfSpans** Number of spaces between points.
ArcLength	**ArcLength** Along-curve distance between points. **Round** If **Yes**, round the distance up or down to fill the whole curve. **RoundingMethod** **Up** **Down**
ChordLength	**ChordLength** Straight-line distance between points. **AddEndPoint** If **Yes**, add a point at the end.

Group

If **Yes**, group the resulting points.

ptGridUVCurves

The **ptGridUVCurves** creates paneling points at curve intersections. Select the curves in each direction. Selection order defines order of rows and columns in the grid. An option orders the curves automatically.



Command flow

1 Start the **ptGridUVCurves** command.

2 Select u-direction curves in order or group select curves and have the command order curves internally using each curve midpoint.

3 Select v-direction curves in order or group select curves and have the command order curves internally using each curve midpoint.

4 Press **Enter** to accept options.

Options

SortCurvesOrder
Sort curves relative to their midpoints.

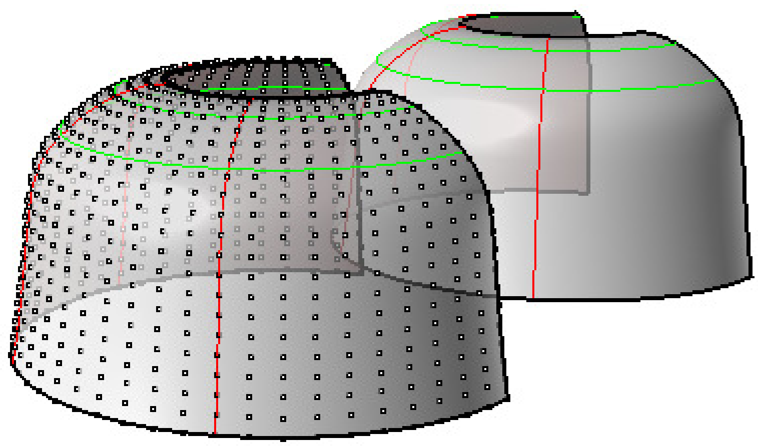
Group
If **Yes**, group the resulting points.

Grid from Surfaces

The **ptGridSurfaceDomain**, **ptGridSurfaceDomainExact**, and **ptGridSurfaceDistance** use a base NURBS surface to generate a paneling grid.

ptGridSurfaceDomain

The **ptGridSurfaceDomain** command divides a surface following its u- and v-directions. Division can be by number, distance, or chord length using any combination in u and v-directions. The grid name references the surface name. You can name the input surface prior to calling the **ptGridSurfaceDomain** command using **Properties** command.



Command flow

1 Start the **ptGridSurfaceDomain** command.

2 Select a surface.

3 Press **Enter** to accept options.

The algorithm:

1 Extracts an isocurve in the v and u directions at the minimum domain.

2 Divides the curve using U and V method set in the options to compile a list of parameters.

3 Use these parameters to divide the surface domain.

Options

U_Method
U-direction division method.

Number	**U_NumberOfSpans** Number of spaces between points.
ArcLength	**U_Length** Along-curve distance between points. **U_Round** If **Yes**, round the distance up or down to fill the whole curve. **U_RoundingMethod** **Up** **Down**
ChordLength	**U_Length** Straight-line distance between points.

V_Method
V-direction division method.

Number	**V_NumberOfSpans** Number of spaces between points.
ArcLength	**V_Length** Along-curve distance between points. **V_Round** If **Yes**, round the distance up or down to fill the whole curve. **V_RoundingMethod** **Up** **Down**
ChordLength	**V_Length** Straight-line distance between points.

Group
If **Yes**, group the resulting points.

ptGridSurfaceDomainExact

The **ptGridSurfaceDomainExact** command divides a surface domain. Division can be by number, arc length, or chord length using any combination in u- and v-directions. The grid name references the surface name. You can name the input surface prior to calling the **ptGridSurfaceUVDomainExact** command using the **Properties** command.

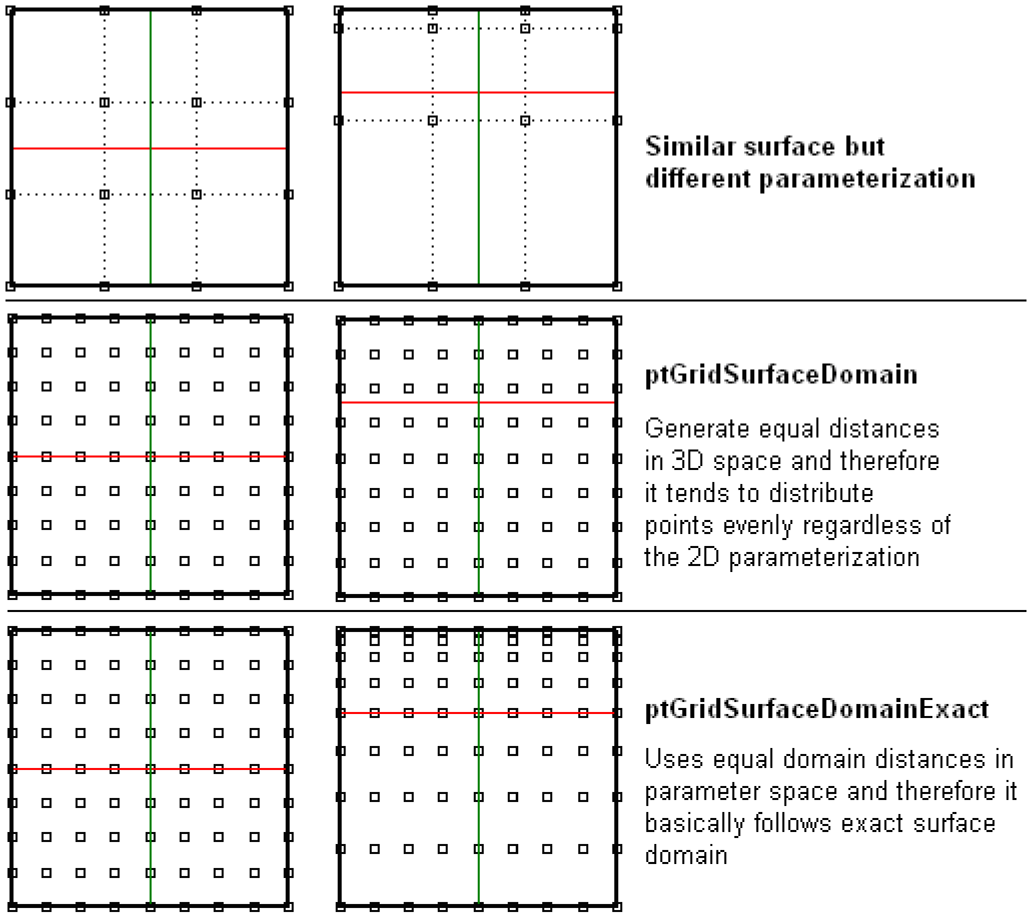
Command flow

1. Start the **ptGridSurfaceDomainExact** command.
2. Select a surface.
3. Allow selecting a base point on surface when dividing by distance or chord length.
4. Press **Enter** to accept options.

The algorithm:

Literary divides the parametric domain of the surface. Result can be similar to ptGridSurfaceDomain depending on how the parametric space of the surface looks like.

See the following comparison that shows an evenly spaced parametric space compared to one that is not and the effect of each using the two surface commands:



Options

Method

Division method.

Number	**U_NumberOfSpans / V_NumberOfSpans** Number of spans.

ArcLength **U_Length / V_Length**
Along-curve distance between points.

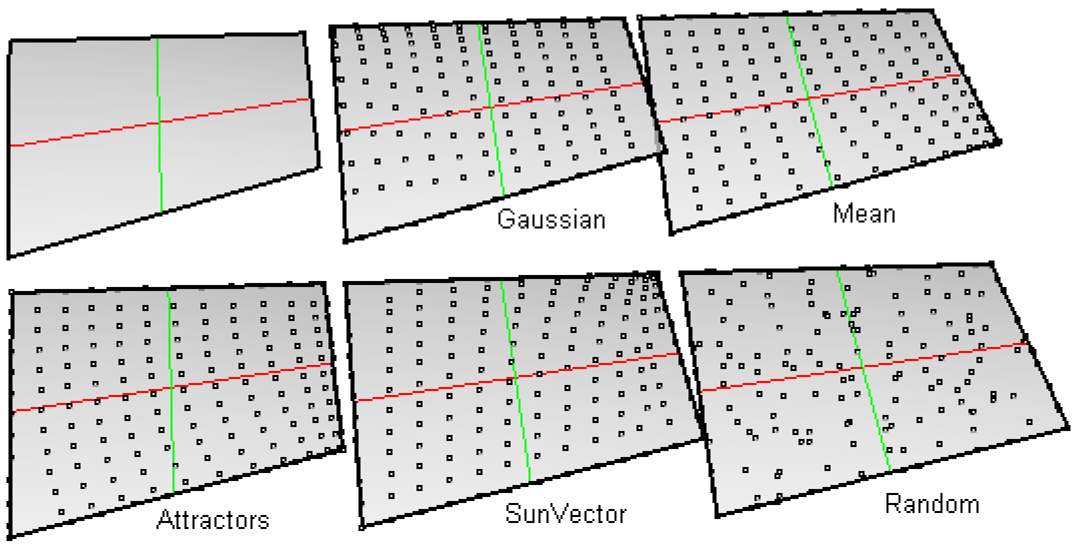
ChordLength **UVDirection**
Change grid base point through changing u-, v- or both directions.
- **Ureverse**
- **Vreverse**
- **ReverseBoth**
- **Default**

SelectBasePoint
Select a base point on surface.

Group
If **Yes**, group the resulting points.

ptGridSurfaceDomainVariable

The **ptGridSurfaceDomainVariable** command divides a surface domain with variable distance grid using surface curvature or other constraints.



Command flow

1. Start the **ptGridSurfaceDomainVariable** command.
2. Select a surface.
3. Press **Enter** to accept options.

The algorithm:

1. Divide with uniform distribution along surface domain (similar to ptGridSurfaceDomainExact command)
2. Adjust the grid using one of the methods.

Options

UNumber
Number of spans in u-direction..

VNumber
Number of spans in V direction.

DistanceMethod
Disribution method.

GaussianCurvature	Use surface gausian curvature values
MeanCurvature	Use surface mean curvature values.
AttractorPoints	Sift towards/away from attractor points
AttractorCurves	Sift towards/away from attractor curves
SunVector	Use dot product between a vector and normal on surface at each point.
Random	Shift points by random amount
Bitmap	Use heightfield of an input image

AttractMethod
Either away or towards attractor points or curves. If distance method is Mean or Gaussian, then attract towards or away from the highest curvature.

Magnitude
Use to reduce or magnify distance variations.

Group
If **Yes**, group the resulting points.

ptGridSurfaceDistance

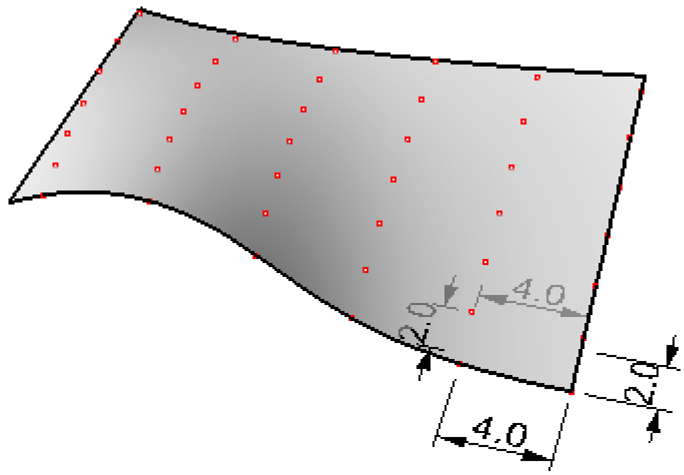
The **ptGridSurfaceDistance** command divides a surface by specified distances in the first and second directions. Since, this command uses an algorithm where every new point depends on previously created points; it might not give complete coverage. The **Extend** option might help creating better coverage. The grid name references the surface name. A point on the surface can be used as a base.

Command flow

1. Start the **ptGridSurfaceDistance** command.
2. Select a surface.
3. Select a base point on surface, or press **Enter** to use the surface minimum.
4. Press **Enter** to accept options.

The algorithm:

1. Extracts a u- and v-isocurve at the selected base point.
2. Divides the isocurves by the chord length.
3. Takes second point on v-isocurve and second point on u-isocurve and finds a point on the surface that is equal to u-distance and v-distance from v and u points. If the point is valid, that new point is used with the third point on the u-isocurve to find the next point, and so on until no valid point is found.



Options

U_Distance
Distance in first direction.

V_Distance
Distance in second direction.

Extend
Extend surface before dividing to possibly get better converge.

Group
If **Yes**, group the resulting points.

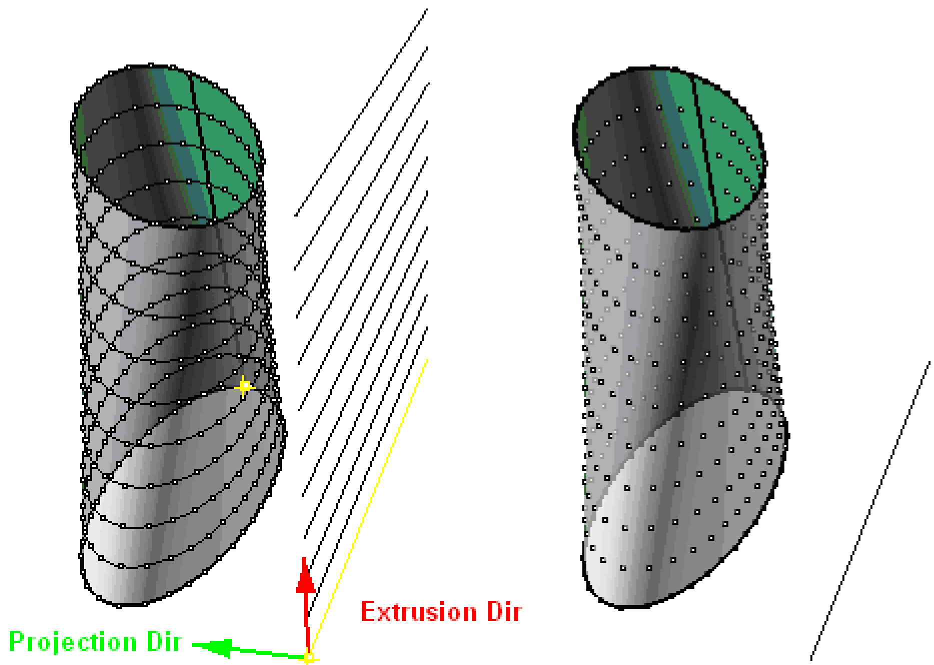
Grid from Projected Curves on Surface or Polysurface

This method is suitable for gridding a polysurface or a surface without using its uv-directions. The general algorithm:

1. Arrays the input curve in a parallel or polar direction.
2. User defines the distance/angle and direction of the array.
3. User defines the direction to project curves towards base surface or polysurface.
4. Curves are then projected and the resulting curves are joined and cleaned.
5. Uses the new curves to divide by number or distance.
6. If the curves are in both directions, grid points are extracted from their intersections.

ptGridCurve (one directional curve)

The **ptGridCurve** command generates a grid based on an object and direction curve. Curves can be open or closed. An open curve is copied in the extrusion direction by the Spacing/Angle distance. A closed curve is offset by that distance.



Options

Line

Option to define direction curve with two points.

CurveOptions

NumberOfCuts

Number of curves to be projected to the object.

Spacing/Angle

Distance or angle between curves.

ExtrudeMethod

Parallel or polar.

ExtrudeDirection

Extrusion direction (for parallel).

ProjectionDirection

Direction the curves are projected.

GridOptions

Method

Curves division method.

Number	**NumberOfSpans** Number of spaces between points.

ArcLength	**Length** Along-curve distance between points. **Round** If **Yes**, round distances to fill the span of the curve. **RoundingMethod** **Up** **Down**
ChordLength	**Distance** Straight-line distance between points. **AddEndPoint** If **Yes**, add a point at the end.

Group

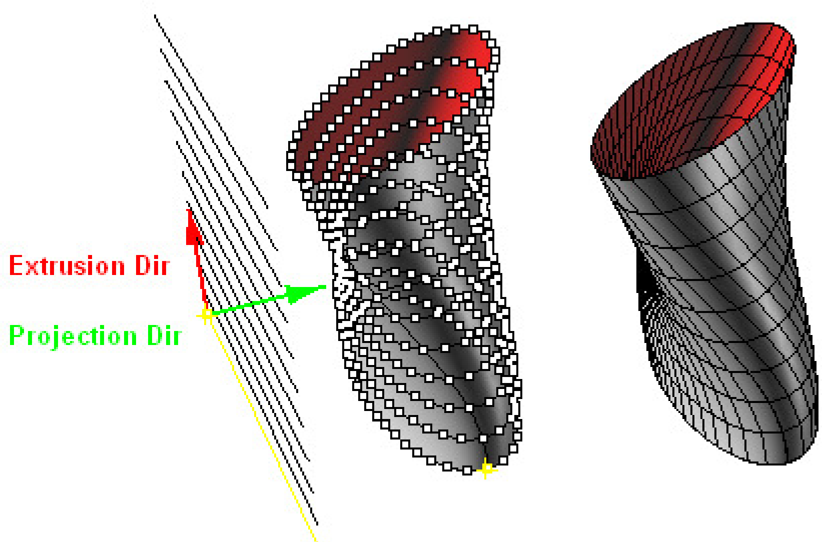
If **Yes**, group the resulting points.

NameOfGrid

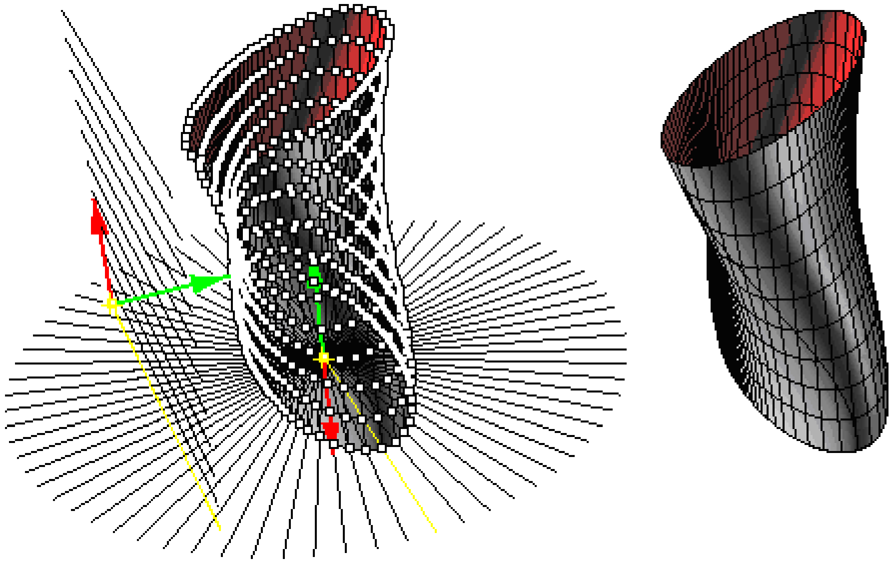
Grid name prefix attached to each point. The row and column location complete the point name.

ptGridCurve2 (two directional curves)

The **ptGridCurve2** command generates a grid using two direction curves. If there is an undesirable surface uv or surface seam, this command can apply the desired directions. In the example below, the surface has twisted seam, this is how the paneling looks using the **ptGridCurve** command (ptGridSurfaceUV gives a similar result):



Using two direction curves, the first in polar and the second in parallel direction, gives desired result in this case:



Options

Line

Pick two points to define the direction curve.

FirstDirCurvesOptions / SecondDirCurvesOptions

NumberOfCuts

Number of curves to be projected to object.

Spacing/Angle

Distance or angle between curves.

ExtrudeMethod

Parallel or polar.

ExtrudeDirection

Extrusion direction (for parallel).

ProjectionDirection

Direction the curves are projected.

Group

If **Yes**, group the resulting points.

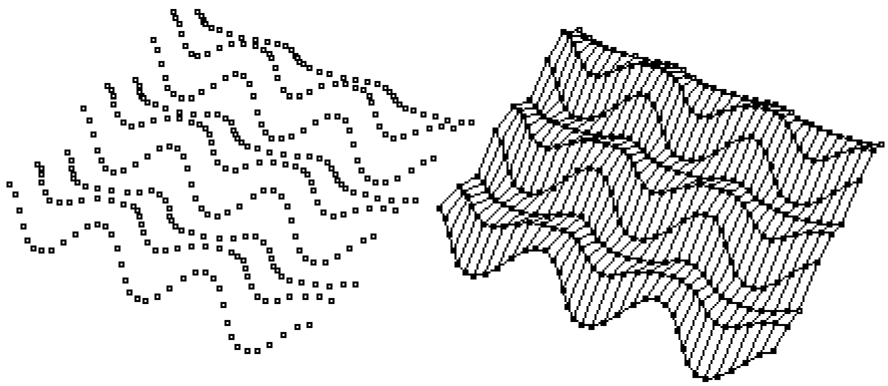
NameOfGrid

Grid name prefix attached to each point. The row and column location complete the point name.

Grid from RhinoScript

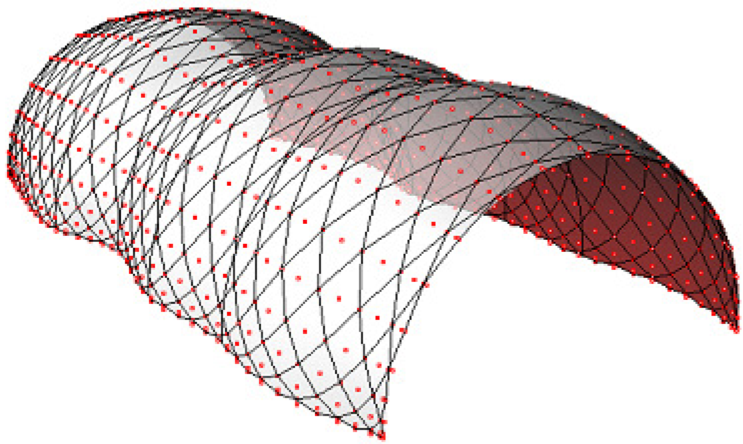
A paneling grid can be generated using RhinoScript. Many of the grid generation commands are accessible directly from RhinoScript. Even without using these commands, a custom point grid can be generated and each point location can be appended to point names.

The following example shows how to create a paneling grid using RhinoScript:



```
Sub Main()
Dim i, j, PTObj, strPt
Dim x, y, z
Dim doubleA, doubleB, doubleStep
doubleA = 2
doubleB = 20
doubleStep = 0.5
On Error Resume Next
'Get PanelingTools Object
Set PTObj = Rhino.GetPluginObject("PanelingTools")
If Err Then
  MsgBox Err.Description
  Exit Sub
End If
For i = 0 To 8 Step 1
  j = 0
  For x = doubleA To doubleB Step doubleStep
    y = (2*i)+Sin(x)
    z = Sin(y)
    strPt = PTObj.InsertPointInGrid(Array(x, y, z),i,j )
    j = j+1
  Next
Next
End Sub
```

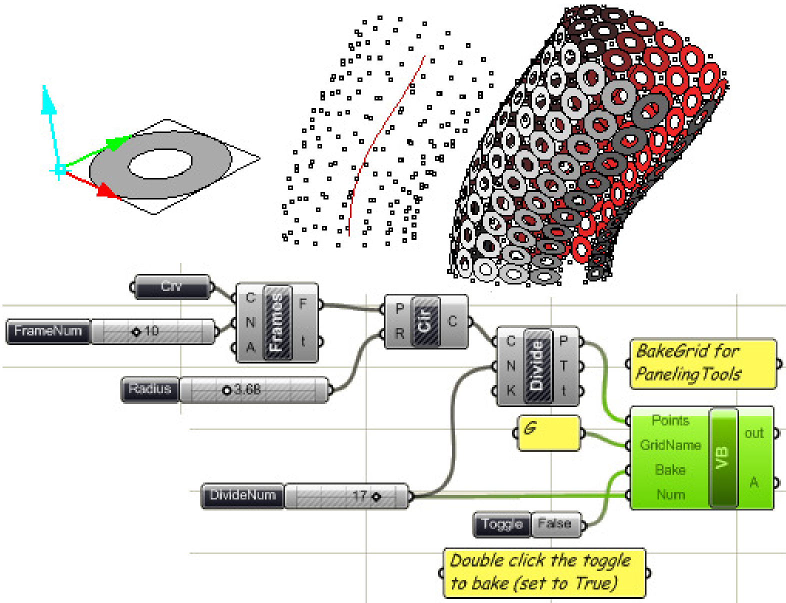
This example uses RhinoScript to generate a variable distance grid, and panel it using diamond pattern:



```
Sub AddGrid( arrPoints, PTObj )
  Dim i, j, arrRow, arrPt, strPt
  i = 0
  j = 0
  If IsArray(arrPoints) Then
    For Each arrRow In arrPoints
      j = 0
      If IsArray( arrRow ) Then
      For Each arrPt In arrow
        If IsArray( arrPt ) Then
          strPt = PTObj.InsertPointInGrid( arrPt, i, j )
        End If
        j = j+1
      Next
      End If
      i = i+1
    Next
  End If
End Sub
Call Main()
Sub Main()
  Dim i,  PTObj, arrPoints, strSrf, dbl_cost, dbl_t
  Dim arr_ulist(10)
  Dim arr_vlist(10)
  On Error Resume Next
  'Get PanelingTools Object
  Set PTObj = Rhino.GetPluginObject("PanelingTools")
  If Err Then MsgBox Err.Description Exit Sub
  'Get surface
  strSrf = Rhino.GetObject("Select surface", 8)
  If IsNull(strSrf) Then Exit Sub
  For i = 0 To 10 Step 1
    dbl_t = 0.1*i
    dbl_cost = cos( dbl_t* (Rhino.PI/2) )
    arr_ulist(i) = dbl_cost
    arr_vlist(i) = dbl_cost
  Next
  arrPoints = PTObj.DivideSurfaceByVariableDistances(strSrf, arr_ulist, arr_vlist, False)
  'Inset points as grid
  Call AddGrid( arrPoints, PTObj )
  Set PTObj = Nothing
End Sub
```


Grid from Grasshopper

Following is an example of a grid generated with Grasshopper and baked with a custom scripting component to attach point locations.



This is how the code inside the VB script component looks:

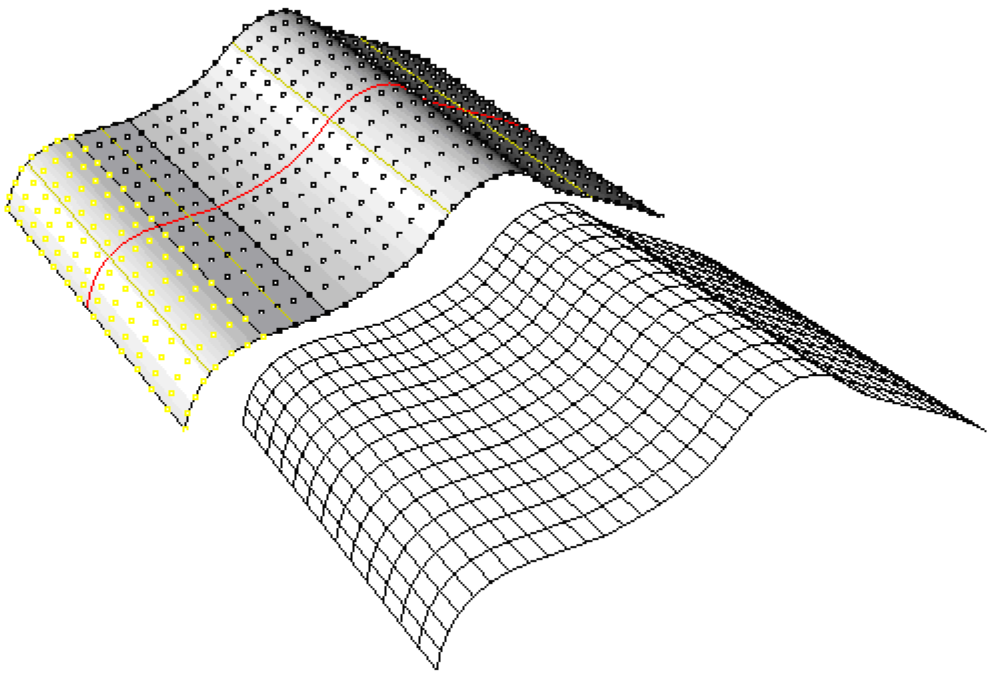
```
Sub RunScript(ByVal Points As List(Of Object), ByVal GridName As String, ByVal Bake As Boolean,
              ByVal Num As Integer)
  If( Not Bake ) Then
    m_count = 0
    Return
  End If
  'Iterate through points by row
  Dim i As Integer
  Dim j As Integer
  j = 0
  For i = 0 To Points.Count() - 1
    If( j > Num + 1 ) Then
      j = 0
    End If
    Dim pt As On3dPoint
    pt = Points(i)
    'Name the point
    Dim att As New On3dmObjectAttributes
    doc.GetDefaultObjectAttributes(att)
    att.m_name = GridName & "(" & m_count & ")(" & j & ")"
    print(m_count)
    'increment index
    j += 1
    'Add to document
    doc.AddPointObject(pt, att)
  Next
  m_count += 1
  A = m_count
End Sub
#Region "Additional methods and Type declarations"
  Private Shared m_count As Integer
#End Region
```

Create Paneling Grid for Polysurfaces

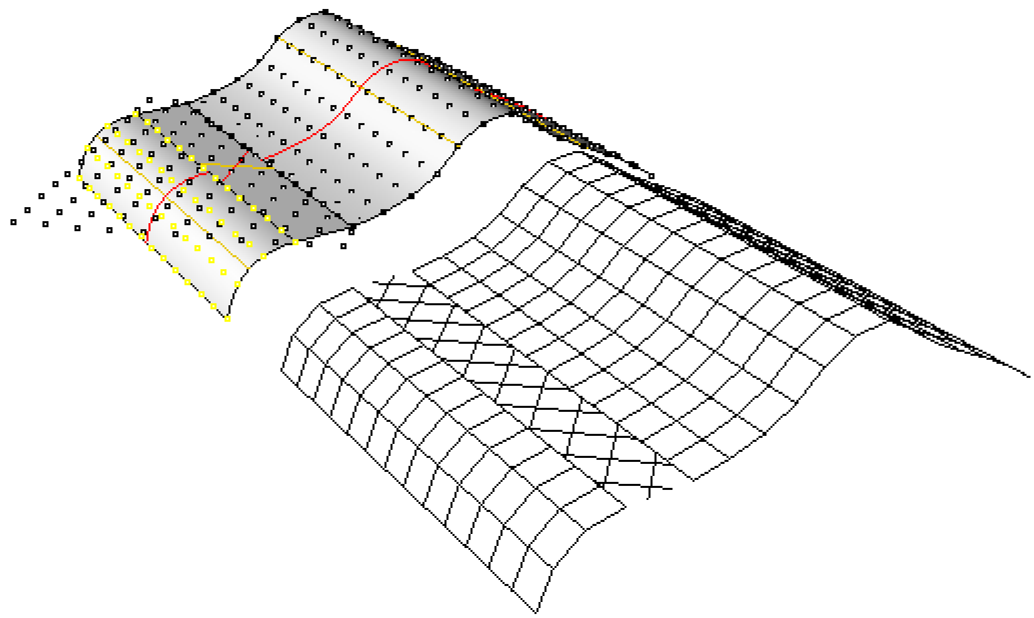
Polysurfaces are joined NURBS surfaces that might not have matching isocurve directions. It is not always possible to define a continuous paneling grid for polysurfaces, but there are few commands that are geared towards dealing with polysurfaces. The main commands are **ptPanelCurve** and **ptPanelCurve2**.

Use ptGridSurfaceUV with ArcLength method

If all surfaces in a polysurface have their isocurves aligned, then using **ptGridSurfaceUV** with Method=*ArcLength* will result in aligned grids. However, these grids will be separate and paneling has to be applied separately to each of them. One way to combine all grids is to use **ptShiftGrid** command to redefine starting row and column for these groups of grids to act as one grid.

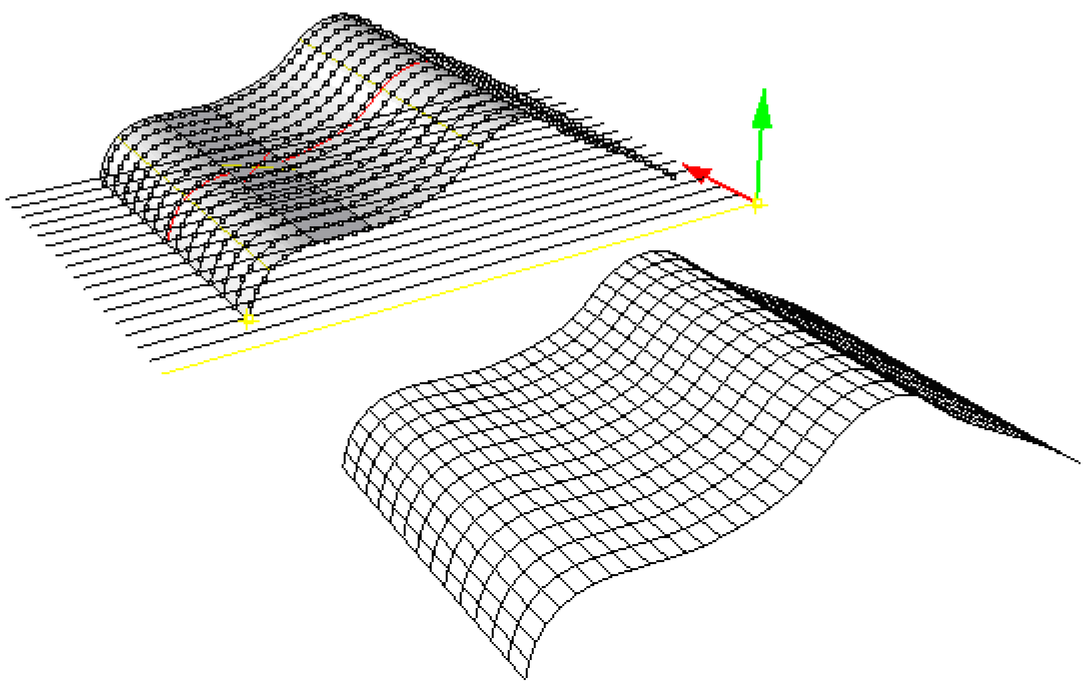


If isocurves of faces are not aligned, then using any of the commands that use surface uv-parameterization will probably not be useful. See the following example.



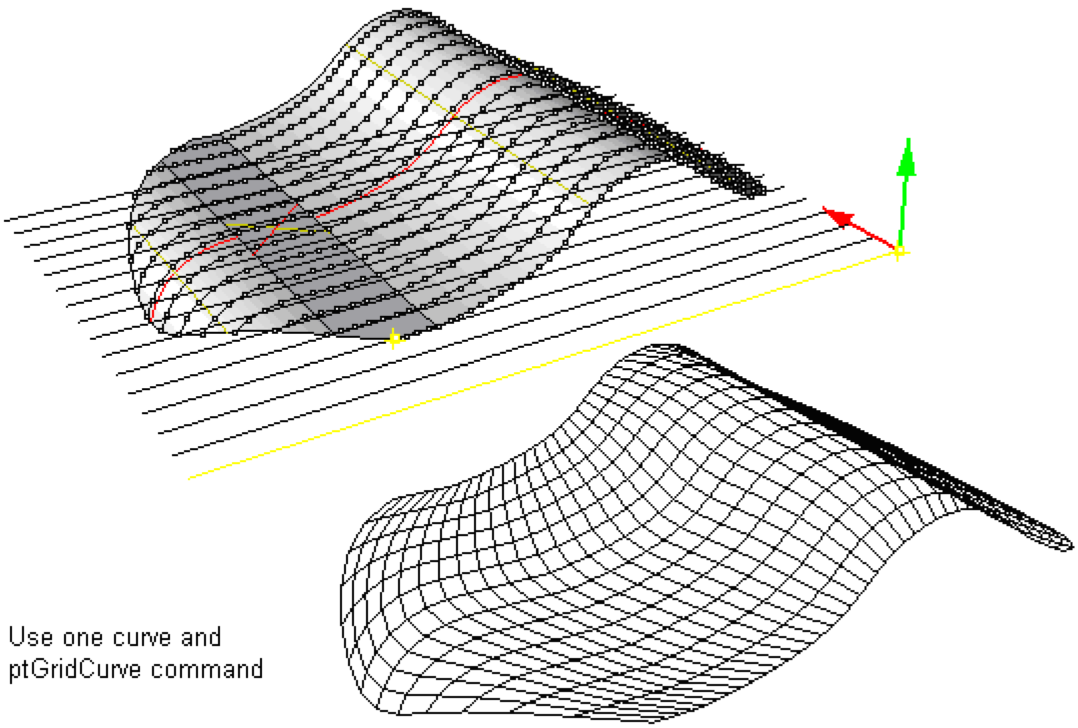
Use ptGridCurve command

The **ptGridCurve** command is useful if there is a general projection plane that covers target polysurface, such as a wiggly roof that runs generally horizontal. Using the previous example, we can generate a continuous grid using **ptGridCurve** and divide by number as in the following:

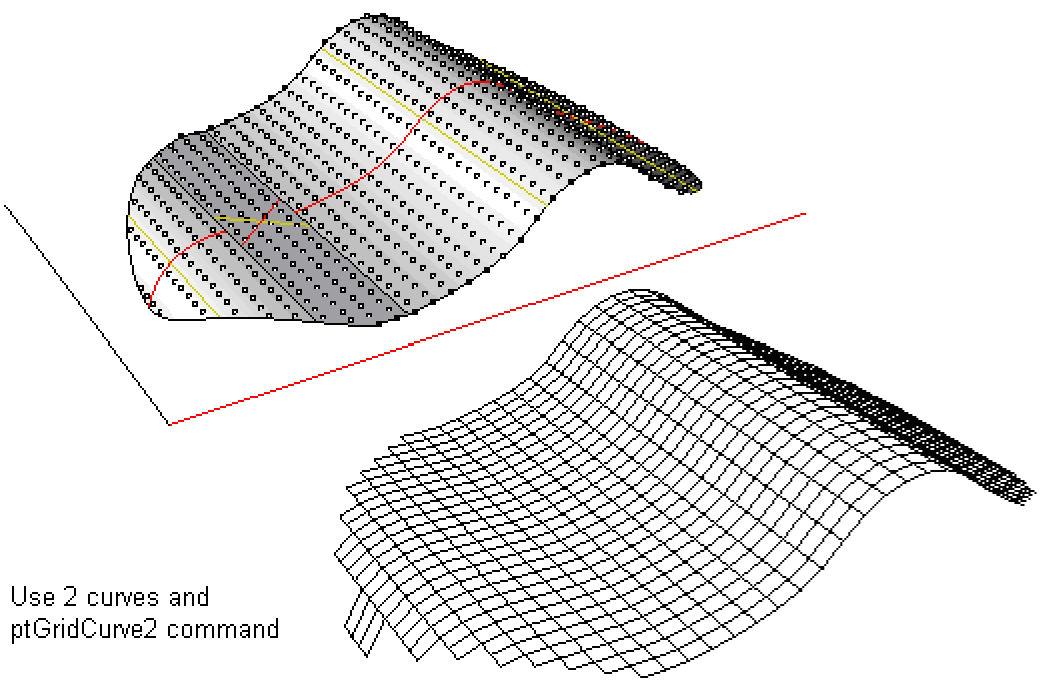


Use ptGridCurve2 command

In cases when the polysurface has no linear edge along the extrusion direction, grid can be undesirable. To force a second direction, you can use **ptGridCurve2**. The following example shows result using one curve (**ptGridCurve**).

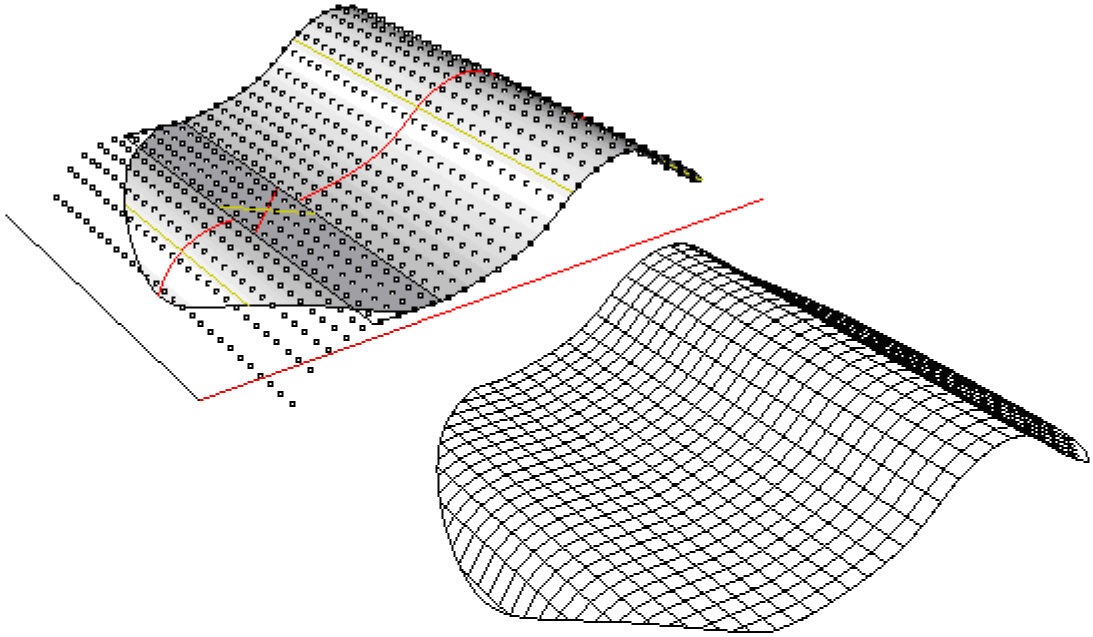


Use one curve and
ptGridCurve command

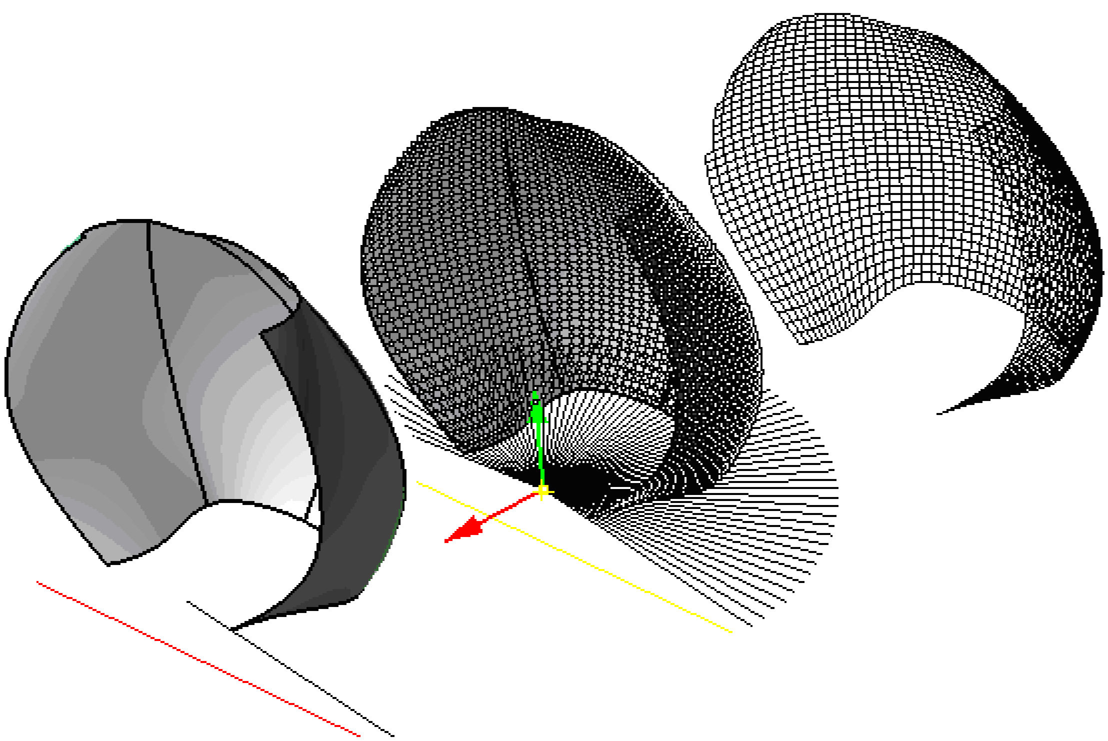


Use 2 curves and
ptGridCurve2 command

The paneling does not run right to the edge because the grid does not extend far enough. In general, it is best to create a grid that bleeds out of the boundaries of base polysurface. The following example uses the untrimmed base polysurface to generate the initial grid, then uses the trimmed polysurface as a reference when paneling.

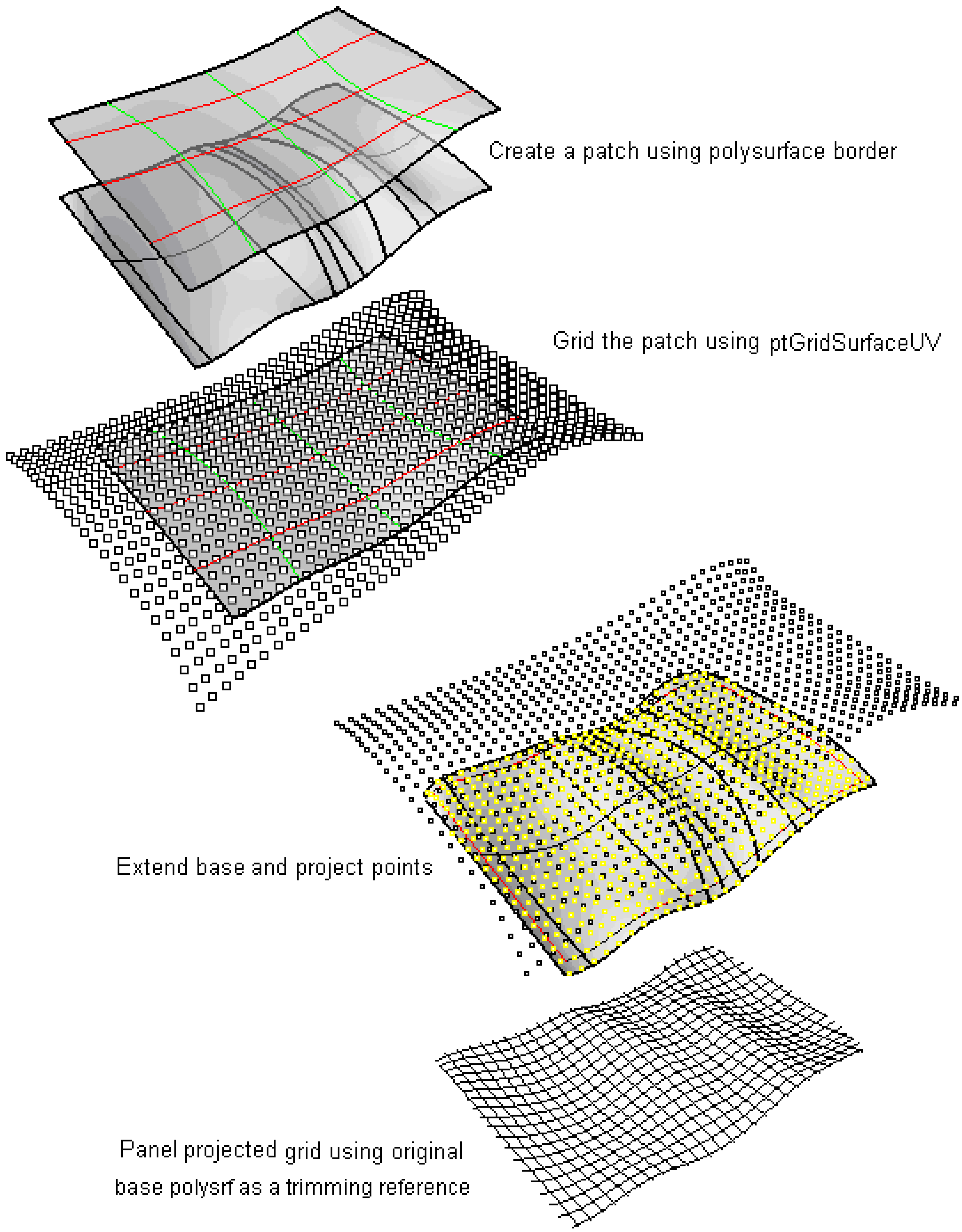


Using one or two curves is also useful when dealing with polysurfaces created from revolved surfaces. The **ptGridCurve** and **ptGridCurve2** polar extrusion direction option is useful in these cases. See the following example.



Use approximate surface and Project or Pull command

Sometimes it is possible to define an approximate surface that is close enough to the target polysurface. In this case, you can grid the approximate surface and then use the Rhino **Pull** and **Project** commands to move the grid points to the polysurface.



4 Generate Paneling

The PanelingTools plug-in supports generating paneling patterns either by connecting paneling grid points or by mapping a given unit pattern to a unit grid.

Connecting paneling points is faster and does not involve time-consuming mapping.

Connecting Grid Points

ptPanelGrid command generates 2-D patterns from a base grid and allows access to pre-defined connecting patterns and user-defined patterns. The **ptPanel3D** command creates 3-D paneling.

The built-in connecting patterns are optimized for speed. 2-D connecting patterns include Box, BoxX, Triangular, TriBasic, Dense, Diamond, AngleBox, Wave, and Brick. Built-in 3-D patterns include WireBox, Partition, Box, Wedge, Pyramid1, and Pyramid2.

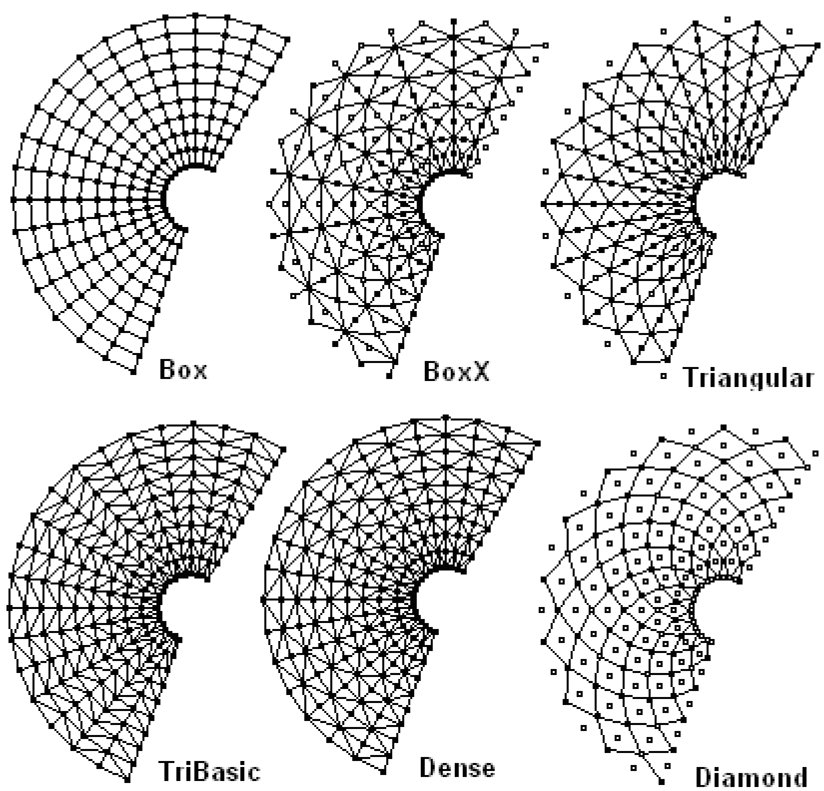
ptManage2DPattern and **ptManage3DPattern** commands create, edit, and delete custom patterns.

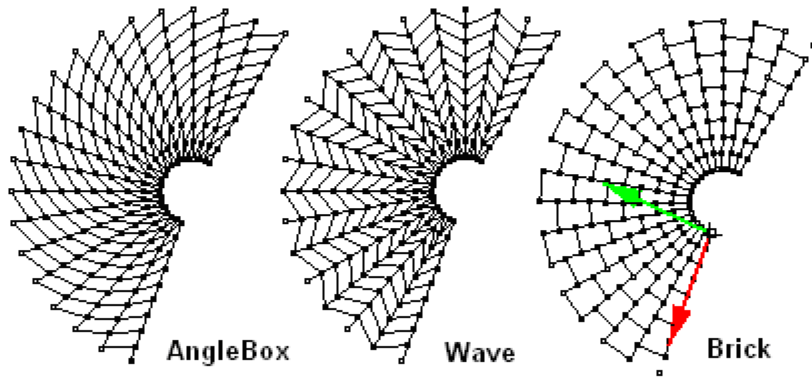
Mapping to Unit Grid

ptPanelGridCustom command supports mapping to populate 2-D free-form patterns. **ptPanel3DCustom** and **ptOrientToGrid** create 3-D patterns.

2-D Connecting Patterns

The **ptPanelGrid** command, **Pattern** option provides built-in connecting patterns. Built-in patterns are optimized for speed and should cover many of the common cases. The following illustration shows these patterns:





ptManage2DPatterns

Custom patterns are created by:

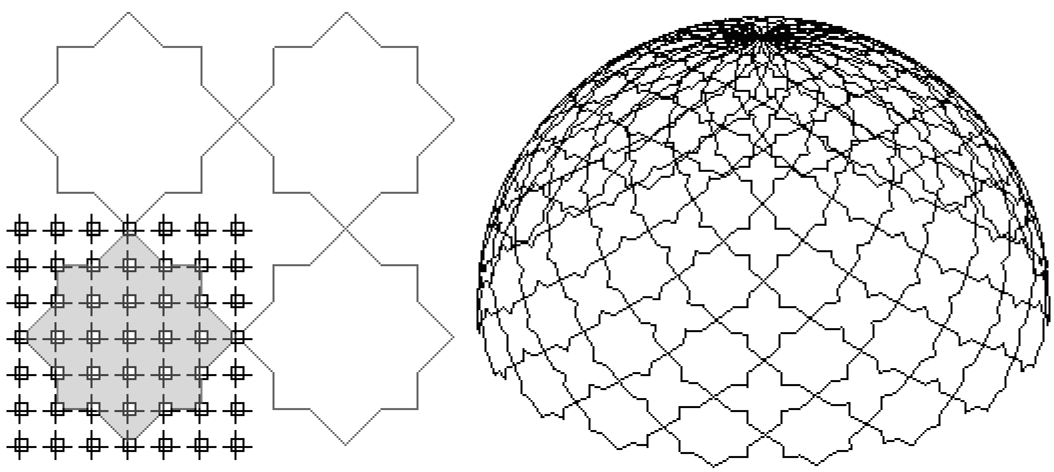
Defining a unit pattern with any number of grid points.

Drawing polylines to connect the points.

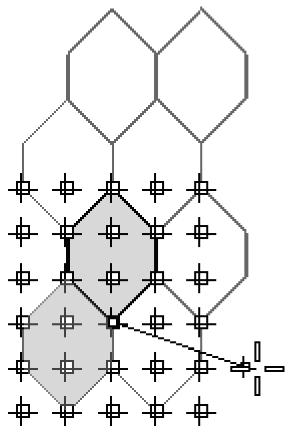
Defining how many units the pattern shifts.

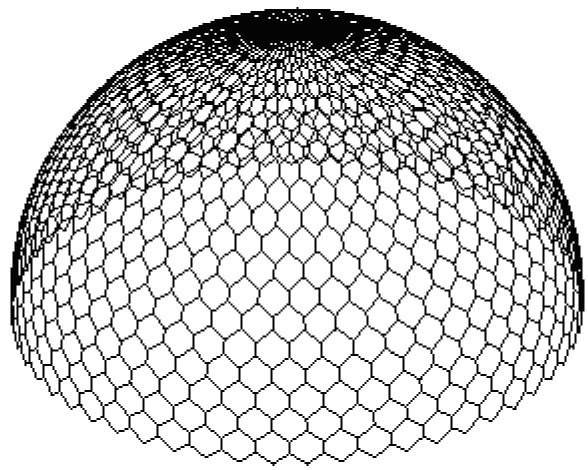
Defining a unique pattern name or reference in paneling command (ptPanelGrid).

Here is an example using one closed polyline with **GridWidth**=7, **GridHeight**=7, **ShiftX**=6 and **ShiftY**=6.



Multiple polylines can be included in the same pattern. The following example used two closed polylines with **GridWidth**=5, **GridHeight**=6, **Shift_x**=2 and **Shift_y**=4.





Command flow

1. Start the **ptManage2DPatterns** command.
2. Create a **New** pattern, **Edit**, or **Delete** existing patterns.
3. When selecting the **New** option, pick two points to define the scale of the preview grid.
4. Pick the grid points to define connecting pattern.
5. Press **Enter** to define additional connections.
6. Press **Enter** to accept that pattern.
7. Press **Enter** to save patterns and exit.

Options

New

Distance in first direction.

GridWidth

Number of grid points in the u-direction to connect.

GridHeight

Number of grid points in the v-direction to connect.

Shift_x

Shift of connecting pattern in the u-direction.

Shift_y

Shift of connecting pattern in the v-direction.

Reset

Clear all connections created for the current pattern.

Undo

Clear all last selection point.

Name

Pattern name.

Edit

Select a pattern name from the list. The command flow and options are similar to when creating new pattern.

Delete

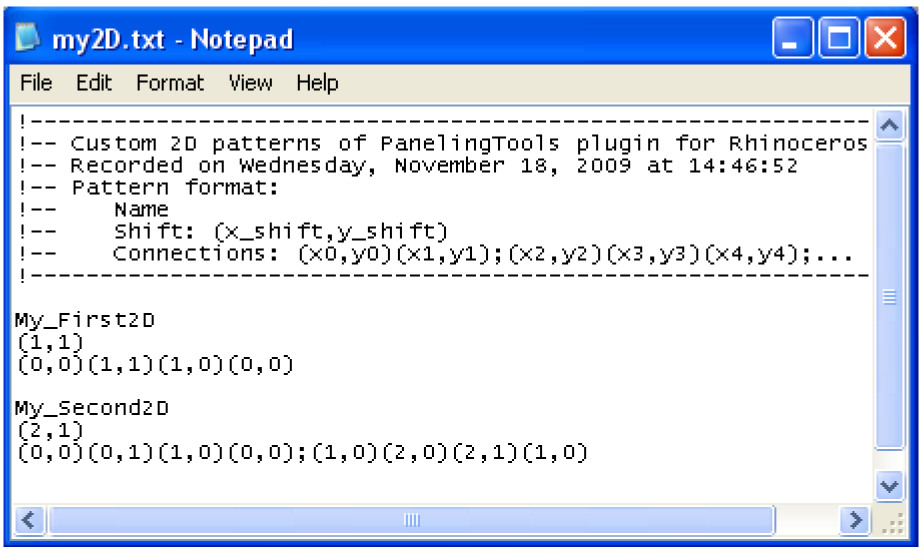
Select the pattern name to be deleted from the list.

Save and load custom 2D patterns

Created 2D patterns persist in a document and are saves with it, but if you like to share patterns across files, then it is best to save these patterns to an external text file. **ptSave2DPatterns** creates a test file of all 2D patterns in a given document. There is an option to append patterns to end of file.

Saved patterns can be loaded using **ptLoad2DPatterns**. If pattern name already exist in the custom patterns list, then it will be overwritten by the newly loaded pattern.

This is what the typical file with saved 2D patterns look like:




```
!--------------------------------------------------------------
!-- Custom 2D patterns of PanelingTools plugin for Rhinoceros
!-- Recorded on Wednesday, November 18, 2009 at 14:46:52
!-- Pattern format:
!--     Name
!--     Shift: (x_shift,y_shift)
!--     Connections: (x0,y0)(x1,y1);(x2,y2)(x3,y3)(x4,y4);...
!--------------------------------------------------------------

My_First2D
(1,1)
(0,0)(1,1)(1,0)(0,0)

My_Second2D
(2,1)
(0,0)(0,1)(1,0)(0,0);(1,0)(2,0)(2,1)(1,0)
```

Options for ptSave2DPatterns

Append

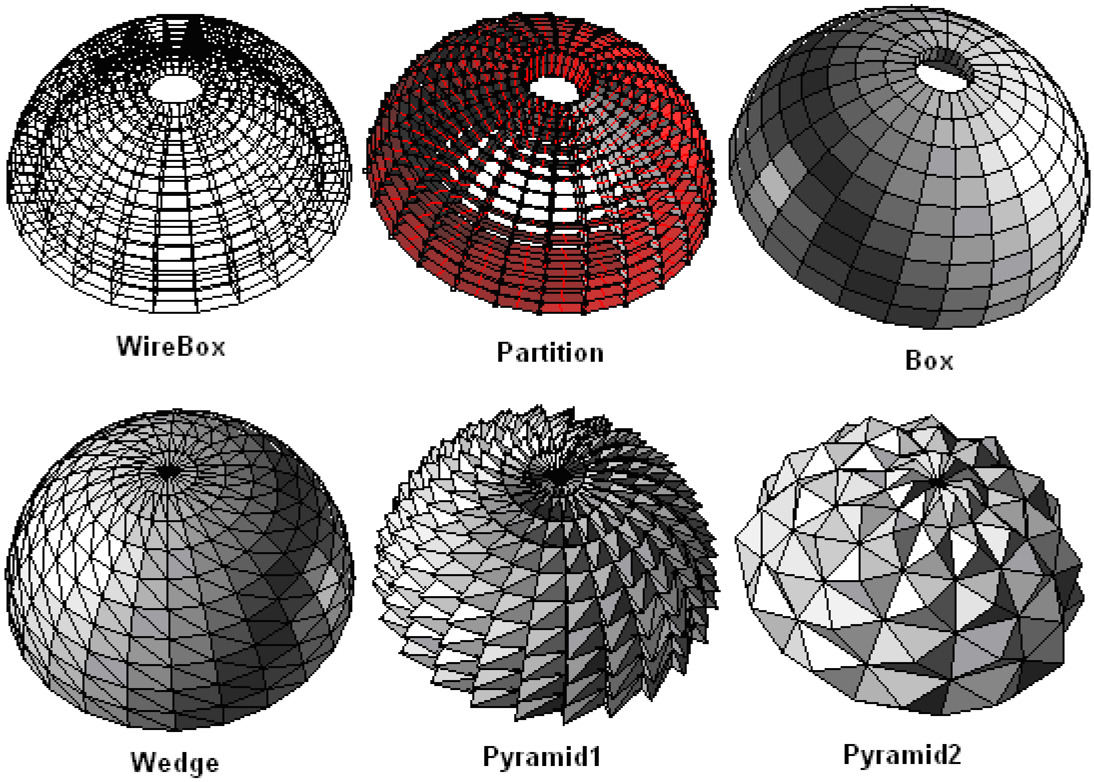
If set to "Yes" then patterns are saved at the end of the file.

SetTargetFile

Select target file. Accept default path or user may type the path at the command line

3-D Connecting Pattern

ptPanel3D command comes with built-in 3-D patterns. The command help create edges, faces, and solids. The following illustration shows built-in patterns:



Built-in 3-D connecting patterns

WireBox
Curves connecting grid points.

Partition
Faces generated from connecting points in first and second bounding grids.

Box
Closed boxes connecting four points from each bounding grid.

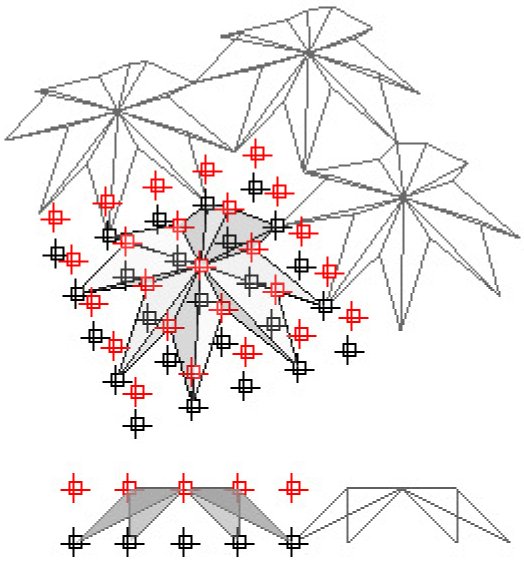
Wedge
Closed trapezoid connecting three points from each bounding grid.

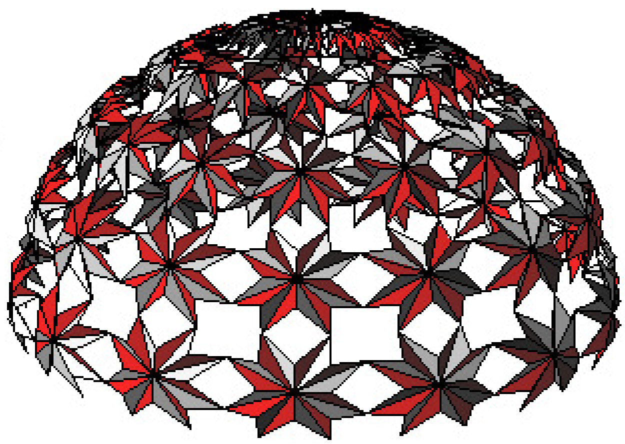
Pyramid1
Connects four points from the first grid with the corresponding minimum point from the second grid.

Pyramid2
Connect four points from first grid that extend over two spans with the corresponding middle point in the second grid.

ptManage3DPattern

3-D pattern require two bounding grids where a pattern is defined with polylines. Closed polylines result in faces that can be joined into a polysurface when pattern is later applied.





Command flow

1. Start the **ptManage3DPattern** command.
2. Create a **New** pattern, **Edit**, or **Delete** existing patterns.
3. When selecting the **New** option, pick two points to define the scale of the preview grid.
4. Pick the grid points to define connecting pattern. Closed polylines define faces.
5. Press **Enter** to define additional connections.
6. Press **Enter** to accept that pattern.
7. Press **Enter** to save patterns and exit.

Options

New

Distance in first direction.

GridWidth

Number of grid points in the u-direction to connect.

GridHeight

Number of grid points in the v-direction to connect.

Shift_x

Shift of connecting pattern in the u-direction.

Shift_y

Shift of connecting pattern in the v- direction.

Reset

Clear all connections created for the current pattern.

Undo

Clear all last selection point.

Name

Pattern name.

Edit

Select a pattern name from the list. The command flow and options are similar to when creating new pattern.

Delete

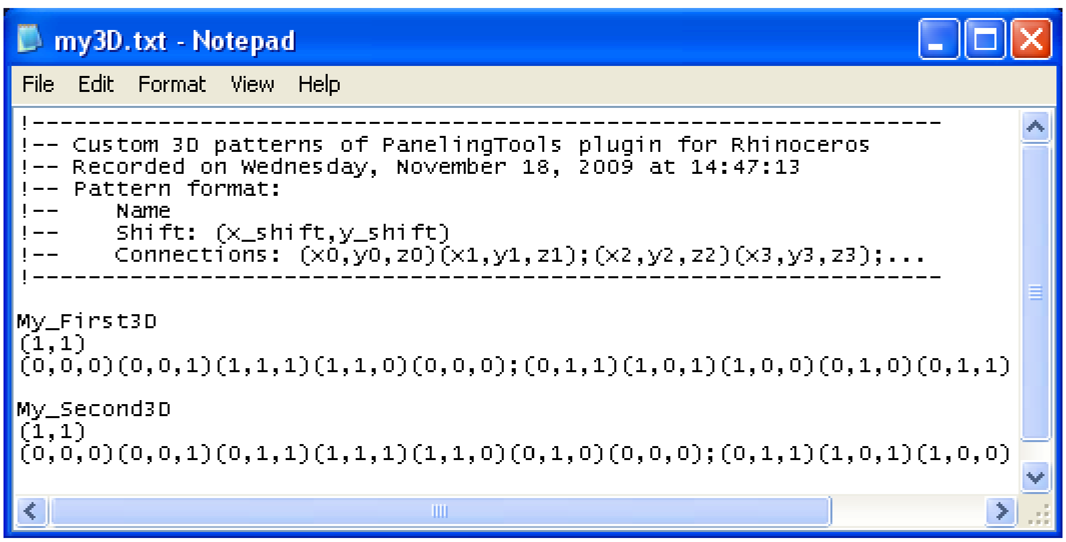
Select the pattern name to be deleted from the list.

Save and load 3D custom patterns

Created 2D patterns persist in a document and are saves with it, but if you like to share patterns across files, then it is best to save these patterns to an external text file. **ptSave3DPatterns** creates a test file of all 2D patterns in a given document. There is an option to append patterns to end of file.

Saved patterns can be loaded using **ptLoad3DPatterns**. If pattern name already exist in the custom patterns list, then it will be overwritten by the newly loaded pattern.

This is what the typical file with saved 3D patterns look like:



```
!-----------------------------------------------------------------
!-- Custom 3D patterns of PanelingTools plugin for Rhinoceros
!-- Recorded on Wednesday, November 18, 2009 at 14:47:13
!-- Pattern format:
!--     Name
!--     Shift: (x_shift,y_shift)
!--     Connections: (x0,y0,z0)(x1,y1,z1);(x2,y2,z2)(x3,y3,z3);...
!-----------------------------------------------------------------

My_First3D
(1,1)
(0,0,0)(0,0,1)(1,1,1)(1,1,0)(0,0,0);(0,1,1)(1,0,1)(1,0,0)(0,1,0)(0,1,1)

My_Second3D
(1,1)
(0,0,0)(0,0,1)(0,1,1)(1,1,1)(1,1,0)(0,1,0)(0,0,0);(0,1,1)(1,0,1)(1,0,0)
```

Options for ptSave3DPatterns

Append

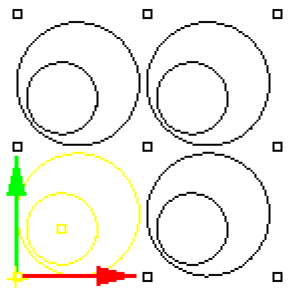
If set to "Yes" then patterns are saved at the end of the file.

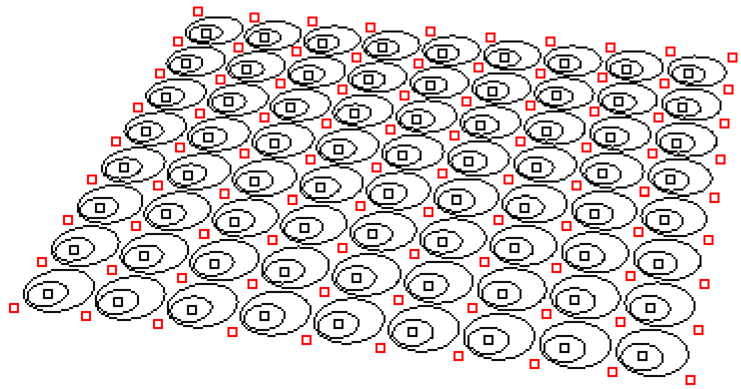
SetTargetFile

Select target file. Accept default path or user may type the path at the command line

ptPanelGridCustom

The **ptPanelGridCustom** command uses a free-form pattern that cannot be represented by connecting grid points. The command scales a given pattern within a unit size then maps it to unit grid. The **GridWidth** and **GridHeight** options scale the pattern. Other options add spacing between each unit pattern and the next in the u- and v-directions.





Command flow:

1. Start the **ptPanelGridCustom** command.
2. Select base paneling grid.
3. Select base surface (optional).
4. Select pattern curves and points.
5. Press **Enter** to accept options.

Options

Base_u
Starting **u** index of the pattern in the grid.

Base_v
Starting **v** index of the pattern in the grid.

Shift_u
An integer value that defines packing density in the **u** direction of the paneling grid. Set the shift to **1** to pack the pattern. Set the spacing to **2** to map every second paneling pattern unit grid, etc.

Shift_v
An integer value that defines packing density in the **v** direction of the paneling grid. Set the shift to **1** to pack the pattern. Set the spacing to **2** to map every second paneling pattern unit grid, etc.

Length
Length of module or its x dimention that is mapped to one full length of the unit grid.
If set the length to be bigger than pattern length then morphed module will be scaled down in the x direction to fit within same relative unit dimension.

Width

Width of module or its y dimention that is mapped to one full width of the unit grid. If set the width to be bigger than pattern width then morphed module will be scaled down in the y direction to fit within same relative unit dimension.

Group

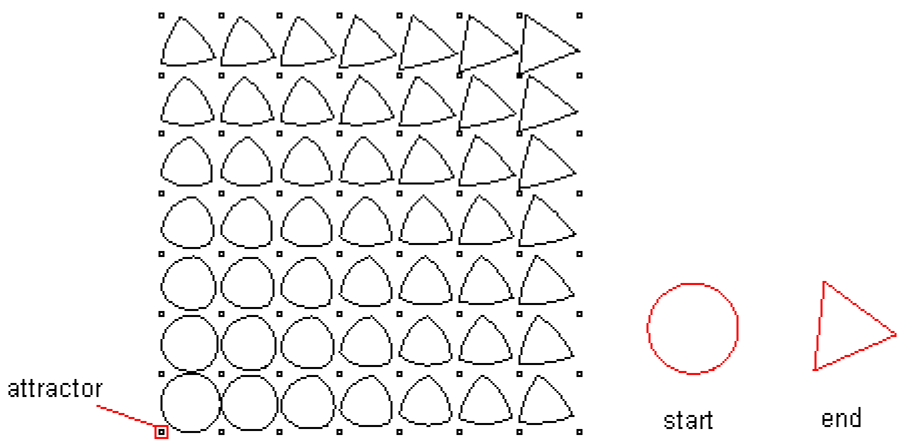
If **Yes**, group the resulting pattern.

Name

Name of resulting paneling. A new layer is created wityh that name and each paneling object name starts with this name.

ptPanelGridCustomVariable

The **ptPanelGridCustomVariable** command is similar to ptPanelgridCustom command except that it allows user to scale, rotate, translate, define a list of shapes or generate mean curves between two shapes. Variation responds to surface curvature, attractors, vector or randomly. This command supports history, so changing the location of attractor points for example, updates the pattern.



Command flow:

1. Start the **ptPanelGridCustomVariable** command.
2. Select base paneling grid.
3. Select base surface (optional).
4. Press Enter to accept options.
5. (if applicable) Select attractor points or curves.
6. Select pattern curves and points.
7. Select bounding objects (optional – if press Enter, then pattern bounding box is used)
8. Press **Enter** to accept options.

Options

Base_u

Starting **u** index of the pattern in the grid.

Base_v

Starting **v** index of the pattern in the grid.

Shift_u

An integer value that defines packing density in the **u** direction of the paneling grid. Set the shift to **1** to pack the pattern. Set the spacing to **2** to map every second paneling pattern unit grid, etc.

Shift_v

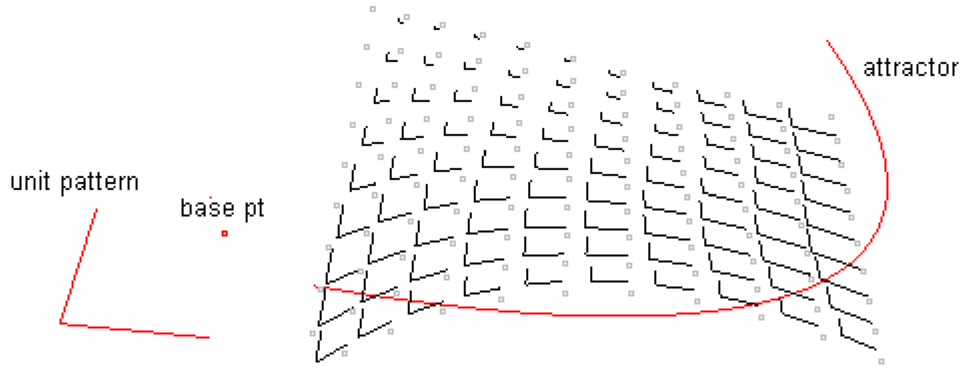
An integer value that defines packing density in the **v** direction of the paneling grid. Set the shift to **1** to pack the pattern. Set the spacing to **2** to map every second paneling pattern unit grid, etc.

PatternMethod

Method of varying input pattern.

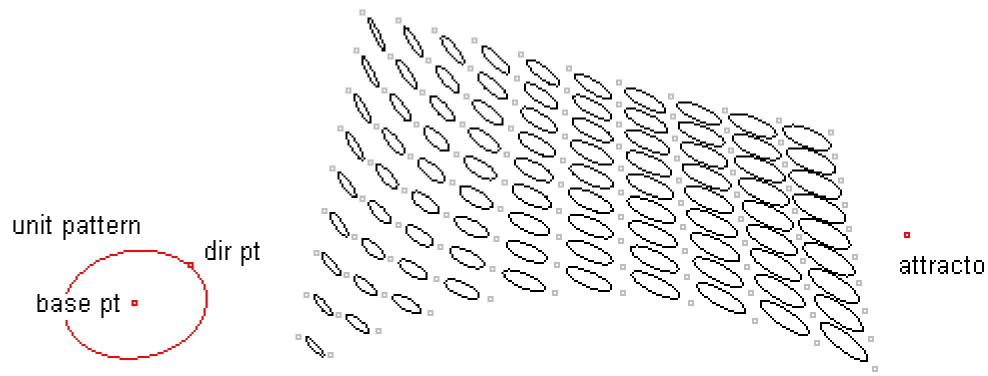
Scale

Scale input unit pattern using base reference point and scale factor range.



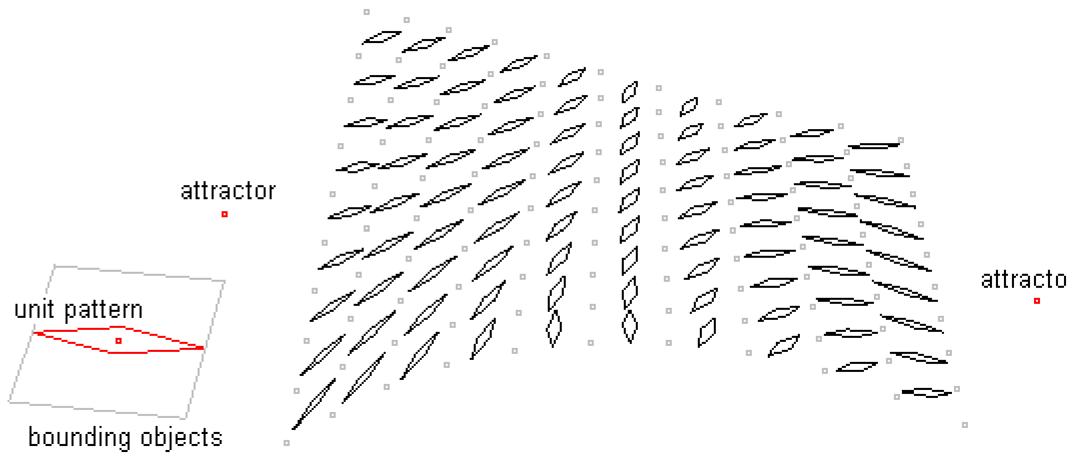
Scale1D

Scale input unit pattern in one direction using base reference point, target reference point and scale factor range.



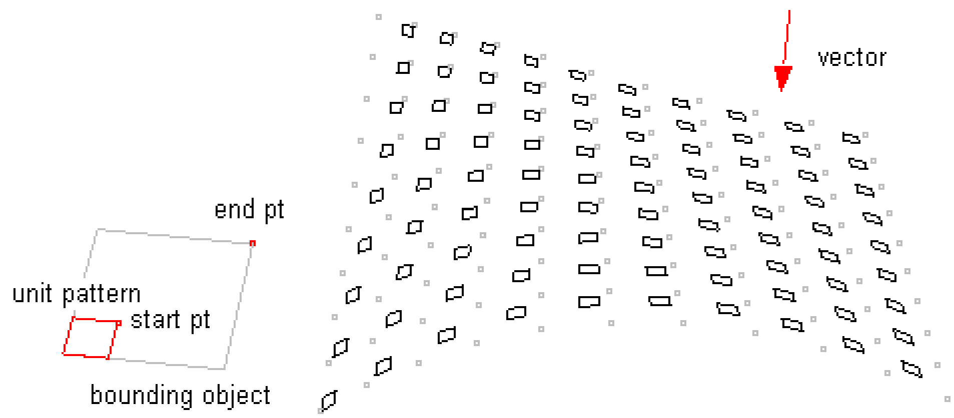
Rotate

Rotate input unit pattern using base reference point and angle range.



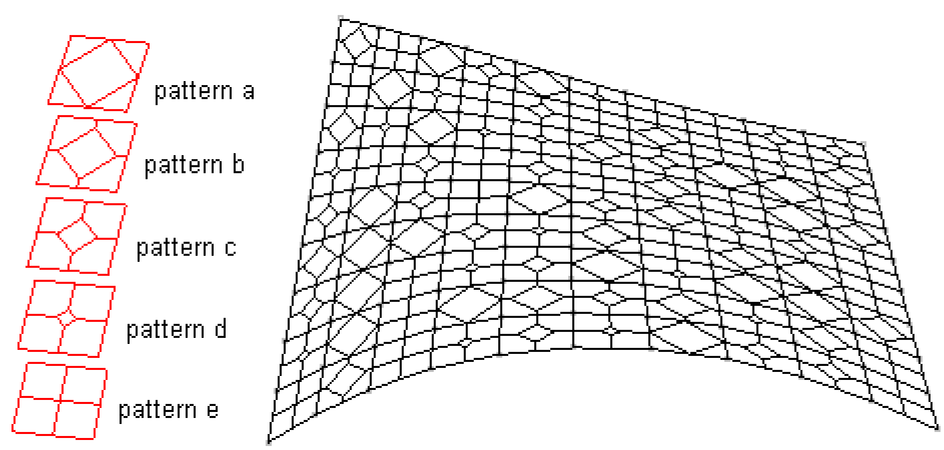
Translate

Move selected pattern between 2 points.



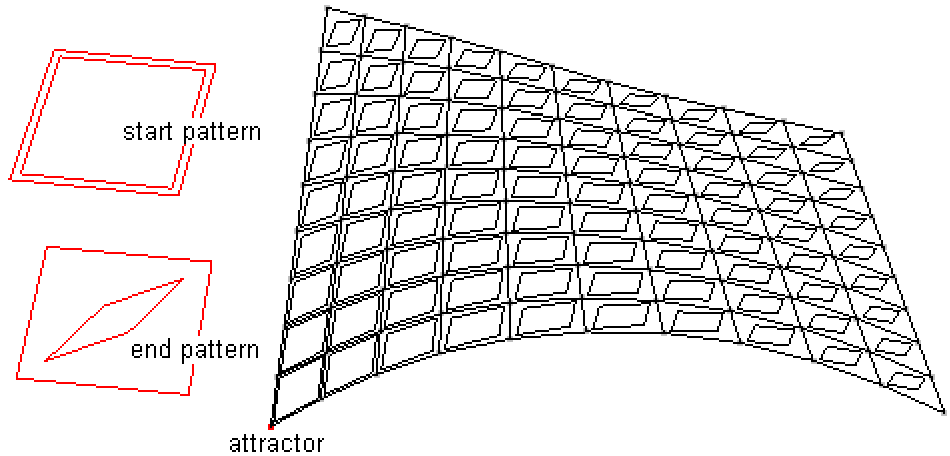
List

Enable selecting a list of patterns in order.



Mean

Calculate mean curves between two sets of input curves. The first curve of the first set is matched with the first curve of the second set.

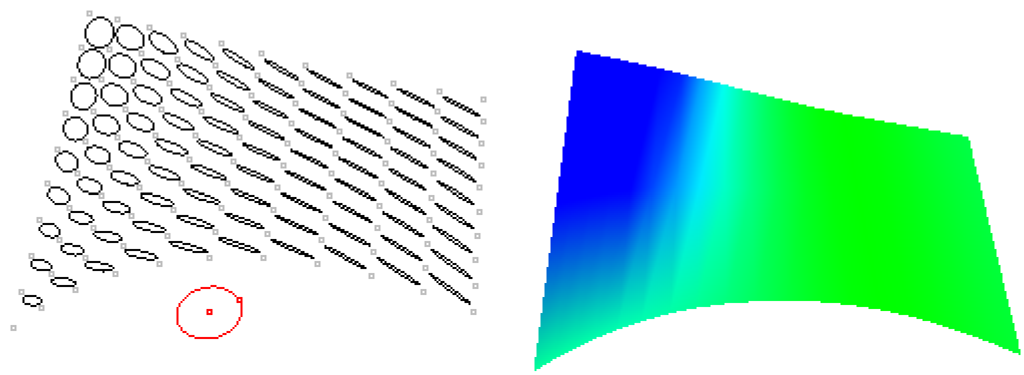


DistributionMethod

Method of calculating distance factor for each square unit pattern. Distance factore is a normalized number between 0 and 1.

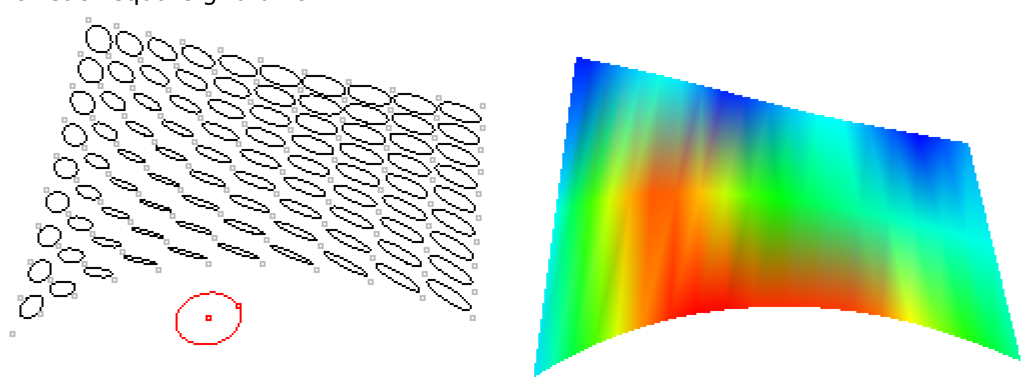
GaussCurvature

Use normalized surface (or grid) Gaussian curvature to define a factor between 0.0 and 1.0 for each square grid unit.



MeanCurvature

Use normalized surface (or grid) Mean curvature to define a factor between 0.0 and 1.0 for each square grid unit.



PointAttractors

The factor is based on the normalized distance from a set of points.

CurveAttractors
The factor is based on the normalized distance from a set of curves.

Vector
The factor is based on the normalized angle with the input vector.

Random
Randomly assign a factor between 0.0 and 1.0 for each square grid unit.

Bitmap
Use heightfield of an input image.

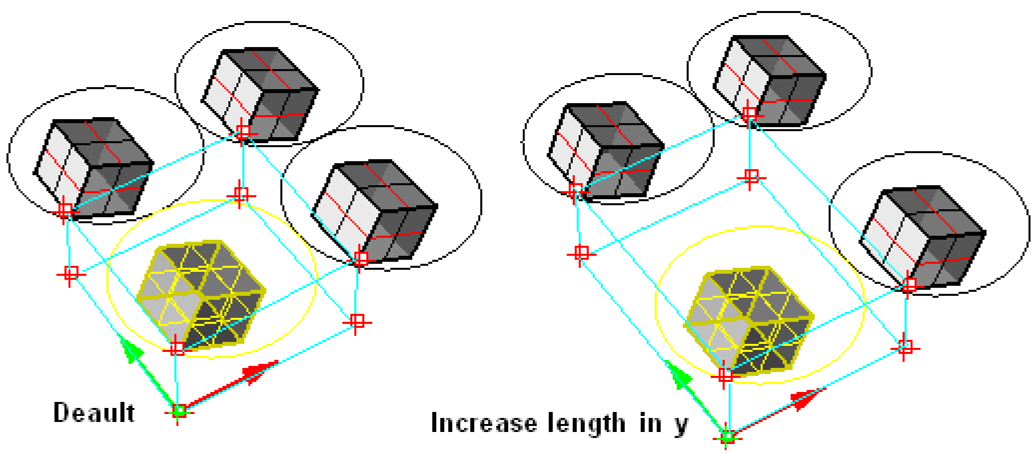
PullCurves
Pull resulting pattern curves to base surface (if available).

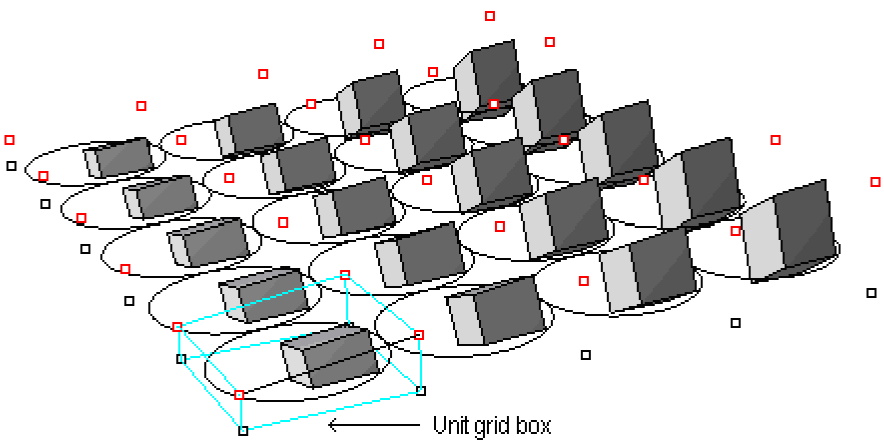
Group
If **Yes**, group the resulting pattern.

Name
Name of resulting paneling. A new layer is created wityh that name and each paneling object name starts with this name.

ptPanel3DCustom

The **ptPanel3DCustom** command scales a given 3-D-pattern bounding box to a unit grid box. (A unit grid is a box bounded by four points from first bounding grid and four points from second bounding grid.) Options scale the pattern and add spacing between each unit pattern and the next in u and v directions. The following is an example paneling uses two bounding grids that do not have to be parallel and maps the bounding box of the 3-D module to each of the one unit grid box:





Command flow

1 Start the **ptPanel3DCustom** command.

2 Select first bounding paneling grid.

3 Select second bounding paneling grid.

4 Select two bounding surfaces (optional).

5 Select 3D pattern (any type object).

6 Press **Enter** to accept options.

Options

Base_u

Starting **u** index of the pattern in the grid.

Base_v

Starting **v** index of the pattern in the grid.

Shift_u

An integer value that defines packing density in the **u** direction of the paneling grid. Set the shift to **1** to pack the pattern. Set the spacing to **2** to map every second paneling pattern unit grid, etc.

Shift_v

An integer value that defines packing density in the **v** direction of the paneling grid. Set the shift to **1** to pack the pattern. Set the spacing to **2** to map every second paneling pattern unit grid, etc.

Length

Length of module or its x dimention that is mapped to one full length of the unit grid.
If set the length to be bigger than pattern length then morphed module will be scaled down in the x direction to fit within same relative unit dimension.

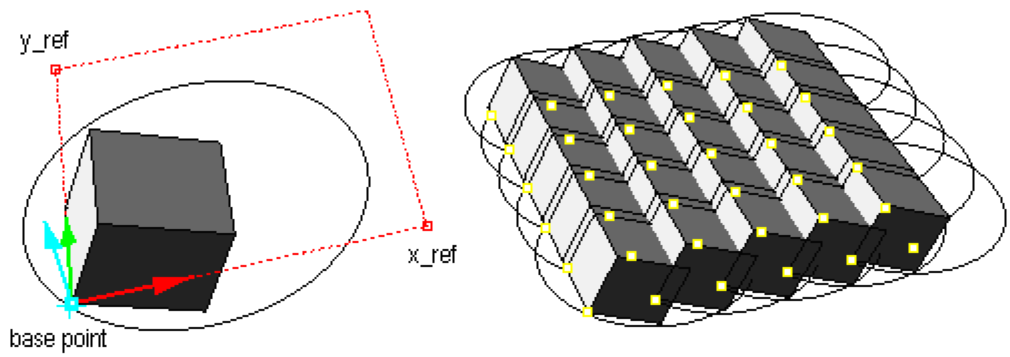
Width

Width of module or its y dimention that is mapped to one full width of the unit grid.
If set the width to be bigger than pattern width then morphed module will be scaled down in the y direction to fit within same relative unit dimension.

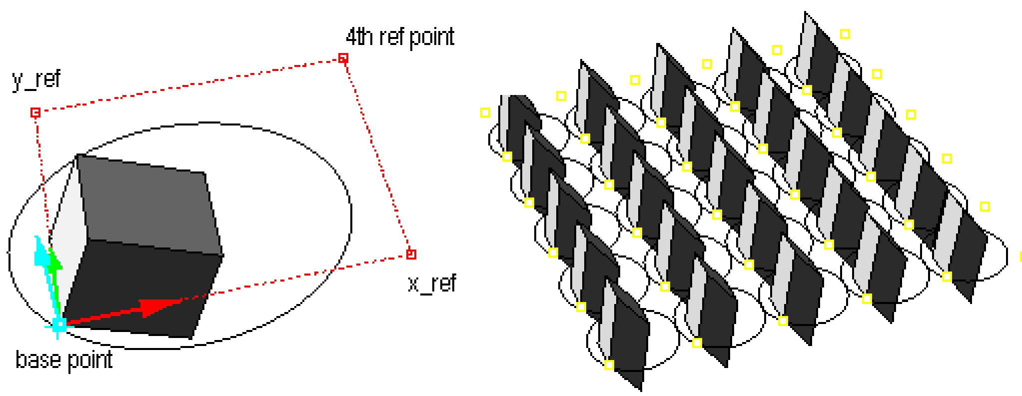
Height
Height of module or its z dimention that is mapped to one full height of the unit grid.
If set the height to be bigger than the module height then morphed module will be scaled down in the z direction to fit within same relative unit dimension.

ptOrientToGrid

The **ptOrientToGrid** command populates 3-D pattern objects to one paneling grid (and one surface if available). This command gives additional control to define input pattern base point, scale, and whether the mapping is rigid or deformed. Following is a rigid transform that uses three reference points (base, x and y):



If a fourth reference point is set, the object will be deformed when populating the grid.



Command flow:

1. Start the **ptOrientToGrid** command.
2. Select module objects. Press **Enter** when done.
3. Select module base point, x reference point and y reference point.
4. The command prompts for an optional fourth point if the module should be deformed. If the module needs to maintain its size, press **Enter**.
5. Select paneling grid.
6. Press **Enter** to accept options.

Options

Base_u
Starting **u** index of the pattern in the grid.

Base_v
Starting **v** index of the pattern in the grid.

Shift_u
An integer value that defines packing density in the **u** direction of the paneling grid. Set the shift to **1** to pack the pattern. Set the spacing to **2** to map every second paneling pattern unit grid, etc.

Shift_v
An integer value that defines packing density in the **v** direction of the paneling grid. Set the shift to **1** to pack the pattern. Set the spacing to **2** to map every second paneling pattern unit grid, etc.

Extend_u
Number of grid units in the v direction to use in the paneling grid.

Extend_v
Number of grid units in the v direction to use in the paneling grid.

ptPanel3DCustomVariable

The **ptPanel3DCustomVariable** command is similar to ptPanel3DCustom command except that it allows define a list of objects or generate mean surfaces between two input surfaces. Variation responds to surface curvature, attractors, vector or randomly.

Command flow:

1. Start the **ptPanel3DCustomVariable** command.
2. Select bounding paneling grids (second grid is optional).
3. Press Enter to accept options.
4. (If applicable) select attractor points or curves.
5. Select list of modules (of start and end surface for mean option).
6. Press **Enter** to accept options.

Options

Base_u
Starting **u** index of the pattern in the grid.

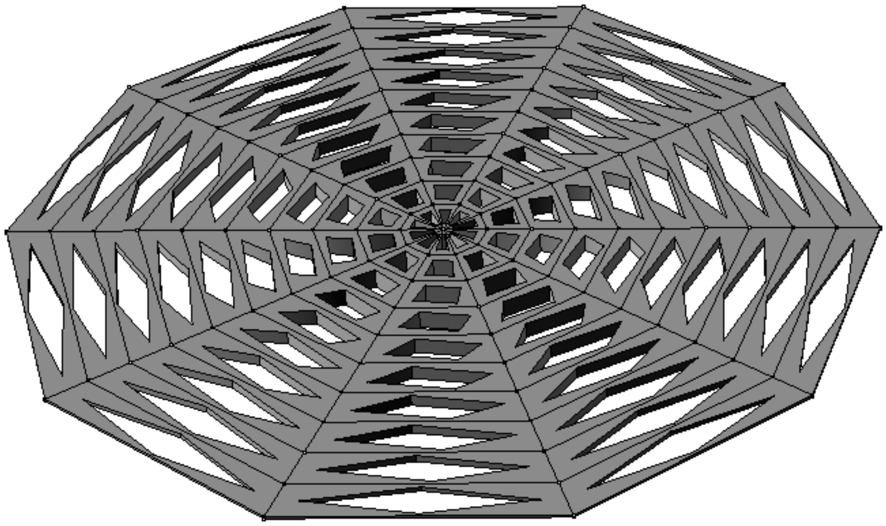
Base_v
Starting **v** index of the pattern in the grid.

Shift_u
An integer value that defines packing density in the **u** direction of the paneling grid. Set the shift to **1** to pack the pattern. Set the spacing to **2** to map every second paneling pattern unit grid, etc.

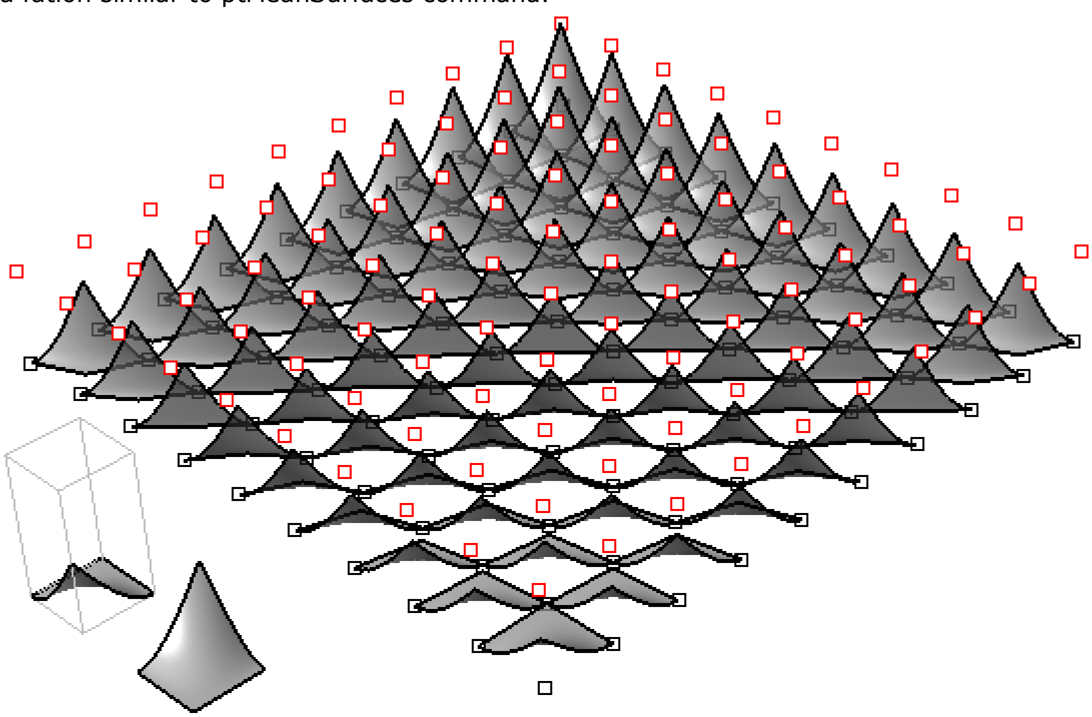
Shift_v
An integer value that defines packing density in the **v** direction of the paneling grid. Set the shift to **1** to pack the pattern. Set the spacing to **2** to map every second paneling pattern unit grid, etc.

PatternMethod
Method of varying input pattern.

List
Enable selecting a list of patterns in order.

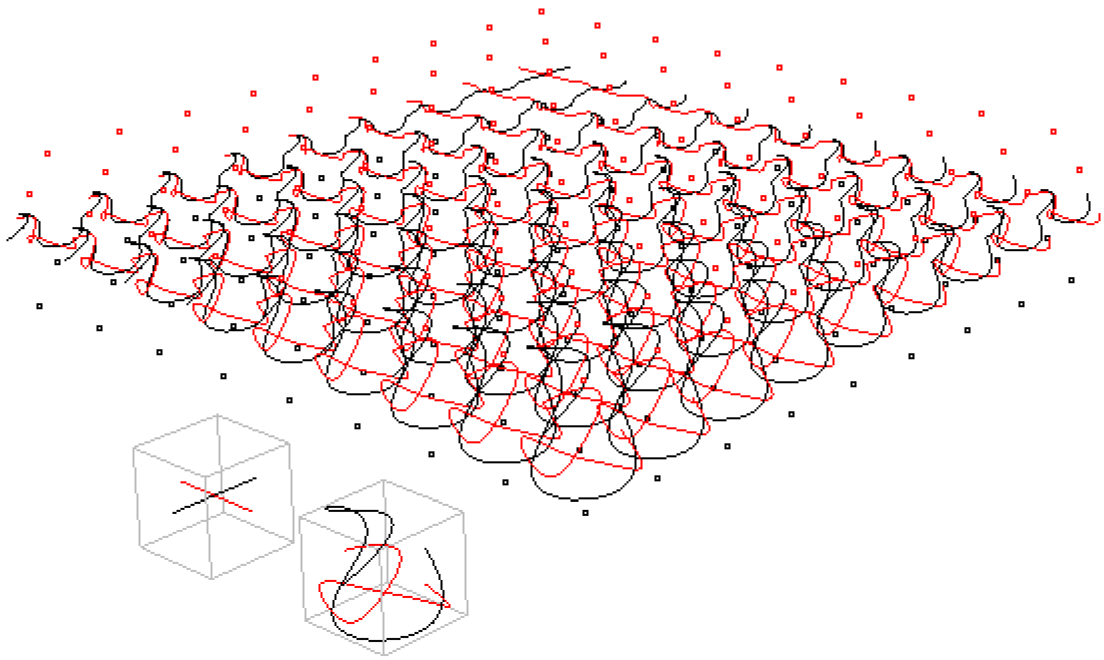


MeanSurfaces
Calculate mean surfaces between two input surfaces. Surfaces have to per-matched by the user or use one of the matching methods. The command generate mean surfaces is a fation similar to ptMeanSurfaces command.



MeanCurves

Calculate mean curves between two input curves. Curves have to per-matched by the user or use one of the matching methods. The command generate mean surfaces is a fation similar to ptMeanCurves command.



DistributionMethod

Method of calculating distance factor for each square unit pattern. Distance factore is a normalized number between 0 and 1.

GaussCurvature

Use normalized surface (or grid) Gaussian curvature to define a factor between 0.0 and 1.0 for each square grid unit.

MeanCurvature

Use normalized surface (or grid) Mean curvature to define a factor between 0.0 and 1.0 for each square grid unit.

PointAttractors

The factor is based on the normalized distance from a set of points.

CurveAttractors

The factor is based on the normalized distance from a set of curves.

Vector

The factor is based on the normalized angle with the input vector.

Random

Randomly assign a factor between 0.0 and 1.0 for each square grid unit.

Bitmap

Use heightfield of an input image.

Group

If **Yes**, group the resulting pattern.

Name
Name of resulting paneling. A new layer is created wityh that name and each paneling object name starts with this name.

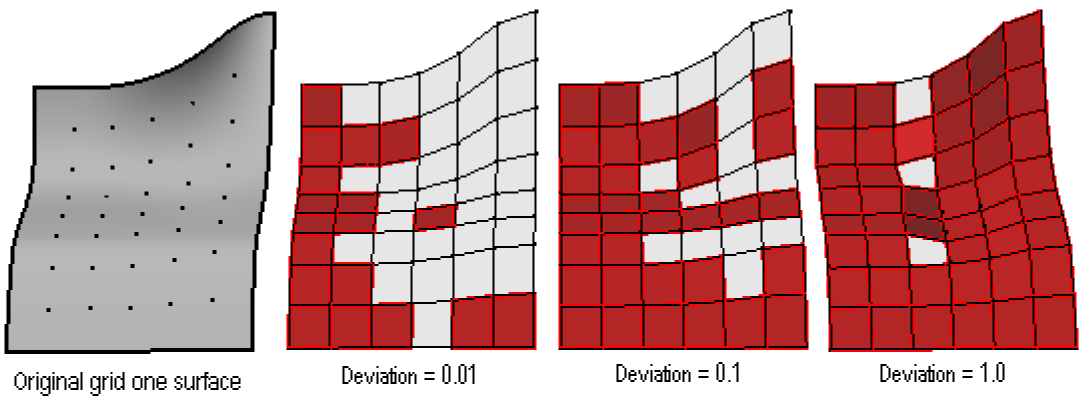
Paneling Planar Quadrangles

Creating planar panels from a free-form base surface is an active area of research. The PanelingTools plug-in provides very basic functionality to approximate an input paneling grid to maximize number of planar quadrangular panels. Following is the details of the command that supports this functionality.

ptPanelGridQuads

The **ptPanelGridQuads** command adjusts paneling grid to create maximum number of quads within tolerance.

One way to have better quadrangle coverage is to increase the maximum deviation, but that increases distortion. Another way is to use a dense grid.



Command flow:

1. Start the **ptPanelGridQuads** command.
2. Select paneling grid.
3. Select base surface or polysurface.
4. Press **Enter** to accept options.

Options

MaxDeviation
Deviation from base grid. Higher deviation=better coverage and more distortion.

Triangulate
If **Yes**, quadrangles that are not made planar are split into two triangles.

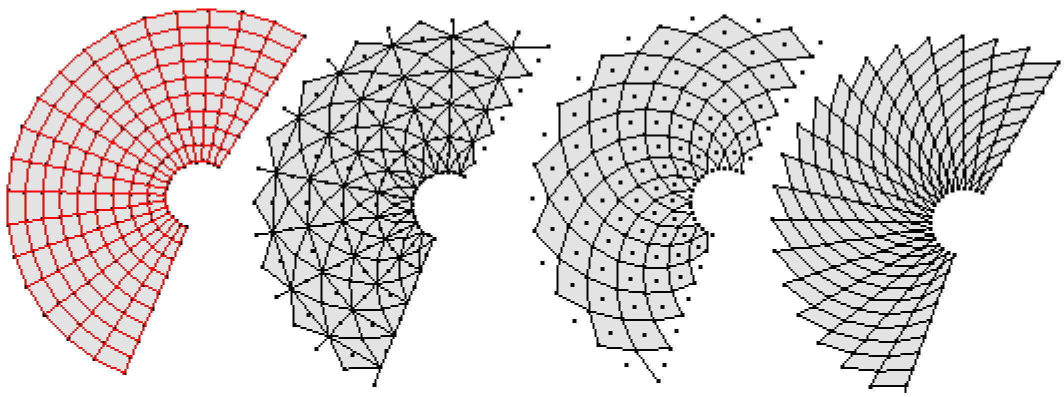
Group
If **Yes**, group the resulting points.

Name
Grid name prefix attached to each point. The row and column location complete the point name.

Paneling with a Grid

ptPanelGrid

The **ptPanelGrid** command creates panels with ordered grid of points. A reference surface or polysurface is optional. A list of patterns includes built-in and connecting patterns created with **ptManage2DPatterns**. Panels are added in the form of edges, surface borders, surfaces (EdgeSrf or Patch), flat surfaces, and a mesh.



Command flow

1. Start the **ptPanelGrid** command.
2. Select paneling grid.
3. Select base surface (optional).
4. Press **Enter** to accept options.

Options

Pattern

Box, BoxX, Triangular, TriBasic, Dense, Diamond, AngleBox, Wave, Brick, and user-defined patterns.

PanelShape

Straight

Line curve connection between points.

Pull

Pull line connection to base surface, if available.

ShortPath

Shortest path on the surface between grid points being connected.

Iso

Isocurve between points if possible, otherwise pull back.

Projected

Project line connection to surface using direction option.

ProjectionDirection

Z_dir

Projection direction = world z-axis.

X_dir
Projection direction = world x-axis
Y_dir
Projection direction = world y-axis.
CPlaneNormal
Projection direction = normal to active construction plane.
PickPoints
Pick two points to define projection direction.

AddEdges
Add edge panels to a new layer. Edges are serialized.

AddFacesBorder
Add border curves panels to a new layer. Borders are serialized.

AddFaces
Add face panels (Patch or EdgeSrf) to a new layer. Faces are serialized.

AddFlatFaces
Create planar faces. Faces might not join. Faces are serialized and added to a new layer.

FlatFaceMethod
Specify how flat panels are calculated.

BestFit
Best-fit plane through all unit grid points.
FitBasePt0
Best-fit plane through three of the fours unit grid points starting from min u, min v and going clockwise.
FitBasePt1
Best-fit plane through three of the fours unit grid points starting from min u, max v and going clockwise.
FitBasePt2
Best-fit plane through three of the fours unit grid points starting from max u, max v and going clockwise.
FitBasePt3
Best-fit plane through three of the fours unit grid points starting from max u, min v and going clockwise.
TangentToCenter
Best-tangent plane to surface center.

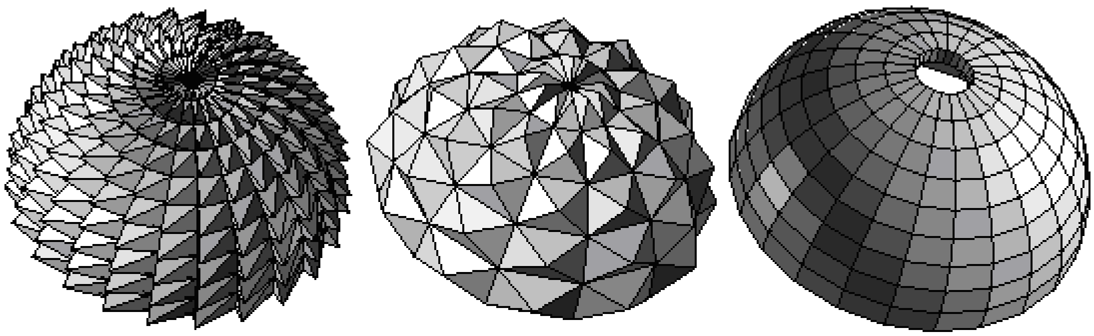
AddMesh
Add a mesh.

Group
If **Yes**, group the resulting points.

Name
Grid name prefix attached to each point. The row and column location complete the point name.

ptPanel3D

The **ptPanel3D** command creates a panel from two grids. A list of patterns includes built-in and user-defined panels. Panels are added in the form of edges, surfaces, and polysurfaces. Spacing of unit patterns depends on grid spacing.



Command flow:

1. Start the **ptPanel3D** command.
2. Select first paneling grid. Set options for pattern in this step.
3. Select second paneling grid.

Options

Pattern
WireBox, Partition, Box, Wedge, Pyramid1, Pyramid2, and user-defined patterns.

Group
If **Yes**, group the resulting points.

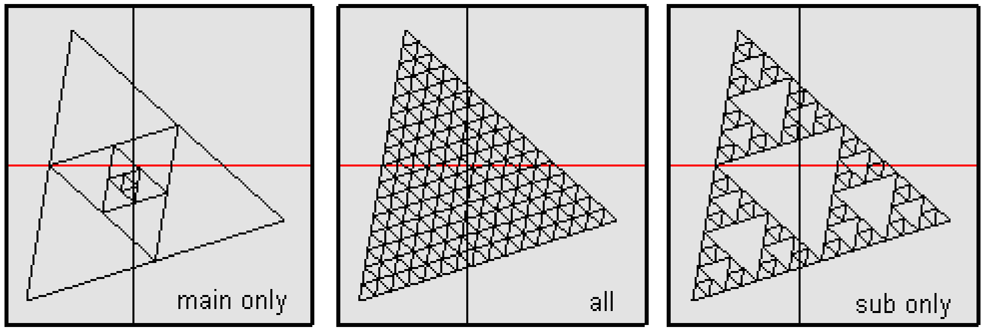
Name
Grid name prefix attached to each point. The row and column location complete the point name.

Paneling without a Grid

The **ptPanelSubDivide**, **ptPanelRandomPoints**, and **ptTriangulatePoints** commands do not create a base grid, but use either polylines or points on surface as an input to panel.

ptPanelSubDivide

The **ptPanelSubDivide** command recursively subdivides any number of polylines on a base surface. Each new polyline connects the midpoints of parent polyline segments.



Command flow

1 Start the **ptPanelSubDivide** command.

2 Select base surface.

3 Select polylines.

4 Press **Enter** when done.

Options

Degree
Number of subdividing steps

Method
If **Yes**, group the resulting points.

All
Subdivide all resulting sub polylines.

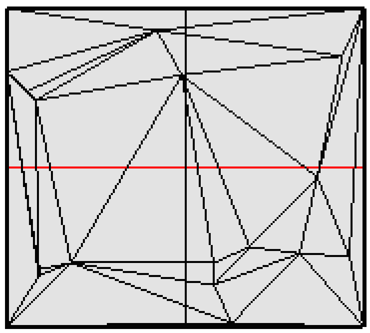
SubOnly
Subdivide sub curves only.

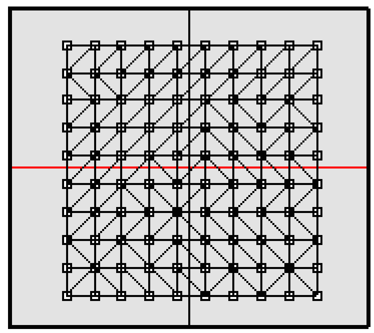
Main Only
Subdivide main curve only.

PanelShape
Straight or Pull.

ptPanelRandomPoints

The **ptPanelRandomPoints** command triangulates points on a base surface. Select any number of points on surface or have the command generate random points. The command solves triangulation of points on surface and solves shortest distance. It can be time consuming for big set of points. The **ptTriangulatePoints** command is more appropriate for big set of data.





Command flow

1. Start the **ptPanelRandomPoints** command.
2. Select base surface.
3. Select points on surface.
4. Press **Enter** when done.

Options

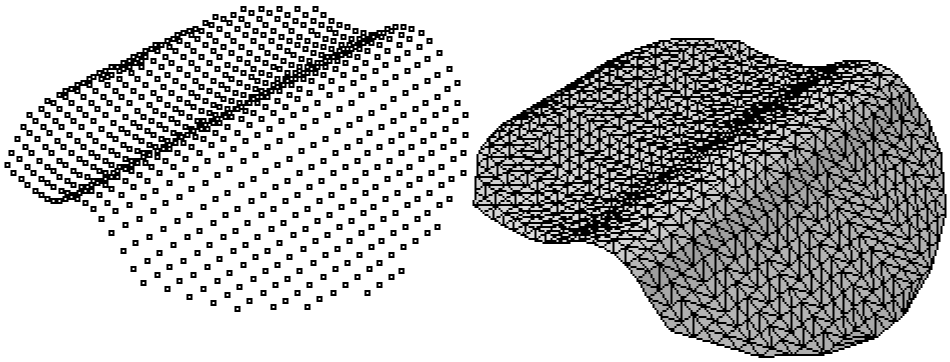
GenerateRandomly
If **Yes**, internally generate random points.

PointCount
Number of points to be generated.

PanelShape
Straight or Pull.

ptTriangulatePoints

The **ptTriangulatePoints** command uses Delauney triangulation to create a mesh from points. The command generates planar surfaces as an output.



Command flow

1. Start the **ptTriangulatePoints** command.
2. Select points.
3. Press **Enter** when done.

5 Paneling Output

Most paneling commands support multiple output formats: edges, surfaces, planar surfaces, patch surfaces and meshes. If a reference surface is used, panels can be pulled back to the surface. Using a base surface can trim panels to that surface. The following sections discuss paneling format and shape and address how panels are trimmed when using a reference surface or polysurface.

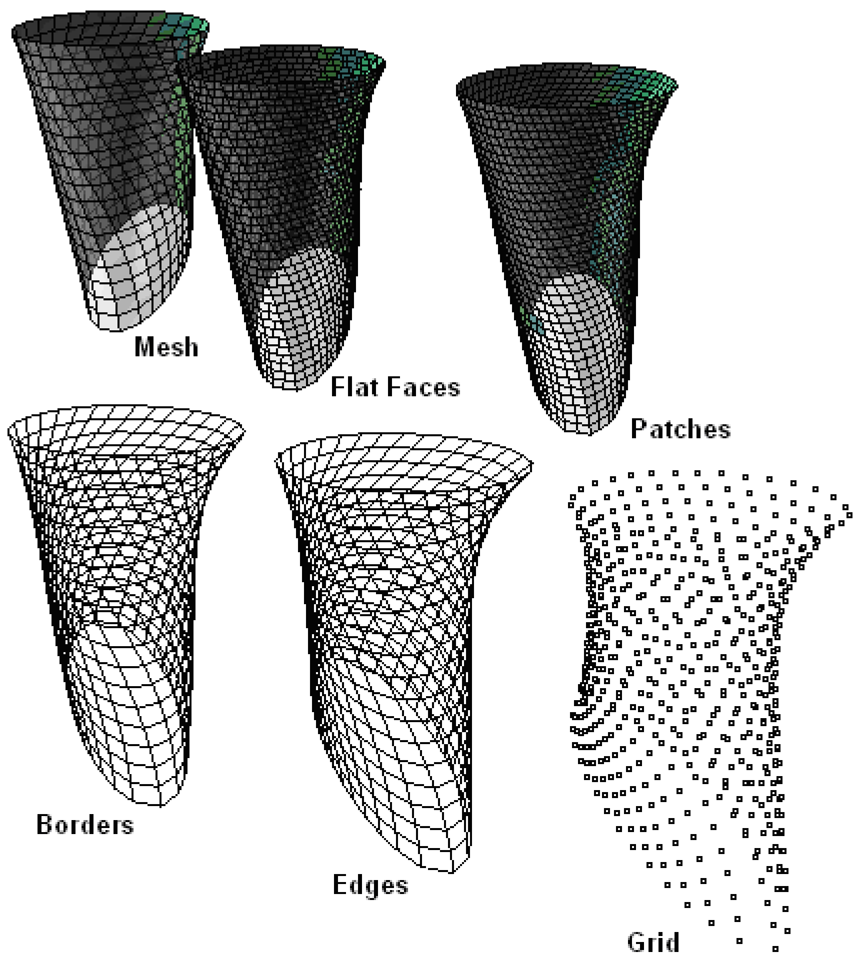
Paneling format

Panels can be curves, surfaces, or meshes. Each format might be desirable for a different situation. Here are few things to remember when deciding which format to use:

Panels are labeled (serialized) and grouped in separate layers. One layer for each format.

Straight edges and meshes are processed fastest.

Creating surfaces can be time consuming especially when they are not planar and need to be trimmed. It is best to start with edges or a mesh when exploring design ideas and use surfaces during the final stages of design.



Rhino geometry used for each format

Grid points
ON_3dPoint

Straight edges
ON_Line or ON_LineCurve.

Straight face borders
ON_PolyLine or ON_PolylineCurve.

Pulled edges
ON_NurbsCurve.

Flat faces
Trimmed ON_Plane.

Faces from straight edges
ON_NurbsSurface from an EdgeSurface.

Faces from pulled edges
ON_NurbsSurface from an a Patch.

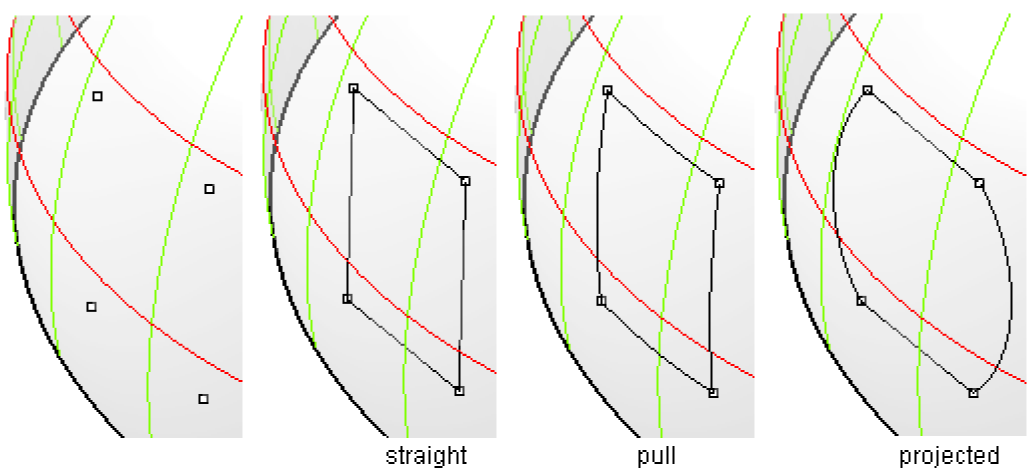
Mesh
ON_Mesh

Paneling shape

The paneling shape can only be straight when there is no reference surface or reference surface is planar. For example, edges are represented by lines connecting paneling grid, and custom patterns are mapped to a bilinear surface connecting unit grid. A straight shape can generate quickly and is recommended in intermediate stages of design.

If there is a reference surface for the paneling, Pulled, Iso and Projected shapes can be used. For example, when generating a simple box pattern, line edges connecting the grid are either pulled to the base surface, made to follow its isocurves (if applicable), or are projected to surface.

Here is an example that compares few of the paneling shapes:



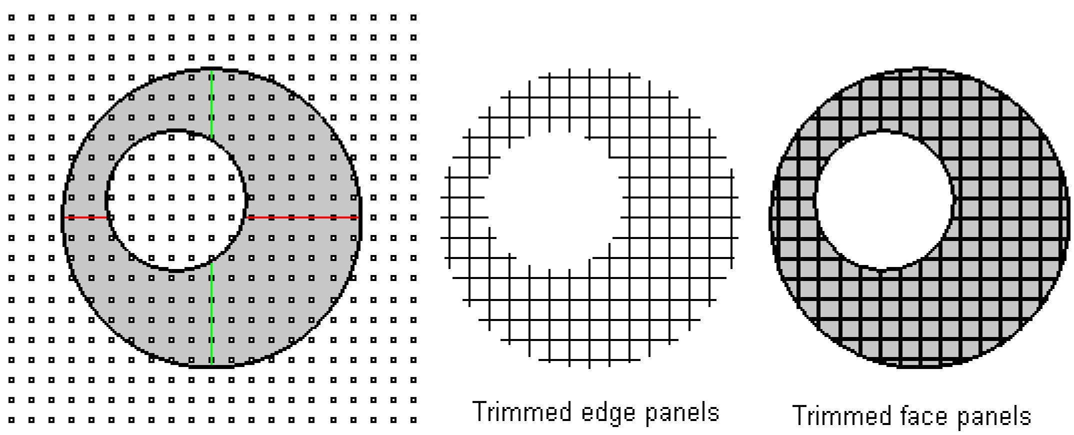
Paneling shape

Straight
Line curve connection between points.
Pull
Pull straight line connection to base surface.
ShortPath
Shortest path on the surface between points being connected.
Iso
Isocurve between points if possible, otherwise pull back the straight line curve.
Projected
Project line connection to surface. Projection direction is user-defined.

Trimmed surfaces

When paneling uses a base surface or a polysurface, the panels are trimmed to the edges of that base. Selecting a base is optional in most cases and therefore it can be skipped if the user doesn't wish to trim output.

Panels are trimmed regardless of what paneling shape is used. For example with "straight" shape, if a line curve happens to connect two point one within base and the other outside it, then the line is pulled to the base and the intersection point with the boundary is used as the new second point. In some cases this process fails to find useful result and few panels might need to be trimmed manually.



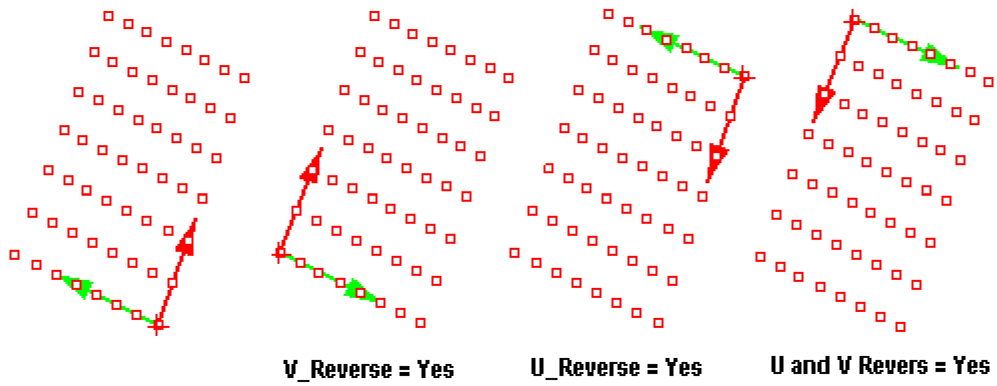
6 Utility Functions

Grid Utility Functions

The paneling grid can be modified directly using Rhino commands to project a grid on a surface, pull back, delete parts of it, or transform it (Move, Scale, Rotate, SoftMove, etc.). In general, any modification that does not change names of the grid of points is acceptable. Utility commands **ptDirection**, **ptRowsDirection**, **ptCompactGrid**, **ptCloseGrid**, **ptGridSeam**, **ptCleanOverlap**, **ptTrimGrid**, **ptOffsetPoints**, **ptChangeGridDensity**, **ptExtendGrid**, and **ptShiftGrid** help manipulate the paneling grid.

ptDirection

The **ptDirection** command flips u- and v-directions of the grid. This changes the names of point in the grid.



Command flow

1. Start the **ptDirection** command.
2. Select a grid.
3. Press **Enter** to accept options.

Options

UReverse
If **Yes**, reverse u-direction of the grid.

VReverse
If **Yes**, reverse v-direction of the grid.

Group
If **Yes**, group the resulting points.

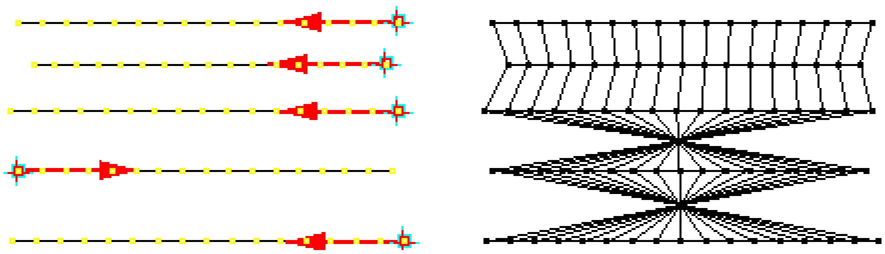
NameOfGrid
Name of paneling grid. Default to selected grid point.

ptSwapGridUV

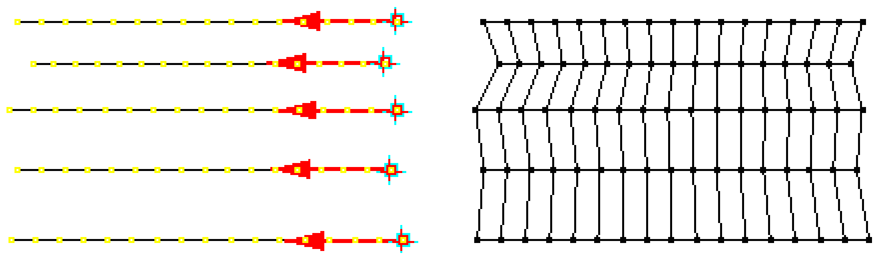
This command swaps the uv direction of a point grid. In other words, the u and v indices of each point are swapped.

ptRowsDirection

The **ptRowsDirection** command reverses rows directions of a paneling grid.



Flipped row direction causes flipped paneling



Use ptRowsDirection command to flip rows direction

Command flow

1. Start the **ptRowsDirection** command.
2. Select a grid.
3. Select a row base point to flip its direction.

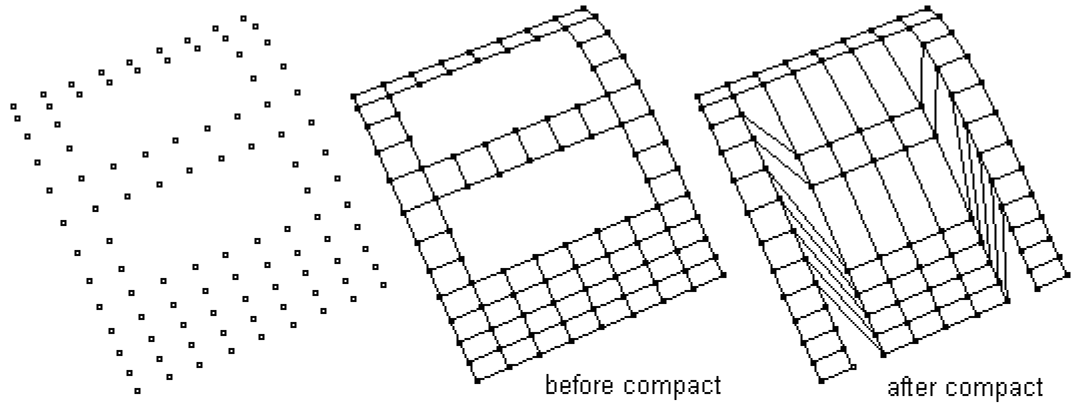
Options

Group
If **Yes**, group the resulting points.

NameOfGrid
Name of paneling grid. Defaults to selected grid point.

ptCompactGrid

The **ptCompactGrid** command removes holes in the selected grid. The command compacts rows and columns of points.

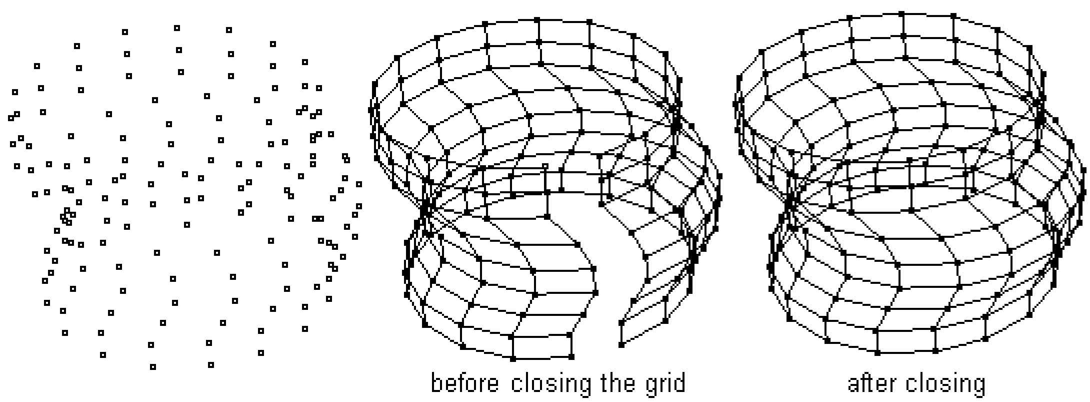


Command flow

1. Start the **ptCompactGrid** command.
2. Select a grid.
3. Press **Enter** to accept.

ptCloseGrid

The **ptCloseGrid** command closes selected grid in u-, v- or both directions.



Command flow:

1. Start the **ptCloseGrid** command.
2. Select a grid.
3. Press **Enter** to accept.

Options

Direction

Close in U, V or Both directions

Group
If **Yes**, group the resulting points.

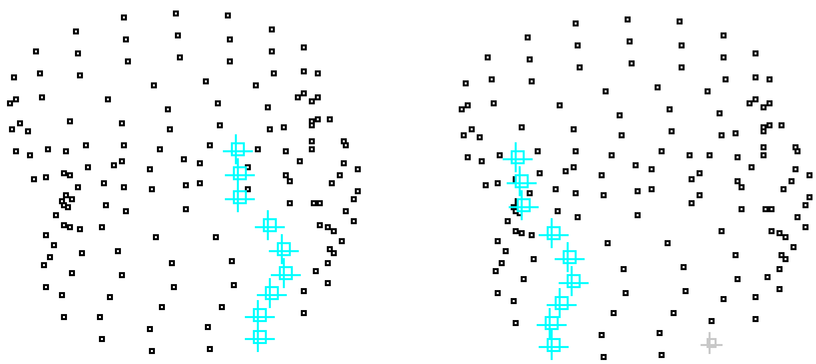
NameOfGrid
Name of paneling grid. Defaults to selected grid point.

Overlap
Number of rows/columns to overlap.

StartIndex
Index of the first row/column to overlap.

ptGridSeam

The **ptGridSeam** command changes the grid seam in a closed paneling grid. This command is useful when seam points do not align.



Shift=3, All=Yes to move all seam points three steps

Command flow:

1. Start the **ptGridSeam** command.
2. Select a grid.
3. Select seam points to shift.
4. Press **Enter** when done

Options

Direction (U/V)
Appears when grid is closed in two directions.

Shift
Can be positive or negative number. Represents the number of steps a selected seam point moves by.

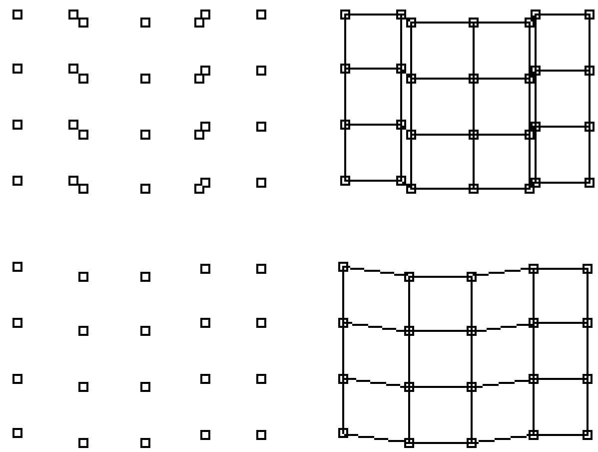
All
move all seam points together.

Group
If **Yes**, group the resulting points.

NameOfGrid
Name of paneling grid. Defaults to selected grid point.

ptCleanOverlap

The **ptCleanOverlap** command removes overlapped points in a paneling grid or merges them within tolerance. The command behaves different if points to be merged are in one row versus in one column. The command deletes grid points that are within tolerance in the u-direction. It moves points within tolerance in the v-direction to overlap.



Grid and panels after merging near grid points with ptGridOvelap

Command flow:

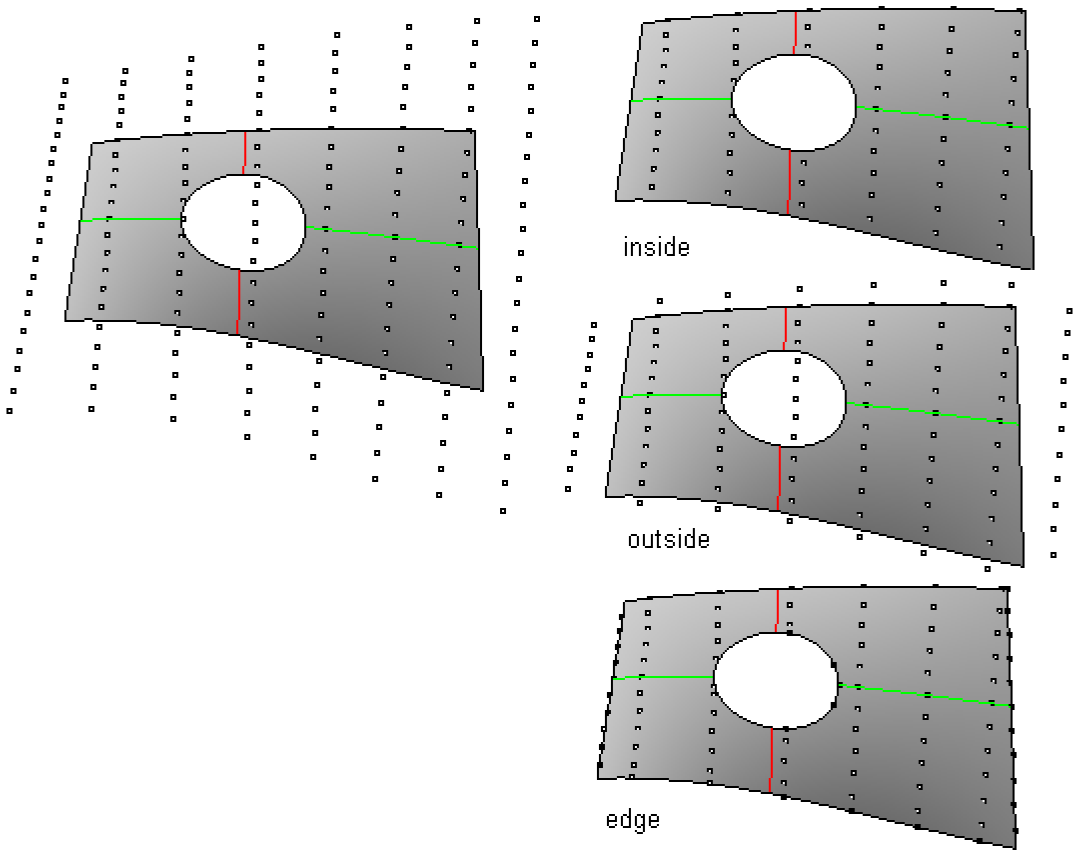
1. Start the **ptCleanOverlap** command.
2. Select a grid.
3. Press **Enter** to accept tolerance option.

Options

Tolerance
Maximum distance between points to be merged.

ptTrimGrid

The **ptTrimGrid** command trims a grid to a base surface or polysurface. It is possible to keep inside points, inside and points immediately outside, or move outside points to closest points on the edge.



Command flow:

1. Start the **ptTrimGrid** command.
2. Select a grid and select options.
3. Select base surface or polysurface.

Options

Mode

Inside
Select only inside points

Outside
Select inside points and ones immediately outside.

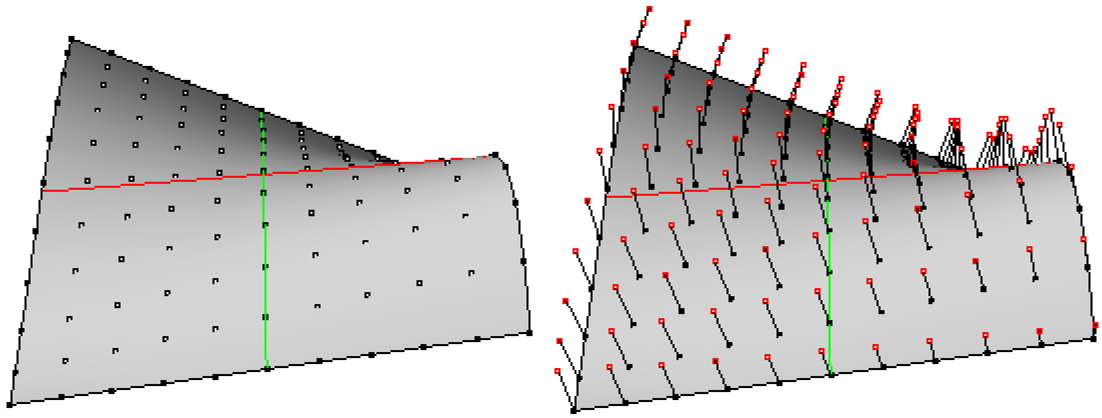
Edge
Move the nearest outside to the closest edge.

Group
If **Yes**, group the resulting points.

NameOfGrid
Name of paneling grid. Defaults to selected grid point.

ptOffsetPoints

The **ptOffsetPoints** command offsets points on surface or polysurface by a specified amount normal to that surface. An option connects input points with offset points.



Command flow

1. Start the **ptOffsetPoints** command.
2. Select a points (not necessary part of a paneling grid) and pick options.
3. Select base surface or polysurface.

Options

DistanceMethod

Fixed	Offset with fixed distance
GaussianCurvature	Use surface gausian curvature values
MeanCurvature	Use surface mean curvature values.
AttractorPoints	Sift towards attractor points
SunVector	Use dot product between a vector and normal on surface at each point.
Random	Shift points by random amount

Distance (when DistanceMethod=fixed)
Offset distance.

MinDistance (when DistanceMethod is not fixed)
Minimum offset distance.

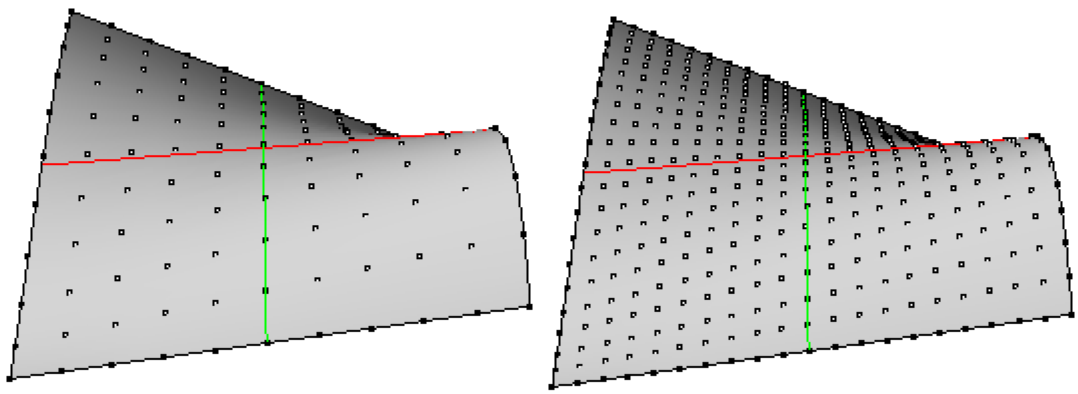
MaxDistance (when DistanceMethod is not fixed)
Maximum offset distance.

Group
If **Yes**, group the resulting points.

Connect
Draw lines between points and their corresponding offset points.

ptChangeGridDensity

The **ptChangeGridDensity** command increases or decreases grid density by adding or removing points in the u-, v- or both directions. It is also possible to keep the same density in either direction.



Command flow

1. Start the **ptChangeGridDensity** command.
2. Select a grid and pick options.
3. Select base surface or polysurface.

Options

UDensity

U-direction density mode.

- **Increase**
- **Decrease**
- **Same**

UNumber

Number of points to add/remove between each two original grid points.

VDensity

V-direction density mode.

- **Increase**
- **Decrease**
- **Same**

VNumber

Number of points to add/remove between each two original grid points.

DeleteInput

Delete input grid.

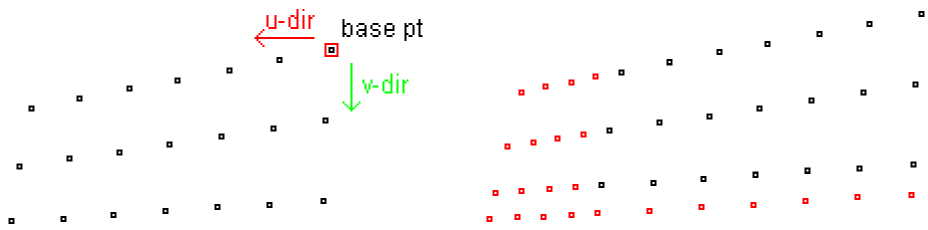
Group

If **Yes**, group the resulting points.

NameOfGrid
Name of paneling grid. Defaults to selected grid point.

ptExtendGrid

The **ptExtendGrid** command adds grid points in u-, v- or both directions at the specified distance. The extension direction is calculated relative to the direction between the last two points in a row or column.



Command flow

1. Start the **ptExtendGrid** command.
2. Select a grid.
3. Press **Enter** to accept options.

Options

UExtend
If **Yes**, extend the grid in the u-direction.

UNumber
Number of points to extend in the u-direction.

UDistance
Distance between points extended in the u-direction.

VExtend
If **Yes**, extend the grid in the v-direction.

VNumber
Number of points to extend in the v-direction.

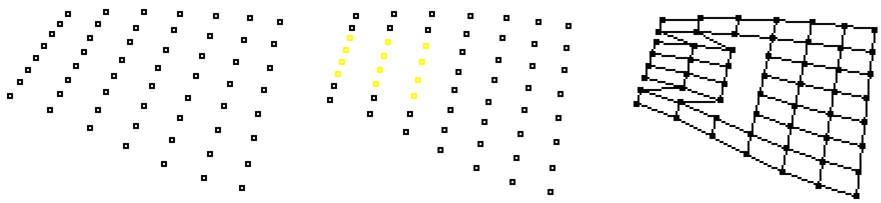
VDistance
Distance between points extended in the v-direction.

Group
If **Yes**, group the resulting points.

NameOfGrid
Name of paneling grid. Defaults to selected grid point.

ptShiftGrid

The **ptShiftGrid** command shifts the index of selected grid points by the specified amount. This helps space out a grid and create holes. It is also useful for combining existing grids.



Shift in u direction by 1

Command flow

1. Start the **ptShiftGrid** command.
2. Select a grid.
3. Press **Enter** to accept options.

Options

RowShift

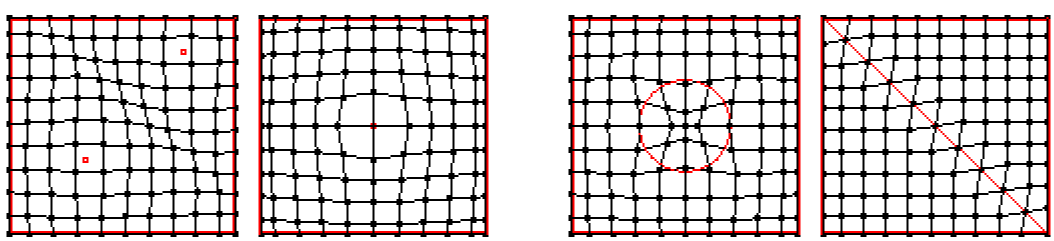
Number of steps shifted in the u-direction.

ColShift

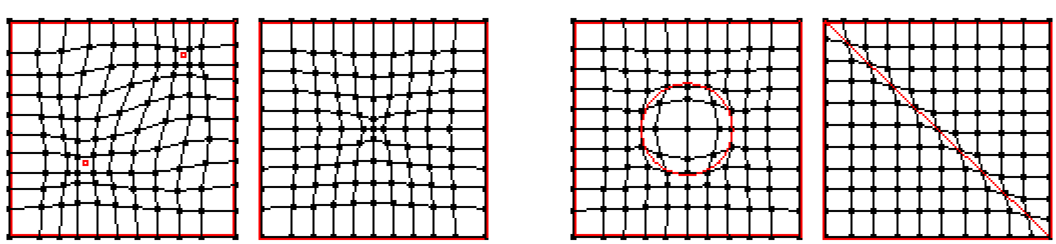
Number of steps shifted in the v-direction.

ptShuffleGrid

The **ptShuffleGrid** command uses reference surface and some parameters to redistribute a given grid. If a surface is not available, then one is created from the input grid on the fly and its parameteric space is used to suffle the grid



variable disribution away from attractor points and curves



variable disribution towards sttractor points and curves

Command flow

1. Start the **ptShuffleGrid** command.
2. Select a grid.
3. Select a surface or press **Enter** to accept options.
4. If using attractor points or curves, then select reference points or curves.

Options

DistanceMethod

GaussianCurvature	Use surface gausian curvature values
MeanCurvature	Use surface mean curvature values.
AttractorPoints	Sift towards/away from attractor points
AttractorCurves	Sift towards/away from attractor curves
SunVector	Use dot product between a vector and normal on surface at each point.
Random	Shift points by random amount
Bitmap	Use heightfield of an input image

AttractMethod

Either away or towards attractor points or curves. If distance method is Mean or Gaussian, then attract towards or away from the highest curvature.

Magnitude

The default=1. Increasing the magnitude exadurates the effect.

Group

Option to group resulting grid.

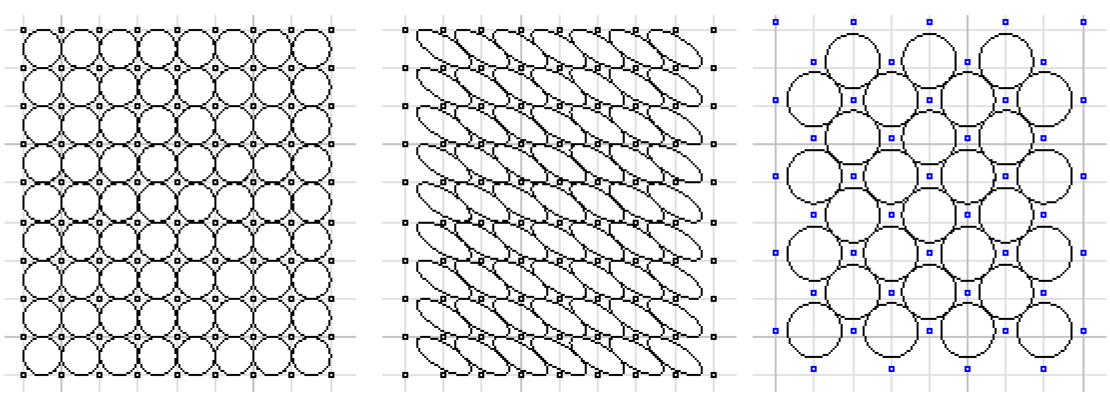
DeleteInput

Option to delete input grid.

ptConvertToDiagonal and ptConvertToDiamond

These commands take a rectangular paneling grid and turn it into diagonal or diamond grids. This is useful when populating patterns that need to go in specific direction other than rectangular. Note that he result grid would not necessarily follow UV surface directions and therefore might not be able to properly modify them with commands like ptShuffleGrid.

In the following example, a circle is populated using ptPanelGridCustom command on a rectangular, diagonal and diamond grids respectively.

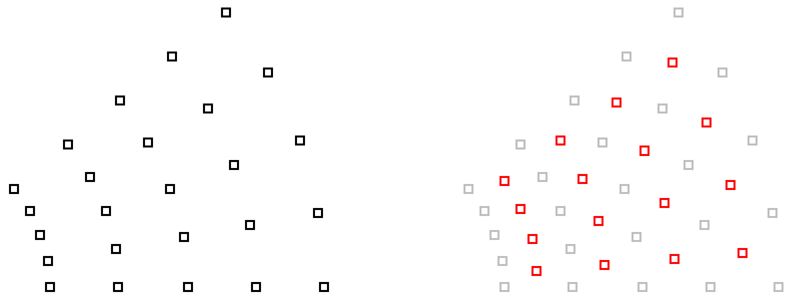


ptWeaveGrids

Create new grid by weaving rows from 2 input grids.

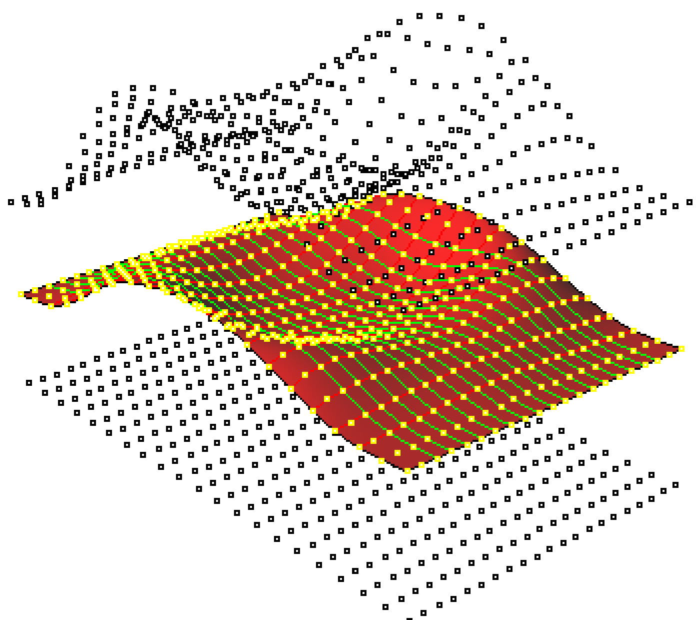
ptExtractCenterGrids

Extracts center point grid of the input grid. Center points are relavent to each four grid unit. There is an option to select a base surface to pull center points to.



ptMeanGrid

Make intermediate surfaces between two input grids. The command does not align seam location for closed surfaces or match UV direction or parameterization.



Command flow

1 Start the **ptMeanGrid** command.

2 Select start grid.

3 Select end grid.

4 Set number of intermediate grids or press Enter to accept default number.

Options

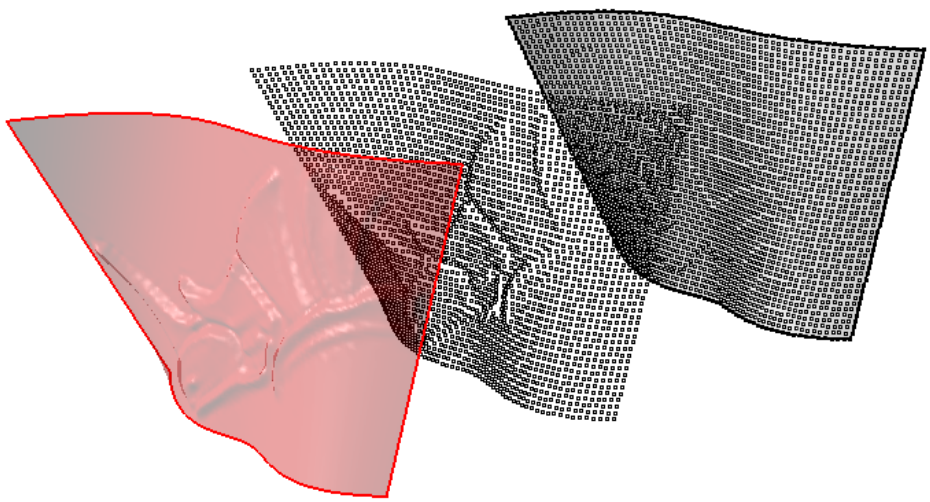
NumberOfGrids
Number of mean grids

CreateSrf
Use intermediate grid to create a surface

Group
Group output.

ptOffsetGridByHeightfield

Offset a paneling grid variably by some min and max offset distance using an image heightfield.



Command flow

1. Start the **ptOffsetGridByHeightfield** command.
2. Select a paneling grid and pick options.
3. Select base surface or polysurface if available.

Options

MinDistance (when DistanceMethod is not fixed)
Minimum offset distance.

MaxDistance (when DistanceMethod is not fixed)
Maximum offset distance.

CreateSurface
If **Yes**, the a surface that goes through the new grid is created.

Group
If **Yes**, group the resulting points.

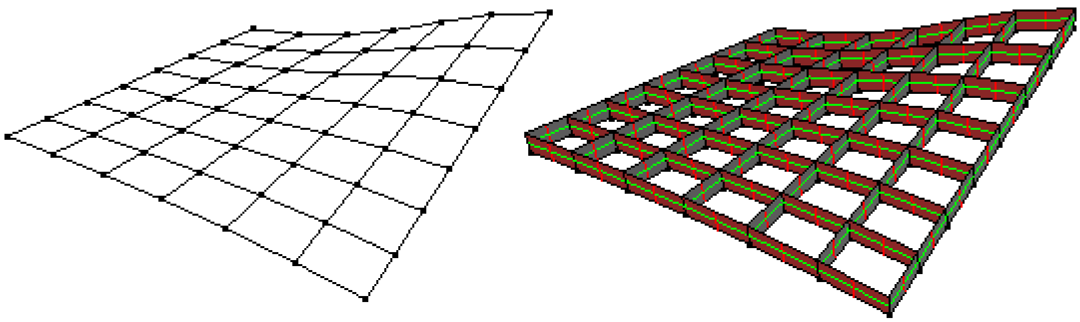
DeleteInput
Delete input grid.

Paneling Utility Functions

Panels generated with paneling commands are standard Rhino geometry. They can be curves, surfaces, polysurfaces, or meshes. Any Rhino command can be used to manipulate them. In addition, **ptExtrudeEdges**, **ptOffsetEdges**, **ptFinEdges**, **ptUnifyFacesDirection**, **ptAnalyzeFlatFaces**, **ptGroupSimilarPanels**, **ptUnrollFaces**, **ptUnrollEdges**, **ptUnrollPoints**, **ptOffsetBorder**, and **ptPlanarLips** commands can help special situations.

ptExtrudeEdges

The **ptExtrudeEdges** command extrudes paneling edges normal to a base surface or a specified direction.



Command flow

1 Start the **ptExtrudeEdges** command.

2 Select curve panels.

3 Select base surface (optional), or pick two points for direction.

Options

HeightMethod

Fixed	Extrude with fixed distance
GaussianCurvature	Use surface gausian curvature values
MeanCurvature	Use surface mean curvature values.
AttractorPoints	Sift towards attractor points
SunVector	Use dot product between a vector and normal on surface at each point.
Random	Shift points by random amount

When **HeightMethod=Fixed,** following option appear:

Height	Extrude distance

When **HeightMethod= [all other options],** following options appear:

MinHeight	Minimum extrude distance
MaxHeight	Maximum extrude distance
AttractMethod	**Towards** or **Away**

AddNotch

Option to add notches to extuded edges. If set to **Yes**, the following options appear:

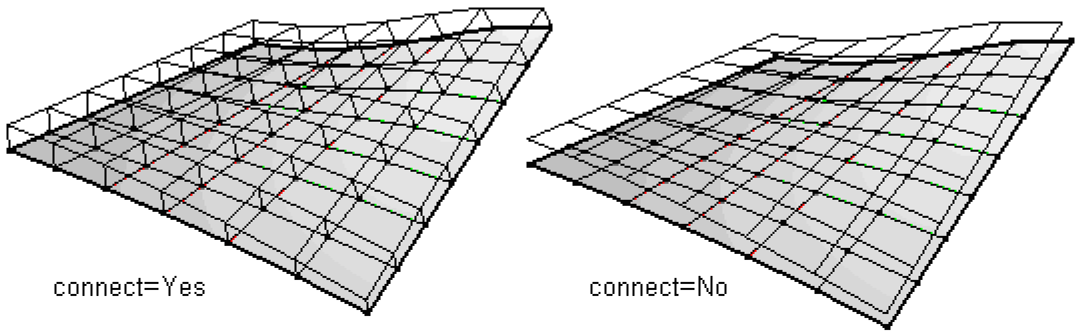
NotchWidth	Width of the notch

NotchHeight Height of the notch
NotchSide Which side to apply the notch (**Start**, **End**, **Both**).

NameEnding
Suffix added to edge name to serialize extruded parts.

ptOffsetEdges

The **ptOffsetEdges** command offsets paneling edges using base surface. If no base is available, use **ptSurfaceFromGridOfEditPoints** command to create one.



Command flow

1. Start the **ptOffsetEdges** command.
2. Select curve panels.
3. Select base surface.

Options

DistanceMethod

Fixed	Offset with fixed distance
GaussianCurvature	Use surface gausian curvature values
MeanCurvature	Use surface mean curvature values.
AttractorPoints	Sift towards attractor points
SunVector	Use dot product between a vector and normal on surface at each point.
Random	Shift points by random amount

Distance (when DistanceMethod=fixed)
Offset distance.

MinDistance (when DistanceMethod is not fixed)
Minimum offset distance.

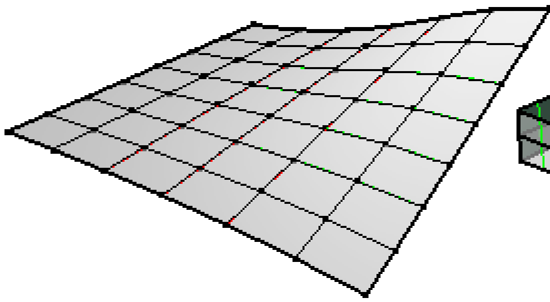
MaxDistance (when DistanceMethod is not fixed)
Maximum offset distance.

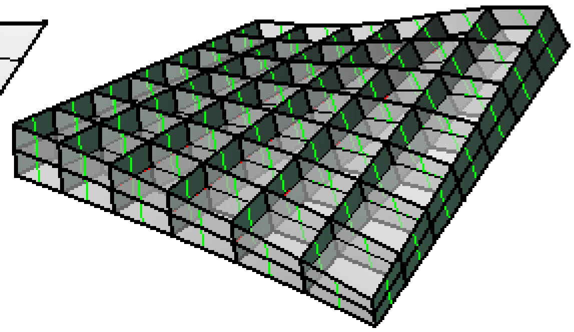
Connect
If **Yes**, connect offset edges with input edges.

NameEnding
Prefix added to edge name to serialize extruded parts.

ptFinEdges

The **ptFinEdges** command extrudes paneling edges using base surface. The fin can be on one or both sides.





Command flow

1. Start the **ptFinEdges** command.
2. Select curve panels.
3. Select base surface.

Options

DistancetMethod

Fixed	Extrude with fixed distance
GaussianCurvature	Use surface gausian curvature values
MeanCurvature	Use surface mean curvature values.
AttractorPoints	Sift towards attractor points
SunVector	Use dot product between a vector and normal on surface at each point.
Random	Shift points by random amount

When **DistaanceMethod=Fixed,** following option appear:

Distance	Extrude distance

When **DistanceMethod= [all other options],** following options appear:

Min Distance	Minimum extrude distance
Max Distance	Maximum extrude distance
AttractMethod	**Towards** or **Away**

AddNotch

Option to add notches to extuded edges. If set to **Yes**, the following options appear:

NotchWidth	Width of the notch
NotchHeight	Height of the notch
NotchSide	Which side to apply the notch (**Start**, **End**, **Both**).
FlipNotch	Define if the notch is applied near the edge or away from it.

NameEnding

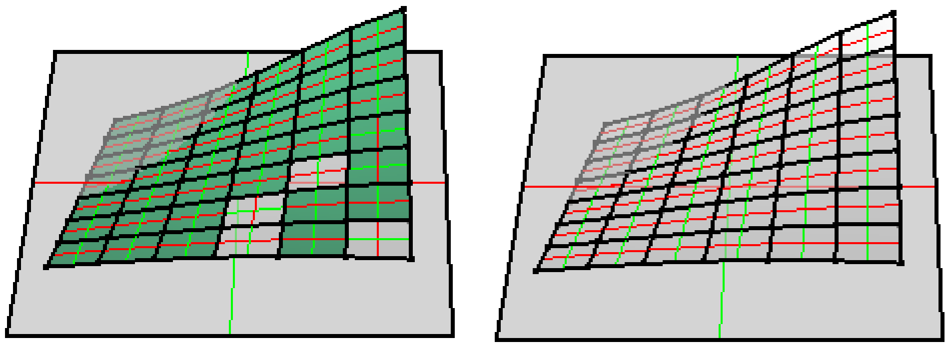
Suffix added to edge name to serialize extruded parts.

BothSides

If **Yes**, fin both sides.

ptUnifyFacesDirection

The **ptUnifyFacesDirection** command orients u-, v-, and normal directions of the input faces relative to a base surface.



Few input faces have flipped normal and swapped uv compared to a base surface

Command flow

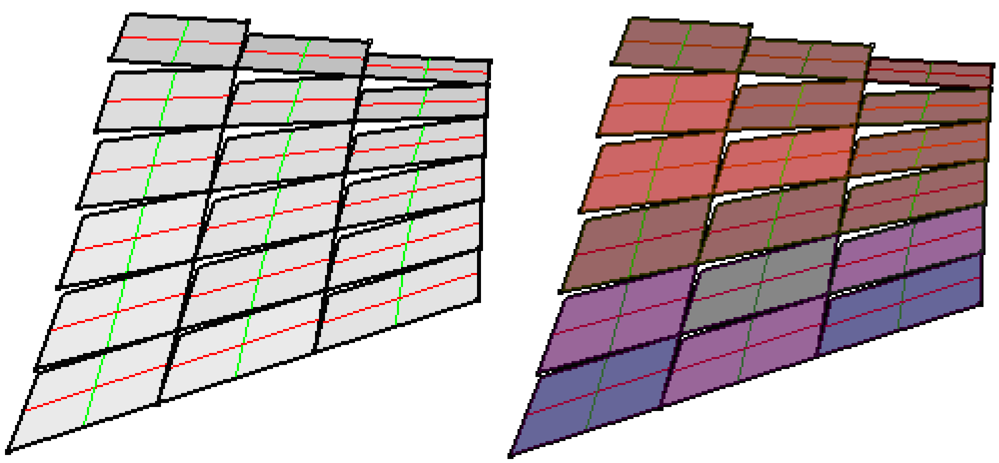
1. Start the **ptUnfyFacesDirection** command.
2. Select input faces.
3. Select base surface to use its u-, v-, and normal direction as a reference.

Options

UnifyUV
Match reference surface u- and v-directions.

ptAnalyzeFlatFaces

The **ptAnalyzeFlatFaces** command creates an analysis mesh to show amount of deviation of flat surfaces from their base surface. When creating flat surfaces with the **ptPanelGrid** command, the deviation amount is saved as user data on each surface. This information is used to create the analysis mesh.

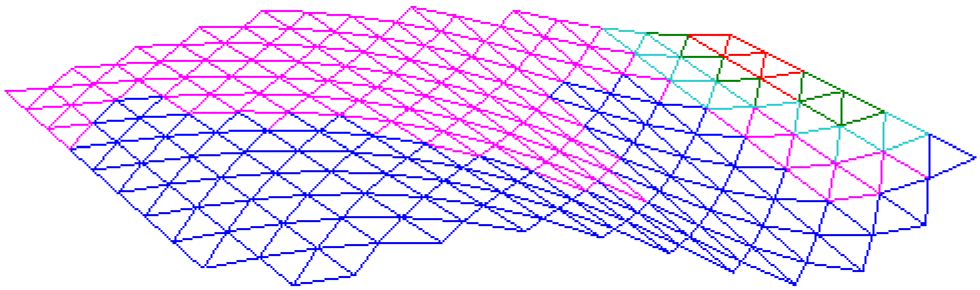


Command flow

1. Start the **ptAnalyzeFlatFaces** command.
2. Select flat faces (faces created with **ptPanelGrid FlatFaces** option).
3. Press **Enter** when finished.

ptGroupSimilarPanels

The **ptGroupSimilarPanels** command groups similar curves together within a given tolerance. Similar curves have similar edge length within tolerance.



Command flow

1. Start the **ptGroupSimilarPanels** command.
2. Select input paneling curves.
3. Press **Enter** to complete.

Options

Tolerance
Difference in edge length allowed for panels to be considered similar.

ptUnrollFaces

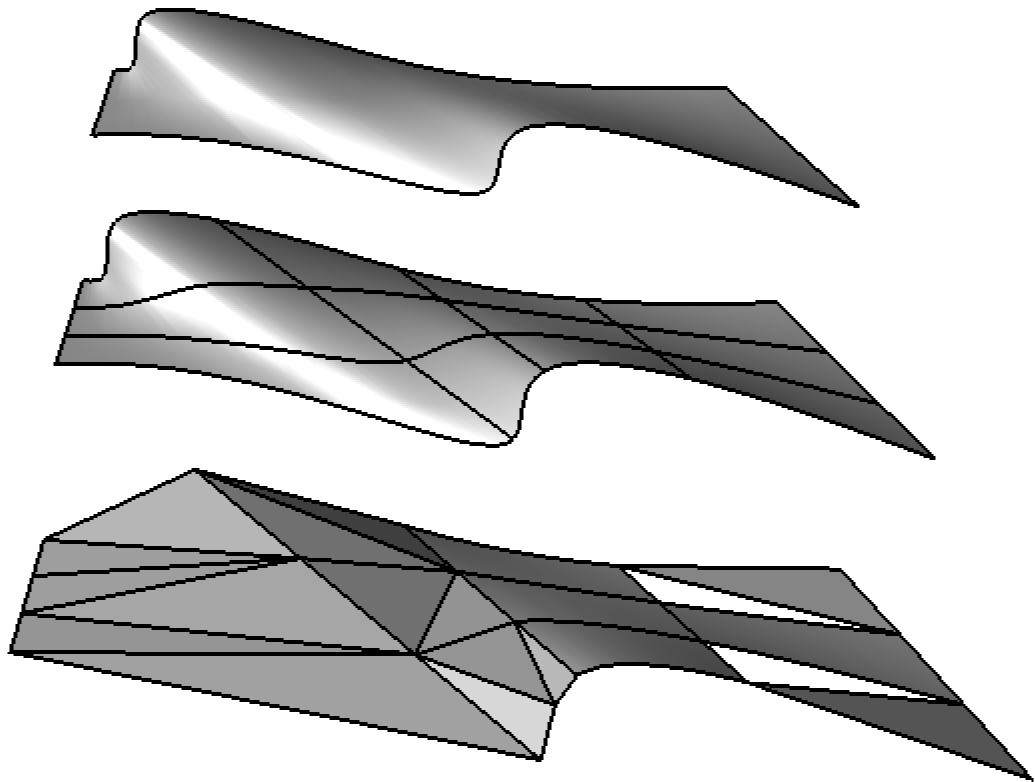
The **ptUnrollFaces** command unrolls surfaces that do not have to be joined in one polysurface and keeps input surface attributes (name, user-data, etc.).

Command flow

1. Start the **ptUnrollFaces** command.
2. Select faces.
3. Press **Enter** to complete.

ptTriangulateFaces

The **ptTriangulateFaces** command processes paneling faces that have 4 or more edges and triangulate them into triangular nurbs faces that can be joined into one polysurface.



Command flow

1 Start the **ptTriangulateFaces** command.

2 Select paneling faces.

3 Press **Enter** to complete.

Options

DeleteInput
Difference in edge length allowed for panels to be considered similar.

Join
Difference in edge length allowed for panels to be considered similar.

ptUnrollFaces

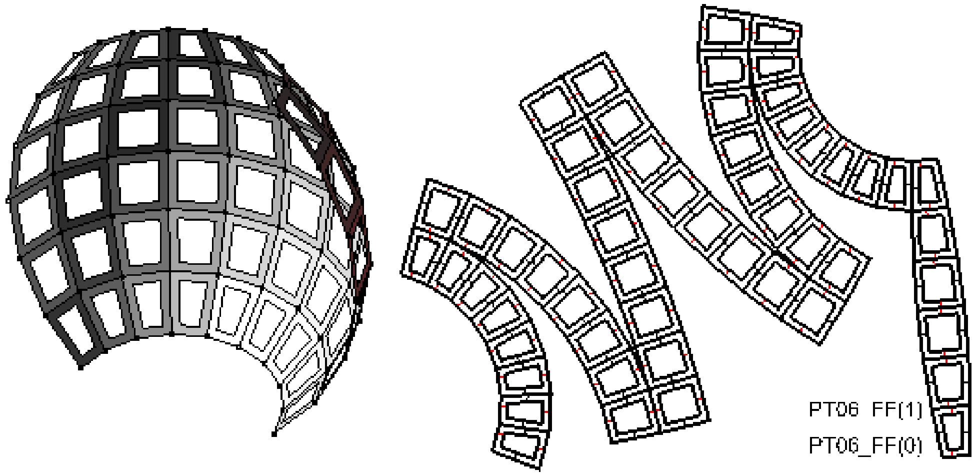
The **ptUnrollFaces** command unrolls surfaces that do not have to be joined in one polysurface and keeps input surface attributes (name, user-data, etc.).

Command flow

1 Start the **ptUnrollFaces** command.

2 Select faces.

3 Press **Enter** to complete.



Options

Explode

If **Yes**, explode the unrolled faces.

Label

Places matching numbered dots on the edges of the original polysurface and the flattened surfaces.

Layer

Current

Add unrolled faces to current layer.

NewSubLayer

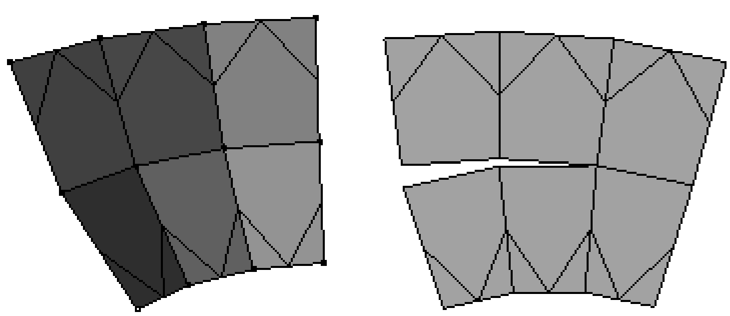
Add unrolled faces to a new sub layer.

SubLayerName

Name of the sub layer.

ptUnrollEdges

The **ptUnrollEdges** command unrolls edges using a base surface or polysurface. Attributes of input edges are passed to unrolled ones.



Command flow

1 Start the **ptUnrollEdges** command.

2 Select curves on a surface or a polysurface.

3 Select the base surface or polysurface.

Options

Layer

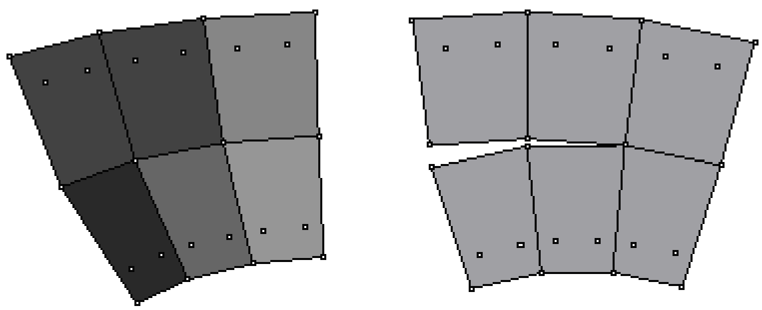
Current
Add unrolled edges to current layer.

NewSubLayer
Add unrolled edges to a new sub layer.

SubLayerName
Name of the sub layer.

ptUnrollPoints

The **ptUnrollPoints** command unrolls points using a base surface or polysurface. Attributes of input points are passed to unrolled ones.



Command flow

1 Start the **ptUnrollPoints** command.

2 Select points on a surface or a polysurface.

3 Select the base surface or polysurface.

Options

Layer

Current
Add unrolled points to current layer.

NewSubLayer
Add unrolled points to a new sub layer.

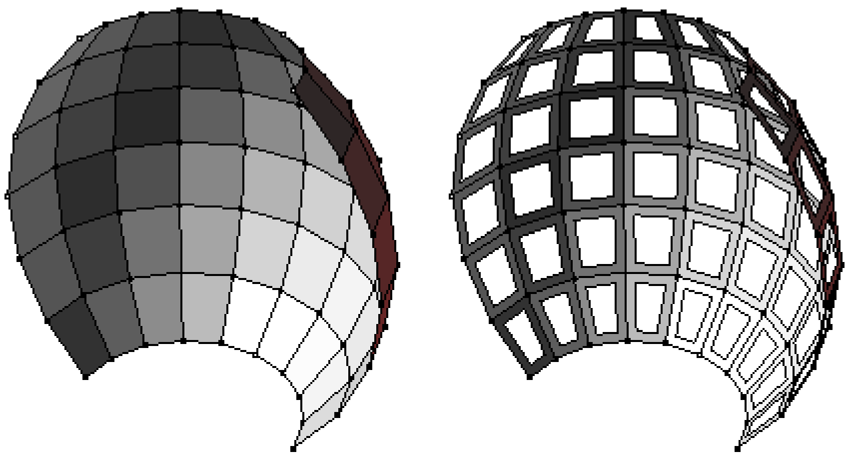
SubLayerName
Name of the sub layer.

ptOffsetBorder

The **ptOffsetBorder** command offsets faces borders inwards with an option to create a hole.

Command flow

1. Start the **ptOffsetBorder** command.
2. Select paneling faces.
3. Press **Enter** to accept.



Options

DistanceMethod

Fixed	Offset with fixed distance
GaussianCurvature	Use surface gausian curvature values
MeanCurvature	Use surface mean curvature values.
AttractorPoints	Sift towards attractor points
SunVector	Use dot product between a vector and normal on surface at each point.
Random	Shift points by random amount

Distance (when DistanceMethod=fixed)
Offset distance on surface.

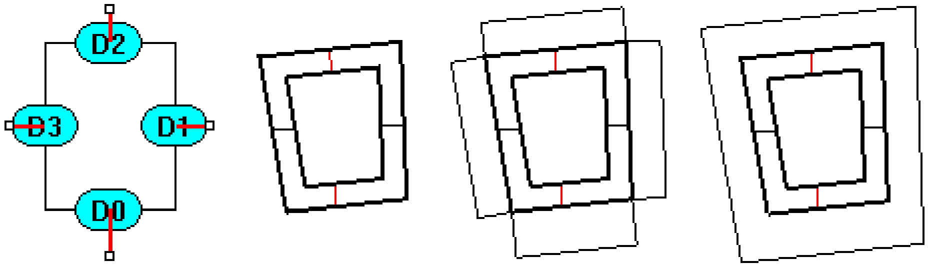
MinDistance (when DistanceMethod is not fixed)
Minimum offset distance.

MaxDistance (when DistanceMethod is not fixed)
Maximum offset distance.

MakeHole
If **Yes**, use offset curve to drill a hole in the face.

ptPlanarLips

The **ptPlanarLips** command generates edge extrusions (lips) to planar surfaces. This is useful for unrolled faces that will be used for fabrication. The command uses a reference polyline to define the offset directions and the offset distance for each direction.



Command flow

1. Start the **ptPlanarLips** command.
2. Select a polyline to use its edges as a direction reference.
3. Select faces to add lips.
4. Press **Enter** to accept.

Options

Output
Output format.

Curve

Surface

ConnectEdges
If **Yes**, extend and connect offset edges of input face.

TypeOfDistance

Uniform
Distance is the same is all directions.

Variable
Each direction can be set to a different offset distance.

DeleteInput

If **Yes**, delete input faces.

Distance

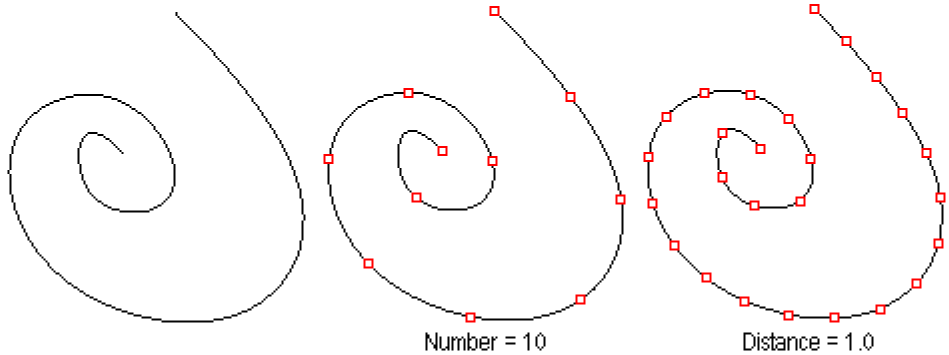
Offset distance. If **TypeOfDistance**=*Variable*, each tagged edge will have a separate distance value to set (D1, D2, etc.)

General Utility Functions

The utility functions **ptDivideCurveSpan**, **ptDivideCurveByChordLength**, and **ptSurfaceFromGridOfControlPoints** divide curves, create NURBS surfaces from paneling grid, and label data.

ptDivideCurveSpan

The **ptDivideCurveSpan** command finds curve division points by number or distance along curve.



Command flow

1. Start the **ptDivideCurveSpan** command.
2. Select curves.
3. Select **Enter** to accept.

Options

Method

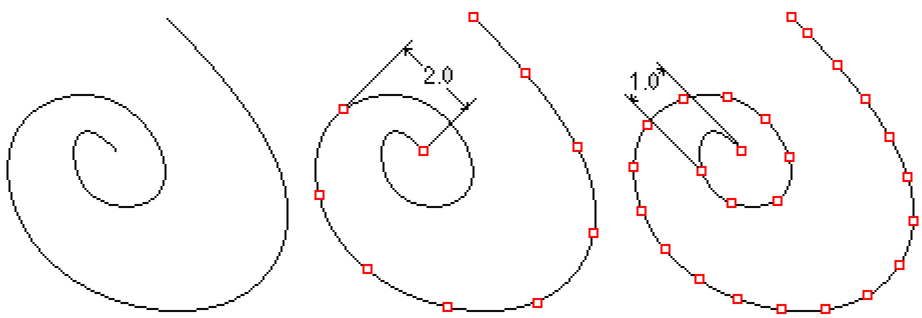
Number — **NumberOfSpans**
Number of spaces between points on curve.

ArcLength — **Length**
Along-curve distance between divide points.
Round
If **Yes**, round the distance up or down to fill the whole curve.
RoundingMethod
Up
Down

Group
If **Yes**, group resulting points.

ptDivideCurveByChordLength

The **ptDivideCurveByChordLength** command finds curve divide points by chord length (straight-line distance) between points. The algorithm uses sphere intersections with the curve to find points.



Command flow

1. Start the **ptDivideCurveByChordLength** command.
2. Select curves.
3. Select **Enter** to accept.

Options

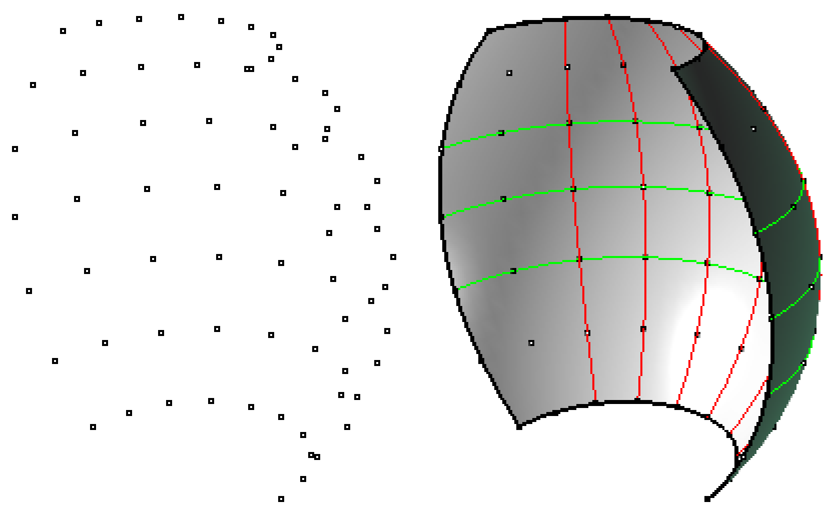
Distance
Straight-line distance between points.

AddEndPoint
If **Yes**, add a point to the end of the curve.

Group
If **Yes**, group resulting points.

ptSurfaceFromGridOfEditPoints

The **ptSurfaceFromGridOfEditPoints** command creates a NURBS surface through the grid points using the grid points as surface edit points.

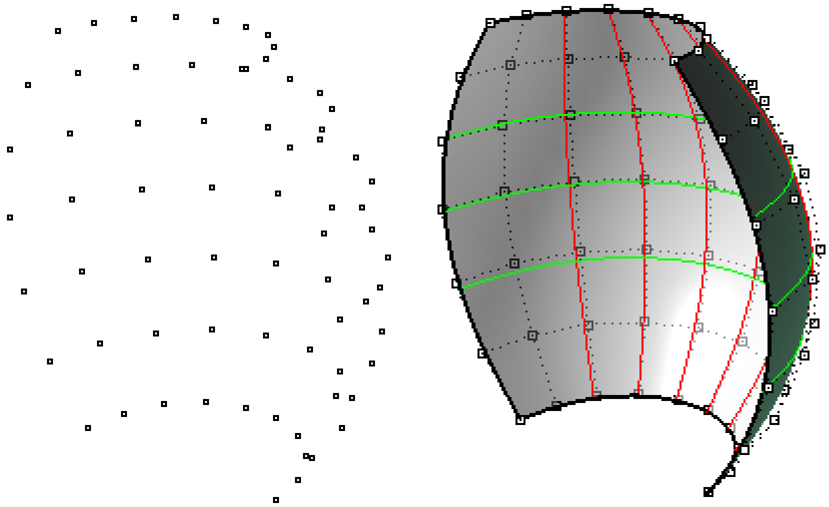


Command flow

1. Start the **ptSurfaceFromGridOfEditPoints** command.
2. Select grid points.
3. press **Enter** to complete.

ptSurfaceFromGridOfControlPoints

The **ptSurfaceFromGridOfControlPoints** command creates a NURBS surface using the point grid as surface control points.

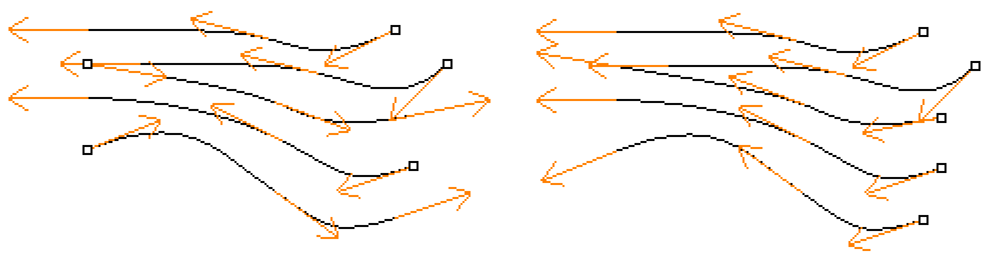


Command flow

1. Start the **ptSurfaceFromGridOfControlPoints** command.
2. Select grid points.
3. press **Enter** to complete.

ptUnifyCurvesDirection

The **ptUnifyCurvesDirection** command unifies the direction of curves to point in the same general direction.



ptTagObjects

The **ptTagObjects** command tags objects with their names as text or dots.

Options

TagMode

Dot
Tag with dots.

Text
Tag with text.

Height
Text height.

ptSerializeObjects

The **ptSerializeObjects** command adds a serialized name to objects (points, curves, and surfaces).

Options

SortMethod
Sort using one of the following four methods.

OrderOfSelection
Selection order.

Coordinates
World coordinates.

Direction
User-defined direction.

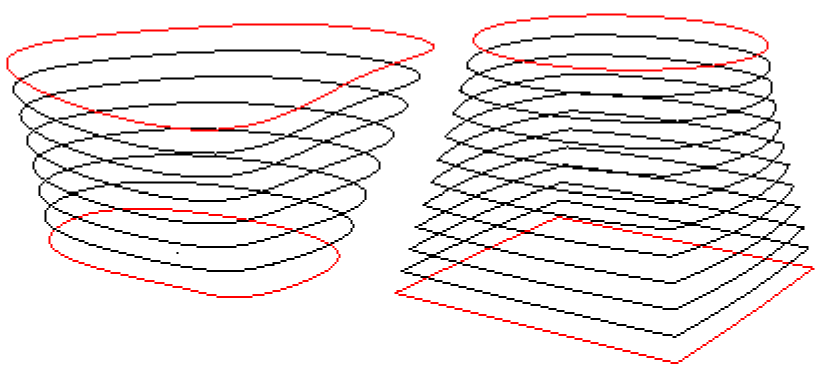
Surface
Reference surface.

Prefix
Name prefixed to serial number.

StartIndex
Starting number.

ptMeanCurves

Make intermediate curves between two input curves. The command does not align seam location for closed curves. It is recommended to run CrvSeam command first to check and align seam location.



Command flow

1. Start the **ptMeanCurves** command.
2. Select start curve.
3. Select end curve.
4. Set number of intermediate curves or press Enter to accept default number.

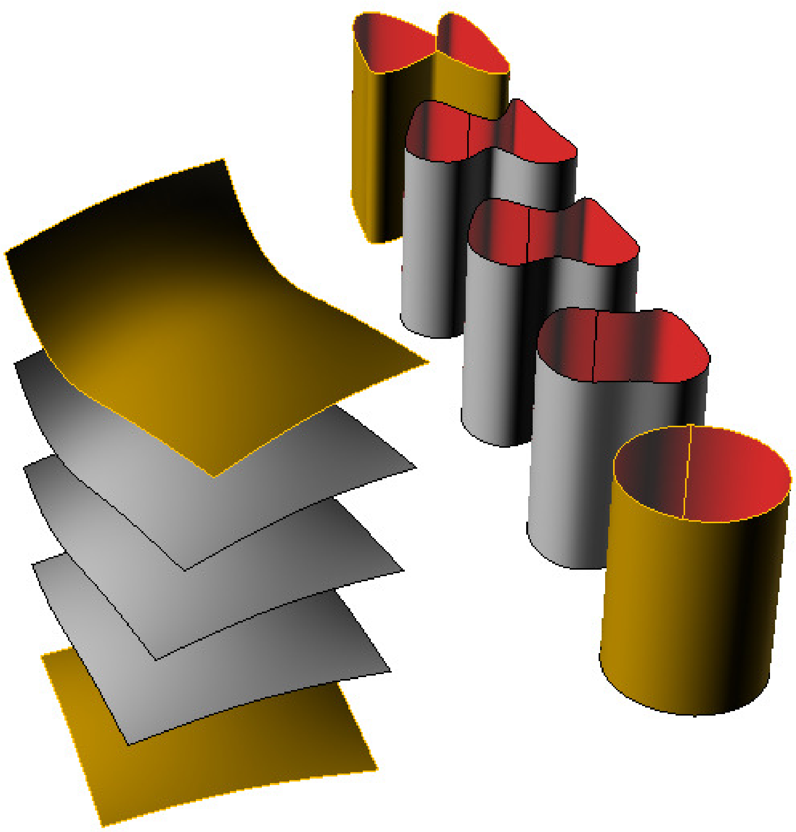
Options

NumOfCurves
Number of mean curves.

MakeCompatible
If set to "No", then the nurbs structure of the input curves is not changed. The user has to check that both curves have same number of control points before running the command.

ptMeanSurfaces

Make intermediate surfaces between two input surfaces. The command does not align seam location for closed surfaces or match UV direction or parameterization. T works best if create start surface, then copy and edit the end surface.



Command flow

1. Start the **ptMeanSurfaces** command.

2 Select start surface (untrimmed).

3 Select end surface (untrimmed).

4 Set number of intermediate surfaces or press Enter to accept default number. There is an option to generate a surface with some distance factor between the two surfaces. The factor is between 0 and 1.

Options

Method
Sort using one of the following four methods.

ByNumber
Specify number of mean surfaces

ByDisFactor
Specify

CreateSrf
Use intermediate grid to create a surface

Group
Group output.

ptRemoveOverlapedPoints

This is a cleaning function to remove overlapped points. Can be used before calling one of the serialize objects or serialize points commands to avoid duplicates.

Serializing joints and connections for FE analysis

There is a set of commands to add user data to serialize and store information on points and edges. Also to label geometry and export a formatted text.

ptSerializePoints

Take a set of points and serialize relative to coordinates and add serial numbers with user string to the point object. ptTagSerializedData can be used to visualize the data in Rhino.

Options

DataString
User may store data associated with the selected points. Set to null if no data is available.

StartIndex
Starting index for serial numbers.

ptSerializeEdges

Take a set of edges and serialize relative to coordinates and add serial numbers with user string to the point object. ptTagSerializedData can be used to visualize the data in Rhino. This command should be called after serializing end points of the edges using ptSerializePoints. The information about serial numbers of end points is also stored in the edges user data. If end points are not serialized, then this command will serialize them first.

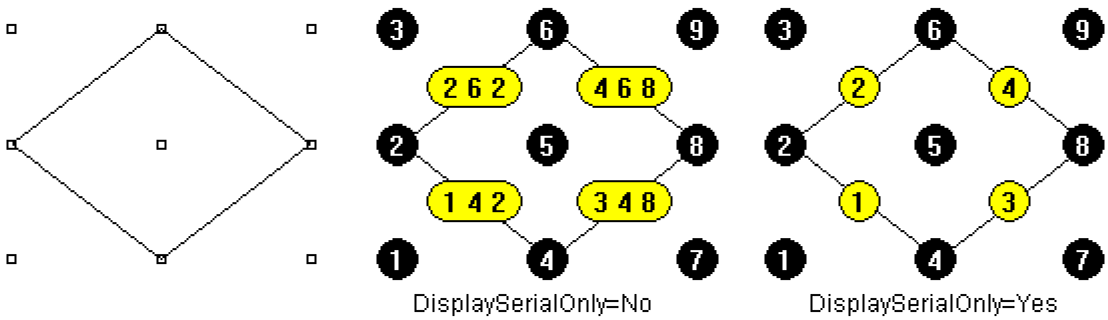
Options

DataString
User may store data associated with the selected edges. Set to null if no data is available.

StartIndex
Starting index for serial numbers.

ptTagSerializedData

Tag objects (points and edges) with the user data created with ptSerializePoints and ptSerializeEdges commands.



Options

TagMode

Dot
Tag with dots.

Text
Tag with text.

Height
Text height.

DisplaySerialOnly
Set to "Yes" to ignore edge end points serial number and point/edge data string.

ptExportPointsSerializeData

Create a text file with serialize data created with ptSerializePoints command.

Command flow

1. Start the **ptExportPointsSerializeData** command.
2. Select points and set options.
3. Set target file

Options

AddPointsCoordinates
Output points coordinates (x, y and z).

Description
User title. Set to “null” if none is available.

StartString
Prefix string to be added before each point data

EndString
Suffex string to be added after each point data

NewLine
If set to “Yes” then separate points output by a new line

PrintPointSerial
If set to “No” then the serial number will not show

Append
Append to exisiting file

SetTargetFile
Click this option to set the file

ptExportEdgesSerializeData

Create a text file with serialize data created with ptSerializeEdges command.

Command flow

1. Start the **ptExportEdgesSerializeData** command.
2. Select points and set options.
3. Set target file

Options

Description
User title. Set to “null” if none is available.

StartString
Prefix string to be added before each edge data

EndString
Suffex string to be added after each edge data

NewLine
If set to “Yes” then separate edges output by a new line

PrintEdgeSerial
If set to “No” then the serial number will not show

Append
Append to exisiting file

SetTargetFile
Click this option to set the file

7 Extending RhinoScript

For a full description of PanelingTools methods exposed to RhinoScript go to http://en.wiki.mcneel.com/default.aspx/McNeel/PanelingScripting.html

In addition, a few samples are included in PanelingTools toolbar.

To access and edit sample codes

- In the **Paneling Tools** toolbar, Shift+right-click the **About** toolbar button.