

# **Pro/ENGINEER<sup>®</sup> Wildfire<sup>®</sup> 4.0**

## **Facet Modeling Help Topic Collection**

**Parametric Technology Corporation**

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# Facet Modeling

## Using Facet Modeling

### About Facet Modeling

Facet modeling involves:

- Importing point sets obtained by scanning the object.
- Correcting errors in the point set geometry that may have resulted due to the limitations of the scanning devices used.
- Creating a wrap and correcting errors. For example, removing unwanted triangles, creating sharp edges, and filling concave areas.
- Creating a faceted geometry and editing it with a variety of commands to refine and perfect the faceted surface.

**Note:** To use Facet Modeling, you must have the Pro/SURFACE and Reverse\_Engineering licenses.

### The Facet Modeling Workflow

A typical facet modeling session would progress in this fashion:

- Point handling
  - Import the point set using **Insert > Facet Feature** and importing a `.pts`, `.acs`, `.vtx`, or `.ibl` file
  - Eliminate erroneous data such as points lying outside the required geometry
  - Add additional point sets into the same feature
  - Delete points if required
  - Minimize noise
  - Sample points to clean data and also reduce the computation time
  - Create a wrap from the point set
- Wrap handling
  - Remove triangles by propagating through the surface in a selected area or until the point density changes
  - Remove webs that are generated in open spaces in the model while creating a wrap from a point set
  - Remove triangles in a straight line throughout the model, similar to drilling a hole

- Add a single layer of triangles to a selected area of geometry
- Fill any concave parts of the geometry that you select
- Fill areas that require additional volume in order to define edges that may have been blurred during scanning
- Facet handling
  - Delete facets that are not required
  - Reduce the number of triangles without compromising surface continuity or detail
  - Fill gaps that may have been introduced during the scanning process
  - Improve the faceted geometry by reducing facet size
  - Smooth the polygonal surface by changing the coordinates of the vertices in an iterative manner
  - Reverse the orientation of two facets that share an edge
  - Add facets by splitting an existing facet or by selecting three open vertices and creating a new facet

### **To Create a Facet Feature**

1. Click **File** > **New** to open a Pro/ENGINEER part.
2. Click **Insert** > **Facet Feature**. The **Open** dialog box opens.
3. Select the file that you want to open and click **Open**. The **Import Options** dialog box opens.
4. Select the coordinate system to be used as a reference for inserting the part.
5. Select the required units from the **Units** box.
6. Click **OK**. Pro/ENGINEER displays the Facet Modeling toolbar.






### **Selecting Entities in Facet Modeling**

Pro/ENGINEER provides you with various tools to enable the selection of entities. Depending on the Facet Modeling phase that you are working on and the tool that you use, you can select points, vertices, edges, or facets.



## Selecting Entities Using Marquee Selection


The following selection marquees are available to you from the system toolbar.

Selection Marquee	Selection
	Selects points, triangles, or facets that completely lie inside the rectangular marquee.
	Selects points, triangles, or facets that partially or completely lie inside the rectangular marquee.
	Selects points, triangles, or facets that completely lie inside the polygon.
	Selects points, triangles, or facets through which the stroke of the paintbrush traverses.
	Selects points, triangles, or facets that completely lie inside the elliptical marquee.

## Changing the Selection Preferences

1. Click **Edit > Select > Preferences**. The **Selection Preferences** dialog box opens.

- To change the paintbrush thickness, change the **Region Style** to **Paintbrush**. Change the value of **Thickness** as required.
- You can change the selection marquee from the system toolbar as well as from the **Selection Preferences** dialog box.





**Note:** To select entities across a box (equivalent to the  marquee), select **Rectangular Marquee** from the **Region Style** list and click the **Include items crossing the region boundary** check box.

- Optionally, click the **Preselection highlighting** check box to highlight a facet over which you place the pointer.
- Optionally, click the **Select visible facets only** check box to select facets using any selection marquee or method that are visible in the current view. If you do not select this option, even those facets that are inside the selected marquee but are not visible in the current view are selected.

2. Click **OK**.

## Selection of Entities in Different Phases of Facet Modeling

In addition to the marquee selection, you can select entities in different phases of Facet Modeling using these methods:

Facet Modeling Phase	Selection Command	Selection
Points		Reverses the selection of points that you select using any of the selection marquees.
Wrap		Selects triangles with a length equal to or more than the specified length. (You can select triangles using this command in both Coarse and Fine Tuning phases.)
Facet		Selects facets with a length equal to or more than the specified length.
Facet		Reverses the selection of facets that you select using any of the selection marquees or selection methods.

### Creating a Facet Feature

The next tables shows the different files that you can use in the Facet Modeling environment, and the results of importing them using **Insert > Shared Data > From File** or **Insert > Facet Feature**.

Type of File	Insert > Shared Data > From File	Insert > Facet Feature
.pts	The <b>Points</b> menu appears.	The <b>Points</b> menu appears.
.vtx	The <b>Points</b> menu appears.	The <b>Points</b> menu appears.
.acs	The <b>Points</b> menu appears.	The <b>Points</b> menu appears.

<b>Type of File</b>	<b>Insert &gt; Shared Data &gt; From File</b>	<b>Insert &gt; Facet Feature</b>
.ib1	The <b>Points</b> menu appears.	The <b>Points</b> menu appears.
.igs	Only the datum points are read and any extra geometry present is ignored.	The <b>Points</b> menu appears.
.vda	The file is read as datum points.	The <b>Points</b> menu appears.
.stl	The facet feature is displayed as is. Use <b>Edit Definition</b> to see the <b>Facets</b> menu.	The <b>Facets</b> menu appears.
.wrl	The facet feature is displayed as is. Use <b>Edit Definition</b> to see the <b>Facets</b> menu.	The <b>Facets</b> menu appears.
.asc	The facet feature is displayed as is. Use <b>Edit Definition</b> to see the <b>Facets</b> menu.	The <b>Facets</b> menu appears.

## Point Handling

### About the Points Phase

This phase involves:


- Importing the scanned file into your Pro/ENGINEER part.
- Specifying the coordinate system as a placement reference for the imported data.
- Using the commands available from the **Points** menu to modify the point set. This enables you to:
  - Eliminate erroneous data.
  - Sample points to reduce the computation time.
  - Reduce noise, that is, reduce deviation of points using statistical methods.
  - Fill gaps or holes in the model.

## The Points Menu

The **Points** menu in Facet Modeling provides the following point handling tools:



- **Reverse Selection**—Reverses the selection of points.
- **Hide Selected**—Suppresses the display of selected points.
- **Unhide All**—Displays all the hidden points.
- **Filter**—Graphically filters points in the point set.
- **Crop Selected**—Deletes all the points outside a selected region.
- **Delete Selected**—Deletes all the points inside a selected region.
- **Delete Outliers**—Deletes points that appear offset from the main point set.
- **Reduce Noise**—Moves points to the locations as determined using statistical methods.
- **Sample**—Creates a sample of the points and helps produce an accurate wrap model with fewer points and less computation time.
- **Fill Hole**—Fills gaps and holes in the model by adding new points.
- **Add**—Allows you to add another point set to the existing point set and merge the two. This is useful when you want to close an open surface and create an object with a closed volume.
- **Save**—Allows you to save the point data to a `.pts` file.
- **Wrap**—Creates a wrap or a triangulated mesh.

## To Reverse the Selection of Points

Click  or **Points > Reverse Selection**.

The selection of points is discarded and the points that were not previously selected are selected and highlighted.

## To Turn the Display of Points On or Off

1. Select the points that you want to hide.
2. Click  or **Points > Hide Selected**. The selected points are hidden.
3. To display all the previously hidden points, click  or **Points > Unhide All**.

## To Filter Points


1. Select a value from the list on the toolbar to graphically filter the points.

For example, if you select **50%**, the number of points are graphically reduced to 50 percent of the original point set.


**Note:** To revert to the original point set, select **100%** in the list.

2. Click **OK**.

### To Crop Selected Points

1. Select the region that you want to retain. Hold down the CTRL key to select multiple regions.
2. Click  or click **Points > Crop Selected**. The points outside the selected region are deleted.

### To Delete Selected Points

1. Select the region from which you want to delete the points. Hold down the CTRL key to select multiple regions.
2. Click  or click **Points > Delete Selected**. The points inside the selected region are deleted.

### To Delete Points Lying Outside the Point Set

1. Click  or click **Points > Delete Outliers**. The **Delete Outliers** dialog box opens.
2. Type a value for **Sensitivity**.

To differentiate between the points lying outside the point set and the legitimate data points, specify a value between 0 and 1. A lower sensitivity value means Pro/ENGINEER selects points farther from the point set, while a higher value means Pro/ENGINEER selects points closer to the point set.


3. If required, click **Preview**. The points that lie outside the point set are highlighted.
4. Click **OK**.

### About Reducing Noise

Due to the limitations of scanning devices, the points in the scanned data may deviate from their original location. This deviation is the noise in the point set.


The **Reduce Noise** command uses statistical methods to determine the correct location for the points and moves the points to that location. Based on the level of noise or deviation of points in the point set, you can choose the level of noise reduction.

## To Reduce Noise

1. Click  or click **Points > Reduce Noise**. The **Reduce Noise** dialog box opens.
2. Select the region for reducing noise. Hold down the CTRL key to select multiple regions.
3. Select the noise reduction method.
  - o **Free-form**—Reduces noise with respect to the surface curvature if the point set represents a freeform or organic shape.
  - o **Mechanical**—Retains sharp corners and edges if the point set represents a mechanical or prismatic shape.
4. Specify the smoothness level depending on the level of noise in the point set. You can select from **Low**, **Medium**, and **High**.
5. Click **OK**.

## To Delete Points by Sampling

1. Select a point set area to sample.

**Note:** If you do not select an area, points are deleted by sampling from the entire point set.
2. Click  or click **Points > Sample**. The **Sample** dialog box opens.
3. Select the method of sampling.
  - o **Random Sample**—Randomly removes the specified percentage of points from the point set.

In the **Sample Percentage** box, type a value for a percentage of the original points that you want to keep.
  - o **Uniform Sample**—Removes points from the point set uniformly. This is done by dividing the point set's model space into equal-sized cubes and deleting all but one point from each cube.

In the **Spacing** box, type a value for the edge length of the cube. You can also click the selection arrow and select two points from the point set to determine the size of the cube.


**Note:** A large cube size means that fewer points are retained from the point set whereas a small cube size retains more points.
  - o **Sample by Curvature**—Removes points from the point set depending on the surface curvature at that point.

More points in the areas of high curvature are retained to maintain the accuracy in that area of the surface. Fewer points in the regions with less curvature or flat regions are retained as these regions require less detail.

In the **Sample Percentage** box, type a value for a percentage of the original points that you want to keep.

4. Click **OK**.

### To Fill Holes in the Point Set

1. Select the points in the point set surrounding the gap that you want to fill.
2. Click  or click **Points > Fill Hole**.

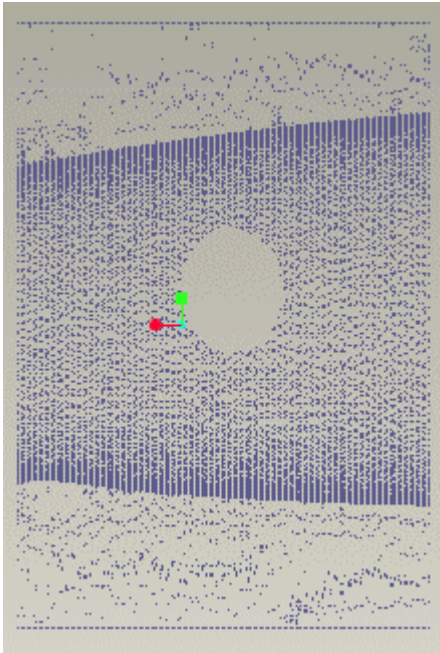
The **Fill Hole** command inserts points in the holes or gaps in the selected area of the point set based on the density and curvature of the surrounding points.

#### Note:

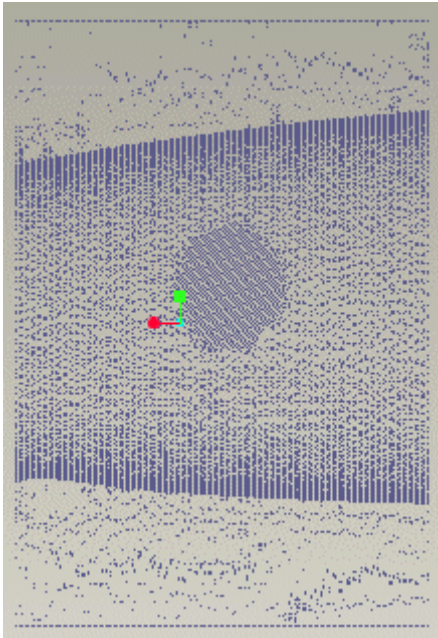
- If you do not select the area while using this command, points are inserted in all the gaps or holes.
- If the region with holes is smooth and continuous, you can get good results after using this command.
- The results of this command depend on the orientation of the model.

### Example: Filling Holes in the Point Set

The next figure shows a point set with a hole.




The next figure shows the result of the **Fill Hole** command.




**Note:** To adjust the point density in the hole that was filled, select that area and use the **Sample** command.

### To Add Point Set Data to the Existing Data

1. Click  or click **Points > Add**. The **Open** dialog box opens.
2. Select a points file.
3. Select a coordinate system as a reference for the point set insertion. The point set is added to the existing point set. The two point sets are merged as a single point set for further point set operations.

**Note:** Use sampling to delete points that may overlap after the addition of the point set.

### To Save Points

1. Click  or click **Points > Save**. The **Save Points** dialog box opens.
2. In the **File Name** box, type the file name.
3. In the **Format** box, specify the file format in which to save the file.

## Wrap Handling

### About the Wrap Phase

After you have modified the point set using the **Points** menu, you can wrap the point set to create a triangulated model, also called a wrap, and edit the wrap to:




- Remove unwanted triangles.
- Reveal any underlying geometry.


A wrap can consist of both closed and open surfaces that, in turn, consist of triangles, edges, and vertices.

As all the points in the point set are used to create a wrap, all the geometric information including internal structures is maintained.

The Wrap phase can be divided into two types of editing operations:

- **Coarse tuning**—The coarse tuning operations are more automated and less precise and enable you to rapidly modify the model.
- **Fine tuning**—The fine tuning operations are less automated but provide a finer and more detailed control for editing the model. Click  or **Wrap > Fine Tune** to make the fine tuning operations available.

### To Return to the Point Phase

1. Click  or **Wrap > Return to Point Phase** to return to the point phase from the wrap phase. You are prompted to confirm that you want to return to the point phase.
2. Click **Yes** to return to the point phase.

### Coarse Tuning

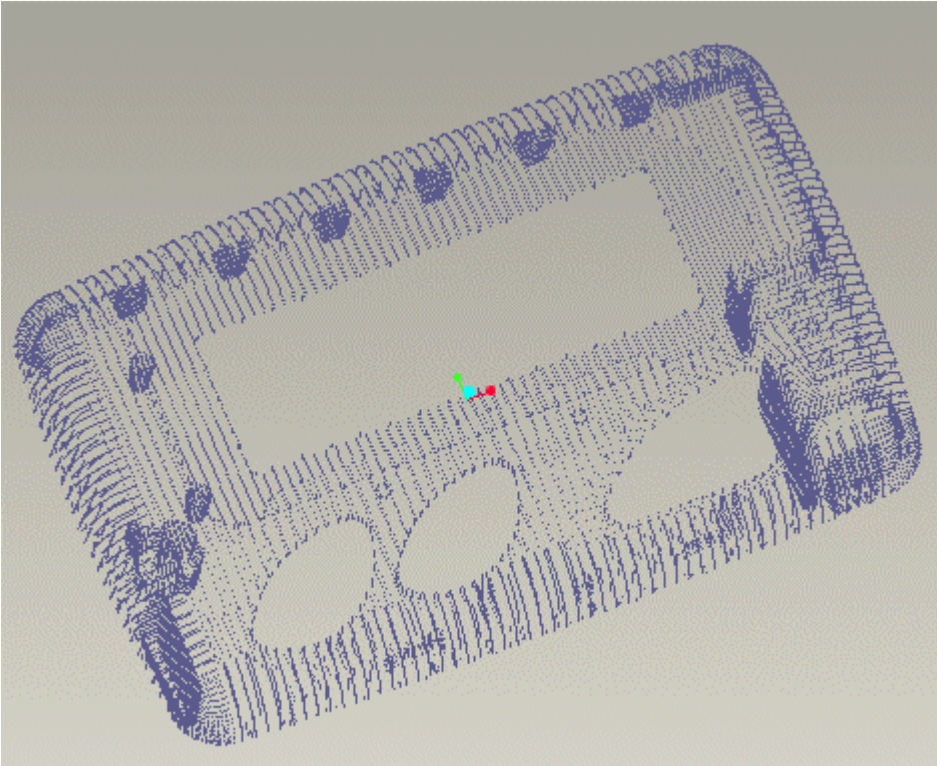
#### The Wrap Menu

The **Wrap** menu in Facet Modeling provides the following wrap handling commands:

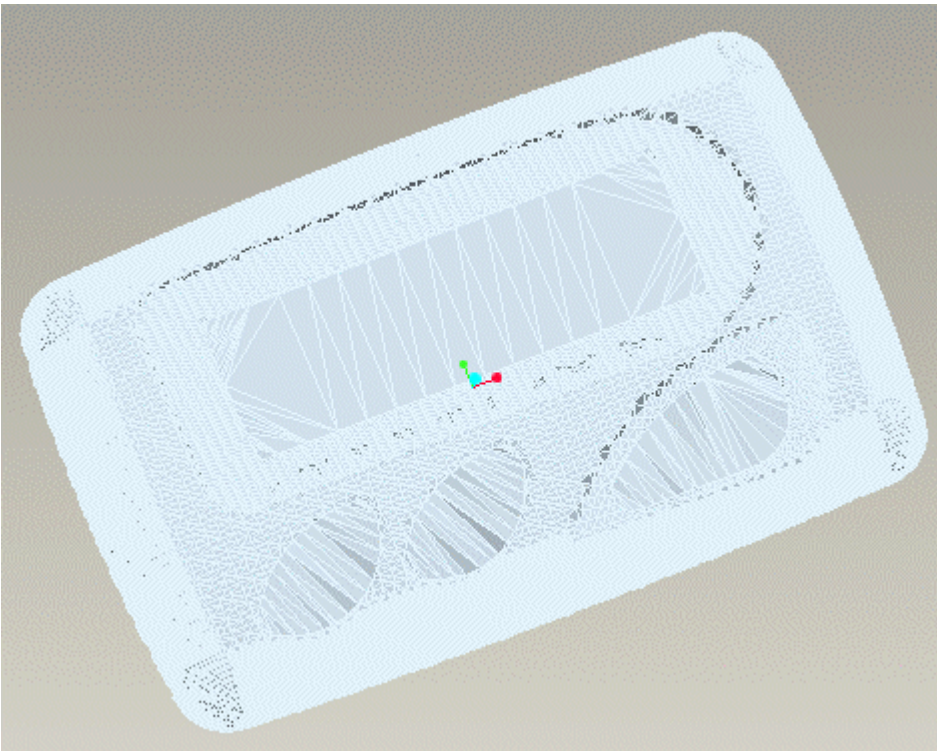
- **Select by Length**—Selects facets with an edge of length greater than or equal to the specified value.
- **Push Shallow**—Removes triangles by propagating through the selected area.
- **Shoot Through**—Deletes triangles in a straight line throughout the selected area. This is done in a manner similar to drilling a hole.
- **Push Deep**—Removes triangles by propagating through the model until the point density changes.
- **Remove Webs**—Removes triangles generated in the open spaces of the original point set while creating the wrap.

**Example: A Wrap Created from a Point Set**


The next figure shows a point set inserted from a file.



The next figure shows a wrap created from the point set.



### To Use the Select by Length Command

1. Click  or click **Wrap > Select by Length**. The **Select by Length** dialog box opens.
2. In the **Length** box, type a value for the length of the facet edge.


Optionally,

- Click the arrow button on the **Select by Length** dialog box.
- Select any two facet vertices.

The distance between the selected facet vertices is calculated and the calculated value is displayed in the **Length** box.

3. Click **OK**. The facets that have an edge of length equal to or greater than this **Length** value are selected and highlighted.

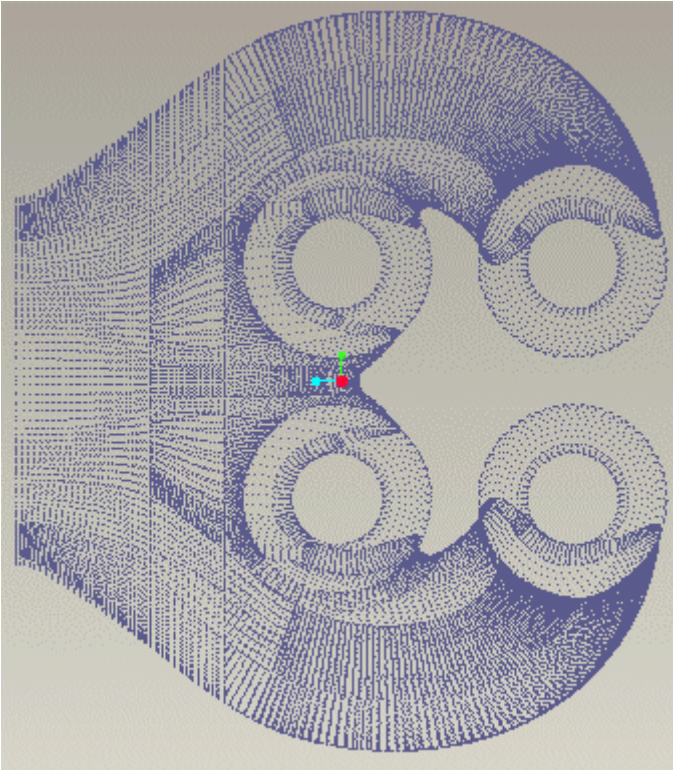
### To Use the Push Shallow Command

1. Select a set of triangles.
2. Click  or click **Wrap > Push Shallow**.

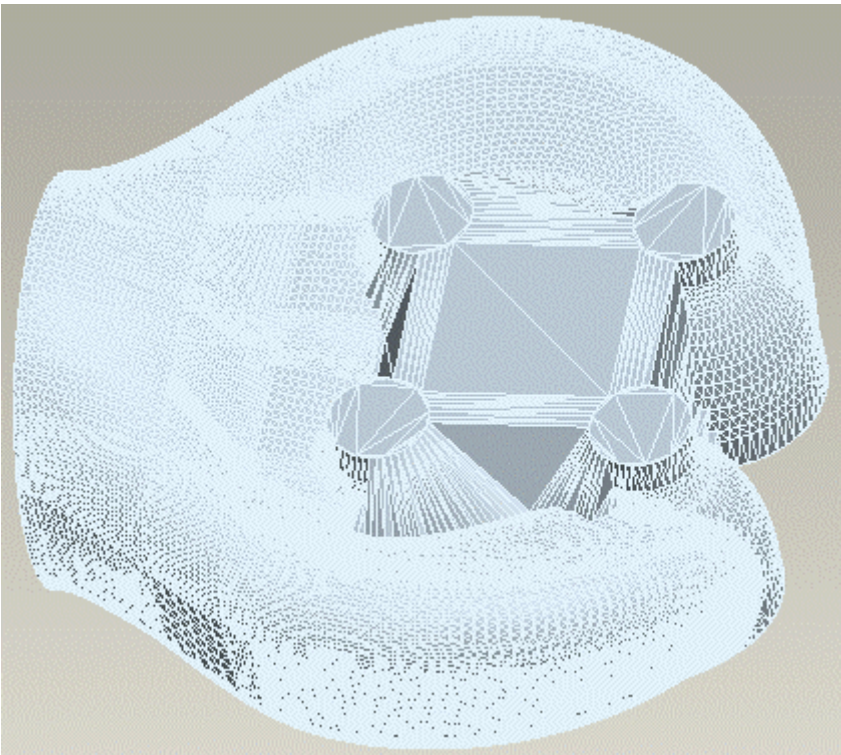
The **Push Shallow** command removes selected triangles and exposes the underlying triangles.

**Example: Using the Push Shallow Command**

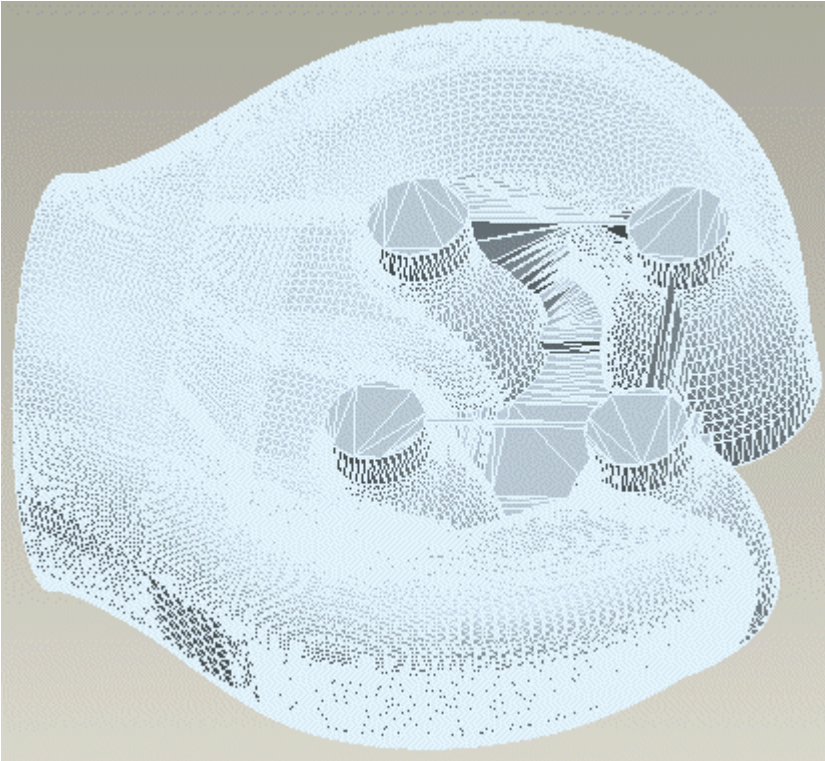
The next figure shows a point set.




The next figure shows a wrap created from this point set using the **Wrap** command.



The next figure shows the usage of the **Push Shallow** command to reveal the underlying geometry.



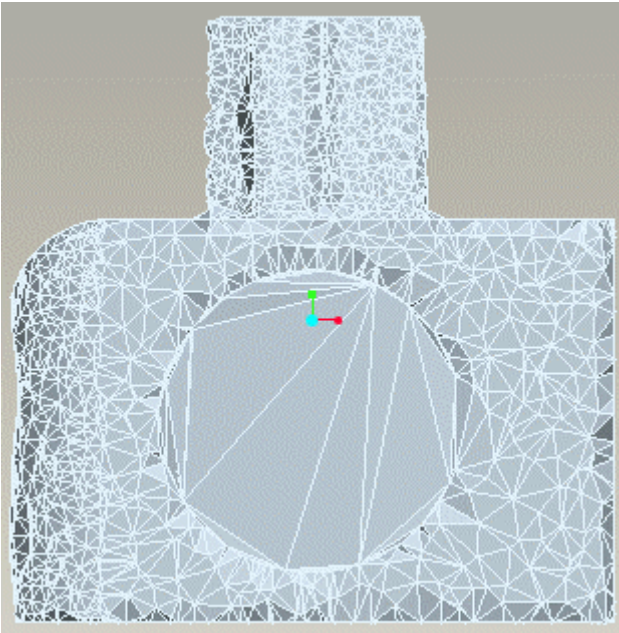
### To Use the Shoot Through Command

1. Click  or click **Wrap > Shoot Through**.
2. Select a set of triangles.

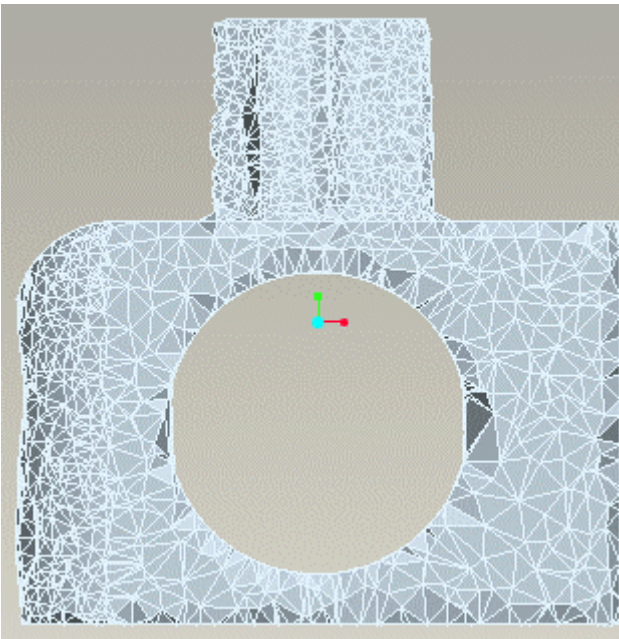
The **Shoot Through** command removes triangles in a straight line throughout the wrap in a manner similar to drilling a hole. The direction in which the hole is drilled is based on the orientation of the model. In addition to the selection area, other internal structures may be removed. The operation propagates through the model until a change in point density is reached.

### Example: Using the Shoot Through Command


The next figure shows a wrap model.



The next figure shows the wrap model after using the **Shoot Through** command.



### To Use the Push Deep Command

1. Select a set of triangles.
2. Click  or click **Wrap > Push Deep**.


The **Push Deep** command removes all the triangles that match the point density of the selected triangles by propagating through the model until the point density changes. This command also removes the internal structures that have the same point density.

This command is similar to the **Push Shallow** command, but the depth of propagation is greater.

## About Webs

When you create a wrap from a point set, triangles may get created in the originally open spaces in the model. These triangles are called webs. These webs are formed internally or between parts of the model where open space exists. The **Remove Webs** command removes these triangles and tetrahedrons.

## To Remove Webs

1. Select a set of triangles.
2. Click  or click **Wrap > Remove Webs**.

The **Remove Webs** dialog box opens. Type the following values:

- **Min. Edge Length**—Selects triangles based on the length of their edges.  
The web triangle edges are longer than those on the actual model. You can select a minimum value for the edge length that is longer than the edge length of the actual model triangles. Adjusting the length selects triangles with a length greater than the specified value.
- **Min. Angle Deviation**—Uses the mathematical normals that extend from the surface to calculate the angle between the normal and the triangles.  
The angle values of the model triangles are lower than those of the web triangles. This enables you to specify a minimum angle to distinguish between the model triangles and the web triangles.

To effectively remove webs, adjust both these parameters. The **Remove Webs** command removes webs that meet at least one of the criteria.

For the removal of webs to be effective, you need not select all the triangles, as this operation propagates through the model in a manner similar to the **Push Deep** command.

3. Click **OK**.

**Note:** The web removal operation does not consider the distribution of points, and, therefore, cannot distinguish between webs and gaps in the wrap.

**Example: Removing Webs**

The next figure shows a wrap created from a point set. While creating the wrap, webs are created in the open spaces in the model.





The next figure has the webs removed using the **Remove Webs** command.



## Fine Tuning


### The Fine Tune Menu

The **Fine Tune** menu in Facet Modeling provides the following wrap handling commands:

- **Select By Length (Fine Tune)**—Selects facets with an edge of length greater than or equal to the specified value.
- **Push Shallow (Fine Tune)**—Removes only the selected triangles and reveals the underlying region.
- **Shoot Through (Fine Tune)**—Deletes triangles in a straight line throughout the selected area in a manner similar to drilling a hole.
- **Remove Webs (Fine Tune)**—Removes triangles generated in the open spaces of the original point set while creating the wrap.

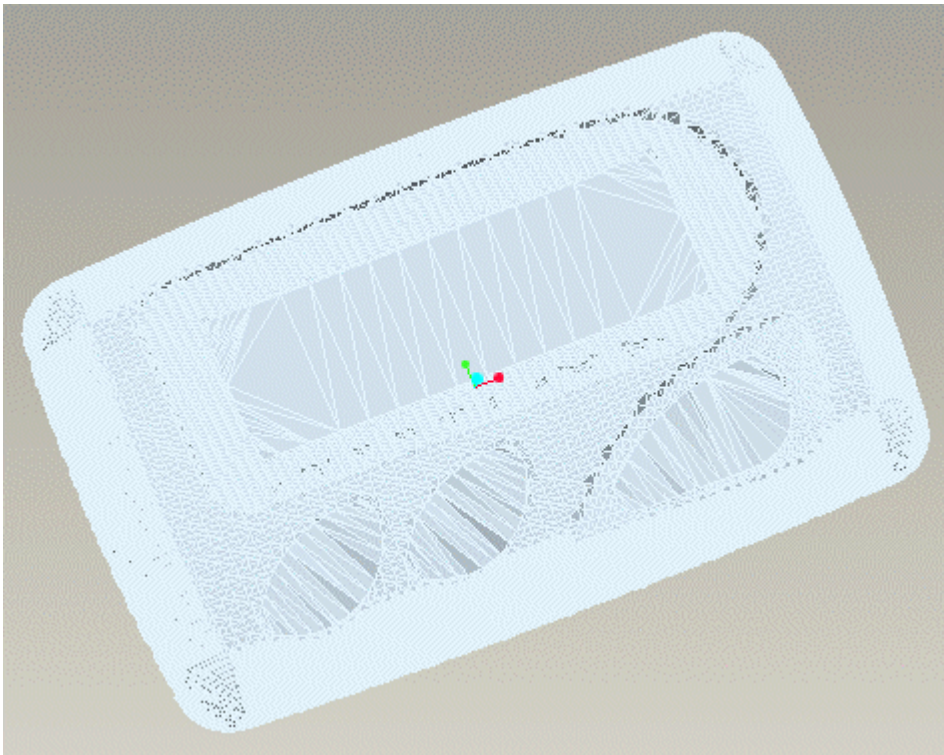
- **Fill Edges**—Adds volume over the selected facets of the model to define sharp features that may have been blurred during the scanning operation.
- **Fill Up**—Adds volume to the concave parts of the selected area of the model.
- **Fill Layer**—Adds a single layer of volume to the selected area of the model.

### To Use the Fine Tune - Select by Length Command

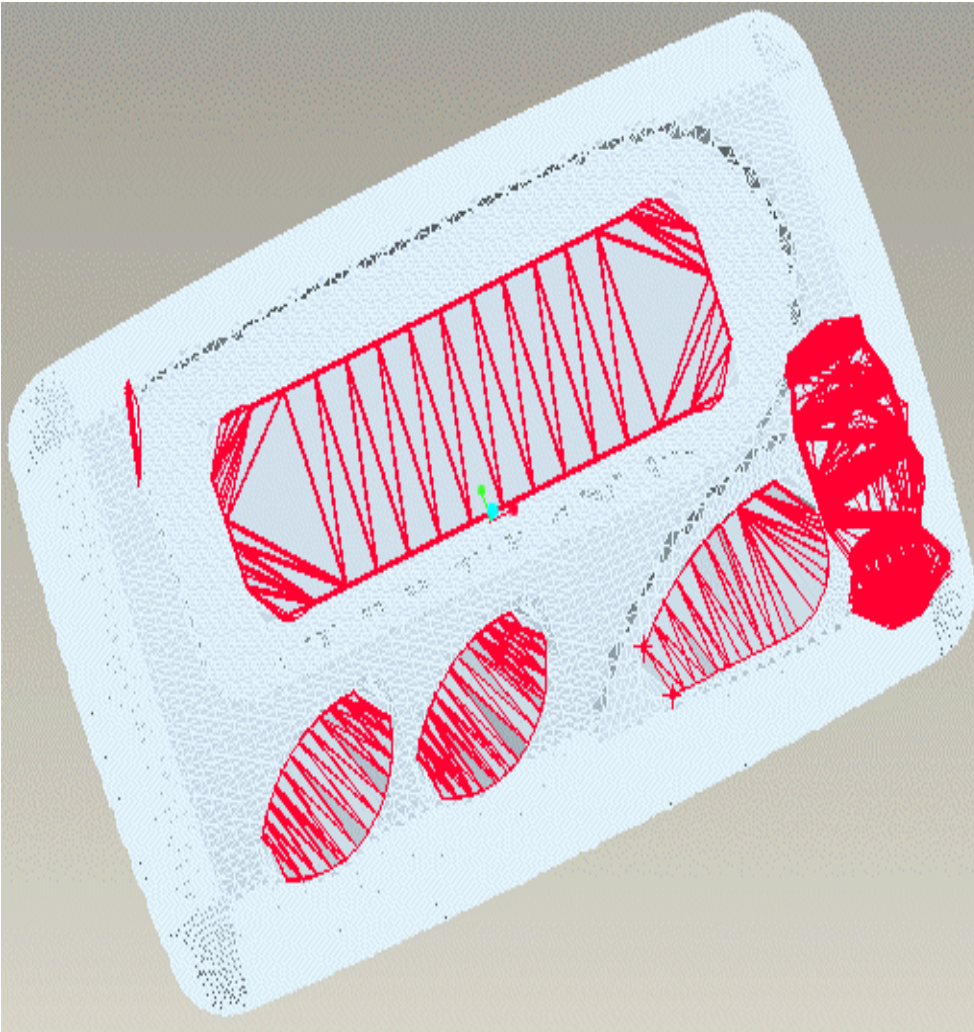
1. Click  or click **Fine Tune > Select by Length**. The **Select by Length** dialog box opens.
2. In the **Length** box, type a value for the length of the facet edge.  
Optionally,
  - Click the arrow button on the **Select by Length** dialog box.
  - Select any two facet vertices.  
The distance between the selected facet vertices is calculated and the calculated value is displayed in the **Length** box.
3. Click **OK**. The facets that have an edge of length equal to or greater than this **Length** value are highlighted.

### Example: Selecting Facets by Length


The next figure shows a wrap created from a point set.



The next figure shows the facets selected by specifying the length of an edge.




### To Use the Fine Tune - Push Shallow Command

1. Select a set of triangles.
2. Click  or click **Fine Tune > Push Shallow**.

The **Push Shallow** command removes only the selected triangles and exposes the underlying geometry.


### To Use the Fine Tune - Shoot Through Command

1. Click  or click **Fine Tune > Shoot Through**.
2. Select a set of triangles.

The **Shoot Through** command removes triangles in a straight line throughout the wrap in a manner similar to drilling a hole. The direction in which the hole is drilled is based on the orientation of the model.

The difference between the coarse and fine tune **Shoot Through** commands is the level of propagation. The coarse **Shoot Though** command removes structures based on the point density. The fine tune **Shoot Through** command removes only those polygons that are intersected by the selection area.

### To Use the Fine Tune - Remove Webs Command

1. Select a set of triangles.
2. Click  or click **Fine Tune > Remove Webs**.

The **Remove Webs** dialog box opens. Type the following values:

- **Min. Edge Length**—Selects polygons based on the length of the triangle edges.

The web triangle edges are longer than those on the actual model. You can select a minimum value for the edge length that is longer than the edge length of the actual model triangles. Adjusting the length selects triangles with a length greater than the specified value.

- **Min. Angle Deviation**—Uses the mathematical normals that extend from the surface to calculate the angle between the normal and the triangles.

The angle values of the model triangles are lower than those of the web triangles. This enables you to specify a minimum angle to distinguish between the model triangles and the web triangles.


To effectively remove webs, adjust both these parameters. The **Remove Webs** command removes webs that meet at least one of the criteria.

For the removal of webs to be effective, you need not select all the triangles, as this operation propagates through the model in a manner similar to the **Push Deep** command.

3. Click **OK**.

**Note:** The web removal operation does not consider the distribution of points, and, therefore, cannot distinguish between webs and gaps in the wrap.

### To Fill an Area by Adding Facets along the Edge

1. Select a set of triangles.
2. Click  or click **Fine Tune > Fill Edges**.

The **Fill Edges** command fills edges by adding polygons to the selected area. This command is useful to define the sharp features of a model such as edges that may have been blurred during scanning.


### To Fill a Concave Area by Adding Facets

1. Select a set of triangles.

2. Click  or click **Fine Tune > Fill Up**.

The **Fill Up** command adds triangles to the concave parts of the selected area. Repeat the procedure until the selected area is filled.

### To Fill an Area by Adding a Layer of Facets

1. Select a set of triangles.
2. Click  or click **Fine Tune > Fill Layer**.

**Note:** This command may add structures that look like spikes. To avoid the addition of such structures, select small regions of the model for adding layers.

## Facet Handling

### About the Facets Phase

When you bring a model into the Facets phase, you can remove the internal structures and edit the model with a variety of commands to refine and perfect the faceted surface.

Most of the commands in this phase change the coordinates of the existing points or add new points. Therefore, the faceted geometry differs from the original point set.

If you must retain the original point set, do not use the editing operations in the Facets phase.


### The Facets Menu

The **Facets** menu in Facet Modeling provides the following facet handling commands:


- **Select By Length**—Selects facets with an edge of length greater than or equal to the specified value.
- **Select Connected Components**—Highlights all the facets in the subset of a facet feature connected to the selected facet.
- **Reverse Selection**—Discards the current selection of the facets and selects facets that were not previously selected.
- **Delete**—Deletes selected facets.
- **Fill Hole**—Fills gaps in the faceted geometry such that the faceted surface is continuous.
- **Clean**—Cleans the faceted geometry by creating sharp edges or by making the surface smooth.
- **Decimate**—Reduces the number of facets.

- **Refine**—Improves the shape of the facet model by increasing the density of facets and optionally moving facet vertices.
- **Relax**—Makes the faceted surface smooth by changing the coordinates of the facet vertices in an iterative manner.
- **Offset**—Offsets an entire faceted model or a subset of a facet feature.
- **Trim**—Trims the faceted surface by using a datum plane.
- **Symmetry Plane**—Creates a symmetry plane for the entire faceted model.
- **Make Manifold**—Creates a manifold representation of the faceted surface.
- **Add Facet**—Adds facets to the facet geometry by using the specified vertices.
- **Flip Edge**—Reverses the orientation of two facets.
- **Split Edge**—Adds facets by splitting the selected facet edge.

### To Select Connected Components

1. Click  or **Facets > Select Connected Components**.
2. Select a facet from the faceted model. Facet Modeling highlights all the facets in the subset of a facet feature connected to the selected facet.

### To Select Facets by Length

1. Click  or click **Facets > Select by Length**. The **Select by Length** dialog box opens.
2. In the **Length** box, type a value for the length of the facet edge.

Optionally,

- Click the arrow button on the **Select by Length** dialog box.
- Select any two facet vertices.

The distance between the selected facet vertices is calculated and the calculated value is displayed in the **Length** box.


3. Click **OK**. The facets that have an edge length equal to or greater than the **Length** value are highlighted.


### To Reverse the Selection of Facets

Click  or **Facets > Reverse Selection**.


The selection of previously selected facets is cancelled and the facets that were not selected earlier are now selected and highlighted.

### To Select Visible Facets Only



Click  or **Edit > Select > Preferences > Select Visible Facets Only**, to select only visible facets. You cannot select hidden facets.

To select both visible and hidden facets, click  again.

### To Delete the Selected Facets

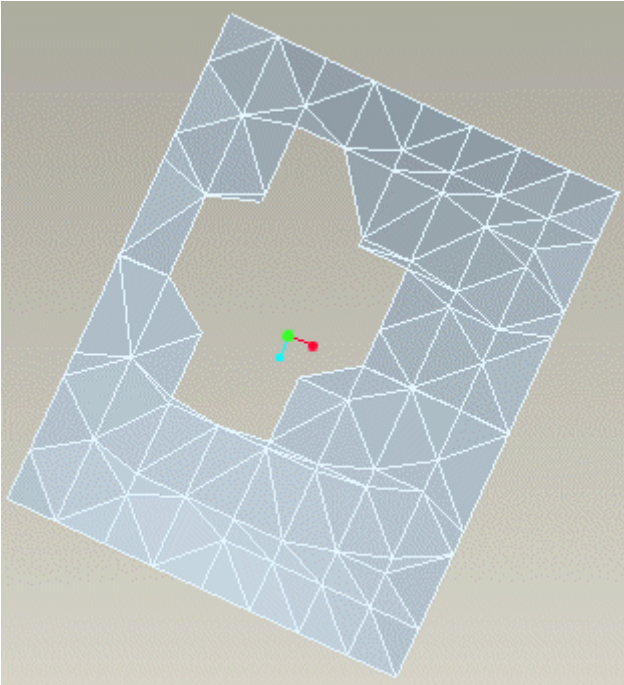
1. Select facets for deletion using the selection marquee or using the **Select by Length** command.
2. Click  or click **Facets > Delete**. The selected facets are deleted.

### To Fill Holes in the Faceted Geometry

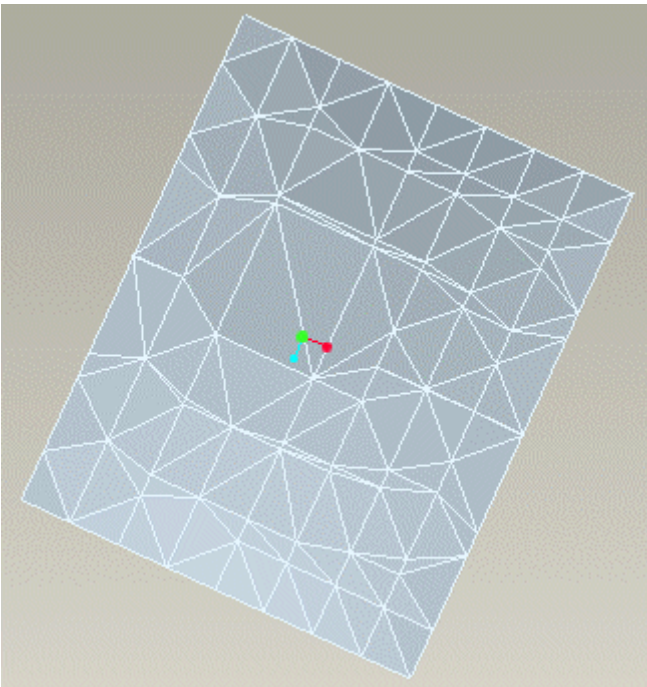
1. Click  or click **Facets > Fill Hole**. The **Fill Holes** dialog box opens.
2. Under **Fill Type**, select one of the following fill types:
  - **Curvature**—Adds facets such that the surface curvature is maintained.
  - **Flat**—Fills the hole but does not maintain the surface curvature.
3. Under **Holes To Fill**, select one of the following options:
  - **Smaller than**—Use the slider to set the size of the holes to be selected. Pro/ENGINEER selects the holes based on percentage of the model size that you specify using the slider.
  - **All**—Selects all holes with open facet edges.
  - **Select**—Allows you to select open facet edges for the holes to be filled.  
Click  and select the open facet edges.
4. If required, click **Preview** to see a preview of the filled holes in the faceted surface.
5. If required, click **Undo** to discard the changes that you made.
6. Click **OK**. The gaps or holes in the faceted surface are filled.

### Example: Using the Fill Hole Command

The next figure shows a faceted surface with a hole in it.



The next figure shows the faceted surface after using the **Fill Hole** command from the **Facets** menu.






## About Cleaning the Faceted Geometry

The **Clean** command uses a shape-correction algorithm. Using this command corrects the triangle of the faceted data. Cleaning the faceted geometry makes the polygonal surface conform to the shape decided by the original point set. This command removes dents, smooths cylindrical sections, or sharpens edges depending on the mode you choose.

## To Clean the Faceted Geometry

1. Click  or click **Facets > Clean**. Select the region for cleaning. If you do not select the region, the operation is performed on the entire model.

The **Clean** dialog box opens.

2. Select the mode for cleaning the facet geometry.

**Free-form**—Cleans and smooths the surface geometry with respect to the surface curvature if the faceted surface represents a freeform or organic shape.

**Mechanical**—Retains sharp corners and edges while cleaning the geometry if the faceted surface represents a mechanical or prismatic shape.

3. Click **OK**.

## Example: Cleaning the Faceted Geometry

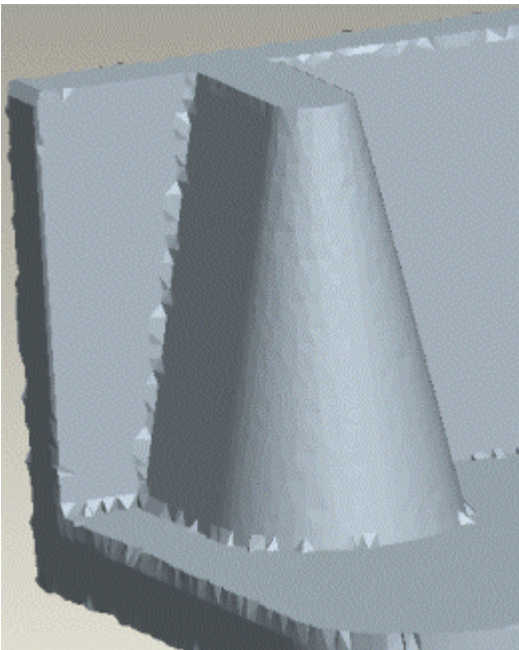
The next figure shows a faceted surface before using the **Clean** command.



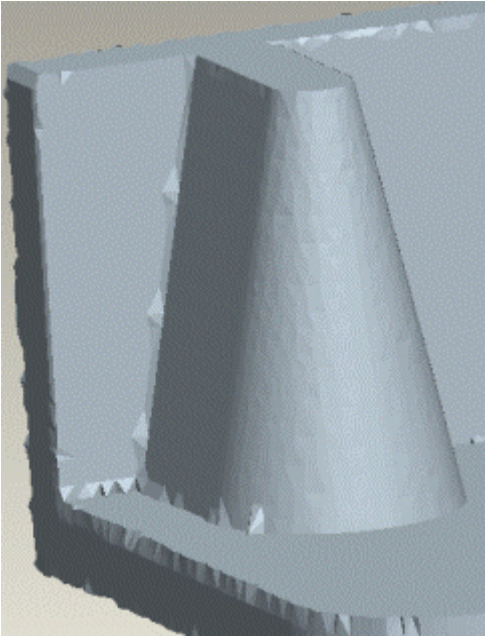
The next figure shows the faceted surface after using the **Clean** command with the **Free-form** option.




The next figure shows the faceted surface before using the **Clean** command with the **Mechanical** option.



The next figure shows the faceted surface after using the **Clean** command with the **Mechanical** option.

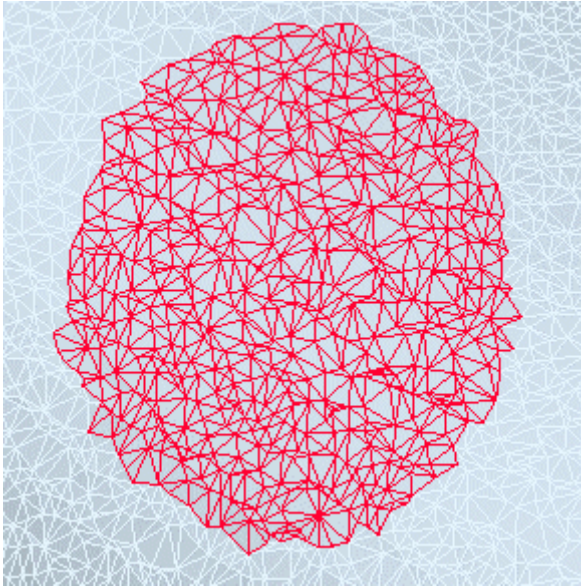


### To Decimate Facets

1. Click  or click **Facets > Decimate**. The **Decimate** dialog box opens.
2. In the **Percentage To Keep** box, type a value for the percentage of original points that you want to retain.
3. To fix the boundary of decimated facets with respect to the surrounding facets after decimation, click the **Fix Boundary** check box. This is useful when the boundary consists of corners or feature lines that you want to retain.
4. Click **OK**. The **Decimate** command enables you to reduce the number of triangles without compromising the surface integrity or detail.

**Example: Using the Decimate Command**

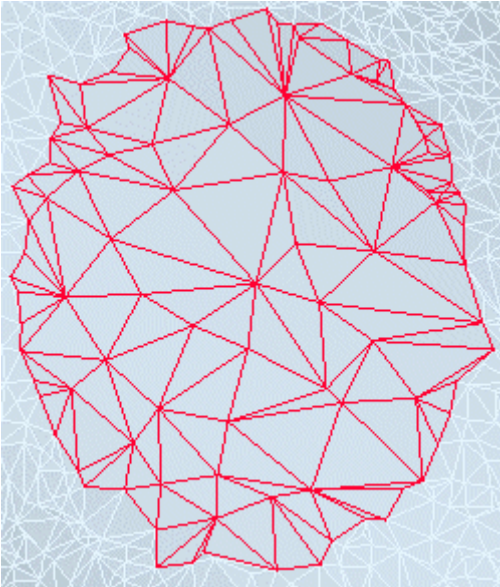
The next figure shows a faceted surface and the facets selected for decimation.



The next figure shows the selected facets after using the **Decimate** command with a reduction to 60 per cent of the original number of facets.



The next figure shows the selected facets after using the **Decimate** command with a reduction to 25 per cent of the original number of facets.



### About Refining the Faceted Geometry

The **Refine** command improves the surface of the facet model by making the mesh denser by subdividing the existing facets. This results in an increased number of facets in the selected area. Using this command results in a more detailed and smoother selected region.

### To Refine the Faceted Geometry

1. Select the area for refining using the selection marquee or using the **Select by Length** command.

**Note:** If you do not select the area, the **Refine** command subdivides the entire faceted surface.

2. Click  or click **Facets > Refine**. The **Refine** dialog box opens.

3. Select a **Refinement Algorithm**:

**3X Subdivision**—Replaces every existing triangle in the selected area with three triangles.

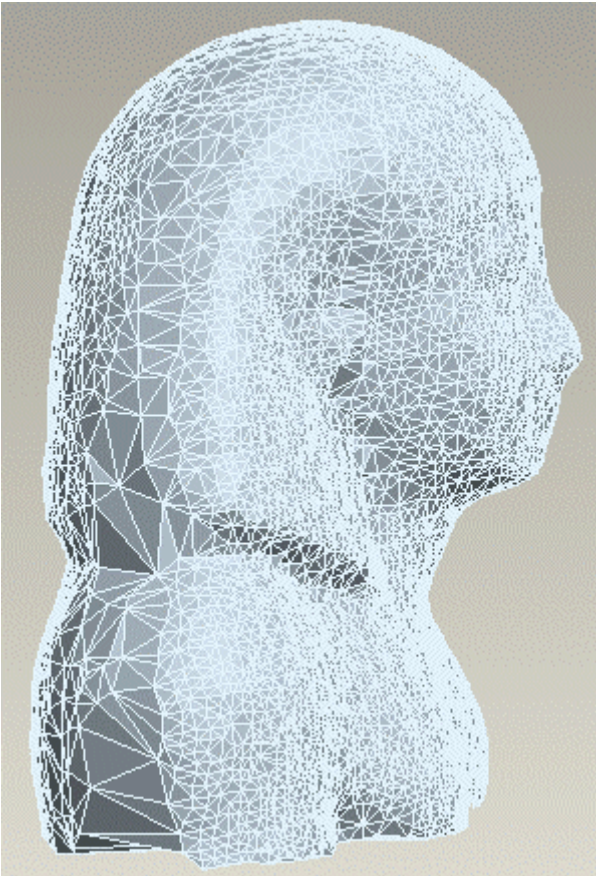
**4X Subdivision**—Replaces every existing triangle in the selected area with four triangles.

4. Click the **Move Points** check box to adjust the position of vertices to accommodate the increased number of triangles and produce a smoother surface.
5. Click the **Fix Boundary** check box to ensure that the boundary edges and sharp edges are not moved. This is useful when the boundary consists of corners or feature lines that you want to retain.

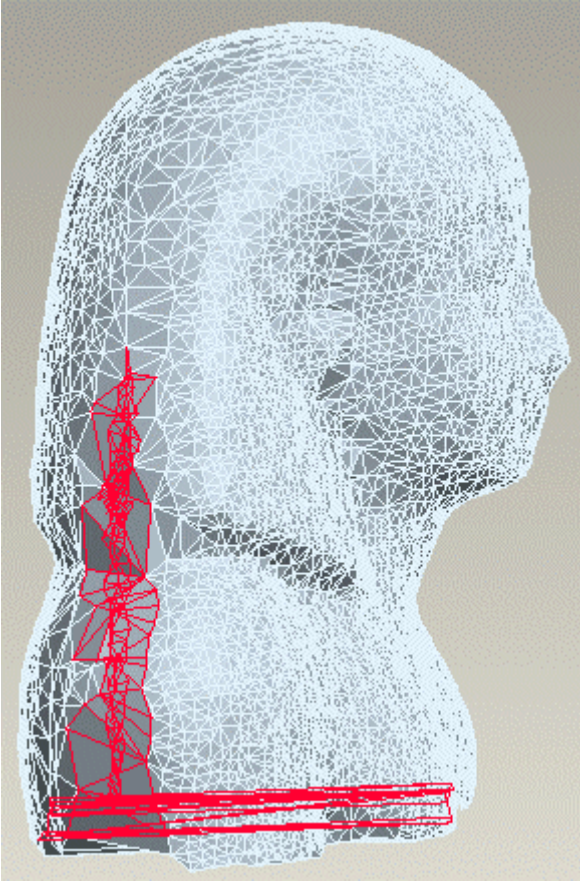
6. Click **OK**.

**Example: Refining the Faceted Geometry**

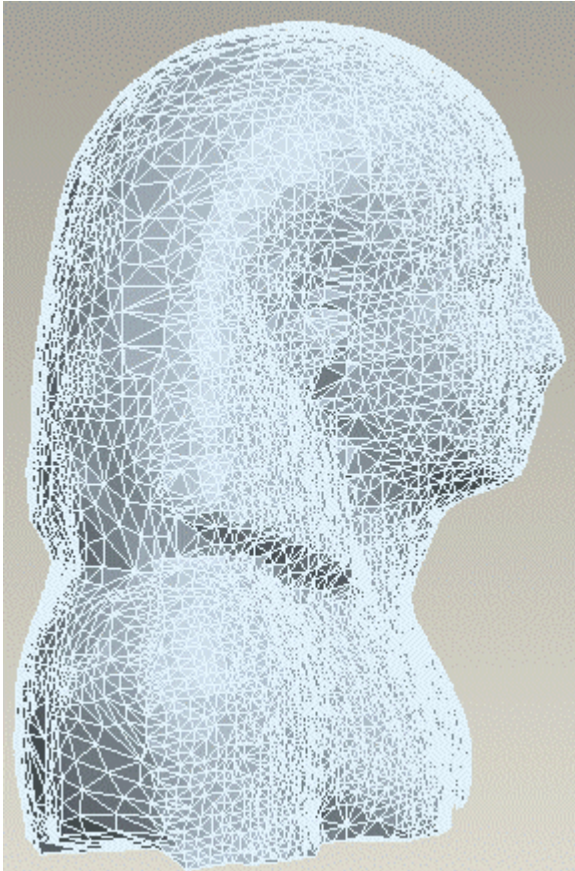
The next figure shows a faceted surface.



The next figure shows the region selected for using the **Refine** command.



The next figure shows the faceted surface after using the **Refine** command to replace every triangle with four triangles in the selected region.



### About Relaxing the Faceted Geometry


The **Relax** command smoothes the surface by moving the coordinates of the facet vertices. This process is iterative.

More iterations mean a smoother surface, but too many iterations significantly change the original scanned data.

### To Relax the Faceted Geometry

1. Select the area for smoothing using the selection marquee or using the **Select by Length** command.

**Note:** If you do not select an area, the **Relax** command smoothes the entire faceted surface.

2. Click  or click **Facets > Relax**. The **Relax** dialog box opens.
3. In the **Iterations** box, type a value for the number of times the operation should be performed. You can also use the spin control to adjust the value.



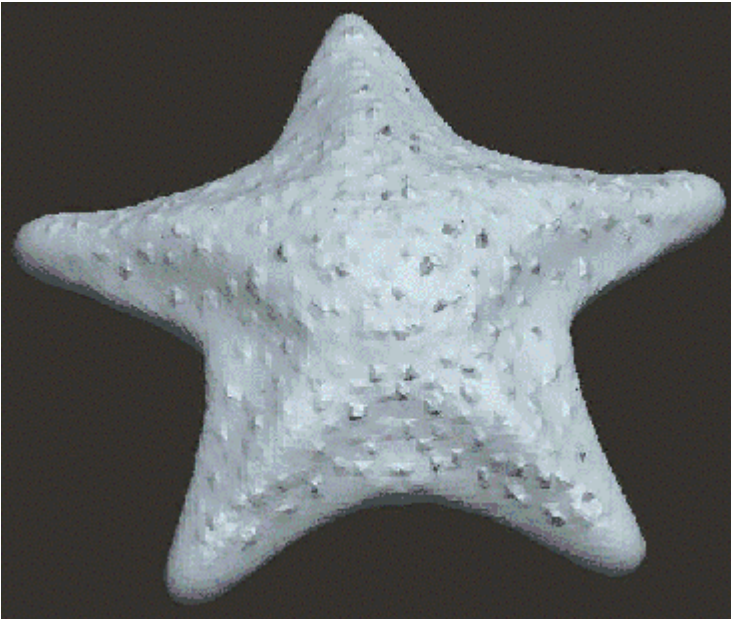
4. In the **Strength** box, type a value for the amount of relaxation to be performed. This value must be between zero and one.

**Note:** In general, there is a balance between the relaxation, or smoothing, and the shrinkage of the model. Increasing the **Strength** increases the amount of smoothing at the expense of additional shrinkage and thus loss of finer details.

5. Click the **Fix Boundary** check box to ensure that the boundary edges and sharp edges are not moved. This is useful when the boundary consists of corners or feature lines that you want to retain.
6. Click **OK**.

### **Example: Relaxing the Faceted Geometry**

The next figure shows a faceted surface.



The next figure shows the faceted surface after a relaxation of facets using the **Relax** command.



### To Offset Facets

1. Select a subset of a facet feature or an entire facet model.

2. Click  or **Facets** > **Offset**. The **Offset** dialog box opens.

3. Specify a value for **Offset Value**. The default is 1.000.

**Note:** To reverse the direction of the offset, enter a negative value.


4. Click the **Maintain Mesh** check box to maintain the existing mesh of triangulated facets while offsetting the facet model.
5. Click the **Thicken** check box to add thickness to the facet model. This thickness is equal to the value specified for **Offset Value**.

For example, if the **Thicken** check box is not selected, only the facet subset or model is offset by the specified Offset Value. If the **Thicken** check box is selected, then the facet subset or model is offset by the specified Offset Value and sidewalls are created.




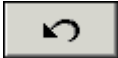
6. If required, click **Preview** to preview the offset of the subset of the facet feature or model.
7. Click **OK** to offset the subset of the facet feature or model.

### To Trim Facets

1. Click  or **Facets** > **Trim**. The **Trim** dialog box opens.

2. Select a datum plane.
3. If required, click  to flip or reverse the direction of the trim.
4. If required, click **Preview** to preview the trimmed faceted surface.
5. Click **OK** to trim the faceted surface.

### To Create a Symmetry Plane


1. Click  or **Facets > Symmetry Plane**. The **Plane** dialog box opens.
2. If required, under **References**, click  and select a **Coordinate System**, **Origin Point**, and **Direction** for the symmetry plane.
3. If required, under **Origin Point Coordinates**, specify values for **X Coordinate**, **Y Coordinate**, and **Z Coordinate**.
4. If required, specify values for **Direction Angular Dimensions**.  
**Note:** **YOZ**, **XOZ**, and **XOY** represent the angular dimensions between the Y and Z, X and Z, and X and Y directions, respectively.
5. If required, click  to preview the symmetry plane.
6. If required, click  to discard changes made in the **Plane** dialog box. You can specify new values for **Coordinate System**, **Origin Point**, **Direction**, **Origin Point Coordinates**, and **Direction Angular Dimensions** again.
7. Click **OK**. The symmetry plane is generated for the entire faceted surface.

### About Manifold Representations of Faceted Geometry


You can create manifold models of the faceted surfaces in Facet Modeling. You can work with both open and closed manifold models.

Manifold representations of a model have all the triangles connected continuously by their edges except for boundary edges.


Closed-manifold objects bound volume whereas open-manifold objects do not.

If a point set represents a closed object, the **Wrap** () command creates a closed object. However, noise in the scan data can result in a wrap model that is not closed or contains nonmanifold edges, that is, some triangles in the model are not connected continuously by their edges.

### To Create a Manifold Representation of the Faceted Geometry

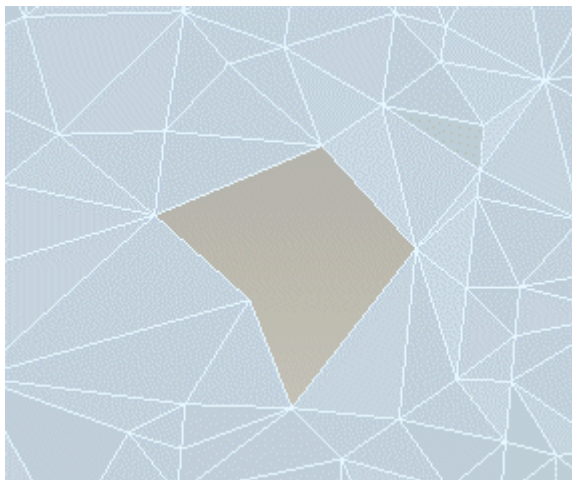
1. Click  or click **Facets > Make Manifold**. The **Make Manifold** dialog box opens.
2. Select the type of manifold representation to create.  
**Open**—Creates a representation of the model where all the triangles are connected continuously by their edges except for boundary edges. This representation is created even if the wrap model does not bound volume.  
**Closed**—Creates a representation of the model where all the triangles are connected continuously by their edges except for boundary edges. This representation is created only if the wrap model bounds volume.
3. Click **OK**.

### To Add Facets to the Faceted Geometry

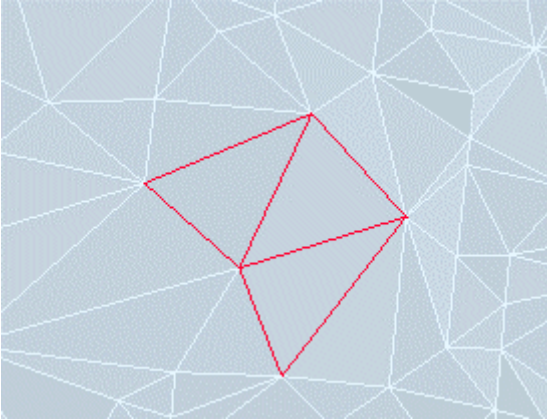
1. Click  or click **Facets > Add Facet**.
2. Select three vertices of the existing facets in such a way that the triangle they form does not overlap or intersect any existing facets. The three selected vertices should create a triangle in an open space in the model. A new facet is created using these vertices.

### Example: Adding Facets to the Faceted Geometry

The next figure shows a faceted surface with a gap in it.



The next figure shows facets added in this gap.



### To Reverse the Orientation of Two Facets

1. Click  or click **Facets > Flip Edge**.
2. Select an edge shared by two facets.

The two facets form a quadrangular area. This command replaces one diagonal of this area with the other, changing the orientation of the two facets.

### Example: Reversing the Orientation of Two Facets


The next figure shows two facets that share an edge.



The next figure shows the same facets after reversing their orientation using the **Flip Edge** command.



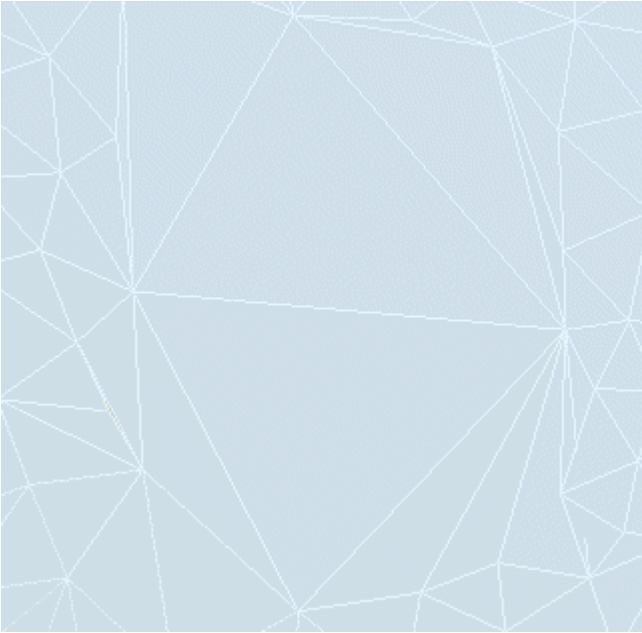
### To Add Facets by Splitting a Facet Edge

1. Click  or click **Facets > Split Edge**.
2. Select a facet edge shared by two facets.

The edge is split into two parts and a facet is added on either side of the edge by dividing each of the two facets into two.

**Example: Adding Facets by Splitting a Facet Edge**

The next figure shows two facets that have a common edge.





The next figure shows the common edge as well as the facets split in two using the **Split Edge** command.

**About Copying Facet Features**

You can create a copy of a facet feature and manipulate it as required. The new or copied facet feature becomes the active facet feature. Copying a facet feature and offsetting the copied facets helps in preserving the original facets.

### To Copy a Facet Feature

1. Select the facet feature that you want to copy.
2. Click  or **Edit > Copy**.
3. Click  or **Edit > Paste**.
4. Select a coordinate system. This coordinate system acts as a reference for placing the copied facet feature.
5. Click **OK**. A copy of the facet feature is created.



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