Module 8B:
Creating an Octagon-Based Star in Inventor

In this *Module*, we will explore the method of creating an octagon-based star in Inventor. The basic step-by-step procedures are:

- Creating an octagon prism in any one of the three **Planes** (**YZ Plane**, **XZ Plane**, and **XY Plane**);

- Cutting the octagonal prism into octagon-based polyhedron from the other two **Planes**;

- Creating a conical spike with the **Revolve** and other tools, on one of the triangular surfaces of the polyhedron; and using the **Circular Pattern**, **Mirror Feature**, and other tools to add conical spikes on all surfaces of the polyhedron.

Step 1: Creating the octagon-based polyhedron

Launch Inventor, start a new **Sheet Metal (in).ipt** file under the **English** tab. An Inventor sheet-metal file opens. "*Sketch1*" is created by default in the **Model** panel on the **XY Plane**; rename the sketch *XY Plane Octagon Profile* in the **Model** panel; select the **Project Geometry** tool button from the **Sketch** tool panel, and then the **Center Point** feature under the **Origin** folder in the **Model** panel; the **Center Point** is projected onto the sketch to provide a snap; next, use the **Line** tool to create a horizontal line (the "radius line") starting from and snapped to the projected **Center Point** and ending at a convenient point on the left, with the help of the **Horizontal** (short – bar) indicator; and use the **General Dimension** tool to apply a 6 in (inch) linear dimension to the horizontal line; next, select the **Polygon** tool, in the tool's dialog window, select the **Inscribed** option (the button with the red dot on the corner) and type 8 in the **Side** text field (*Figure 8B-1A*), click the projected **Center Point** and then the left endpoint of the "radius line" to create the octagon profile (*Figure 8B-1A*); click the **OK** button to exit the sketch. Save the file as *Tut-Octagonal Star.ipt* in a folder to be created and named *Tut-Octagonal Star* in the **Save As** dialog window.

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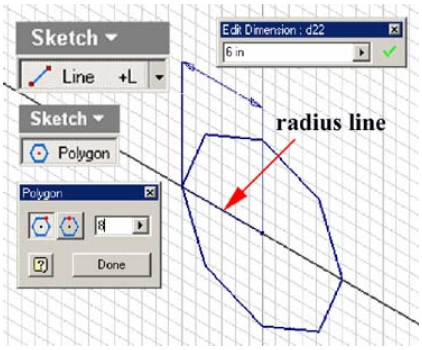
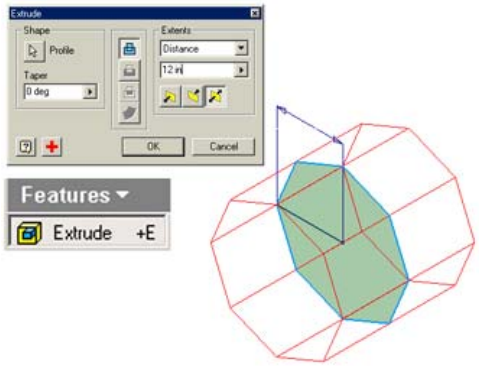


Figure 8B-1A: The XY Plane Octagon Profile.



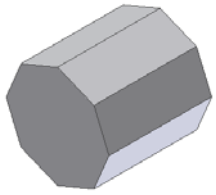


Figure 8B-1B: Creating the XY Plane Octagonal Prism.

Next, select the **Extrude** tool; in the tool's dialog window, select the **Midplane** for **Direction**, and **Distance** in the **Extents** drop-down menu, and type 12 in (inch) in the text field, click the **OK** button to create the **Extrude** feature and rename it *XY Plane Octagonal Prism* in the **Model** panel (*Figure 8B-1B*).

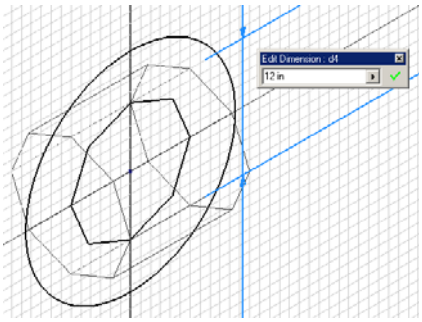


Figure 8B-1C: The YZ Plane Octagonal Cut Profile sketch.

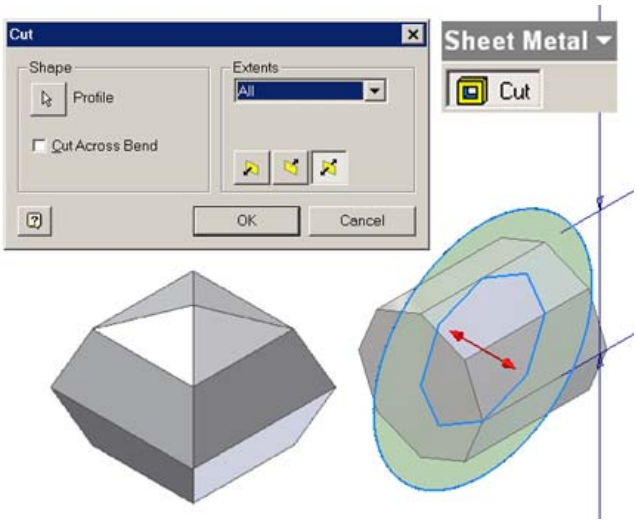


Figure 8B-1D: The YZ Plane Octagonal Cut feature.

Next, select the **YZ Plane** from the **Model** pane and click the **Sketch** button to start a new sketch, and rename it *YZ Plane Octagonal Cut Profile* in the **Model** panel; use the **Project Geometry** tool to project the **Center Point** onto the new sketch; use the **Polygon** tool with the **Inscribed** option to create an octagon centered at the projected **Center Point**, and with the corner point set somewhere along the vertical or horizontal grid, with the help of dotted tracking line; use the **General Dimension** tool to apply a 12 in (inch) height dimension between the top and base points of the octagon; and use the

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Center Point Circle tool to create a circle centered at the projected **Center Point** and with size large enough to encompass the entire 3D model of the *XY Plane Octagonal Prism* (*Figure 8B-1C*); click the **Return** button to exit the sketch.

Next, select the **Cut** tool from the **Sheet Metal** tool bar, click the **Profile** button in the tool's dialog window and click-select the area between the large circle and the octagon in the *YZ Plane Octagonal Cut Profile* sketch; click the **Midplane** button and the **OK** button to cut the prism; rename the **Cut** feature *YZ Plane Octagonal Cut* in the **Model** panel (*Figure 8B-1D*).

Next, go to the **Command Bar** to select **Wireframe Display** option from the drop-down menu for a better visualization (*Figure 8B-1E*); select the **XZ Plane** from the **Model** pane and click the **Sketch** button to start a new sketch, and rename it *XZ Plane Octagonal Cut Profile* in the **Model** panel; use the **Project Geometry** tool to project the **Center Point** onto the new sketch; use the **Polygon** tool with the **Inscribed** option to create an octagon centered at the projected **Center Point**, and with the corner point set somewhere along the vertical or horizontal grid, with the help of dotted tracking line; use the **General Dimension** tool to apply a 12 in (inch) height dimension between the top and base points of the octagon; and use the **Center Point Circle** tool to create a circle centered at the projected **Center Point** and with size large enough to encompass the entire 3D model created and modified so far; click the **Return** button to exit the sketch. Go to the **Command Bar** to switch back to the **Shaded Display** option from the drop-down menu.

Next, select the **Extrude** tool from the **Feature** tool bar, click the **Profile** button in the tool's dialog window and click-select the area between the large circle and the octagon in the *XZ Plane Octagonal Cut Profile* sketch; click the **Midplane** button and the **OK** button to cut the model; rename the **Extrude** feature *XZ Plane Octagonal Cut* in the **Model** panel (*Figure 8B-1F*). To see that the polyhedron has octagonal outline in its principal views, select the **Rotate** tool, right-click for the shortcut menu and choose **Common View [SPACE]** option; the **Common View [SPACE]** cube appears; click any of the arrows attached to the middle point of edge to switch to an orthographic view; continued clicking the arrow attached to the middle point of the edge to switch to different principal views (*Figure 8B-1G*).

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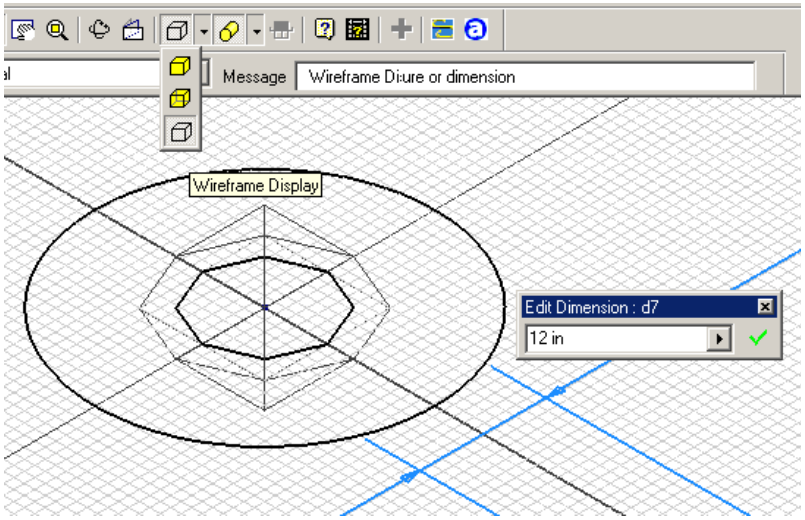

Figure 8B-1E: The XZ Plane Octagonal Cut Profile sketch.

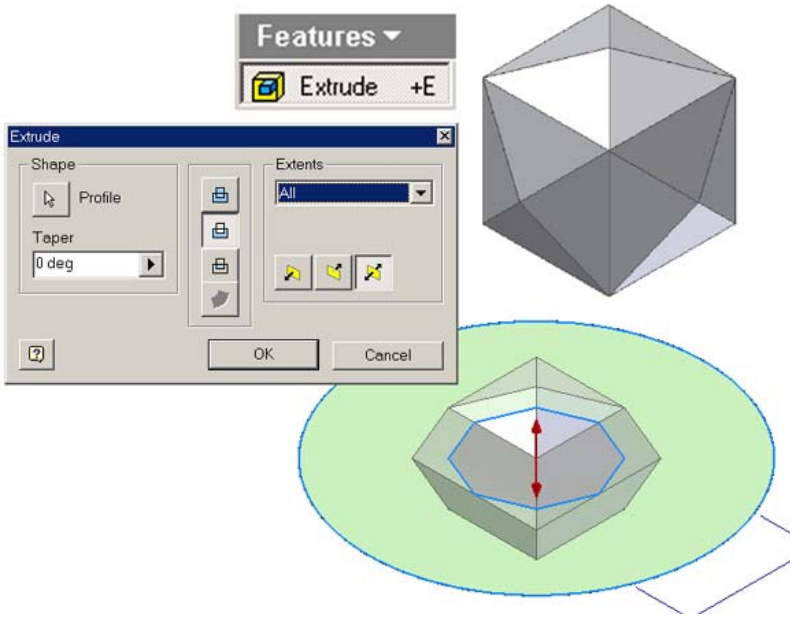

Figure 8B-1F: The XZ Plane Octagonal Cut Extrude feature and the completed polyhedron.

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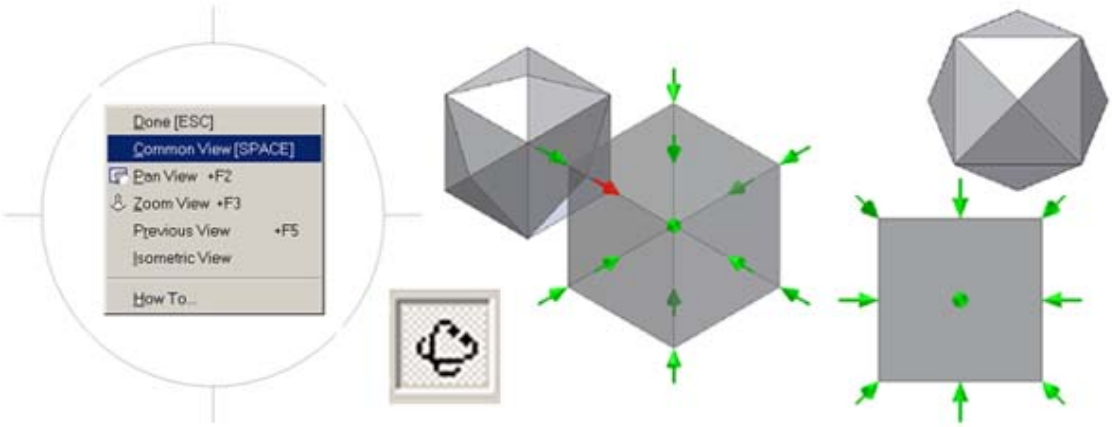

Figure 8B-1G: Using the Rotate tool with Common View [SPACE] option (left and middle) to see the octagonal outline of the polyhedron in the principal views (right).

Step 2: Creating the first conical spike on one of the triangular surfaces of the polyhedron

To create the conical spike on one of the triangular surfaces of the polyhedron, a **Work Plane** for the **Revolve** feature's profile must be created first. Some construction sketches must be created first in order to create this **Work Plane**. The procedures to accomplish this task are explained as follows. Select one of the triangular surfaces of the polyhedron as shown in *Figure 8B-2A*; use the **Project geometry** tool to project the three edges lines of the triangle onto the sketch; use the **Center Point Circle** tool to draw a circle of any convenient size inside the project6ed triangle; and use the **Tangent** tool to apply tangency constraints between the circle and all three edges of the triangle, so as to allow the circle's center point to relocate to the center of the triangle (*Figure 8B-2B*); click the **Return** button to exit the sketch; and rename is *Construction* in the **Model** panel.

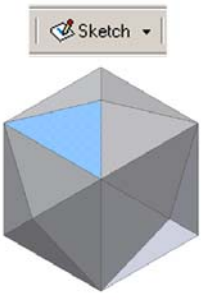

Figure 8B-2A: Selecting one of the triangular surfaces to start the Constructio n sketch.

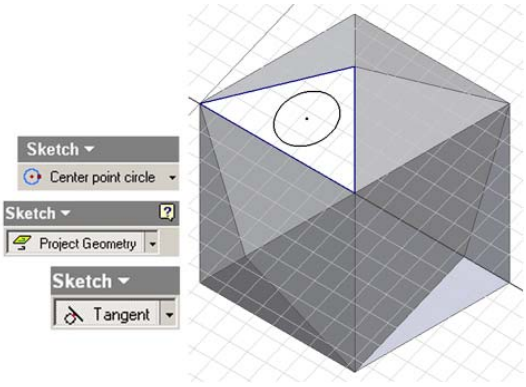

Figure 8B-2B: Projecting the triangular edge lines, drawing an inscribed circle and applying Tangent constraint.

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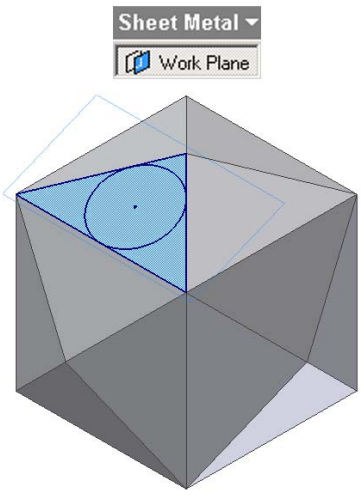

Figure 8B-2C: Starting a new Work Plane above the triangular surface.

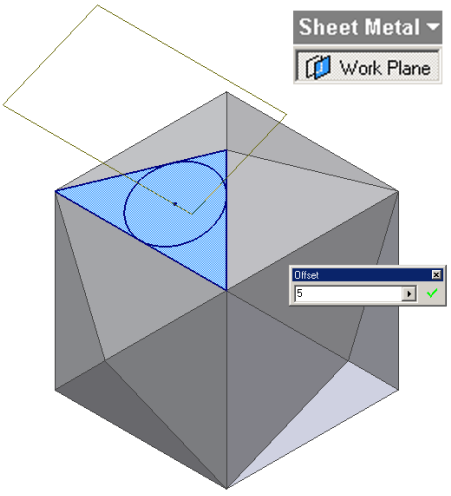

Figure 8B-2D: Setting the Offset height of the new Work Plane relative to the triangular surface.

Next, click the **Work Plane** tool button on the **Features** tool panel, click-select the same triangular surface and drag the mouse cursor up to create a new **Work Plane** (*Figure 8B-2C*), in the **Offset** pop-up text field, type 5 (inches), or any convenient value for the height, and click the green check mark (or press the **Return** key on the keyboard) to create the new **Work Plane**, and rename it *Construction Work Plane* in the **Model** panel (*Figure 8B-2D*).

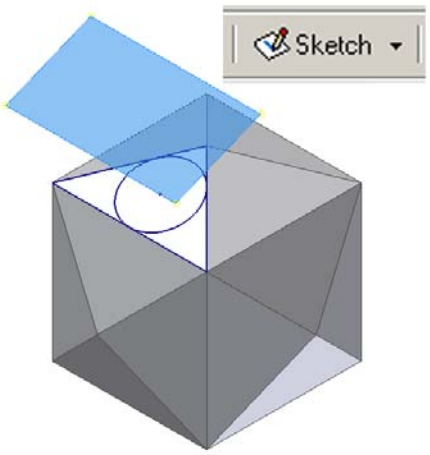

Figure 8B-2E: Selecting the Construction Work Plane to start the Points for A Plane sketch.

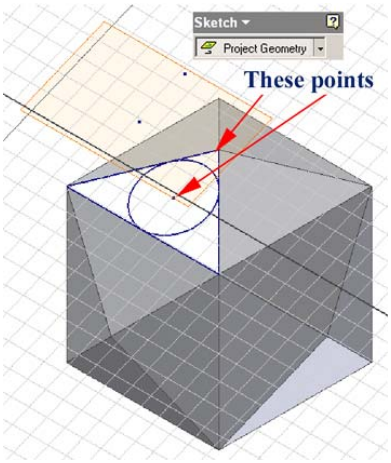

Figure 8B-2F: Projecting the center point of the circle and one corner point of the triangle onto the sketch.

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Next, select the *Construction Work Plane* and click the **Sketch** button to start a new sketch (*Figure 8B-2E*); rename it *Points for A Plane* in the **Model** panel; use the **Project Geometry** tool to project the center point of the circle and one of the corner points of the triangle onto the sketch, as shown in *Figure 8B-2F*; click the **Return** button to exit the sketch.

Next, select the **Work Plan** tool; click-select the two projected points on the *Points for A Plane* **Sketch** and the center point of the circle in the *Construction* **Sketch** to create a **Work Plane** defined by three points, and rename it *Work Plane for Spike* in the **Model** panel (*Figure 8B-2G*). Next, select the **Work Axis** tool and click-select the two points as shown on *Figure 8B-2H* to create a **Work Axis**, and rename it *Spike Central Axis* in the **Model** panel.

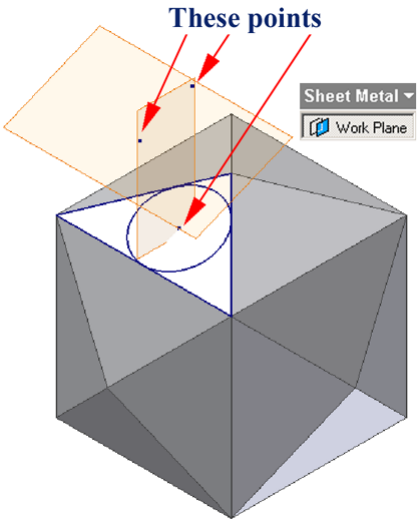

Figure 8B-2G: Creating the Work Plane for Spike defined by three points.

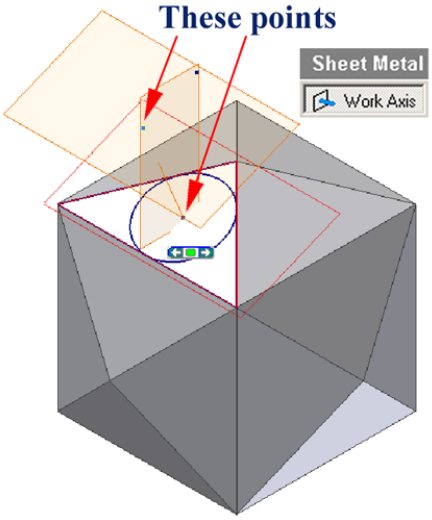

Figure 8B-2H: Creating the Spike Central Axis.

Next, select the *Work Plane for Spike* and click the **Sketch** button to start a new sketch; and rename it *Spike Profile* in the **Model** panel (*Figure 8B-1A*); select the **Project Geometry** tool and click the *Spike Central Axis* and one of the edge line of the triangle from the *Construction* sketch, as shown on *Figure 8B-2K*, to project them onto the new sketch (*Figure 8B-2L*); window-select the two projected lines and go to the **Command Bar** to change their **Style** to Normal; next, select the **Trim** tool to trim off the left portion of the projected horizontal line and the lower portion of the projected vertical line (*Figure 8B-2M*); next, select the **Fix** tool and click on both vertical and horizontal lines to fix them (*Figure 8B-2N*); next, select the **General Dimension** tool to apply a 9 in (inch) **Aligned** dimension (click the vertical line, hold the left mouse button, drag the mouse

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out, release the left mouse button, click the right mouse button for the shortcut menu, move the mouse down until the **Aligned** option is highlighted and click the left or right mouse button to select the option, click once on the screen to create the dimension, and double-click the dimension feature to open the pop-up text field, type 9 in and press the **Enter** key on the keyboard, as shown in *Figure 8B-2P* and *Figure 8B-2Q*); next, apply a 1.5 in (inch) **Aligned** dimension to the horizontal line (*Figure 8B-2R*); next, use the **Line** tool to draw a line connecting the top endpoint of the vertical line and the right endpoint of the horizontal line, so as to complete the cross-section profile for the conical spike (*Figure 8B-2S*); click the **Return** button to exit the sketch.

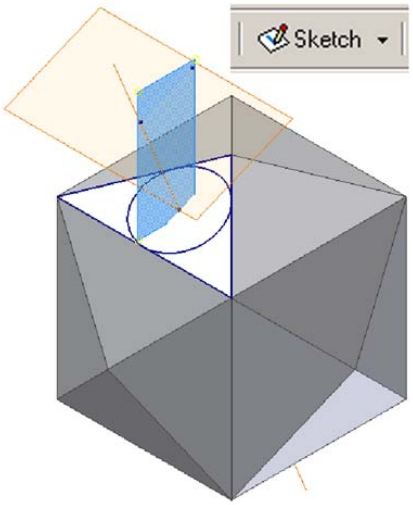

Figure 8B-2J: Selecting the Work Plane for Spike and click the Sketch button to create the Spike Profile sketch.

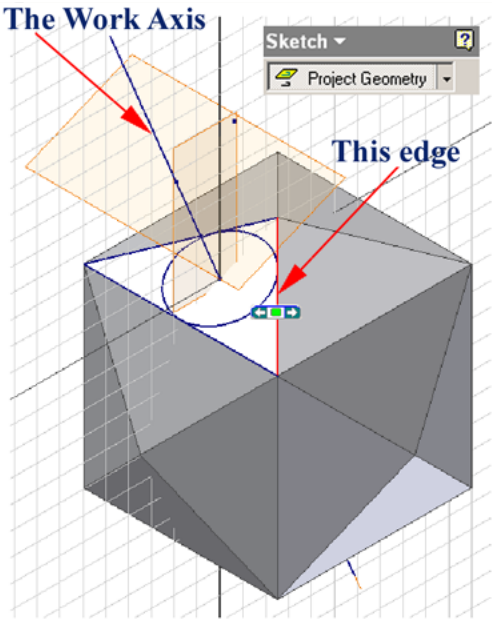

Figure 8B-2K: Projecting the triangular edge and the Spike Central Axis onto the Spike Profile sketch.

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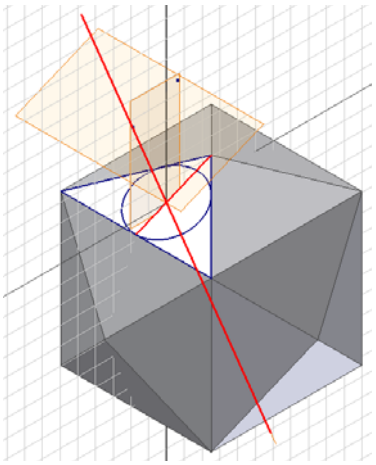

Figure 8B-2L: The projected lines in the sketch.

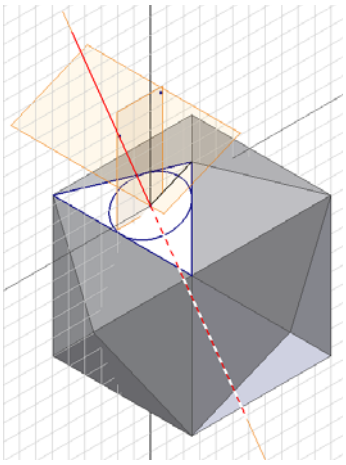

Figure 8B-2M: Trimming off the lower portion of the vertical line and the left portion of the horizontal line.

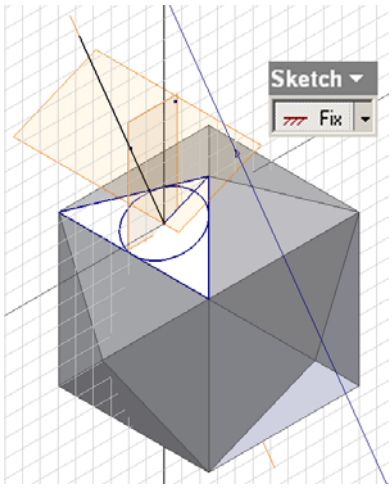

Figure 8B-2N: Fixing both horizontal and vertical lines.

Next, select the **Revolve** tool, click the **Axis** button in the tool's dialog window and then the vertical profile line (or the *Spike Central Axis*, on the screen or from the **Model** panel), click the **OK** button to create the **Revolve** feature (*Figure 8B-2T*) and rename it *Spike* in the **Model** panel. The first spike for the star is completed and ready for duplication onto all surfaces of the polyhedron.

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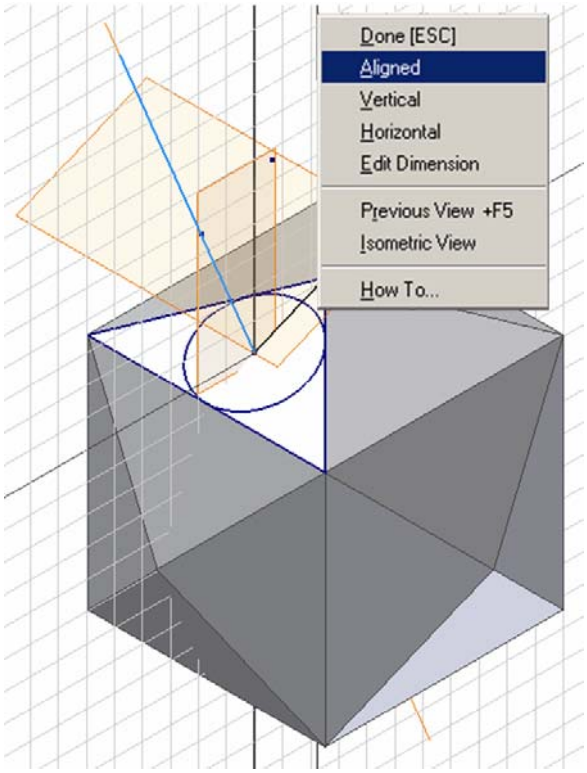

Figure 8B-2P: Choosing the Aligned option for the General Dimension tool.

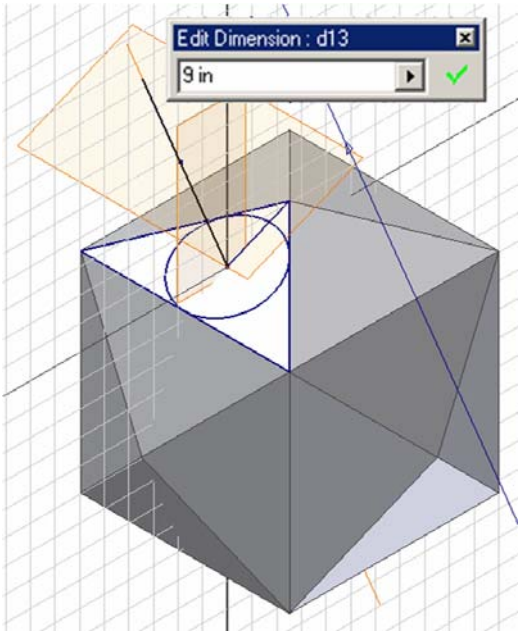

Figure 8B-2Q: Applying a 9-inch Aligned height dimension to the vertical line.

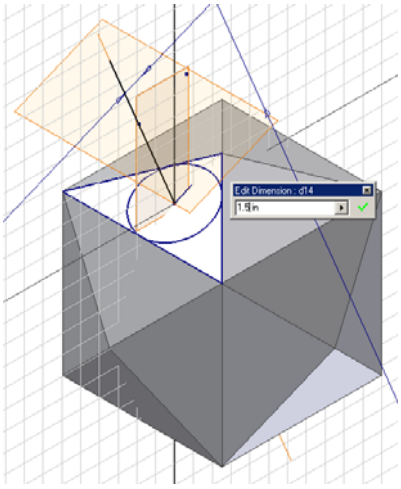

Figure 8B-2R: Applying an Aligned width dimension to the horizontal line.

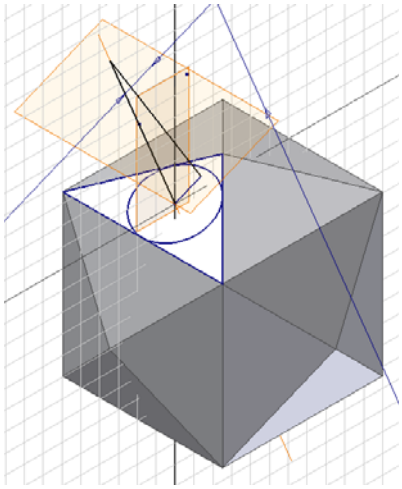

Figure 8B-2S: Adding a third line to complete the profile for the conical spike.

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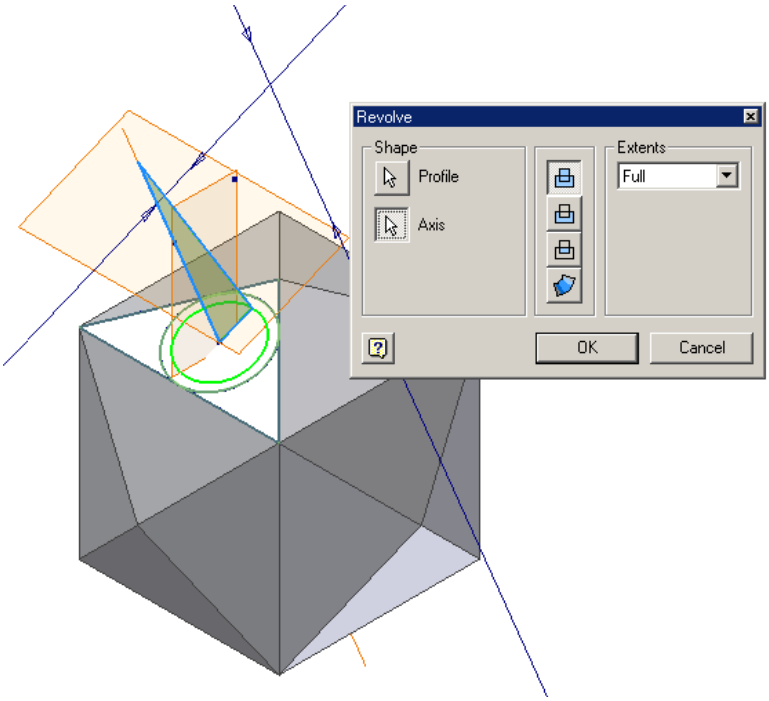

Figure 8B-2T: Creating the Spike feature with the Revolve tool.

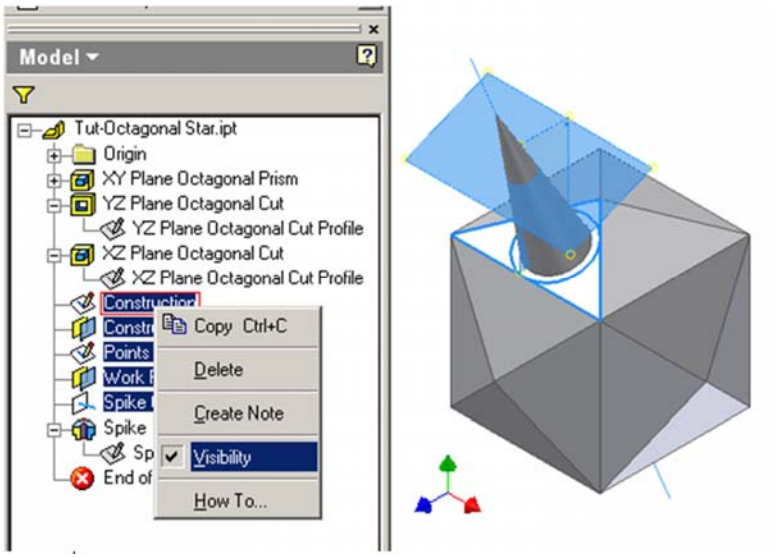

Figure 8B-2U: Turning off Visibility.

To avoid visual confusion on the screen, go to the **Model** panel and select the *Construction* **Sketch**, the *Construction Work Plane*, the *Points for A Plane* **Sketch**, the *Work Plane for Spike*, and the *Spike Central Axis* **Work Axis** features, right-click for the shortcut menu and uncheck **Visibility**.

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Step 3: Duplicating the conical Spike feature onto all surfaces of the polyhedron

Select the **Circular Pattern** tool, click the **Features** button in the tool's dialog window and select the *Spike* **Extrude** feature; click the **Rotation Axis** button and click-select the **Y Axis** feature from the **Model** panel; green outline geometry of spikes appears on three adjacent triangular surfaces; type *4 ul* in the **Count** text field and *360 deg* in the **Angle** text field; click the **OK** button to create the **Circular Pattern** feature (*Figure 8B-3A*), rename it *Spikes Circular Pattern 1* in the **Model** panel.

Next, select the **Mirror Feature** tool, click the **Features** button in the tool's dialog window and click-select the *Spikes Circular Pattern1* feature from the **Model** panel; click the **Mirror Plane** button and click-select the **XZ Plane** feature (*Figure 8B-3B*); click the **OK** button to create the **Mirror Feature**, and rename it *Spikes Mirror 1* in the **Model** panel.

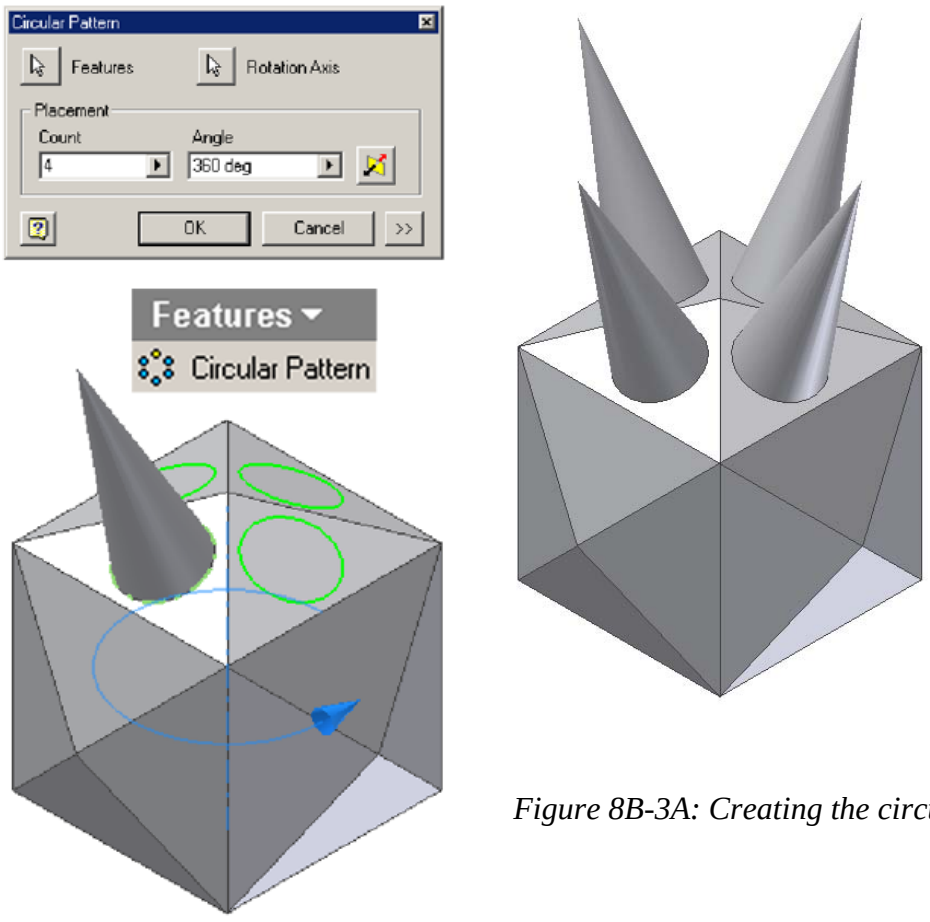

Figure 8B-3A: Creating the circular Pattern1.

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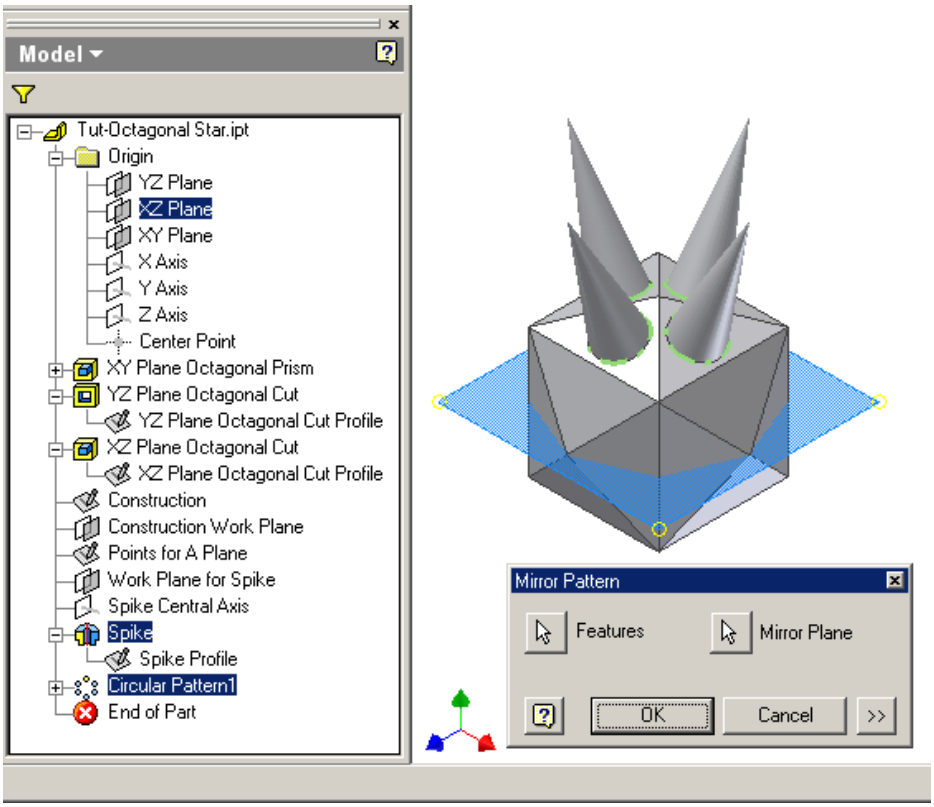

Figure 8B-3B: Creating the Spikes Mirror 1 Mirror Pattern feature.

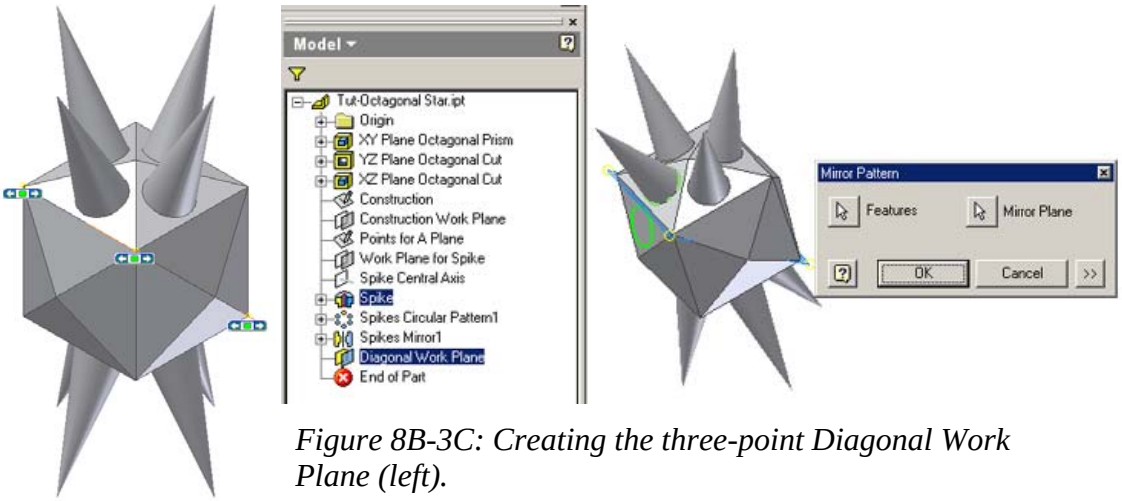

Figure 8B-3C: Creating the three-point Diagonal Work Plane (left).

Figure 8B-3E: Mirroring the first spike across the Diagonal Work Plane (right).

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Next, create a new **Work Plane** feature for mirroring the first spike onto its adjacent triangular surface; select the **Work Plane** tool and click select the three corner points as shown in *Figure 8B-3C*; rename the new **Work Plane** feature *Diagonal Work Plane* in the **Model** panel.

Next, use the **Rotate** tool to rotate the model slightly so that the *Diagonal Work Plane* can be seen more clearly (*Figure 8B-3F*). Next, select the **Mirror Feature** tool again; use the *Spike* **Extrude** for **Features** and the *Diagonal Work Plane* for **Mirror Plane**, create another spike on the adjacent triangular surface (*Figure 8B-3G* and *Figure 8B-3H*); rename the feature *Diagonal Mirror 1* in the **Model** panel.

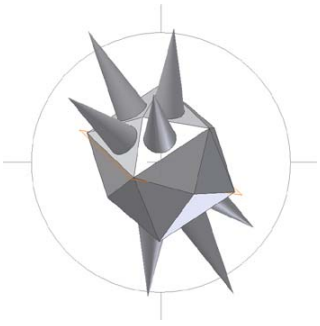

Figure 8B-3F: Rotating the model to show the Diagonal Work Plane better.

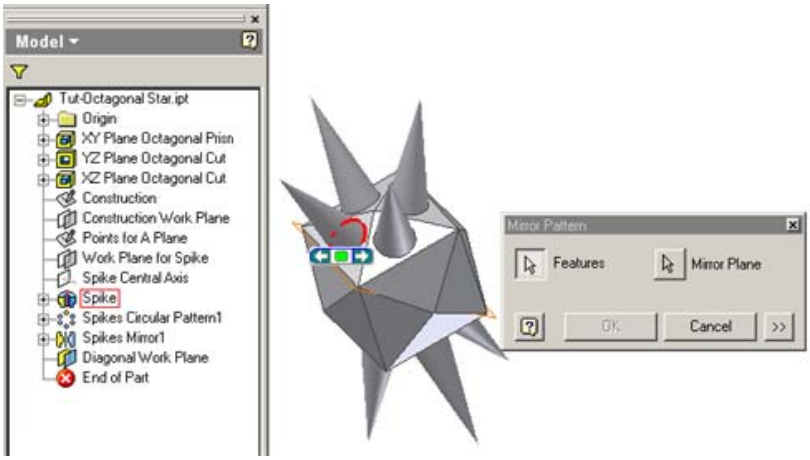

Figure 8B-3G: Mirroring the first Spike feature across the Diagonal Work Plane, onto the adjacent triangular surface.

Next, select the **Circular Pattern** tool, click the **Features** button in the tool's dialog window and select the *Diagonal Mirror 1* **Mirror Feature**; click the **Rotation Axis** button and click-select the **Z Axis** feature from the **Model** panel; green outline geometry of spikes appears on three adjacent triangular surfaces; type *4* in the **Count** text field and *360 deg* in the **Angle** text field; click the **OK** button to create the **Circular Pattern** feature (*Figure 8B-3J* and *Figure 8B-3K*), rename it *Spikes Circular Pattern 2* in the **Model** panel.

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Figure 8B-3H: The first Spike mirrored onto the adjacent surface.

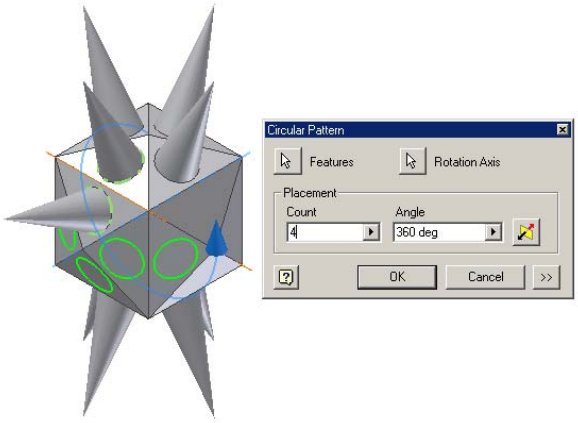

Figure 8B-3J: Creating the Spikes Circular Pattern 2.

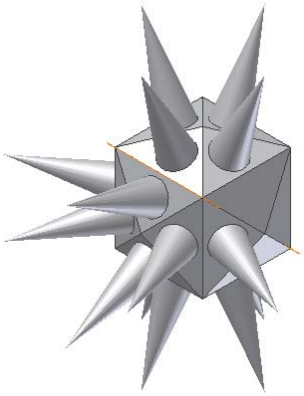

Figure 8B-3K: More spikes added to triangular surfaces of the polyhedron.

Next, use the **Rotate** tool to rotate the model so that the back side of the model can be seen more clearly; select the **Mirror Feature** tool again; use the *Spike Circular Pattern 2* **Features** and the **XY Plane** for **Mirror Plane**, create additional spikes on the other triangular surfaces across the **XY Plane** (*Figure 8B-3L* and *Figure 8B-3M*); rename the feature *XY Plane Mirror* in the **Model** panel.

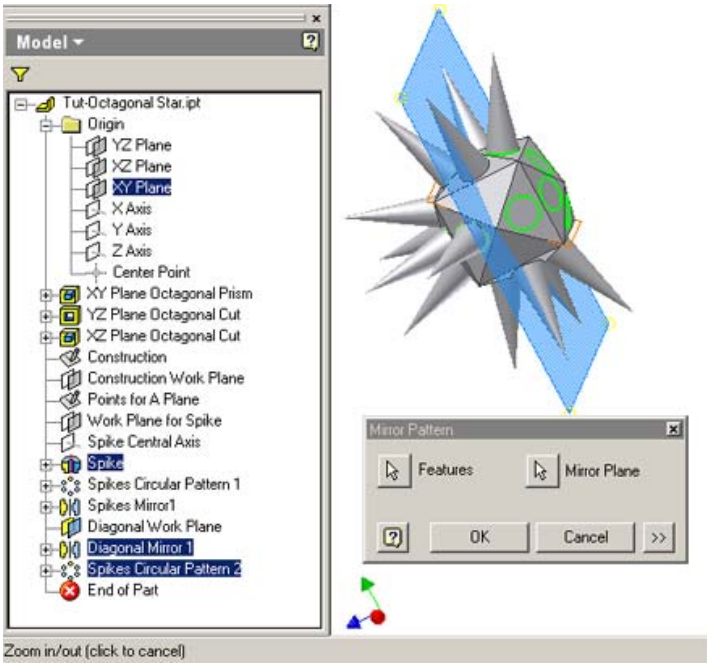

Figure 8B-3L: Creating the XY Plane Mirror.

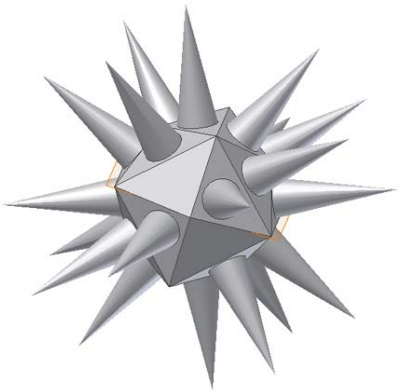

Figure 8B-3M: Additional spikes added onto the other triangular surfaces across the XY Plane.

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Next, create another diagonal **Work Plane** feature to help adding additional spikes to more triangular surfaces of the polyhedron. First go to the **View→Isometric** menu to switch to the regular isometric view. Select the **Work Plane** tool; click-select the three corner points as shown on *Figure 8B-3N*; a new **Work Plane** feature is created; rename it *Diagonal Work Plane 2* in the **Model** panel.

Next, select the **Mirror Feature** tool; click the **Features** button in the tool's dialog window and click-select the *Spikes Circular Pattern 1* from the **Model** panel; click the **Mirror Plane** button in the tool's dialog window and click-select the *Diagonal Work Plane 2* in the **Model** panel; click the **OK** button to create the **Mirror Feature** (*Figure 8B-3P*); rename it *Diagonal Mirror 2* in the **Model** panel.

Next, use the **Rotate** tool to check if there are surfaces where spikes are missing (*Figure 8B-3P*); the answer is yes.

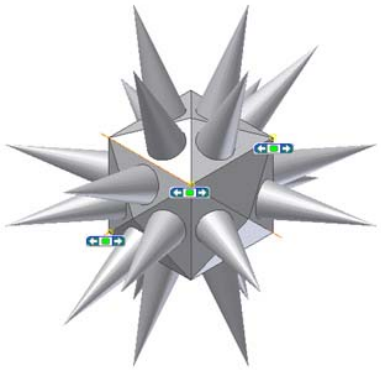

Figure 8B-3N: Creating the Diagonal Work Plane 2 defined by three points.

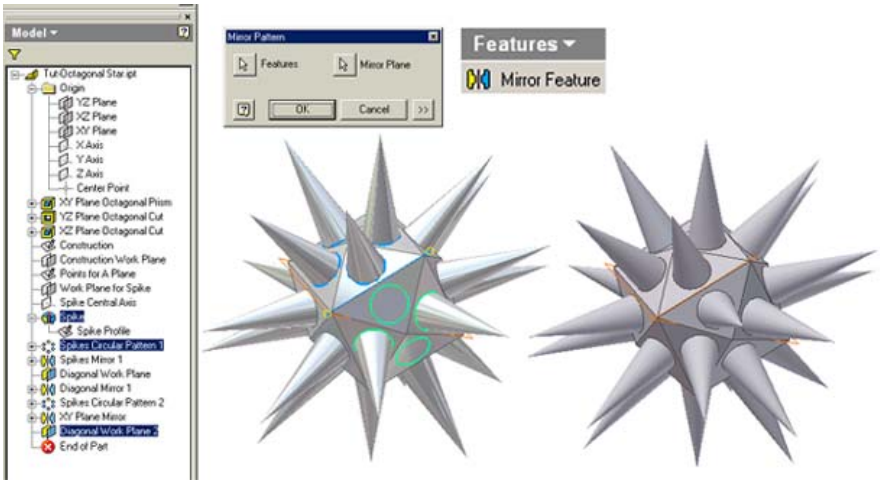

Figure 8B-3P: Creating the Diagonal Mirror 2 to add spikes to more triangular surfaces of the polyhedron.

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Next, select the **Mirror Feature** tool; click the **Features** button in the tool's dialog window and click-select the *Diagonal Mirror 2* from the **Model** panel; click the **Mirror Plane** button in the tool's dialog window and click-select the **YZ Plane** in the **Model** panel; click the **OK** button to create the **Mirror Feature** (*Figure 8B-3R*); rename it *YZ Plane Mirror* in the **Model** panel. The octagon-based star is completed. Now save the file.

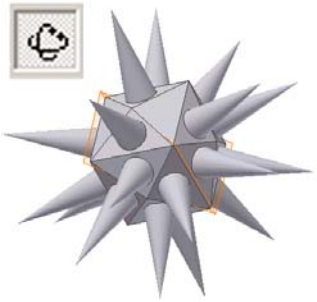

Figure 8B-3Q: Usint the Rotate tool to check if spikes are still missing on some surfaces.

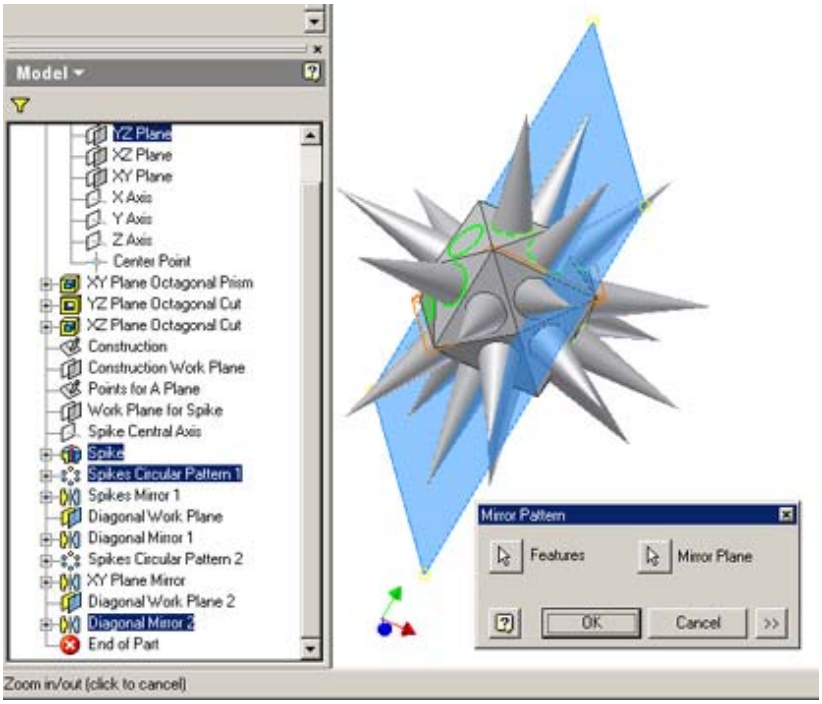

Figure 8B-3R: Creating the YZ Plane Mirror feature.

If so desired, use the **Rotate** tool with both **Free Rotate [SPACE]** and **Common View [SPACE]** options to view the model from different angles (*Figure 8B-3S*). In addition, colorful rendering can be applied by going to the **Command Bar** to select a material **Color** from the drop-down list. All features of the part are listed in the **Model** panel (*Figure 8B-3S*).

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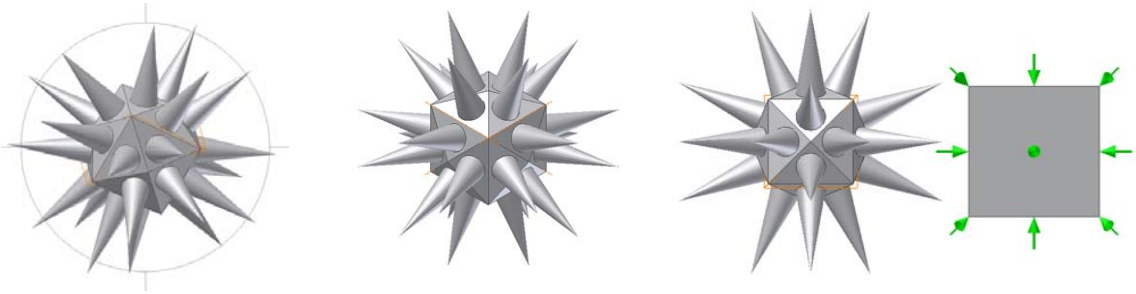

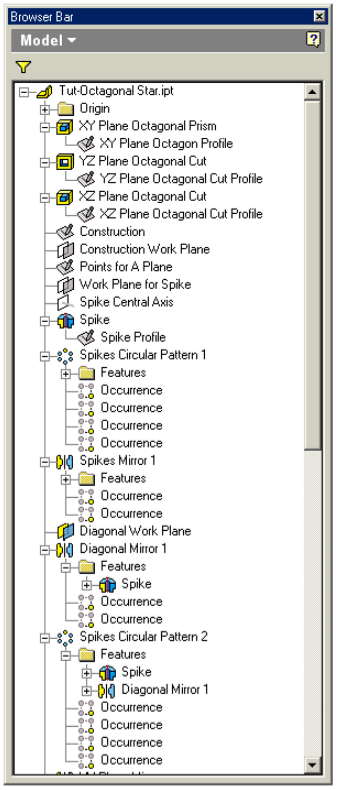

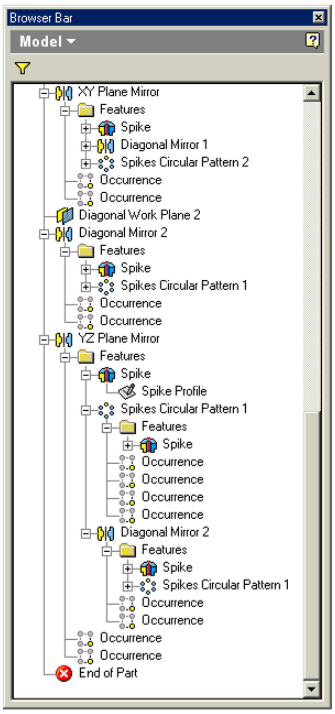

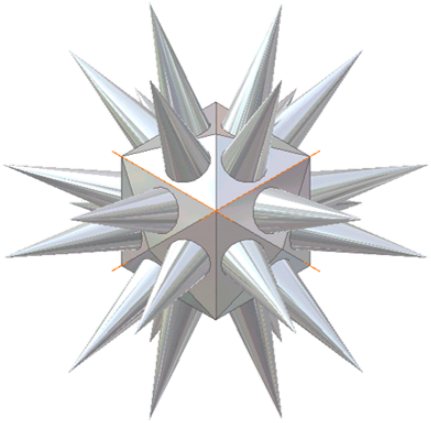

Figure 8B-3S: Using the Rotate tool with both Free Rotate [SPACE] and Common View [SPACE] options to view the model from different angles.
Figure 8B-3V: All features of the part listed in the Model panel.

Congratulations!

In this Module, you have leaned how to create an octagon-based polyhedron and to add conical spikes to turn it into a star. You have got an opportunity to review some important tools in Inventor used in the study of descriptive geometry, such as **Work Plane** and **Work Axis**.

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