Modeling a Centrifugal Compressor Wheel

Faculty Member Name: Trian Georgeou

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School District: Arizona State University's
                    Mechanical and Manufacturing Engineering Technology Department

Teacher's School email address: trian.georgeou@asu.edu

Title of Lesson/Unit: Modeling a Centrifugal Compressor Wheel

Science, Technology, Engineering and Math STEM Concepts Addressed:

This lesson is to be used as an in class exercise for students whom are taking a beginning SolidWorks course. Students will be exposed to curved surface modeling techniques along with elements of mechanical design. Furthermore, the product from this lesson can be used in other parts of a Mechanical or Manufacturing Engineering Technology curriculum. For instance, the solid model can be used in a 5-Axis CNC programming class. The compressor wheel solid model can be imported into a Computer Aided Manufacturing (CAM) program and CNC code can be generated. This is just one of the many different ways this lesson can be further integrated into a STEM based curriculum.

Length of instruction period: 45 - 60 minutes

**How many periods needed to implement lesson unit:** ___1_____

Grade Level(s) for use: High School &100 Level College Students

Objectives: The objective of this lesson is to use SolidWorks to model a centrifugal compressor wheel. It is intended for beginning SolidWorks students, as an exercise to familiarize them with curved surface modeling aspects within SolidWorks. This assignment requires the student to use solid modeling techniques including, revolved protrusions, swept protrusions, 2D & 3D sketches, and revolved cutouts. A centrifugal compressor wheel is a complex part that is commonly found in many different types of fluid pumps throughout industry.

Materials: PC with *Solid Works 2005 Student Edition* installed.

Procedure:

- We are going to use SolidWorks to create the solid model of a centrifugal compressor wheel shown in the picture below.
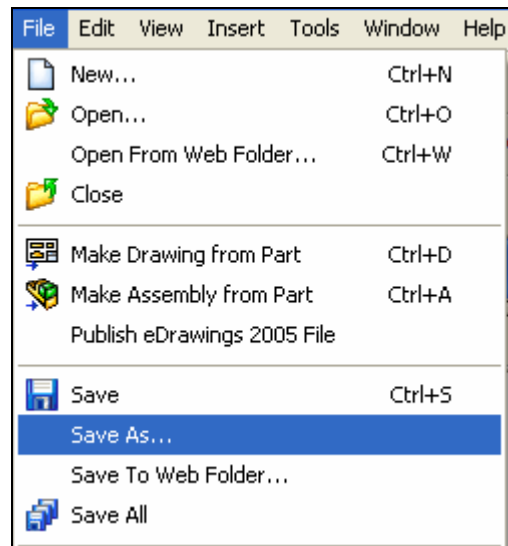 Follow the step-by-step instructions to successfully complete this lesson!
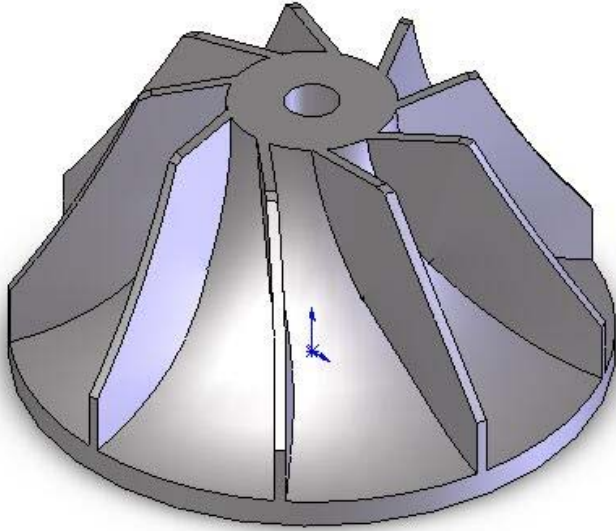
1. The first step is to open a New Part Document and save it with a unique file name.

   a. Open a new file by clicking on the New Icon or go to the File Menu and select New.
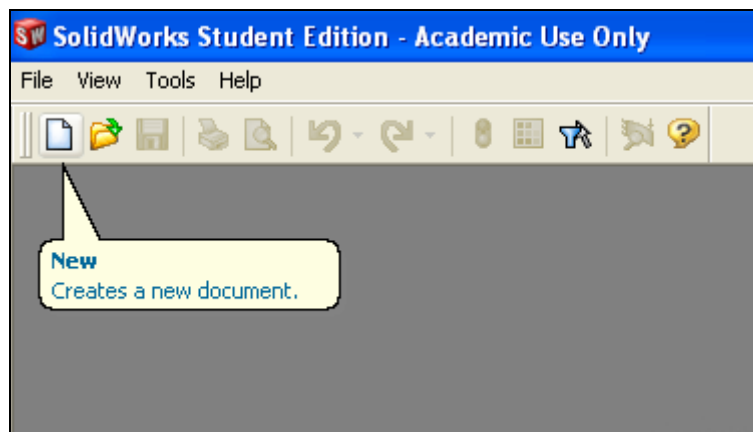
b. Select a New Part Document and click Ok.

Part	a 3D representation of a single design component
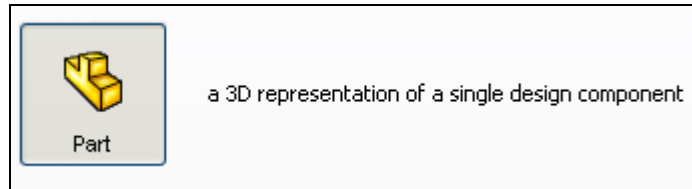
c. Save the file as "compressor wheel + your last name."
   Select the Save Icon on the Standard Toolbar and save the document.

File	Edit	View	Insert	Tools	Window	Help

New...   Ctrl+N
Open...   Ctrl+O
Open From Web Folder...   Ctrl+W
Close

Make Drawing from Part   Ctrl+D
Make Assembly from Part   Ctrl+A
Publish eDrawings 2005 File

Save   Ctrl+S
Save As...
Save To Web Folder...
Save All

2. In the second step, we are going to create the base feature using the Revolved Boss/Base feature. The base feature will consist of the profile of the compressor wheel without any of the blades on it.

a. First, create a 2D sketch on the Front Plane.

Sketch
Creates a new sketch, or edits an existing sketch.

Compressor Wheel
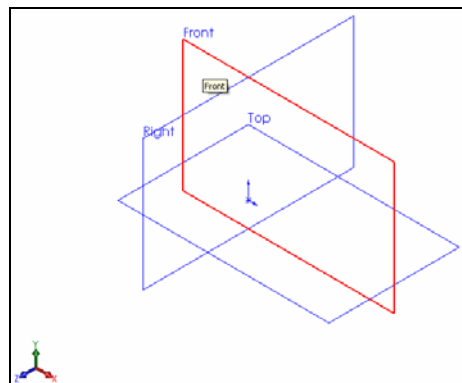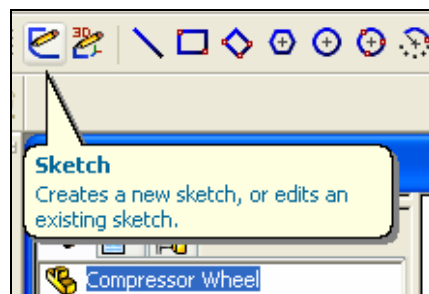
b. Sketch the 2-D geometry pictured below on the Front Plane.
    Draw a Construction Line down the center of the Y-Axis. The
    Construction Line will be used as an "Axis of Revolution" for the profile to
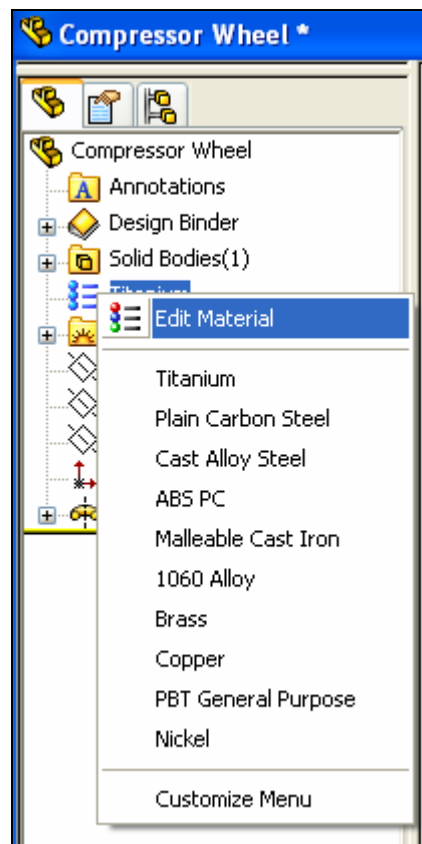   revolve around.
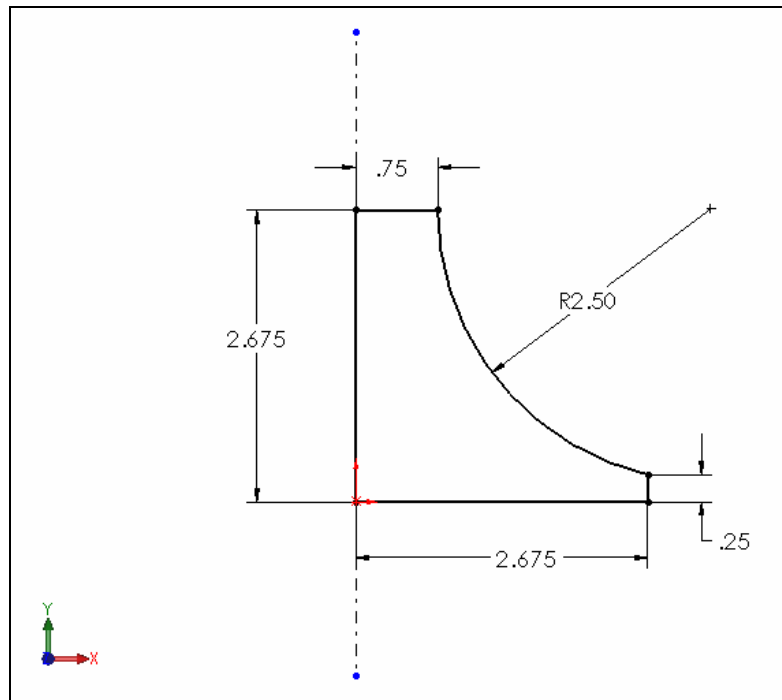
c. Select Revolved Boss/Base from the Features Toolbar.

d. Revolve the profile 360° around the Axis of Revolution.
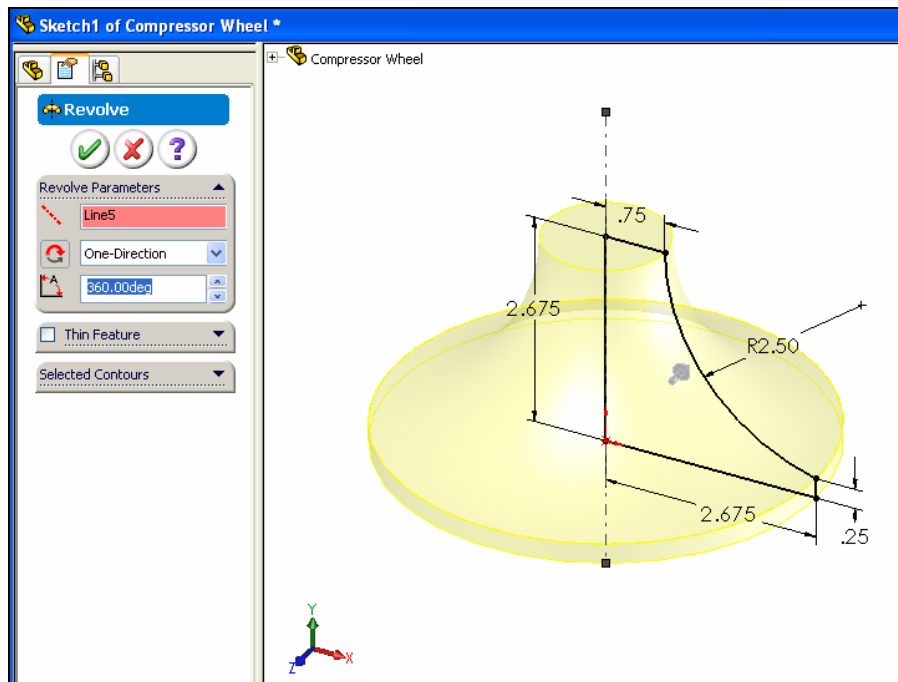
e. Change the compressor wheel's material type to titanium. Right click on the Material Icon in the design tree and select Edit Material. Select titanium as the material for the compressor wheel.

f. Press the space bar to bring up the Orientation Window and select
    Isometric View. Or you can use the "Isometric" Icon in the View Toolbar.
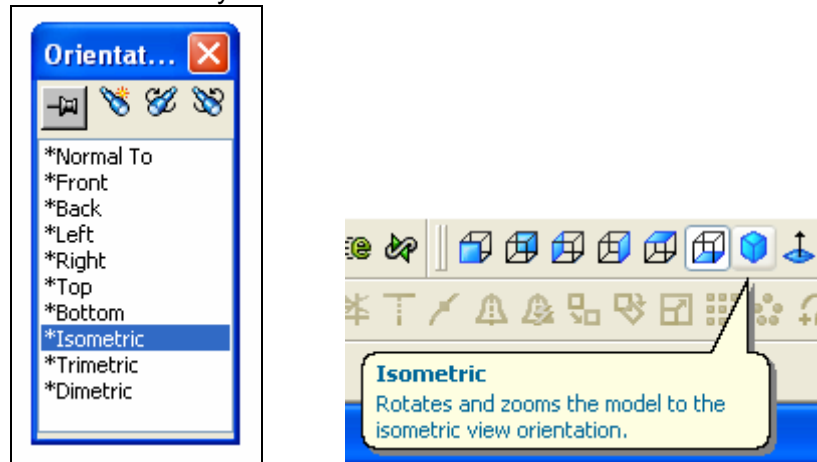
g. Click on the Zoom to Fit Icon in the View Toolbar.
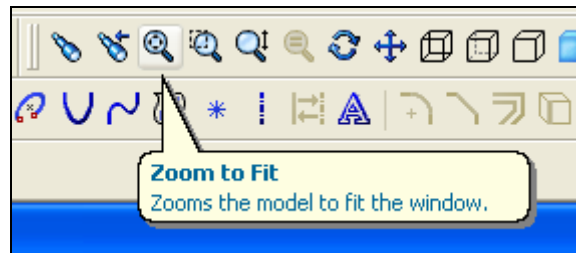
h. Upon completion of Step #2 your solid model should look like the one in
    the picture below.
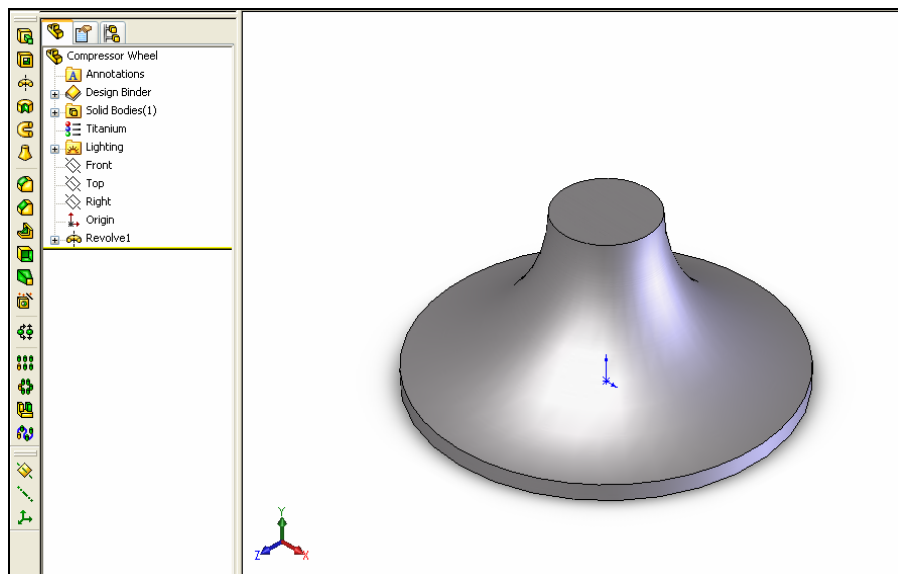
3. The next step involves creating the compressor blade shape on the wheel. We are going to use the Swept Boss/Base command in the Features Toolbar to create the blade shape. The Swept command requires a sketch of a profile and a path to follow.

   a. We are going to sketch the blade profile on the bottom of the compressor wheel's base. Press the space bar to bring up the View Orientation window. Select the Bottom View.
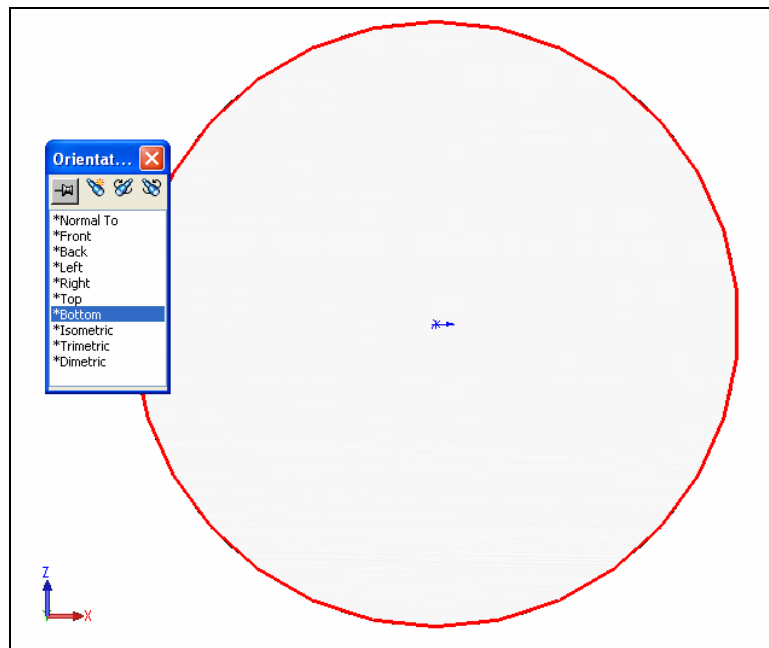
   b. Create a 2D Sketch on the bottom of the compressor wheel.

   c. Sketch the blade profile geometry as seen in the picture below.
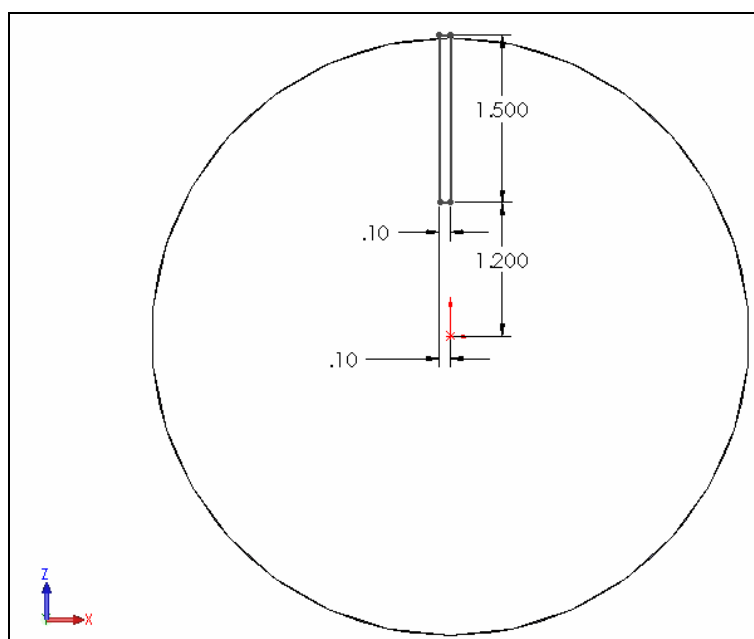
d. Exit the blade profile sketch by clicking on the 2D Sketch Icon.

e. Name the 2D Sketch "Blade Profile" by right clicking on the 2D Sketch in the design tree and selecting Properties.
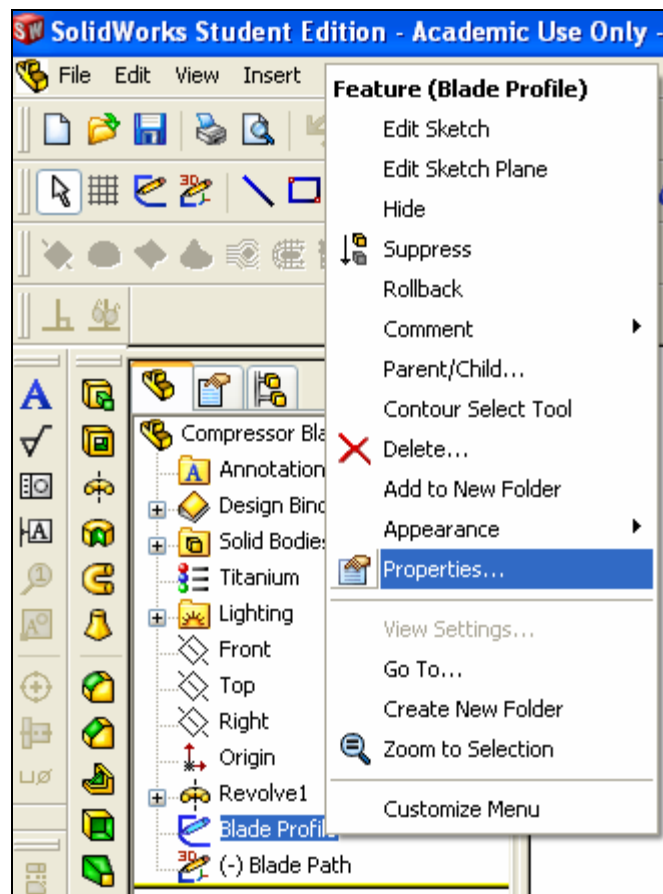
f. Now, we are going to draw the path for the Swept Boss/Base command using a 3D Sketch.

g. Select Isometric View from the Orientation Window.
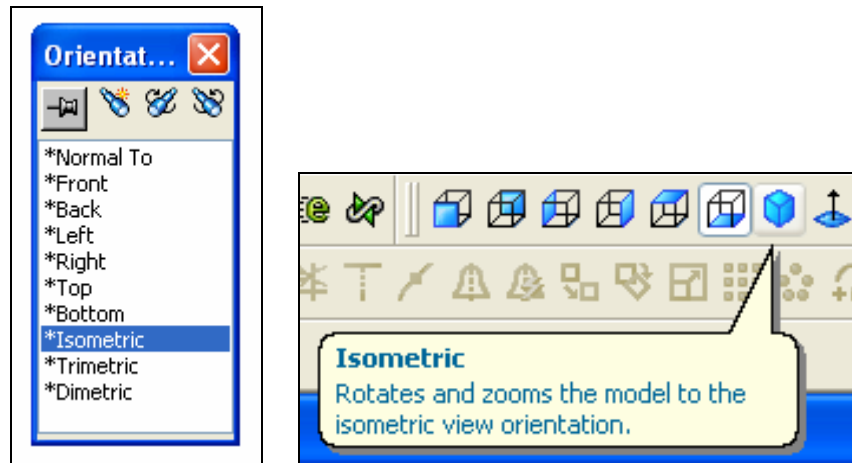
h. Create a new 3D Sketch.
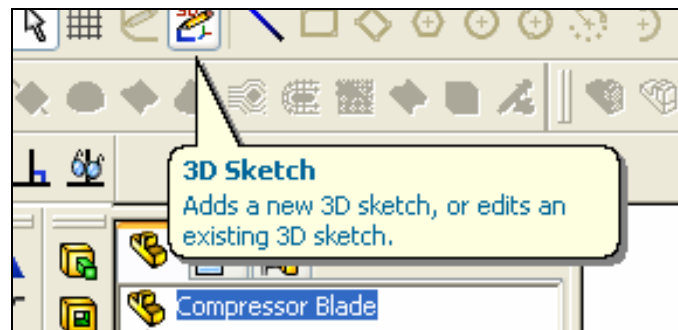
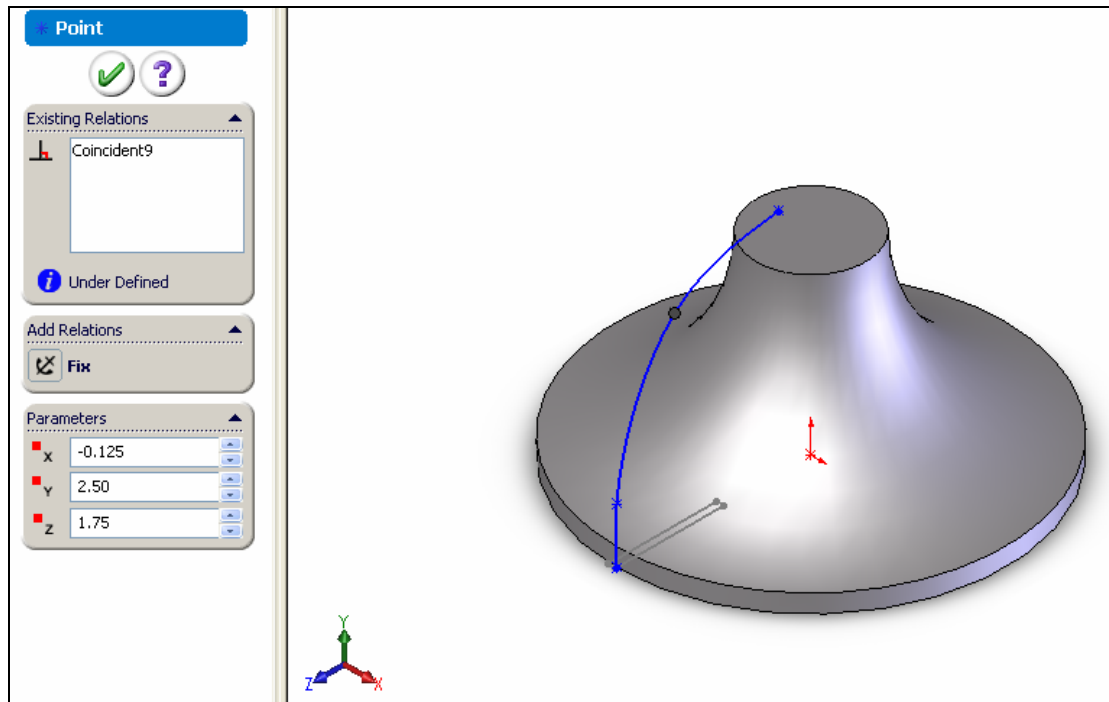i. We are going to use the Point Icon to sketch four points in space for our spline path to follow.
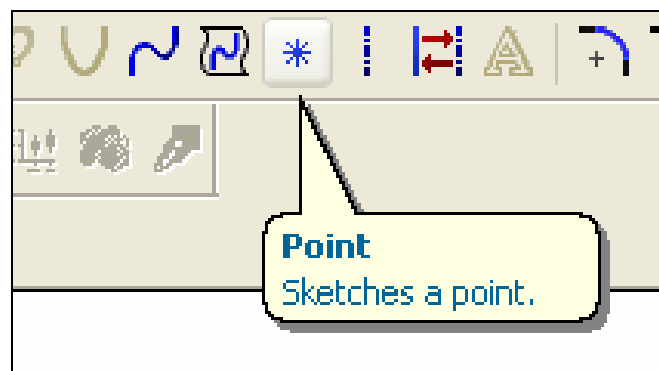
j. Place the first point at X = 0, Y = 0, and Z = 2.675. After initially placing the point, you can type the point coordinates in the point window.
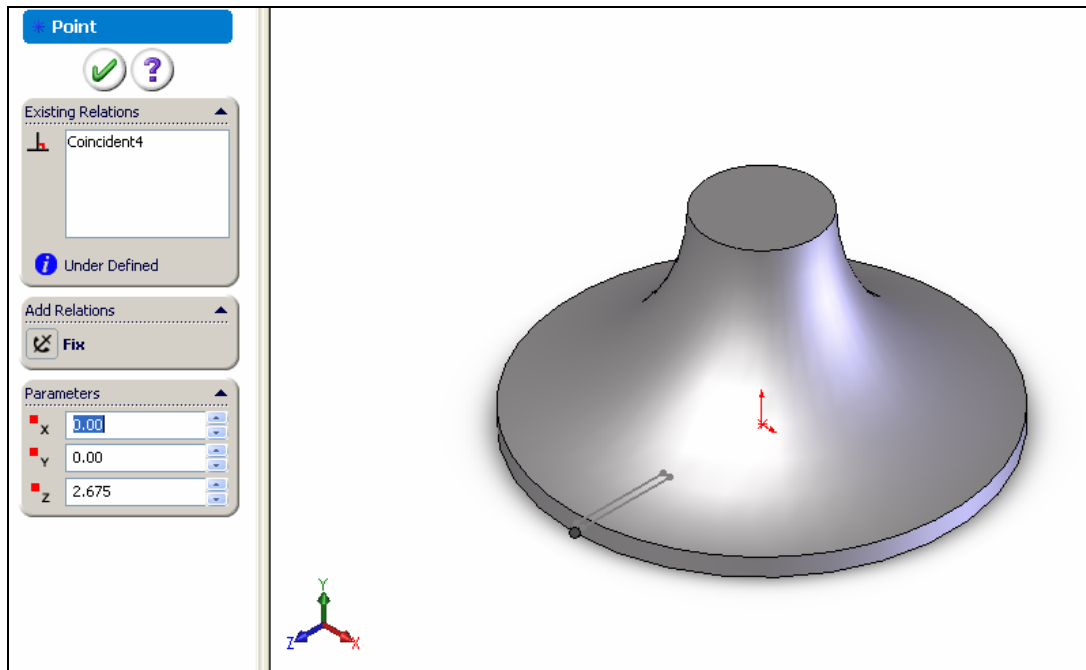
k. Place the second point at X = 0, Y = 0.75, and Z = 2.675.
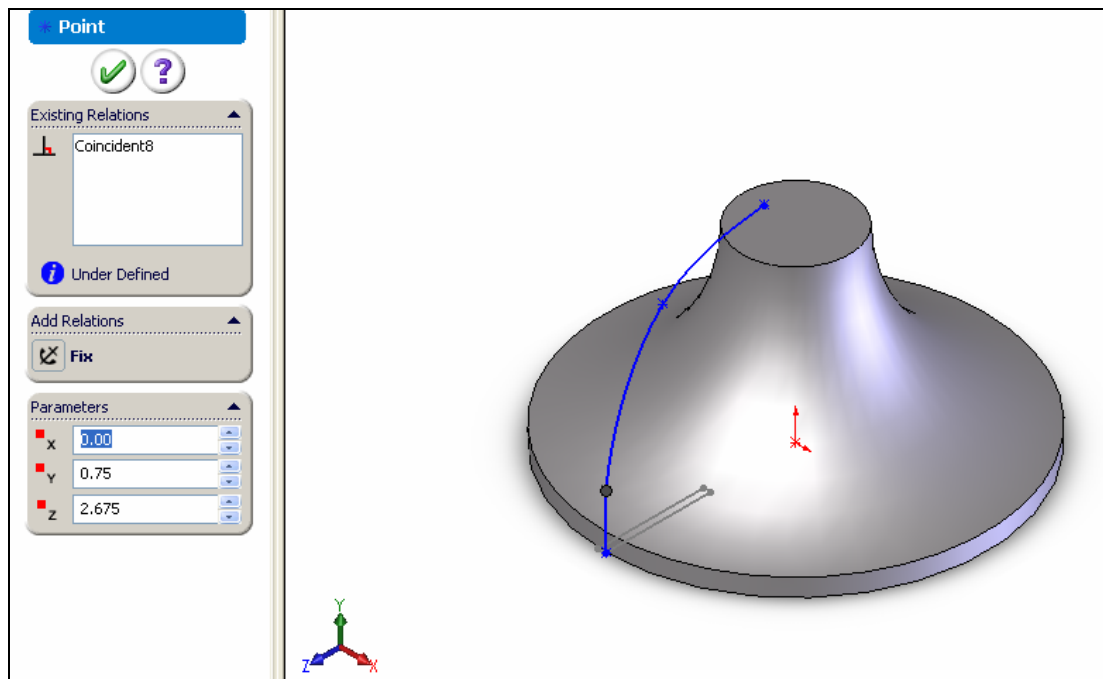
l.   Place the third point at X = -0.125, Y = 2.50, and Z = 1.75.

m. Place the fourth point at X = -0.125, Y = 2.50, and Z = 1.75.
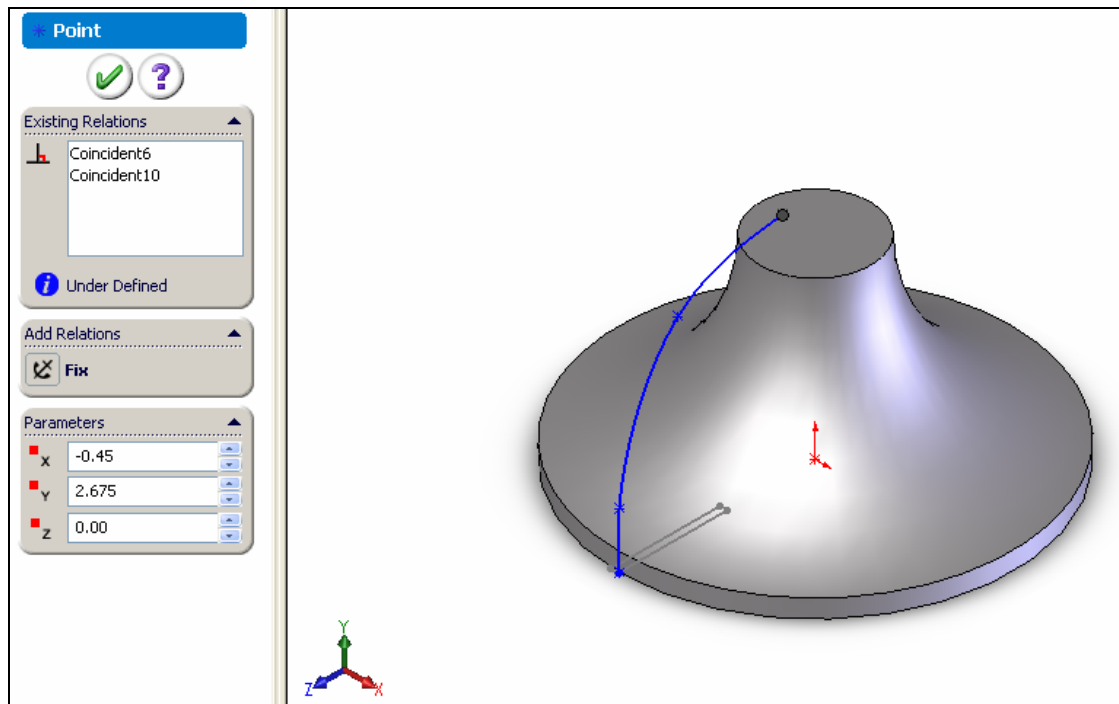
n. Use the Spline Icon to create a spline which connects the four points.
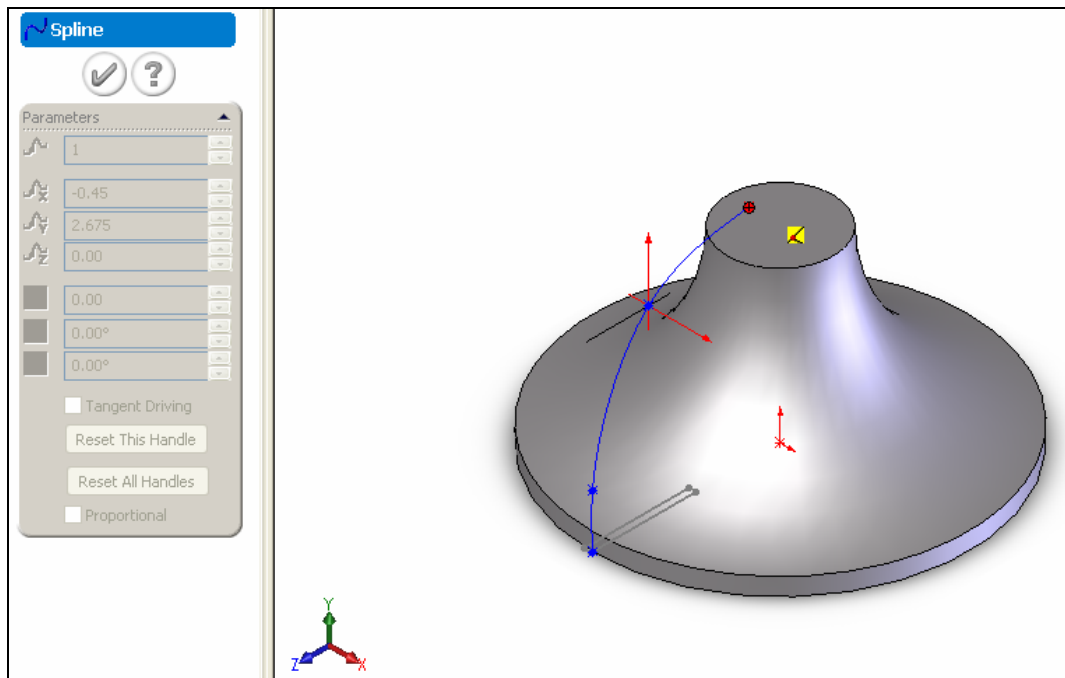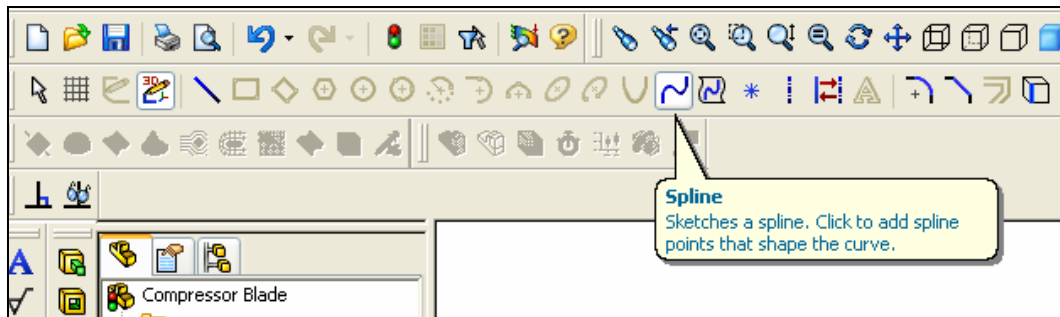
o. Exit the 3D Sketch by clicking on the 3D Sketch Icon.

p. Name the 3D Sketch "Blade Path" by right clicking on the 3D Sketch in the design tree and selecting Properties.
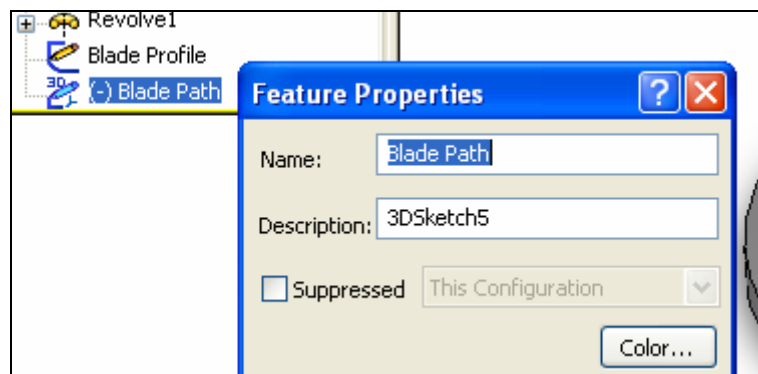
q. Now we are going to create the blade. Select the Swept Boss/Base in the Features Toolbar.

r. Use blade profile sketch as the sweep's profile and the blade path sketch as the path and click on Ok.
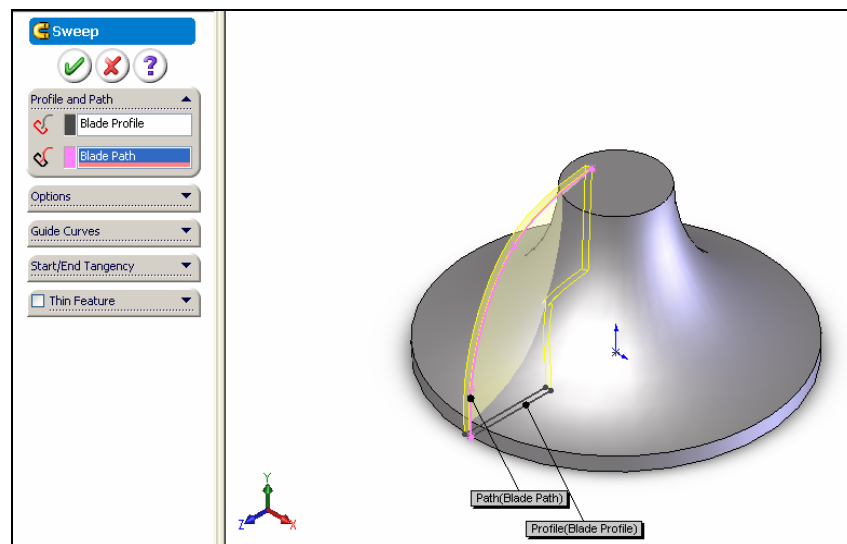
s. Upon completion of this section, your model should look like the picture below.
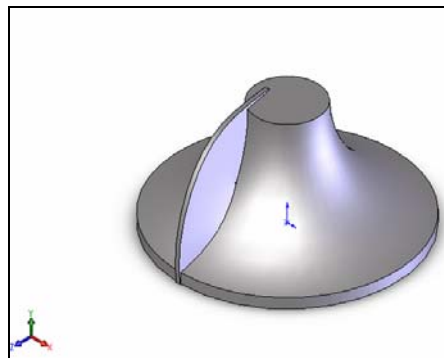
4. The next step involves creating a circular pattern for the compressor wheel's blades to revolve around. We are going to create a small cutout in the center of the wheel in order to have an axis to revolve the Circular Pattern around. Furthermore, we will use the Circular Pattern to create the rest of the blades in the compressor wheel.

   a. Create a 2D Sketch on the compressor wheel's top plane.
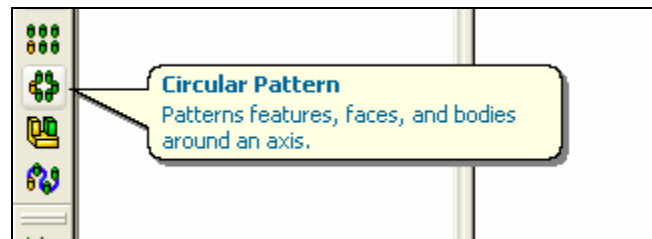
   b. Draw the 2D Sketch geometry as pictured below.
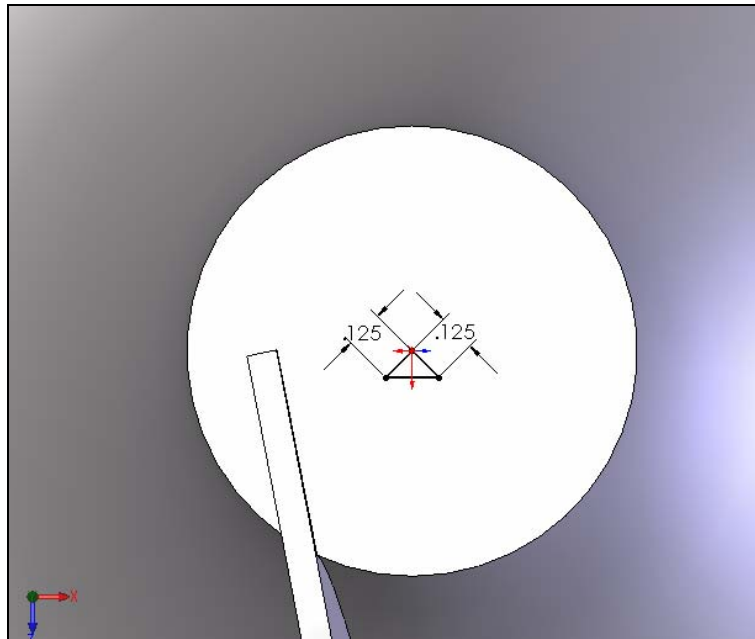
   c. Create the cutout by selecting Extruded Cut from the Features Toolbar.
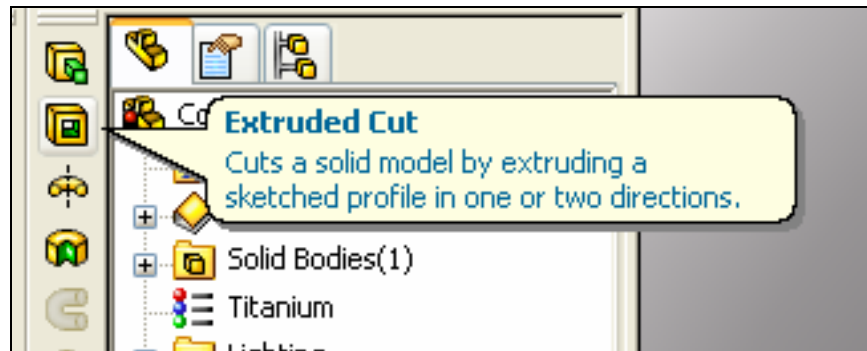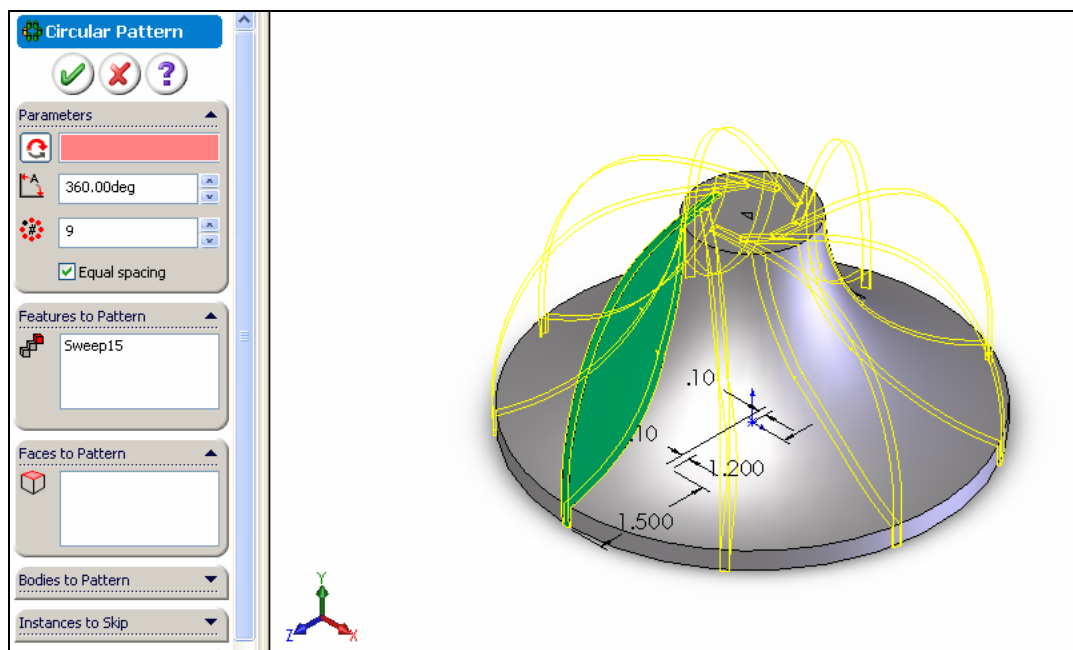
d. Cut the 2D Sketch out using the "Through All" option and click on Ok.
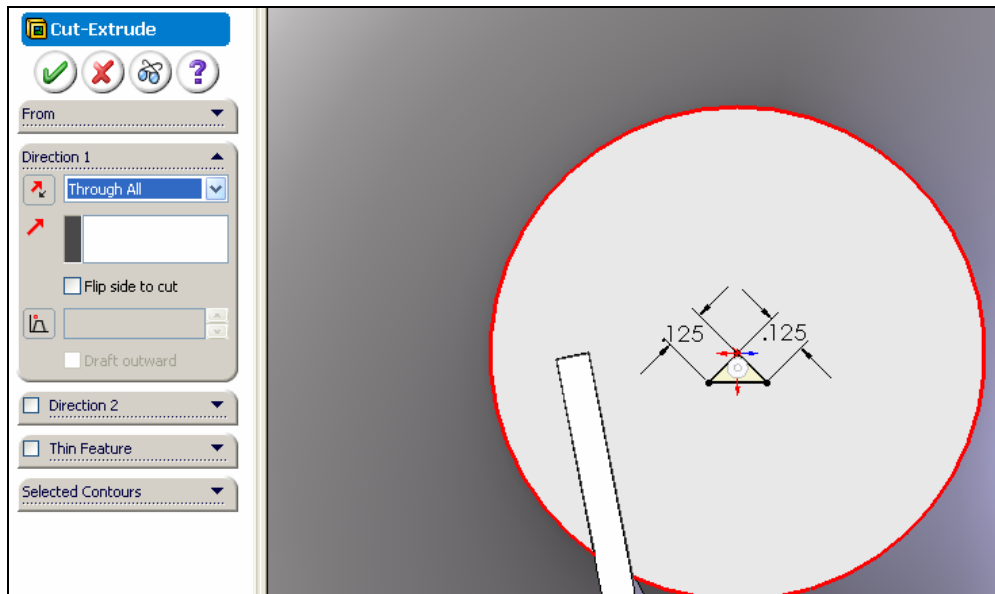
e. Once the cutout is complete, select the Isometric View Icon in the Orientation Toolbar.

f. Next, Select the Circular Pattern Icon on the Features Toolbar.

g. Select the blade extrusion as the feature to pattern. Furthermore, key in 9 instances for the feature to pattern around 360º.

h. Select the top edge of the triangle cutout, the edge that is coincident with the center of the compressor wheel, as the pattern axis edge. Finally click on Ok.
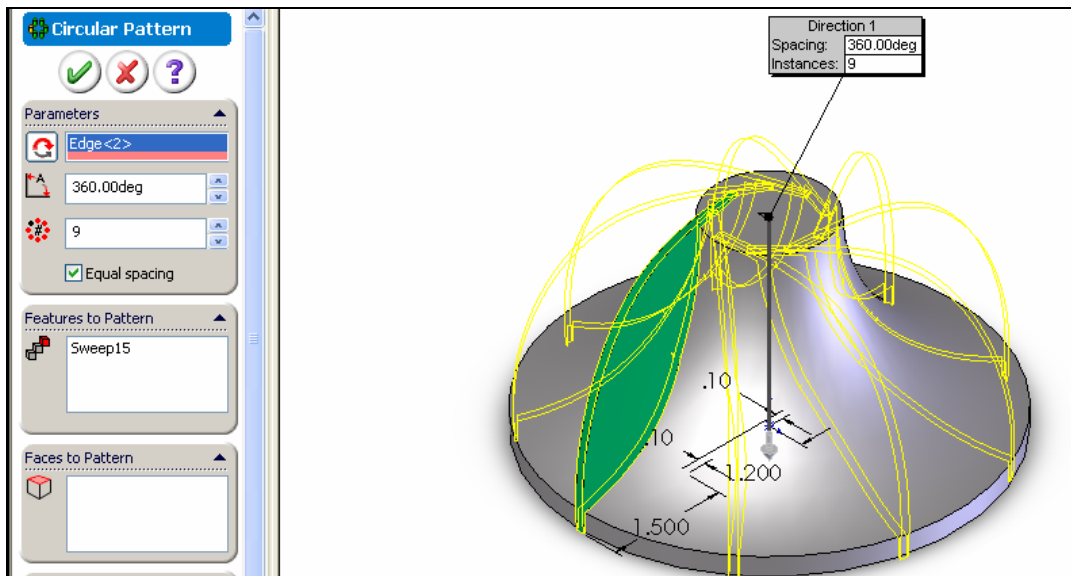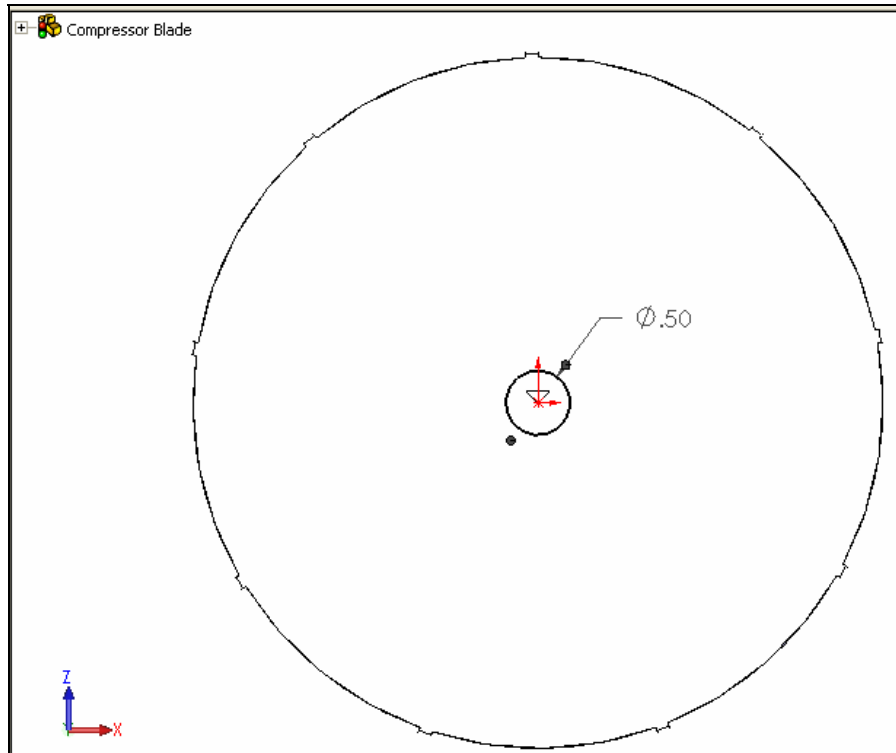

i. Upon completion of this section, your model should look like the one pictured below.
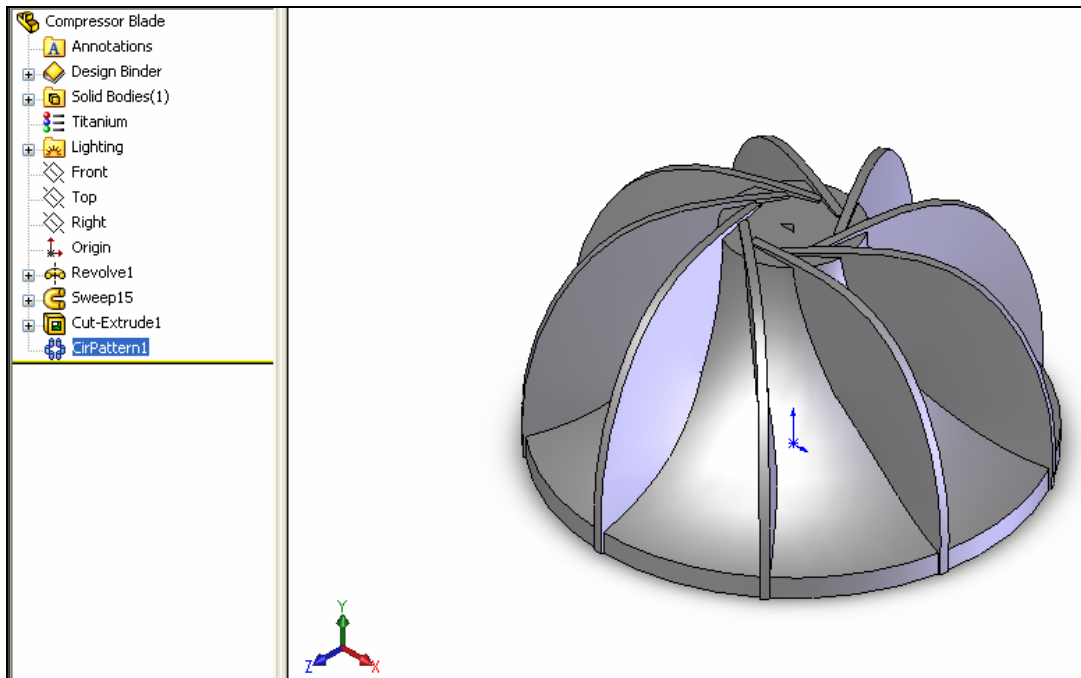
5. In this section we are going to create the hole in the center of the compressor wheel for a shaft to attach to.

    a. Select the Bottom View from the Orientation Toolbar.

    b. On the bottom of the compressor wheel, create a 2D Sketch using the geometry pictured below.

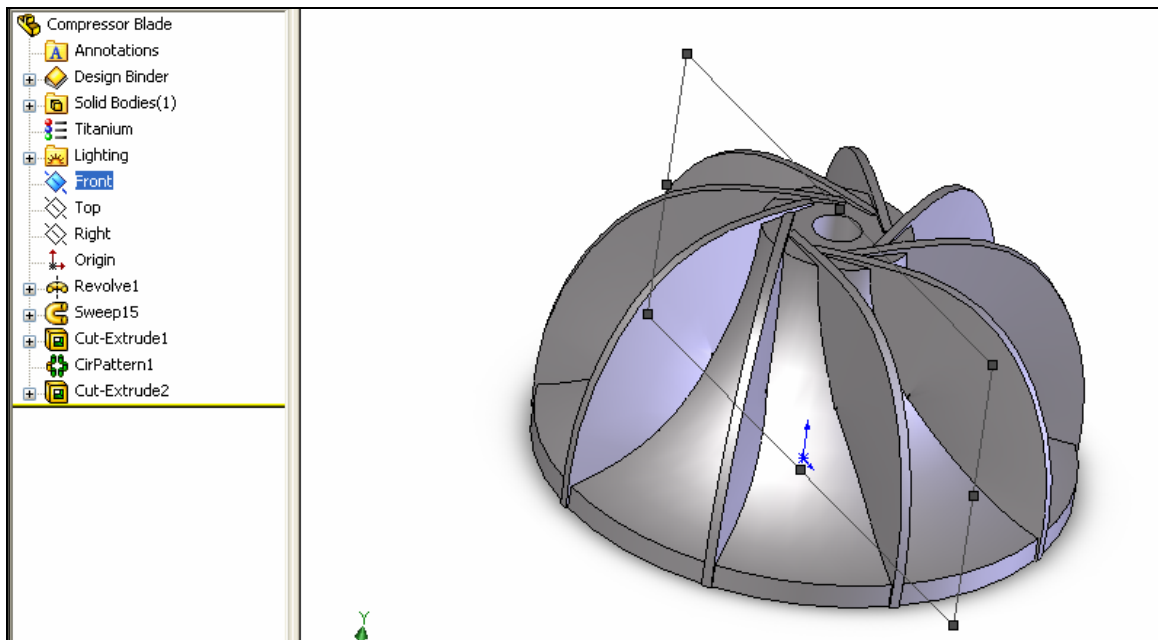   c. Create a cutout by selecting Extruded Cut from the Features Toolbar.
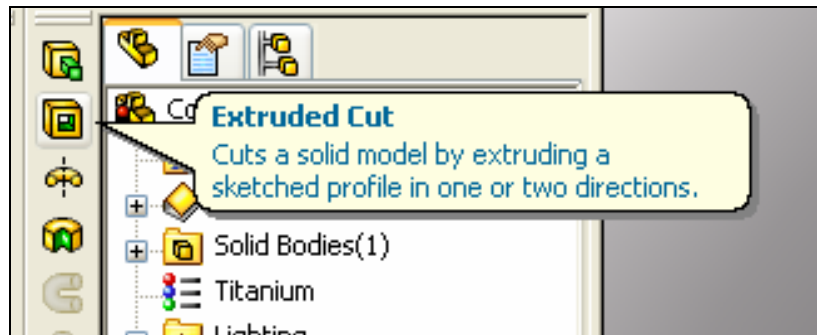
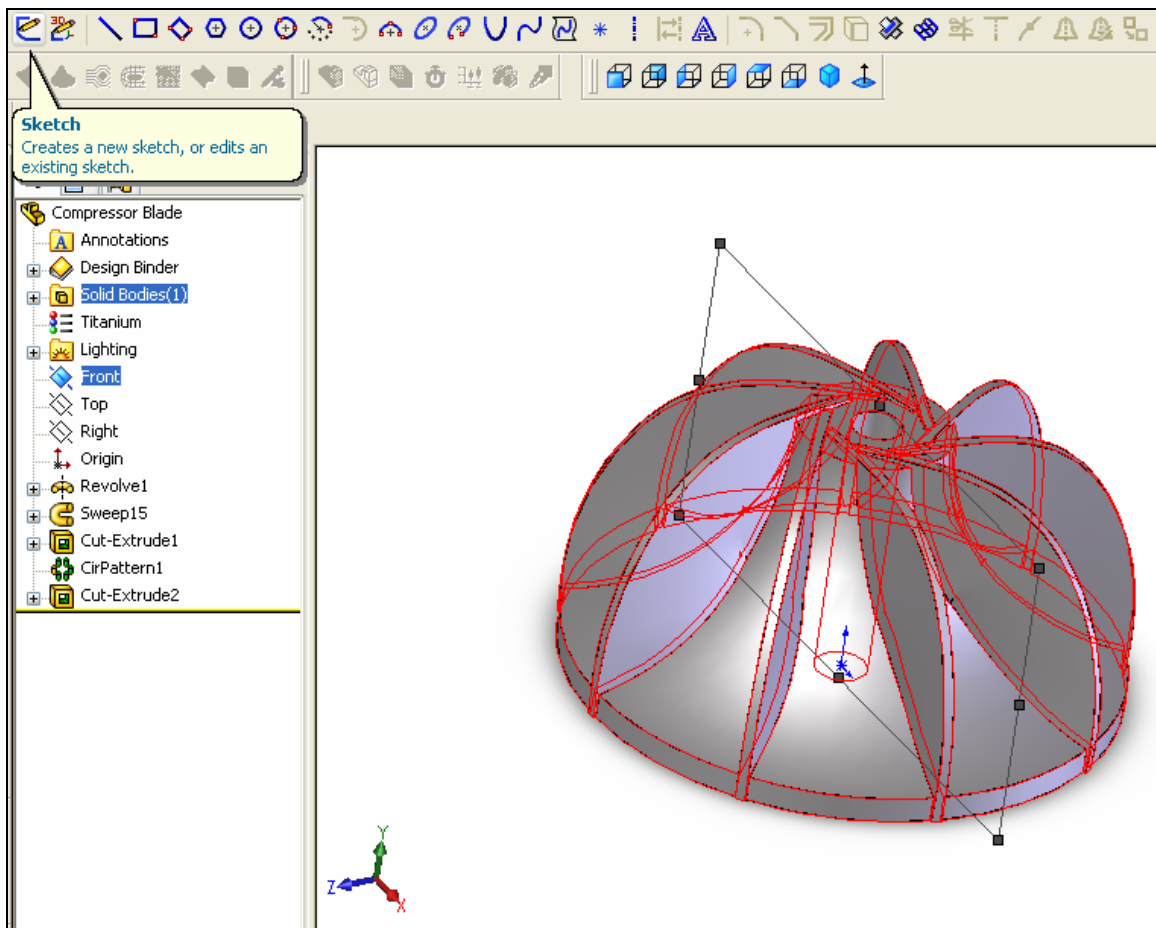d. Cut the 2D Sketch out using the "Through All" option and click on Ok.
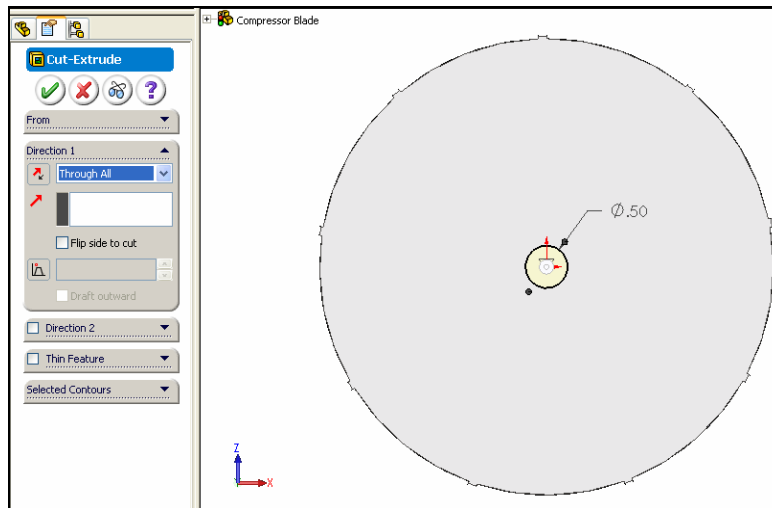
6. The final step is to use the Revolved Cutout tool to refine the compressor wheel's blade profile.   The Revolved Cutout will remove excess material from the compressor wheel.
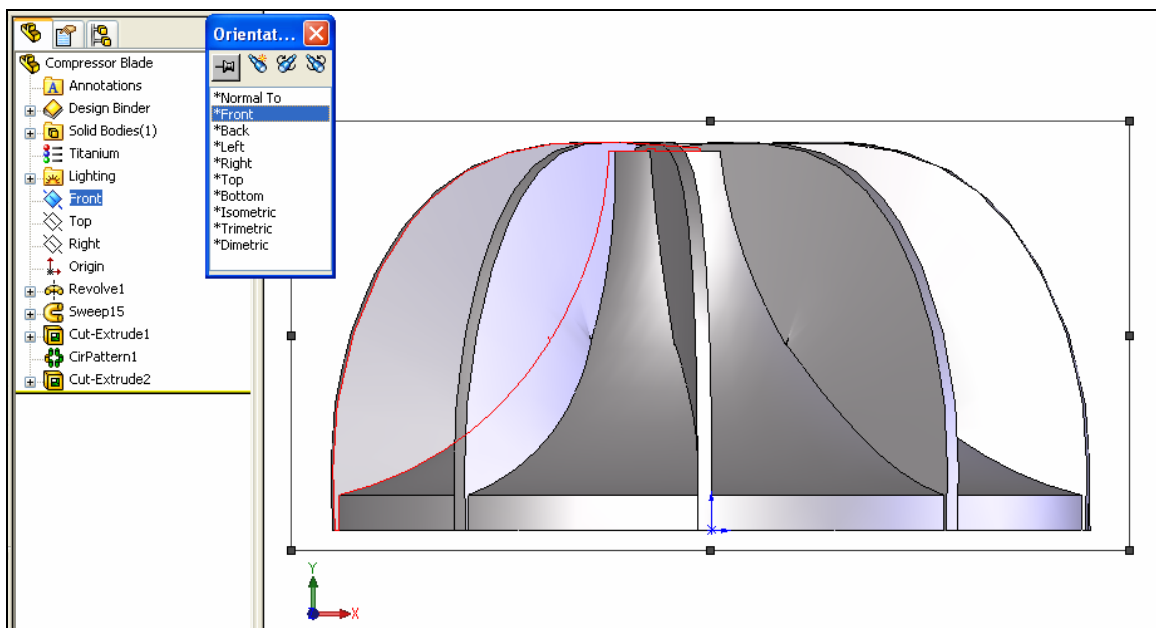
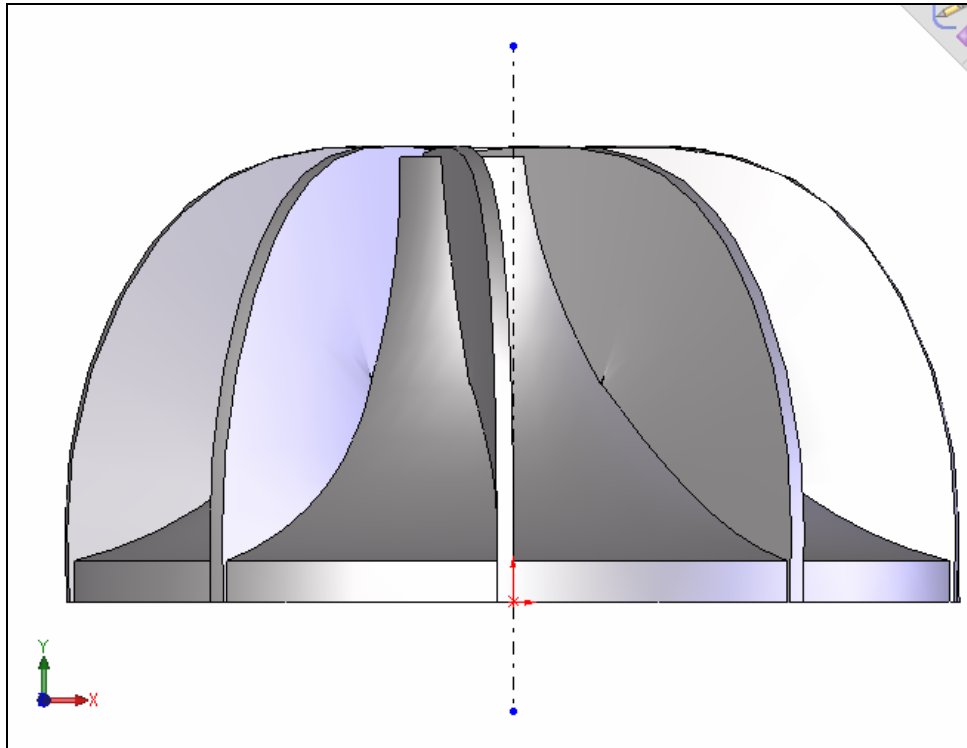a. Select the Front Plane in the design tree.

b. Select the 2D Sketch Icon to start a sketch on the Front Plane.
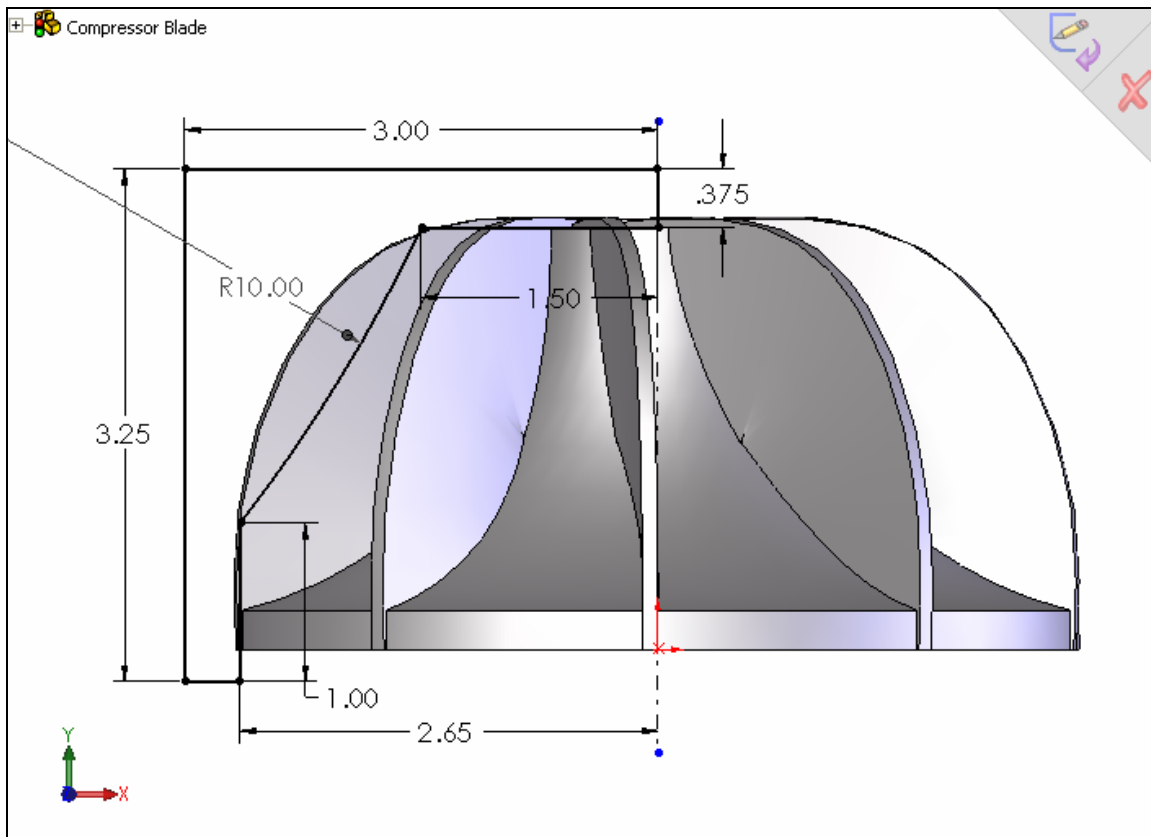

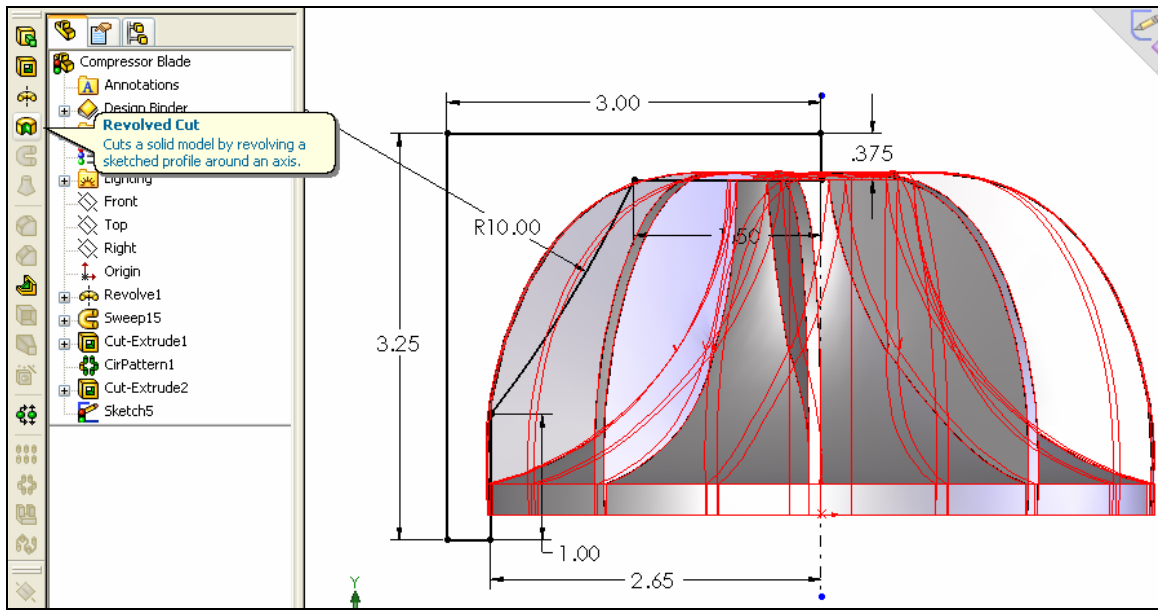c. Select Front View from the Orientation Toolbar or Window.

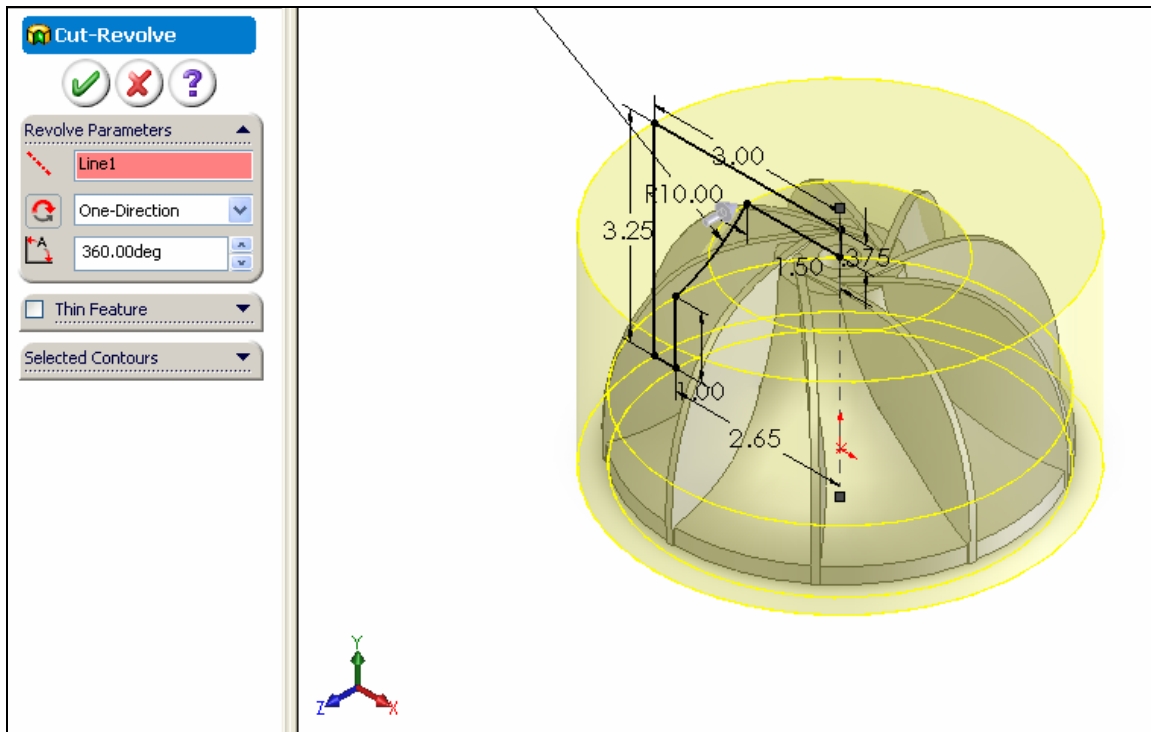d. Draw a Construction Line through the center of the part.

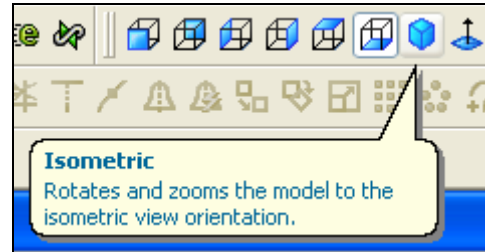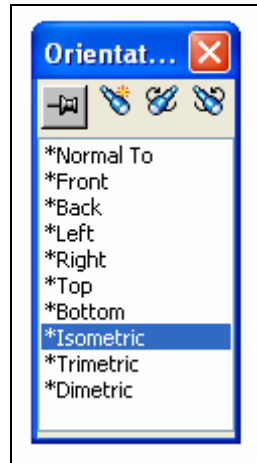e. Draw the 2D sketch geometry as pictured below.

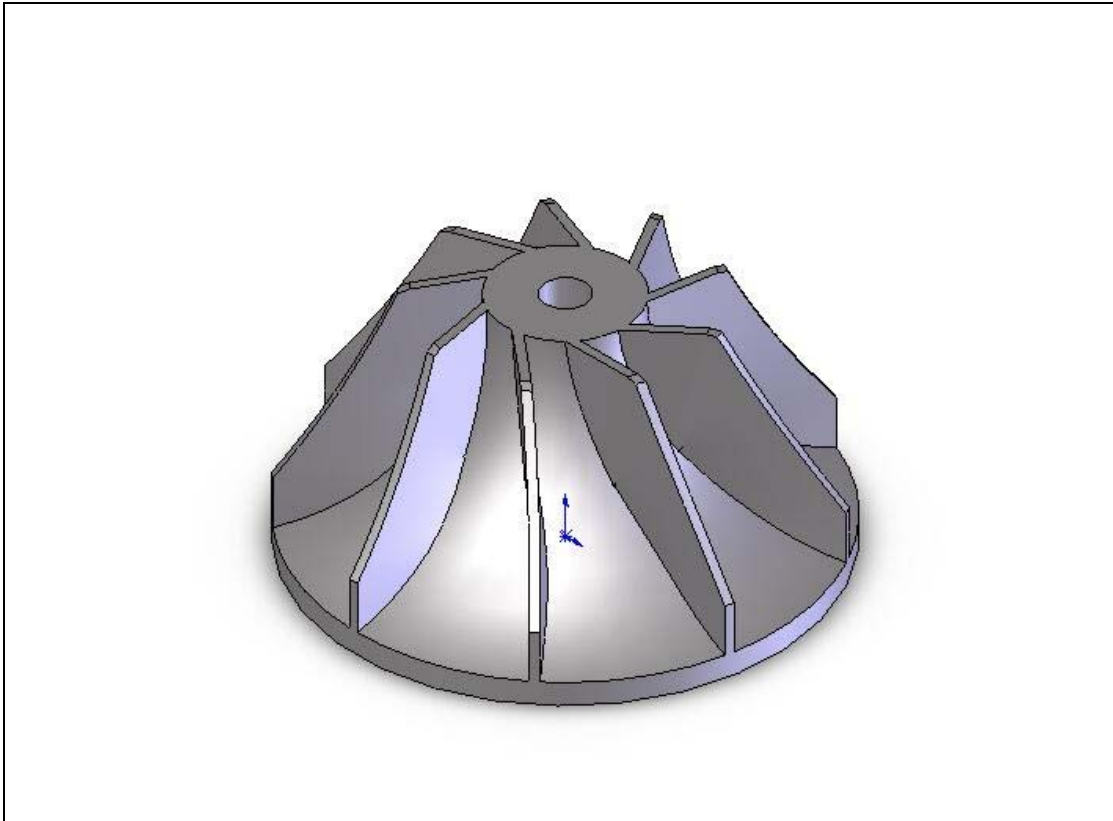f.   Select Revolved Cutout from the Features Toolbar.

g.   Revolve the 2D Sketch around the Construction Line 360° and select Ok.

h. Select Isometric View from the Orientation Toolbar or Window.

i. Upon completion of this section, your model should look like the one pictured below.

7. Congratulations, you have successfully modeled a centrifugal compressor wheel!

Assessment: This is a hands-on lesson. The students should be graded on whether they were able to successfully complete this lesson.

Resources Used: Trian Georgeou's Dell Laptop, Solid Works 2005 Student Edition, and Microsoft Paint were used to make this lesson.

Copyrighted Materials: None