Geomagic Qualify

Complete Inspection – Turbine Blade

Quick Start Guide

About Geomagic, Inc.

The Company

Geomagic is a software company dedicated to removing the barriers between the physical and digital worlds, and ultimately to changing the way we think and communicate in 3D. From mass customization of consumer products to 3D-enabled web marketing, from replacement of physical inventories by digital inventories to reproduction on demand of human bones and teeth, the 3D information technology pioneered by Geomagic has the potential to touch – and improve – nearly every facet of human life. The company has developed a powerful enabling technology that provides Digital Duplication™ solutions for design and manufacturing today, and a 3D foundation for the future.

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Guide Release History

Version	Date	Revision
7	2004-Sep-30	Original Release

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Guide Description

Intended Audience

This guide is suited for any user who will be using the *Geomagic Qualify* product to perform digital inspections.

Guide Objective

Provide the user with a working knowledge of the commands and workflows that are used in the *Geomagic Qualify* product. This knowledge will allow the user to develop a process using *Geomagic Qualify* that is suitable for his or her company.

Prerequisites

None

Guide Length

N/A

System Information

All files referred to in this guide are found in the folder specified below.

Folder of downloaded files from training web site.

Definition of Terms

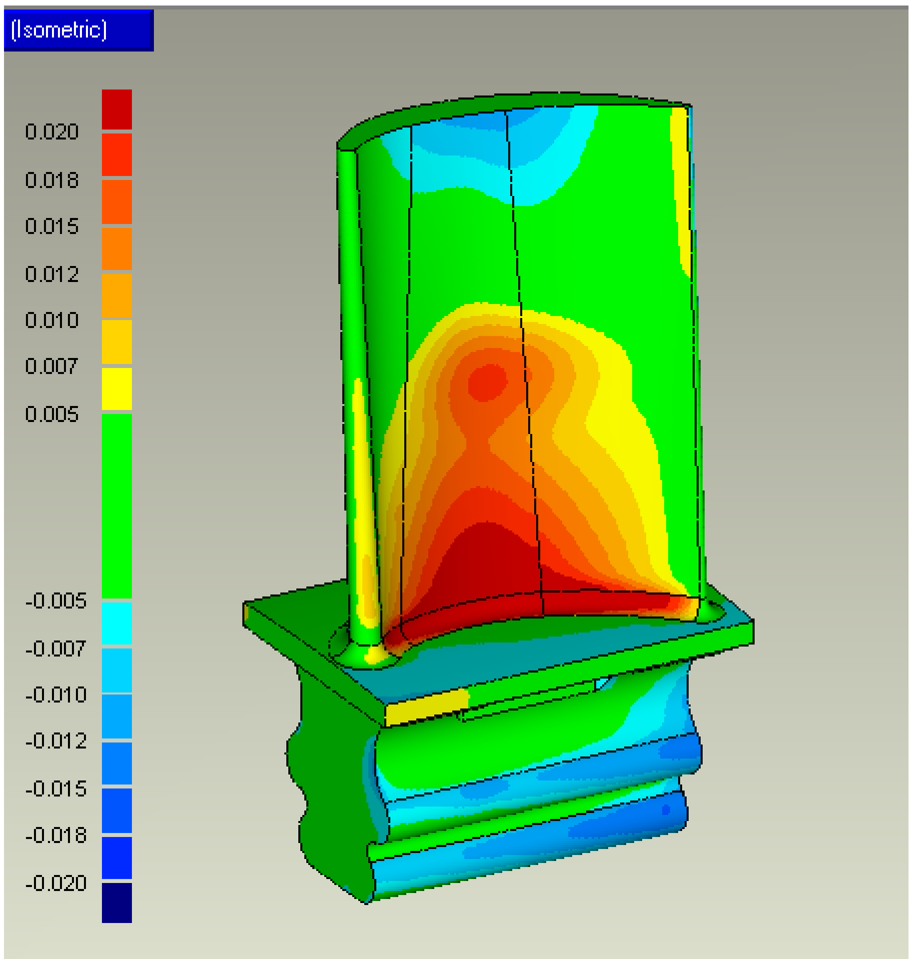
N/A

Introduction

This Quick Start Guide will cover the basic commands and workflow used in the *Geomagic Qualify* product when inspecting a turbine blade.

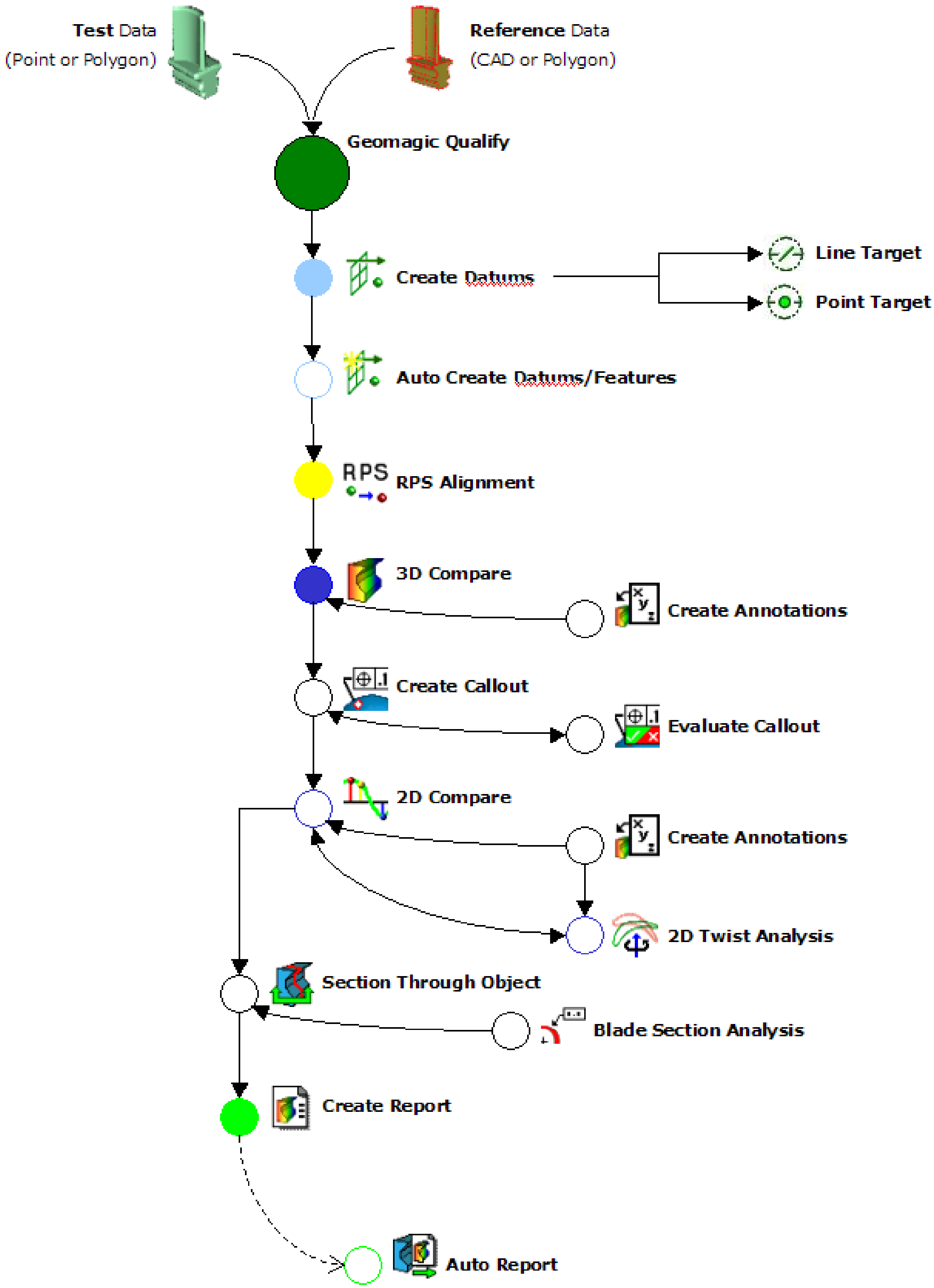
For more details on each command or function, please consult the on-line help by placing the cursor over the command in question and pressing F1.

For more tutorials on *Geomagic* products please visit the online training site at http://training.geomagic.com.



Turbine Blade displayed with Deviation Results

Geomagic Qualify Workflow



Turbine Blade Inspection

Objective

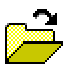
Learn how to align scan data of a turbine blade with a reference model using Line Target Datums and Point Target Datums. Use the Blade Section Analysis command to extract key characteristics of an airfoil cross-section. Determine blade twist at any given section height.

File

turbine_blade.wrp	Geomagic Qualify file containing all required data.

Defining Datums on Reference Object

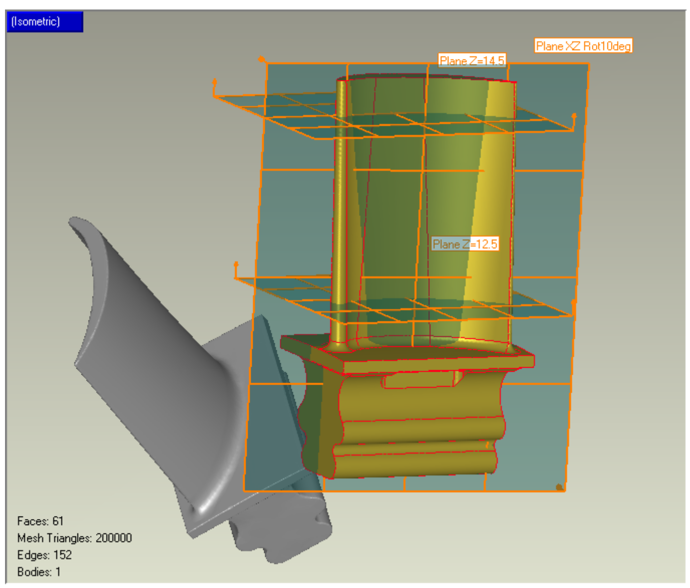
1. Open the sample file.



   a. Click **File > Open** or click the **Open File** icon.

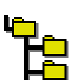
   b. Select **turbine_blade.wrp** from folder that file was saved in.

   c. Click **Open.** Model is displayed in the Viewing Area.



CAD Model and Scan Data in Viewing Area

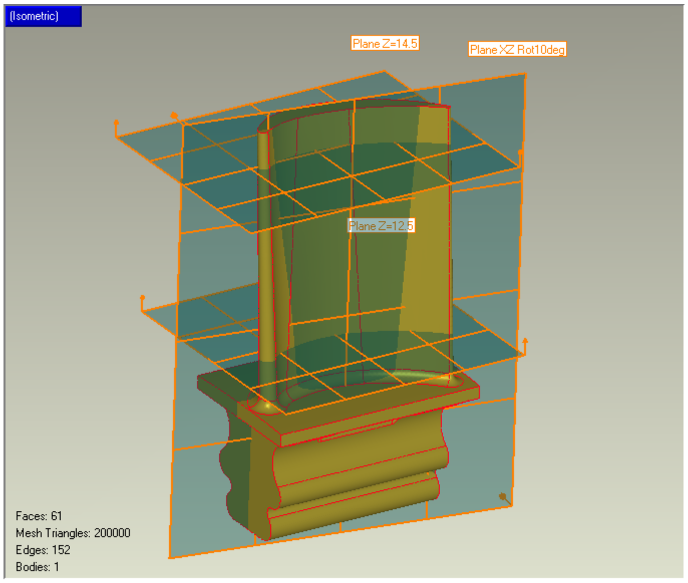
2. Make Reference object the active object in *Model Manager*.



   a. Click **Model Manager** tab so that model objects are available for selection.

b. Select **REF – Turbine_Blade-CAD** with cursor so that gold-colored reference object is displayed in the Viewing Area. Three datum planes have been predefined and saved with the model. These predefined datums will be used to construct the six target datums.

NOTE:
The Reference object can be a CAD object or a polygon object



CAD Model in Viewing Area

3. Define datums for alignment. This particular blade requires four line target datums and two point target datums for a proper six-point alignment.

a. Click **Tools > Datums > Create Datums**, or select the icon on the main toolbar.

b. Under **Datum Type**, click **Line Target**.

c. Under **Line Target Method**, click **Plane / Direction**.

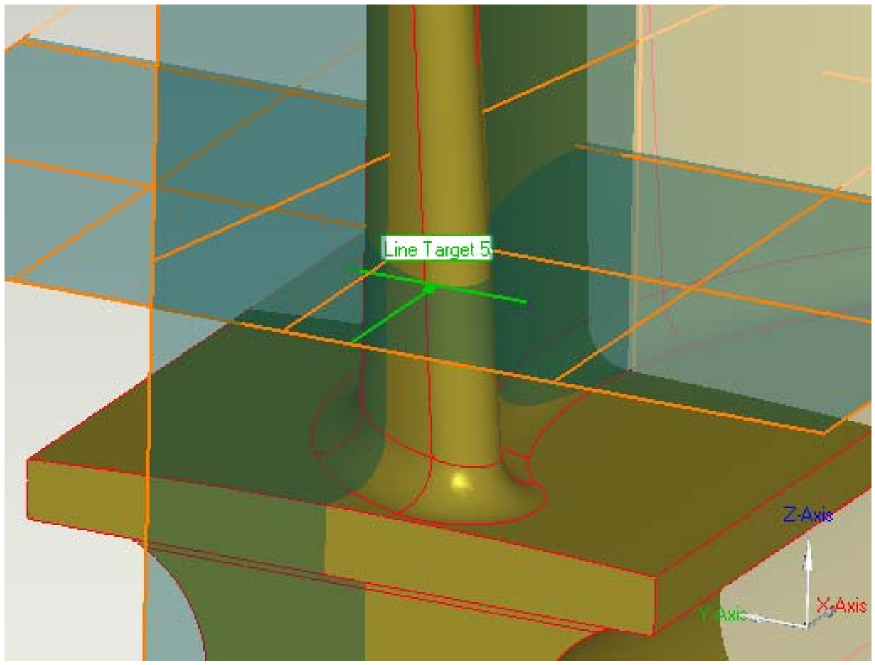
d. From the **Section Plane** dropdown menu, select the predefined datum labeled **Plane Z=12.5**.

NOTE: This plane is parallel to XY, at a height of Z=12.5 inches.

e. From the **Contact Direction** dropdown menu, select **X Axis.**

f. Click **Apply** button. A green line target datum is created *tangent to the surface*, *perpendicular to the X Axis* and in a plane *parallel to XY* at a *Z height of 12.5 inches*. This datum location and orientation is typically defined on the part drawing.

g. Click **Next** to save this datum and construct another.



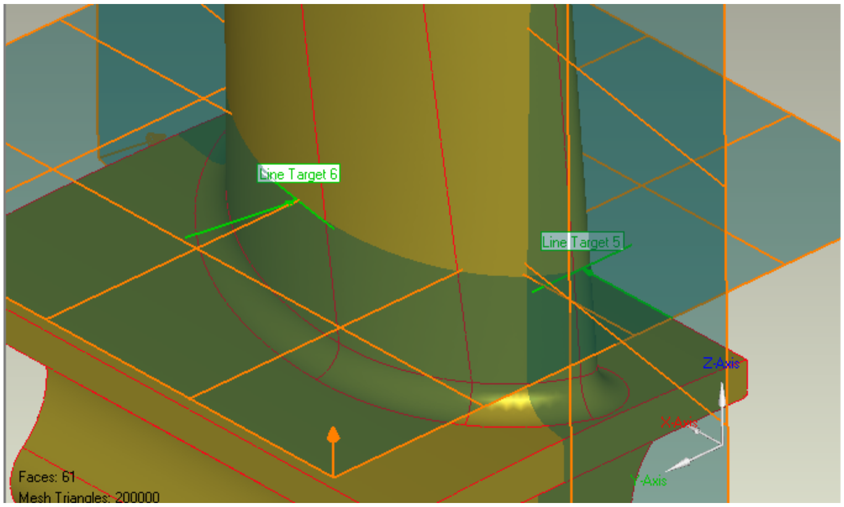
First Line Target

h. Change the **Contact Direction** dropdown to the predefined plane **Plane XZ Rot10deg Normal**.

NOTE: This predefined plane was created parallel to the XZ plane, and then rotated 10 degrees about the Z-axis.

i. Click **Apply**. A green line target datum is created *tangent to the surface*, *perpendicular to the normal of Plane XZ Rot10deg,* and in a plane *parallel to XY* at a *Z height of 12.5 inches*.

j. Click **Next** to save this datum and construct another.



Second Line Target

k. Change **Section Plane** dropdown to **Plane Z=14.5**.

l. Keep **Contact Direction** dropdown set to **Plane XY Rot10deg Normal**.

m. Click **Apply**. A green line target datum is created *tangent to the surface*, *perpendicular to the normal of Plane XZ Rot10deg,* and in a plane *parallel to XY* at a *Z height of 14.5 inches.*

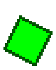
n. Click **Next**.

o. Keep **Section Plane** dropdown set to **Plane Z=14.5**

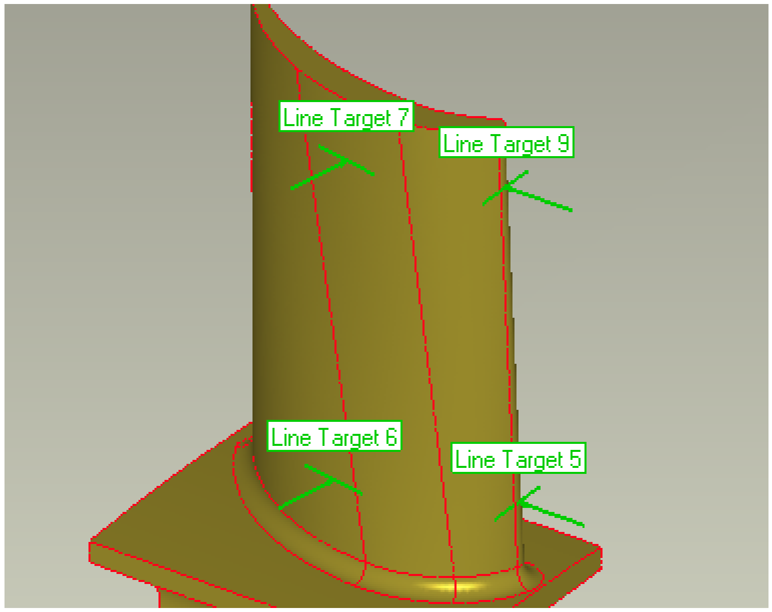
p. Set **Contact Direction** dropdown to **X Axis.**

q. Click **Apply**. A green line target datum is created *tangent to the surface*, *perpendicular to the X Axis,* and in a plane *parallel to XY* at a *Z height of 14.5 inches.*

r. Click **Next**.



s. From the toolbar at the top of the screen, select the Tog**gle Datum Planes** icon, or select **Tools > Datums > Toggle Datum Planes**. Your screen should resemble the image below, with four line target datums defined.



Four Line Target Datums

t. Under **Datum Type**, select **Point Target**.

u. Enter the following coordinates into the **X,Y,Z** box: 0.750, -0.050, 12.500.

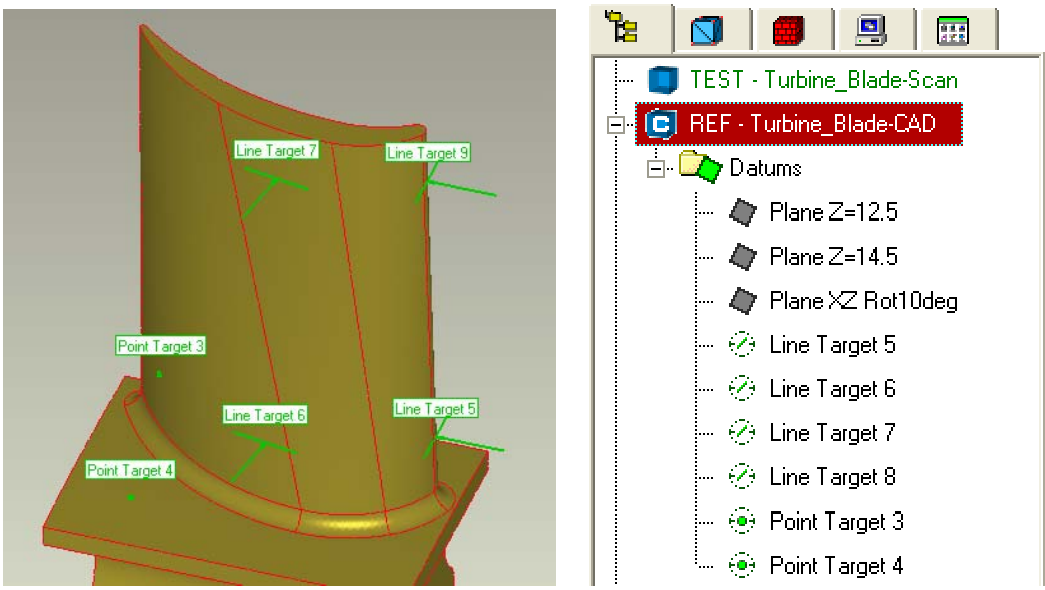
v. Click **Apply**. A target point is created at this spot on the model with a radius of .005 inches. If desired, change the radius and click Apply again to update.

w. Click **Next**.

x. Enter the following coordinates into the **X,Y,Z** box: 0.750, 0.500, 12.000.

y. Click **Apply**.

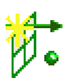
z. Click **OK** to exit the command.



After Creating Datums

Auto-Creating Datums on Test Object

4. Create a matching set of datums automatically on the Test object.

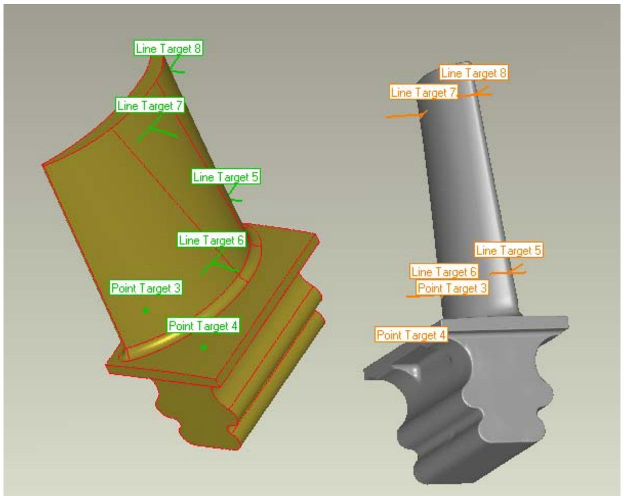


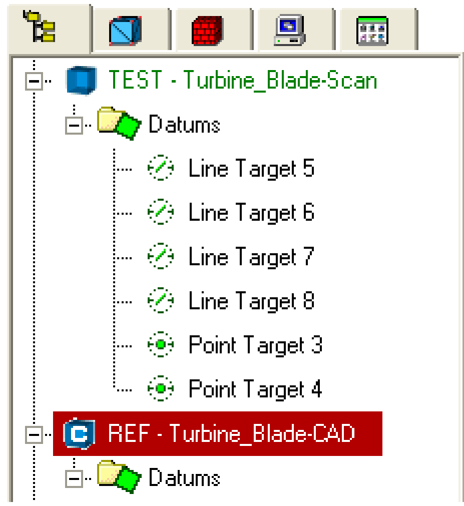
a. Click **Tools > Auto Create Datums/Features**, or click the icon on the main toolbar.

b. Toggle *on* **Perform Alignment**, and toggle *off* **Check Symmetry** and **Fine Adjustments Only**.

c. Click **Apply**. After several minutes, all six datums manually defined on the Reference object will be automatically created on the Test object.

d. Click **Done** to exit the command.





After Auto Create Datums

Aligning the Test Object to the Reference Object

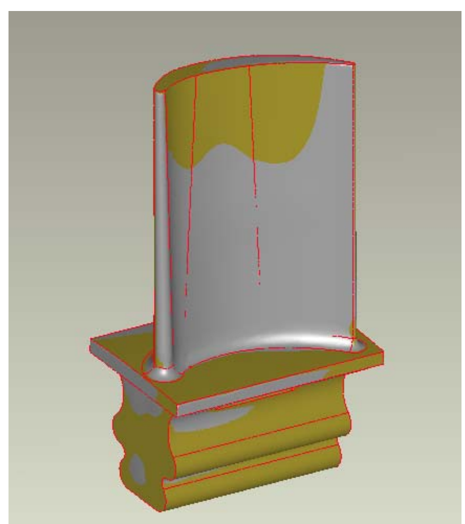
5. Use an iterative alignment technique to align the models.

a. Click **Tools > Alignment > RPS Alignment,** or click the icon.

b. Click the **Auto** button to automatically create pairs out of datums with matching names. The Auto button also automatically constrains each pair to only align in the datums' normal direction.

c. Click the **Align** button to begin an iterative alignment. After several minutes, the Statistics section of the dialog will update and should show zero deviation for each of the six pairs. The two models are now aligned. This alignment scheme simulates placing a manufactured blade in a physical fixture with four lean bars and two pins.

d. Click **OK** to exit the command.



After Alignment

Creating the Result Model

6. Create a color-mapped Result model to display deviations between the models.

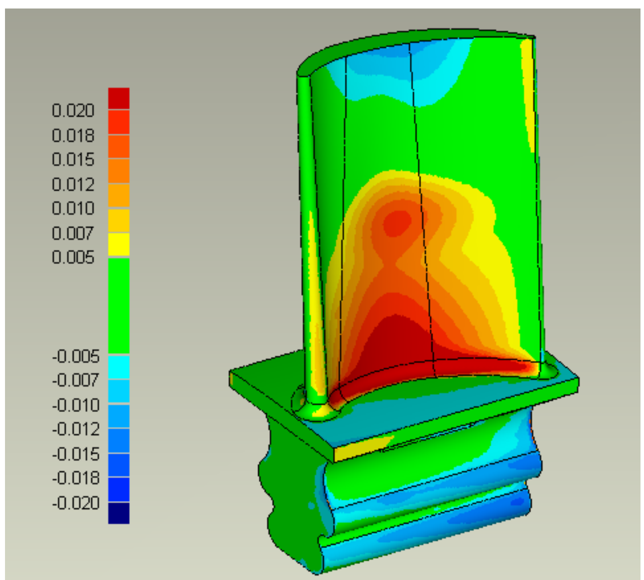
   a. Click **Analysis > 3D Compare**, or click the icon on the toolbar.

   b. Click **Apply** to being the comparison. After a few minutes, a color-mapped model will appear.

   c. When calculation is complete, override the default spectrum values by entering **.020** in the **Max. Positive** field and hitting the **Enter** key on the keyboard. Colored model will update accordingly.

   d. Enter **0.005** for the **Min. Positive** field and hit **Enter** on keyboard.

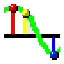
   e. Click **OK** to exit the command.



Result Model

Creating a 2D Whisker Plot

7. Create a 2D Compare section.



   a. Click **Analysis > 2D Compare**, or click the icon on the toolbar.

   b. Under **Type**, click **Planar Deviation**.

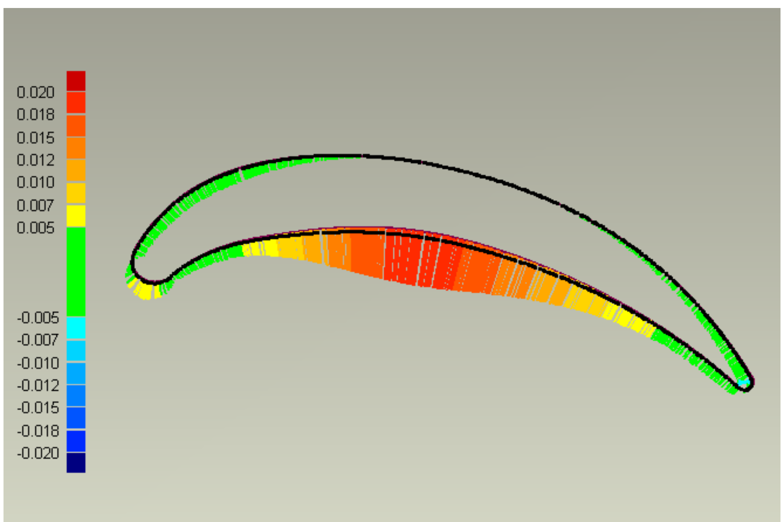
   c. From the **Align Plane** dropdown menu, select **System Plane**, and then from the dropdown menu beneath that, select **XY-Plane**.

   d. Enter a **Position** value of **13.0 in**. This indicates we are going to section the model at a plane parallel to XY at a Z height of 13 inches.

   e. Click **Compute**.

   f. Move the slider wheel under **Scale** to approximately **10.0**. This will exaggerate the length of the whiskers, enabling a better view of which portions of the cross-section deviate the most.

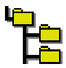
   g. Click **OK** to exit the command.



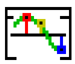
2D Comparison Section

Determining Blade Twist at a Cross-Section

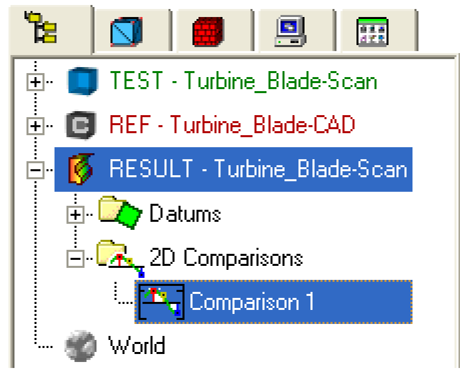
8. Select the section to be analyzed in the Model Manager.



a. In the **Model Manager**, expand the **2D Comparisons** folder under the Result object.



b. Click on the object called **Comparison 1** in the **2D Comparisons** folder. This will display the 2D whisker plot view.



9. Determine the amount of twist in the blade at this section.

a. Click **Analysis > 2D Twist Analysis**.

NOTE: You can place the icon for this command on the main toolbar by customizing the interface. See the Help menu to learn how.

b. Leave the three checkboxes under **Constrain Movement** unchecked, so that the section will be free to rotate and translate as much as is needed.

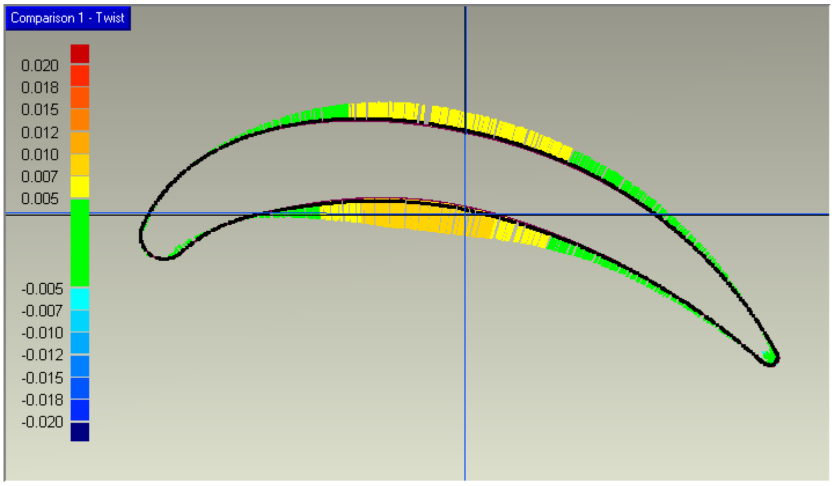
c. Click **Apply**. After a very brief calculation, the view will update to the show the result of best fitting the 2D test section to the reference section. The resulting rotation and translation values appear in a table at the bottom of the view.

	Amount	Status
X	0.000356 in	
Y	0.005746 in	
Rotation	0.085087 deg	

Translation & Rotation Values

d. Click **OK** to exit the command. Notice a new view appears in the 2D Comparisons folder called **Comparison 1 – Twist**.

NOTE: Once you perform a twist analysis on a 2D section, you cannot edit that section, nor can you add annotations to it.



Result of 2D Twist Analysis

Extract Dimensional Characteristics of a Cross-Section

10.Determine the section where you want to take measurements.

a. Click **Tools > Section Through Object**, or click the icon.

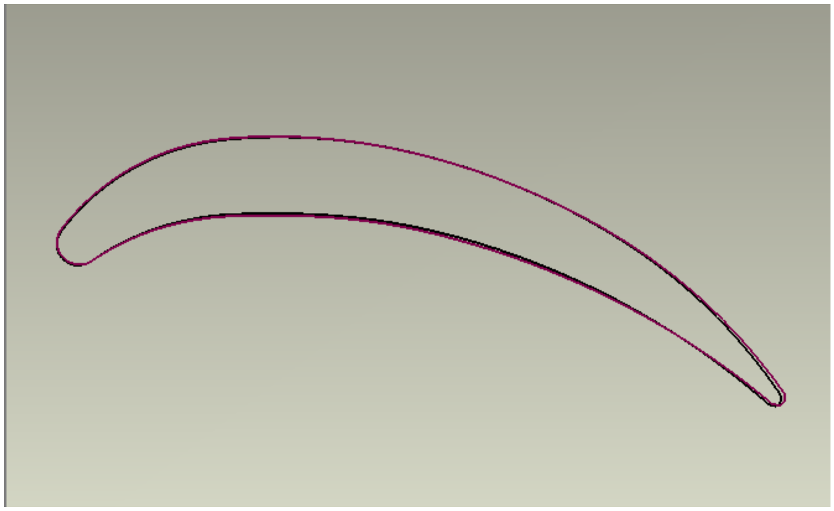
b. Toggle *on* **Section Reference and Test Objects** checkbox, if not already.

c. From the **Align Plane** dropdown menu, select **System Plane**, and then from the dropdown menu beneath that, select **XY-Plane.**

d. Enter a **Position** value of **14.5 in**. This indicates we are going to section the model at a plane parallel to XY at a Z height of 14.5 inches.

e. Click **Compute**. A cross-section is taken through both the Reference and the Test objects.

f. Click **OK** to exit the command.



Cross-Section Through Reference and Test Objects

11.Make the Test object active.

a. Click **Model Manager** tab so that model objects are available for selection.

b. Select the **Test** object.

12.Extract dimensions from this section.

a. Click **Analysis > Blade Section Analysis**.

NOTE: A dashed white line will appear through the airfoil section. This is the mean camber line.

b. Click the **Auto Dimensions** button.

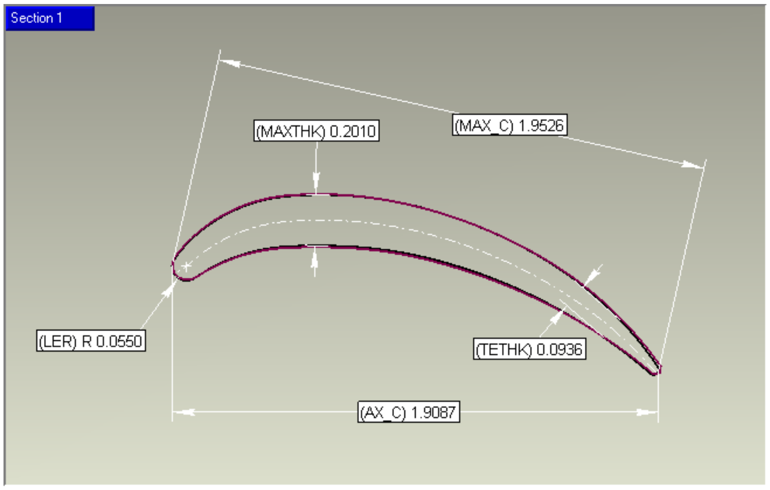
c. Toggle *on* only the checkboxes for: **Max Chord**, **Axial Chord**, **Leading Edge Radius**, and **Max Thickness**.

d. Click **Apply**. The requested dimensions will appear on the section.

NOTE: If necessary, use the Shift+RMB (Right Mouse Button) to zoom out such that all dimensions are visible in the view.

e. Click the **Trailing Edge Thickness** icon to add this dimension to the section.

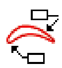
f. Click **OK** to exit the command.



Blade Section Dimensions

Editing Dimensioned Cross-Sections

13.Edit the previously created dimensioned view.



a. Click **Analysis > Blade Section Analysis** again.

b. From the dropdown menu at the top, select which view you wish to edit (there is only one view in this case, so it is displayed by default).

c. Click on the **Axial Chord (AX_C)** dimension.

d. Click the **Delete** key on the keyboard to delete the dimension.

e. Click on the **Trailing Edge Thickness (TETHK)** dimension.

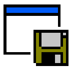
f. In the **Offset** field, enter a value of **0.25 in** and click **Apply**. The dimension will update.

g. Click on the **Leading Edge Radius (LER)** dimension and drag it around the leading edge. Notice that while the dimension is active, the arc that was fit to the leading edge points is displayed in gray.

h. Click the **Edit** button on the dialog. Here you can modify default dimension names and tolerances. In addition, you can switch between two different methods of chord line calculation: Camber Line Intersection, where the chord line is determined by the intersection of the mean camber line with the LE and TE; and Tangent, where the chord line is determined by the tangency points of the LE and TE, simulated by lying the blade concave side down on a table and drawing a line between the two contact points.

i. Click **OK** to dismiss the **Options** pop-up window.

j. Use **Shift+RMB (zoom)** and **Alt+RMB (pan)** to orient the view how you want it shown in the report.



k. Click the **Save** icon at the top of the dialog under **View Control** to save this view orientation.

l. Click **OK** to exit the command.