Perceptron Scanner Plugin

for compatibility with Geomagic products, see Release Notes for Geomagic Perceptron Plugin

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Plugins > Perceptron is the interface in Geomagic Studio and Geomagic Qualify to a Perceptron Contour Probe.

The purpose of this (or any) scanner plugin is to eliminate the need to import scan data into Geomagic Studio or Qualify. With the plugin, scanned data exists in the application's Model Manager immediately after the data capture process.

In This Document:

Activating the Perceptron Plugin

1. Turn on the Perceptron interface box by pressing the power button. Allow up to 90 seconds for startup.
2. Turn on the arm to which the scanner is mounted.
3. Turn on the scanner by pressing the Sensor Power rocker switch on the interface box.
4. Start **Geomagic Studio** or **Geomagic Qualify**.

5. To activate the scanner control dialog, click the [icon] Perceptron icon on the toolbar, or select **PlugIns > Perceptron Scan**.

    (This menu item in Geomagic products is an optional, separately licensed feature. If Perceptron does not already appear on the Plugins menu, download the software from support.geomagic.com/downloads, install it according to instructions on the web site, and re-start this procedure.)

6. In response to the "arm joint" dialog, exercise joints on the arm until all bars are solid blue. When you hear a long tone, the arm is ready.

Controls on the Arm

After you press the **Start Capture** button in the dialog, the arm buttons are enabled and the scanner is in the Paused state. Looking from the elbow toward the laser scanner, the three buttons on the arm are:

*   *During Laser Scanning*:
    *   **Side** Buttons (identical function; known as the **Stop** buttons) - Stops and returns control to the plugin dialog.
    *   **Center** Button (known as the **Pause/Unpause** button) - Press once to activate the laser and scan the physical object. Press again to pause the scanner. During the pauses, the application performs shading and sampling (if configured in the plugin dialog) on the data that was just collected. Each cycle of Unpause/Pause generates a uniquely numbered "Scan N" object in the Geomagic model manager. When a sufficient number of Scans are complete, press the Left button to **Stop** scanning and return control to the plugin dialog.
*   *During Hard Probing*:
    *   **Side** Buttons (identical function; known as the **Offset/Stop** buttons) - stops an operation or defines an offset.
    *   **Center** Button (known as the **Collect** button) - collects a point.

Controls and Indicators
in the Dialog

This section details the controls and indicators on the user interface of the EXAMPLE plugin.

- **Hardware Alignment** icon button **-** Alignment is the synchronization of the coordinate system of a reference object with the coordinate system of the scanner and test object, such that the coordinates of incoming data points can be correctly compared to points on the reference object. This button activates controls and indicators for the alignment process. Every scan must be performed with respect to a known spatial orientation (also called a "coordinate system", also incorrectly called an "alignment"). The spatial orientation remains in effect on subseqeunt scans and the next time Geomagic Studio or Qualify is started.
  - **Display Units** - specifies the units of measure that will display in the Viewing Area, such as inches or millimeters; not the same as the units that will be stored in the data file.
  - **Probe Controls** group - configures the hard probe.
    - **Disconnect Arm** button - deactivates the arm so you can make changes with the **Probe Profile** or **Probe Special Functions** buttons. (To reactivate the arm, restart the plugin.)

      - **Probe Profile** icon button - allows configuration of device connectivity, profiles, and button assignments.

      - **Probe Special Functions** icon button - allows arm testing, arm calibration, and the definition of special functions.

  Define an orientation by one of the following methods.

  - **3-2-1 Alignment** button **-** Allows the user to establish spatial orientation by defining the position of the X, Y, and Z planes. See 3-2-1 Alignment on page 2-10.

  - **Last Test Model Alignment** button (selectable only when an object has been designated as the test object, or when a Feature/

Datum object is present in the Model Manager) - specifies that the spatial orientation be based on the scheme of an existing object. In Geomagic *Qualify*, use the orientation of the currently designated test object. If no test object exists, use the spatial orientation of the Feature/Datum object. If this is Geomagic *Studio*, use the spatial orientation of the Feature/Datum object. (See Example of "Last Test Model Alignment" with Geomagic Qualify on page 2-25.)

- **Load Transform** button **-** allows the user to select a .tfm or .xal file that defines a spatial orientation.

- **Use Arm CSYS** button **-** sets the spatial orientation (also called Coordinate SYStem) to the arm default, where the arm base is the origin.

- **"Move Device" Wizard** is a specialized procedure for aligning the multiple scans of an object that is larger than the reach of the arm. It involves the hard-probing of reference points, moving the object or the arm itself, and hard-probing of the same reference points to re-establish bearings. This section presents two buttons that are the entry point to the "Move Device" feature. See Move Device on page 2-18.

- **Hard Probe** icon button - Hard probing is the creation of datums and features by use of the scanner's hard probe. This button activates controls and indicators for the touch probe. For detailed procedures, see Datum and Feature Creation on page 2-14.
  - **Display Units** - specifies the units of measure that will display in the Viewing Area, such as inches or millimeters; not the same as the units that will be stored in the data file.
  - **Probe Controls** group - configures the hard probe.
    - **Disconnect Arm** button - deactivates the arm so you can make changes with the **Probe Profile** or **Probe Special Functions** buttons. (To reactivate the arm, restart the plugin.)

    - **Probe Profile** icon button - allows configuration of device connectivity, profiles, and button assignments.

    - **Probe Special Functions** icon button - allows arm testing, arm calibration, and the definition of special functions.

- **Object Name** field - indicates the name of the object that will be stored in the Geomagic Model Manager.
- **Datum/Feature Type** group - specifies the kind of datum or feature that will be defined by use of the hard probe. A datum or feature can be defined even if no scan data exists yet. If no scan data yet exists, an "empty" point object called Datums/Features is created in the Model Manager and the new datum and feature sub-objects are stored under it.
  The datum types are: *plane*, *axis*, *point*, and *point target*.
  The feature types are *circle*, *slot*, *rectangle*, and *line*.
 For complete definitions, see the online help in the Geomagic product at Tools > Datums > Create Datums.
- **Input Method** group - (applicable with some of the Datum types) specifies the method by which you will use the hard probe to define the datum. A datum can be defined even if no scan data exists yet. If no scan data yet exists, an "empty" point object called Datums/Features is created in the Model Manager and the new datum and feature sub-objects are stored under it. The Input Methods are:
  - **Cylinder** (for the *axis datum*) - the user is instructed to click six or more points on the surface of the cylinder
  - **Cone** (for the *axis datum*) - the user is instructed to click six or more points on the surface of the cone
  - **Surface Point** (for the *point* datum and *point target* datum) - the user is instructed to probe three points to define a plane, then one point on the surface of that plane.
  - **Best Fit Centroid** (for the *point* datum and *point target* datum) - the user is instructed to select three or more points to define a plane. The defined point is at the best-fit center of this collection.
  - **Sphere** (for the *point* datum) - the user is instructed to select four or more points on the sphere surface. The defined point is at the center of this sphere.
  - **Single Point** (for the *point* datum) - the user is instructed to probe one point. The defined point is at the center of the probe.
  - **Show Instructions** checkbox - specifies whether the user interface presents a sentence explaining how to define the datum or feature given the Datum/Feature Type and the Method Input that is chosen.
    - **Instructions** (if requested by the **Show Instructions** checkbox) - presents a sentence explaining how to define the datum or feature given the Datum/Feature Type and the Method Input that is chosen.
  - **Show Information** checkbox - specifies whether the user interface presents the following details about the just-created datum or feature:
    - **Feature Information** group - The following fields are populated when appropriate for the datum or feature that is being detailed:
      - Feature - the name of this feature.

- Radius - the radius of this feature, if applicable.
- Length - the length of this feature, if applicable.
- Width - the width of this feature, if applicable.
- Center X - the center of this feature on the X axis.
- Center Y - the center of this feature on the Y axis.
- Center Z - the center of this feature on the Z axis.

- **Laser Capture** icon button - Laser Capture is the process of collecting data points from a physical part. This button activates controls and indicators for the laser scanner.
  - **Display Units** - specifies the units of measure that will display in the Viewing Area, such as inches or millimeters; not the same as the units that will be stored in the data file.
  - **Scanner Controls** group - adjusts laser scanner settings.

    - **Scanner Profile** icon button - allows adjustments like power, point density, scan rate, and laser on/off.

    - **Scanner Calibration** icon button - allows import of a calibration file saved in a previous session.
  - **Object Name** field and **Reset** button - indicates the name of the object that will be stored in the Geomagic Model Manager. Names are of the form Scan 1, Scan 2, Scan 3, …. **Reset** restores the numeric part to 1.
  - **Scanning Options** - control the operation of the scanner and the display of data.
    - **Shade Points on Pause** checkbox - By the time a scan is stored in the Model Manager, the plugin will have calculated individual point normals based on the scanner direction at time of acquisition. This checkbox specifies whether to perform these calculations during pauses (in which case you must wait for a calculation to complete before resuming a scan) or after you press OK to store the object in the Model Manager (in which case you might have to wait for a relatively long time).
    - **Virtual Camera** checkbox - toggles the Virtual Camera functionality of the laser scanner.
    - **Highlight Scan Pass** checkbox - toggles scan pass hi-lighting. When selected, the incoming scan data will appear red, otherwise the incoming scan data will match the light green of previously created scan passes.
    - **Display Polygons** checkbox - toggles the display between Polygons and Points. Acts on all scan passes in the current plugin instance.

- **Edge Ratio** slider (five settings from Low to High) - specifies the propensity of the software to leave gaps between scan lines in the scan image if you are scanning too fast. [A triangle with *high edge ratio* is one that has two relatively long sides caused by rapid scanning, and a relatively short side which is influenced by the scan line density setting on the FARO Scanner Settings dialog.]
  - When density of scan is more important, such as in a reverse engineering scenario, use a lower Edge Ratio. If you scan too fast, gaps will appear on the scan image. In that case, slow down or make a second pass.
  - When density of scan is less important, such as some inspection scenarios, use a higher Edge Ratio. If you scan relatively fast and scan lines are far apart, software will triangulate the space between scan lines and thereby suggest that the scan is "good". If you are still scanning too fast and gaps appear, slow down or make a second pass.

- **Start Capture** icon button - begins the data capture process by passing control to the scanning device.
- **Data Options** - affect the appearance of collected data *after* the plugin is closed.
  - **Merge Scan Passes** checkbox - specifies whether to perform a point merge on all individual scan passes created during the current session of the plugin. The result will be one point object in the Model Manager.
  - **Sampling** checkbox - specifies whether to perform uniform sampling (a reduction of point density) on the resulting point cloud at the end of a scan pass.
    - **Spacing** - specifies the spacing parameter used by the Uniform Sample operation.
  - **Smoothing** slider (None, Min, Med, and Max) - specifies whether to perform a smoothing operation on each scan line as it is received from the scanner. The intent is that noisy data can be smoothed in real-time to provide better wrapping results. The values are: None, Min, Med, Max.
  - **Filter Angle** field (0 to 90 degrees) - offers the ability to ignore points collected by the scanner beyond the specified angle. This results in much cleaner data. The filter angle can be adjusted between 0.0 and 90.0 degrees. This operation, like smoothing, is on a per scan line basis.
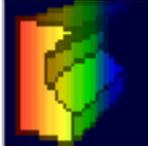
- **Real-Time 3D Comparison** icon button (visible in Geomagic Qualify, not Geomagic Studio) - Real-Time 3D Comparison is a scanning method during which the deviations between scanned points and a reference object are graphically illustrated in real time.. This button activates the laser scanner in a mode that performs real-time 3D comparison of the scanned object to a reference object.
  - **Display Units** - specifies the units of measure that will display in the Viewing Area, such as inches or millimeters; not the same as the units that will be stored in the data file.
  - **Scanner Controls** group - adjusts laser scanner settings.

    - **Scanner Profile** icon button - allows adjustments like power, point density, scan rate, and laser on/off.

    - **Scanner Calibration** icon button - allows import of a calibration file saved in a previous session.
  - **Initialize** button - initializes the comparison process by creating an empty Result object in the Geomagic Model Manager.

    - **Start Compare** icon button - begins the data comparison process by passing control to the scanning device.
  - **Objects** group -
    - **Reference** - indicates the name of the object in the Geomagic Model Manager that is designated as the Reference object.
    - **Scan** - indicates that the test object is the "New Object" that is being scanned.
  - **Max. Deviation** field - indicates the greatest difference between corresponding reference and test points to allow in the test data. Points beyond this deviation are not included in the test data set.
  - **Color Averaging** slider (five settings from Low to High) - affects the degree to which colors are blended and averaged across the entire surface, like an airbrush that hides small blemishes.
  - **Display** group - controls various aspects of the graphical display:
    - **Test Object** checkbox - specifies whether to display the raw test data points during the data capture process.
    - Color radio buttons - specifies the one attribute that will be colored in the Viewing Area:
      - **Color Reference** - color will appear on the reference object.
      - **Color Test Points** - color will appear on test points.

- **Color Deviations** - color will appear on whisker lines that extend between test points and the reference object.
- **Edit Spectrum** checkbox - allows modification of the color coding scheme of the deviation map in the Viewing Area.
- **Edit Texture Resolution** checkbox - specifies whether to display the following controls:
  - **Texture Resolution** group - For the purpose of generating color on the reference object, a grid with uniform cell sizes is placed across its surface. Each square cell is called a texel. Scan points are projected onto the texels. When 0 scan points correspond to a texel, the texel is gray, indicating that the test object has insufficuent data in that region for color to be rendered on the reference object. When one point corresponds to a texel, the texel assumes the color that represents the distance of that scan point from the reference. When two or more scan points correspond to a texel, the texel assumes a color that represents the one point that is furthest from the reference.
    - **Resolution** dropdown - controls the total number of texels on the surface of the reference object. The choices are:
      - **Automatic** (the default) - the software selects the number of texels.
      - **Fixed Texture Size** - the user selects an absolute size of each texel.
      - **Fixed Resolution** - the user selects an absolute number of texels. The absolute number is of texels is spread across the reference object, which therefore determines the size of each texel.
      - **Texture Size** dropdown (applicable when **Resolution** is Fixed Texture Size) - specifies an absolute number of texels, measured in megatexels (millions of texels).
      - **Texel Size** dropdown (applicable when **Resolution** is Fixed Resolution) - specifies the absolute width of each square texel, usually in millimeters.
- **Statistics** checkbox - specifies whether to include the following indicators:
  - **Maximum Distances** - indicates the maximum distance between any two corresponding points on the test and reference objects.
  - **Average Distances** - indicates the average deviation between corresponding points on the test and reference objects.

- **Standard Deviation** - indicates the standard deviation between cor-
responding points on the test and reference objects.

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*The **OK** and **Cancel** buttons described here apply to the **Alignment**, **Scan**,
Probe, and **Real-Time 3D Comparison** (Qualify only) functional areas
simultaneously.*

- **OK** button -

  For the **Alignment** function - saves the currently configured alignment.
  The same alignment will be in effect the next time this plugin is started.

  For the **Probe** function - saves datums and features into the Model
  Manager in an "empty" point object called Datums/Features, or, if data
  was collected with the **Laser** function, as datum and feature sub-
  objects.

  For the **Scan** function - performs any incomplete shading and saves
  scanned data into the Model Manager.

  For the **Real-Time 3D Comparison** function (Qualify only) - saves
  scanned data into the Model Manager as a point object named the same
  as the reference object, designates the point object as the test object,
  and creates a Result object in the Model Manager that indicates differ-
  ences between the test and reference objects.

- **Cancel** button - cancels all un-OK'd processing in the **Alignment**,
  Laser, **Hard Probe**, and **Real-Time 3D Comparison** functional areas.

3-2-1 Alignment

This is a sub-procedure referenced by the Alignment section under Controls
and Indicators in the Dialog on page 2-3.

This describes "3-2-1 Alignment" -- how to specify an object's coordinate sys-
tem by defining the position of three orthogonal planes. The origin of the
object's coordinate system will be the point of intersection of the three
planes.

1. Click the large Alignment icon, then the 3-2-1 Alignment
   icon.

   Recall that:

   The plane orthogonal to the *X* axis is the *YZ* plane.

   The plane orthogonal to the *Y* axis is the *XZ* plane.

   The plane orthogonal to the *Z* axis is the *XY* plane.

The *letter* on each of the following icons represents the axis to which a plane is orthogonal. The *sign* on each icon represents a *side* of the plane.

2. If the purpose of this alignment is to synchronize the coordinates a test part with a CAD object, look at the CAD object and ascertain the position of the X, Y, and Z axes (the YZ, XZ, and XY planes) with respect to the CAD object. (Note that a CAD object's coordinate system always uses the right-hand rule).

3. Based on information ascertained in the previous step, perform *any two* of the following three actions:
    - Click the **+X** icon *or* the **-X** icon.
      (+X means that "above" YZ is the positive side of YZ.
      -X means that "above" YZ is the negative side of YZ.)
    - Click the **+Y** icon *or* the **-Y** icon.
      (+Y means that "above" XZ is the positive side of XZ.
      -Y means that "above" XZ is the negative side of XZ.)
    - Click the **+Z** icon *or* the **-Z** icon.
      (+Z means that "above" XY is the positive side of XY.
      -Z means that "above" XY is the negative side of XY.)

    The first button you press is designated as **Plane 1**.

    The second button you press is designated as **Plane 2**.

    Adhering to the right-hand rule, the software automatically selects a third button (either the **+** or **-** variant of the plane you didn't pick), and designates it as **Plane 3**. The sign that the software picks is always the sign of **Plane 1** times the sign of **Plane 2**. (+ * + = +) ; (+ * - = -) ; (- * - = +)

4. On the physical object, position the hard probe on a point that lies in **Plane 1**, then click the **Collect** button on the scanner. Position the probe on a second point that lies in **Plane 1**, then click the **Collect** button on the scanner. Position the probe on a third point that lies in **Plane 1**, then click the **Collect** button on the scanner.

    You have just defined the position of **Plane 1**.

5. Pull the probe out and away from **Plane 1**, then click the **Offset/Stop** button on the scanner.

    If **Plane 1** was designated in Step **3** by a + icon, you have established the + side of **Plane 1**.

    If **Plane 1** was designated in Step **3** by a - icon, you have established the - side of **Plane 1**.

6. On the physical object, position the hard probe on a point that lies in **Plane 2**, then click the **Collect** button on the scanner. Position the probe on a second point that lies in **Plane 2**, then click the **Collect** button on the scanner. There is no need to select a third point on **Plane 2**.

    You have just defined the position of **Plane 2**.

7. Pull the probe out and away from **Plane 2**, then click the **Offset/Stop** button on the scanner.

    If **Plane 2** was designated in Step **3** by a + icon, you have established the + side of **Plane 2**.

    If **Plane 2** was designated in Step **3** by a - icon, you have established the - side of **Plane 2**.

8. On the physical object, position the hard probe on a point that lies in **Plane 3**, then click the **Collect** button on the scanner. There is no need to select a second or third point on **Plane 3**.

9. Pull the probe out and away from **Plane 3**, then click the **Offset/Stop** button on the scanner.

    Based on the right-hand rule, the software already knew the + and - side of **Plane 3**, but this was necessary to complete the process.

10. The current coordinates of the probe appear in a coordinate indicator box. Move the indicator box by dragging it to any location of the screen, or click the **Offset/Stop** button to close the indicator. Click **Show Coordinates** to re-display the coordinate indicator box.

11. Hover the probe above the YZ plane and verify that the X coordinate in the indicator is appropriately positive or negative.

    Hover the probe above the XZ plane and verify that the Y coordinate in the indicator is appropriately positive or negative.

    Hover the probe above the XY plane and verify that the Z coordinate in the indicator is appropriately positive or negative.

12. Coordinate system definition is complete. To un-do the coordinate system, click **Reset** and go to Step **2**.

Detailed Example

To specify the *YZ* plane (with a total of four points), then the *XZ* plane (with a total of three points), then the *XY* plane (with two points): Designate Plane 1 by clicking the **+X** icon, then designate Plane 2 by clicking the **+Y** icon. The

software automatically designates Plane 3 as **+Z**. Make nine clicks, some **Collect** and some **Offset/Stop**, according to the illustration below.

🟢 Denotes clicking the GREEN button on the Faro Arm
🔴 Denotes clicking the RED button on the Faro Arm
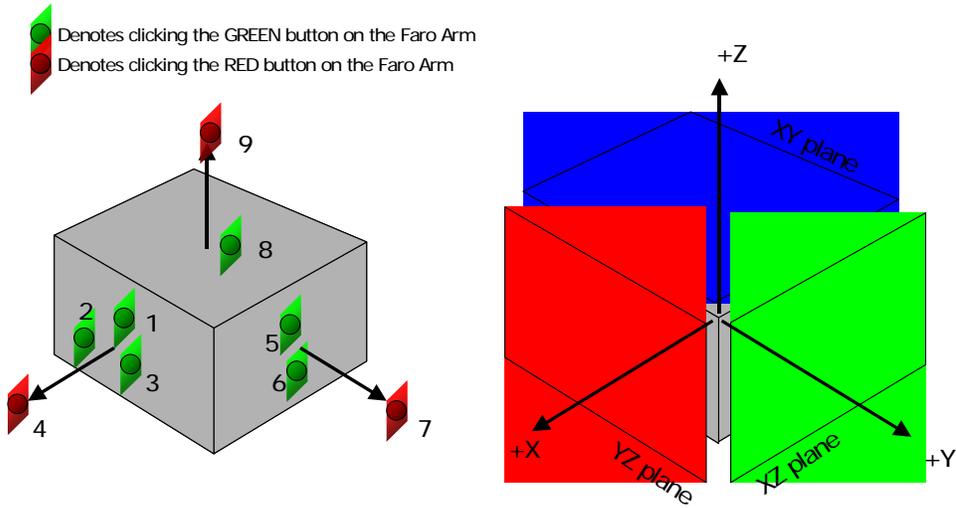
Datum and Feature Creation

Datums and features can be created by use of this scanner plugin software, *or* by the use of tools that are native to the Geomagic products. In theory, datums or features can be identified more precisely by touching the original object and by use of the plugin. Depending on the accuracy of the scan and the user's experience, however, it may be advantageous to create datums and features using the native Geomagic tools.To create datums and features using the scanner software:

1. Click the **Hard Probing** icon.
2. In the **Current Probe** pulldown, identify the currently installed hard probe, such as **3mm Ball Probe**, then click **OK**.
3. Click the icon of a datum type or feature type to be created.
4. Check the **Show Instructions** box for guidance on how to create each datum or feature type. Instructions also appear below. A summary of the instructions is:
   • Click the **Collect** button to define points.
   • Click the **Offset/Stop** button to define offset directions and go on to the next step.
   • When you have finished creating all datums or features of a given type, click the **Offset/Stop** button again.

NOTE: When defining several features on the same plane, you do not need to define that plane for each feature. To recall the last defined plane, click on the plane with a single **Collect** click followed by an **Offset/Stop** click.

Creating a DATUM PLANE

1. Click the datum **Plane** icon.
2. Define a plane by clicking **Collect** on 3 or more points on the surface of the object.
3. Define the offset direction by clicking **Offset/Stop** on a single point above the plane.
4. Repeat steps 2 and 3 to define other planes, or click **Offset/Stop** to return to the dialog.

Creating a DATUM AXIS Using CYLINDER Method

1. Click the datum **Axis** icon.

2. Click the **Cylinder** method icon.

3. Define a cylinder by clicking **Collect** on 6 or more points on the surface of the object.

4. Define the axial direction by clicking **Offset/Stop** on a single point inside or outside the cylinder.
5. Repeat steps 3 and 4 to define other axes, or click **Offset/Stop** to return to the dialog.

Creating a DATUM AXIS Using CONE method:

1. Click the datum **Axis** icon.

2. Click the **Cone** method icon.

3. Define a cone by clicking **Collect** on 6 or more points on the surface of the object.
4. Define the axial direction by clicking **Offset/Stop** on a single point inside or outside the cone.
5. Repeat steps 3 and 4 to define other axes, or click **Offset/Stop** to return to the dialog.

Creating a DATUM POINT Using SPHERE Method

1. Click the datum **Point** icon.

2. Click the **Sphere** method icon.

3. Define a sphere by clicking **Collect** on 4 or more points on the surface of the object.
4. Click **Offset/Stop** on a single point inside or outside of the sphere.
5. Repeat steps 3 and 4 to define other points, or click **Offset/Stop** to return to the dialog.

Creating a DATUM POINT or DATUM POINT TARGET Using CENTROID Method

1. Click the Datum **Point** icon.   or the Datum **Point Target** icon   .

2. Click the **Centroid** method icon.

3. Click **Collect** on 3 or more close points on the surface of the object.
4. Define the offset direction by clicking **Offset/Stop** on a single point above the group of points.
5. Repeat steps 3 and 4 to define other points, or click **Offset/Stop** to return to the dialog.

Creating a DATUM POINT or DATUM POINT TARGET Using SURFACE POINT Method

1. Click the Datum **Point** icon.   or the Datum **Point Target** icon   .

2. Click the **Surface** method icon.

3. Define a plane by clicking **Collect** on 3 or more points on the surface of the object.
4. Define the offset direction by clicking **Offset/Stop** on a single point above the plane.
5. Click **Collect** on a single point on the surface.
6. Click **Offset/Stop** to complete the process.
7. Repeat steps 3 through 6 to define other points, or click **Offset/Stop** to return to the dialog.

Creating a DATUM POINT Using SINGLE POINT Method

1. Click the Datum **Point** icon.   .

2. Click the **Single Point** method icon.

3. Click **Collect** on a single point.
4. Click **Offset/Stop** to complete the process.
5. Repeat steps 3 and 4 to define other points, or click **Offset/Stop** to return to the dialog.

Creating a FEATURE CIRCLE

1. Click the feature **Circle** icon.

2. Define a plane by clicking **Collect** on 3 or more points on the surface of the object.
3. Define the offset direction by clicking **Offset/Stop** on a single point above the plane.
4. Click **Collect** on 3 or more points on the cylindrical wall perpendicular to the plane.
5. Define the offset direction by clicking **Offset/Stop** on a single point inside the circle (to make a hole) or outside the circle (to make a protrusion).
6. Repeat steps 2 through 5 to define other circles, or click **Offset/Stop** to return to the dialog.

Creating a FEATURE SLOT

1. Click the feature **Slot** icon.

2. Define a plane by clicking **Collect** on 3 or more points on the surface of the object using the **Collect** button.

3. Define the offset direction by clicking **Offset/Stop** on a single point above the plane.

4. Click **Collect** on 3 or more points on the cylindrical wall of one end of the slot perpendicular to the plane.

5. Define the offset direction by clicking **Offset/Stop** on a single point inside the slot (to make a hole) or outside the slot (to make a protrusion).

6. Repeat steps 4 and 5 to define the opposite end of the slot.

7. Repeat steps 2 through 6 to define other slots, or click **Offset/Stop** to return to the dialog.

Creating a FEATURE RECTANGLE

1. Click the feature **Rectangle** icon.

2. Define a plane by clicking **Collect** on on 3 or more points on the surface of the object using the **Collect** button.

3. Define the offset direction by clicking **Offset/Stop** on a single point above the plane.

4. Click **Collect** on 2 or more points on one of the rectangular walls perpendicular to the plane.

5. Define the offset direction by clicking **Offset/Stop** on a single point away from the rectangle wall.

6. Repeat steps 4 and 5 for the remaining three walls, working in a counter-clockwise order.

7. Repeat steps 2 through 6 to define other rectangles, or click **Offset/Stop** to return to the dialog.

Creating a FEATURE LINE

1. Click the feature **Line** icon (for the intersection of two planes)

2. Click **Collect** on 3 or more points on the surface of the object.

3. Define the offset direction by clicking **Offset/Stop** on a single point above the plane.

4. Click **Collect** on 2 or more points on a rectangular wall perpendicular to the plane.

5. Define the offset direction by clicking **Offset/Stop** on a single point away from the wall.

6. Repeat steps 2 through 5 to define other lines, or click **Offset/Stop** to return to the dialog.

Move Device

"Move Device" is a specialized procedure for aligning the multiple scans of objects that are larger than the reach of the arm. It involves the hard-probing of reference points, moving the object or the arm itself, and hard-probing of the same reference points to re-establish bearings.

The following summary describes a process of scanning, moving the scanner because the object is large, and continuing with the scan.

1. Scan part of an object.
2. If "Move Device" is not necessary, save the scan by pressing **OK**.

   If "Move Device" is necessary (because space or the length of the arm did not allow a complete scan), press the **Alignment** icon button.
3. Press the **Move Device Wizard** button.
4. In the **Move Device Wizard**, click **Begin**.
5. On the Reference Point Collection Panel, use the hard probe to identify four to seven reference points on the physical object, each by one of four methods. On paper, write the name of each point, its location and identification method. Then click **Next**.
6. In response to a prompt, move the physical part or the scanner itself, then click **OK**.
7. On the Target Point Collection Panel, use the hard probe to re-identify the named reference points. As a result, the software can recalculate the orientation of the scanner with respect to the physical object. The next scan will be a continuation of the previous scan. Press **Next**.
8. On the Correspondence Report Panel, the software displays the precision to which it was able to associate the target points to the reference points. Eliminate any associations that are unacceptable, then press **Done** to specify that reference points and target points are sufficiently "connected." Go to Step **1** to scan more of the same physical object.

The detailed process is:

1. Press the **Laser Capture** icon button, then **Start Capture**. Scan as much of the physical object as space or the length of the arm allows.
2. If "Move Device" is not necessary, save the scan by pressing **OK**.

   If "Move Device" is necessary (because space or the length of the arm did not allow a complete scan), press the **Alignment** icon button.
3. Press the **Move Device Wizard** button. The Move Device Wizard group appears on the dialog.

4.   This is the "Move Device" Home Panel. It has two buttons:
   • **Begin** button - begins a new "Move Device" process. Go to the Refer-
     ence Point Collection Panel in Step **5**.
   • **Resume** button - returns to the panel on which you previously
     pressed **Exit** and saved the state of the "Move Device" process: the
     Reference Point Collection Panel in Step **5**, the Target Point Collection
     Panel in Step **7**, or the Correspondence Report Panel in Step **8**.
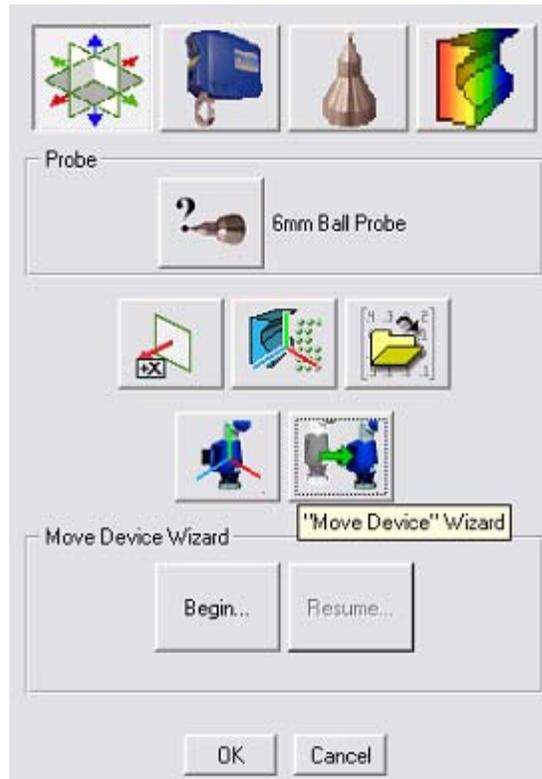
"Move Device" Home Panel

5.   On the Reference Point Collection Panel, use the hard probe to identify
     four to eight reference points on the physical object, each by one of three
     methods described below, *or* click **Previous Targets** to re-use the set of

targets from a previous "move". On paper, write the name of each point, its location, and collection method. Then click **Next**.
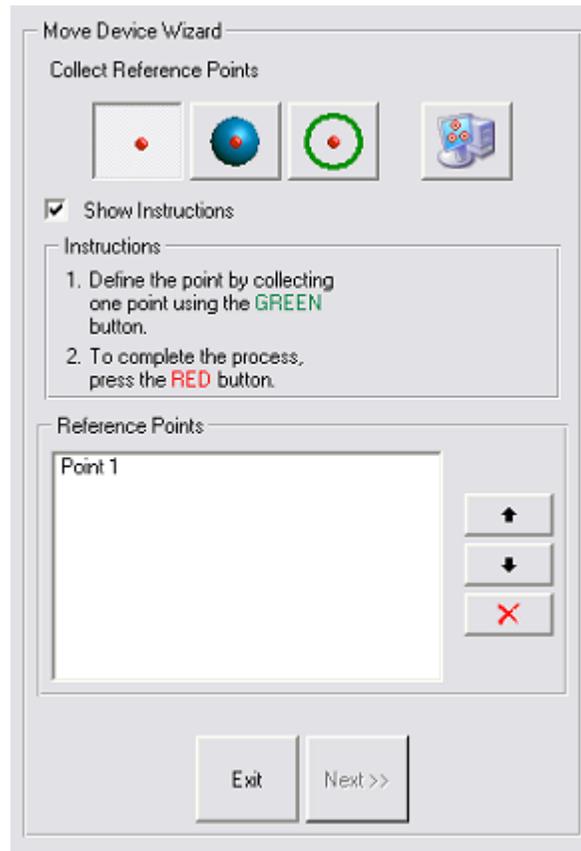
Reference Point Collection Panel

- Reference Point Collection Methods:

    - **Single Point** - You will touch the probe ball to a single point on the physcial object. For precision, the single point should be in a tight corner such as an inverted cone or hole whose diameter is smaller than the probe ball.

    - **Sphere Center** - You will touch the surface of a sphere, either on the inside or outside, then a point in space to specify inside or outside. The defined point will be the center of the sphere.

    - **Circle Center** - You will touch three or more points to define a plane, then several points on the inside or outside of a cylinder. The defined reference point will be the intersection of the plane and the axis of the cylinder.

- **Previous Targets** - You will replicate the same set of target points that were used in the previous "move". Use this method when the same points will still be within reach of the probe after the arm or part is moved.
- **Show Instructions** checkbox - specifies whether to display instructions on how to collect center points.
  - **Instructions** - the instructions, if requested.
- **Reference Points** section
  - List of Points - lists the collected reference points by name. Each name is based on the method by which it was collected, such as Single Point 1, Circle Center 1, Circle Center 2, and Sphere Center 1.
  - **Up** and **Down** button - changes the order in which the reference points must be *re*-collected on the Target Point Collection Panel at step **7**.
  - **Delete** button - deletes the highlighted reference point from the list.
- **Exit** button - stops the reference point collection process, and returns to the "Move Device" Home Panel in Step **4**. The prompt is "Save Current State?" The choices are:
  - **Yes** - saves the state of the "Move Device" process (in an un-named temporary location), returns to the "Move Device" Home Panel. The **Resume** button on the "Move Device" Home Panel will bring you back to this Reference Point Collection panel.
  - **No** - returns to the "Move Device" Home Panel without saving the state of this process. On the "Move Device" Home Panel, the **Resume** button will be inactive.
  - **Cancel** - returns to this Reference Point Collection panel, as if **Exit** had not been pressed.
- **Next** button - Reference points have been collected, so the scanning device or the part can be moved. You will be prompted to move the device or the test part. Go to Step **6**.

6. This is the Prompt to Move Device or Part. Move the scanner or the physical part, click **OK**, then go to the Target Point Collection Panel in Step **7**.

Prompt to Move Device or Part

7. On the Target Point Collection Panel, use the hard probe to re-identify the named reference points. When the wizard prompts for the re-identification of a particular reference point, use the written notes to re-create the

reference point using the same method by which it was originally identi-
fied.
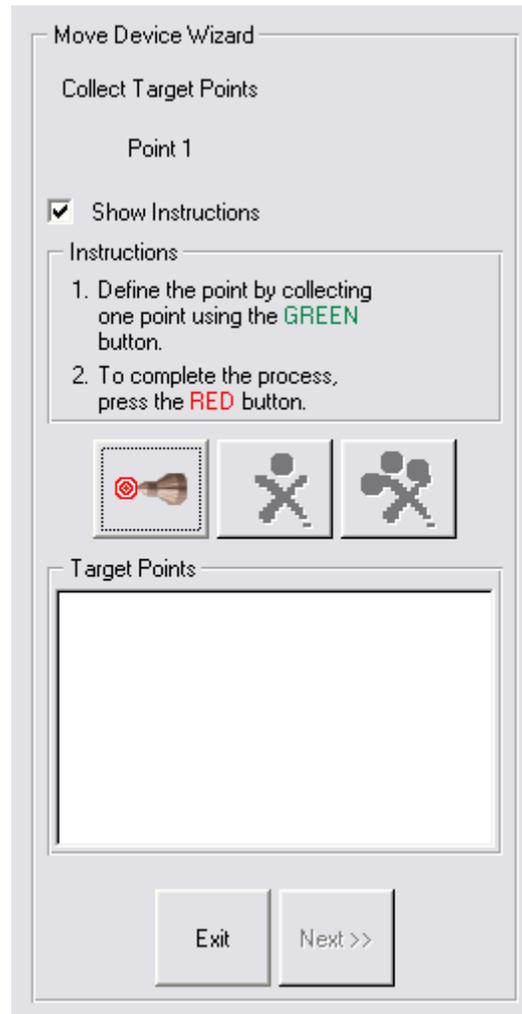
Target Point Collection Panel

The controls are:
- **Show Instructions** - specifies whether to display the **Instructions** box
- **Instructions** box - instructs the user how to collect the reference point.

- **Define Targets** button - press this to re-start the identification

  of targets (to re-start identifying the points that were previously identified as reference points). When this dialog first pops up, it is already in target collection mode, so use this button to *re*-start the process if you have pressed the **Offset/Stop** button on the scanner.

- **Re-Define Last Target** icon button - after pressing the **Offset/**

  Stop button on the scanner to stop collection, press this to delete the most recently collected target point and to automatically re-start the identification of targets.

- **Clear All Targets** icon button - after pressing the **Offset/Stop**

  button on the scanner to stop collection, press this to delete all collected target points. To re-start collection of target points, you must press the **Define Targets** button.
- **Exit** button - stops the target point collection process, and returns to the "Move Device" Home Panel in Step **4**. The prompt is "Save Current State?" The choices are:
  - **Yes** - saves the state of the "Move Device" process (in an un-named temporary location), returns to the "Move Device" Home Panel. The **Resume** button on the "Move Device" Home Panel will bring you back to this Target Point Collection panel.
  - **No** - returns to the "Move Device" Home Panel without saving the state of this process. On the "Move Device" Home Panel, the **Resume** button will be inactive.
  - **Cancel** - returns to this Target Point Collection panel, as if **Exit** had not been pressed.
- **Next** button - Press this when all reference points have been re-identified by use of the hard probe. Go to the Correspondence Report Panel in Step **8**.

8. The Correspondence Report Panel displays the precision to which the software was able to associate the target points to the reference points. Eliminate any associations that are unacceptable, then press **Done** to

specify that reference points and target points are sufficiently "connected." Go to Step **1** to scan more of the same physical object.

Correspondence Report Panel

The controls and indicators are:

- **Best Fit Result** list - a list of the associations of target points to reference points.
- **Delete** button (applicable only when there are four or more point pairs in the **Best Fit Result** list) - allows any target/reference pair to be deleted from the result list. When a pair is deleted, the data is lost and the remaining paris are immediately re-evaluated.
- **Datum Deviations** list - displays the precision to which each of the reference/target pairs was associated. A pair with a large deviation was not scanned precisely enough, and may be hindering the best-fit more than it is helping, and is therefore a candidate for deletion.
- **Done** button - Press this to accept this set of reference points and associated target points (and modify the cumulative transformation matrix) and return to the Faro Scanning panel (in Step **1**) for continuation of the scan process.

Detailed Examples

This section contains examples that are referenced earlier in this document.

EXAMPLE OF "LAST TEST MODEL ALIGNMENT" WITH GEOMAGIC QUALIFY

This example demonstrates the use of Last Test Model Alignment in a CAI process with Geomagic Qualify. This assumes a working knowledge of Geomagic Qualify.

If a hard probe is installed with the laser equipment, use the variant of this procedure called "Hard Probe Technique". If no hard probe is installed, use the variant called "Laser Technique".

1. Load a CAD object into the Model Manager and designate it as the reference object.
2. Perform one of the following:
   * *Hard-Probe Technique* - use **Tools > Datums > Create Datums** or **Tools > Features > Create Features** to create datums and features on the reference object.
   * *Laser Technique* - Continue to the next step.
3. Start the scanner plugin.
4. Perform one of the following:
   * *Hard-Probe Technique* - Hard probe the corresponding datums and features on a test object that is resting in a test fixture (without laser scanning the test object). The datums and features become sub-objects of a special special "blank" test object named "Features/Datums" that records the position of the datums and features with respect to the test fixture.
   * *Laser Technique* - Scan a portion of the object, at least enough points that it could be aligned to the reference object using the best-fit alignment function of Geomagic Qualify.
5. Exit the plugin by clicking the **OK** button.
   * *Hard-Probe Technique* - In the Model Manager, note the existence of the CAD object and the new test object called "Features/Datums". Note the existence of feature and datum sub-objects under the Features/Datums object.
   * *Laser Technique* - Continue to the next step.
6. Perform one of the following:
   * *Hard-Probe Technique* - Use **Tools > Alignment > Datum/Features Alignment** on the test and reference objects (which aligns the reference object with the special test object by aligning their common datums and features).
   * *Laser Technique* - Use **Tools > Alignment > Best Fit Alignment** on the test and reference objects (which aligns the reference object with the test object by detecting the similarity of their surfaces.

The side effect of this process is that it creates an internal *transformation matrix*, which is a mapping of the spatial difference between the reference object and the test object. In this case, the transformation matrix represents the spatial difference between the reference object and the place where a test object will lie in the test fixture.

7. Place a real test part in the test fixture.
8. Start the scanner plugin again, and click the **Alignment** icon.

9. Click the ![icon] **Use Last Test Alignment** button. This is a special alignment technique that uses the most recent transformation matrix to specify the spatial difference between the reference object and the test object. The net result is that scan data from the test part will be correctly aligned with the reference object. Next, you will scan the test part.

10. Click the large **Laser** icon to activate scanning mode. Begin scanning. Scan data appears on the screen in alignment with the CAD reference object.

11. Exit the plugin by clicking the **OK** button. In the Model Manager, notice that the newly created scan object is now the test object.

12. To prepare to scan another test object, go to step 8. Every new test object will be aligned correctly.

EXAMPLE OF LASER SCANNING

1. Click the **Laser Scanning** icon. ![icon]

2. In the **Current Probe** pulldown, select **Laser Probe** then click **OK**.

3. Set the controls on the **Laser Capture** dialog.

4. To perform a scan and thus create an object in the Geomagic Model Manager:

    • Click the **Start Capture** icon ![icon] .

    • Click the **Pause/Unpause** button on the scanner and make scan passes.
        • During the scanning process, use the on-screen range finder or the LEDs on the scanner to keep the scanner at a suitable distance from the physical object.
        • At any time, click the **Pause/Unpause** button again to pause scanning. The scan arm acts as a virtual camera when scanning is not active. Click the **Pause/Unpause** button to resume scanning.
    • Click the **Stop** button to end scanning. The scan arm behaves like a mouse.

EXAMPLE OF REAL-TIME 3D COMPARISON

This section describes the concepts of computer-aided inspection with Geomagic Qualify and any Geomagic scanner plugin.

1. The first step of a CAI process is to align the coordinate system of a reference object to the scanner so that collected data can be compared to the reference object in the same coordinate system. Use one of the alignment methods summaraized at **Hardware Alignment** on page 3.
2. Next, designate a CAD object as the reference object in the Geomagic Model Manager.
3. Click the **Real-Time 3D Comparison** icon button.
4. Click the **Calibrate** or **Options** icon button if necessary.
5. Click the **Initialize** button. The **Start Capture** icon button becomes active.
6. Click the **Start Capture** icon button.
7. Use the hardware-appropriate procedure under Example of Laser Scanning on page 2-26.
8. If the physical part is larger than the reach of the scan arm, go to Move Device on page 2-18, then return to this step.
9. If more scanning is necessary, go to Step 6.
10. When scanning is complete, click **OK** on the dialog. Scanned data is saved into the Geomagic Model Manager, the saved object is automatically designated as the test object in the Model Manager, and the comparison results are saved to a Result object in the Model Manager.