

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

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.

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# Activating the 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 the ScanWorks application listed in the Release Notes. Depending on the version of Scanworks, verify that the "Output Data to TCP/IP" option is enabled or the "Output" option is enabled.
5. Start **Geomagic Studio** or **Geomagic Qualify**.
6. To activate the scanner control dialog, click the  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 the Geomagic support site, install it according to instructions on the web site, and re-start this procedure.)
7. 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.
- ***During Probe Capture:***
  - **Center** Button (known as the **Collect** button) - collects one or more points.

# Controls and Indicators

This section details the controls and indicators on the user interface of the Perceptron plugin. The major categories of controls are:



- **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 subsequent 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.



- **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 a coordinate system (an orientation) by one of the following methods.



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



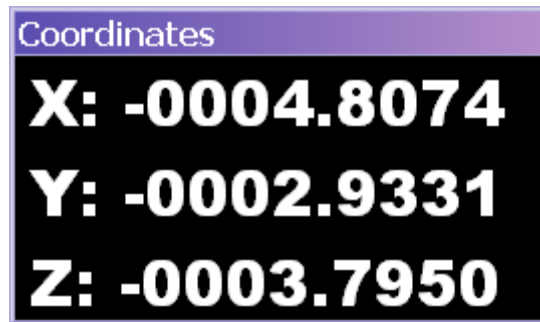
- **Use Arm CSYS** button - sets the spatial orientation (also called Coordinate SYStem) to the arm default, where the arm base is the origin.






- **"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 21.

- **Alignment Matrix** group - presents the spatial orientation that was loaded or set.
- **Show Coordinates** button (active if a hard probe is connected) - generates a popup that represents the current position of the probe, such as the following. To close the coordinate popup, press the Stop button on the arm.



-  **Features and Datums** 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 17.
  - **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.
    -  **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.
  - **Feature Plane** group -
    - **Feature Plane** list with **Delete** button - is a list of Datum Planes that you have created with the hard probe. These Datum Planes can be referenced during the creation of planar Features

(holes, slots, rectangles, and lines). "Define Plane" is a special case that requires the user to define a plane during Feature creation rather than by referencing one from this list.

- **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:









The feature types are:




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.
- **Point Size** decimal field - controls the size of points that appear in the Viewing Area during the probing of a feature or datum.
- **Show/Hide Information Window** button - toggles the display of the Feature/Datum Information Window (the feedback window that pops up when a Feature or Datum is being collected). See [Feature/Datum Info Window](#) on page 15.
- **Save Compensated Points** checkbox - causes probed points to be saved to the Model Manager with the new feature or datum. The probed points are saved to the point object (named "Features/Datums") of which the feature or datum is a member.
- **Automatic Resize** checkbox - causes automatic scaling or re-orientation of objects so that all collected points remain within bounds of the Viewing Area.
- **Instructions** group - presents instructions on how to define the Datum or Feature given by the Datum/Feature Type and the Method Input that is chosen.

*If you are defining a Feature (hole, slot, rectangle or line), **and** if a specific Datum Plane name is highlighted in the **Datum Plane List** above, the highlighted plane will serve as the Feature's plane and the instructions will describe how to complete the process in minimal number of steps. If "Define Plane" is highlighted in the **Datum Plane list** above, the instructions will also describe how to probe the Feature's plane.*

-  **Probe Capture** icon button - Probe Capture is a data collection method that utilizes the hard probe only. Even after laser scanning, it is often useful to hard-probe sharp edges of a part.
  - **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.)
  - **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.

-  **Calibrate Probe** icon button - allows arm testing, arm calibration, and the definition of special functions.
-  **Probe Profile** icon button - allows configuration of device connectivity, profiles, and button assignments.
- **Probe Modes** group - specifies the technique by which multiple data points are collected.
  -  **Single Point** icon button - one point is collected per press of the button.
  -  **Time** icon button - points are collected continuously at a regular time interval (specified in the **Interval** decimal field), until the button is released.
  -  **Distance** icon button - a point is collected every time the probe has traveled a distance from the previous point (specified in the **Interval** decimal field and **Units** field)
- **Object Name** field - indicates the name of the object that will be stored in the Geomagic Model Manager. **Reset** sets the name to "Scan 001".
- **Scanning Options** group -
  - **Automatic Resize** checkbox - specifies that the real-time graphical Viewing Area will automatically zoom to accommodate the incoming data.
  - **Virtual Camera** checkbox - causes the Viewing Area to continuously reorient itself to simulate the view from an imaginary camera on the arm.
-  **Start Capture** icon button - begins the data capture process by passing control to the arm.
- **Data Options** group -
  - **Merge Scan Passes** checkbox - specifies whether to merge the data from all scan passes into a single object in the Model Manager (or to store every scan pass as a separate object).
  - **Sampling** checkbox - specifies whether to reduce the density of points on each probed object. Sampling occurs at the end of each probe pass. **Spacing** is the target distance between points.

- **Spacing** decimal field - (in conjunction with **Sampling**) specifies the target distance between points.



- **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.

**Definitions:** *Ordered data* is a point cloud of consistent density whose points exist in orderly rows and/or columns. *Unordered data* (also called **Raw** data) is a point cloud of variable density whose points exist at any location in space.

- **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.



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



- **Scanner Profile** icon button (only for the Perceptron V5 Sensor) - allows adjustments like power, point density, scan rate, and laser on/off.




- **Scanner Calibration** icon button (only for the Perceptron V5 Sensor) - allows import of a calibration file from a ScanWorks calibration session.



- **Auto Exposure** icon button (only for the Perceptron V5 Sensor) - sets the exposure time. Exposure is the amount of time the laser light is on.
- **Object Options** group - controls the organization of new scans in the Geomagic Model Manager.
  - **Data Format** dropdown - specifies the kind of data that will be stored in the Geomagic Model Manager. (This choice affects the Store Data In dropdown below.)
    - **Ordered Data Only** - Data will be stored as ordered data.
    - **Raw Data Only** - Data will be stored as unordered (raw) data.
    - **Ordered and Raw Data** - Data will be stored as Ordered data and as Unordered (raw) data in two separate objects.



- **Store Data In** dropdown - The set of choices depends on the Data Format below.
  - **New Group** (selectable when Data Format is **Raw Data Only**, **Ordered Data Only**, or **Ordered and Raw Data**) - A new group (named Group *N*) will be created in the Model Manager and the data will be stored therein (in an object named Scan *NNN*).
  - **New Object** (selectable when Data Format is **Raw Data Only**) - A new object named Scan *NNN* will be created in the Model Manager.
  - **Scan *NNN*** (selectable when Data Format is **Raw Data Only**) - Data will be *added* to the *existing* object named Scan *NNN*.
  - **Group *N*** (selectable when Data Format is **Ordered Data Only** or **Ordered and Raw Data**) - Data will be *added* to the *existing* group named Group *N*, in a new object named Scan *NNN*.
- **Name** field and Reset button - indicates the name of the scan object that will be stored in the Geomagic Model Manager. Names are of the form Scan 001, Scan 002, Scan 003, .... **Reset** restores the numeric part to 001.
- **Scanning Options** - control the operation of the scanner and the display of data.
  - **Automatic Resize** checkbox - specifies that the real-time graphical Viewing Area will automatically zoom to accommodate the incoming data.
  - **Virtual Camera** checkbox - causes the Viewing Area to continuously reorient itself to simulate the view from an imaginary camera on the arm.
  - **Highlight Scan Pass** checkbox - activates 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.
-  **Start Capture** icon button - begins the data capture process by passing control to the scanning device.
- **Enable Clip Plane** checkbox - activates the **Clip Plane** group of controls (which allows a spurious plane such as a tabletop to be eliminated from a scan automatically).
- **Data Options** group - controls the storage of data in the Geomagic Model Manager.
  - **Data Format** dropdown - specifies the kind of data that will be stored in the Geomagic Model Manager. (This choice affects the **Store Data In** dropdown above.)
    - **Ordered Data Only** - Data will be stored as ordered data.
    - **Raw Data Only** - Data will be stored as unordered (raw) data.
    - **Ordered and Raw Data** - Data will be stored as Ordered data and as Unordered (raw) data in two separate objects.

- **Enable Clip Plane** checkbox - activates the **Clip Plane** group of controls (which allows a spurious plane such as a tabletop to be eliminated from a scan automatically). When enabled, use **Clip Plane** group of controls in the **Advanced Options** group, below.
- **Advanced Options** group - presents advanced settings.
  - **Remove Overlap** checkbox - specifies that an entire scan line be rejected if it is mathematically "too close" to the previous scan line. This setting prevents an over-abundance of scan data.
  - **Remove Outliers** checkbox and **Spacing** decimal field - specifies that points be rejected if they are more than Spacing distance from any other.
  - **Reduce Noise** checkbox and **Noise Level** slider - performs a degree of smoothing on the surface that is suggested by the captured points.
  - **Ordered Data Options** group - affects data that is stored in the Model Manager as Ordered Data.
    - **Spacing** decimal field - specifies the exact spacing of the grid-like structure of the ordered data.
    - **Max. Edge Length** decimal field - specifies the maximum length of any side of any square cell. Gaps in the data that are wider than this value are considered to be holes in the object.
    - **Max. View Deviation** decimal field - specifies the change in the scanner angle that causes one scan object to terminate and another to be started automatically. All points in an ordered data object must be visible from a single point of view, so this field controls the automatic breakdown of a "complex" scan into multiple single-view scans.
    - **Filter Angle** decimal field (0.0 to 90.0 degrees) - offers the ability to ignore points collected by the scanner beyond the specified angle. This can result in cleaner data. This operation, like smoothing, is per-scanline.
  - **Raw Data Options** group - affects *all incoming data*, even if it will be stored in the Model Manager as Ordered data.
    - **Shade Points** checkbox - specifies whether to apply shading to the unordered data so that it can be better visualized in the Viewing Area (possibly at the expense of performance).
    - **Sample Points** checkbox with **Spacing** decimal field and **Max. Error** decimal field - specifies whether to reduce the density of points on each scan line. Sampling occurs at the end of each scan pass. **Spacing** is the target distance between points. Sampling tends to "smooth" (reduce the precision of) a scan, so the **Max. Error** parameter controls the maximum distance that a point is allowed to move as the result of such smoothing. Point reduction is performed to achieve the requested Spacing along each scan line, except at specific locations on the line where the

distance between points is allowed to be smaller in order to accommodate the **Max. Error**.

- **Clip Plane** group - (applicable when **Enable Clip Plane** checkbox is checked) specifies a plane that must be eliminated from a scan automatically, such as a tabletop.
  - **Plane** dropdown ("Last Used" plus the names of every plane listed in the Model Manager) specifies a plane that will be eliminated from a future scan. All data above the plane (in the plane's normal direction) will be considered good data. "Last Used" is the most recently used clip plane, from this or a *previous* session of the application or plugin.
  - **Display Plane** checkbox - specifies whether to display the clip plane during the scan.
  - **Flip Normal** checkbox - reverses the normal direction of the clip plane.
  - **Offset** decimal field - specifies a distance in the normal direction by which to shift the clip plane. If an object is resting on an uneven tabletop, and a plane P representing this tabletop is therefore created 2 millimeters higher than intended, and the normal direction of Plane P is "up", and plane P is designated as a clip plane, the scanned object would be missing 2 millimeters of data near its bottom. By setting this **Offset** field to negative 2 mm, the clip plane is lowered. Everything above the tabletop will be included in the scan and every point on and below the clip plane is eliminated.
  - **Add Scanned Plane** button - When pressed, control is passed to the scanning device. The user is expected to scan the tabletop only. When capture is complete, a plane is derived from the captured data and added to the Model Manager as a sub-object called Plane N in a Datums folder under a separate unordered object called Scanned Planes. Next, the plane representing the tabletop may be selected in the **Plane** dropdown above, causing the tabletop to be excluded from future scans.
- **Set to Defaults** button - sets all Advanced Options to their default values.



- **Laser Compare** icon button (visible in Geomagic Qualify, not Geomagic Studio) - Laser Compare 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 (only for the Perceptron V5 Sensor) - allows adjustments like power, point density, scan rate, and laser on/off.



- **Scanner Calibration** icon button (only for the Perceptron V5 Sensor) - allows import of a calibration file saved in a previous session.



- **Auto Exposure** icon button (only for the Perceptron V5 Sensor) - sets the exposure time. Exposure is the amount of time the laser light is on.
- **Initialize** button - initializes the comparison process by creating an empty Result object in the Geomagic Model Manager.
- **Scanning Options** - control the operation of the scanner and the display of data.
  - **Virtual Camera** checkbox - activates the Virtual Camera functionality of the laser scanner.



- **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 no 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 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 corresponding points on the test and reference objects.

*These buttons apply to the just-completed **Hardware Alignment, Features and Datums, Laser Capture, Probe Capture, Laser Capture**, and (in Qualify only) the **Laser Compare** process.*

- **OK** button -
  - For the **Hardware Alignment** function - saves the currently configured alignment. The same alignment will be in effect the next time this plugin is started.
  - For the **Features and Datums** 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 **Probe Capture** function - saves captured data into the Model Manager as an unordered point object.
  - For the **Laser Capture** function - performs any incomplete shading and saves scanned data into the Model Manager.
  - For the **Laser Compare** 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 differences between the test and reference objects.
- **Cancel** button - cancels un-OK'd results of the just-completed process.
- **Merge** button - closes the plugin and pops up the Merge Scans Dialog for the purpose of merging any set of objects that exist in the Model Manager. Optionally, the Merge Scans dialog can merge the Features and Datums from a specified object into the merged result. This mechanism eliminates the need to perform similar actions manually using multiple commands in the Studio or Qualify application. The controls and indicators in the Merge Scans dialog are:
  - **Output Type** radio buttons - specify the type of the resulting object.
    - **Point Cloud** radio button - ordered or unordered point objects are merged into an unordered point object.
    - **Polygon Model** radio button - the resulting point object is “wrapped” to produce a polygon object.
  - **Datums and Features** group - specifies whether to merge the Datums and Features of a given object into the resulting object.
    - **Copy datums and features from** checkbox and dropdown - adds the named object's Datums and Features into the merged result.
    - **Delete object after copying** checkbox - whether to delete the entire object named above when the merge is complete.
  - **Object Type** radio buttons (**Unordered** and **Ordered**) - specify the sub-type of the point objects that are included in the Select Objects to Merge list.
  - **Select Objects to Merge** list - lists point objects that exist in the Model Manager. Click, Ctrl-Click, or Shift-Click to select a set that will be merged when you click **OK**.
  - **OK** button - performs the merge, saves results, and closes the dialog.
  - **Cancel** button - terminates the **Merge Scans** dialog without saving.

# Feature/Datum Info Window

The Feature/Datum Information Window is a standalone program that launches automatically when a user begins hard probing features or datums. This window supplies more real-time feedback than the basic plugin.

Probe Information (in)	
Current Position	Last Point
X:	X: 39.3701
Y:	Y: -196.8504
Z:	Z: 0.0000

Feature Information	
Entity	Points Collected
Circle: Hole 001	6
Dimensions (in)	
Diameter: 324.8582	ERROR: 12.3531
Position	Normal
X: 98.3004	X: 0.0000
Y: -50.9561	Y: 0.0000
Z: -7.8740	Z: 1.0000

Unless minimized, this window is always on top.

This window uses the same units as the plugin. Changing the units in the plugin will change the units of this window. Units affect these values: Current Position, Last Point, Dimensions, and Position.

## Elements of the Display

The elements of the display are:

- **Probe Information** group - indicates real-time data about the physical probe.
  - **Current Position** - indicates the current location of the hard probe.
  - **Last Point** - indicates the xyz coordinates of the last collected point.
- **Feature Information** group -
  - **Entity** group - indicates the type, name, and number of the feature or datum being probed.
    - Feature or Datum **Type** (such as "Circle")
    - Feature or Datum **Name and Number** (such as "Hole 001")

- **Points Collected** group - indicates the number of points collected.
- **Dimensions** group - indicates physical dimensions of the feature or datum, but only if and when such dimensions can be ascertained.
  - **Diameter** (if and when ascertainable) - indicates the diameter of the feature or datum.
  - **Length** and **Width** (if and when ascertainable) - indicates the length and width of the feature or datum.
  - **Error** - indicates the least squares fitting error. The feature or datum is refit every time a new point is collected (once enough points are collected to attempt a fitting) and the error for that fit is displayed.
- **Position** group (if ascertainable) - indicates the xyz coordinates of the center of the feature or datum in real time. Some features and datums have no center, such as a plane.
- **Normal** group - indicates the normal or axis or direction of the feature or datum.

## Dropdown Menus

The dropdown menus of this application are: **File**, **Options**, and **Show**.



- **File > Close** - hides the Information Window. This is the same as pressing the top-right **x**. The window can be made visible again by pressing the **Show/Hide Information Window** button on the main plugin dialog.
- **Options > Font Size** - changes the font size of displayed information. Titles are always half the height of displayed information.
- **Options > Decimal Places** - changes the number of digits displayed after a decimal place.
- **Options > Set Background Color** - controls the background color of the data display area and automatically changes the font color to a contrasting color.
- **Options > Set Border Color** - controls the border color of the data display area.
- **Show** menu - controls the set of elements that are included in the window. If all parts of a group box are unchecked, that group box disappears as well.




# 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

*(If the name of a Datum Plane is highlighted in the **Datum Plane list** above, that Plane will serve as the new Feature's plane and you will skip steps 3 and 4 here.)*


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


*(If the name of a Datum Plane is highlighted in the **Datum Plane list** above, that Plane will serve as the new Feature's plane and you will skip steps 2 and 3 here.)*

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

*(If the name of a Datum Plane is highlighted in the **Datum Plane list** above, that Plane will serve as the new Feature's plane and you will skip steps 2 and 3 here.)*

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

*(If the name of a Datum Plane is highlighted in the **Datum Plane list** above, that Plane will serve as the new Feature's plane and you will skip steps 2 and 3 here.)*

1. Click the feature **Rectangle** 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 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

*(If the name of a Datum Plane is highlighted in the **Datum Plane list** above, that Plane will serve as the new Feature's plane and you will skip steps 2 and 3 here.)*

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.

## Special Use of Del Key During Feature and Datum Creation

During the hard-probing of a feature or datum, the most recently probed point appears in red in the Viewing Area. *(After the hard-probing of a feature or datum -- after you probe the offset, all points revert to black.)* To delete the most recent (red) point, press the **Del** key. Press **Del** again to delete the second most recent point, or repeatedly to delete all points.

When the hard-probing of a feature or datum is complete (when you have probed the offset, and points in the Viewing Area have reverted to black), you can start probing the points of a new feature or datum, stop the probing process and return to the dialog, *or* press **Del** to delete the most recent feature or datum.



## 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.

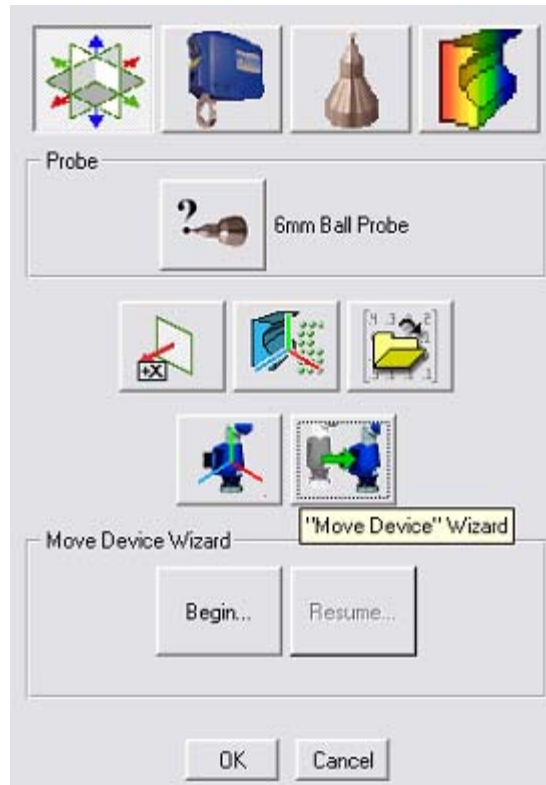
1. Scan part of an object.
2. If "Move Device" is not necessary, save the scan by pressing **OK**.  
If "Move Device" is necessary (because space or the length of the arm did not allow a complete scan), press the **Alignment** icon button.

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.

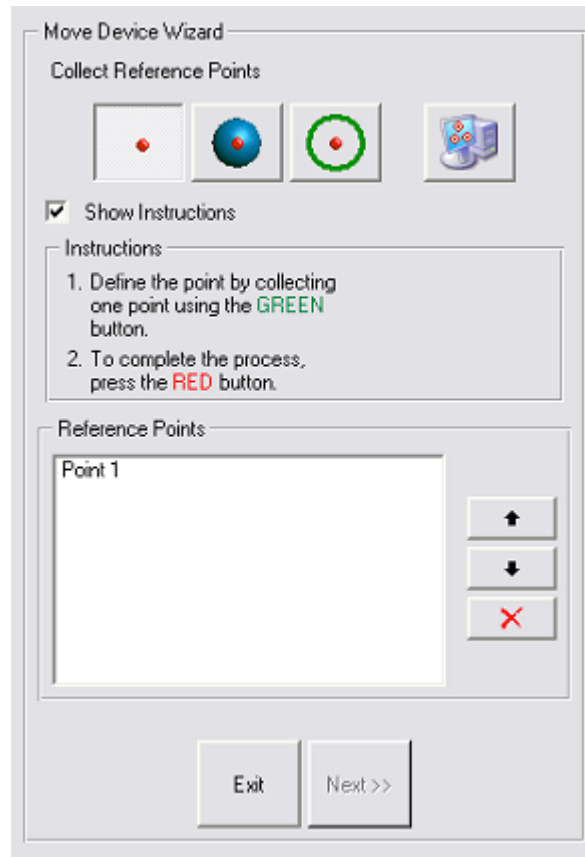
4. This is the "Move Device" Home Panel. It has two buttons:
- **Begin** button - begins a new "Move Device" process. Go to the Reference Point Collection Panel in Step 5.
  - **Resume** button - returns to the panel on which you previously pressed **Exit** and saved the state of the "Move Device" process: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



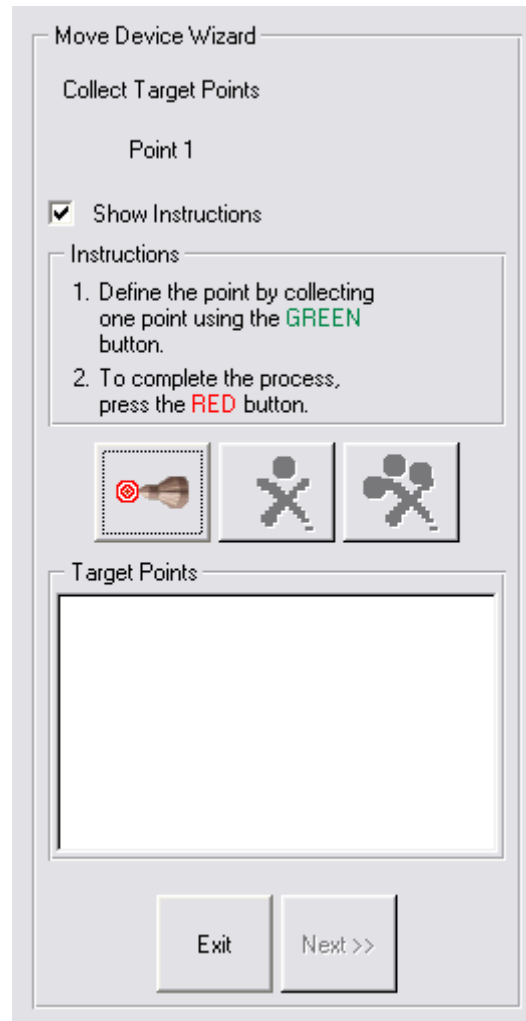
-  **Previous Targets** - You will replicate the same set of target points that were used in the previous “move”. Use this method when the same points will still be within reach of the probe after the arm or part is moved.
  - **Show Instructions** checkbox - specifies whether to display instructions 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 identified.



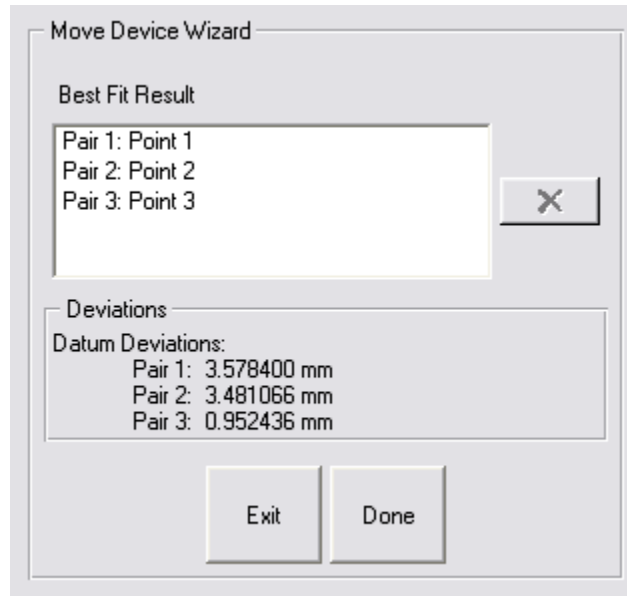
Target Point Collection Panel

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 pairs 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 Scanning panel (in Step **1**) for continuation of the scan process.

# Detailed Examples

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

## ALIGNING TEST AND REFERENCE PARTS WITH 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.
9. Click the large **Laser** icon to activate scanning mode. Begin scanning. Scan data appears on the screen in alignment with the CAD reference object.
10. Exit the plugin by clicking the **OK** button. In the Model Manager, notice that the newly created scan object is now the test object.
11. 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.
2. In the **Current Probe** pulldown, select **Laser Probe** then click **OK**.
3. In the **Laser Capture** dialog, **Data Options** section, pick a **Data Format**. This specifies whether future scan(s) will be stored in the Model Manager as ordered data, unordered data, or as both (in two separate objects). With Geomagic Qualify, you probably want unordered data because it is an exact representation of the object and lends itself to inspection. With Geomagic Studio, you probably want ordered data because it is easier to handle during an engineering process.
4. In the **Laser Capture** dialog, **Object Options** section, pick a **Store Data In** option. This controls whether the scan data will go to the Model Manager as: a new object in a new object group, as a new stand-alone object that is not in an object group, as data to be appended to an existing scan object, or as a new object in an existing object group. Your choice depends on how you like to organize scan data.
5. To perform a scan and thus transfer data to the Geomagic Model Manager:



- Click the **Start Capture** icon.
  - Click the **Pause/Unpause** button on the scanner and make scan passes.
    - During the scanning process, use the on-screen range finder to keep the scanner at a suitable distance from the physical object. The “blue range” is ideal.
    - 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.
6. If all scanning is complete, press **OK** to close the plugin.


7. If it is necessary to change the **Data Format** option, go back to Step 3.
8. If it is necessary to change the **Store Data In** option, go back to Step 4.
9. Go to Step 5 and perform the next scan.

### EXAMPLE OF LASER COMPARE

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 summarized at **Hardware Alignment** on page 3.
2. Next, designate a CAD object as the reference object in the Geomagic Model Manager.
3. Click the **Laser Compare** 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. To perform a scan and thus transfer unordered (raw) data to the Geomagic Model Manager:



- Click the **Start Capture** icon .
- Click the **Pause/Unpause** button on the scanner and make scan passes.
  - During the scanning process, use the on-screen range finder to keep the scanner at a suitable distance from the physical object. The “blue range” is ideal.
  - 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.
- 7. If the physical part is larger than the reach of the scan arm, go to [Move Device](#) on page 21, then return to this step.
- 8. If more scanning is necessary, go to Step 6.
- 9. 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.

