

FARO ScanArm Plugin

For compatibility with Geomagic products, see *Release Notes for Geomagic FARO Plugin*

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This plugin enables Geomagic Studio and Geomagic Qualify to interact with a FARO ScanArm. (This plugin is an optional, separately licensed feature for Geomagic products. If the name of this plugin does not already appear at **Hardware > Scan**, download the software from the plugin area of support.geomagic.com and install it according to instructions on the web site.)

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

Turn on the FARO scanner *before* selecting **Hardware > Scan > FARO**.

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.

- **During Laser Scanning:**
 - **Red** Buttons (identical function; known as the **Stop** buttons) - Stops and returns control to the plugin dialog.
 - **Green** Buttons (known as the **Pause/Unpause** buttons) - Press once to activate the laser and scan the physical object. Press again to pause the scanner. 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 **Red** button to stop scanning and return control to the plugin dialog.
- **During Hard Probing:**
 - **Red** Buttons (identical function; known as the **Offset/Stop** buttons) - stops an operation or defines an offset.
 - **Green** Buttons (known as the **Collect** buttons) - collects a point.

Software Controls and Indicators

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

Hardware Alignment icon button



- **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 incor-

rectly 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 on the object that will be scanned, such as inches or millimeters.
- **Probe Controls** group - contains hardware-specific controls.



- **Hardware Configuration** button - presents device-specific configuration settings.



- **Probe Options** button - presents a popup window in which you specify and calibrate the physical probe that is attached to the FARO arm. In the **Current Probe** dropdown, identify the currently installed hard probe (such as **3mm Ball Probe**). Optionally, perform calibration of that probe. Click **OK**.

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



- **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” procedure. See [“Move Device Procedure”](#).
- **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.

Coordinates

| | |
|-----------|-------------------|
| X: | -0004.8074 |
| Y: | -0002.9331 |
| Z: | -0003.7950 |

Probe Capture Icon Button



- **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.



- **Hardware Configuration** button - presents device-specific configuration settings.



- **Probe Options** button - presents a popup window in which you specify and calibrate the physical probe that is attached to the FARO arm. In the **Current Probe** dropdown, identify the currently installed hard probe (such as **3mm Ball Probe**). Optionally, perform calibration of that probe. Click **OK**.
- **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).



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

Laser Capture Icon Button



- **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 on the object that will be scanned, such as inches or millimeters.
- **Scanner Controls** group - adjusts laser scanner settings.



- **Hardware Configuration** button - presents device-specific configuration settings.



- **Calibrate Scanner:** Click this if calibration is required for the laser probe. Some procedures may also require calibration of the hard probe..



- **Scanner Options:** Brings up a device-specific dialog that allows specific adjustment of the laser scanner operations.
- **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** above.
 - **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 scan data.
 - **Virtual Camera** checkbox - activates the Virtual Camera functionality of the laser scanner.
 - **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.



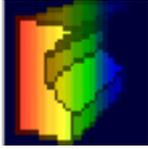
- **Start Capture** icon button - begins the data capture process by passing control to the scanning device.
- **Enable Clip Plane** checkbox - activates the **Clip Plane** group of controls (which allows a spurious plane such as a tabletop to be eliminated from a scan automatically).
- **Advanced Options** 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 - 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 - 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 subobject called Plane *N* in a Features 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 Capture Icon Button



- **Laser Compare** icon button (visible in Geomagic Qualify, not Geomagic Studio) - **Laser Compare** (previously called 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 Laser Comparison of the scanned object to a reference object.
 - **Scanner Controls** group - is identical to the “**Scanner Controls** group” for the **Laser Capture** icon button.
 - **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 insufficient 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 corresponding points on the test and reference objects.

OK, Cancel, and Merge Buttons

*These buttons apply to the just-completed **Hardware Alignment**, **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 **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. 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.
 - **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.

Referencing the Encoders

If a graphical representation of the FARO arm pops up, you must now “reference the encoders”. Exercise the arm in every direction until the red arrows on the graphical display disappear.

Calibrating the Hard and Laser Probes

From time to time, especially after moving the scanner to a new location, you will calibrate the hard and laser probes.

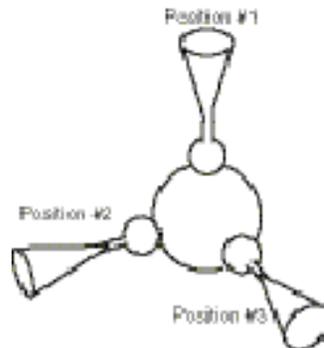


1. Press the large **Laser Capture** icon, then the **Calibrate Scanner** icon.
2. Before calibrating the laser scanner, the hard probe must be calibrated (or must have been calibrated already). In response to the prompt, select one of the following radio buttons based on the “condition” of the hard probe.
 - **Hard Probe Sphere Calibration** - Neither the hard probe nor the laser scanner have been calibrated. Press this button to be taken to the beginning of the hard probe calibration process, then to the laser scanner calibration process. (This is the same as selecting **Alignment | Probe button | Sphere Calibration** or **Hard Probe | Probe button | Sphere Calibration**.) Go to Step 3.
 - **Measure Sphere With Current Hard Probe** - The hard probe has been calibrated, but it is now clamped to the table in a different position with respect to the calibration sphere. Press this button to be taken to the positioning part of the hard probe calibration process, then to the laser scanner calibration process. Go to Step 2.
 - **Use Previous Values** - The hard probe has been calibrated and it is still clamped to the table in the same position with respect to the calibration sphere. Press this button to be taken to the laser scanner calibration process. Go to Step 5.
3. In the **Current Probe** pulldown, identify the currently installed hard probe, such as **3mm Ball Probe**, then click **OK**.
4. If a graphical representation of the FARO arm pops up, you must now reference the encoders. Exercise the arm in every direction until the red arrows on the graphical display disappear.

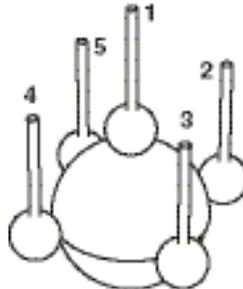
- Based on the availability of FARO accessories, choose between sphere calibration and plane calibration. See *Sphere Calibration Sub-Procedure* or *Plane Calibration Sub-Procedure*.

Sphere Calibration Sub-Procedure

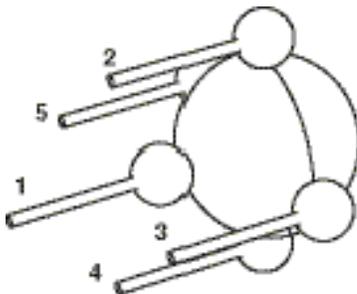
- You have chosen sphere calibration. The next three steps refer to Position #1, #2, and #3 as indicated in the following diagram.



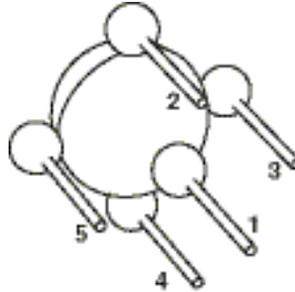
- In the order indicated by the on-screen illustration, digitize five points around the top of the sphere in probe position number 1.



- In the order indicated by the on-screen illustration, digitize five points around the front of the sphere in probe position number 2.



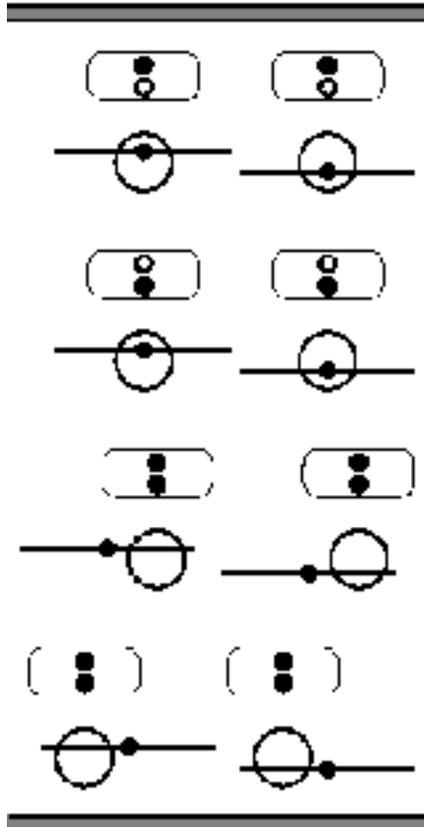
- In the order indicated by the on-screen illustration, digitize five points around the side of the sphere in probe position number 3.



After five points are digitized on each of three angles, an internal calibration process begins.

- If the probe passes the test, the **Calibration Status** is set to Passed and the current date and time appear in the time indicator. Click **OK**. Calibration of the standard (hard) probe is complete.
 - If the probe fails the test, the **Calibration Status** is set to Failed. Click **Retry** and go to Step 2.
5. To calibrate the laser probe, you will digitize eight points from *each* of the three positions, starting with the top view (position 1), a side view (position 2), then the front view (position 3).

Use the on-screen range finder or the two LEDs on the back of the scanner to judge the definition of **Near** range and **Far** range. Starting at position 1, digitize two points in the **Near** range with the **center** of the laser -- one point on the upper half of the calibration sphere and one point on the lower half. The Near range is indicated by the upper green LED on the range finder. The Center range is indicated by both green LEDs on the range finder. The Far range is indicated by the lower green LED on the range finder.



6. Digitize two points in the **Far** range with the **center** of the laser -- one point on the upper half of the calibration sphere and one point on the lower half.
7. Digitize two points in the **Center** range with the **left** side of the laser -- one point on the upper half of the calibration sphere and one point on the lower half.
8. Digitize two points in the **Center** range with the **right** side of the laser -- one point on the upper half of the calibration sphere and one point on the lower half.
9. Move to position two, which is the left or right side of the sphere.
10. Digitize two points in the **Near** range with the **center** of the laser
11. Digitize two points in the **Far** range with the **center** of the laser
12. Digitize two points in the **Center** range with the **left** side of the laser
13. Digitize two points in the **Center** range with the **right** side of the laser
14. Move to position three, which is the front side of the sphere.
15. Digitize two points in the **Near** range with the **center** of the laser
16. Digitize two points in the **Far** range with the **center** of the laser
17. Digitize two points in the **Center** range with the **left** side of the laser
18. Digitize two points in the **Center** range with the **right** side of the laser

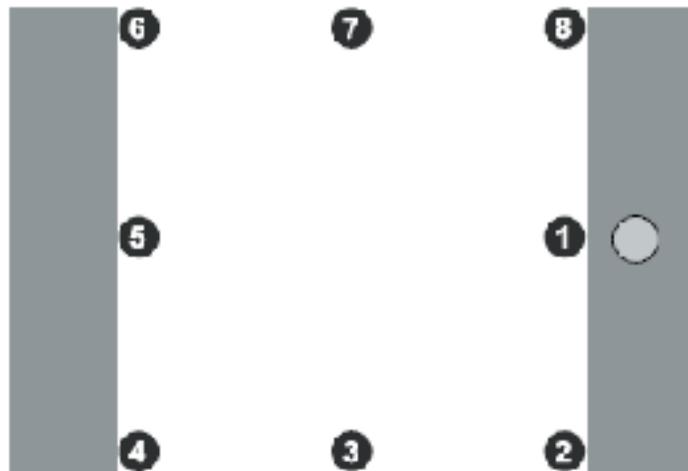
After eight points are digitized in each of three positions, an internal calibration process begins.

- If the probe passes the test, the **Calibration Status** is set to Passed and the current date and time appear in the time indicator. Click **OK**. For details on the calibration of both the hard and laser probes, click **View Log** and see the FaroArm USB manual for details. Calibration of the laser probe is complete.
- If the probe fails the test, the **Calibration Status** is set to Failed. Click **Retry** and go to Step 5.

Plane Calibration Sub-Procedure

You have chosen plane calibration. You will calibrate the hard and laser probes to a plate that is installed on the table.

1. To calibrate the hard probe, touch the white surface with the hard probe at position 1, then press the **FRONT** button, then repeat at seven more positions.

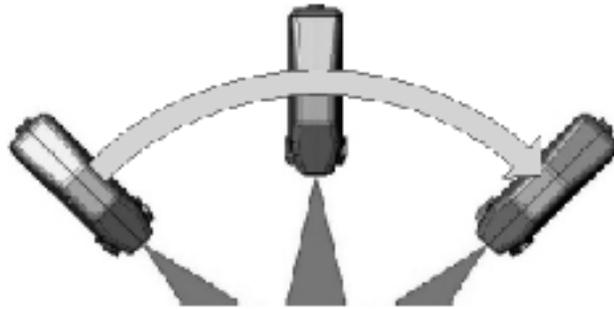


2. Pull the probe away from the surface and press the **BACK** button.
3. If the dialog box indicates failure, click **RETRY** and go to Step 1. If the dialog box indicates success (flatness of the plate), click **OK** to continue.
4. You will now digitize the white area of the calibration plate with the laser probe. Aim the laser line at the middle of the white surface.

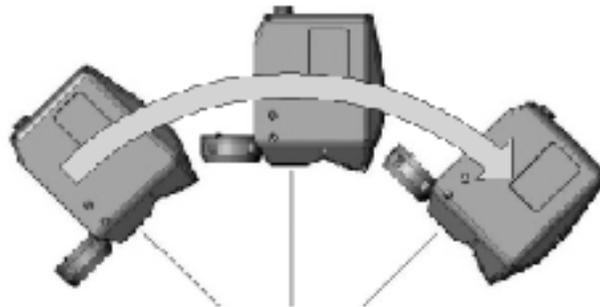


5. Move the laser probe until the laser is in the **center** range.
6. Press the **FRONT** button and move the laser probe according to the diagram while maintaining aim at the center of the white sur-

face.

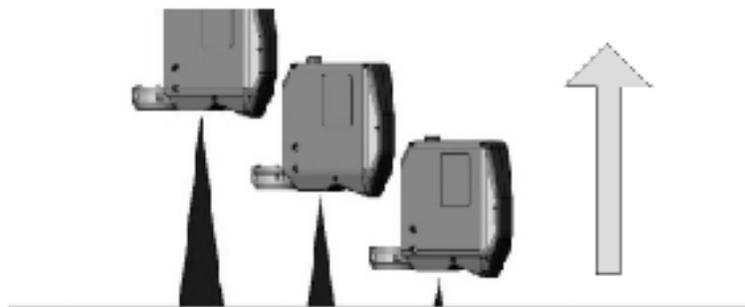


7. Press the **BACK** button.
8. Rotate the laser probe 90 degrees and repeat steps **4** thru **7**.



9. You will again digitize the white area of the calibration plate with the laser probe. Aim the laser line at the middle of the white surface.
10. Move the laser probe until the laser is in the *near* range .
11. Press the **FRONT** button and move the laser probe to the *far* range

 while maintaining aim at the center of the white surface.



12. Press the **BACK** button.
 - If the probe passes the test, the **Calibration Status** is set to Passed and the current date and time appear in the time indicator. Click **OK**. For details on the calibration of both the hard and laser probes, click **View Log** and see the FaroArm USB manual for details. Calibration of the laser probe is complete.
 - If the probe fails the test, the **Calibration Status** is set to Failed. Click **Retry** and go to Step **1**.

“Move Device” Procedure



“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 Scan** icon button, then **Start Scan**. 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.

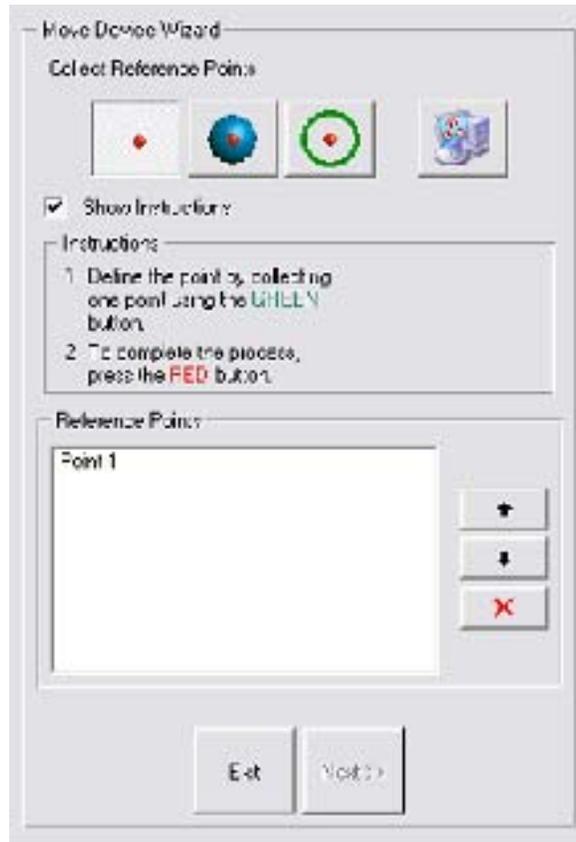
4. This is the “Move Device” Home Panel. It has two buttons:
- **Begin** button - begins a new “Move Device” process. Go to the Reference Point Collection Panel in Step 5.
 - **Resume** button - returns to the panel on which you previously pressed **Exit** and saved the state of the “Move Device” process: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

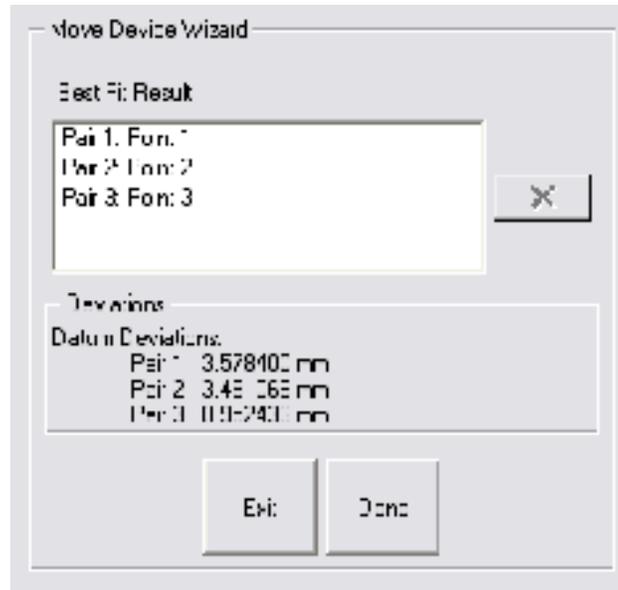


- **Re-Define Last Target** icon button - after pressing the **stop** button on the scanner to stop collection, press this to delete the most recently collected target point and to automatically re-start the identification of targets.



- **Clear All Targets** icon button - after pressing the **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 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.

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 the **Features** tab to create 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 features on a test object that is resting in a test fixture (without laser scanning the test object). The features become sub-objects of a special "blank" test object named "Feature Object" that records the position of the 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 "Feature Object". Note the existence of feature sub-objects under the Feature Object.
 - *Laser Technique* - Continue to the next step.
6. Perform one of the following:
 - *Hard-Probe Technique* - Use **Alignment > Object Alignment > Feature-Based Alignment** on the test and reference objects (which aligns the reference object with the special test object by aligning their common Features).
 - *Laser Technique* - Use **Alignment > Object 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 ref-

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 **start** 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 **start** button again to pause scanning. The scan arm acts as a virtual camera when scanning is not active. Click the **start** 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 available behind the **Hardware Alignment** icon button.
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 Scanner** or **Scanner 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 **start** 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 **start** button again to pause scanning. The scan arm acts as a virtual camera when scanning is not active. Click the **start** 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 Procedure](#)", 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 automati-

cally designated as the test object in the Model Manager, and the comparison results are saved to a Result object in the Model Manager.