LaserQC AFM Training

Entering the 3rd Dimension with Automated Form Measurement
This Presentation assumes you have completed & understand the Standard LaserQC (2D) training

1. How it works
2. 3D Surface Scan Settings
3. AFM Dimensioning
4. Heights, Slopes, & Flatness
5. Formed measurements & Part “Fixturing”
6. Cross-Sectional Scanning
Traditional Laser scan data is first collected from the part (2D review)

• Laser light is emitted from the diode, gets collimated through a lens, and 2 mirrors mounted to galvanometers steer the beam around the table.
  • The laser straddles the edge of the part in a “zigzag” motion.
  • The system gains and loses the return signal as the Laser moves on and off the edges of the part.
• This data is collected and rendered in real time on the screen.
We perceive depth & 3D objects by processing the same image from 2 separate positions (Our left & Right eye).

The AFM system can do a similar thing using the Laser & the Camera, to measure height.
How it Works

- The Laser Projects a small circle onto the part
- Second Set of Galvos allows the camera to “follow” the Laser
- The Camera takes multiple pictures of the circle
- Height then calculated by triangulation using the position of the Laser and the camera, which is then rendered on screen
Corrective Height Scanning

Height Measurements taken by the Camera can be automatically applied to the Laser Scan data to increase the Accuracy & Repeatability of inspection results in 2D scanning, as well as measure heights and slopes.

There are several ways to automatically acquire height data that are specified in the scan settings dialog box prior to scanning.

“Features” is most commonly used
Corrective Height Scanning

- Specify height sample spacing.
- Spacing can be specified for X and Y direction for “Grid” & “Full”
  (separated by a comma “,”)
- Example: 1.00, 0.5
  One inch spacing in X & half inch spacing in Y
3D Adjust Only

- System takes height measurements only when required to calculate dimensions in an ICS file that have the “3D Adjust” Modifier box checked.
- Camera is essentially disabled when scanning without a CAD model.
3D Surface Scan Settings

Features

• System takes height measurements along all scanned edges of the part.
• Distance between measurements is defined by the value entered beside the selected “3D surface scan” type.
• Height data collected is applied to the adjacent scan data.
Grid

- System takes height measurements in a grid pattern.
- Grid size is defined by the value(s) entered beside the selected “3D surface scan” type
- Grid is always parallel to system axis (the frame/glass edge)
- Location of height measurements is defined by part orientation and Grid size.
- Most common use is when a full flatness colour coded profile is desired
3D Surface Scan Settings

Full

- A combination of Features and Grid surface scanning.
- All scan data is corrected for height
- Full colour coded flatness profile can be generated
AFM Dimensioning

General Considerations

• AFM is not a true “full 3D” system.
• It does not read 3D CAD/surface models directly. It employs Height measurements from the camera to apply a height correction to data, measure slopes, heights, distances, etc, matched to a 2D/Orthographic 1st or 3rd Angle projected CAD view(s) of a formed part.
• 3D Datums & Origin can be established to measure from a plane other than the glass surface.
• Part Edges, though corrected for height, are ALWAYS considered perpendicular to the glass surface, regardless of established Datums and CAD entities, and properties applied.
• Height should NOT be taken on visible areas smaller than 0.125”x 0.125” or within 0.125” (3mm) of part edges. If smaller samples are required special care & considerations may be needed when generating ICS’s & inspecting parts.
• Projected circle size used to take height measurements is defined by the radius of the reference circle added using the Add CAD feature.
• Slope & Flatness dimension types require a minimum of 3 reference points to create a plane.
• Reference circle locations should not be collinear. Meaning the point locations selected should be asymmetrical, and not have to ability to be resolved into a line.
• Turn on the Add CAD tool.
• Right click at the desired location to add the reference circle.
• Enter the nominal height of the circle on the part. (Default is the value entered for Thickness in the Inspection report.)
• Radius defines the size of the circle.
  • 95% of the time the default is acceptable.
  • A smaller radius may be required if the local area is smaller than 0.125”² (3.2 mm²), keeping in mind you should also be approx 0.125” (3.2mm) away from part edges as well.
  • (Do Not enter a radius smaller than 0.040” (1.0 mm). This can result in inaccurate or failed measurements.
  • There is no logical reason to use a reference circle with a radius larger than the default.

• Click “NEW” then “CLOSE” to add a reference circle
• Scan the part using the partially completed ICS file.
• Select the Digitize tool
• Select height gauge, then Digitize.
• Using the mouse move the Laser projected cross hair to the desired location and left click to take height sample.
• Repeat as required.
• Click left & right mouse button to complete Digitizing and OK to close.
• Using Add CAD tool, right click on measured height, to add a reference circle at that specific X,Y,Z location.
Height Measurements

• Measurements can be taken by using either:
  • Existing CAD holes
    OR
  • Reference Circles added using Add CAD feature

• Only Single circles can be used
• If multiples are used a single height is reported by creating a plane and calculating the height at the centroid of the constructed tangent circle or extent box (represented on screen as a dashed line).
• Heights that are not created relative to another point on the part are measured relative to the glass surface (bottom surface of the part touching the glass) or a user defined 3D Origin or Datum.
Absolute Height Measurement

Measure single height or part thickness (relative to glass surface/3D Origin/Datum)

- To create a measurement right click twice on the hole or reference circle.
- Select Height dimension type.
- Nominal default height is the value entered when creating the reference circle
  OR
- The Height offset applied in the material properties.
- Modify Nominal height & tolerance as required.
Relative Height Measurement

Measure the height of flange, stand-off, embossment, depth of cutout etc…

• To create the height measurement right click on the first circle, then right click the second circle.
  • First selection defines the measured height.
  • Second selection defines what the measurement is relative to.
• Select Height dimension type.
• Nominal default height will be the relative difference between the nominal height of each entity selected.
AFM Dimensioning

Height Using Multiple Samples

Measure relative height of planes

• First create 2 groups using the Grouping tool
• Right click 1 any entity in the group, then Right click on any 1 entity in the second group.
• Nominal default height will be the relative difference between the nominal planar height of each group selected.
  • First selection defines the measured height.
  • Second selection defines what the measurement is relative to.
  • To/From modifiers can change nominal/measured value if the established planes are not parallel to the glass surface as they determine point of measurement.

• Creating Groups: Crtl+ Left Click all entities in group, then click group icon
Measuring Slopes

- A Plane describes a surface in 3D that has Zero (0) thickness and Zero (0) curvature.
- Minimum 3 reference points required to create a plane.
- A Slope is the relative angle of a plane.
- Generally speaking it’s a bad idea to use CAD circles (cut holes) to create a plane when the intent is to measure slope.
  
  Since projected CAD views must be used, in which case some holes, may import as ellipses, or have deceptive locations based on the view. CAD holes parallel to the glass would be acceptable, however there is no control over the location of height sample, possibly influencing repeatability.

- It is better to use reference circles added using the Add CAD tool.
• The 3 points must be asymmetrical and not form a line.
• LaserQC projects 3D measurements onto 2D orthographical (angle projection) CAD models. As a result there may be cases where the reference circles appear to form a line, however; when the Z (height) component is considered, the minimum requirements to define a plane are satisfied.
AFM Dimensioning

Measuring Slopes

Measuring a single slope relative to the glass surface.

- create a group containing a minimum of 3 reference circles.
- Using the Report Inspection button, right click twice on any of the circles in the group.
  - Select Slope Dimension Type
  - If the height for each grouped reference circle is exact, the calculated nominal angle will be correct.
  - Adjust nominal value accordingly
Measuring Slopes

Measuring the angle between slopes

• create 2 groups containing a minimum of 3 reference circles each.
• Using the Report Inspection button, right click on any of the circles in the 1st group, then right click on the second.
• Select Slope Dimension Type
• If the height for each grouped reference circle is exact, the calculated nominal angle between planes will be correct.
• Adjust nominal value accordingly
Measuring the Flatness of single plane

- Using a group containing a minimum of 3 reference circles.
- Right click twice on any circle in the selected group
- Select Flatness Dimension Type
- Nominal value is always 0.0000
Colour Coded Flatness Profile

Typically works best for parts that are nominally flat (not formed/bent parts)

The system graphically displays the height of each point, relative to the plane:
• Points well below the plane in Blue
• Points near the specified nominal distance from the plane (typically 0, or in the plane) are in Green.
• Points above the plane in Red.
• Intermediate colours illustrate the full range of heights.
Colour Coded Flatness Profile

Second Level Inspection option available from the Set Inspection Tolerance window

• Select what page you wish the profile to be drawn on.
• Select what reference plane to use.

• Click Auto to the scale range.
Colour Coded Flatness Profile

Second Level Inspection option available from the Set Inspection Tolerance window

- Plane fit
  Profile displayed relative on an auto created best fit plane

- Support glass
  Profile displayed relative to the main support glass plane

- 3D datum
  User defined plane generated using CAD entities & Datum ref. Dimension type

- 3D Origin
  User defined plane generated using only scan data and the origin tool.
Creating a 3D Datum

3 Datums are required to correctly locate a part of inspection; Primary, Secondary, Tertiary (“Plane, Point, & Line” or A, B, C)

- LaserQC assumed the Primary Datum to be bottom surface of the part (support glass surface)
- AFM system now allows the Primary datum be redefined.

- Ctrl + Left click minimum 3 reference circles to group
- Right click twice using report dimension tool
- Select Datum Ref. dimension type
- In the Inspection Report Select 3D Datum
- Order the dimension IDs according to B, C, A as they are shown on your drawing.
Creating a 3D Origin

3D origin can be created only when no CAD model existing. It allows height measurements reported using Virtual Calipers tool and flatness profiles to be measured relative to a user defined plane.

- Using the Origin button
- Right click on the height sample (or multiple samples to determine a planar average) to define a Z component for the origin
- Z component of the origin is represented on screen using a black dash-line crosshair.
- (If required) right click on scan data entities to define the 2D axis as normal
Formed parts can be measured provided the 2D projection drawing views are available.
Formed Measurements & Part “Fixturing”

• Measurements along a Bend Radius or Folded Edge can be inaccurate and unreliable due to the fact that the location of the data points can not be accurately predicted and is greatly affected by part position, orientation and scan settings.

• Folded Edges present a problem due to the fact that there is inadequate surface area to for the camera to accurately apply height correction to the scanned edge.
• Measuring the height of a folded edge may be possible provided
  • The material thickness is 0.6” or greater,
  • The bend angle is 90”, making the part edge parallel to the glass surface.
Formed Measurements & Part “Fixturing”

Adding Magnetic Reference Disks

- Problems can be avoided by measuring using Tangent points on the vertical surfaces
- Tangents are created by using Magnetic references Disks

- Using the Add CAD feature
- Right click twice on the CAD entity representing the edge/surface requiring the Disk.
- Check “Reference Location”
- Select 0.1350” x 0.5000” x 0.5000” or 3.43 x 12.70 x 12.70mm from drop down menu.
- Default position of the Disk is the centre of the line segment.
- Use >>> Button to cycle through start, end middle of line. Or position by using the slider bar
- A precise position can be selected by typing a value in the text box.
Formed Measurements & Part “Fixturing”

Adding Magnetic Reference Disks

• Add the height of the Disk **FROM THE BOTTOM OF THE DISK TO THE BOTTOM OF THE PART!!!!!!**
• Select the appropriate position of the Disk from the drop down menu.
• Click New then Close
• Using the Report Inspection button, right click the Reference Disk and then right click the appropriate CAD entities to create the desired dimension.
• Select appropriate Dimension Type.
• Check the appropriate Edge modifier.

It is possible to create tangent lines using multiple Reference Disk.

OR
Dimension from one Disk to another
Placing Magnetic Reference Disks

• Reference Disks should be positioned in such a way as not to influence the dimension(s) they are intended for.

  If used for height they must be placed on the top edge, and a formula dimension used to subtract the height of the Disk, or measured relative to a second disk so to eliminate the disk height from the relative dimension

• The height offset entered when adding reference disks to the ICS file must be accurate enough to ensure their location is projected accurately to aid user in precise placement of the disks onto the part for inspection. Incorrect positioning may result in missing dimensions.
Selecting Alignment Features

The only purpose of the alignment features is to bring the match in close enough alignment with the CAD model in order to correctly identify and measure features (make Auto Match work more efficiently)

This is especially important when a 3D formed part is matched to a 2D projected CAD model (top view). Selected features are projected by the Laser prior to part inspection to allow an operator to align specifically to the key features.

E.g.; features parallel to the support glass, with a known height, that would work well if projected to help the operator align the part
If none exist use Magnetic reference disks
Selecting Alignment Features

Selected alignment features will appear red in the Scan Sequence preview window.

- Ctrl + Left click appropriate features for alignment.
- Click Inspection Report button
- Click Scan Sequence
- Select User defined from drop down menu
- Check “Use selected entities
- Confirm prompt messages that appears.
- OK & Close
Cross-Sectional Scanning

How it works

Using Selected Alignment features can prove useful when using this feature.

- Camera takes numerous height measurements along a reference line.
- Number of measurements (sample density) is user defined when creating the section dimension
- Height measurements are converted to scan data points and translated onto the part profile.
Height measurements are then converted to scan data and translated onto the profile view of the part, defined by the section command dimension created.
CAD Requirements

- Side view used for section command must be a projected view.
- Meaning it must be the same scale (1:1), and line up exactly either left and right or as in this case top to bottom.
- It must be known whether the view is first or Third angle projection.
- Measurement spacing (resolution) is user defined when creating the section dimension and is different from what is defined when scanning the part.
- A reference line must be added to the Top View to define where the height measurements to plot the profile are to be taken.
- The reference line should be outside of 0.125” (3mm) from inside features & part edges where possible.
First Vs. Third Angle Projection

- First Angle used primarily in Europe
- Third Angle in Australia & The Americas
- Projected views describe a 3D part in 2D; using multiple views.
- Imagine placing the part in a glass box.
- 3rd Angle projection would have you trace the what you see on the glass
  - the higher parts of the profile are closer to the central, top view of the part
- 1st Angle view would have you shine a light on the part and trace the shadow cast on the opposite side.
  - the higher parts of the profile are furthest from the top view.
- Both 1st and 3rd angle projection will fully describe the part, it’s just a matter of how you look at it!
• To change the projection angle, if different to global default (set in system configuration)
• Click Inspection report button,
• Click Default settings
• Under Drawing, change the Orthographic projection from the drop down menu
• Don’t forget to check the save default to save the change.
Adding Cross Sectional Reference

The Alternate view representing the Cross section must first be transferred to the reference layer, by selecting the entire view, go to Edit/Layers, Then transfer selected entities to the reference layer.

• Using the Add CAD tool, right entities of the Top/Bottom view CAD to create a line that best represents the length and orientation of the line required.
• In this example Ctrl+ right click was used create 2 intersection points defining line length.
Adding Cross Sectional Reference

• Uncheck Reference location if currently checked.
• Adjust the offset, position, and/or X,Y values to move the reference line to desired location
• Keep in mind the line:
  • Position must match the profile in the side view
  • Length must match the length or width of side view used.
• The line must also conform to rules discussed in slide 39
Cross-Sectional Scanning

Adding Cross Sectional Reference

• Offset
  Adjusts Vertical line left & right
  Adjusts Horizontal line up & down

• Position
  \Adjusts Vertical line Up & down
  Adjusts Horizontal line left & right

Click new then Close when line length and position are correct
•**Height**
Change height to the height at which the first height measurement will be taken. First height measurement is taken at the beginning (From co-ordinate) of the reference line.

![Diagram showing height measurement]

4.92”

•**Length**
Adjusting the length can help identify the start location of the line, as this will be the point does NOT change with the length.

![Diagram showing length measurement]
Creating the Section Dimension

Section dimension is created the same way as any other dimension & controls how the height data will be transferred to the CAD profile view.

- Ctrl + Left click to select all side view CAD entities associated with the profile that correspond to the reference line.
  - Lines selected should be those that represent the top surface of the part
- Using report dimension tool, right click the selected CAD entities, then right click reference line
- Select Section Dimension type
- Make appropriate changes to section Modifiers
Creating the Section Dimension

These options control the tradeoff between Speed & Accuracy (number of data points collected).

• **Section Spacing**
  • gives the maximum spacing between adjacent height measurements. A larger spacing will result in faster scanning but will produce less height data.
  • The default spacing is 0.125” (3.18 mm)

• **Height Resolution**
  • If the height difference between two adjacent height measurements is larger than the value specified, an additional height measurement is taken closer to the first measurement.
  • Using a larger value will result in faster scanning, but a smaller value will produce more data in areas where the height is changing.
  • The default value is 0.040” (1.02 mm).

• **Auto**
  • When checked, If a height measurement cannot be taken (for example if it is hidden by inside bends, or measurement is off the part, or inside a hole, due reference line placement, and/or part alignment) the system “searches” by attempting more height measurements using a smaller section spacing.
  • When Unchecked, the hidden/missing height measurement is simply skipped, resulting is a faster scan
Creating the Section Dimension

These options control how the height measurements are matched to the CAD profile. If measurements between 2 section areas is required, fit options should not be used.

- **X/Y**
  Default option. Should be used when the reference line for height measurements is lined up with the cross section edges (as is with the examples used in this document.) This directly translates the height data on the CAD cross sectional profile.

- **X/Y Fit**
  Performs X/Y alignment, then shift data either up/down for vertical profiles, or left/right for horizontal, to optimize alignment with CAD.

- **Extent**
  Used when the reference line for height measurements is not lined up with the cross section edges. The scan data produced from height measurements at the left (for horizontal profiles) or bottom (for vertical) of the reference line is assigned to the left (or bottom) of the cross section edges.

- **Extent fit**
  Initially aligns performs Extent alignment, and then shifts the data left/right (for horizontal cross sections) or up/down to produce the optimal alignment.
Creating the Section Dimension

These options control how the height measurements are matched to the CAD profile.

- **Height fit**
  Default option. Performs a fit of the height data to the height of the profile edges. Used when only a single edge (usually top) of the profile is used.

- **Offset Value**
  Entered into the control, (previously used offset value is displayed by default.) Provides the ability to enter manual offset. Value used should be the height at the lowest point in the profile.
Add all dimensions required as defined by drawing.
Do You Have Any Questions?

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