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- 42 Years Exp.
  - Automotive
  - Aerospace
    - Engineering
    - Manufacturing
    - Quality

- Technical Book Author
  - Quality
  - Engineering
  - Shop Technical

Photos Reference: Geometric Tolerancing Applications and Inspection (Prentice Hall)
Outline – Session 1

- Form Tolerances
  - Flatness
  - Straightness
  - Circularity
  - Cylindricity

- Orientation Tolerances
  - Parallelism
  - Perpendicularly
  - Angularity

Limitations are:
1. Inspector’s Knowledge / Skills
2. Available Inspection Equipment
Some Geometric Tolerance measurements are:

T.I.R. – Total Indicator Reading
F.I.M. – Full Indicator Movement

TIR = .0005”
Flatness measurement is a T.I.R. (or F.I.M.) that is achieved with a probe or dial indicator.
Flatness Tolerance

Surface must be leveled (optimum plane) so that the probe sees only hills and valleys of flatness error.

- Jack Screws Method
- Leveling ("Wobble") Plate Method
Flatness Tolerance

Alternative is “Indian” Pins. Three pins at exactly the same height within millionths. The pins level the surface.

“Indian” Pins Set
Straightness of Surface Elements

Applies to individual line elements at the surface, not the axis.
Straightness of Surface Elements

Setup with two jack screws, a parallel, and a V-Block. Jacks are used to level the line element, then a top-dead-center T.I.R.
Straightness of Surface Elements

Alternative is two equal height gage block stacks, then a bottom-dead-center T.I.R.
Challenging inspection. Differential measurements are required for inspection. Two opposing indicators to track axial deviation.
Straightness of an Axis - MMC

This type of straightness could be evaluated with a Functional Gage (as with any tolerance at MMC)
Circularity (Roundness)

Roundness tolerance zone is two concentric circles. Roundness is a radial measurement, not diametral.
A precision spindle (or CMM) could be used.
Cylindricity combines measurement of roundness, straightness of surface elements, and taper per side.
Parallelism of a Surface

Parallelism measurement is a T.I.R. once the datum has been mounted.
Parallelism of a Surface

Dial indicator is being traversed across the entire surface. The resulting T.I.R. shall not exceed the tolerance. Flatness is automatically controlled.
Perpendicularity of a Surface

Perpendicularity measurement is also a T.I.R. Flatness is inherently controlled.
Perpendicularity of a Surface

Since there is only one datum, the part must be best-fit for secondary alignment.
Perpendicularity of a Surface (Secondary Datum)

When there is a secondary datum, the part is aligned.

Perpendicularity of a Surface Inspection
Angularity measurement is also a T.I.R. Flatness is inherently controlled.
Angularity

A Sine Bar, Sine Plate, or CMM could be used.

Angularity Requirement

Inspection
Griffith Training

On-Site Tailored GD&T Training:
- Basic
- Intermediate
- Advanced
- Tolerance Stackup Analysis
- Functional Gage Design
- Inspection
- Quality Courses

Consulting:
- Functional Design Drawing Reviews
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Questions and Answers

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