GD&T - Profile Tolerancing
PMPA Technical Conference

Rapid Response to Make the Cut

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

- Technical Book Author
  - Quality Assurance
  - Engineering
  - Shop Technical

Functional Gauge Designs

For Geometric Tolerances

Gary K. Griffith

4th Edition
Per ASME Y14.5M - 1994 Standard
Profile Tolerances

Profile of a Line
Individual Line Elements

Profile of a Surface
All Line Elements Collectively

Profile tolerances are widely misunderstood
Profile Tolerances - Overview

- Profile was originally designed for mating contours
- Profile applies only to surfaces
- Profile is view-specific (applies only in view shown)
- Profile tolerances are automatically bilateral (U.O.S.)
- Profile requires basic dimensions (shape and/or location)
- Profile tolerance may, or may not specify datums
- Profile cannot be applied at MMC
  - Except on datums of size
Contours

- Irregular shapes
- A **collective** of various dimensions combined
  - Radii
  - Angles
  - Etc.
- Profile would be necessary if all of the components of a contour are simultaneously related / engaged
- Not all contours need profile control
Profile Tolerances - Overview

Profile of a Line
Applies to individual line elements of the surface (one at a time)

Profile of a Surface
Applies to all line elements collectively (simultaneously)
## Datums or No Datums?

<table>
<thead>
<tr>
<th>FAMILY</th>
<th>SYMBOLS</th>
<th>DATUMS?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Form Tolerances</td>
<td><img src="image" alt="Form Tolerances Symbols" /></td>
<td>Never</td>
</tr>
<tr>
<td>Orientation</td>
<td><img src="image" alt="Orientation Symbols" /></td>
<td>Always at least one</td>
</tr>
<tr>
<td>Runout Tolerances</td>
<td><img src="image" alt="Runout Symbols" /></td>
<td>Always at least one</td>
</tr>
<tr>
<td>Location Tolerances</td>
<td><img src="image" alt="Location Symbols" /></td>
<td>Always at least one</td>
</tr>
<tr>
<td>Profile Tolerances</td>
<td><img src="image" alt="Profile Symbols" /></td>
<td>Depends!</td>
</tr>
</tbody>
</table>
Datums or No Datums?

MATING CONTOURS
TWO INTERFACES – TWO DATUMS
(NEED SHAPE & LOCATION CONTROL)

MATING CONTOURS
NO INTERFACES – NO DATUMS
(ONLY NEED SHAPE CONTROL)
Profile Inspection Comparator

- Using Overlays
  - Thickness limited
  - Overlays needed
    - Cross-hairs where datums apply
    - No cross-hairs where there are no datums
- Or a Vision System
Profile Inspection
CMM

- Need GD&T Software
- Proper probes
- Decide points
- Best fit capability when there are no datums
Profile Inspection Fixture

- Variable Inspection Fixture
  - Where datums apply
  - Pantograph follows true profile template
  - Dial indicator (or probe) must be perpendicular to the contoured surface
  - Zeroed on the template
Profile Tolerance Example (No Datum)

- The tolerance zone is two lines (± .0025) around the perfect profile.

- Only shape is controlled.
- Limited between X and Y.

Note: Best fit is allowed during inspection.
Profile Tolerance
No Datums

- Mylar does not need cross-hairs
- Best fit is allowed during inspection
Profile Tolerance
No Datums

Mylar overlay for the comparator

Best fit is allowed when there are no datums

Rough Sketch
Profile Tolerance
No Datums

Mylar can be shifted or rotated for best fit
Profile Tolerance
Datums Specified

- Controls shape and location
- Mylar needs cross-hairs

Two Datums
Two Cross-hairs

Mylar Overlay Includes Cross-Hairs
Profile Tolerance Datums Specified

- Datums restrict best fit
- The surface must be within shape and location

Part must be indexed into the zone. Mylar cannot be shifted.
This part is not in profile tolerance
This part is too thick for optical comparator use. A CMM would be necessary in this case.

BETWEEN X AND Y LIMITS THE CONTROL
Irregular Features – Mating Parts

2X R .330

4X R .380

\( \phi 1.745 \pm .002 \)

2X .1242

4X R .400

\( \phi 2.800 \pm .010 \)

2X .350

\( \phi 1.750 \pm .002 \)

2X .1248

X \rightarrow Y

Z \rightarrow W

X \rightarrow Y

Z \rightarrow W

2X \phi .005 A
Composite Profile Tolerance

- Loose tolerance for location from datums A and B
- Tighter tolerance for shape
Profile Tolerance
“Coplanar” No Datums

The two surfaces must be in-plane within .0005”

- Both surfaces establish Datum plane A
- Part must mount without wobble
Profile Tolerance
“Coplanar” No Datums

- Profile controls coplanarity and flatness
- Both surfaces must be between two planes .0005” apart (FIM)
Profile Tolerance
“Coplanar” – Datums Applied

Each surface can be no further away from datum plane A-B than .0025”

This is not a FIM measurement
Profile Tolerance
“Coplanar” - Datums Applied

Part is mounted on datums A-B. Dial indicator is zeroed on datums A-B. Each surface must be ±.0025 from A-B.
Profile – All Around (View Specific)

Profile Tolerance Zone

Limited Best Fit is Allowed
Profile Controls Size, Shape, and Location
Combined Controls (Profile and Position)

- Profile for shape and size
- Position for location
Profile to Locate a Surface

- Controls location, angularity and flatness
Unilateral Tolerance Zones

Profile is needed to control contour shape, coaxiality, and location.

Blades must clear housing.
Unilateral Tolerance Zones

Phantom Line Method

New Circle U Modifier
(2009 Standard)
Profile Includes Coaxial Control (due to Datum A)

This is controlling:
- Concentricity
- Straightness
- Angularity

Two Coaxial Boundaries .002" apart (Coaxial to Datum A)
Profile Using MMC Modifier
(Clearance fit on datum holes)

Datum shift is allowed if datums depart from MMC size
Griffith Training

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- Intermediate
- Advanced

- Tolerance Stackup Analysis
- Functional Gage Design
- Inspection
- Quality Courses

Consulting:

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- Tolerance Stackups
- Functional Gage Designs
Questions and Answers

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