NOTICE: LUNCH 'N LEARN

This presentation was given at the October 2007 “Lunch N Learn” at Ellison Technologies in Charlotte.

The presentation is meant to be viewed with the narration and detailed explanation of the presenter.
Understanding True Position

Part 1 : Grasping the “Basics”
The Part

1.00 ± 0.01

2.00 ± 0.01
The Tolerances
The Tolerance Zone
The Question… Which Part is Better?
Part 1 is within the tolerance zone, but…
Part 2 is closer to the Nominal Center and will assemble easier than Part 1
How can we set up a tolerance band that fairly and functionally judges the position of features?
Use a Circle instead of a Square!
Definition Time!!!

The result of a True Position Characteristic is the diameter of a circle, centered on the basic dimensions from the specified datums, that contains the actual center point.
Mathematically Speaking....

True Position = $\sqrt{\Delta X^2 + \Delta Y^2} \times 2$

$\Delta X = $ Difference from Basic X value from Actual X value

$\Delta Y = $ Difference from Basic Y value from Actual Y value
New Part Print w/True Position

No Tolerances

True Position

Diametral Zone

Tolerance

Primary, Secondary, Tertiary Datums

Ø 0.01

A

B

C

1.00

2.00

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Understanding True Position
Here’s an Example Calculation
Actual Measurements:
X = 2.003
Y = 1.004

Can we ship it?
Actual X = 2.003  Actual Y = 1.004
Basic X = 2.000  Basic Y = 1.000
\[ \Delta X = 0.003 \quad \Delta Y = 0.004 \]

\[ TP = \sqrt{0.003^2 + 0.004^2} \times 2 \quad \text{or} \]
\[ TP = \sqrt{0.009 + 0.016} \times 2 \quad \text{or} \]
\[ TP = \sqrt{0.025} \times 2 \quad \text{or} \]
\[ TP = 0.005 \times 2 \quad \text{so…..} \]
True Position Result = 0.010

Nominal Center at X=2, Y=1 from Basic Dimensions

Hole Center 0.005 from Nominal

True Position = 0.010
Our True Position is within the Specification.... Barely!

YES, WE CAN!
Let’s do this very example in Calypso and see if the math works out!
This is a Theoretical feature with X Y coordinates placed exactly at 2.003 and 1.004.
Understanding True Position

It WORKS!
Same Print, this time a “Real” Part
On a “Real” Part:

<table>
<thead>
<tr>
<th>Tolerance For</th>
<th>Nominal</th>
<th>Actual</th>
</tr>
</thead>
<tbody>
<tr>
<td>X</td>
<td>2.0000</td>
<td>1.9619</td>
</tr>
<tr>
<td>Y</td>
<td>1.0000</td>
<td>1.0081</td>
</tr>
<tr>
<td>Z</td>
<td>0.0000</td>
<td>0.0004</td>
</tr>
<tr>
<td>D</td>
<td>1.1000</td>
<td>1.0522</td>
</tr>
</tbody>
</table>

X = 1.9619
Y = 1.0081
Actual $X = 1.9619$  \hspace{1cm}  Actual $Y = 1.0081$

Basic $X = 2.000$  \hspace{1cm}  Basic $Y = 1.000$

$\Delta X = -0.0381$  \hspace{1cm}  $\Delta Y = 0.0081$

$TP = \sqrt{-0.0381^2 + 0.0081^2} \times 2$  \hspace{1cm}  or

$TP = \sqrt{0.0015 + 0.0001} \times 2$  \hspace{1cm}  or

$TP = \sqrt{0.0016} \times 2$  \hspace{1cm}  or

$TP = 0.0390 \times 2$  \hspace{1cm}  so…..
True Position = 0.0779

Hole Center 0.0390 from Nominal

Nominal Center at X=2, Y=1 from Basic Dimensions

True Position Result = 0.0779
Explanation Time!!!

The GD&T standard specifies that the FUNCTIONAL center be used for calculations. This means for a hole, that the Maximum Inscribed fit be used. Calypso does this automatically!
Let’s see how this changes things.
Watch out for Outliers!

Circle3("Roundness1")
Now that we have that sorted out, ONE MORE TIME!

X = 1.9504

Y = 1.0104
Actual X = 1.9504       Actual Y = 1.0104
Basic X = 2.000         Basic Y = 1.000
Δ X = -0.0496          Δ Y = 0.0104

\[ TP = \sqrt{(-0.0496)^2 + (0.0104)^2} \times 2 \] or
\[ TP = \sqrt{0.0025 + 0.0001} \times 2 \] or
\[ TP = \sqrt{0.0026} \times 2 \] or
\[ TP = 0.0507 \times 2 \] so.....
True Position = 0.1014

Hole Center 0.0507 from Nominal

Nominal Center at X=2, Y=1 from Basic Dimensions

True Position Result = 0.1014
ONE MORE THING…..

You might say:

“So if True Position only gives me distance from center, how do I know how to make my offsets?”
Turn on Additional Position Result in the Characteristic Settings Editor.
You’ve got Questions, We have answers.

Understanding True Position

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