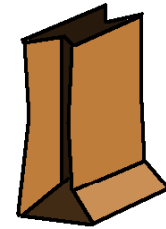
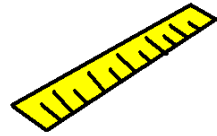


LUNCHEON LEARN

OK - now we know what the Profile Result means.

How do we improve our part next time (where and how can the shape be improved)?

If the profile was reported on a plane, it's easy - report flatness, parallelism, and position and see what is causing the profile deviations.

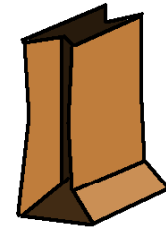
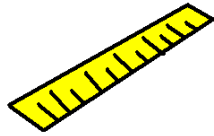


LUNCHEON LEARN



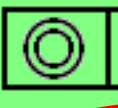


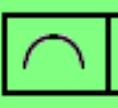
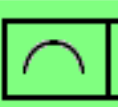

If the profile is applied to a “shape”, understanding cause of the numeric result becomes impossible.

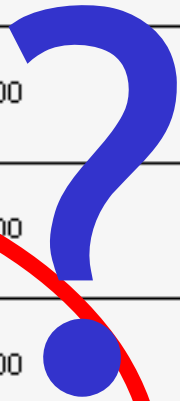
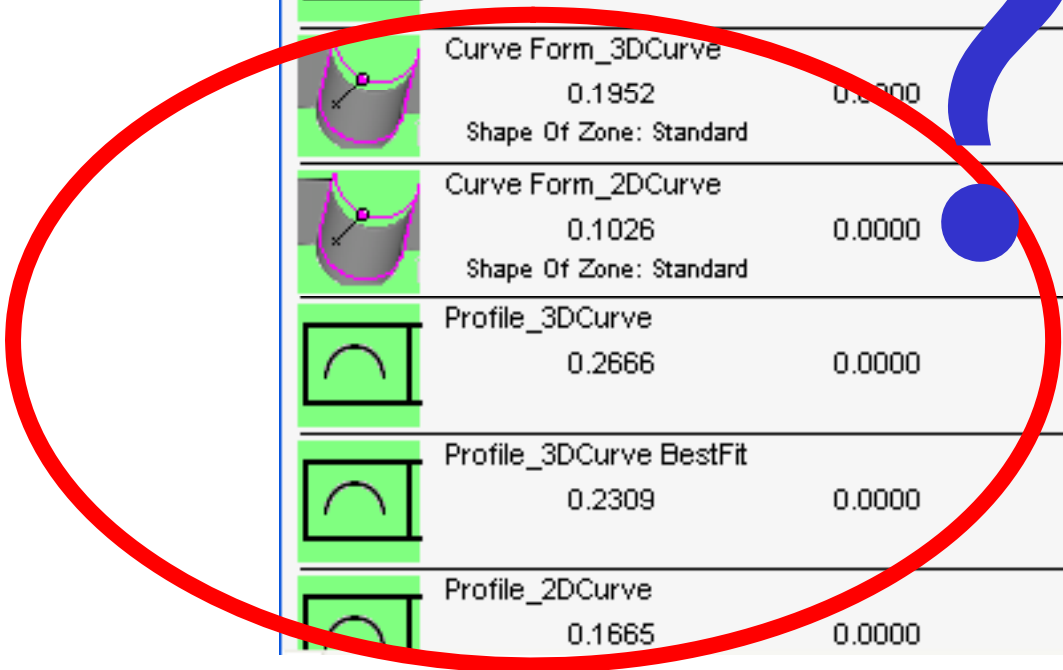
We need to apply the tools Calypso provides us in order to determine what the heck is going on.

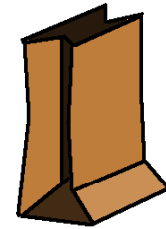
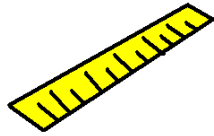
You may or may not have certain tools, depending upon your software options.



LUNCHEON LEARN

	Diameter_-A- 22.0762	22.1000	0.0000	-0.0500	-0.0238
	Diameter_Circle 66.00 62.0843	62.0000	0.1000	0.0500	0.0843
	Concentricity 66.00 -A- 0.0117	0.0000	0.0300	0.0643	0.0117
	Curve Form_3DCurve 0.1952 Shape Of Zone: Standard	0.0000	0.2500	-0.2500	0.1952
	Curve Form_2DCurve 0.1026 Shape Of Zone: Standard	0.0000	0.2500	-0.2500	0.1026
	Profile_3DCurve 0.2666	0.0000	0.5000		0.2666
	Profile_3DCurve BestFit 0.2309	0.0000	0.3000		0.2309
	Profile_2DCurve 0.1665	0.0000	0.5000		0.1665





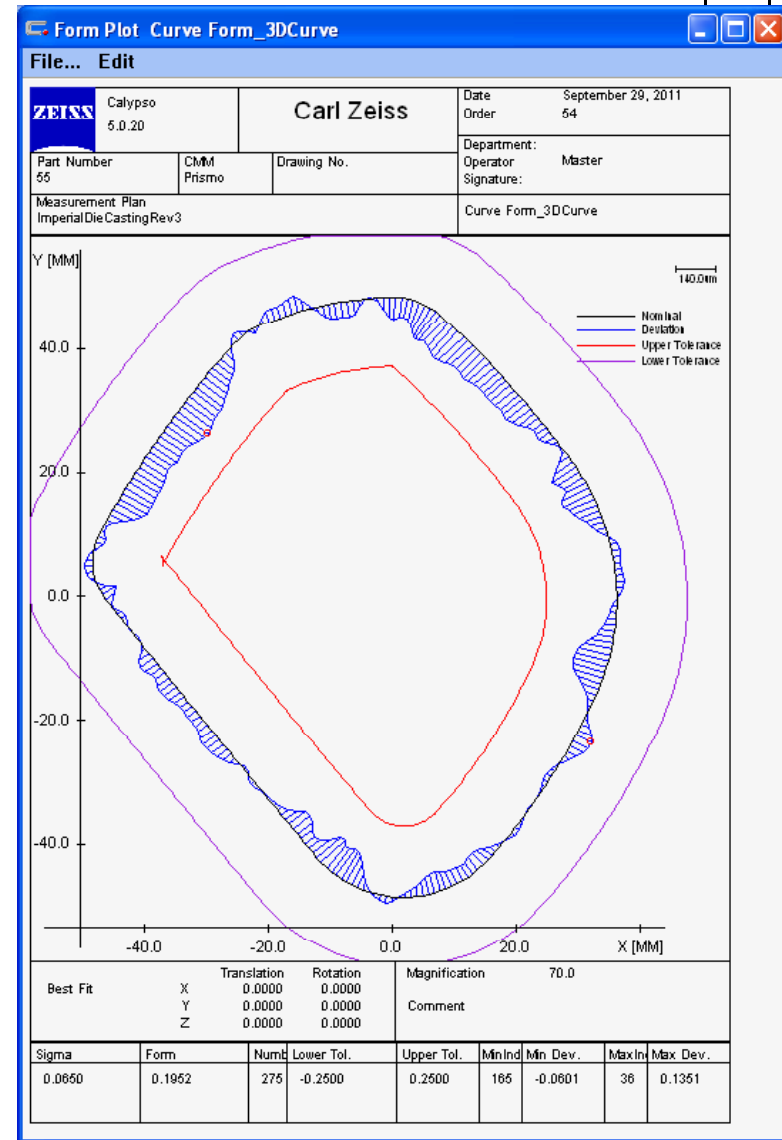
LUNCHEON LEARN

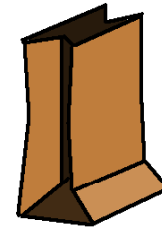
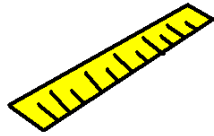
Software Option: Curve

Characteristic: Curve Form

Output Option: Old-School
"Curve Form 2D" Graphic in characteristic.

Tip: Right-Click to modify the chart settings. In the "DEVIATION" tab, choose "Plot Bar Lines" for best looking graphic





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Calypso 5.0.20	Carl Zeiss	Date	September 29, 2011
Part Number 55	CMM Type Prismo	Drawing No.	Order 54
Meas. Plan Name ImperialDieCastingRev3		Department:	Master
		Operator	Signature:

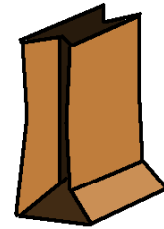
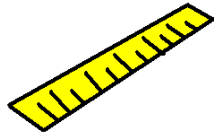
Software Option: Curve

Characteristic: Curve Form

Output Option: Graphic Element (in RESOURCES>UTILITIES).

Tip: Hold down CTRL and click a point for a deviation flag.





LUNCHEON LEARN

Software Option:
Curve/Freeform

Characteristic: Curve
Form/Profile

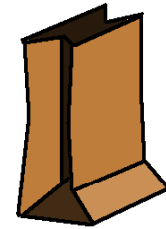
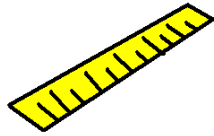
Output Option: CAD VIEW
graphic in Characteristic.

Tip: Squeeze Calypso's CAD window narrow so the graphic fills the paper better.

	Calypso 5.0.20	Carl Zeiss	Date September 29, 2011
Part Number 55	CMM Prismo	Drawing No.	Order 54
Measurement Plan ImperialDieCastingRev3			Department: Operator Signature: Master
			CAD View

X = -3.7717
Y = 1.2833
Z = 0.0110
zoom = 5

10 mm



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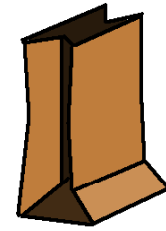
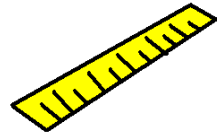
Software Option:
Curve/Freeform

Characteristic: Curve
Form/Profile

Output Option: POINTS LIST
graphic in Characteristic.

Tip: Right-Click, Modify Chart
Settings, Font Tab to increase
font so you can read it! Also,
turn off XYZ deviations to just
show "surface normal" values

ZEISS		Calypso 5.0.20		Carl Zeiss		Date Order	September 29, 2011 54
Part Number 55	CMM Prismo	Drawing No.		Department: Operator		Master	
Measurement Plan Imperial Die Casting Rev3						Curve Form_3DCurve	
		Actual	Nonupper	Upper Tolerance	Lower Tolerance	Deviation	
1	Dist	0.0361		0.2500	-0.2500	0.0361	-
2	Dist	0.0588		0.2500	-0.2500	0.0588	-
3	Dist	0.0249		0.2500	-0.2500	0.0249	-
4	Dist	0.0036		0.2500	-0.2500	0.0036	-
5	Dist	-0.0163		0.2500	-0.2500	-0.0163	-
6	Dist	-0.0279		0.2500	-0.2500	-0.0279	-
7	Dist	-0.0309		0.2500	-0.2500	-0.0309	-
8	Dist	-0.0245		0.2500	-0.2500	-0.0245	-
9	Dist	-0.0091		0.2500	-0.2500	-0.0091	-
10	Dist	0.0087		0.2500	-0.2500	0.0087	-
11	Dist	0.0278		0.2500	-0.2500	0.0278	-
12	Dist	0.0308		0.2500	-0.2500	0.0308	-
13	Dist	0.0093		0.2500	-0.2500	0.0093	-
14	Dist	0.0093		0.2500	-0.2500	0.0093	-
15	Dist	0.0238		0.2500	-0.2500	0.0238	-
16	Dist	0.0496		0.2500	-0.2500	0.0496	-
17	Dist	0.0788		0.2500	-0.2500	0.0788	-
18	Dist	0.1013		0.2500	-0.2500	0.1013	-
19	Dist	0.1148		0.2500	-0.2500	0.1148	-
20	Dist	0.1126		0.2500	-0.2500	0.1126	-
21	Dist	0.1098		0.2500	-0.2500	0.1098	-
22	Dist	0.1076		0.2500	-0.2500	0.1076	-
23	Dist	0.1084		0.2500	-0.2500	0.1084	-
24	Dist	0.1085		0.2500	-0.2500	0.1085	-
25	Dist	0.1065		0.2500	-0.2500	0.1065	-
26	Dist	0.0990		0.2500	-0.2500	0.0990	-
27	Dist	0.0890		0.2500	-0.2500	0.0890	-
28	Dist	0.0911		0.2500	-0.2500	0.0911	-
29	Dist	0.1007		0.2500	-0.2500	0.1007	-
30	Dist	0.1030		0.2500	-0.2500	0.1030	-
31	Dist	0.0963		0.2500	-0.2500	0.0963	-
32	Dist	0.1006		0.2500	-0.2500	0.1006	-
33	Dist	0.1137		0.2500	-0.2500	0.1137	-
...	-



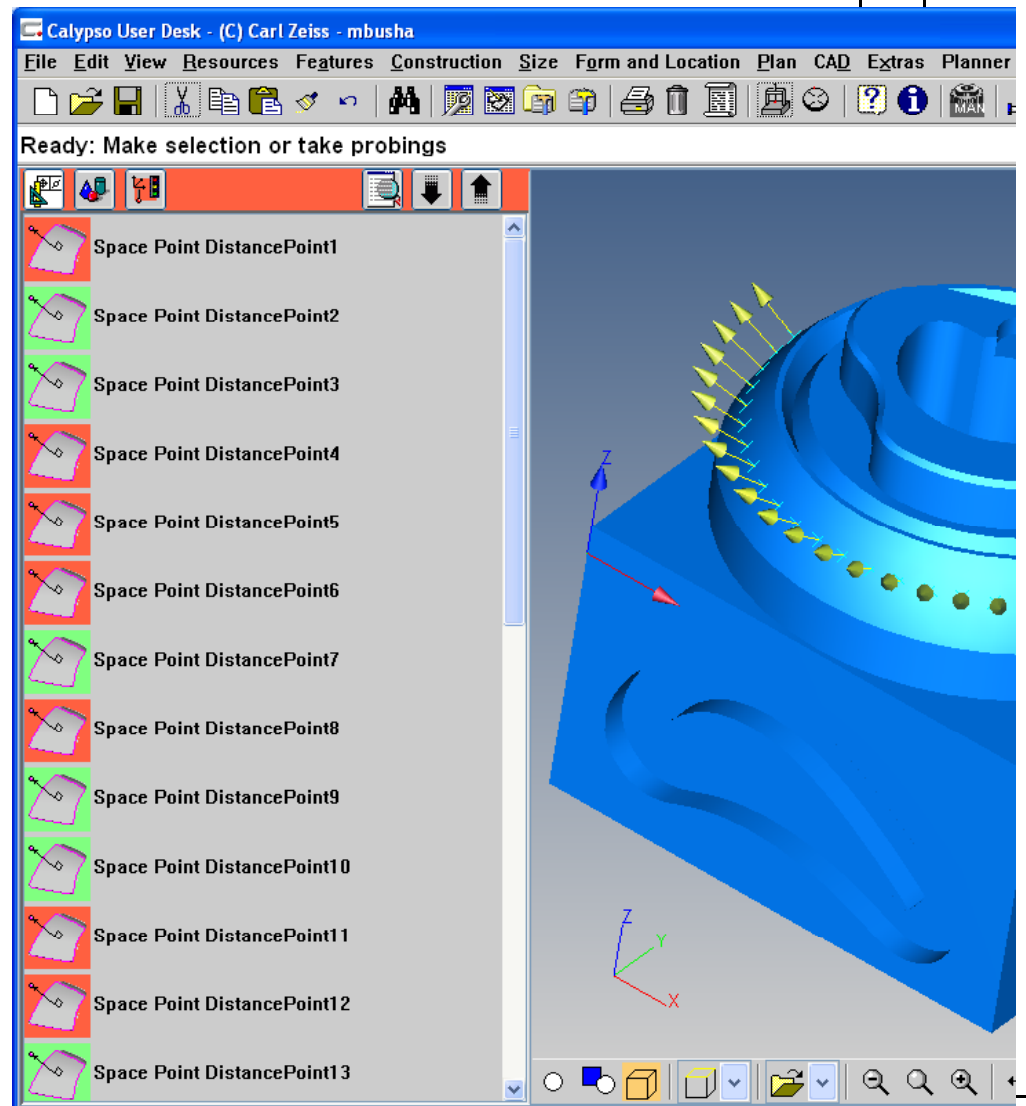
LUNCHEON LEARN

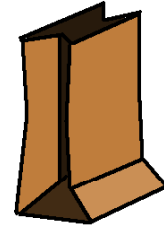
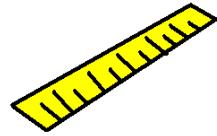
Software Option: None -
Use lots of Space Points

Characteristic: Space
Point Distance or Profile

Output Option: Standard
Numeric Printouts or
Deviations displayed on
CAD model (no automatic
printout)

Tip: Use Space Point
Distance to show direction
of deviation





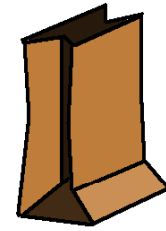
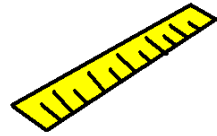
LUNCHEON LEARN

One more thing...

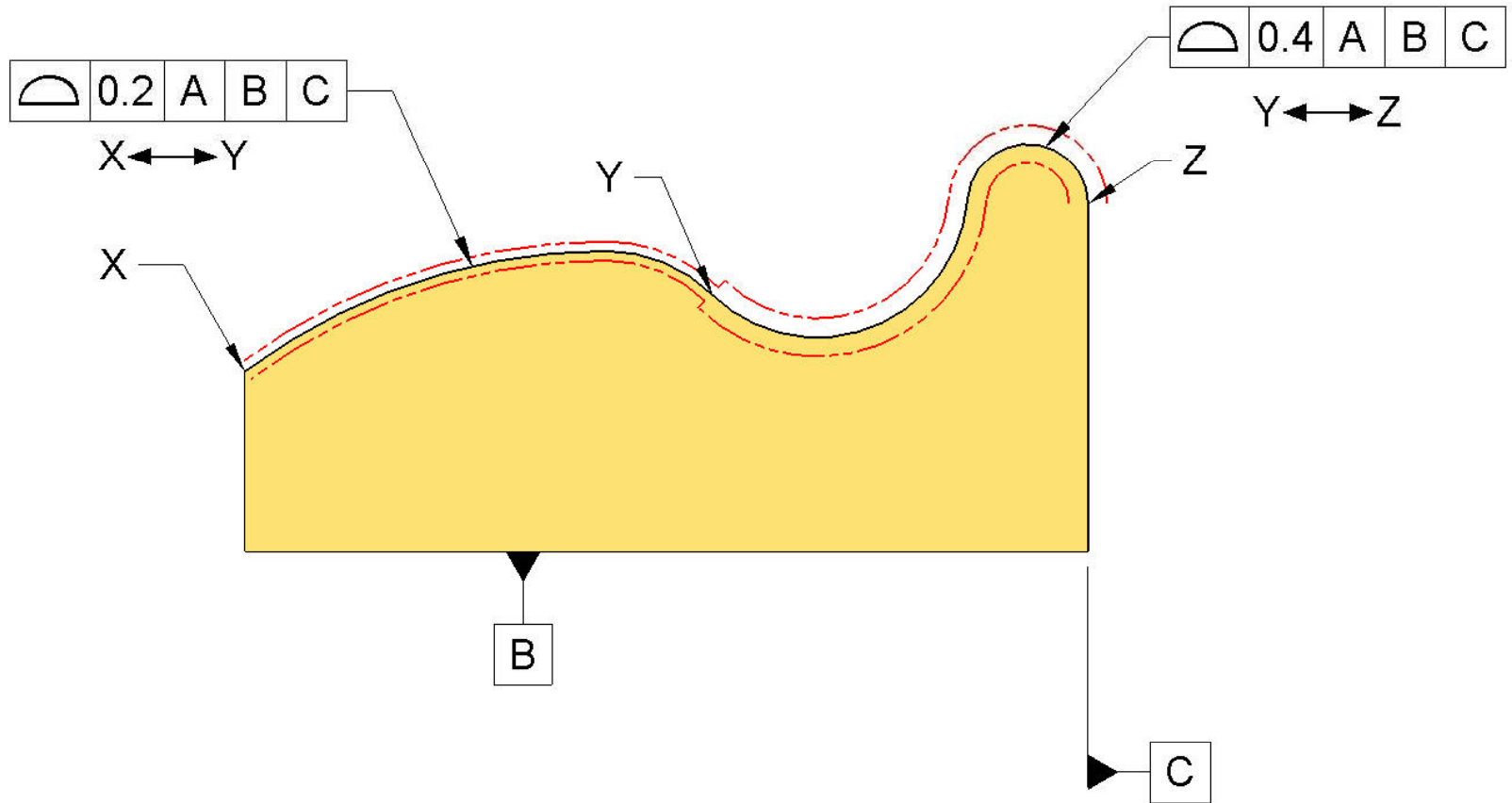
OK - I get it.

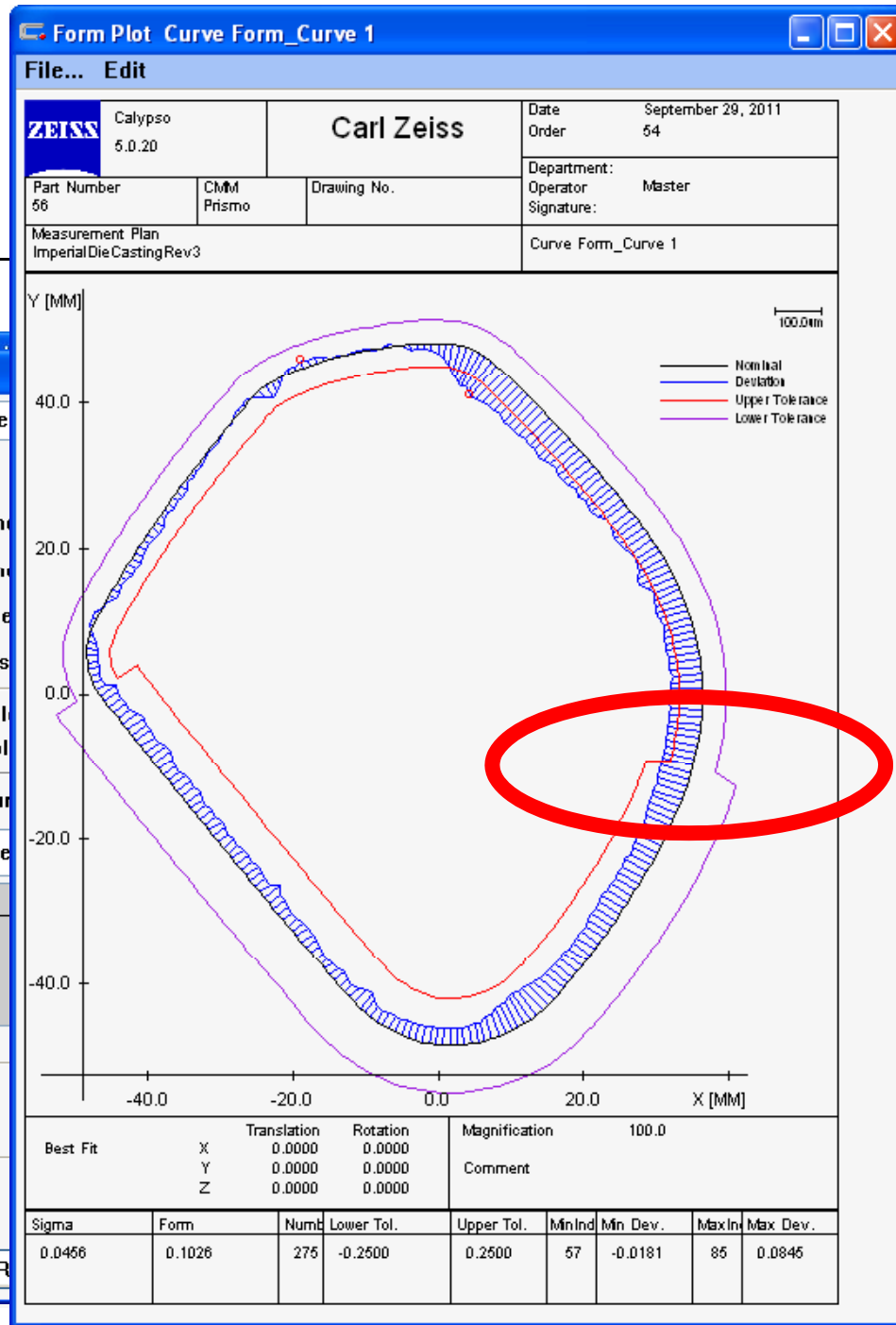
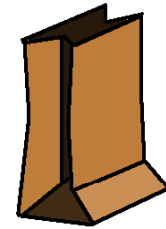
But I remember seeing something Mark showed us with a variable tolerance band.

How do I do that, wise-guy?



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Calypso User Interface - Curve Form

Basic Status

- Diam
- Diam
- Conc
- Grap
- Curve
- Grap
- Grap
- Grap
- Profil
- Profil
- Curve
- Profil
- Profil

Upper Tolerance

Lower Tolerance

Shape Of Zone

Tolerance Offs

Curve jump tol

Actual value pl

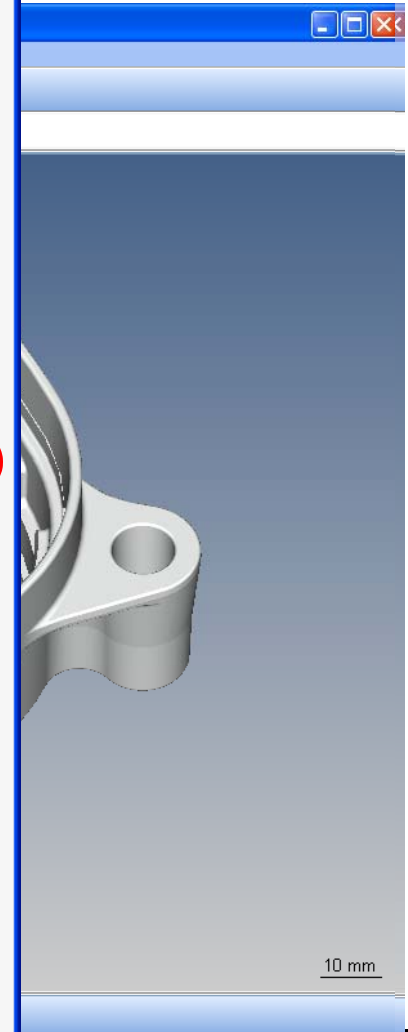
Feature

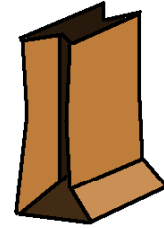
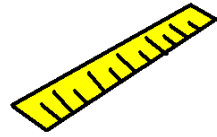
Curve

To Point

Deviation Max: 0.0845

OK R

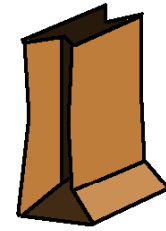
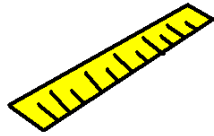




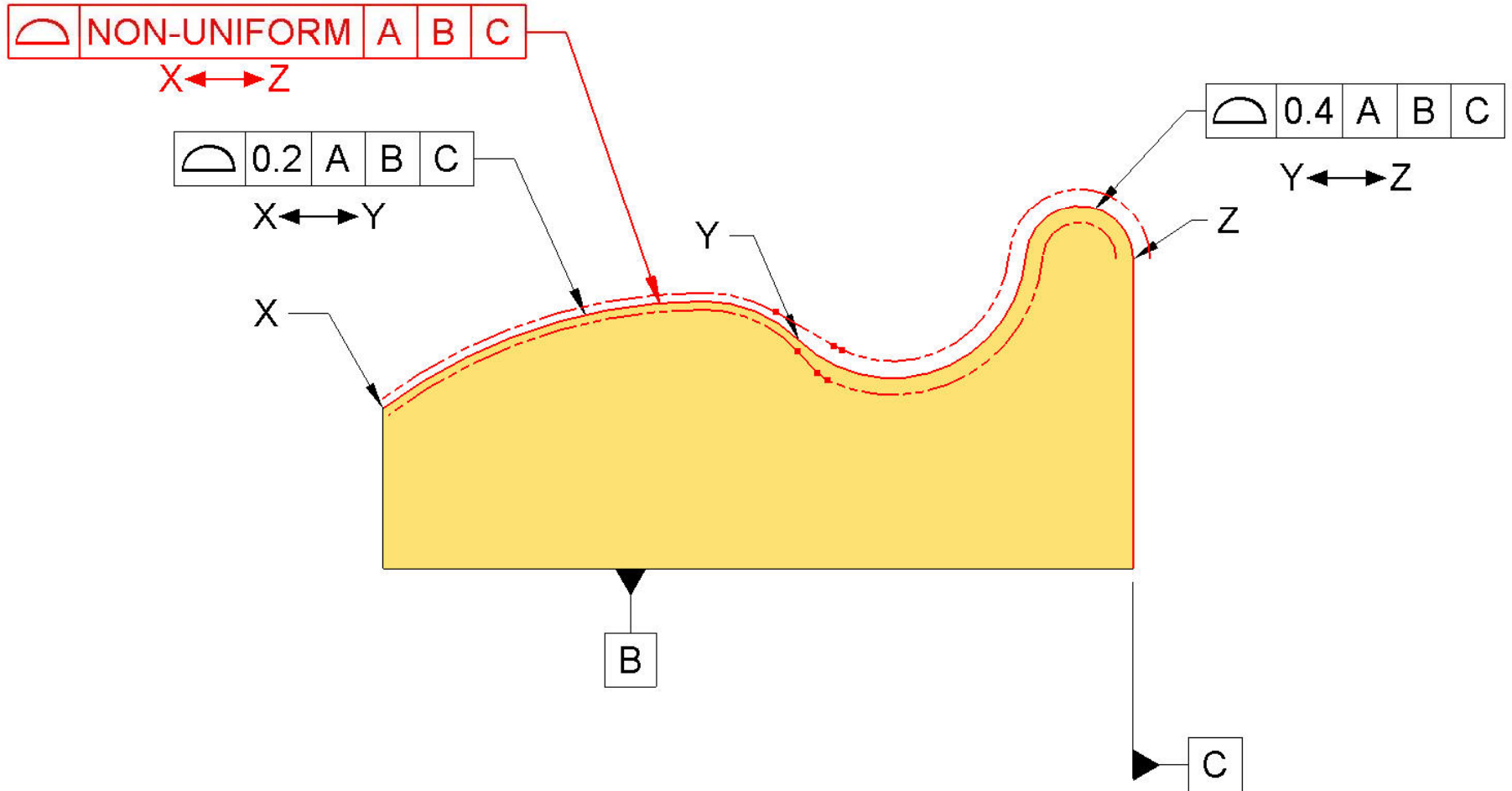
LUNCHEON LEARN

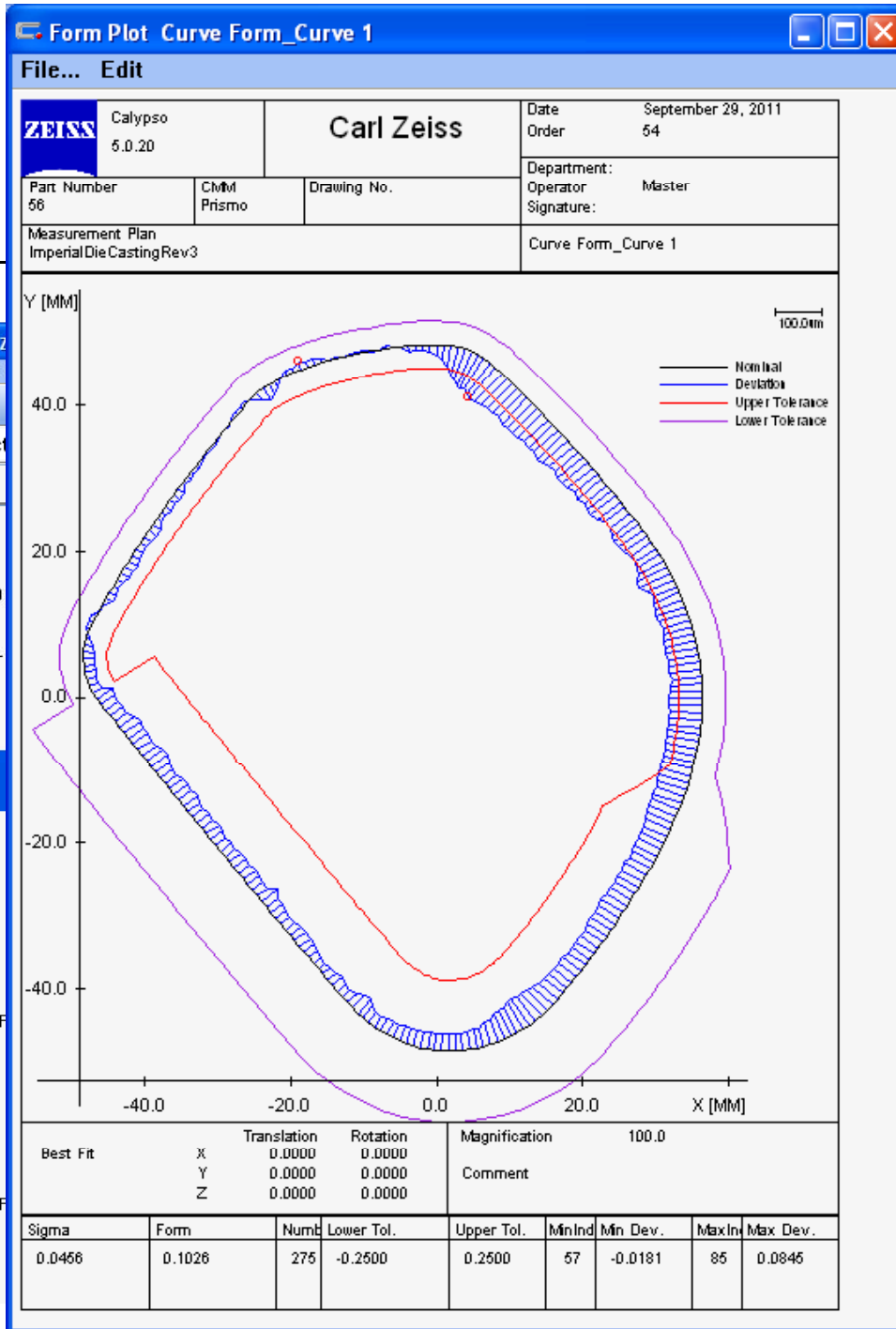
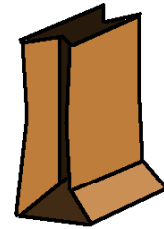
That was easy...

But what about this????



LUNCHEON LEARN



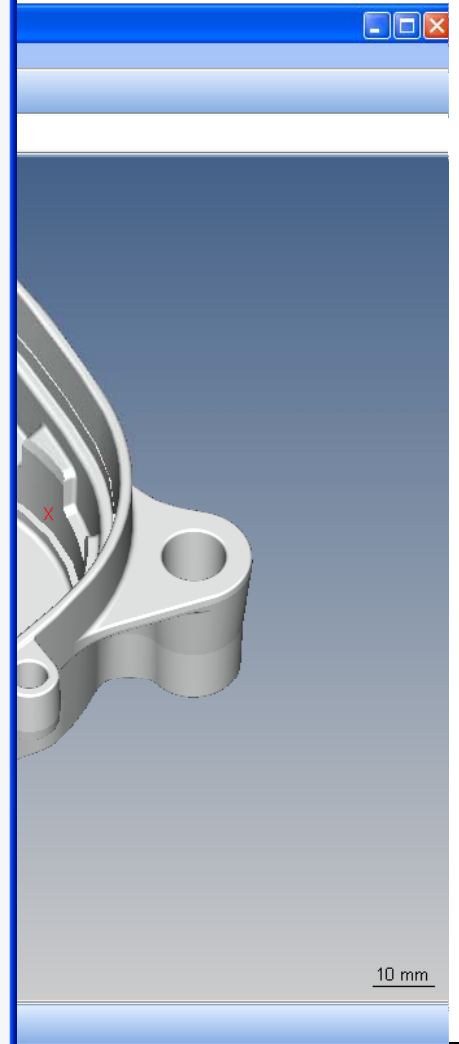


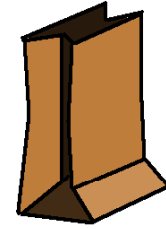
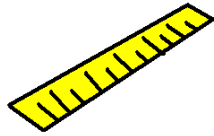
Calypso User Desk - (C) Carl Z

File Edit View Resources


Basic Status: Select func

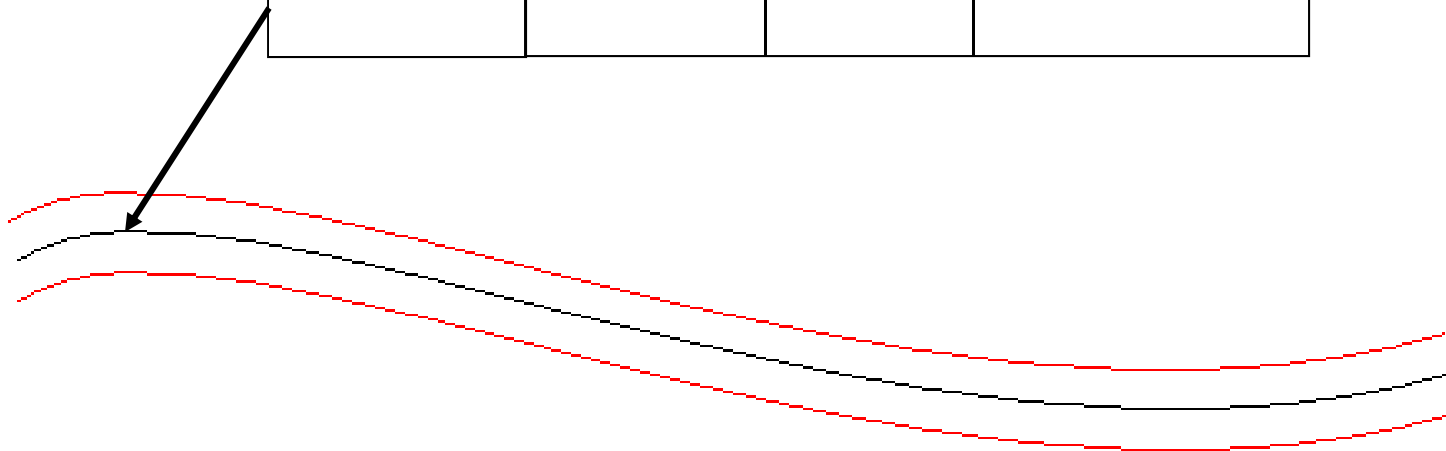
- Diameter_A-
- Diameter_Circle 66.00
- Concentricity 66.00 -A-
- Graphics Element2
- Curve Form_3DCurve**
- Graphics Element4
- Graphics Element5
- Profile_3DCurve
- Profile_3DCurve BestF
- Curve Form_Curve 1
- Profile_2DCurve
- Profile_2DCurve BestF



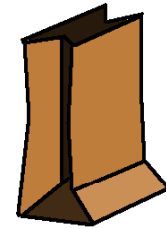
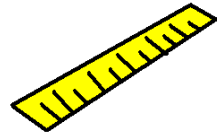


LUNCHEON LEARN

	How's Your Profile ?		
---	----------------------	--	--



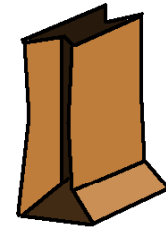
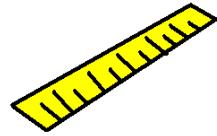
GOT QUESTIONS?



LUNCHEON LEARN

Concentricity

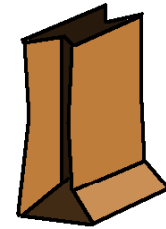
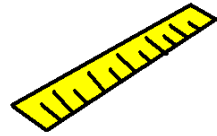
More than you ever wanted to know



LUNCHEON LEARN

**So, you need to measure
Concentricity?**

**No problem, right? Just drop
in a concentricity
characteristic and fill in the
template. You get an answer.**

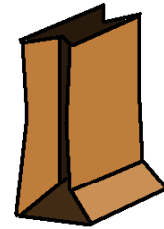
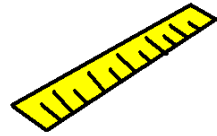


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Easy.

So, what **EXACTLY** is
Calypso telling us?

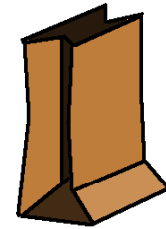
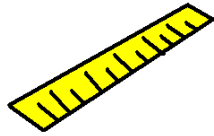
Actually, it's telling us
POSITION, not **Concentricity** as
defined in the Y14.5 standard....



LUNCHEON LEARN

You don't believe me?

Check it out:



LUNCHEON LEARN

Calypso User Desk - (C) Carl Zeiss - 1141 Fin

File Edit View Resources Features Con

Basic Status: Select function or probe

- Concentricity1
- True Position1**

True Position

True Position1 Comment

Shape Of Zone Tolerance
Diametral YZ 0.0100

Nominal Position
0.0000 X 0.0000 Y 0.0000 Z

Feature (RFS)
Bearing Journal Circle

Clear Datum Reference Datum Reference Special

Primary Datum (RFS)
Stroke Pin Bearing Cylinder

Secondary Datum

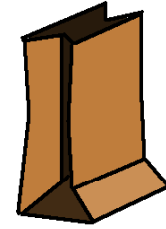
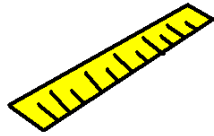
Tertiary Datum

Actual 0.0044

OK Reset

Stroke Pin Bearing Cylinder

6 mm



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Concentricity

Concentricity1 Comment

0.0100 Tolerance

Feature (RFS)
 Bearing Journal Circle

Primary Datum (RFS)
 Stroke Pin Bearing Cylinder

Secondary Datum

Actual 0.0044

OK Reset

True Position

True Position1 Comment

Shape Of Zone Tolerance
 Diametral YZ 0.0100

Nominal Position
 0.0000 X 0.0000 Y 0.0000 Z

Feature (RFS)
 Bearing Journal Circle

Clear Datum Reference Datum Reference Special

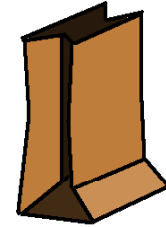
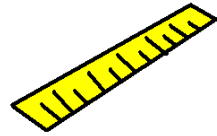
Primary Datum (RFS)
 Stroke Pin Bearing Cylinder

Secondary Datum

Tertiary Datum

Actual 0.0044

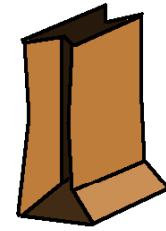
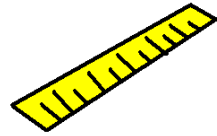
OK Reset



LUNCHEON LEARN

So is Concentricity just a special case of Position when the feature and datum happen to be on the same axis????

Great question.



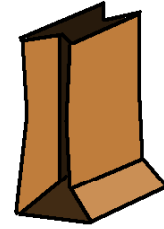
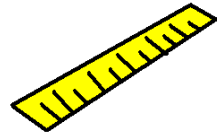
LUNCHEON LEARN Definition Time!

“Concentric
median points
elements of
corresponding
disposed feature
datum feature.
zone whose axis is
datum feature(s).
feature(s) being concentric
tolerance zones.



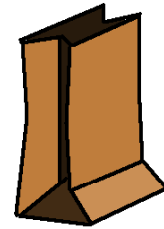
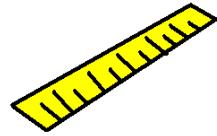
z z z
re the
sed

more radially-
center point) of a
spherical) tolerance
center point) of the
defined elements of the
cylindrical (or spherical)



LUNCHEON LEARN

**WAKE
UP!**

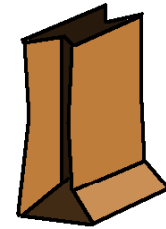
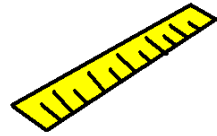


LUNCHEON LEARN

**Calypso DOES NOT do this...
easily.**

Can it be done?

Absolutely.

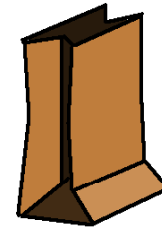
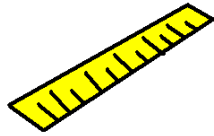


LUNCHEON LEARN

ANYTHING can be done if you
have the right resources...

In this case, **CURVE** is one of
those resources needed to pull
this off.

Here's how to do it:



LUNCHEON LEARN

Calypso User Desk - (C) Carl Zeiss - Concentricity2

File Edit View Resources Features Construction Size Form and Location Plan CAD Extras Planner Window ?

Define Nominal Geometry (Probe, Enter, or Read)

0.1000
0.0000
0.0000

Features

3-D Line1

Comment Strategy
Evaluation...

Clearance Group Nominal Definition Alignment

CP +Z Pattern (Base Alignme)

Tolerance For:

- X
- Y
- Z
- A1 Y/X
- A2 Z/X

Space Axis ±

Depth

Start Angle

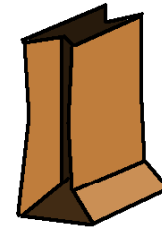
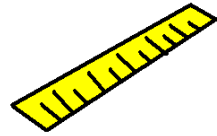
Options

- Recall
- Pattern: Rotational Pattern (use for scallop)
- Recall One Feature
- Recall Feature Points
- Theoretical Feature
- Actual To Nominal

Sigma	Form	Points
Min	Point no	Point no
		Max

OK Reset

1 mm



LUNCHEON LEARN

Calypso User Desk - (C) Carl Zeiss - Concentricity2

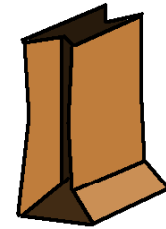
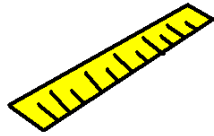
File Edit View Resources Features Construction Size Form and Location Plan CAD Extras Planner Window ?

Basic Status: Select function or probe for surface measurement with single points

- Datum
- Feature
- Curve1
- 3-D Line1[36]
- Intersection1[36][3-D Line1,Curve1]
- Intersection2[36][3-D Line1,Curve1]
- Symmetry1[36][Intersection1,Intersection2]

X = 0.0000
Y = 0.0000
Z = 0.0200

1 mm

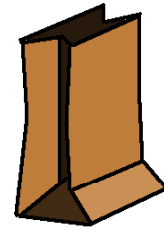
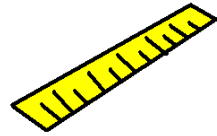


LUNCHEON LEARN

The screenshot displays the Calypso User Desktop interface. A 'Concentricity' dialog box is open, showing the following details:

- Feature:** (RFS)
- Feature:** (empty field)
- Primary Datum:** Datum
- Secondary Datum:** (empty field)
- Tolerance:** 0.0000
- Actual:** 0.3000

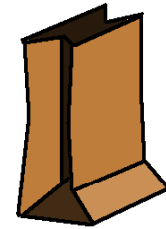
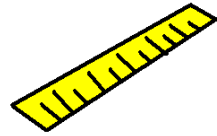
The background shows a 3D model of a part with a concentricity feature highlighted. The coordinate system (X, Y, Z) is visible, and a scale bar indicates 1 mm.



LUNCHEON LEARN

Shoooo. Lots of programming.

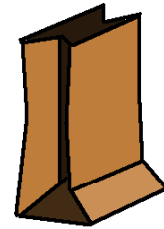
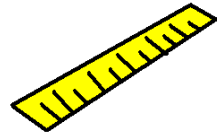
It's really not THAT bad.



LUNCHEON LEARN

You could make it a macro so you never have to program it again. Just supply feature circle coords and diameter.

Go to a training class if you want to learn about macros.

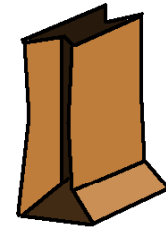
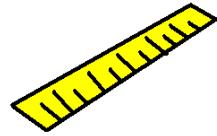


LUNCHEON LEARN

Let's test it out.

First, a theoretical example to see if it makes sense.

Let's change the FEATURE circle to $X=0$, $Y=0.05$ and run it in simulation.



LUNCHEON LEARN

YAY!

Same
Result!

The results
make sense!

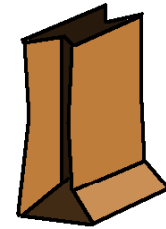
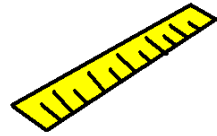
Calypso Custom Printout Concentricity1 1

Printout Display

ZEISS Calypso

Measurement Plan: Concentricity1
Date: September 7, 2011
Drawing No. *drawingno*
Time: 3:32:32 pm
Order *order*
Operator: Master
CMM: Simulation
Incremental Part Number: 10

	Actual	Nominal	Upper Tol.	Lower Tol.	Deviation
Overall Result					
All Characteristics:		3			
Out of tolerance:		2			
Over Warning Limit:		0			
Not Calculated:		0			
Concentricity	0.1000	0.0000	0.0500		0.0500 0.1000
Concentricity1	0.1000	0.0000	0.0500		0.0500 0.1000

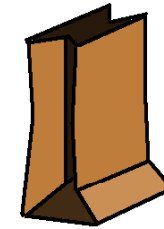
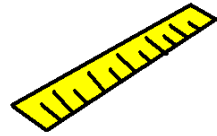


LUNCHEON LEARN

One more try...

Another theoretical example to see if it makes sense.

Let's change the FEATURE circle to $X=0.00707$, $Y=0.00707$ and run it in simulation.



LUNCHEON LEARN

YAY again!

The results
make sense!

Calypso Custom Printout Concentricity1 1

Printout Display

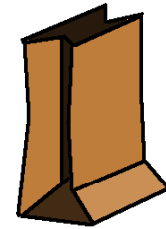
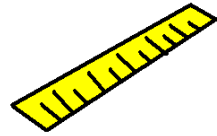
ZEISS Calypso

Measurement Plan Concentricity1 Date September 7, 2011

Drawing No. * drawingno * Time 3:38:00 pm Order * order *

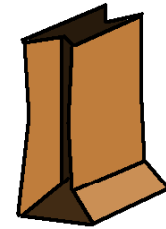
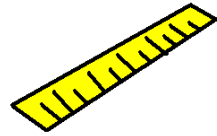
Operator Master CMM Simulation Incremental Part Number 11

	Actual	Nominal	Upper Tol.	Lower Tol.	Deviation
Overall Result					
All Characteristics:		3			
Out of tolerance:		0			
Over Warning Limit:		0			
Not Calculated:		0			
Concentricity	0.0200	0.0000	0.0500		-
Concentricity1	0.0200	0.0000	0.0500		-



LUNCHEON LEARN

**Now a REAL program with
REAL data...**



LUNCHEON LEARN

YAY again!

The results
STILL
make sense!

Calypso Custom Printout Concenticity1 1

Printout Display

ZEISS Calypso

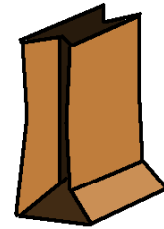
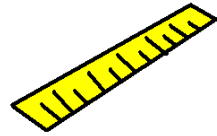
ZEISS

Measurement Plan: Concenticity1
Date: September 7, 2011

Drawing No. *drawingno*
Time: 3:46:17 pm
Order *order*

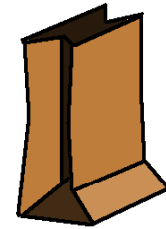
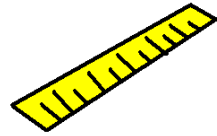
Operator: Master
CMM: Simulation
Incremental Part Number: 6

	Actual	Nominal	Upper Tol.	Lower Tol.	Deviation
Overall Result					
All Characteristics:		3			
Out of tolerance:		0			
Over Warning Limit:		0			
Not Calculated:		0			
Concenticity1	0.0041	0.0000	0.0100		-- 0.0041
REAL concenticity	0.0042	0.0000	0.0100		-- 0.0042



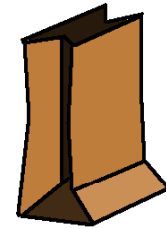
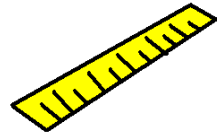
LUNCHEON LEARN

**Well, now you know how to check
“REAL” concentricity...**



LUNCHEON LEARN

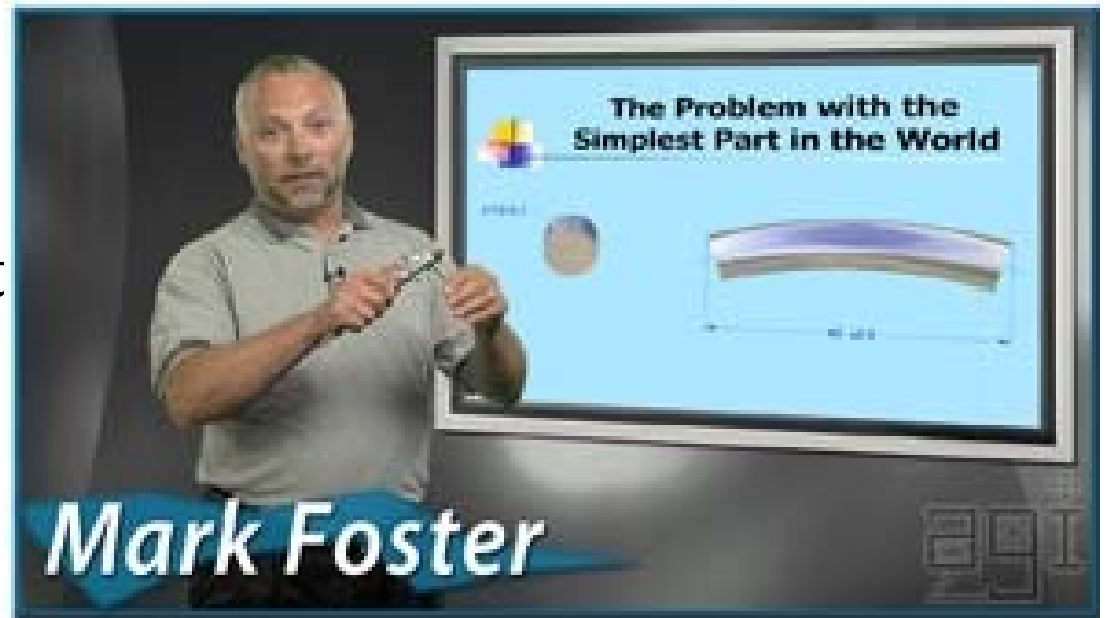
Why in the world would you ever want to do that considering the “REAL” answer is a whole 0.0001mm different than the way Calypso does it?!?!?

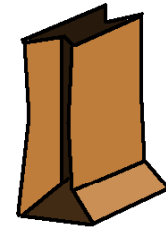
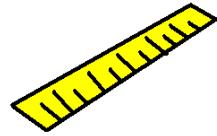


LUNCHEON LEARN

I honestly don't know considering we can use position, roundness, and runout...

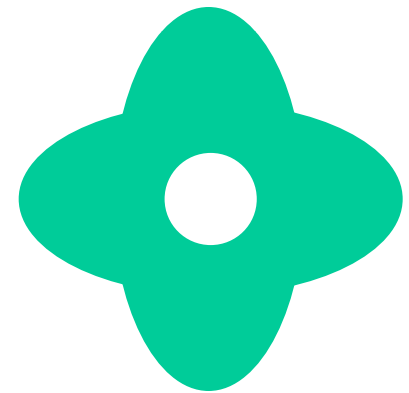
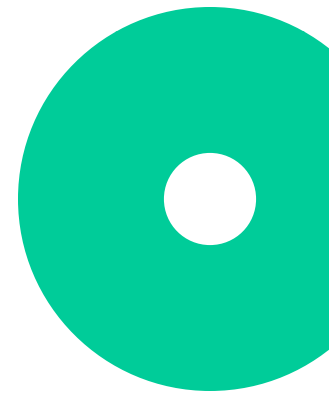
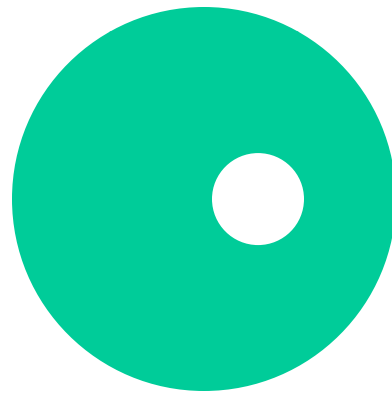
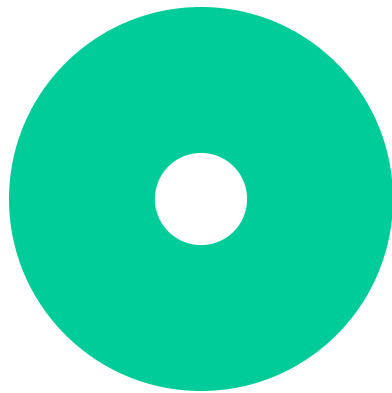
is what I said before talking to Mark Foster at Applied Geometrics, Inc. (www.gdandt.com)





LUNCHEON LEARN

Here's what's going on and WHY
"REAL" concentricity is used...



Roundness: **GOOD**

GOOD

BAD

BAD

Position: **GOOD**

BAD

GOOD

GOOD

Runout: **GOOD**

BAD

BAD

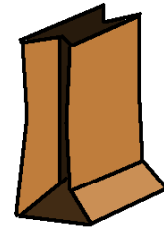
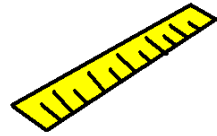
BAD

Concentricity: **GOOD**

BAD

BAD

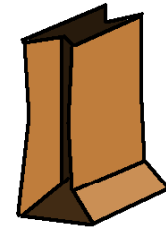
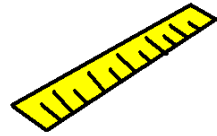
GOOD



LUNCHEON LEARN

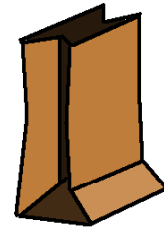
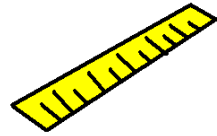
**With all that understood,
“REAL” concentricity does not
apply in MOST applications.**

The Y14.5 standard says it best...



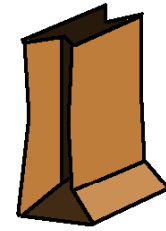
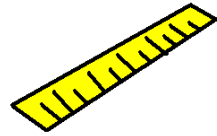
LUNCHEON LEARN

...Therefore, unless there is a definite need for the control of a feature's median points, it is recommended that a control be specified in terms of a runout tolerance or a positional tolerance.

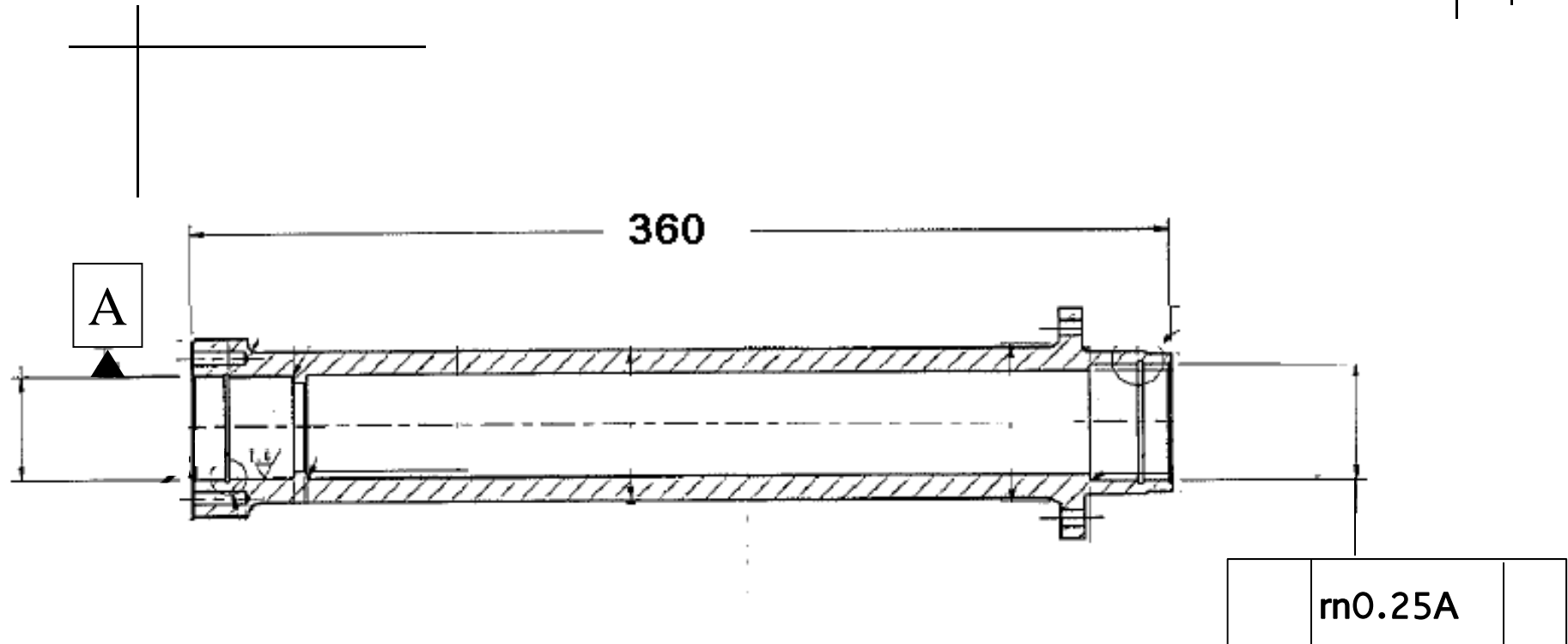


LUNCHEON LEARN

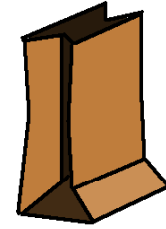
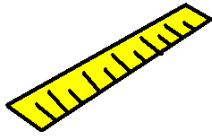
Let's take a look at a REAL part and a REAL print with a REAL bad dimension we have to check.



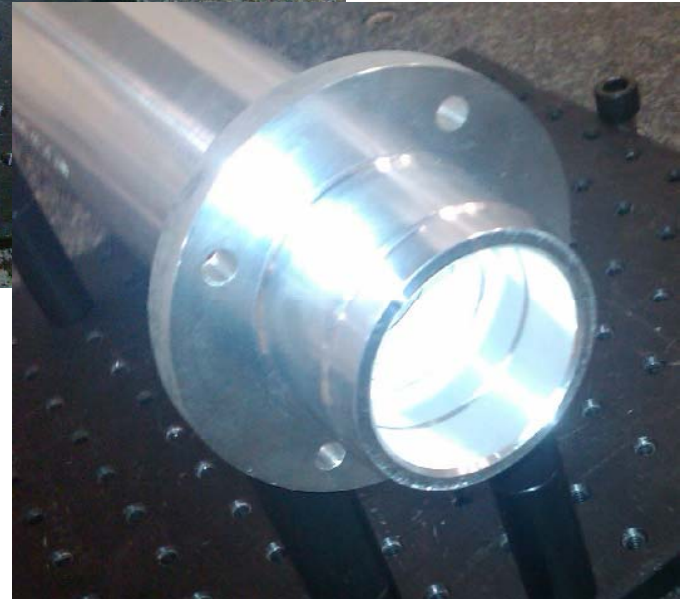
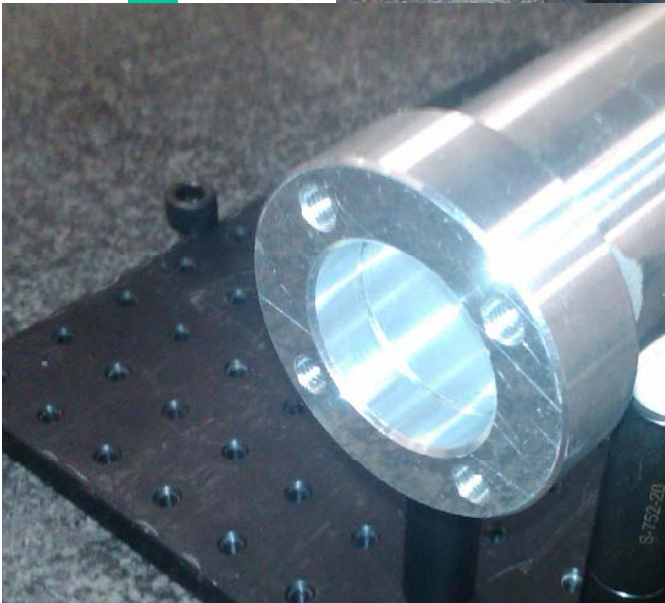
LUNCHEON LEARN

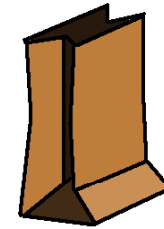
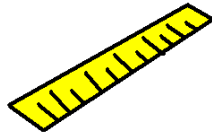


**I'm going to assume the designer meant
"Calypso Concentricity" ("Position")
and not "REAL Concentricity".**



LUNCHEON LEARN





LUNCHEON LEARN

Calypso User Desk - (C) Carl Zeiss - Concentricity1

File Edit View Resources Features Construction Size Form and Location Plan CAD Extras Planner Window ?

Basic Status: Select function or probe for surface measurement with single points

Concentricity

Concentricity8 Comment

0.2500 Tolerance

Feature (RFS) Circle9

Primary Datum Cylinder1

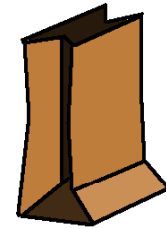
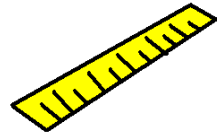
Secondary Datum

Actual 0.3082

OK Reset

“Circle 9” is the feature, about 350mm away

“Cylinder 1” is Datum A, and is 8mm long

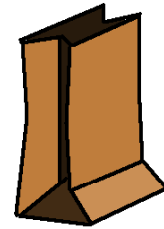
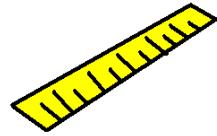


LUNCHEON LEARN

The tolerance is 250 microns for goodness sake.

I'm using a ZEISS after all. The machine has an accuracy of 1.7 microns. PIECE OF CAKE!

What could go wrong?

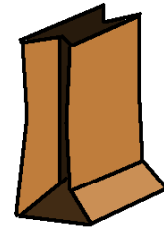
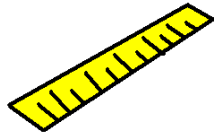


LUNCHEON LEARN

Run the part 10 times in a Loop.

Don't Touch the part.

Let's check repeatability...



LUNCHEON LEARN

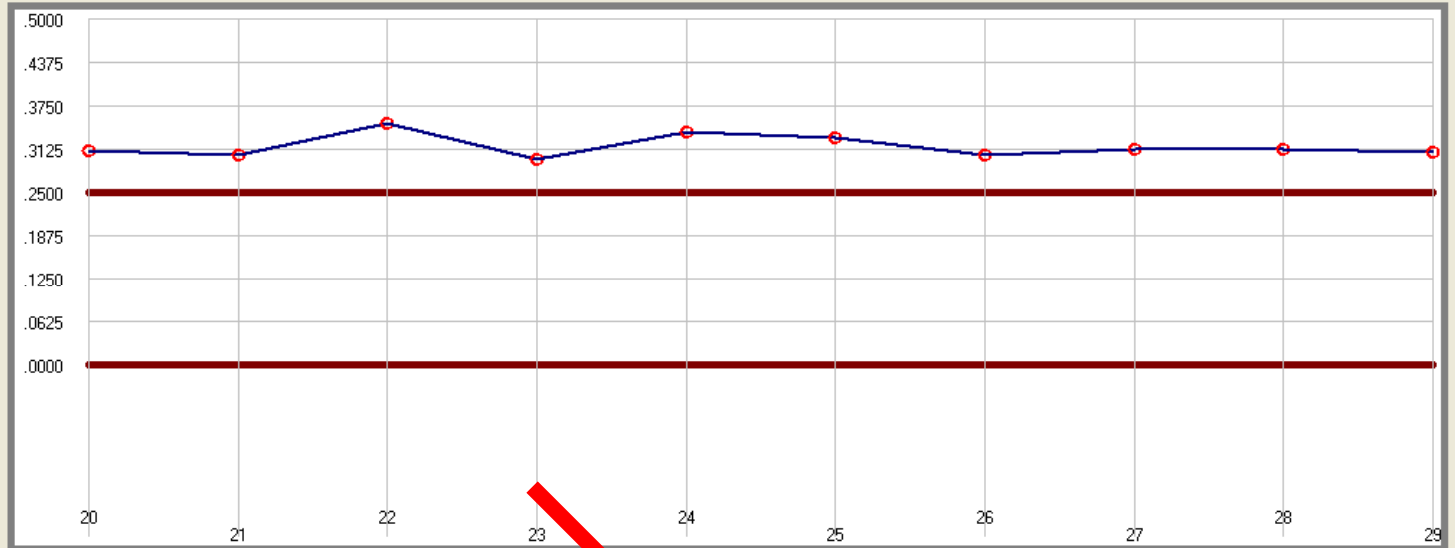
Statistical Analysis



BASIC STATISTICAL ANALYSIS Concentricity8

RUN CHART

- Concentricity1
- Concentricity2
- Concentricity3
- Concentricity4
- Concentricity5
- Concentricity6
- Concentricity7
- Concentricity8**



Show True Pos. Target Charts



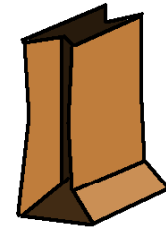
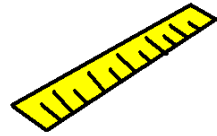
Specification Limit
 Average
 Data Point In Tolerance
 Data Point Out-of-Tolerance
 Data Point off Chart Scale
 Data Point Masked

Upper Spec : 0.25
 Lower Spec : 0
 Average : 0.316546

Maximum : 0.35003
 Minimum : 0.29821
 Range : 0.05182

6σ/Tol : 39.84%
 Cpk : -1.339
 Total Measurements: 10
 Masked: 0

20:	.31069
21:	.30490
22:	.35003
23:	.29821
24:	.33739
25:	.32840
26:	.30421
27:	.31182
28:	.31157
29:	.30824

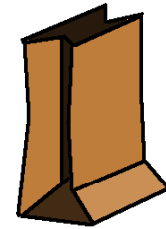
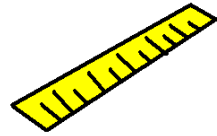


LUNCHEON LEARN

Range of 52 microns?

An estimated GR&R of 40%?

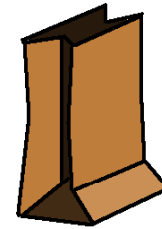
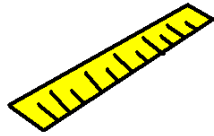
I think I need to call service...



LUNCHEON LEARN

...before I do, I wonder if the distance from the Datum has anything to do with it.

Check this out:



LUNCHEON LEARN

Statistical Analysis



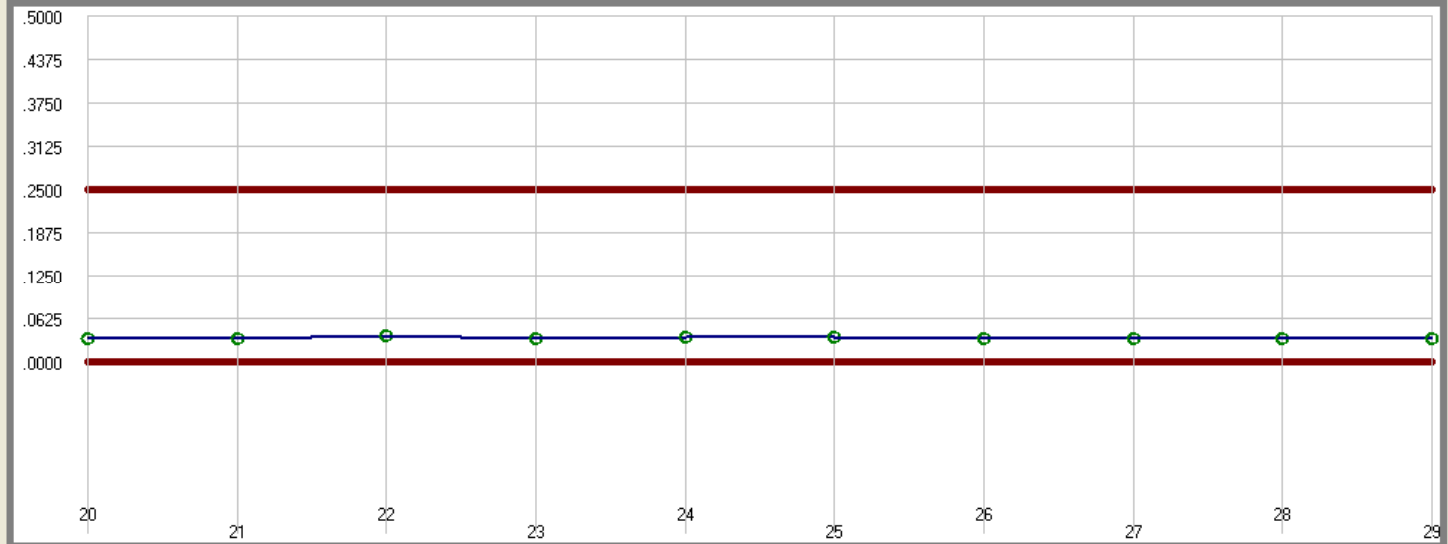
BASIC STATISTICAL ANALYSIS Concentricity1

30mm from Datum A

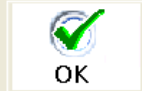
RUN CHART

Concentricity1

- Concentricity2
- Concentricity3
- Concentricity4
- Concentricity5
- Concentricity6
- Concentricity7
- Concentricity8



Show True Pos. Target Charts



Specification Limit	Average	Data Point In Tolerance	Data Point Out-of-Tolerance	Data Point off Chart Scale	Data Point Masked from Statistics
---------------------	---------	-------------------------	-----------------------------	----------------------------	-----------------------------------

Upper Spec : 0.25

Lower Spec : 0

Average : 0.034459

Maximum : 0.0366

Minimum : 0.03338

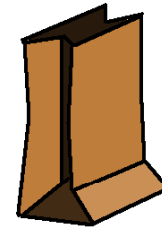
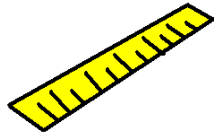
Range : 0.00322

6σ/Tol : 2.5%

Cpk : 68.890

Total Measurements: 10
Masked: 0

- 20: .03426
- 21: .03366
- 22: .03660
- 23: .03338
- 24: .03572
- 25: .03511
- 26: .03353
- 27: .03432
- 28: .03384
- 29: .03417



LUNCHEON LEARN

Statistical Analysis

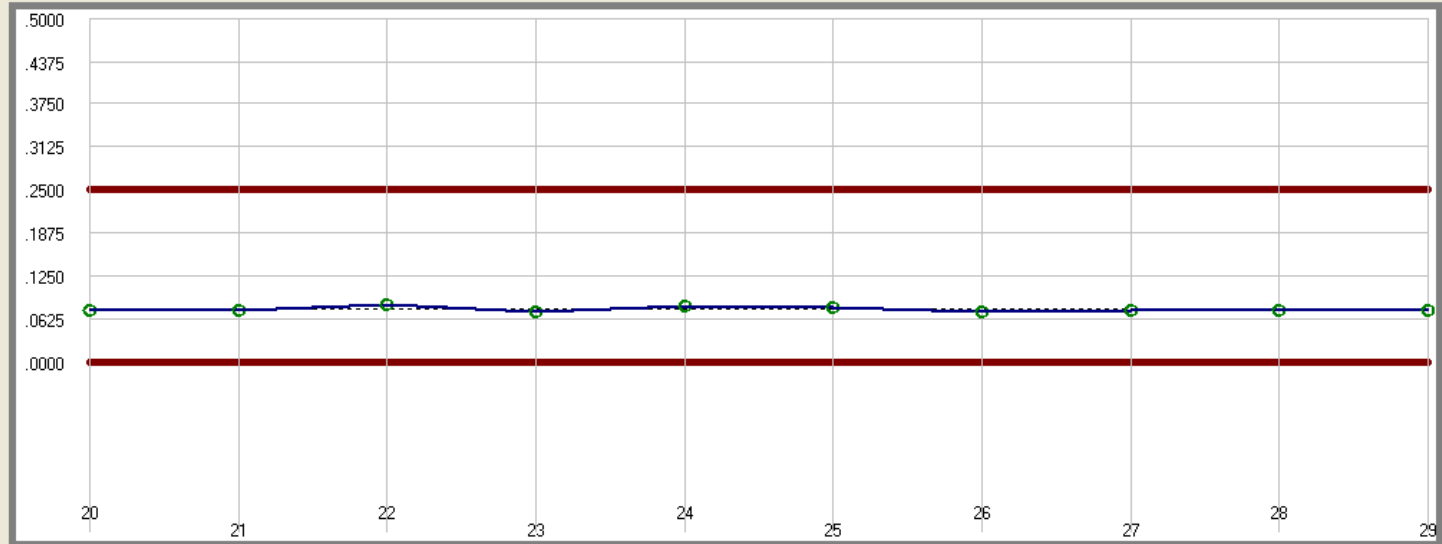


BASIC STATISTICAL ANALYSIS Concentricity2

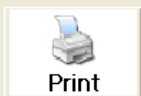
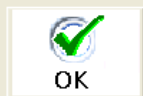
70mm from Datum A

RUN CHART

- Concentricity1
- Concentricity2
- Concentricity3
- Concentricity4
- Concentricity5
- Concentricity6
- Concentricity7
- Concentricity8



Show True Pos. Target Charts



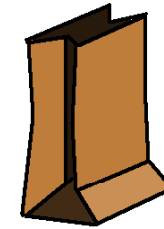
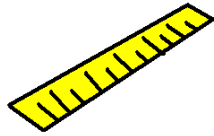
Specification Limit	Average	Data Point In Tolerance	Data Point Out-of-Tolerance	Data Point off Chart Scale	Data Point Masked from Statistics
---------------------	---------	-------------------------	-----------------------------	----------------------------	-----------------------------------

Upper Spec : 0.25 Maximum : 0.08263 6σ/Tol : 7.6%

Lower Spec : 0 Minimum : 0.07273 Cpk : 18.289

Average : 0.076282 Range : **0.01010** Total Measurements: 10
Masked: 0

20:	.07589
21:	.07398
22:	.08263
23:	.07273
24:	.08023
25:	.07840
26:	.07353
27:	.07560
28:	.07498
29:	.07485



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Statistical Analysis

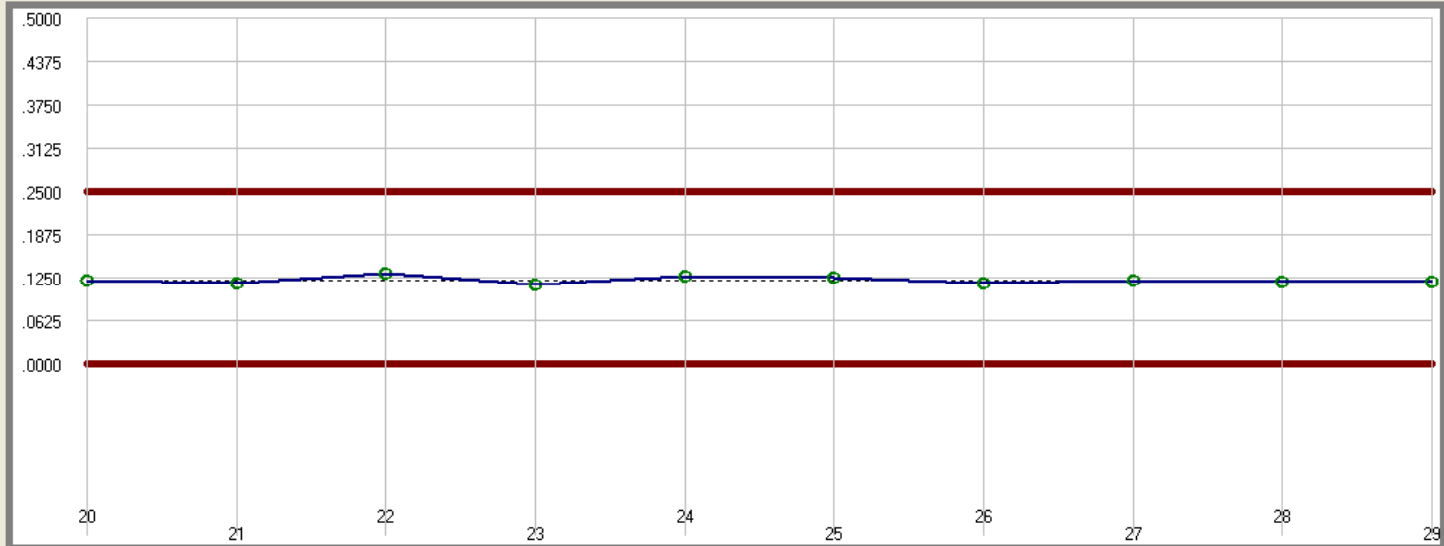


BASIC STATISTICAL ANALYSIS Concentricity3

110mm from Datum A

RUN CHART

- Concentricity1
- Concentricity2
- Concentricity3**
- Concentricity4
- Concentricity5
- Concentricity6
- Concentricity7
- Concentricity8



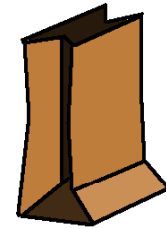
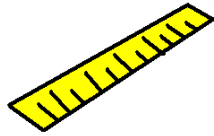
Show True Pos. Target Charts



Specification Limit	Average	Data Point In Tolerance	Data Point Out-of-Tolerance	Data Point off Chart Scale	Data Point Masked from Statistics
Upper Spec : 0.25	Maximum : 0.13149	6σ/Tol : 12.45%			
Lower Spec : 0	Minimum : 0.11536	Cpk : 8.278			
Average : 0.121085	Range : 0.01613	Total Measurements: 10			Masked: 0

[Click to show Percentage](#)

20: .12012
21: .11735
22: .13149
23: .11536
24: .12758
25: .12466
26: .11658
27: .11998
28: .11922
29: .11851



LUNCHEON LEARN

Statistical Analysis

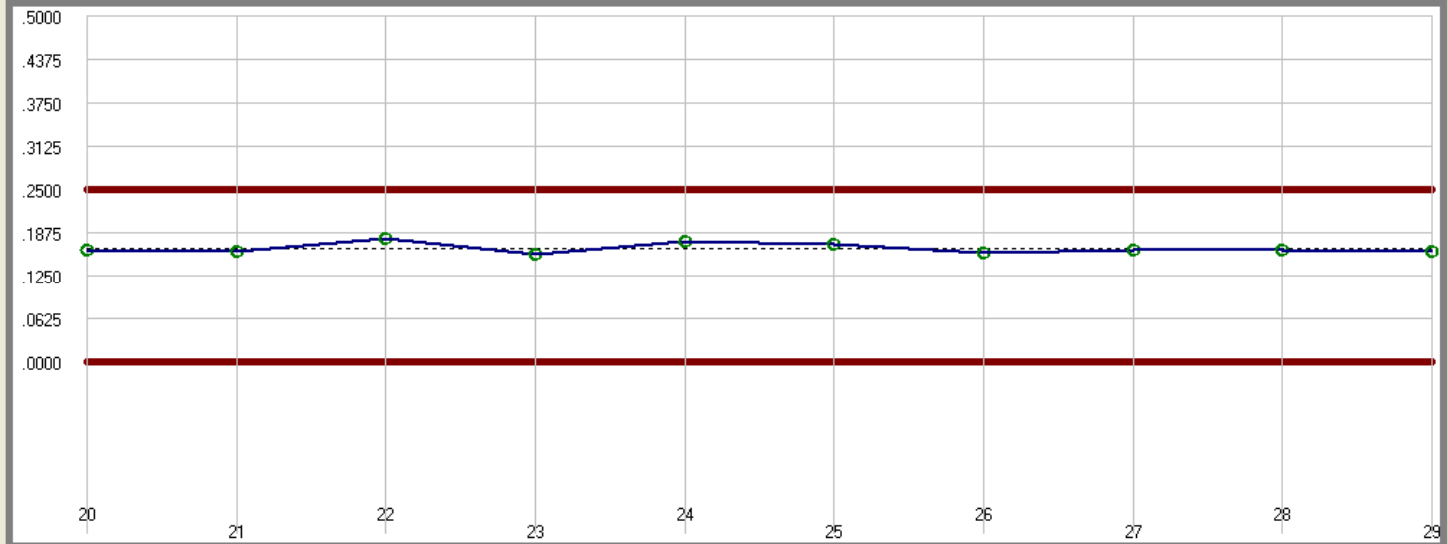


BASIC STATISTICAL ANALYSIS Concentricity4

150mm from Datum A

RUN CHART

- Concentricity1
- Concentricity2
- Concentricity3
- Concentricity4**
- Concentricity5
- Concentricity6
- Concentricity7
- Concentricity8

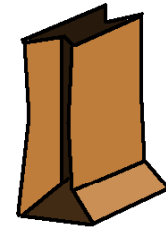
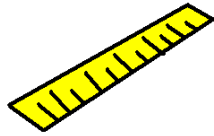


Show True Pos. Target Charts



Specification Limit	Average	Data Point In Tolerance	Data Point Out-of-Tolerance	Data Point off Chart Scale	Data Point Masked from Statistics
Upper Spec : 0.25	Maximum : 0.17938	6σ/Tol : 17.18%			
Lower Spec : 0	Minimum : 0.1572	Cpk : 3.957			
Average : 0.165	Range : 0.02218	Total Measurements: 10			Masked: 0

- 20: .16338
- 21: .15984
- 22: .17938
- 23: .15720
- 24: .17399
- 25: .16999
- 26: .15894
- 27: .16338
- 28: .16259
- 29: .16131



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Statistical Analysis

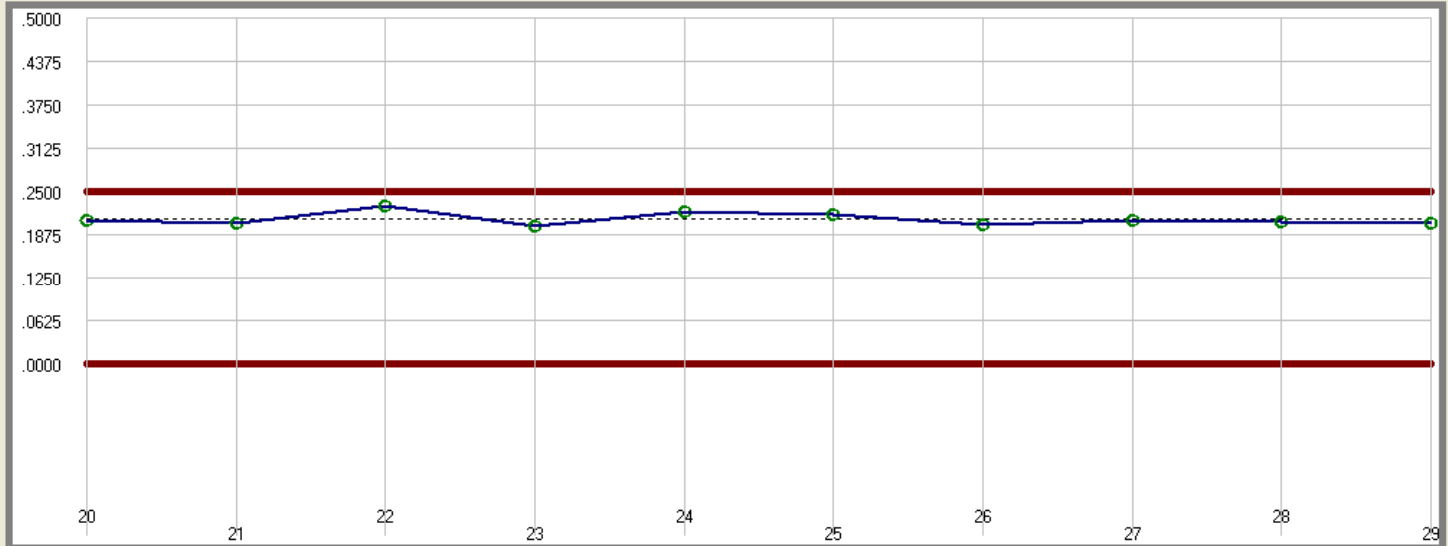


BASIC STATISTICAL ANALYSIS Concentricity5

190mm from Datum A

RUN CHART

- Concentricity1
- Concentricity2
- Concentricity3
- Concentricity4
- Concentricity5**
- Concentricity6
- Concentricity7
- Concentricity8

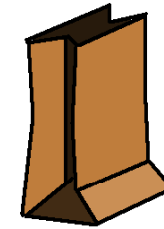
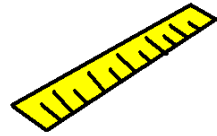


Show True Pos. Target Charts



Specification Limit	Average	Data Point In Tolerance	Data Point Out-of-Tolerance	Data Point off Chart Scale	Data Point Masked from Statistics
Upper Spec : 0.25	Maximum : 0.22827	6σ/Tol : 21.88%			
Lower Spec : 0	Minimum : 0.20008	Cpk : 1.466			
Average : 0.209944	Range : 0.02819	Total Measurements: 10			Masked: 0

20:	.20766
21:	.20336
22:	.22827
23:	.20008
24:	.22138
25:	.21636
26:	.20246
27:	.20783
28:	.20694
29:	.20510



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Statistical Analysis

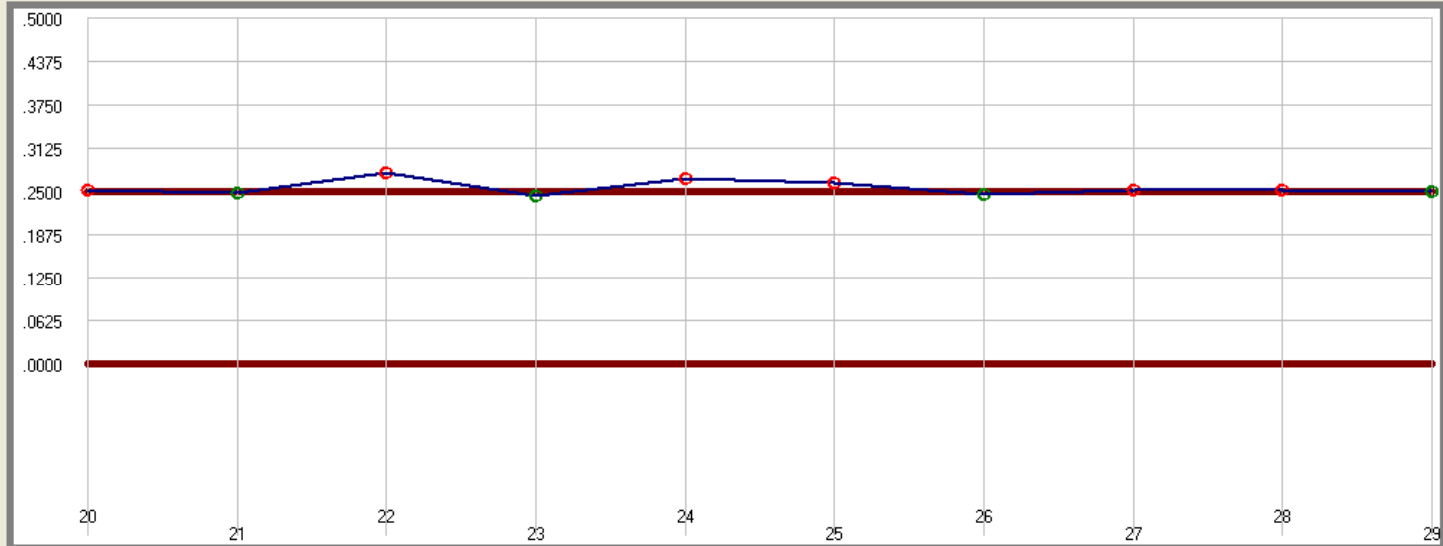


BASIC STATISTICAL ANALYSIS Concentricity6

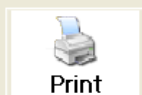
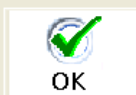
230mm from Datum A

RUN CHART

- Concentricity1
- Concentricity2
- Concentricity3
- Concentricity4
- Concentricity5
- Concentricity6**
- Concentricity7
- Concentricity8



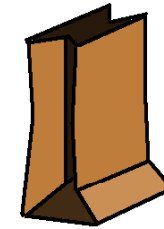
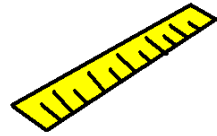
Show True Pos. Target Charts



Specification Limit	Average	Data Point In Tolerance	Data Point Out-of-Tolerance	Data Point off Chart Scale	Data Point Masked from Statistics
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Upper Spec : 0.25	Maximum : 0.27738	6σ/Tol : 26.53%
Lower Spec : 0	Minimum : 0.2431	Cpk : -.154
Average : 0.255104	Range : 0.03428	Total Measurements: 10 Masked: 0

20:	.25203
21:	.24710
22:	.27738
23:	.24310
24:	.26893
25:	.26291
26:	.24638
27:	.25248
28:	.25154
29:	.24919



LUNCHEON LEARN

Statistical Analysis

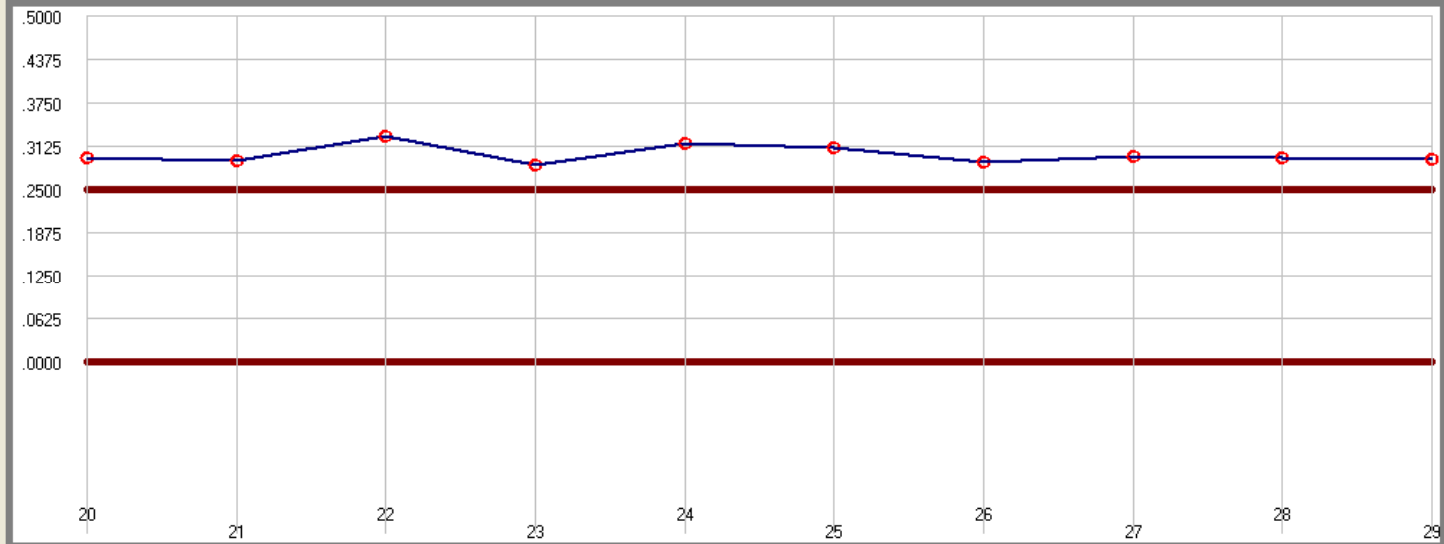


BASIC STATISTICAL ANALYSIS Concentricity7

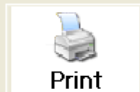
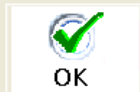
270mm from Datum A

RUN CHART

- Concentricity1
- Concentricity2
- Concentricity3
- Concentricity4
- Concentricity5
- Concentricity6
- Concentricity7**
- Concentricity8



Show True Pos. Target Charts



— Specification Limit
 - - - - - Average
 ● Data Point In Tolerance
 ● Data Point Out-of-Tolerance
 ● Data Point off Chart Scale
 ● Data Point Masked from Statistics

Upper Spec : 0.25

Lower Spec : 0

Average : 0.300479

Maximum : 0.32674

Minimum : 0.28604

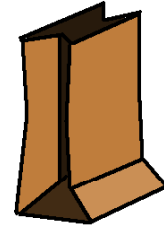
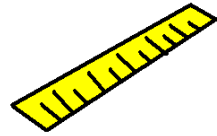
Range : 0.0407

6σ/Tol : 31.25%

Cpk : -1.293

Total Measurements: 10
Masked: 0

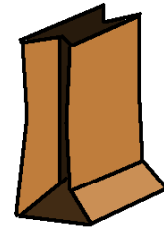
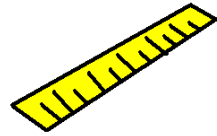
- 20: 29673
- 21: 29107
- 22: 32674
- 23: 28604
- 24: 31674
- 25: 30963
- 26: 29049
- 27: 29734
- 28: 29638
- 29: 29357



LUNCHEON LEARN

I think I'm seeing a trend here.

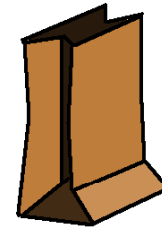
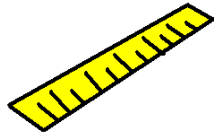
**Distance from the Datum has a
serious effect on the
Concentricity (Position) result.**



LUNCHEON LEARN

**I wonder if the length of the Datum
has anything to do with the results
as well?**

**Let's shorten a Datum a bit,
from 8mm down to 5mm and
see the effect.**



LUNCHEON LEARN

Statistical Analysis



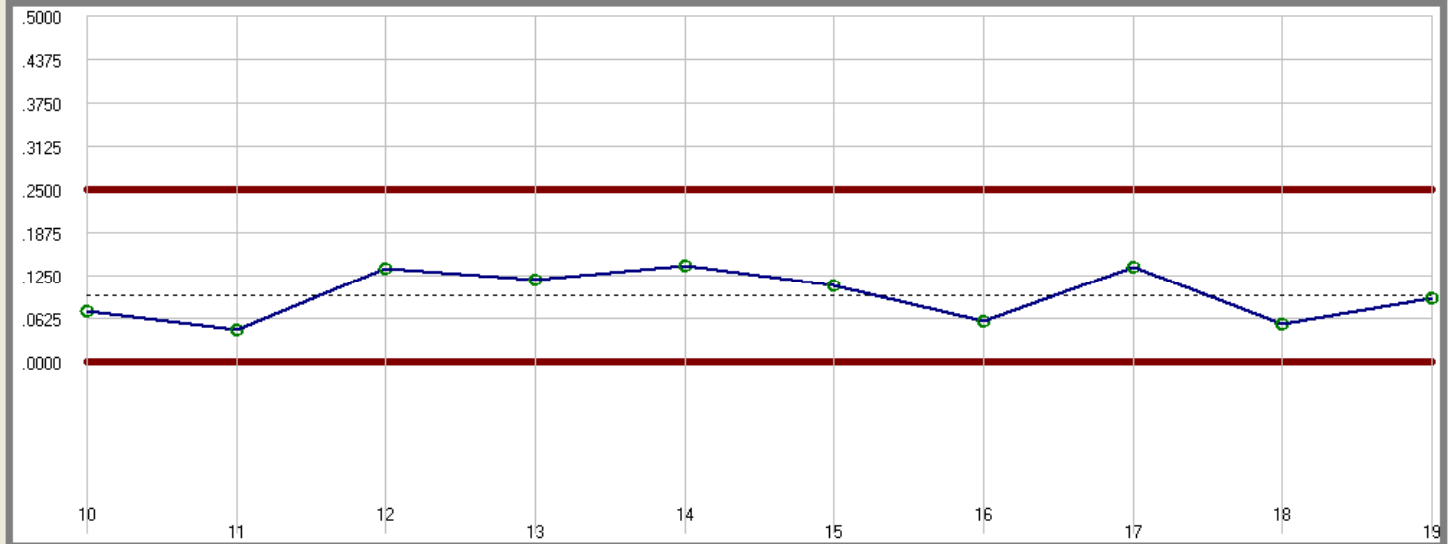
BASIC STATISTICAL ANALYSIS Concentricity1

30mm from Datum A

RUN CHART

Concentricity1

- Concentricity1
- Concentricity2
- Concentricity3
- Concentricity4
- Concentricity5
- Concentricity6
- Concentricity7
- Concentricity8



Show True Pos. Target Charts



	Specification Limit		Average		Data Point In Tolerance		Data Point Out-of-Tolerance		Data Point off Chart Scale		Data Point Masked from Statistics
--	---------------------	--	---------	--	-------------------------	--	-----------------------------	--	----------------------------	--	-----------------------------------

Upper Spec : 0.25

Lower Spec : 0

Average : 0.096347

Maximum : 0.13858

Minimum : 0.04498

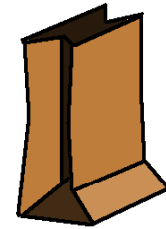
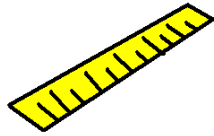
Range : 0.0936

6σ/Tol : 88.5%

Cpk : 1.393

Total Measurements: 10
Masked: 0

- 10: .07282
- 11: .04498
- 12: .13586
- 13: .11873
- 14: .13858
- 15: .11098
- 16: .05901
- 17: .13734
- 18: .05382
- 19: .09135



LUNCHEON LEARN

Statistical Analysis

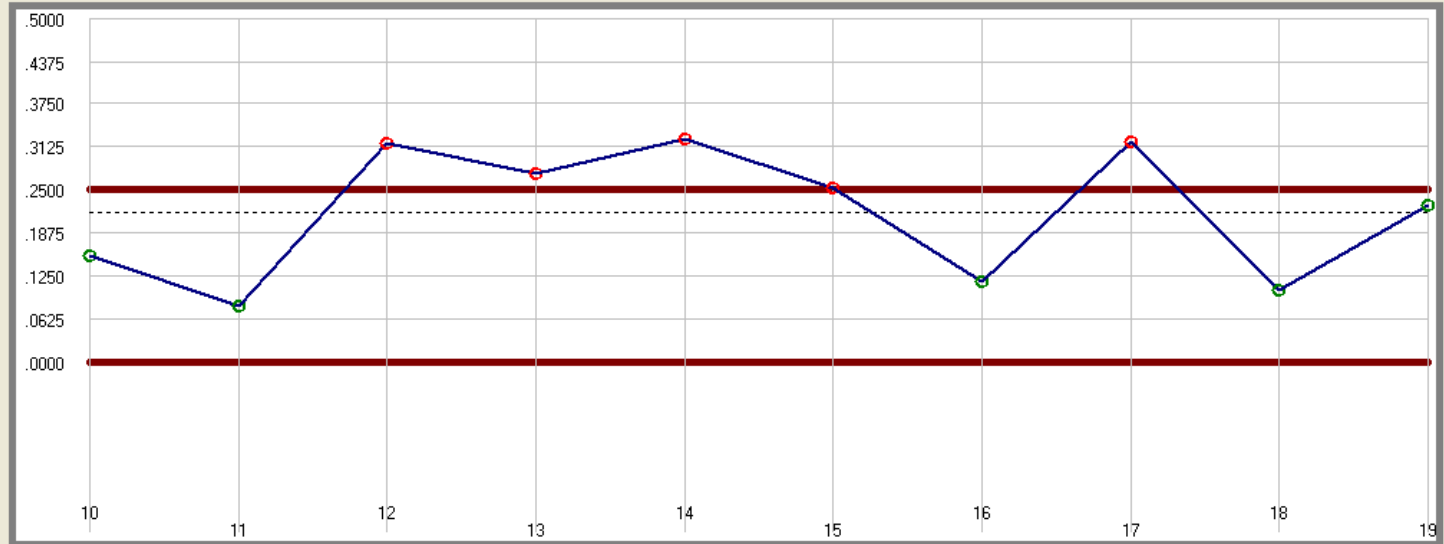


BASIC STATISTICAL ANALYSIS Concentricity2

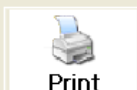
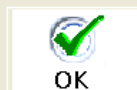
70mm from Datum A

RUN CHART

- Concentricity1
- Concentricity2
- Concentricity3
- Concentricity4
- Concentricity5
- Concentricity6
- Concentricity7
- Concentricity8

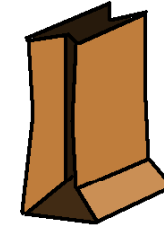
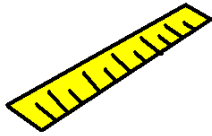


Show True Pos. Target Charts



Specification Limit	Average	Data Point In Tolerance	Data Point Out-of-Tolerance	Data Point off Chart Scale	Data Point Masked from Statistics
Upper Spec : 0.25	Average : 0.21672	Maximum : 0.3221	Minimum : 0.08111	6σ/Tol : 227.27%	Cpk : .117
Lower Spec : 0	Average : 0.21672	Range : 0.24099	Total Measurements: 10	Masked: 0	

10: .15387
11: .08111
12: .31676
13: .27235
14: .32210
15: .25279
16: .11757
17: .31960
18: .10460
19: .22645



LUNCHEON LEARN

Statistical Analysis

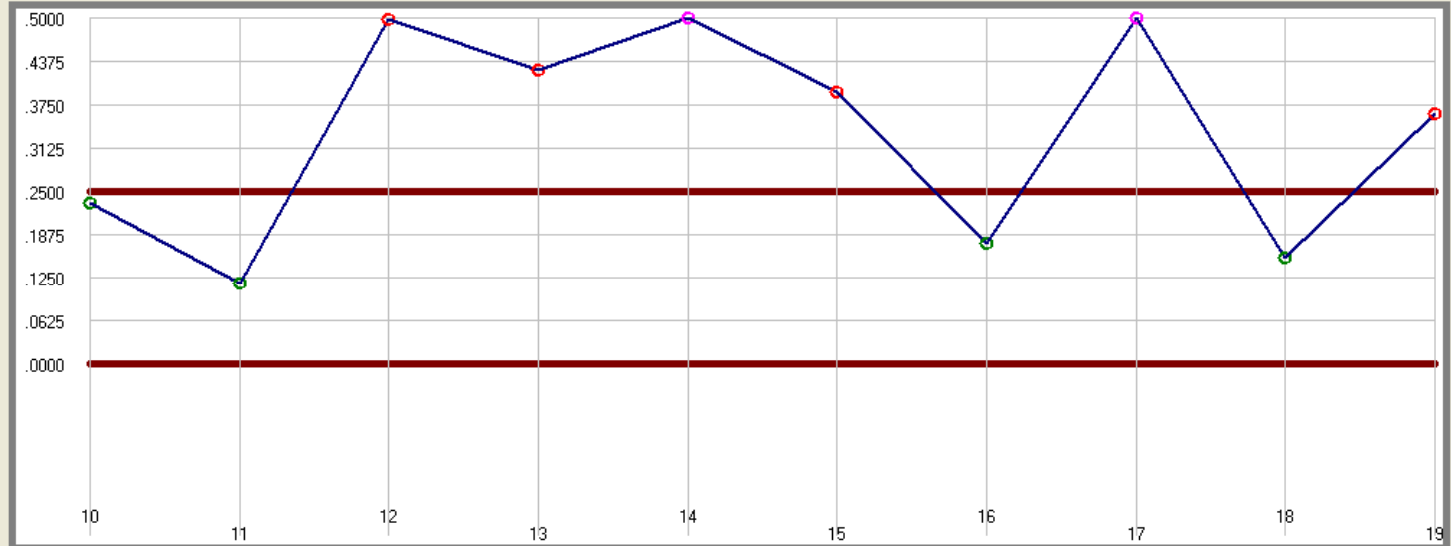


BASIC STATISTICAL ANALYSIS Concentricity3

110mm from Datum A

RUN CHART

- Concentricity1
- Concentricity2
- Concentricity3
- Concentricity4
- Concentricity5
- Concentricity6
- Concentricity7
- Concentricity8



Show True Pos. Target Charts

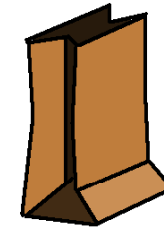
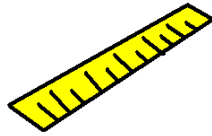


— Specification Limit
 --- Average
 ● Data Point In Tolerance
 ● Data Point Out-of-Tolerance
 ● Data Point off Chart Scale
 ● Data Point Masked from Statistics

Upper Spec : 0.25 Maximum : 0.50503 6σ/Tol : 370.37%
 Lower Spec : 0 Minimum : 0.11584 Cpk : -.188
 Average : 0.33643 Range : 0.38919 Total Measurements: 10
 Masked: 0

[Click to show Percentage](#)

- 10: .23421
- 11: .11584
- 12: .49705
- 13: .42548
- 14: .50503
- 15: .39388
- 16: .17520
- 17: .50118
- 18: .15424
- 19: .36219



LUNCHEON LEARN

Statistical Analysis

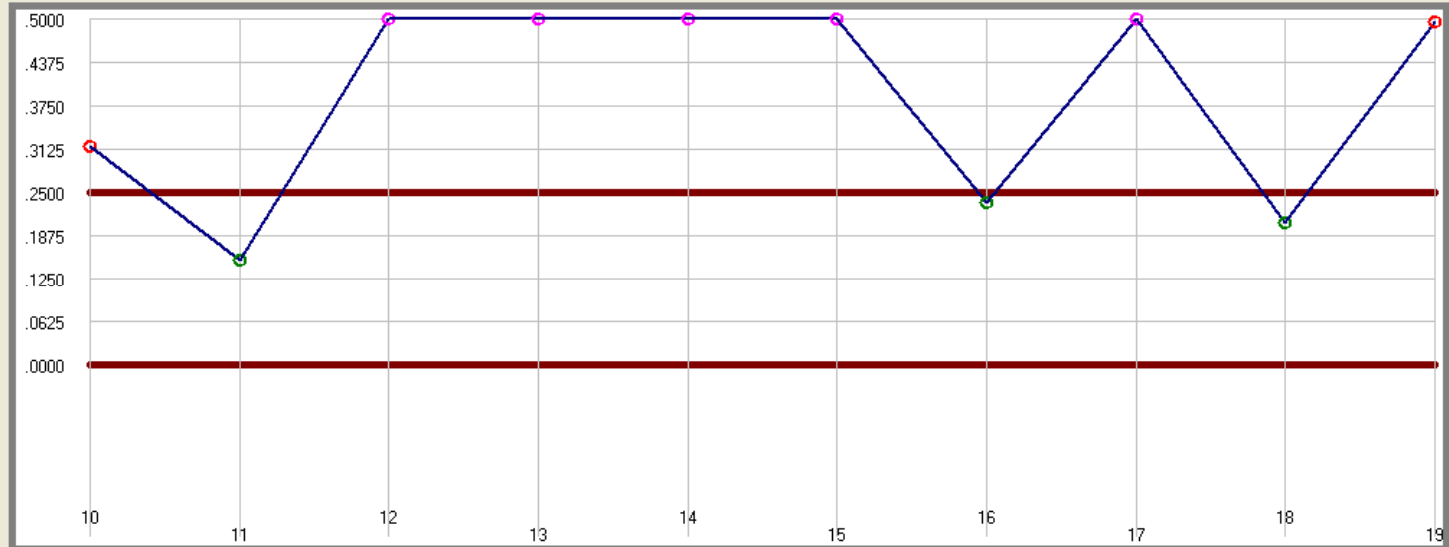


BASIC STATISTICAL ANALYSIS Concentricity4

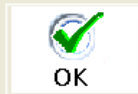
150mm from Datum A

RUN CHART

- Concentricity1
- Concentricity2
- Concentricity3
- Concentricity4**
- Concentricity5
- Concentricity6
- Concentricity7
- Concentricity8



Show True Pos. Target Charts



Specification Limit	Average	Data Point In Tolerance	Data Point Out-of-Tolerance	Data Point off Chart Scale	Data Point Masked from Statistics
---------------------	---------	-------------------------	-----------------------------	----------------------------	-----------------------------------

Upper Spec : 0.25

Lower Spec : 0

Average : 0.458054

Maximum : 0.6901

Minimum : 0.15309

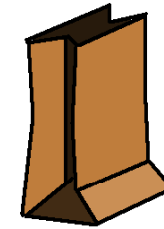
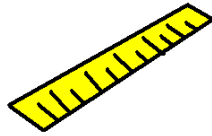
Range : 0.53701

Cp : .197

Cpk : -.328

Total Measurements: 10
Masked: 0

- 10: .31695
- 11: .15309
- 12: .67938
- 13: .58082
- 14: .69010
- 15: .53705
- 16: .23538
- 17: .68495
- 18: .20628
- 19: .49654



LUNCHEON LEARN

Statistical Analysis

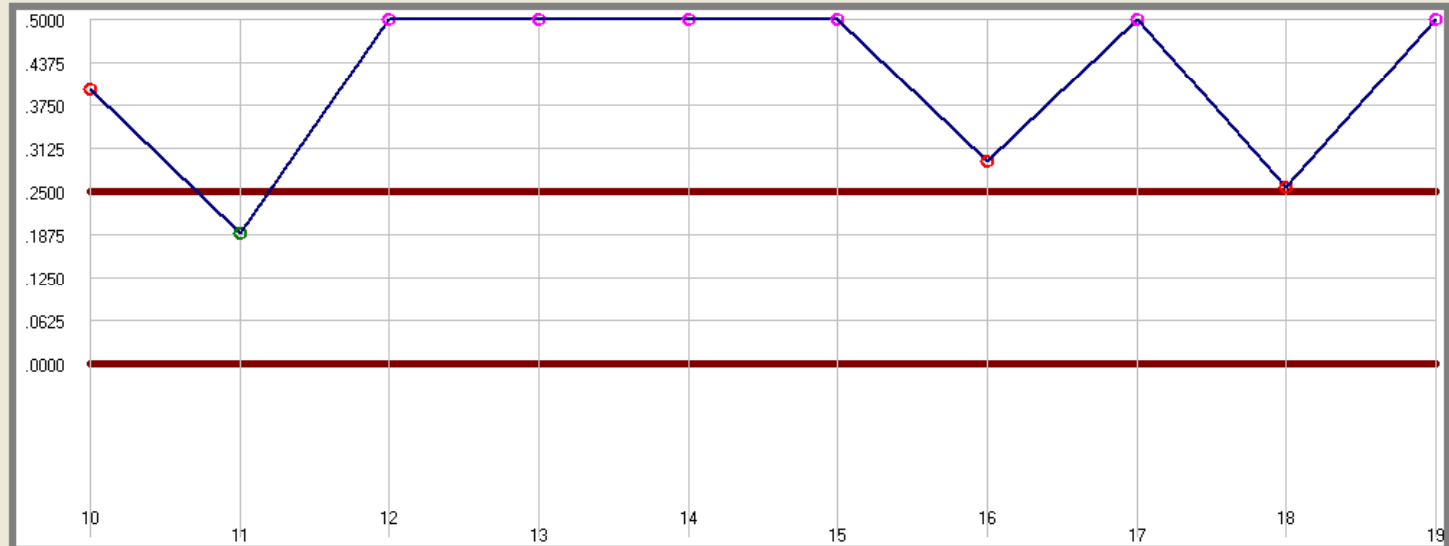


BASIC STATISTICAL ANALYSIS Concentricity5

190mm from Datum A

RUN CHART

- Concentricity1
- Concentricity2
- Concentricity3
- Concentricity4
- Concentricity5**
- Concentricity6
- Concentricity7
- Concentricity8



Show True Pos. Target Charts



Specification Limit
 Average
 ● Data Point In Tolerance
 ● Data Point Out-of-Tolerance
 ● Data Point off Chart Scale
 ● Data Point Masked from Statistics

Upper Spec : 0.25

Lower Spec : 0

Average : 0.578671

Maximum : 0.87406

Minimum : 0.18899

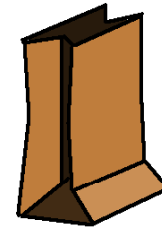
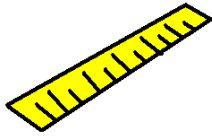
Range : 0.68507

Cp : .154

Cpk : -.406

Total Measurements: 10
Masked: 0

- 10: .39852
- 11: .18899
- 12: .86088
- 13: .73502
- 14: .87406
- 15: .67905
- 16: .29427
- 17: .86764
- 18: .25704
- 19: .63124



LUNCHEON LEARN

Statistical Analysis

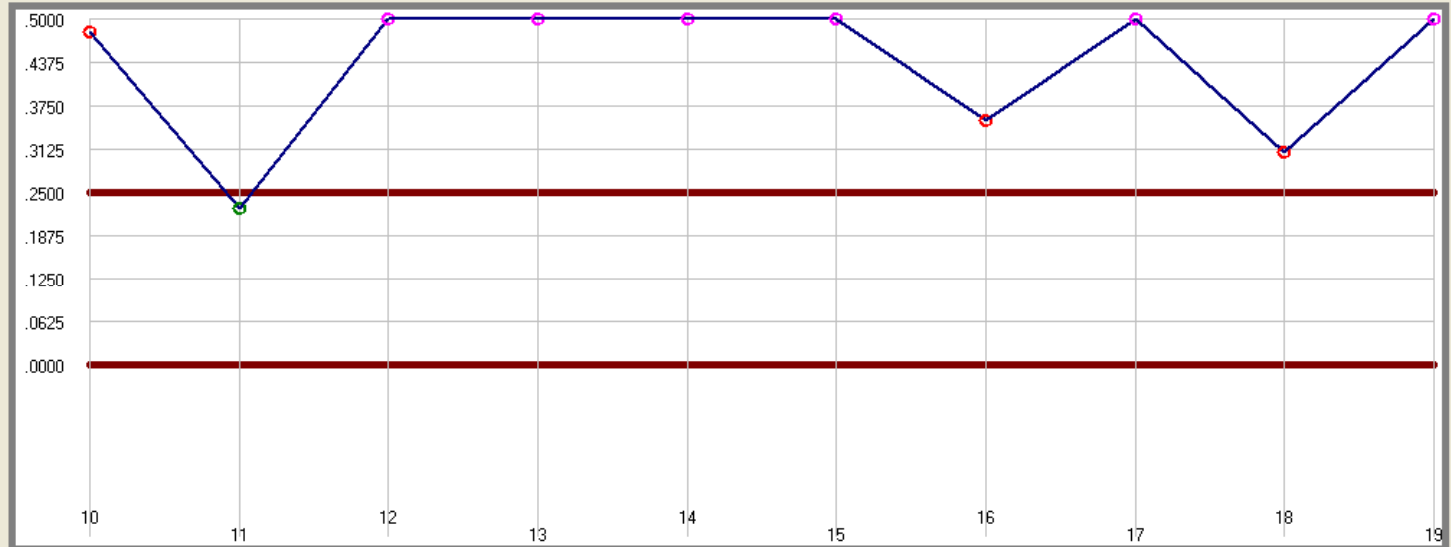


BASIC STATISTICAL ANALYSIS Concentricity6

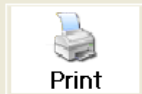
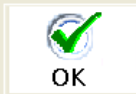
230mm from Datum A

RUN CHART

- Concentricity1
- Concentricity2
- Concentricity3
- Concentricity4
- Concentricity5
- Concentricity6**
- Concentricity7
- Concentricity8



Show True Pos. Target Charts



Specification Limit
 Average
 ● Data Point In Tolerance
 ● Data Point Out-of-Tolerance
 ● Data Point off Chart Scale
 ● Data Point Masked from Statistics

Upper Spec : 0.25

Lower Spec : 0

Average : 0.699846

Maximum : 1.05835

Minimum : 0.22615

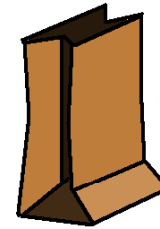
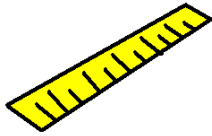
Range : 0.8322

6σ/Tol : 769.23%

Cpk : -.457

Total Measurements: 10
Masked: 0

- 10: .48072
- 11: .22615
- 12: 1.04281
- 13: .88963
- 14: 1.05835
- 15: .82150
- 16: .35404
- 17: 1.05060
- 18: .30858
- 19: .76608



LUNCHEON LEARN

Statistical Analysis

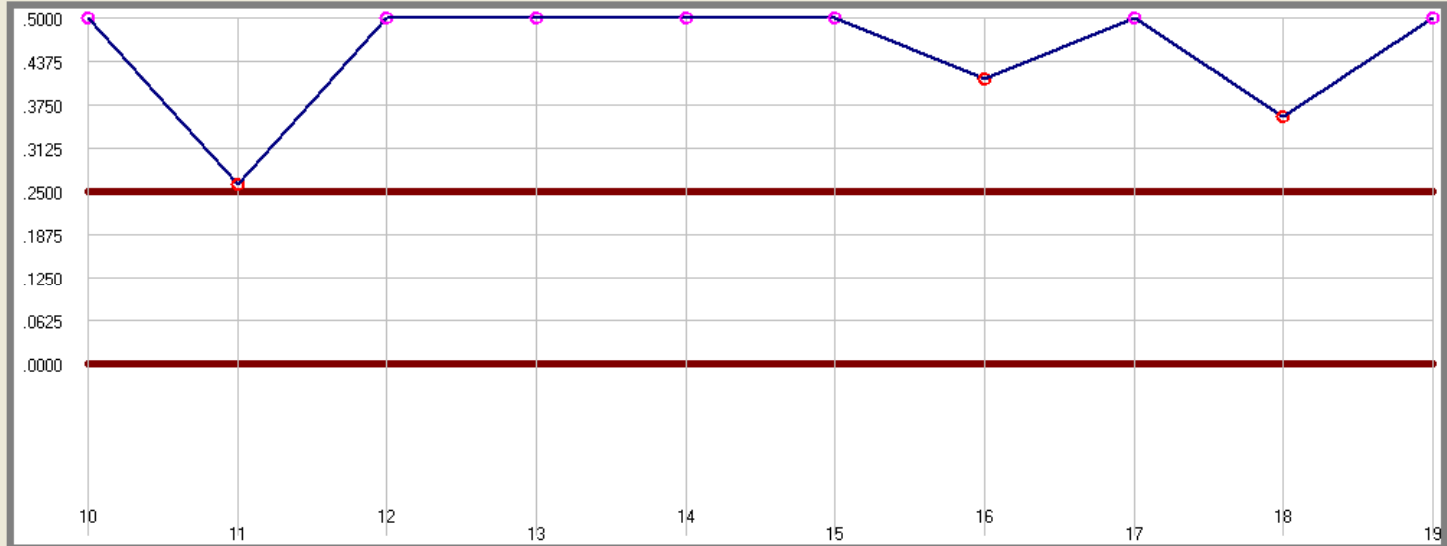


BASIC STATISTICAL ANALYSIS Concentricity7

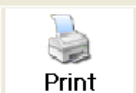
270mm from Datum A

RUN CHART

- Concentricity1
- Concentricity2
- Concentricity3
- Concentricity4
- Concentricity5
- Concentricity6
- Concentricity7**
- Concentricity8



Show True Pos. Target Charts



Specification Limit	Average	Data Point In Tolerance	Data Point Out-of-Tolerance	Data Point off Chart Scale	Data Point Masked from Statistics
---------------------	---------	-------------------------	-----------------------------	----------------------------	-----------------------------------

Upper Spec : 0.25

Lower Spec : 0

Average : 0.820086

Maximum : 1.24187

Minimum : 0.26137

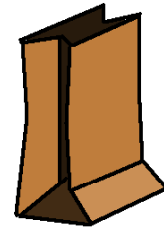
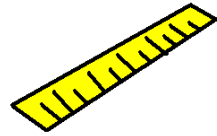
Range : 0.9805

6σ/Tol : 909.09%

Cpk : -.491

Total Measurements: 10
Masked: 0

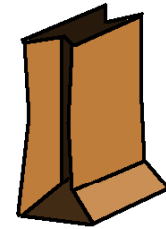
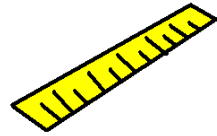
10:	.56170
11:	.26137
12:	1.22407
13:	1.04340
14:	1.24187
15:	.96314
16:	.41227
17:	1.23285
18:	.35845
19:	.90174



LUNCHEON LEARN

WOW!

**A 3mm difference in Datum Length
had a HUUUGE difference in
results.**

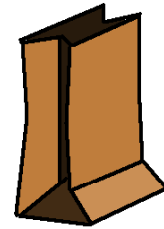
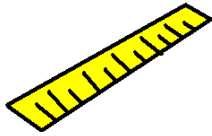


LUNCHEON LEARN

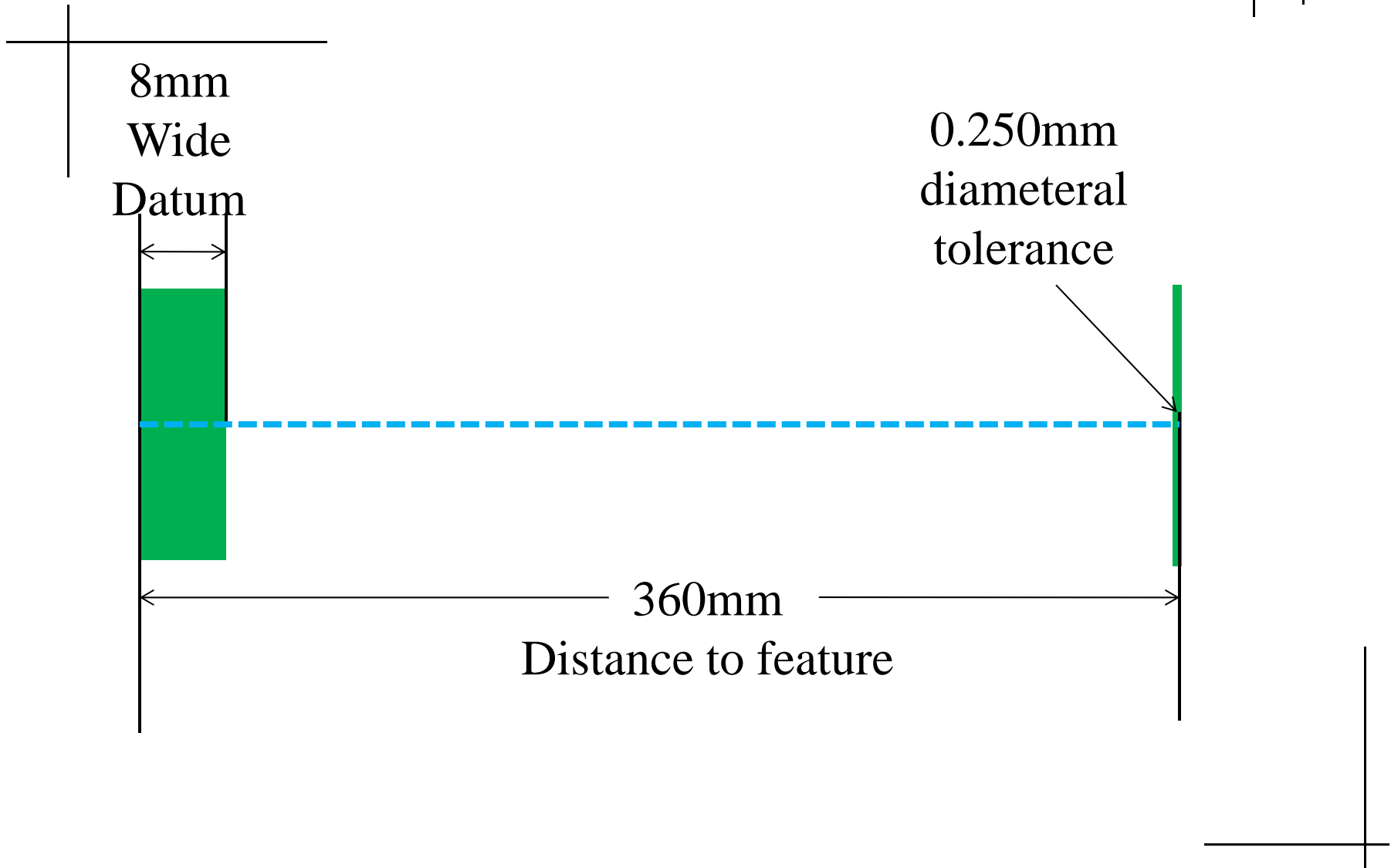
So, we have two problems here:

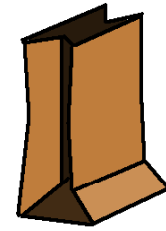
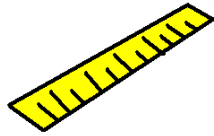
- **Feature located a long way from Datum**
- **Short, Unstable Datum**

Let's think about what we
are trying to do...

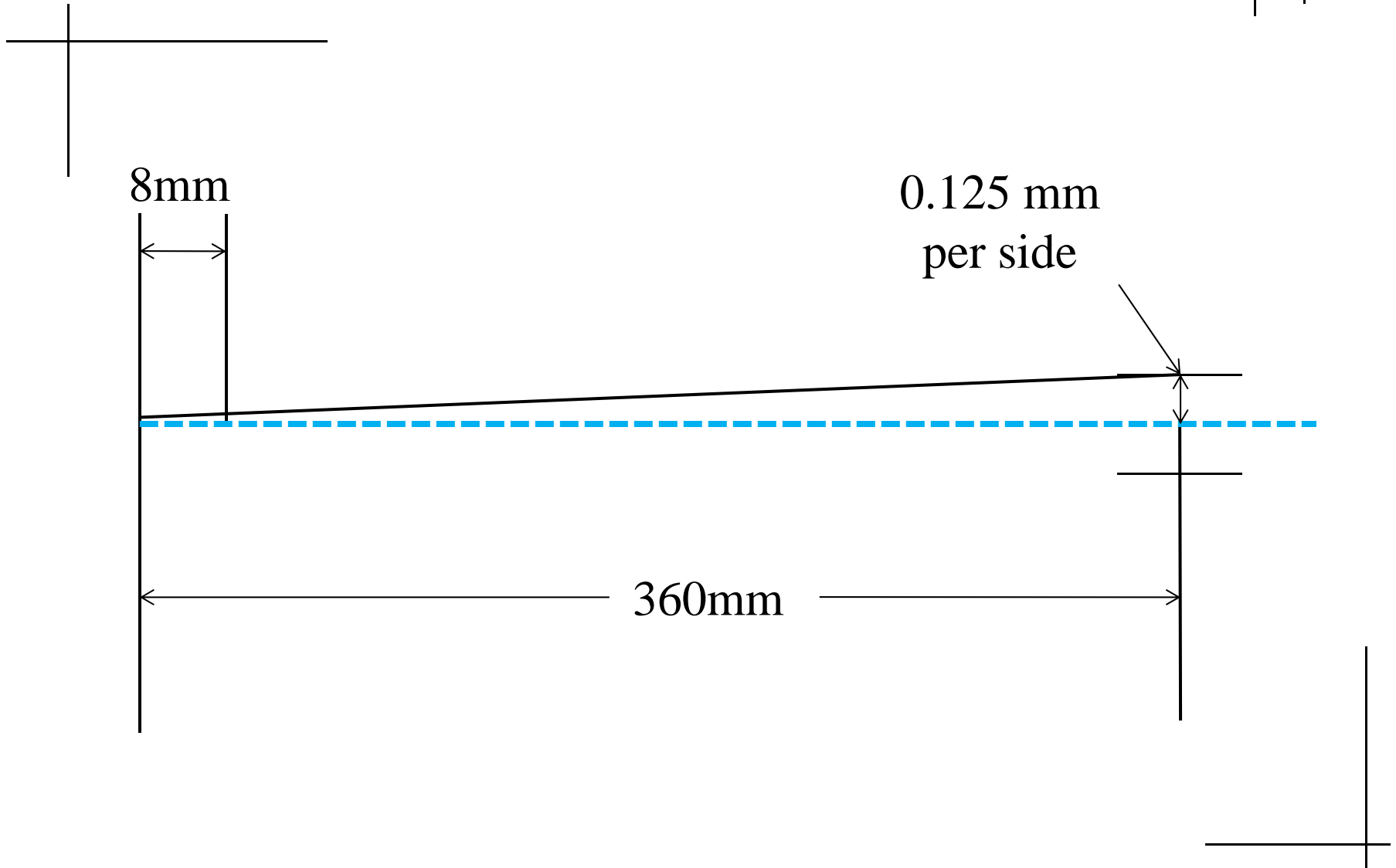


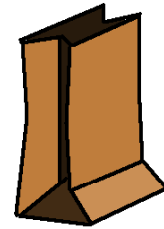
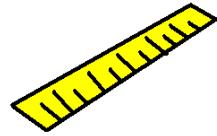
LUNCHEON LEARN





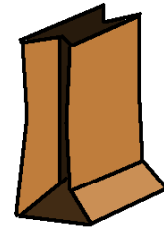
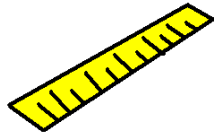
LUNCHEON LEARN



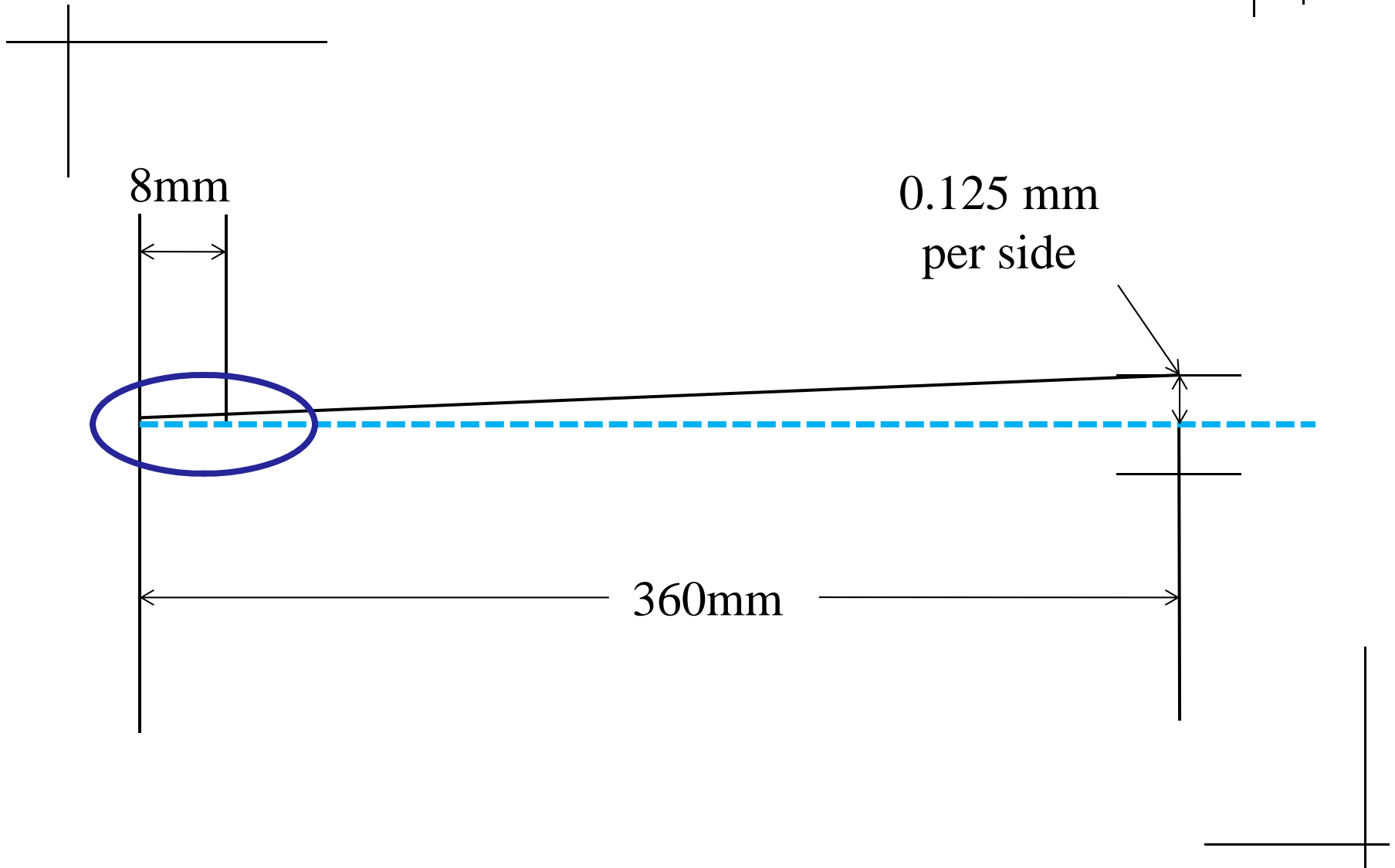


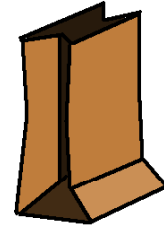
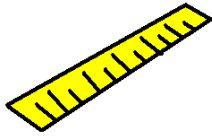
LUNCHEON LEARN

**Assuming we hold the feature
left side of the datum and the
feature still, what tolerance is on
the right side of the datum?**

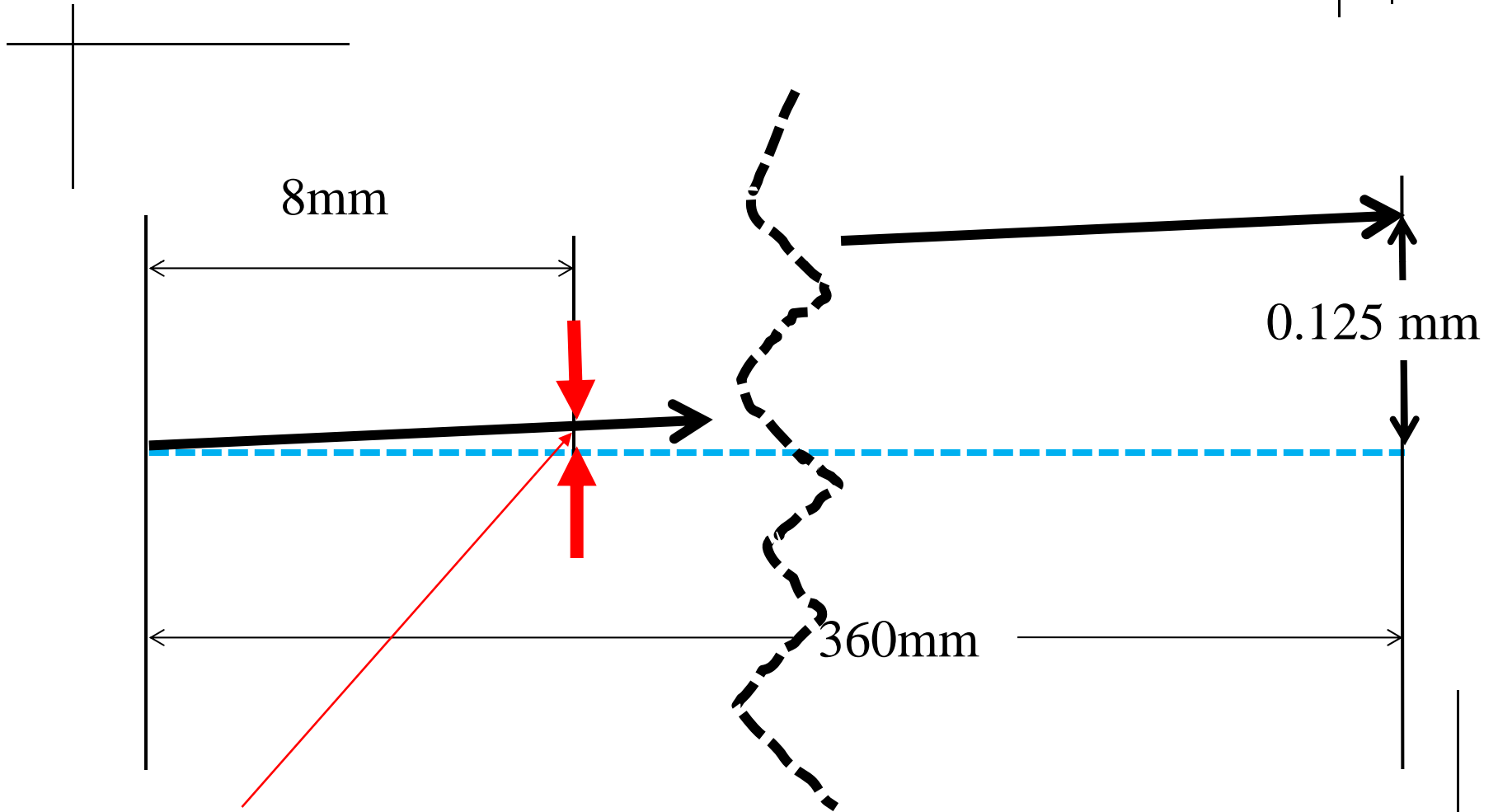


LUNCHEON LEARN

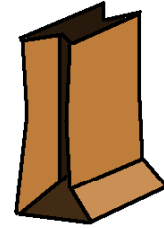
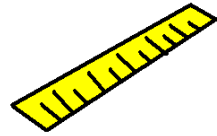




LUNCHEON LEARN



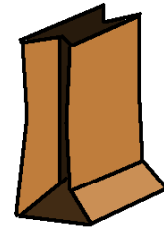
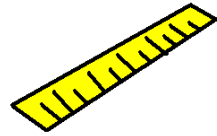
$$0.125/360*8=0.0028\text{mm!}$$



LUNCHEON LEARN

**So, in this case, a tolerance of
250 microns is REALLY a
tolerance of 2.8 microns.**

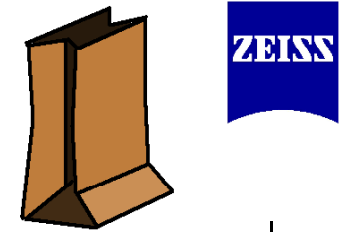
**YIKES! No wonder we are
having problems!**



LUNCHEON LEARN

**Time to go buy a
UPMC ultra with
an accuracy spec
of 0.4 microns!**

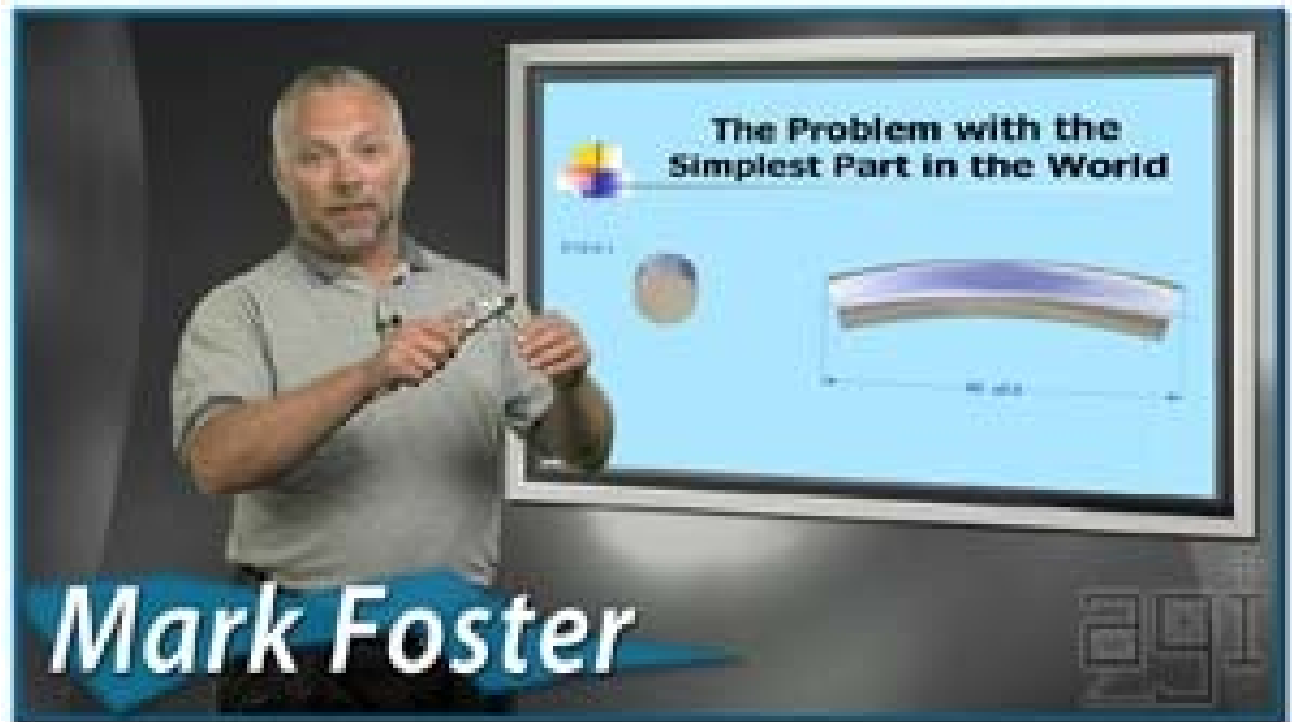


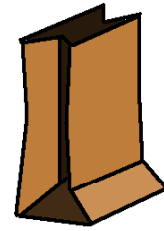
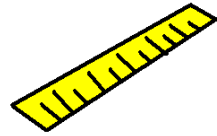


I can't buy a UPMC ultra right now...

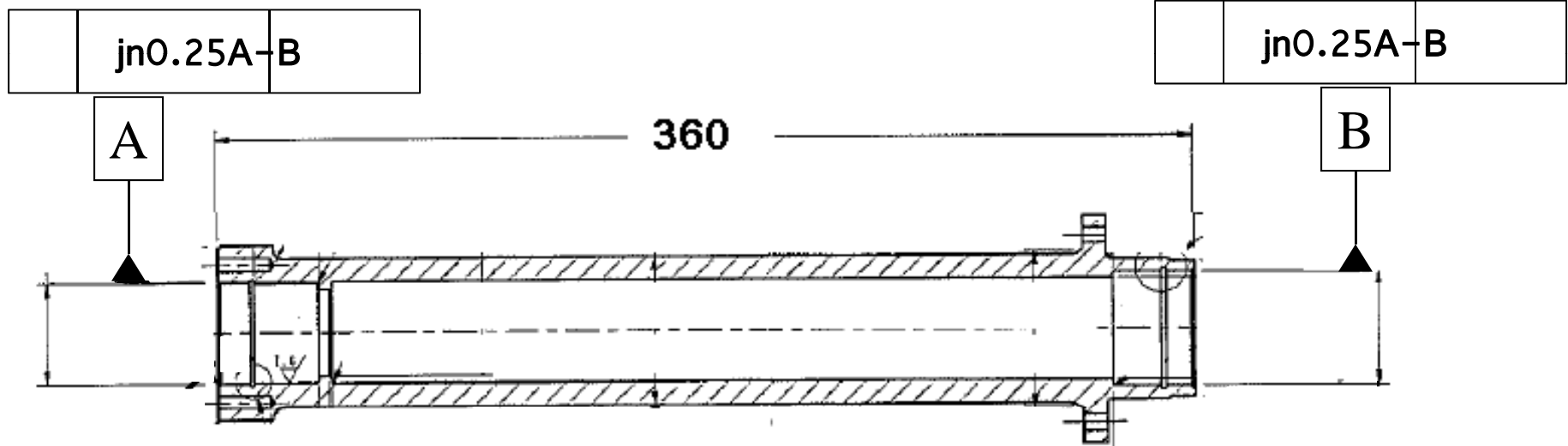
So I ask myself "WWMFD"?

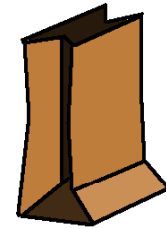
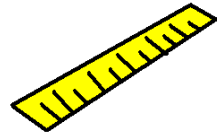
What
Would
Mark
Foster
Do?





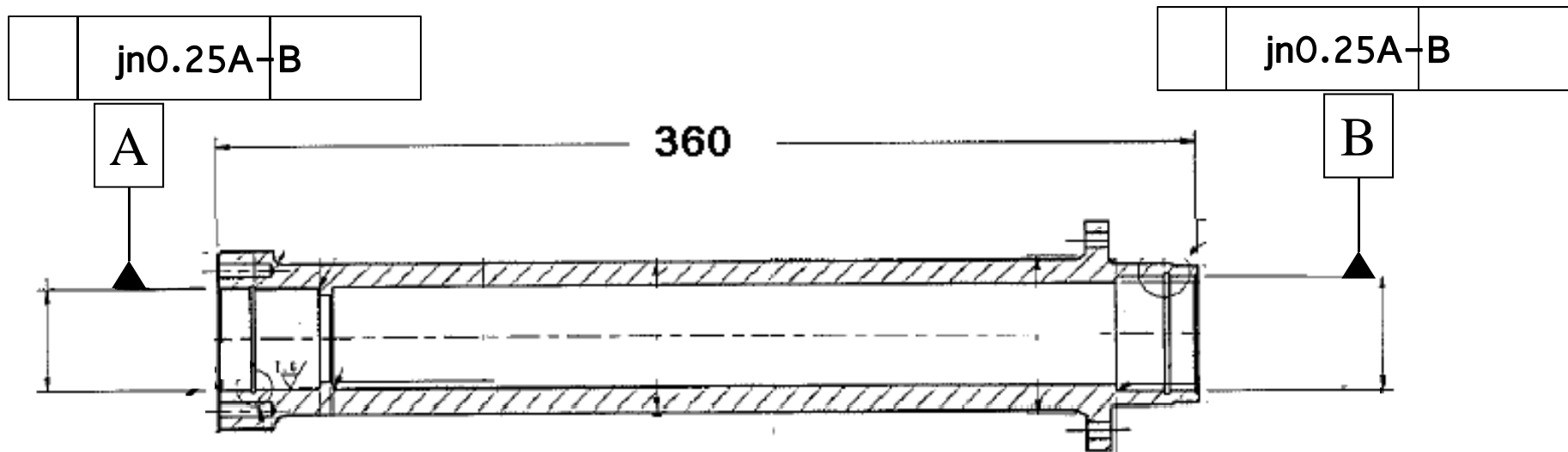
LUNCHEON LEARN

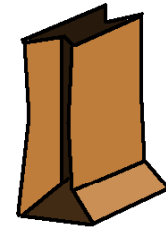
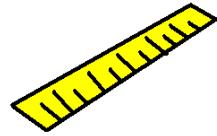




LUNCHEON LEARN

That makes sense! Functionally, -A- does not 100% control how a shaft fits through there!

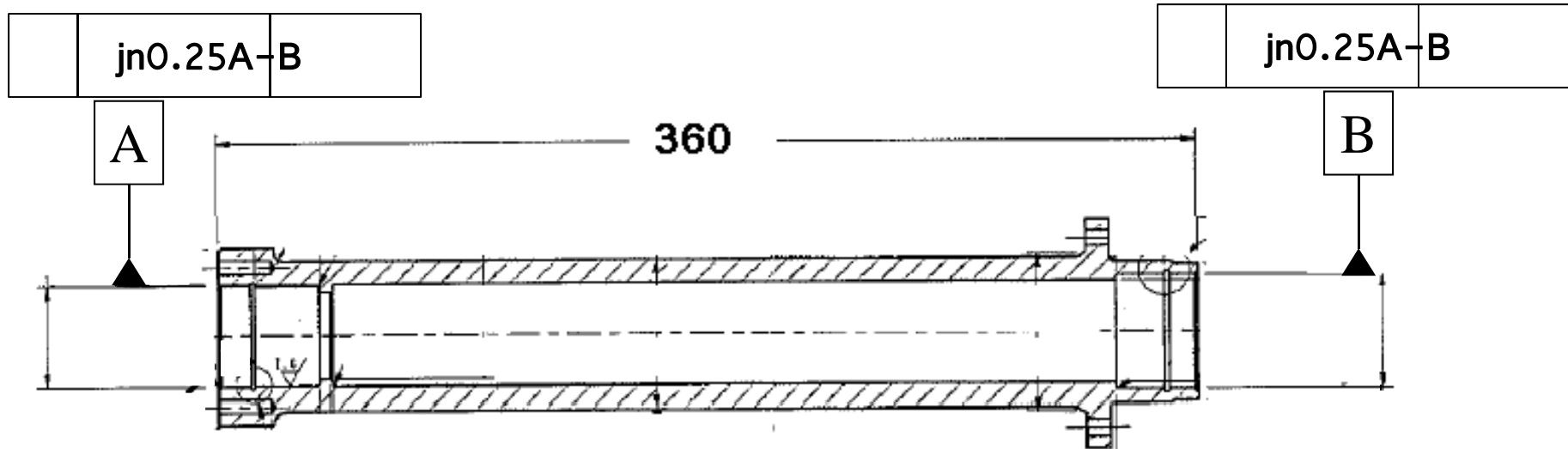


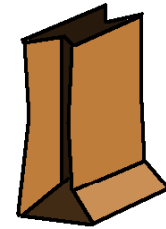
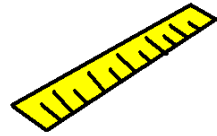


LUNCHEON LEARN

-A- and -B- equally control things.

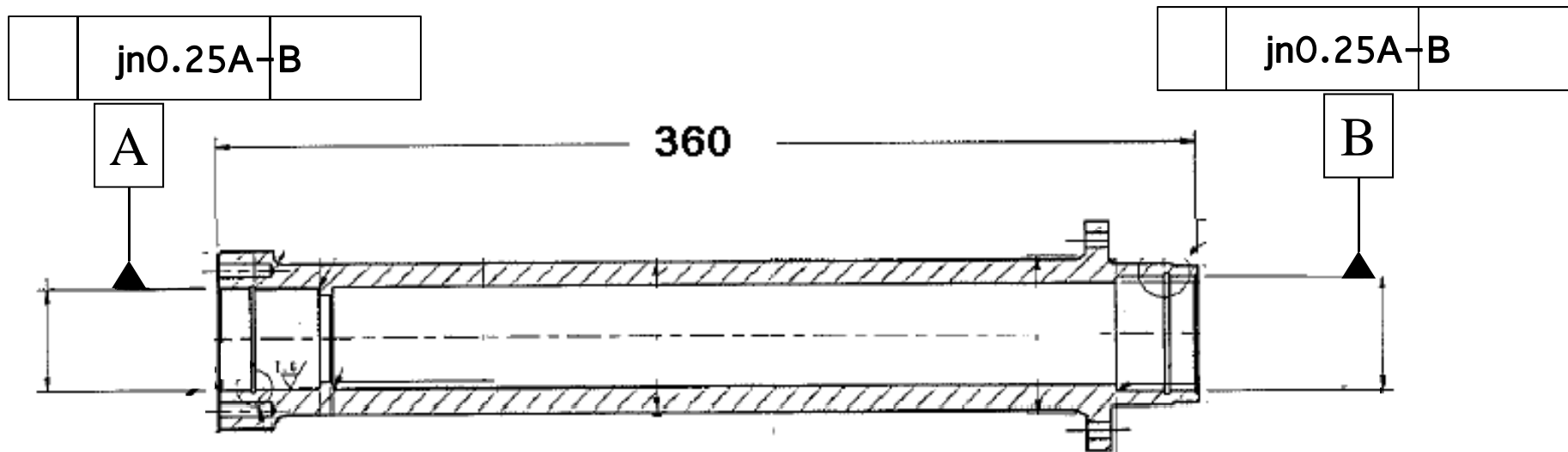
An axis created through -A- and -B- is now Datum A-B.

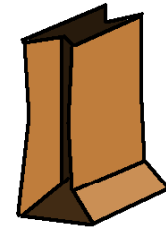
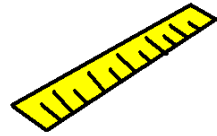




LUNCHEON LEARN

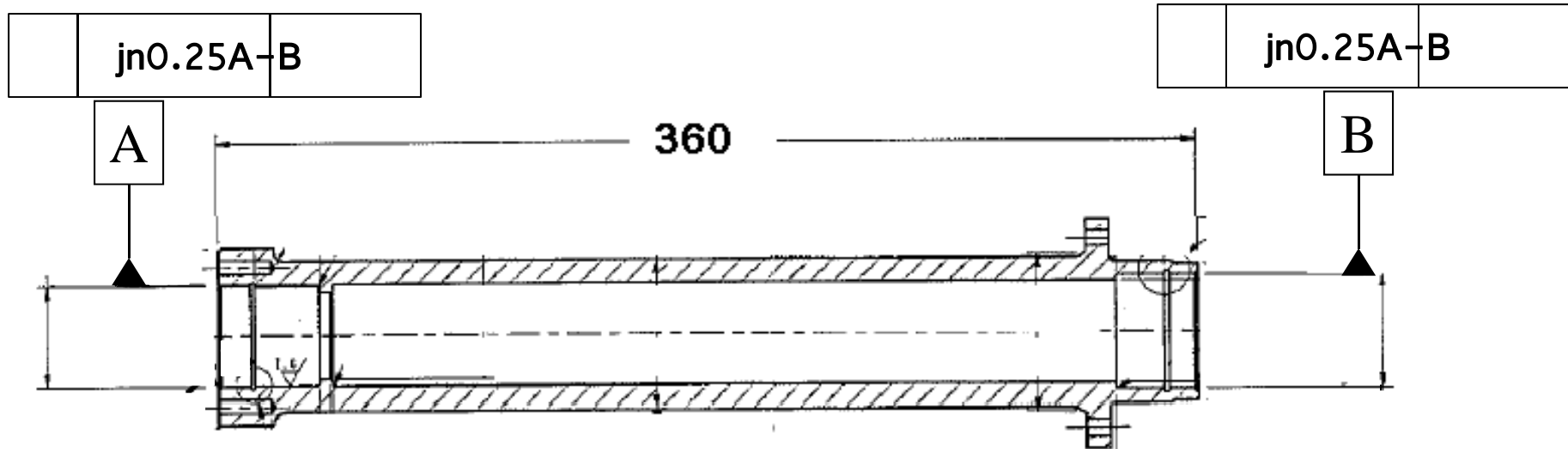
We are trying to make sure –A- and –B- are positioned the same way on the same axis so nothing gets bound up.

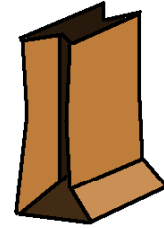
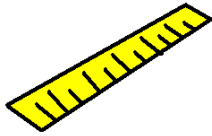




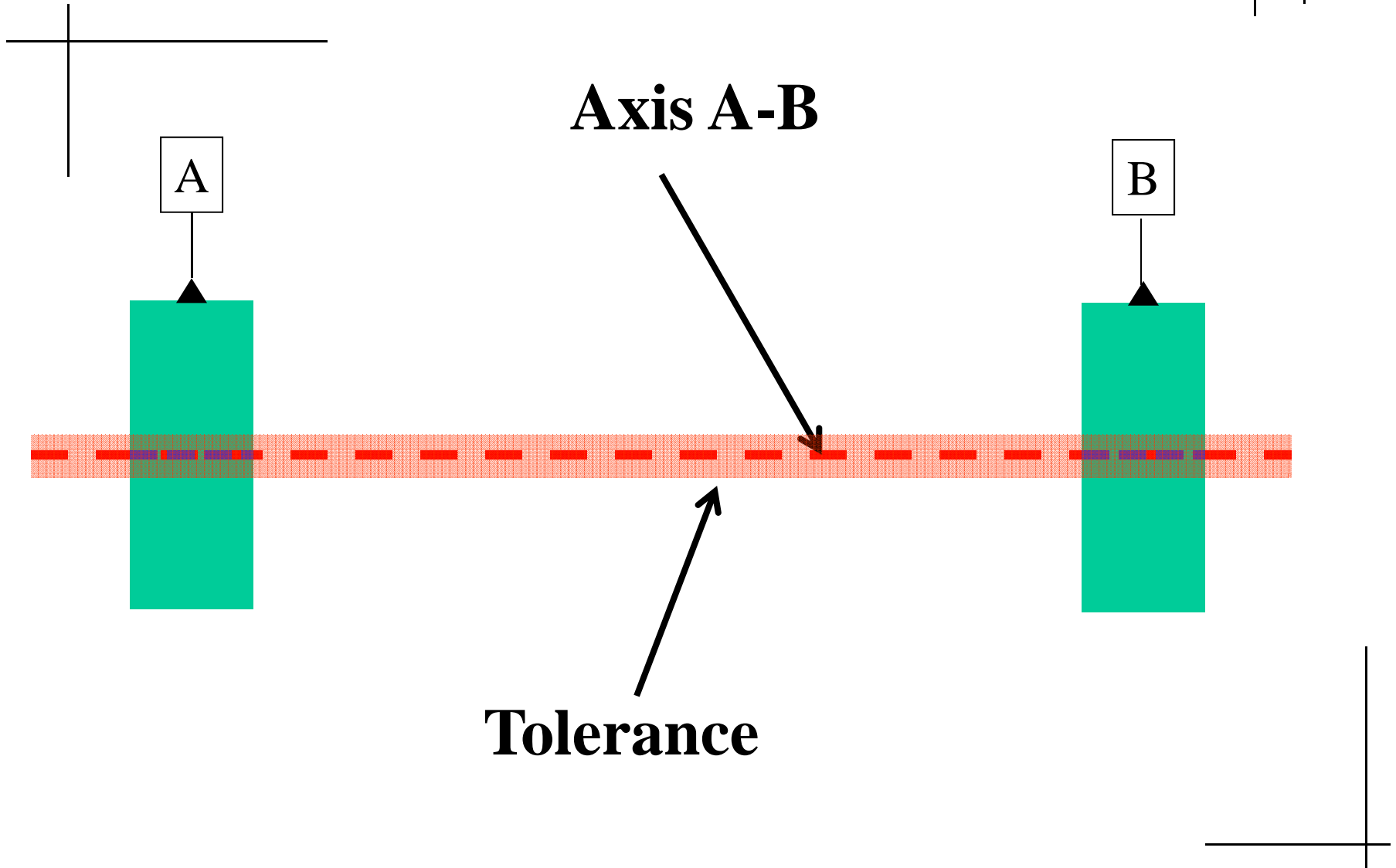
LUNCHEON LEARN

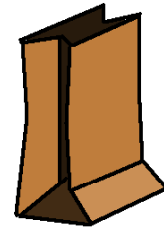
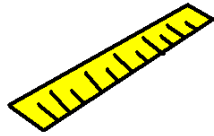
The individual axes of the cylinders of A and B need to be within a cylindrical zone centered on A-B.



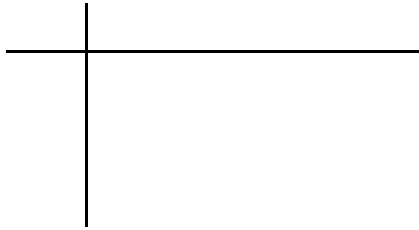


LUNCHEON LEARN

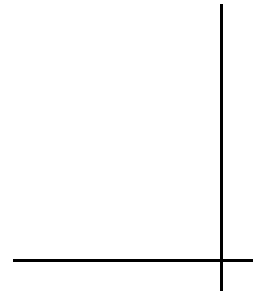
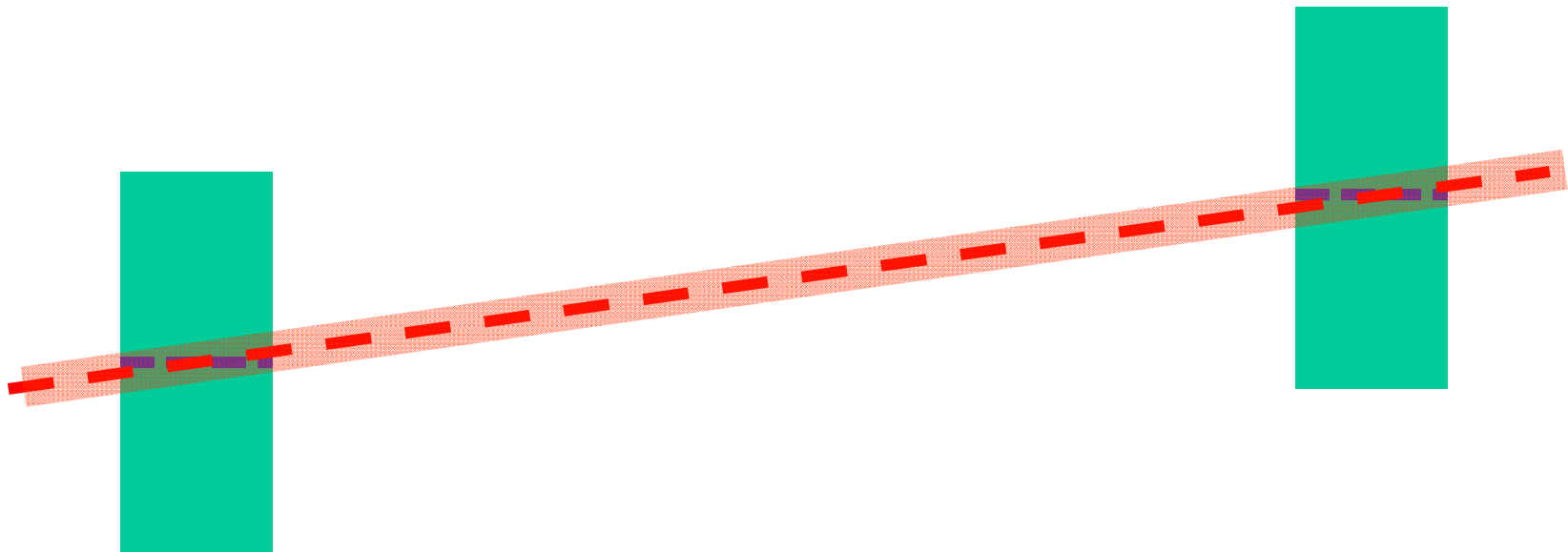
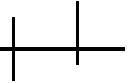


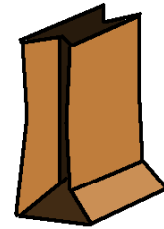
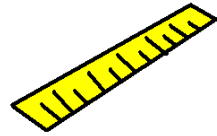


LUNCHEON LEARN



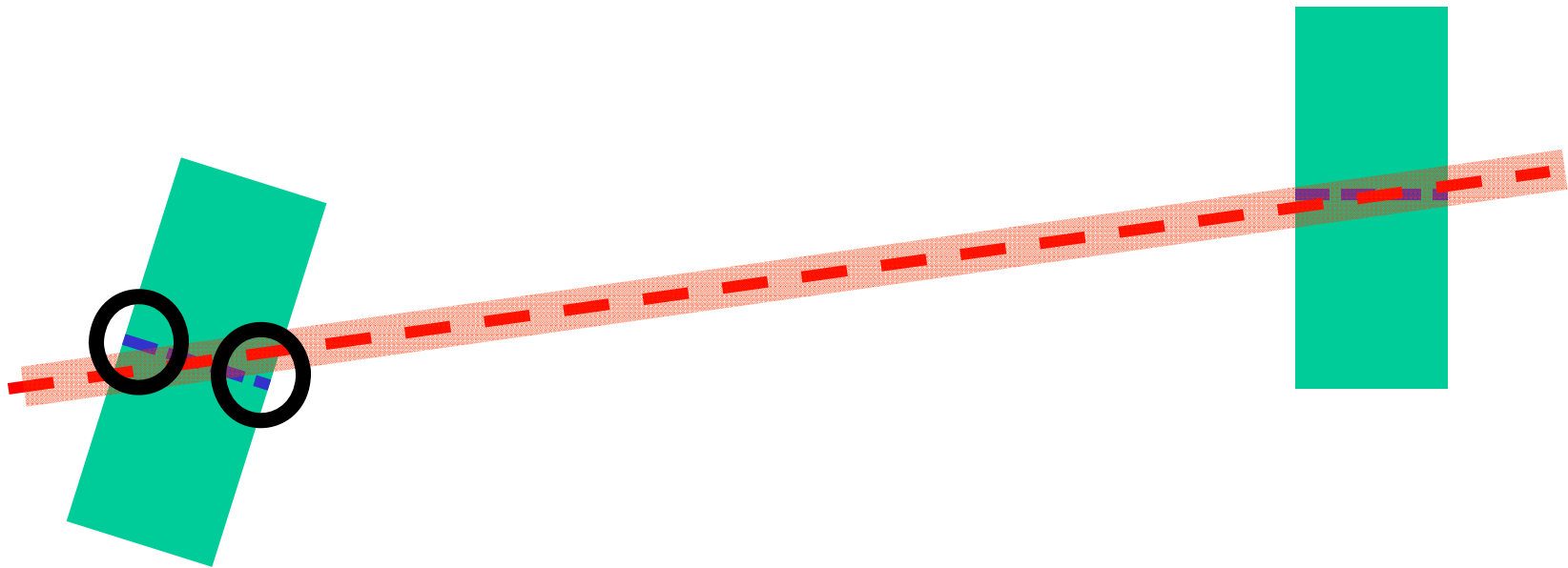
OK

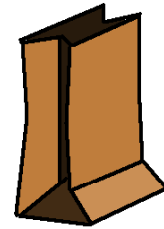
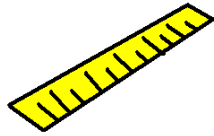




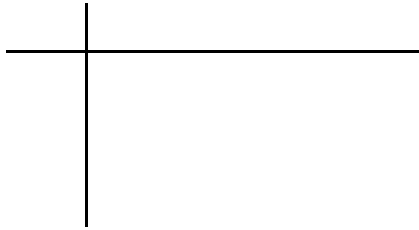
LUNCHEON LEARN

NOT OK

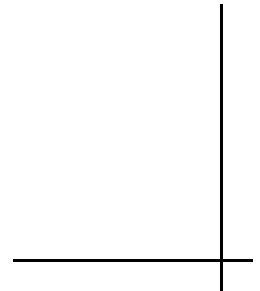
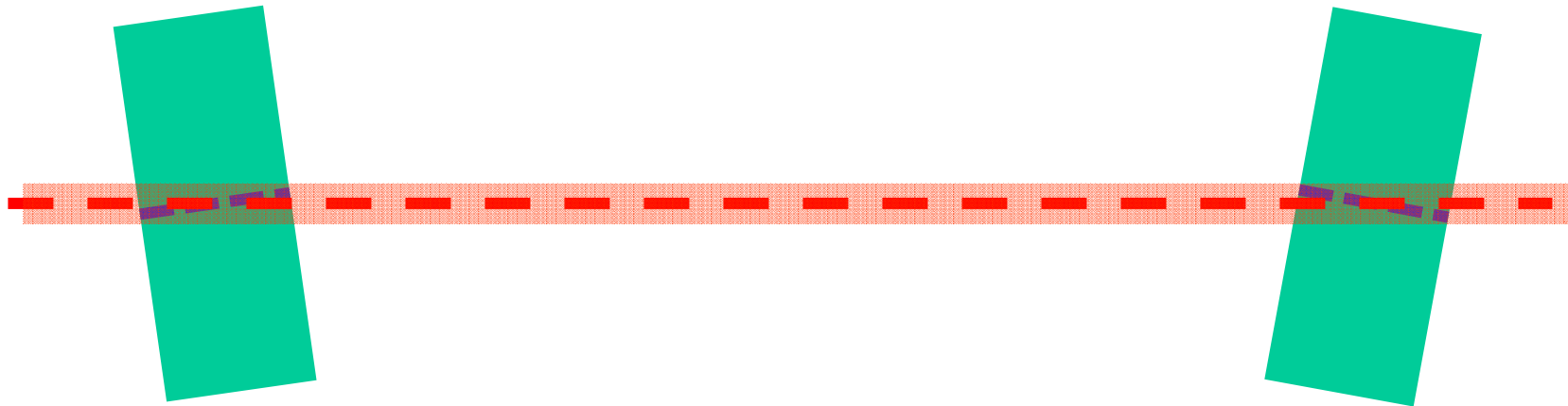
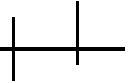


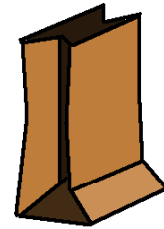
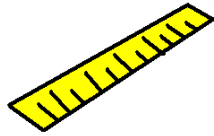


LUNCHEON LEARN



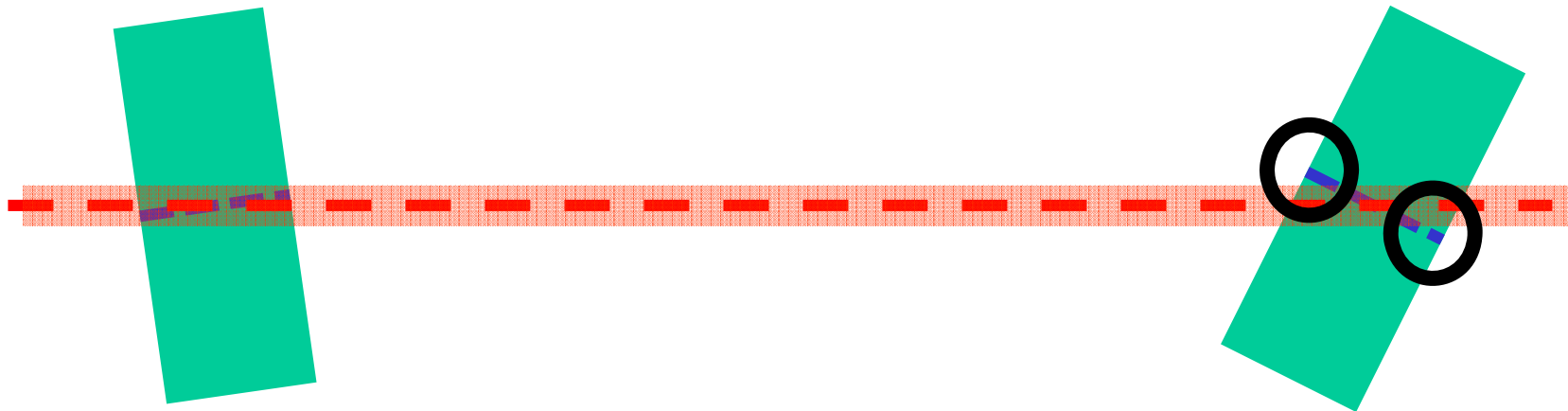
OK

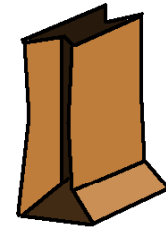
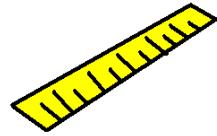




LUNCHEON LEARN

NOT OK

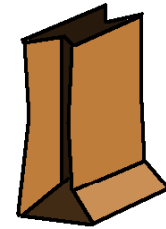
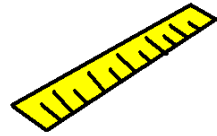




LUNCHEON LEARN

Let's do this in Calypso.

**Fortunately, this is MUCH
easier than trying to figure
out "REAL" Concentricity!!!!**



LUNCHEON LEARN

Calypso User Desk - (C) Carl Zeiss - Stepped Cyl

File Edit View Resources Features Construction Size Form and Location Plan CAD Extras Planner Window ?

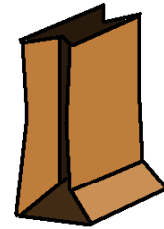
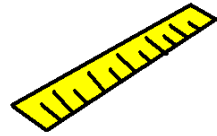
Basic Status: Select function or probe for surface measurement with single points

Cylinder1
Cylinder2
3-D Line1[Cylinder1,Cylinder2]

X = 2.5500
Y = 0.1044
Z = -0.0044

Cylinder1
Cylinder2

7 mm

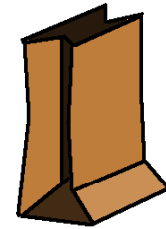
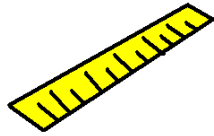


LUNCHEON LEARN

NOTE:

Using a 3-D line with RECALL creates a line between the CENTERS of the two cylinders selected.

Make sure LSQ is selected in the feature window for each cylinder.



LUNCHEON LEARN

Calypso User Desk - (C) Carl Zeiss - Stepped Cyl

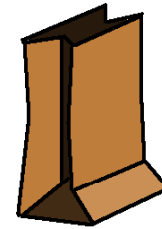
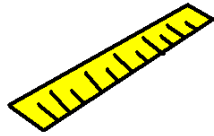
File Edit View Resources Features Construction Size Form and Location Plan CAD Extras Planner Window 2

Basic Status: Select function or probe for surface measurement with single points

- True Position1
- True Position2
- Coaxiality1**

7 mm

Fit



LUNCHEON LEARN

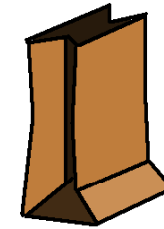
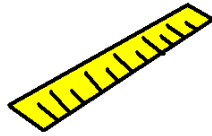
Calypso User Desk - (C) Carl Zeiss - Stepped Cyl

File Edit View Resources Features Construction Size Form and Location Plan CAD Extras Planner Window ?

Basic Status: Select function or probe for surface measurement with single points

- True Position1
- True Position2
- Coaxiality1
- True Position3**

7 mm



LUNCHEON LEARN

WOW!

That's a big difference.

Maybe our part isn't as bad as I thought after all!

Calypso Custom Printout Stepped Cyl 1

Printout Display

ZEISS Calypso

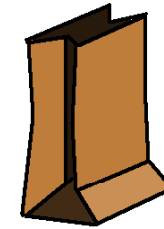
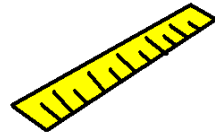
ZEISS

Measurement Plan: Stepped Cyl
Date: September 9, 2011

Drawing No. *drawingno*
Time: 11:35:50 am
Order *order*

Operator: Master
CMM: Simulation
Incremental Part Number: 1

	Actual	Nominal	Upper Tol.	Lower Tol.	Deviation
Overall Result					
All Characteristics:		4			
Out of tolerance:		2			
Over Warning Limit:		0			
Not Calculated:		0			
True Position1	0.0065	0.0000	0.2500	-	0.0065
True Position2	0.0298	0.0000	0.2500	-	0.0298
Coaxiality1	0.9661	0.0000	0.2500		0.7161 0.9661
True Position3	0.9661	0.0000	0.2500		0.7161 0.9661



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Coaxiality is the same as True Position of a Cylinder when the Feature Nominals are zeroed on the datum.

Calypso Custom Printout Stepped Cyl 1

Printout Display

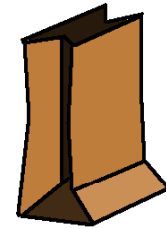
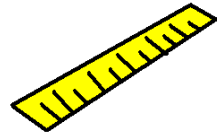
ZEISS Calypso

Measurement Plan: Stepped Cyl Date: September 9, 2011

Drawing No. * drawingno * Time: 11:35:50 am Order * order *

Operator: Master CMM: Simulation Incremental Part Number: 1

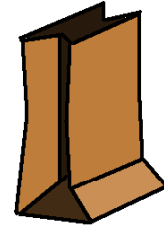
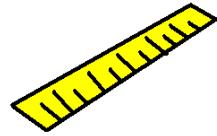
	Actual	Nominal	Upper Tol.	Lower Tol.	Deviation
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True Position3	0.9661	0.0000	0.2500		0.7161 0.9661



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We suggest reporting both results and document WHY you did what you did:

- 1) You reported “concentricity/coaxiality” as the print states, however that was probably not the design intent.**
 - 2) You reported Position to A to A-B and B to A-B because functionally, that is what the part really “sees” and you presume that was the design intent.**
-



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Concentricity

More than you ever wanted to know

Questions?