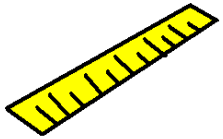
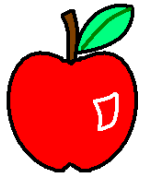
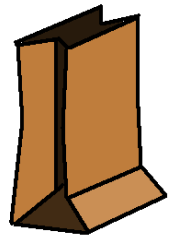
J&H Machine Tools





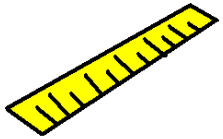
LUNCH 'N LEARN

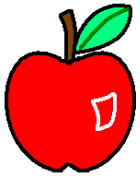


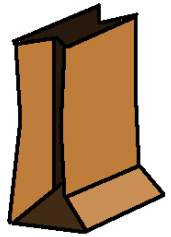
ZEISS

Spline Measurements…

with Calypso!





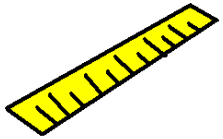


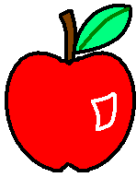
So…

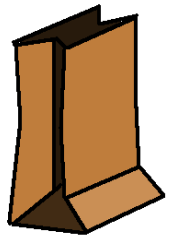
You have a part with a spline on it.

You need to measure pitch, “over pin” diameter, and runout.

J&H Machine Tools







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I HAVE THE ANSWER!

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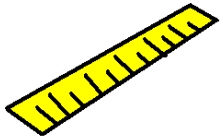

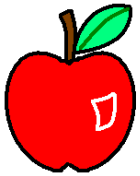

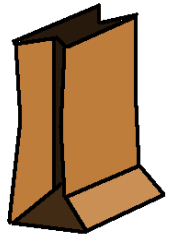

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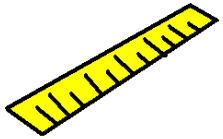
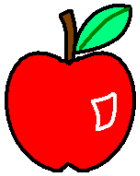
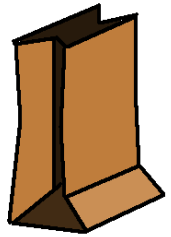
If you desktop looks like this…

J&H Machine Tools







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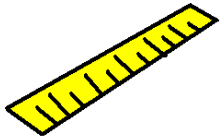
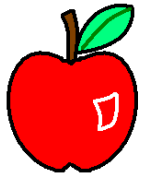
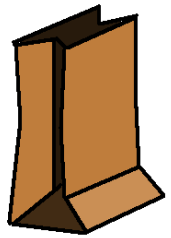
make it look like this…

J&H Machine Tools





LUNCH 'N LEARN



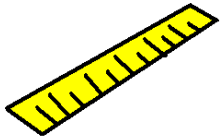
ZEISS

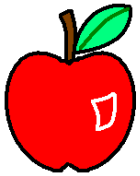
Spline Measurements…

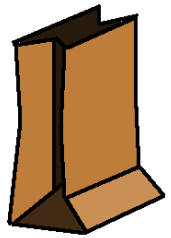
with Calypso!

Any Questions?

J&H Machine Tools







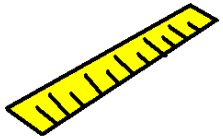
ZEISS

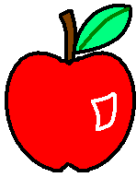
You don’t have Gear Pro?

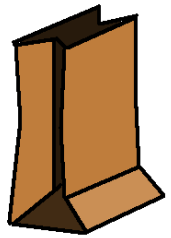
You can do it in Calypso!!!!

ZEISS

J&H Machine Tools







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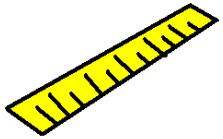
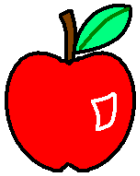
To pull it off, you need to know lots of little tricks!

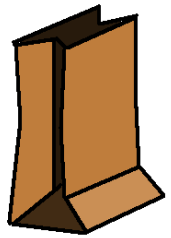
Trick 1

Self-Center Points

J&H Machine Tools







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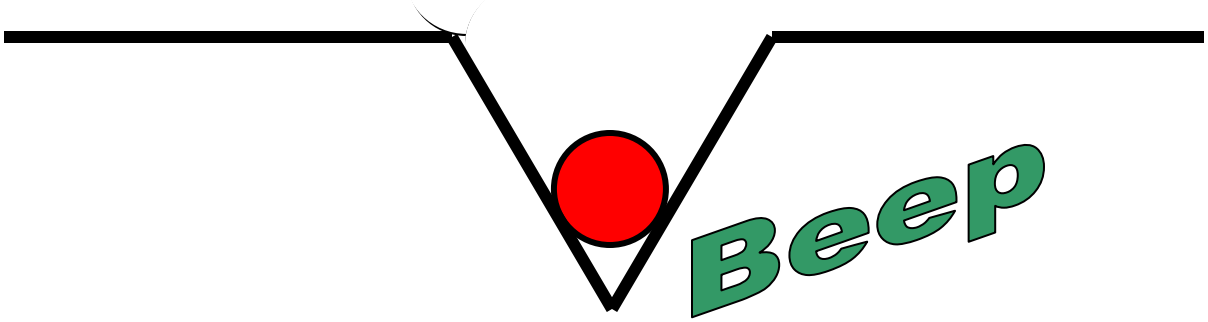
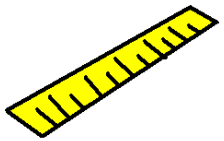
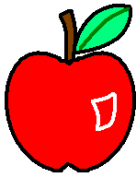
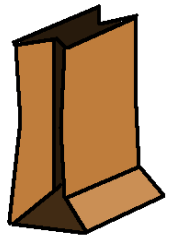
Self-Center Points



J&H Machine Tools







ZEISS

Calypso User Desk - (C) Carl Zeiss - spline

File Edit View Resources Features Constructi

Define Nominal Geometry (Probe, Enter, or

Features

Point1

Comment | Projection | Strategy

None | Evaluat

Clearance Group | Nominal Definition | Alignment

CP +Z | Options | Base Alignme

Tolerance For: | Nominal | Actual

	Nominal	Actual
X	0.9120	0.908
Y	-0.0000	-0.076
Z	-0.0476	-0.114
i	-1.0000	-1.000
j	0.0000	0.000
k	0.0000	0.000

Sigma | Form | Points

0.0000 | 0.0000 | 1

Min | Point no | Point no | Max

OK | Reset

Strategy

Point1

***

Evasion S

Clearance D

Probing Poi

OK

Point List

Point1

Display of | Normal

Coordinates Relative T

Feature

No.	X Coord
1	0.0000

OK | Reset | Self Center Probing | Execute Now!

Self Center Probing: Point1

Probe Self Centering

Clamping of the machine axis in

X clamped

Y clamped

z clamped

Adjust measuring force

Probe In Normal Direction

Own Selection

Fx: 0.0000 mN

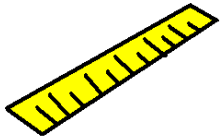
Fy: 0.0000 mN

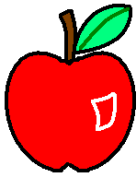
Fz: -200.0000 mN

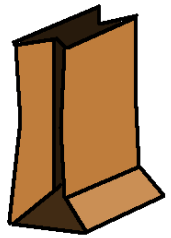
Coordinates relative to Feature

OK | Cancel

J&H Machine Tools







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Self-Center Points

are available in :

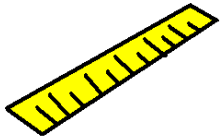
Points

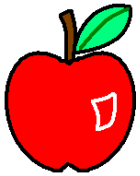
Lines

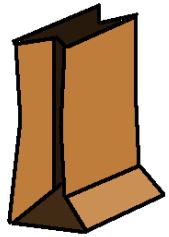
Circles

Mid Point Point Evaluation

J&H Machine Tools







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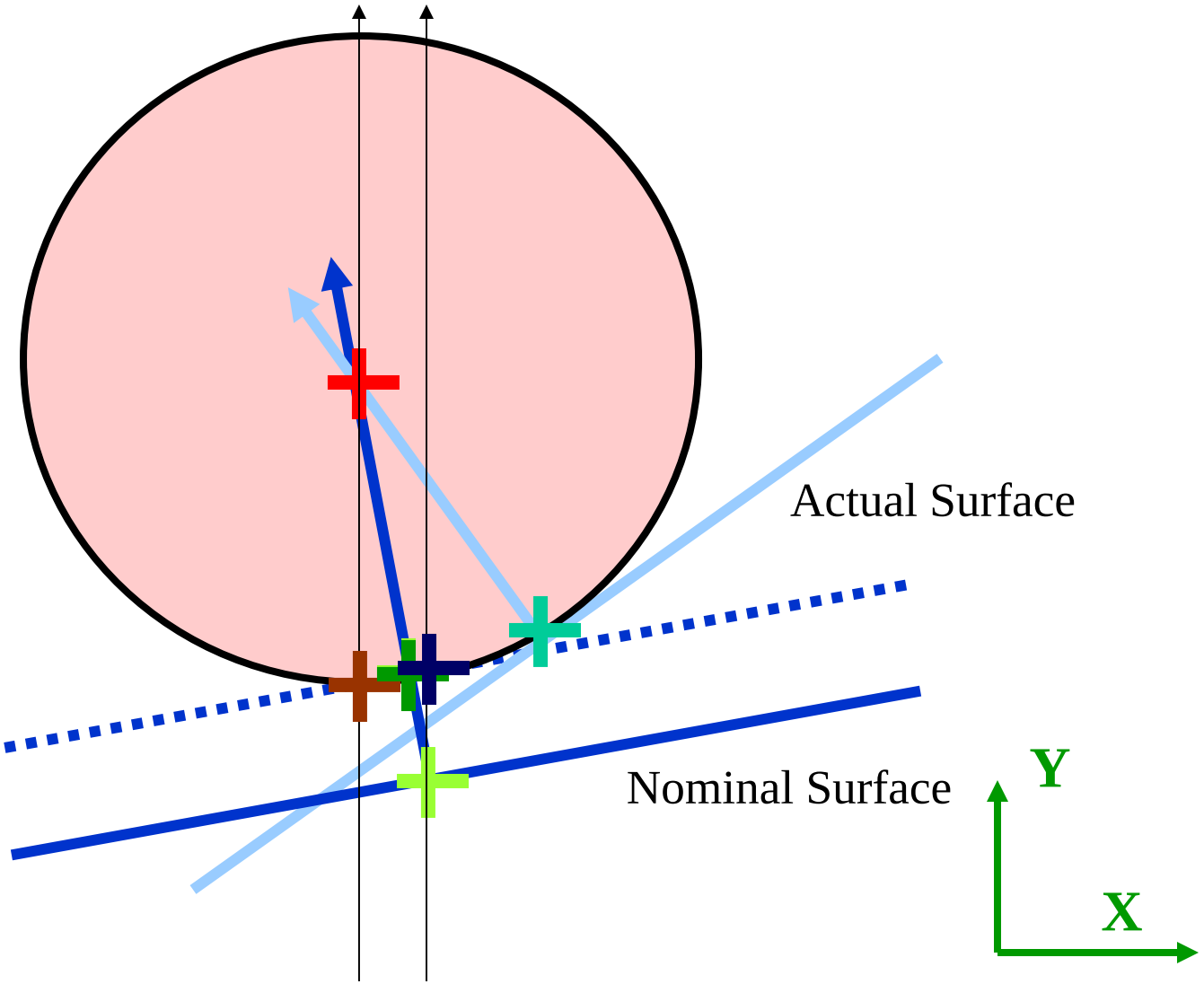
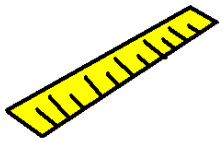
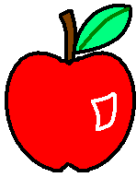
Types of Point Evaluation

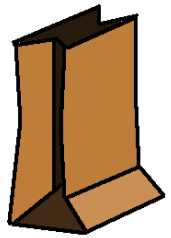
- Mid Point
- Cad Point
- Touch Point
- Plane Point
  Assuming plane measurement always
- Space Point
- Net Point



J&H Machine Tools







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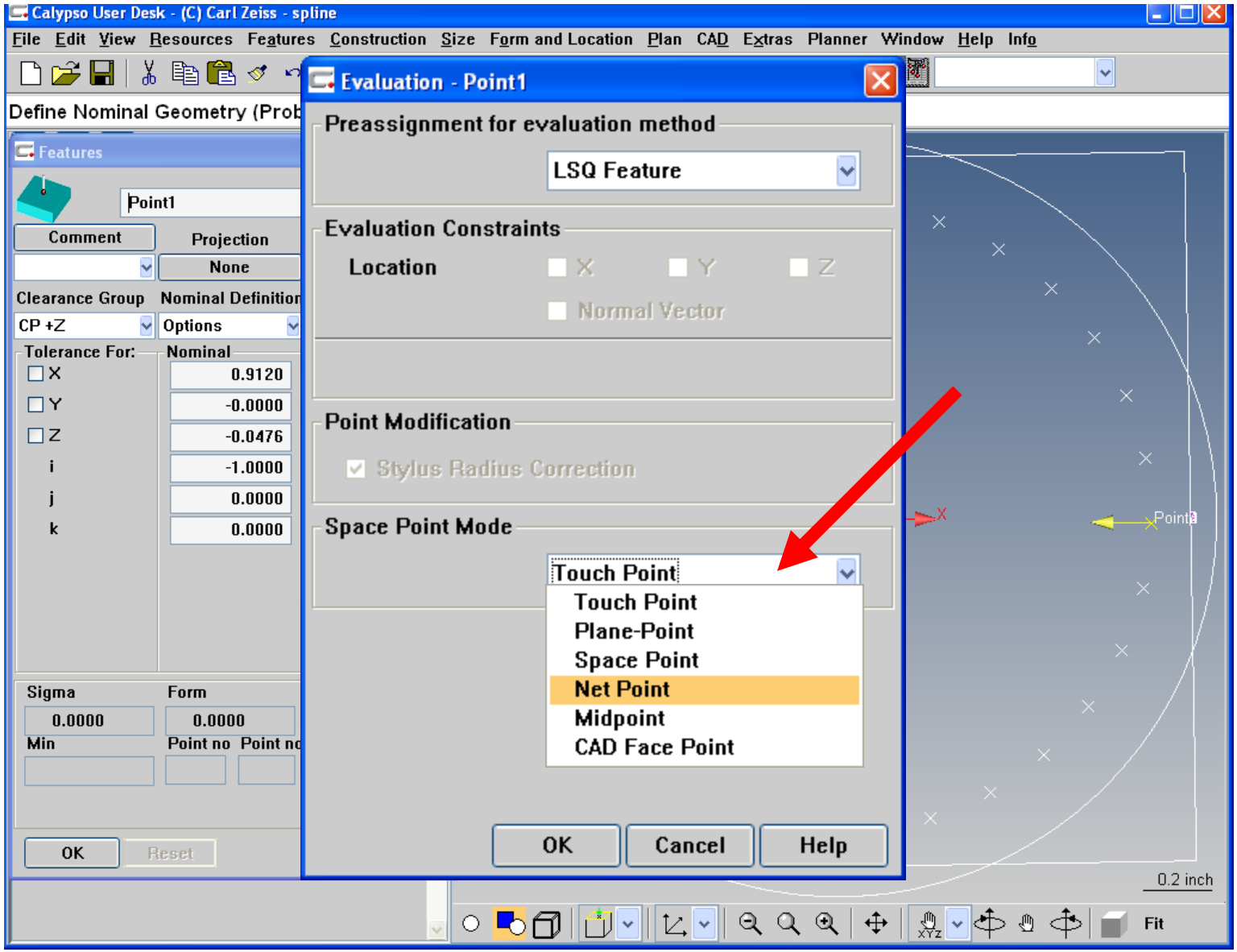
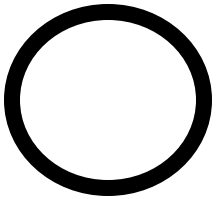


Maximum or Minimum Feature

Max/Min Features

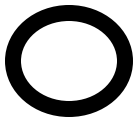


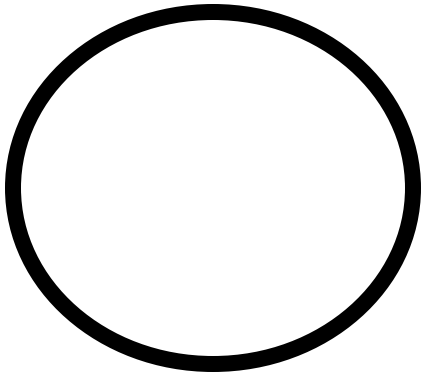
Max Y

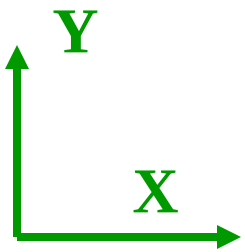
Min X

Max X

Min Diameter







Min Y

Max Diameter

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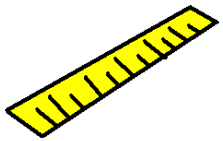

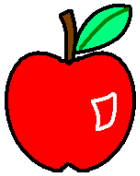

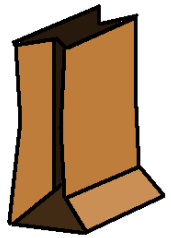

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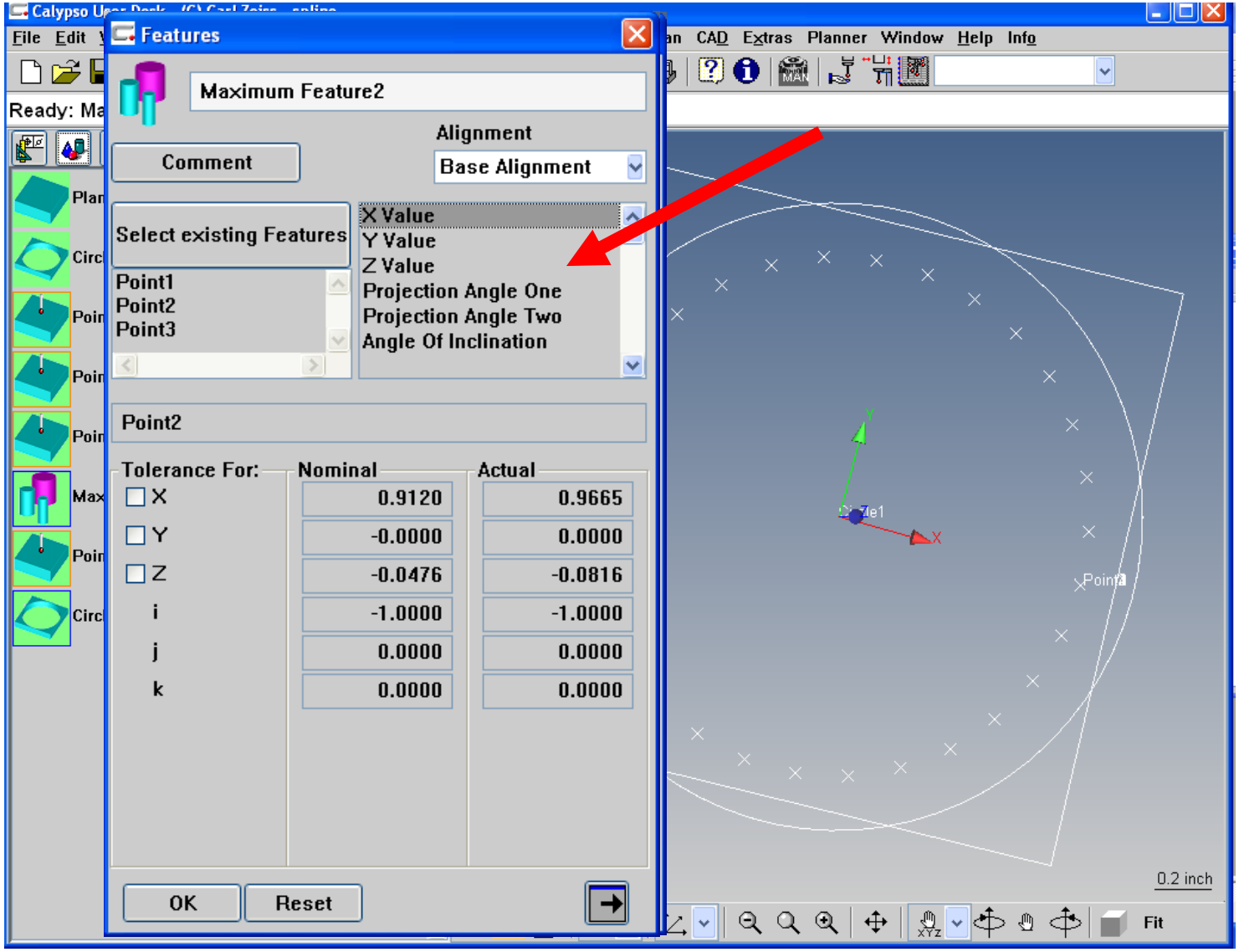
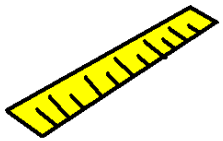
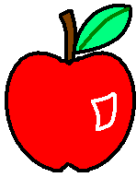
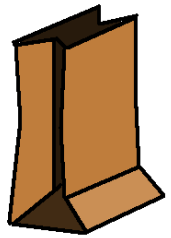


J&H Machine Tools







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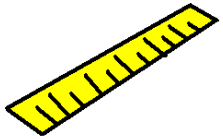
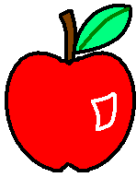
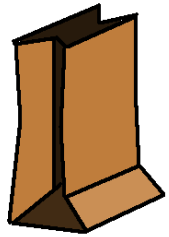
Trick 4

Rotational Patterns

J&H Machine Tools







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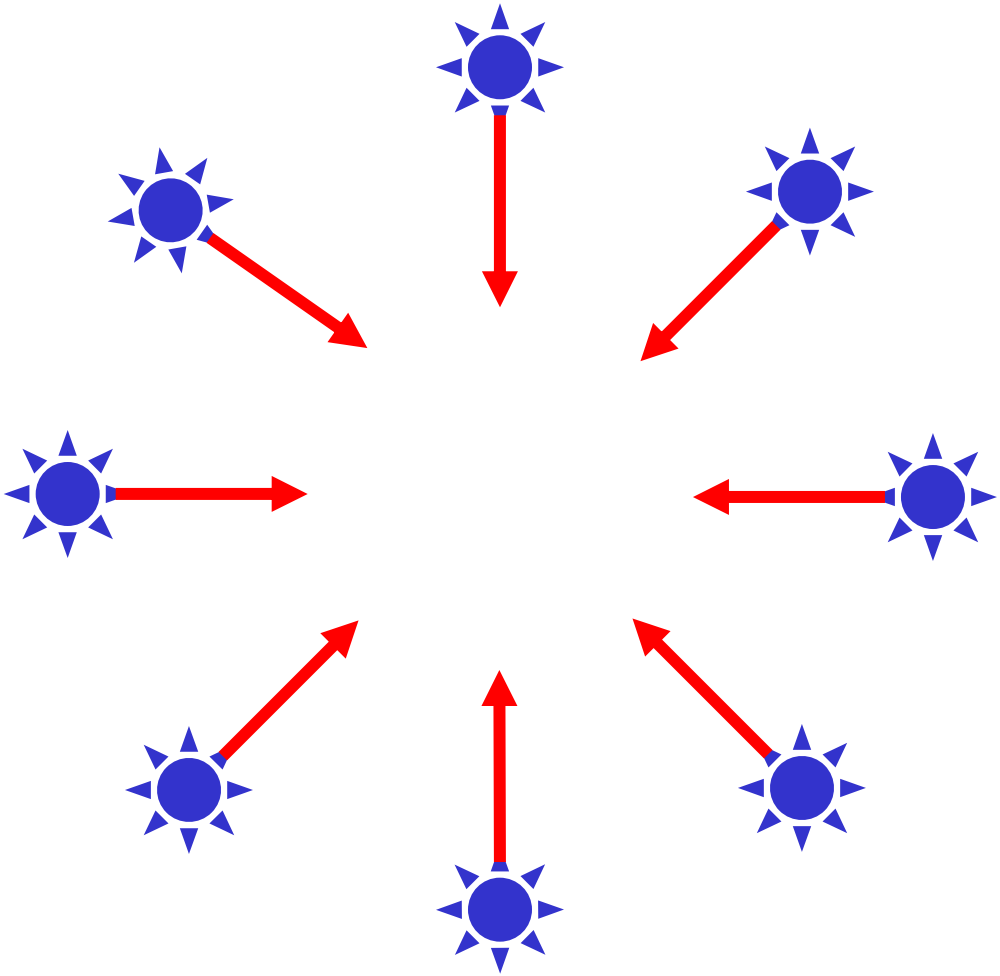
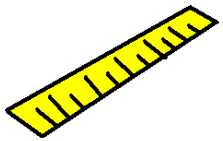
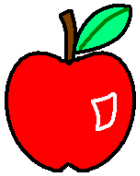
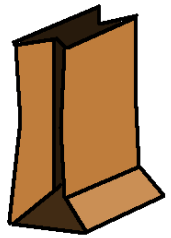
Rotational Patterns



J&H Machine Tools







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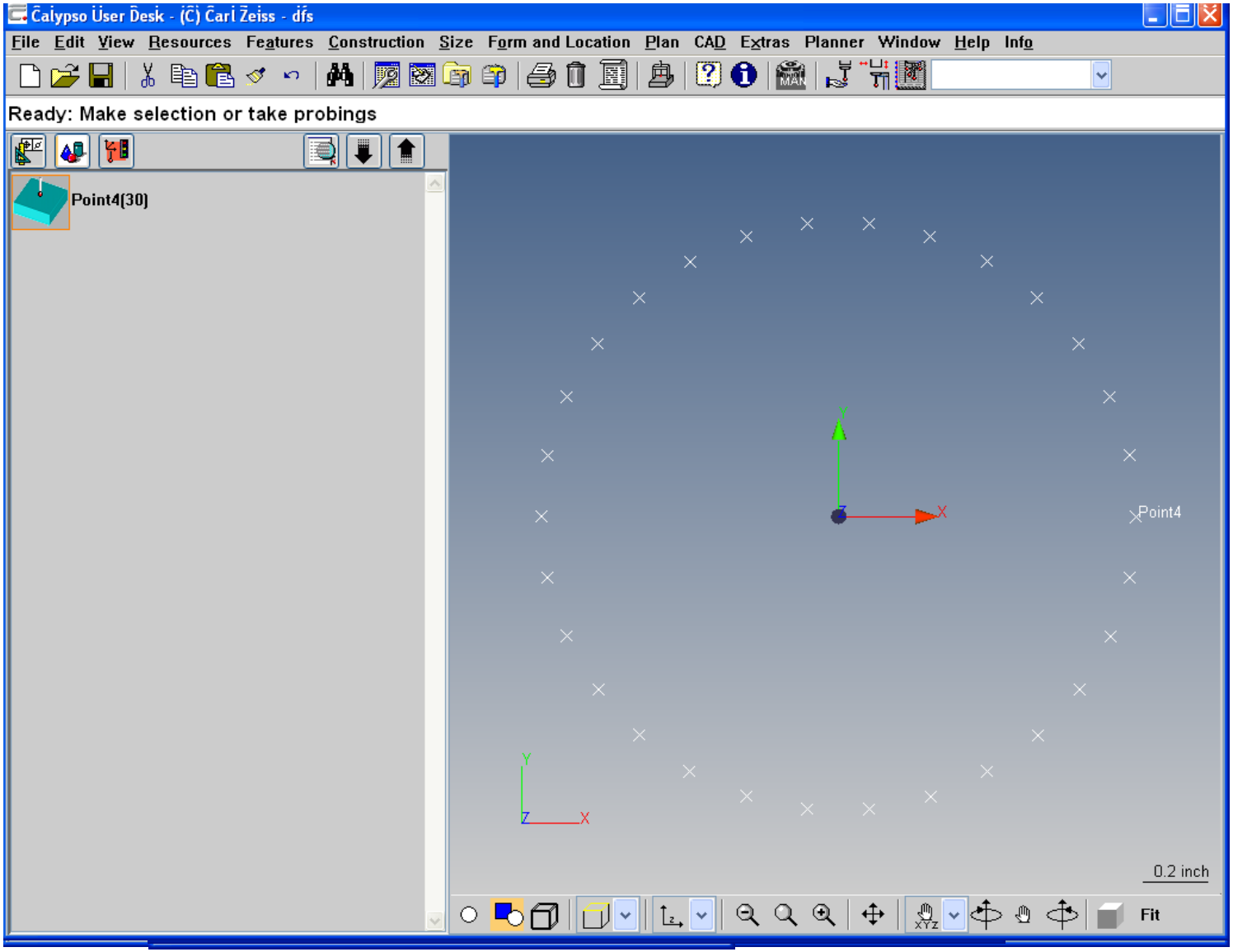
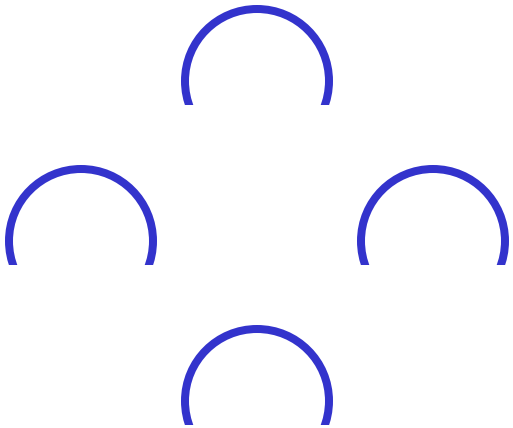
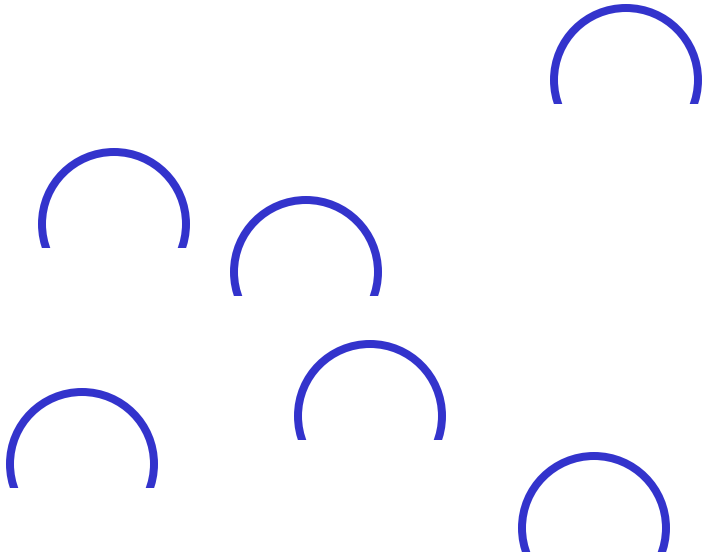


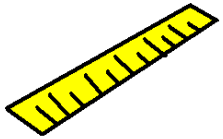
Other Types of Patterns

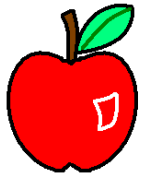


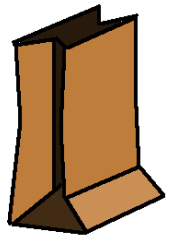
Rotational



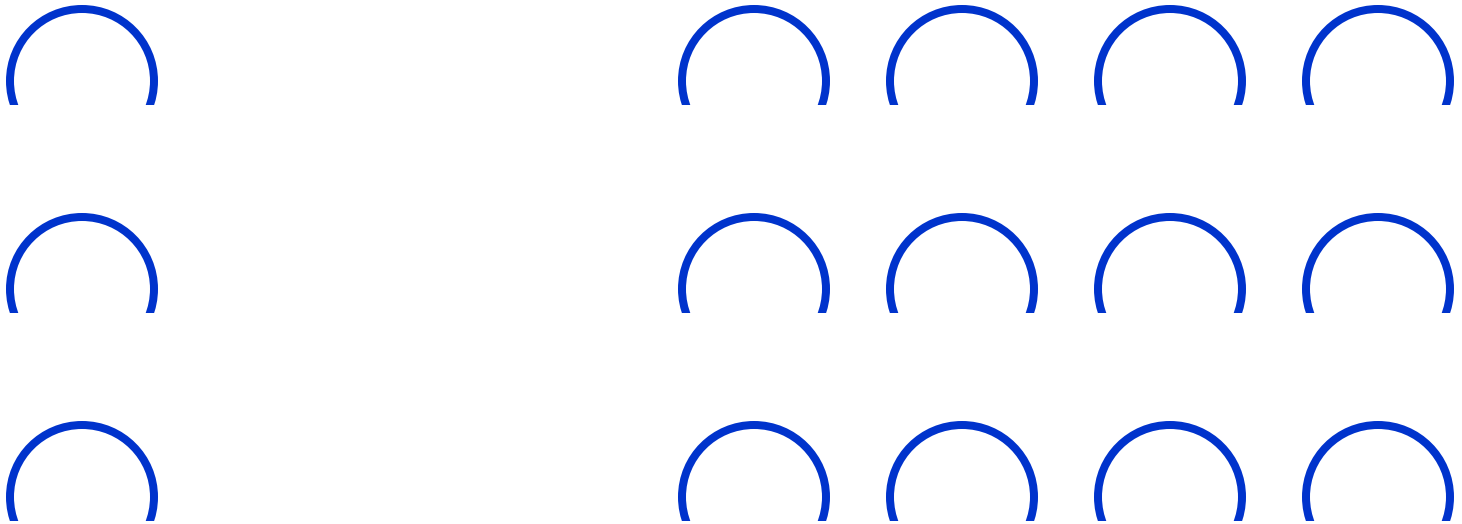
Position List







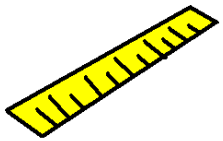
Other Types of Patterns

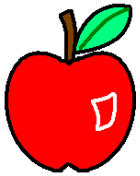


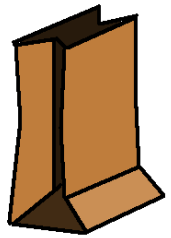
1D Linear

2D Linear

J&H Machine Tools







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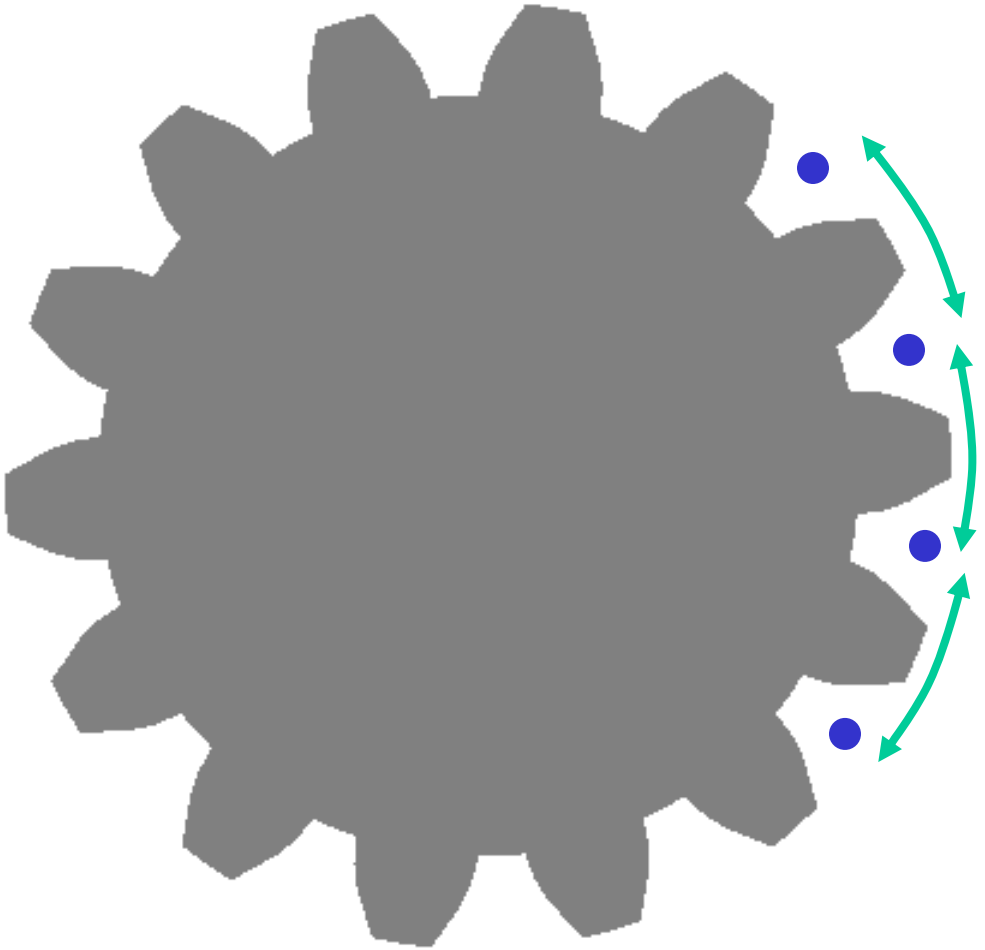
Trick 5

Circular Pitch

Circular Pitch Parameters

fp : Individual Pitch Error



Compared to Nominal Arc Length

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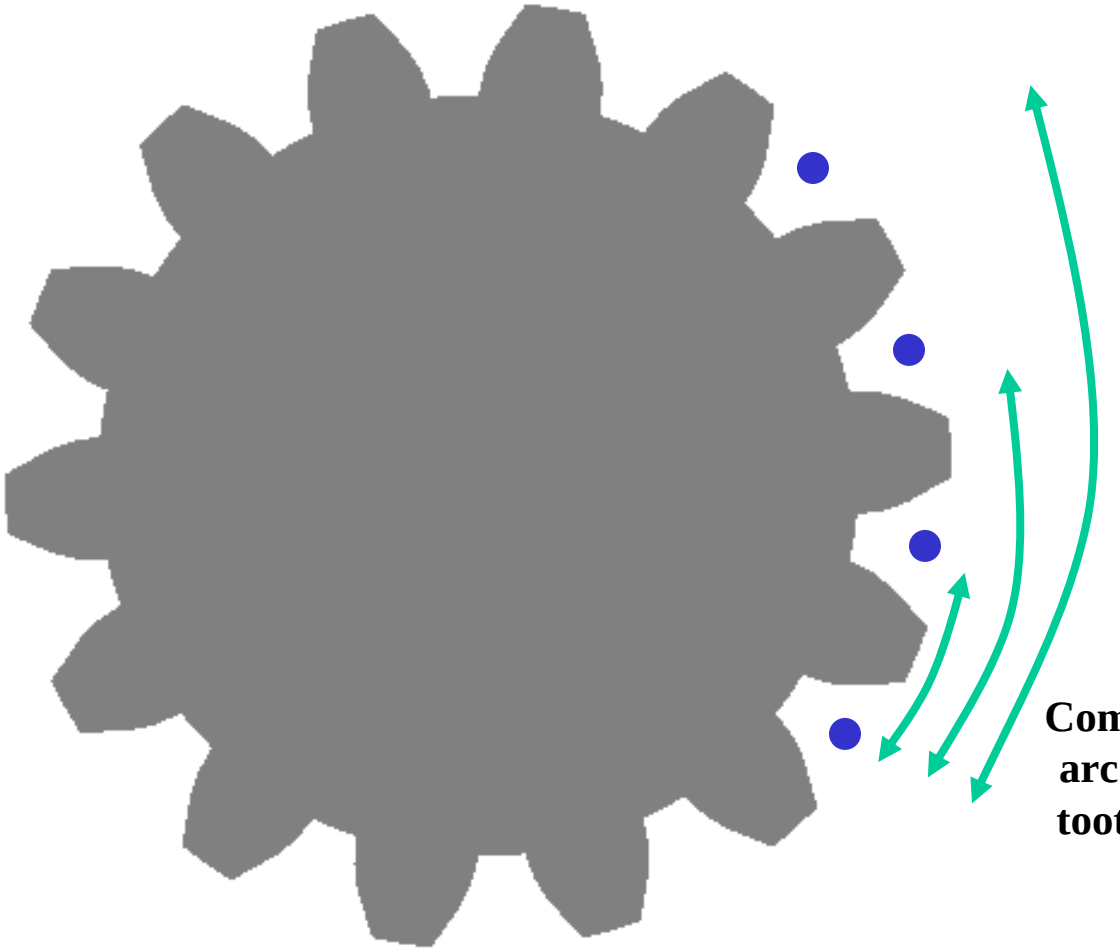
Circular Pitch Parameters

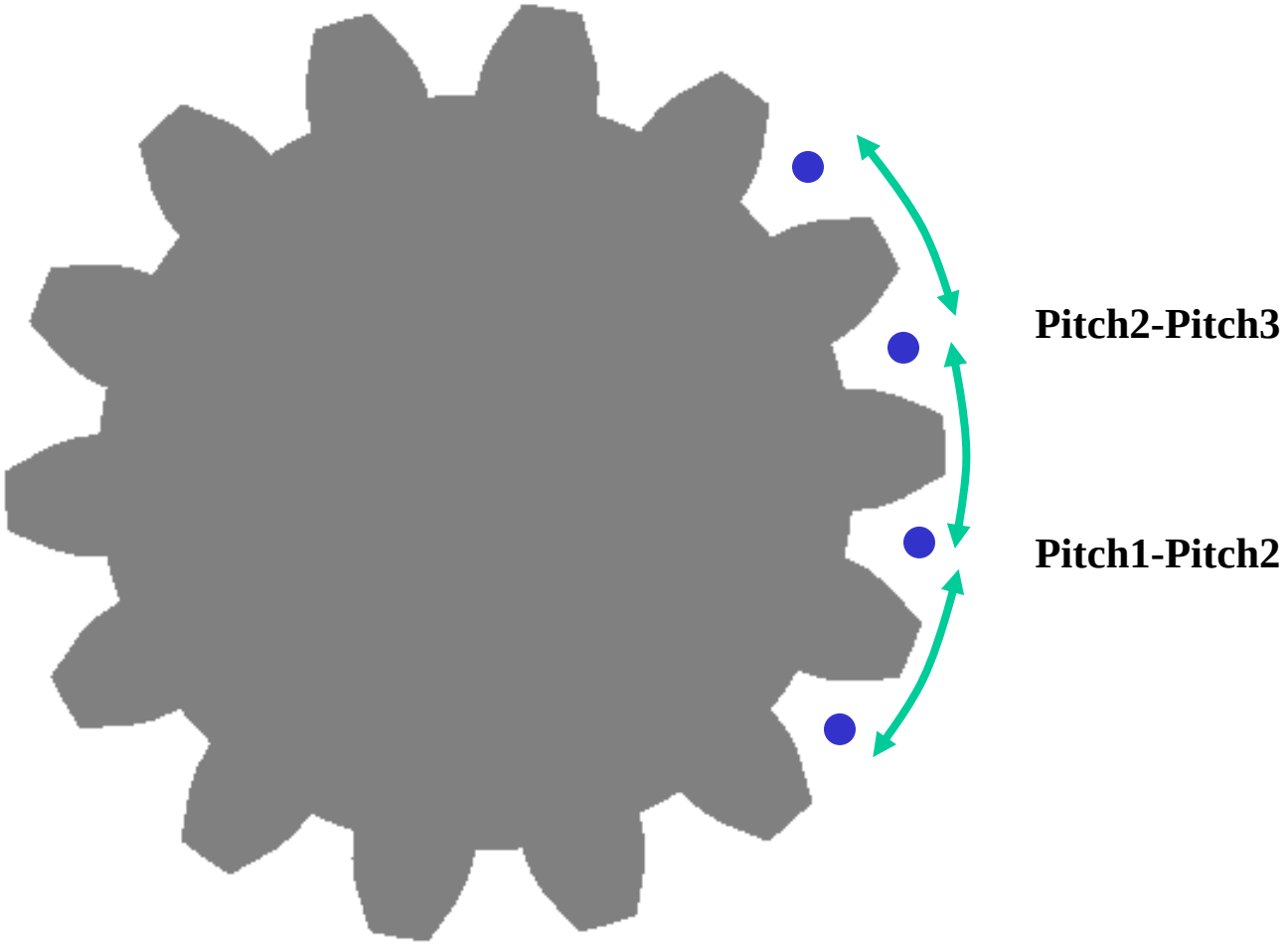
Fp : Cumulative Pitch Error



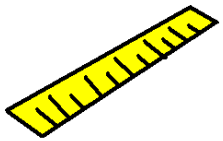
Compared to nominal arc length from first tooth to all following teeth

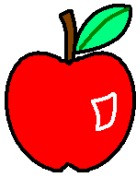
Circular Pitch Parameters

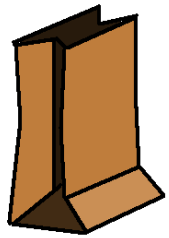
fu : Pitch Error (comparative)



J&H Machine Tools







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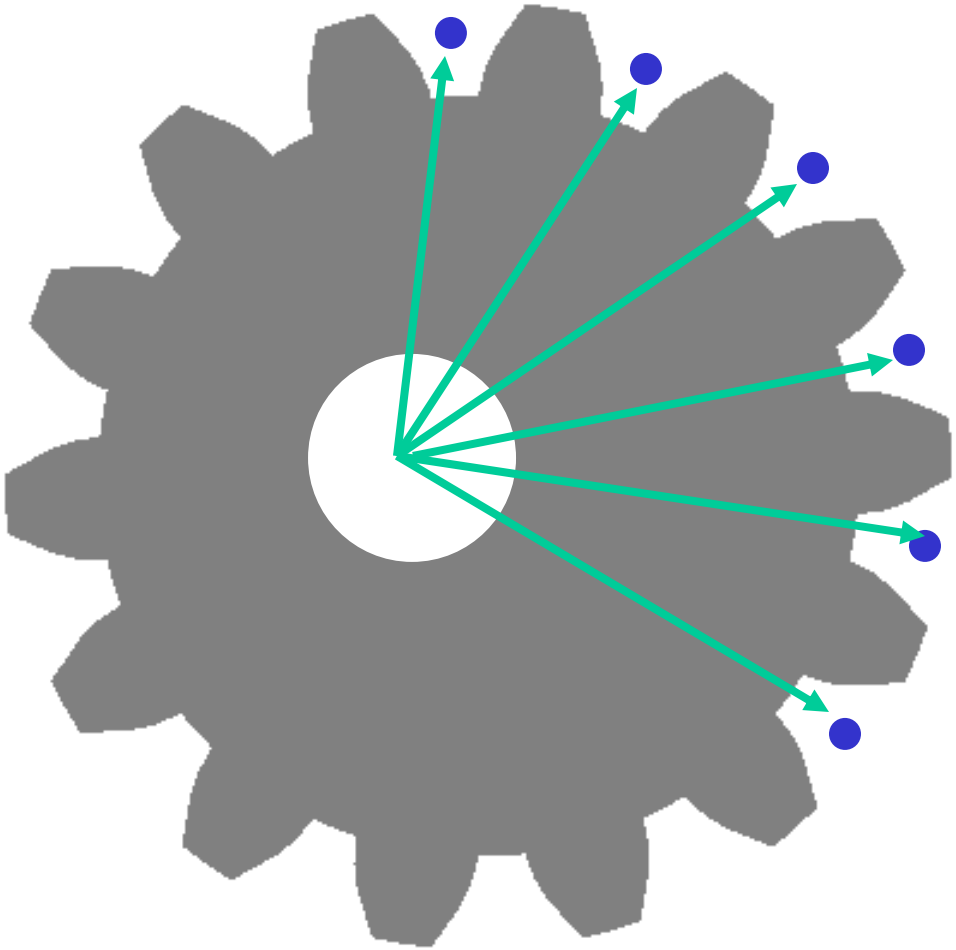
Circular Pitch Parameters

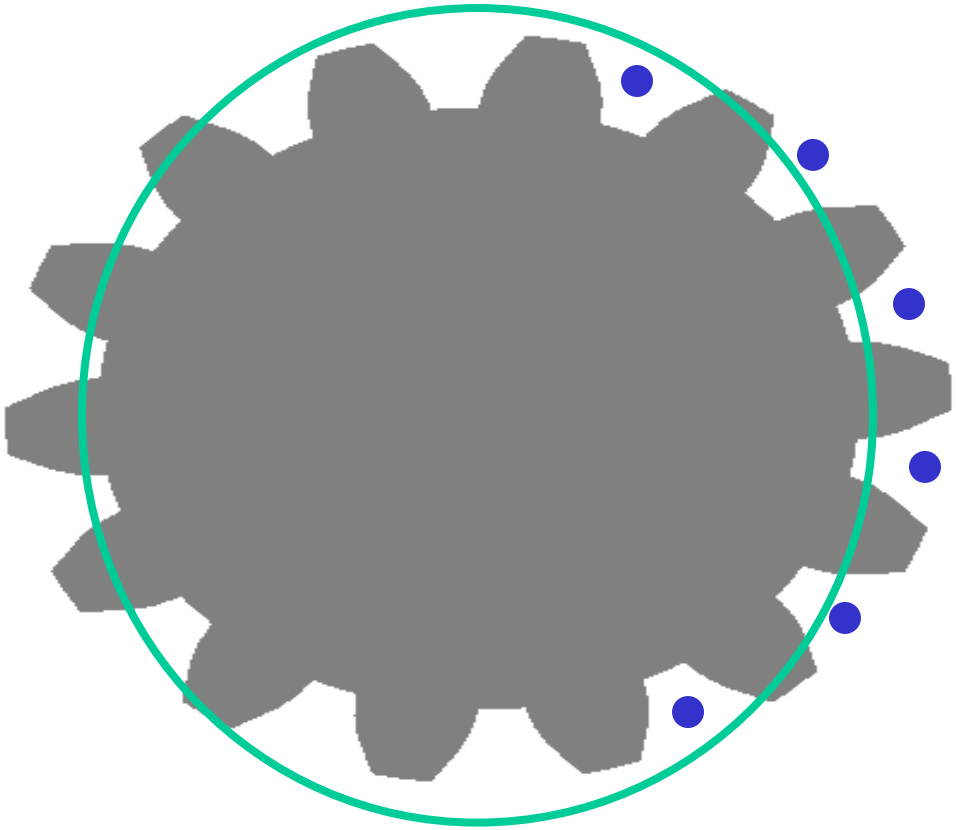
fr : Pitch Radial Runout



Radial error from datum

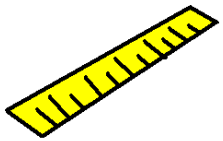
Circular Pitch Parameters

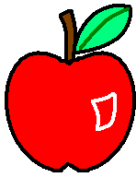
fre : Pitch Roundness

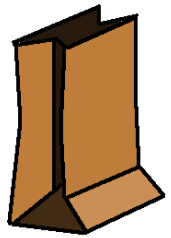


Error of points to a perfect Circle

J&H Machine Tools







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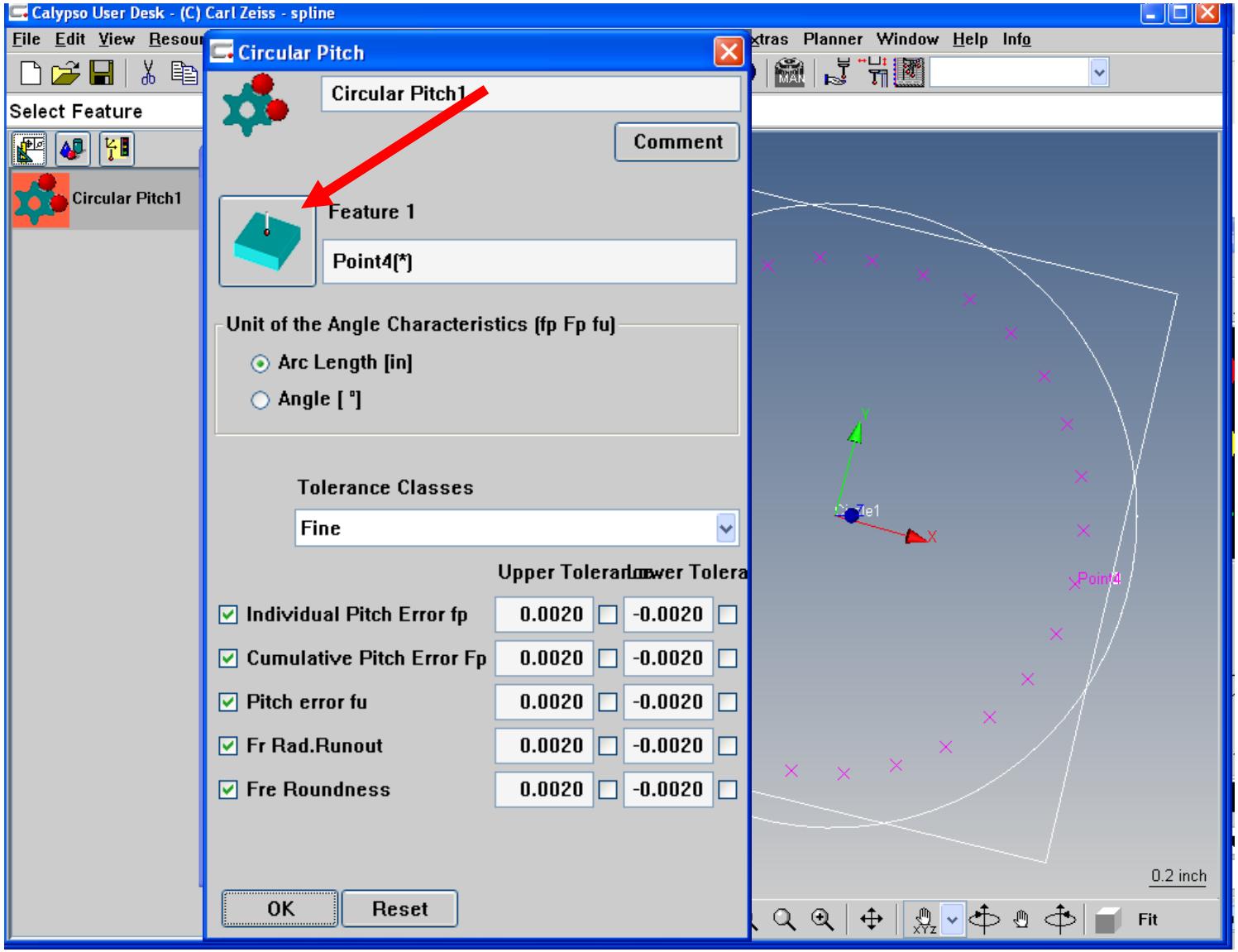
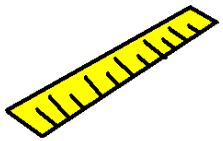
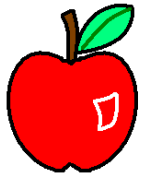
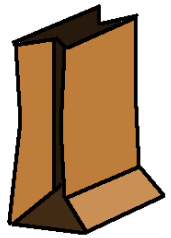


J&H Machine Tools







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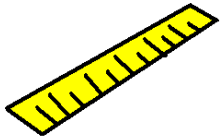
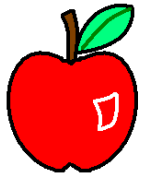
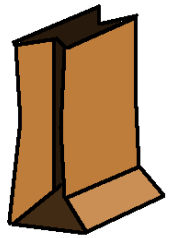
Circular Pitch Output

Circular Pitch1(12)^fp				--|	
0.1903 Minimum Individual Pitch Error	0.1910	0.0020	-0.0020		-0.0007
Circular Pitch1(14)^fp				|---	
0.1923 Maximum Individual Pitch Error	0.1910	0.0020	-0.0020		0.0013
Circular Pitch1(5)^Fp				---|	
0.9538 Minimum Cumulative Pitch Error	0.9551	0.0020	-0.0020		-0.0013
Circular Pitch1(18)^Fp				|----	
3.4399 Maximum Cumulative Pitch Error	3.4383	0.0020	-0.0020		0.0016
Circular Pitch1(15)^fu				---|	
-0.0014 Minimum Pitch Error	0.0000	0.0020	-0.0020		-0.0014
Circular Pitch1(13)^fu				|---	
0.0010 Maximum Pitch Error	0.0000	0.0020	-0.0020		0.0010
Circular Pitch1(14)^Fr				-0.0006	
-0.0026 Minimum Radial Runout	0.0000	0.0020	-0.0020		-0.0026
Circular Pitch1(20)^Fr				|----	
0.0016 Maximum Radial Runout	0.0000	0.0020	-0.0020		0.0016
Circular Pitch1(14)^Fre				-0.0003	
-0.0022 Minimum Roundness	0.0000	0.0020	-0.0020		-0.0022
Circular Pitch1(19)^Fre				|---	
0.0013 Maximum Roundness	0.0000	0.0020	-0.0020		0.0013

J&H Machine Tools







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Circular Pitch Output

Calypso Default Printout c:\Zeiss\Calypso\home\om\workarea\inspections\spline

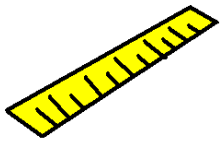
Printout

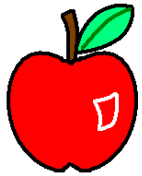
Point4(*)

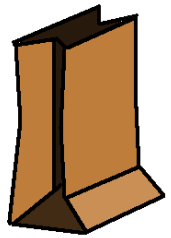
	p	pk	fp	Fp	fu	Fr	Fre
1/2	0.1903	0.1903	-0.0007	-0.0007	0.0000	-0.0003	-0.0002
2/3	0.1909	0.3812	-0.0001	-0.0008	0.0005	0.0002	0.0005
3/4	0.1908	0.5720	-0.0002	-0.0010	0.0000	-0.0001	0.0002
4/5	0.1907	0.7628	-0.0003	-0.0013	-0.0001	-0.0001	0.0003
5/6	0.1910	0.9538	0.0000	-0.0013	0.0003	-0.0005	0.0000
6/7	0.1912	1.1449	0.0001	-0.0012	0.0002	-0.0007	-0.0001
7/8	0.1912	1.3361	0.0002	-0.0010	0.0000	-0.0014	-0.0008
8/9	0.1913	1.5275	0.0003	-0.0007	0.0002	-0.0008	-0.0001
9/10	0.1913	1.7187	0.0003	-0.0004	-0.0001	-0.0006	0.0000
10/11	0.1911	1.9098	0.0001	-0.0003	-0.0002	-0.0007	0.0000
11/12	0.1913	2.1011	0.0003	-0.0001	0.0002	-0.0011	-0.0005
12/13	0.1903	2.2914	-0.0007	-0.0008	-0.0010	-0.0022	-0.0017
13/14	0.1913	2.4827	0.0003	-0.0005	0.0010	-0.0024	-0.0019
14/15	0.1923	2.6750	0.0013	0.0008	0.0010	-0.0026	-0.0022
15/16	0.1909	2.8659	-0.0001	0.0007	-0.0014	-0.0012	-0.0010
16/17	0.1914	3.0573	0.0004	0.0011	0.0005	-0.0004	-0.0002
17/18	0.1915	3.2488	0.0005	0.0015	0.0001	0.0011	0.0011
18/19	0.1911	3.4399	0.0000	0.0016	-0.0004	0.0013	0.0012
19/20	0.1909	3.6308	-0.0001	0.0015	-0.0002	0.0015	0.0013
20/21	0.1910	3.8217	0.0000	0.0014	0.0001	0.0016	0.0012
21/22	0.1909	4.0127	-0.0001	0.0013	-0.0001	0.0009	0.0005
22/23	0.1909	4.2036	-0.0001	0.0013	0.0000	0.0000	-0.0004
23/24	0.1913	4.3949	0.0003	0.0015	0.0004	-0.0014	-0.0018
24/25	0.1906	4.5855	-0.0004	0.0011	-0.0007	-0.0009	-0.0014
25/26	0.1911	4.7766	0.0001	0.0012	0.0005	-0.0010	-0.0014
26/27	0.1910	4.9675	-0.0001	0.0011	-0.0001	-0.0009	-0.0012
27/28	0.1909	5.1585	-0.0001	0.0010	0.0000	-0.0007	-0.0010
28/29	0.1908	5.3493	-0.0002	0.0009	-0.0001	-0.0007	-0.0009
29/30	0.1906	5.5399	-0.0004	0.0004	-0.0002	0.0000	-0.0001
30/1	0.1906	5.7305	-0.0004	0.0000	0.0000	0.0000	0.0000

Graphic Element

J&H Machine Tools







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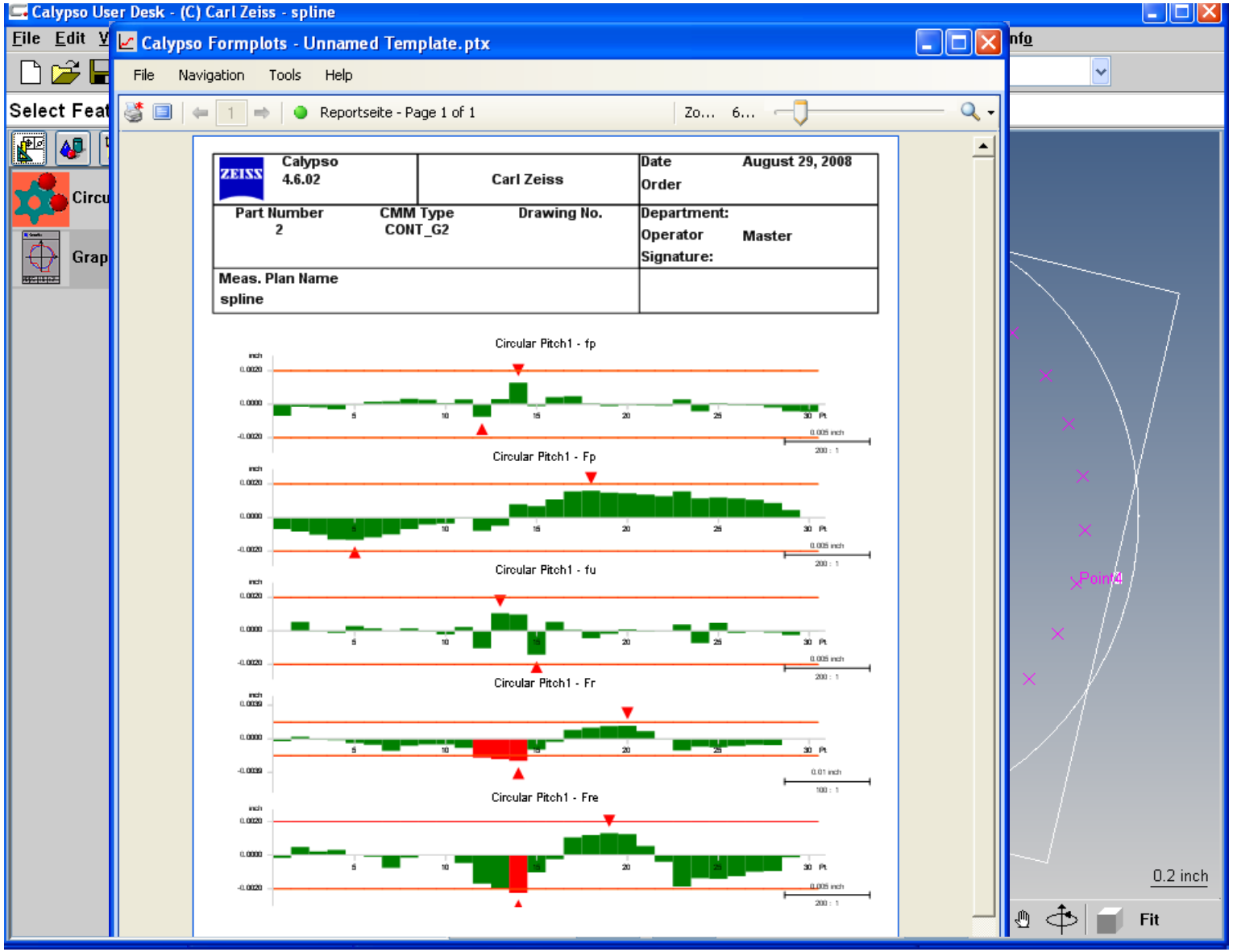
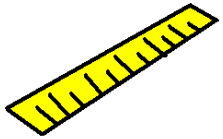
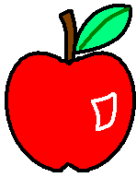
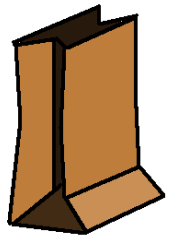


J&H Machine Tools







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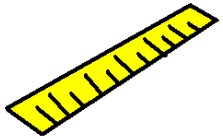
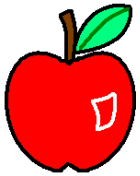
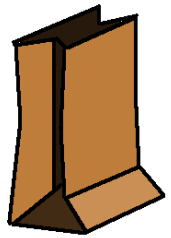
Tricky

Recall

J&H Machine Tools







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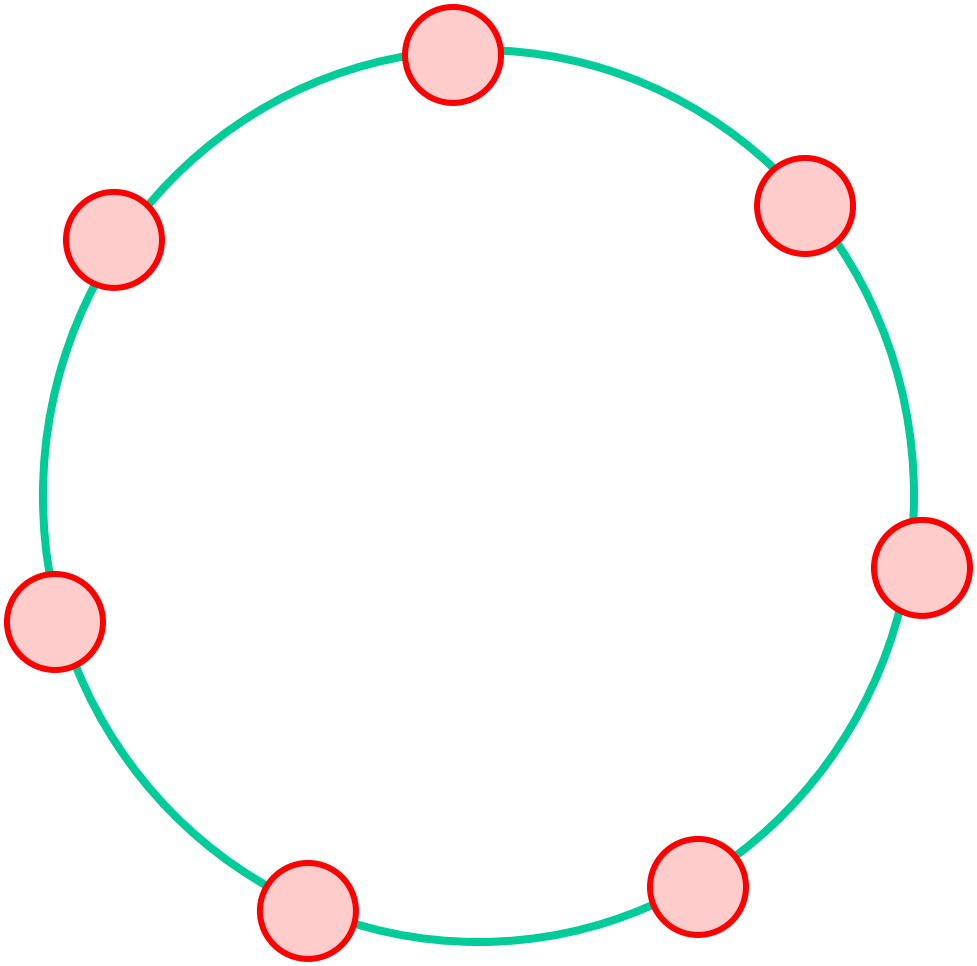
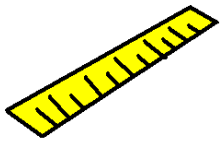
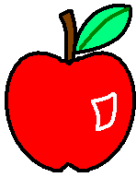
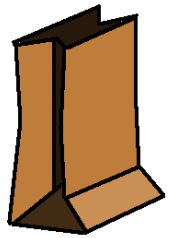
Recall



J&H Machine Tools







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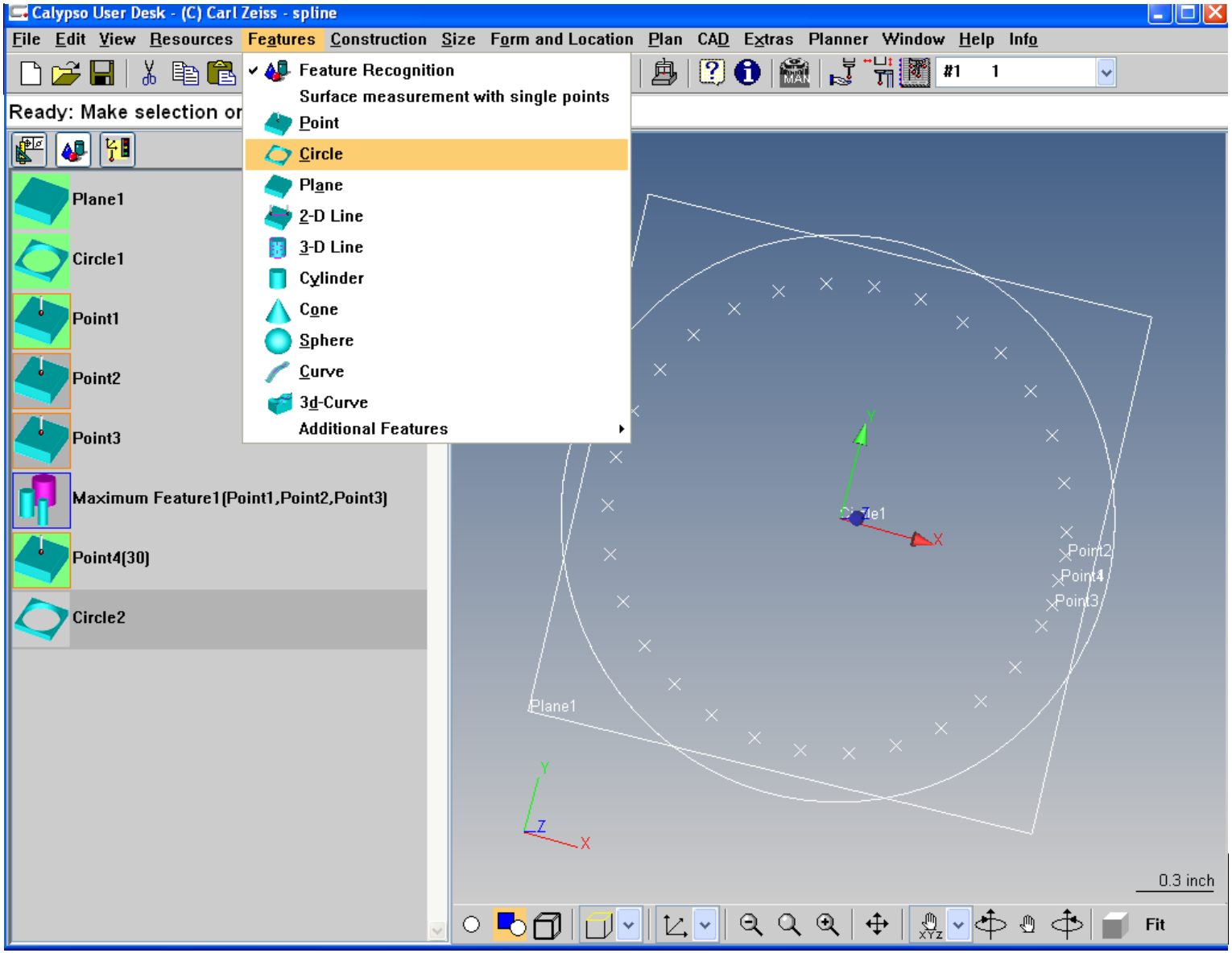
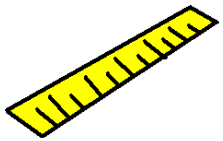
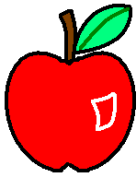
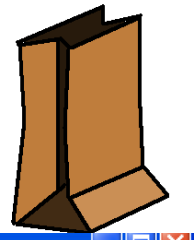


J&H Machine Tools







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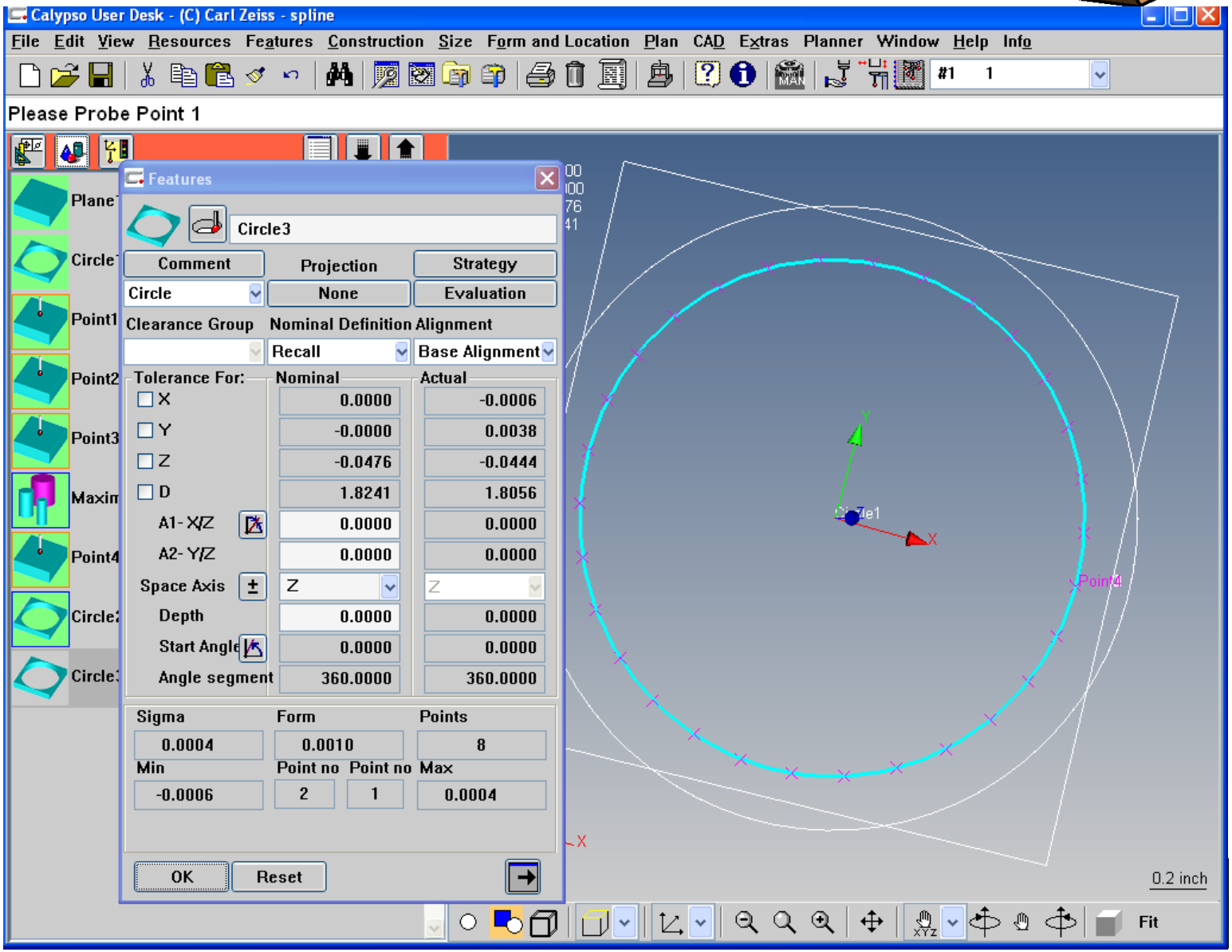
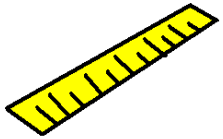
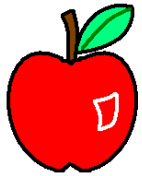
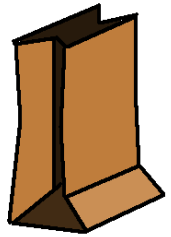


Result Element







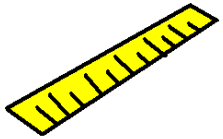
Result Element

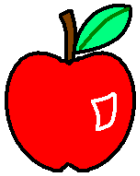
Result Elements can be used to report values that are a calculations from measured features.

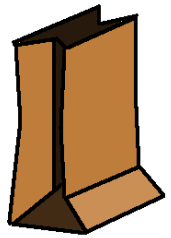
For Example...

Over Balls Dia = Self Center Circ Dia + Stylus Dia

J&H Machine Tools







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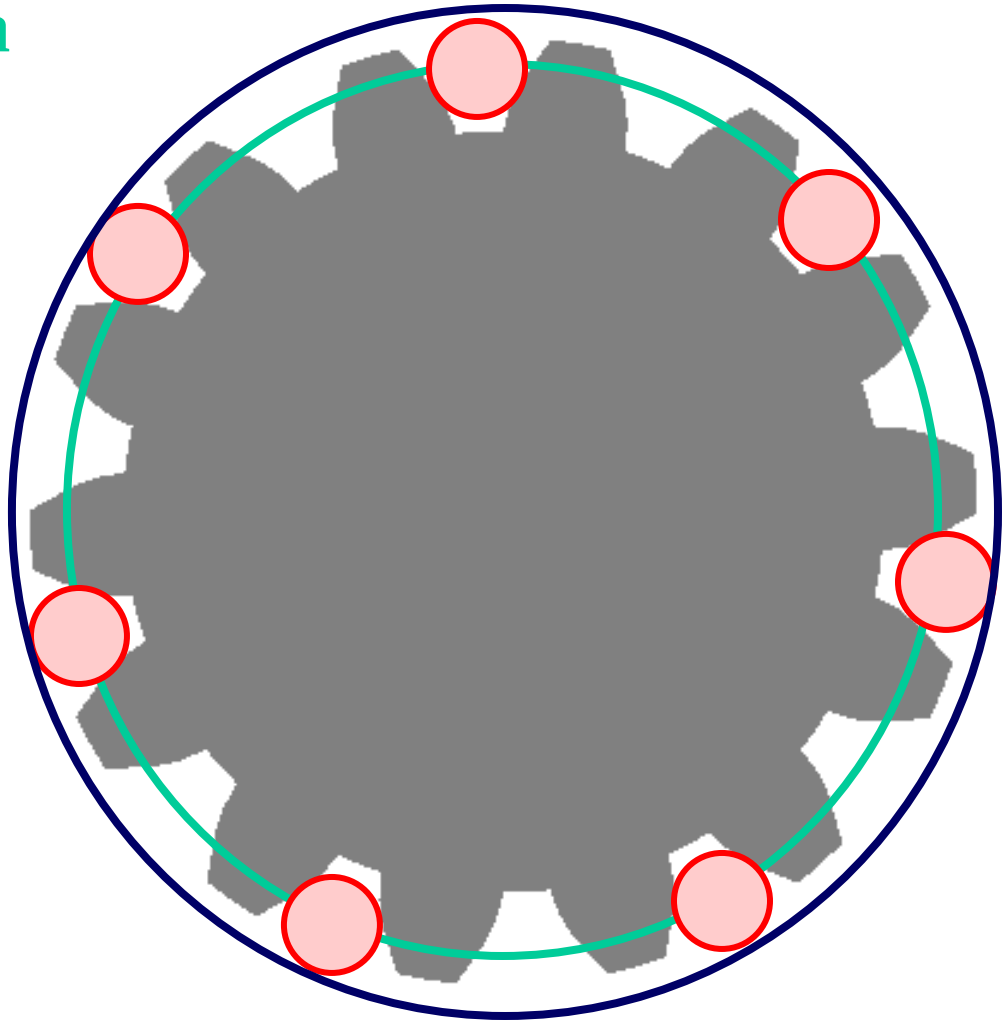
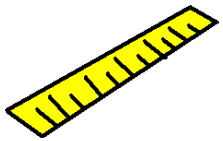
Self Center Circ Dia

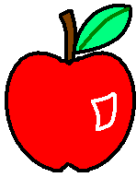
+ Stylus Dia

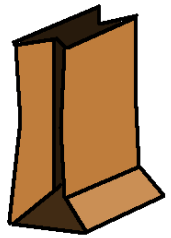
Over Balls Dia



J&H Machine Tools







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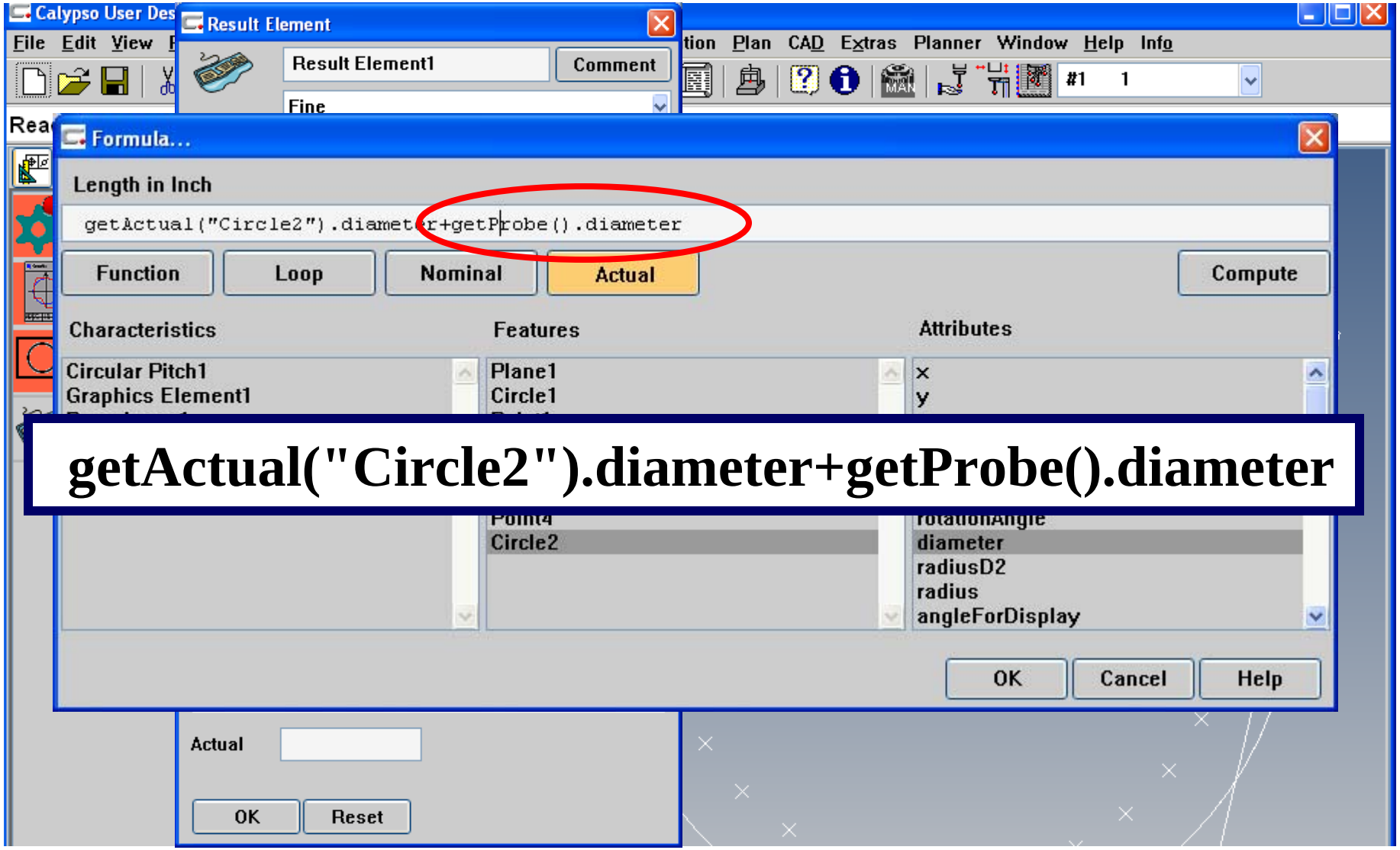

getActual("Circle2").diameter+getProbe().diameter

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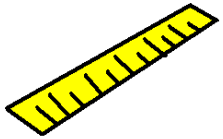

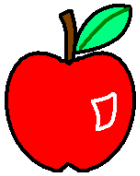

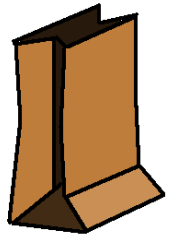

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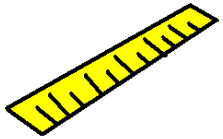
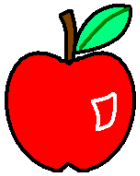
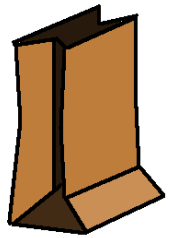
NOW….

We put it all together!





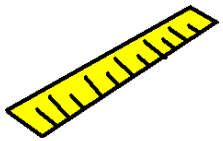


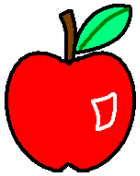
Alignment is the first task.

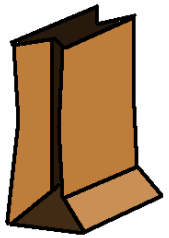
There is a challenge!

Orientation of the spline causes difficulty. Self-center points may hit the top of the spline square and not fall into the geometry.

J&H Machine Tools







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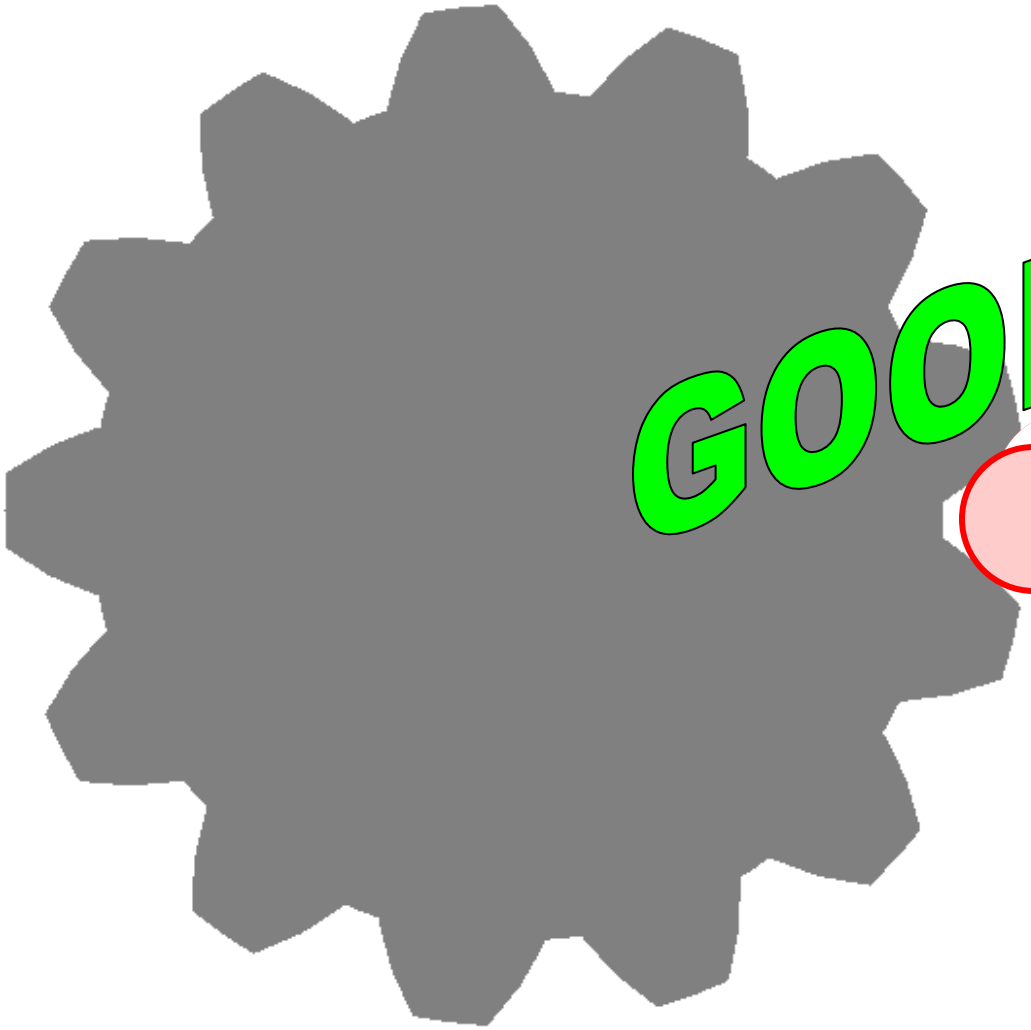
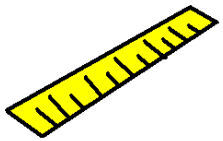
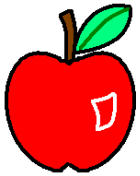
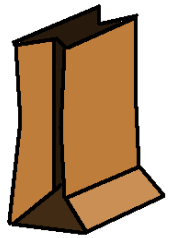


J&H Machine Tools







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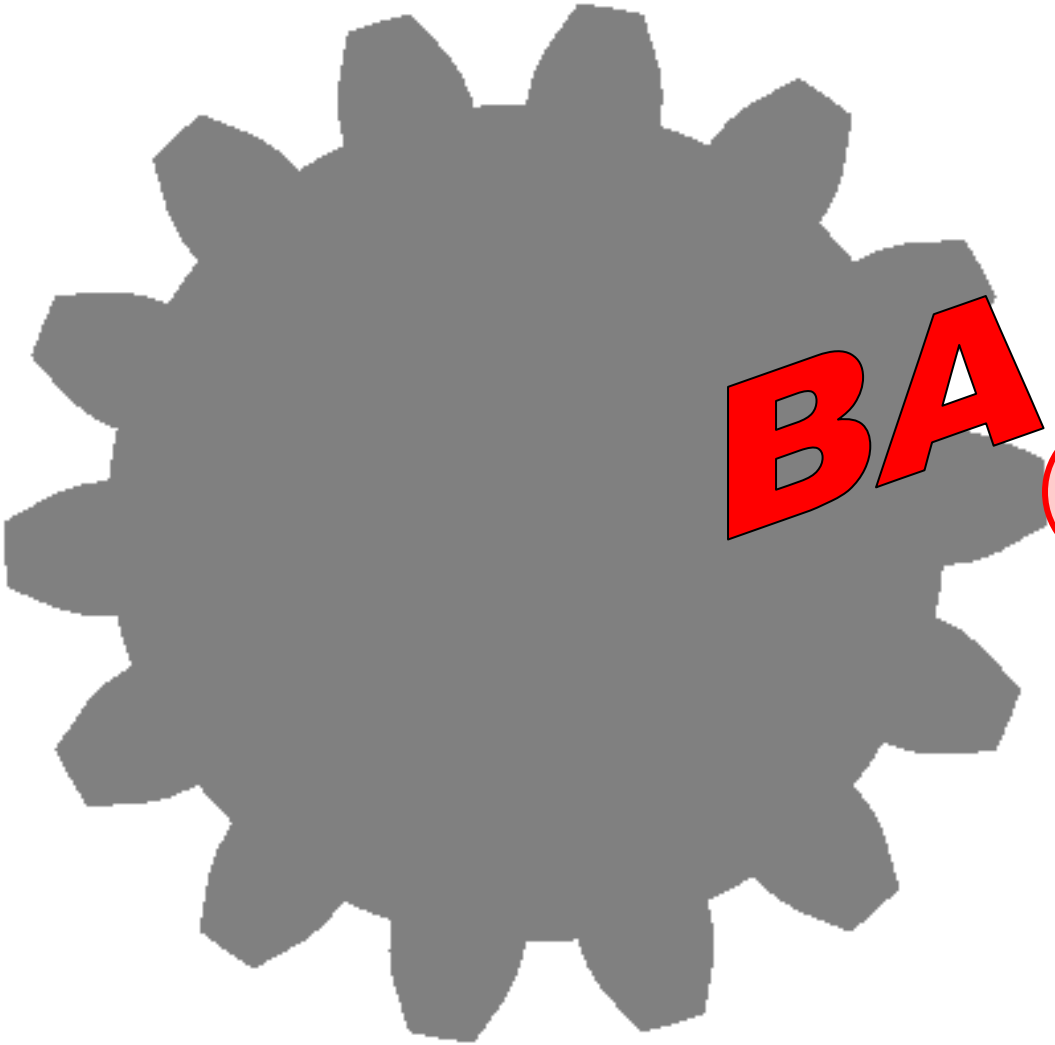
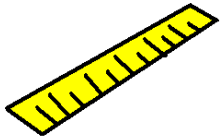
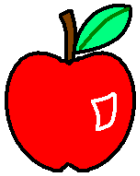
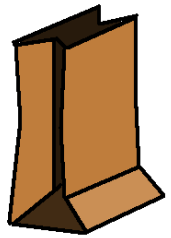


J&H Machine Tools







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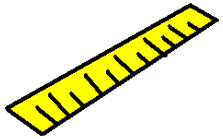

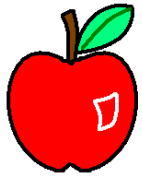

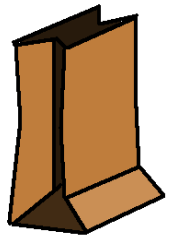

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Here's the part.

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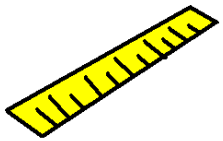

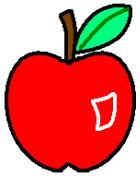

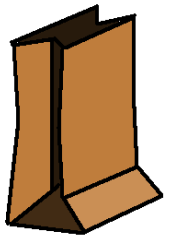

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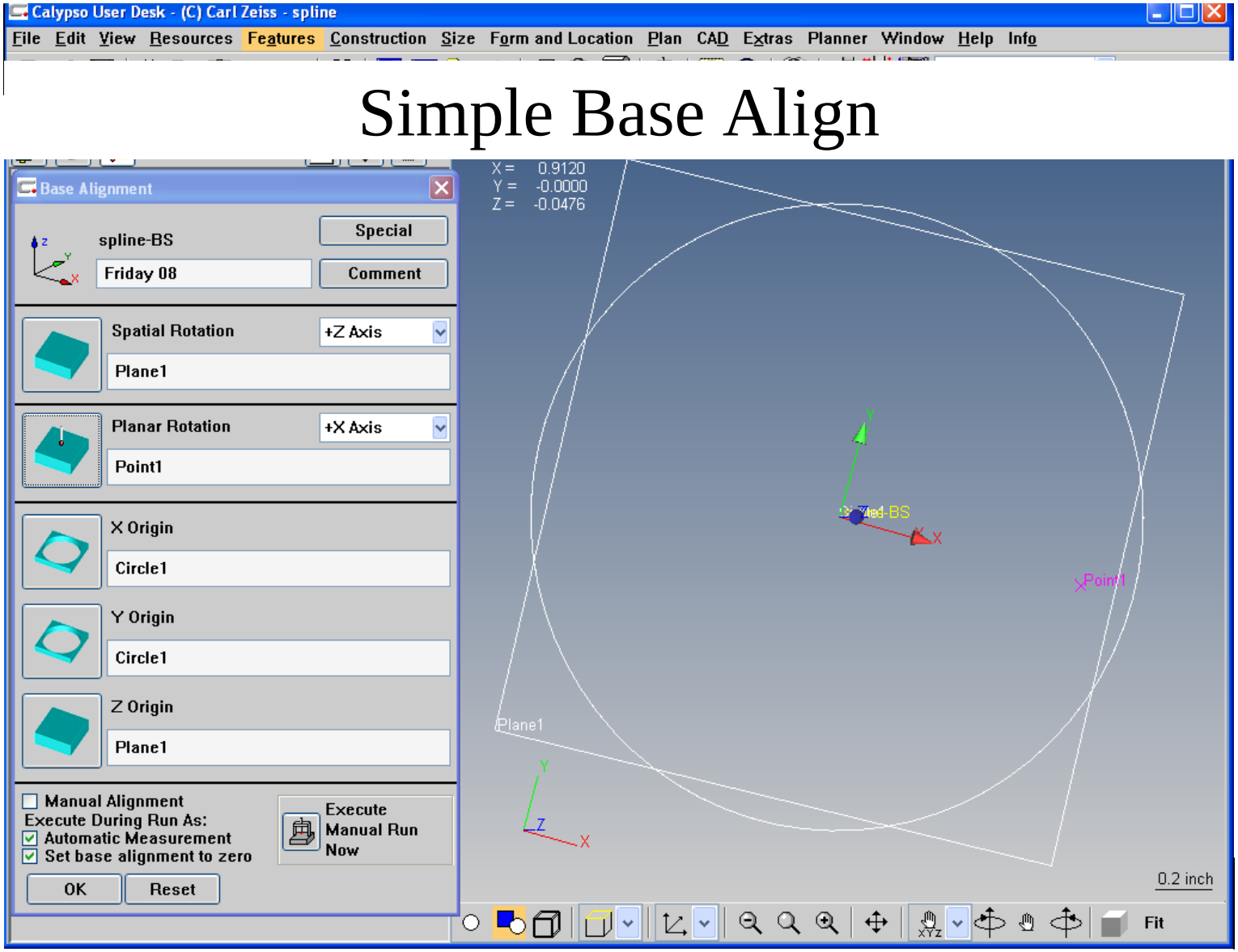

Simple Base Align

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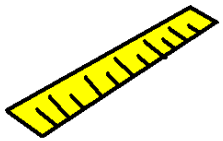

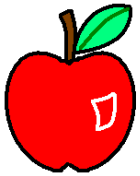

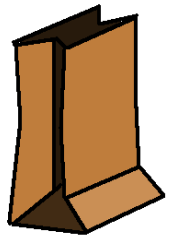

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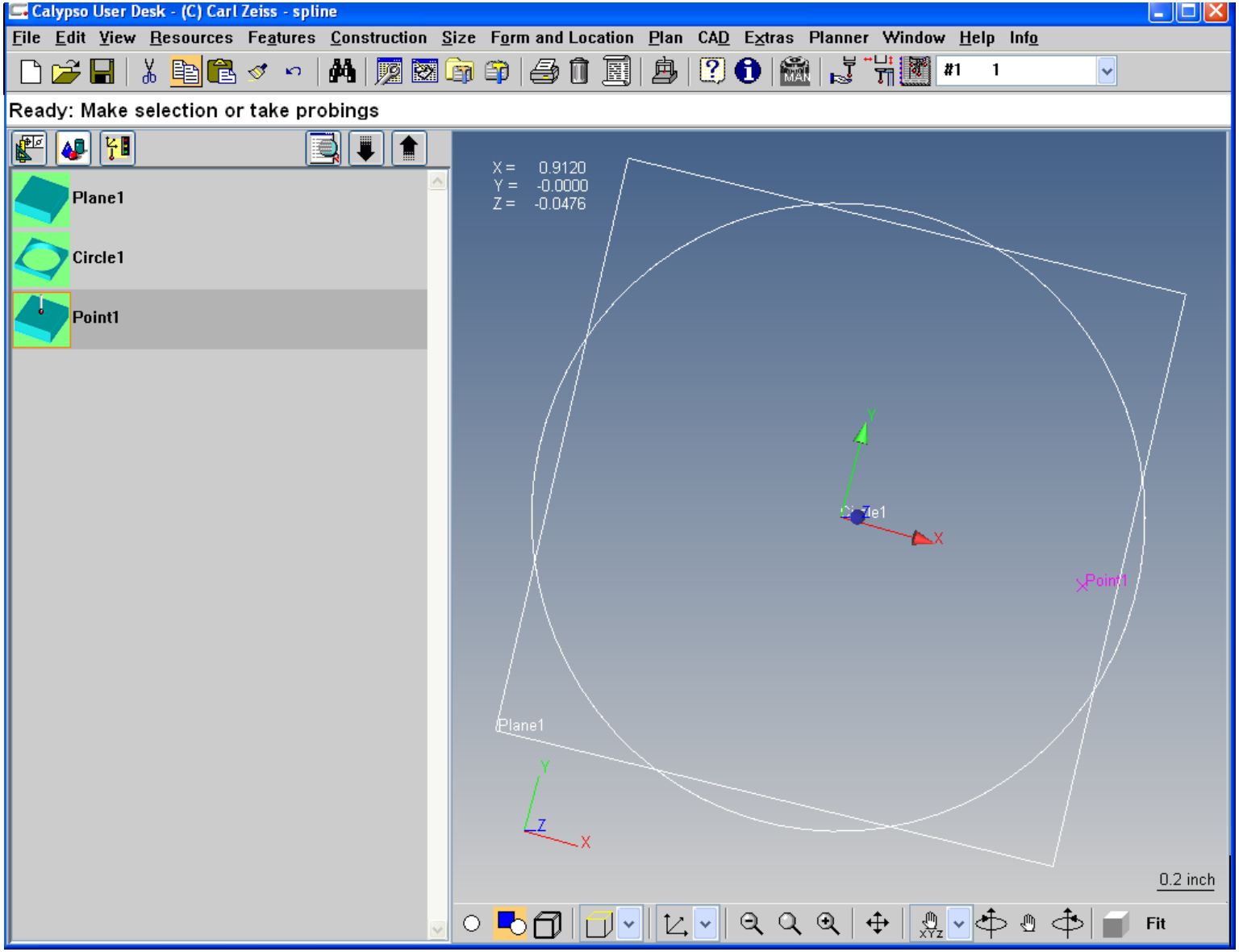
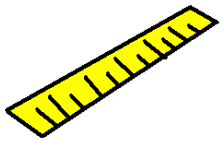
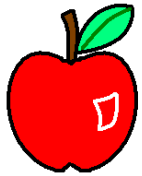
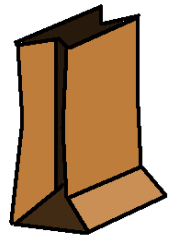


J&H Machine Tools







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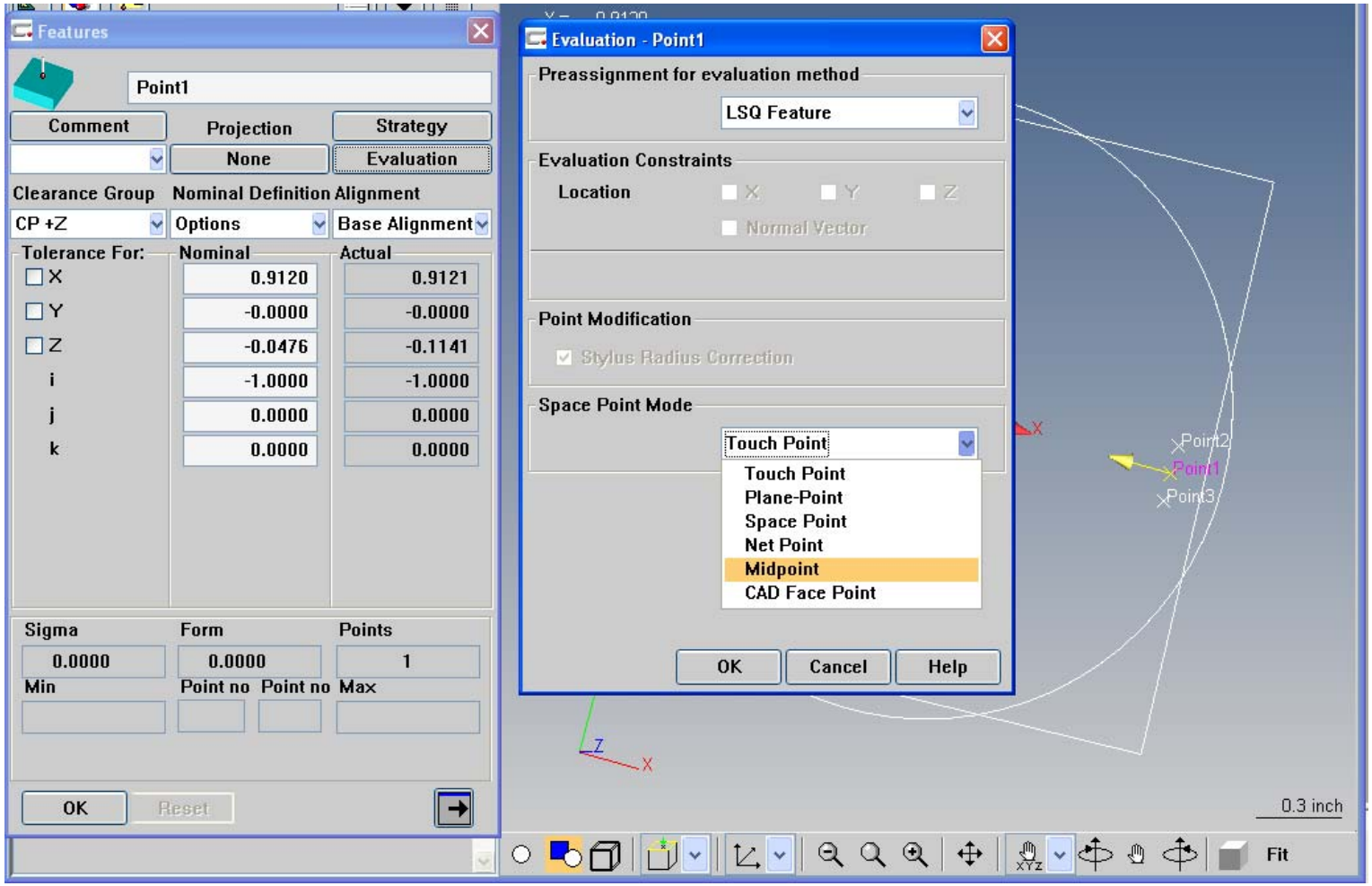
Change Point 1's evaluation to Midpoint



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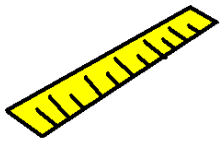

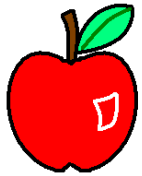

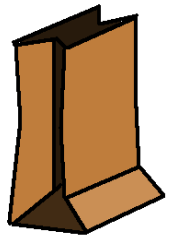

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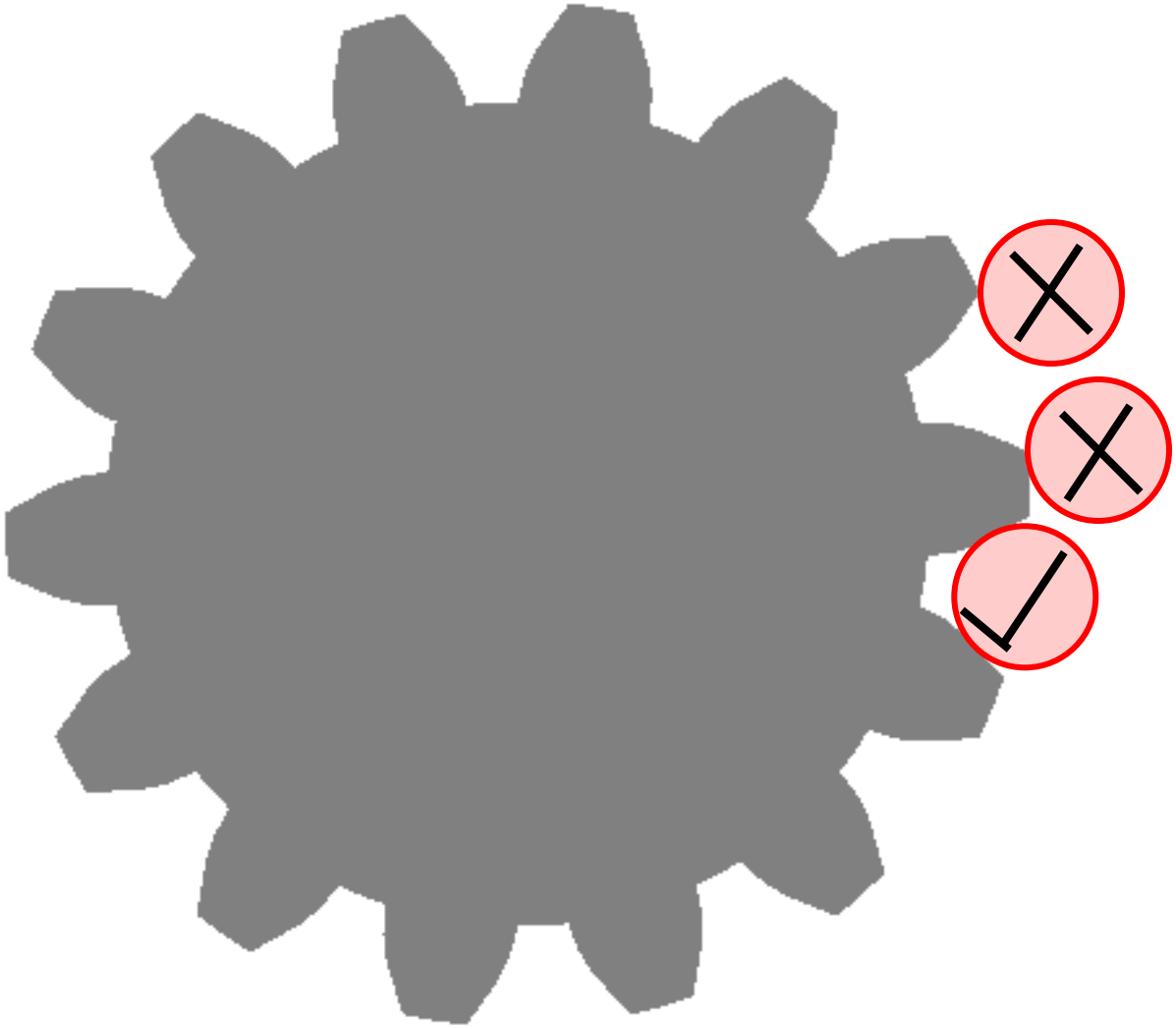
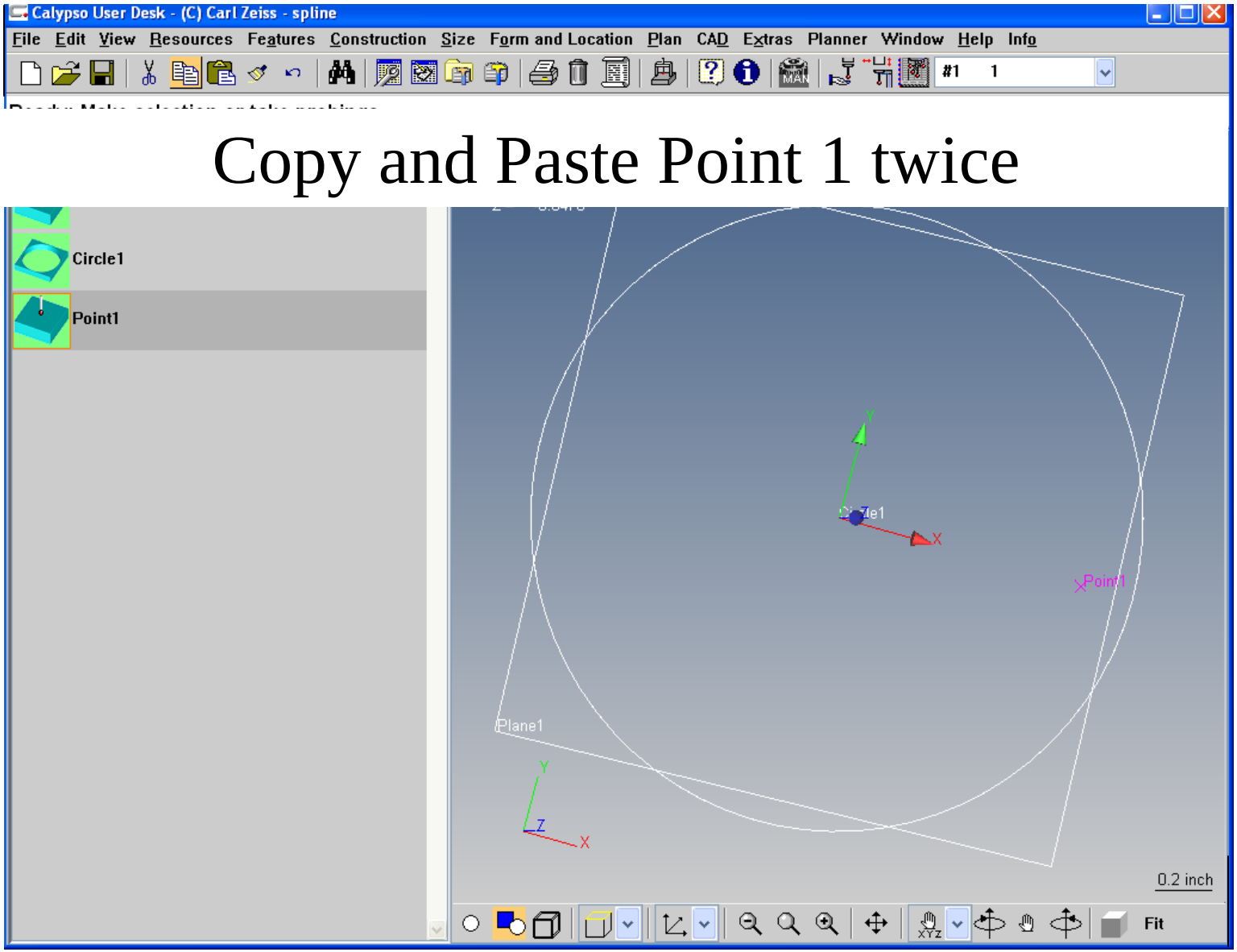
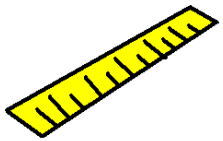
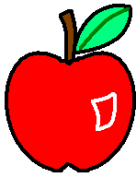
One MUST work…

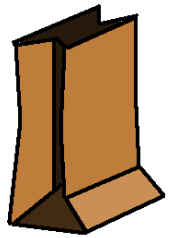



Calypso User Desk - (C) Carl Zeiss - spline
File Edit View Resources Features Construction Size Form and Location Plan CAD Extras Planner Window Help Info
#1 1
Copy and Paste Point 1 twice
Circle1
Point1
Plane1
0.2 inch
Fit

J&H Machine Tools







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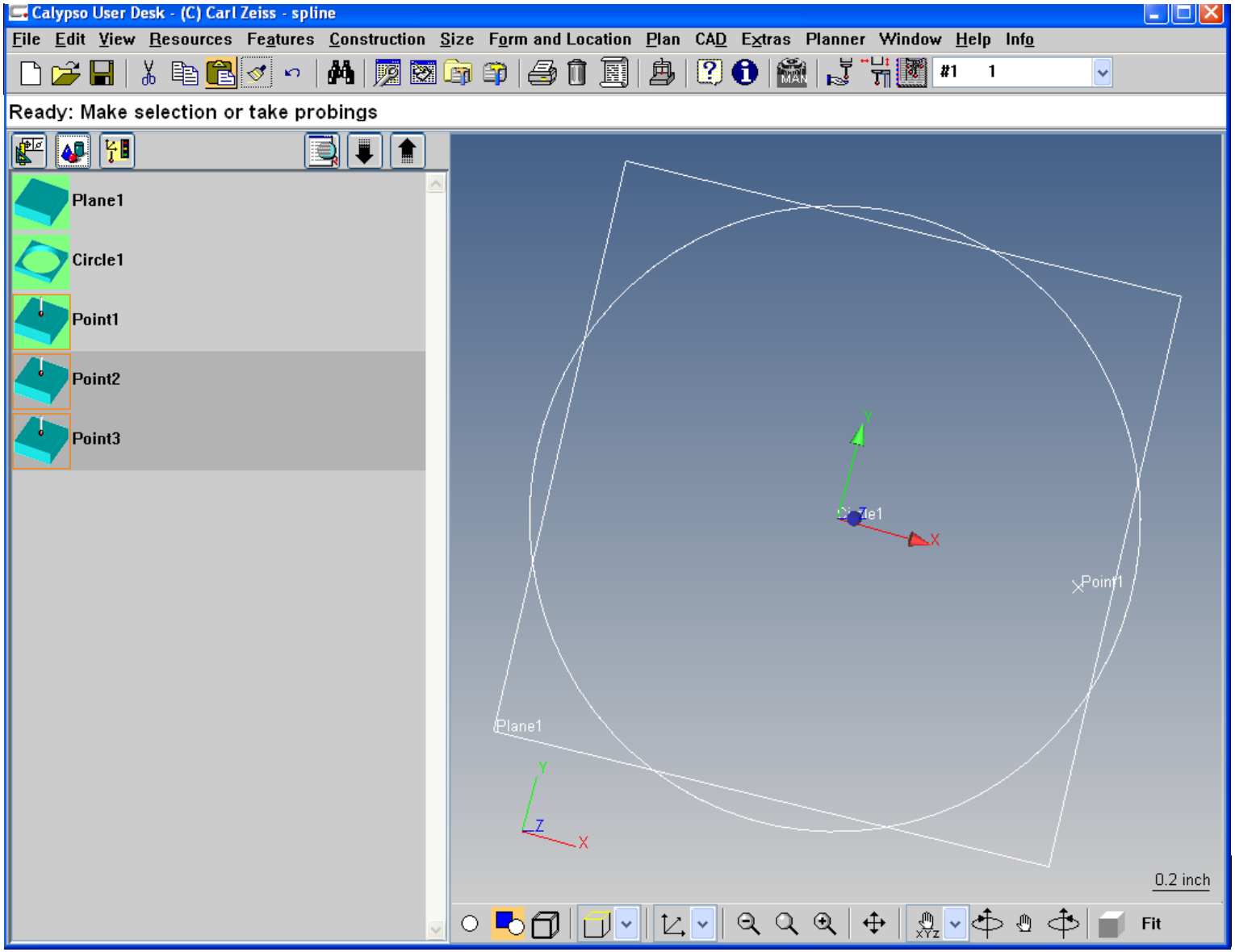
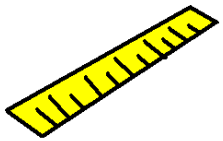
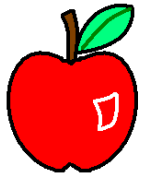
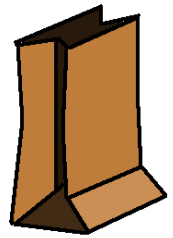


J&H Machine Tools







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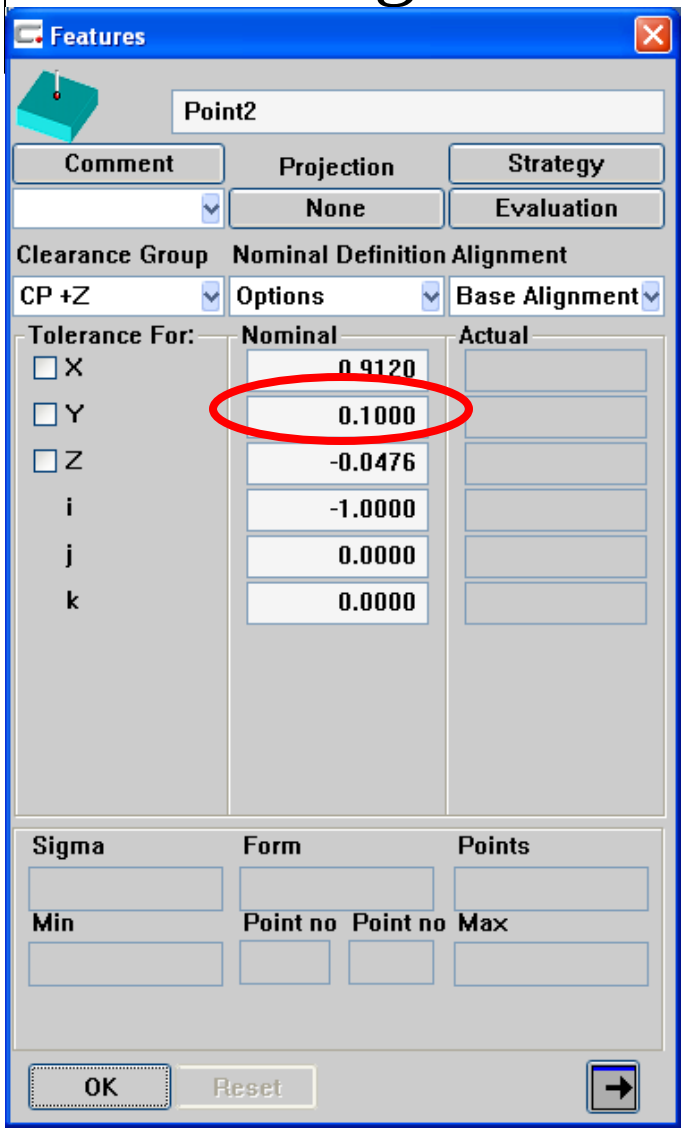
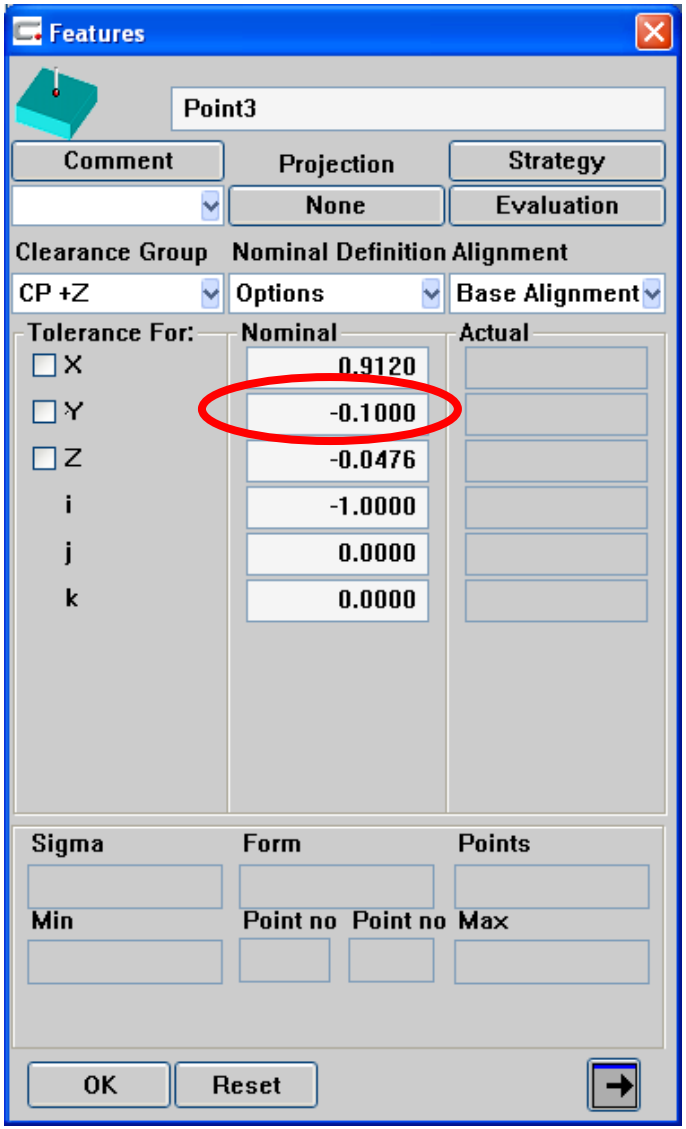
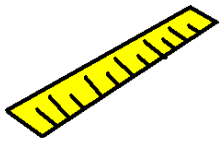
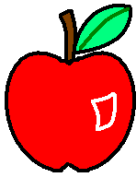
Change the Y value to +/- a little.

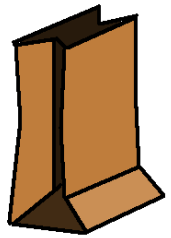




J&H Machine Tools

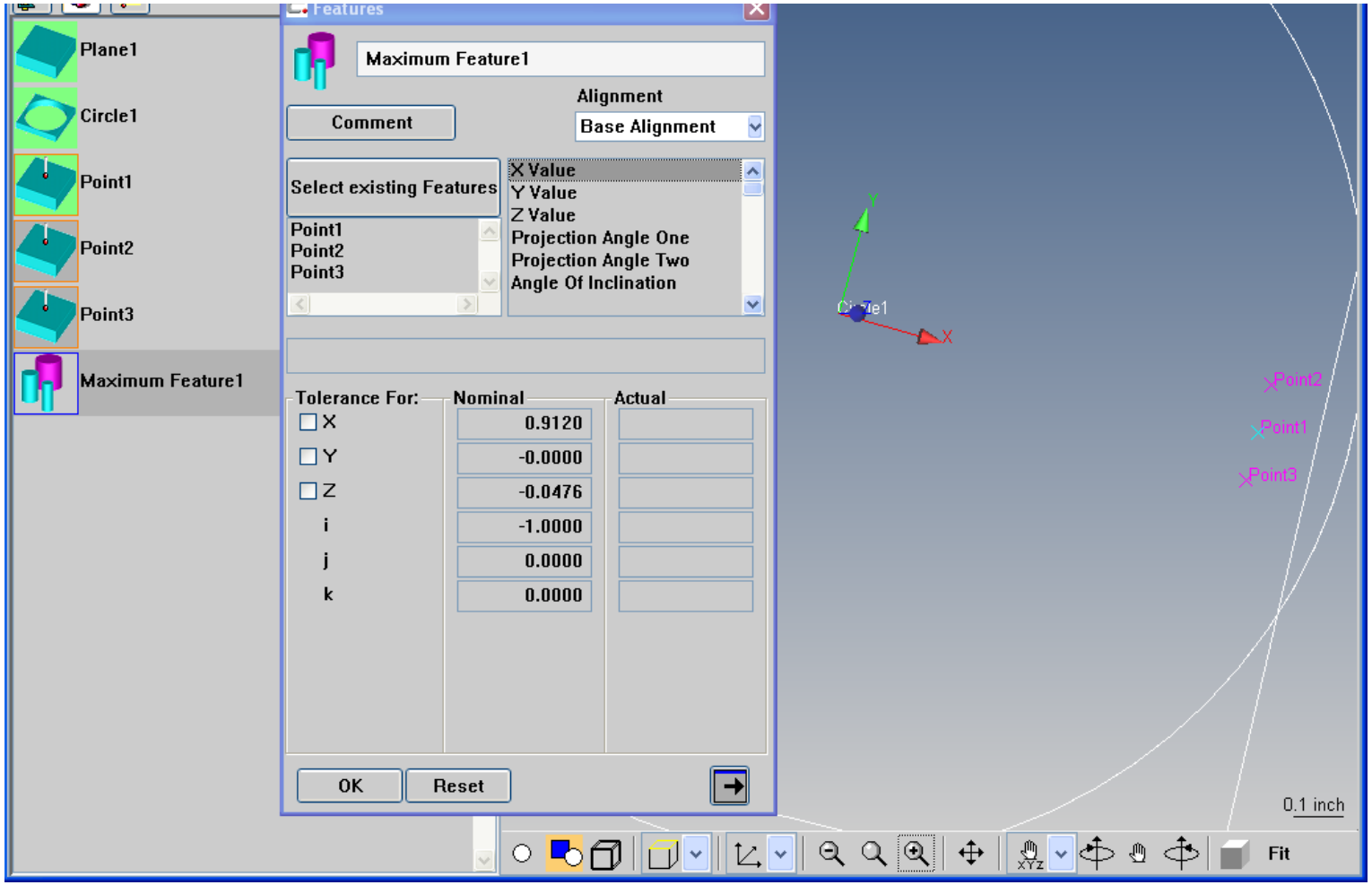




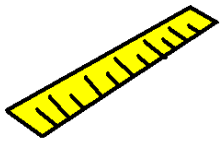


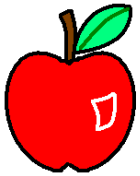
ZEISS

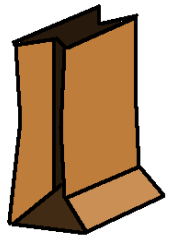
Using MAX Feature since an ID spline



J&H Machine Tools







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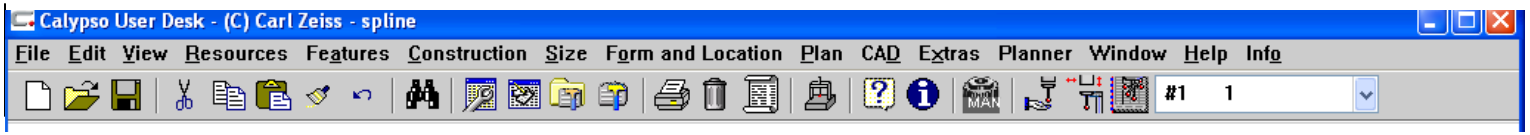
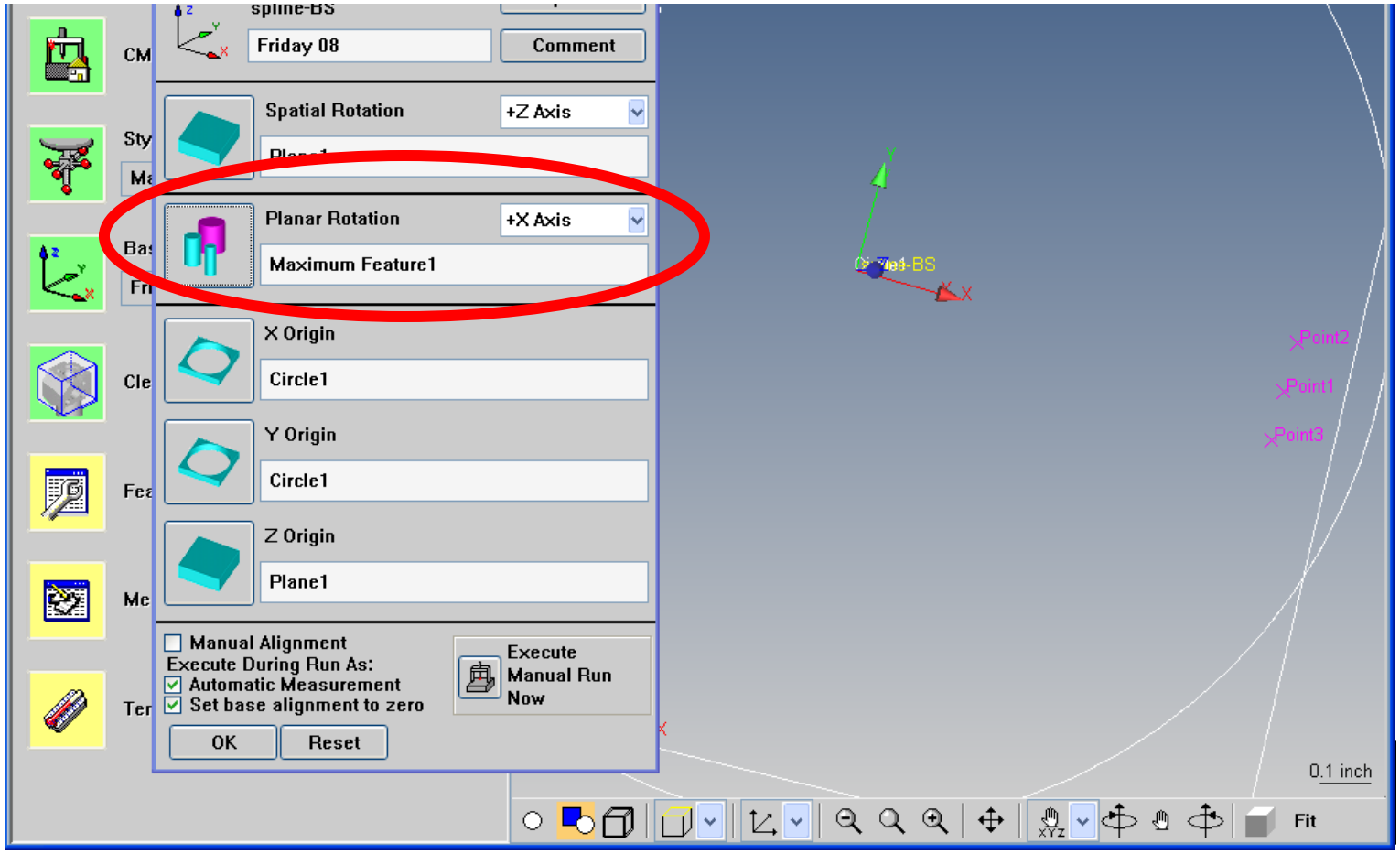
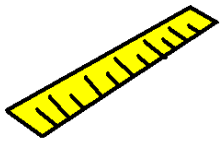
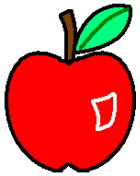


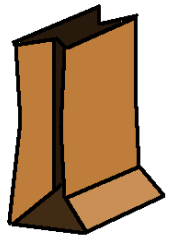
Change Alignment to Max Feature for Planar



J&H Machine Tools







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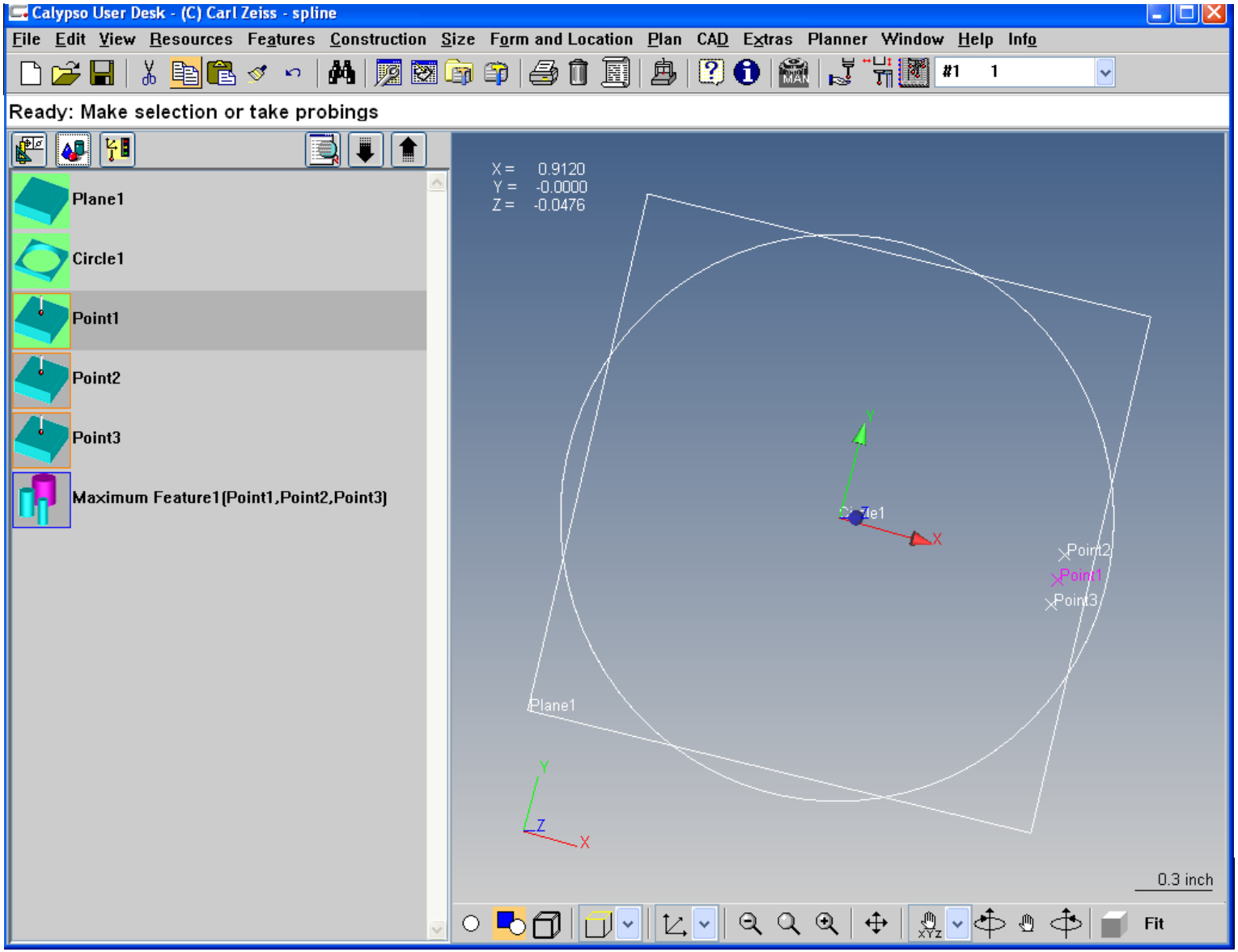
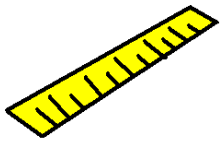
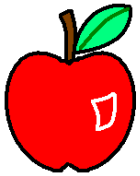
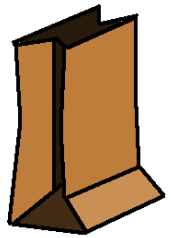


J&H Machine Tools







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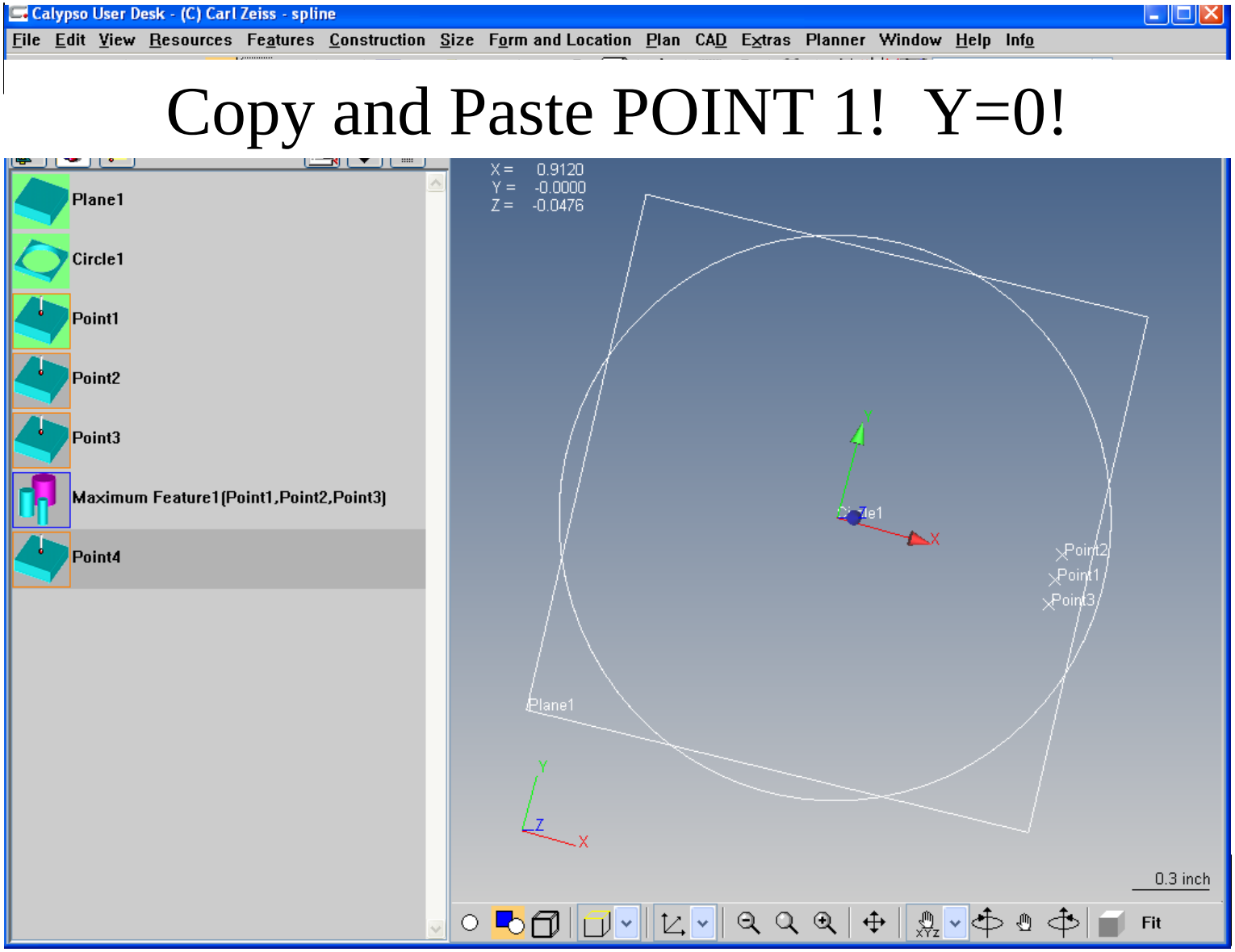
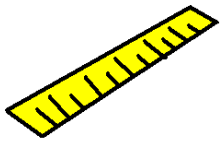
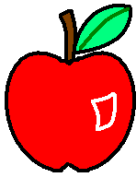
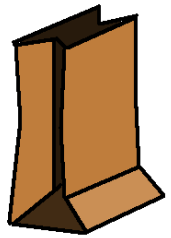


Copy and Paste POINT 1! Y=0!

J&H Machine Tools







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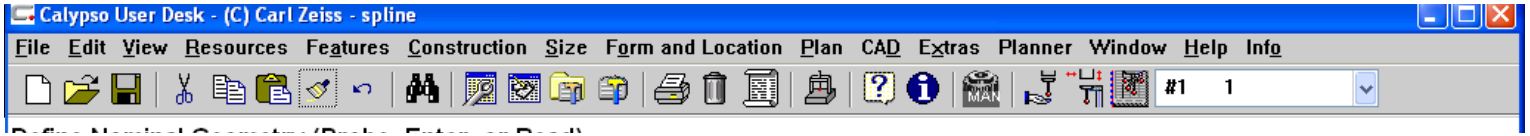
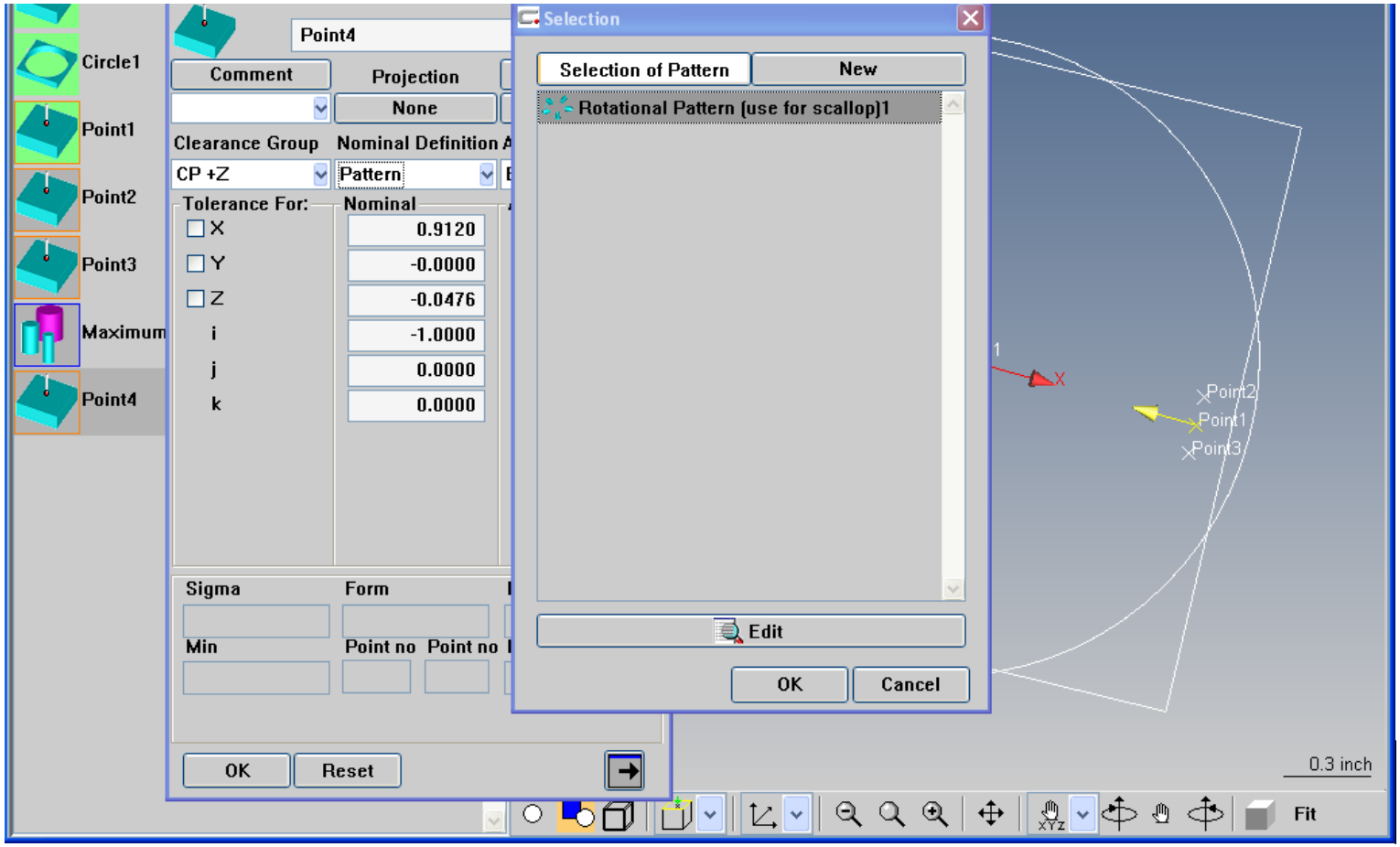
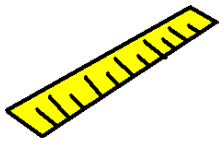
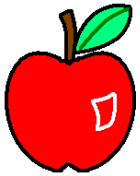


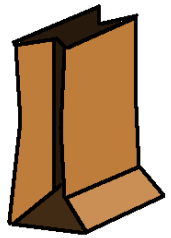
Apply appropriate Pattern to the copied Point 1



J&H Machine Tools







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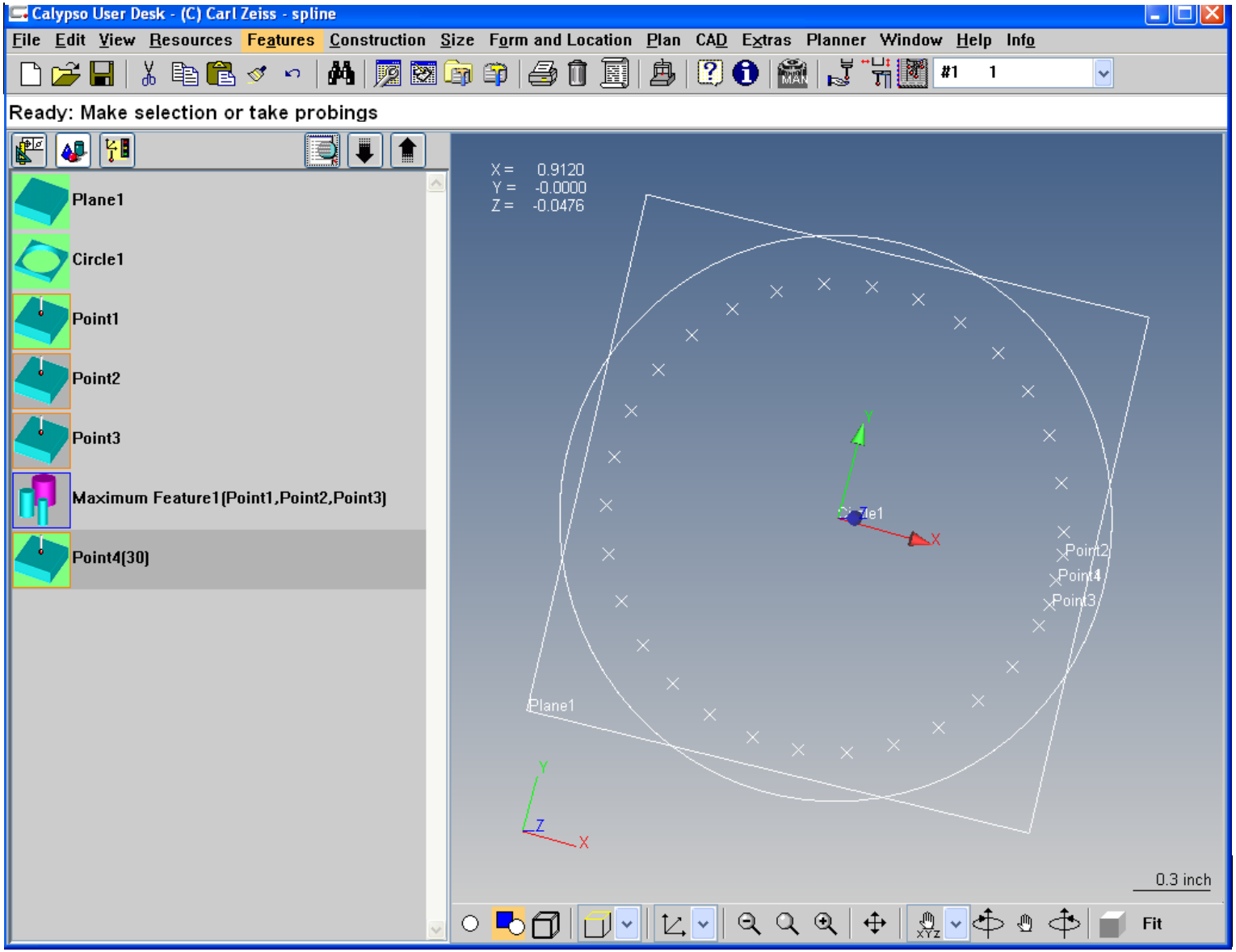
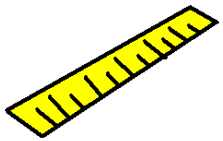
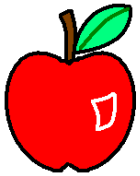
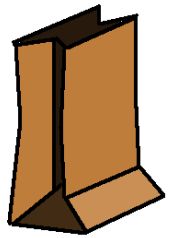


J&H Machine Tools







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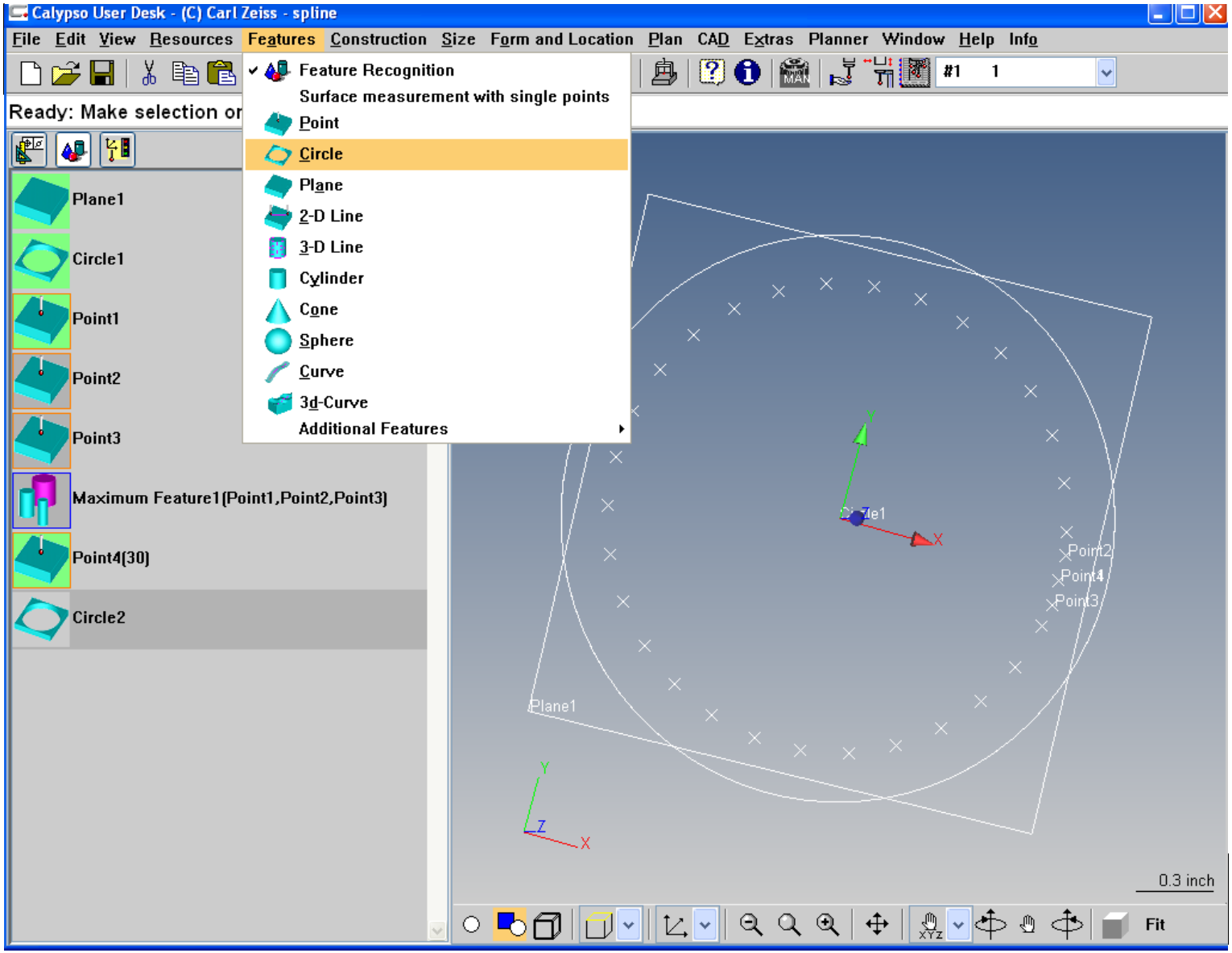
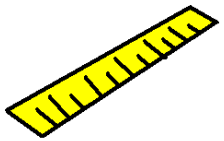
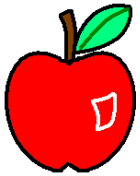
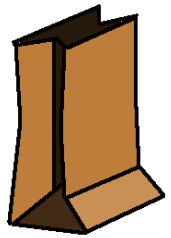


J&H Machine Tools







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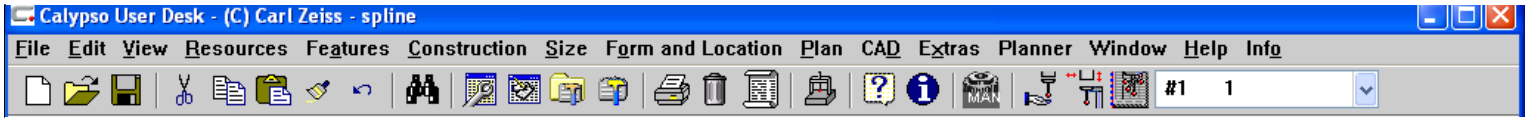
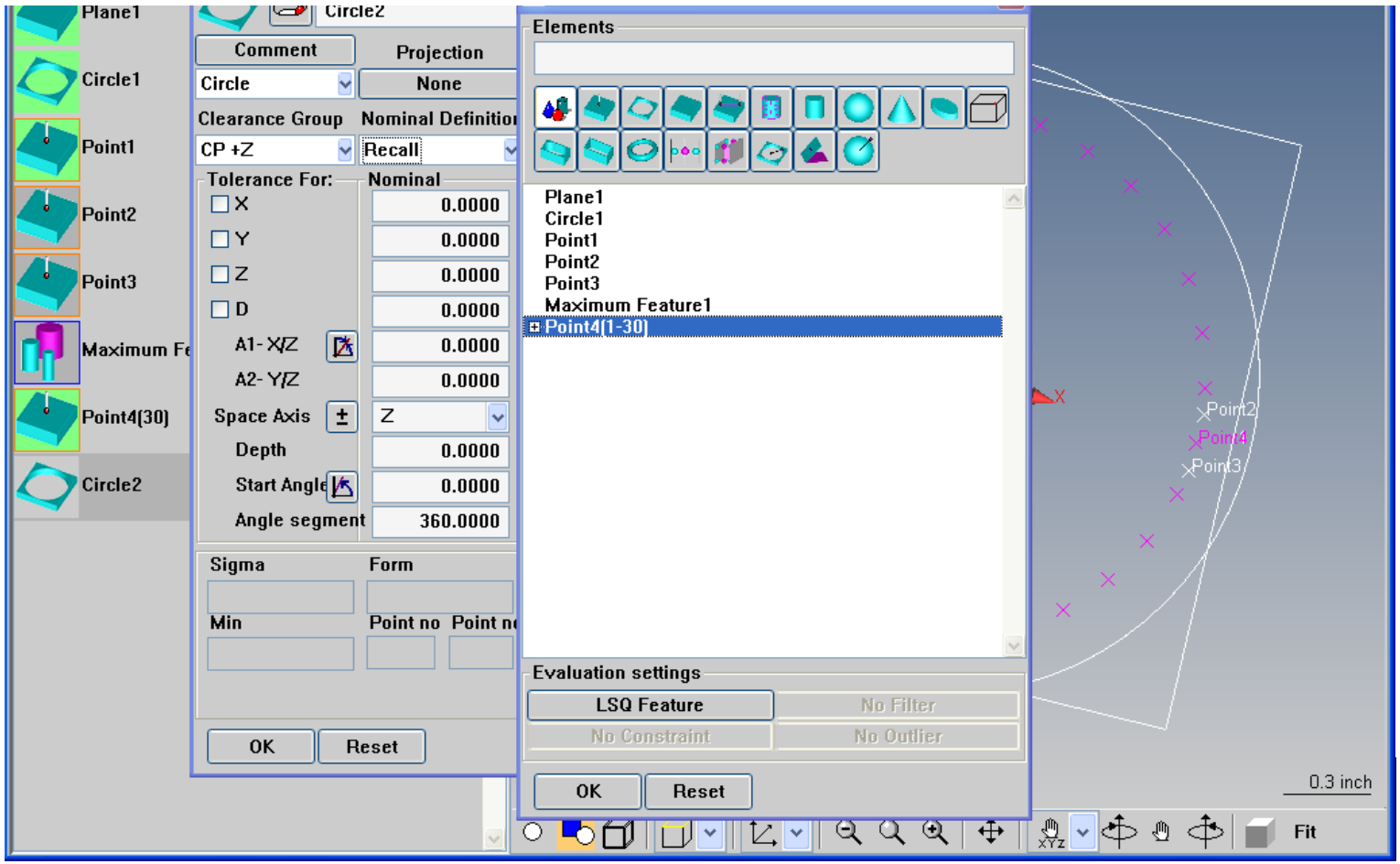
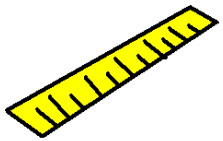
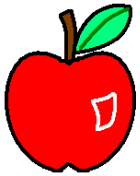


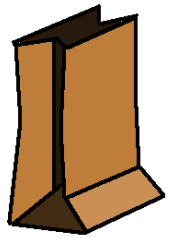
Recall the Patterned Point into a Circle



J&H Machine Tools







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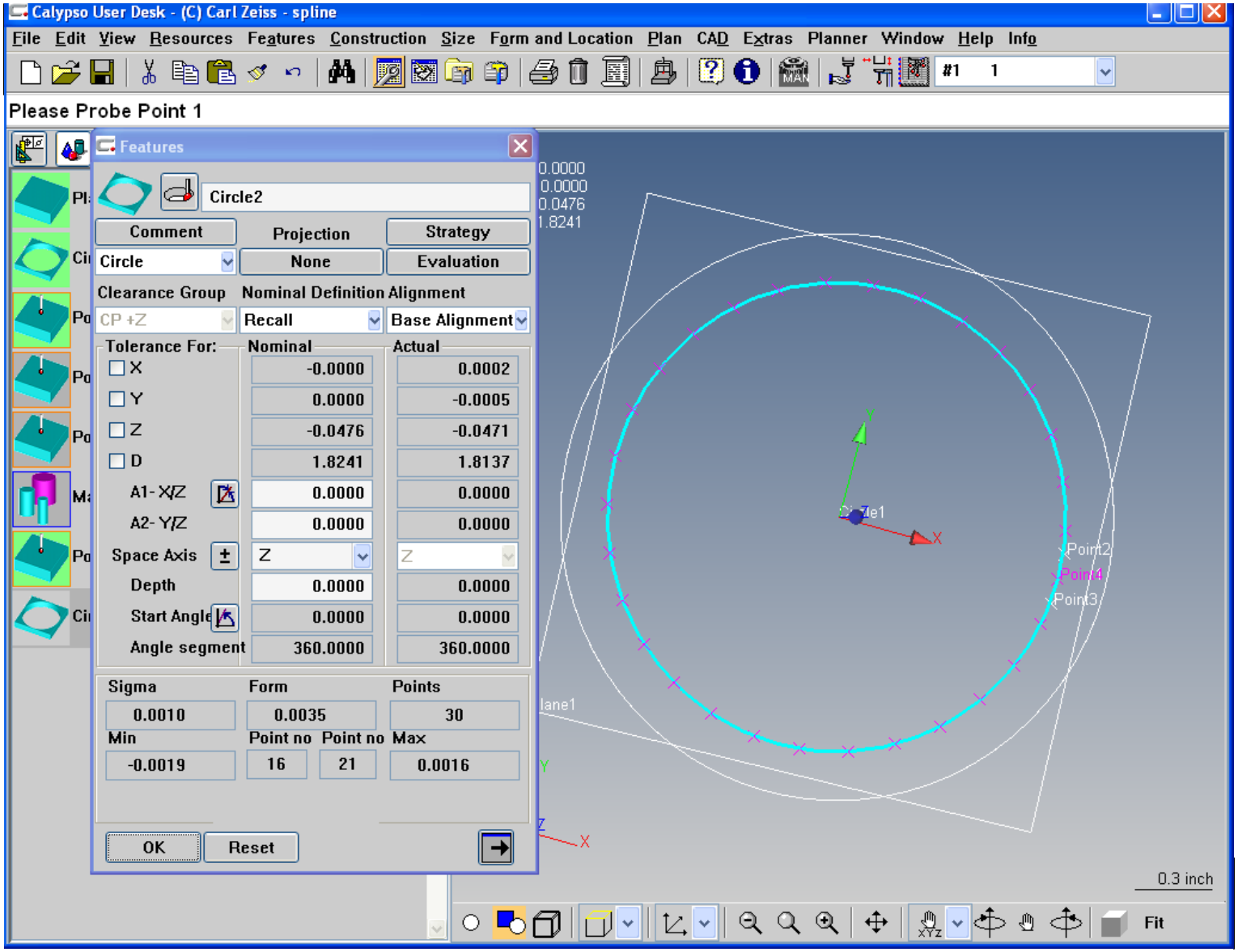
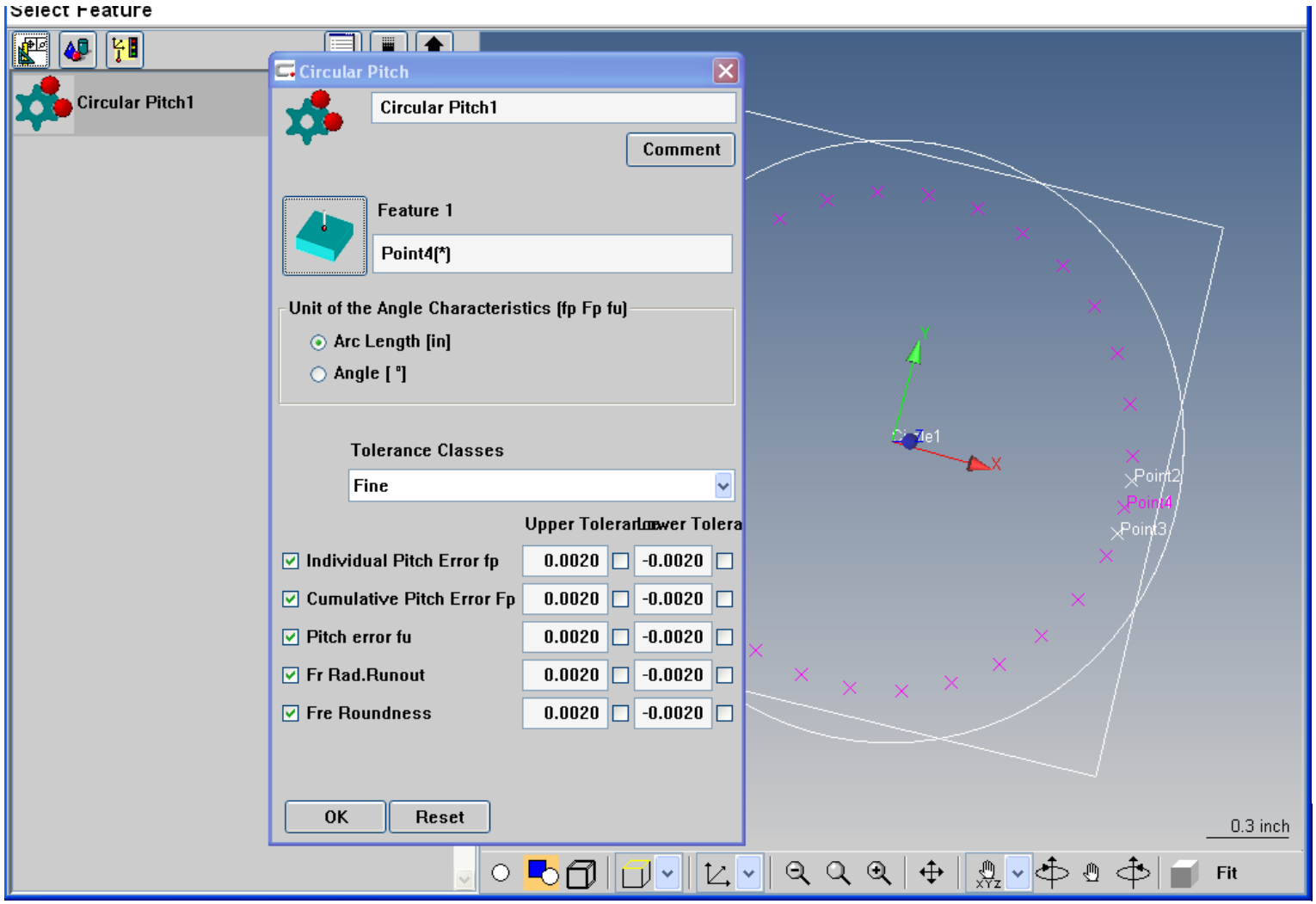
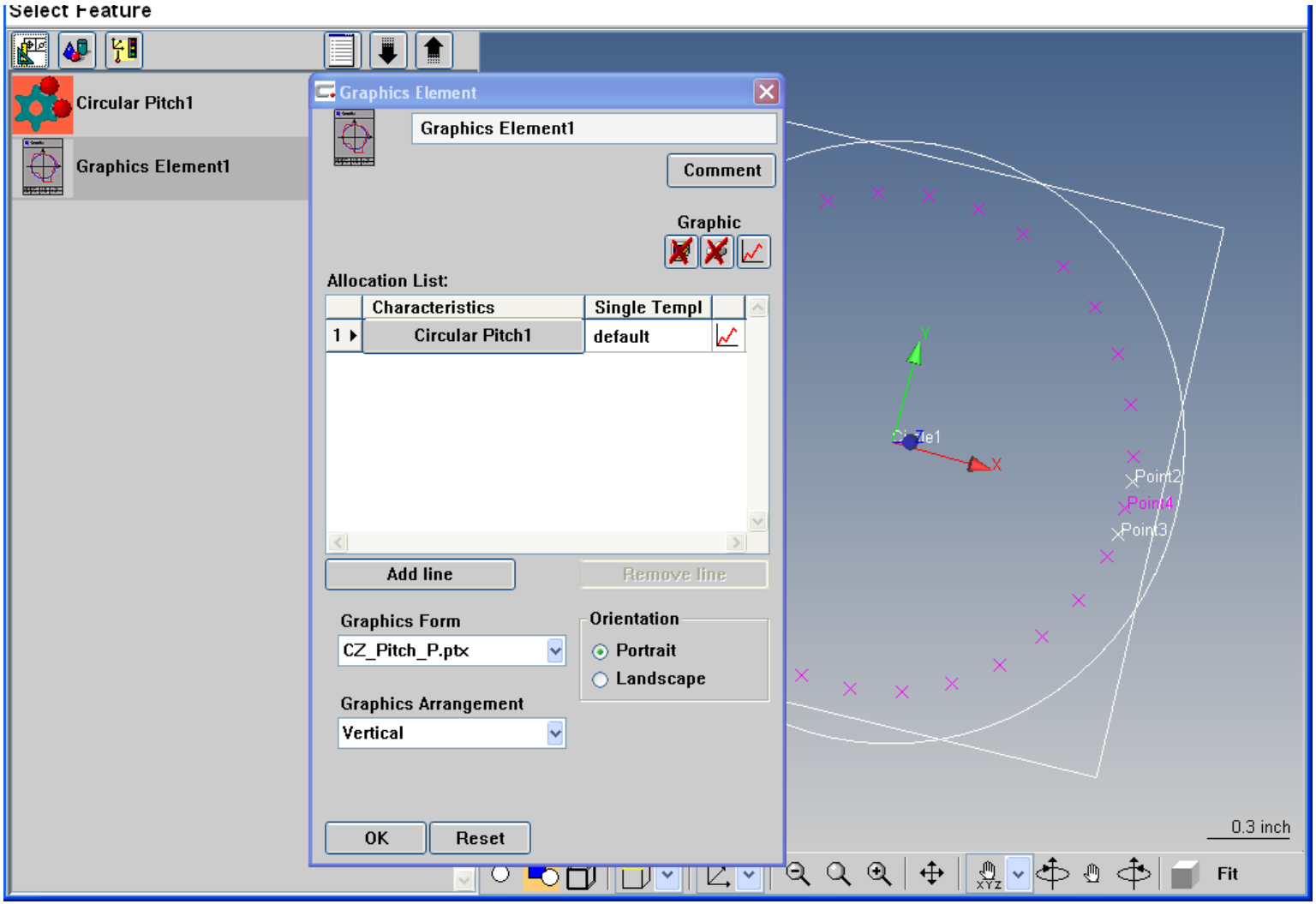


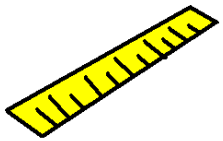
Do a Circular Pitch on the Patterned Point

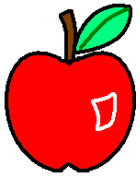


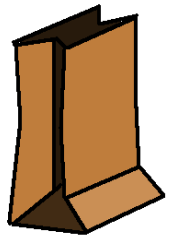
Setup a Graphics Element for the Circular Pitch



J&H Machine Tools







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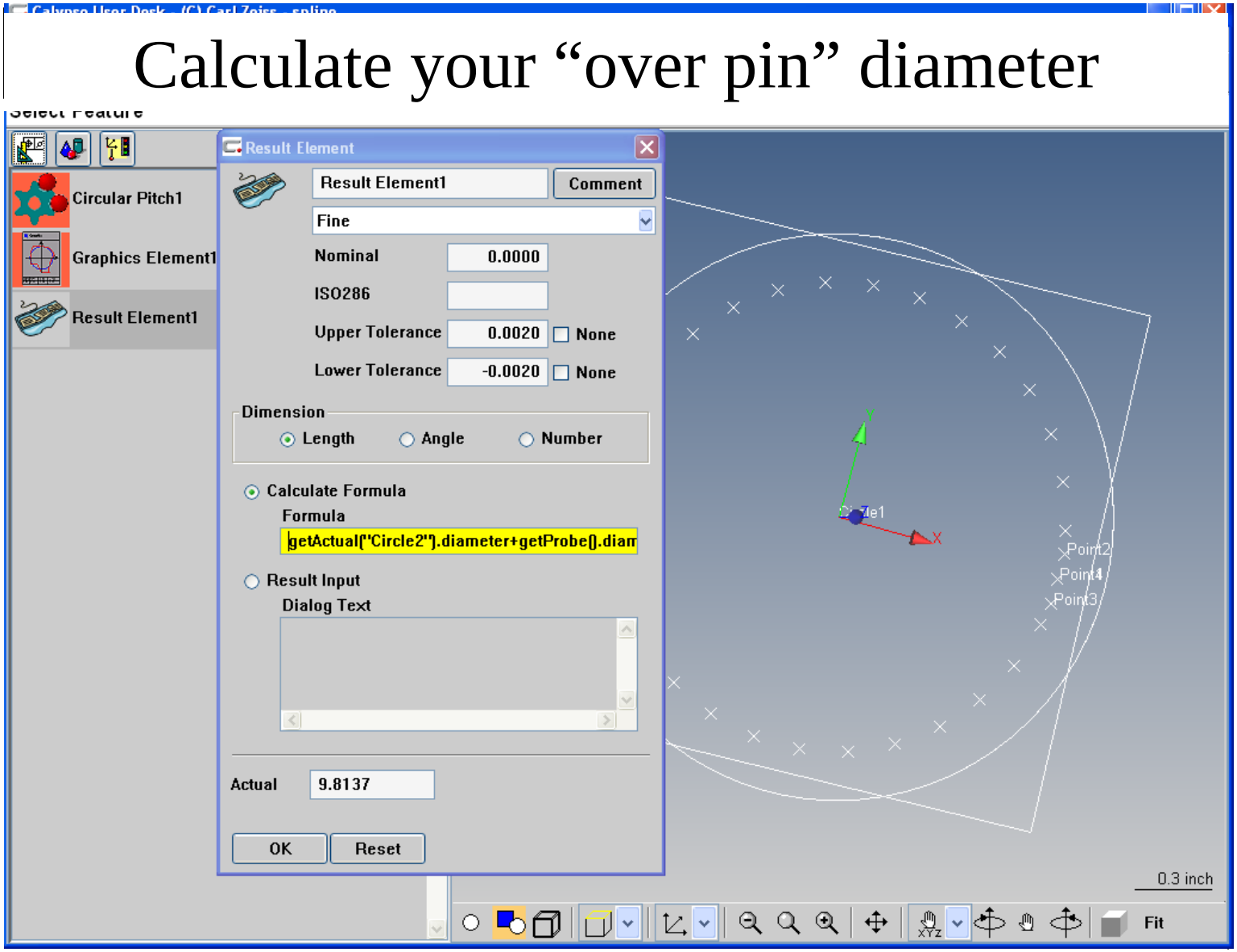
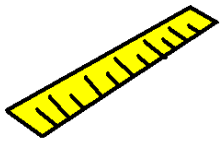
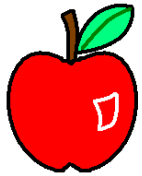
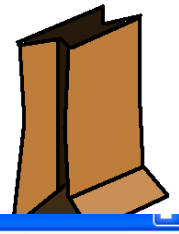
Calculate your “over pin” diameter



J&H Machine Tools







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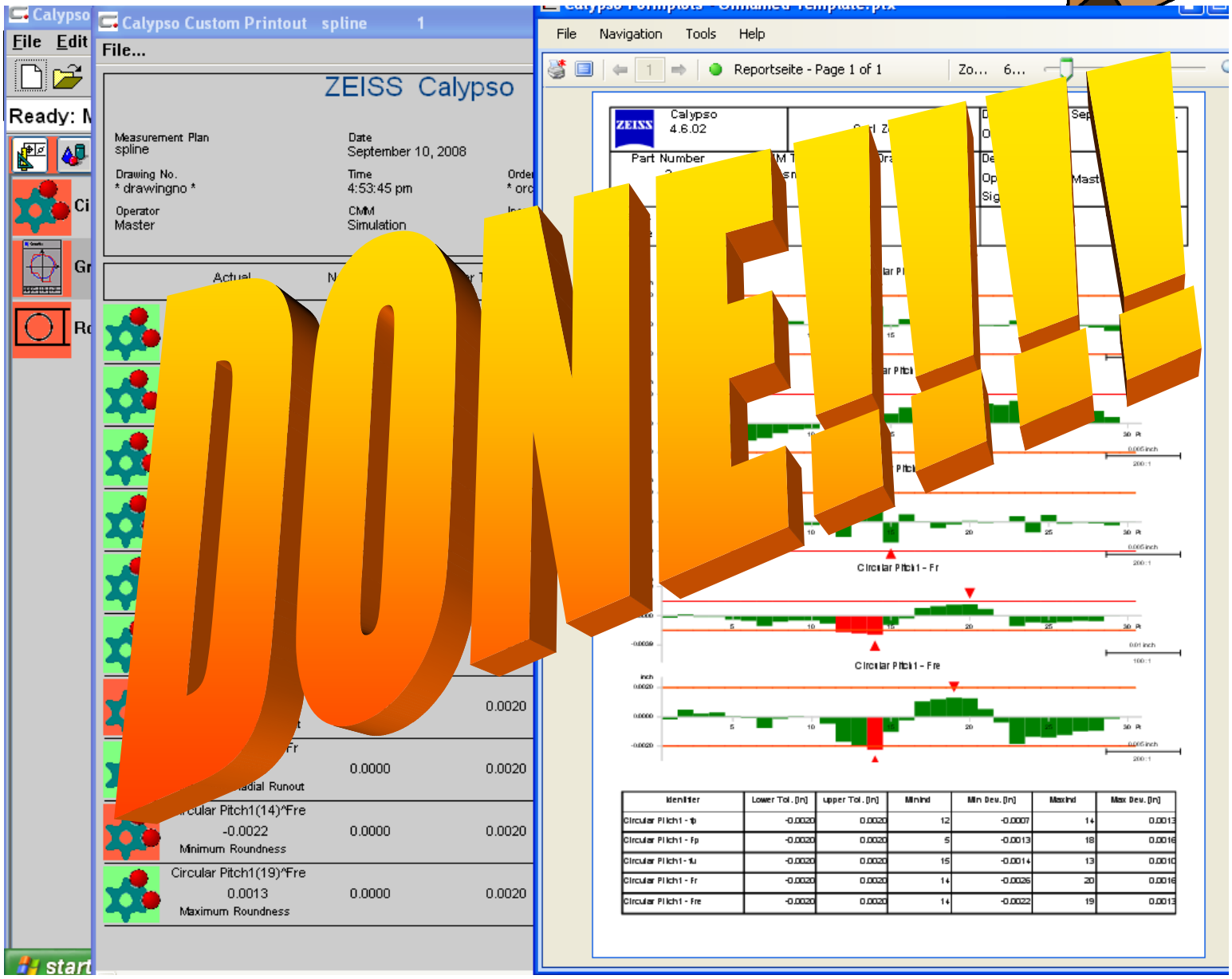
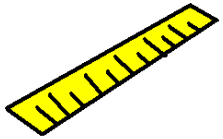
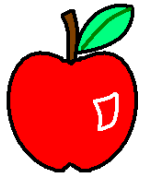


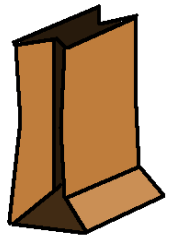
DONE!!!

J&H Machine Tools





LUNCH 'N LEARN



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Spline Measurements…

with Calypso!

Any Questions?