MAKING MEASUREMENT

MORE ACCURATE, EFFICIENT, *PRODUCTIVE*

GD&T Inspection in SpatialAnalyzer

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GD&T Inspection

Incorporating

Standardized Inspection within SpatialAnalyzer

Check Pre-Eval Validator

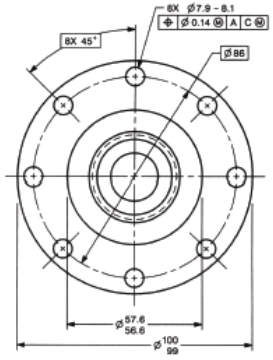
None | ASME (1994) | ASME (2009) | ISO (1983) | ISO (2004) | ISO (2012)

(If an ASME or ISO option is selected, additional validation is done before check eval according to the selection and this is also indicated in the reports.)

(The choice of None/ASME/ISO does not affect the numeric results from the GD&T evaluation. It only controls the validation done before evaluation to determine if the check can be evaluated)

Dimensioning and Tolerancing

Engineering Drawing and Related Documentation Practices



AN INTERNATIONAL STANDARD

The American Society of Mechanical Engineers

ASME SETTING THE STANDARD

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GD&T Inspection

	GD&T	"Regular Inspection"
Alignments	Datum Structure Check Specific	Current Position
Computation	Bounding Tol. Zone Outlier Pts = Part Error	RMS (root mean square) User controls rejection rules
Goals:	Pass/Fail at Tolerance	Is the part good and if not.., how do I fix it?

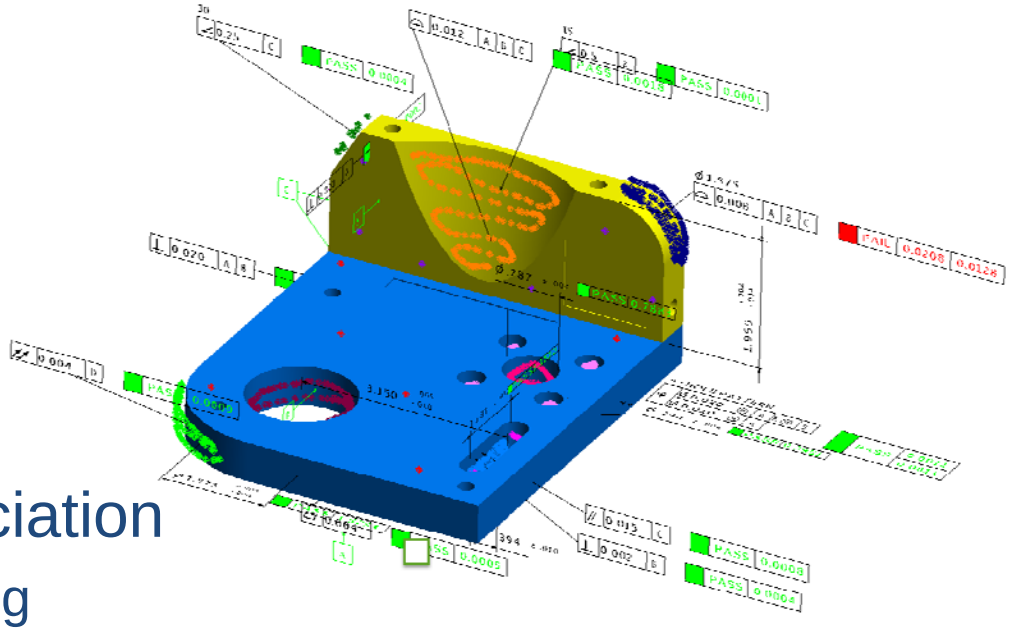
GD&T Inspection

GD&T Inspection can be Divided into 2 Distinct Steps

1. Defining the Checks

   Building Annotations

   - Tolerance Structure
   - Nominal designation

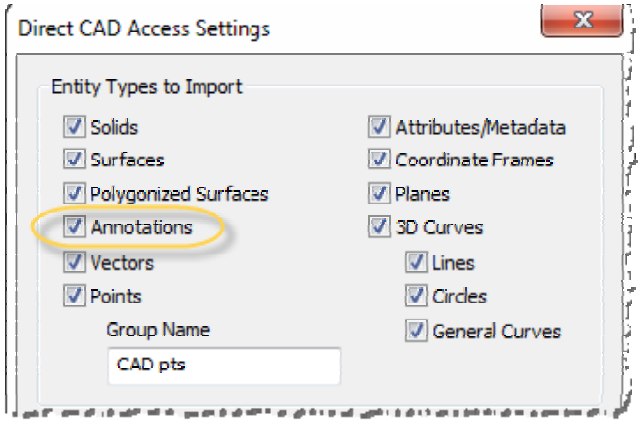


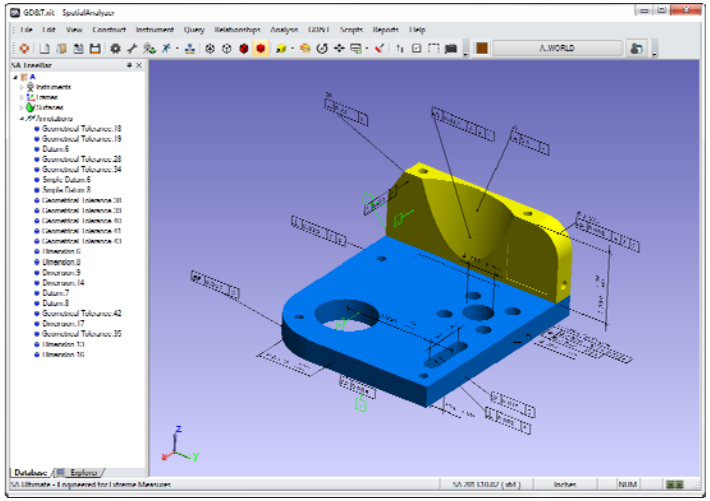
1. Measurement Process

   Data Gathering & Association

   - Inspection/ inspect scripting
   - Toolkit or direction Association
   - or Measurement Plan (MP)

GD&T and CAD Import





Manufacturer	Format	Version	Polygonized Surfaces	Surfaces	Annotations
Standard	PRC (.PRC)	All Versions	✓	✓	✓
	IGES (.IGS, .IGES)	5.1, 5.2, 5.3	✓	✓	N/A
	Industry Foundation Classes (.IFC, .IFCZIP)	IFC2x Editions 2, 3, & 4	✓	N/A	N/A
	STEP (.STP, .STEP)	AP 203 E1/E2, AP 214, AP 242	✓	✓	✓
	Stereo Lithography (.STL)	All Versions	✓	N/A	N/A
	VDA-FS (.VDA)	v1.0 & v2.0	✓	✓	N/A
	VRML (.WRL, .VRML)	v1.0, v2.0	✓	N/A	N/A
Adobe	Adobe 3D PDF (.PRC)	All Versions	✓	✓	✓
McNeel North America	Rhinoceros (.3DM)	v4, v5	✓	✓	N/A
DASSAULT SYSTEMES	CATIA V4 (.MODEL, .SESSION, .DLV, .EXP)	Up to 4.2.5	✓	✓	✓
	CATIA V5 (.CATDRAWING, .CATPRODUCT, .CATPART, .CATSHAPE, .CGR)	R4 to R21, V5-6R2014	✓	✓	✓
	CATIA V6 (.3DXML)	2011 to 2013	✓		✓
	SolidWorks (.SLDASM, .SLDPRT)	Up to 2014	✓	✓	
	ACIS (.SAT, .SAB)	Up to v23	✓	✓	N/A
SIEMENS	NX (.PRT)	Unigraphics v11.0 to NX 9.0	✓	✓	✓
	JT (.JT)	Up to 10.0	✓	✓	✓
	Parasolid (.X_T, .X_B, .XMT, .XMT_TXT)	Up to v26	✓	✓	N/A
	Solid Edge (.ASM, .PAR, .PWD, .PSM)	V19-20, ST-ST7	✓	✓	
	I-DEAS (.MF1, .ARC, .UNV, .PKG)	Up to 13.x (NX 5) & NX 6	✓	✓	✓
PTC	Pro/ENGINEER (.ASM, .NEU, .PRT, .XAS, .XPR)	Up to Wildfire 5	✓	✓	✓
	Creo Elements/Pro/Parametric (.ASM, .NEU, .PRT, .XAS, .XPR)	v5.0 (Pro) v3.0 (Parametric)	✓	✓	✓
Autodesk	Inventor (.IPT, .IAM)	Up to 2015	✓	✓	N/A

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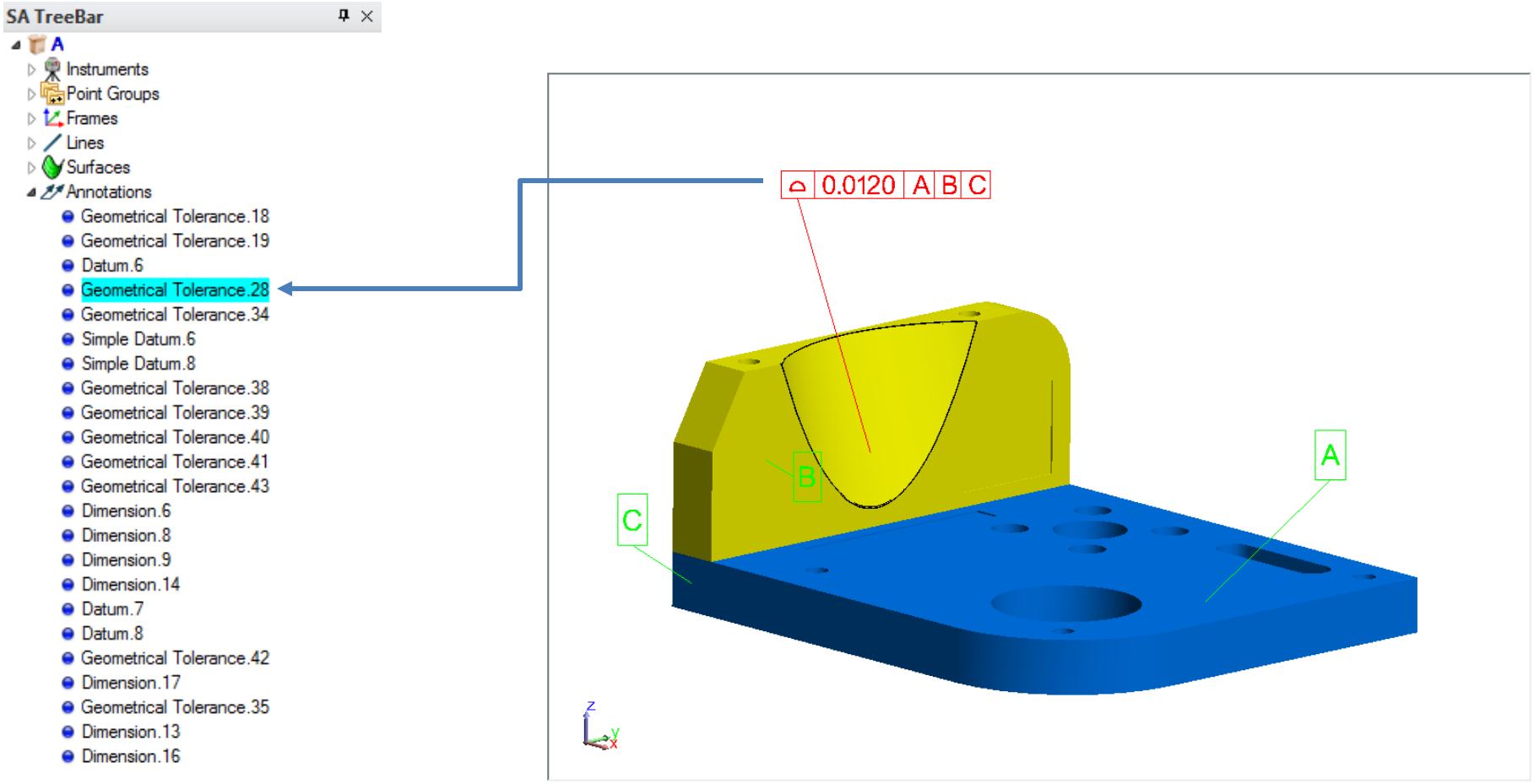
GD&T Annotations



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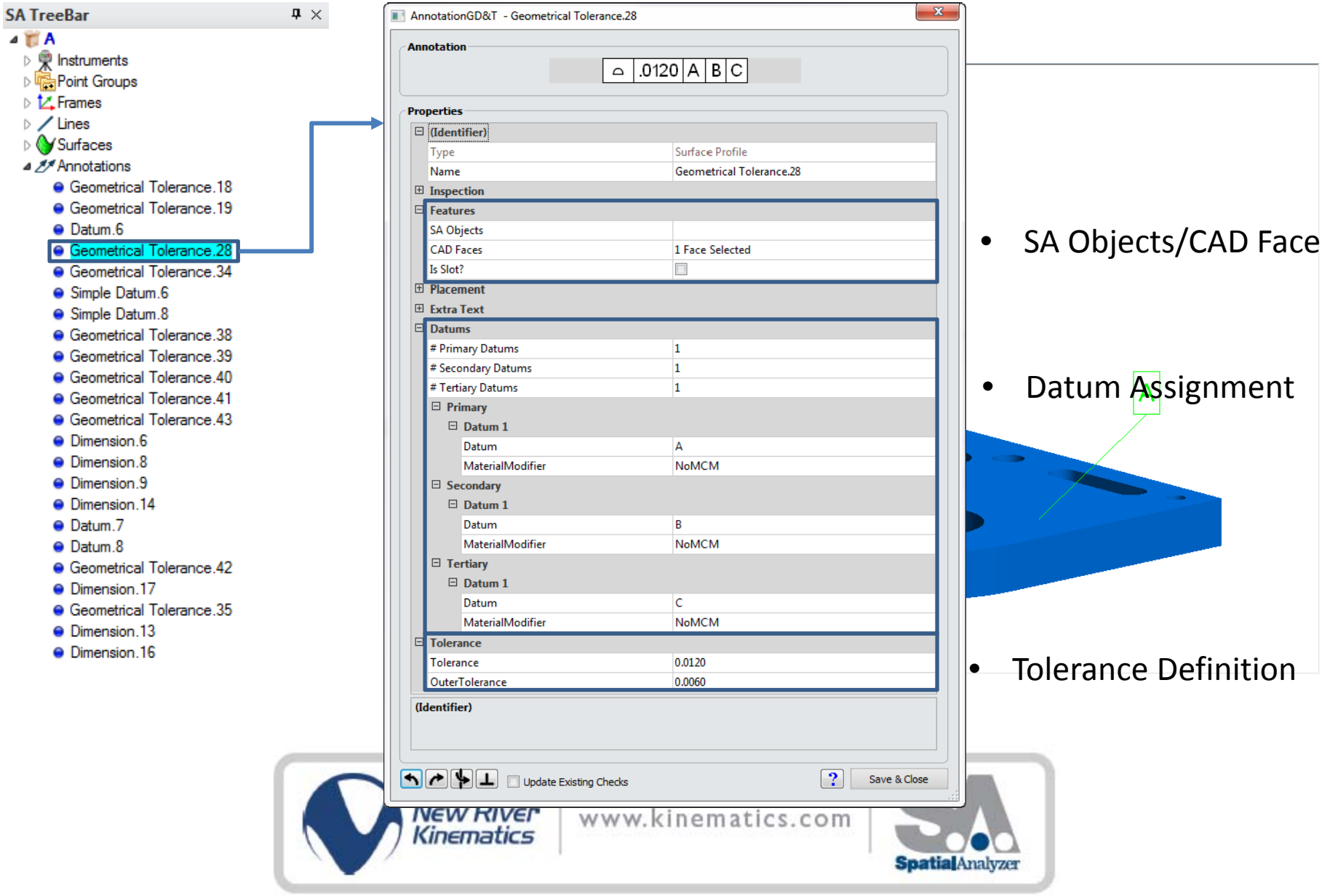
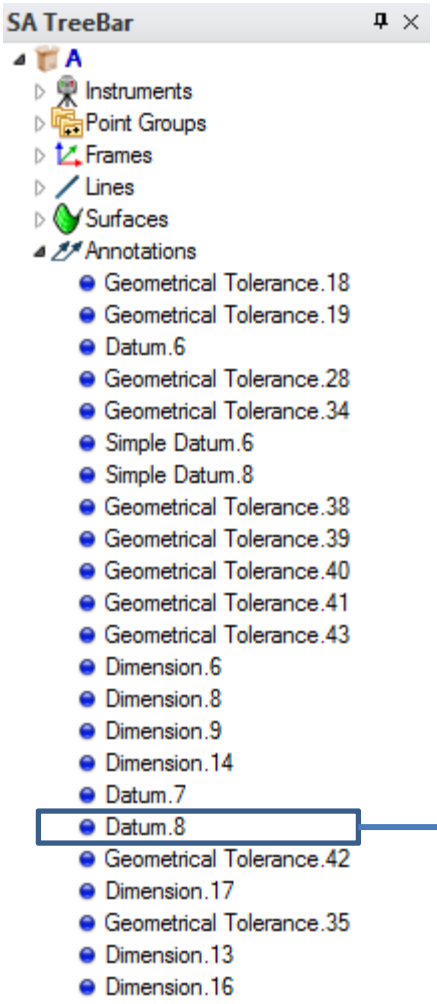
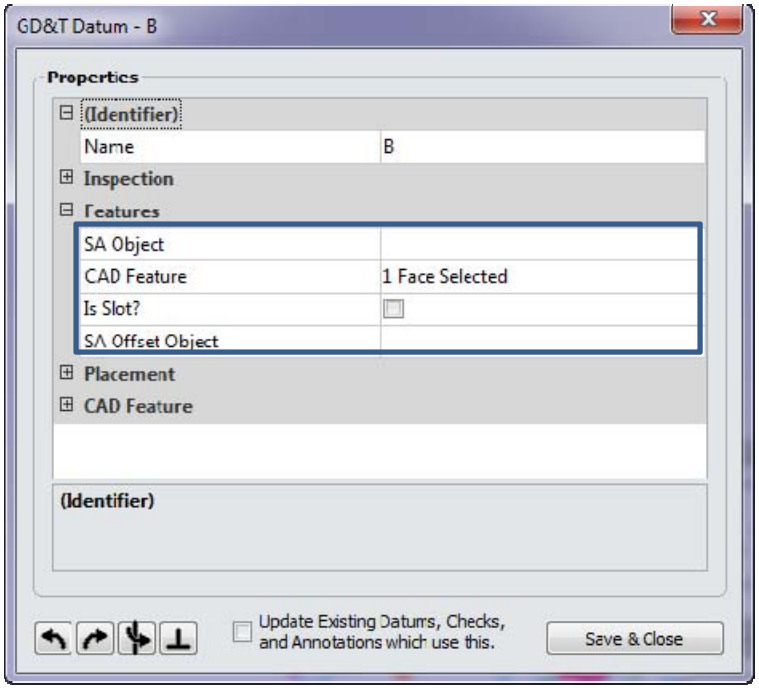
GD&T Annotations



GD&T Annotations



Datum Annotations:



- SA Objects/CAD Face

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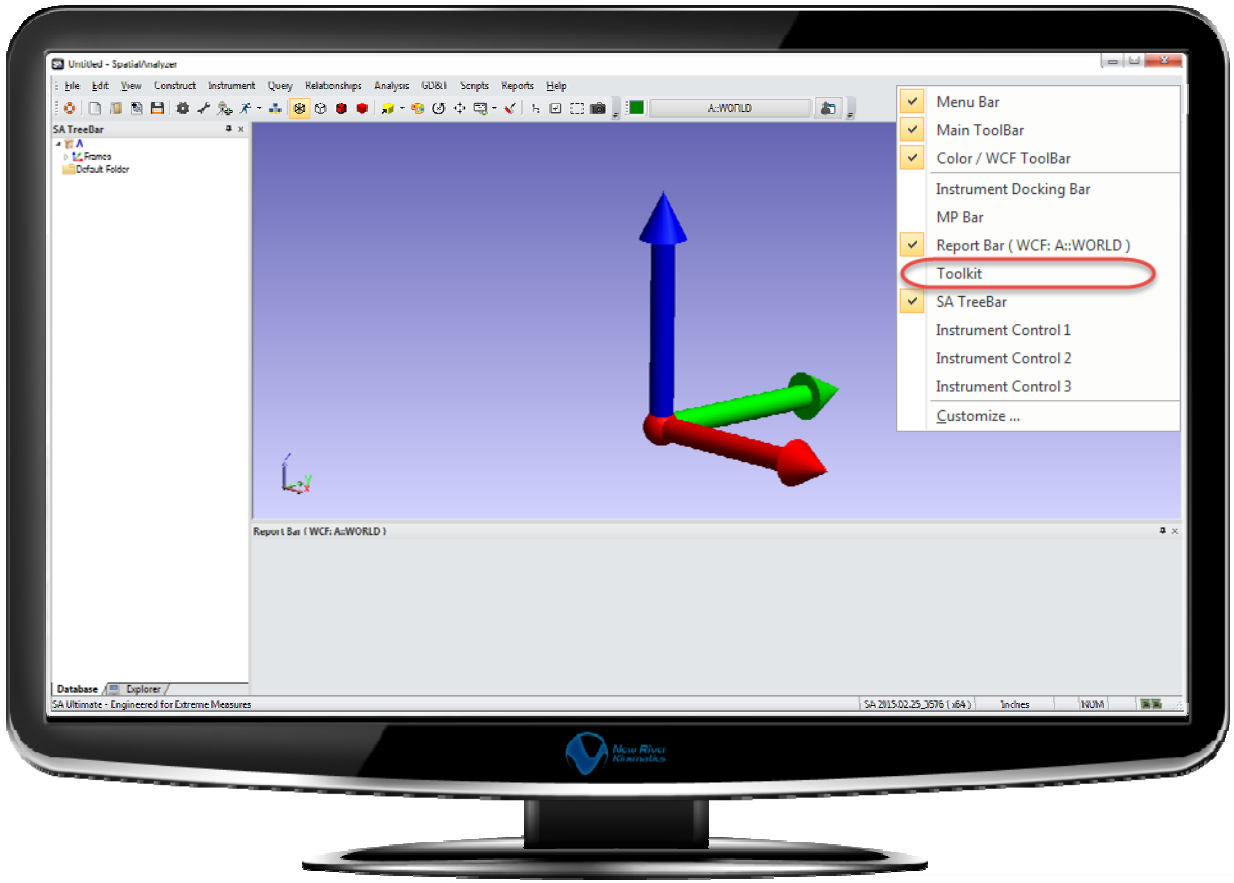
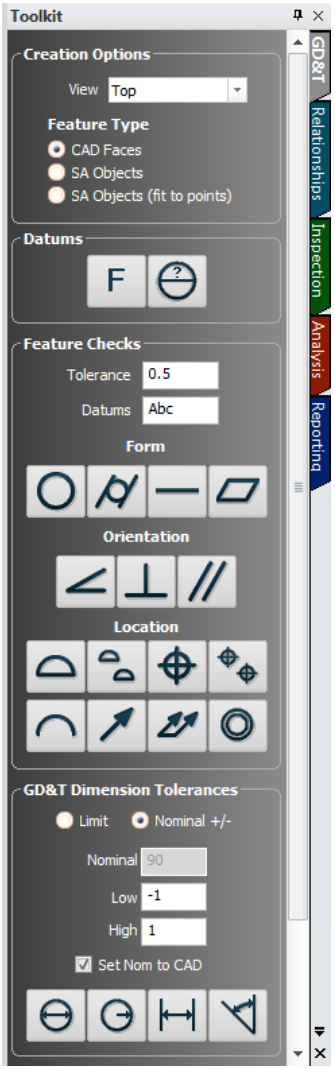
Building Annotations





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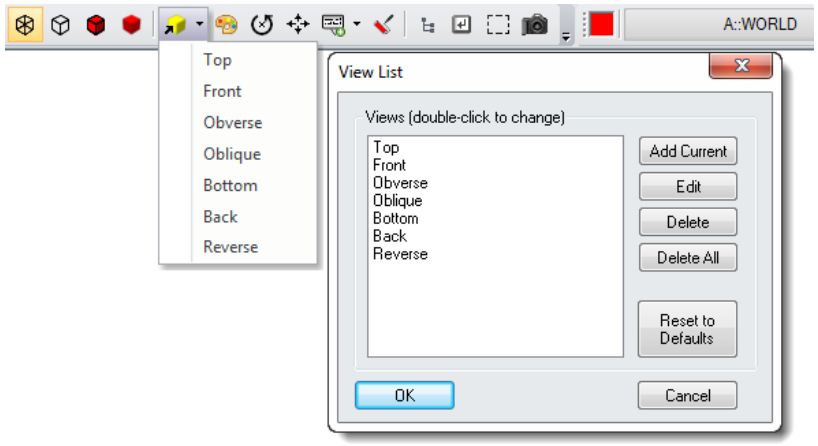
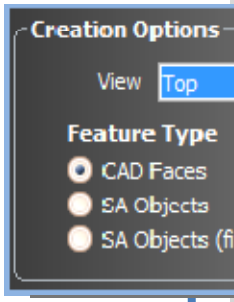
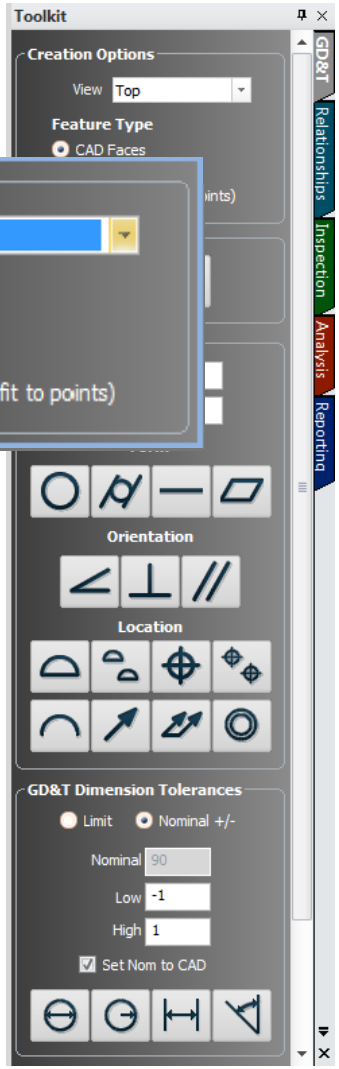
GD&T Annotations

- Annotation View Orientation:

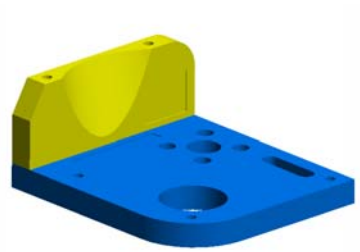


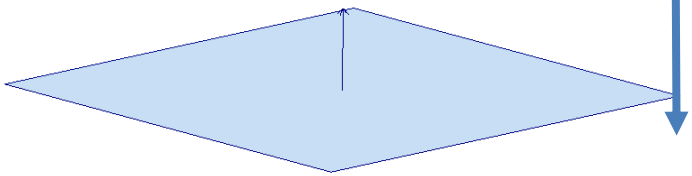




- CAD Faces vs. SA Objects

  SA Objects (Fit to Points)





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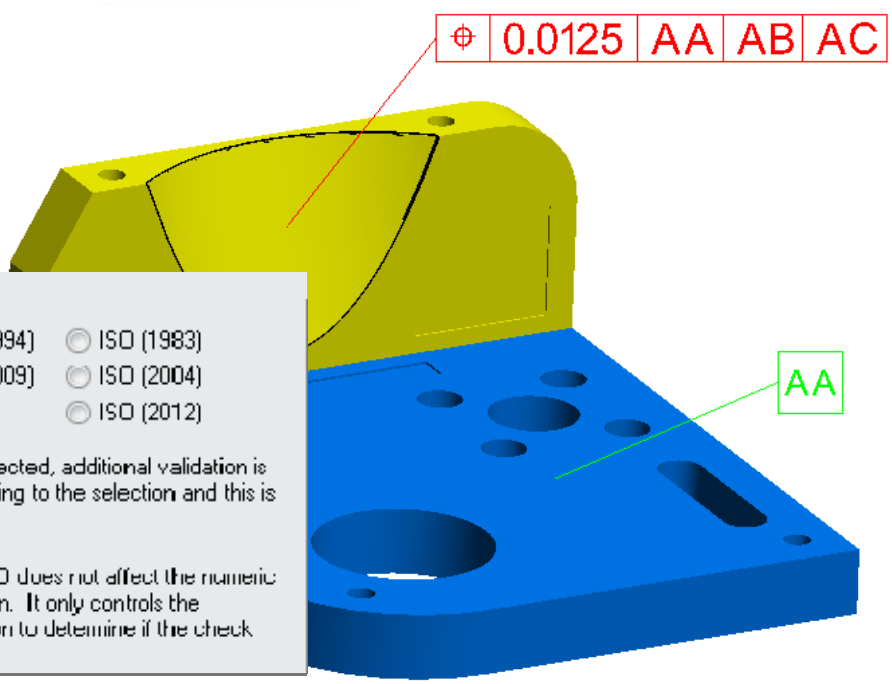
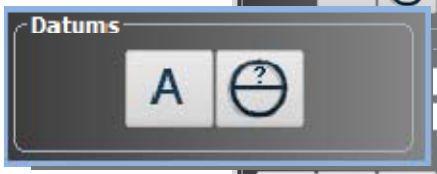
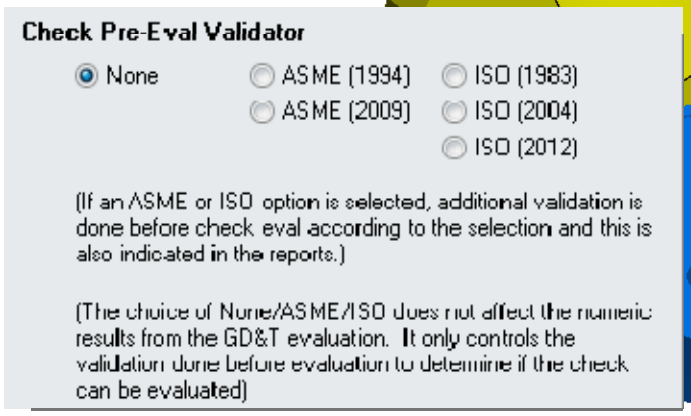
GD&T Annotations

Datum and Datum Target Designations

- (Hold down A-Z to pick a letter)
- Click-point defines leader line anchor point







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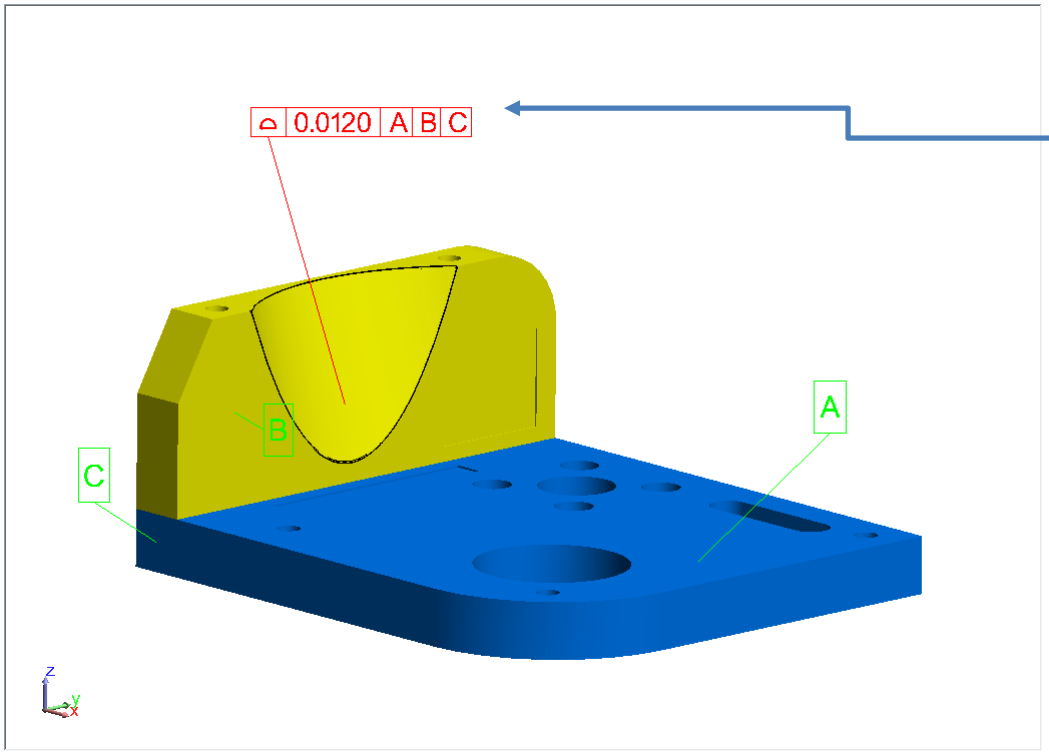
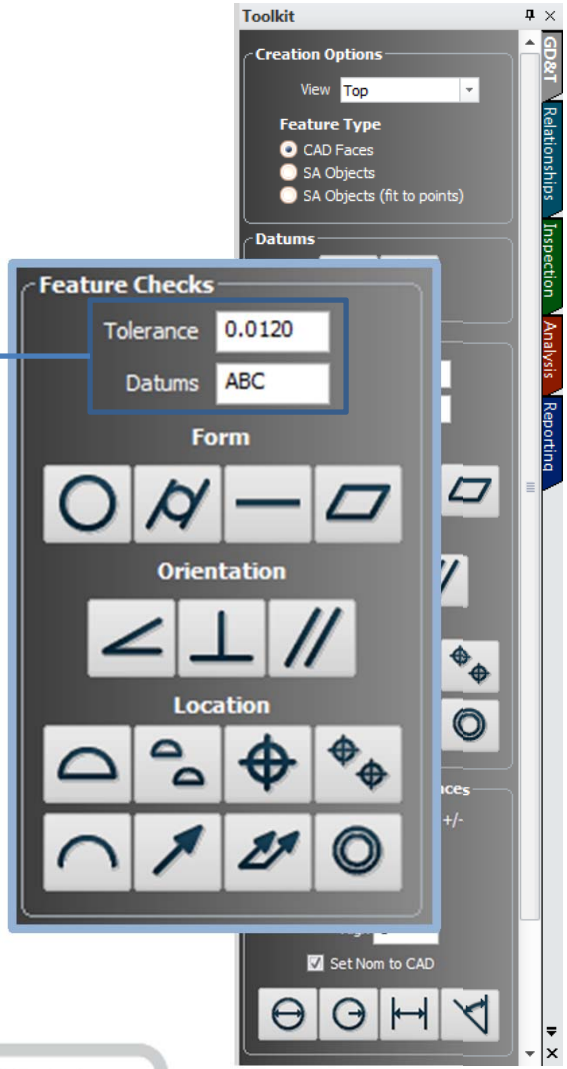
GD&T Annotations

Feature Checks Designation:





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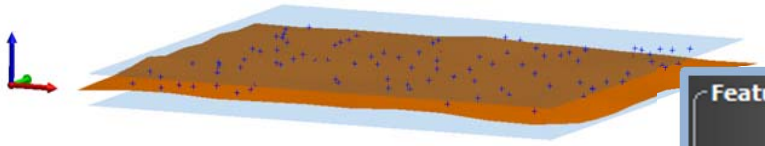
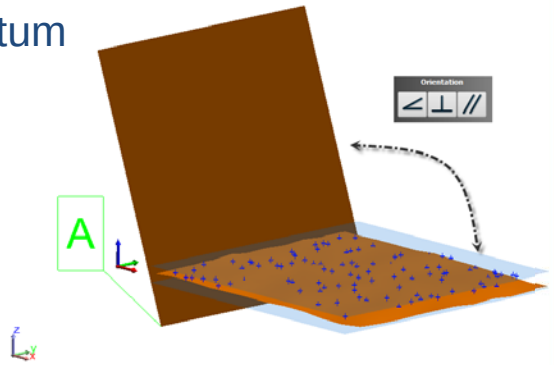
GD&T Annotations

Feature Checks Designation:

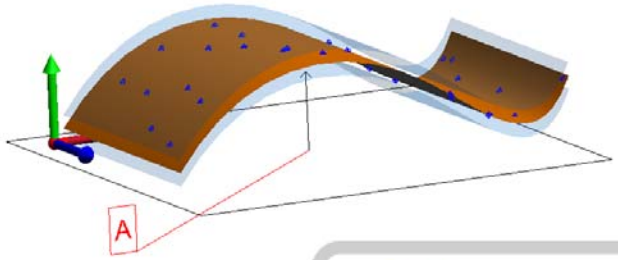
- Form Checks
  - Datum Independent



  - Orientation Checks
    - Depend on 1 Datum

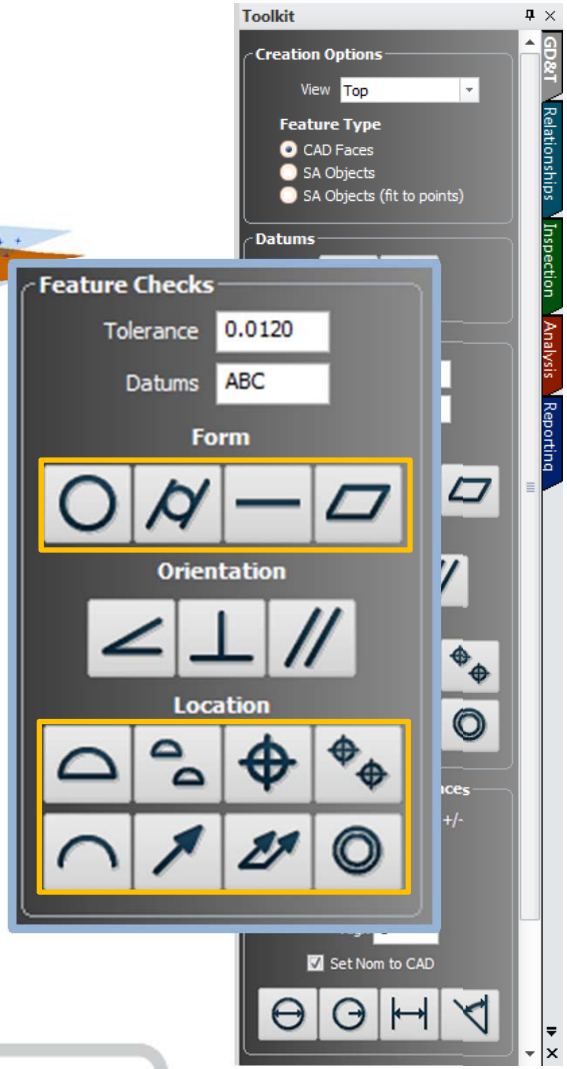


- Location Checks
  - Can Include 1-3 Datums
  - Can Include 1-2 Tiers



4 - HOLE PATTERN

⌖	⌀0.0200Ⓜ	A	E Ⓜ	B
	⌀0.0100Ⓜ	A		



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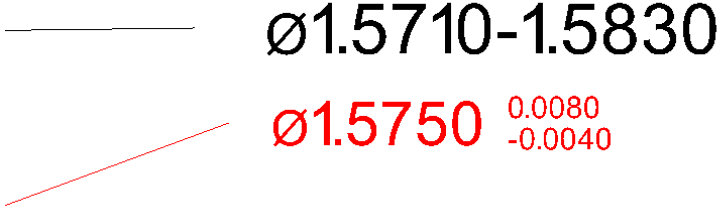
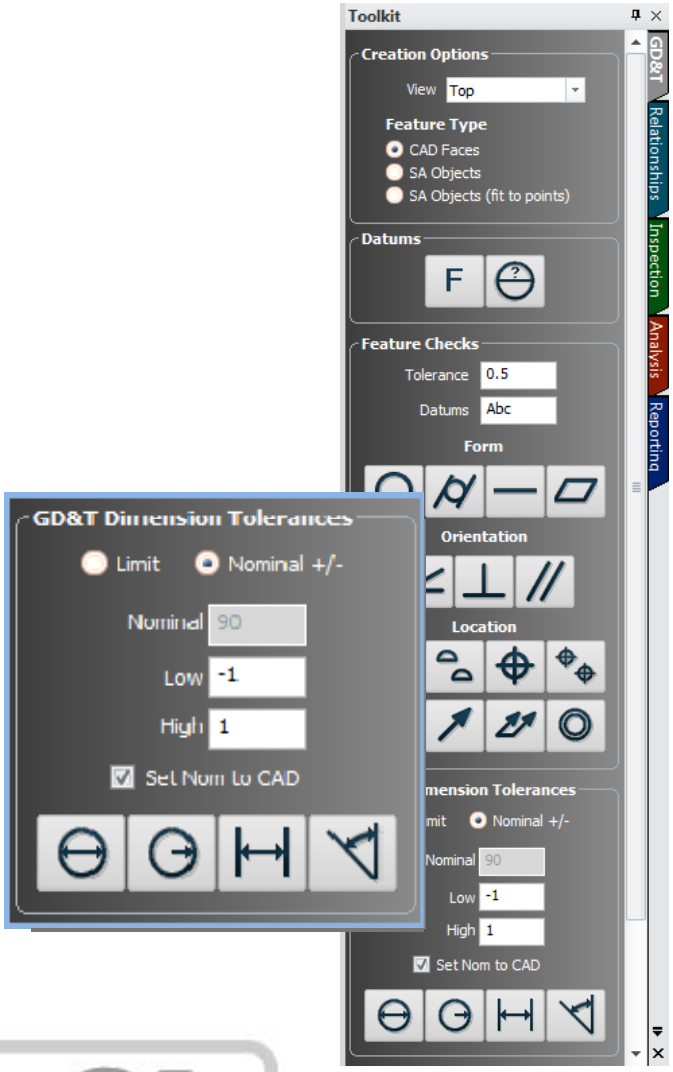
GD&T Annotations

- Dimensional Tolerances
  - Datum Independent



- Required for Material Modifiers
  - MMC, LMC



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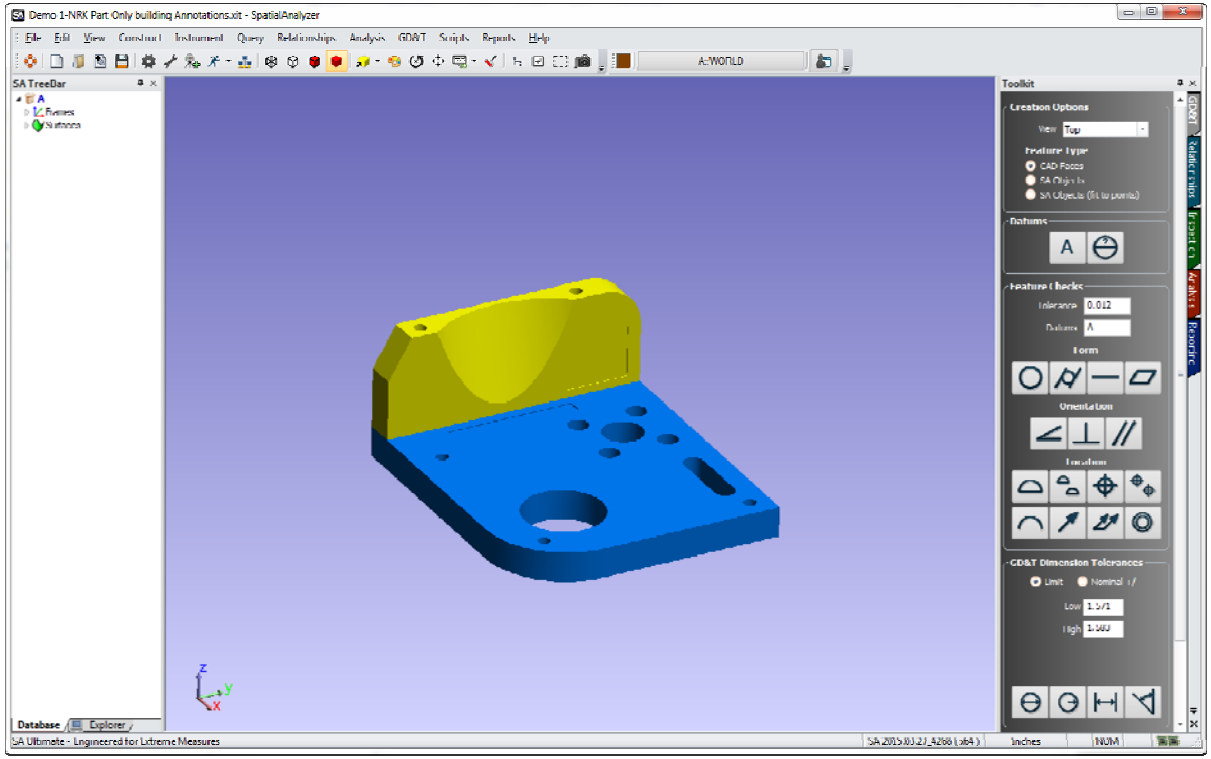
Building Annotations Demo



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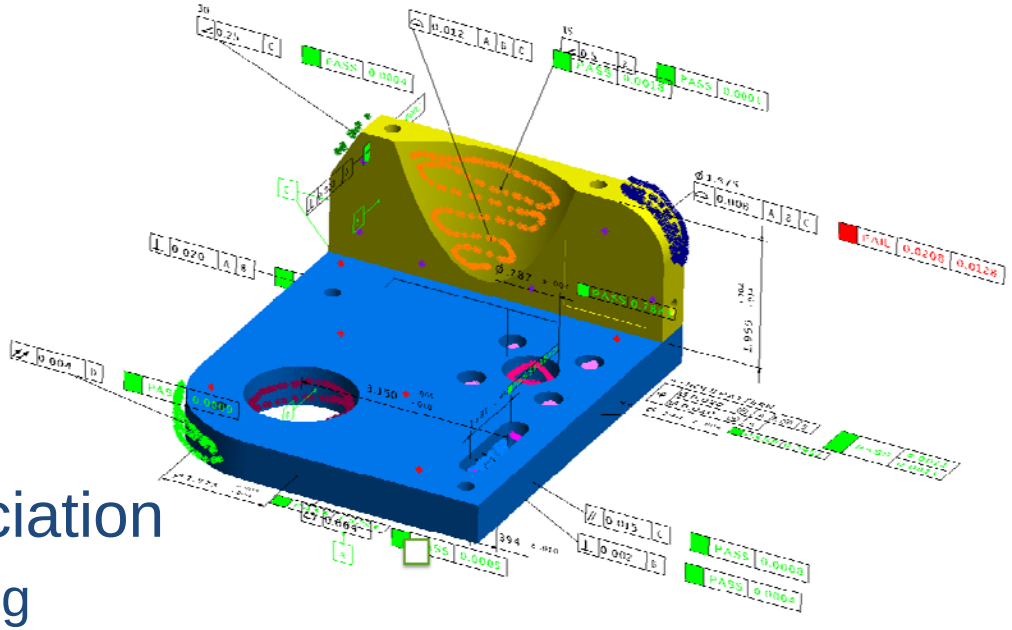
GD&T Inspection

GD&T Inspection can be Divided into 2 Distinct Steps

1. Defining the Checks
   - Building Annotations
     - Tolerance Structure
     - Nominal designation



1. Measurement Process
   - Data Gathering & Association
     - Inspection/ inspect scripting
     - Toolkit or direction Association
     - or Measurement Plan (MP)

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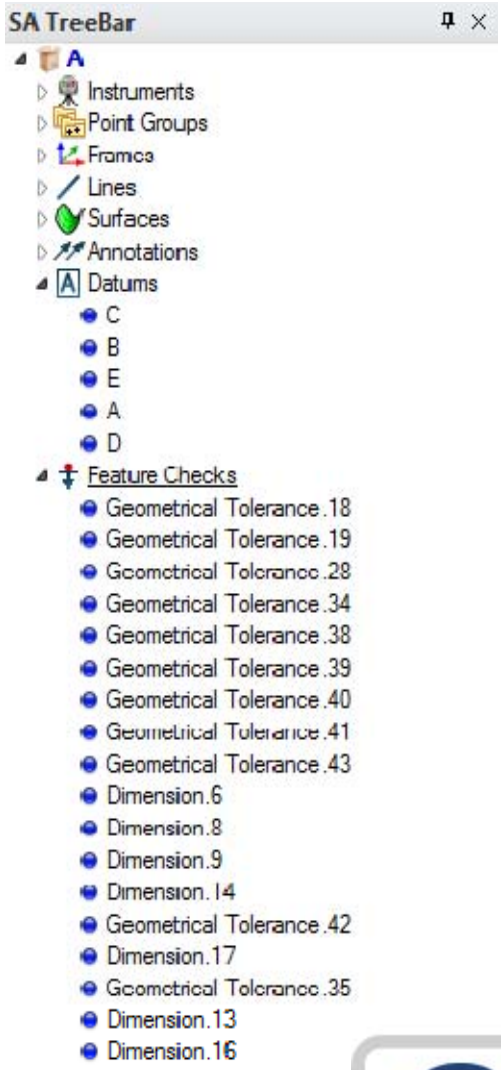
Building Feature Checks

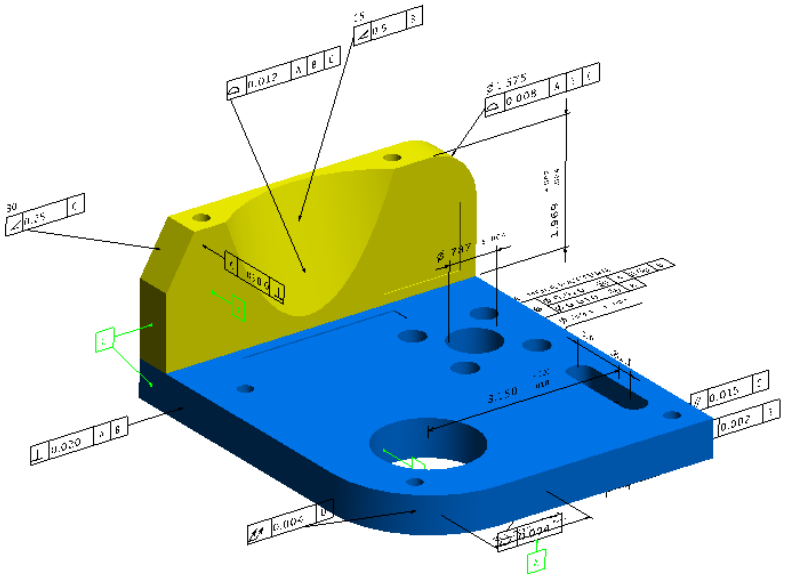


- Tree Structure
  - Annotations
    - Tolerance & check definition
  - Datums & Feature Checks
    1. Link points to annotations
    2. Point offset & evaluation control
    3. Contain guided inspection controls

Building Feature Checks

SA TreeBar

- A
  - Instruments
  - Point Groups
  - Frames
  - Lines
  - Surfaces
  - Annotations
  - Datums
    - C (4 meas)
    - B (6 meas)
    - E (74 meas)
    - A (6 meas)
    - D (131 meas)
  - Feature Checks
    - Geometrical Tolerance.18 (11 meas)
    - Geometrical Tolerance.19 (153 meas)
    - Geometrical Tolerance.28 (153 meas)
    - Geometrical Tolerance.34 (123 meas)
    - Geometrical Tolerance.38 (6 meas)
    - Geometrical Tolerance.39 (60 meas)
    - Geometrical Tolerance.40 (78 meas)
    - Geometrical Tolerance.41 (60 meas)
    - Geometrical Tolerance.43 (4 meas)
    - Dimension.6 (74 meas)
    - Dimension.8 (60 meas)
    - Dimension.9 (6 meas)
    - Dimension.14 (131 meas)
    - Geometrical Tolerance.42 (6 meas) (PASS)
    - Dimension.17 (11 meas)
    - Geometrical Tolerance.35 (188 meas)
    - Dimension.13 (131 meas)
    - Dimension.16 (188 meas)



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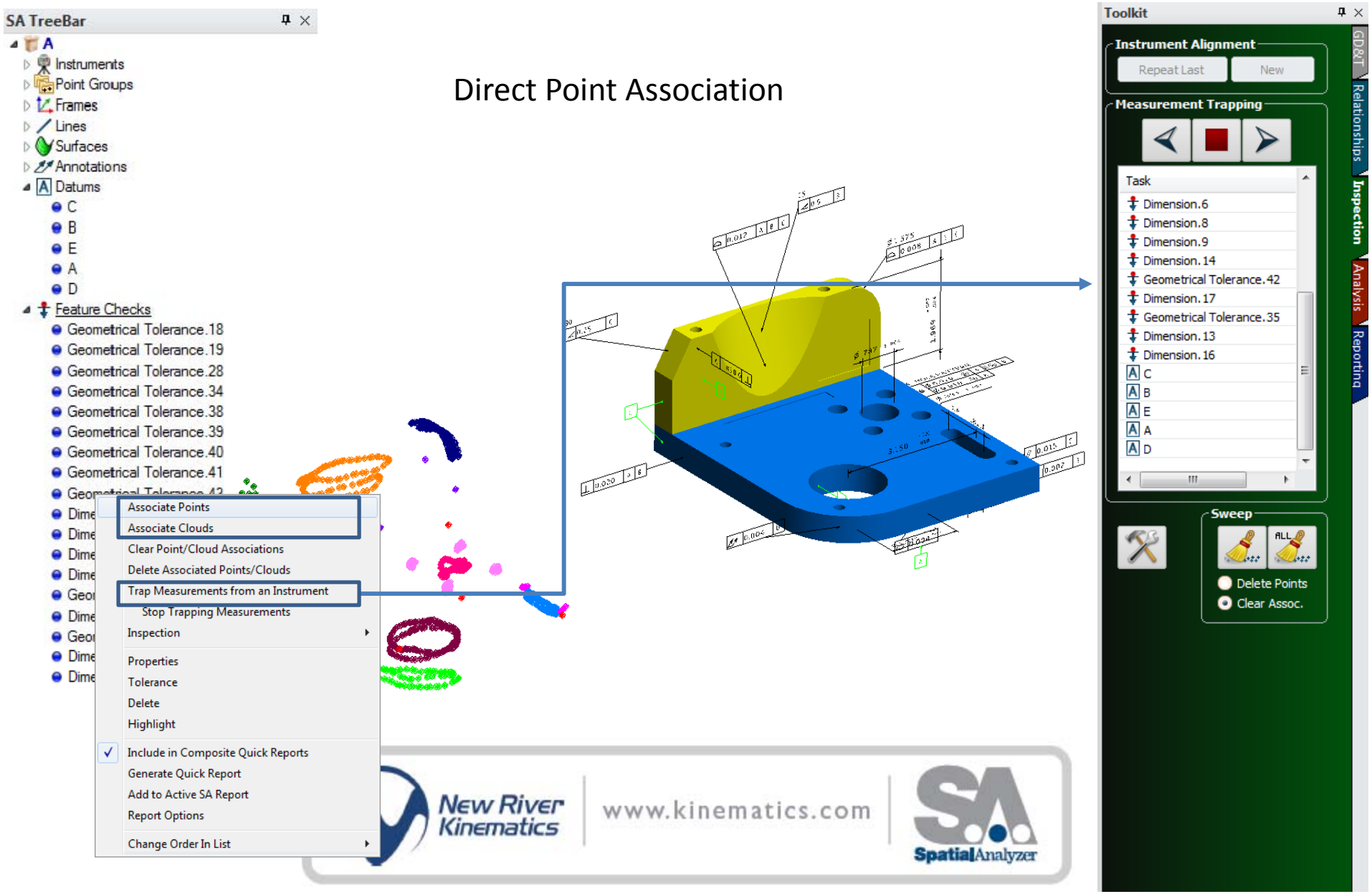
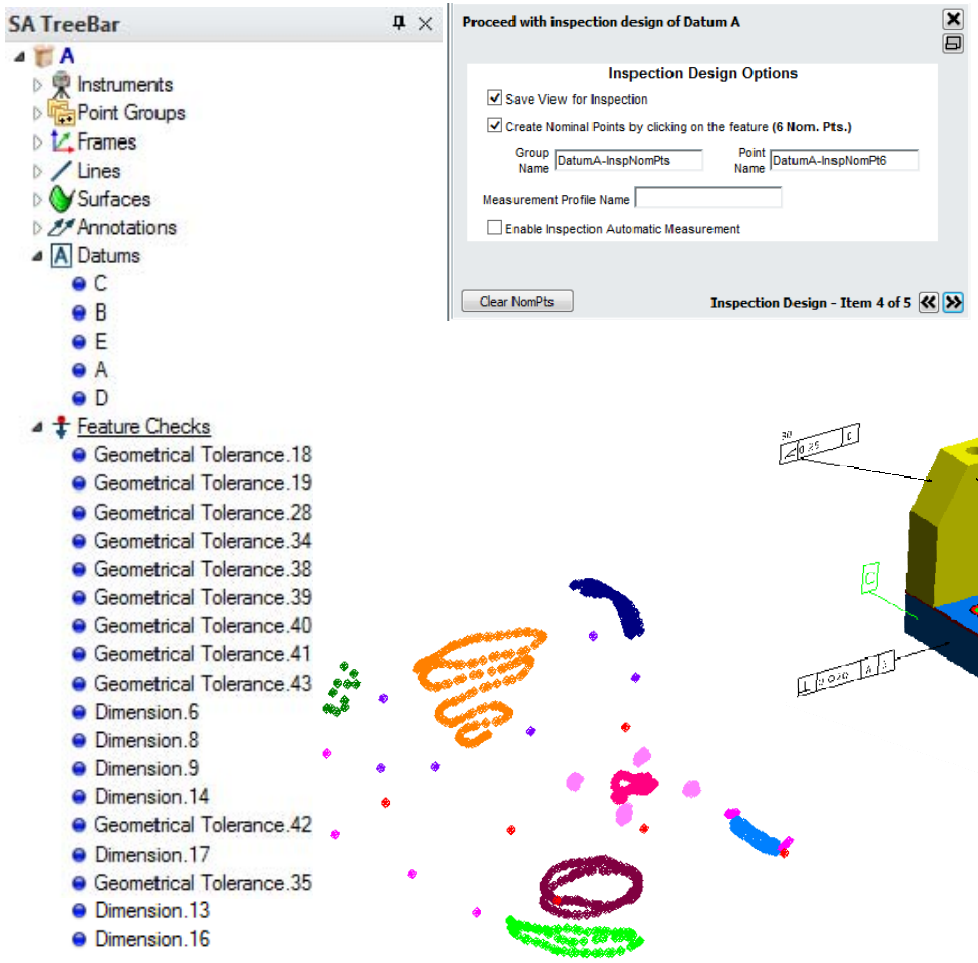
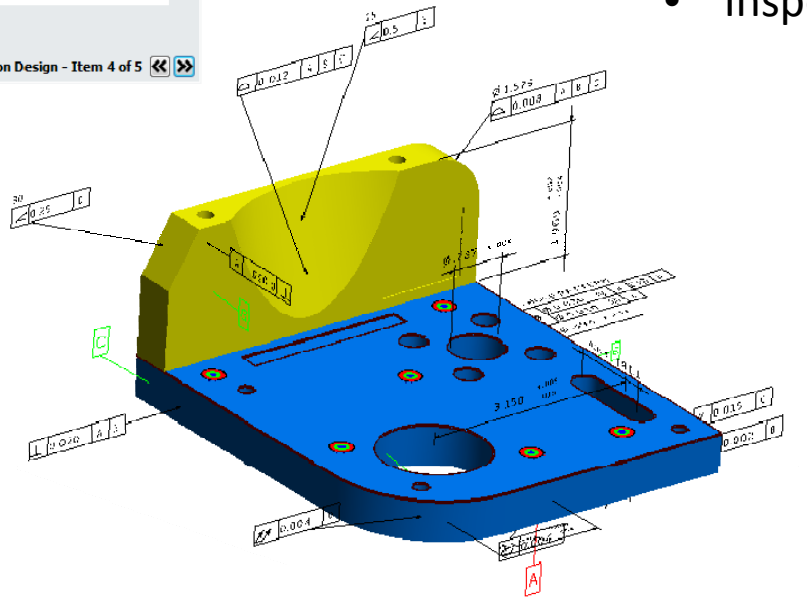
GD&T Inspection



GD&T Inspection





Guided Inspection

- Design
- Rehearse
- Inspect

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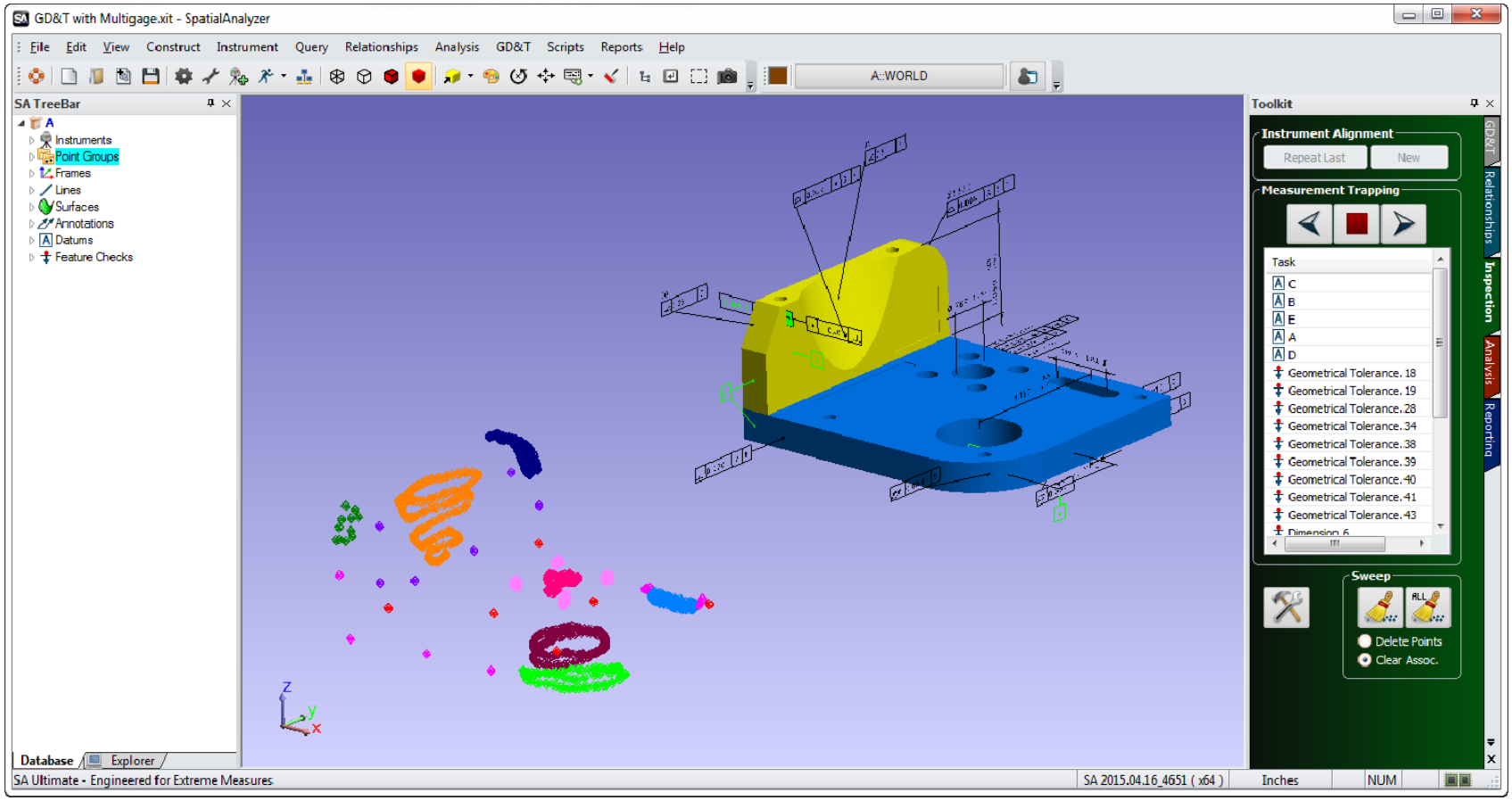
Demo- Basic Fit & Link



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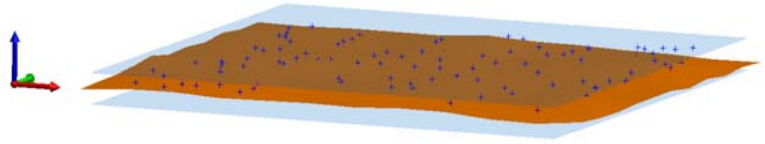
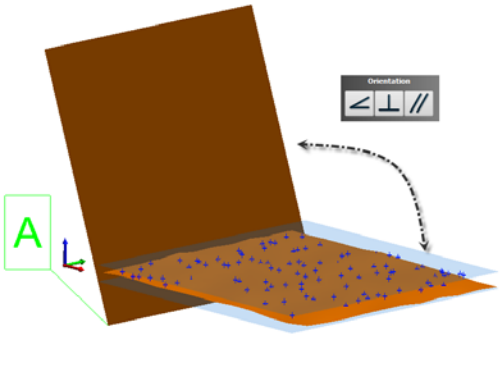
Check Details

Feature Checks come in 3 Categories:

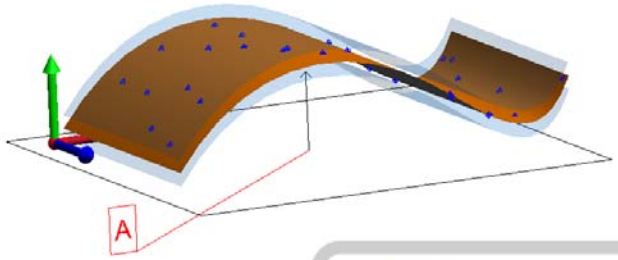
- Form Checks

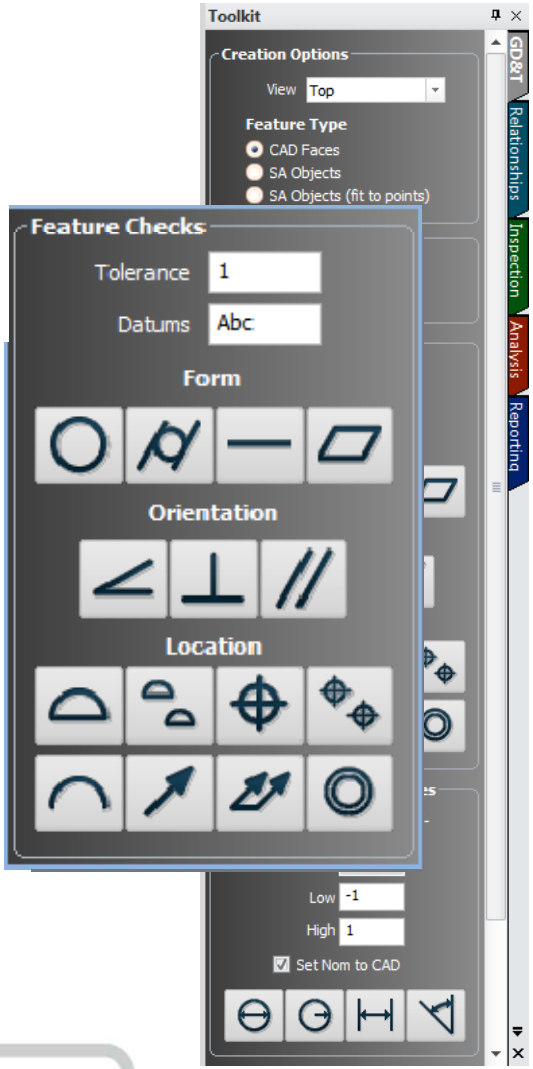


- Orientation Checks



- Location Checks





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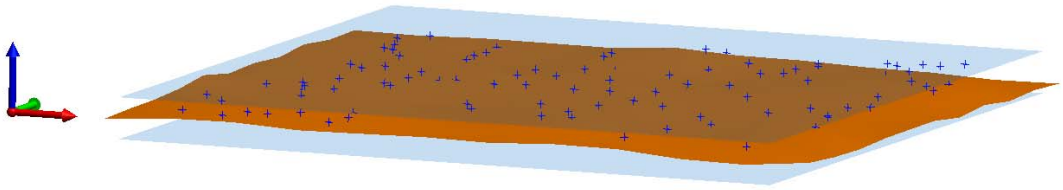
Flatness

Flatness Evaluation Process within SA:

1. Two parallel planes are built bounding the extents of the data.
2. These planes are allowed to freely rotate to establish the minimum distance between them while still containing the data.



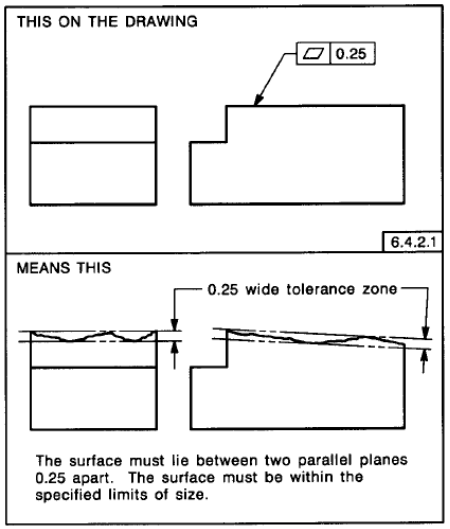
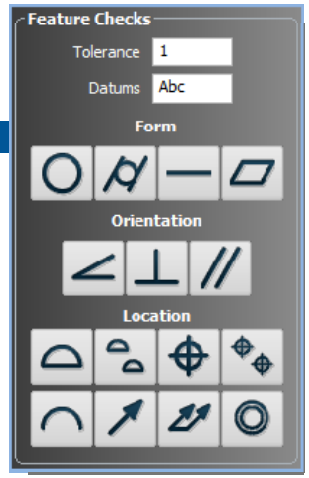
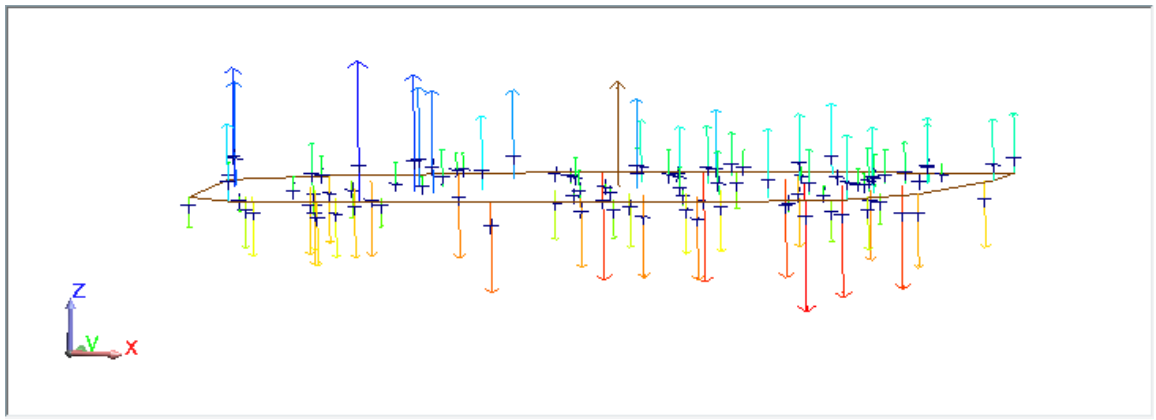


FIG. 6-7 SPECIFYING FLATNESS

Flatness



Standard Inspection (RMS):



Flatness

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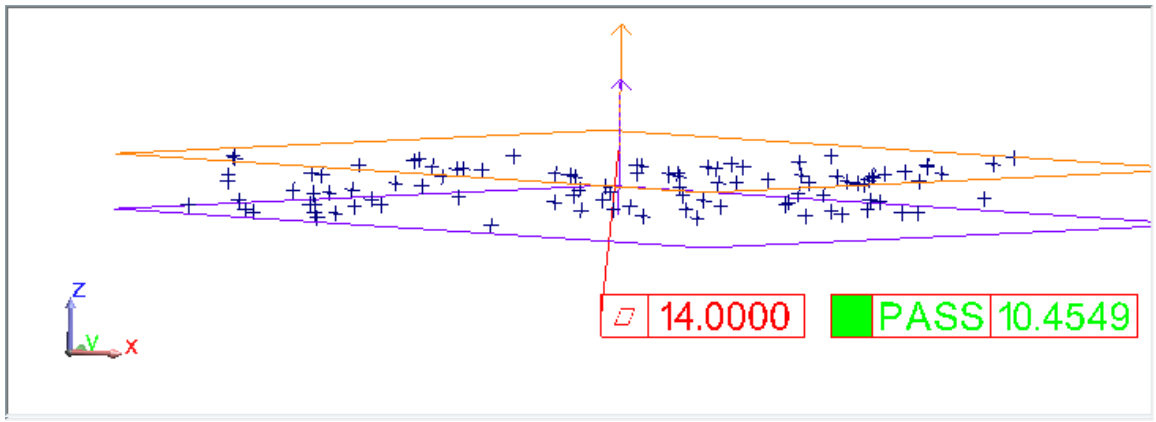
2. These planes are allowed to freely rotate to establish the minimum distance between them while still containing the data.



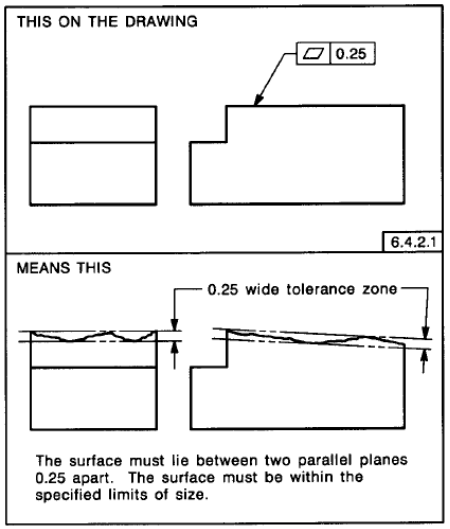


FIG. 6-7 SPECIFYING FLATNESS

Cylindricty

Cylindricity Evaluation Process within SA:

1. Two coaxial cylinders are built bounding the extents of the data.
2. The cylinders are allowed to freely rotate to establish the minimum distance between them while still containing the data.

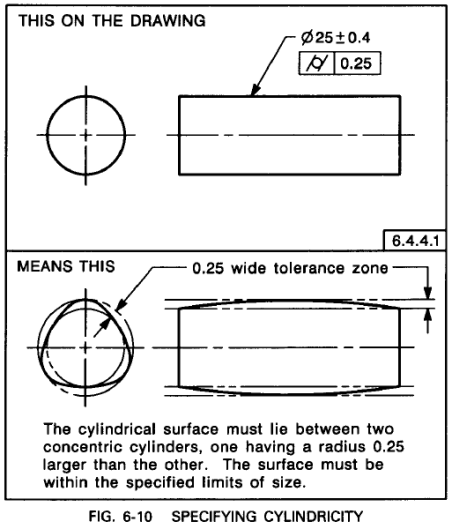
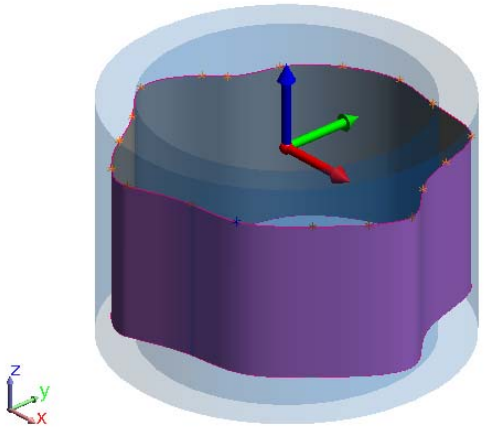
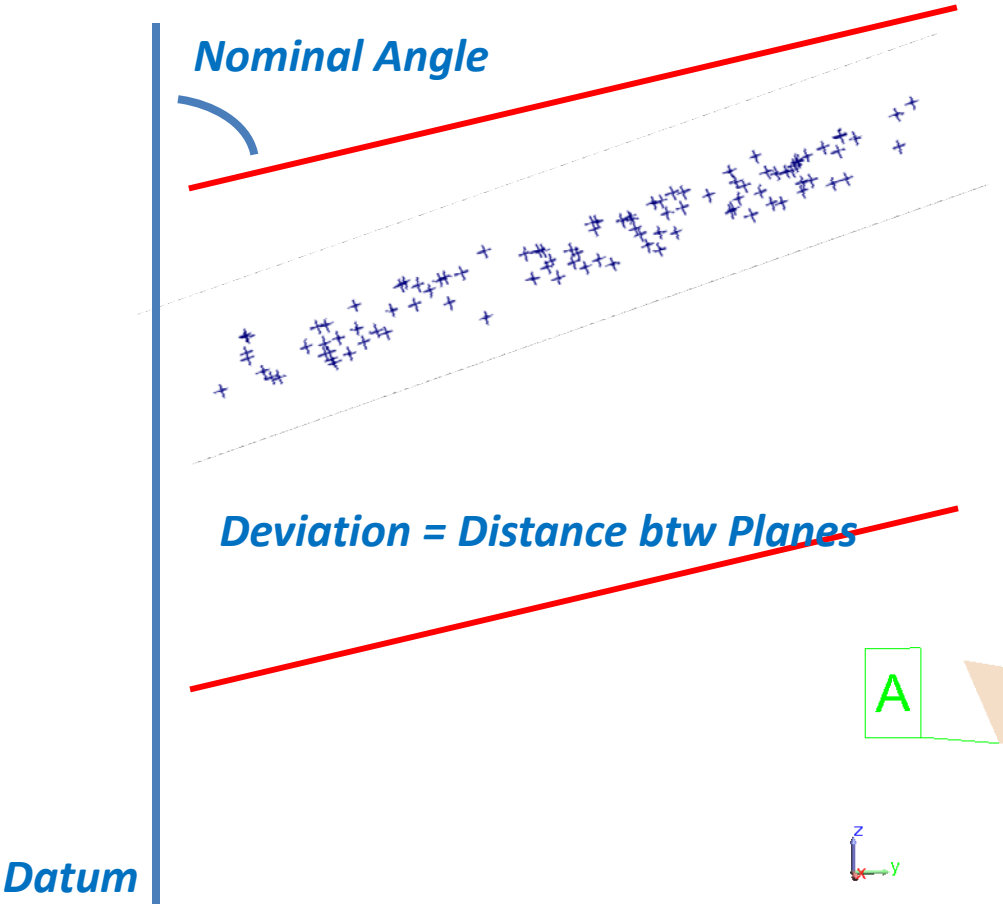
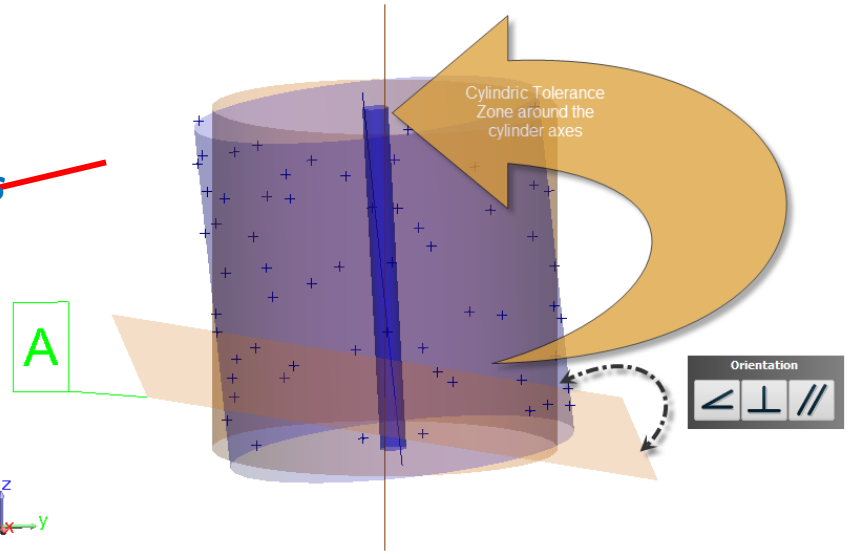


FIG. 6-10 SPECIFYING CYLINDRICITY



Orientation Checks

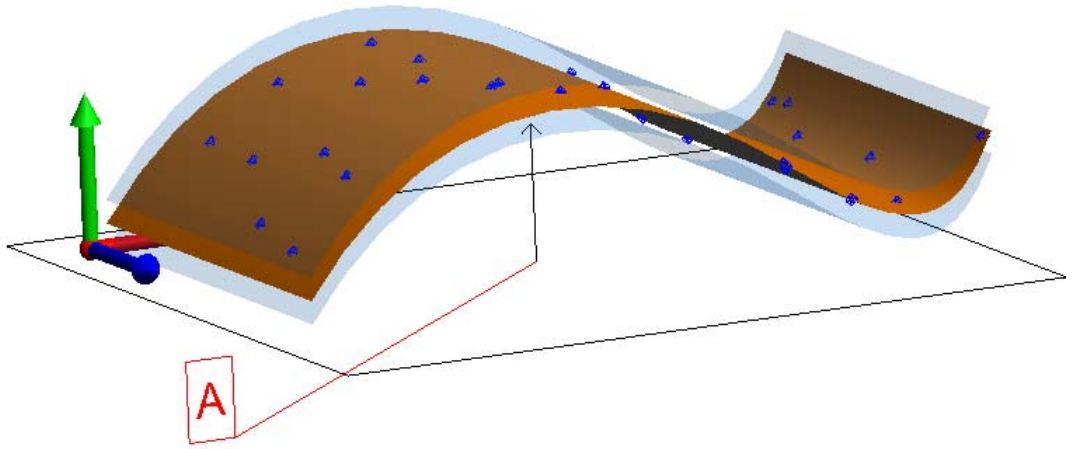




Surface Profile

Surface Profile Evaluation Process within SA:

1. An inner and outer tolerance boundary is established
2. The profile is allowed to rotate based on the datum constraints to minimize the deviations
3. The extent of the max and min deviation is used to establish the measured profile deviation



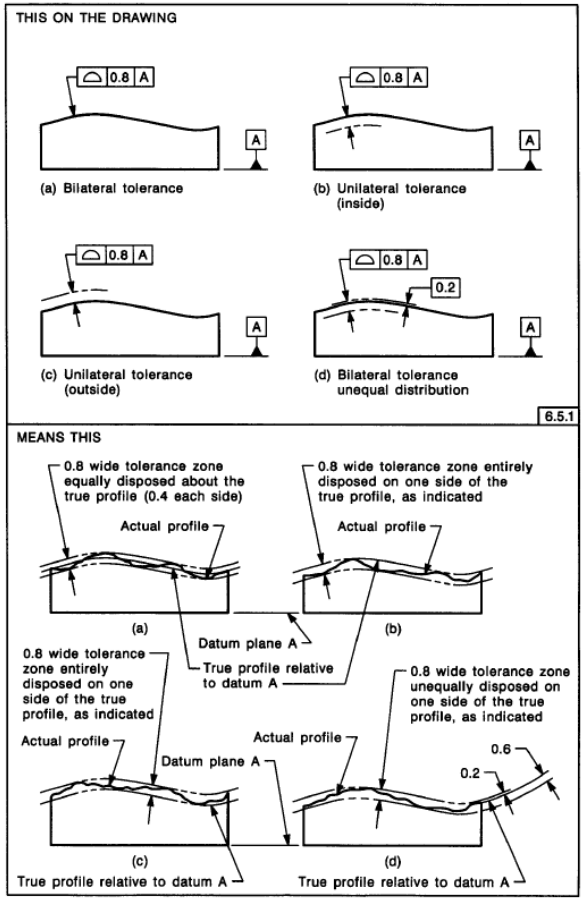
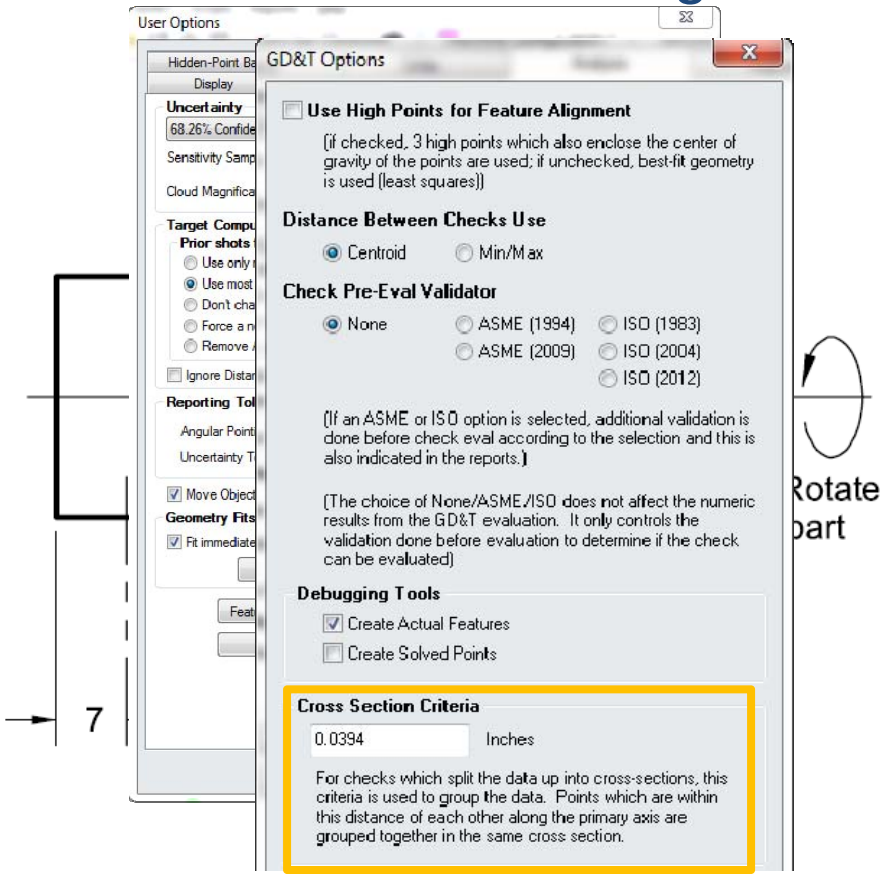


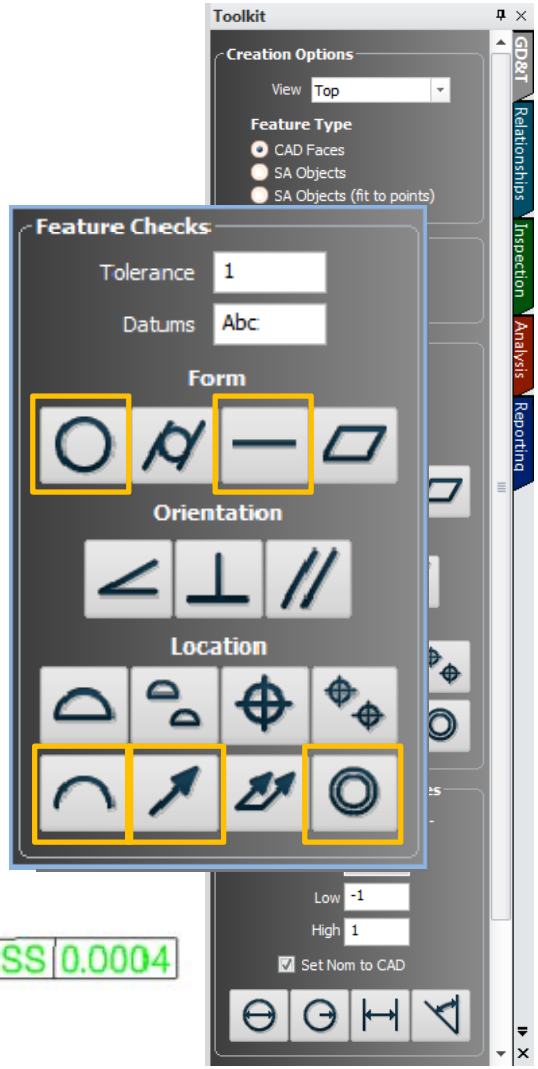
FIG. 6-11 APPLICATION OF PROFILE OF A SURFACE TOLERANCE TO A BASIC CONTOUR

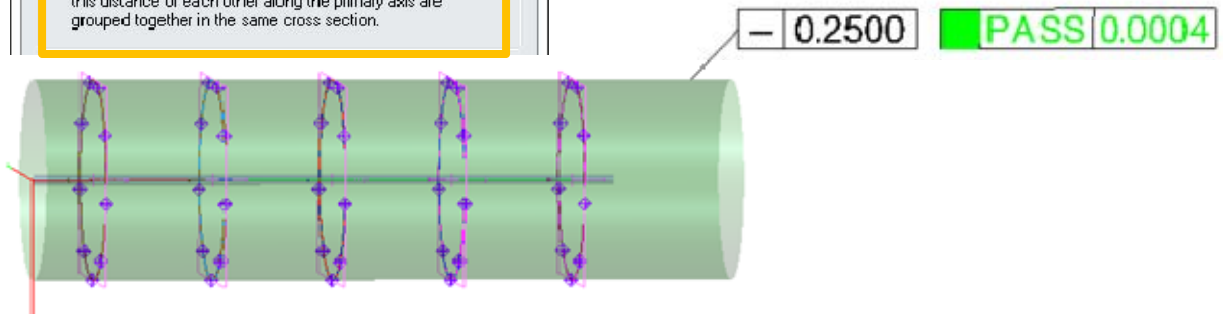
GD&T Annotations

Feature Checks Categories:



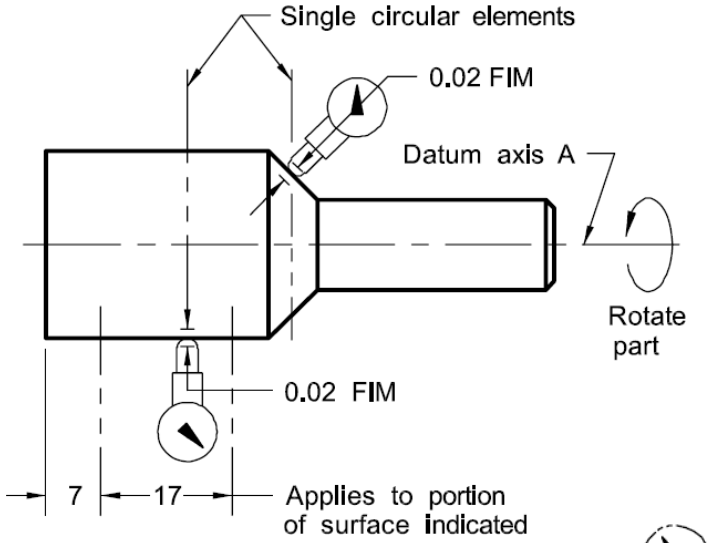
Cross Section Checks



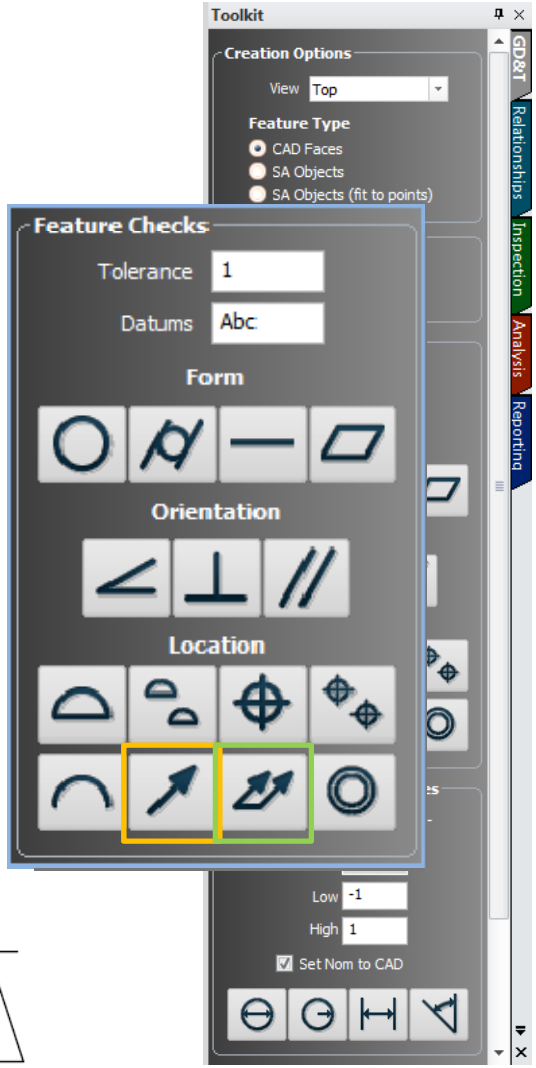


GD&T Annotations

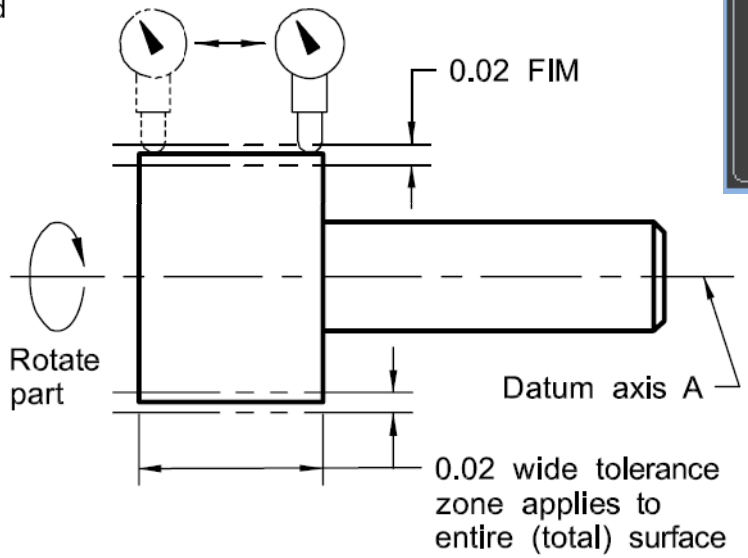
Cross Section Checks:



Runout
Cross Section Check

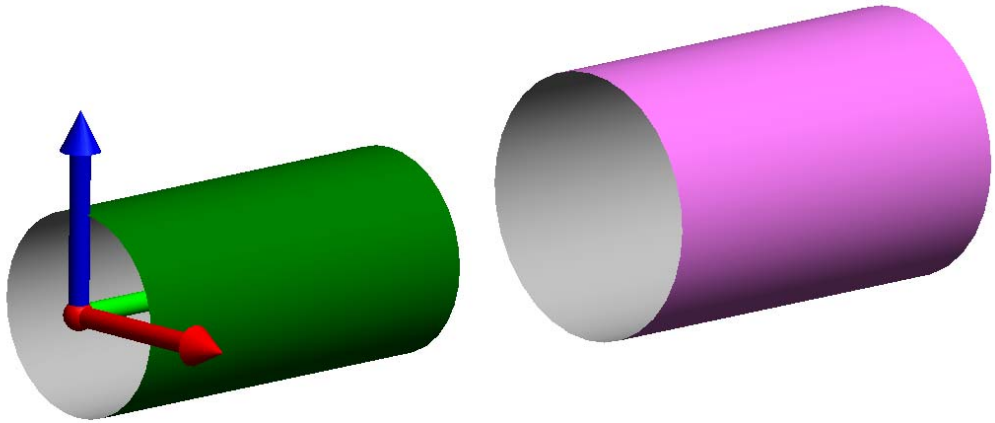


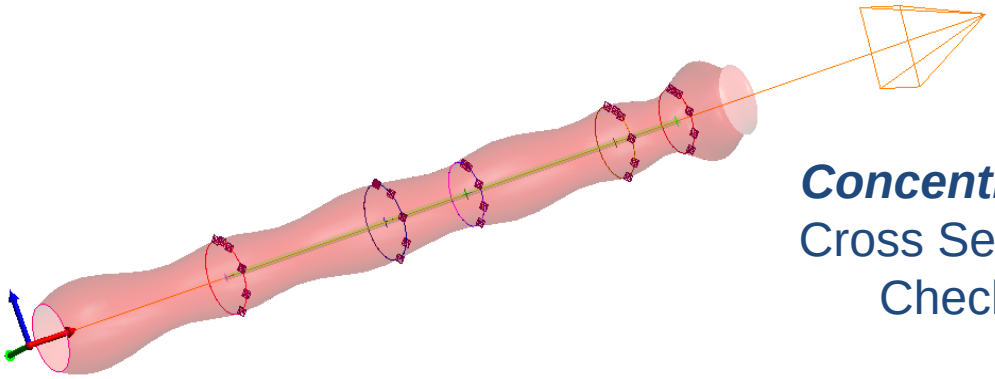
Total Runout
Surface Check



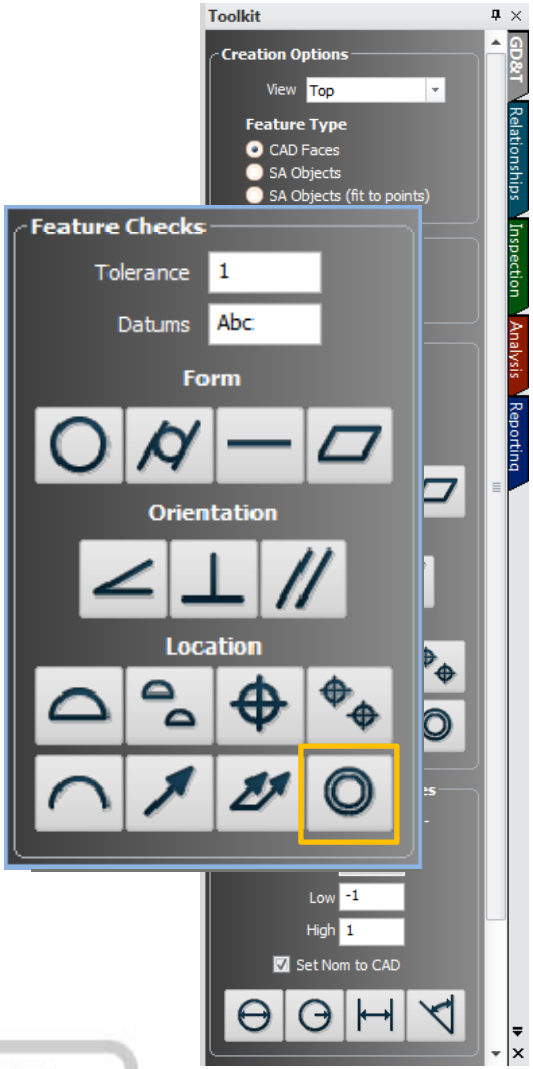
Concentricity

Cross Section Checks:





Concentricity
Cross Section
Check



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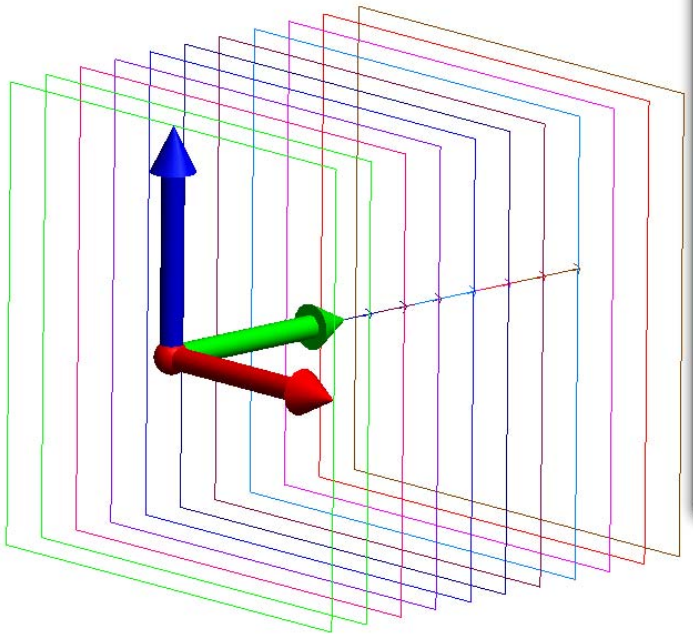
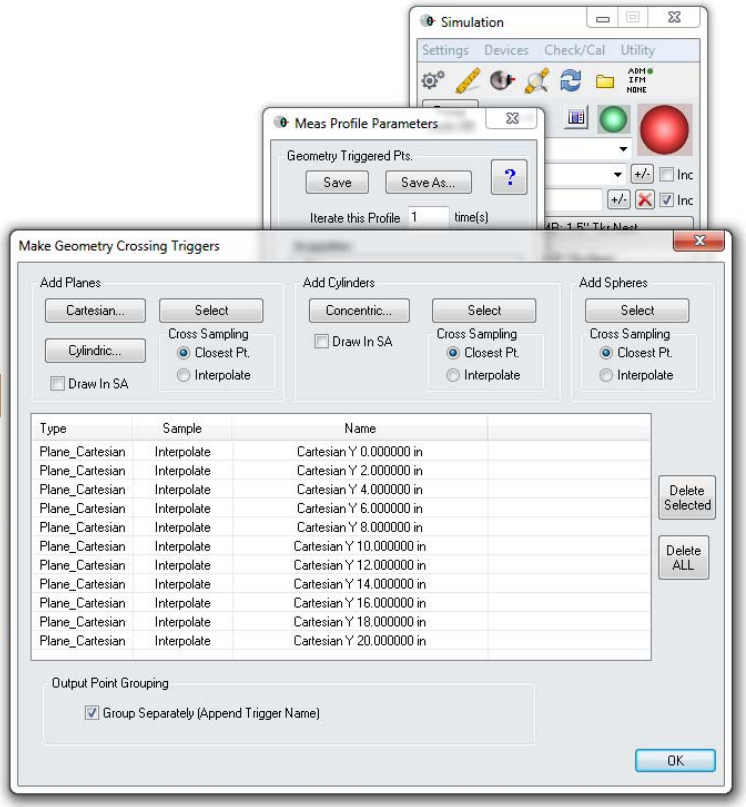
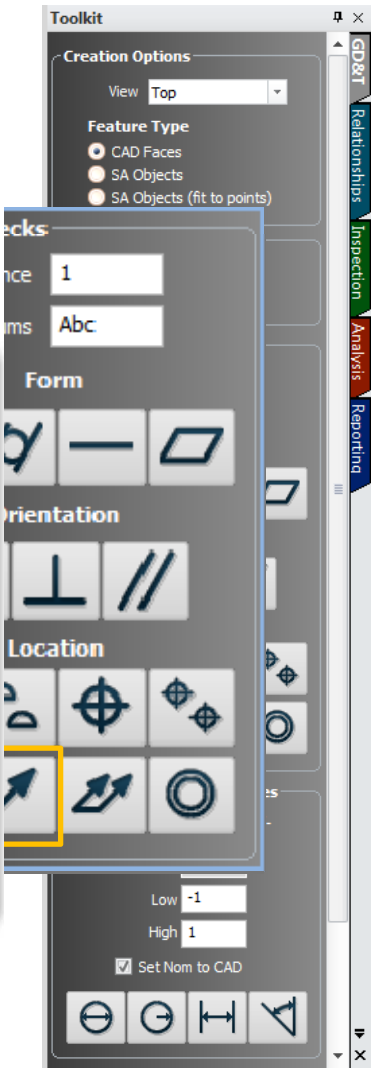
GD&T Annotations

Cross Section Checks







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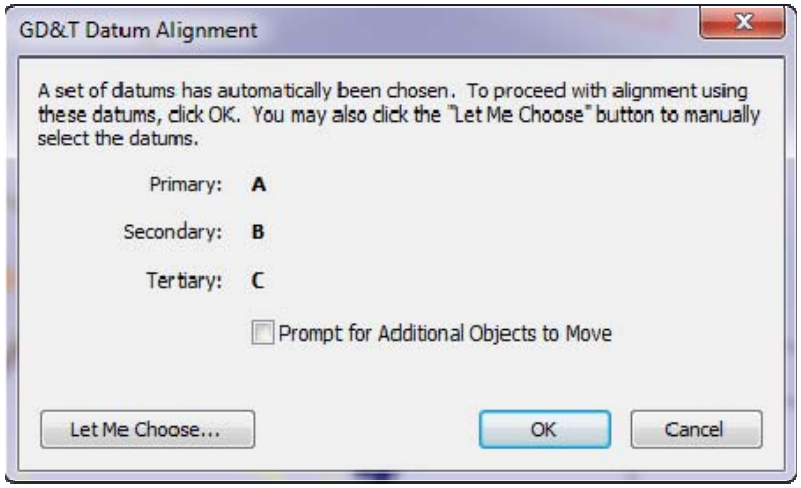
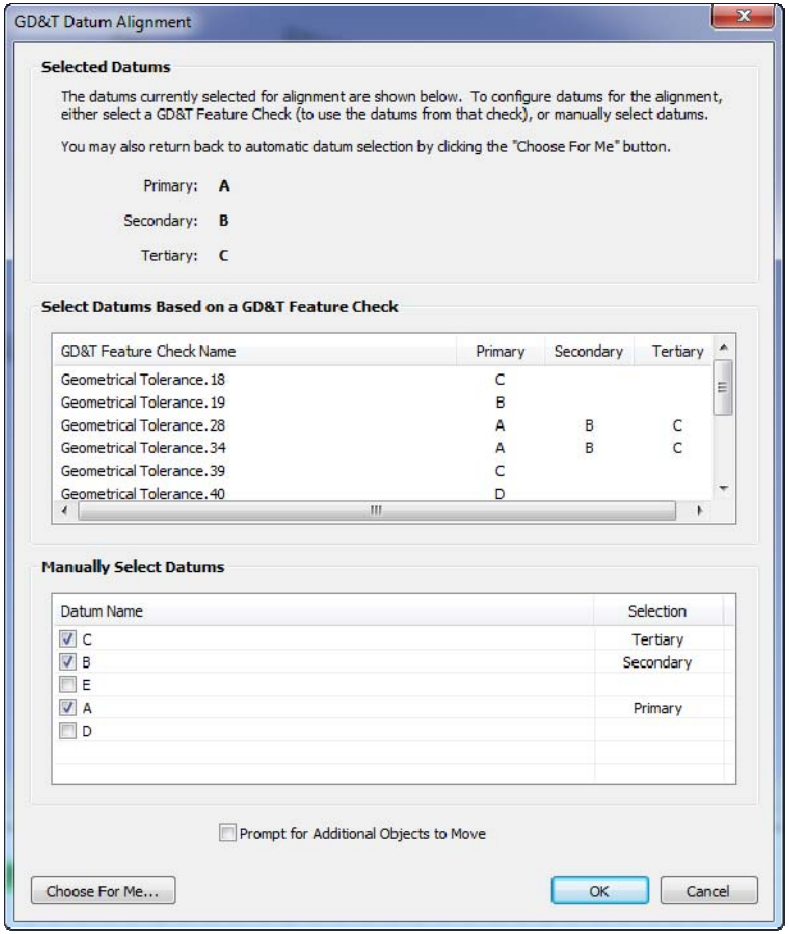
Datum Alignment

Right- Click Datum Category

- Select “Align”





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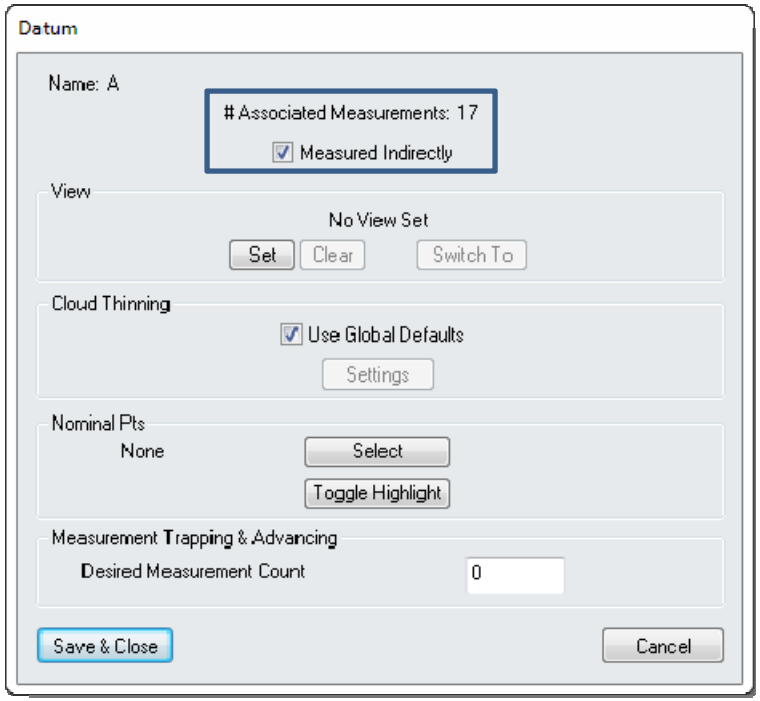
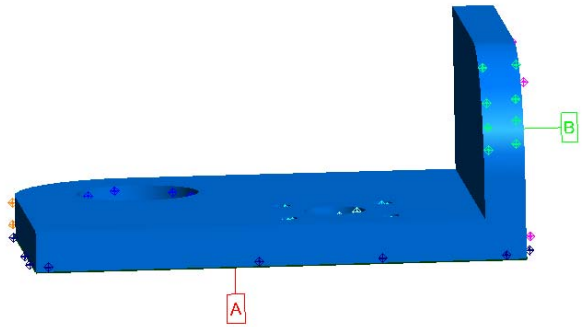
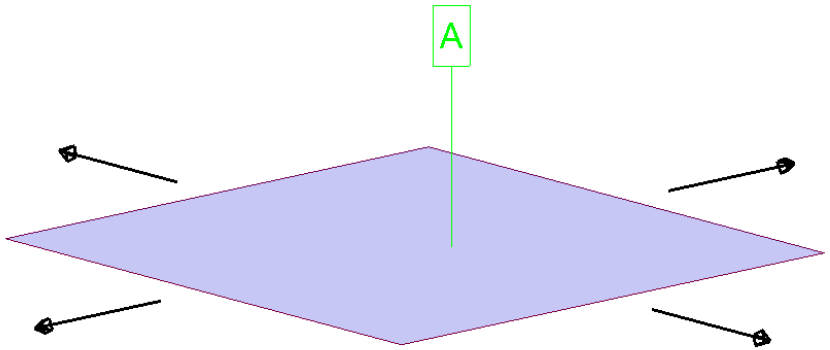
Building Feature Checks

- Cylinder Evaluation Method
- Probe Compensation



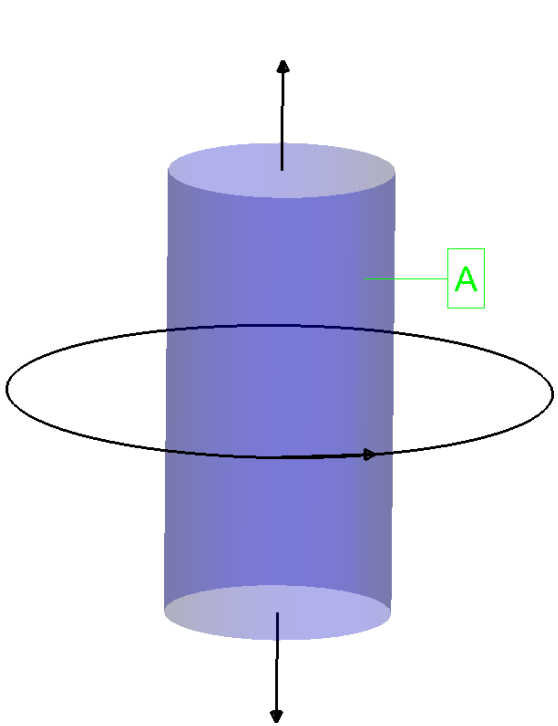


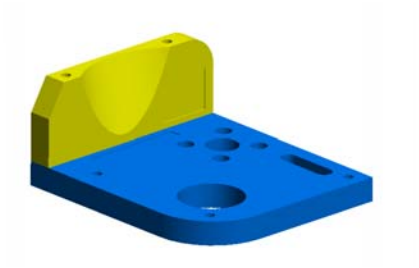


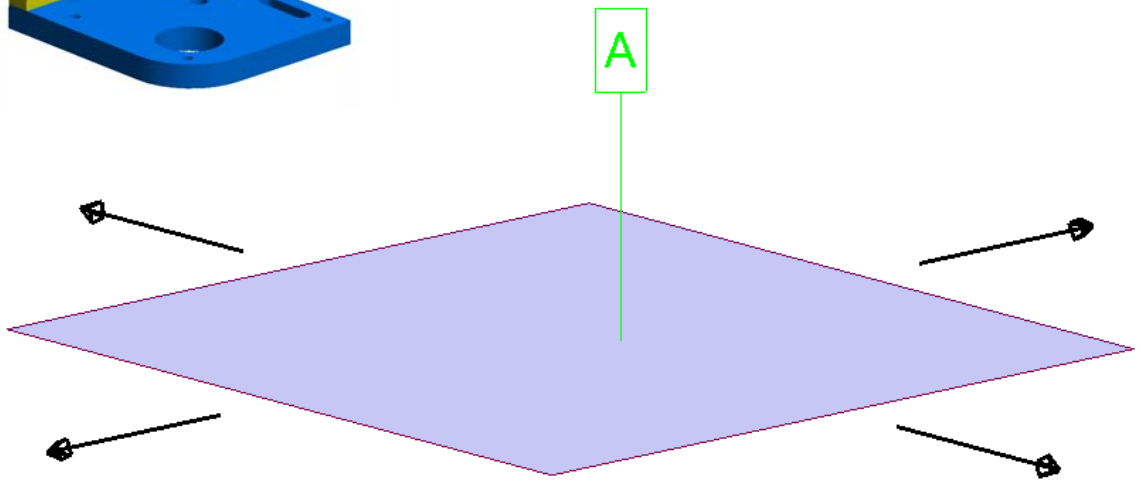
Datum Alignment

Datums and Degrees of Freedom

- Geometry Type is the Key

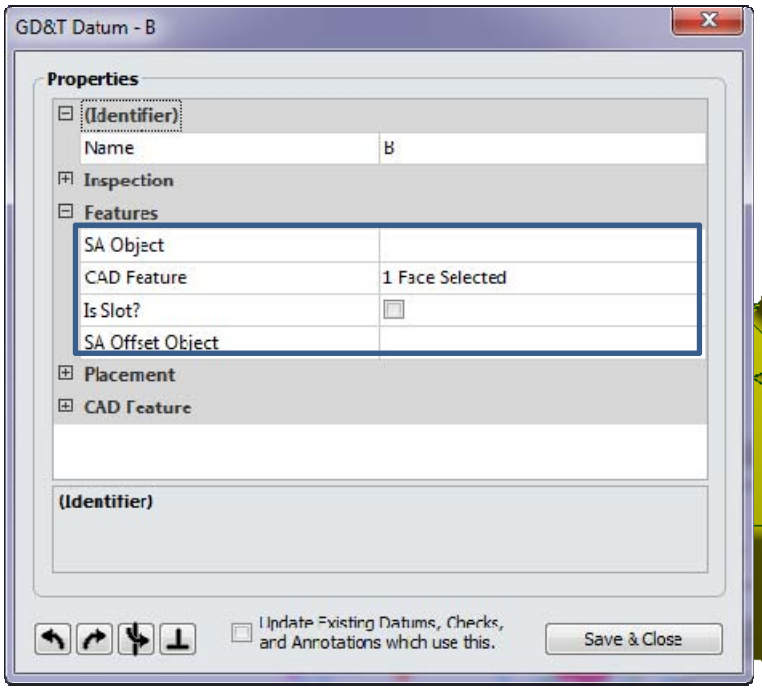




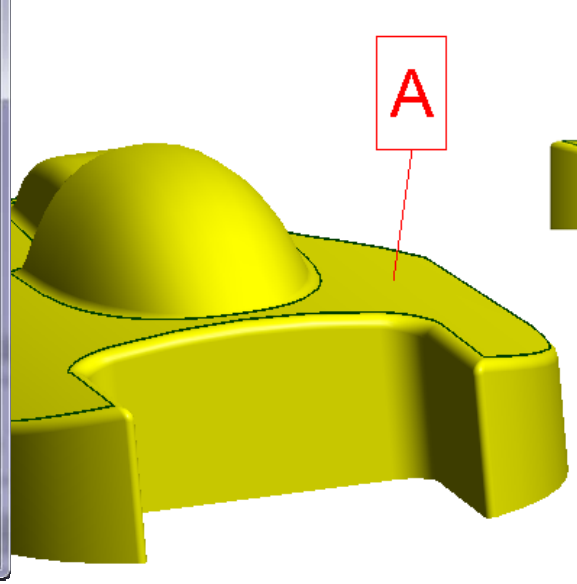


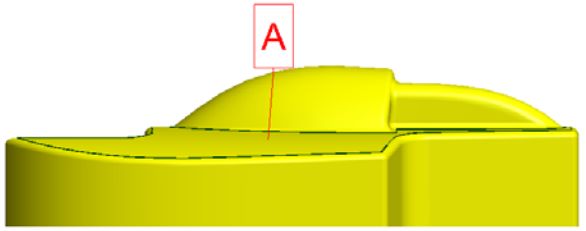
Datum Alignment

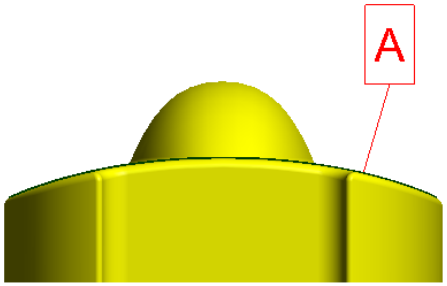
The number of datums specified and the feature type selected controls the degrees of freedom for the check:



- SA Objects/CAD Face
- SA Offset object







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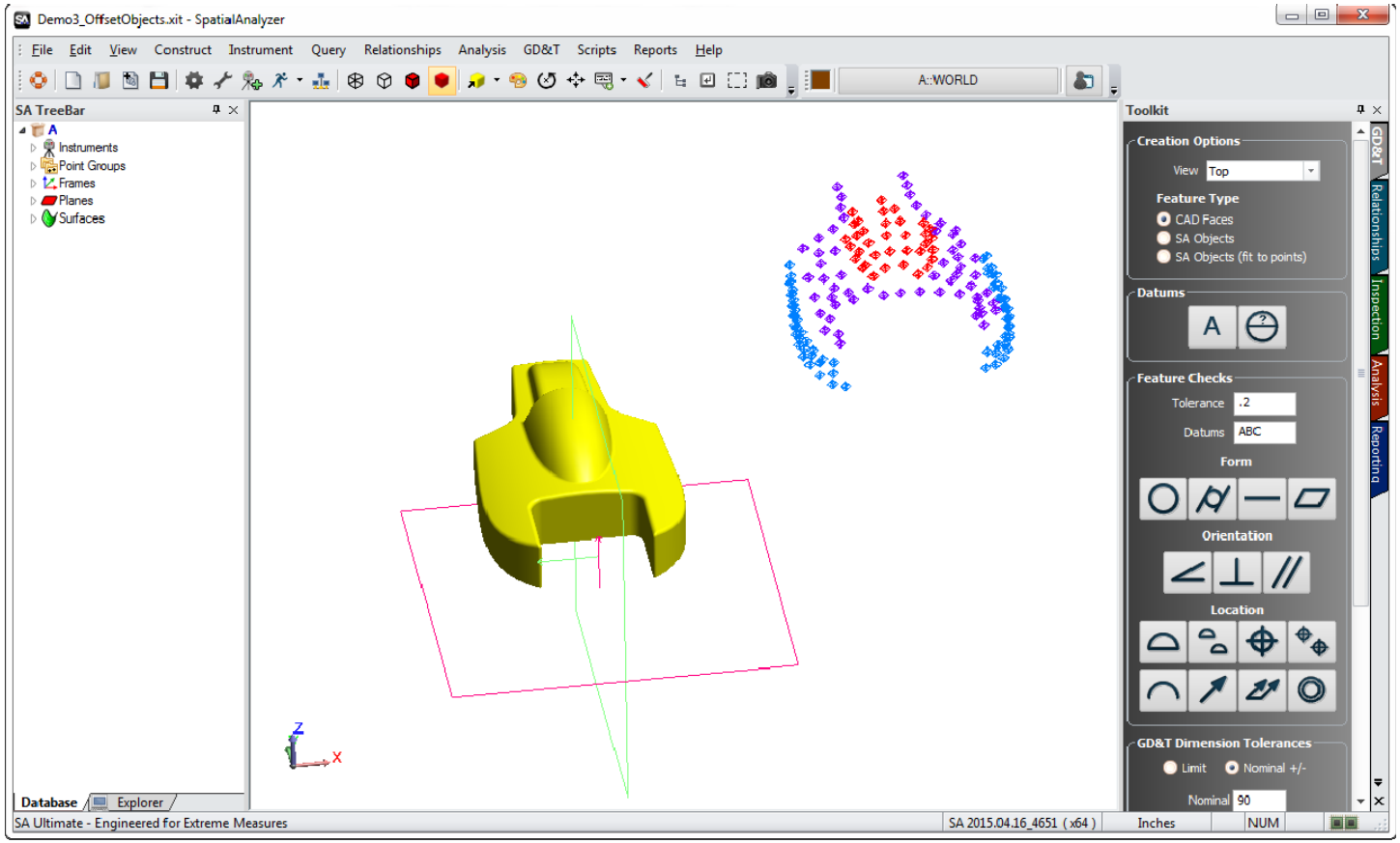
Demo- Basic Fit & Link



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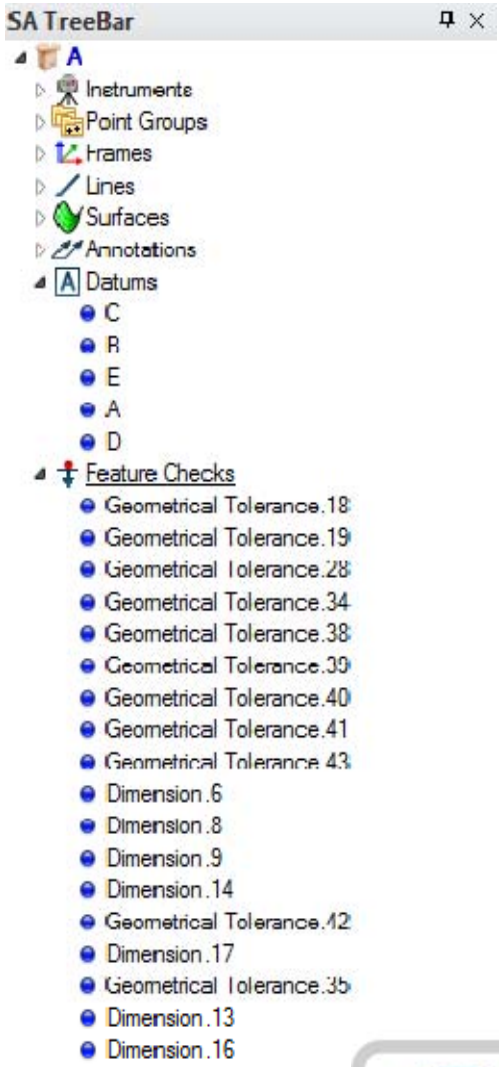
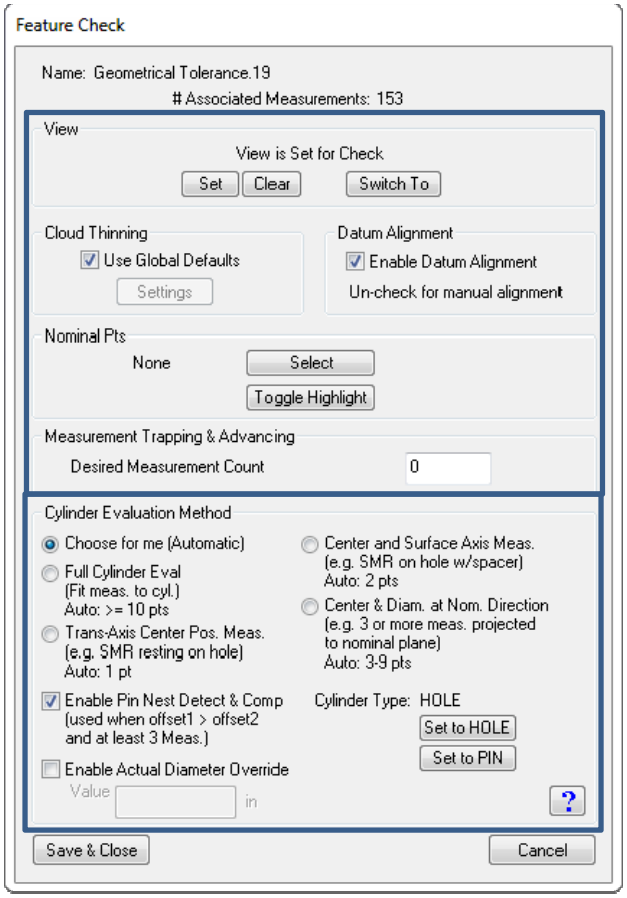
Building Feature Checks





Inspection Controls

Evaluation Method

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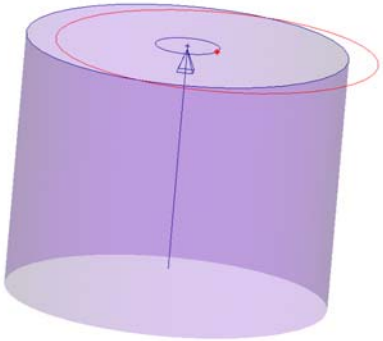
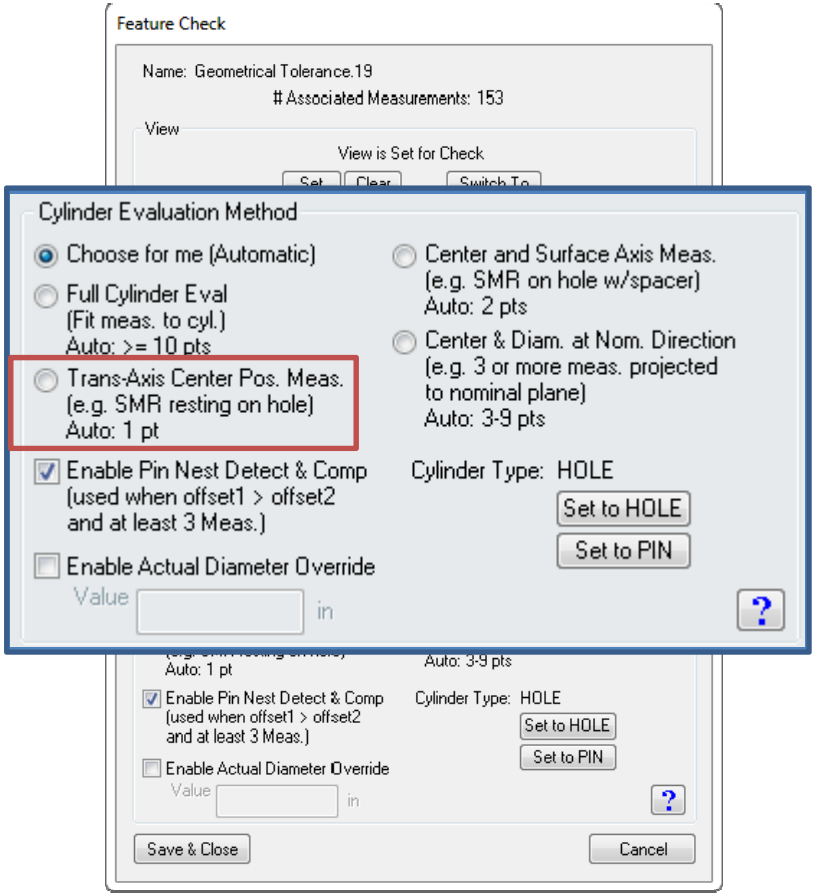
Building Feature Checks

- Cylinder Evaluation Method





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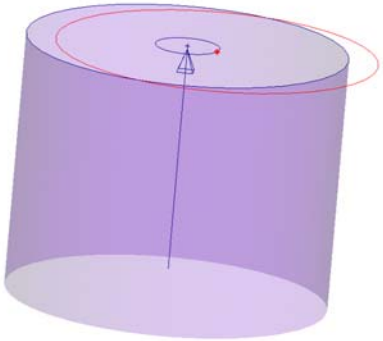
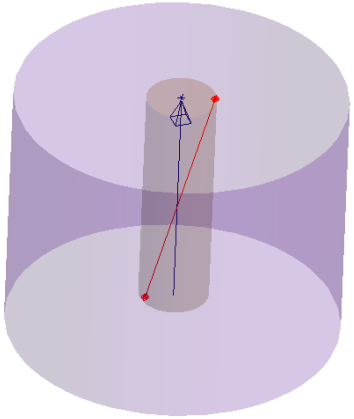
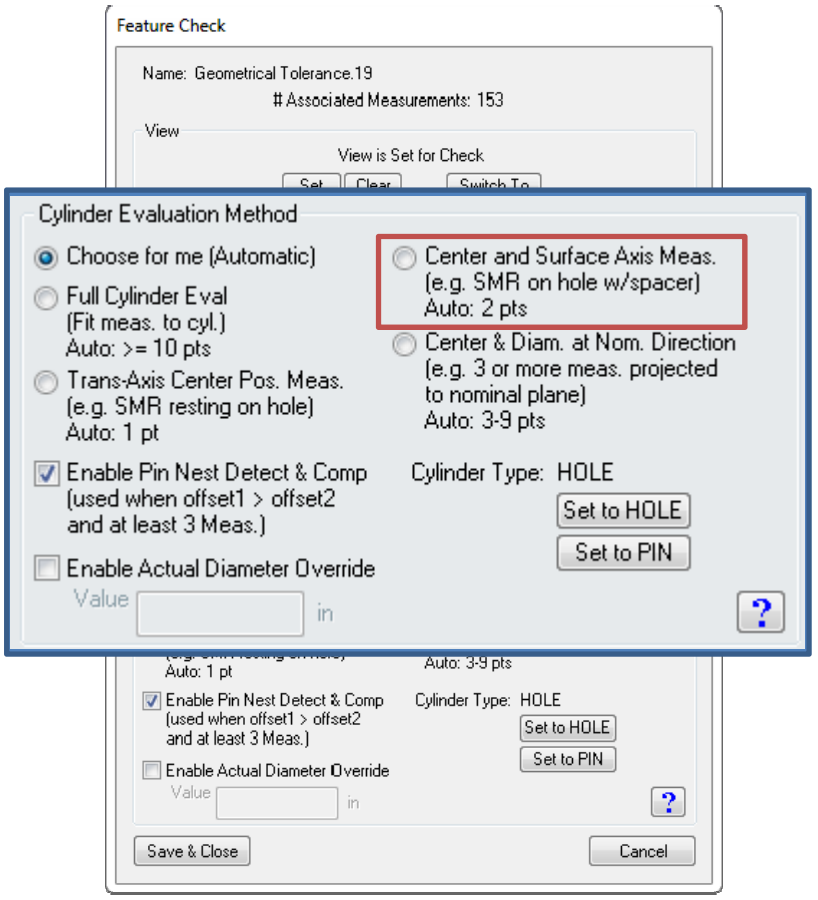
Building Feature Checks

- Cylinder Evaluation Method

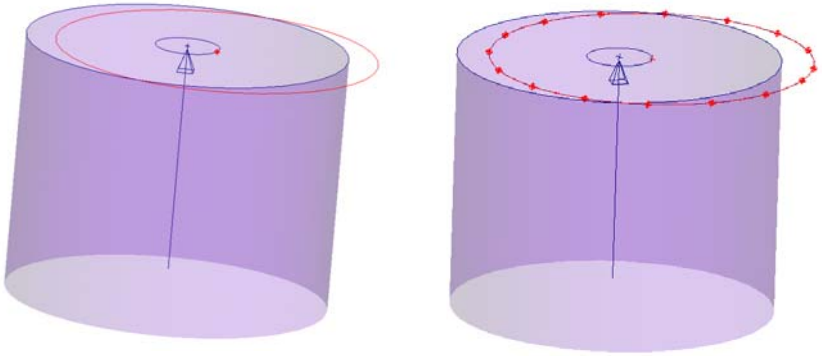


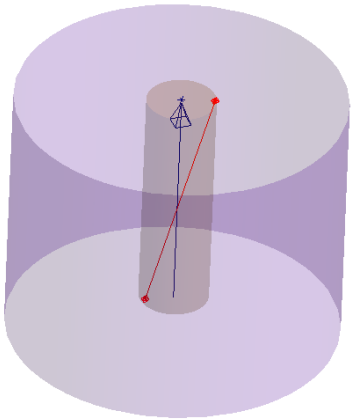


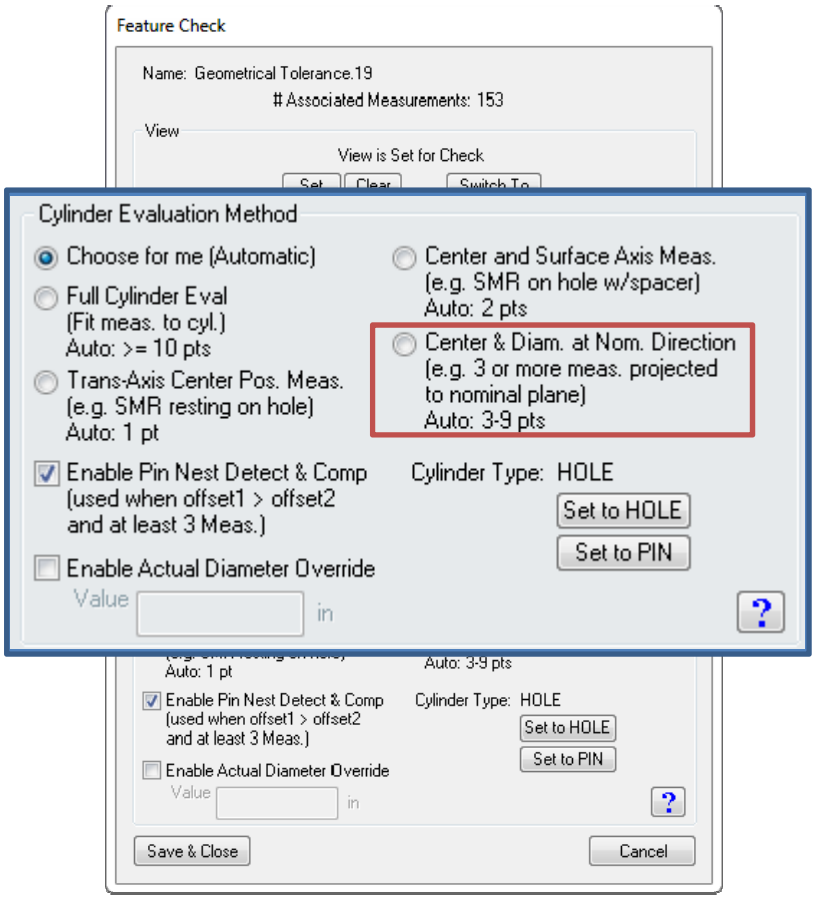


Building Feature Checks

- Cylinder Evaluation Method







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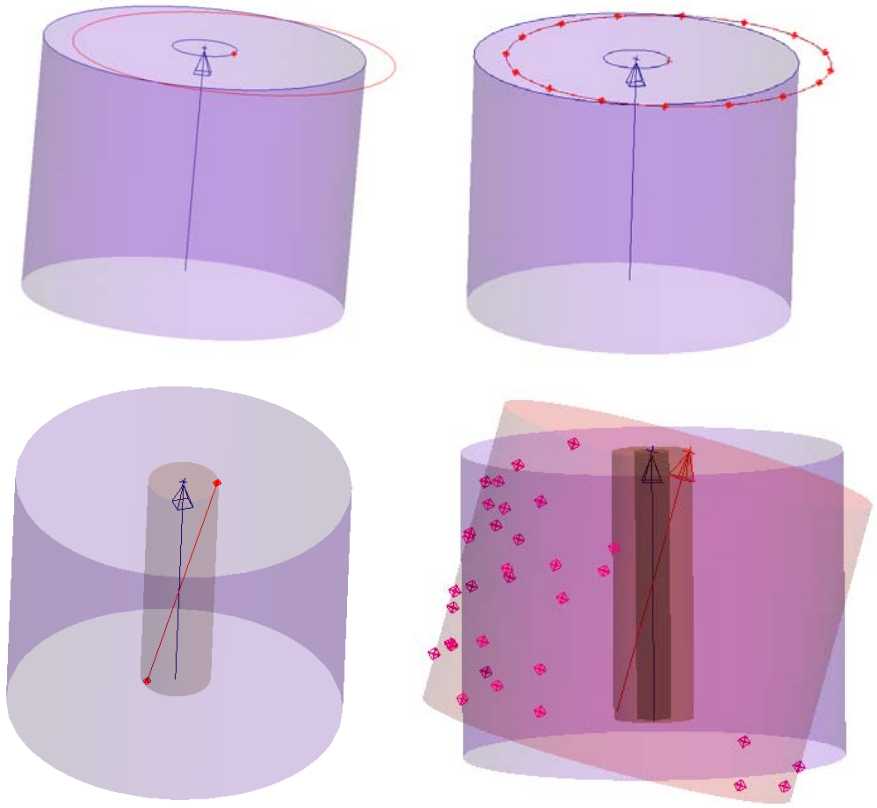
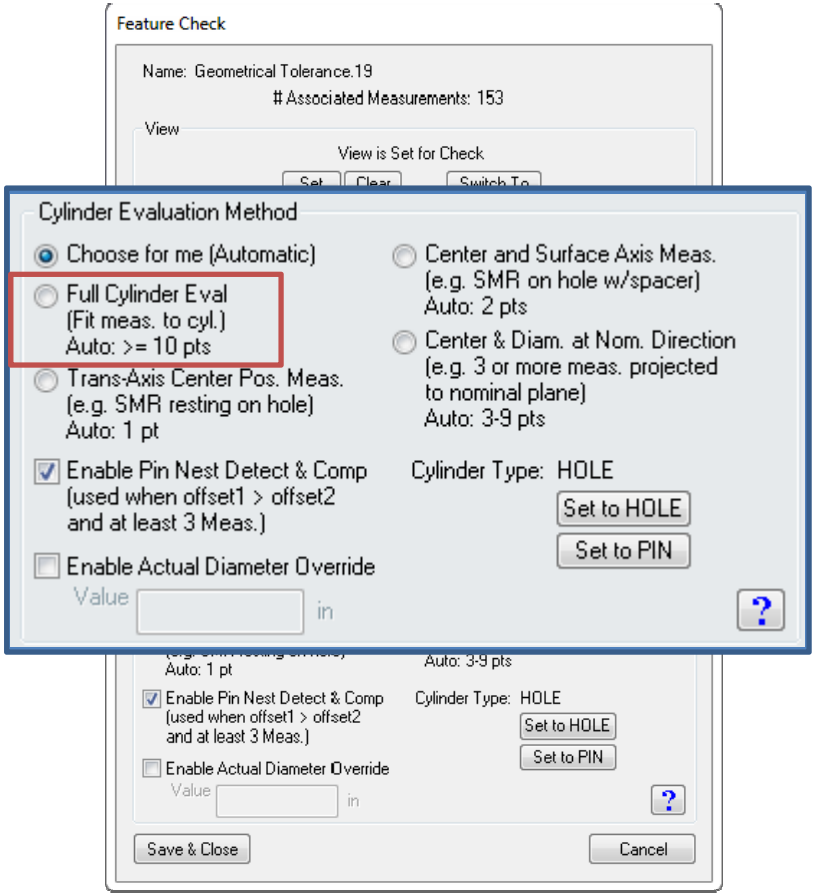
Building Feature Checks

- Cylinder Evaluation Method





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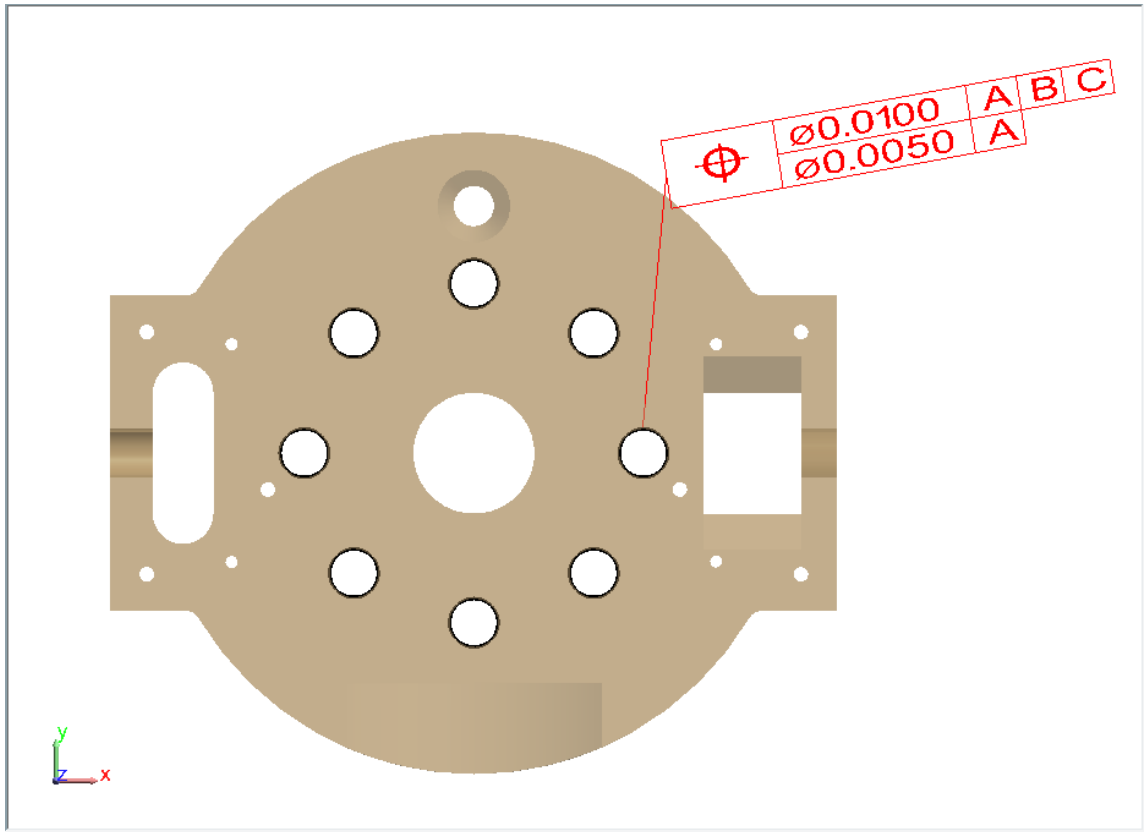
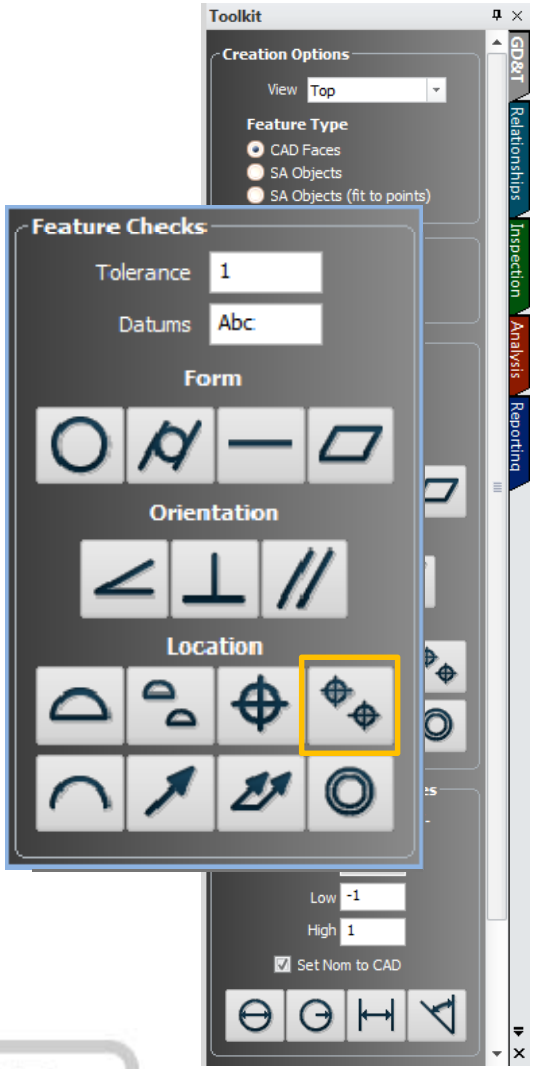
Composite True Position

Composite Checks:

⌖	ø0.0100	A	B	C
⌖	ø0.0050	A		





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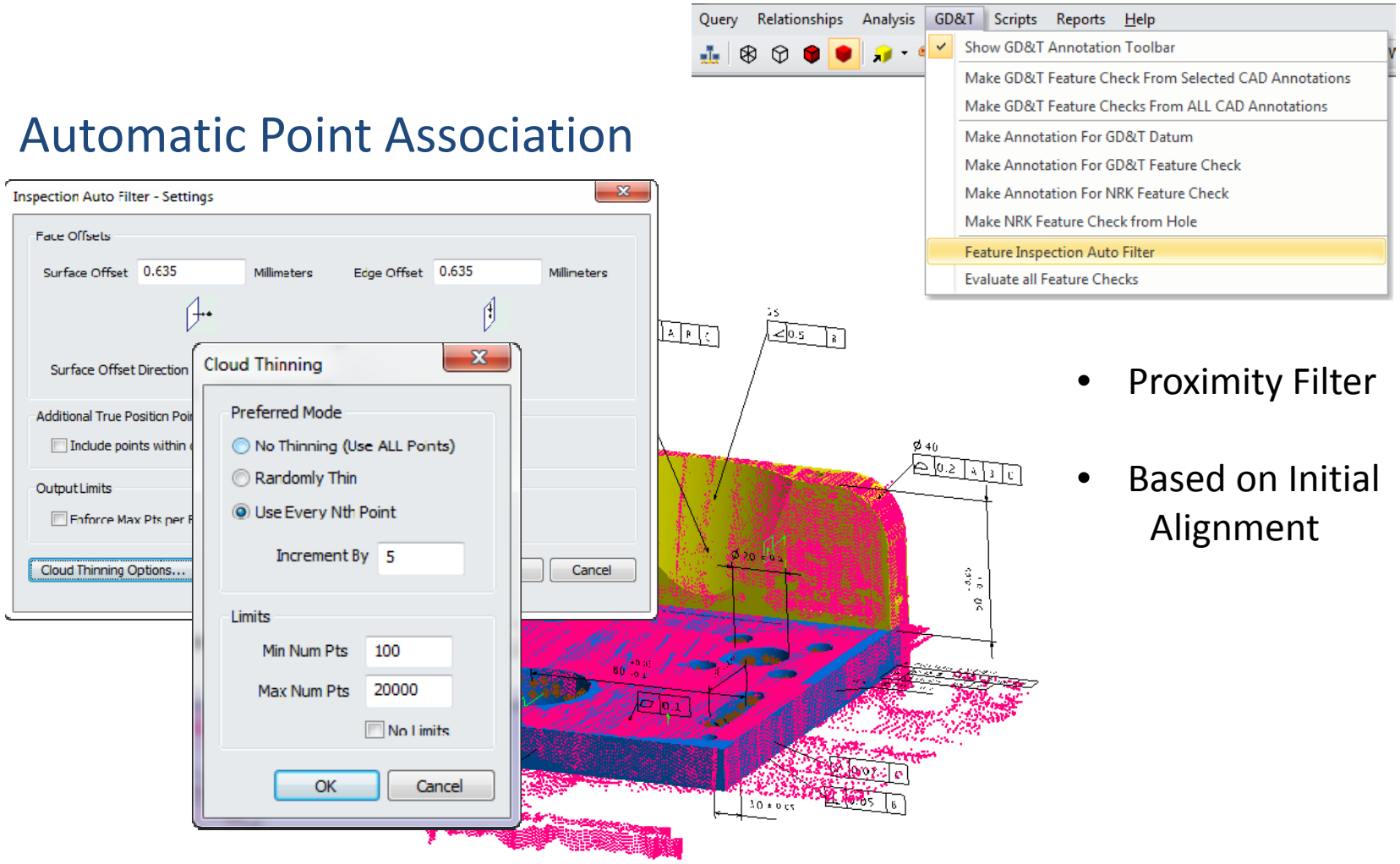
GD&T Inspection

Automatic Point Association



- Proximity Filter
- Based on Initial Alignment

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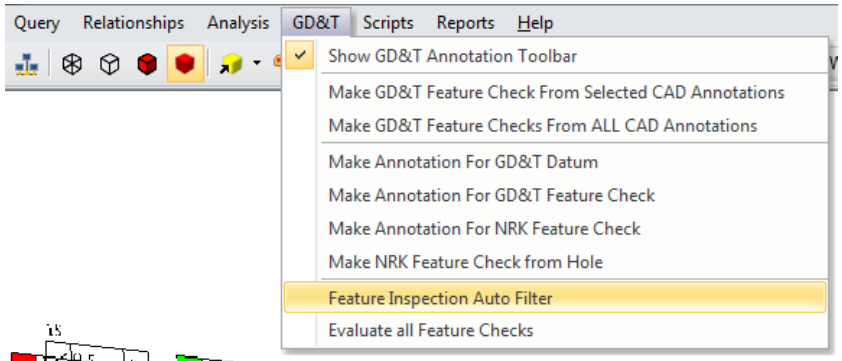
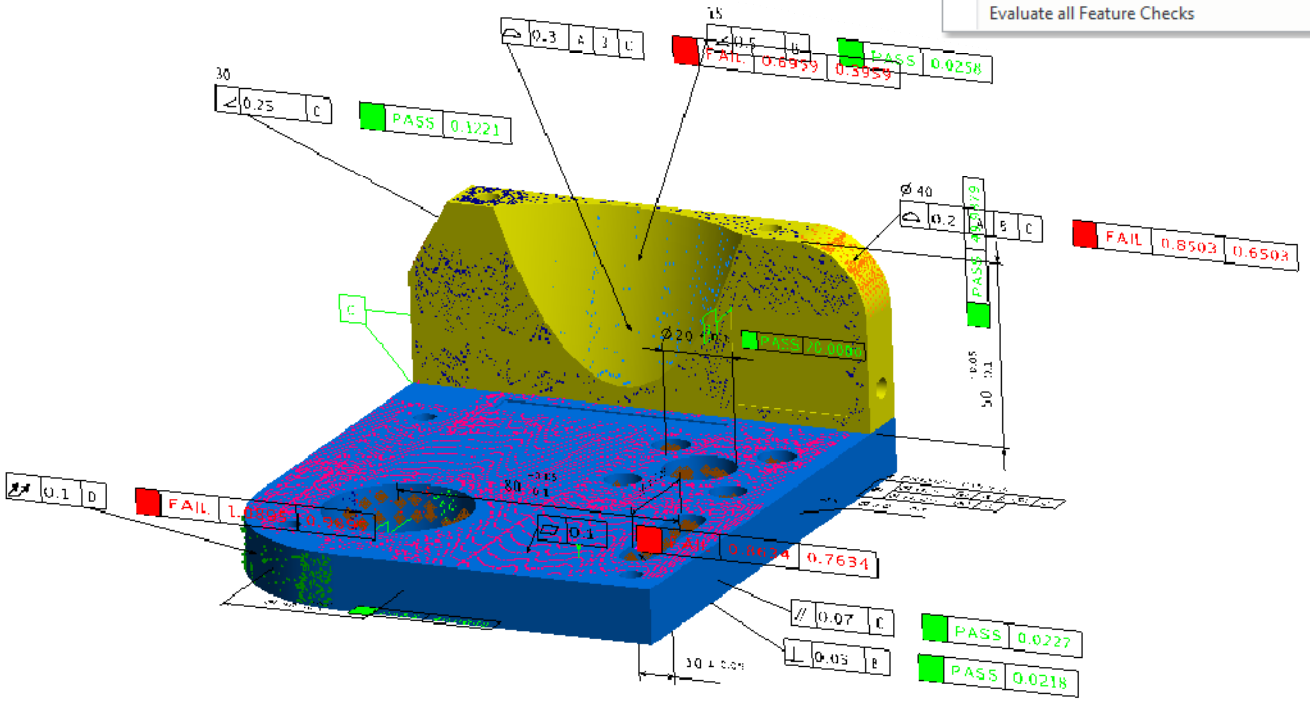
GD&T Inspection

Automatic Point Association





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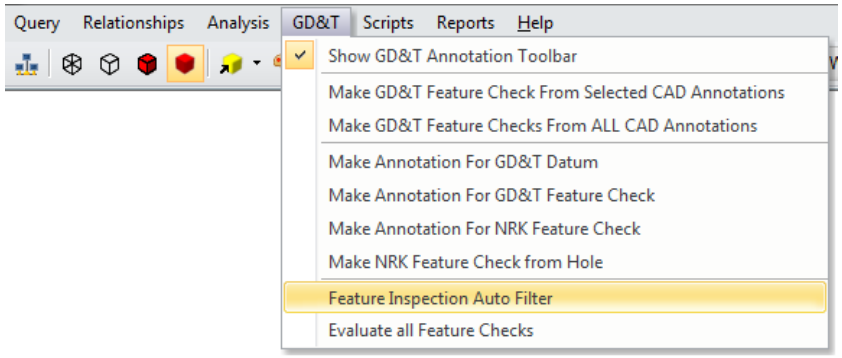
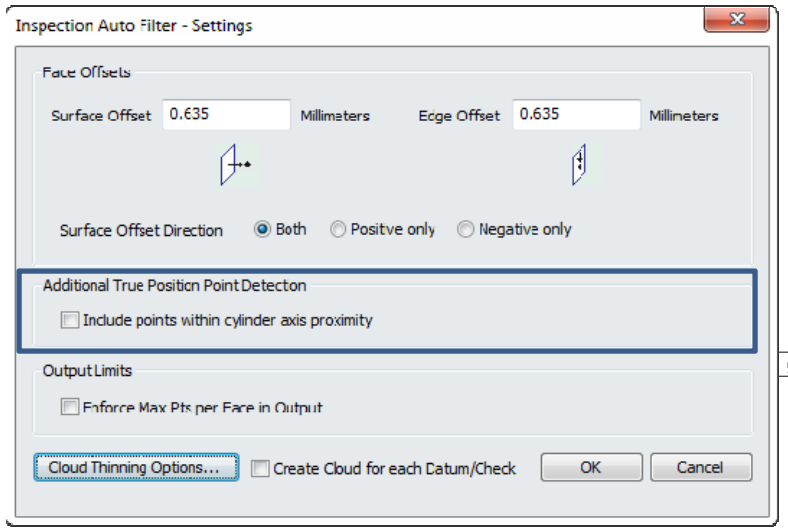
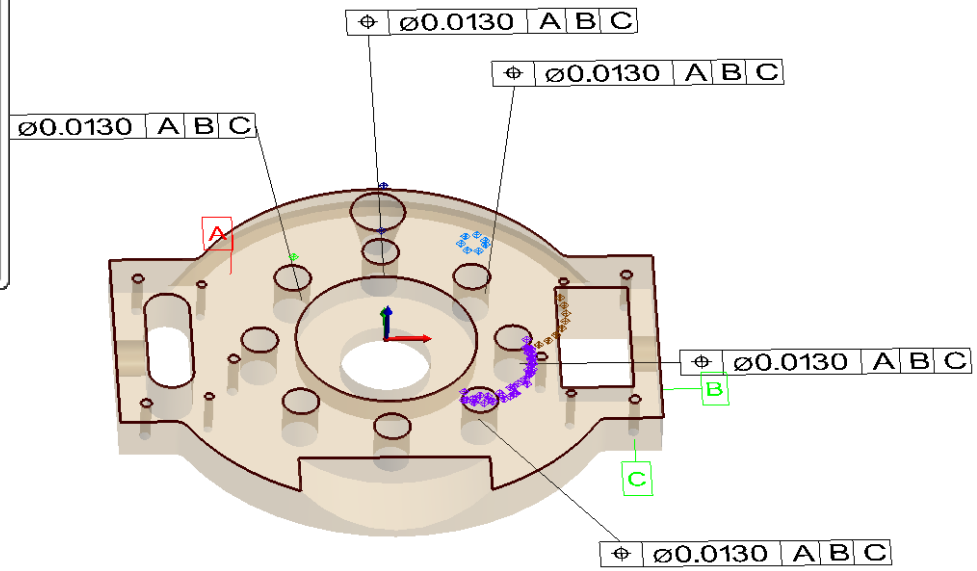
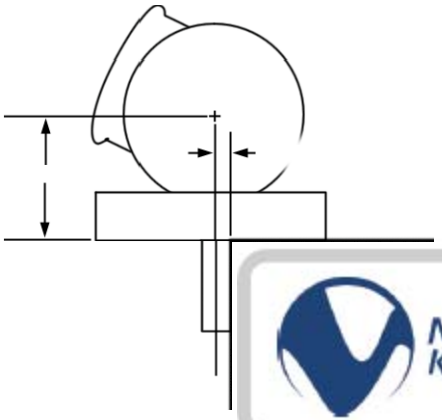
GD&T Inspection

Automatic Point Association









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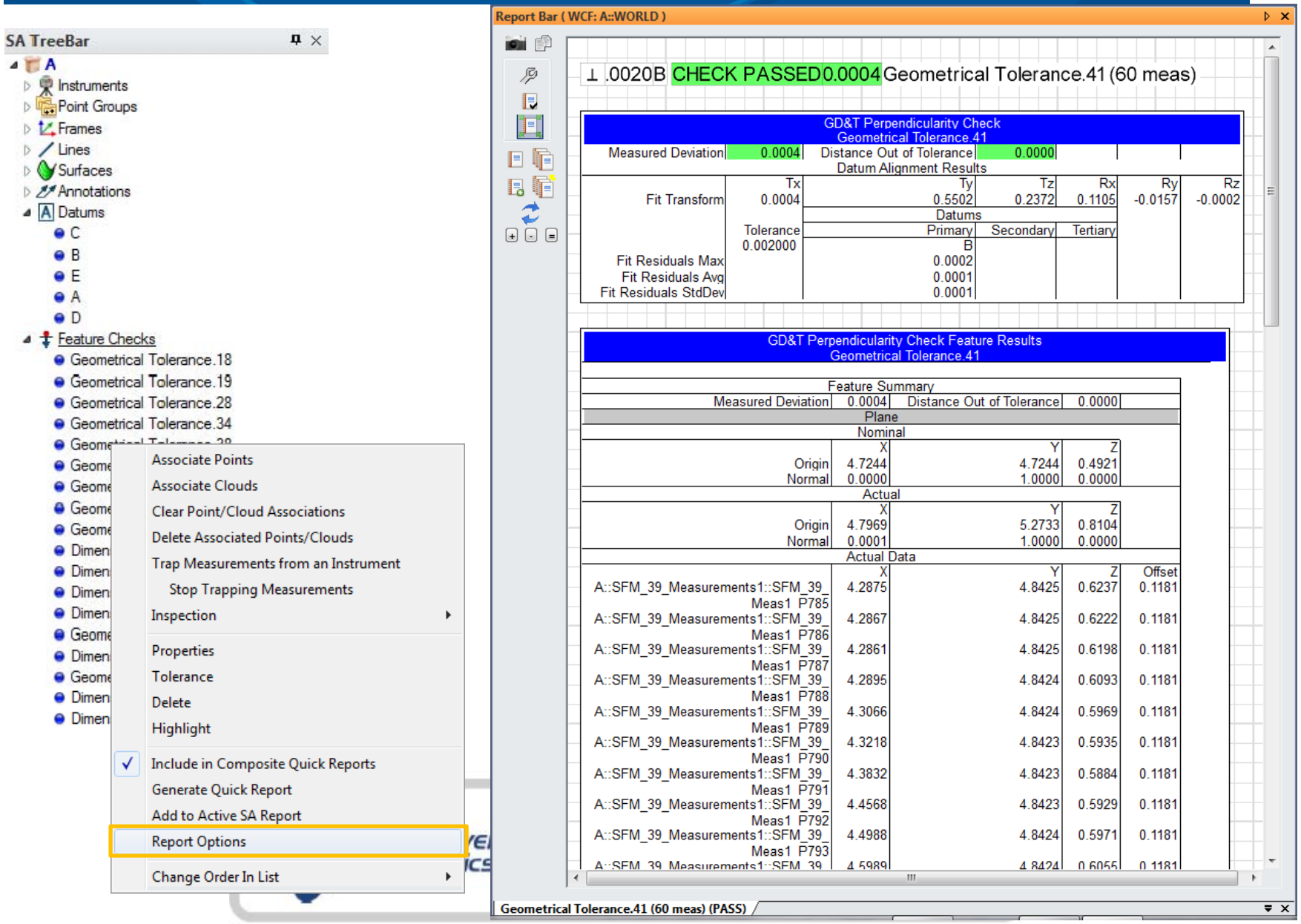
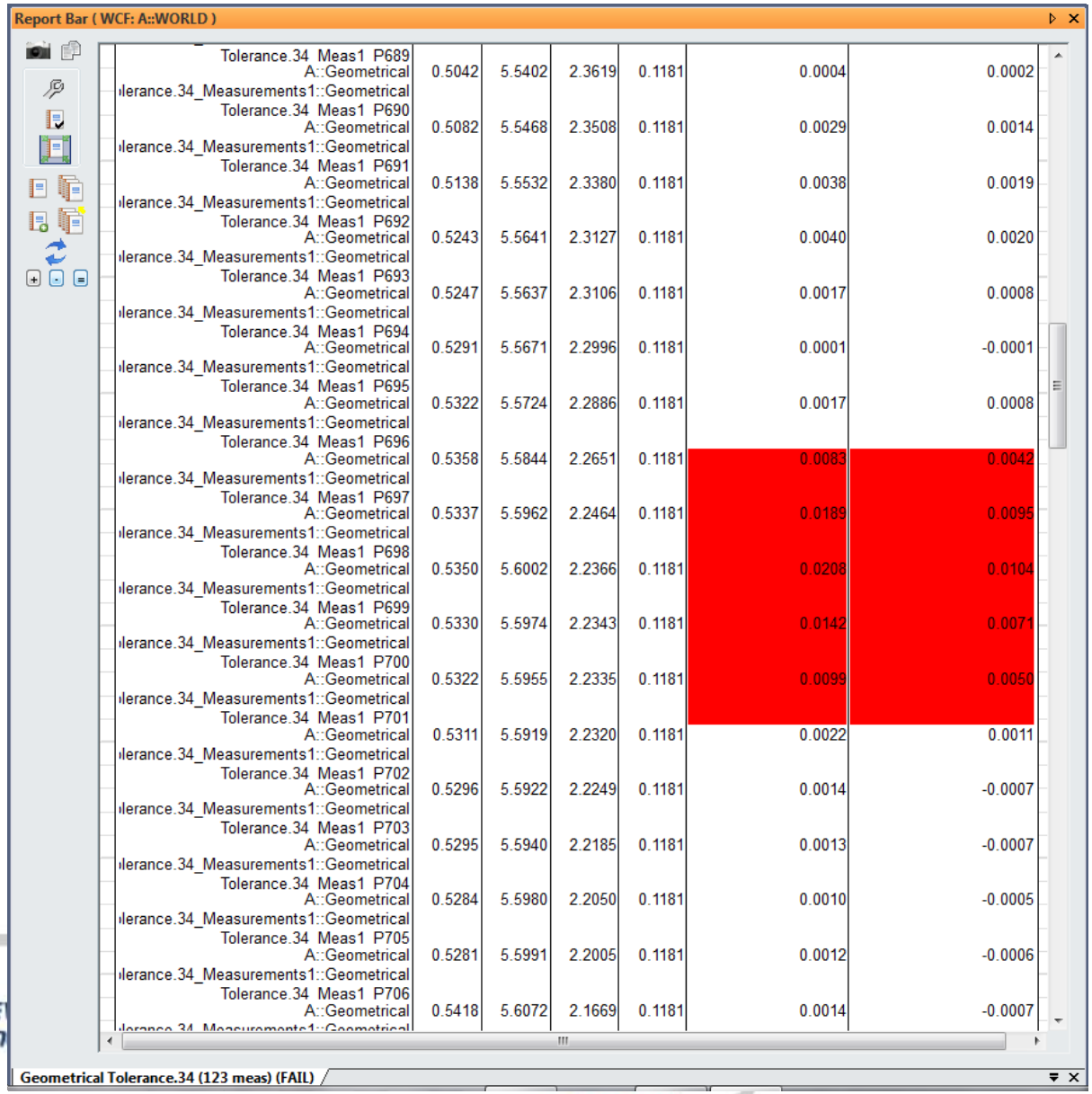
Reporting


SA TreeBar
A
Instruments
Point Groups
Frames
Lines
Surfaces
Annotations
Datums
C
B
E
A
D
Feature Checks
Geometrical Tolerance.18
Geometrical Tolerance.19
Geometrical Tolerance.28
Geometrical Tolerance.34
Associate Points
Associate Clouds
Clear Point/Cloud Associations
Delete Associated Points/Clouds
Trap Measurements from an Instrument
Stop Trapping Measurements
Inspection
Properties
Tolerance
Delete
Highlight
Include in Composite Quick Reports
Generate Quick Report
Add to Active SA Report
Report Options
Change Order In List
Report Bar (WCF: A::WORLD)
⊥ .0020B CHECK PASSED 0.0004 Geometrical Tolerance.41 (60 meas)
GD&T Perpendicularity Check
Geometrical Tolerance.41
Measured Deviation 0.0004 Distance Out of Tolerance 0.0000
Datum Alignment Results
Tx Ty Tz Rx Ry Rz
Fit Transform 0.0004 0.5502 0.2372 0.1105 -0.0157 -0.0002
Datums
Tolerance Primary Secondary Tertiary
0.002000 B
Fit Residuals Max 0.0002
Fit Residuals Avg 0.0001
Fit Residuals StdDev 0.0001
GD&T Perpendicularity Check Feature Results
Geometrical Tolerance.41
Feature Summary
Measured Deviation 0.0004 Distance Out of Tolerance 0.0000
Plane
Nominal
X Y Z
Origin 4.7244 4.7244 0.4921
Normal 0.0000 1.0000 0.0000
Actual
X Y Z
Origin 4.7969 5.2733 0.8104
Normal 0.0001 1.0000 0.0000
Actual Data
X Y Z Offset
A::SFM_39_Measurements1::SFM_39_Meas1_P785 4.2875 4.8425 0.6237 0.1181
A::SFM_39_Measurements1::SFM_39_Meas1_P786 4.2867 4.8425 0.6222 0.1181
A::SFM_39_Measurements1::SFM_39_Meas1_P787 4.2861 4.8425 0.6198 0.1181
A::SFM_39_Measurements1::SFM_39_Meas1_P788 4.2895 4.8424 0.6093 0.1181
A::SFM_39_Measurements1::SFM_39_Meas1_P789 4.3066 4.8424 0.5969 0.1181
A::SFM_39_Measurements1::SFM_39_Meas1_P790 4.3218 4.8423 0.5935 0.1181
A::SFM_39_Measurements1::SFM_39_Meas1_P791 4.3832 4.8423 0.5884 0.1181
A::SFM_39_Measurements1::SFM_39_Meas1_P792 4.4568 4.8423 0.5929 0.1181
A::SFM_39_Measurements1::SFM_39_Meas1_P793 4.4988 4.8424 0.5971 0.1181
Geometrical Tolerance.41 (60 meas) (PASS)

Reporting

Summary Table
- Fit Transform
- Datum Statistics

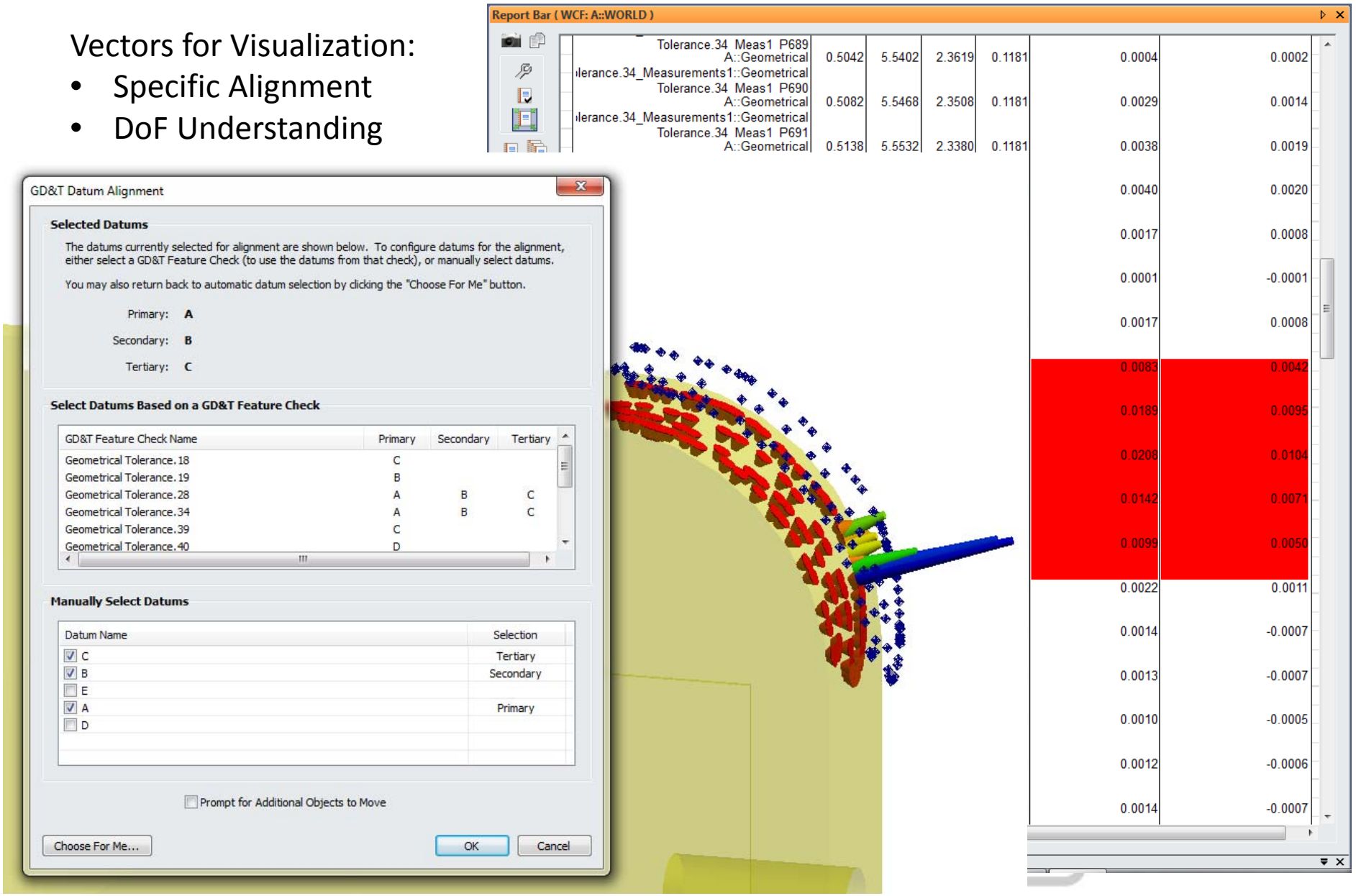
Details Table
- Point Deviations



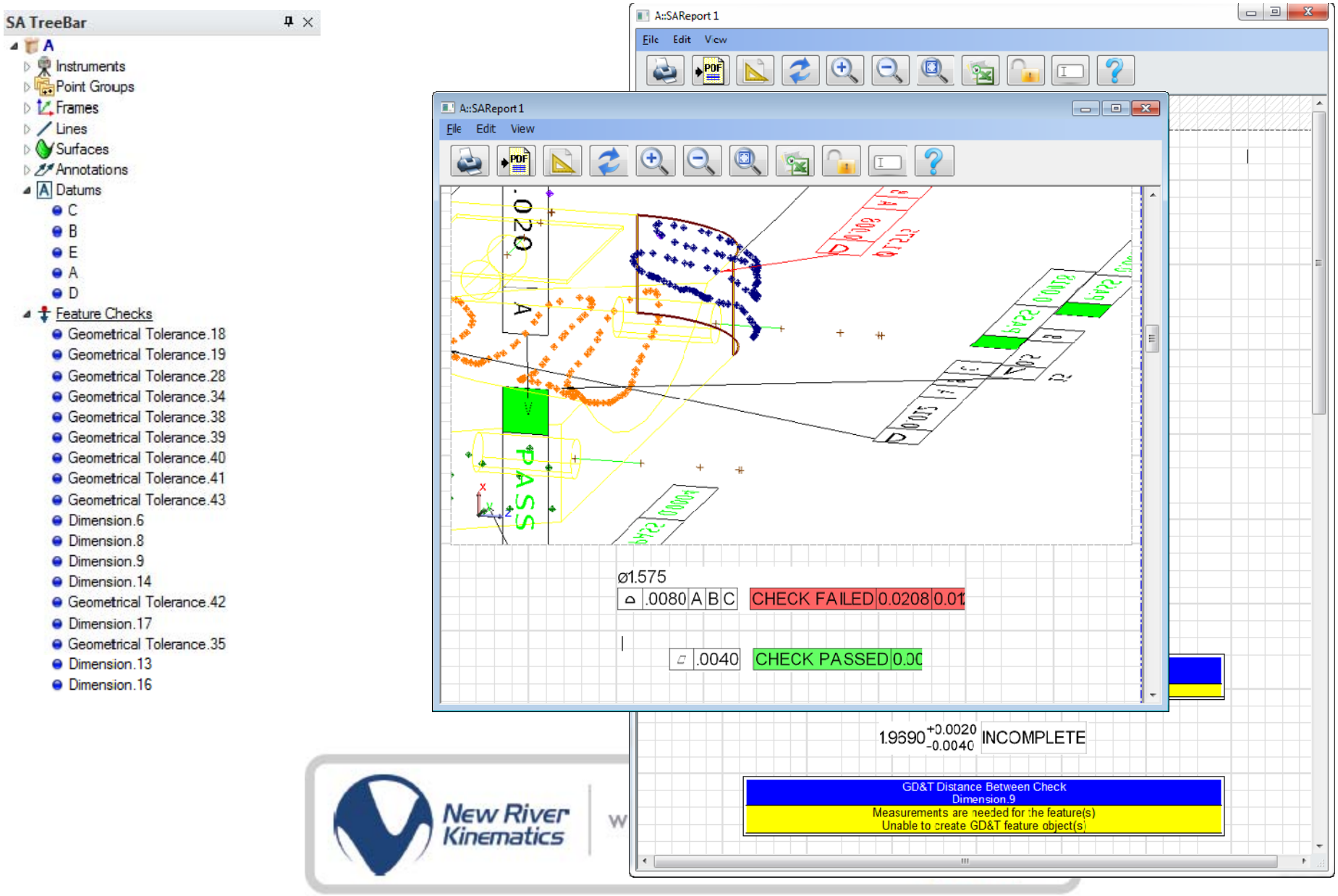
Reporting

Vectors for Visualization:

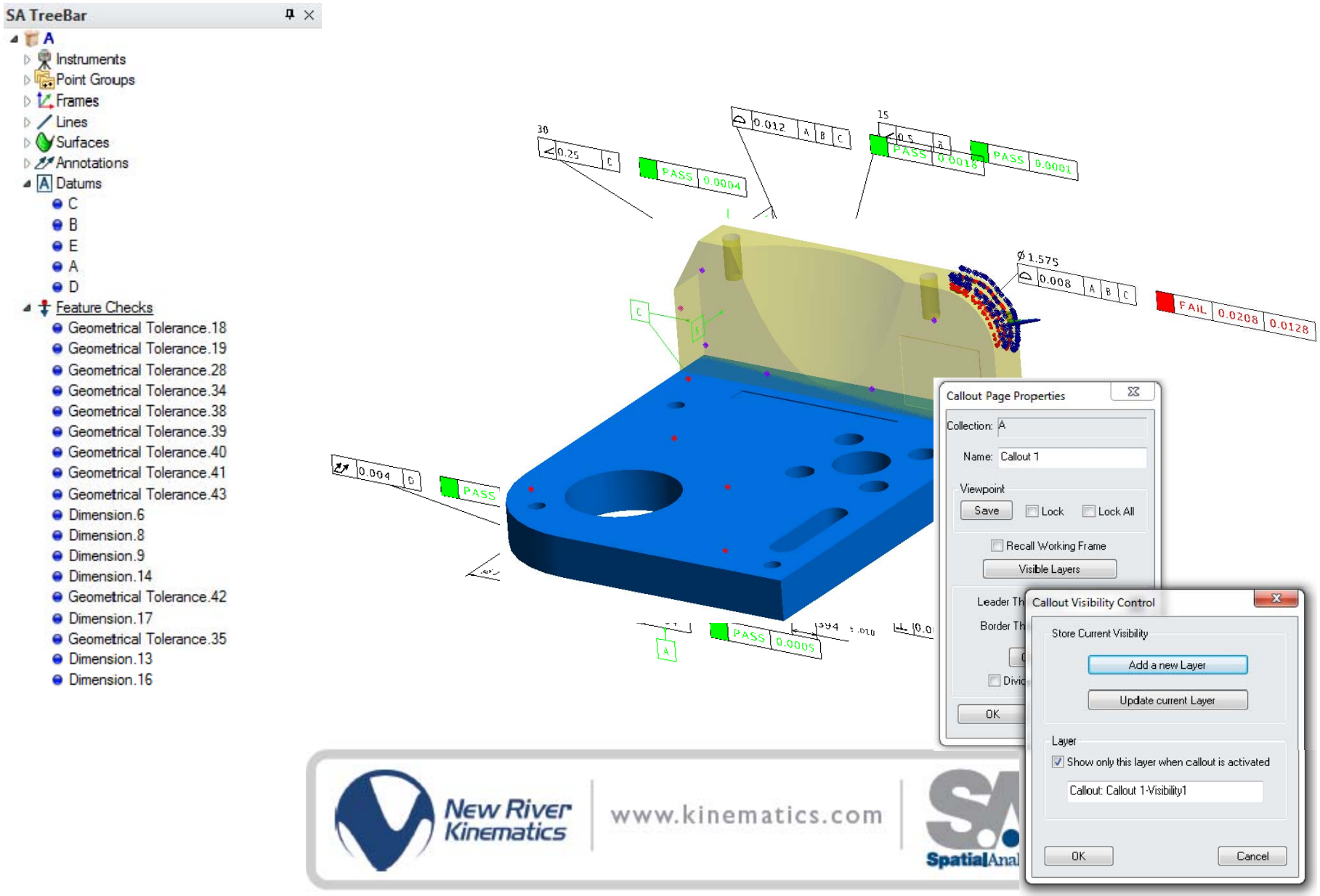
- Specific Alignment
- DoF Understanding



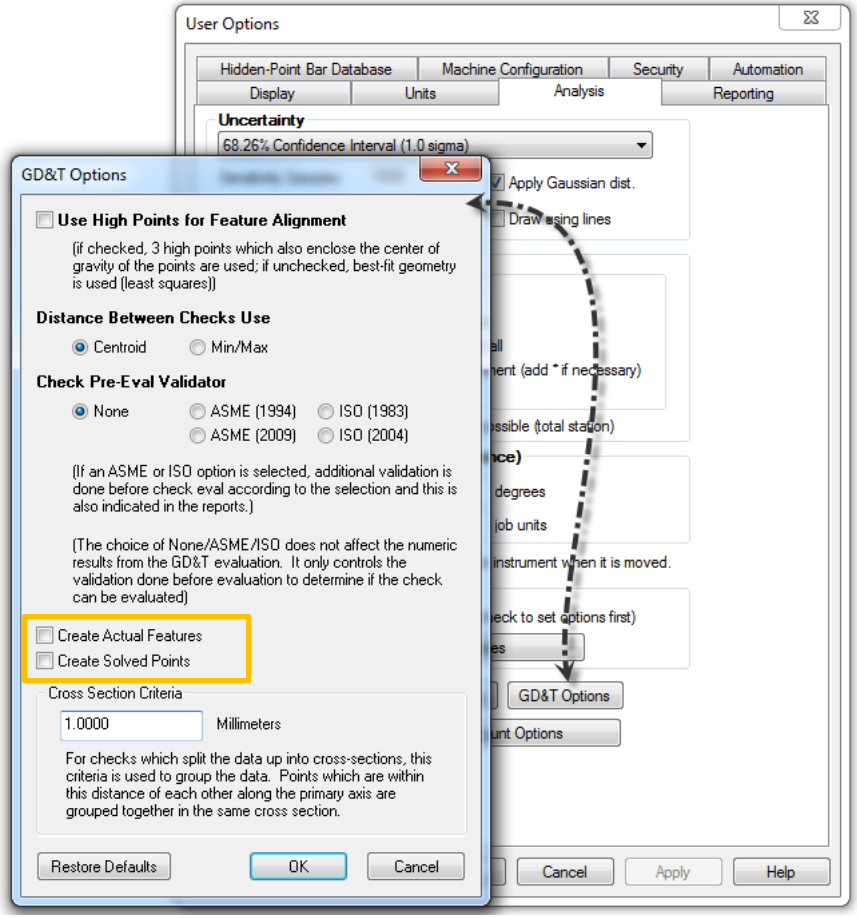
Reporting

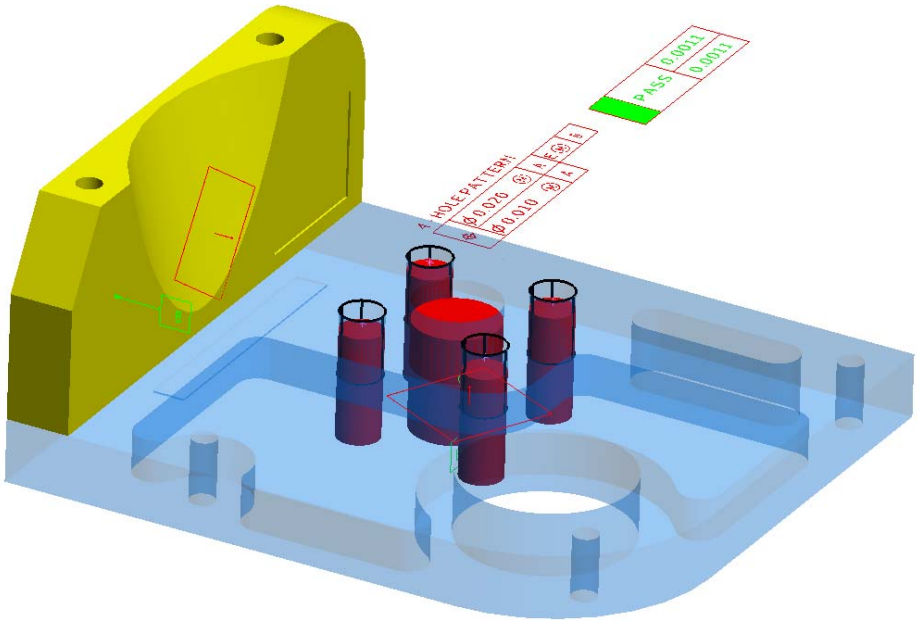

SA TreeBar
A
Instruments
Point Groups
Frames
Lines
Surfaces
Annotations
Datums
C
B
E
A
D
Feature Checks
Geometrical Tolerance.18
Geometrical Tolerance.19
Geometrical Tolerance.28
Geometrical Tolerance.34
Geometrical Tolerance.38
Geometrical Tolerance.39
Geometrical Tolerance.40
Geometrical Tolerance.41
Geometrical Tolerance.43
Dimension.6
Dimension.8
Dimension.9
Dimension.14
Geometrical Tolerance.42
Dimension.17
Geometrical Tolerance.35
Dimension.13
Dimension.16
A::SAReport 1
File Edit View
PASS
ø1.575
.0080 A B C
CHECK FAILED 0.0208 0.01
.0040
CHECK PASSED 0.00
1.9590 +0.0020 -0.0040
INCOMPLETE
GD&T Distance Between Check
Dimension.9
Measurements are needed for the feature(s)
Unable to create GD&T feature object(s)
New River Kinematics

Reporting


SA TreeBar
A
Instruments
Point Groups
Frames
Lines
Surfaces
Annotations
Datums
C
B
E
A
D
Feature Checks
Geometrical Tolerance.18
Geometrical Tolerance.19
Geometrical Tolerance.28
Geometrical Tolerance.34
Geometrical Tolerance.38
Geometrical Tolerance.39
Geometrical Tolerance.40
Geometrical Tolerance.41
Geometrical Tolerance.43
Dimension.6
Dimension.8
Dimension.9
Dimension.14
Geometrical Tolerance.42
Dimension.17
Geometrical Tolerance.35
Dimension.13
Dimension.16
PASS 0.0004
PASS 0.0018
PASS 0.0001
FAIL 0.0208 0.0128
PASS 0.0005
Callout Page Properties
Collection: A
Name: Callout 1
Viewpoint
Save
Lock
Lock All
Recall Working Frame
Visible Layers
OK
Callout Visibility Control
Store Current Visibility
Add a new Layer
Update current Layer
Layer
Show only this layer when callout is activated
Callout: Callout 1-Visibility1
OK
Cancel
New River Kinematics
www.kinematics.com

Evaluations Tools





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MAKING MEASUREMENT

MORE ACCURATE, EFFICIENT, *PRODUCTIVE*

Thank You