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Sandia National Laboratories

ASME Y14.5-2009
Update on Changes from 1994 Standard

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U.S. DEPARTMENT OF ENERGY | NNSA

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ASME Y14.5-2009
Principal Changes & Improvements

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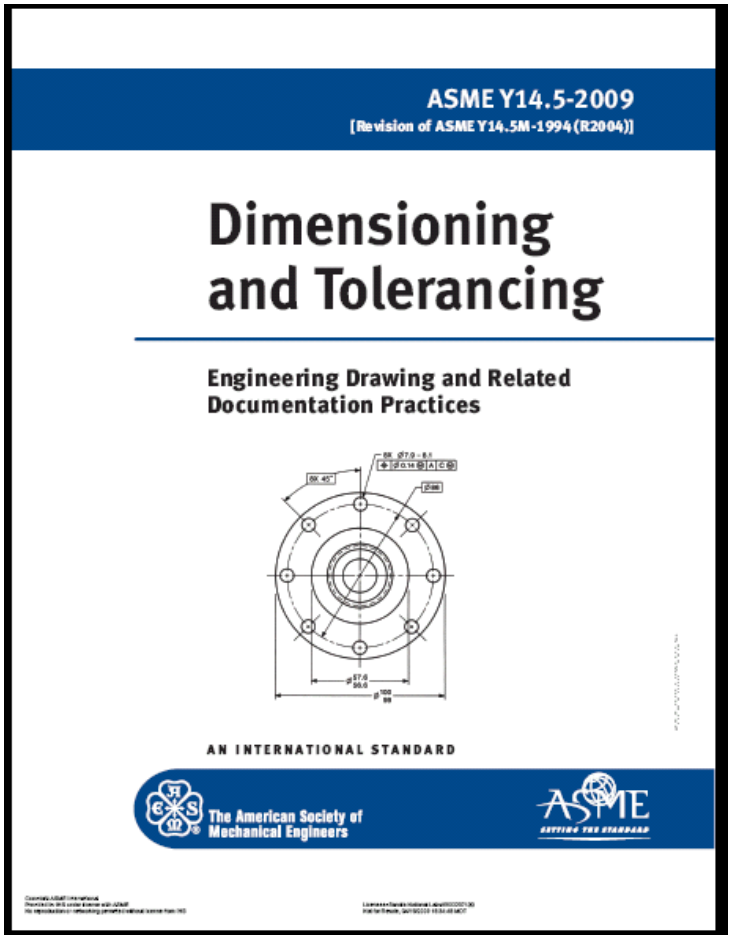
  - See Appendix for approval authorization from ASME and Tec-Ease.

ASME Y14.5-2009
Principal Changes & Improvements

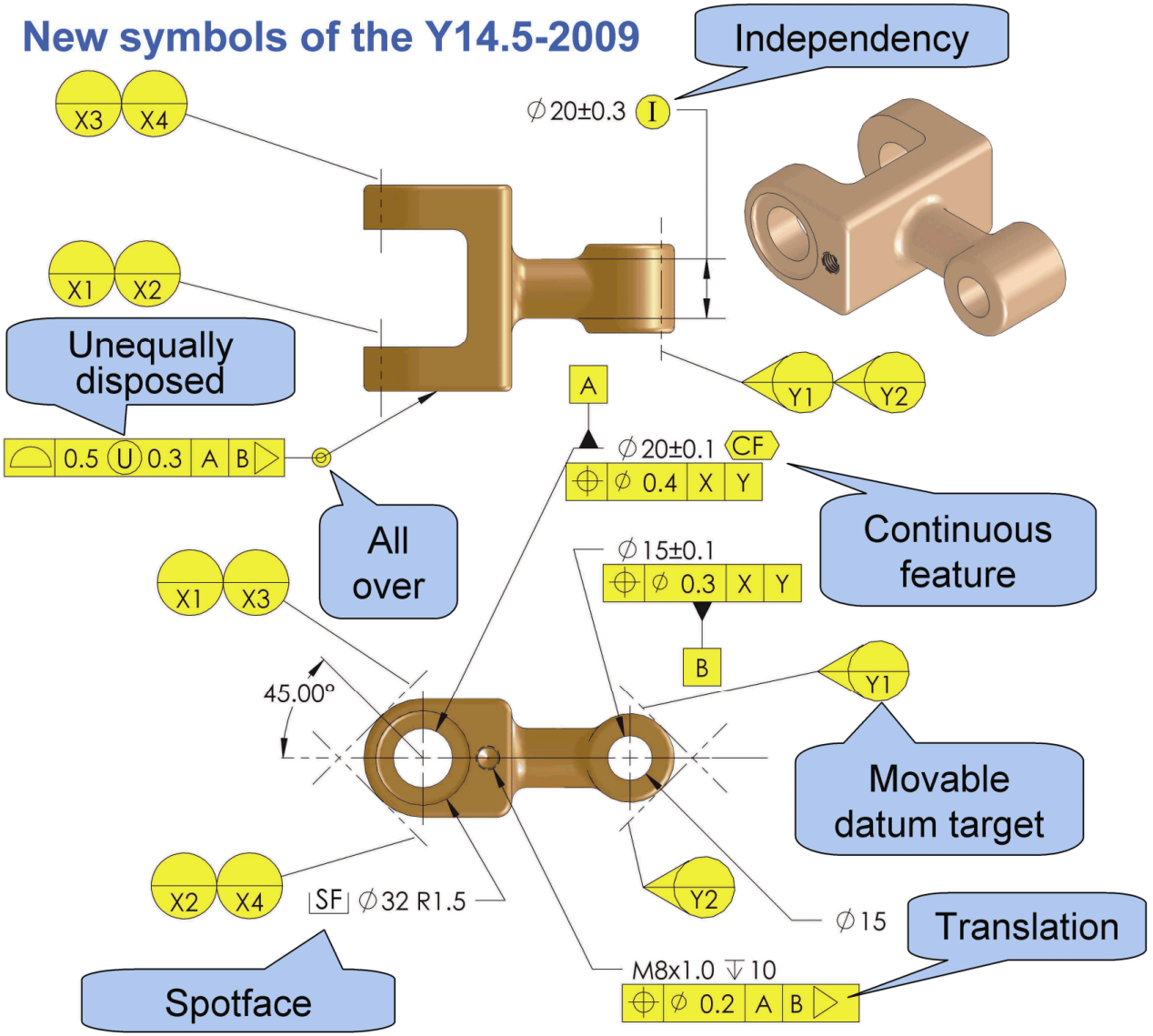
- Released March 2009
  - Two draft reviews made in 2008.



New Symbols

Symbol for	Symbol	Y14.5-2009 Section #
Independency	Ⓘ	2.7.3
All Over		8.3.1.6
Continuous Feature	CF	2.7.5
Movable Datum Target		4.24.6
Spotface	SF	1.8.14
Datum Translation	▷	4.11.10
Unequally Disposed Profile	Ⓤ	8.3.1.2
At Maximum Material Condition (when applied to a tolerance value) At Maximum Material Boundary (when applied to a datum reference)	Ⓜ	1.3.39 1.3.4
At Least Material Condition (when applied to a tolerance value) At Least Material Boundary (when applied to a datum reference)	Ⓛ	1.3.38 1.3.3

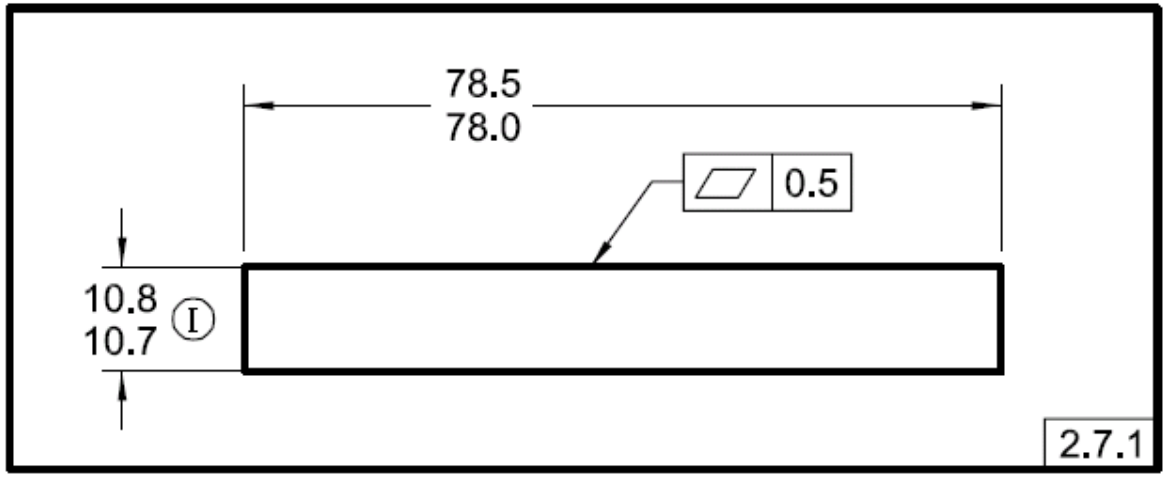
New symbols of the Y14.5-2009



ASME Y14.5-2009
Principal Changes & Improvements

- Independency
  - Used when perfect form at MMC not required
- Should have supplementary form control

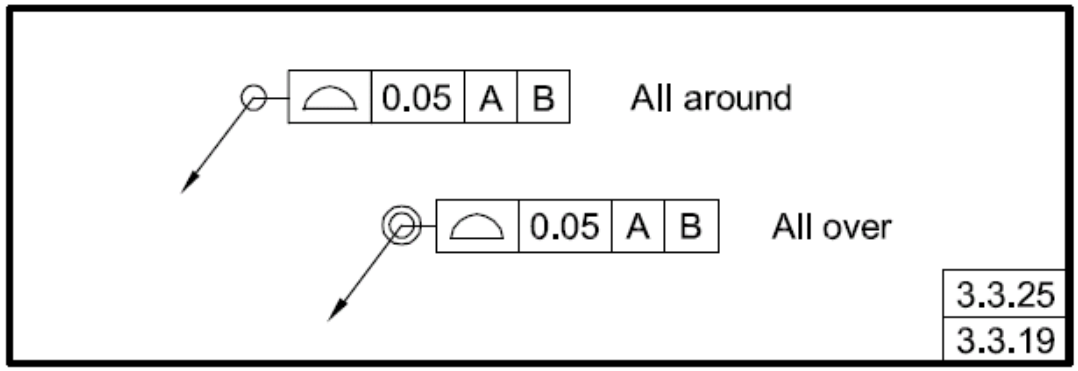
Fig. 2-7 Independency and Flatness Application

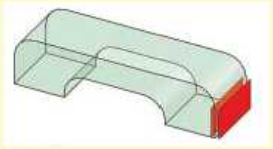
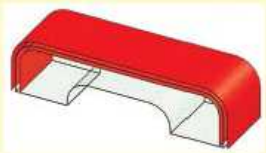
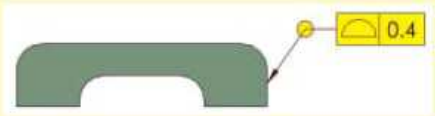
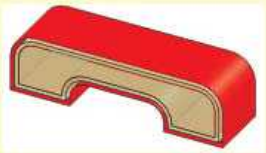
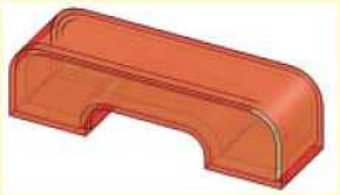


ASME Y14.5-2009
Principal Changes & Improvements

- Tolerance applies “all over” a three dimensional surface

Fig. 3-20 All Over and All Around Symbols Applications



This on the drawing:	Means this: (The tolerance zones are shown in red.)
 An individual feature controlled by profile.	
 Profile applied to a region.	
 Profile applied “all around”.	
 Profile applied “all over”, unless otherwise specified. The same tolerance zone would result if a general profile tolerance is specified in the title block.	

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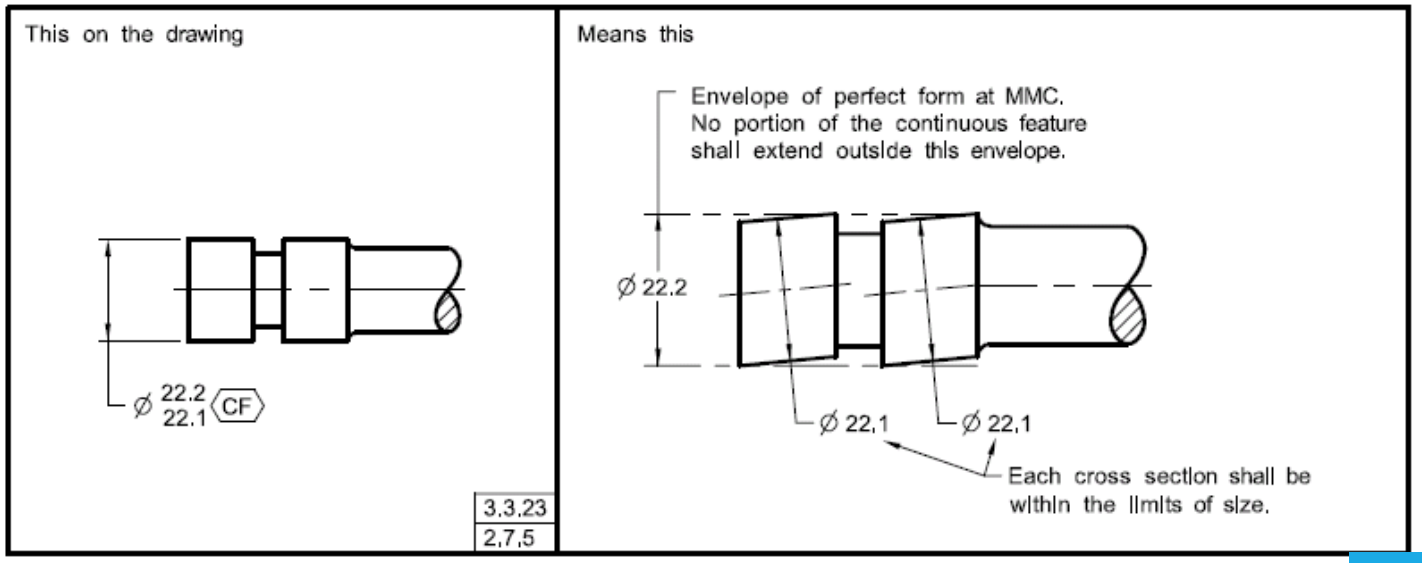
ASME Y14.5-2009
Principal Changes & Improvements

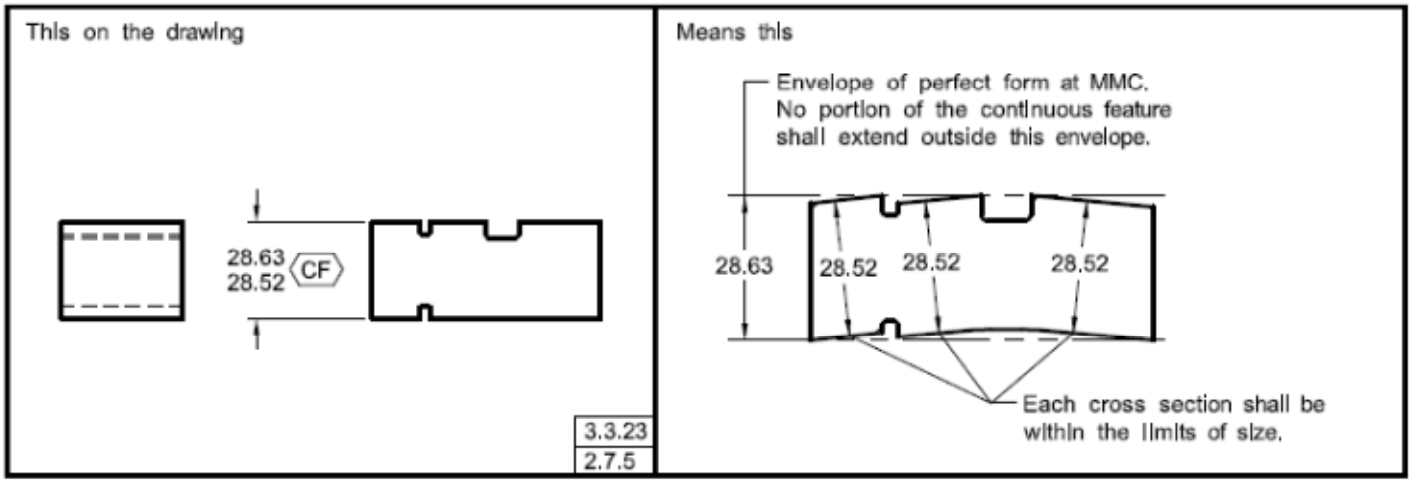
- Continuous Feature
  - Identifies group of features of size to be treated as a single feature

Fig. 2-8 Continuous Feature, External Cylindrical

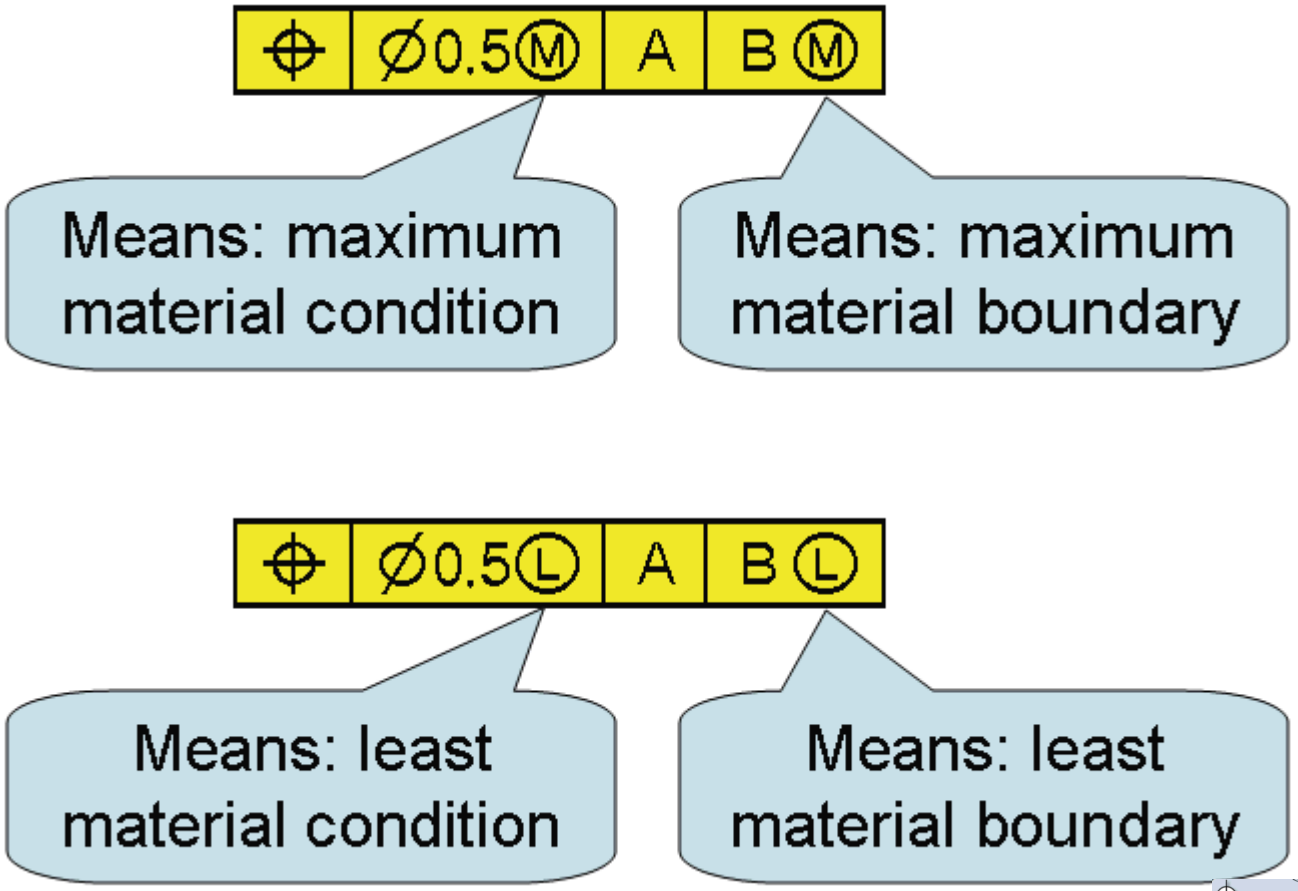


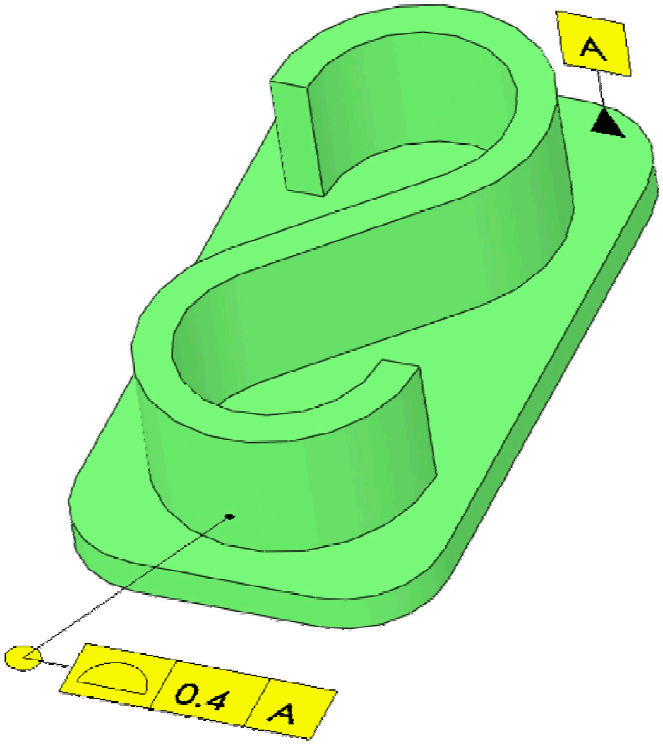
ASME Y14.5-2009
Principal Changes & Improvements

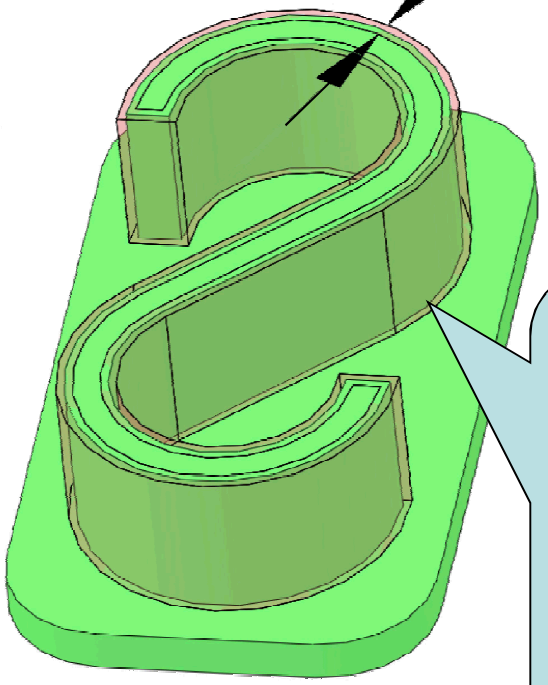
Fig. 2-10 Continuous Feature, External Width



MMC – Condition & Boundary Term







Profile tolerance zone

The maximum material boundary changes from an inner to an outer boundary

Former Practice

The default RFS condition, MMC and LMC have been revised to RMB, MMB and LMB respectively when they are applied to datum references. This change was made to help clear up confusion between the MMC, LMC and virtual condition This also enabled the modifiers to be applied to surfaces that are not features of size.

Former Practice

Rather than use the term virtual condition, the 2009 Standard uses the terms MMB and LMB.

Revision of the Standard ⇨		1994	2009
Type of Datum Feature ⇩	Datum Reference Modified ⇩	Virtual Condition ⇩	Boundary Controlled ⇩
Internal (hole or slot)	Ⓜ	Inner Boundary	MMB
	Ⓛ	Outer Boundary	LMB
External (shaft, tab or pin)	Ⓜ	Outer Boundary	MMB
	Ⓛ	Inner Boundary	LMB

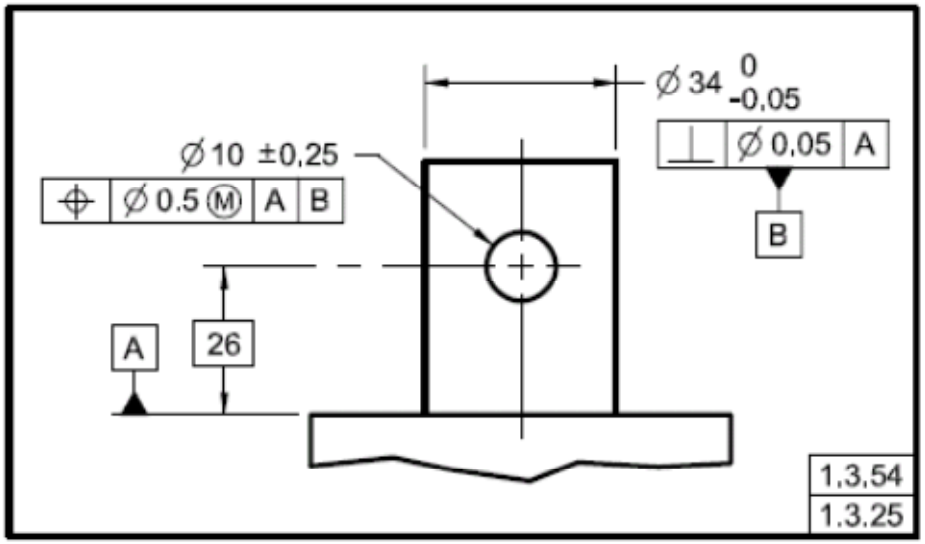
Readability [1.7.5.4 and 1.7.5.5]

Feature control frames and datum feature symbols should be placed to read from the bottom of the drawing. This was and is true for notes and dimensions (except for baseline dimensions which may also be read from the right side of the drawing). This clarifies the requirement for feature control frames and datum feature symbols.

ASME Y14.5-2009
Principal Changes & Improvements

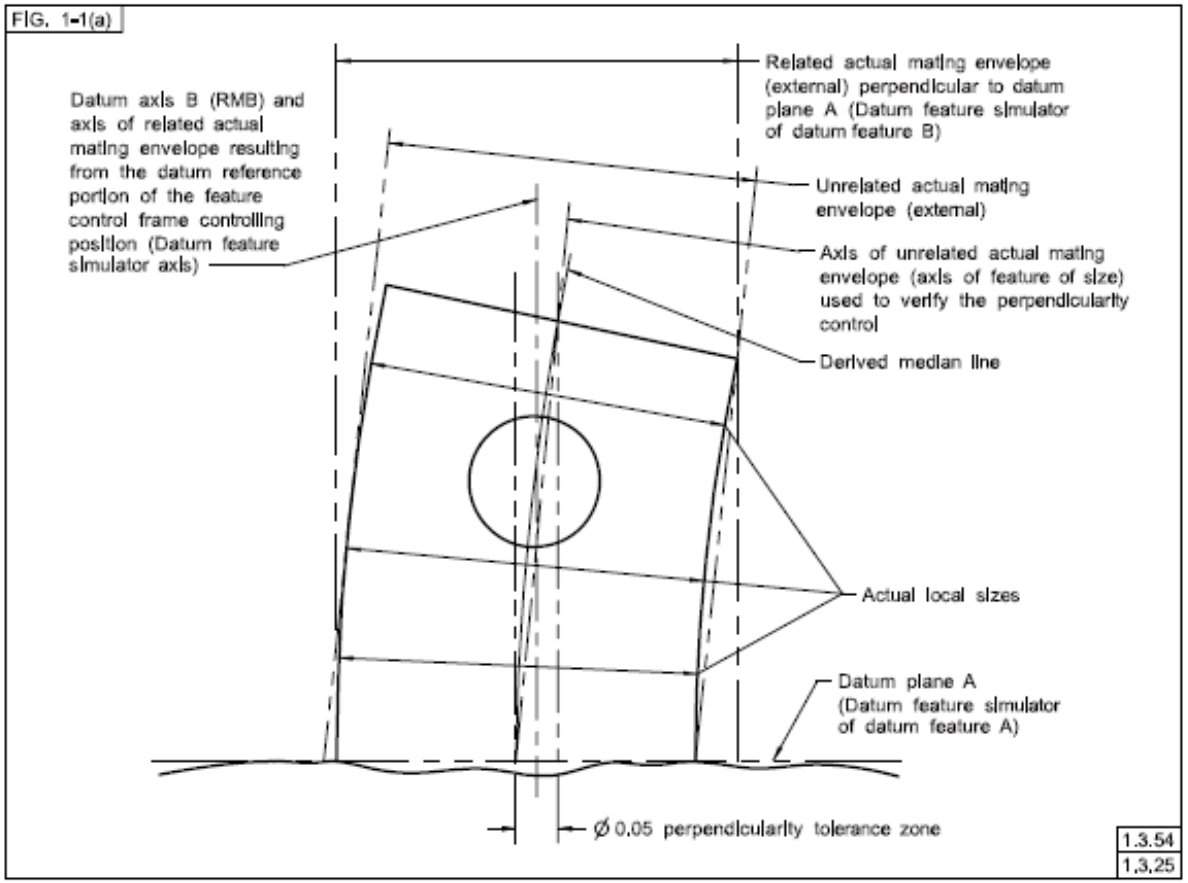
- Envelope Terms
  - Related
  - Unrelated
    - True Geometric Counterpart (TGC) removed
  - Feature Axis
    - unrelated

Fig. 1-1 Related and Unrelated Actual Mating Envelope

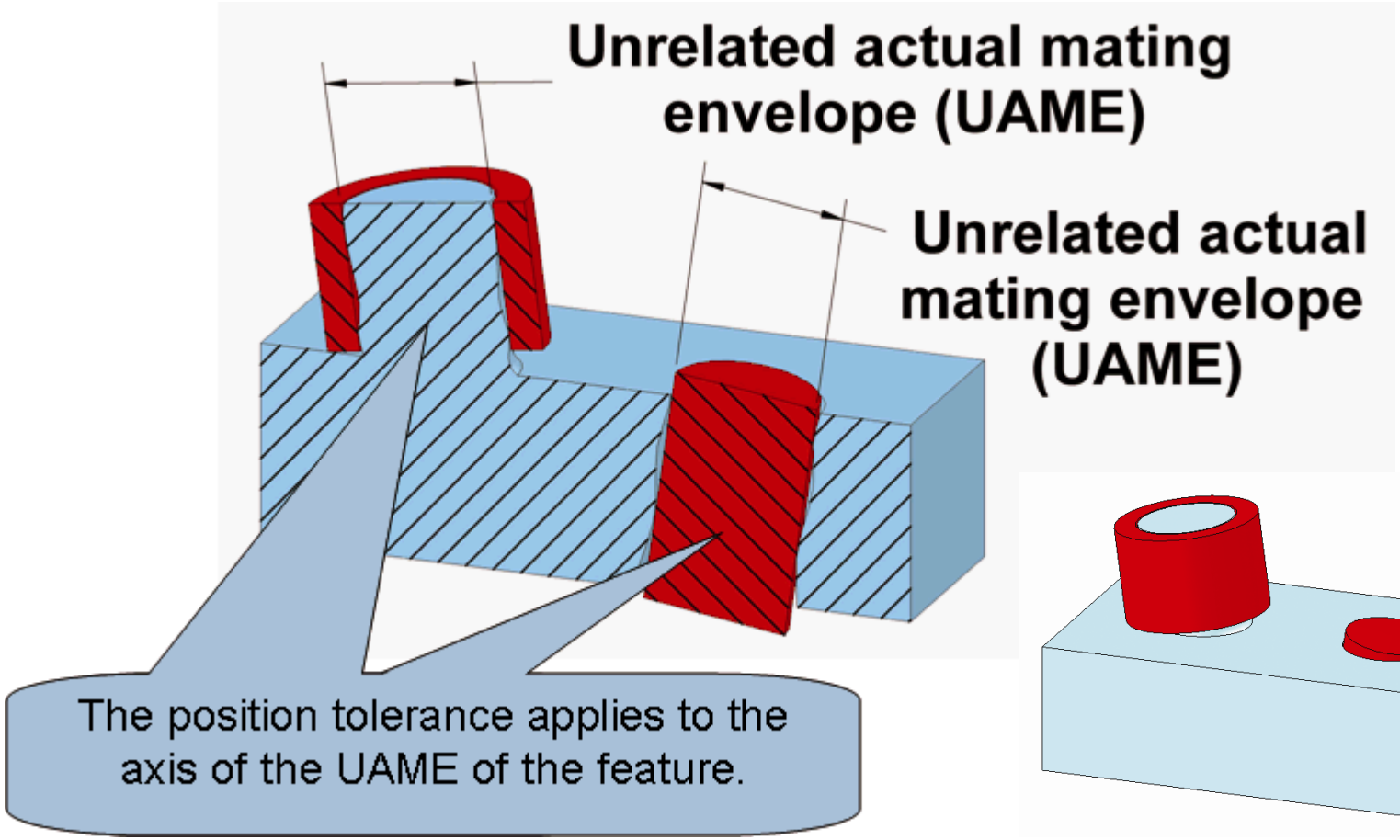


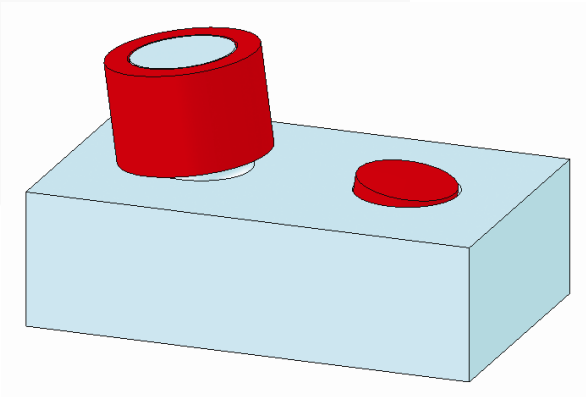
ASME Y14.5-2009
Principal Changes & Improvements

Fig. 1-1 Related and Unrelated Actual Mating Envelope (Cont'd)

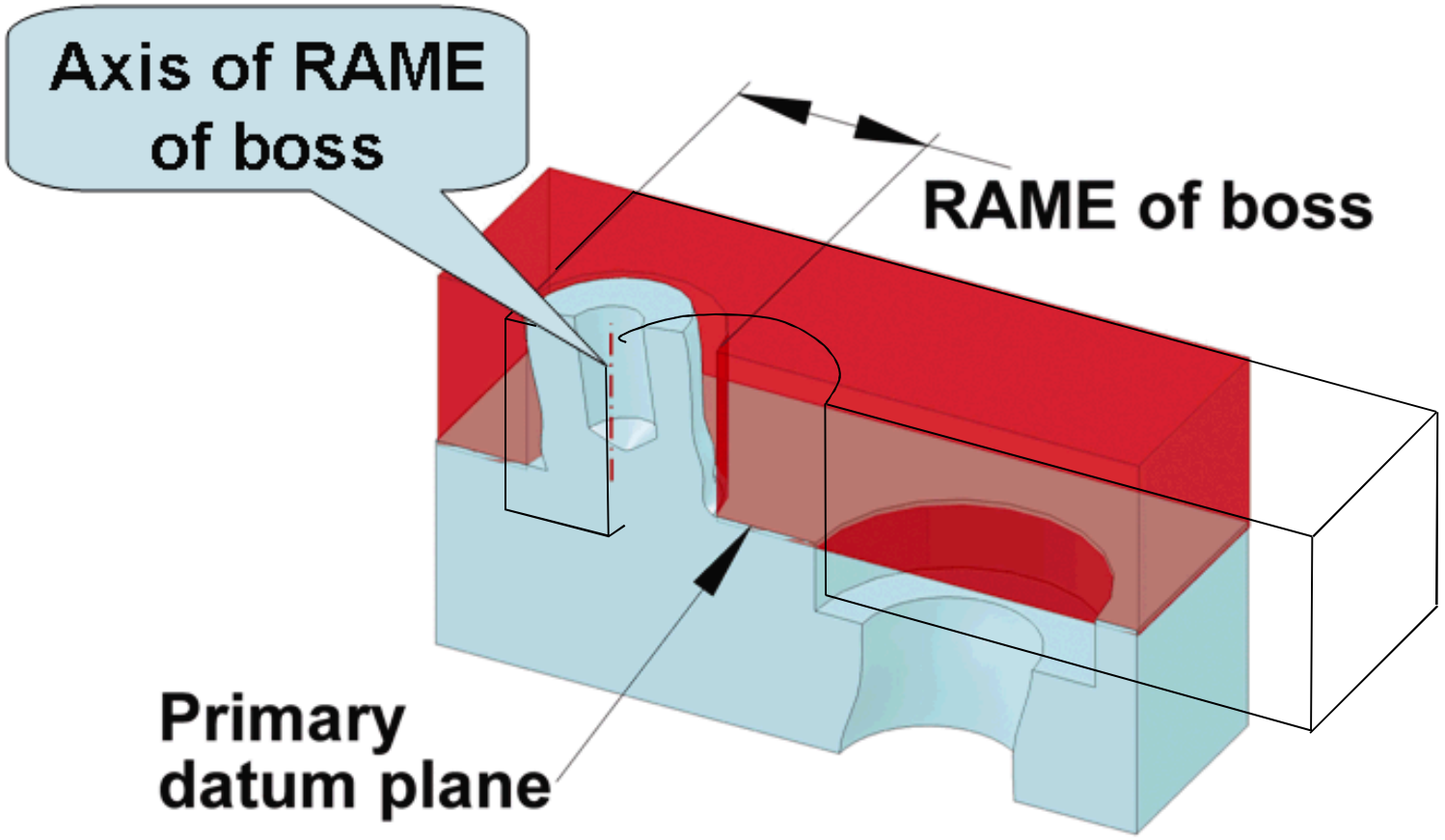


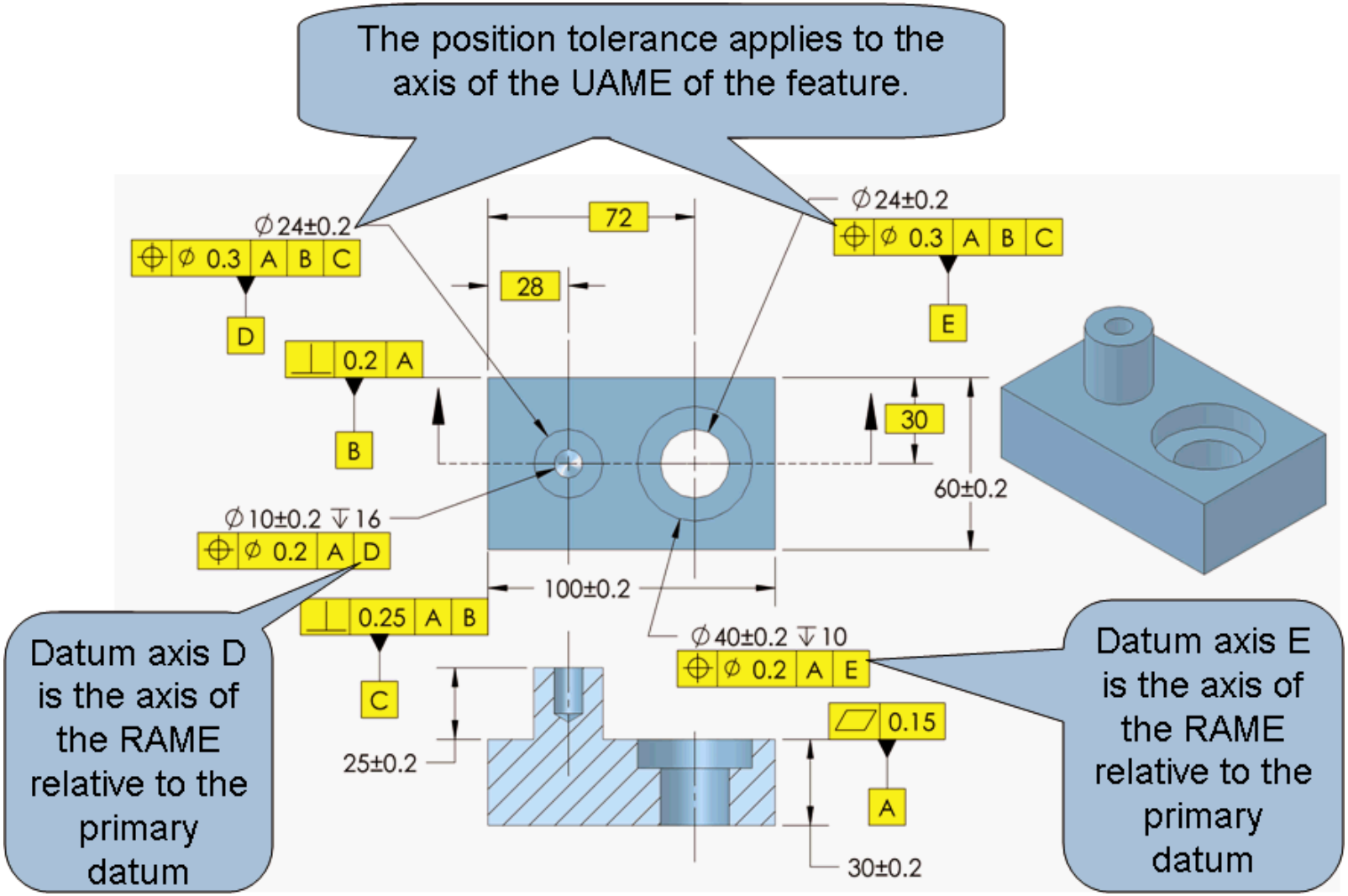
Actual Mating Envelope (AME)





Related Actual Mating Envelope (RAME) [1.3.25.2]



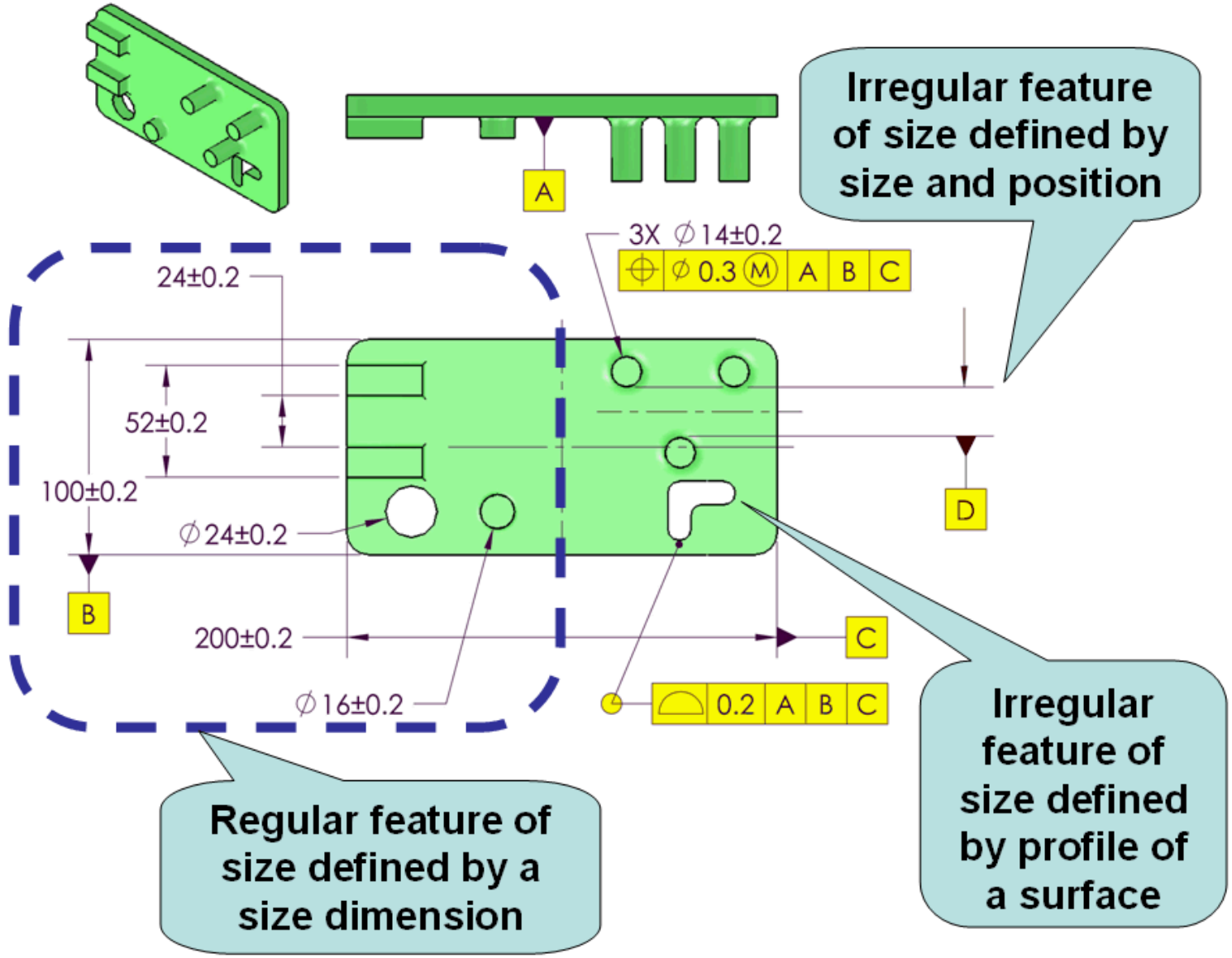

The position tolerance applies to the axis of the UAME of the feature.
Ø24±0.2
⌖ Ø 0.3 A B C
D
Ø24±0.2
⌖ Ø 0.3 A B C
E
72
28
⊥ 0.2 A
B
30
60±0.2
Ø10±0.2 ↧16
⌖ Ø 0.2 A D
100±0.2
⊥ 0.25 A B
C
Ø40±0.2 ↧10
⌖ Ø 0.2 A E
▱ 0.15
A
25±0.2
30±0.2
Datum axis D is the axis of the RAME relative to the primary datum
Datum axis E is the axis of the RAME relative to the primary datum

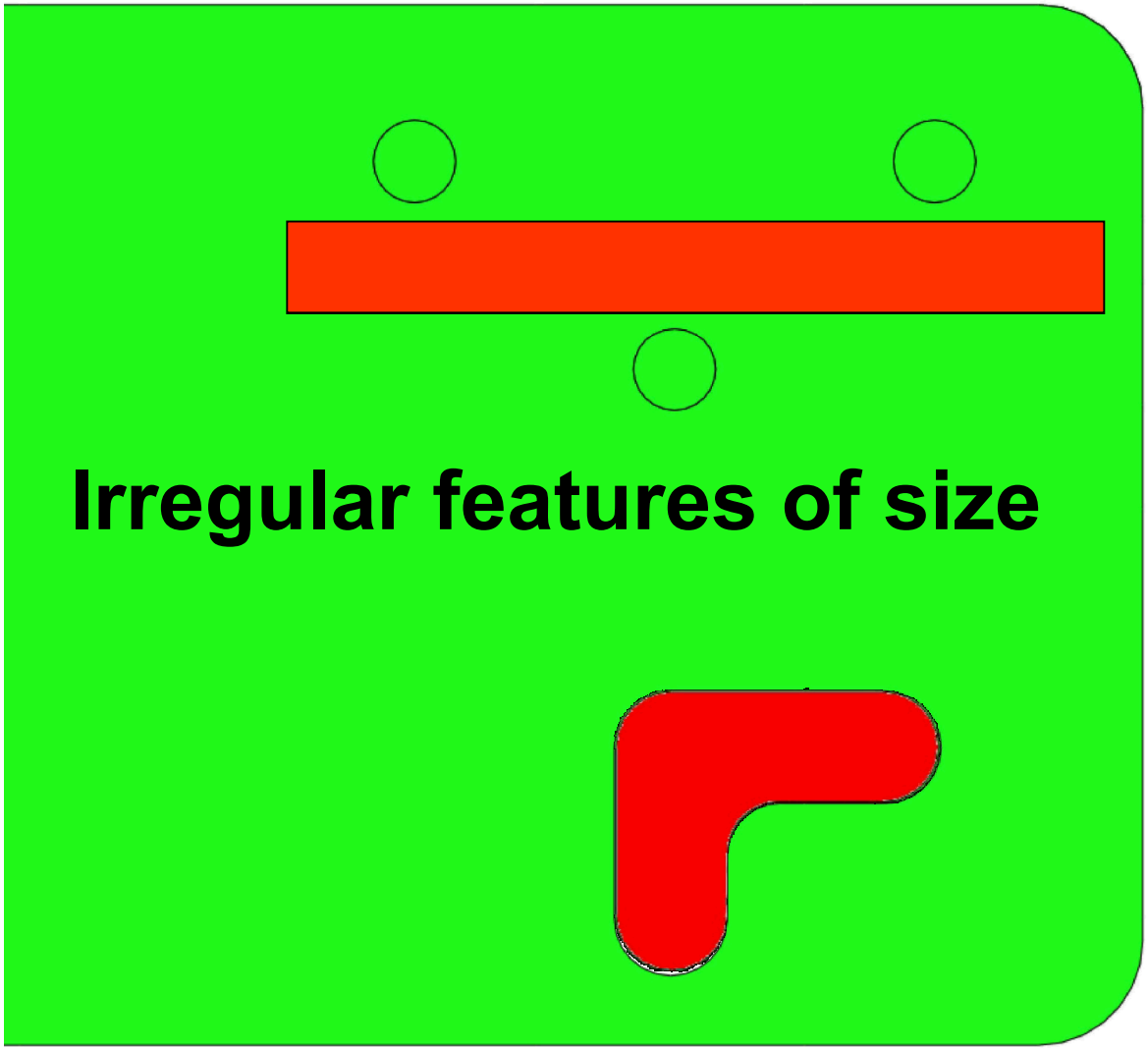
Irregular Features of Size

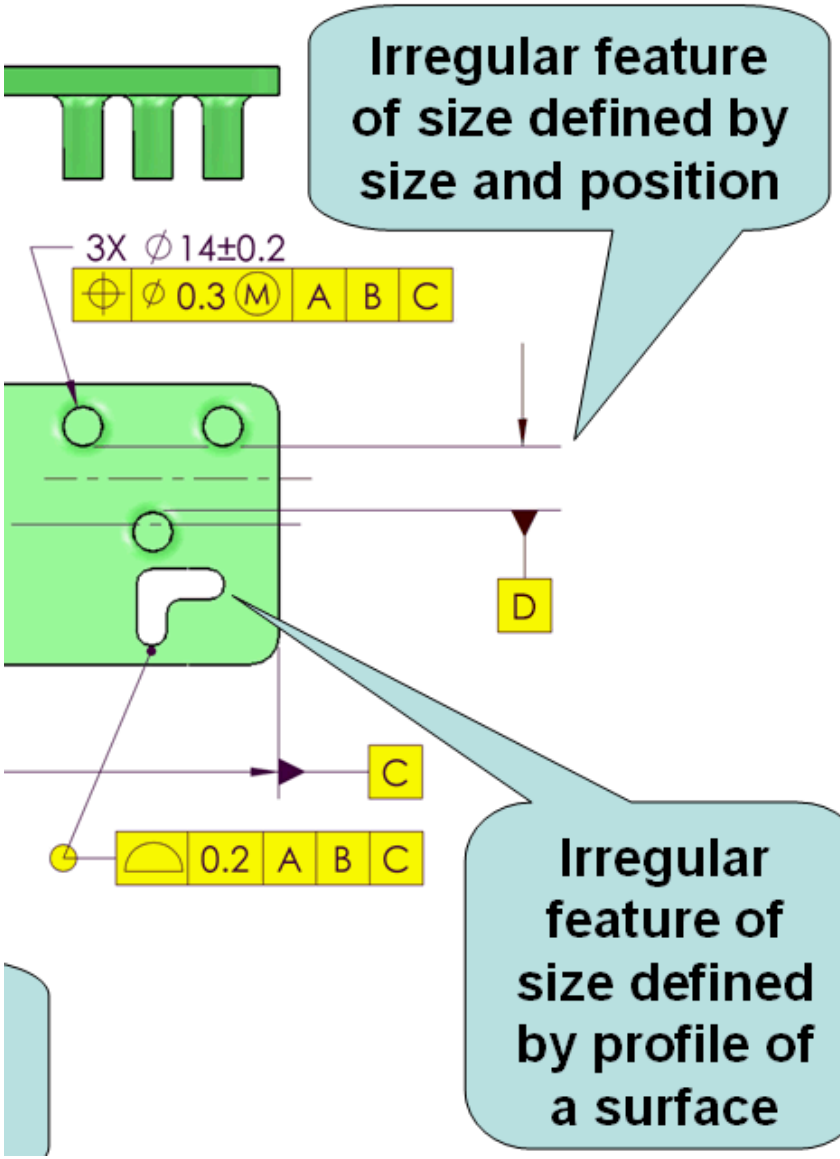
- The irregular features of size have some but not all of the attributes of a regular feature of size.
- Irregular features of size do not rely on Rule #1 to define the meaning of size.
- The feature's size might be controlled by profile of a surface or a combination of size and position.
- Some irregular features of size do not have a clearly defined or reproducible center, axis or center plane.

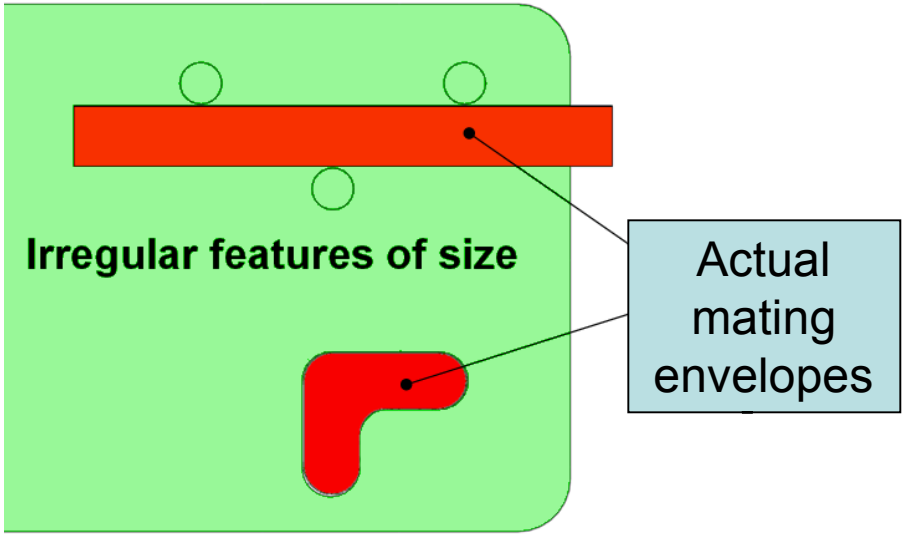
Irregular Features of Size

- **Irregular features of size are features or collections of features that may either contain or be contained by an actual mating envelope.**
- **If the irregular feature actual mating envelope is a sphere, cylinder or pair of parallel planes, a center, axis or center plane respectively will be obvious.**


A
3X ∅14±0.2
∅ 0.3 M A B C
24±0.2
52±0.2
100±0.2
∅24±0.2
B
200±0.2
∅16±0.2
0.2 A B C
D
C
Irregular feature of size defined by size and position
Irregular feature of size defined by profile of a surface
Regular feature of size defined by a size dimension


Irregular features of size


Irregular feature of size defined by size and position
3X ∅14±0.2
∅ 0.3 M A B C
D
C
0.2 A B C
Irregular feature of size defined by profile of a surface


Irregular features of size
Actual mating envelopes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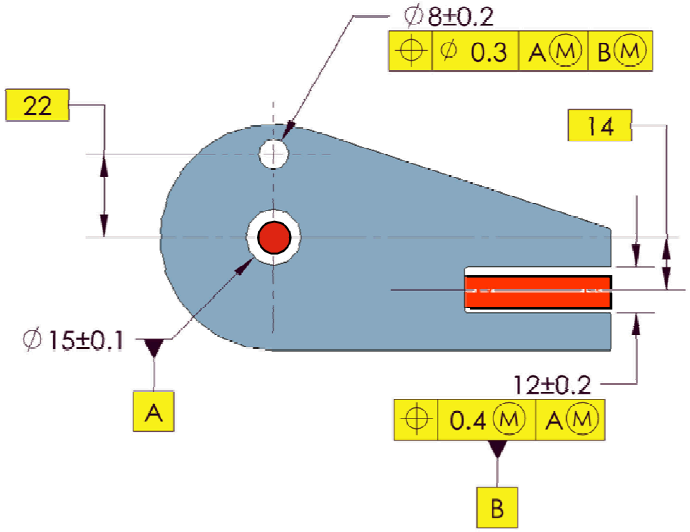
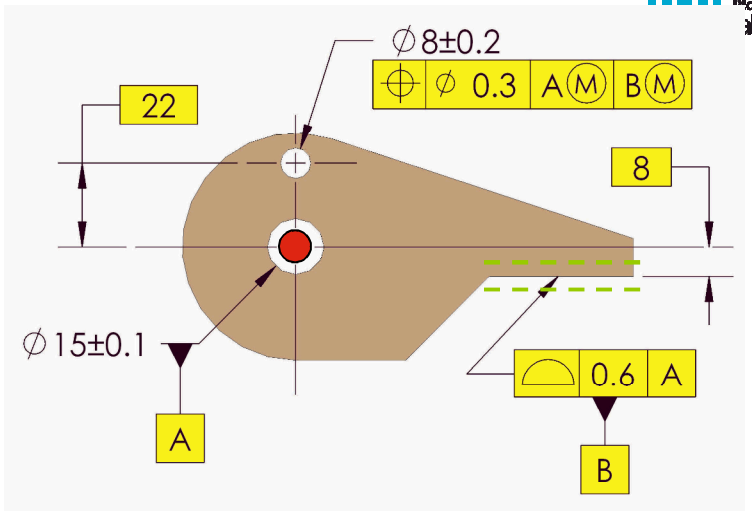
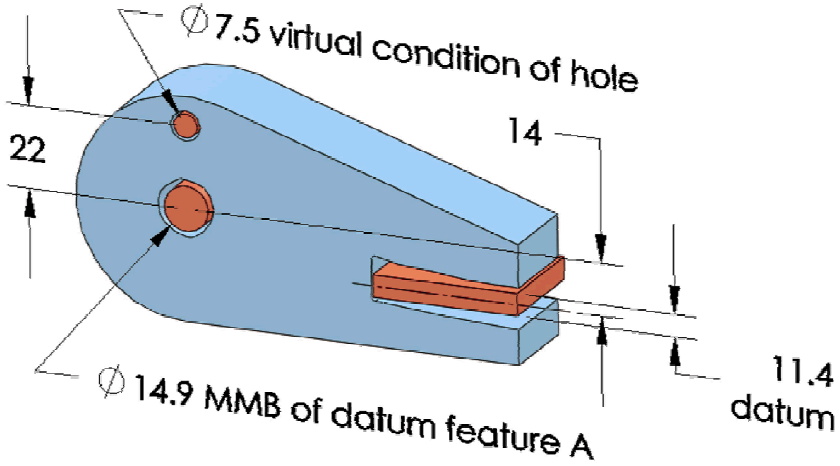
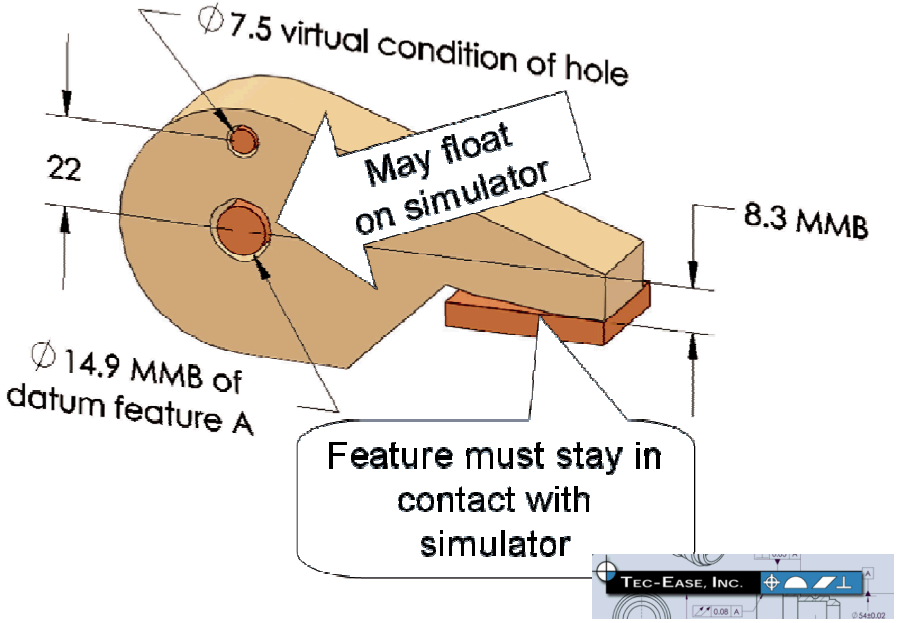

∅8±0.2
∅ 0.3 A M B M
22
14
∅15±0.1
A
12±0.2
0.4 M A M
B


∅8±0.2
∅ 0.3 A M B M
22
8
∅15±0.1
A
0.6 A
B


∅7.5 virtual condition of hole
22
14
11.4
datum
∅14.9 MMB of datum feature A


∅7.5 virtual condition of hole
22
May float on simulator
8.3 MMB
∅14.9 MMB of datum feature A
Feature must stay in contact with simulator
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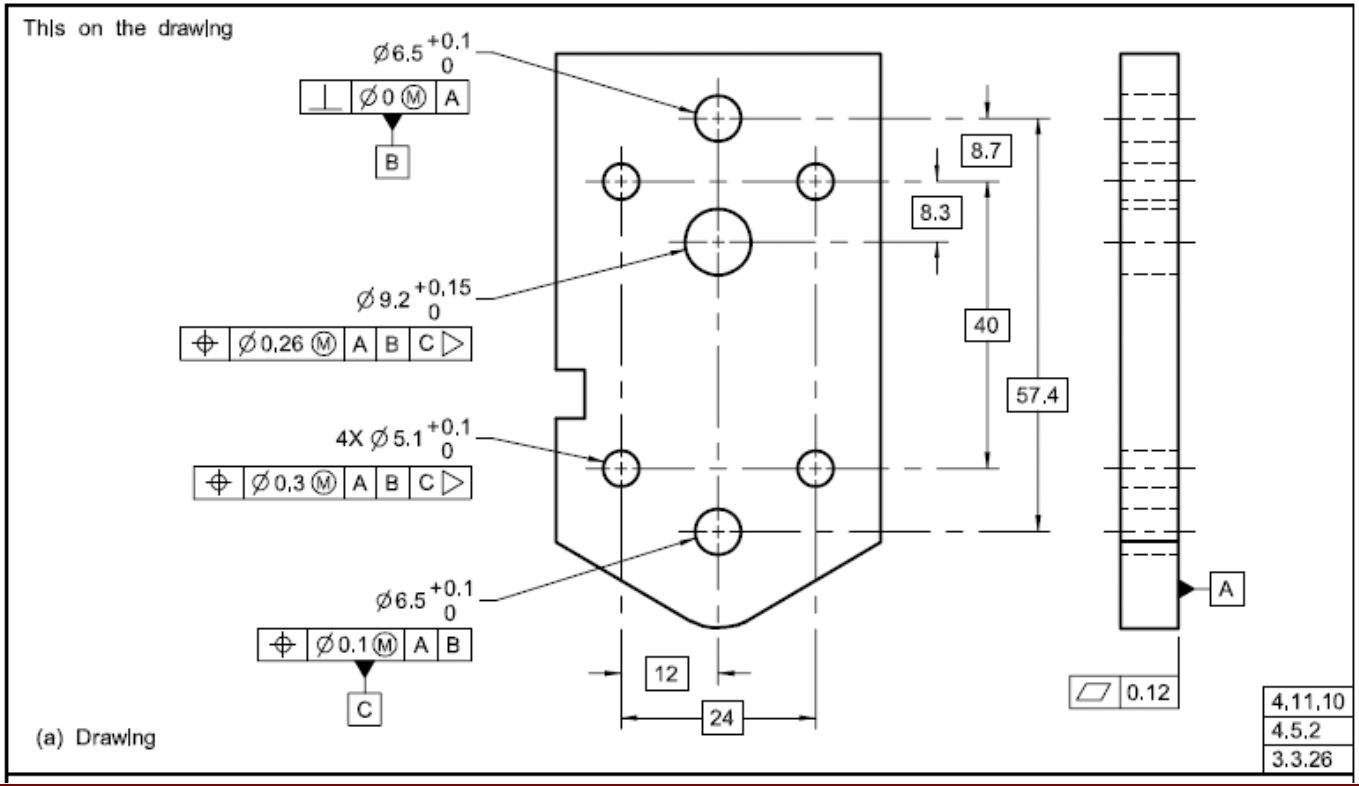
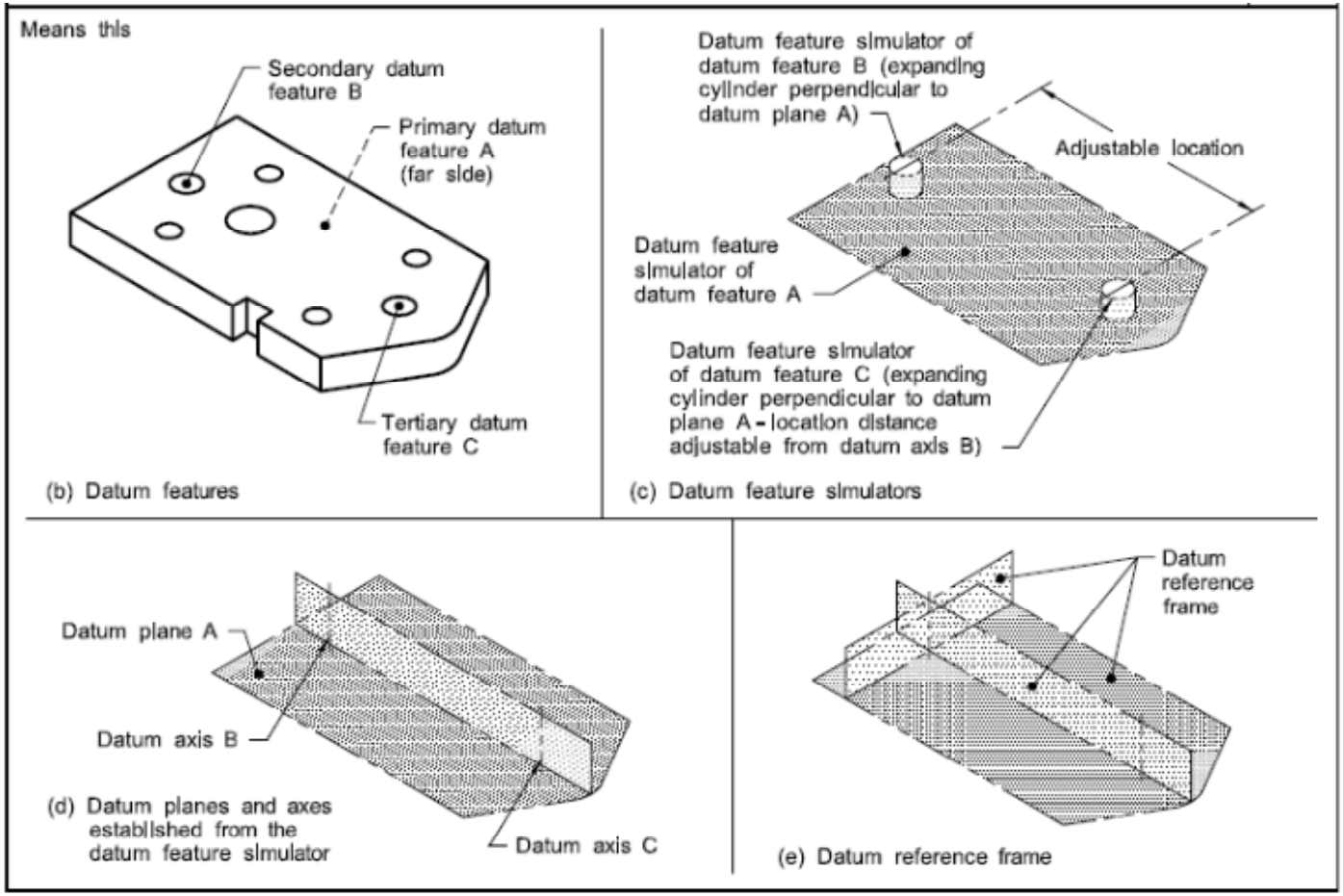
ASME Y14.5-2009
Principal Changes & Improvements

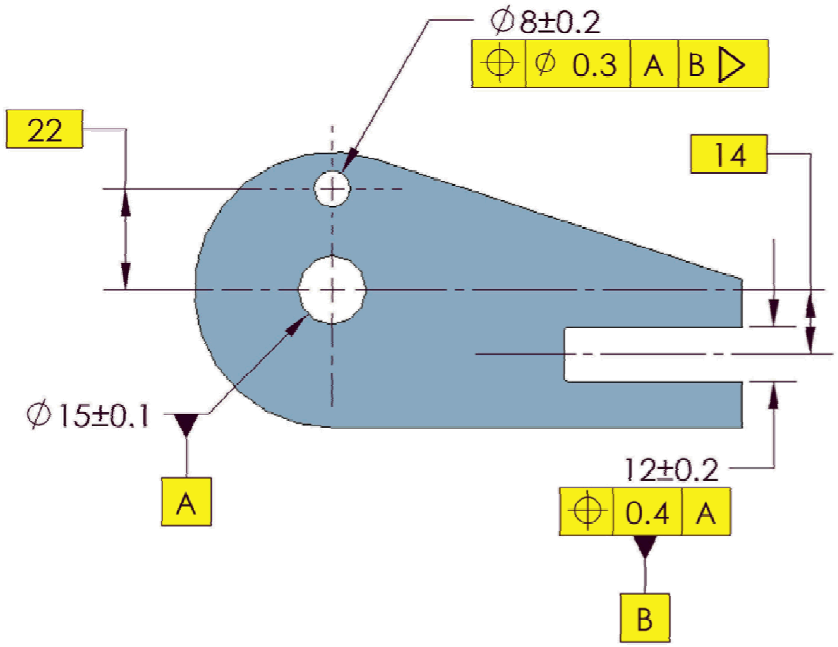
- Translation modifier allows simulator to translate within tolerance zone

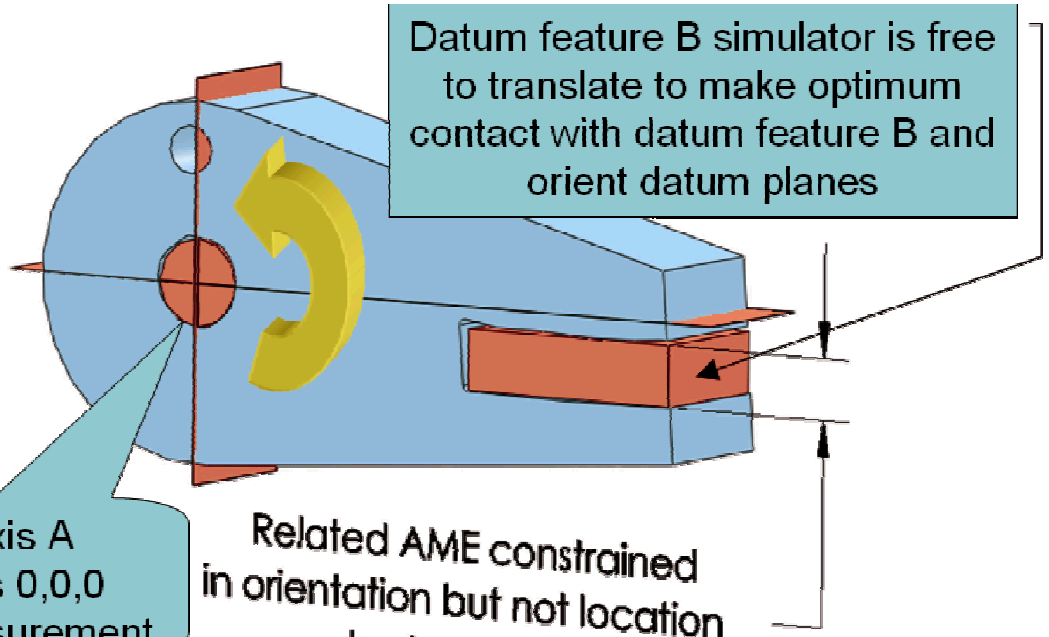
Fig. 4-19 Development of a Datum Reference Frame With Translation Modifier



ASME Y14.5-2009
Principal Changes & Improvements



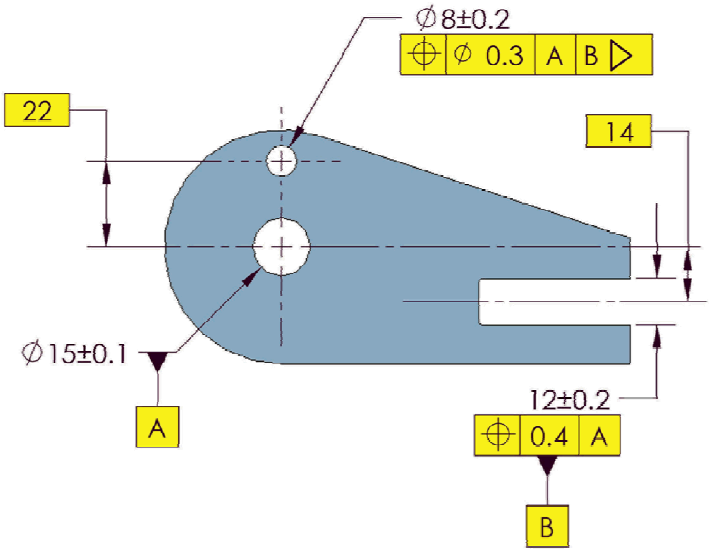




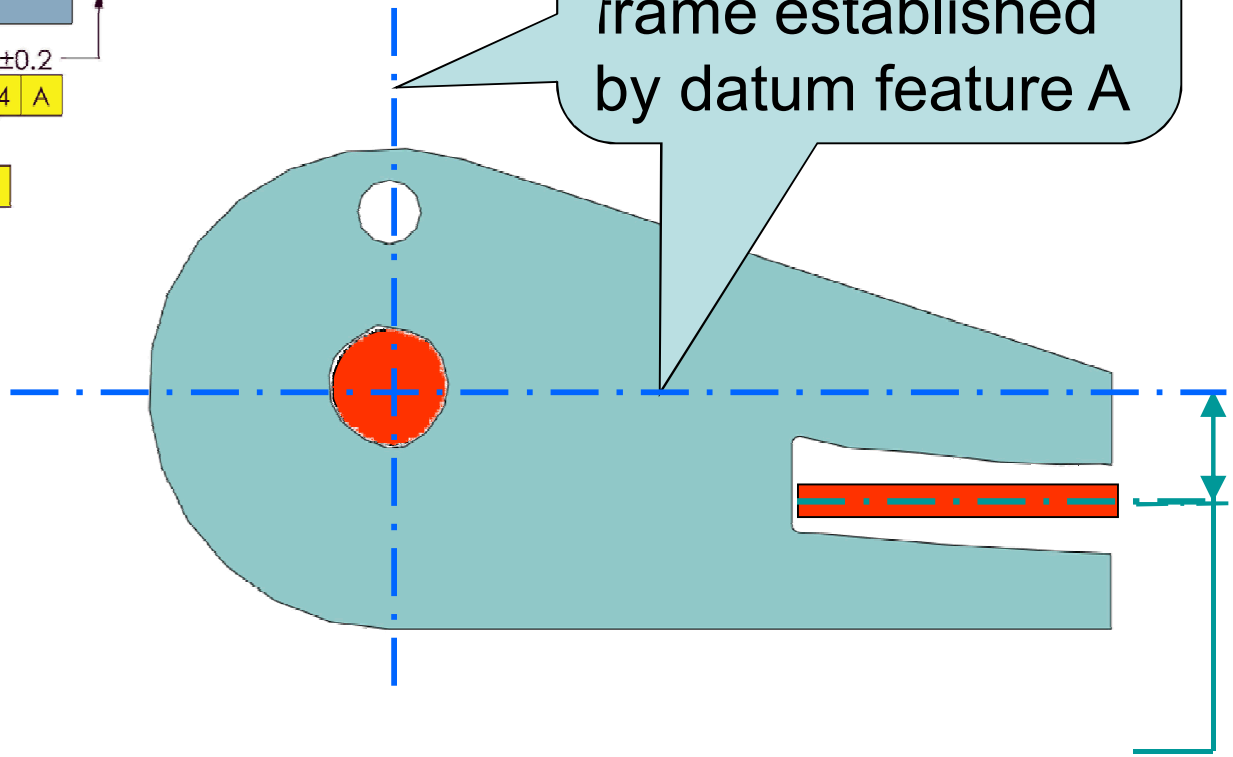
Datum feature B simulator is free to translate to make optimum contact with datum feature B and orient datum planes

Datum axis A establishes 0,0,0 origin of measurement

Related AME constrained in orientation but not location to datum axis A



Datum planes of datum reference *f*rame established by datum feature A



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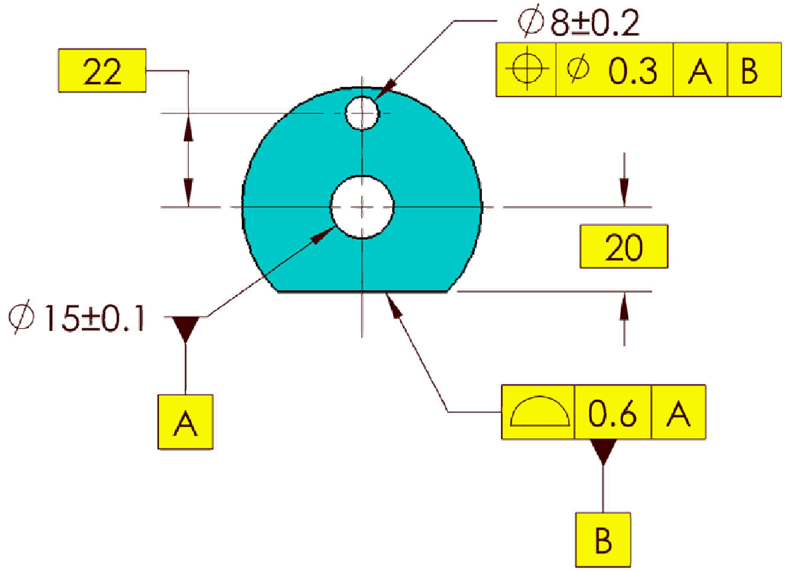
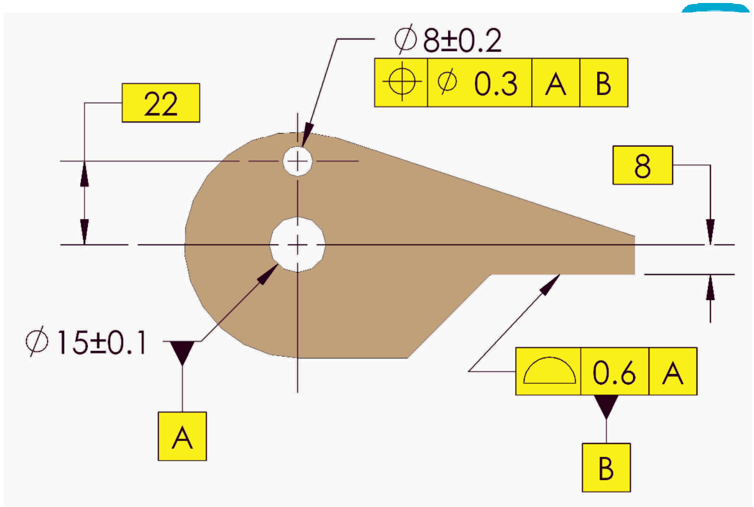
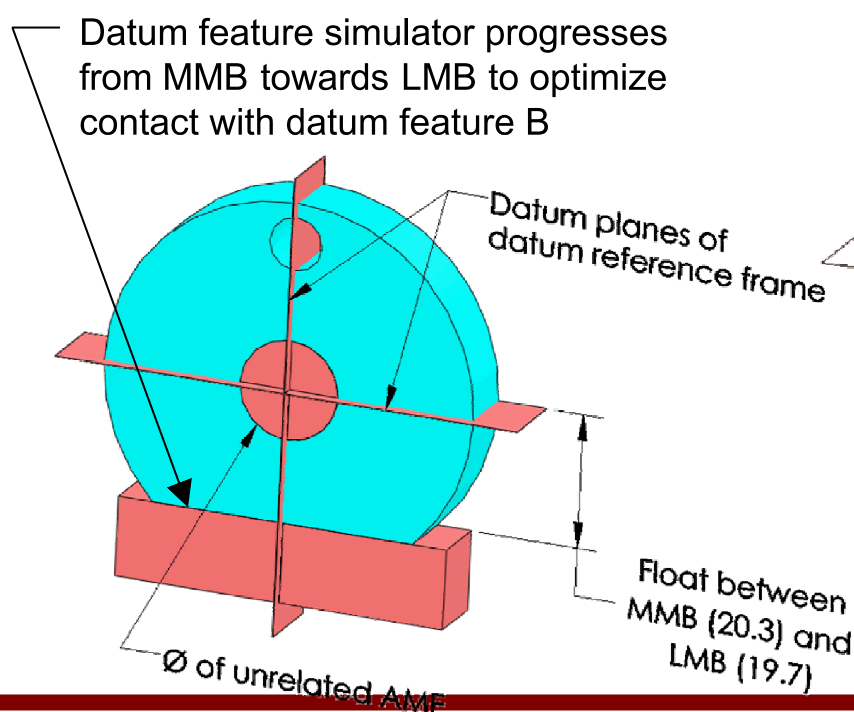
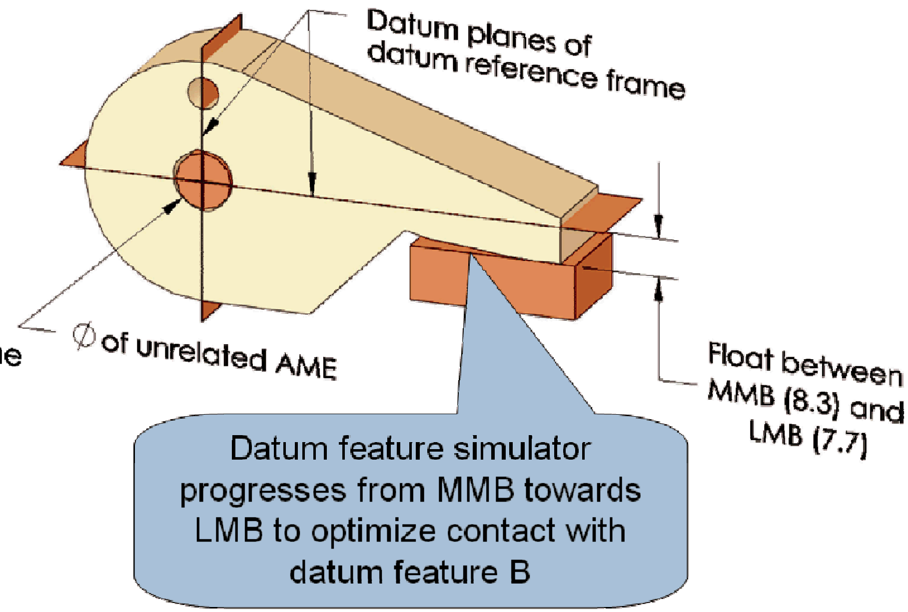
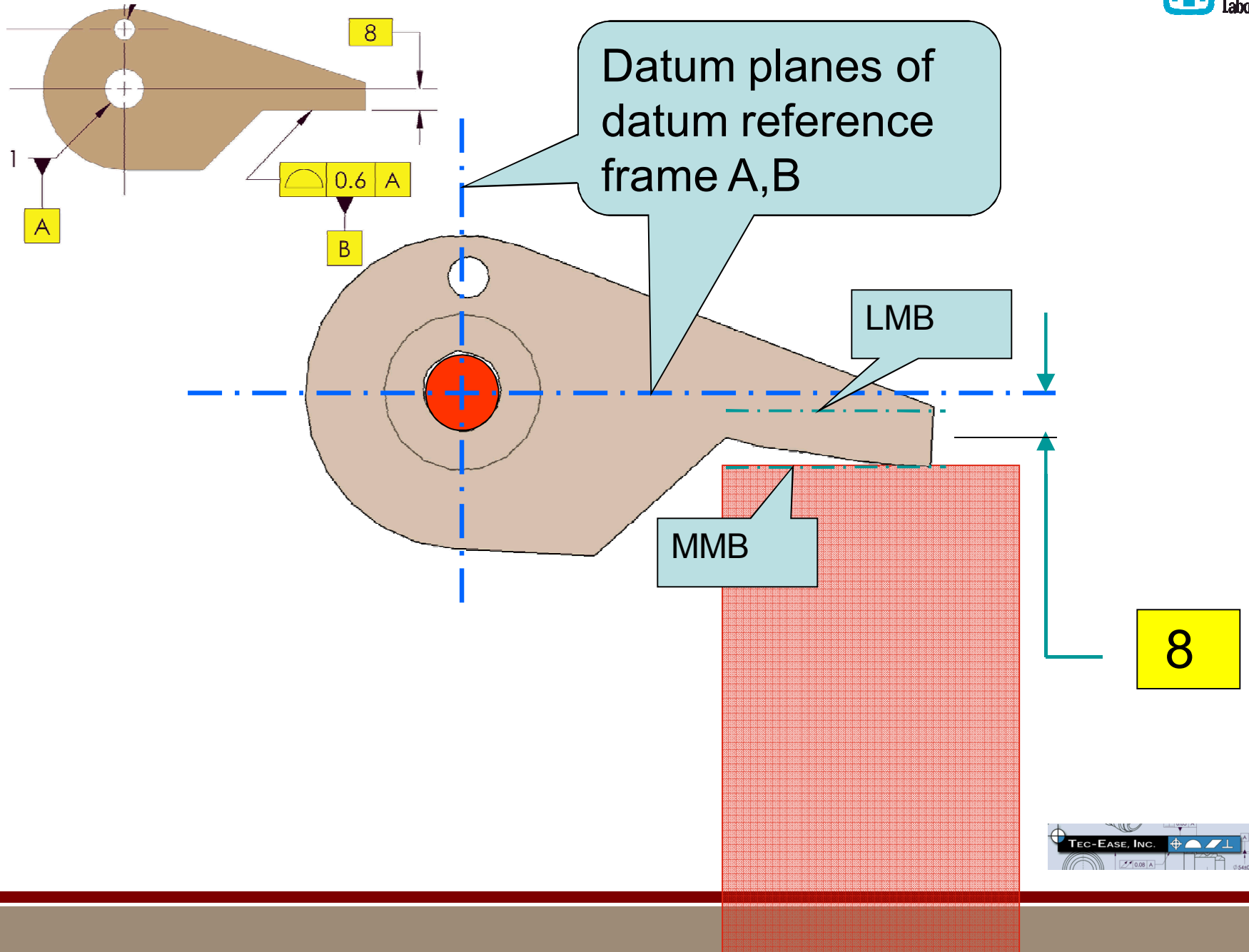
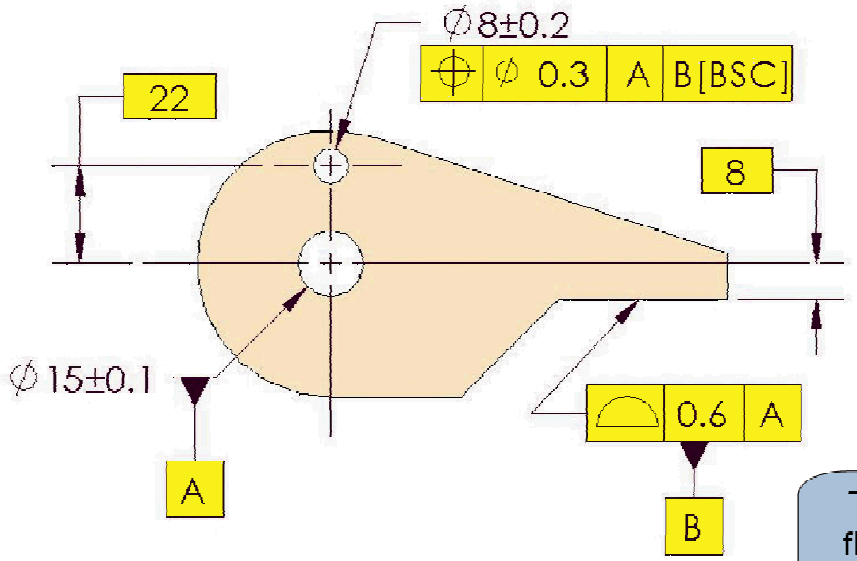

∅8±0.2
⌖ ∅ 0.3 A B
22
20
∅15±0.1
A
⌓ 0.6 A
B

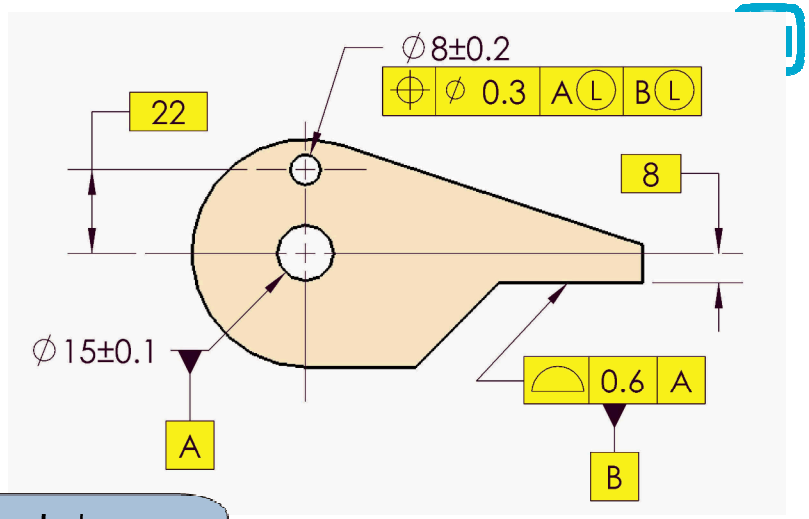

∅8±0.2
⌖ ∅ 0.3 A B
22
8
∅15±0.1
A
⌓ 0.6 A
B

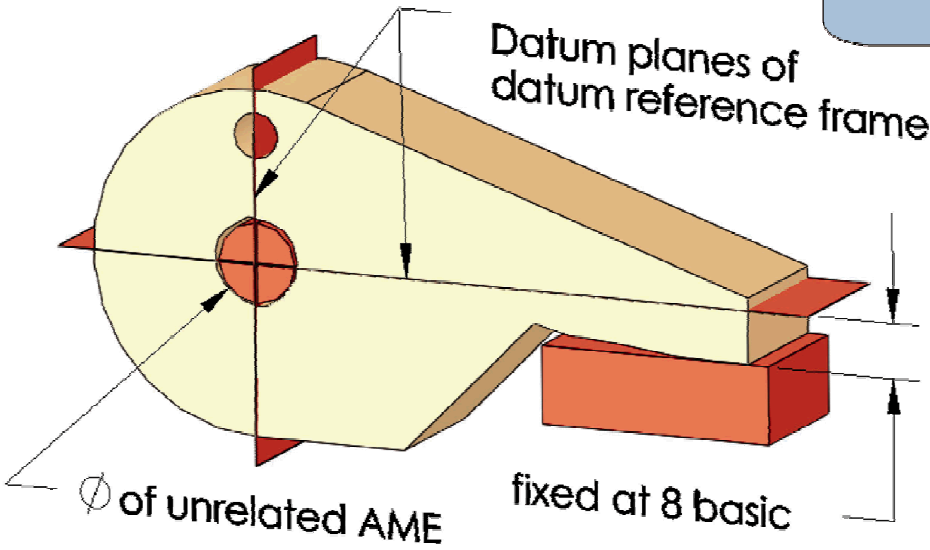

Datum feature simulator progresses from MMB towards LMB to optimize contact with datum feature B
Datum planes of datum reference frame
Float between MMB (20.3) and LMB (19.7)
Ø of unrelated AME

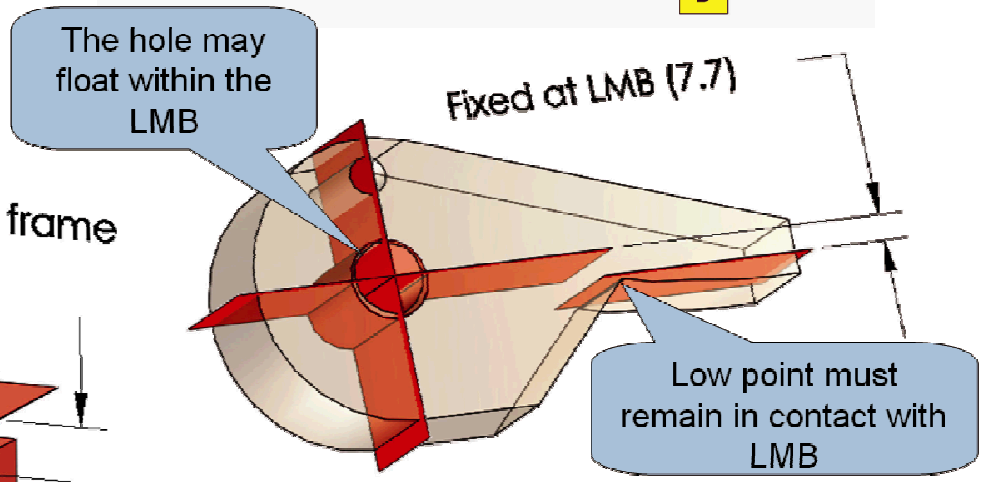

Datum planes of datum reference frame
∅ of unrelated AME
Float between MMB (8.3) and LMB (7.7)
Datum feature simulator progresses from MMB towards LMB to optimize contact with datum feature B


8
1
A
0.6
A
B
Datum planes of datum reference frame A,B
LMB
MMB
8


∅8±0.2
∅ 0.3 A B[BSC]
22
8
∅15±0.1
0.6 A
A
B


∅8±0.2
∅ 0.3 A(L) B(L)
22
8
∅15±0.1
0.6 A
A
B


Datum planes of datum reference frame
∅ of unrelated AME
fixed at 8 basic


The hole may float within the LMB
Fixed at LMB (7.7)
Low point must remain in contact with LMB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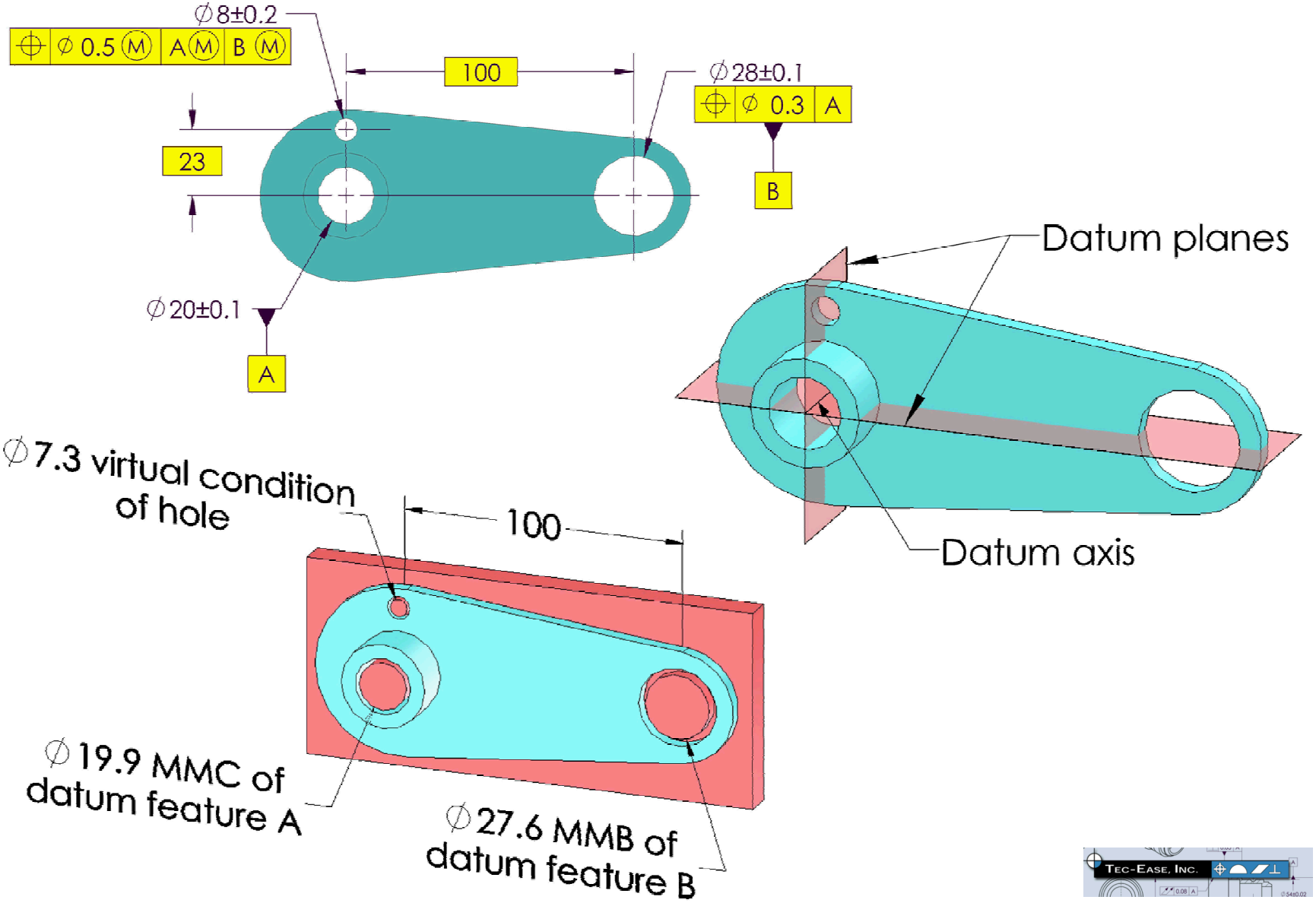
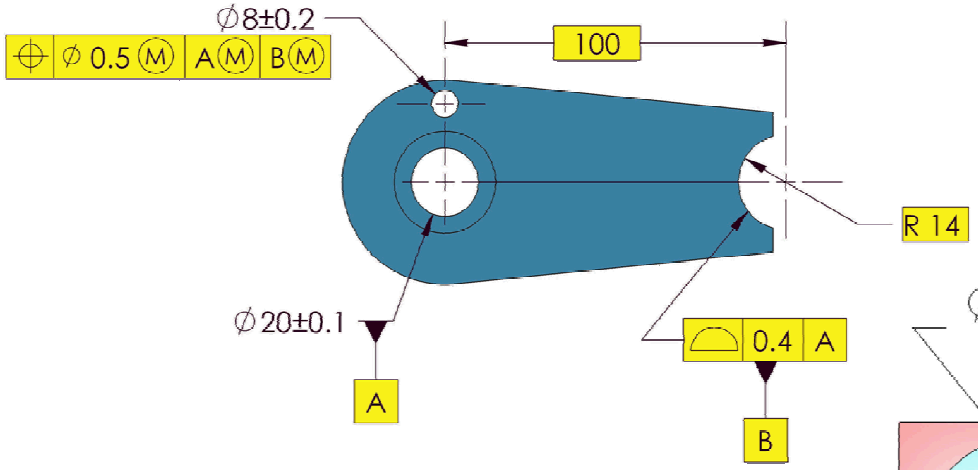
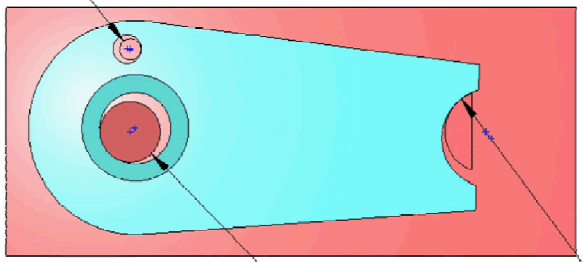

∅8±0.2
⌖ ∅ 0.5 M A M B M
100
∅28±0.1
⌖ ∅ 0.3 A
23
B
∅20±0.1
A
Datum planes
Datum axis
∅7.3 virtual condition of hole
100
∅19.9 MMC of datum feature A
∅27.6 MMB of datum feature B



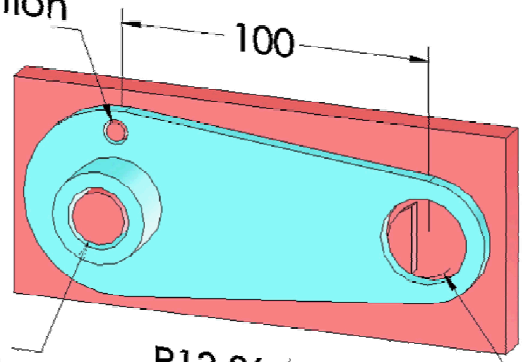
⌀7.3 virtual condition of hole



R13.8 MMB

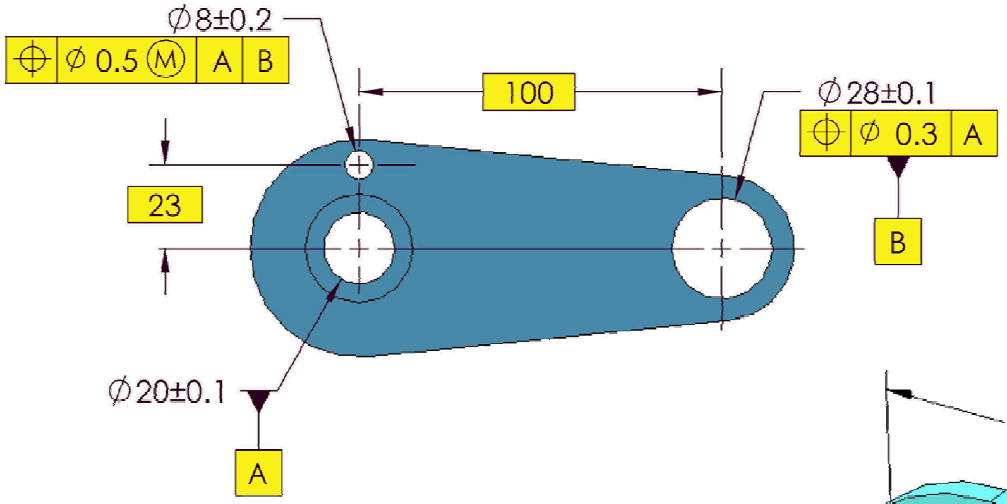
⌀19.9 MMC of datum feature A

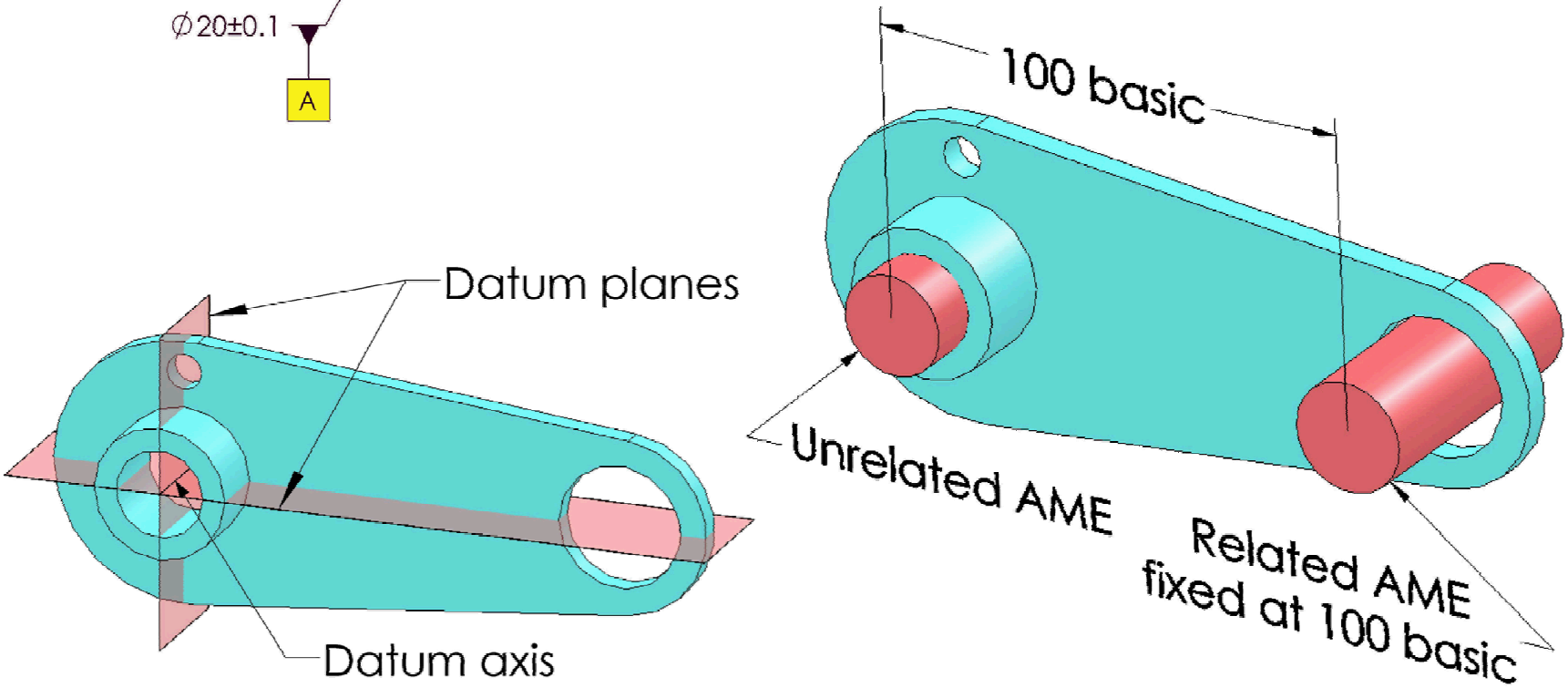
⌀7.3 virtual condition of hole

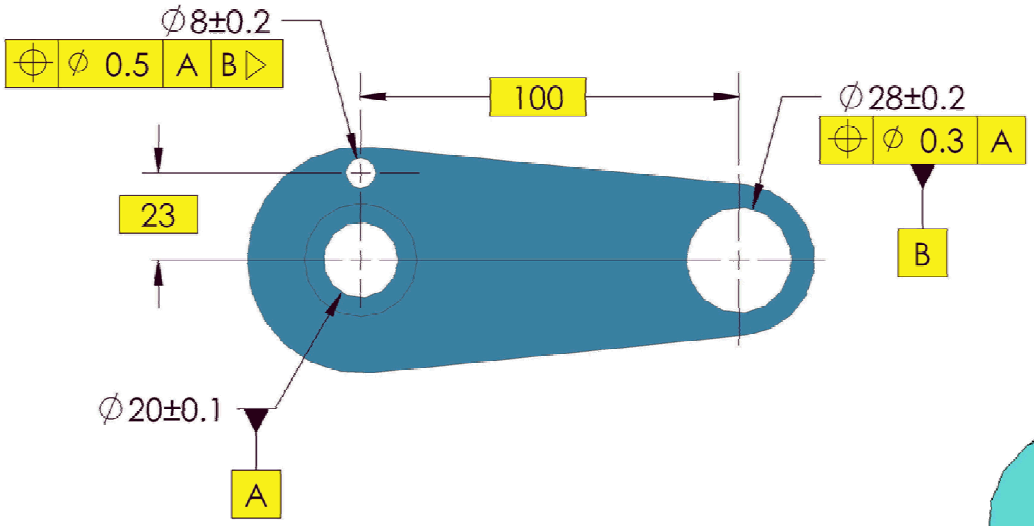


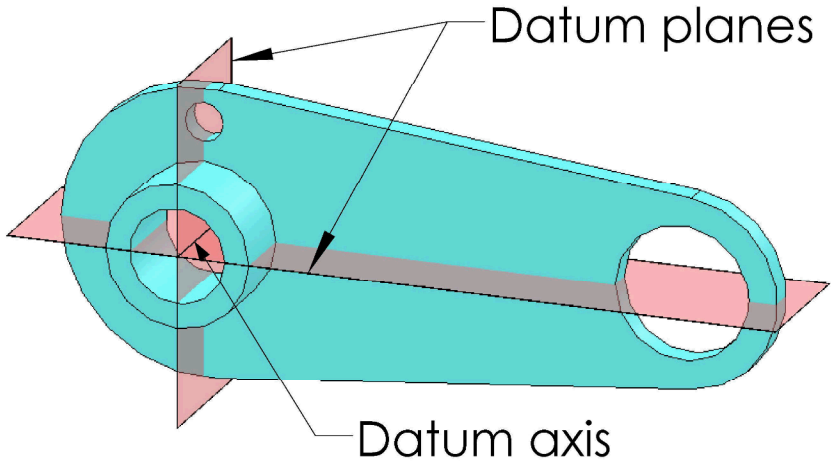
⌀19.9 MMC of datum feature A

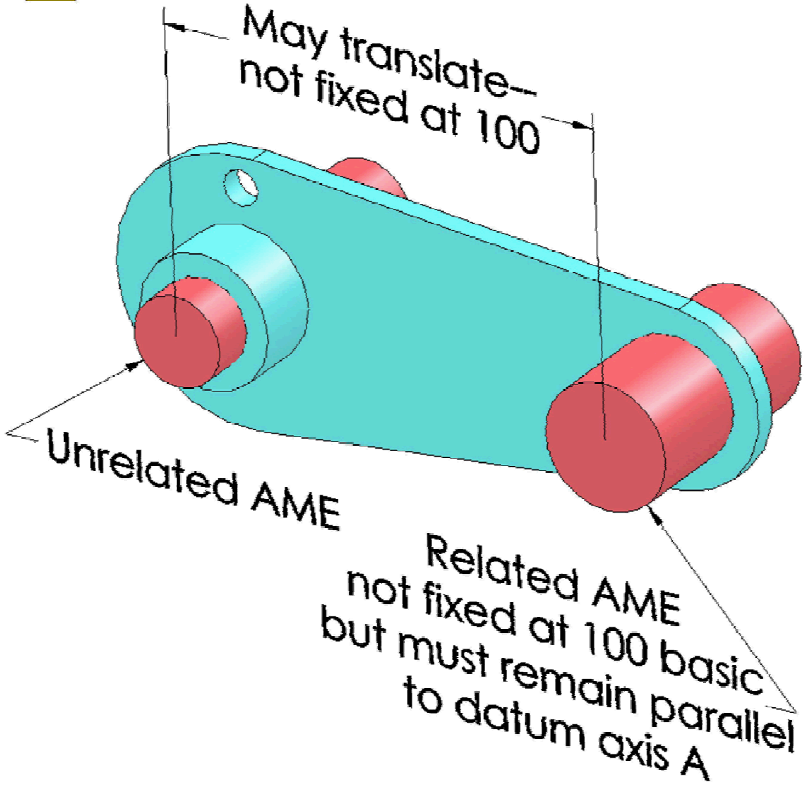
R13.8(⌀27.6/2) MMB of datum feature B

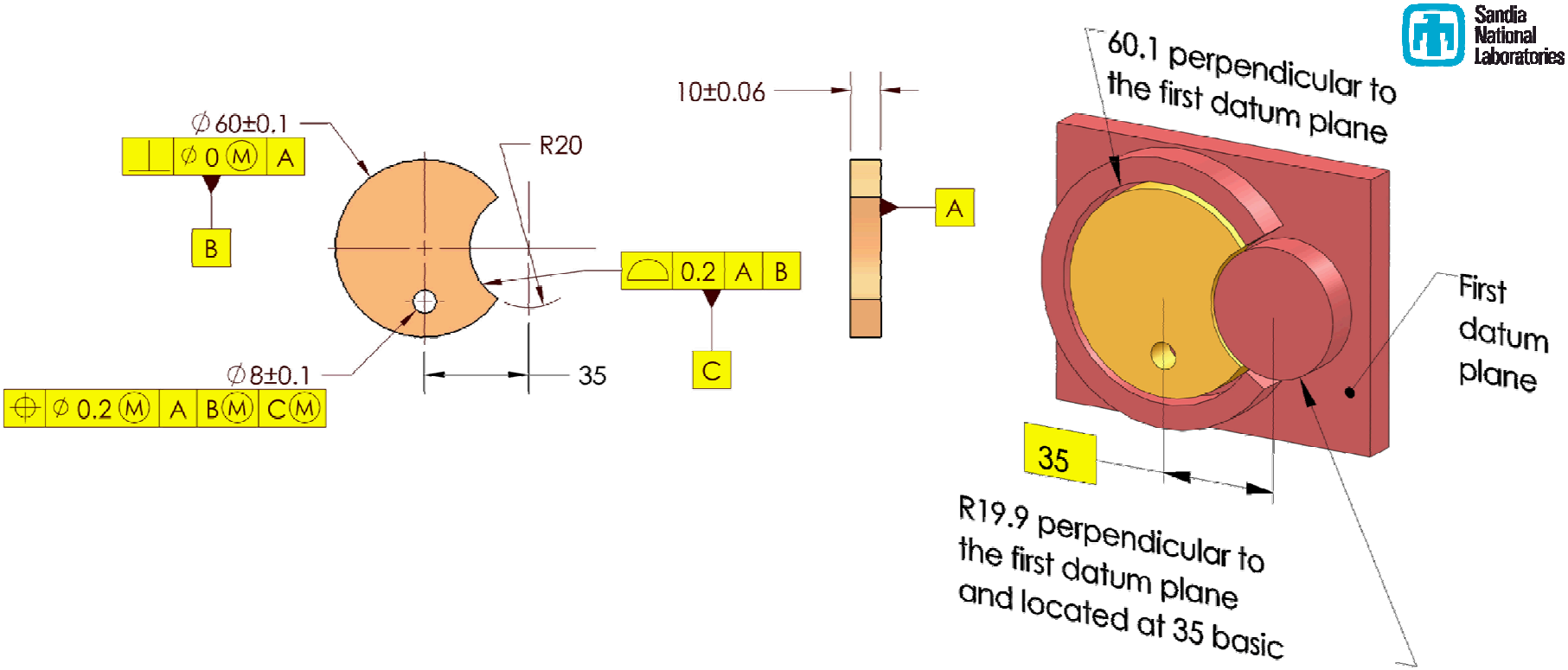

∅8±0.2
⌖ ∅ 0.5 Ⓜ A B
100
∅28±0.1
⌖ ∅ 0.3 A
23
B
∅20±0.1
A


Datum planes
Datum axis
100 basic
Unrelated AME
Related AME
fixed at 100 basic

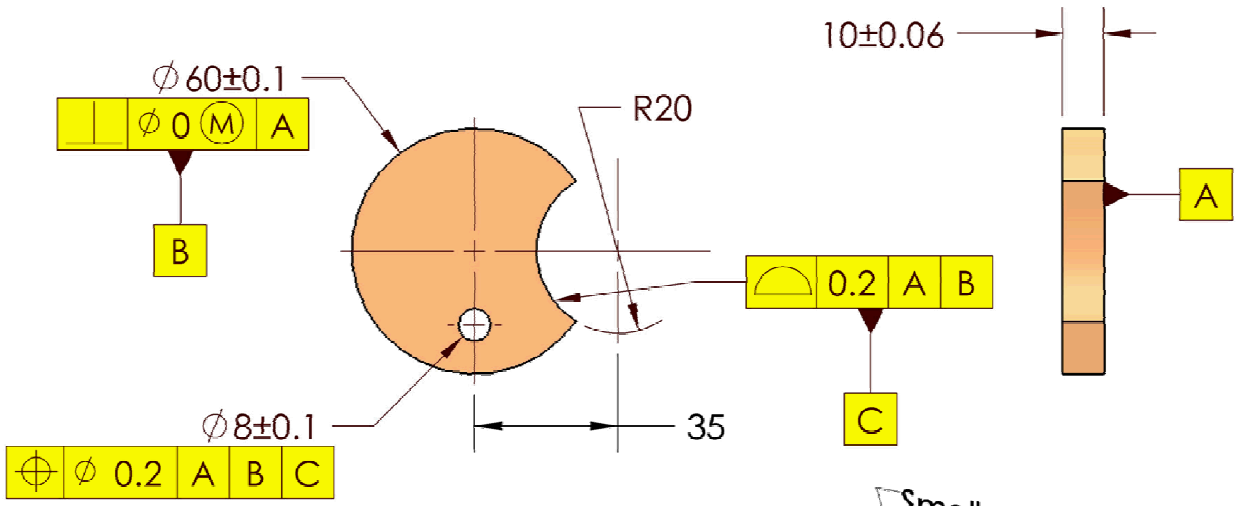

∅8±0.2
⌖ ∅ 0.5 A B
100
∅28±0.2
⌖ ∅ 0.3 A
23
B
∅20±0.1
A

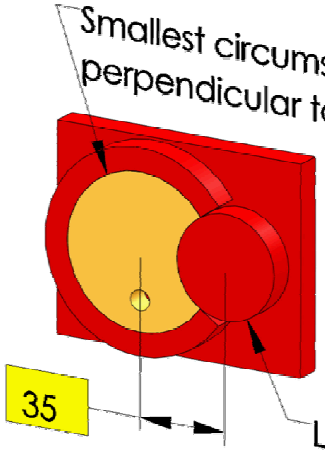

Datum planes
Datum axis


May translate–
not fixed at 100
Unrelated AME
Related AME
not fixed at 100 basic
but must remain parallel
to datum axis A


Sandia National Laboratories
∅60±0.1
∅ 0 M A
B
R20
10±0.06
A
0.2 A B
C
∅8±0.1
∅ 0.2 M A B M C M
35
60.1 perpendicular to the first datum plane
First datum plane
35
R19.9 perpendicular to the first datum plane and located at 35 basic

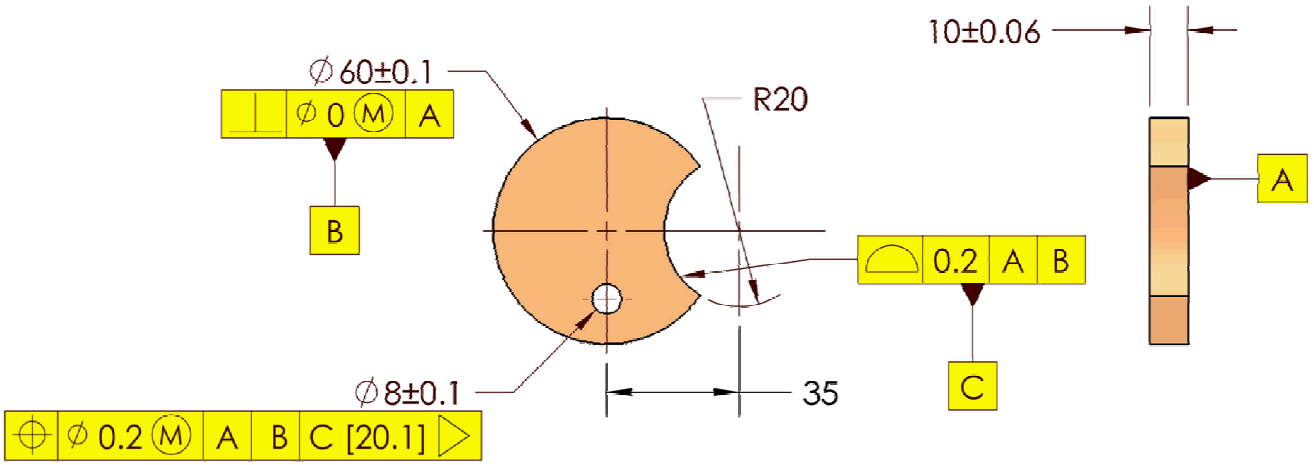

Tec-Ease, Inc.

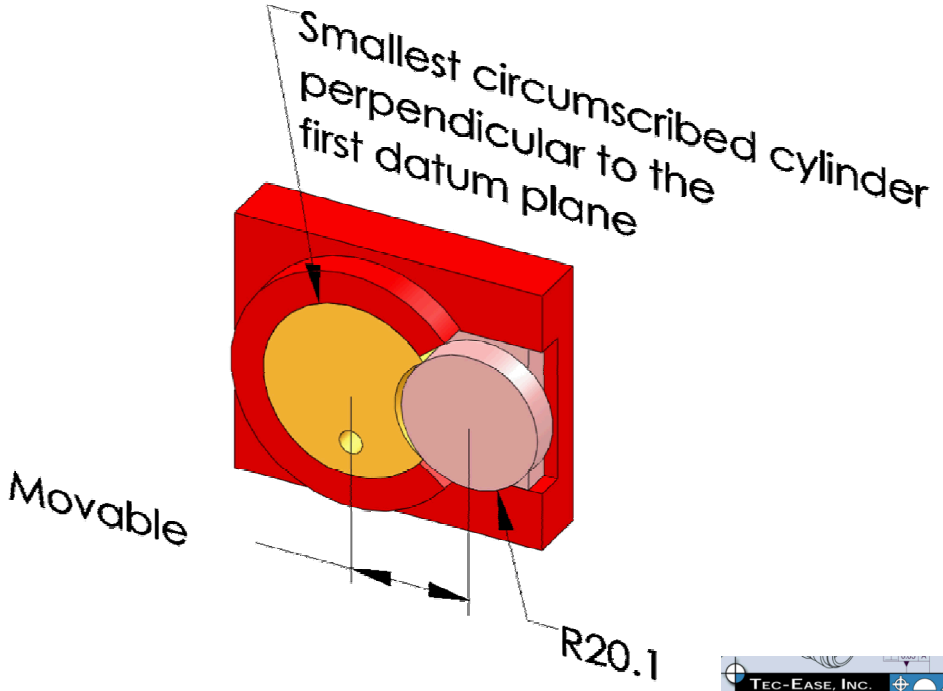




Smallest circumscribed cylinder perpendicular to the first datum plane

Largest inscribed cylinder perpendicular to the first datum plane and located at 35 basic

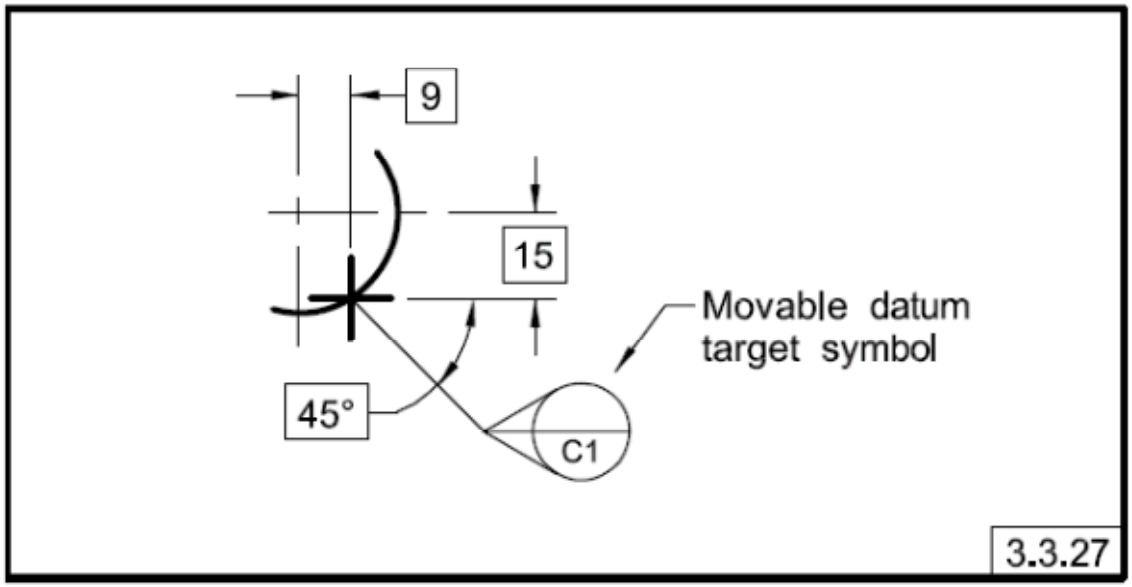

∅60±0.1
∅ 0 M A
B
R20
10±0.06
A
0.2 A B
C
∅8±0.1
35
∅ 0.2 M A B C [20.1]

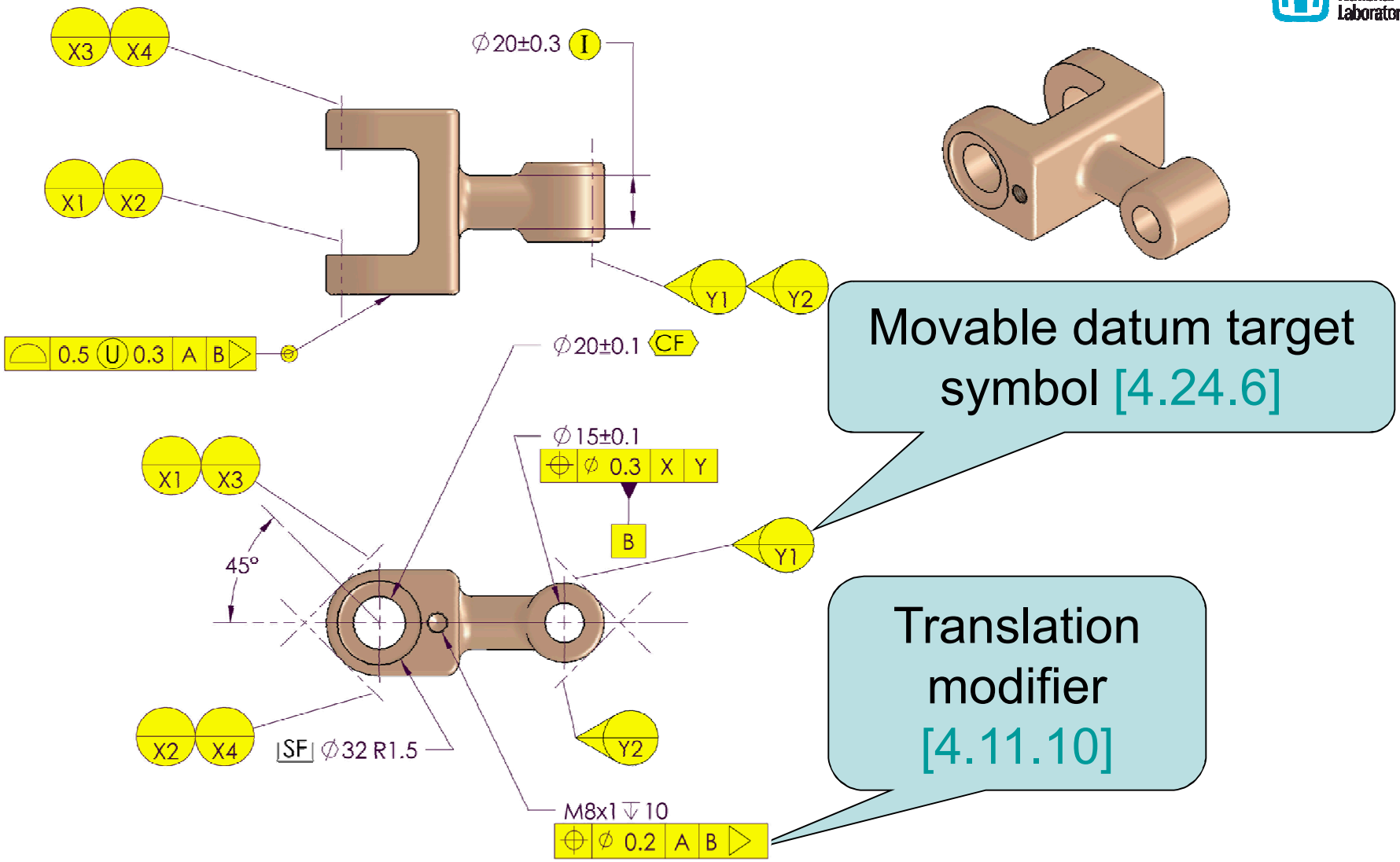

Smallest circumscribed cylinder
perpendicular to the
first datum plane
Movable
R20.1

ASME Y14.5-2009
Principal Changes & Improvements

- Datum target is not fixed at basic location and is free to translate

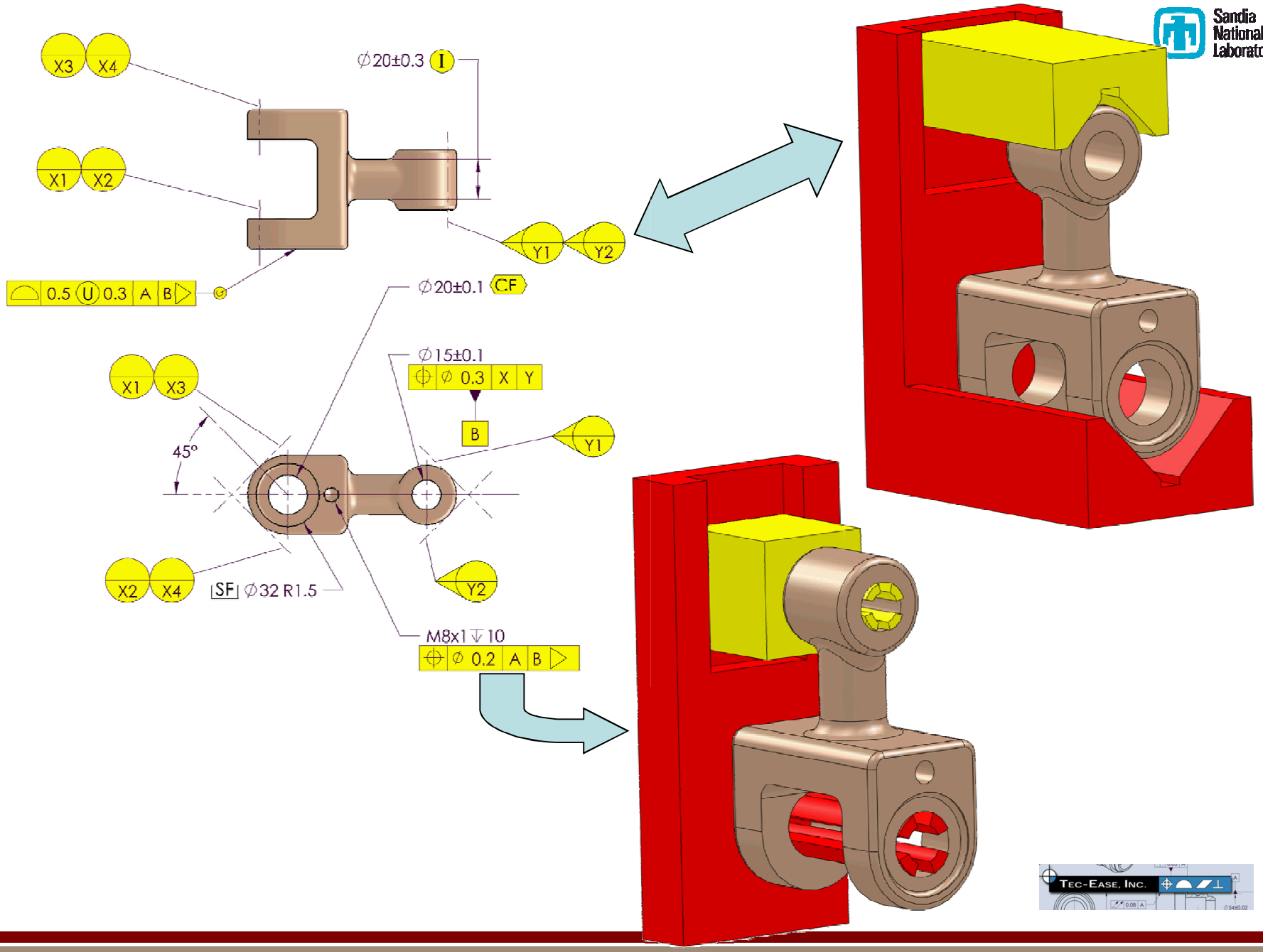
Fig. 3-22 Movable Datum Target Symbol Application

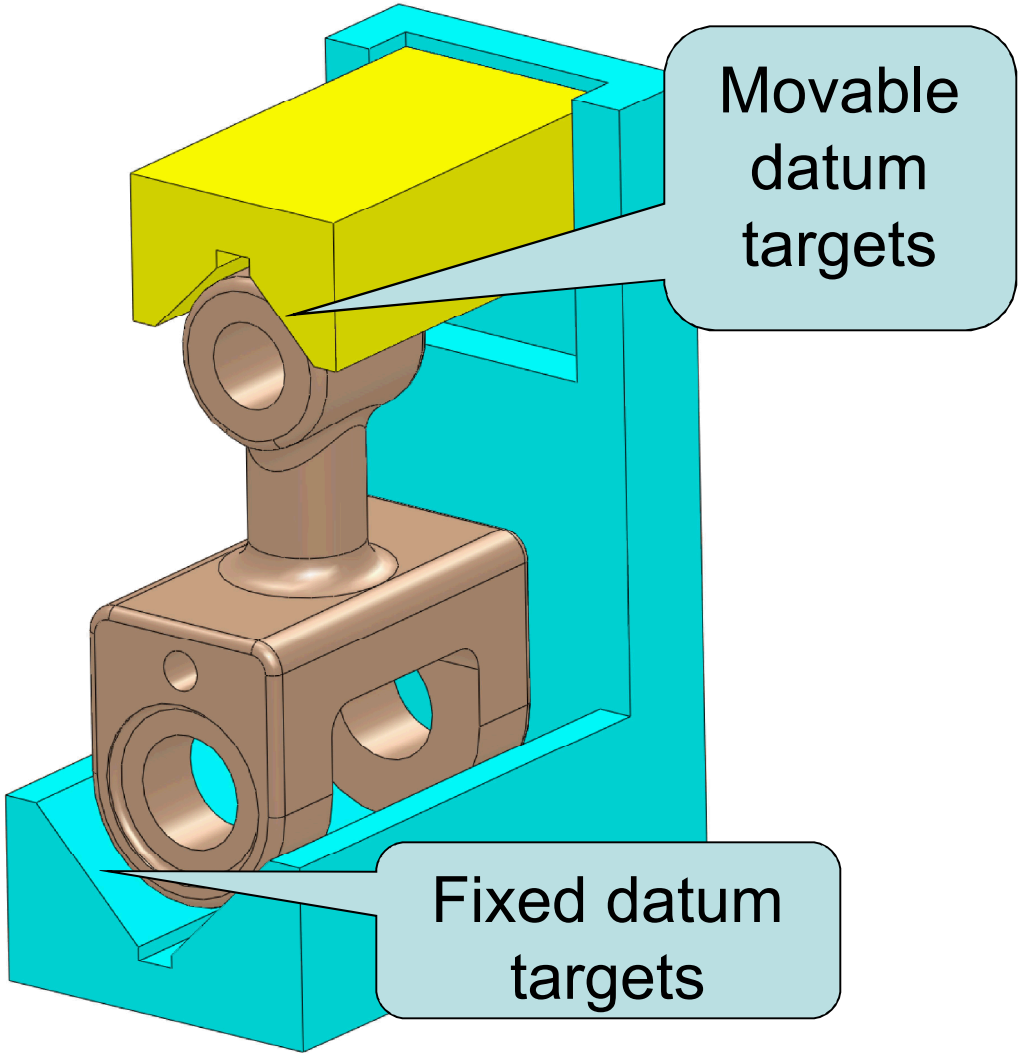


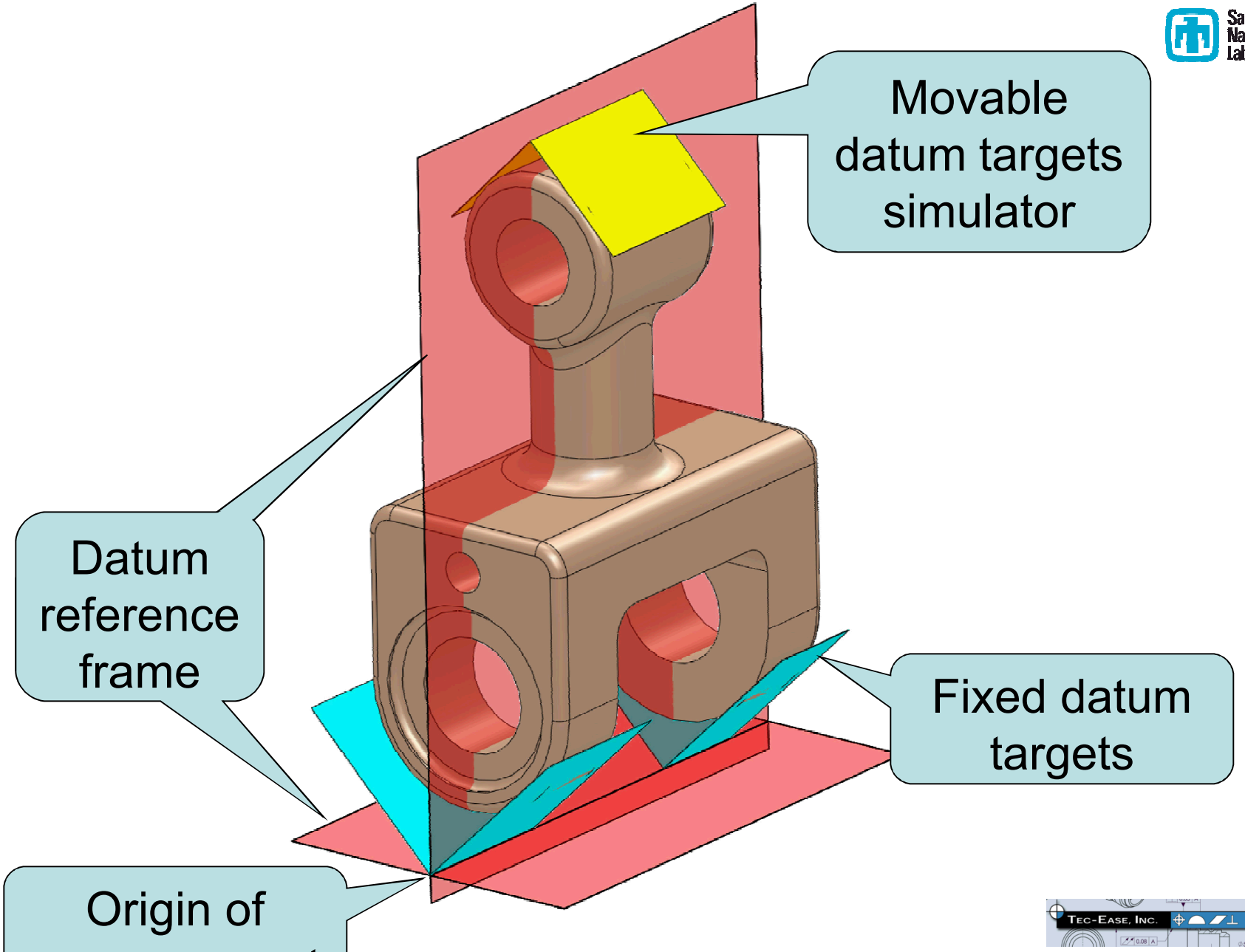


Movable datum target symbol [4.24.6]

Translation modifier [4.11.10]


X3
X4
∅20±0.3 I
X1
X2
Y1
Y2
0.5 U 0.3 A B
∅20±0.1 C F
∅15±0.1
∅ 0.3 X Y
B
X1
X3
45°
Y1
X2
X4
SF ∅32 R1.5
Y2
M8x1↧10
∅ 0.2 A B
Sandia National Laboratories
TEC-EASE, INC.


Movable datum targets
Fixed datum targets


Movable datum targets simulator
Datum reference frame
Fixed datum targets
Origin of measurement

ASME Y14.5-2009
Principal Changes & Improvements

Fig. 4-11 Establishment of Datums — For External Cylindrical Feature — RMB

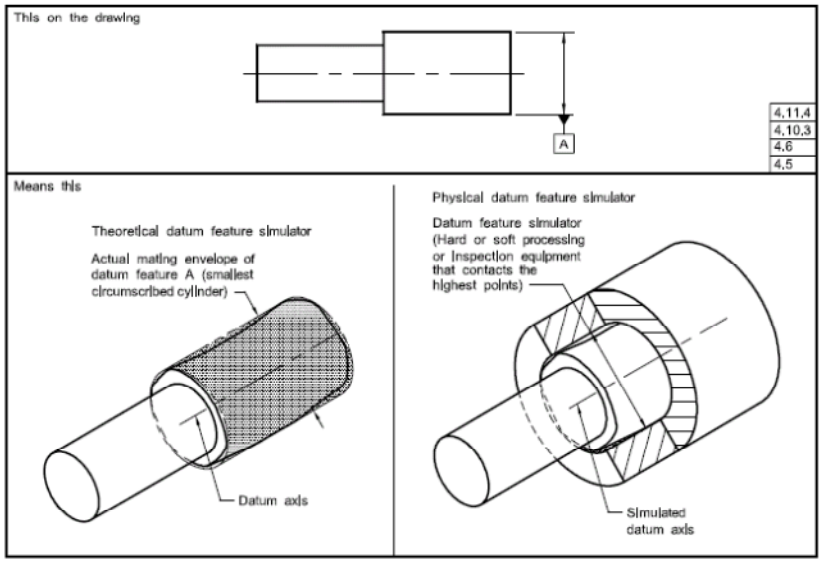
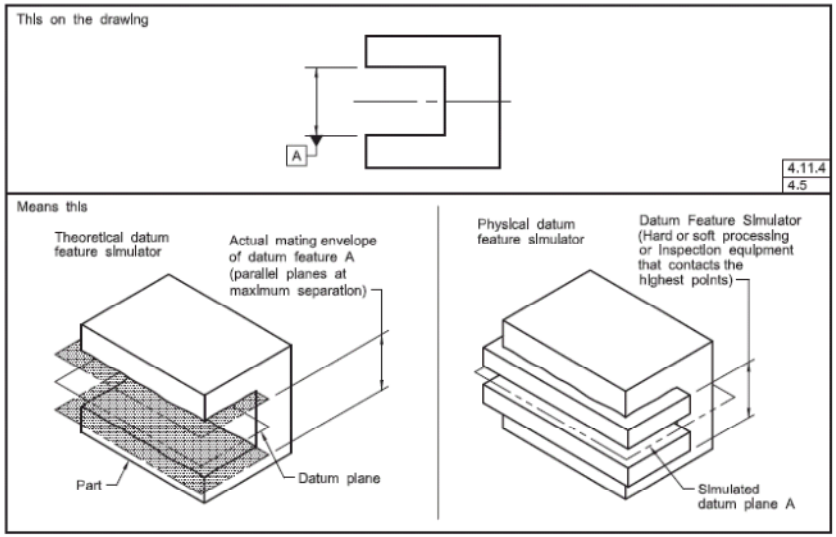
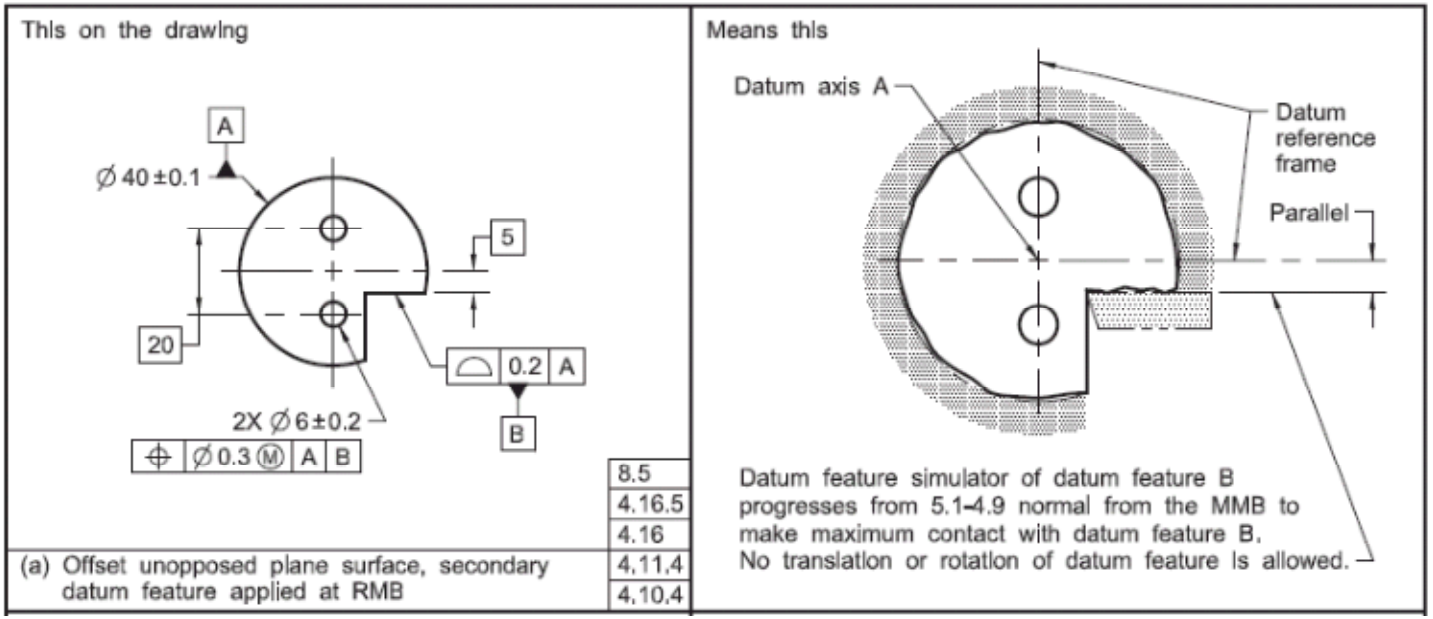


Fig. 4-14 Establishment of Datums — For Internal Datum Width — RMB

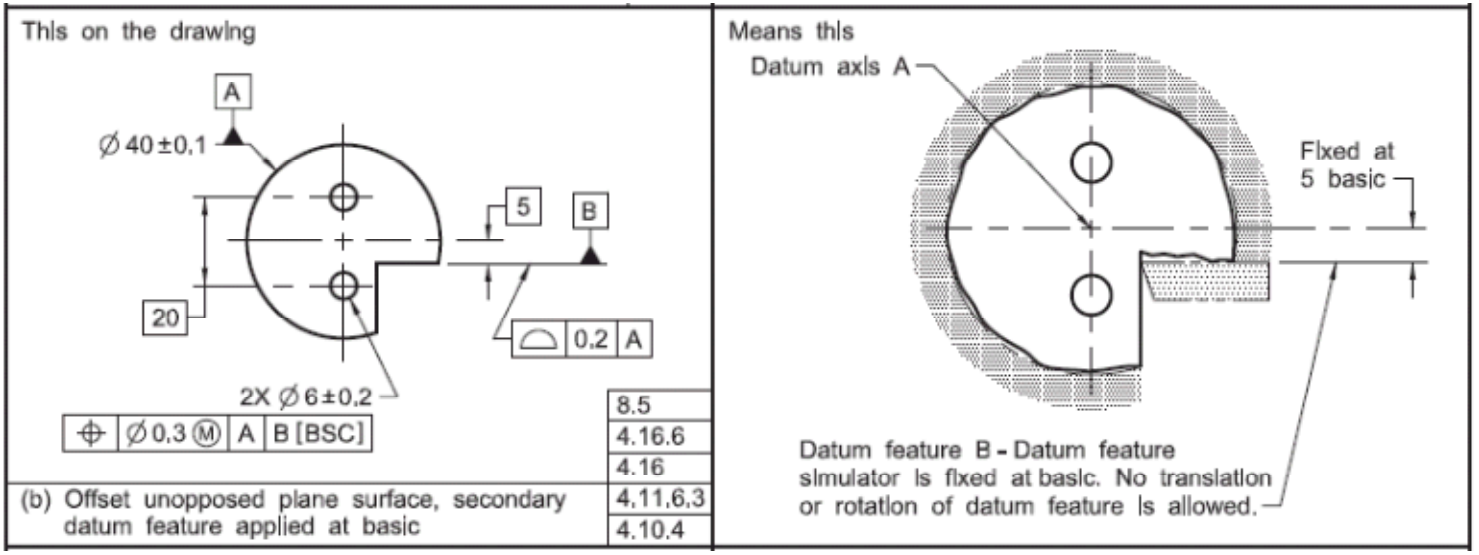


ASME Y14.5-2009
Principal Changes & Improvements

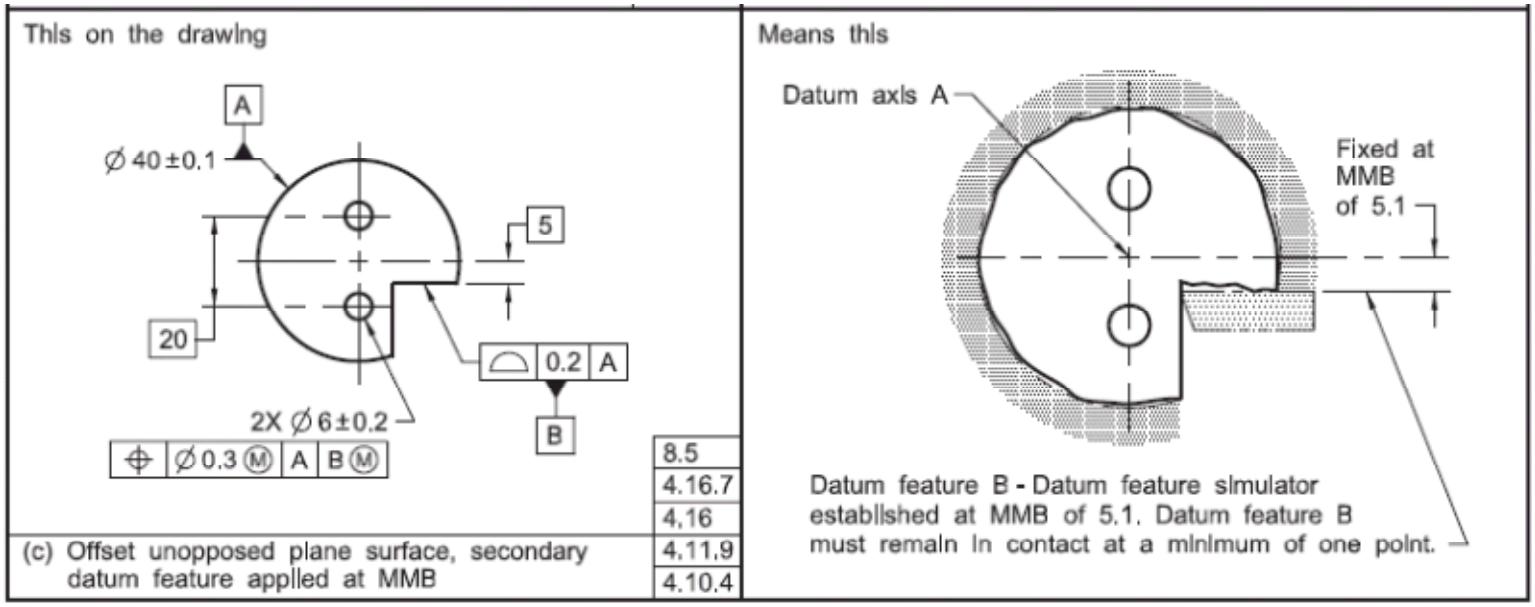
Fig. 4-31 Datum Modifier Effects — Plane Surface



ASME Y14.5-2009
Principal Changes & Improvements

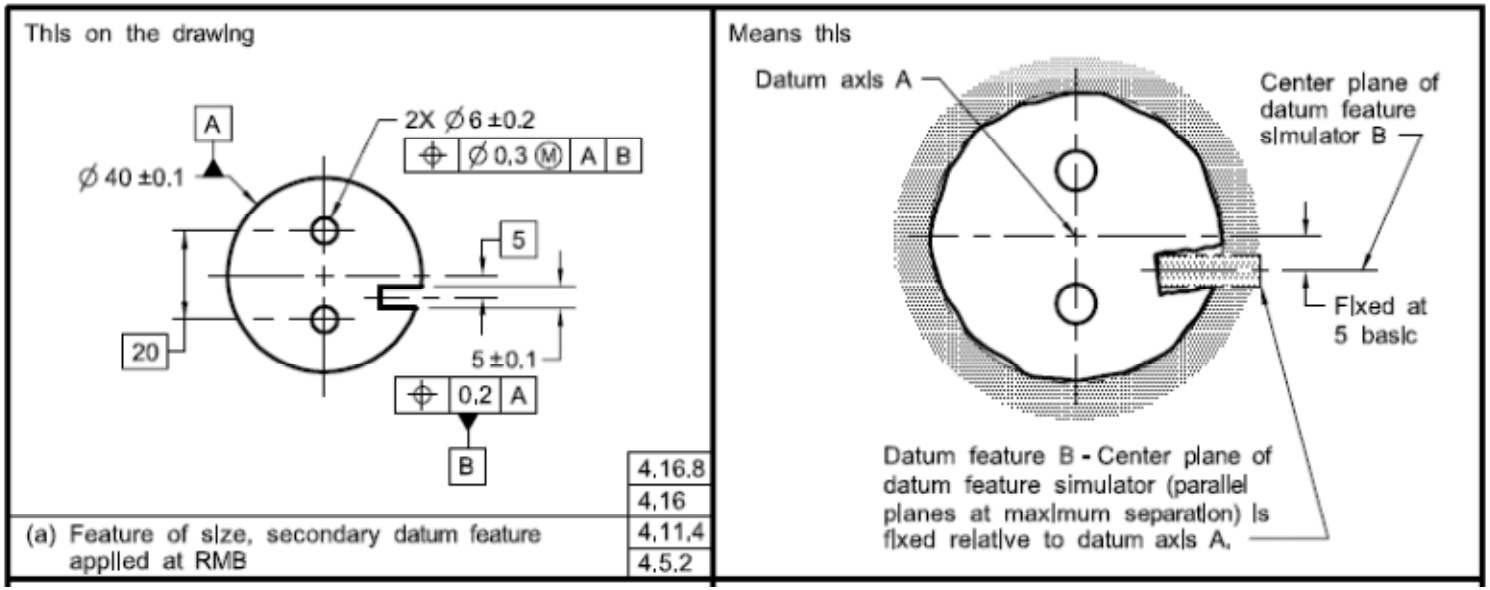


ASME Y14.5-2009
Principal Changes & Improvements

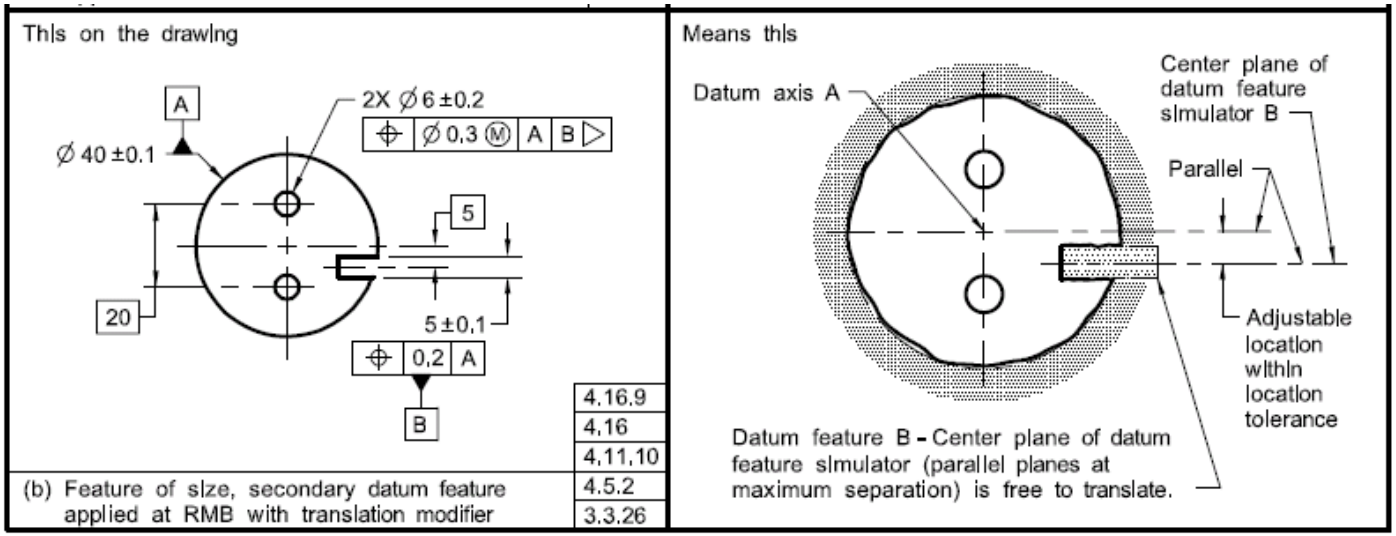


ASME Y14.5-2009
Principal Changes & Improvements

Fig. 4-32 Datum Modifier Effects — Size Feature



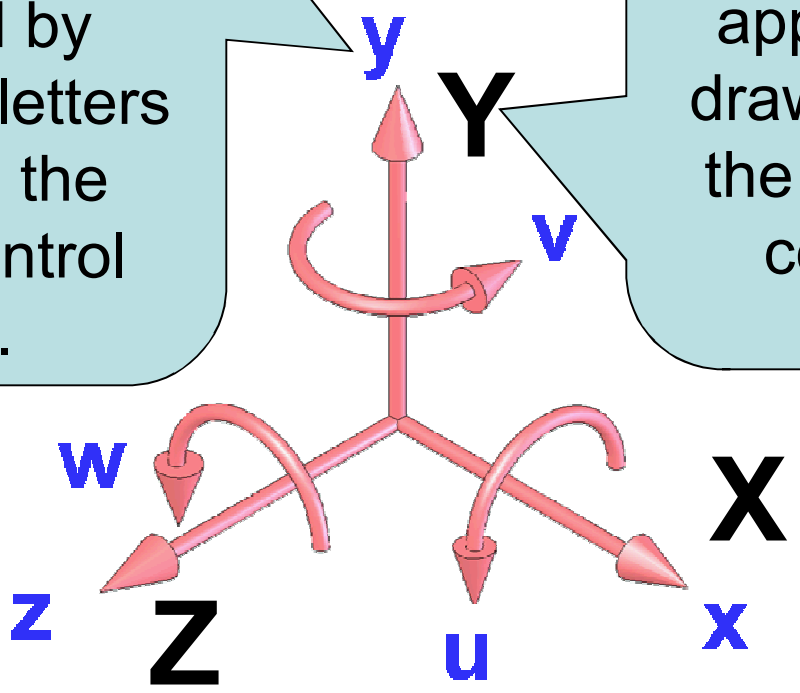
ASME Y14.5-2009
Principal Changes & Improvements



Customized Datum Reference Frame Construction [4.22]

Degrees of freedom are indicated by lower case letters appear in the feature control frame.

Coordinate axis labels are upper case and **do** appear on the drawing to label the axes of the coordinate system.



ASME Y14.5-2009
Principal Changes & Improvements

- Customized Datum Reference Frame
  - Allow degrees of freedom constrained to be overridden

Fig. 4-44 Conical Datum Feature

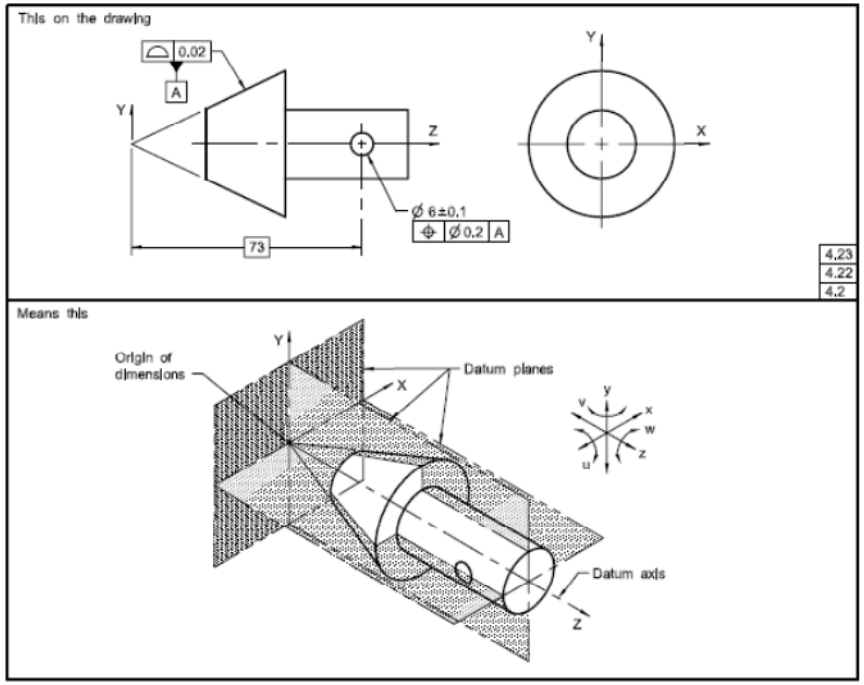
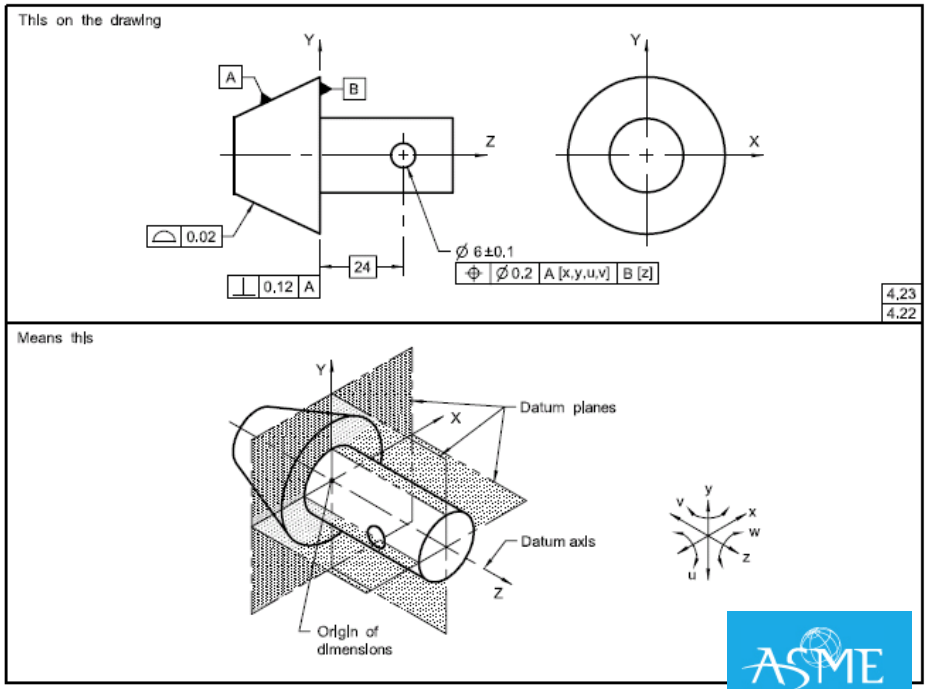
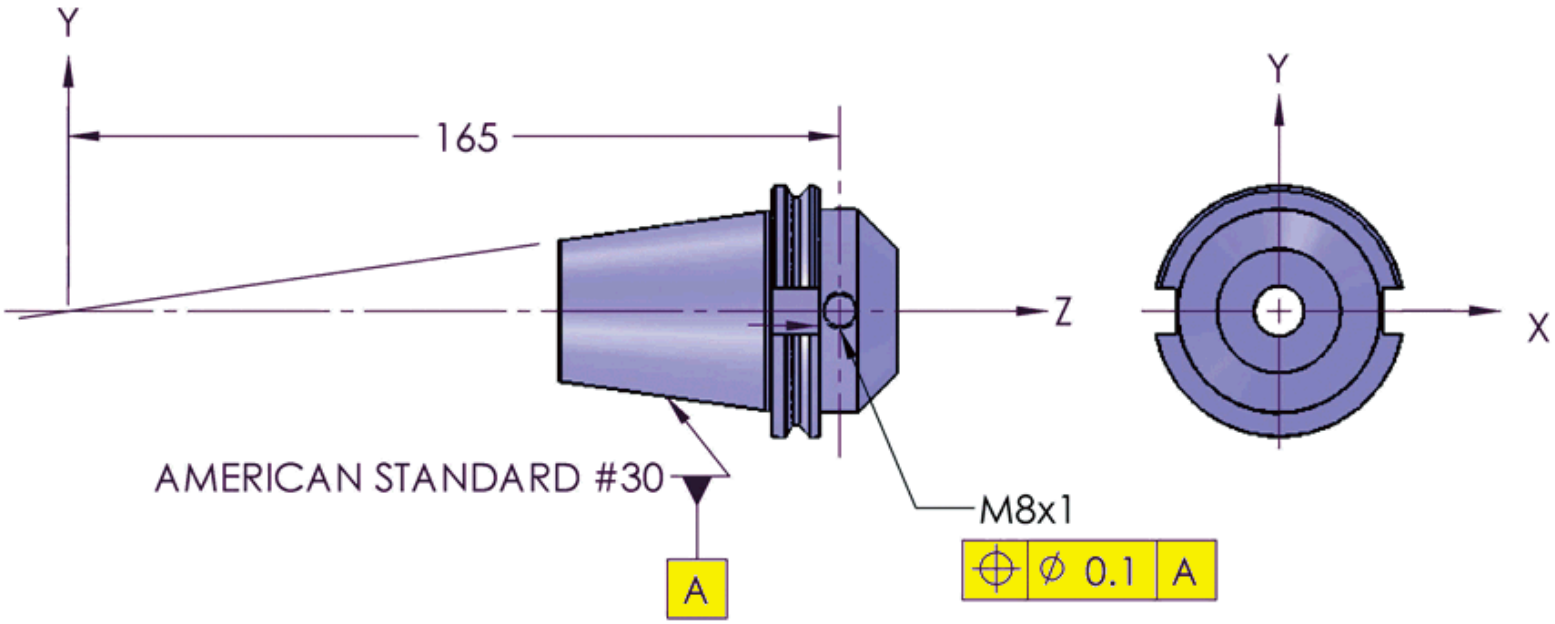
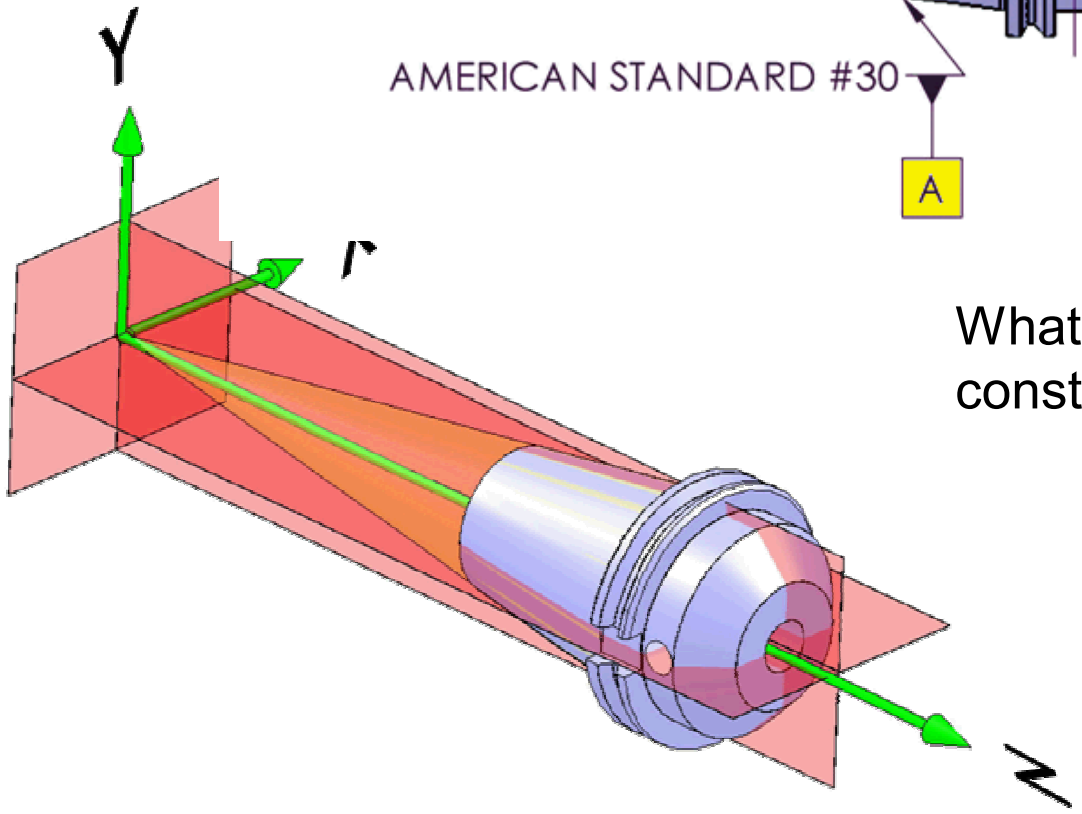


Fig. 4-45 Conical Datum Feature



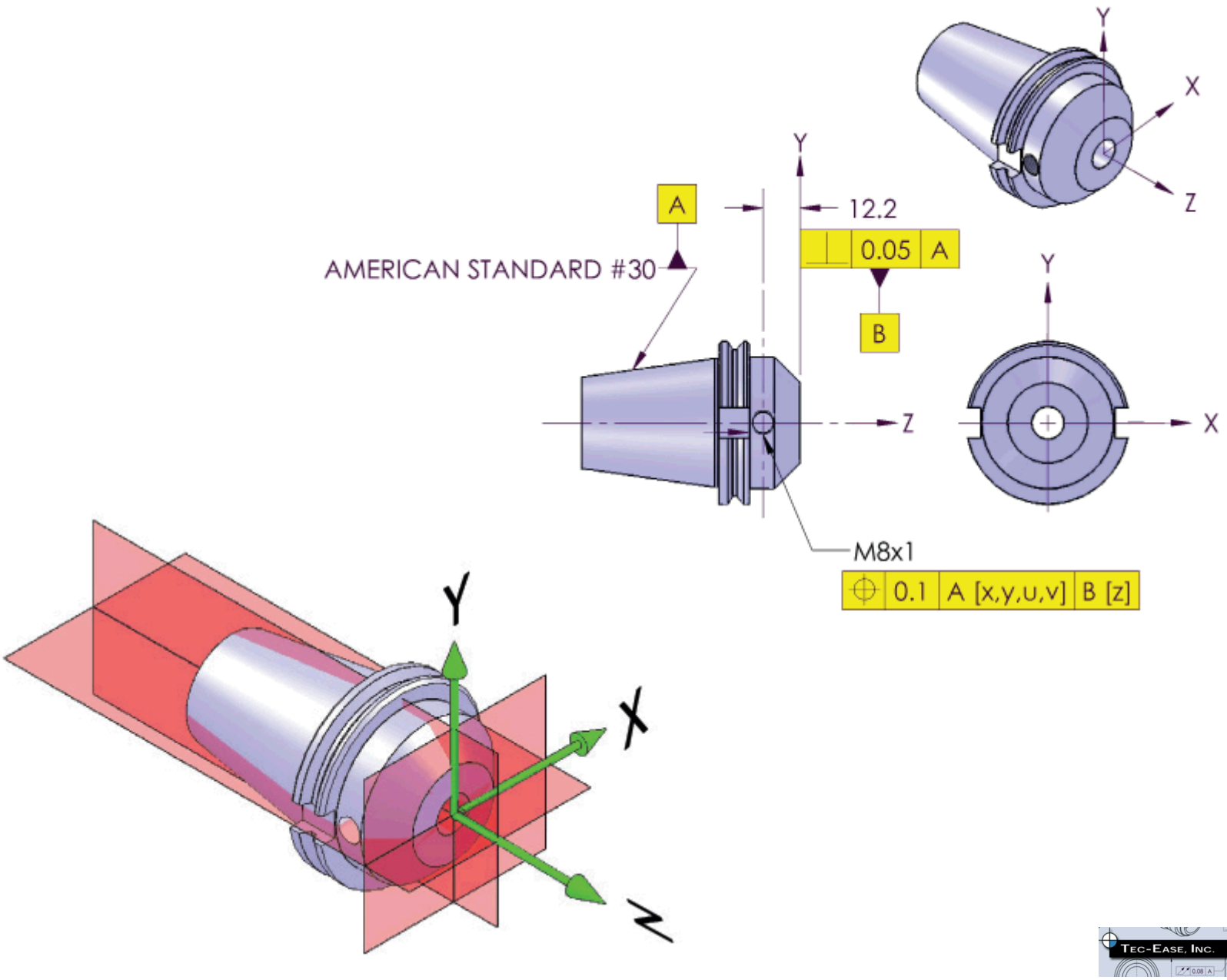




What degrees of freedom are constrained by datum feature A?

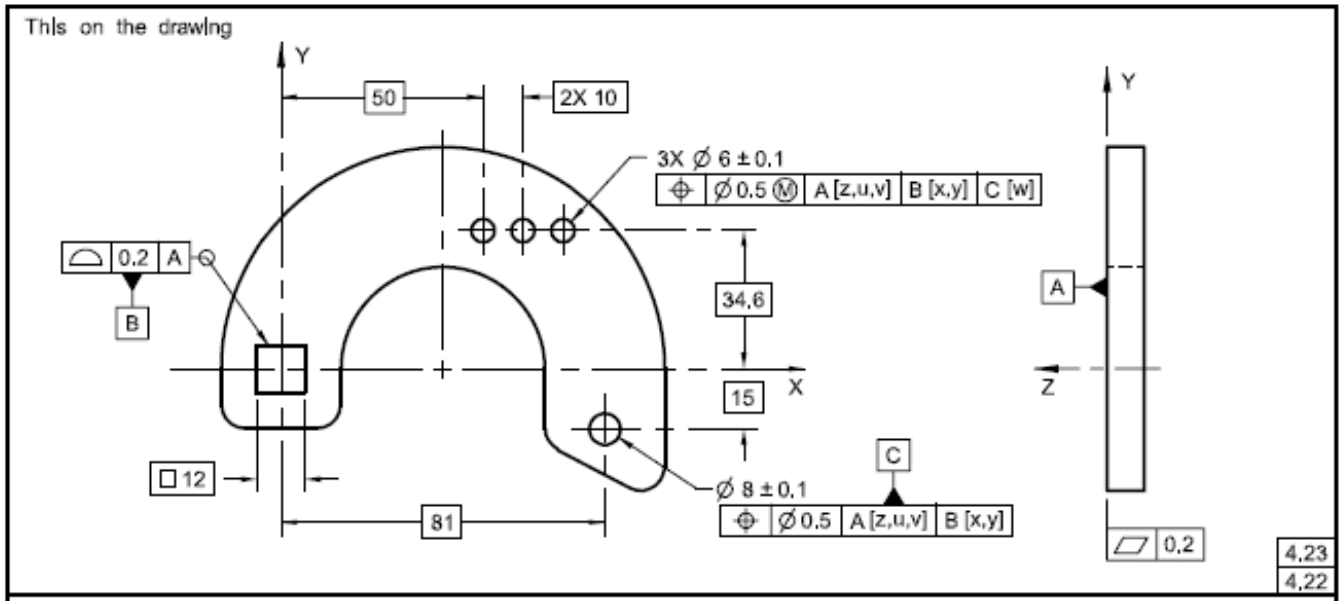
u, v, x, y, z

Everything except w

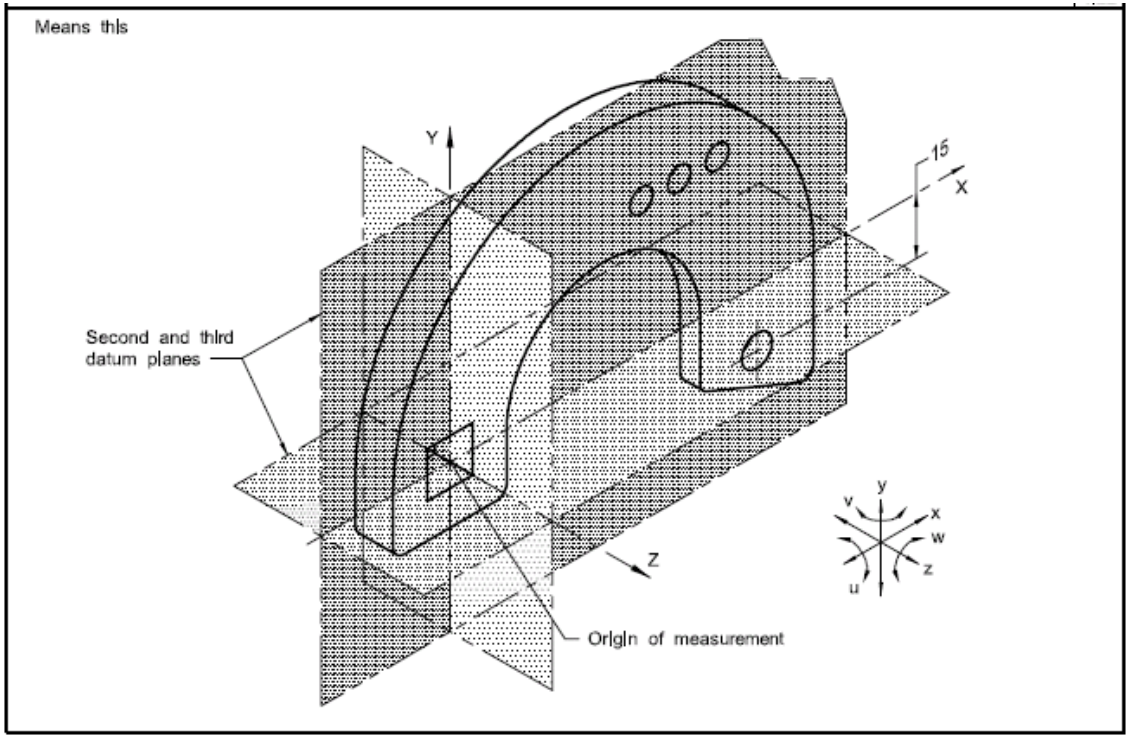

Y
X
Z
A
12.2
0.05 A
AMERICAN STANDARD #30
B
Y
Z
X
M8x1
0.1 A [x,y,u,v] B [z]
Y
X
Z

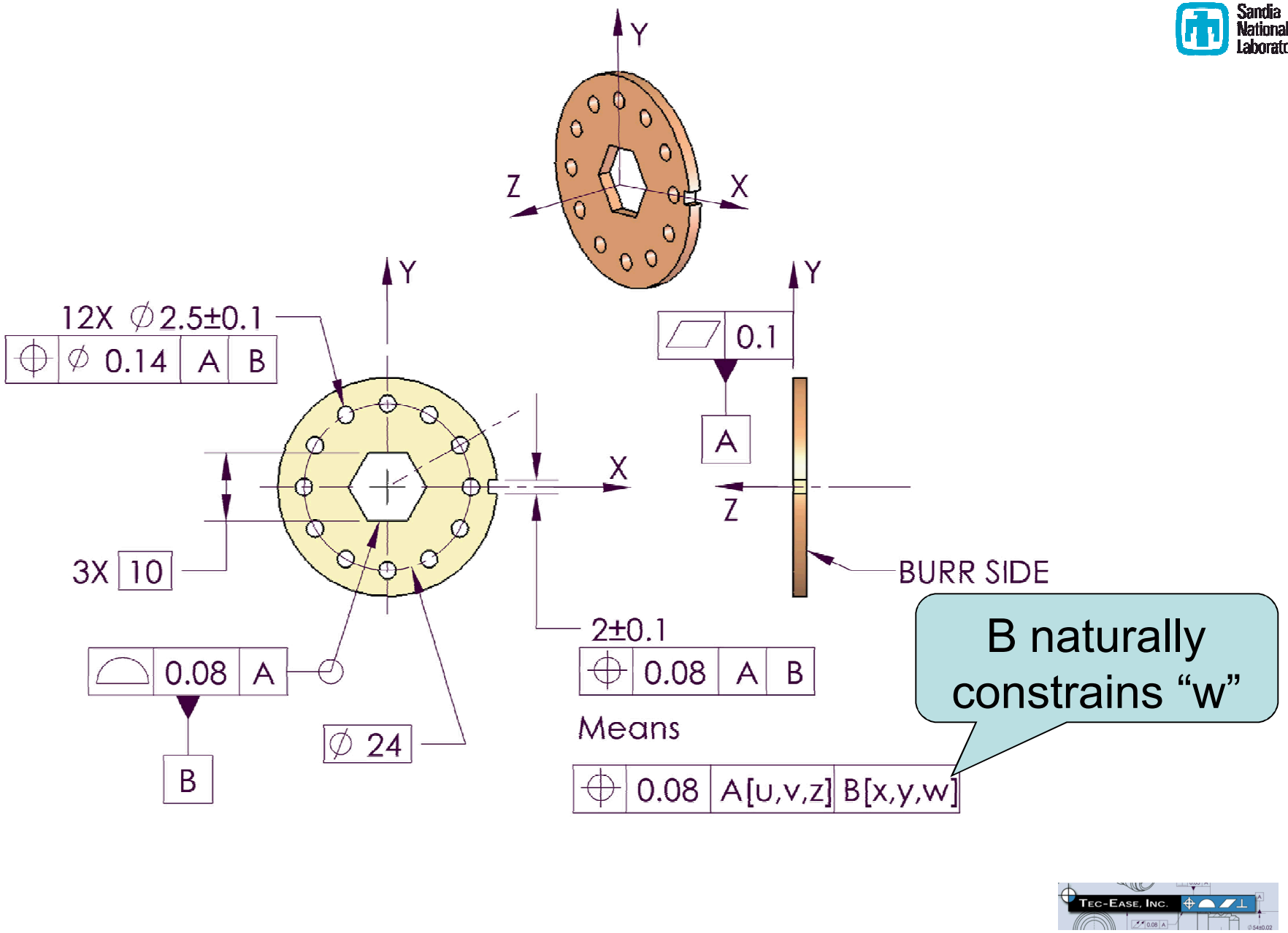
ASME Y14.5-2009
Principal Changes & Improvements

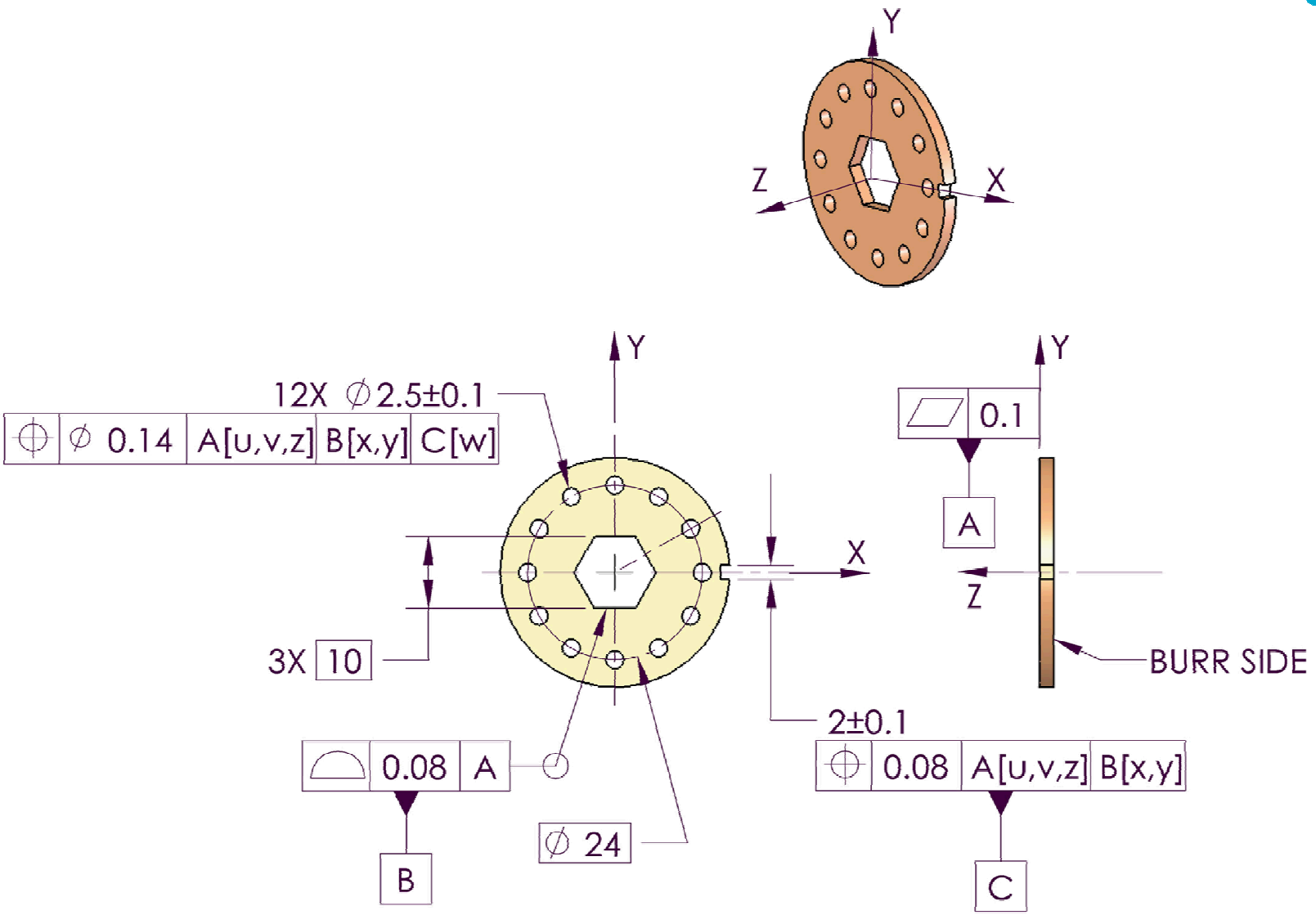
Fig. 4-46 Customized Datum Reference Frame



ASME Y14.5-2009
Principal Changes & Improvements

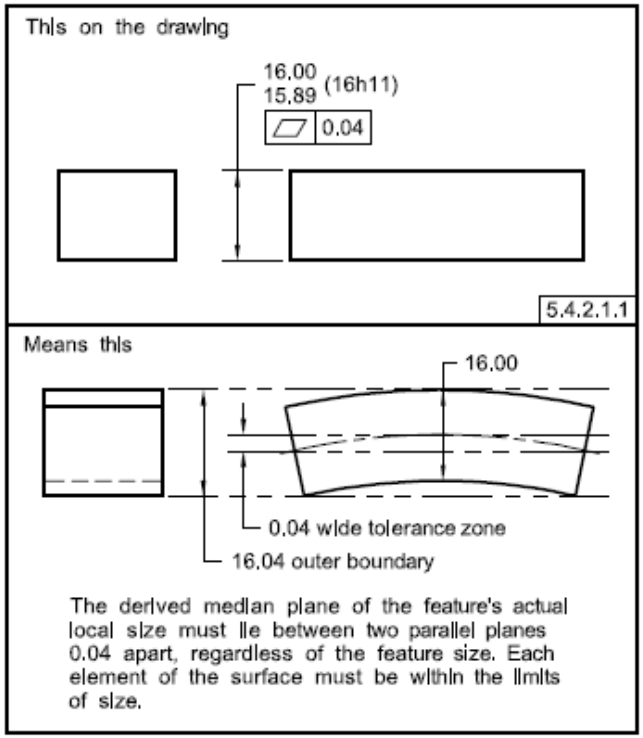



Y
Z
X
12X ∅2.5±0.1
⌖ ∅ 0.14 A B
3X 10
⌓ 0.08 A
B
∅ 24
2±0.1
⌖ 0.08 A B
Means
⌖ 0.08 A[u,v,z] B[x,y,w]
⏥ 0.1
A
BURR SIDE
B naturally constrains “w”


Y
Z
X
12X ∅2.5±0.1
⌖ ∅ 0.14 A[u,v,z] B[x,y] C[w]
3X 10
0.08 A
B
∅ 24
2±0.1
⌖ 0.08 A[u,v,z] B[x,y]
C
0.1
A
BURR SIDE

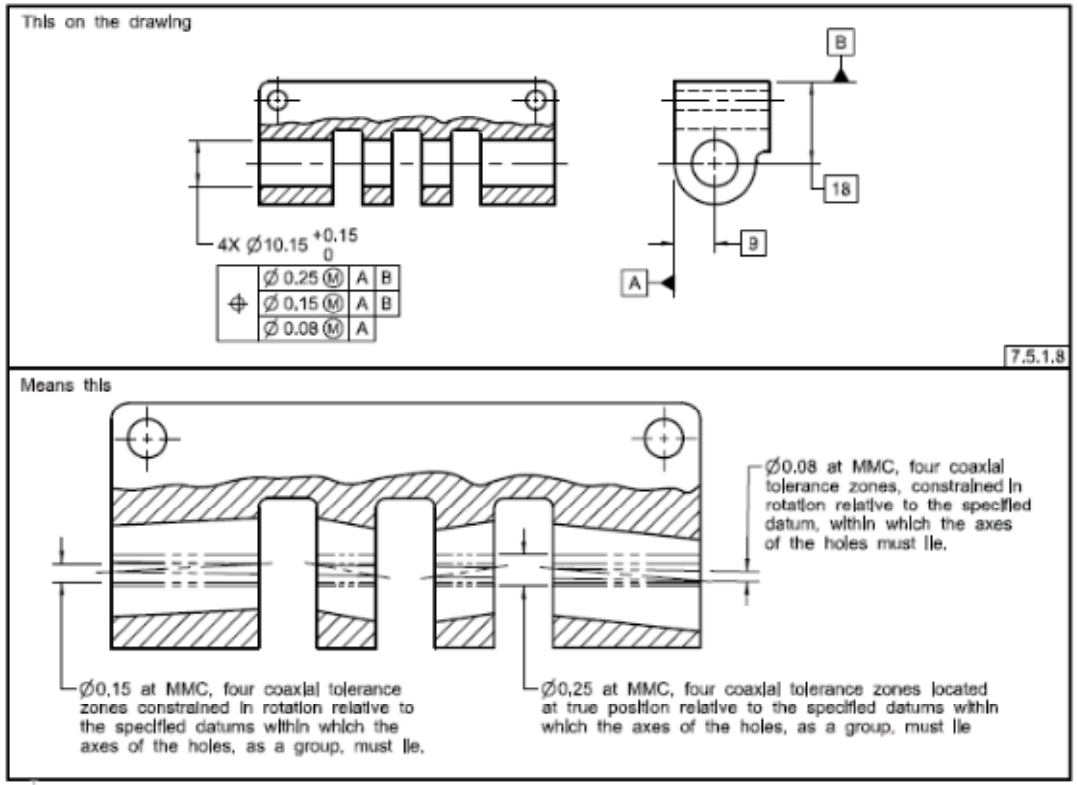
ASME Y14.5-2009
Principal Changes & Improvements

Fig. 5-8 Specifying Flatness of a Derived Median Plane — RFS



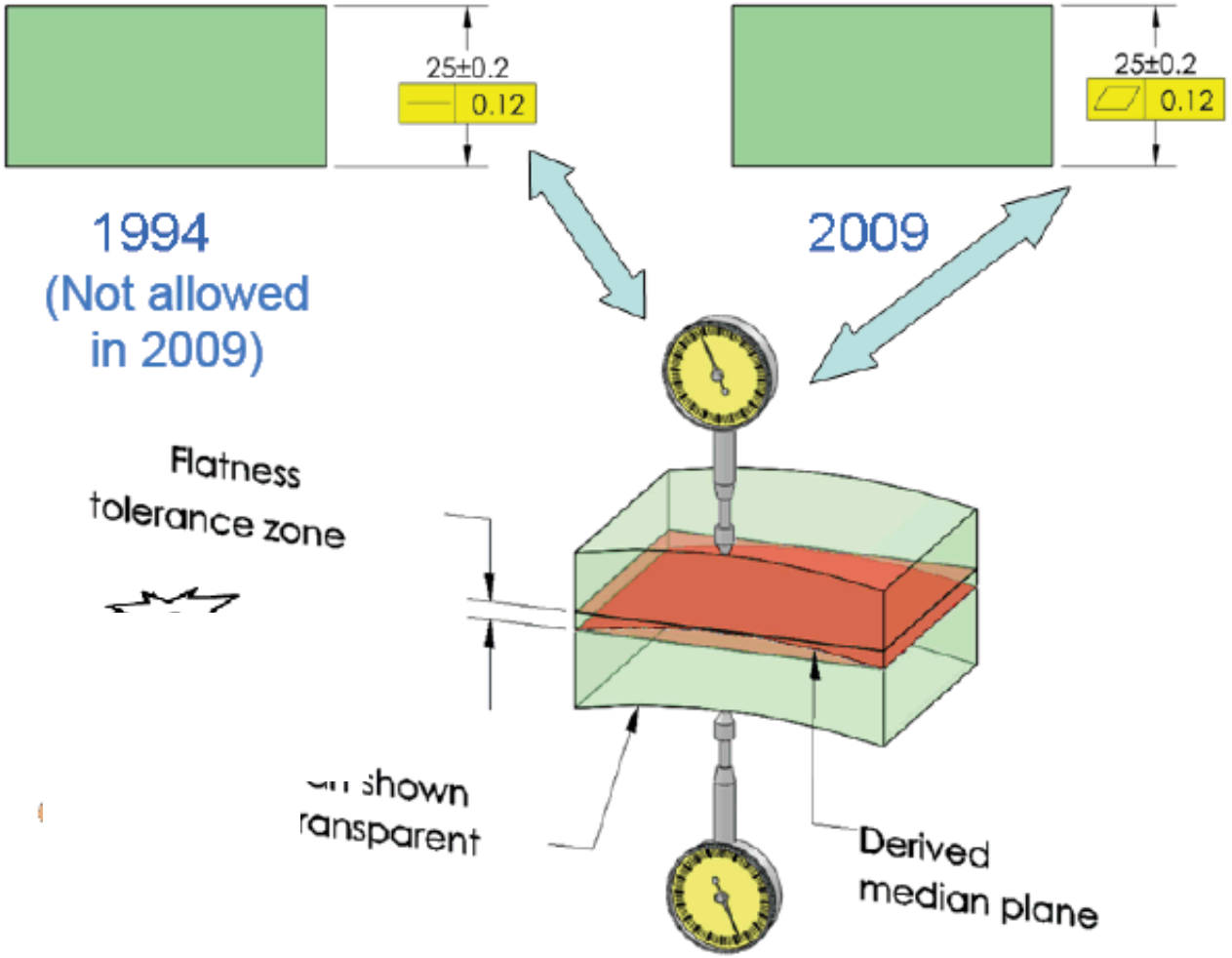
ASME Y14.5-2009
Principal Changes & Improvements

Fig. 7-44 Positional Tolerancing for Coaxial Holes of Same Size, Partial (Parallelism) Refinement of Feature-Relating Axis Relative to Datums A and B With Further Refinement of Parallelism to Datum A



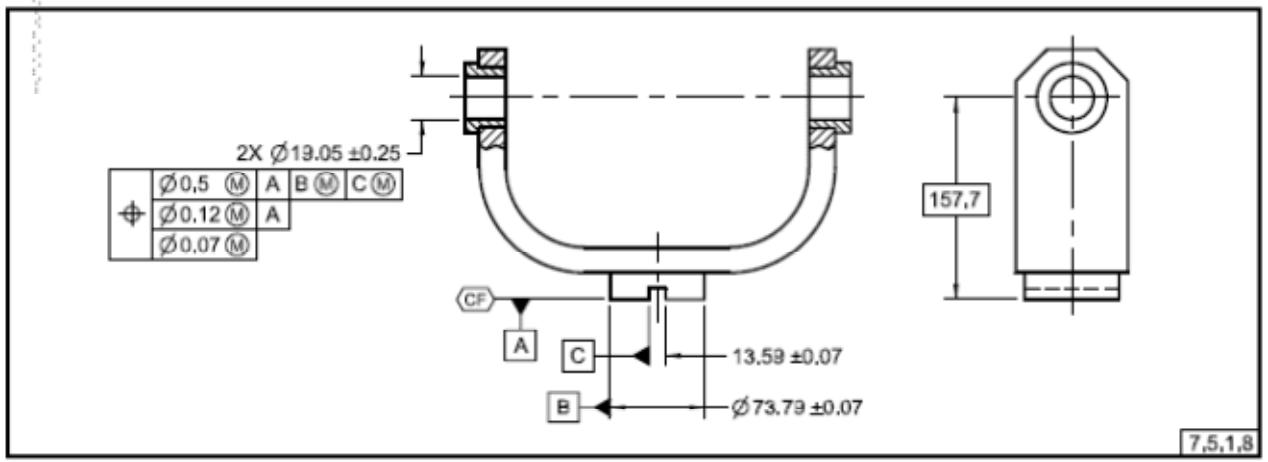
Former Practice

They have the same meaning.



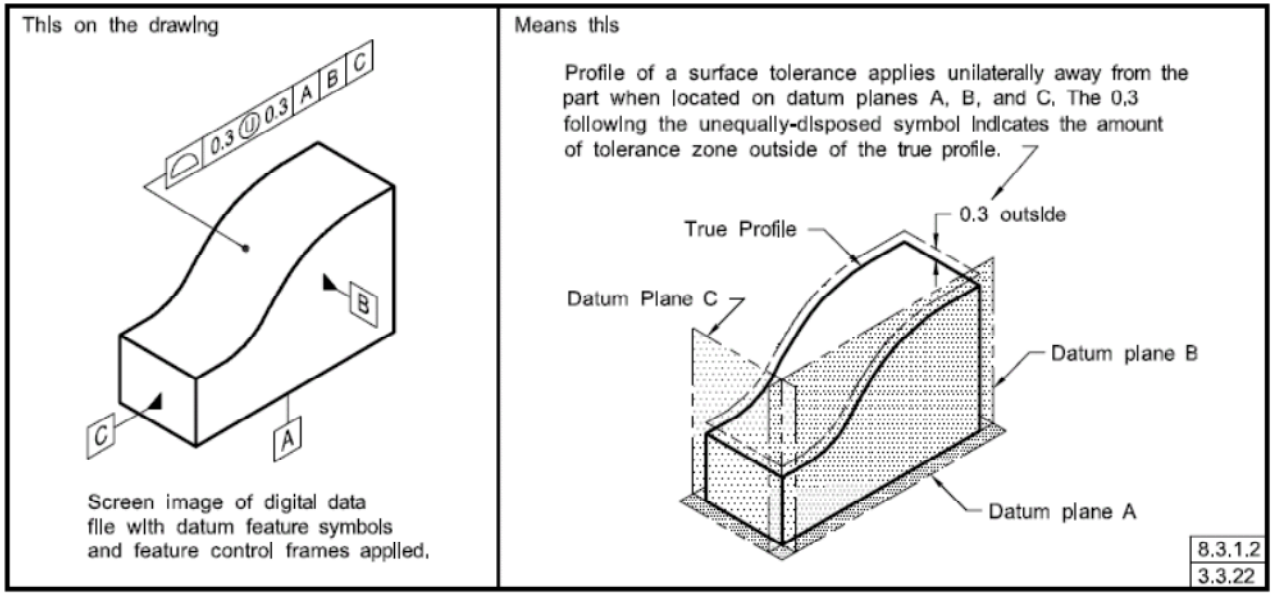
ASME Y14.5-2009
Principal Changes & Improvements

Fig. 7-45 Three Segment Composite Tolerance



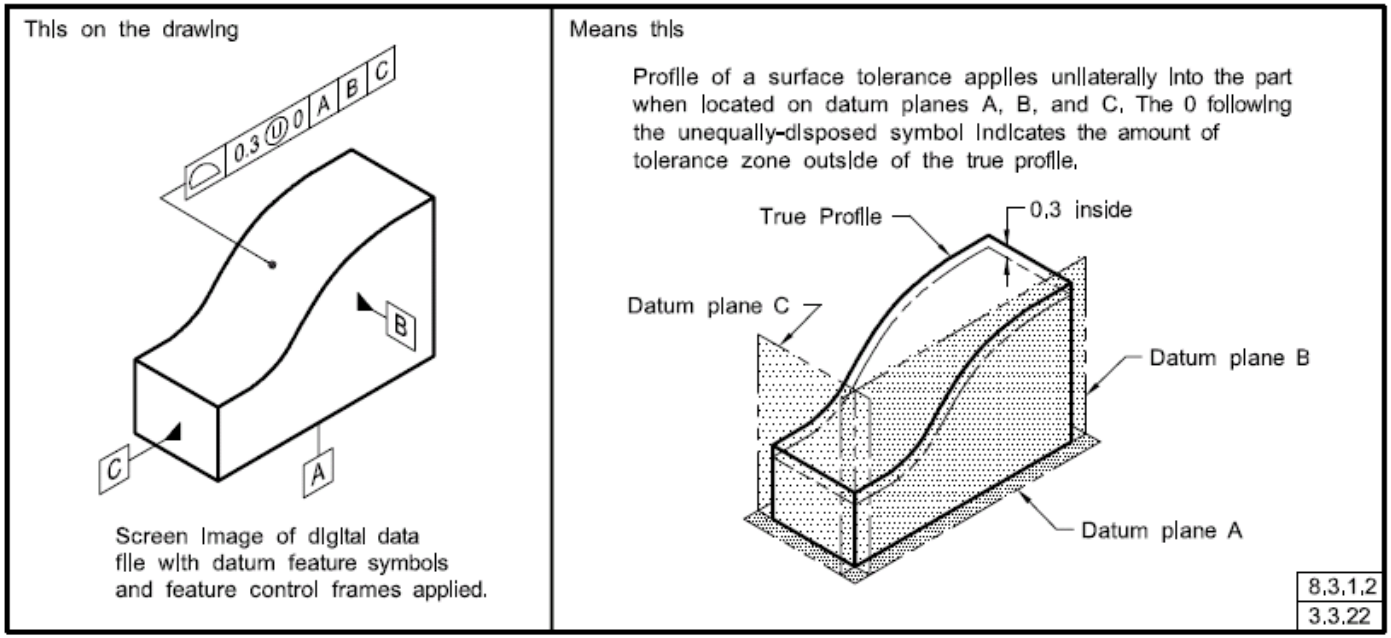
ASME Y14.5-2009
Principal Changes & Improvements

Fig. 8-1 Profile of a Surface Application (Unilaterally Outside)



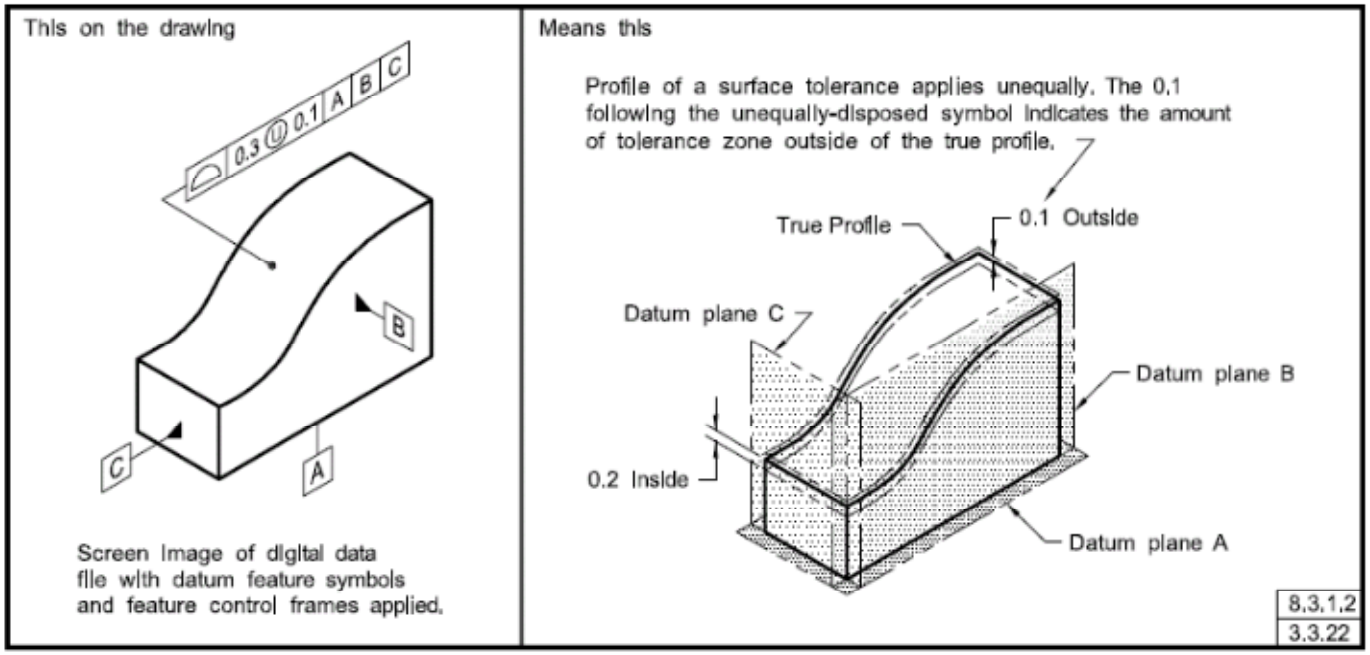
ASME Y14.5-2009
Principal Changes & Improvements

Fig. 8-2 3D Profile of a Surface Application (Unilaterally Inside)



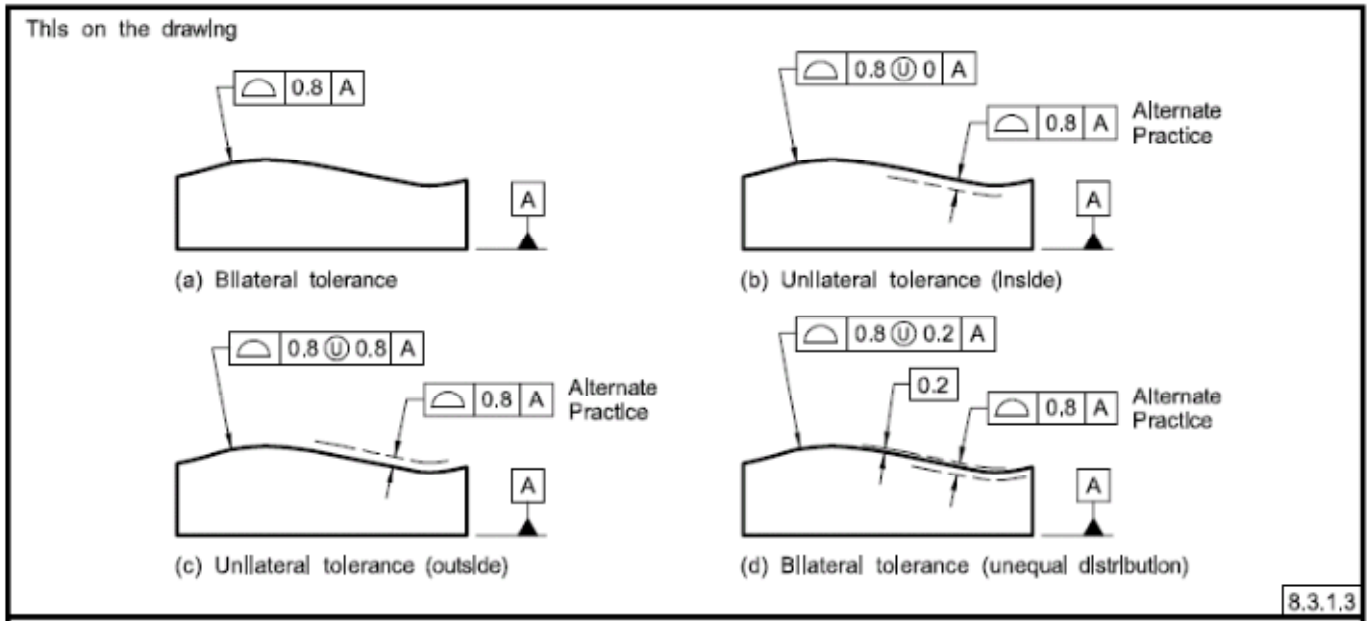
ASME Y14.5-2009
Principal Changes & Improvements

Fig. 8-3 3D Profile of a Surface Application (Unequally Disposed)

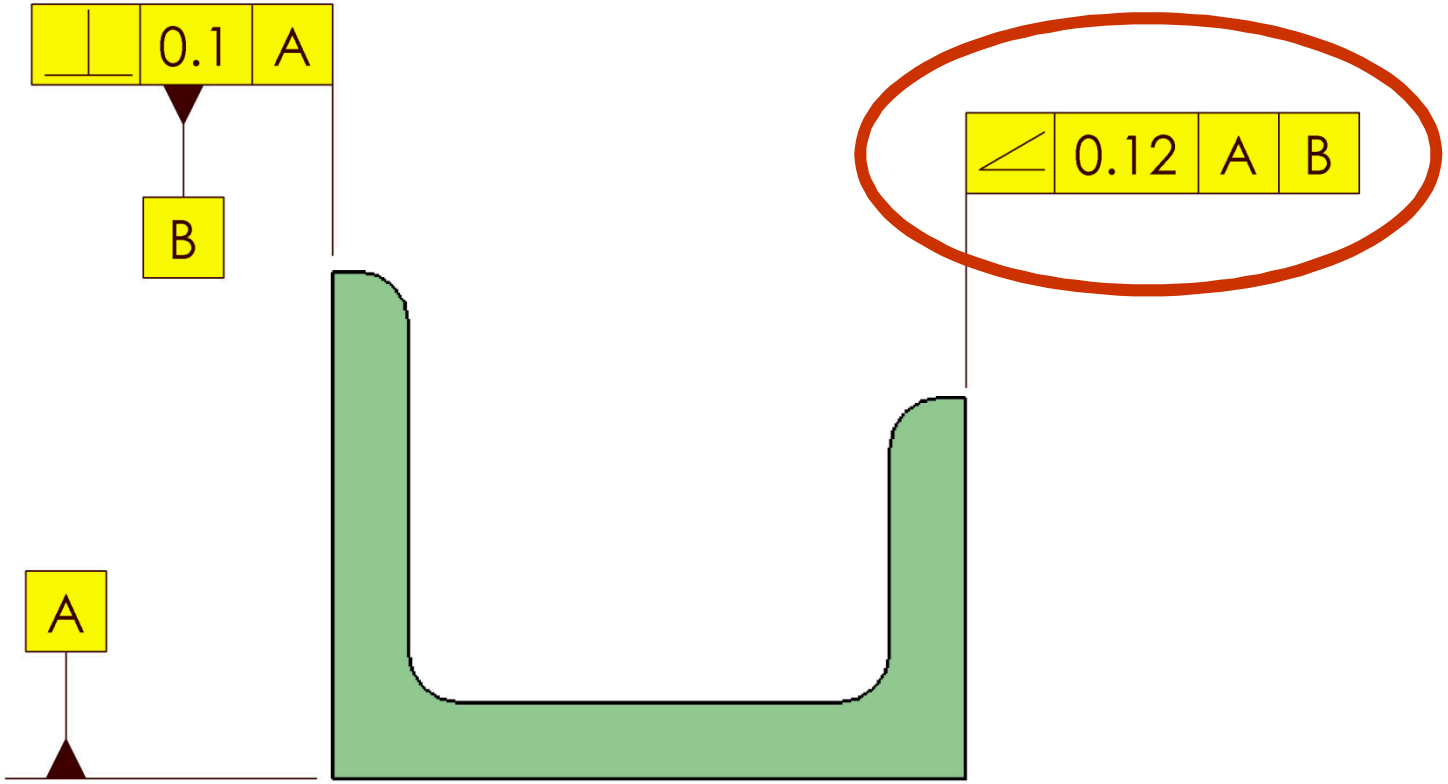


ASME Y14.5-2009
Principal Changes & Improvements

Fig. 8-4 Application of Profile of a Surface Tolerance to a Basic Contour



ASME Y14.5-2009



Alternative Practice

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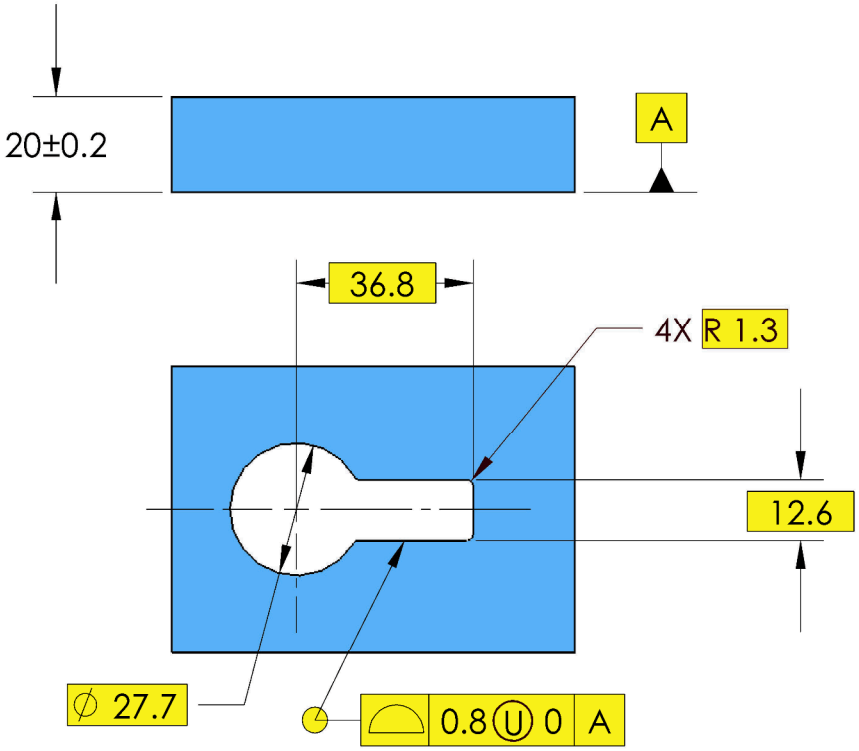
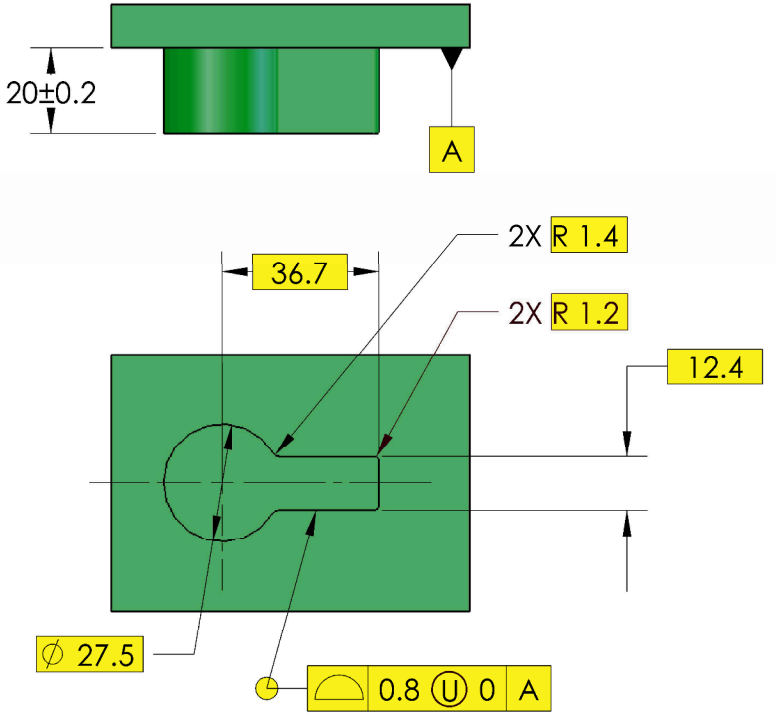
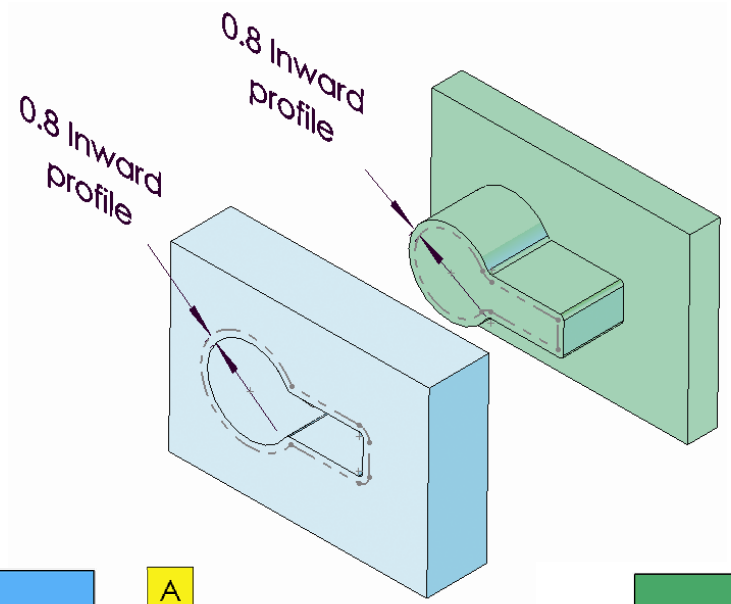
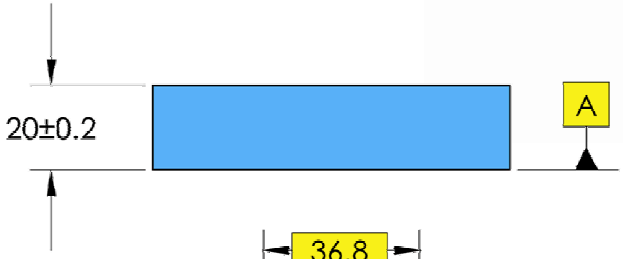
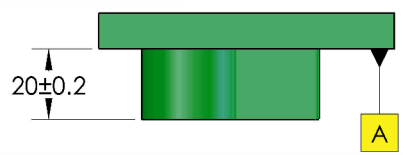
Amount of the tolerance that is in the direction that would allow additional material to be added to the true profile.

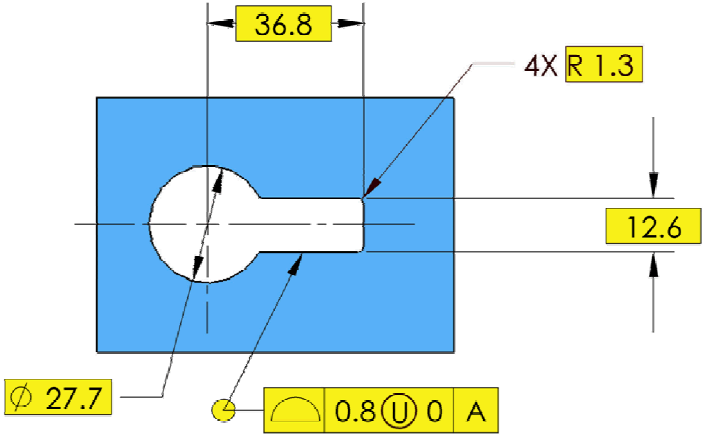


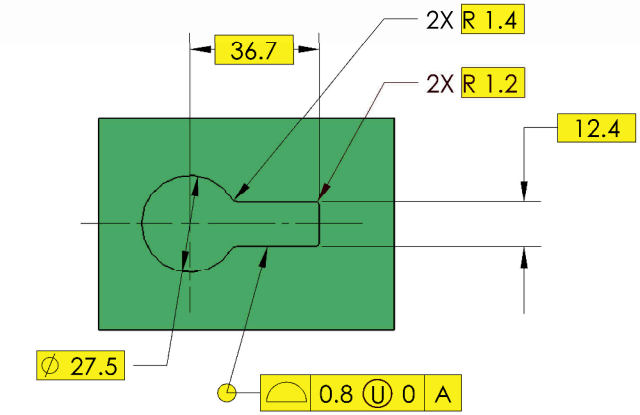



0.8 Inward profile
0.8 Inward profile


20±0.2
A


20±0.2
A


36.8
4X R 1.3
12.6
∅ 27.7
0.8 Ⓤ 0 A


36.7
2X R 1.4
2X R 1.2
12.4
∅ 27.5
0.8 Ⓤ 0 A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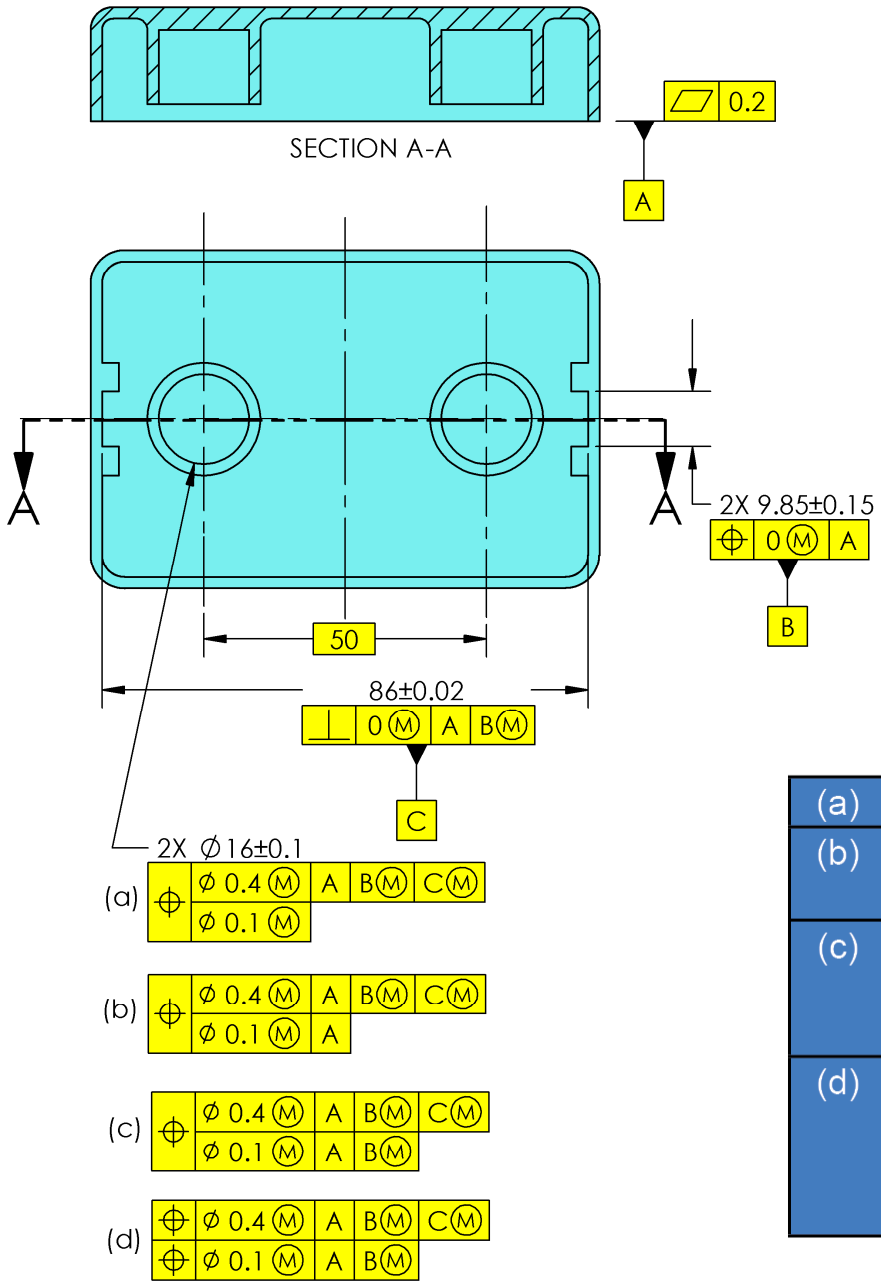
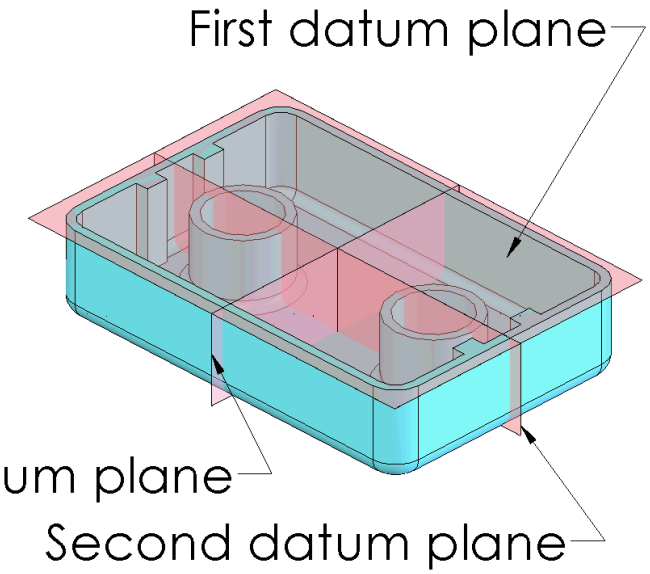
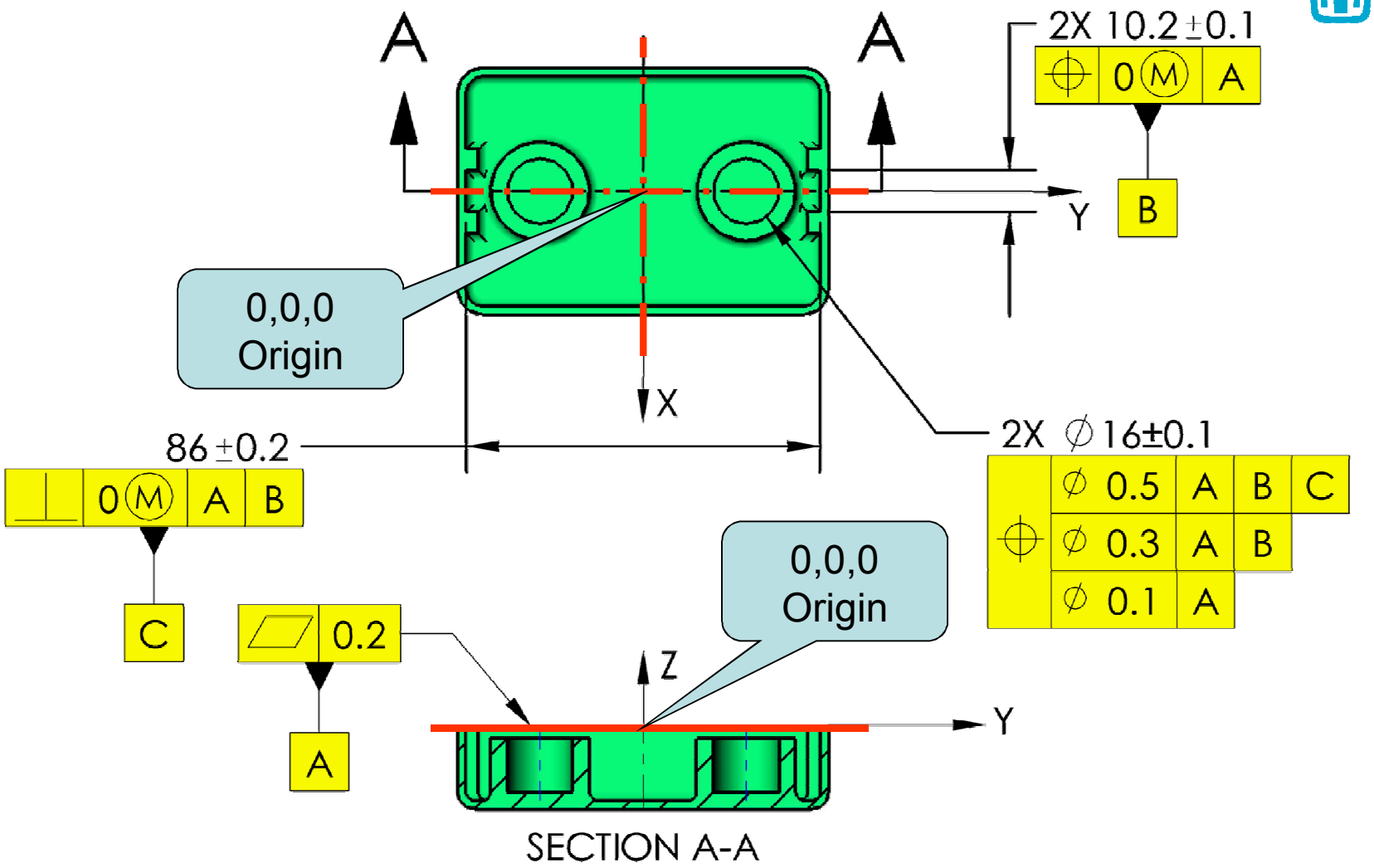
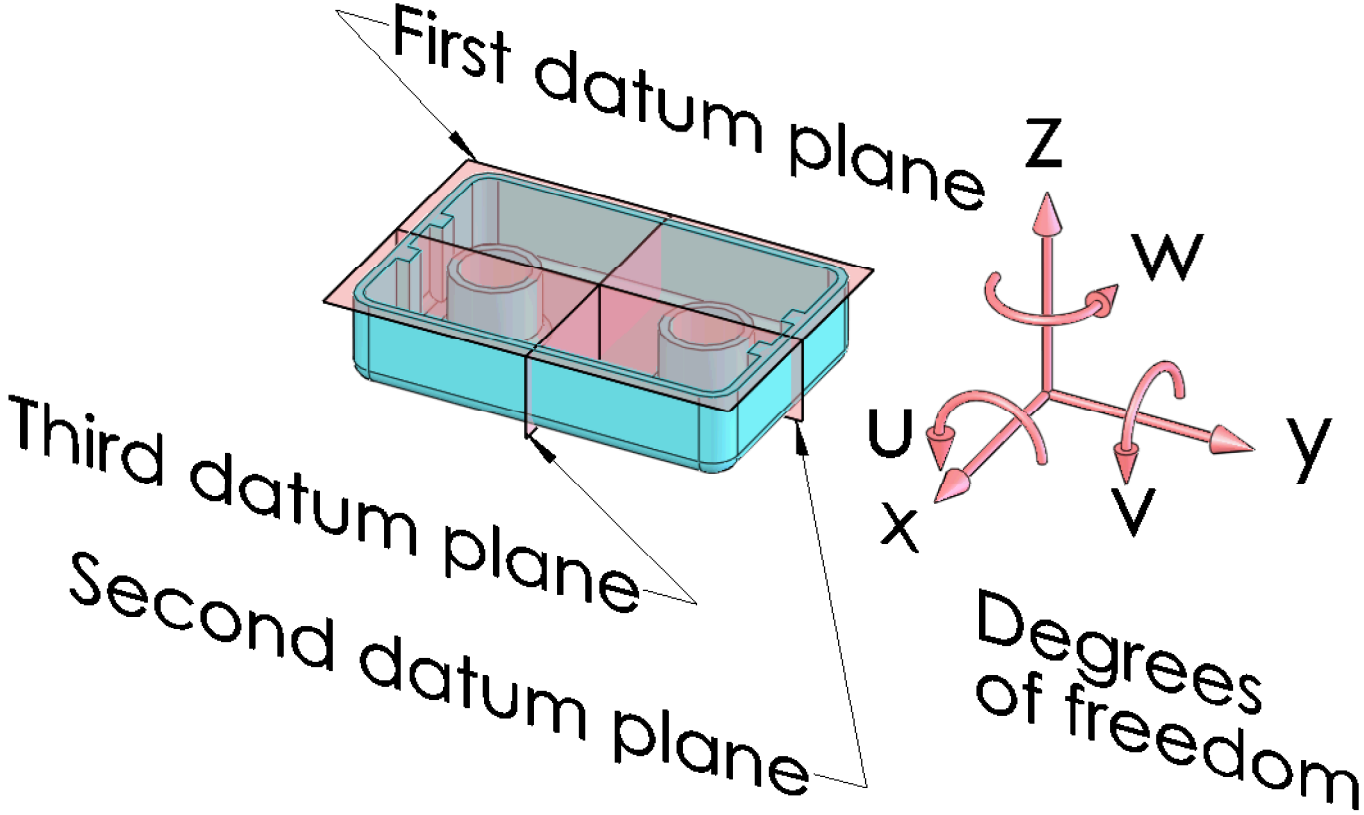
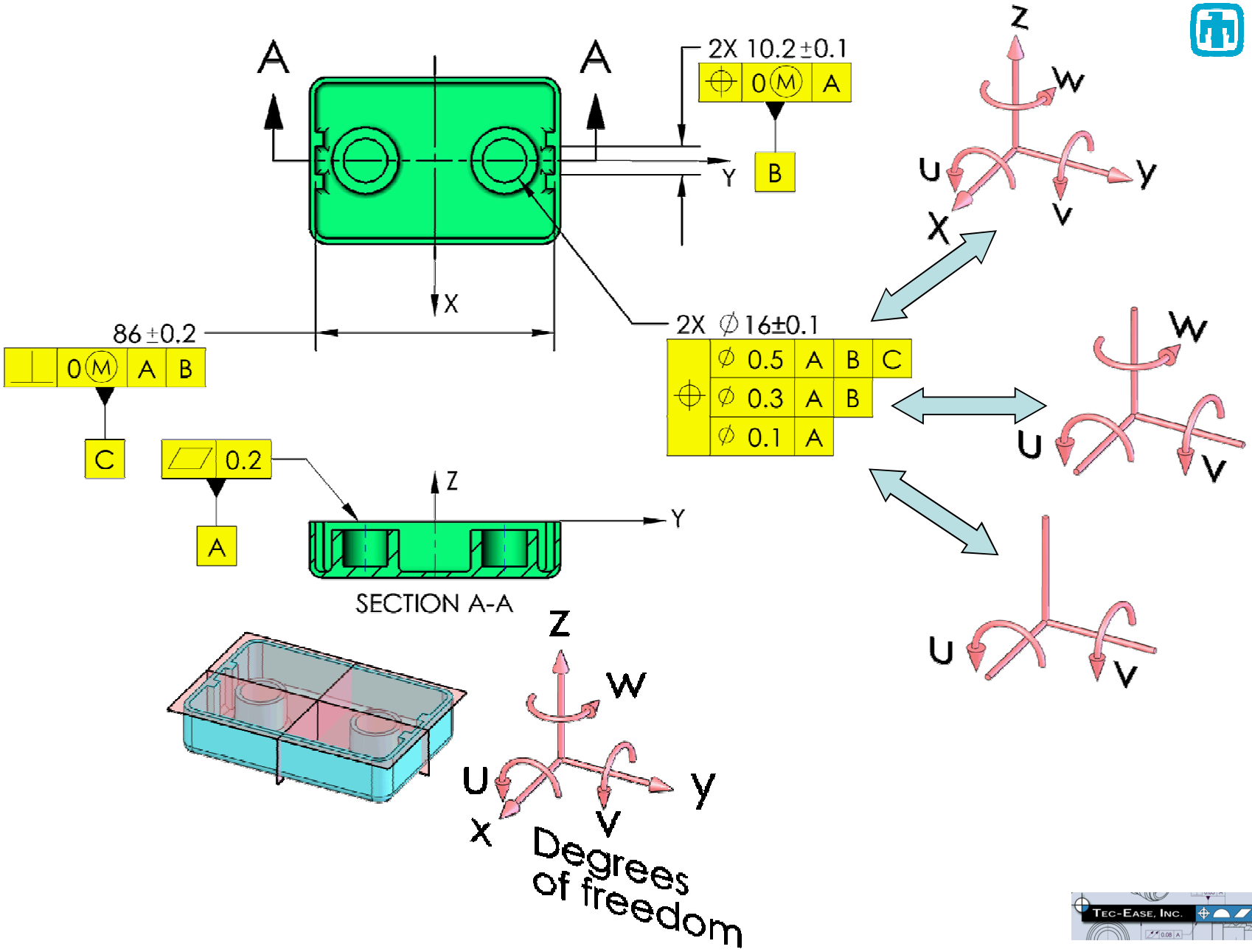


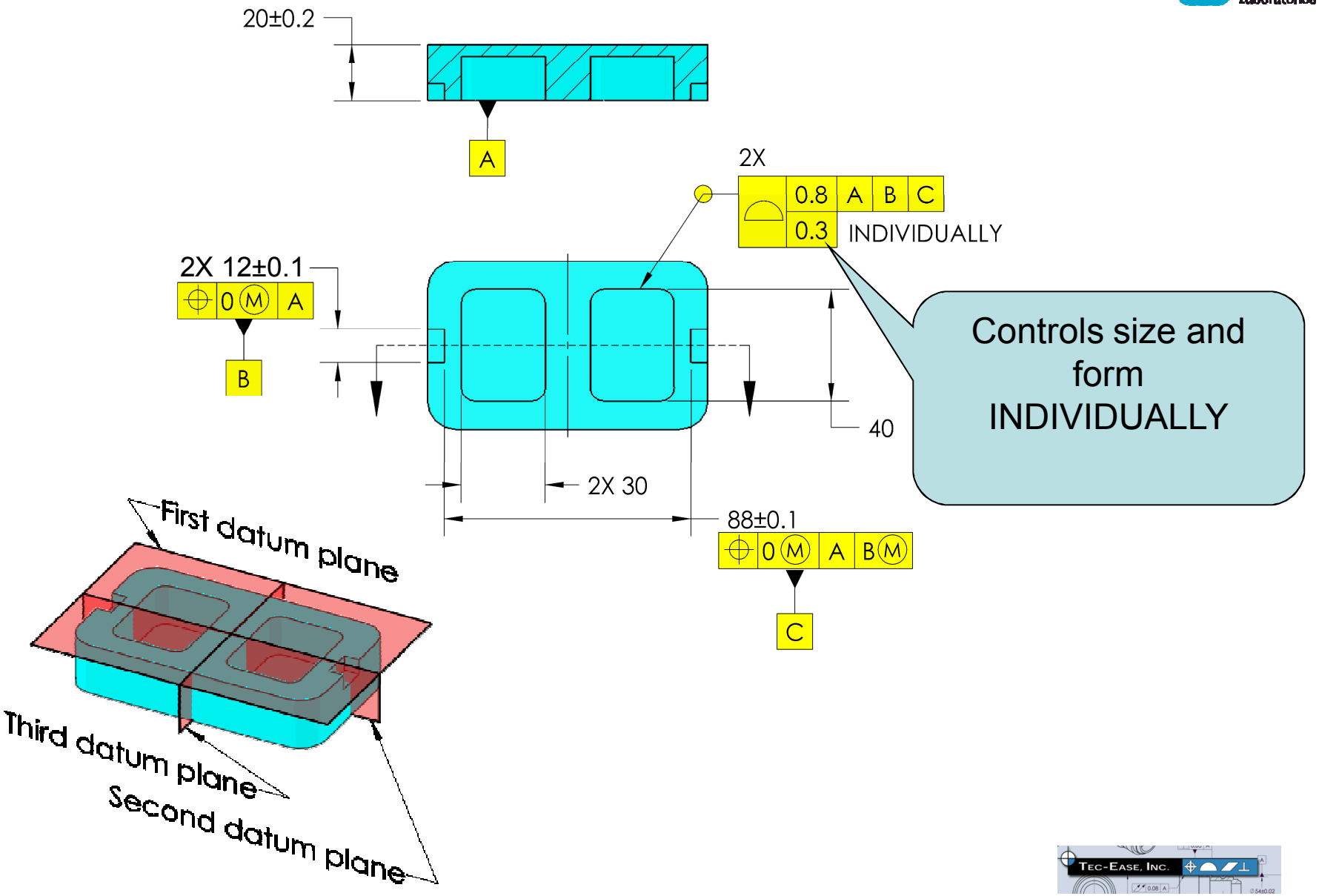


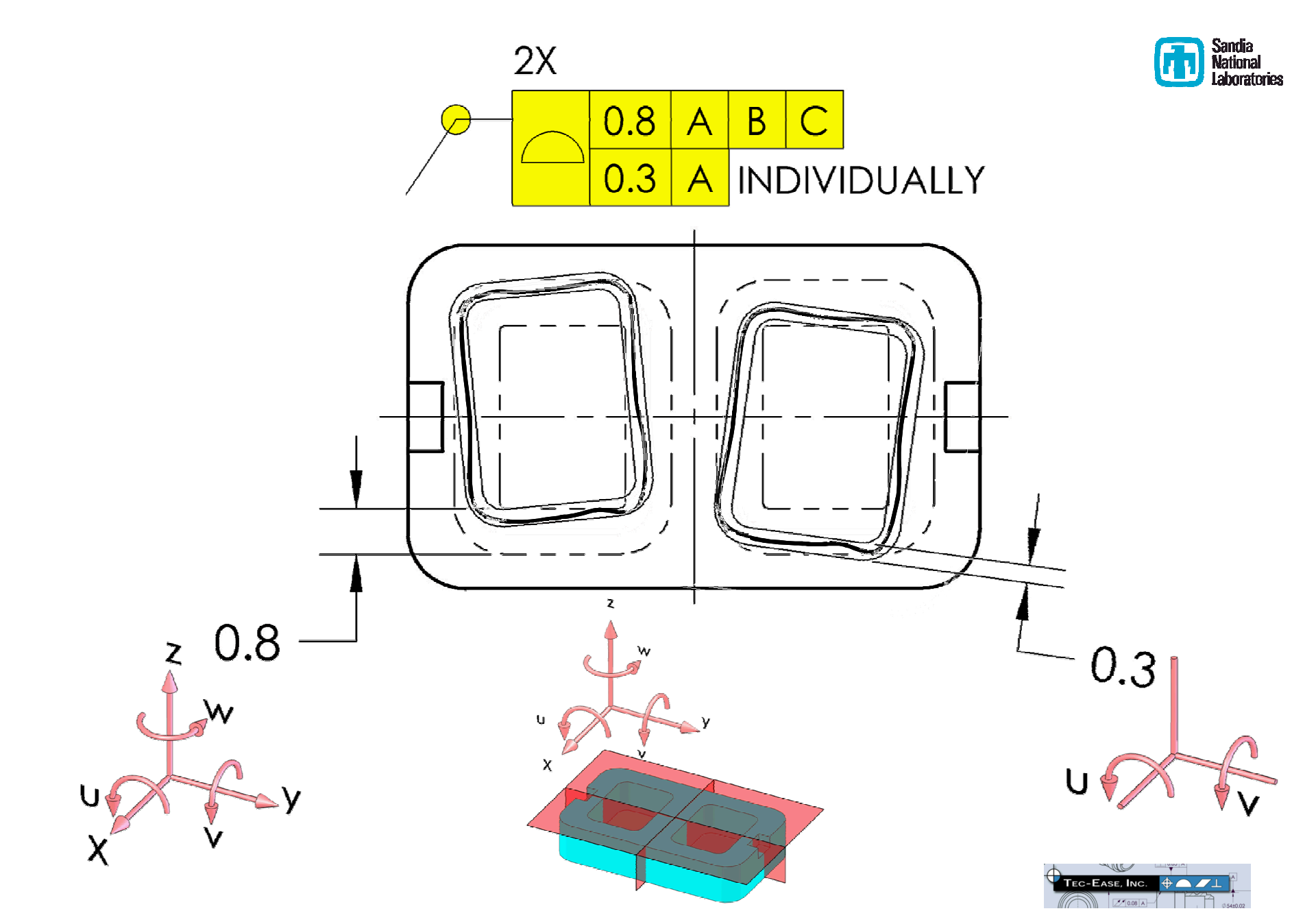
	Controls Provided by the Lower Segment
(a)	Location of the holes to each other
(b)	Location of the holes to each other Perpendicularity to the first datum plane
(c)	Location of the holes to each other Perpendicularity to the first datum plane Orientation to the second datum plane
(d)	Location of the holes to each other Perpendicularity to the first datum plane Orientation to the second datum plane Location to the second datum plane


A
A
2X 10.2 ±0.1
0 M A
B
Y
0,0,0
Origin
X
86 ±0.2
2X ∅16±0.1
∅ 0.5 A B C
∅ 0.3 A B
∅ 0.1 A
0 M A B
C
0.2
A
0,0,0
Origin
Z
Y
SECTION A-A


First datum plane
Third datum plane
Second datum plane
Z
W
U
y
X
V
Degrees of freedom


A
A
2X 10.2±0.1
0 M A
B
Y
X
86±0.2
0 M A B
C
0.2
A
Z
Y
SECTION A-A
2X ∅16±0.1
∅ 0.5 A B C
∅ 0.3 A B
∅ 0.1 A
Z
W
U
y
V
X
Degrees of freedom


20±0.2
A
2X
0.8 A B C
0.3 INDIVIDUALLY
2X 12±0.1
0 M A
B
40
2X 30
88±0.1
0 M A B M
C
Controls size and form INDIVIDUALLY
First datum plane
Third datum plane
Second datum plane


2X
0.8 A B C
0.3 A INDIVIDUALLY
0.8
0.3
z
w
u
y
x
v
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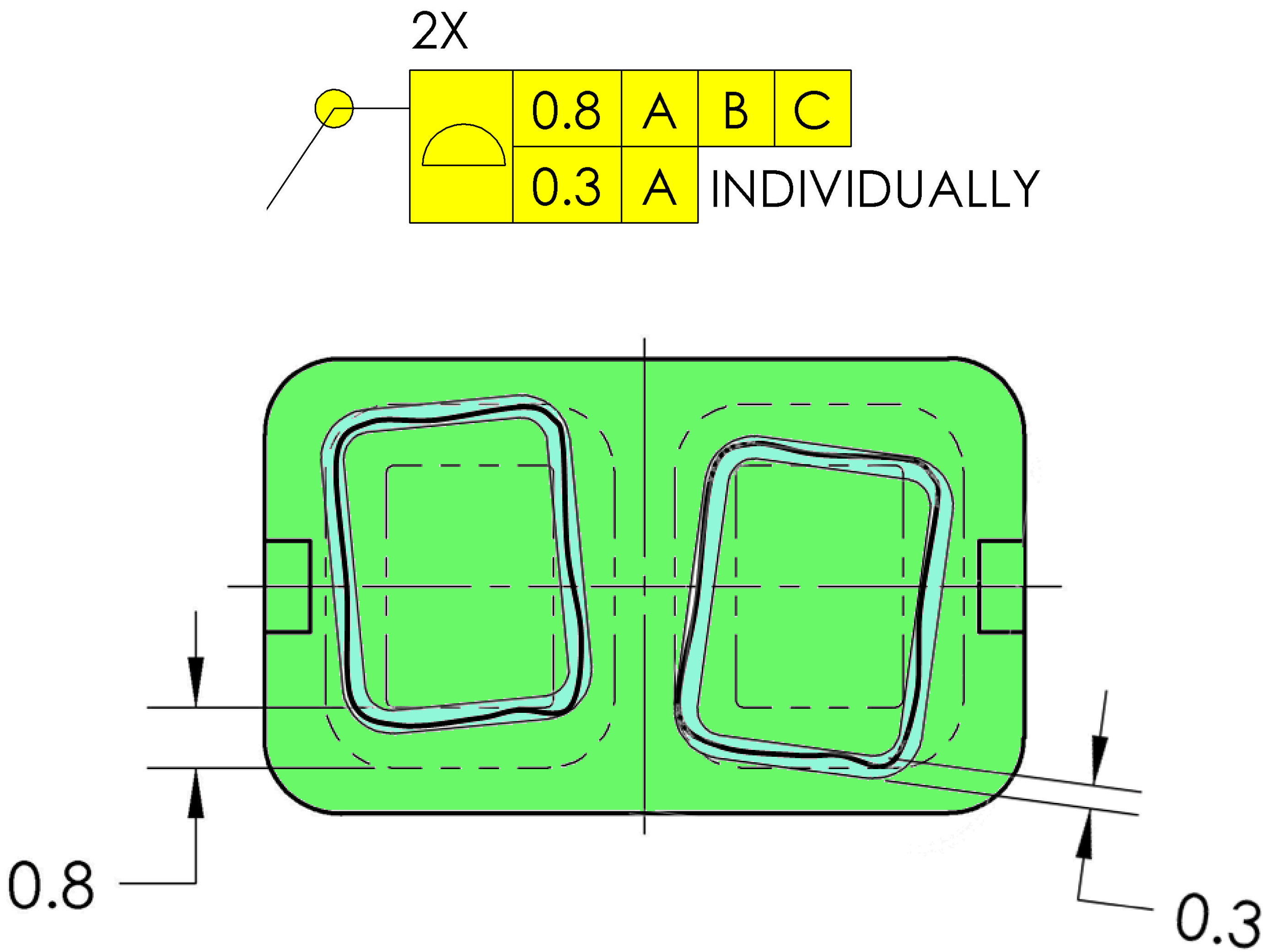

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QUESTIONS?

Appendix A – Approval Authorizations

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STANDARDS & CERTIFICATION

January 6, 2012

Mr. E.A. "Tony" Bryce
Technical Team Leader – Mechanical Calibration (2542-2)
Sandia National Laboratories
P.O. Box 5800
Mail Stop 0616
Albuquerque, NM 87185

Subject: Copyrighted Material

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Sincerely,

Ivette Rodriguez
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TEC-EASE, INC.

January 9, 2012

Mr. E. A. "Tony" Bryce
Technical Team Leader – Mechanical Calibration
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P. O. Box 5800
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Albuquerque, NM 87185

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