Size Concepts

Size Tool: The Size tool is a toleranced nominal dimension. It defines a tolerance zone consisting of the space between a "Maximum Material Condition boundary" of perfect form and a non-interssecting, "Least Material Condition boundary" of not necessarily perfect form, which is the surface swept by the "Least Material Condition Sphere".

Size control concepts:

(1) the **Maximum Material Condition Size** = the extreme permissible size of the feature at Maximum Material Condition

(2) the **Least Material Condition Size** = the extreme permissible local size of the feature at Least Material Condition,

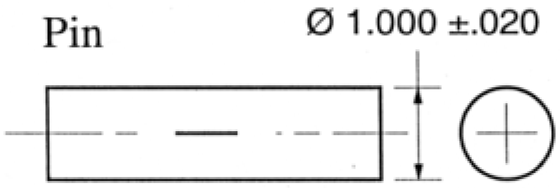
(3) the **Unconstrained Actual Mating Size** = the size of the Unconstrained Actual Mating Envelope of an actual feature,

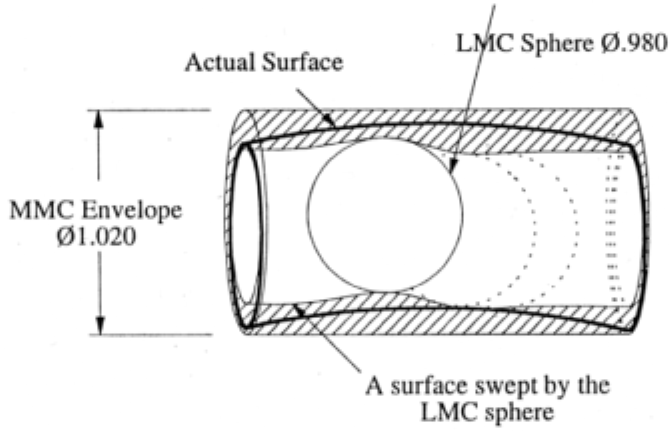
(4) the **Orientation Constrained Actual Mating Size** = the size of the Orientation Constrained Actual Mating Envelope of an actual feature,

(5) the **Location Constrained Actual Mating Size** = the size of the Location Constrained Actual Mating Envelope of an actual feature,

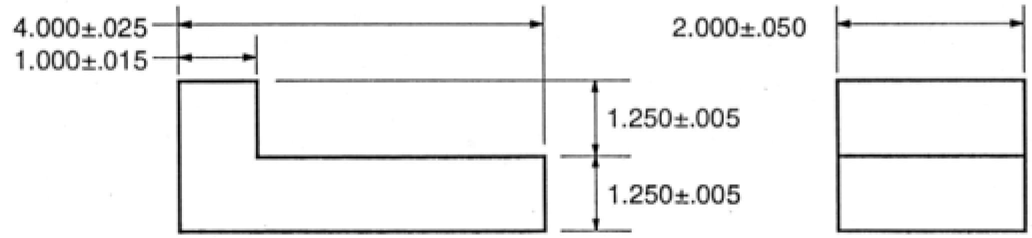
(6) the **Actual Local Size** = the diameter of the maximum inscribed or minimum circumscribed sphere (opposed point distance) at any location in an actual feature,

(7) the **LMC Actual Local Size** = the extreme LMC value of the **Actual Local Size** of a feature.

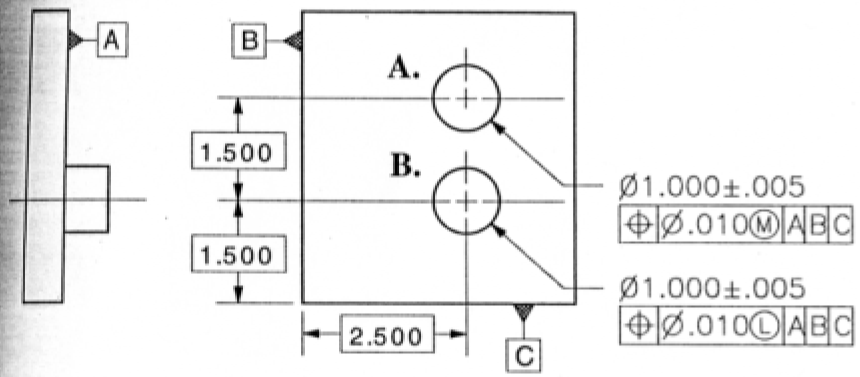




The features illustrated on the right are <u>not</u> features of size, and should not be controlled with the Size tool!



Virtual and Resultant Condition
or
Material Free & Filled Boundaries



Definition: The terms Virtual and Resultant Condition refer to the "size" of the <u>Material</u> <u>Free</u> and <u>Material</u> <u>Filled</u> Boundaries of a feature, as a result of the collective effects of the tolerances imposed on its size, form, orientation and location.

Application: The "Material Free Boundary" of the Considered Feature establishes the extreme limit of the "Material Free Boundary" of the mating feature. The concept thus serves to ensure assemblability.

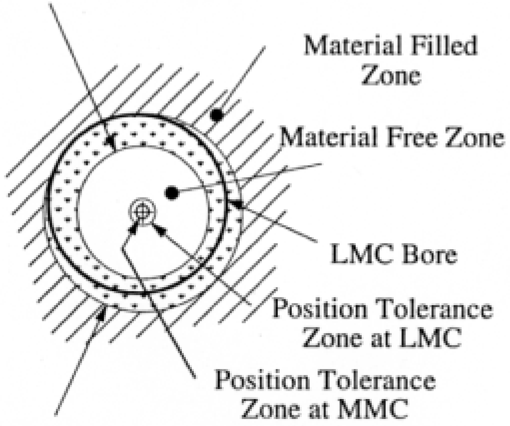
Note: The terms "Virtual" and "Resultant" condition are poorly defined in the ASME Y14.5M 1994 standard (§1.3.23 p. 3 and § 1.3.37 p. 4) recommending substitution by the terms "Material Free Boundary" and "Material Filled Boundary" as highlighted below.

A. Internal Cylinder

Material Free Boundary (Virtual Condition Boundary / Inner Boundary / In Air Boundary)

Ø1.000
Size Tol. -.005
<u>Pos. Tol. -.010</u>
Ø.985

Ø1.000
Size Tol. +.005
Pos.Tol. +.010
<u>Pos. Bonus +.010</u>
Ø1.025



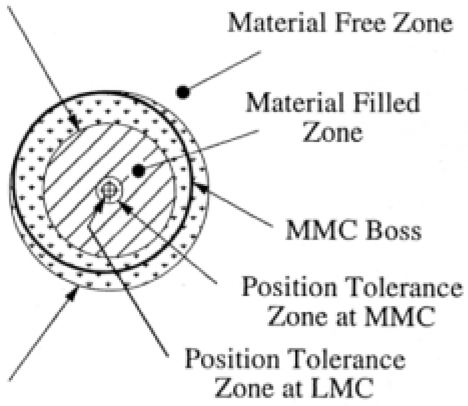
Material Filled Boundary (Resultant Condition Boundary / Outer Boundary / In Material Boundary)

B. External Cylinder

Material Filled Boundary (Virtual Condition Boundary / Inner Boundary / In Material Boundary)

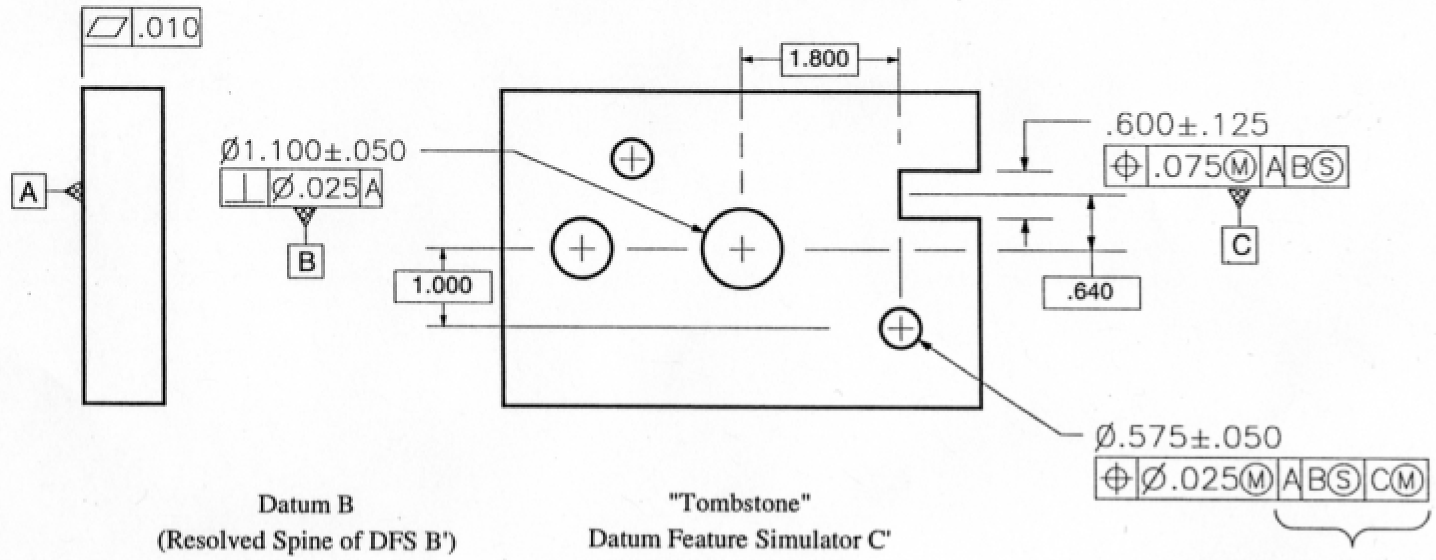
Ø1.000
Size Tol. -.005
<u>Pos. Tol. -.010</u>
Ø.985

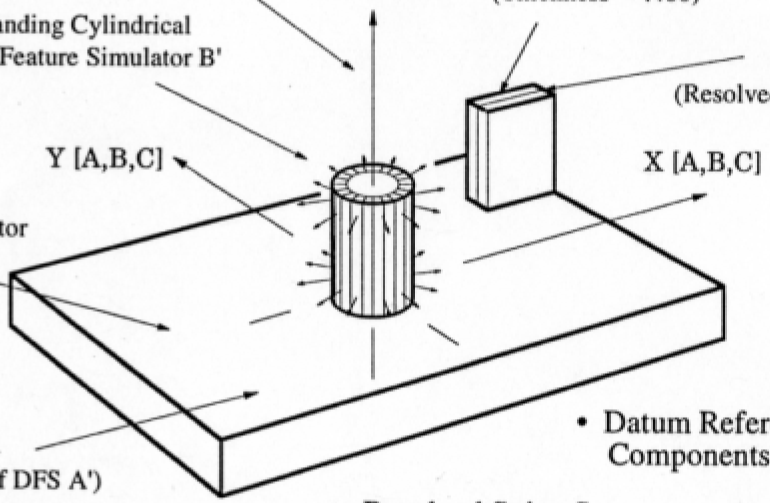
Ø1.000
Size Tol. +.005
Pos.Tol. +.010
<u>Pos. Bonus +.010</u>
Ø1.025



Material Free Boundary (Resultant Condition Boundary / Outer Boundary / In Air Boundary)

Datum Reference Frame Construction Process
Introduction





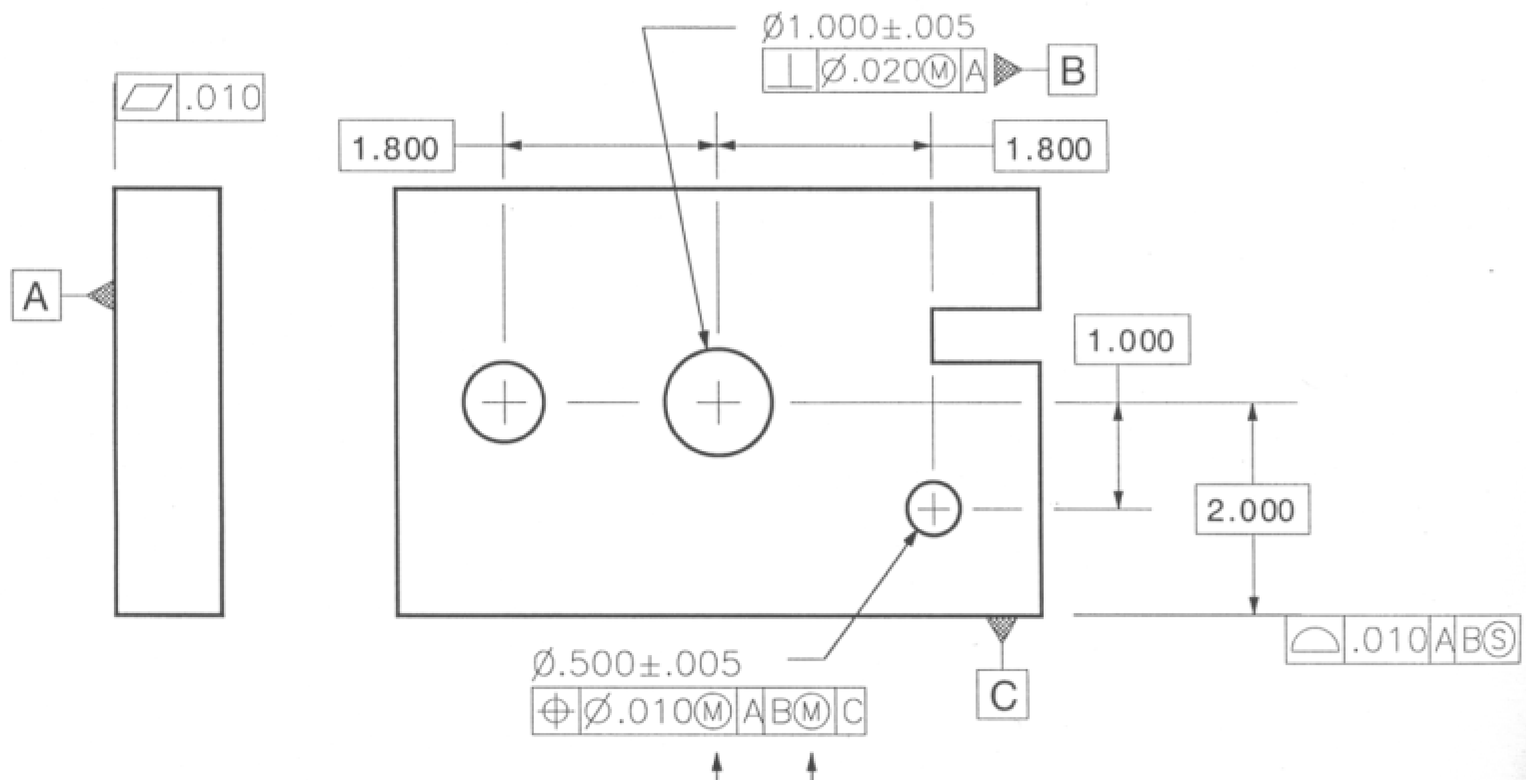
- Datum Feature Simulator Set
- Datum Reference Frame Components
- Resolved Spine Set

The Sullivan - Tandler
Degrees of Constraint Matrix

	P+Y	R	X	Y	Z
A	X	--	--	--	X
B	(X)	--	X	X	--
C	(X)	X	--	(X)	--

Datums are the Resolved Spines of Datum Feature Simulators

Tolerance Zone Expansion & Mobilization



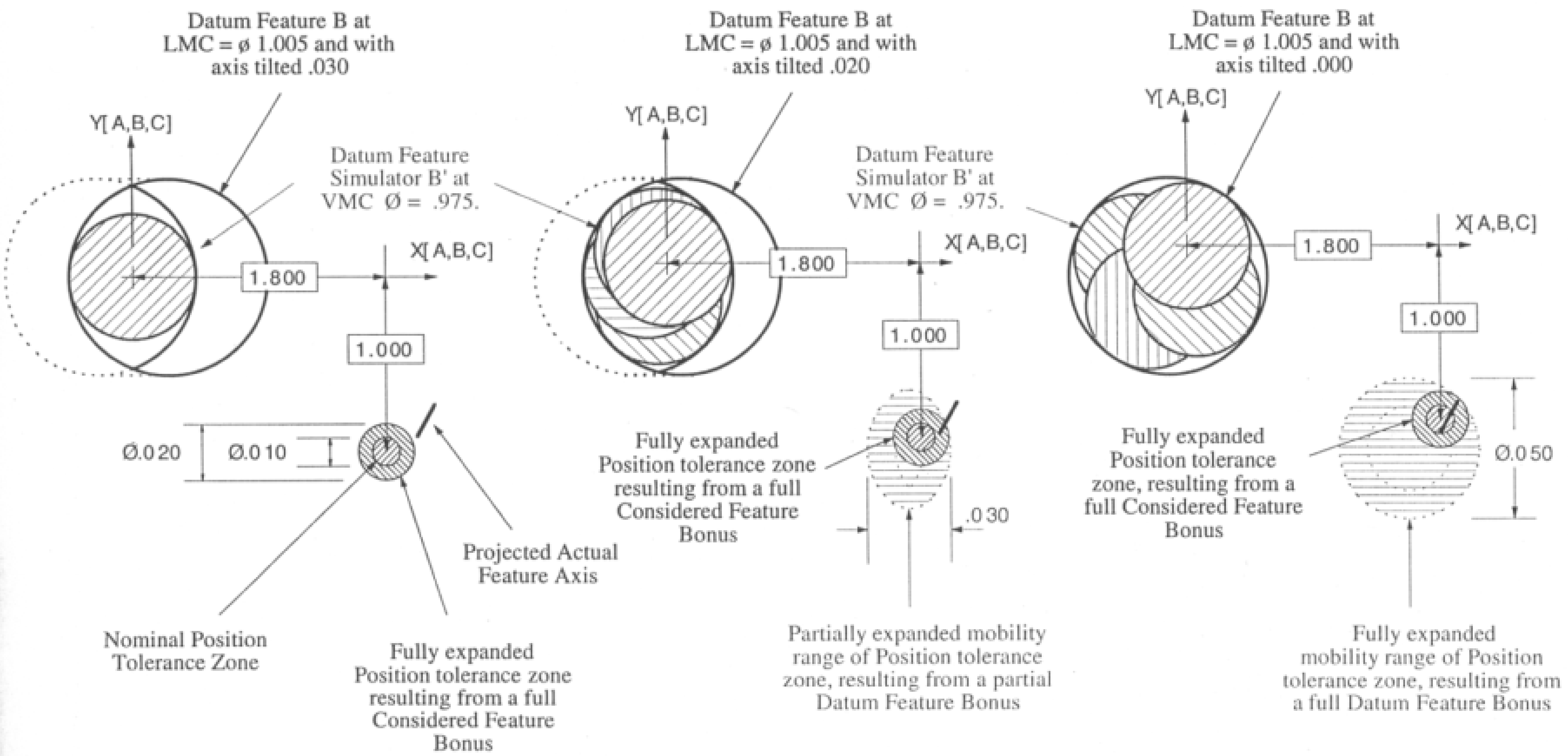
Considered Feature Material Condition Modifier	Datum Feature Material Condition Modifier
Provides a **numeric** Considered Feature Bonus which **expands** the Position tolerance zone	Provides a **non-numeric** Datum Feature Bonus which **mobilizes** the DRF and its associated tolerance zones
"M" stands for "**More**" Tolerance	"M" stands for Tolerance Zone "**Mobility**"
"S" stands for a Tolerance "**Stuck**" at Nominal	"S" stands for Tolerance Zone "**Stability**"
"L" stands for "**Lots More**" Tolerance	"L" stands for Tolerance Zone "**Lability**"

Tolerance Zone Expansion & Mobilization

As the diameter of the Considered Feature departs from MMC toward LMC, its Position tolerance zone expands due to the associated MMC modifier. Furthermore, as Datum Feature B departs from its Maximum Material Condition and becomes ever more perpendicular to Datum A, Datum Reference Frame AB(M)C and the attached Position tolerance zone of the Considered Feature become ever more free to move in both X and Y. The illustration below shows the effects on the size and mobility of the Considered Feature's Position tolerance zone as a function of (1) changes in the Material Condition of the Considered Feature and (2) changes in the Orientation of Datum Feature B with B fixed at LMC.

Note that no rotational mobility accompanies the Material Condition induced translational mobility of the DRF, because the Datum Feature Simulator representing Datum Feature C is traditionally "interpreted" to be a spring loaded, floating fence.

Note that the full Datum Feature Bonus is required to permit the fully expanded Position tolerance zone to move far enough to accommodate the actual axis of the Considered Feature!

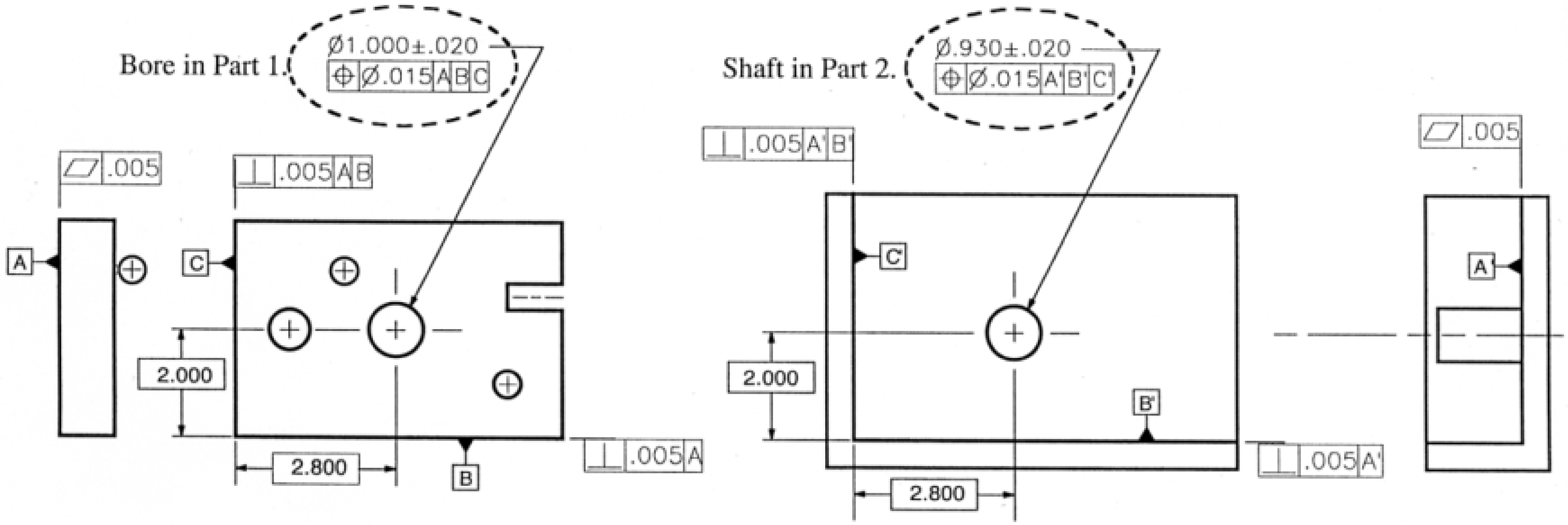


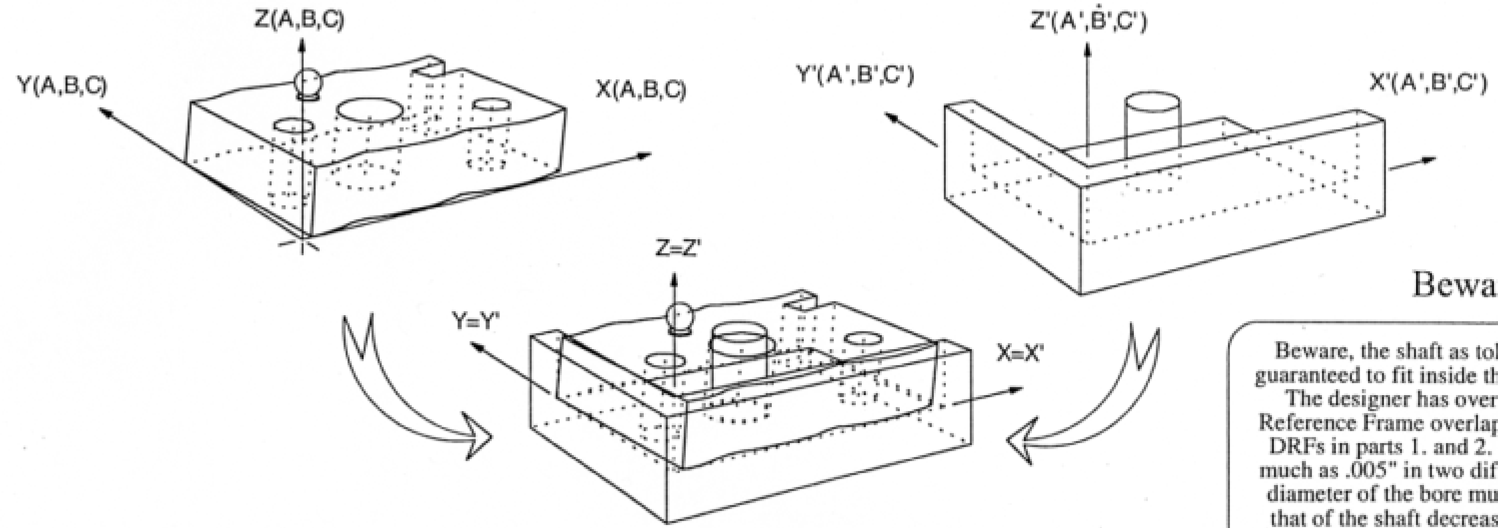
DRF Unification

The governing Concept in Mating Part Design

Unifying DRF (A,B,C) in Part 1. with DRF (A',B',C') in Part 2. by sequentially mating their respective Datum Features, ensures that the Bore in Part 1. will accommodate the shaft in Part 2. if both meet their respective tolerances.

If Part 2., now missing the shaft, is a machining fixture whose DRF (A',B',C') has been united with the coordinate system in a machine tool, then uniting DRF (A,B,C) in Part 1. with DRF (A',B',C') in the machining fixture (Part 2.) ensures that Part 1. is properly oriented and located relative to the machine tool, and that the Bore in Part 1. will be manufactured in the right place.





Beware!

Beware, the shaft as toleranced, cannot be guaranteed to fit inside the hole as toleranced! The designer has overlooked the Datum Reference Frame overlap problem. Since the DRFs in parts 1. and 2. could overlap by as much as .005" in two different directions, the diameter of the bore must be increased, and that of the shaft decreased, by $\sqrt{2}$ x .005" = .0071" in order to ensure assemblability.

DRF Construction Process Overview