Datum Definition When the Datum Is a Cylinder

A datum is defined in ISO 5459:1981 [2] as:
. A theoretically exact geometric reference (such as axes, planes, straight lines, etc.) to which tolerance features are related. Datums may by based on one or more datum features of a part.

When measuring a part with a datum feature requirement that requires you use a cylinder as the spatial orientation datum (base plane datum) there are several considerations you must keep in mind. The surface of the datum cylinder will never be 'true'. When measuring a part surface form, waviness, and roundness deviations will cause some variation in the calculation of the cylinder thus changing the orientation of the cylinder. The orientation (See Figure 1 a) is the angular deviation of 3d line through the center of the cylinder. It will be imperative that you take as many points as possible when measuring a cylinder on a part that are equally distributed around each circle segment of the cylinder to create a more consistent best-fit cylinder.

A datum simulator is the best method to get consistent measurement values.

When creating a simulated datum the specs state:

ISO *.A real surface of adequately precise form (such as a surface plate, a bearing, or a mandrel, etc.) contacting the datum feature(s) and used to establish the datum(s).*
NOTE: Simulated datum features are used as the practical embodiment of the datums during manufacture and inspection.

ANSI Y14.5: When a diameter is designated as a datum feature, the datum axis is derived from placing the part in a datum feature simulator. This simulator can be a pin gage (internal) or a ring gage (external). The datum feature is the surface of the part. The gage, the pin or ring gage is the simulated datum and is the datum axis.

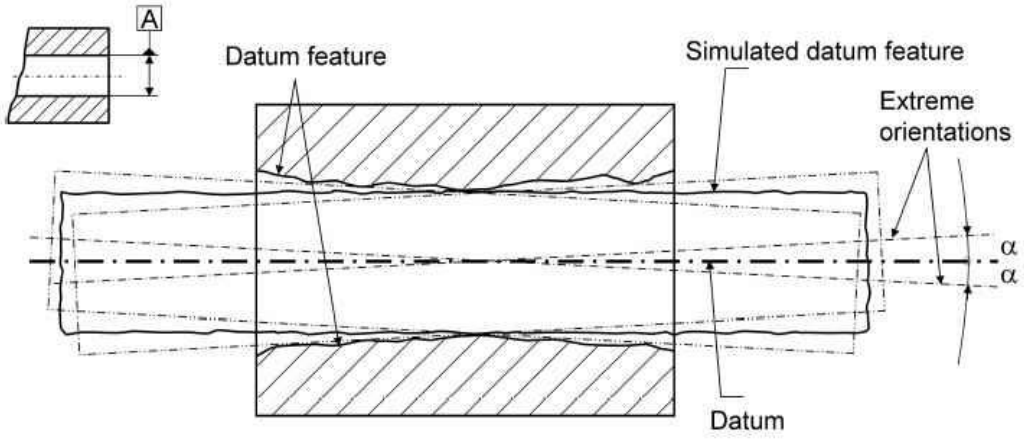

Figure 1: Datum is the axis of a cylinder

If you measure the physical hole or the datum simulator an issue will arise. See Figure 1. This shows the largest inscribed cylinder and its axis for a hole. The orientation of the cylinder depends on the surface condition and form of the hole and might therefore not produce an unambiguous orientation. For that case the standard requires an equalization of the angles *a* in all directions of space. The same will be for the smallest circumscribed cylinder respectively and consequently its axis for a shaft. Due to the geometry of a cylinder, it lies on two planes of orientation. These planes are the center axis of the cylinder and will be averaged during the spatial orientation process of establishing a datum structure on your CMM.

In addition to the single axes, it is necessary to define common axes as well. When the part has two different sized diameters but share the same axis both diameters must be used to create the datum axis.

For establishing a datum being the common axis of two cylinders (see figure 2) the following definition is stated in ISO 5459:1981 [2]:. In *the example (.), the datum is the common axis formed by the two smallest circumscribed coaxial cylinders…*

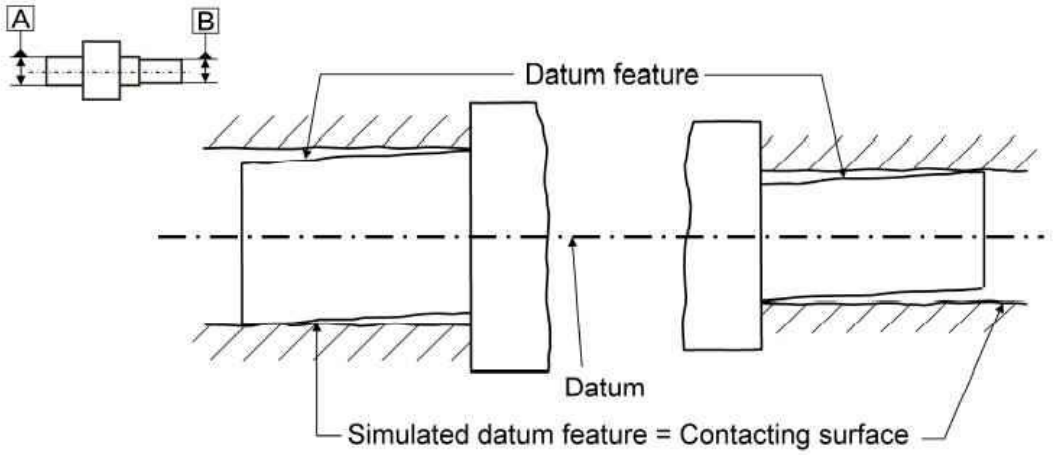

Figure 2: Datum axis with two coaxial cylinders.

When measuring features as in Figure 3 the datum axis line must be created between Datum A and Datum B to measure the runout of the journal. In Figure 3 both datum A and datum B have a angular orientation roughly in the same axis but we measure in a real world and if the orientation between the two datums pointed in the opposite direction then we are faced with a dilemma. At what point along the datum cylinder do we make our measurement?

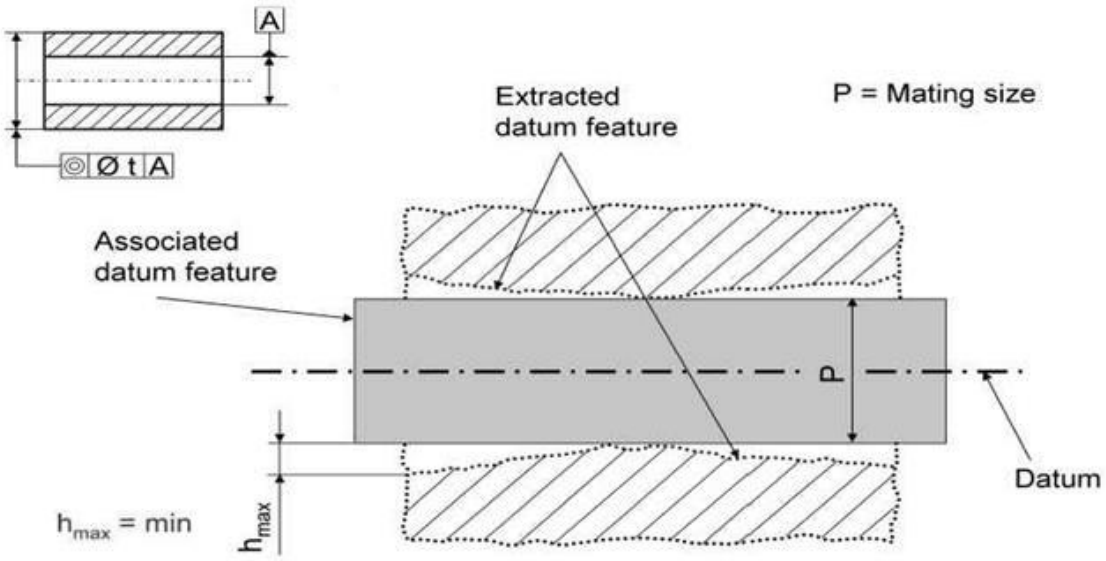

Figure 3: Establishing a common axis between two different size diameters

In this case we need to measure two circles one on each datum and connect those with a 3d line to get the datum center. While this will give us the orientation of the part based on an axis center line it still does not give us the true datum axis line like a datum simulator would but usually a datum simulator is not practical in a production environment. Slipping a pin gage in a hole or placing the part in a ring gage to make sure in both cases I am really contacting the 'working' part on the datum feature is not practical. Having parts with good form and proper surface condition will reduce your measurement variation.

All figures are from ISO 5459:1981