MechNEWS

May/June 2004 Rev.1

Welcome

Welcome to the May/June edition of Mech*NEWS*™, a service provided by MechSigma Consulting, Inc. Since the last newsletter, we received several questions about "radii". On the surface, this topic may seem trivial, but in some situations, it can be confusing. The key issue seems to be whether or not we should treat a radius as a size feature or a non-size feature. This month's featured article will explore: 1) how to establish a radial feature as a datum, and 2) how to control the variation of a radial feature.

We hope you enjoy this issue of Mech*NEWS*™ and continue to [tell your colleagues about it](#).

Radial Features

Paragraph 2.15 of ASME Y14.5M-1994 defines a *radius* as "any straight line extending from the center to the periphery of a circle or sphere." Subparagraph 2.15.1 states: "A radius symbol R creates a zone defined by two arcs (the minimum and maximum radii). The part surface must lie within this zone." If no center is drawn for the radius, each arc shall be tangent to the adjacent part surfaces and form the boundaries for the radius tolerance zone. (See Figure 1.) Where a center is drawn for the radius, the two arcs are concentric as shown in Figure 2. Although Y14.5 does not explicitly state it, we generally consider a radius a portion of a cylindrical surface encompassing *less than* (or equal to) 180° of arc length.

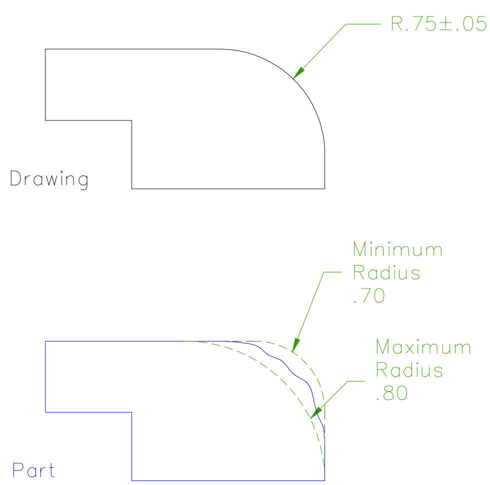

Figure 1

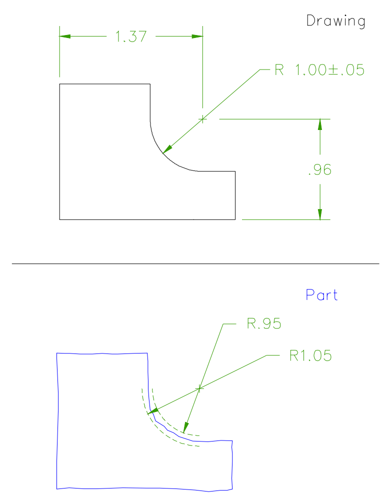

Figure 2

Size or Non-size Feature

The rules for establishing a radial feature as a datum and for controlling the variation of a radial feature depend on whether it is a *size* feature or *non-size* feature. Y14.5 defines a size feature as "one cylindrical or spherical surface, or a set of opposed elements or opposed parallel surfaces, associated with a size dimension." Since a radius is less than 180° degrees, it does not meet the requirements for a feature of size, and it should not be modified with a material condition modifier. *(Continued)*

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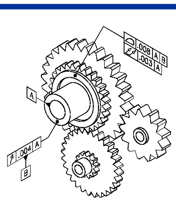

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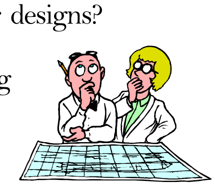

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Using a Radius as a Datum

We sometimes have problems where we try to reference a radius as a datum. The trouble is in determining the true geometric counterpart. Paragraph 4.2 of Y14.5 states that the true geometric counterpart of the feature that is used to establish a datum may be:

(a) a plane;
(b) a maximum material condition boundary (MMC concept);
(c) a least material condition boundary (LMC concept);
(d) a virtual condition boundary;
(e) an actual mating envelope;
(f) a mathematically defined contour.

Since a radius is not a feature of size (and it's not a plane), it cannot be (a) through (e). We could, however, identify the radial feature as a mathematically defined contour.

Identifying a True Geometric Counterpart Mathematically

Paragraph 4.5.0.1 of Y14.5 states that a contoured surface may be used as a datum feature. " Such a feature can be used as a datum feature only when it can be mathematically defined and can be related to a three-plane datum reference frame. In such cases, the theoretically true geometric counterpart of the shape is used to establish the datum."

Figure 3 shows one way to identify a radial feature as a datum. Using a note, we have identified the method to establish simulated datum B. We could have chosen other mathematical methods to define the radius, depending on the function of the part. Depending on the inspection capabilities, this may not be the most practical way to establish the datum because it may be difficult and/or time consuming to establish the simulated datum.

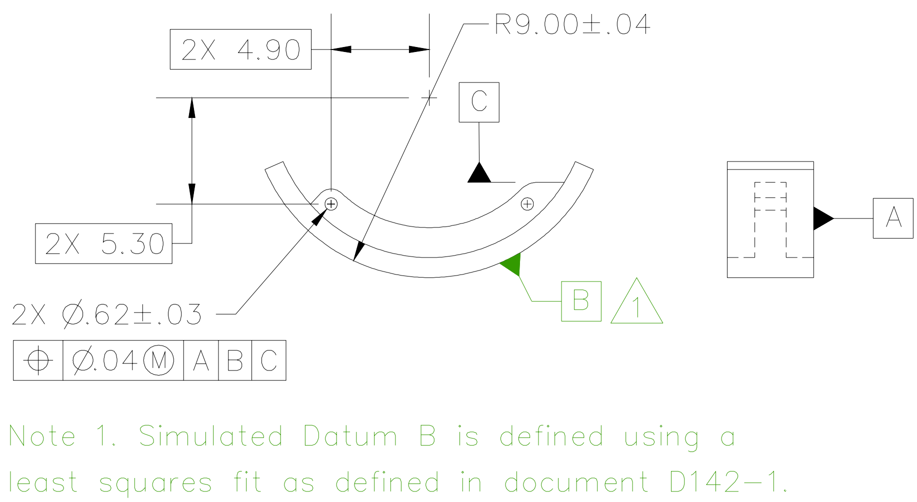

Figure 3

Using Targets to Establish a Datum

Practically, it may be best to use portions of the radial surface to establish the datum. Datum targets may be used to establish a simulated datum axis, as shown in Figure 4. Note that although Y14.5 does not show it, we attached the datum

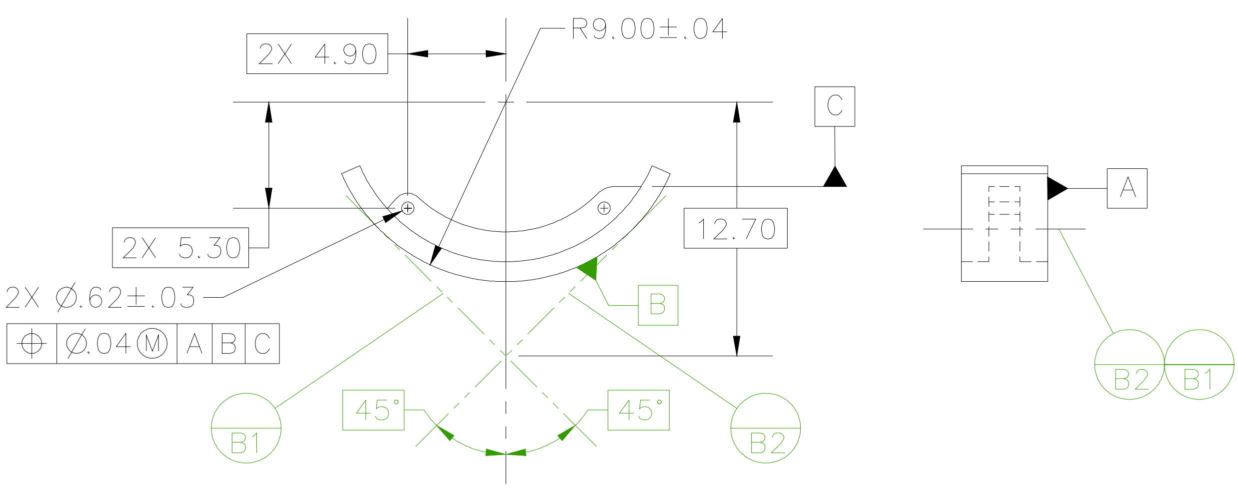

Figure 4

feature symbol to the feature. We justify it with paragraph 4.6.1 which states: "The datum feature itself is usually identified with a datum feature symbol."

Controlling the Location of the Radial Feature

Figure 1 shows a common method to control the variation of a radial feature where the radial feature is tangent to two planar features. The location of the radial feature is controlled by the tolerance zone, and the location of the adjacent planar features. Figure 2 may be used where the center of the radial feature is controlled relative to other features, and the radial feature is controlled from this center. This method uses implied datums and will likely introduce ambiguous interpretations. To avoid this problem, we recommend using GD&T controls to locate the radial feature to a datum reference frame.

Oftentimes, we see applications where radial features are located with a position feature control frame, such as |⌖|Ø.05Ⓜ|A|B|C| . This type of control works well for cylindrical features, because they are features of size. For radial features (which are non-size), we cannot use a position feature control frame. Therefore, we generally use a profile feature control frame to control the variation of the feature along with basic dimensions to establish the location of the radial feature to the datum reference frame.

Summary

Since radial features are not features of size, we cannot think of them the same way we think about cylindrical features (holes and pins). For holes and pins, we can establish MMC boundaries, LMC boundaries, virtual conditions, and actual mating envelopes. For radial features, we cannot.

Therefore, one way to define radial features as datums is to treat them as we would any other mathematical or profiled feature. Where this is not practical, we recommend using datum targets.

Since we cannot establish an axis from a radial feature (without documenting a fitting routine), we generally use profile to control the location of a radial feature to other part features. A

Events: The next GD&T committee meeting is scheduled for October 2-8, 2004 in Las Vegas, Nevada. These meetings are open to the public. For more information, contact ASME or visit their website at:
http://cstools.asme.org/wbpms/CommitteePages.cfm?Committee=C64041000

Joke of the Bi-Month

A weightlifter decided to get a job working as a laborer at a construction site. One day he decided to brag that he could outdo anyone in a feat of strength. He made a special case of making fun of the wiry engineer on the site. After several minutes, the engineer had enough.

"Why don't you put your money where your mouth is," said the engineer. "I will bet a week's pay that I can haul something in a wheelbarrow over to that building that you won't be able to wheel back."

"You're on, little guy!" the weightlifter replied. "Let's see what you got."

The engineer reached out and grabbed the wheelbarrow by the handles. Then, nodding to the weightlifter, he said, "All right: Get in."