

## Welcome

Welcome to the March/April issue of MechNEWS™, a service provided by MechSigma Consulting, Inc. In a prior issue, we discussed datum axis displacement for coaxial features. This month we received a request to expand the topic and discuss datum reference frame displacement as it applies to patterns of features.

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

## Datum Reference Frame Displacement

ASME Y14.5M-1994 tells us that a datum is “a theoretically exact point, axis or plane derived from the true geometric counterpart of a specified datum feature.” It also tells us that for datum features that are size features, the true geometric counterpart is a virtual condition boundary. Although this virtual condition may be easy to understand in principle, understanding the effect on parts can sometimes be confusing. A good way to help understand this effect is by looking at an example.

Figure 1 shows a pattern of two holes that are located from datum reference frame  $\boxed{A \ B \textcircled{M}}$ . Paragraph 5.4.5.6.3 of ASME Y14.5M-1994 states:

“The datum axis is the axis of a virtual condition cylinder of fixed size that is perpendicular to the datum plane A. Variations in the size and perpendicularity of datum feature B are permitted to occur within this cylindrical boundary. Furthermore, as the actual mating envelope of datum feature B departs from its MMC size, a displacement of its axis relative to the datum axis is allowed”.<sup>1</sup>

Figure 2 shows a receiver (functional) gage to inspect the positional requirement for the two-hole pattern. In order to pass the positional requirement, each manufactured part must fit the gage. Notice, however, that there is no requirement for datum feature B to be centered on the virtual condition gage pin. In fact, the datum feature may shift around, or be *displaced*, relative to the gage pin.

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1. Note: We switched datums A and B from the example shown in Y14.5.

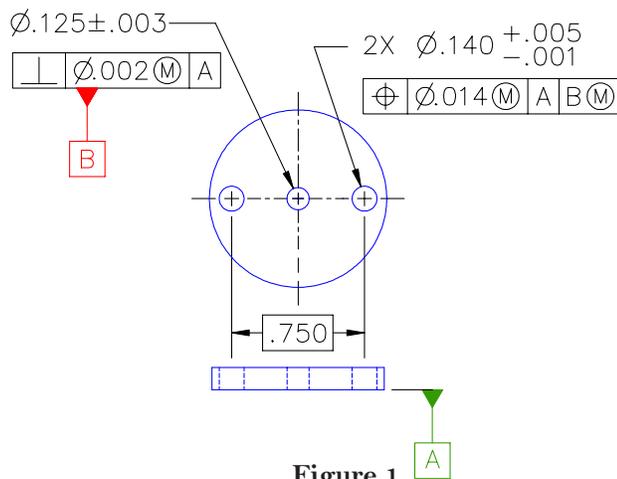


Figure 1

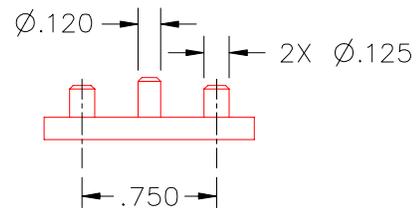
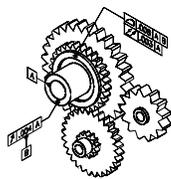


Figure 2

## Free Newsletter

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MechSigma Consulting, Inc.  
7301 Moss Ridge Rd.  
Parker, TX 75002  
Tel: 972.808.0153  
Fax: 972.442.2398  
[info@mechsigma.com](mailto:info@mechsigma.com)  
[www.mechsigma.com](http://www.mechsigma.com)



## Public Seminars

The schedule for our three-day [GD&T](#) course and our two-day [Mechanical Tolerancing for Six Sigma \(MTSS\)](#) course for the first half of 2005 follows.

### Geometric Dimensioning and Tolerancing

- Houston, TX: May 23-25
- Las Vegas, NV: June 6-8

### Mechanical Tolerancing for Six Sigma

- Houston, TX: May 26-27
- Las Vegas, NV: June 9-10

If you are interested in signing up for a public offering, please call or [email](#) us.

Y14.5 calls the clearance between the datum feature and the gage feature a *datum displacement*. Paragraph 5.3.2.2 states:

“Where datum feature B departs from MMC, its axis may be displaced relative to the location of the datum axis....

If a functional gage is used to check the part, this shift of the axis of the datum feature is automatically accommodated. However, if open set-up inspection methods are used to check the location of the feature pattern relative to the axis of the datum feature’s actual mating envelope, this must be taken into account.

Since the axis of the datum feature’s actual mating envelope must serve as the origin of measurements for the pattern of features, the features are therefore viewed as if they, as a group, had been displaced relative to the axis of the datum feature’s actual mating envelope. This relative shift of the pattern of features, as a group, with respect to the axis of the datum feature does not affect the positional tolerance of the features relative to one another within the pattern.”

Figure 3 shows a manufactured part with datum feature B’s (restrained) actual mating envelope size at  $\phi.126$ . For this part, the allowable clearance between the actual mating envelope and the gage may be approximated<sup>2</sup> by subtracting the two values. Therefore, the *radial* clearance between the datum feature and the gage is equal to one-half the calculated size difference ( $\phi.126 - \phi.120 = \phi.006 \div 2 = .003$ ).

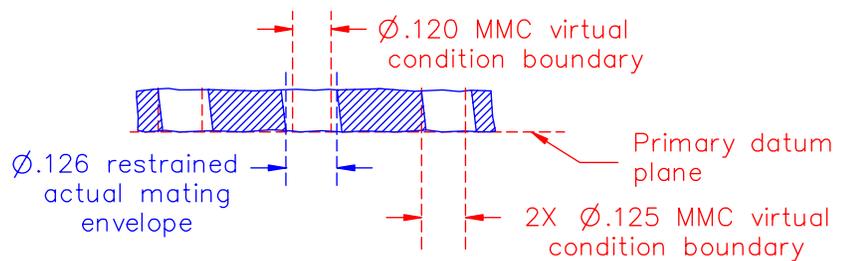


Figure 3

## Simultaneous Requirements

Figure 4 shows an example where two patterns of features are positioned to the same datum reference frame. For this example, datum displacement can occur, but it can only occur once. For example, we cannot have a datum displacement for the first pattern that is different from the datum displacement for the second pattern. Paragraph 4.5.12 of Y14.5 states:

“Where two or more features or patterns of features are located by basic dimensions related to common datum features referenced in the same order of precedence and at the same material condition, as applicable, they are considered a composite pattern with the geometric tolerances applied simultaneously.”

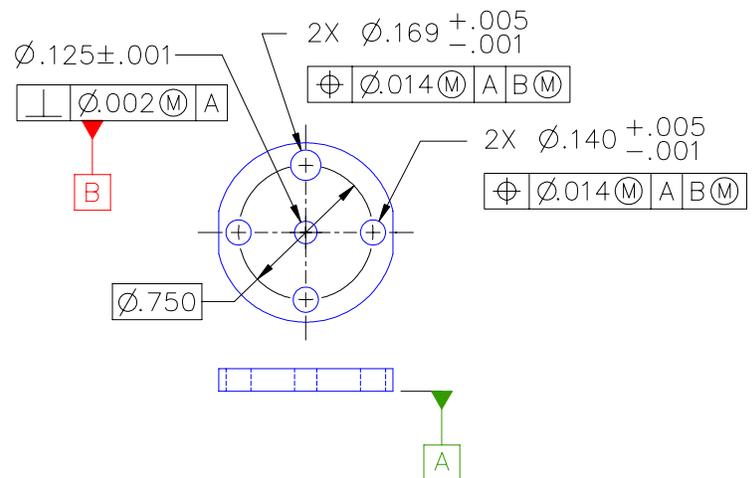


Figure 4

If we think about how parts fit together, this default condition makes sense. If we have two sets of bolts that must assemble at the same time, we are not allowed to shift the datum hole “to the left” to get the first set of bolts to drop in and then shift it “to the right” to get the second set of bolts to fit. Therefore the default is that all of the bolts must be fit simultaneously.

(Continued)

2. See the [Jan./Feb. 2005](#) newsletter if you don’t know why it’s an approximation.

## Engineering Services and On-site Training



Having problems with your designs?

MechSigma offers consulting and on-site training in mechanical tolerancing and GD&T.

Contact us at: [info@mechsigma.com](mailto:info@mechsigma.com)

## Events:

The next GD&T committee meeting is scheduled for May 2-5, 2005 at the Marriott Hotel in Minneapolis, MN. These meetings are open to the public.

Please contact ASME for more information.

Paragraph 4.5.12 continues:

“If such interrelationship is not required, a notation such as SEP REQT is placed adjacent to each applicable feature control frame.”

Figure 5 shows a part where the four-hole pattern is not related to the five-hole pattern. In this example, we override the default simultaneous requirement, by placing SEP REQT adjacent to each feature control frame.

Although *simultaneous requirements* is the general default, it does not apply to the lower segments of composite feature control frames. Paragraph 4.5.12.1 of Y14.5 states:

If a simultaneous requirement is desired for the lower segments of two or more composite feature control frames, a notation such as SIM REQT is placed adjacent to each applicable lower segment of the feature control frames.

If we think about how parts fit together, this default condition also makes sense. In general, where composite position is used on multiple patterns of features, each pattern has nothing to do with other patterns. For example, there may be two bolt hole patterns on a large panel. If the bolt hole patterns assemble to different parts, their requirements are separate.

## Summary

Datum displacement is analogous to “jiggling” parts when we try to assemble them. Conceptually, this means that mating (datum) features do not have to be centered when two parts assemble. If we have two or more sets of features that must assemble at the same time, we must treat them as a composite pattern. This makes sense for parts to assemble.

If we don’t want simultaneous requirements to apply, the standard gives us the tools to free this requirement. We do this by adding SEP REQT adjacent to the feature control frames.

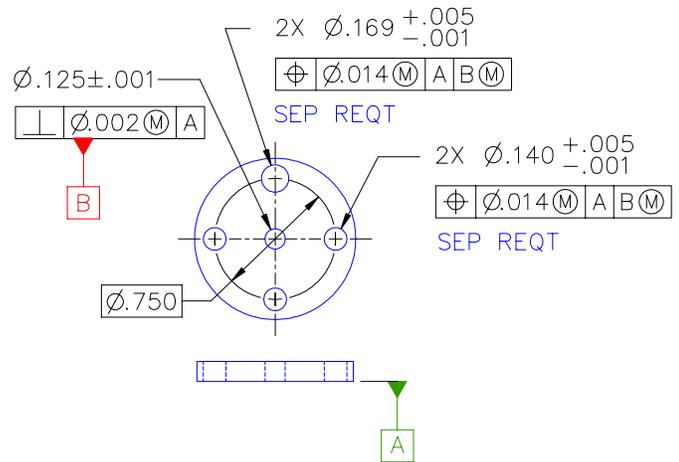


Figure 5

## Joke of the Bi-Month

### FIFTY DOLLARS IS FIFTY DOLLARS

Every year, Ester would say, “Morris, I’d like to ride in that helicopter.” Morris always replied, “I know Ester, but that helicopter ride is \$50 dollars and \$50 dollars is \$50 dollars.”

One year later, Morris and Ester went to the fair. Ester said, “Morris, I’m 85 years old. If I don’t ride that helicopter now, I might never get another chance.” Morris replied, “Ester, that helicopter is \$50 dollars and \$50 dollars is \$50 dollars.”

The pilot overheard the couple. He said, “Folks, I’ll make you a deal. I’ll take the both of you for a ride. If you can stay quiet for the entire ride and not say a word, I won’t charge you! But if you say one word, it’s \$50 dollars.”

Ester and Morris agreed — and up they went.

The pilot did all kinds of fancy maneuvers. But not a word was heard. He did his daredevil tricks over and over again, but still not a word.

When they landed, the pilot turned to Ester. He said, “by golly, I did everything I could to get you to yell out, but you didn’t. I’m impressed!”

Ester replied, “well, I was going to say something when Morris fell out.....but \$50 dollars is \$50 dollars.”

