MechNEWS

Nov. / Dec. 2005

Welcome

Welcome to the Nov./Dec. issue of Mech*NEWS*™, a service provided by MechSigma Consulting, Inc. In this issue, we show how a three-plane reference frame restricts motion of a part. We discuss how datums restrain up to six degrees of freedom. We also talk about why some parts don't need all six degrees of freedom restrained.

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

Using Datums to Restrain Degrees of Freedom

14.5 discusses datum reference frames as a means to *immobilize a part.* Paragraph 4.2 states: "Where features of a part have been identified as datum features, the part is oriented and immobilized relative to the three mutually perpendicular planes of the datum reference frame in a selected order of precedence." Oftentimes, we refer to datum reference establishment as a means of immobilizing (or taking away) a part's *degrees of freedom.*

In aeronautics we think of aircraft motion as having three translational directions (longitudinal, vertical, and lateral) and three angular directions (pitch, roll and yaw.) Likewise, we can think of parts as having *six degrees of freedom* in a reference frame.

Figure 1 shows a three-plane reference frame. We labeled one plane "A", one "B", and one "C." The intersections of each pair of planes are axes, which are labeled "AB", "BC", and "CA." The six degrees of freedom are defined as:

- Translation in the CA direction
- Translation in the AB direction
- Translation in the BC direction
- Rotation about the CA axis
- Rotation about the AB axis, and
- Rotation about the BC axis.

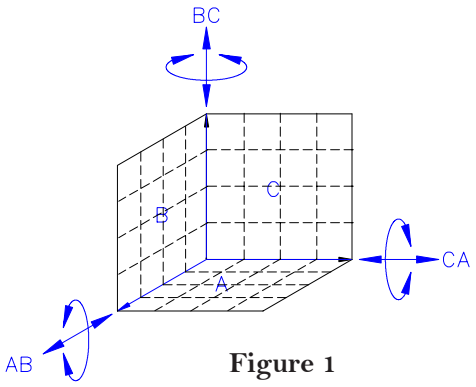

Figure 1

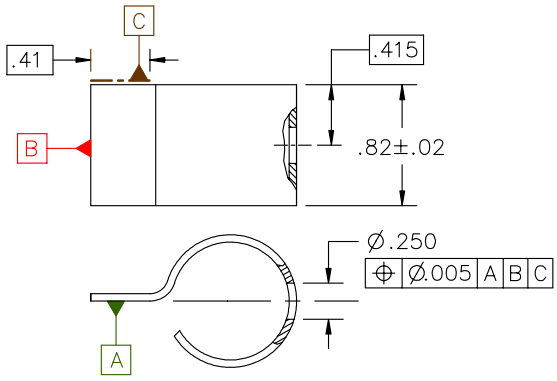

Figure 2

Figure 2 shows a simple example where we use three planar features to establish a datum reference frame. According to Y14.5, the order of precedence of the datums designates how we immobilize the part in the reference frame. Thus, we know that datum feature A should contact its simulator first, datum feature B second, and datum feature C last.

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Public Seminars

We have a limited number of public offerings for our three-day GD&T course and our two-day Mechanical Tolerancing for Six Sigma (MTSS) course. If you are interested in signing up for a public offering, please call or email us.

Geometric Dimensioning and Tolerancing

- Dallas, TX: Apr. 17-19
- Houston, TX: May. 1-3

Mechanical Tolerancing for Six Sigma

- Las Vegas: Apr. 6-7 (through ASME)
- Dallas, TX: Apr. 20-21
- Houston, TX: May 4-5

Figure 3 shows how we begin to arrest the degrees of freedom. By taking the cover and resting datum feature A against plane A, we *restrain* three (of the six) degrees of freedom.

- Translation in the BC direction
- Rotation about the CA axis, and
- Rotation about the AB axis.

The part is still allowed to translate in the AB and CA directions and rotate about the BC axis.

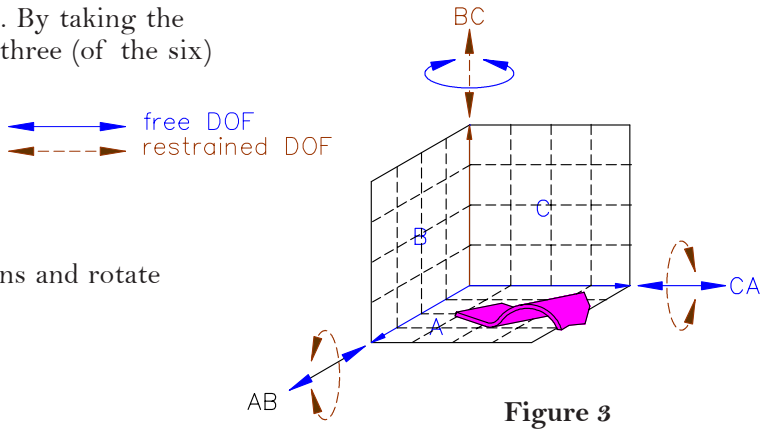

Figure 3

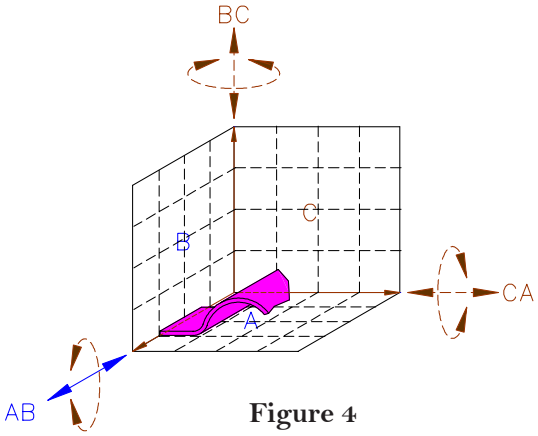

Figure 4

Figure 4 shows how datum B arrests two more degrees of freedom. Since B is a secondary datum, we must stay in contact with datum feature A while contacting datum feature B. Thus, datum feature B can only arrest degrees of freedom left over by datum feature A. In this example, datum feature B restrains:

- Translation in the CA direction
- Rotation about the BC axis.

This leaves translation in the AB direction. By referencing datum C, we see that we can restrain this last degree of freedom (Figure 5.)

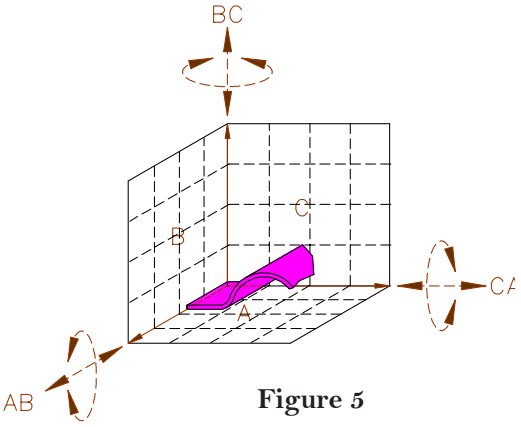

Figure 5

The concept of datums is simple. We don't make perfect parts. We must, however, measure from a perfect datum reference frame (within the limits of metrology.) We place the imperfect part into the perfect datum reference frame based on the order of precedence of the datums. By doing so, we restrain three degrees of freedom for a primary plane, two degrees of freedom for a secondary plane, and one degree of freedom for a tertiary plane.

Application to Parts

For parts with three planar features as datums, it is easy to visualize how the part *rests* inside the three-plane datum reference frame. For parts that do not have planar datum features, it is more difficult. For example, if a round feature is designated as a primary datum, it restrains four degrees of freedom. In Figure 6, a planar feature is designated as a primary datum and a round feature as a secondary. Together they restrain five degrees of freedom.

To make things more complicated, datum reference frames don't always restrain all six degrees of freedom. As Figure 6 shows, since the pattern of holes is symmetric about the axis of the part, the sixth degree of freedom does not need to be restrained.

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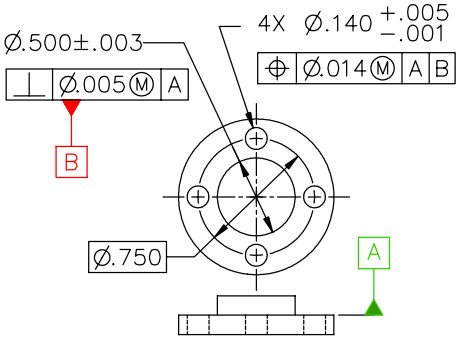

Figure 6

Events:

The next GD&T committee meeting is scheduled for the week of May 1, 2006. These meetings are open to the public.

Please contact ASME for more information.

Summary

For parts that have three planar surfaces as datum features, restraining degrees of freedom is straightforward. For parts that don't have three planar surfaces, it is not so intuitive. Some geometric controls don't need to have all six degrees of freedom restrained. Oftentimes we see datum reference frames that over-restrain the parts. This is a common error because inspectors often want to restrain six degrees to inspect the part. In a future issue, we will address how to handle these situations..

Joke of the Bi-Month

Friendship Between Women:

A woman didn't come home one night. The next day she told her husband that she had slept over at a girlfriend's house. The man called his wife's 10 best friends. None of them knew anything about it.

Friendship Between Men:

A man didn't come home one night. The next day he told his wife that he had slept over at a buddy's house. The woman called her husband's 10 best friends. Eight of them confirmed that he had slept over, and two claimed that he was still there.