MechNEWS

July 2003

Welcome

Welcome to the July edition of Mech*NEWS*™, a service provided by MechSigma Consulting, Inc. This month, we discuss a topic that often becomes a heated discussion in our classes where we have a mix of designers and inspectors. The question often arises as to how to dimension and tolerance parts where a functional callout may not be the easiest (translated *cheapest*) to inspect. This issues highlights the concerns.

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

Functional or Nonfunctional

Following the release of our April newsletter, we received a few inputs from people who preferred to dimension threaded holes at MMC (we recommended RFS). Their reasoning was that this would make it easier for them to inspect the holes. We refer to this as "nonfunctional" dimensioning. In the *real-world* we often resort to nonfunctional methods because we want to minimize costs. This article highlights the issues associated with nonfunctional dimensioning.

Functional Dimensioning/Tolerancing to Control Orientation

Fig. 1 is a simple example of a pin on Part 2 that must fit inside a hole on Part 1.[1]

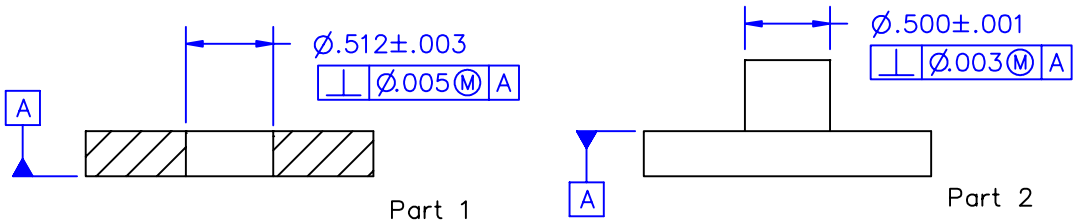

Figure 1 - Functional dimensioning and tolerancing

To keep this simple, our only design requirement is that the pin must always fit inside the hole, while the datum surfaces contact. In this example, we met this requirement by ensuring that the virtual conditions (ø.504) of both parts are equal, thus ensuring 100% interchangeability (Fig. 2). This ensures that all functional parts are accepted (per the drawing) and all nonfunctional parts are rejected.[2]

(Continued)

1. Though we are using a simple example to illustrate the concept, this discussion applies to complex problems, as well.
2. We have chosen not to confuse this discussion by using zero perpendicularities.

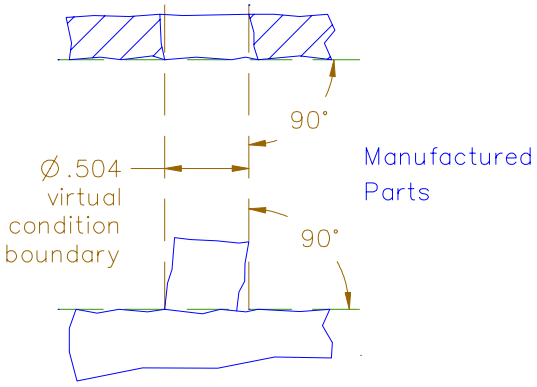

Figure 2

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GD&T Overview • Sept. 16
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Nonfunctional Dimensioning and Tolerancing

After reviewing Part 2 with our inspector, we're told that we could significantly reduce our inspection time if we used the bottom surface as the datum. Now, we know that Y14.5 clearly states that the drawing "shall clearly define engineering intent" (Section 1.4), and "Dimensions shall be selected and arranged to suit the function and mating relationship of a part" (Section 1.4 (d)), *but* we've got to do what's best for our company and minimizing costs is a major concern. Therefore we decide that Fig. 3 may be a better way to *reduce costs*.

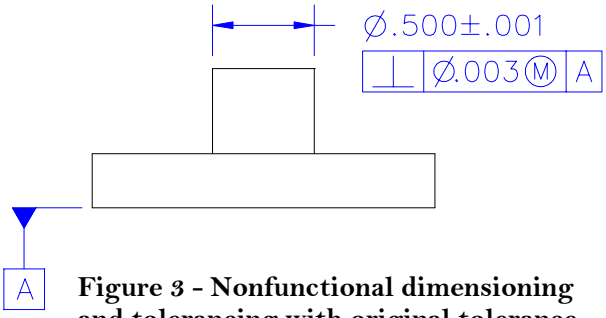

Figure 3 - Nonfunctional dimensioning and tolerancing with original tolerance

After more consideration, we are concerned that the part that *reduces costs* may not always work. In fact, the only way to ensure that the pin always fits inside the hole (while the original datum surfaces are contacting) is to manufacture parts where the top surface (the original datum) is perfectly parallel to the bottom surface (the new datum). Fig. 4 illustrates this better.

Since we cannot ensure that the top and bottom surfaces will always be perfectly parallel, we decide that a parallelism control is in order. After studying the problem a little further, we determine (in Fig. 3) that:

- the maximum allowable angle between the top and bottom surfaces, *added to*
- the maximum angle allowed by the perpendicularity feature control frame,

should equal (in Fig. 2)

- the maximum allowable angle between the pin and the datum.

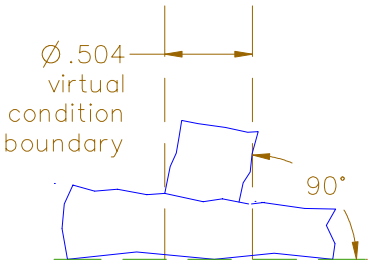

Figure 4

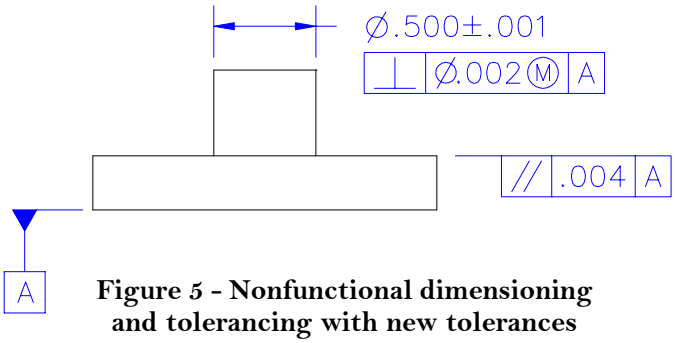

Figure 5 - Nonfunctional dimensioning and tolerancing with new tolerances

Another way to generalize this is to say that the sum of the allowable variations of the top surface and the pin to the nonfunctional datum (in Fig. 3) should equal the variation allowed by the functional callout (in Fig. 2). After reviewing our trigonometry, we arrive at Fig. 5. These new values also ensure 100% interchangeability.

Summary

There are many reasons why we may want to dimension nonfunctionally. In addition to the inspection reasons given here, we may want to do it for manufacturing reasons, such as tooling, minimizing operations, minimizing setups, etc. For each of these scenarios, we must determine how the nonfunctional

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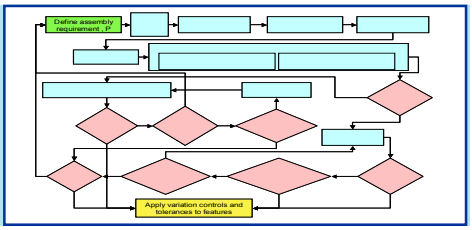
Digital Product Data Practices (ASME Y14.41-2003)

ASME will release their new Digital Product Definition Data Practices (ASME Y14.41-2003) standard in August. The Y14.41 standard extends ASME Y14.5M into the 3D world. It establishes requirements and reference documents applicable to the preparation and revision of digital product definition data, referred to as data sets. Y14.41 defines the exceptions and additional requirements to existing ASME standards for using product definition data sets or drawings in 3D digital format.

For complete details, visit **http://www.asme.org/codes/pr/y1441.html**

Mechanical Tolerancing Methodology

We offer a comprehensive methodology, *MechPRO*™, that takes your assembly tolerance requirements and automatically defines the (GD&T) controls and allowable tolerances to control part variation to Six Sigma quality. We offer: an analysis software tool, *MechTOL*™ ; a database software tool, *MechDATA*™, and a three-day workshop to support this methodology.



method of dimensioning is going to save us money. In our example, we had to reduce the perpendicularity tolerance and we added another variation requirement (that requires another inspection.)

We also introduced another potential problem. Suppose we inspected the perpendicularity of a part built to Fig. 5 and we measured a perpendicularity of .0025. We inspected the parallelism to be .0005. The drawing in Fig. 5 would reject this part, even though it is functional (and meets the drawing in Fig. 1). Thus, Fig. 5 potentially rejects some functionally good parts.

Every time we change a functional datum to a nonfunctional datum, we should decrease the tolerance value in the feature control frame and add another requirement to control the functional datum to the nonfunctional datum. By doing so, we run the potential risk of rejecting some functionally good parts.

In theory, we could dimension functionally (as in Fig. 1, Part 2) and inspect to the requirements in Fig. 5. If the part fails the requirements of Fig. 5, then we have a choice to make. We can inspect the requirements of Fig. 1, scrap the part, or rework it. Although this scenario is difficult pull off, it offers more choices than dimensioning nonfunctionally.

So, are we advocating always dimensioning functionally? Not necessarily. We must, however, consider the potential additonal costs from reducing the functional tolerances and adding variation controls. If Fig. 5 has "producible" tolerances and we can minimize (or eliminate) inspection times, then it might be the better choice. A

Joke of the Month

An elderly couple who were childhood sweethearts had married and settled down in their old neighborhood . They were celebrating their 50th wedding anniversary and decided to walk down the street to their old school. There, they hold hands as they find the old desk they'd shared and where he had carved “I love you, Sally.”

On their way back home, a bag of money falls out of an armored car and lands practically at their feet. Sally quickly picks it up and decides to take it home until they decide what to do with it. There, she counts the money, and it’s fifty thousand dollars. The husband says, “We’ve got to give it back.” She says, “finders keepers” and puts the money back in the bag and hides it up in their attic.

The next day, two FBI men are going door-to-door in the neighborhood looking for the money and show up at their home. They say, “Pardon me, but did either of you find or know about some money that fell out of an armored car yesterday?” She says, “No.” The husband quickly interjects, “She’s lying!! She hid it up in the attic.” She says, “Don’t believe him, he’s getting senile.” However, the agents sit the man down and begin to question him. “Sir, please tell us the story from the beginning.”

The old man says, “Well, when Sally and I were walking home from school yesterday...” The FBI agents immediately look at each other and say, ”Let’s get out of here!!”

Engineering Services

Having problems with your designs? MechSigma offers consulting in mechanical tolerancing. Contact us at:

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Events:

The next GD&T committee meeting is scheduled for the week of Oct. 13 in Kansas City, MO. These meetings are open to the public. For more information, contact ASME or visit their website at:
http://www.asme.org/cns/departments/Standardization/Public/Y14/nextmeetNEW.htm#Meetings%20Schedule

ASME Geometric Dimensioning and Tolerancing Professional (GDTP) Certification

For more information, visit ASME's website at:
http://www.asme.org/cns/departments/AccredCertif/gdtp/

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