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Known as the "Doctor of Dimensioning," Alex Krulikowski is a noted educator, author, and expert on Geometric Dimensioning and Tolerancing (GD&T). A design manager with one of the world's largest manufacturing corporations, he has more than 30 years of industrial experience putting GD&T to practical use on the shop floor.

Web Highlights

QUALITY ONLINE

No Room for Error
There is no room for error in the production of these parts, both for safety reasons and because the parts are expensive. Some are worth $75,000 a piece. This article is from the June 2001, *Quality Online* E-zine.

To read more about it, Click here

Learning to Lead A Virtual Team
Manufacturing personnel have long been expected to

ETImail *is a regular online publication devoted to Geometric Dimensioning & Tolerancing. Each edition features a host of GD&T resources and links, as well as dimensioning tips by noted GD&T author and ETI founder, Alex Krulikowski. We also invite you to visit our website, etinews.com. To view past issues of ETImail, see the archives.*

ETImail is now available in PDF format. To read the PDF file, you will need Adobe Acrobat Reader.

Minding Mechanical Specs Pays Off in Production

Alex Krulikowski (Published in *OEM Technology & Expositions*, 1999)

When you specify electrical components on a drawing, you use electrical specs. Mechanical components need their own spec system that's repeatable, clear, and not overly restrictive. ASME Y14.5M-1994 is fast becoming the spec system of choice for mechanical components by today's OEMs. Two reasons for this preference are:

- Geometric tolerancing is the key to specifying mechanical parts that can be measured repeatedly.
- The latest revision of Y14.5 is 90% compatible with the GD&T sections of the ISO standards, bringing OEMs more in step with the global manufacturing scene.

An International Language
GD&T is an international language used on drawings to accurately describe a part. The language consists of a well defined set of symbols, rules, definitions, and conventions that can be used to describe the size, form, orientation, and location of part features. GD&T is an exact language that enables designers to "say what they mean" on a drawing, thus improving product designs. Production uses the language to interpret the design intent, and inspection looks to the language to determine set up. By providing uniformity in drawing specification and interpretation, GD&T reduces controversy, guesswork, and assumptions throughout the manufacturing process.

Cost Benefits
Because of the lack of studies demonstrating the cost benefits of GD&T, many upper management people, especially those without engineering backgrounds, lack the understanding needed to estimate actual savings. Consequently, they may be reluctant to fund GD&T training programs. The benefits of using GD&T to specify mechanical parts can readily be demonstrated when we compare GD&T to coordinate dimensioning, which has been used for over 150 years. Here are seven advantages that add up to significant savings in production.

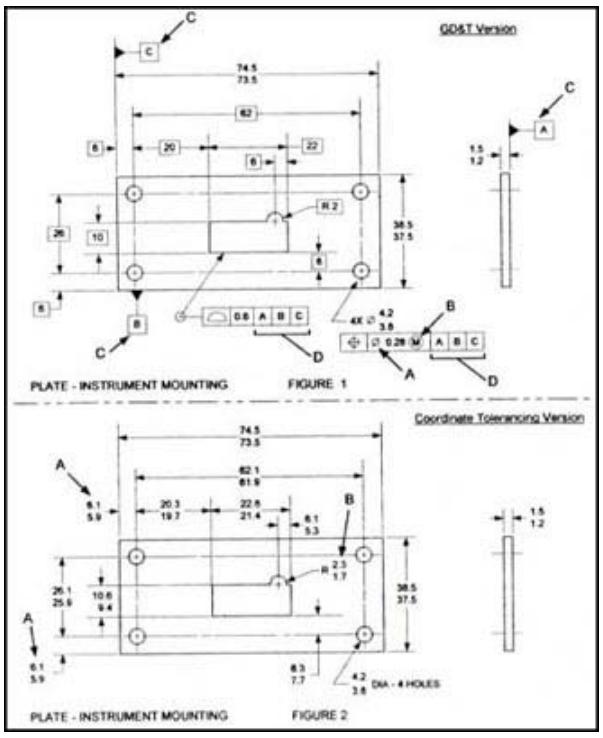
#1.The design philosophy of GD&T is that of functional dimensioning, which means that a part is defined by how it functions in the final product. Instead of copying a tolerance from an existing drawing, the designer bases the tolerance on what is needed for proper function. Assigning dimensions and tolerances based on part function allows the maximum amount of tolerance to produce the part. When properly applied, functional dimensioning can often double or triple the amount of tolerance on many component dimensions, which reduces manufacturing costs.

With coordinate dimensioning, tolerance zones are not related to functional requirements. Problems can result when designers assign tight tolerances because they are not focused on determining a functional tolerance.

Click on the figure below to see an enlarged view.

work well with others on project teams, implementation teams, quality-improvement teams, and more. Author Nancy Chase explains how the growth of the Internet and the increasing globalization of industry, has led to a new kind of team: the virtual team.

[Editor's note: This article has been removed from the Quality Magazine Online website.]



#2. GD&T allows round tolerance zones. In Figure 1, Arrow A points to a GD&T symbol that specifies a round tolerance zone (for the mounting holes). The zones specified by coordinate dimensioning (see Figure 2, Arrows A) result in a square tolerance. Round tolerance zones allow for 57% more tolerance than square zones, resulting in more usable parts. By allowing more tolerance on parts, the process will be more capable, reducing manufacturing costs.

#3. In addition to the tolerance gained from using round zones, **GD&T allows a "bonus" tolerance under certain conditions.** This bonus tolerance is gained by using the MMC (Maximum Material Condition) modifier, as indicated by Arrow B in Figure 1. The MMC modifier allows a hole to have additional tolerance when it is produced larger than its minimum size. This is a win-win situation for the OEM because engineering can be assured that the part will assemble when the holes are the smallest, and manufacturing can have additional tolerance when the holes are larger than their minimum size.

In coordinate tolerancing, the tolerance zone is always fixed in size (Figure 2, Arrow A), at all hole conditions. This results in a number of functional parts being scrapped and a more stringent condition for manufacturing. With bonus tolerance, more functional parts are used, and more tolerance is allowed for production, resulting in lower operating costs.

#4. GD&T's datum system communicates clearly one set up for inspection. Datums are theoretical planes, points, or axes, and are simulated by the inspection equipment. The symbol used to specify a datum feature is shown in Figure 1, Arrows C. These symbols denote which part surfaces touch the gaging equipment assembly requirements; they are often the features that mount and locate the part in its assembly. Datum reference letters are specified (see Figure 1, Arrows D) inside the geometric controls and denote the sequence in which the part surfaces contact the gaging equipment. This sequence is needed in order to have multiple inspectors set up the part in an identical manner.

#5. GD&T reduces assembly problems. Since the inspection process with GD&T ensures that parts will assemble properly, assembly methods no longer need to be addressed by the guy on the assembly line with a two-by-four and a hammer. The inspection process with GD&T ensures that OEMs can use competitive sourcing or obtain multiple sources for the same part, resulting in increased profitability.

#6. In the area of inspection, GD&T supports the use of SPC. GD&T's datum system provides the repeatable part measurements that are necessary for making a meaningful SPC chart. With

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Quality Quote

In an ideal world, inspection should not be necessary, and the goal should always be to minimize the need for inspection through the continuous improvement of processes.

--David Hutchins, *Achieve Total Quality*, 1992

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coordinate tolerancing, SPC data may include assumptions which reduce the accuracy of the data.

The use of the profile control is another example of how GD&T supports SPC. The profile control helps in two ways: it establishes a mathematically-defined tolerance zone, and it relates the measurement to datums. When coordinate tolerancing is used, the precise tolerance zone definition simply doesn't exist. For example, try to define the size and location of the radius (Arrow B) in Figure 2.

Because the datum system and profile control allow SPC data to be more accurate, needless changes in the manufacturing process are avoided, rewarding the OEM with time and cost savings.

#7. GD&T is supported by national and international standards. ASME Y14.5M-1994 and a series of ISO standards rigorously document the interpretation of each GD&T symbol and concept. On the other hand, coordinate tolerancing is like folklore; it's not well documented, even though it has been around for 150 years.

Producing parts to GD&T's documented standards assures the OEM that parts will be accepted by the customer. Fewer replacement parts will be needed and recalls can be avoided, saving time and money.

Send comments about this article to: ETImail.
Your opinions will be posted in the next issue.

Standards in the News

ETImail's Standards in the News *takes a look at real-life issues where standards have failed or need improvement. This month: Open source software finds creating standards critical to success.*

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Excerpts from the Siliconvalley.internet.com news section

LACK OF STANDARDS BLOCKING OPEN SOURCE DEVELOPMENT
The biggest obstacle in the path of open source development doesn't appear to be Microsoft. According to a survey released by Santa Clara-based Evans Data Corp, the real problem is proprietary software and the lack of standards. The survey says 25% of development managers at companies with more than 2000 employees complained about the lack of standards as a stumbling block to developing open standards software. Full story

PROVIDING COMMON STANDARDS CALLED "A CRUCIAL AND CRITICAL MOVEMENT"
Some software developers are reluctant to jump to Linux because they fear it will fragment. Red Hat, Inc. has come under fire over a new certification program that teaches information technology workers about its version of Linux. When asked specifically what the company's plans were regarding standards, Red Hat CEO Bob Young downplayed concerns. "It's clearly not in our interest to put the steering wheel on one side of the car when everyone else puts the accelerator on the other side," he said. Jeff Carr, the founder of Linux PPC, called the Linux standards base -- a move to provide common standards for Linux distributions -- "a crucial and critical movement." Full story

Excerpted from the articles, "Survey: Lack Of Standards Blocking Open Source Development" by Michael Singer in the Siliconvalley.internet.com News and "Linux Hamstrung by Lack of Standards?" By Lisa Bowman, ZDNet News April 19, 1999,

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The ETI Mailbag

Do you know if ASME plan to incorporate target holes in the new version of ASME Y14.5M-200x? We have target area, line & point. Some companies use target hole.

I have not heard any discussion on target holes at the Y14.5 meetings. Typically, targets are considered gage elements that are used as datum simulators to establish datums. Datum targets are often located with basic dimensions to ensure gage to gage repeatability. The point lines and areas can all be used on cylindrical shapes (including holes).

If you feel there is a need for a new type of datum target, I encourage you to write a proposal and send it to ASME for consideration by the Y14.5 Committee. When submitting a proposal to ASME, it may take 3 to 10 years for the new concept to appear in the standard.

Also, if you send your proposal to the ETInews discussion board, you could get other comments from knowledgeable people from other companies. Submitting your proposal to the GD&T discussion board will probably result in quicker feedback and could gain additional support from industry. You may want to use this method to refine your proposal before submitting it to the ASME Committee.

Send your GD&T questions to: ETImailbag.

Alex's Tech Tip

From teaching ideas to new products that will assist you in training or on the job, the ETImail Tech Tip will keep you informed about new technology and ideas. This month's Tech Tip is about making the most of your study time.

THE TEN PRINCIPLES TO PRODUCTIVE STUDY
Educators utilize many different study methods to assist students in the learning process. I have adapted ten commonly known principles of productive study that assist in successful goal-setting and lead the way to a proper understanding of GD&T. If you plan to begin a GD&T course, make an effort to apply these principles to your study plan.

1. Learning occurs in **small steps**. Begin here and now--not tomorrow--to study and to solve problems.
2. Study **daily**. Don't expect to learn a lot the night before a test.
3. First, **scan** performance objectives, then carefully read the material and ask yourself relevant questions. Write down questions you can't answer.
4. **Read** the material again, take notes, and **list** key points. Learning is aided by repetition.
5. **Think** about interconnections with what you know, including on-the-job applications.
6. **Visualize** GD&T applications, formulas, and key points until you can "see" them with your eyes shut.
7. **Write** down key points. You really don't know it if you can't write it.
8. **Think** about each key point. **Say** it! **Write** it! **Review** it! **Relate** key points to each other and compare their similarities and differences.
9. **Study sample problems** in the text. Consider the strategies used to solve these problems and how you would recognize and approach similar problems presented in the text on a test or a job.
10. **Solve problems** included in the exercise workbook. Work problems daily. Become familiar with different types of problems.

Although these principles can work for you, you alone can decide to commit the time and effort it will take to apply them.

If you know about a new tech tool or an innovative idea that would aid our readers, please write us: ETImailbag.

ETImail Feedback

Have comments about anything you've read in ETImail? ETI will post your comments here and provide a forum for more discussion about GD&T topics.

Response to the March 2002 article: "The 9 Myths of GD&T"
You could have printed a better response than the one you did to "Myth Three: GD&T and Y14.5 Are Confusing." My answer to Myth Three would have run something like this:

"There is a great deal of fact to this myth. GD&T and the ASME Y14.5M-1994 standard are very complex and can be very confusing to anyone who is unfamiliar with GD&T and the ASME standard or who has been poorly trained in it. But with proper instruction by a highly qualified instructor with excellent training skills a person can understand GD&T well and have his confusion relieved." Hampton Scott Tonk

Response to the February 2002 article: "The 9 Rules of Composite Position Tolerancing"
I found your condensed rules for Composite Position Tolerancing helpful and interesting. It has prompted me to open up my [fundamentals of GD&T] book and read the section. You obviously have spent quite a bit of time with [the subject] to be able to boil down the contents to your Nine Rules. Thanks so much -- David C. Lemke

ETI would like to hear from you. If you have an opinion about any ETImail article or feature, please write to our ETImailbag.

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