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Effective Training Inc., Westland MI, 800.886.0909

Volume 02: Issue 3



Known as the "Doctor of Dimensioning," [Alex Krulikowski](#) is a noted educator, author, and expert on Geometric Dimensioning and Tolerancing (GD&T). He has more than 30 years of industrial experience putting GD&T to practical use on the shop floor.

Alex has taught GD&T to tens of thousands through his workshops and seminars, and to countless others through his books, self-study courses, videos, and computer-based training programs.

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](#).

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Alex Answers The Top 10 GD&T Questions, Part I

[Alex Krulikowski](#)

ETI was founded by Alex Krulikowski in 1985. This issue celebrates 20 years of providing GD&T products and services and takes a look at five of the ten most common GD&T questions Alex has received in the past twenty years. Volume 2, Issue 4, will feature five more.

Web Highlights

Web classic

This 2001 article gives a short introduction to GD&T.

Engineering Times A classic article about GD&T

John Sabo gives a to-the-point explanation of GD&T in this Electrical Engineering Times Asian Edition article from 2001.

To read the article, [click here](#).



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Many significant events took place in 1985. Desktop publishing began. The first laser printers went on the market. The first British mobile phone company was incorporated. Microsoft started the first version of Windows. The Internet Domain Names System was initiated.

Most of these technological changes have had a significant impact on our daily lives. Can you imagine life without a cell phone? Do you remember a time before companies had domain names and websites? Thousands of Windows-based computer programs have allowed us to do everything from calculate our own taxes to create spreadsheets, databases, and documents easily at home and work.

Who can imagine going back to the time before Microsoft Windows, desktop publishing, and laser printers? Typing documents on manual typewriters (and retyping when changes occur), or paying printing companies to do layout and design for small company newsletters is a thing of the past. Printing our own documents within minutes at home or work is so commonplace that we hardly remember a time when we didn't. Having access to affordable desktop publishing programs and personal laser printers has greatly simplified our lives.

Another important event occurred twenty years ago. In 1985, I began a small start up company that provided training and consulting in a little-known discipline called geometric dimensioning and tolerancing. One year later, I developed a GD&T self-study course. Twenty years later, Effective Training Inc. has evolved into a corporation that provides GD&T training, products and services to organizations across the globe.

Just as the cell phone, Windows, and other computer technologies have affected and improved our lives, using GD&T on engineering drawings has made a significant impact on how companies communicate their design requirements. Over the years, geometric tolerancing has saved organizations valuable time and money in the manufacturing stage. In fact, GD&T is now used by tens of thousands of manufacturers world-wide. That's quite a change from twenty years ago.

New at ETI



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Dimensiones y Tolerancias Geometricas La Ultima Guia Del

In 1985, I recognized what a valuable tool geometric dimensioning and tolerancing is. I have spent the past 20 years of my life extolling its virtues and trying to help others understand the significance that the language of GD&T can have on any company's design process. For two decades, I have developed courses, books, software, and other training resources to help others learn how to correctly utilize GD&T. I have spent years of my life teaching hands-on workshops to thousands of students who want to learn how to apply and interpret GD&T correctly. I understood twenty years ago that geometric dimensioning and tolerancing was a technological advancement that vastly improves design quality and production, and I have devoted my life to sharing this knowledge with others.

Since 1985, there have been significant improvements in the topic of GD&T, the technology I use to teach GD&T, the tools companies use to apply GD&T, and the role of GD&T in industry. The GD&T standards have evolved to be more complete and to accommodate electronic gauging and the use of solid models. Several new or updated standards are available to industry: the Y14.5 standard had a major update in 1994, a new standard on tolerancing of solid models (Y14.41) and a gauging standard (Y14.43) were both published in 2003. These standards filled in many of the gaps that industry was struggling with. The use of ISO standards is also increasing in the United States.

Dimensioning and tolerancing standards will continue evolve to meet the changes in industry. My start-up product, the [self-study workbook](#) has evolved into [video training](#), [computer-based training programs](#), and [web-based GD&T training](#). Industry has implemented several new tools that use GD&T to work properly. CAD programs use GD&T, and some can even embed GD&T with the model features. Digital drawings have become mainstream in industry. Several programs are available to interpret and inspect GD&T from the solid model. A number of tolerance analysis programs are available that include the use of GD&T in the software.

In 20 years, I've been asked quite a few questions about GD&T usage and details. In this issue and the next, I'll reveal the top 10 questions about GD&T and their answers. I hope you find them helpful.

Top 10 GD&T Questions, part 1:

1. I have a fundamental question. What kind of control would one have on say, a machined circular part with a thru hole and a counterbored hole midway thru the part? Size dimensions are not important, but we are not using any positional tolerancing, just plain sizes given for the different diameters and counterbore hole depth. If there are no location controls given, does that mean that the thru hole can be anywhere on the cylindrical part? Thank you, KW

[Read Alex's Answer](#)

2. I am employed with a large company and am a recent student of Advanced Concepts of GD&T taught using your textbook, but by a GD&T instructor who is not from Effective Training.

When auditing one of my drawings, a gasket, I was docked points for not specifying a tertiary datum. The GD&T scheme of my drawing is to use the 4 bolt pattern as datum B and one side as A. My thinking and what I have learned by your textbook is that the part is constrained in 6 degrees of freedom. The instructor told me that the part requires a tertiary datum since the four holes create a center axis, and a tertiary datum is required controlling rotation. I use this method quite often when part function dictates and the instructor insists it is incorrect.

ASME Y14.5M-1994 4.5.8 states "When the part is mounted on the primary datum surface, the pattern of holes establishes the second and third datum planes of the datum reference frame."

Advanced Concepts of GD&T states "When a hole pattern is used as a secondary datum feature, it restricts the part movement in three directions. It serves as both a secondary and tertiary datum feature; therefore, no tertiary datum feature is used."

I have trouble questioning the instructor, but he doesn't appear to be correct in this case. I hope you can shed some light on this subject. Thank you, DE

[Read Alex's Answer](#)

3. We design and develop one-of-a-kind experiments to be used on the International Space Station. As such, the parts we make are one of a kind. At best, we make two copies of the same part. Our designers have a minimal knowledge of GD&T. For the work we do (one of a kind) does it make sense to spend the time and money to educate our designers on GD&T?

Some people within our organization say for one-of-a-kind projects, GD&T is overkill and a waste of time. What argues in favor of GD&T for these drawings? I am a proponent of GD&T

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and know the cost savings available over time in production situations. I also know the cost savings available if a designer is sufficiently knowledgeable about GD&T to use it as a design tool.

Educating our designers in GD&T will take years. In the end, it will be worth it, but today people say it's not worth the schedule slip (i.e. its more trouble than its worth) for one-of-a-kind items. I can't come up with a good argument to refute the short term schedule, one-of-a-kind arguments. Any suggestions?? Thanks, Joe

[Read Alex's Answer](#)

4. Under ASME Y14.5M-1994, are metric dimensions quoted with a digit preceding the decimal, whereas English dimensions are not? (For example, a metric dimension might read 0.01 and an English dimension would read .0004) If so, where would this be stated in the ASME document? Thank You, Jim

[Read Alex's Answer](#)

5. I would like information on "simultaneous requirement default." Is this subject covered in Y14.5 or in any of your materials?

[Read Alex's Answer](#)

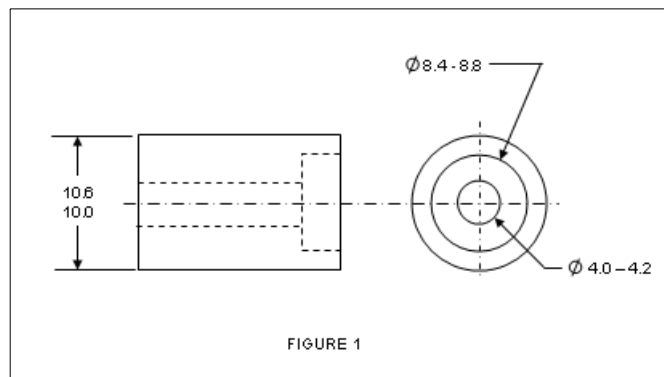
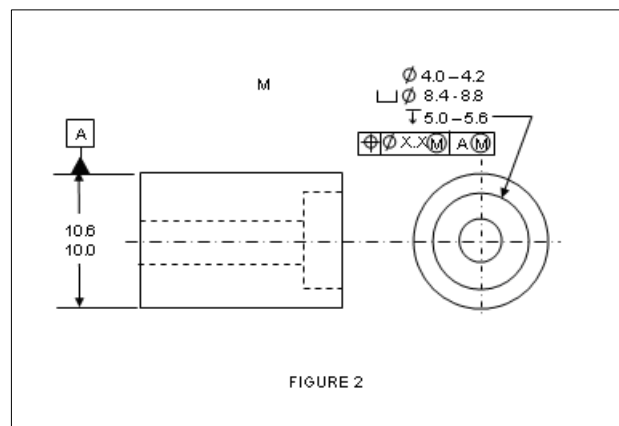
Answer to Question 1


Figure 1 shows the part you described. You asked "If there are no location controls given, does that mean that the thru hole can be anywhere on the cylindrical part?" That is correct. With this drawing, there is no specification on how much the hole and counter can be offset from each other, or in relation to the outside diameter. The drawing is incomplete. The supplier could produce a part that had any amount of offset between the diameters and it would pass the vague print specifications.

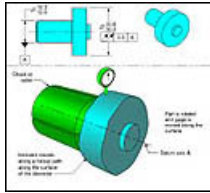


Depending on how the part functions, position control or runout controls could be used to complete the part definition. One possible solution to completing the part tolerancing is shown in Figure 2.

I would like to point out the additional controls do not add cost; they complete the part definition. The amount of tolerance that is specified in the geometric tolerances is what determines the costs involved.

GD&T Training Made Easy

The GD&T Trainer Professional Edition (Y14.5M-1994) contains 28 student-focused lessons covering the fundamentals of GD&T. Instant lesson feedback and quizzes reinforce the material.



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Highlights include a GD&T glossary, tolerancing application and inspection examples, audio narration, full-color technical animations, 3-D solid part examples, and a certification exam.

To read more about it, [Click here](#)

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GD&T Advanced Concepts taught by the experts. . .



Advanced Concepts of GD&T Textbook

The textbook stresses the application of GD&T in industry and takes an in-depth look at many GD&T topics. Position, profile, and datums are covered in detail. Covers common industry tolerancing practices not documented in ASME Y14.5M-1994. An indispensable on-the-job reference.

To read more about it, [Click here](#)

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Knowledge of stacks separates the exceptional engineers from the rest

Answer to Question 2

I am glad to hear that you have been learning GD&T using my advanced concepts book. In regards to your question, I have the following thoughts to offer.

I believe that a hole pattern as a secondary datum feature removes all remaining degrees of freedom as stated in my textbook, thus serving as both the secondary and tertiary datum feature. You also cited a paragraph from Y14.5 that supports this belief. There may be some exceptions to this, but they would be rare. I suspect your part is OK with using the hole pattern as a secondary datum feature, but can not say for certain without seeing the drawing.

There may be other circumstances that could influence the situation. If you send or FAX the drawing to me, I will provide you with a more certain answer.

GD&T consultants do not always agree on all applications of the language. Just like lawyers and doctors do not always agree on points of law or medicine. If you are interested, we can audit a few of your drawings and offer an analysis of the tolerancing. –Alex

Answer to Question 3

The problem you describe is fairly common. I feel your pain. It is very difficult to get people to step out of their comfort zone and let go of old habits.

However, the short answer is yes, it does make sense to spend time training. I have a few suggestions for you to consider when discussing if GD&T is appropriate for low volume parts (or even one or two part runs). Here is a list of the top twenty-one reasons why GD&T should be used on low volume products. I hope this information helps.

The proper use of GD&T will enable you to. . .

1. Create a part design that focuses on the product function.
2. Convert product requirements into dimensional specifications.
3. Better define parts without the need for assumptions.
4. Document the design for future use.
5. Discover problems in the design stage.
6. Ensure that parts will assemble.
7. Have less "hand fitting" at assembly.
8. Ensure that parts are inspected as intended.
9. Inspect parts more quickly.
10. Specify additional tolerance for the manufacture of parts.
11. Reduce scrap or rework.
12. Make a replacement that fits into the assembly.
13. Have multiple sources on various parts of an assembly.
14. Have critical dimensions that will be related to product function.
15. Make valid engineering calculations.
16. Have common parts across similar assemblies.
17. Design subassemblies in different locations and have them function correctly.
18. Do tolerance analysis to study the effect of part tolerances on the assembly.
19. Use state of the art software tools to analyze parts in an assembly.
20. Use state of the art software tools to inspect the parts.
21. Reduce the risk due to vague specifications.

Download and print a free "Top 21 Reasons to Use GD&T" chart. ETI would like you to have a free copy of our "Top 21 Reasons to Use GD&T" chart. The printable chart is 11" x 17" and in pdf format. For a free copy of the chart, [click here](#).

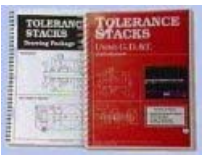
Answer to Question 4

For metric unit dimensions, Y14.5M-1994 paragraph 1.6.1(a) Millimeter Dimensioning states, "Where the dimension is less than one millimeter, a zero precedes the decimal point." For English unit dimensions, Y14.5M-1994 paragraph 1.6.2(a) Decimal Inch Dimensioning states "a zero is not used before the decimal point for values less than one inch."

Answer to Question 5

The simultaneous requirement concept is often misunderstood. It is a default condition on many drawings, so drawing users don't find any modifiers, notes, or symbols to remind them when simultaneous requirements must be used. It is important because, in some cases, it allows additional tolerance that must be comprehended in inspection and engineering analysis.

The concept of simultaneous or separate requirements affects the part in two cases: when



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the datum references are size datum features and when the angular relationship between patterns are involved. When the simultaneous requirement is used, it eliminates tolerance between the tolerated patterns. When the separate requirement is invoked, it allows additional tolerance between the tolerated patterns.

This article provides a brief explanation of the concepts involved with simultaneous and separate requirements. A more in-depth discussion of simultaneous and separate requirements is provided in my book, *Advanced Concepts of GD&T*. The "simultaneous requirement default" is covered in sections 5.3.6.1 and 5.3.6.2 in Y14.5. The sections are shown below.

5.3.6.1 Simultaneous Requirement — RFS.

Where multiple patterns of features are located relative to common datum features not subject to size tolerances, or to common datum features of size specified on an RFS basis, they are considered to be a single pattern. For example, in Fig. 5-16 each pattern of features is located relative to common datum features not subject to size tolerances. Since all locating dimensions are basic and all measurements are from a common datum reference frame, verification of positional tolerance requirements for the part can be collectively accomplished in a single setup or gage as illustrated by Fig. 5-17. The actual centers of all holes must lie on or within their respective tolerance zones when measured from datums A, B, and C.

NOTE: The explanation given in Fig. 5-17 still applies where independent verification of pattern locations becomes necessary due to size or complexity of the part.

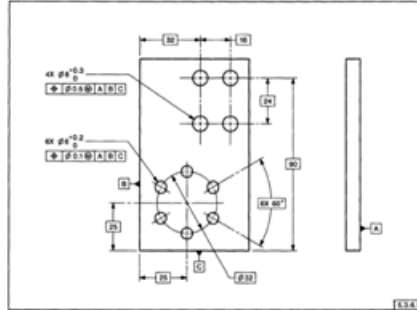


FIG. 5-16 MULTIPLE PATTERNS OF FEATURES

[Click on graphic for larger view of Figure 5-16.](#)

In this paragraph, the standard defines the conditions for when the simultaneous requirement default apply. In this case, the specifications are at RFS. Figure 5-16 shows a drawing where the conditions are met for a simultaneous requirement.

Alex's comments: When RFS or planar datums are involved, it doesn't matter if the features are treated as a simultaneous or separate requirement, the results will be the same.

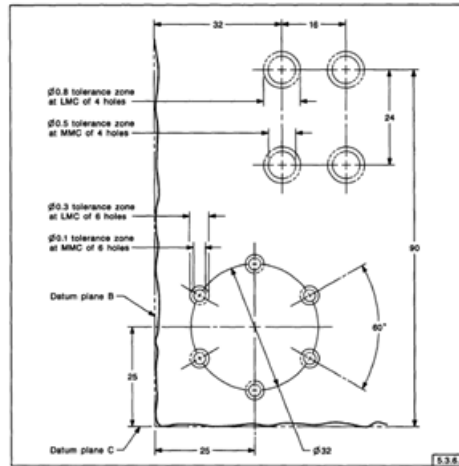


FIG. 5-17 TOLERANCE ZONES FOR PATTERNS SHOWN IN FIG. 5-16

Figure 5-16 shows the tolerance zones resulting from a simultaneous requirement.

[Click on the figure for a larger view.](#)

5.3.6.2 Simultaneous Requirement — MMC.

Where any of the common datums in multiple patterns of features is specified on an MMC basis, there is an option whether the patterns are to be considered as a single pattern or as having separate requirements. If no note is added under the feature control frames, the patterns are to be treated as a single pattern. Where it is desired to permit the patterns to be treated as separate patterns, a notation such as SEP REQT is placed beneath each feature control frame. See Fig. 5-18. This allows the datum features of size to establish a separate datum reference frame for each pattern of features, as a group. These datum reference frames may shift independently of each other, resulting in an independent relationship between the patterns. This principle does not apply to the lower segments of composite feature control frames except as noted in para. 4.5.12.1.

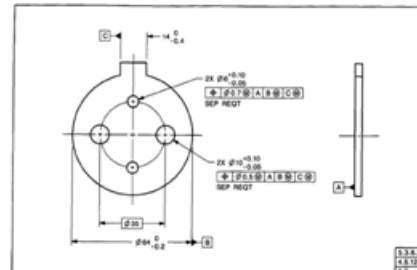


FIG. 5-18 MULTIPLE PATTERNS OF FEATURES, SEPARATE REQUIREMENTS

[Click on graphic for larger view.](#)

In this paragraph, the standard defines the conditions for when the simultaneous requirement default apply in MMC applications. Figure 5-18 shows a drawing where the simultaneous requirement has been overridden by the SEPT REQT notation.

Alex's comments: In MMC applications, with size datum features, if a separate requirement is

your team!

involved a datum shift between the patterns is available.

To read more about it, [Click here](#)

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There you have it...five of the top ten most frequently asked questions that I've received in 20 years as a GD&T instructor and consultant. Look for five more in the next issue of ETImail, and, as always, I welcome your questions or comments.

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ETI offers convenient, customized, onsite workshops in a variety of GD&T-related topics.



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[ASME Y14.41 - 2003 GD&T Fundamentals Fundamentals Overview](#)
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Fundamentals of

ETI's 20th Anniversary: In 2005, Effective Training Incorporated (ETI) celebrated their twentieth anniversary as a training and consulting corporation based in Westland, Michigan. The company was founded in August 1985 in the home of local design engineer, Alex Krulikowski, and now provides geometric dimensioning and tolerancing (GD&T) products and training to organizations across the globe. [Read more about it.](#)

We welcome your feedback. Send comments about this article to [ETImailbag](#). Your opinions will be posted in the next issue.

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Standards in the News

ETImail's Standards in the News takes a look at real-life issues involving standards. This month: failure to meet its own company standards creates costly problems for Sony.



Excerpt from the [interfax.cn website](#)

SONY WILL REFUND CHINESE CONSUMERS WHO BOUGHT DIGITAL CAMERAS THAT FAILED INSPECTION

This issue of Standards in the News features an article from Interfax about a costly problem for Sony when its digital cameras failed to meet the company's own standards.

Shanghai. December 19. INTERFAX-CHINA - Sony will allow Chinese consumers that bought one of six Sony digital camera models that failed a quality inspection to return their cameras for a refund, the Japanese electronics giant said Sunday.

The Zhejiang Administration for Industry and Commerce announced last week that six Sony digital cameras had failed a quality inspection, and ordered a ban on sales of the cameras in eastern China's Zhejiang Province. Sony announced Friday that it would stop sales of the six digital cameras nationwide.

Because China does not yet have national standards for digital camera products, the Zhejiang Administration for Industry and Commerce carried out its inspections using standards provided by Sony, as well as recommended industrial standards. Two of Sony's digital cameras failed to meet the company's own standards, while four failed to meet recommended industrial standards for digital cameras.

"We agreed with the inspection results," Kang Jian, a PR official with Sony (China), told Interfax. "But part of the reason for the failure to meet standards was that we submitted the wrong enterprise standards for use in the inspections."

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Excerpt is from the article, "Sony will refund Chinese consumers who bought digital cameras that failed inspection," by Rachel Chen, in the December 17, 2005, issue of [Interfax China](#) online. Copyright 1991-2005 Interfax Information Service.

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ETI's Discussion Board: Talk about GD&T issues with other peers and professionals.

**Alex's Tech Tip**

From teaching ideas to new products that will assist you in training or on the job, the ETI Email Tech Tip will keep you informed about new technology and training trends. This month's Tech Tip: a dictionary of design terms.

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|--|
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| The GD&T Trainer (S) |
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| Prior GD&T Questions |
| This Discussion Group contains questions the small mail, etc. |
| ASME Y14.5M |
| Discussion Group for questions/comments on represented in the ASME Y14.5M standard |
| Tolerance Analysis |

ACCESS OVER 200 TECHNICAL TERMS WITH THE DIGITAL DESIGN DICTIONARY

The Digital Design Dictionary is an online research tool that defines over 200 technical terms used on engineering drawings. It includes drawing conventions; geometric dimensioning and tolerancing (GD&T); solid model tolerancing; gages and fixtures; casting and forgings; and more.

ETI'S Discussion Board

ETI's website has an interactive forum that's easy to access and may give you a broader knowledge of GD&T-related topics.

To visit the board, [click here](#).

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The terms are cross-referenced to the paragraphs in various ASME standards, including:

- Y14.5M-1994 - GD&T
- Y14.41-2003 - Solid Modeling
- Y14.43-2004 - Gages and Fixtures
- Y14.100-2004 - Engineering Drawing Practices
- Y14.8M-1996 - Castings and Forgings
- Y14.2M-1992 - Line Conventions and Lettering

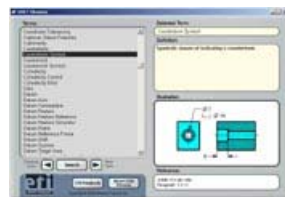
The Digital Design Dictionary is a valuable on-the-job resource for designers, engineers, and anyone else involved in product design. It includes explanations of over 200 design topics, many with full-color detailed graphics and ASME Standard references — all in one affordable and convenient software package.

Quality Quote

We are what we repeatedly do. Excellence, then, is not an act but a habit.

— Aristotle

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Contains over 200 topics that cover product design and GD&T principals, many definitions contain ASME Standard references and colorful graphics.



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Install this computer-based reference tool on a PC or laptop to gain instant access to an excellent product design resource. Each page of the Digital Design Dictionary displays a term and definition. Many definitions include graphic illustrations and/or ASME paragraph references. Terms can be easily selected from a list and by using the handy search options.

The Digital Design Dictionary is the perfect on-the-job resource for product design topics. This valuable desktop reference is recommended for anyone involved in product design.

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ETI continues to add new GD&T products and services and provide you with more GD&T training options. Keep an eye on this section to read about our latest news. This month: ETI brings hands-on GD&T workshops to a city near you.

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ETI is presenting a series of training events around the country in 2006. All of the courses were developed by GD&T expert and ETI president, [Alex Krulikowski](#), including our newest one-day Blueprint Reading workshop. We offer a variety of savings plans, including registration and corporate discounts. Register early to receive substantial savings on a workshop near you.



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- [Advanced Concepts of GD&T 2-Day \(ASME Y14.5M-1994\)](#)
- [Tolerance Stacks 2-Day \(Concept Driven\)](#)
- [Intro to Statistical Tolerance Stacks 1-Day \(Concept Driven\)](#)
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- [GD&T Overview 1-Day \(ASME Y14.5M-1994\)](#)
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