



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.

Web Highlights



Adding Value for True Position Measurement

Portable CMM technology has reduced the difficulty of measuring GD&T properties, including the deviation from true position of features.

This article by Robert Sanville was published in the June 2008 Quality Magazine, and is now available at Quality Online.

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



Article by Robert Sanville, technical product manager for Faro Technologies. Published June 2, 2008, [qualitymag.com](#), a BNP website

[Back to top](#)

ETI Services

ETI is dedicated to client success by providing world-class dimensional engineering solutions

ETI provides a variety of engineering services that will help your organization improve product design and save money. We can review your drawings and evaluate them before production, helping you to reduce costs through proper specification. We can also help you apply GD&T to your existing drawings.

To read more about our services, [click here](#).

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.

To view past issues of ETImail, [see the archives](#). ETImail is available in PDF format. To read the file, you will need Adobe Acrobat Reader. We also invite you to visit our website, [etinews.com](#).

In This Issue

Here are this issue's highlights. Click on any link to jump directly to a feature:

Featured Article: [Five Language Mastery Tips That Can Be Used With GD&T](#)

Alex's Tech Tip: [ISO Geometrical Tolerancing Ebook](#)

ETI News: [2011 Public Workshop Schedule Available](#)

Learn New ASME Y14.5-2009 Symbol: [Circle U symbol](#)

ETI Mailbag: [Inseparable assembly drawings](#)

In the sidebar:

Web Highlights: [Adding Value for True Position Measurement](#)

ETI Services: [Engineering Services: Consulting Services and Drawing Review/Checking Services](#)

ETI Training: [Onsite Workshops](#)

ETI Products: [Web Special, GD&T Trainer Professional Edition, Advanced Concepts, Stacks](#)

ETI Resources: [GD&T and Tolerance Stacks Skills Surveys](#)

Other Features: [Quality Quote of the month](#)



Five Language Mastery Tips That Can Be Used With GD&T

Alex Krulikowski

Learning the language of GD&T has some similarities to learning a foreign language. Here are five language tips that can be used to keep your GD&T skills sharp.

When I teach GD&T, I often use the analogy that learning GD&T is like learning a foreign language. Although it's not quite the same as learning French or Spanish, there are many similarities between learning a foreign language and learning the language of GD&T.

When learning French or Spanish, we memorize new words, syntax, definitions, and conventions to describe people, places, and things. With GD&T, we learn a set of symbols, rules, definitions and conventions that are used to accurately describe a part.

There are numerous articles that contain quick tips for learning a foreign language. Many of them can be adapted into advice for how improve your knowledge of GD&T.

1. Immerse yourself.

When learning a language like French or Spanish, experts advise immersing yourself in the culture of the language. By doing this, you surround yourself with the sights and sounds of those who use the language every day. You pick up cues about language usage by native speakers, and you understand more about ways to communicate with others using your new language.

The obvious way to immerse yourself in a foreign language is to visit a locale where it's spoken, but there are other ways to achieve immersion when learning the language of GD&T.

One option is to join a social network, where you can take part in discussions about geometric dimensioning and tolerancing. ETI has a GD&T/Dimensional Engineering discussion group on LinkedIn that anyone can join. It discusses real world cases and practical solutions related to the topics of engineering drawing standards, GD&T usage, inspection, design analysis, and tolerance stack-ups. Topics include ASME Y14.5M-1994, ASME Y14.5-2009, ISO GPS, tolerance stacks, gaging and measurement, and GD&T training.

Becoming a member of LinkedIn is free, so join our group and take part in the discussion. It will help you immerse yourself in the topic, learn more about GD&T and its usage, and keep those GD&T language skills fresh.

2. Keep reference materials handy.

Many foreign language sites advise using flashcards for quick study. They're compact, and they can be kept on hand for review several times during the day.

When learning GD&T, you can create your own flashcards with symbols or modifiers on the front, and their definitions on the back. You can also use ETI's Ultimate Pocket Guide for quick study sessions while waiting in line at a bank or grocery store, or—more importantly—for use on the job. The pocket guide has an explanation of each GD&T symbol and modifier, handy charts, and detailed drawings that illustrate concepts. Study a little each day to refresh what you've learned in class.

Take advantage of other free GD&T resources that are available at our website, including a short glossary of terms that you can access when you need a quick answer online. While at our site, click on the "GD&T Resources" link in the left menu to read our white papers on GD&T, access skills surveys, or — if you haven't already — subscribe to ETImail, the free online GD&T newsletter. Visit our blog to read about products and find answers to GD&T questions. All these reference materials will keep your knowledge of GD&T fresh.

If you learned geometric tolerancing using ETI's *GD&T Trainer Professional Edition*, don't put that software away. Use it as a handy resource on the job, or any time you feel the need to practice your new skills. If you learned GD&T in an ETI workshop, remember to take advantage of the coupon for free access to our fundamentals web-based course after the training is done.

3. Learn from an expert.

When learning a foreign language, you want to be sure the instructor is well versed in the language and all its idiosyncrasies. When learning GD&T, it's important to find an instructor who knows the subject and has actually used it on the job.

All of ETI's instructors are ASME certified industry professionals who have used GD&T in their manufacturing careers. That's the equivalent of a foreign language instructor who has lived and worked in a country that speaks the language.

I personally created all of ETI's materials. I have a degree in industrial vocational education, over 30 years of industry experience, and I've been involved in standards writing for more than 20 years.

I understand GD&T and utilize the latest and best professional teaching methods. All of my materials utilize a set of performance goals and objectives that keeps the training focused and on task. Elements of critical thinking are also interwoven into my classes. Because a variety of learning methods are necessary to meet each student's unique learning needs, I've developed GD&T training in many different formats. ETI's traditional classroom workshops work well for those who prefer "live" training in a classroom with an instructor. Our computer-based GD&T training, web-based training, and self-study course workbooks were created for those who learn better working at their own pace. My advice is to select the learning method that works best for you and stick with it.

4. Practice, practice, practice.

"Use it or lose it" is especially true with a new language. What you don't use, you forget. By far, the best way to continue to hone your new language skills is to practice using the language often. It is also important to speak to other people who understand the language.

The same principle applies to GD&T. Besides using your new GD&T skills on the job, be sure to find coworkers and others who understand

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[Back to top](#)

ETI Workshops

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

ETI Offers On-Site Training

Effective Training brings hands-on GD&T instruction right to your location. Workshops can be customized to include your drawings and parts

Click on any course to learn more about it.

[Applications of GD&T](#)

[ASME Y14.5M-1994 to 2009 Update](#)

[ASME-ISO Comparison](#)

[Engineering Drawing Requirements](#)

[Executive Overview of GD&T](#)

[Functional Gaging and Measurement](#)

[GD&T Advanced Concepts](#)

[GD&T Fundamentals](#)

[GD&T Fundamentals for Inspectors](#)

[GD&T Overview Workshop](#)

[ISO Geometrical Tolerancing](#)

[Solid Model Tolerancing](#)

[Statistical Tolerance Stacks](#)

[System Approach to Component Tolerancing](#)

[Tolerance Stacks](#)

To learn more about what ETI has to offer your organization, [click here](#). To request a training quote, [click here](#).

[Back to top](#)

ETI Products

Monthly Web Special

ETI offers a special deal on a different product each month. Check out this month's Web Special.

The GD&T Trainer Professional Edition—a virtual classroom at your desktop

Professionals use Geometric Tolerancing



GD&T Trainer Professional Edition

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

geometric tolerancing to discuss concepts with you skills active. Read and participate in ETI's discussion board, join the GD&T group on LinkedIn that I mentioned above, and submit questions to our blog.

Frequently review your course materials. Go over vocabulary words. Study how GD&T is used on engineering drawings.

For practice interpreting GD&T on drawings, use ETI's *GD&T Workbook With Engineering Drawings*. Questions in the workbook refer to content in the *Fundamentals of GD&T* textbook, and are designed to let you gain practice using GD&T in the same manner you would on the job. Drawings are like those used in industry and include adaptors, retainers, shafts, plates, pulleys, housings, and more. Set realistic daily or weekly goals to do practice problems to keep your new GD&T language skills alive.

5. Take it to a higher level.

With any foreign language, once you know the language basics, you can start to build on that knowledge and use it in more complicated ways. Vocabulary words become full sentences, which turn into complete paragraphs. You begin writing in the language, or you may travel to other countries and attempt to use the language with native speakers and in the public arena.

There is more to understanding GD&T than memorizing a set of symbols and a few rules. It's a fully developed language that communicates accurately and effectively. Start moving up the GD&T "training pyramid." Once you've learned GD&T basics in our fundamentals course, our advanced concepts course will build on those fundamental skills. The course teaches higher level concepts like composite tolerancing, tolerance analysis, datum select, non-rigid part dimensioning, and many more key dimensioning topics.

GD&T TRAINING LEVELS

Workshops and Services from Effective Training



Arrange for ETI to bring onsite GD&T training, mentoring, or consulting to your organization. We also offer public workshops in Michigan and instructor-led live web GD&T training.

[Click on the pyramid to see a pdf with details about each training level](#)

A closing thought...

Remember, there are no limits to how successful you can become with your new GD&T language. To master this language, you need to learn, study, practice and continue to strive for a deeper knowledge of tolerancing principles. Don't stop at the fundamentals. Continue up the pyramid by learning advanced concepts and tolerance stacks. Become an expert on functional dimensioning and the system approach to component design.

Successfully learning and understanding a second language can bring personal satisfaction as well as career rewards. It's an important asset on anyone's resume. With proper training and tools anyone can master the language of GD&T.

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We welcome your feedback. Send comments about this article to ETI mail. Your opinions will be posted in the next issue.

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[Back to top](#)

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- President at Effective Training Inc. (GD&T)

Past

- Engineering Group Manager - Dimensional Engineering at General Motors

Education

- Eastern Michigan University

Connections

309 connections

Industry

Mechanical or Industrial Engineering

Websites

- GD&T Products/Services
- Alex Krulikowski bio
- ETI's GD&T blog

Public profile powered by: **LinkedIn**
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[View Full Profile](#)

Join Alex's LinkedIn network and take part in discussions about GD&T.

[Click here to connect with Alex.](#)

Alex's Tech Tip

Alex Krulikowski's ISO reference guide is now available in ebook format. The guide is written with the influence of nearly 70 ISO geometrical product specification (GPS) standards. More than 20 ISO GPS standards are directly covered in the text with dozens more cited throughout the book.

feedback and quizzes reinforce the material.

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](#)
To download a demo, [click here](#)

[Back to top](#)

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. It's an indispensable on-the-job reference.

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

[Back to top](#)

Knowledge of stacks separates the exceptional engineers from the rest



Learn Tolerance Stacks With On-The-Job Focus

Our stacks textbook stresses applications found in actual industrial situations. Solve tolerance stack problems involving flatness, straightness, tolerance of position, runout, concentricity, and more. Practice stacks are from actual drawings and provided in the Drawing Package.

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

[Back to top](#)

Teaching GD&T has never been easier: digital kits have course materials on CD-ROM

Digital Instructors' Kits
ETI now offers all of our instructor's materials in a convenient digital format. Each kit includes everything needed to teach an entire course on one handy CD-ROM.

To read more about them, [click](#)

To download a demo, [click here](#)

[Back to top](#)

The "ultimate" GD&T reference tool is only available from ETI



Alex Krulikowski's ISO Geometrical Tolerancing Guide

ISO Geometrical Tolerancing Now in Ebook format

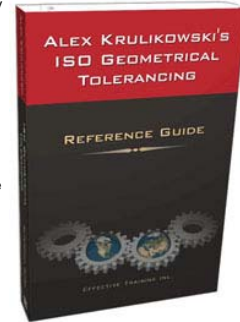
Look inside the book

Alex Krulikowski's ISO Geometrical Tolerancing Reference Guide simplifies using ISO standards by collecting volumes of information into one book with clearly marked topics. Cross-referenced concepts, a glossary, a topical index, and hundreds of easy-to-understand tables and figures complete the explanation of ISO practices. This thorough guidebook explains basic ISO dimensioning concepts and conventions, geometrical tolerances, surface texture and imperfections, and even includes a symbol-by-symbol comparison of ASME Y14.5 and ISO specifications.

Alex and two other dimensional engineering experts spent over a year completing the research, comparison, and analysis of the ISO geometrical product specification (GPS) system. This collective effort, combined with Alex's insights from his contributions to the ISO TC213 Committee, increased the ability to sort through seemingly conflicting or vague ISO requirements. In industry, this reference guide can save companies hundreds of hours searching for tolerancing information spread over dozens of ISO standards.

Alex Krulikowski's ISO reference guide is written with the influence of nearly 70 ISO geometrical product specification (GPS) standards. More than 20 ISO GPS standards are directly covered in the text with dozens more cited throughout the book. This reference guide provides the user with a comprehensive understanding of the ISO GPS system as well as preparing the reader to better understand the text of the ISO standards themselves. Read more about it...

[Back to top](#)



ETI News

ETI continues to add new GD&T products and services in order to provide you with more GD&T training options. Keep an eye on this section to read about our latest news. This issue: ETI offers many of our workshops at our Detroit-area headquarters. Plan next year's training, and visit us at our Westland location..

Public Workshop Calendar for 2011 Now Available

Plan ahead: take a look the available courses

[Workshops by subject](#)

[Workshop info in pdf format](#)

| January 2011 | | | | | | | February 2011 | | | | | | | March 2011 | | | | | | | |
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| April 2011 | | | | | | | May 2011 | | | | | | | June 2011 | | | | | | | |
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- GD&T Advanced Concepts**
- ASME Y14.5 1994-2009 Update - new!**
- Functional Gaging - new!**
- Fundamentals of GD&T - 1994**
- Fundamentals of GD&T - 2009**
- Fundamentals for Inspectors - new!**
- ISO Geometrical Tolerancing - new!**
- Statistical Stacks**
- Tolerance Stacks**

ETI offers a series of training events in the Detroit area and by live web. All of the courses were developed by GD&T expert and ETI president, Alex Krulikowski. *We are now offering three new courses:*

Fundamentals of GD&T for Inspectors - 2-Day Workshop

This 2-day workshop includes an introduction to geometric dimensioning and tolerancing and how to inspect GD&T requirements. The course is based on ASME Y14.5M-1994, Y14.5.1 and Y14.43 standards. [Read more about the course.](#)

Functional Gaging and Measurement- 2-Day Workshop

This 2-day workshop includes an introduction to functional gaging design and how to verify part dimensional requirements using functional gages and other measurement methods. The course is based on ASME Y14.5M-1994, Y14.5.1, Y14.43, and various B89 standards. [Read more about the course.](#)

ISO Geometrical Tolerancing - 2-Day Workshop

Enable global sourcing for your company and learn to read drawings created in other countries. The ISO Geometrical Tolerancing workshop will teach you the ins and outs of utilizing the ISO standards. The 2-day course will give you a fundamental knowledge of ISO 1101:2004 and related standards and their application on drawings. [Read more about this course.](#)



Economical Tool You Can't Afford To Miss

Carry this pocket-sized reference with you on the job and have a resource to all your GD&T questions at your fingertips. Order one for each member of your team!

To read more about it, click here

[Back to top](#)

ETI Resources



How Well do You Know GD&T?

Do you know the geometric symbols, each symbol's requirements, tolerance zones, and limitations?

[Click here to take the GD&T Skills Survey.](#)

Do You Understand Tolerance Stacks?

The Stacks Skills Survey measures how well an individual can use tolerance stacks to determine part distances or assembly conditions, like clearances, or part travel.

[Click here to take the stacks Skills Survey.](#)

[Back to top](#)

Quality Quote



Design is not just what it looks like and feels like. Design is how it works.

—Steve Jobs

[Back to top](#)

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Upcoming 2011 Public Workshops

| Workshop Title | Dates | Cost | Register Now |
|---|--|-------|------------------------------|
| Advanced Concepts of GD&T (ASME Y14.5M-1994) | April 6-7 Sept 28-29 | \$695 | Register Now |
| ASME Y14.5-2009 8-Hour Update Workshop | April 8 July 13 Sept 30 | \$375 | Register Now |
| Functional Gaging and Measurement: 2-Day (ASME Y14.5M-1994) | April 18-19 Oct 24-25 | \$695 | Register Now |
| Fundamentals of GD&T 2-Day (ASME Y14.5M-1994) | April 4-5 July 11-12 Sept 26-27 | \$695 | Register Now |
| Fundamentals of GD&T 16-Hour (Live Web) (ASME Y14.5M-1994) | April 11-14 July 18-21 | \$595 | Register Now |
| Fundamentals of GD&T 2-Day (ASME Y14.5-2009) | March 28-29 June 13-14 Oct 12-13 | \$695 | Register Now |
| Fundamentals of GD&T for Inspectors 2-Day | Mar 7-8 Sept 12-13 | \$695 | Register Now |
| ISO Geometrical Tolerancing 2-Day | Oct 10-11 | \$695 | Register Now |
| Statistical Tolerance Stacks 1-Day | May 25 | \$375 | Register Now |
| Tolerance Stacks 2-Day | May 23-24 Oct 17-18 | \$695 | Register Now |

ETI's public workshops are complete courses that teach how to apply and interpret GD&T on the job. They are more in depth than most public seminars, and much more than simply lectures. Each workshop provides hands-on training that includes practice exercises to help reinforce concepts. When you register for any ETI workshop, you know you'll be receiving the most thorough GD&T training available.

[Register Now](#)

Don't have time to travel? ETI can bring the workshops to your site. To learn more about our onsite workshops, call 1-800-886-0909 or [click here](#) for more information.



[Back to top](#)

Learn a New ASME Y14.5-2009 Symbol

Each new issue of ETImail will discuss a new symbol from the ASME Y14.5-2009 Standard. This issue focuses on the CIRCLE U symbol.



The Circle U symbol

The circle U unequal tolerance zone symbol is seen as another improvement in the ASME Y14.5-2009 Standard. It allows the designer to unambiguously communicate a unilateral or unequal distribution tolerance zone.

Without the benefit of the unequal symbol in the 1994 Standard, one had to use supplemental geometry (phantom lines) to represent the unilateral or unequal profile tolerance zone to communicate the direction of the tolerance zone and the amount of the zone that either exists to the inside or outside of the true profile in orthogonal views or axonometric views shown on 2D drawings. Often, enlarged auxiliary views would have to be created in order to be able to clearly see the phantom lines that communicated the unilateral or unequal tolerance zone.

With the use of the unequal symbol, the designer no longer has to rely on supplemental geometry shown in auxiliary views. As long as the true profile (surface) is clearly shown in the applicable view, one can just point to the true profile with a profile tolerance feature control frame that includes an unequal symbol. The value before the unequal symbol is the total width of the tolerance zone, and the value after the unequal symbol represents the amount of the tolerance zone that exists to the outside of the true profile (surface). The standard defines the outside of the surface as the direction that add mass to the part. This is clearly defined in paragraph 8.3.1.2 and figures 8.1, 8.2, 8.3, and 8.4 of the 2009 Standard.

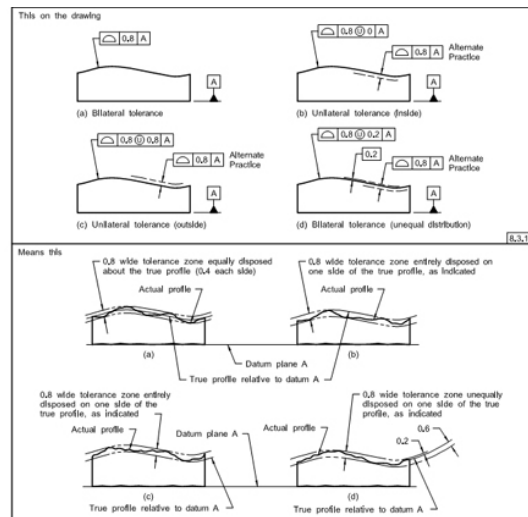


Figure 8.4 from ASME Y14.5-2009 Standard. [Click on the figure for larger view.](#)

[Back to top](#)

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www.etinews.com

Visit our blog

ETI's blog is dedicated to GD&T and contains tolerancing insights from Alex, training tips, product announcements, and more.

[Read the ETI blog.](#)

The ETI Mailbag

Inseparable Assembly Drawing:

Is there a standard in ASME that states that an inseparable assembly should be detailed on the inseparable assembly drawing itself, instead of creating separate detail drawings for each part?

Example: If you have a bracket with press fit studs in the holes – shouldn't the GD&T be applied to the studs and not the clearance holes?

There isn't a separate standard for this issue alone. However, this issue is covered as part of the Y14.5 standard under the fundamental rules (See rule "n" ASME Y14.5M-1994, paragraph 1.4).

Dimensions and tolerances apply only at the drawing level where they are specified. A dimension specified for a given feature on one level of a drawing (for example, a detail drawing) is not mandatory for that feature at any other level (for example, an assembly drawing).

The fundamental rules of the Y14.5 standard are the basic premises of any drawing where the standard is referenced. These rules cannot be removed or omitted from a drawing's interpretation where the standard is to be used. This rule clearly states that if you want to be able to inspect an assembly (inseparable or otherwise) that the assembly needs to have dimensions and tolerances. To manufacture (and inspect) the components that make up the assembly, you will also need individual details (dimensions and tolerances) for each component. Having detailed drawings for each component does not assure that the assembly meets any dimensional limits, nor does having a detailed assembly fully define the requirements of the components that make up that assembly.

If I were to design a bracket assembly which consisted of a bracket and several press-fit studs, I would need to detail the bracket, the studs, and the bracket assembly, which would include the projection height of each stud after press-fit assembly, the position of each stud with respect to the other studs in the assembly pattern, and datum features as the functional interface required. I would be sure to allow the maximum possible tolerance on the assembly so as to permit variations from the free-state component to the restrained condition after assembly. Each component would likely need a slightly smaller tolerance to avoid the need to machine the assembly into meeting its dimensional requirements.

I recently worked with a client who was unable to inspect several subassemblies they had received from a supplier. The problem was this very issue. The designer had detailed each component of the subassembly, but the subassembly was the deliverable from the supplier. Without a detailed subassembly, the inspectors had nothing to verify that the incoming units were acceptable.

*ETI appreciates your questions and comments.
Send your GD&T questions to: [ETI Mail](#).*

[Back to top](#)



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