



Effective Training Inc., Westland MI, 800.886.0909

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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). 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.

ETIemail 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 ETIemail, see the [archives](#).

ETIemail is now available in [PDF format](#). To read the PDF file, you will need [Adobe Acrobat Reader](#).

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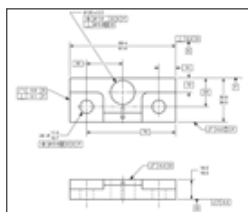
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Guidelines for Implementing GD&T on Drawings

[Alex Krulikowski](#)

Understanding GD&T and using it correctly is critical to good design. Here are some guidelines for getting started.

Is your company confused about where to start using geometric dimensioning and tolerancing? Do they wonder how much GD&T they should use on drawings?

Some engineers fear using too much GD&T. In many cases, the GD&T skills outside of engineering are scarce. This raises concerns that adding GD&T to the drawings may cause confusion in the plants and at suppliers. This mind set causes a prolonged use of the antiquated tolerancing method known as coordinate tolerancing.

Some managers feel that they are getting along well using coordinate tolerances. They are afraid to upset the system by introducing the additional complexity of GD&T to drawings. In reality, the organization is often not "getting along" so well. There is often wasted effort trying to meet unrealistic tight tolerances, and the measurement of the parts is left up to assumptions instead of being explicitly defined on the drawing. There are often difficulties with parts from suppliers. In engineering it is difficult, if not impossible, to debug field problems because no one really knows what the tolerance is on the parts in production.

Although some may feel that coordinate tolerancing is simpler, it is not. Coordinate tolerancing looks easier to interpret, but it does not address three areas:

1. Coordinate tolerancing does not define the part with a repeatable definition for inspection.
2. The part tolerances are overly restrictive.

Web Highlights



Does Youtube Have Competition? Now You Can View or Post Engineering Videos

ENGINEERING.com has a new Engineering Videos Section. Video categories include engineering projects, the manufacturing process, software tutorials and more.

Check out the [most recent engineering videos](#). Anyone can view the videos, but to add

videos, you must register to become a member.



Sample video: [Gear cutting a spline on a Hobbing machine](#)

The site also has a variety of other resources, including articles, tips and calculators.

To view the videos, [click here](#).
To see the calculators, [click here](#).

<http://engineering.com>

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New at ETI

Learn to correctly interpret engineering drawings with ETI's new one-day Engineering Drawing Requirements workshop



New Course Offering: Engineering Drawing Requirements

Creating standard-compliant drawings is critical for manufacturing and outsourcing parts. ETI's one-day course explains the requirements for creating or interpreting engineering drawings in accordance with national

3. The dimensioning does not represent how the part functions.

Using GD&T does add some complexity to the drawings, because it is more complete. GD&T fully defines the part requirements and, therefore, eliminates the shortcomings of coordinate tolerancing. If the same level of part requirement definition was attempted with coordinate tolerancing, many notes would have to be added, making the drawings much more complex and confusing. GD&T is the most efficient method for defining parts to the level needed for part production.

Using GD&T adds three important benefits to your designs:

1. The manufacturing tolerances will be significantly larger.
2. The sequence for addressing the part to gage measurement is defined.
3. The drawings will clearly define parts that fit and function as intended by engineering.

The fear that the suppliers won't understand the GD&T is not realistic. I have heard of several overseas companies that have requested their customers add GD&T to the drawings so they can clearly understand the part requirements and know how the part should be measured.

When you understand the language of GD&T, you want to realize its benefits as much as possible. Still, some managers are concerned that they do not want to use too much GD&T on their designs. Is there such a thing as too much clarity, too much tolerance for manufacturing, or too much measurement repeatability on drawings? The question becomes how much GD&T needs to be specified?

Here are some guidelines that can help an organization use GD&T appropriately:

1. All parts (except very simple parts, like a pin or a sphere) must have assembly (or mounting) datum features identified.
2. The interrelationship between the datum features (orientation and location) must be specified with GD&T.
3. All mating surfaces must be oriented and located with GD&T.
4. All critical functional relationships must be oriented and located with GD&T.
5. Form tolerances for datum features, mounting features, and mating features must be specified with GD&T.
6. Non-critical part features may be defined with coordinate tolerances or general tolerances.

Each GD&T specification on a drawing will be a direct result of one or more of the above guidelines. The rationale for each guideline is shown in Table 1.

Guideline	Reason for using GD&T
1. All parts (except a very simple part, like a pin or a sphere) must have assembly (or mounting) datum features identified.	Datums are the origin for measurement. Every part (or at least 99% of them) needs at least one set of datums. The surfaces that orient and locate the part in the assembly are used as datum features.
2. The interrelationship between the datum features (orientation and location) must be specified with GD&T.	Since datums are the origins for measurement, the datum feature boundaries need to be clearly defined for datum simulation. Using GD&T to define the interrelation between datum features allows the datum simulator boundaries to be easily calculated.
3. All mating surfaces must be oriented and located with GD&T.	Part mating surfaces are important features for tolerancing functional relationships on a part. Mating surfaces are often related to the part assembly datum(s). Therefore, they need to be dimensioned in a repeatable, measurable method.
4. All critical functional relationships must be oriented and located with GD&T.	These are the tolerance-sensitive relationships that make your product a success. To avoid any confusion in these sensitive areas, GD&T should be used to establish one set-up for inspection and to ensure clear definition of the tolerance zones.
5. Form tolerances for datum features, mounting features, and mating features must be specified with GD&T.	The form of a surface dictates how much contact it will have with its mating surfaces. Using form controls on datum features establishes the part-to-gage contact. Using form tolerances on mating surfaces establishes the part-to-part contact. Using GD&T is the clearest method for specifying form requirements on drawings.
6. Non-critical part features may be defined with coordinate tolerances or general tolerances.	Non-critical features are those with no effect on part-to-gage set up, mating relationships, or critical functional relationships. A few examples are wall thickness, fillets, tangent radii, hole depths, and non-mating surfaces. These may be defined with coordinate tolerances or general tolerances.

standards. It covers many common topics used on engineering drawings.

This course will improve a student's understanding of drawing requirements and interpretation.

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

ETI Resources



How well do you know GD&T?

Do you understand tolerance stacks?

Try Our Free Skills Surveys, Today

The GD&T Skills Surveys are free resources from ETI designed to challenge your GD&T and tolerance stacks knowledge. Discover what level of GD&T training you need:

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

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

ETI Products




Using these GD&T guidelines will ensure that all the important part features are fully defined for measurement, allow maximum tolerance for manufacturing, and protect the part function. The drawing will clearly communicate the engineering requirements for the part.

Some plants and suppliers will embrace the use of GD&T. Some suppliers may resist using GD&T. The question you need to ask is, should we make our drawings with less tolerance, less clarity, and less ability to analyze problems in order to accommodate an unskilled supplier, or should we find a better, more skilled supplier? If your suppliers decide against using email or CAD technology, will you stop using these tools to accommodate them? You expect your suppliers to keep abreast of technology, so using GD&T should be a requirement.

To download a free "Guidelines for Implementing GD&T" chart in PDF format, click on the image below.

Guidelines for Implementing GD&T	
By Alex Krulowicki	
When beginning to implement geometric dimensioning and tolerancing, how much GD&T needs to be specified? Here are some guidelines that can help an organization use GD&T appropriately:	
Guideline	Reason for Using GD&T
1. All parts (except a very simple part, like a pin or a sphere) must have assembly (or mounting) datum features identified.	Datums are the origin for measurement. Every part (or at least 80% of them) needs at least one set of datums. The surfaces that orient and locate the part in the assembly are used as datum features.
2. The interrelationship between the datum features (orientation and location) must be specified with GD&T.	Since datums are the origins for measurement, the datum feature boundaries need to be clearly defined for datum simulation. Using GD&T to define the interrelationship between datum features allows the datum simulator boundaries to be easily calculated.
3. All mating surfaces must be oriented and located with GD&T.	Part mating surfaces are important features for tolerancing functional relationships on a part. Mating surfaces are often related to the part assembly datum(s); therefore, they need to be dimensioned in a repeatable, measurable method.
4. All critical functional relationships must be oriented and located with GD&T.	These are the tolerance-sensitive relationships that make your product a success. To avoid any confusion in these sensitive areas, GD&T should be used to establish one set-up for inspection and to ensure clear definition of the tolerance zones.
5. Form tolerances for datum features, mounting features, and mating features must be specified with GD&T.	The form of a surface dictates how much contact it will have with its mating surfaces. Using form controls on datum features establishes the part-to-gage contact. Using form tolerances on mating surfaces establishes the part-to-part contact. Using GD&T is the correct method for specifying form requirements on drawings.
6. Noncritical part features may be defined with coordinate tolerances or general tolerances.	Noncritical features are those with no effect on part-to-gage fit or mating relationships, or critical functional relationships. A few examples are wall thickness, fillets, tangent radii, hole depths, and non-mating surfaces. These may be defined with coordinate tolerances or general tolerances.

This list of guidelines is from "Guidelines for Implementing GD&T on Drawings," by Alex Krulowicki, in ETIReal, Volume 2, Issue 5: <http://www.etinews.com/etimail/>


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Alex's Tech Tip

Understanding GD&T and using it correctly is critical to good design. Here are seven GD&T actions you should strive to follow on the job.

Resolutions or Self Improvement?

At this time of year, it's traditional for most of us to resolve to change our behavior or meet personal goals. We'll lose weight, stop smoking, or finish that lingering home improvement project. As ardent and admirable as these promises are, they rarely pan out or survive past January 31st. We shake our heads, look chagrined and have a good chuckle at our own expense. Then we get back to who we really are and business as usual.

Monthly Web Special
ETI offers a special deal on a different product each month. Check out this month's [Web Special](#).

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



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.

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](#)

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GD&T advanced concepts taught by the experts. . .

Breaking our resolutions — more so than making them — has become the real tradition.

But in today's rapidly evolving business world, this kind of tradition doesn't cut it. Successful individuals must commit to — and consistently deliver on — their promises. Successful individuals need to improve themselves constantly. There's no such thing as business as usual. I don't need to tell you that learning is a critical component of this process of self-improvement. You already know that.

So instead of adding to a list of traditional resolutions, I am providing you a list of actions to encourage self improvement in an area that is important to our careers.

Seven GD&T Resolutions Actions

1. I resolve to learn more about GD&T.

Learning about GD&T is an ongoing endeavor. Each year, we should plan to increase our GD&T skills. Read a new book, a standard, or attend a refresher course. Plan to do something to increase your understanding. If you don't plan an activity, the year will pass and you will not have increased your knowledge.

2. I will use GD&T on all drawings.

Many engineers feel that GD&T is only for product drawings, or drawings of high volume parts. This is not true. Many companies use GD&T on low volume parts, gages, tooling, or special machines. The use of GD&T ensures that the parts are fully defined, enables outsourcing, and allows replacement parts to be used.

3. I will mentor two coworkers on the benefits of GD&T.

If each person would take the time to mentor two coworkers, the use and acceptance of GD&T would grow. A large part of resisting the use of GD&T is that people do not understand how to use GD&T or the benefits it can provide.

4. I will document examples of where GD&T reduces cost or resolves problems on my designs.

One of the roadblocks to getting management to support the use of GD&T is a lack of examples on how GD&T saves the company money. If each person would take the time to document savings that result from using GD&T, its value would soon become apparent to the organization.

5. I will study the part functions when dimensioning a part.

An understanding of part function is critical to making decisions about the part dimensioning. Without this information, the dimensioning may not protect the part function and the tolerances will be unnecessarily tight.

6. I will perform tolerance stacks before releasing a drawing.

When tolerance stacks are done before the drawing is released, it provides a design that has a much greater chance of functioning properly, has larger tolerances, and has more complete drawings.

7. I will follow the guidelines on "How to Implement GD&T."

The guidelines remind us that we should be using GD&T in places we often don't think about on a daily basis.

The key to self improvement is self discipline. Self discipline is the bridge between your resolutions and your accomplishments. What you get by achieving your resolutions is not as important as what you become by keeping them. Start today. Remember the old Chinese proverb: A journey of a thousand miles begins with a single step.

Good luck.

Alex Krulikowski

To download a free "Seven GD&T Resolutions Actions" chart in PDF format, click on the image below.



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](#)

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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](#)

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Seven GD&T Resolutions Actions	
By Alex Krullowicz	
Don't make —and break — resolutions this year. Take action! This list of actions encourages self-improvement in an area that is important to our careers.	
1	I will resolve to learn more about GD&T. Learning about GD&T is an ongoing endeavor. Each year, we should plan to increase our GD&T skills. Read a new book, a standard, or attend a refresher course. Plan to do something to increase your understanding if you don't plan an activity, the year will pass and you will not have increased your knowledge.
2	I will use GD&T on all drawings. Many engineers feel that GD&T is only for product drawings, or drawings of high volume parts. This is not true. Many companies use GD&T on low volume parts, gears, tooling, or special machines. The use of GD&T ensures that the parts are fully defined, enables outsourcing, and allows replacement parts to be used.
3	I will mentor two coworkers on the benefits of GD&T. If each person would take the time to mentor two coworkers, the use and acceptance of GD&T would grow. A large part of resisting the use of GD&T is that people do not understand how to use GD&T or the benefits it can provide.
4	I will document examples of where GD&T reduces cost or resolves problems on my designs. One of the roadblocks to getting management to support the use of GD&T is a lack of examples on how GD&T saves the company money. If each person would take the time to document savings that result from using GD&T, its value would soon become apparent to the organization.
5	I will study the part functions when dimensioning a part. An understanding of part function is critical to making decisions about the part dimensioning. Without this information, the dimensioning may not protect the part function and the tolerances will be unnecessarily tight.
6	I will perform tolerance stacks before releasing a drawing. When tolerance stacks are done before the drawing is released, it provides a design that has a much greater chance of functioning properly, has larger tolerances, and has more complete drawings.
7	I will follow the guidelines on "How to Implement GD&T" from ETIEmail. The guidelines remind us that we should be using GD&T in places we often don't think about on a daily basis. See ETIEmail, volume 2, Issue 5, at the ETI website to read the article.

This list of actions is from the Techtips column in ETIEmail, Volume 2, Issue 5: <http://www.etinews.com/etiemail>.



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If you know about a new tech tool or an innovative idea that would aid our readers, please write us: [ETIEmailbag](#).



Standards in the News

ETIEmail's Standards in the News takes a look at real-life issues involving standards. This month: the importance of standards in life-saving technology.



Excerpt from the [MSNBC website](#)

Flaws found in firefighters' last line of defense

U.S. waited 5 years to heed expert's warning on 'man down' alarms

Worn by a million firefighters in the U.S., the PASS device is a motion sensor that makes an awful racket if a firefighter stops moving for 30 seconds while battling a blaze. It flashes its lights and lets loose a series of ear-splitting beeps — an urgent call to help a fallen comrade.

It's a call that hasn't always been heard. Tests by federal and independent labs show that some PASS alarms can fail to perform as intended if they get too hot or wet — a serious problem for people who rush into burning buildings with water hoses. And federal

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

Digital Instructors' Kits from ETI

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 here](#)

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

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



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! Also available in a Spanish-language version.

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

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ETI Services

investigative reports reviewed by MSNBC.com show that 15 firefighters have died since 1998 in fires where a PASS, or Personal Alert Safety System, either didn't sound or was so quiet that rescuers weren't given a chance to find the firefighter quickly.

Tests in a convection oven at the National Institute of Standards and Technology found a problem with the two models it tested: The volume of the beeping diminished substantially at temperatures as low as 300 degrees Fahrenheit — the sort of temperatures that firefighters encounter in a room next to a fire. Researchers said they believe that all of the half-dozen or so brands of PASS alarms on the market would be similarly affected.

In addition, some PASS devices made by at least three manufacturers have had problems over the past decade with water leaking into the electronics or battery compartments, causing them to either beep continually or stop working altogether, according to interviews and documents reviewed by MSNBC.com.

A tougher new standard for testing PASS devices in heat and water was issued by the National Fire Protection Association in early 2007. But manufacturers said it would be months before an improved device would be on the market. And even when new models are available, there is no plan for recalling the old ones, so fire departments may have to bear the cost of replacing them.

[Full story](#)



Excerpt is from the article, "**Flaws found in firefighters' last line of defense**," by **Bill Dedman**, Investigative reporter, in an [MSNBC](#) Special Report, Feb 28, 2007.

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ETI continues to add new products and services that provide you with more GD&T training options. Keep an eye on this section to read about our latest news. This issue highlights the *System Approach to Component Tolerancing and the GD&T Trainer Professional Edition, v3.5*.

System Approach to Component Tolerancing Workshop

Public Workshop - Westland, MI - March 12-14, 2008

Register Now

Learn the thought processes involved in assigning GD&T to components. This workshop will change the way many engineers think about part tolerancing.

ETI's new System Approach to Component Tolerancing [public workshop](#) will be held in March at ETI headquarters. We can also bring the training to your workplace in an [onsite workshop](#).

The workshop focuses on four key areas:

- Understanding what constitutes good and poor drawing practices
- Understanding the common dimensioning methods used in industry
- Using geometric tolerancing to communicate system functions on component dimensions
- Understanding the logic of how to apply GD&T to components.

Students will actually perform a design function analysis on a part assembly provided by your company, then specify GD&T on assembly components during the

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.

[ASME Y14.41 - 2003 Engineering Drawing Requirements](#)
[GD&T Fundamentals Fundamentals Overview](#)
[GD&T Advanced Concepts](#)
[Tolerance Stacks](#)
[Statistical Tolerance Stacks](#)
[ASME-ISO Comparison](#)

NEW - [System Approach to Component Tolerancing](#)

To find out more about what ETI has to offer your organization. [Click here](#)

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

workshop.

Each workshop participant receives:

- A copy of the *System Approach to Component Tolerancing Class Notes*
- An official certificate of completion
- Continental breakfast and morning snack

PLUS

- ETI's [Digital Design Dictionary](#) software (\$79 value)
- A 30-day pass to the [Fundamentals of GD&T web training](#) (\$159 value)

See the complete list of course topics and more details about this 3-day workshop, [here](#).



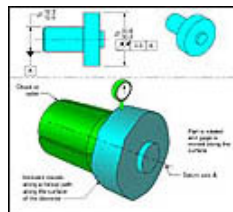
GD&T Trainer Professional Edition Version 3.5 Now Available

The best GD&T training software just got even better

GD&T Trainer adds new features and course

The GD&T Trainer Professional Edition has been updated and improved. The software now supports Windows Vista and 64-bit operating systems. More than 35 illustrations have been added to the integrated Digital Design Dictionary, which can be accessed through more than 200 "hotwords" interspersed throughout the lessons.

Graphics, audio files, and lesson answers have been updated, and the software registration process has been modified for easier use.



[Click for animation sample](#)

LAN, site, and corporate purchasers also receive:

The GD&T Overview Course - a 10-lesson course that provides a general overview of the symbols, modifiers, rules and concepts used in geometric tolerancing. The course includes quizzes, and the approximate completion time is 5 hours.

The GD&T Quick Reference program - a GD&T reference tool that contains 220 topics covering all aspects of the fundamentals of GD&T. Each topic page shows a detailed graphic and full explanation of the concept. Key GD&T terms are cross-referenced with the Digital Design Dictionary and to paragraphs in the ASME Y14.5M-1994 Dimensioning and Tolerancing Standard.

The software can be used to learn the fundamentals or improve upon GD&T skills. It can also be used as a resource when training is done. [Read more about it.](#)

[Click here](#) to see a GD&T Trainer comparison chart. Find out which version of our training software is right for you.



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board name	
Questions about ETI Products	
	Fundamentals of GD&T Textbook 21
	The GD&T Trainer (S) GD&T Trainer Discussion Area - Includes Ink Updates, etc.
Geometric Dimensioning and Tolerancing	
	Prior GD&T Questions The Discussion Group contains questions that prel mail, etc.
	ASME Y14.5M Discussion Group for questions/comments on represented in the ASME Y14.5M standard
	Tolerance Analysis

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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Quality Quote



Quality is the result of a carefully constructed cultural environment. It has to be the fabric of the organization, not part of the fabric.

— Philip Crosby

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The ETI Mailbag

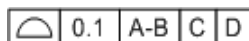
Hello, Mr. Krulikowski,

I have a question for you. Can I have more than 3 datum references in one control frame (more than 3 compartments)? Is this legal? Catia V5 does not allowed to have more than 3 compartments in one control frame. Thanks.

Thank you for your inquiry. The short answer to your question is no.

There are never more than three datum references in a feature control frame. The primary reason for this is the degrees of freedom constrained by each reference; after the third datum reference you are certain to over constrain the feature.

There are, however, times when we may see more than three datum features referenced in the datum feature boxes. When A-B appear together in the same box, as in this example, they are considered co-primary datums.



At other times, a feature may have a functional relationship to more than three datum features. Tolerance of position and the profile of a surface tolerance will allow designers to specify multiple single-segment feature control frames. There are some rules for doing this as outlined in my *Advanced Concepts of GD&T* textbook.

The ASME Y14.5M-1994 Standard gives some examples and explanation; however, most users feel that the standard is more difficult to understand. Again, you will find that even in a multiple single-segment application, no more than three datums are used in any segment of the feature control frame.



I have a quick question about reference dimensions. If a character is in parenthesis, is that a designation for a reference dimension?

Absolutely, the ASME Y14.5M-1994 makes this clear on page 2 in the definition of a reference dimension.

Now the question is, does your drawing reference the ASME Standard? If not, ISO standards follow the same practice, but they're called auxiliary dimensions. If the drawing is to be interpreted per some other standard (such as a corporate standard), then the rules of that standard must be followed.



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

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Dennis Moore

Website Administrator/
Online Services
Brandon Billings

Graphic Designer
Matthew Pride

Network Administrator/
Computer Services
Chris Wioskowski

Writer/Marketing
Katherine Palmer

Order Processor
Gary Walls

Dimensional Engineering
Mentors
Michael Adcock
Roy Cross

Instructors
Bob Bourland
Dan Carlson
Robert Charlton
Brent Davis
Don Holder
Dale MacPherson
Dan Meyers
Christopher Nolan
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think—take a **short**
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ETIEmail Feedback

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What products or training would you like to see added to our line-up? Take a short 5-question survey to let us know what you think.

[Click here to take survey](#)



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