Corporate GD&T Implementation Strategies

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February 2009

What is GD&T?: CAD (Computer Aided Design), and GD&T (Geometric Dimensioning & Tolerancing) are the two equally important halves of the science of machine part geometry specification. CAD provides the means to generate, manipulate and communicate the perfect, imaginary geometry of parts. GD&T on the other hand, serves to research, refine and "encode" the functions of machine part features, and, by specifying functional limits of imperfection, guarantee their manufacturability, inspectability, assemblability and operation, prior to model release. CAD without GD&T is "bad", because it represents just half the story, and the lack of reliable GD&T is demonstrably responsible for bumpy, new product ramp up cycles, unnecessarily costly manufacturing processes, and questionable inspection results based on tribal understandings. In short, GD&T is a highly sophisticated "encodable" and "decodable" symbolic language for managing machine part design, manufacturing, inspection and assembly risk, and consists of the following components:

• Concepts   • Tools   • Rules   • Processes   • Best Practices

GD&T's Corporate Contributions: Properly implemented, GD&T makes big contributions to corporate profitability. It does so by substantially reducing new product ramp-up times, on-going piece part manufacturing costs, and assembly floor delays. GD&T accomplishes this by enabling Design Engineering to research and refine the operational and assembly functions of parts up front, instead of through costly trial and error on the assembly floor. It does so by highlighting potential mating feature conflicts, by maximizing tolerances without compromising function, by guaranteeing the assemblability of in-tolerance mating parts, and by "encoding" requirements so clearly as to permit completely unambiguous "decoding" for reliable manufacturing and inspection process management. Nowhere is GD&T more important than in the newly disintegrated world of global manufacturing, where its symbolic language makes the user independent of differing "tribal understandings", and "allows us to say so precisely what we do, that others can do precisely what we say".

In spite of this, why do machine shops often charge more for parts based on GD&T encoded drawings? There are many reasons, all resulting from legitimate fears which should be addressed and eliminated. These include 1) inadequate understanding of the code (Training should be required), 2) fear that the GD&T on most drawings is not "code" but mere "decoration" and will cause problems due to differing "interpretations" (True! In fact, "bad" GD&T is far more common than "good" GD&T, and "bad" GD&T is much worse than "no" GD&T. It's time to work on producing "good" GD&T.), 3) fear of complaining about "bad" GD&T for fear of angering customers (Suppliers should be encouraged to complain), and finally 4) the opinion that lots of GD&T requires lots of inspection (Wrong! GD&T does not impose inspection requirements, merely delivery requirements). And in the end, expensive parts that can be relied upon to assemble and operate from the outset, are definitely less expensive than cheap parts which interrupt assembly and fail in operation. All these matters can and should be dealt with in client – supplier relations.

Who Needs GD&T: The GD&T user community is broadly based, and the needs of each group are very different. By far the most important group is the GD&T Advisor team:

• Level I Users - Technical Specialists, including machinists, assembly leads, mechanical inspectors, and machine part buyers, are primarily dedicated to "decoding" GD&T to implement design objectives. In order to succeed, they must be familiar with basic GD&T concepts, tools, rules, and decoding processes, but must also have ready access to a "GD&T Advisor" team.

- Level II Users - Engineers, including design, manufacturing and metrology engineers, are primarily dedicated to "encoding" GD&T to specify and manage engineering objectives. Design engineers use GD&T to research and refine the functionality of designs, to guarantee assemblability of mating parts, and to specify design intent in absolutely unambiguous terms. Manufacturing and QA Engineers support the design process at the same time as they work to decode GD&T drawings and turn them into reliable manufacturing and inspection processes. In order to succeed, they must be familiar with all the fundamental concepts, tools, rules, encoding and decoding processes. But they must also recognize that they may not use GD&T often enough to be fully in control. As a result, they too must have access to a "GD&T Advisor" team to ensure success.

- Level III Users – "GD&T Advisors" are those team members in design, manufacturing and metrology who have been tasked by management to implement and maintain GD&T, and have reached the highest levels of GD&T expertise because they use it all the time. They are the "go-to" people. In order to truly benefit the organization, GD&T Advisors must be required participants in engineering review meetings, must be required signatories for drawing releases, and should offer occasional in-house training sessions to further refine their own and others' knowledge.

Training Requirements: Recommended training and training maintenance for each group is as follows:

- Level I Users: At the outset, a two day, broad based Beginner course, followed within weeks by a one day application training session, followed by annual, half day refresher courses with applications.

- Level II Users: At the outset, a two day Beginner course - in order to establish a secure foundation in common with others, and to eliminate the many "interpretations" and frozen paradigms found in tribal understandings - followed within weeks by a one day application training session and a Beginner Skills Quiz. Next, two months later, a three day Intermediate course - followed within weeks by two, one day application training sessions and an Intermediate Skills Quiz. Next, six months later, a three day Advanced course - followed within weeks by two, one day practical implementation sessions in part design and tolerance analysis, in manufacturing process and fixture design, and in metrology process and gage design, followed by an Advanced Certification exam. These efforts should be followed by annual, one day refresher and occasional special application courses.

- Level III Users - GD&T Advisors   GD&T Advisors are discovered during Level II training sessions and should be encouraged to assume support duties during the Advanced course and all application sessions in order to test and enhance their abilities.   Their training should comprise a total of at least fifteen to twenty days spread out over the course of the first year, and should conclude with oral and written Advisor certification exams and annual Advisor Group refresher sessions.

Implementation Strategies: Corporate implementation success is critically dependent on top management support. Top management must therefore be aware of the financial benefits of GD&T, and must be committed to ensuring the benefits are achieved. Implementation should be undertaken in measured steps, division by division or product line by product line, and time should be taken to assess methods and success at each step. In the long run, successful implementation depends substantially on building and maintaining an accomplished and empowered "*Smart* **GD&T™** Advisor" team and can be further enhanced with Multi Metrics' live Advisor Team support, our live "*Smart* **GD&T** *Encoding & Decoding*" services - including the development of standardized GD&T encoding schemes for part families - and with internal trainer training and training materials.

Implementation Costs: The greatest potential out-of-pocket cost of an implementation effort is the cost of failure, because failure means continuing to be saddled with not using, or misusing GD&T. It is therefore recommended to proceed carefully with a well considered plan. The next greatest cost is the cost of time lost on the job while training proceeds. This cost can be minimized by selecting the most effective training possible and combining it with on-the-job application. The smallest costs are those associated with training fees and materials, making selection of the best and most effective, rather than the least expensive provider, of the utmost importance.

Selecting Training Providers: Compare training materials, compare responses to well defined sets of highly specific design, manufacturing and inspection challenges, compare their abilities to cover the full spectrum of requirements, compare their willingness and ability to customize, to provide on-going support, implementation, certification and consulting, and invite them to make sample presentations on selected topics to witness their methods, assess their materials and experience how they interact with people.

Multi Metrics, Inc.

About Multi Metrics, Inc.

Multi Metrics delivers *Smart* **GD&T** ™ training products and services to leading Design, Manufacturing and Inspection companies around the world. Through a unique blend of implementation planning, customization, on-site training and ongoing consulting and support, Multi Metrics enables companies to not only learn, but to realize the promise of GD&T, namely to achieve the significant reductions in new product ramp-up times, manufacturing costs and waste, leading to increased productivity and profits.

Bill Tandler, president of Multi Metrics, founded the company in 1975 to focus on and advance the art of machine part geometry management. During the 32 years of its existence, he has been the guiding force behind its activities beginning with the sale of sophisticated mechanical inspection equipment (including the Carl Zeiss line of computer controlled coordinate measuring machines from 1978 to 1988), including the delivery of sophisticated mechanical inspection services, continuing with the development of two revolutionary software products: the world's first software system, dubbed "Inspector S", for computer automating the use of digital electronic calipers, micrometers, indicators and height gages, followed by the world's first universal 3D geometry retrofit software system for coordinate measuring machines, dubbed "GEOMET".   In the year 2004, the Canadian company InnovMetric purchased a license to *Smart* **GD&T** technology with which they have in the meantime fully automated GD&T decoding and Actual Value assessment in their PolyWorks™ Inspector software system for dimensional inspection. Bill is supported by a marketing and business development team, and by a group of GD&T Advisor associates. Training is available in both English and German.

About *Smart* GD&T™ *Technology*

Smart **GD&T** is a highly organized set of concepts, tools, rules and processes, developed by Multi Metrics, which convert GD&T from an uncertain art, into a precise symbolic language. *Smart* **GD&T** provides the means to rigorously "encode" and "decode" the function of each feature of a part, and in the process to

1. analyze and refine geometric functionality,
2. increase the fault tolerance of the design,
3. simplify tolerance stack-up analysis and guarantee assemblability of mating parts, and finally,
4. communicate design intent in absolutely unambiguous terms for scientific manufacturing and inspection process management.

Smart **GD&T** can be oriented toward the ASME Y14.5M 1994 or ISO 1101 standard, depending on user requirements, and turns each of them into a tool with which to manage imperfect geometry, perfectly. As mentioned above, *Smart* **GD&T** is the foundation for the GD&T engine in the dense point cloud metrology software system PolyWorks™, manufactured by our partner InnovMetric.

For more information, visit our Web Site:

www.multimetrics.com

or call us in California at

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We appreciate the opportunity to help you !

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