Understanding Model Based Definition MBD with an Expert in GD&T

Norm Crawford has an ASME GDTP Senior level certification, is an expert in MBD implementation and shares his experiences with DCS.

In this series of Model Based Definition (MBD) articles, Norm Crawford discusses MBD with us at DCS, and shares his experiences in both successes and failures in Model Based Definition.

From Norm Crawford - https://www.linkedin.com/in/normcrawford/

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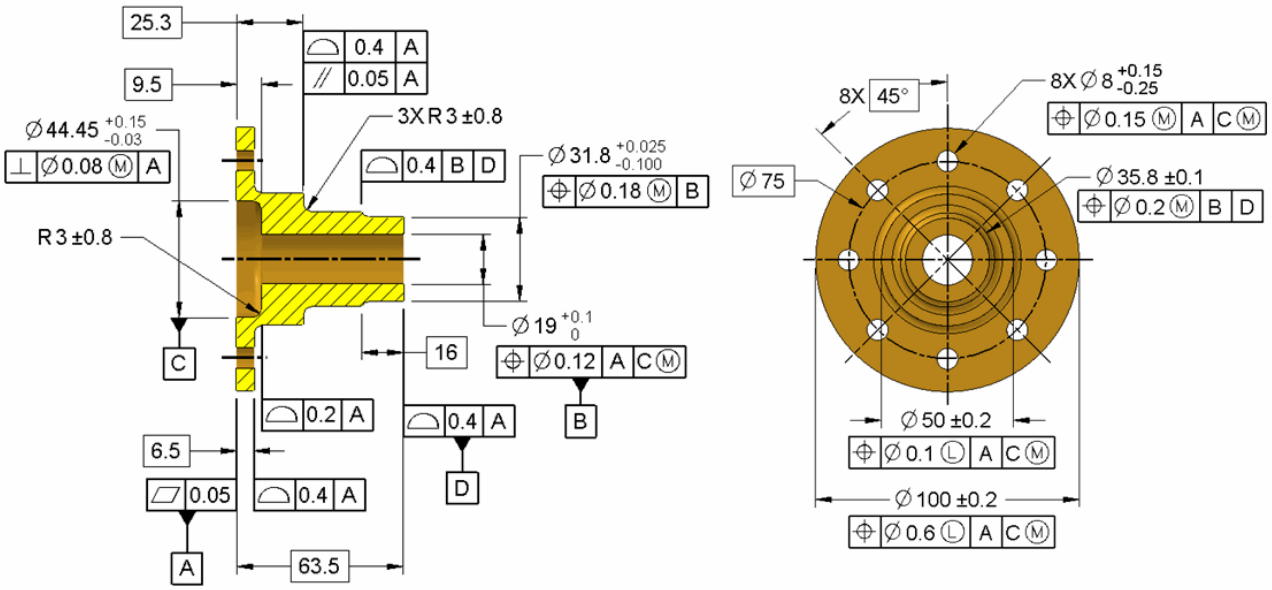
I have 40 years of experience and have worked in numerous industries. I started Geometric Dimensioning and Tolerancing (GD&T) [link to relevant definition] in aerospace working for Northrup Corporation. I've seen lots of successes and a lot of failures early in my career. I've especially seen a lot of successes, which is why I'm so passionate about GD&T.

At that time, I wasn't really involved in trying to be innovative with MBD. Nobody at the time used the term MBD. Instead we just used terms like Master Model or even just the model. I've been big on using the 3D CAD model way back when it was just wireframe or surface models for manufacturing and inspection, long before 3D CAD Solids came along.

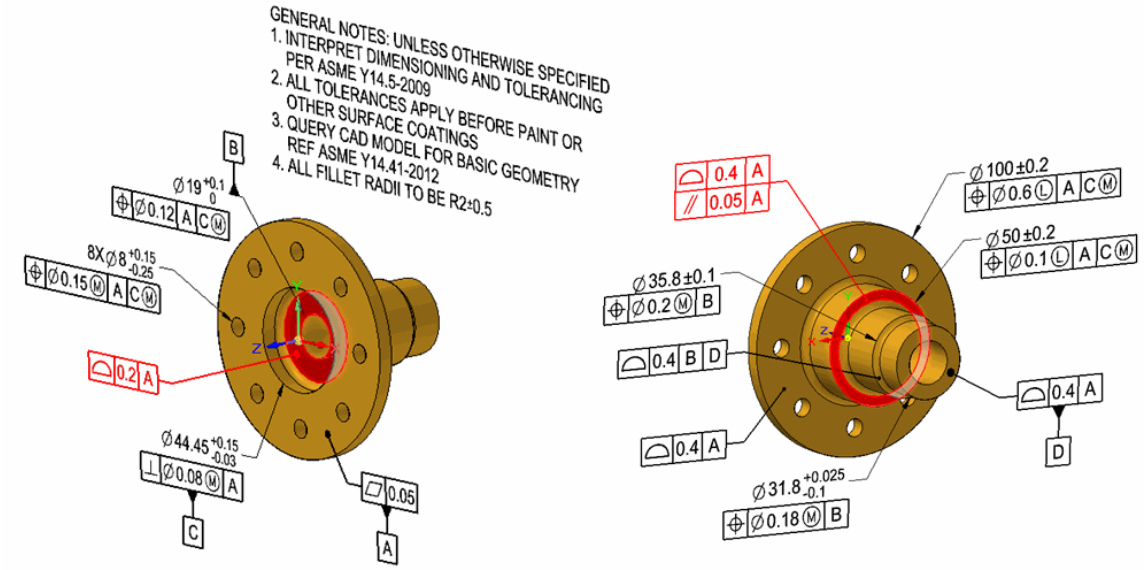
Throughout the years, I have worked both full time and in consulting positions with a number of industries such as: aerospace, custom products and automotive, before moving into the medical industry; where I did a lot and still do. In medical, the tolerancing is typically more critical due to quality needs. The tolerances are also much tighter, and cost is always an issue. So, you're constantly trying to open those tolerances with decent analysis and knowledge.

I've always promoted that the 3D model should always be complete and accurate. The limitations we used to have in the CAD systems have been mostly eliminated, and so the capability for model based definition has become that much better, and in turn, I've been following along ever since.

As an MBD specialist, I focus on helping companies implement MBD. I'm very fluent in NX and SOLIDWORKS when it comes to MBD. The key talent I bring in when it comes to implementing MBD is helping a client understand the technology they have, and whatever technology they need to bring in to make the MBD process actually work. Part of that talent means knowing what strengths and weaknesses to look for in different software applications. I do not need to be an expert at every CAD system or CMM package. I just need to help bring to the surface what capability they do and do not have that fits a company's needs when designing an MBD process. A company's MBD modeling process will change depending on their existing technology or otherwise desire to implement new technology. The MBD process is not simply the same as creating 2D drawings and going through a 2D drawing check cycle. Talking about mistakes people make, bringing MBD into a 2D drawing process just doesn't work. So, from a dimensional management perspective, I help design a MBD process, down to the specific applications that'll actually be used, to achieve something that does work and gain the real benefits of Model Based Definition.

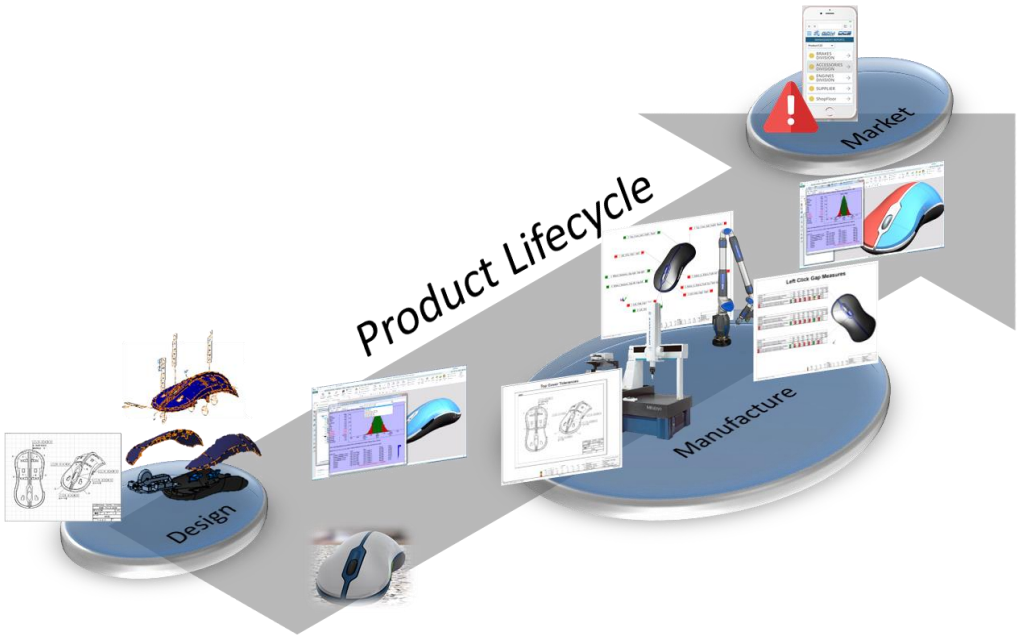


The image above shows a model in a traditional 2D drawing format using the 3D annotation. (Courtesy of Applied Geometrics, inc. https://gdandt.com/)



The more efficient MBD approach is shown above. Note that centerlines and BASIC dimensions are not used saving significant time and clutter. With either method, features attached to annotation highlight when the annotation is selected. (image courtesy of Applied Geometrics, Inc. https://gdandt.com/)

If MBD is not involved, I'll still get into improving the overall dimensional management. Dimensional management is not just about dimensioning parts nor is GD&T. It's about designing parts while dimensioning them and getting manufacturing and inspection to follow through on the dimensional requirements. This is because you can dimension parts syntactically perfect, but if manufacturing and inspection don't understand it or misinterpret it, then it's all for naught anyway. So, dimensional management has to do with, 'can that manufacturing process handle this or not?' and 'does the manufacturing group know?' The same is true for the inspection group. This allows me to help with dimensional management lifecycle throughout the product development lifecycle, not just simply dimensioning parts.



Start Sooner - Resolve Issues Cheaper

You know, one of the key things with dimensional management is to get the dimensioning going on early, much earlier than traditionally expected. I've always been a huge advocate of getting manufacturing and inspection involved in the dimensioning early on. When I say early on, I mean early in the design. When teaching GD&T, I always teach that GD&T, at its core, is not just about dimensioning parts, it is about designing parts. Often someone says,

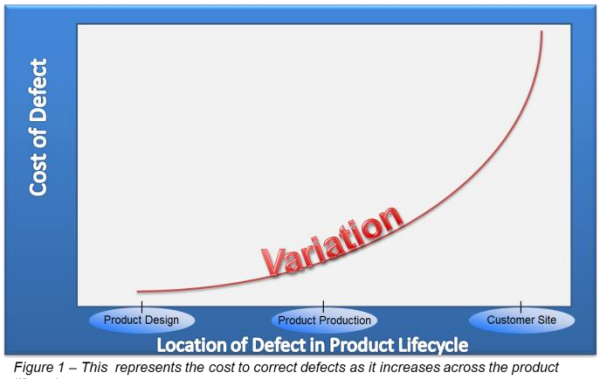


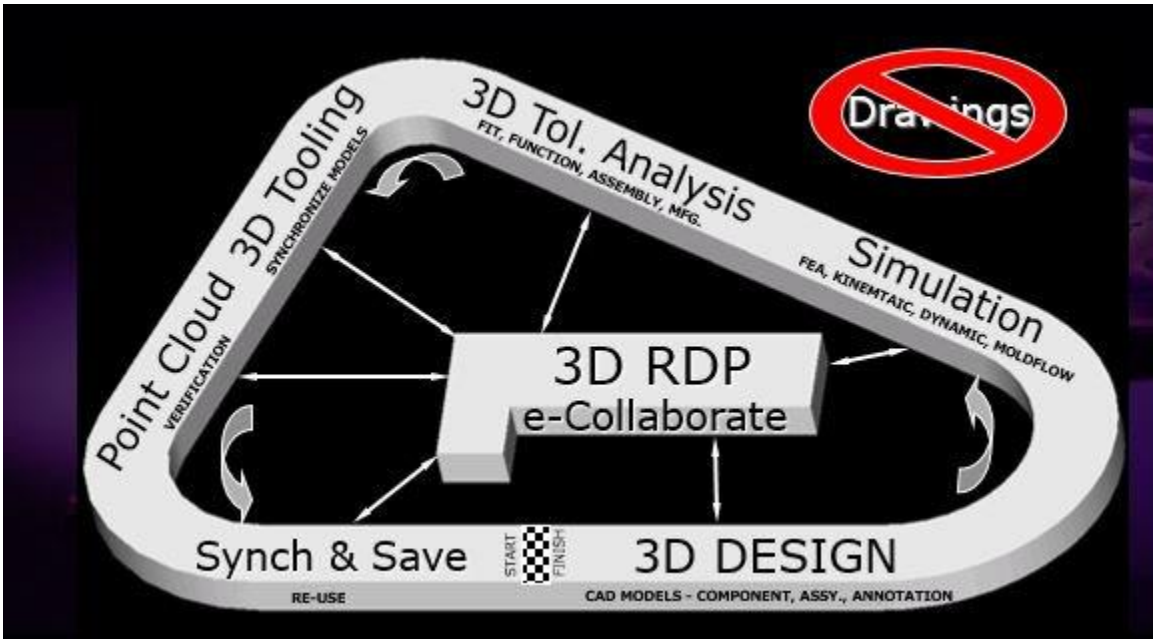
Figure 1 – This represents the cost to correct defects as it increases across the product lifecycle.

'I don't remember the GD&T because I've been doing the solid modeling and design for years, and usually we just have someone else do the 2D drawing.', I wonder and ask how in the world do you design the parts?

Their answer is usually,

'Well, I never use GD&T to design the part.'

Well, they should try it. Use the right tool for the right purpose. You can try and change a tire with a 3/8th inch socket wrench or you can get a power tool to get those lug nuts off. Often when companies like mine or I imagine DCS attempt to do tolerance analysis, we realize people did not think about how to dimension the part when they designed the part. So, the GD&T and whatever linear dimensioning that gets misused just gets on a 2D drawing or even in MBD form for the sake of 'dimensioning the part." The stuff just suddenly appears out of nowhere without thinking about how the part actually works and therefore how it needs to be inspected to verify a fit and functional part. So, analysts like myself, especially when doing 3D tolerance analysis, see where datum reference frames and other dimensions just don't work to meet true assembly and functional specifications. We see part definitions that just don't work. But if GD&T was used as a design tool then designs would be better, and when working with manufacturing and inspection, your ability to communicate those designs will go way smoother and faster as well.



Above is a generic Dimensional Management flow that highlights the key groups that can benefit from a well thought out Model Based Definition process. 3D Rapid Development (3D RDP) along with good electronic collaboration (MBE) is something Norm presented back in 2002.

It is a whole different mentality. Remember concurrent engineering in the 1980s? We're all still trying to do that. People say we want to get manufacturing involved early. So, they just start sending them solid models without any tolerance information, not even the datum features. If manufacturing can have a better understanding of the true tolerance requirements, the critical features, and have be involved as part of the design, proper GD&T can capture the collaboration between design and manufacturing earlier in the design process. Manufacturers can often come up with good design recommendations.

Manufacturing often has a lot of experience producing different kinds of parts and has made a lot of things work, in spite of bad CAD models and really bad drawings and so they offer a wealth of information with good design ideas. You can't explain a good design idea with just a solid model. You need the GD&T on there to have clear and concise communication. That also means of course that manufacturing needs to understand GD&T. For example, when you say I'm going to use this feature to stop four degrees of freedom by way of GD&T, a manufacturer needs to understand to sometimes make design change recommendations to achieve the necessary goal while perhaps reducing the cost. They can suggest;

"How about you use a feature like this or a combination of features like that to stop those four degrees of freedom." They can in turn communicate that suggestion with the

language of GD&T so everyone understands that recommendation to make final decisions, fast!

Manufacturing is wise whether it's an aluminum casting, a forging or injection molding. You know, all those kinds of parts, that can be manufactured different ways and manufacturers have a lot of experience in determining the best method to do what needs to be done. Now, that's not to say that engineers don't have that kind of knowledge too, because engineers know a lot of different methods as well, but engineers often have a different point of view than manufacturers, and it is important to include both during a design process to get the optimal outcome.

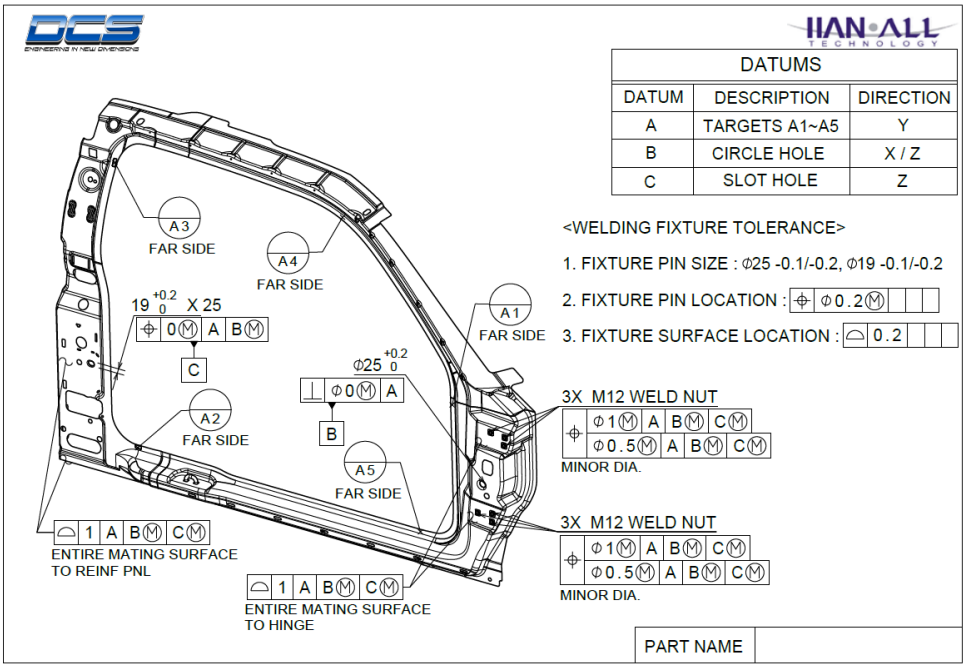
The key is proper dimensioning and GD&T is a standardized language to capture the collaboration and truly work concurrently. MBD just facilitates that communication because now the tolerances are clearly shown on a dynamic 3D model. It's just one of the many benefits of a well thought out MBD process. And again, concurrently developing the measurement plan with inspection also relies on proper dimensioning early in the program that is clearly communicated with GD&T. In today's technology, the inspection group can really benefit from the technology of Model Based Definition.

What is Model Based Definition MBD? Why Implement Model Based Definition?

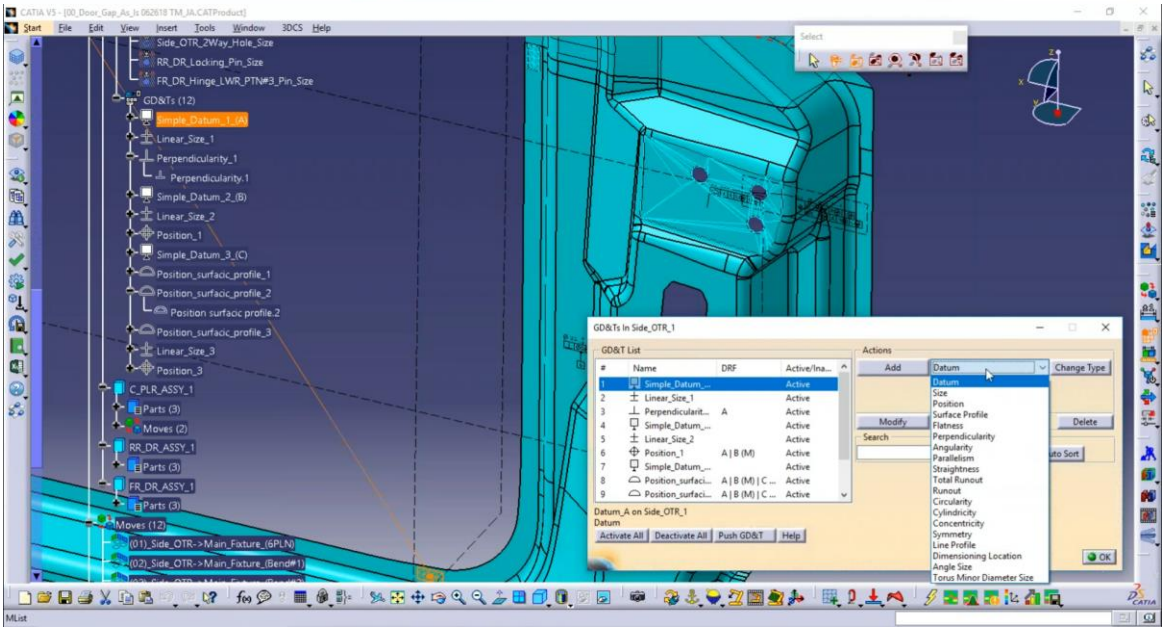
Model Based Definition – MBD - Defined

People want that one clear and concise definition.

Succinctly, MBD is a computerized design or CAD model that over the years has had lots of crazy terms. But essentially it is when the 3D solid model is the master and contains all the information necessary to produce a part that you would often find on a 2D drawing.



2D drawings are the traditional method of documenting part designs and GD&T



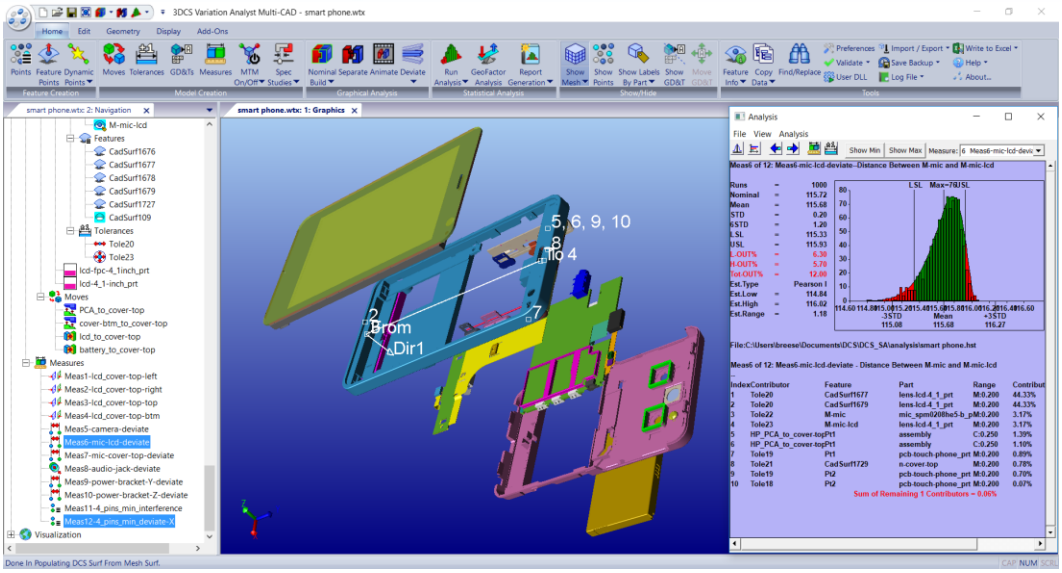
MBD places all of the design information on the CAD model, reducing or removing the need for 2D drawings

You can get into arguments that all the information to produce a part isn't on the 2d drawings, as there are also other documents incorporating the manufacturing process, suppliers, tooling, equipment, assembly lines and inspection plans, which gets more into Model Based Enterprise (MBE)

MBD is specifically around the piece part geometric Definition and the tolerances permitted to meet those Geometric Definitions.

Why Implement Model Based Definition MBD?

There is a big separation between MBD and MBE, which is a common mistake that causes confusion and cultural issues within a company. So, if we stick with MBD, it is simply way more efficient and reliable to produce the PMI or annotations on the CAD model than it is to transfer to a drawing format that often requires a different environment in the CAD system often requiring a different set of menus. So, MBD PMI is just faster and it is simply more clear; easier to visualize and understand.



Easier to understand when the information is in context and on a 3D representation

When reading blue prints – we have to go back to reading various section and detail views often scattered on multi-sheet drawings. Finding the details of any one feature is often unclear especially when sections can become very complex zig zag sections, sometimes defined on separate sheets and then sometimes rotated by some angle all in the intent to clarify what is going on with the section. With the technology in MBD far fewer section or detail views are needed and even if such views are created, they are just easier to visualize, understand and read in a dynamic 3D model. Each feature involved with such views is much more identifiable and on many CAD systems, the section detail can be echoed on and off for additional clarification.

Do companies understand why they are doing this or just following the trend?

Companies get a high level sense that there is some value. So, any company trying to implement MBD usually has some objectives in mind. Typically, they are looking for those efficiencies in part definition and collaboration during initial development. Many companies that have initiated MBD practices are reporting that annotating in 3D is faster than 2D. When they run pilot projects, they are looking to see if they can save man hours in producing their final part definition document.

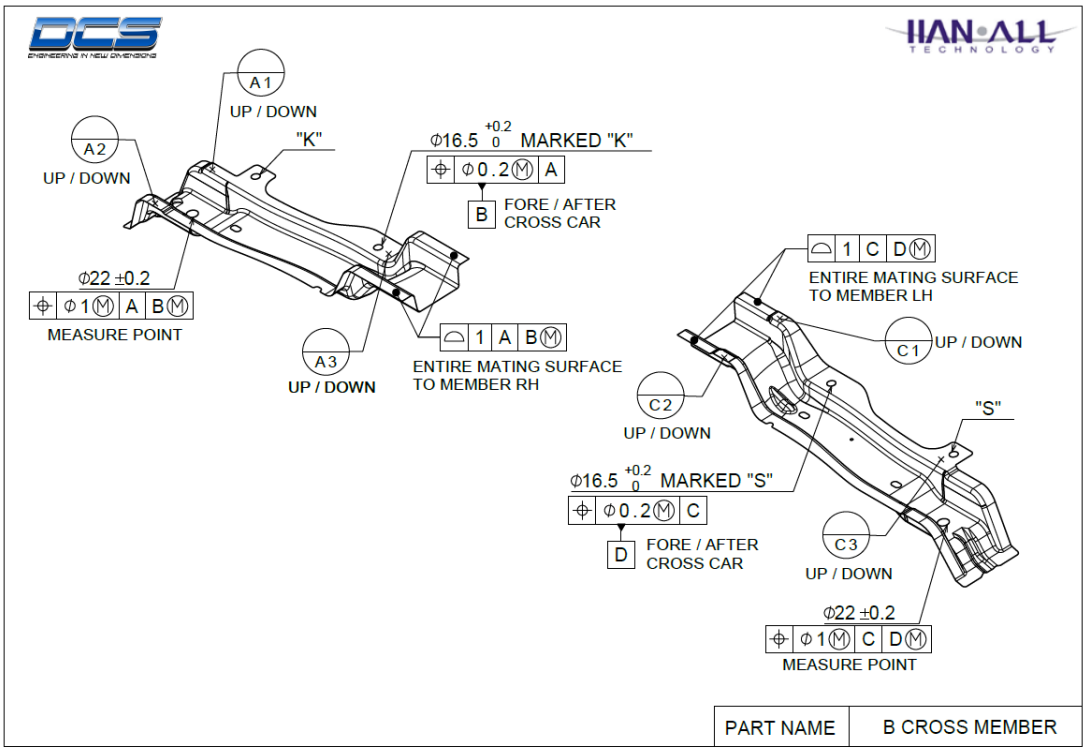
Most companies recognize they want that benefit, now, whether they get that benefit is another issue.

Using MBD to Improve Version Control

The 3D model is infinitely better at version control. Companies, for years and years, have struggled with how to keep their drawings directly associated to their models. Thus, enter the PDM systems (and now PKM, PLM) in order to keep that connectivity going on. However, 2D pdfs of CAD drawings get pulled down from the system and often all stand alone and unconnected once pulled down from their container.

If I'm working on a 3D model, in the attributes of most 3D models, the way a CAD system will produce an MBD, is the inbuilt revision control within the metadata on the model itself so that I can click on the model and know what version the model is. Whatever PMI is on that model is directly associated to that model. Whereas if I need to review a standalone 2D PDF or hard copy, I have to do all sorts of checking on whatever CAD model I 'think' is associated with that PDF before I can continue to work through whatever information I am looking for. This takes a lot of extra time and prone to many human errors. And the revision control box on the 2D drawing is not always up to date. So, that is very difficult to rely on. People say well that means you could be still working on revision B and there could be a revision C released out there. Yeah, that's true, but at least I know that I'm working with version B and the tolerances associated to version B.

If I am not told about or otherwise notified about version C, that's another issue. But at least I know what I have in my hands. In many PDM or other document control systems, the model can be at revision C and the drawing still at revision B until someone actually takes the extra time and effort to go into the separate drawing world of the CAD system, update the drawing, and then file it away at the new revision level. Many may say this is all handled automatically. Trust me. I have been involved with PDM, PLM, and PKM systems since before they were invented. Keeping separate, although associated, 2D drawings updated and at the proper revision levels along with the solid model remains a royal pain to keep synchronized. Don't believe me? Ask any supplier dealing with an OEM having drawings that do not match the model.



Is this up to date? How do I know?

It follows that the version will also be noted in reports and outputs, making downstream users aware of the version and related information. MBE can automate all of that, making it much cleaner rather than having to reference something in the text body of a report. And any such report can easily be associated to just the MBD CAD model and not deal with the additional linkage of an out of date drawing.

The revision control, it is much more fluid in MBD because users are only updating the CAD model. They are not continually updating both the CAD model and the associated drawings. And as I previously said, it is very common that the drawings are not continually updated. If you have a 2D drawing associated with a CAD model, and you're working on the CAD model taking it from revision C to revision D and even if you have a good system that associates the 2D drawing, when you open the 2D drawing you can have entire views missing. Detail dimensions sometimes disappear making it difficult to realize that they did. Granted some dimensions may change color or font notifying a user of a change, whatever that is when looking at only a 2D view. You get all kinds of notifications telling you that the drawing is out of date, but it is still out of date. Drawings simply do not get updated because it is an extra step to go into the drawing environment to update the drawing. I always hated having to do that.

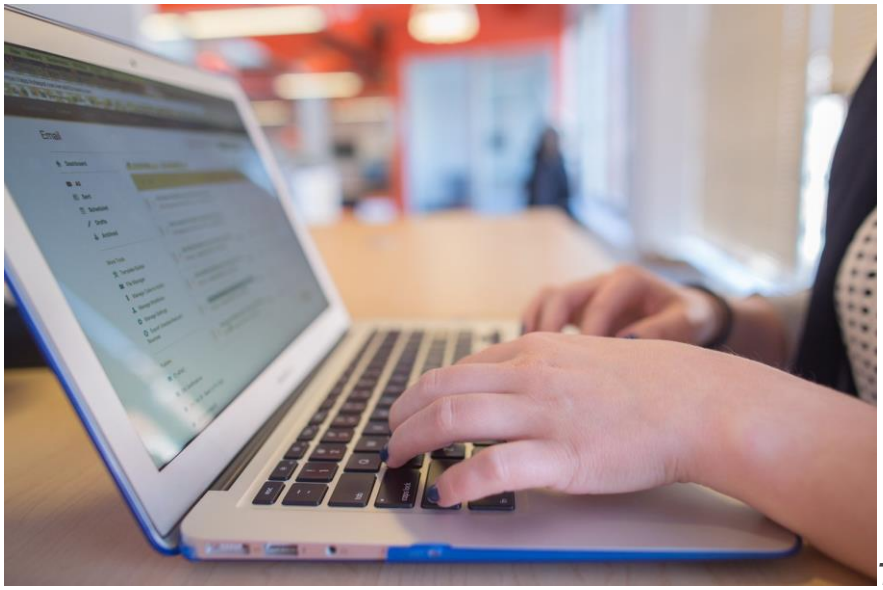
With MBD the 3D PMI may go out of date, and a good cad system will notify you the PMI is out of date, but it is right there in front of you on the model and so it can be quickly realized and instantly corrected on the fly. So, the information and PMI stay up to date much more easily in MBD. There are of course modeling techniques so that the PMI automatically stays up to date without any correction. The same is true for good associated drawings. But again, the user doesn't know if the dimensions correctly updated based on the modeling techniques or not until the user switches over to that 2D drawing environment. And does anybody think users are going to do that with every model change? No way! It's a hassle.

The Greatest Challenge and Common Mistakes in Implementing Model Based Definition

MBD offers a lot of value to those companies that implement it, however, it is often more difficult to implement than predicted from an unexpected source.

Technology has Advanced, Now People and Culture Need to Catch Up

That's what surprises me about MBD; the culture just stays locked in to the 2D drawing world when it comes to manufacturing information, the PMI. We say PMI, but that's something SDRC coined a long time ago in 1997 or so. That's what exists on 2D drawings too. We've been in the 3D cad world for a long time, especially solid modeling, then we break away from that and try to explain everything we did in 3D with 2D drawings. The limitations were there, you just couldn't annotate models in the 80's or early 90's, as at that time few CAD systems had the ability to annotate the model, so the culture just hangs on to the 2D drawings. Really any decent cad system today has 3d drawing capabilities. Now there are limitations on CAD systems, which is why someone like me comes along to try and help companies understand what the limitations are based on whatever tech they presently use or plan to use based on what they want to do with MBD.



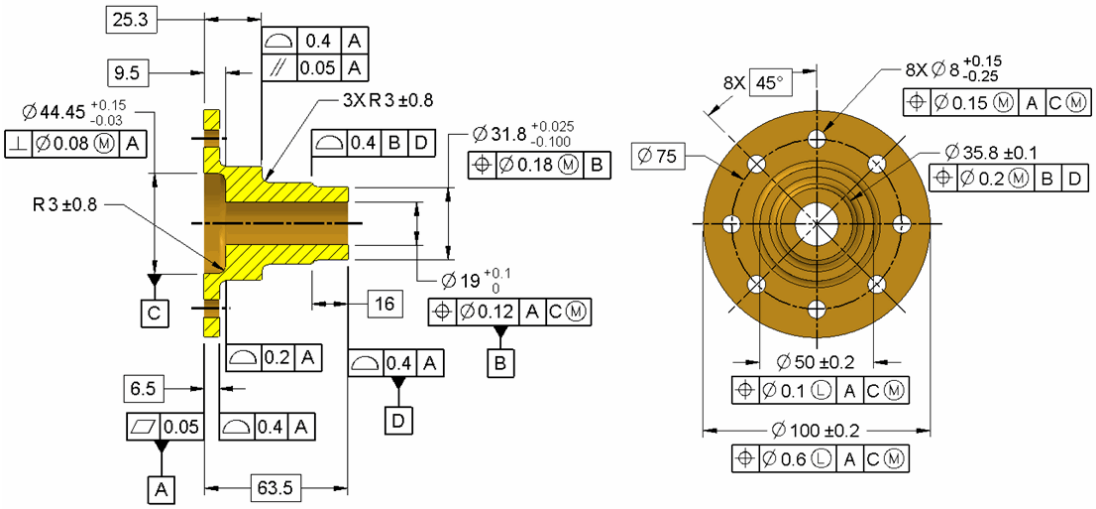
The largest barrier to MBD is between the keyboard and chair

What are common barriers or mistakes in implementing MBD?

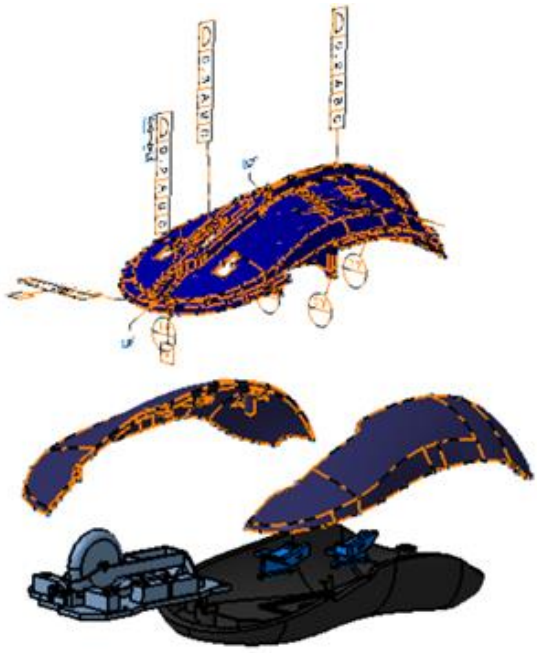
One of the greatest barriers is when companies expect that MBD is going to somehow automatically fix their dimensioning and tolerance practices. People often think that MBD will automatically make their GD&T compliant and applied correctly. First thing is, people need to understand GD&T, whether ASME or ISO standard, which are the two big ones, but you have to understand the GD&T for MBD to truly get the benefit.

Is it quicker to produce the final document? Yes, that's the low hanging fruit but…

But if the GD&T and dimensioning practices are still the same as seen on 2D drawings and people do not understand the GD&T, then you lose all the downstream benefits. It's almost not worth going through the cultural change and the roadblocks if you don't know GD&T. The real value just isn't there. You need to establish the foundation first.



People believe that a consultant who helps with MBD, or does the GD&T correctly, assume that the GD&T is specific to MBD. So what has to happen is the realization that the GD&T would be exactly the same regardless of MBD implementation, if the design or the definition is correct on a 2D drawing as on a 3D model. The myth is that MBD drives people to over use GD&T, which is just not correct. If you are going for the true benefits, they really are the downstream applications; CMM and Tolerance Analysis software that can utilize the PMI and annotations. These inputs make tolerance analysis and CMM programming easier by standardizing inputs and automating the transfer of that information from CAD system to integrated tolerance analysis or CMM control software.



That is true with 2D or 3D, for example doing 3D analysis by bringing in cad models then reading 2D drawings, but that will take a lot longer (and cost a lot more!), versus 3D definition. If the software can read the PMI off the 3D model and make the features off the PMI, even if it's not 100%, it'll improve efficiency by a far greater amount than copying from 2D drawings.

Even if I'm using a system that doesn't pull in those features, but if I can right click on a feature but can look into a 3d model I'm doing analysis on and get the GD&T, whatever GD&T or otherwise tolerance specifications are on a given surface, hole, slot tab or any key feature. I can do that instantly rather than hunt through 2D drawings for the section view or detail views on a multi-page drawing.

If I have to read 2D drawings on fairly sophisticated parts, analyses would take at least 4 times longer than if I have all the information on the CAD parts and that is regardless of whether it can be brought in automatically or not, the mere fact that I have a single place to access all the information about the model is a huge time savings. On top of that, there is the accuracy; I know the annotations that are on the 3D model belong to it. This as opposed to hunting down a pdf of the 2D drawings, and figuring out whether that drawing is up to date with the model.

What Kind of Challenges Have You Faced in Implementing MBD

The single biggest challenge is company culture, and I've done papers about that since 1999 for numerous publications.

New process? Business change? RUN! RUN! RUN!

But even present day, the biggest roadblock is company culture, not technology. Even when they say, "Yeah, let's do it," it gets very personal, very political very quickly and

people want to protect their own territory, whatever that is. So trying to get that culture to change is the most difficult part of implementing any form of MBD.

There are some things that will lead you into having more trouble with company culture. One of them is when someone doesn't know GD&T or when the company doesn't implement GD&T the way they should, you're going to have a much larger culture fight, because the culture that is fighting the adoption of MBD will blame MBD for having all the GD&T on their models and drawings. The other primary challenge is the CAD system, because the customer is going to have mistakes in their CAD. The customer will put the GD&T, the PMI, on incorrectly or have interfaces that drive mistakes, but the culture is going to look for those mistakes and blame it on MBD, and say, "See?! That wouldn't happen if we just use our 2D drawings."

So a company that self teaches themselves how to put the PMI on their model instead of working with a consultant to help them implement PMI into their process, who will work to stop having all these little mistakes that don't need to happen, because if you don't have mistakes the culture can't blame MBD, and that's the biggest source of error; knowing the limitations of the cad system and what it is capable of doing, and how you're going to produce the model and view it downstream. Getting that right in the beginning is paramount to success in MBD.

The reason behind this is because as soon as you have issues with the CAD system, as you can still have a lot of pilot error in the CAD system, and do not have a solid plan on how to view it downstream, instead deciding to do it later resulting in a clunky process, the company culture will jump all over those errors in order to squash a pilot program quickly.

If I know I'm going to have to fight the company culture, I start simple,

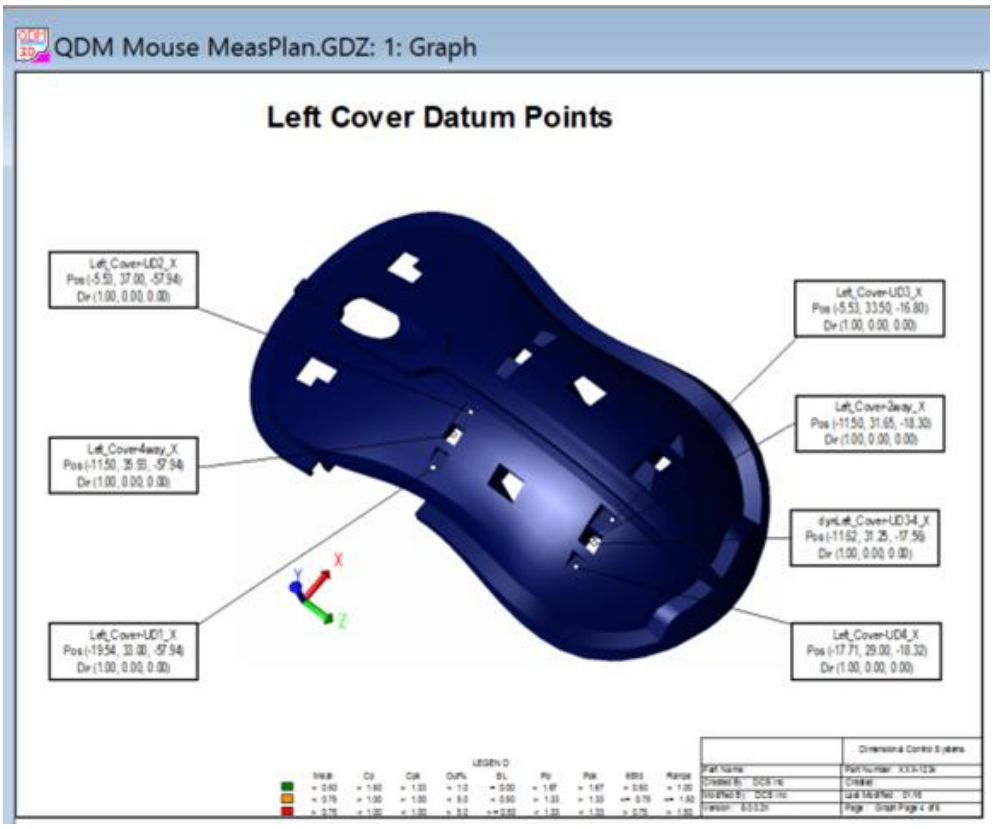
- "Do you know GD&T?"
- "Ok, what is your CAD system?"

- “Have you had any official training on how to put the PMI on the CAD model and do you know what the limitations are?”

  So the people putting the PMI on the model need to be trained. And then finally,

- “What is your plan for downstream users?”

  The people who need to read the model, how are they going to do that? With 3D pdf’s, 3D JT files and viewers, reports, whichever method, and how are downstream suppliers – how are they going to read the model information? Without laying out the process up front, you’ll keep running into issues that make MBD look bad that the company culture will jump on and try to use to squash it.



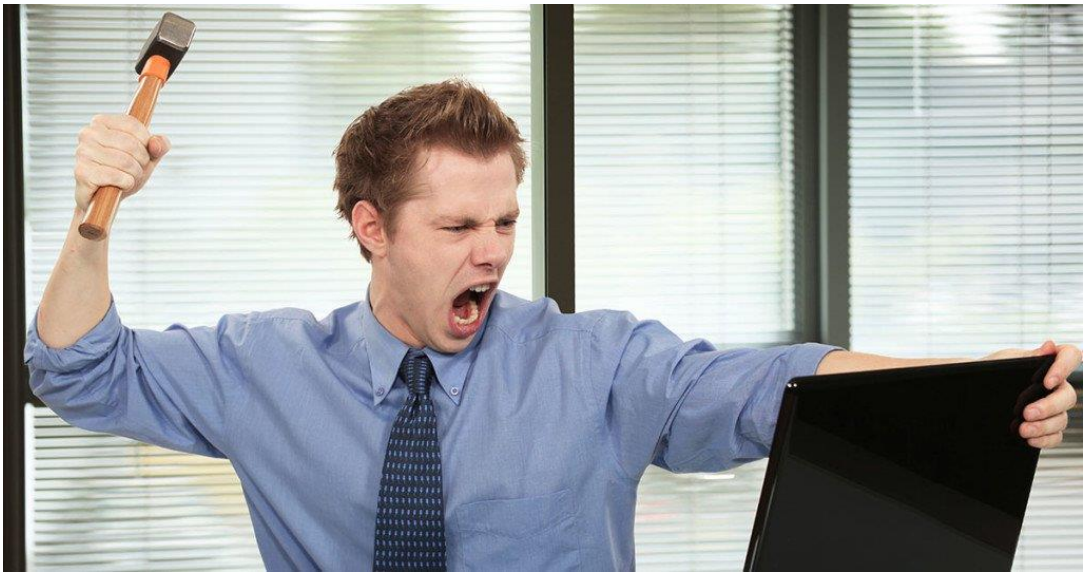
Adopting GD&T as Part of Model Based Definition

Model Based Definition MBD truly shines when used with GD&T, which can be a challenge of itself.

Do You Often Encounter a Stubbornness to Acknowledge the Need for Geometric Dimensioning & Tolerancing GD&T?

Companies acknowledge the need for GD&T, but the real issue, that people like myself encounter, is that the culture does not recognize the need to be formally trained in GD&T. Many companies believe that they can self-train, and I know of one example of someone who can read the standard and understand it and go right to testing and get certified without formal training, but that is the exception not the norm. Going back to the company culture with 15, 20, 30 years of experience and say they have been doing it a certain way for that long and do not want to hear they have been doing it wrong or could be doing it better.

The roadblock with GD&T is just that; tackling the traditional method of manufacturing that has taken root over years. Take the Department of Defense as an example, who mandated that their suppliers have to use GD&T, but failed to mandate how to use it or that it should be learned from a certified trainer. There was no true requirement to show training or experience, because it was dictated that they had to use it, right or wrong, and not how. This led to its failure to provide a positive impact on the process as a whole.

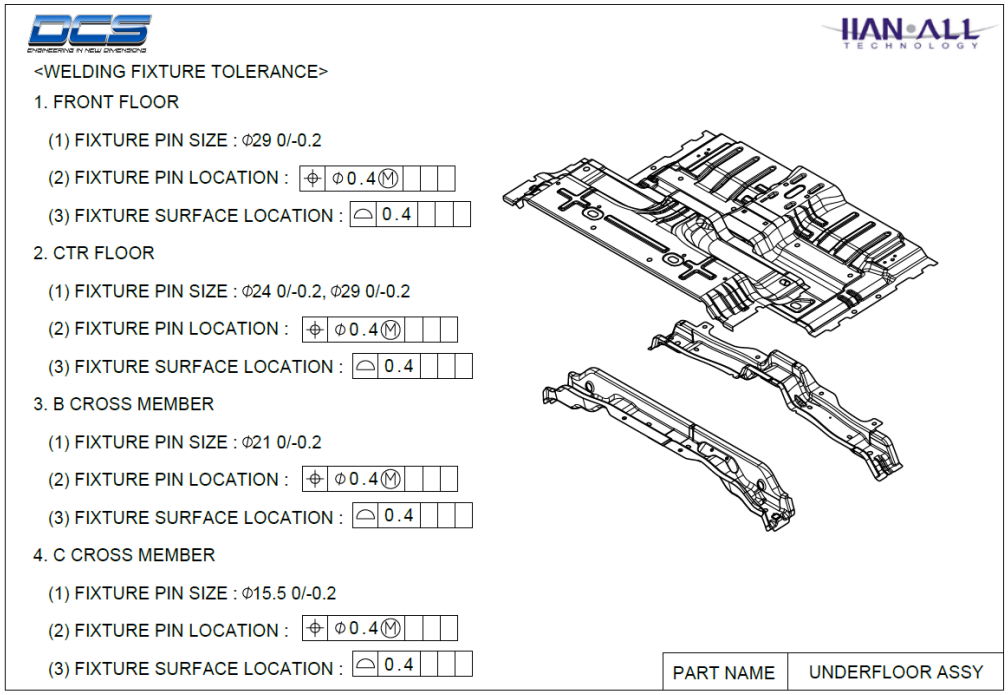


It is getting better, it continues to get better, but we still struggle with people who fail to understand the basics of GD&T. What is funny is that they understand that the tolerance analysis has to be done, but I can't do tolerance analysis with the way they have the model dimensioned, so now we're stuck.

They say, "Do the analysis on how we have it dimensioned, then do it with the way you think it should be done, and we'll compare it." So the results they have clearly show a much more favorable design. Yes, true, but that's sticking your head in the sand. With that mindset, we're just doing an analysis on the way things are dimensioned that having nothing to do with how they fit or function. So we're just checking the box, in your design excellence program, that we did an analysis, but it isn't a very accurate analysis. You know in tolerance analysis if the GD&T isn't right the analysis isn't right. Garbage in, garbage out, because tolerance analysis' primary output is optimized GD&T. If the GD&T doesn't make any sense for the part, then the optimized version isn't going to make sense either.

When someone asks me about coming in and helping, there are **two things I like to see first**:

1. Their 3D model
2. A sample of some of their drawings; such as 3 drawings on some of the more complex parts



This gives me an idea of what the current situation is. With this, I can determine if they need GD&T training, as some companies apply GD&T well but probably not at the level they could be. They may not be using some of the advanced capabilities of GD&T such as datum features or a datum system.

So, I can see they are pretty good with GD&T, syntactically you're correct, but the features you chose to constrain degree of freedom are not the ones that actually do it based on what I see in the 3D model. Those companies usually have a company culture that will listen, and where I've had greatest success, because they do know enough, they've had the training, they're tried to apply it, they do a pretty good job, but now they just need to get to the next level where it truly represents the fit and function of the parts.

For example, some companies that do a fairly good job on the GD&T, but it is often from a manufacturing or inspection-centric viewpoint, so that the GD&T, inspection wise, will give repeatable measurements, but what you're measuring isn't how the part fits into the assembly. Typically, that's the next step, when someone does a good job with the GD&T but from a very manufacturing or inspection-centric viewpoint, a guy like me comes in and says, 'you need to get into a product-centric viewpoint. Consider what is the product's fit and function? What is the product definition?' That can usually be brought along pretty well using GD&T.

That case is versus one where I open up a drawing and it is all linear dimensions, and I see a couple of tolerances decorated on the drawing along with datum symbols that do not make any sense. I'll say, 'look, unless you're willing to take formal GD&T training, whether through me or someone else, you need the training because if you're not open to that then there isn't much I can do to help.'

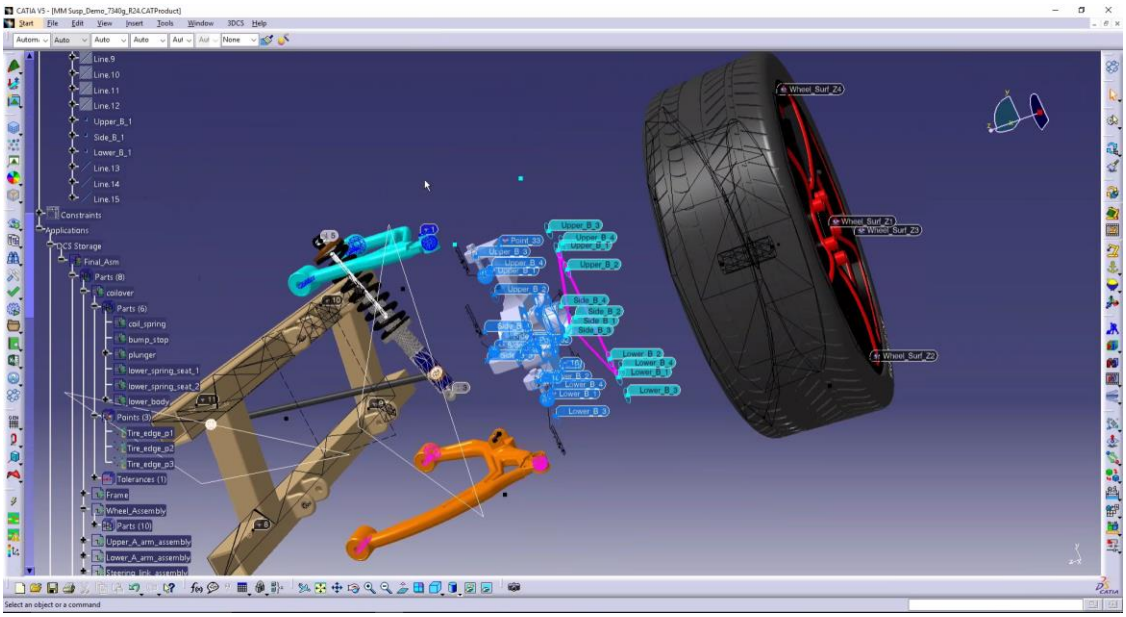
How I go about resolving these kinds of issues depends on why someone is approaching me. If a company needs help implementing MBD *and* they need formal GD&T training as well, I recommend they not use me for formal GD&T training as they will start calling that Norm's GD&T. They will tie it to MBD, and think it is MBD styled GD&T rather than the formal way of doing it. People get very personal about the entire process.

If they get trained by the same person as they deal day in and out on MBD implementation, they get worn out with Norm's way or the highway. It's not Norm Standard, its ASME (or ISO) standard, I'm just here to help them learn how to do it. Granted, on the fly GD&T instruction, you take the training anywhere you can get it, so I'm certainly going to help the company improve on its application of GD&T, but it is way easier to do that if they at least understand the basics from training. I partner with a number of companies that specialize in GD&T instruction and training, as they have specific instructors who offer training. Then I get to come in after the training classes have been completed and offer on-the-job training; actually applying the GD&T on their parts, as understanding the academic application and purpose can be a lot different from using it in practice.

At the end of the day, I can come in and help a company do a good 2D drawing, as I know how to do a good 2D drawing, I have a few thousand under my belt, I don't like

them, but I know how to do them and read them, and I can certainly help someone with their product definition, but if they want MBD I can do so much more to help them.

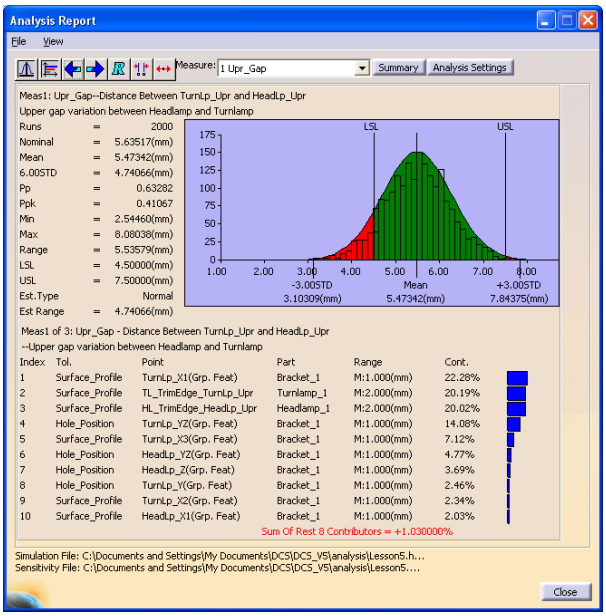
When we do 3D tolerance analysis or MBD, we're digging in deep and looking at every feature, every single degree of freedom. We're looking at details most people don't catch. So when we go to talk about degrees of freedom or the sequence of datum features or in a case where 3DCS has a Move called Pattern Move, that's very helpful, I am able to convey the advantages and disadvantages of various methods. For example, a lot of companies can't do that pattern move that 3DCS illustrates, and I can see that advantage instantly versus someone else who might think, 'what does that mean?' or 'what's the difference between me just doing these in order, first, that second and this third?'



There is a big difference between these methods and more importantly, the results. Knowledge of GD&T helps me improve communication between analysts and the client, so that if, for example, I'm a liason between DCS and a client, and DCS is talking to me about the GD&T and the constraints, and someone says for example, this datum callout needs to be BAC and not ABC, and let me tell you why. I can hear that and know whether that is right or wrong, and if wrong, I can explain why to the analyst and speak in the language of GD&T and your analyst can say, I don't know if I fully agree, but they'll understand the reason. However, what happens so often is that you need to call the client and say, 'we need to talk about how you have this dimensioned and toleranced.'

Well, you start talking GD&T, and when we say 'we think you need to do it this way,' and explain why, the client often doesn't understand because they don't understand the language. So not only do you burn up a lot of time, but the client often gets frustrated,

and doesn't like someone telling them how to tolerance their parts and becomes defensive. There is a need to tiptoe and be careful so that everyone understands. So a lack of GD&T understanding simply complicates the whole process, so that if one person speaks in plus or minus tolerancing and the other is speaking in GD&T, you're really not going to get anywhere, and that is regardless of whether its MBD or not.



So now you bring in MBD, and the beauty is, and one of the advantages of MBD, when you're trying to explain the GD&T to someone, and you can utilize a 3D model of the assembly or a single part in dynamic 3D with the annotation on there that highlights the features, and you can show the part in the context of the 3D assembly, and show it in a 3D view, they often understand much better what you are saying as opposed to pointing at section views on a 2D drawing. So the communication tool of MBD in the form an annotated 3D model can really bring GD&T experts and some that may not know GD&T very well, together. It makes that gap much smaller and everyone learns much faster.

Academic and Generational Influence on Model Based Definition Adoption

Is there an increase in GD&T or MBD in Academia, and is there any influence from the younger generation on MBD adoption

Have You Seen a Generational Gap in Adoption of MBD

I have seen new engineers, the new generation coming in, being more open minded, but have not seen it to the degree that I would expect. I do see young engineers often cling to the older people, and they don't have much choice as they don't have much reference yet, where if they were introduced to MBD more in college, adoption of MBD would improve greatly. Before, engineers didn't know how to do any solid modeling out of college, and a lot of them still cannot. More and more, new engineers come out of school more capable with CAD systems. Back in the day, we used to say 'don't let the engineers anywhere near the cad system,' and in some companies they probably still say that, but before we said that all the time. The engineers wouldn't even be allowed to have a login to the CAD system, as back in the day, they wouldn't be allowed to touch that thing.

So that's gotten better, and the reason it's gotten better is that colleges and high schools have started to bring in CAD systems and teach at least some CAD modeling. And with that, in regards to MBD, the gap between what I expected and what I see will get better. To answer, I see an improvement and more open mindedness to MBD, but I don't see that anywhere near the degree I would like to as there is still a lot of push back.

Have You Seen MBD in Academic Institutions?

I've seen some academic presentations. I'm never too thrilled with those, but at least their trying. Purdue is the one I'm most familiar with, and the University of North Carolina, when it comes to GD&T, has an engineering department that does an excellent job. There really aren't a lot of academic organizations getting on board with that.

CAD training is becoming more common in college courses, but GD&T and MBD aren't as common. The thing is, the question as a whole is much more complex. Why don't they have more GD&T or more MBD in college? Where do they put it in a college schedule. If you're going to get a bachelors in mechanical engineering, you already have 4 years and a pretty full set of academics to go through. Now more and more you have calculus in high school, so they've done even better job moving courses to high school so that you can get through it faster in college. There is a lot to get through, so where do you put 3D modeling, where do you put GD&T in there? I think they should spend more time on GD&T, but I just don't see a good plan to get mechanical engineers very good at GD&T while trying to study an engineering degree.

Back in the day, we had detailers. One of the MBD culture shocks was the fear that detailers and draftsmen would lose their jobs. What do you mean? We still need them to detail and finish the parts. Just with MBD, engineering, as now engineering does get into the CAD models, or you have someone as just your CAD modeler, or designer, they can start putting on the fundamental GD&T to capture design intent early on, then hand it to a detailer to complete your full final documented MBD model. You still need those people, because you can't tie up your best designers or engineers, well I don't think you should be tying up any engineer, with the complete model definition of MBD model or even a 2D drawing. So academic wise, I think they should be putting more GD&T and MBD into the technical certifications, for the people who get technically certified for modeling or dimensioning CAD parts.

Learn more about GD&T with DCS at https://www.3dcs.com/