Model-Based Definition (MBD)

How reusing rich 3D models helps you manage complexity, maximize customer value and move ahead of the pack

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About the author

Madhavi Ramesh is the founder of Punditas, a Product Intelligence company. Punditas is a Social Product Intelligence platform that unlocks the value of Enterprise Application Software through Structured and Contextual End-user feedback in a Visual environment. Punditas supports mission-critical business processes and provides the foundation for employee productivity and drives operational efficiency and profitability of organizations.

Madhavi has over 25 years of experience in the development of software solutions for research, engineering and manufacturing organizations worldwide. She has extensive experience in defining, developing and deploying products for use by aerospace, defense, automotive and heavy equipment companies. Until recently, she was the Product Management Director at PTC responsible for PTC's Model-Based Enterprise solution and the Visualization product line. Madhavi has a history of entrepreneurship. She was the co-founder and Chief Technologist of Visual Collaboration Technologies Inc. Ms. Ramesh earned her master's degree in Computer Science from University of Mysore, India and is Six Sigma certified.
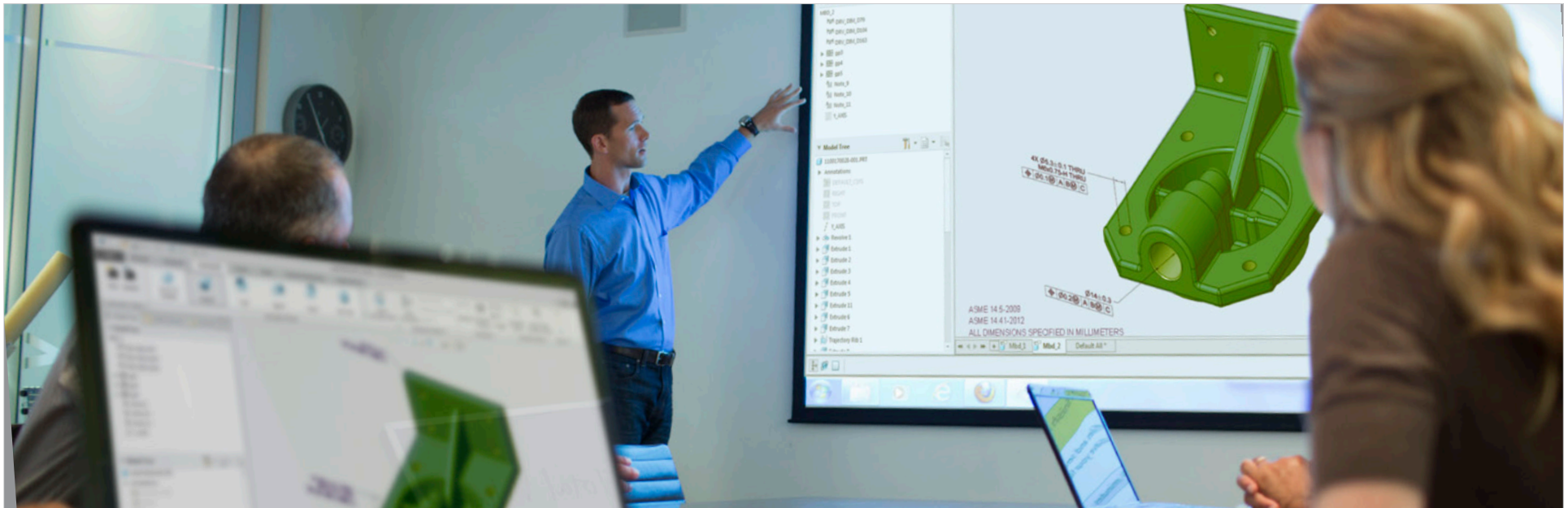
Is your organization ready?

Today's business environment is complex, dynamic and intricately inter-dependent and hence challenges the limits of traditional approaches. Product development is becoming ever-more complex and dynamic. Traditional engineering practices, processes, tools, and mindsets need to evolve not only to address this complexity but to capitalize on it.

Model-Based Definition is an emerging approach to engineering that holds great promise for addressing the increasing complexity of systems, while reducing the time, cost, and risk to develop and deliver these systems.

Model-Based Definition (MBD) is about creating rich "Technical Data Packages (TDP)" which includes 3D model and associated data elements that fully define the product in a manner that can be communicated and used effectively by all downstream customers without the need for 2D drawings. This TDP becomes the single source of truth that is exchanged with the downstream organizations such as quality, inspection, manufacturing, procurement and others to interrogate, analyze, build and inspect the product.

Model-Based Enterprise (MBE) in contrast is a fully integrated and collaborative environment that shares the validated and authorized MBD data across the enterprise that enables the realization of products from concept through sustainment.

What is Model-Based Definition (MBD)?

• MBD is ABOUT empowering all stakeholders within the organization to access rich Digital Product Definition not only **Just-In-Time** but also **Just-What-They-Need**

• MBD is ABOUT creating, organizing and managing a fully defined 3D Model that captures design intent and serves as the Master Product Definition for the extended Enterprise

• MBD is ABOUT creating TDP that encapsulates various facets of the design for use by manufacturing, inspection, service, marketing, suppliers and other downstream users.

What Model-Based Definition (MBD) is NOT!

• Model-Based Definition is NOT Paperless Engineering!

• Model-Based Definition is NOT just about passing "Models" from one domain or tool to another (i.e. Engineering, Design, Analysis, or from one Process Planning tool to another)
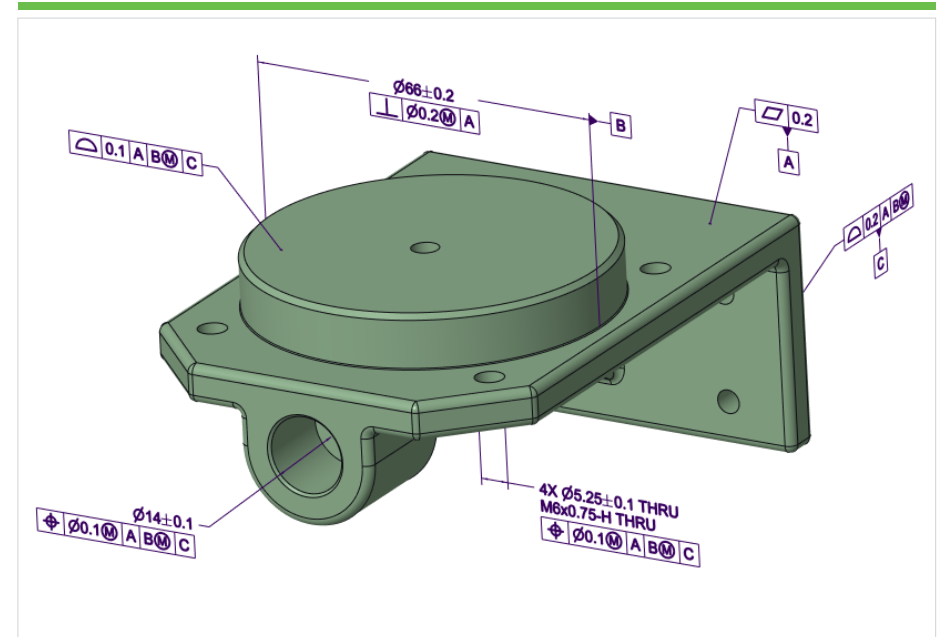
Accurate 3D geometry plus annotations are the foundation for MBD.

" At the MBD stage, record of authority shifts from Drawing to Annotated 3D model."

– Raphael Nascimento, Product Manager, PTC

What's the problem with 2D Drawings?

Historically, engineering processes have been centered around 2D drawings. Drawings are the master records and have been the primary product definition deliverables for innumerable years. Most of Engineering, Manufacturing and other downstream users have relied on a physical or a digital representation of 2D drawing to convey form & fit information that's required to drive manufacturing processes. With the advances in technology and the ongoing business challenges to shorten product development cycles, 2D drawings fall short in a number of ways.

2D Drawings fall short in the following areas:

- Explosive growth of mobile technologies and the future of affordable 3D technologies. 3D visualization is becoming mainstream.

- 2D drawings are generated from 3D models. Its time consuming to re-create drawings and is a wasted effort

- 2D drawings alone are not adequate to capture the innovations that engineers create. Hence, complete definition of the design must be stored in multiple data sources that are disconnected from the 2D drawing

- 2D drawings are not suitable for wide-spread collaboration across geographical barriers

- 2D drawings are more prone to interpretation errors and result in design non-conformances and data inaccuracies.

- Young engineers of today are not the same as the young engineers of yesterday. Creating 2D drawings for them is like a step backwards as they "think, see and play in 3D"
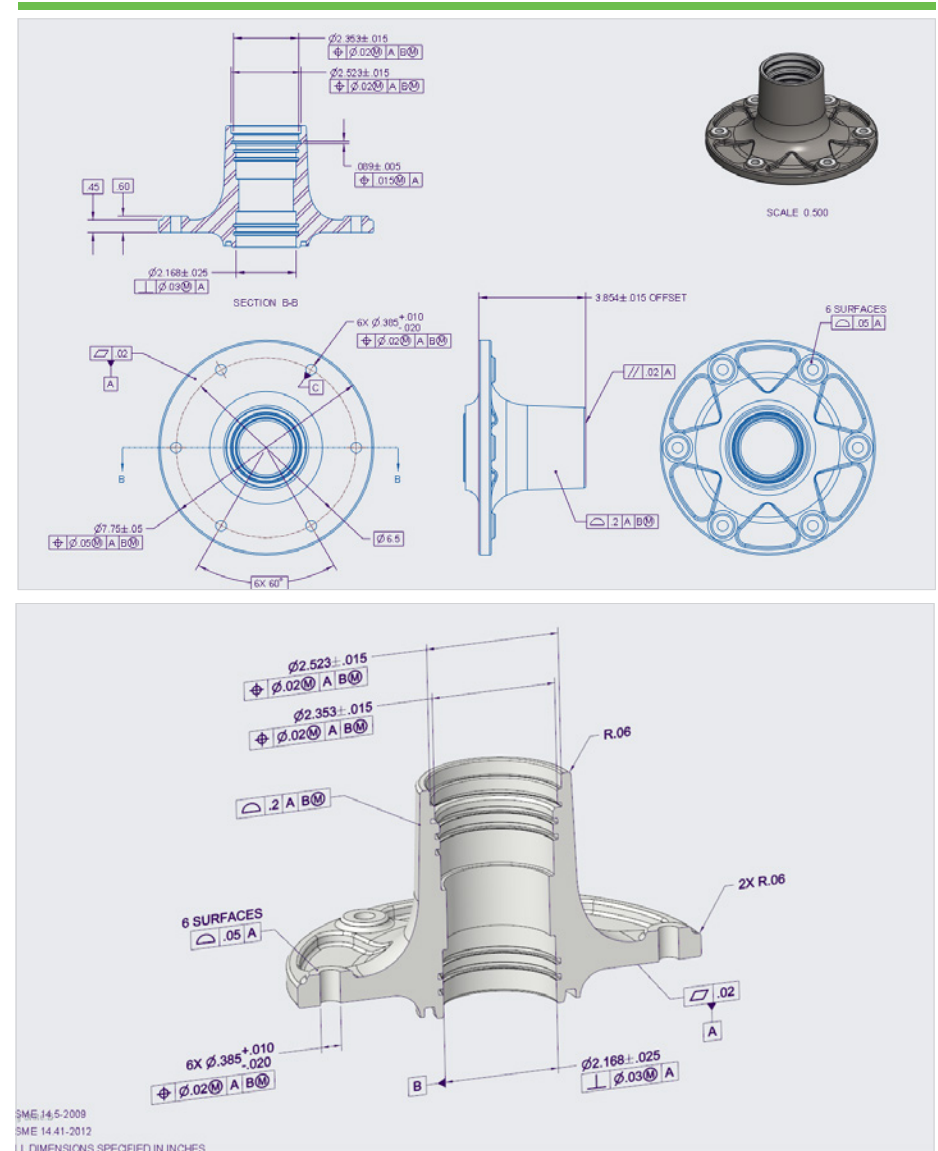
Annotated 3D models eliminate the interpretation issues of 2D drawings.

Key business drivers for Model-Based Definition/Enterprise (MBD/MBE)

A number of key market and technology forces are changing our fundamental approach to engineering methods, processes and tools. Some of the key trends include
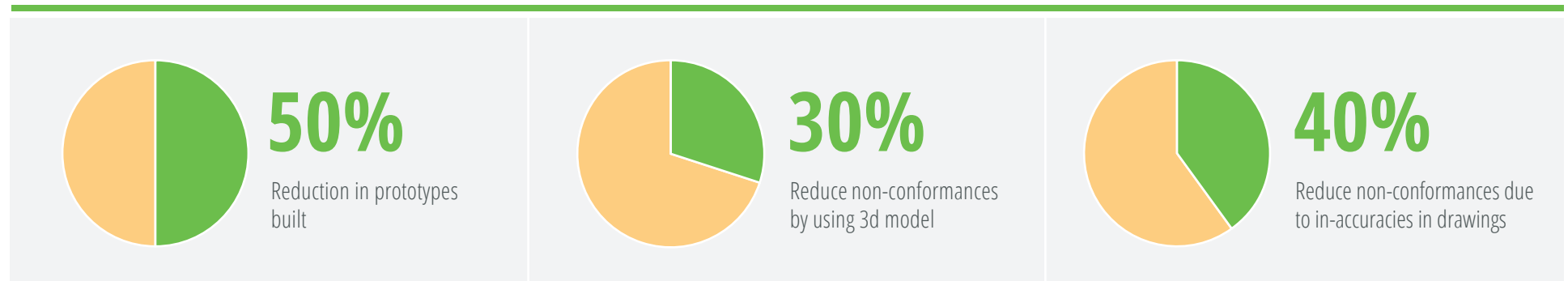
Key Trends

- Pervasive technology trends
  - Mobile, affordable 3D technology
- Economic trends
  - Cost pressures, Shrinking resources
- Regulatory trends
  - Encryption, Archival
- Cultural trends
  - Always connected, Democratization of knowledge, Social media
  - Revenue attractiveness

Market Drivers

- Needs & Demands
  - Reduced time to market, Process efficiencies, Revenue attractiveness
- Switching costs
  - Vendor/Tool consolidation
- Value chain actors
  - Design reuse, Product variants
- Competitors
  - New entrants, Low barriers to entry

Benefits

50% Reduction in prototypes built

30% Reduce non-conformances by using 3d model

40% Reduce non-conformances due to in-accuracies in drawings

Source: Aberdeen

Challenges and risks for Model-Based Definition/ Model-Based Enterprise

MBD and MBE are promising solutions to address increasing product and business complexities of today. As with any new approach, there are a number of barriers that hinder adoption. Some of these barriers include not only business & technology barriers but also cultural barriers.

Technology barriers

- Maturity of tools
- Long standing data exchange and data validation issues
- Standards and practices for long term storage and archival of data
- Risks and other unknowns associated with the introduction of new technologies

Cultural barriers

- Adoption to digital user interfaces as compared to pen and paper based methods
- Resistance to change and acceptance of the new way of working
- Personnel training on new software and user interfaces
- Misconception about the value drivers for MBE

Business related barriers

- Customer readiness and acceptance of 3D deliverables instead of traditional 2D drawings
- Supplier readiness
- Management buy-in
- ROI justification
- Investments required in tools, training and infrastructure
- Adjustments to existing business process

" It's no secret that Industry has long desired the MBD approach. However, I believe we're now at the point where Model-Based Definition is beginning to become practical."
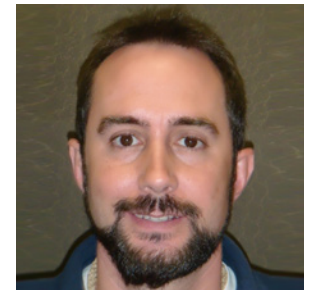
– Dustin Whitlow,
MBD Evangelist, FA&D

Business case for MBD

A trusted Model-Based Definition is a prerequisite for achieving Model-Based Enterprise. Although the concept of MBD has been around for years, it has certainly met its share of challenges along the way. Now, it seems that many of the hurdles that were once considered stumbling blocks for the adoption of MBD are quickly dissolving. With advances in technology and standards we are now at a point where MBD will increasingly become the preferred way of design in the immediate future. Five key business drivers for an MBD approach and its resultant MBE are:

• Faster – through Increasing Velocity of Product Realization

• Smarter – by Allowing Next Generation Automation

• Better – through Improving both Model and Product Quality

• Cheaper – by Enabling Cost-Effective Downstream Processes

• Safer – through Incorporating Innovative Ideas

Eliminate ambiguity while conveying Design Intent to downstream consumers. Increase Clarity

Humans respond well to 3D interactive visuals while digital automation requires explicit model definitions.

MBD enables a digital product realization enterprise with a 3D annotated master model which can be confidently reused by all key stakeholder within your enterprise. This allows various teams in Design, Engineering, Analysis, Manufacturing, Procurement, and Quality to access the same rich digital Product Definition that includes 3D interactive models, product & manufacturing information (PMI), and all its associated data. 3D MBD allows users to directly view, interrogate, analyze, inspect, and build as opposed to reading and interpreting 2D static drawings.

Model-Based Enterprise starts with a Trusted MBD
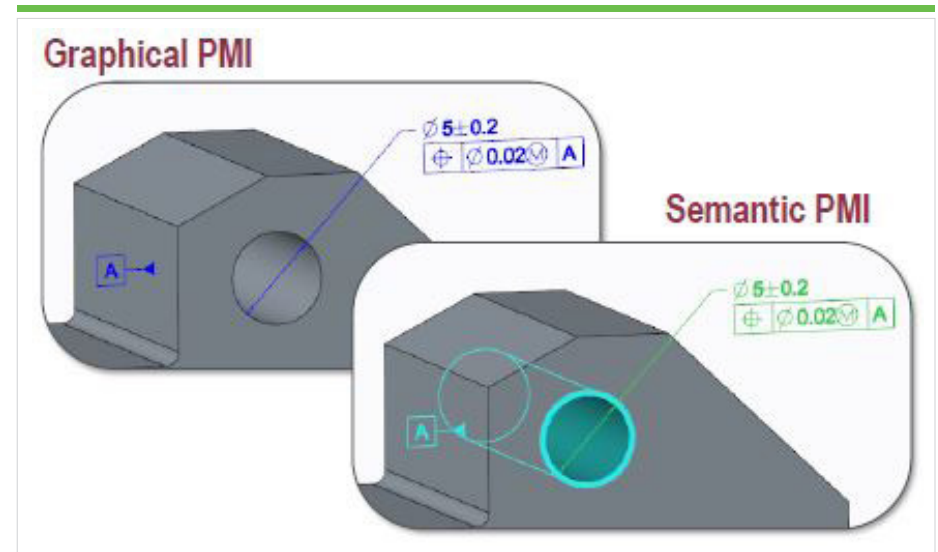
PMI embedded in 3D MBD model.

" Product MBD/Quality lives and dies by the PMI (Product Manufacturing Information) embedded in the 3D MBD model. Our MBE vision is to attain trusted product models, managed for confident reuse throughout our enterprise"
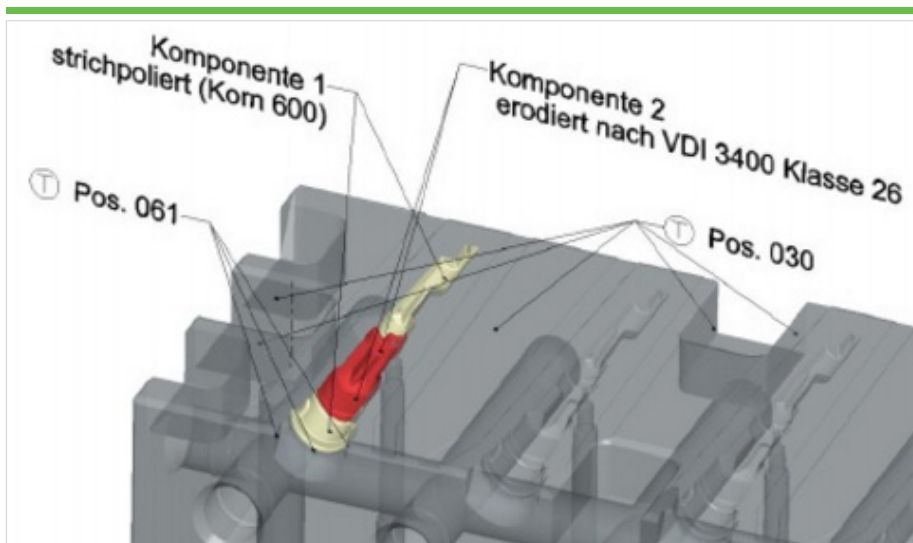
– Curtis Brown, Principal Mechanical Engineer, Honeywell FM&T

Simplify complexity. Eliminate inaccuracies, reduce errors

2D drawings are more prone to interpretation errors resulting in design non-conformances and data inaccuracies.

The MBD methodology reduces rework and errors introduced in the process. Take the example of communicating the split line in a complex plastic part. This line can be represented using 25 or more views on an A0 sheet. Even with these many views, it's extremely hard to imagine how this line "splits up" the model.

On the contrary, using the MBD methodology this complex plastic part with the split line can be easily represented using 2 colors one for each side of the model – for example red side of the model and green side of the model. This visual cue is extremely easy and straightforward to understand. The risk of mis-interpreting information, using the wrong manufacturing tool, etc. are minimized if not eliminated.

An annotated rich model can be re-used by measurement folks without having to bother the designer with questions about the tolerances to be measured, etc.

The more complex your drawings are the greater the value to be realized through MBD

Split lines in a complex plastic part.

" I'm a big fan of MBD. MBD is not a hype anymore, its boiling over and yes there are hurdles not roadblocks that we can overcome.
We have successfully carried out tests and trials and have been able to document the positive business outcomes and benefits. "

– Stephan Prosser, PLM Professional, P & G

Reduce costs. Improve product quality

What's on the 2D drawing is as important as what's left off the 2D drawing...

Downstream organizations stand to gain the most from MBD data. The ability for downstream users who "touch" a 2D drawing by opening a 3D model for that drawing allows them to interrogate the design more efficiently.

The current process is for the designer to front load the drawing with the information that explains his/her rationale and when it gets over to inspection, the inspection engineers are having to duplicate and recreate that same information and hence errors are introduced.
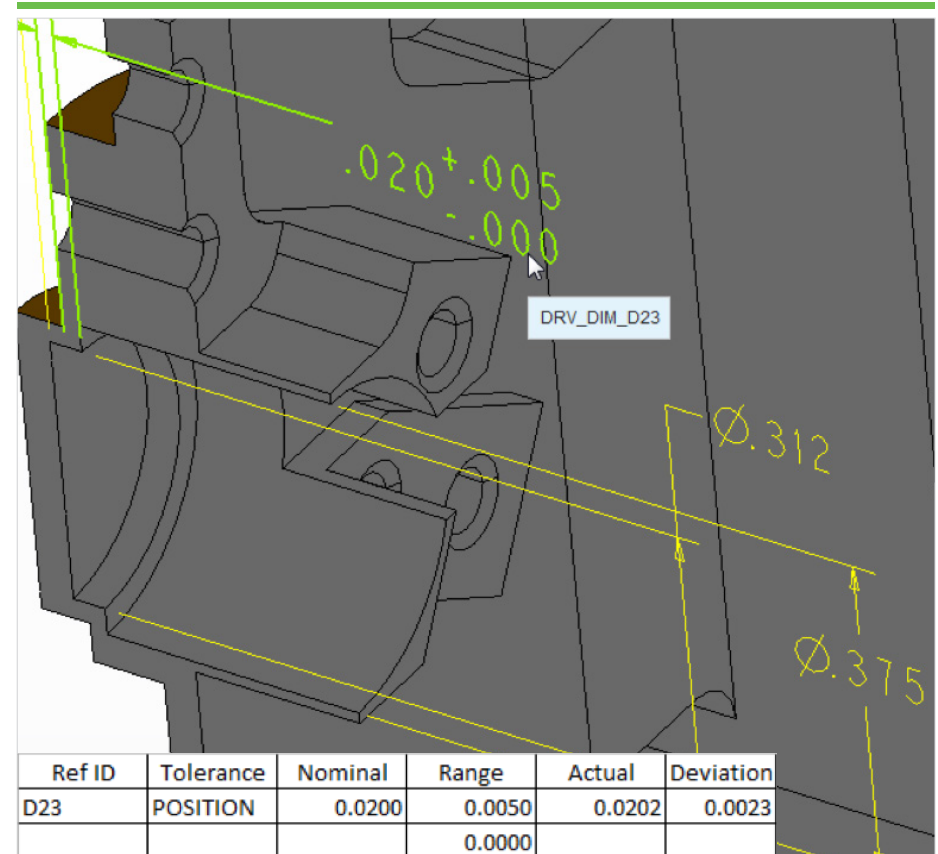
With MBD data, information contained in the 3D model can be automatically pulled into a First Article Inspection (FAI) or to program CMM machine. This reduces time and effort and hence costs.

Being able to spin, analyze and interrogate a 3D model for Form, Fit and Function is powerful

> " MBD is how design intent is developed, reviewed and analyzed and MBE is how the information is consumed. The key driver for going down the MBD path is Cost of Quality. Our pilot project has been a success and is promising. "
>
> – Chris McKee, Specialist Senior Engineering Support, Honeywell Aerospace

Ref ID	Tolerance	Nominal	Range	Actual	Deviation
D23	POSITION	0.0200	0.0050	0.0202	0.0023
			0.0000		

MBE Dimension Model with a Dimension Verification Sheet Result.

## Going Model-Based – Where do you start?

Moving to a Model centric approach is not a simple "switch" that can be turned On/Off. Small steps might involve optimizations to the existing processes but larger steps will require changes across organizational boundaries and a fundamental cultural change. A capability maturity model for realizing Model-Based Enterprises include different stages depending on the availability and "richness" of Technical Data Package. TDP encapsulates all product related data including Form, Fit & Function required by various stakeholders throughout the Product Lifecycle.

Drawing Centric	Model Centric	Model-Based Definition	Model-Based Enterprise
MATURITY LEVEL 0	MATURITY LEVEL 1	MATURITY LEVEL 2	MATURITY LEVEL 3
2D Drawing is the Master	**2D Drawing** is the Master	**3D Model** is the Master	**Fully Loaded 3D Model** is the Master
• 3D Model is not verified • 3D Model is not configuration controlled • 2D Drawings are the Master • 2D Drawings are primary deliverables for internal and external customers	• 3D Model is verified • 3D Model may be configuration controlled • 2D Drawings continues to be the authority	• Design intent captured in 3D annotated model • 3D Model validated and configuration controlled • Technical Data Package (TDP) generated from these 3D models used for limited downstream consumption	• Fully loaded, 3D Models with associated artifact completely define the Product • Configuration management, automatic creation of "rich" TDP's, archival procedures in place • Rich TDP's directly used by all downstream users

Try Creo Parametric today with a free 30 day trial!

The most robust, scalable 3D product design toolset with more power, flexibility, and speed to help you accelerate your entire product development process. Creo Parametric provides all the capabilities to support you and your company on the move to a Model-Based Definition approach. New functionality has been added in Creo 4.0 to make the process of adding and checking 3D annotations easier and faster than ever.

Start your trial today ›
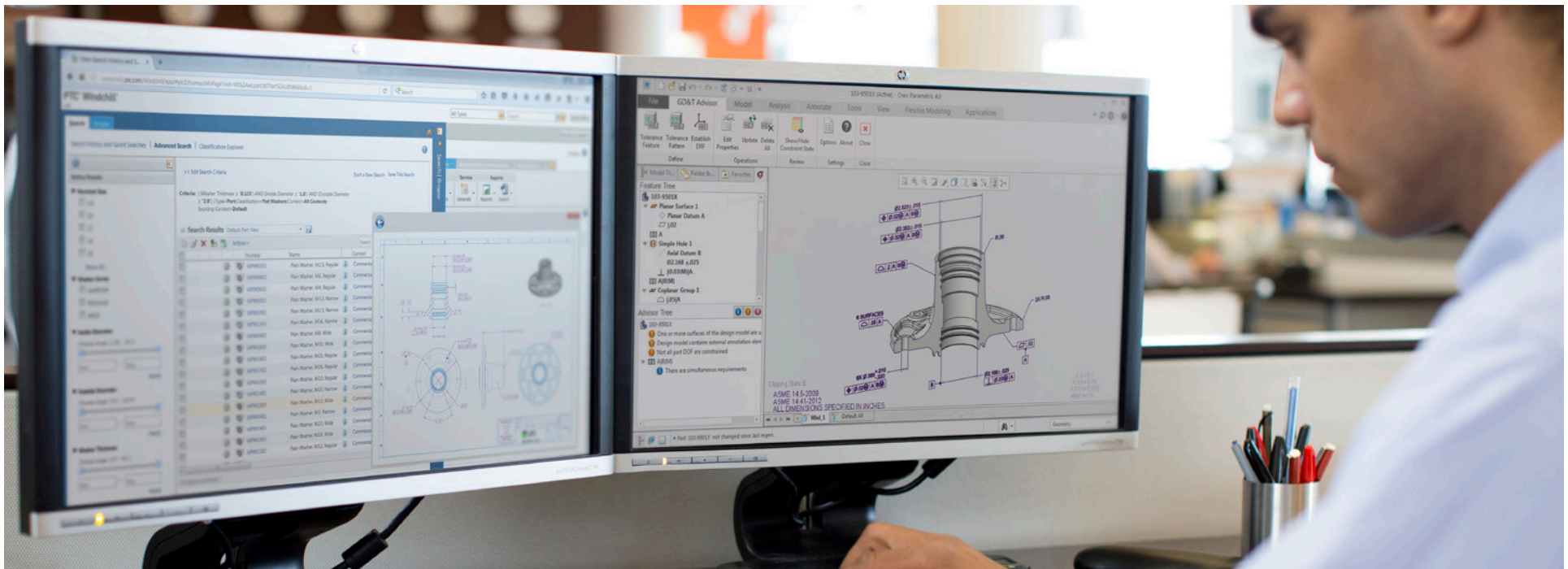
J8216–MBD–EN–0117

Visible Edge
1-888-VIS-EDGE (847-3343)
sales@visible-edge.com
www.visible-edge.com