ITC INFOTECH
Business-friendly Solutions

DxP Services
an ITC Infotech Brand
Business Performance. Delivered

Model Based Definition (MBD) Replacing Technical Drawings

Part 1

Management Summary

Model-Based Definition (MBD) is an approach to product lifecycle management (PLM) that involves using a 3D digital model, containing both geometrical and non-geometrical information, to fully define a product. This digital master model serves as a single source of truth throughout the entire product development process, replacing traditional 2D technical drawings. MBD enables better collaboration, data sharing, and streamlines processes across the entire product lifecycle, from design and engineering to manufacturing and quality control.

MBD offers numerous advantages for manufacturing companies compared to traditional 2D drawing-based processes. By using a single 3D digital model, MBD improves data accuracy and consistency, streamlining collaboration among teams involved in product development.

MBD enables faster time-to-market by easily incorporating design changes, reducing time spent on iterations. Cost reduction is another significant benefit, as companies can cut expenses associated with design, manufacturing, and quality control by eliminating the need for 2D drawings.

Furthermore, MBD simplifies automation and integration with digital tools, enhances data exchange, and improves overall efficiency. It provides better visualization, allowing for more informed decision-making and improved product quality. Lastly, MBD strengthens quality control and compliance, making it easier to meet regulatory requirements. This makes it easier for companies to meet quality control and regulatory requirements.

In conclusion, transitioning to Model-Based Definition can yield significant benefits for manufacturing companies. By improving data accuracy, enhancing collaboration, speeding up time-to-market, reducing costs, facilitating automation and integration, providing better visualization and simulation, and strengthening quality control and compliance, MBD is a valuable approach for modernizing and streamlining product lifecycle management processes.

Technical drawings precede Model Based Definition.

The history of technical drawings dates back centuries, with early examples of technical drawings being used to document and communicate engineering designs and manufacturing specifications. Over time, the use of technical drawings became more widespread, with 2D engineering drawings becoming the primary means of communication between design and manufacturing teams.

However, as technology advanced and the complexity of products increased, the limitations of 2D engineering drawings became apparent. 2D drawings can be difficult to interpret, and errors can easily occur due to misinterpretation or transcription errors. This can lead to delays, increased costs, and even safety issues.

What constitutes a technical drawing?

The information that constitutes a technical drawing includes various elements that are used to accurately represent the product, component, or system being designed. These elements may include:

Geometric dimensions and tolerances

Technical drawings typically include precise measurements of length, width, height, and other dimensions, as well as information on allowable variations in these dimensions.

Material specifications

Technical drawings may also specify the type of material to be used in the product, including its physical properties and other relevant information.

Assembly instructions

Technical drawings may provide instructions on how to assemble the product or component, including information on the order in which parts should be assembled and how they should be fastened together.

Manufacturing instructions

Technical drawings may also provide instructions on how to manufacture the product or component, including information on how to cut, shape, bend, or form materials.

Other important details

Technical drawings may include other details as needed, such as surface finish requirements, labeling instructions, and other relevant information. These elements are determined by the standards of ISO and DIN as well as by factory standards and guidelines.

Transitioning from 2D drawings to 3D models

In response to the limitations of technical drawings , Model-Based Definition (MBD) emerged as a new methodology for capturing and communicating product design and manufacturing requirements. MBD relies on 3D models to define and communicate all product requirements, including geometric dimensions and tolerances, material specifications, and other relevant information.

The use of 3D models as the authoritative source of product definition has numerous benefits, including increased accuracy, improved communication, faster time-to-market, and increased efficiency. MBD also supports greater automation in manufacturing processes, as 3D models can be directly used to program CNC machines and other manufacturing equipment.

As a result, MBD has become an increasingly important part of modern product development practices, with many companies adopting MBD as part of their broader PLM (Product Lifecycle Management) strategies. While technical drawings are still widely used in many industries, the emergence of MBD has provided a powerful new tool for improving product quality, reducing development time, and increasing efficiency throughout the entire product lifecycle.

> Nowadays, 3D models are indispensable and serve as the single source of truth.

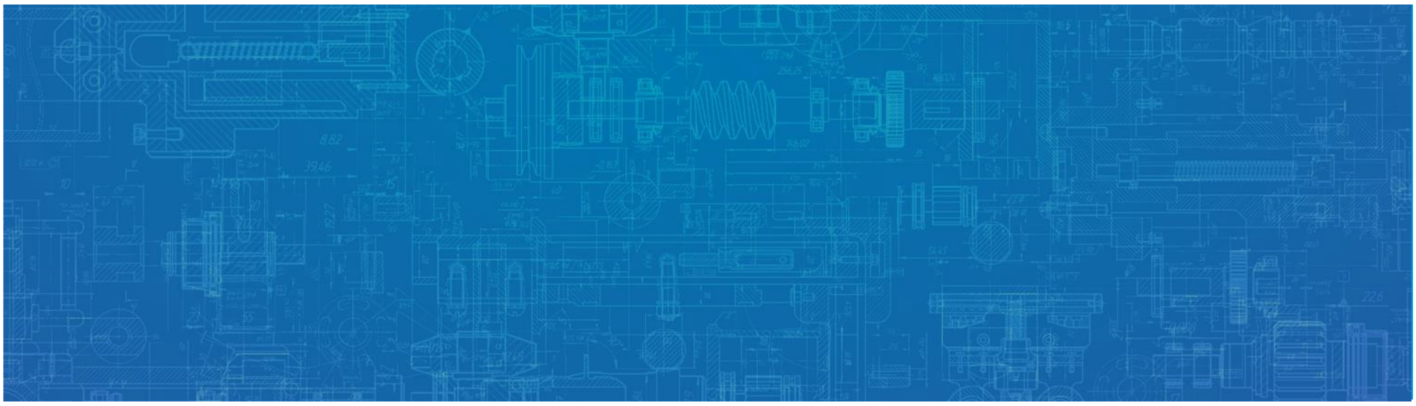
How is the handling of technical drawings mapped in everyday design?

Nowadays, high-fidelity 3D models of products are created instead of technical drawings. However, deriving technical drawings from 3D models is still widely used, as process chains have not yet fully transitioned to the holistic evaluation of models based on MBD.

This approach comes with several issues and potential drawbacks. In essence, the technical drawing serves as the legal and contractual foundation, even though it is merely a representation of the 3D model on a 2-dimensional plane.

One significant risk is that the 3D model and the derived drawing may no longer match while advancing in subsequent steps throughout the process chain. This may result in defective products leading to various scenarios such as mismatched ordering processes, unfeasible assembly, or unsatisfying load-bearing capacity in practical applications.

Additionally, the information workflow is disrupted, and thus, not consistent. Both entities, technical drawings and MBD-models, are mandatory for subsequent processes, and each stakeholder using product information must know which information is contained in which entity.



A significant challenge arises from increasingly complex geometries that are difficult or even impossible to describe in a 2D document. Many companies are already operating in a gray area in this regard, with the notice "*Missing dimensions see CAD model*" almost becoming the de facto standard in technical drawings.

As such, it is becoming increasingly important to establish more robust and efficient methods of documenting, structuring, and managing technical information to avoid the risks and challenges associated with the error-prone, double tracked approach.

> If both 3D and 2D information are necessary in the process, maintaining a consistent information flow is challenging and poses economic risks.

How does a 2D drawing compare to a 3D model?

Running a thought experiment, clearly reveals the limitations of a 2D drawing. Imagining a bolt or a stepped shaft on a 2D drawing is rather simple. Any technically savvy reader will instantly have a mental image of each of these examples.

However, imagining a motor block housing or a complex gearbox demonstrates the flipside. With more complex products conveying necessary information through a drawing becomes increasingly difficult, if not impossible. The effort is further amplified when dealing with emerging technologies such as generative design that have unconventional geometries. Figure 1 displays a 3D-CAD model of a part created using generative design. Trying to depict the geometry of a part created using generative design on a 2D-plane proves challenging. Thus, technical drawings inherently lack the capability of comprehensively presenting parts with generative geometries.

Even with a highly descriptive and complex drawing, not all employees are capable of interpreting the geometric information of a complex object through a drawing: simple 3D geometries tend to look overloaded when projected on a 2D-plane with annotations as geometric information. Reading and interpreting technical drawings requires technical expertise. Figure 2 displays a common shaft as a technical drawing on a 2D-plane.

Figure 1. 3D model picturing geometry of a part created using generative design.

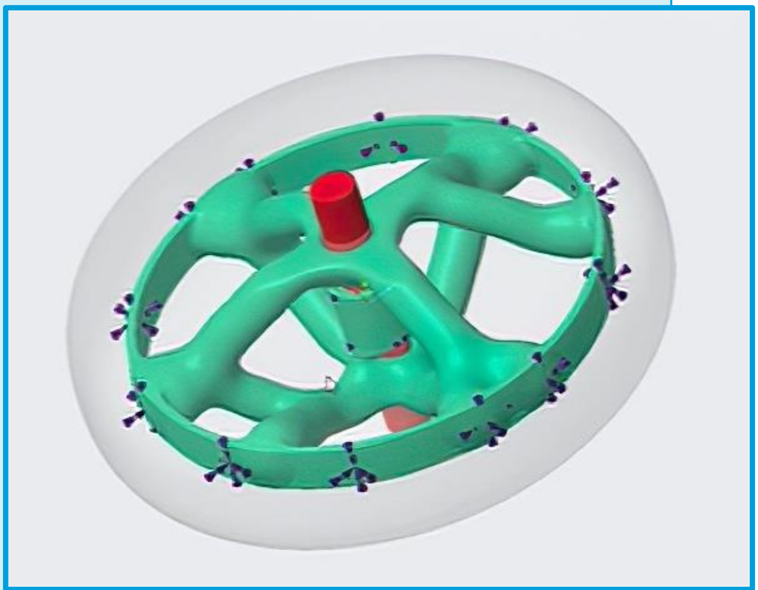
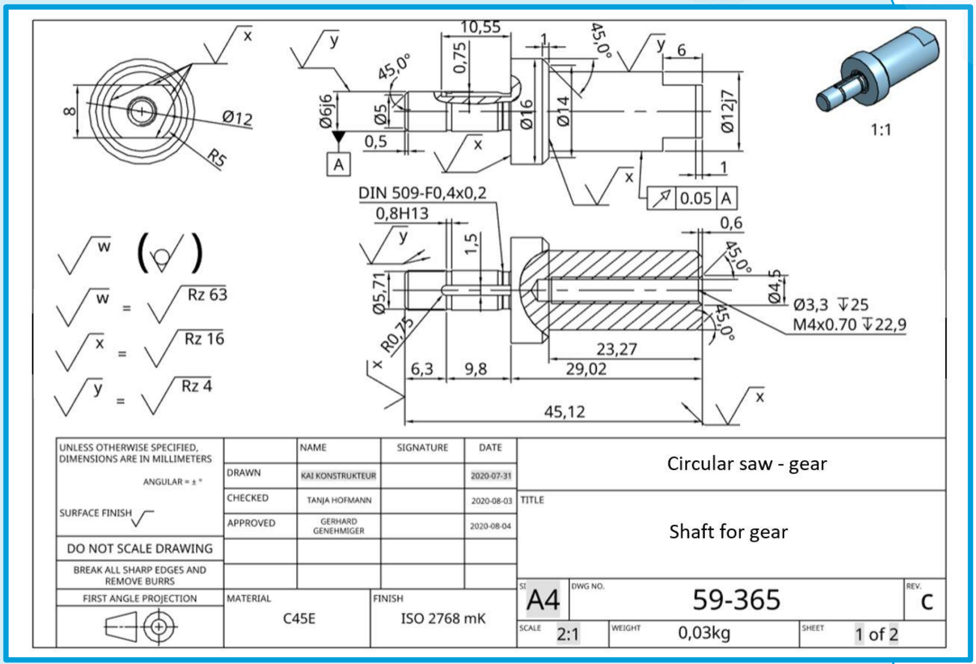


Figure 2. Shaft depicted in a technical drawing. The 2D presentation of a rather simple geometry impedes the readibility.



With a 3D model, every employee is capable of recognizing, filtering, highlighting, and visually examining geometric shapes.

What is Model Based Definition (MBD)?

MBD is a methodology that uses 3D models to capture and communicate product design and manufacturing requirements. Instead of relying on 2D engineering drawings as the primary means of communication, MBD uses 3D models to define and communicate all product requirements, such as geometric dimensions and tolerances, material specifications, and other relevant information. MBD can be implemented through various software tools, including CAD (Computer-Aided Design) software, simulation software, and other digital tools used in product development.

MBD can be considered as both a presentation and a representation of product information.

As a presentation, MBD uses 3D models to convey product information in a clear and comprehensive manner. The 3D models provide a visual representation of the product and its components, which can include details such as geometric dimensions and tolerances, material specifications, assembly instructions, and other relevant information. The 3D models can be viewed and manipulated from different angles and perspectives, providing an interactive and engaging way to communicate product information.

At the same time, MBD also serves as a representation of product information. The 3D models used in MBD are structured and organized in a way that reflects the product's design and manufacturing requirements. This includes the use of different views and perspectives to represent different aspects of the product, as well as the use of standardized symbols and conventions to represent specific features and requirements.

What does current CAD software offer in dealing with MBD?

Nowadays, MBD is supported by common CAD software. This makes it possible to define and manage information in a single entity. The 3D model becomes the master model.

Accordingly, all common and necessary information such as dimensions, tolerances, surface information, notes, or symbols, can be created in the 3D model and added to the geometric shapes; a master model is born.

In practice, this does not require any additional effort.

> The goal of MBD is to semantically link all information of a product with the geometry and thus create a master model.

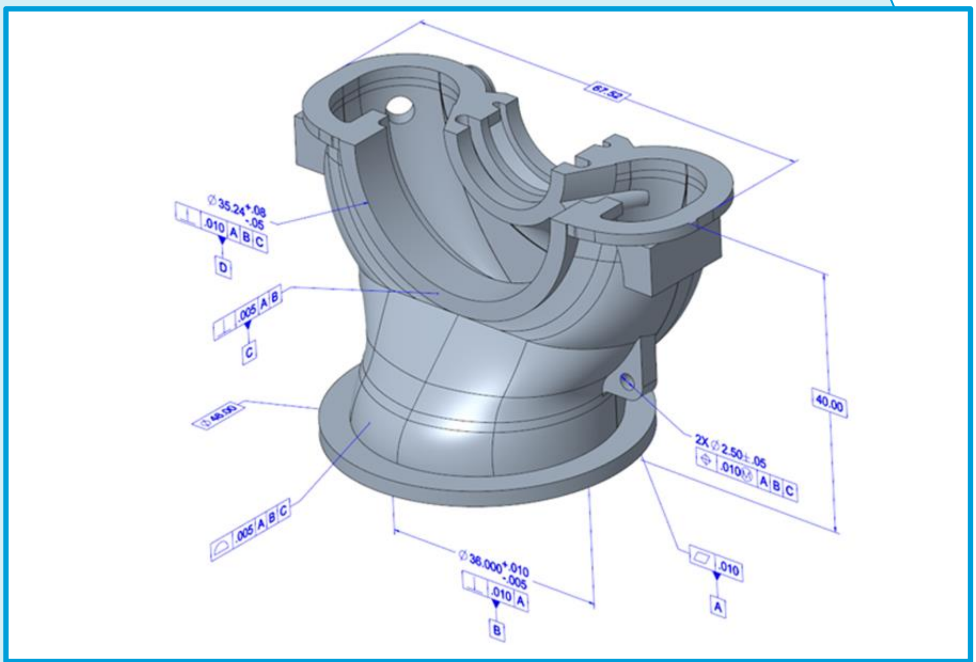


Figure 3. 3D model of a cast body enhanced with processing information using MBD.

How is product information exchanged within organizations? Where does product lifecycle management (PLM) complement MBD?

When considering the information flow within a company, there are multiple senders responsible for generating information and recipients who interpret and use information.

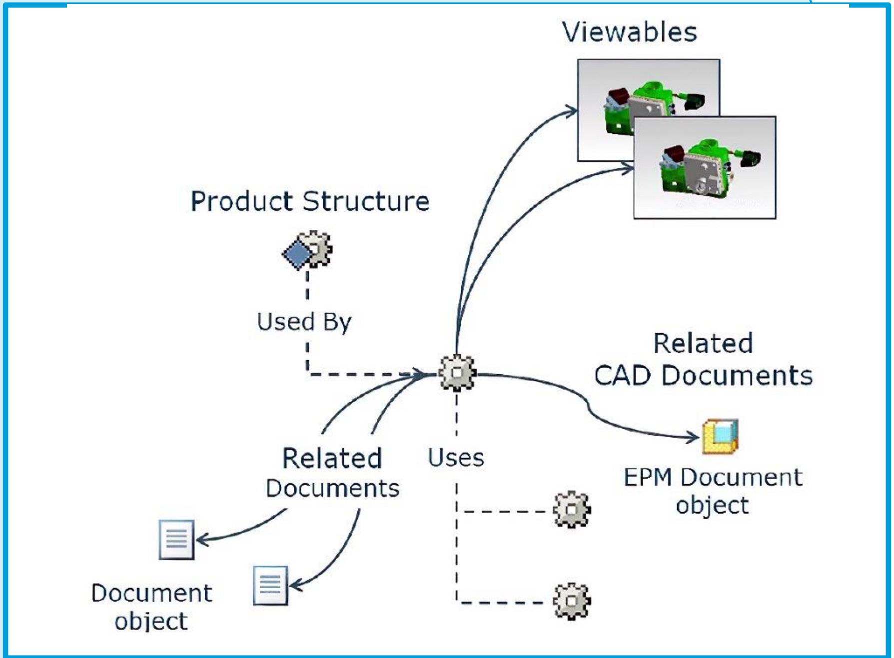
Ideally, a sender should know which information is intended for which recipient. In traditional 2D drawing, all information is provided for various potential recipients, which can lead to drawings becoming overcrowded with information that is not relevant for certain recipients.

Today, technical documents are centrally managed in PLM systems as the foundation for the information flow. Senders provide various information in databases and link them to a digital master of the object (also known as digital prototype, part, item, article, material in PLM systems). Recipients have access to the master and can view the linked documents.

A further step towards holistically operated MBD is linking a master model to the PLM system so that information from the 3D model becomes directly accessible within the PLM system e.g. information on post-processing, which can directly impact process control.

Moreover, it is now common practice to assign factory standards, manufacturing-related information, and more to 3D models through PLM structures, rather than creating them directly in the 3D model.

Figure 4. Master object (center) with links to CAD and other documents and objects.



MBD collects and provides information to recipients in a targeted manner via a PLM structure.

What impact does MBD have on design processes?

MBD has a significant impact on design processes as it revolutionizes the traditional approach of creating and managing product information. With MBD, the 3D-CAD model is to be understood as a master document and is passed through the design process. All relevant information is defined in the 3D-CAD model, including geometric information, tolerances, and other product definitions.

MBD introduces the concept of linking all information to semantic references, enabling more efficient and accurate design processes. This linkage ensures that all information is connected and can be accessed easily by anyone who needs it, reducing the likelihood of errors or misinterpretations.

Furthermore, MBD eliminates the need for 2D drawings, which can often be outdated and lead to discrepancies between the design and manufacturing processes. This streamlines the design process and reduces the likelihood of errors or misinterpretations.

Overall, MBD improves design processes by introducing a more efficient and accurate approach to creating and managing product information, which is linked to semantic references in the CAD model.

What challenges does the future hold for MBD?

One of the big challenges manufacturing companies face is the accurate representation of increasingly complex geometries, structures, and processes.

This raises the question of whether the classical technical drawing is still up to date, meets current technological standards, and is therefore capable of meeting future demands.

Many companies intend to explore new solutions and offer their customers as well as end-users, the benefits of technologies such as augmented reality or digital twins. All of these new technologies are based on digital master models. Therefore, MBD is the prerequisite for any enterprise competing in the market of tomorrow.

Manufacturing companies face various challenges, both desired and undesired.

These challenges cannot be addressed by continuing to work with 2D drawings. They demand the introduction of MBD.

What do companies need to consider when implementing MBD?

The introduction of MBD requires consideration of various factors. The most significant influencing factors include:

1 Legal considerations

Contractual and legal foundations must be established that define a 3D-CAD model as the master document.

2 Process adaptation:

Internal and external process structures must be adapted, and senders and recipients must be clearly defined.

3 PLM strategy:

The PLM landscape should be aligned with MBD requirements.

4 Hardware

An investment in hardware will be essential. All departments must be equipped with digital media.

5 MBD methodology

Existing CAD methodology must be adapted to meet the new MBD requirements.

Furthermore, an additional factor is frequently overlooked: the human factor. The introduction of MBD elicits various reactions from employees. Past implementations have shown that reactions have ranged from acceptance to entire rejection. Well-structured and coordinated measures are essential to successfully implement the shift from 2D drawings to master models based on MBD. Users must master new technologies, understand processes and guidelines, and ultimately embrace the changes.

There are solutions available for all the aforementioned factors. These solutions need to be customized to the specific challenges and relevant influencing factors, and the introduction needs to be planned with the involvement of the users.

Why should enterprises introduce MBD?

The benefits of MBD over a document-based 2D drawing engineering methodology are significant.

Here are a few of the key advantages:

Improved accuracy and reduced errors

MBD eliminates the potential for errors that can occur with 2D drawings, which may be misinterpreted or incorrectly transcribed. By using a 3D-CAD model as the authoritative source of product definition, MBD ensures that everyone in the development process is working with the same information, reducing the potential for errors.

Enhanced communication

MBD provides a common language and platform for all stakeholders in the product development process. This means that designers, engineers, and manufacturers can all work with the same model and have a shared understanding of product requirements. This helps to reduce communication barriers and misunderstandings, improving collaboration and overall product quality.

Faster time-to-market

By eliminating the need to create and manage 2D drawings, MBD can significantly reduce the time it takes to get a product to market. With MBD, designers and engineers can create and modify models more quickly, and manufacturers can use the models directly to program machines and other equipment, reducing the time needed for manual programming and other manual tasks.

Increased efficiency

MBD can help streamline product development processes by reducing the need for manual tasks and automating workflows. For example, the use of MBD can lead to faster design iterations, better collaboration between teams, and more efficient manufacturing processes.

In summary, classical 2-dimensional drawing can hardly or no longer meet future requirements.

The introduction of MBD is essential to obtain a comprehensive representation of components and assemblies. Furthermore, MBD serves as a pioneer for the transition towards a beneficial PLM infrastructure.

Taking full advantage of future technologies requires the introduction of MBD - MBD is indispensable.

Author Information

Christian Wein is a Principal Consultant at DxP Services within ITC Infotech. Christian Wein is an expert in CAD Methodology and CAD Data Management.

Christian.Wein@itcinfotech.com

Serdar Bulut is a Senior Consultant at DxP Services within ITC Infotech. Serdar Bulut is an expert in Variant Management and PLM Roadmapping.

Serdar.Bulut@itcinfotech.com

ABOUT DxP SERVICES

DxP Services is an ITC Infotech specialized business unit focused on the implementation and adoption of PTC's industry-leading Windchill®, Product Lifecycle Management (PLM) software, as well as Cloud and Windchill+® SaaS offerings. Created through the acquisition of PTC's PLM implementation services division, DxP Services is the largest global PTC PLM ecosystem. The combination of PTC Heritage and ITC Infotech Power means that DxP Services is uniquely positioned to help accelerate customers' digital transformation initiatives.

Our portfolio of services augments value at every step of Modern Industrial Evolution; covering Consulting, Implementation, Deployment, and Migration. DxP Services' team of PLM Professionals are trusted advisors to our Customers during their Digital Transformation.

https://www.itcinfotech.com/dxp-services/