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Embracing model-based definition design

Providing a single source of truth to enhance communication across project lifecycles

Siemens Digital Industries Software

Documentation is a critical part of the product design and development process. It defines the specifications to which components and assemblies must adhere, providing manufacturers with the information required to plan, build and optimize the world's next generation of products.

Replacing paper with a digital definition

Traditionally, organizations have relied on 2D paper-based documentation to provide this information, even though many of these organizations have been producing 3D designs in their engineering departments for years. Companies are shifting their focus, replacing paper-based drawings to embrace annotated 3D computer-aided design (CAD) models. These models help organizations realize an improved time-to-market, optimized efficiencies and greater product quality. As a result, many companies are leaving 2D paper-based drawings behind and are transitioning their documentation processes to use a model-based definition (MBD).

An MBD is a digital definition of a part or assembly using annotated models in which the models contain all the information required for procurement, manufacturing, service and other development activities. Compared to a 2D drawing, an MBD provides a single source of truth: the 3D model. The 3D model or assembly contains information, including the geometric details, annotations, bill-of-materials (BOM), surface information, metadata and other such digital data. This single source also provides engineers with a clear understanding and method for communicating throughout the design and development process, reducing the number of costly amendments across the project lifecycle and allowing engineers to complete their jobs efficiently.

Three key market trends accelerate the demand for MBDs:

- Need for increased clarity
- Removing redundancy
- Improved collaboration between manufacturers and suppliers

Need for increased clarity

The first is the need for increased clarity. Many organizations embrace an MBD because they want to eliminate downstream errors by removing ambiguity from their documentation and design processes. Avoiding these errors using traditional ways of working requires experienced engineers with the skills and knowledge to successfully interpret 2D drawings.

Engineers often sit side-by-side with 2D drawings printed out or on a shared screen in order to instill further confidence in the interpretation process. They may work between 2D drawings and CAD applications, manually entering information and making sourcing or production decisions based on potentially incorrect interpretations of 2D designs. Or they may simply make changes to 2D paper-based documents, not relying on any digital tools at all.

Such ways of working are not only highly inefficient, relying on manual entry of information, but also introduce the possibility for human error. These errors can translate into scrap, unnecessary waste, change orders and other disruptions to the design process.

Product complexity only adds to this problem. As designs become ever more complex, it can be difficult to adequately document design requirements on a paper drawing.

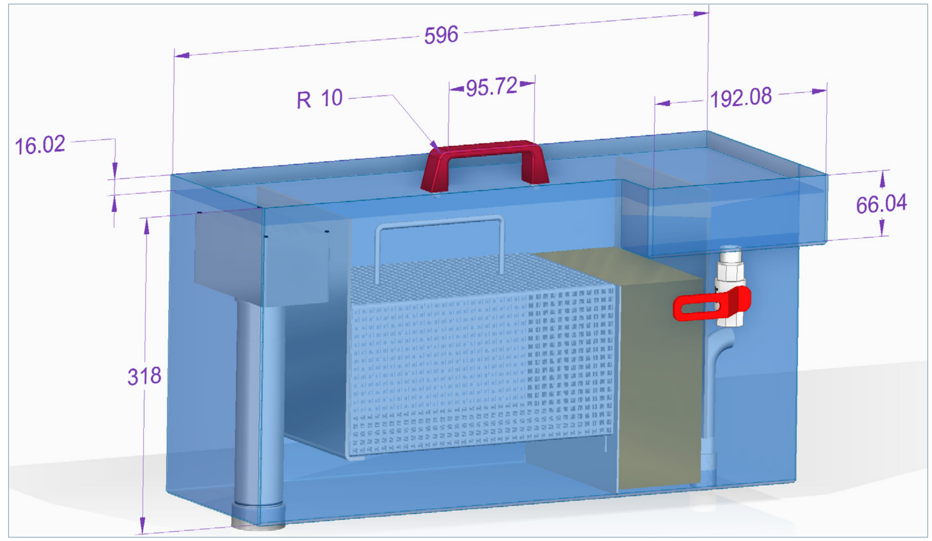
MBD workflows remove the potential for such errors. They can be machine-readable, which enables automation, removes the potential for human error, provides cost savings and accelerates the design process. They are also less ambiguous in human interpretation. That's why many organizations are moving towards MBD: Because it provides more clarity in design documentation, allowing engineers to seamlessly interpret, share and directly visualize and interrogate designs without any specialized skills and knowledge.

Removing redundancy

The second driving trend for MBD demand is the desire to streamline the development process. MBD workflows remove redundant tasks from the design process and increase engineering productivity. In particular, digital annotation is one area where engineers can realize massive time savings.

Using an MBD, the engineer no longer needs to manually define dimensions in a drawing because the 3D models already contain this information. In fact, the MBD defines the spatial location of every piece of geometry for the design. Moving to an MBD approach also allows engineers to add annotations directly onto 3D models, which means engineers no longer have to recreate annotated 2D CAD drawings. As a result, many engineers now regard the creation of fully dimensioned 2D drawings as a redundant process.

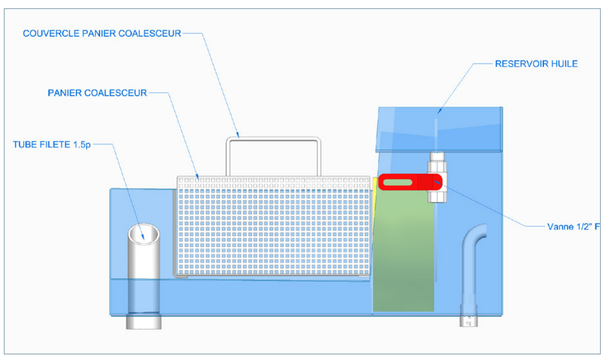
MBD can also remove redundancy in downstream processes. For example, instead of the quality engineer manually transferring all of the specifications to a coordinate measuring machine (CMM) program, the model-applied MBD is automatically transferred to the CMM. That speeds up the process tremendously.

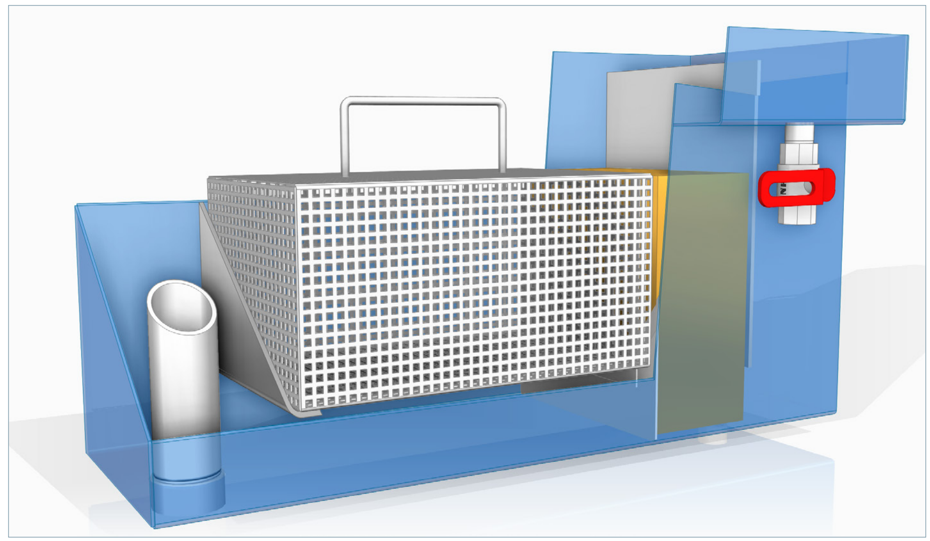


Improved collaboration between manufacturers and suppliers

In today's industry, collaboration across disciplines and organizations is also common, allowing resource sharing between different entities to complete various design tasks. The requirement for increased collaboration between manufacturers and suppliers is the final driving trend for the MBD.

An MBD allows the exchange of product and manufacturing information (PMI) across CAD applications. This is an important feature because when engineers use one set of 3D CAD tools and other teams use different technologies, a disconnect between design and manufacturing processes often exists. Without cross-platform collaboration, this product and process information is projected into 2D drawings later in project lifecycles, leading to potential errors and inefficiencies. Paper-based 2D drawings also lack the interactivity required to optimize design or manufacturing processes.





An MBD is not constrained in this way, as PMI and metadata are often communicated via 3D PDFs or other shareable file formats, which allow engineers to access interactive viewings of the manufacturing data. This provides them with the most up-to-date version of the product, allowing them to maintain holistic digital threads across project lifecycles as designs are passed between stakeholders.

This is also an important point: Any MBD initiative must not just work across different platforms, but also be intelligible across different people and enterprises. Engineers from different disciplines usually work on the same models, for example, and MBD solutions must provide common ground between so many different companies, technologies and disciplines.

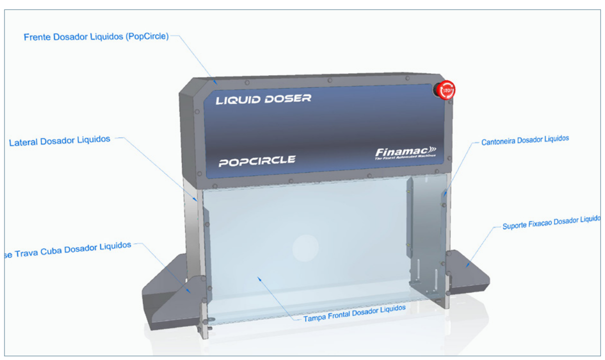
The shift away from 2D drawings and to the digital domain of a 3D MBD also provides one final benefit: It's paperless. This not only prevents out-of-date versions of drawings from floating around manufacturing floors where they can result in errors and scrap, but also enables more seamless cross-organizational and cross-industry collaboration.

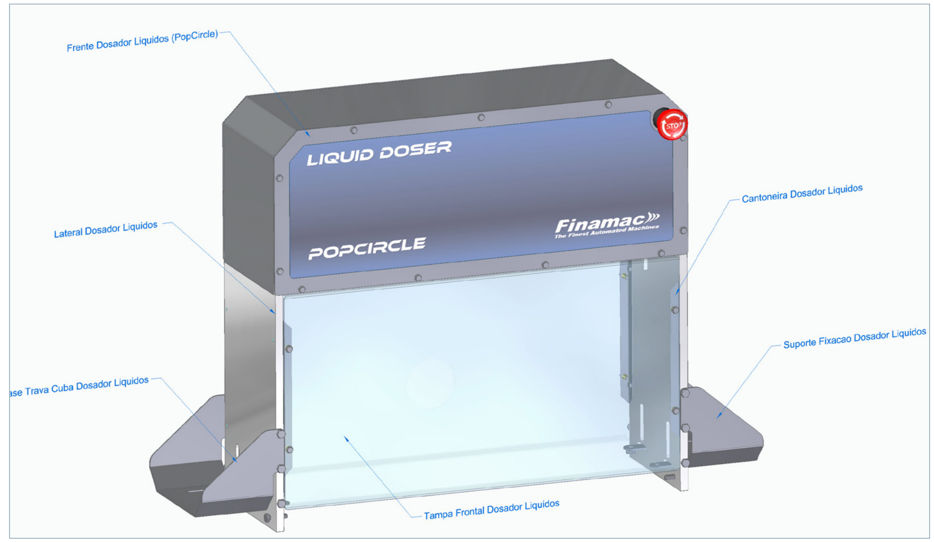
Critical capabilities

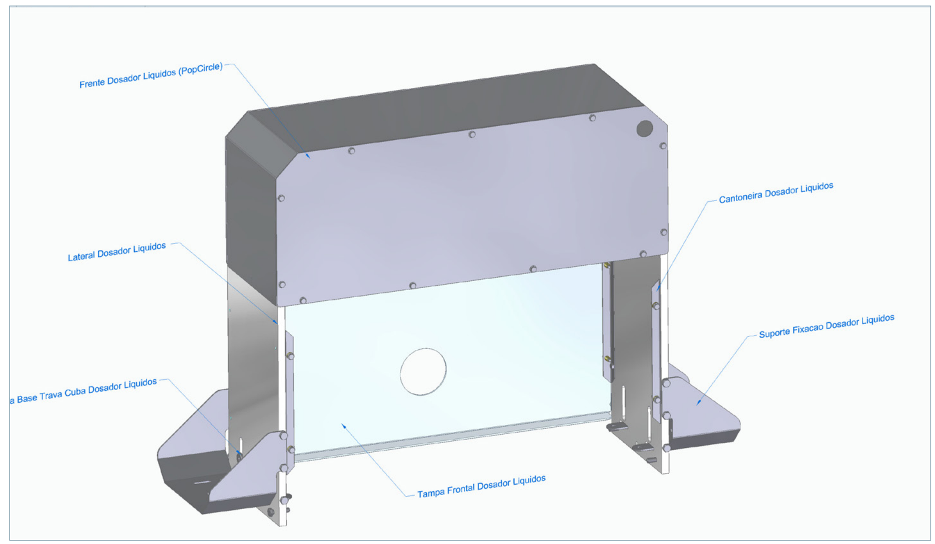
To succeed with any MBD initiative, organizations must have a complete set of capabilities. These capabilities will enable the full range of benefits of using 3D models to document product design and development processes. In this section, we review each of these capabilities at different stages of the documentation lifecycle.

Authoring an MBD

During the authoring stage, engineers add the PMI and geometric dimensioning and tolerancing (GD&T) information to 3D models. Engineers also save a view state, which includes a definition of which annotations to include with which view. This allows users to quickly toggle between different views, which show specific annotations, simplifying and clarifying the MBD documentation. These annotated, 3D digital models are also much easier to understand compared with complex 2D drawings. After all, we live in a 3D world and 3D representations of objects are more intuitive. What's more, the user does not have to mentally translate 2D abstractions into 3D representations, reducing the likelihood of miscommunication and fatigue.







Sharing an MBD

The MBD must be easy to share across different technologies, teams and enterprises to enable cross-organizational and cross-industry collaboration. To allow this, the MBD is usually saved in a format that is accessible to users working across manufacturing, procurement, services and other departments. This is often done using 3D PDFs, which are a widely used universal file format, allowing users easy access to the information.

In some cases, users can also save the information as the JT™ data format models. This precludes the need to create additional PMI documentation, which is typically the case for 2D paper-based drawings. What's more, 3D PDFs can easily be translated into 2D printouts if required to gain certification or compliance in certain circumstances. As a result, the engineering, manufacturing and procurement teams can exchange PMI without having to operate in the same environment.

Viewing an MBD

Further down the design process, users want to open, visualize and interrogate the design documentation independently. To achieve this, interactive and responsive 3D visualization applications can help users spin, pan or zoom around 3D models and their PMI. Users then gain valuable insights into proposed designs, and can investigate the shape, form and constraints on designs. Because everything is held in the same place, they can also identify the geometry referenced by specific tolerances, notes, surface finishes and other PMI, providing clarity and removing ambiguity. What's more, because the MBD is a single source of truth, only one file needs to be shared with different users. The end user saves time by only needing one file, and consistency is guaranteed as everyone can work with the most up-to-date information.

This limits the likelihood of information being misinterpreted or lost. Downstream consumers can work with intuitive 3D annotated models, reducing the likelihood that these models need to be scrapped or reworked due to miscommunication between different teams.

Automation with an MBD

Different software applications provide different levels of automation. Most applications can autonomously read the annotations in an MBD. Once completed, the software can then automatically generate elements, including the numerically-controlled (NC) toolpaths, according to predefined specifications. Other applications can automatically read and act on 3D PMI information. This avoids data re-entries and human errors, while speeding up design processes. This automation also allows organizations to introduce standardization and compliance, which results in higher quality products and fewer human-related errors.

Using Solid Edge to enable paperless 3D engineering communications

With the Solid Edge® software MBD capabilities, 3D models include PMI and other digital data using universal 3D PDFs. Users can access and view interactive representations of the manufacturing data. This enables the seamless exchange of information between engineers, suppliers and manufacturers across different software environments and organizations.

To create an MBD using Solid Edge, which is part of the Xcelerator™ portfolio, the comprehensive and integrated portfolio of software and services from Siemens Digital Industries Software, PMI is added and displayed using 3D models as opposed to 2D drawings. This reduces the need for traditional 2D drawings in the first place. Once the 3D model is available, the user can harness one of many features available in Solid Edge. The smart dimension command, for example, allows the user to place dimensions in 3D spaces. The annotations tab also allows the user to create various PMI and GD&T symbols. It's easy to convert the PMI using a range of available and configurable templates, included in Solid Edge.

The resulting MBD is saved as a universal 3D PDF, allowing everyone to access the same, up-to-date information. The software is used to import and export PMI using the international Standard for the Exchange of Product model data (STEP AP242) to ensure consistency with support for JT formats. What's more, users can select and edit the referenced geometry using annotation terminator elements.

The PMI information used to drive 3D models is the same information leveraged to create 3D PDF files, which also prevents the need to create additional PMI documentation. However, when required for certification efforts, Solid Edge can be used to easily produce paper documentation in 3D PDF format.

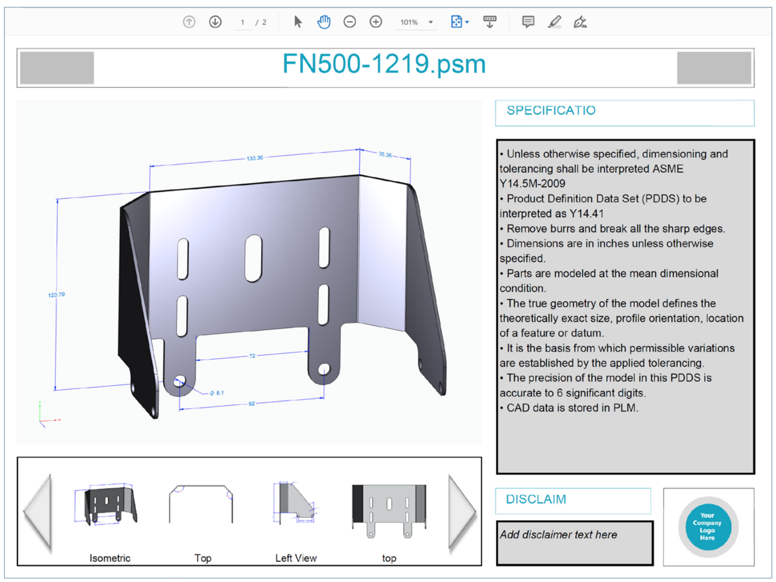
Because anyone can view 3D PDFs, users can visualize and interrogate specific deliverables to access the necessary information. Users can now manage model-based 3D engineering efforts digitally using a cost-effective, nonproprietary process.

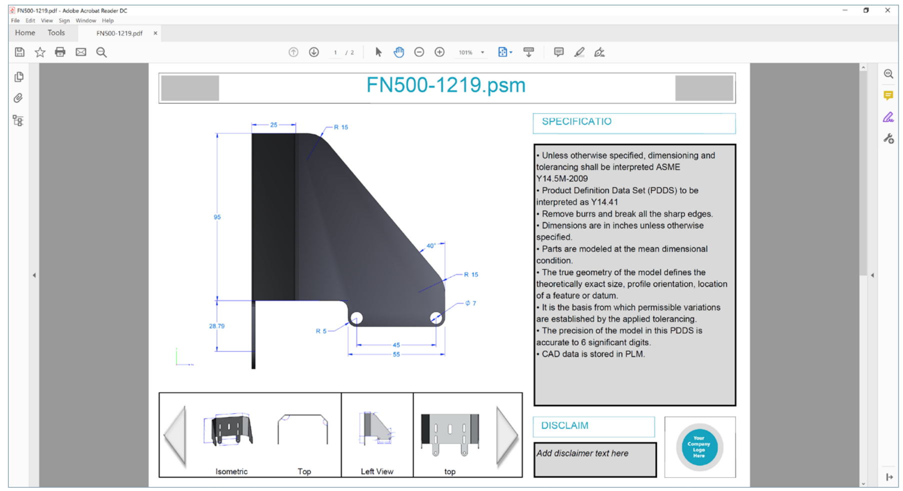
Saving time and money across project lifecycles

Solid Edge provides organizations with the MBD capabilities to create complete digital characterizations of product parts and assemblies. It achieves this using template-based 3D PDFs, which leverages existing model views and PMI with full support for the STEP AP242 standard and compliance with other industry standards.

Thanks to these features, Solid Edge reduces the need to create traditional 2D drawings, expedites the creation of manufacturing documentation and enables clearer communication across design lifecycles. This nonproprietary solution helps every stakeholder, allowing engineers to seamlessly manage their documentation processes, improving supplier response times and reducing expensive scrapping and reworking of project documentation to ultimately save time and money across project lifecycles.

To learn more about Solid Edge Model Based Definition, visit: https://solidedge.siemens.com/en/solutions/products/3d-design/model-based-definition/





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