# A VISUAL TOUR OF THE DIGITAL THREAD

LIFECYCLE INSIGHTS

# STARTING THE DIGITAL THREAD IN ENGINEERING

Modern product development relies on a foundation of digitization. Each department takes the digital work of others and builds on it, enhances it, and adds value to it. Throughout the digital development process, this builds up a network of interdependent digital deliverables, each dependent on one another. This network is the Digital Thread.

The entire company contributes to the Digital Thread, but it undeniably starts in engineering. Engineering develops designs for parts, assemblies, systems, and products and documents their form, fit, and function in drawings, specifications, models, and simulations. These definitions become components in procurement contracts, specifications for manufacturing, the basis for service procedures and much more. These are the individual pieces of the Digital Thread.

Over the past decade, engineering has been exploring new forms of documentation. For many years, the single source of the truth for design has been the engineering drawing. However, the advent of 3D models offered an opportunity to change that. Today, many companies are replacing drawings with something called a Model-Based Definition (MBD).

This eBook provides a tour of how companies use an MBD throughout their organization to build the Digital Thread.

# LEVERAGING MBD FOR BIDDING PROCESSES

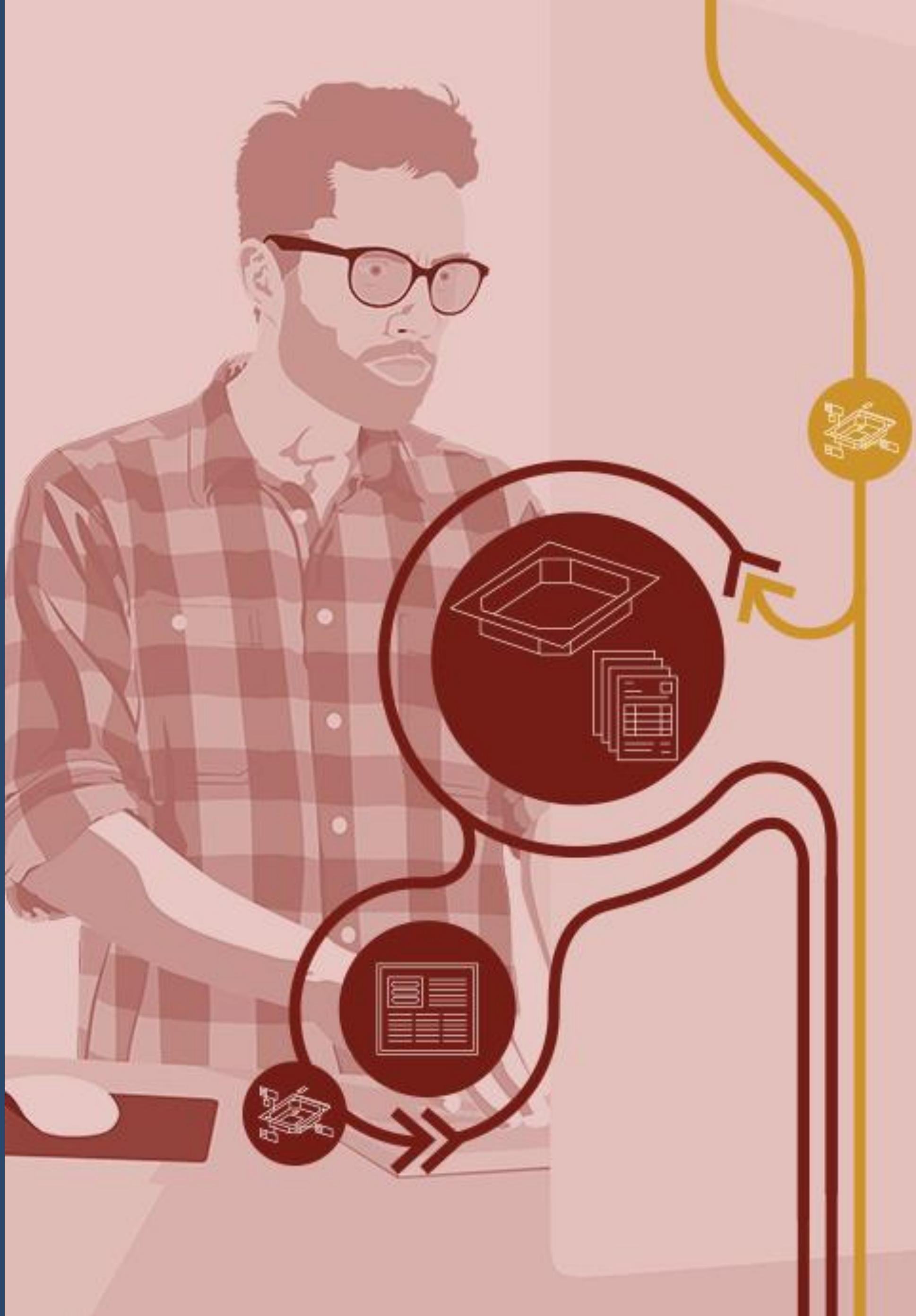
Very few companies manufacture all of their products' components internally. Instead, they turn to suppliers to produce and deliver components, assemblies, and systems. The procurement department runs Request-for-Quote (RFQ) processes to obtain pricing from numerous suppliers before awarding a contract to one of them.

The process starts by bundling up all the information that a supplier might need to estimate costs and generate pricing into something called a Technical Data Package (TDP). Many companies now use a single MBD instead of a 3D model and a drawing. An MBD provides a single unambiguous definition of a component that is easier to view and interrogate.

Once received, suppliers use the information in the TDP to mock up the effort to manufacture the component, assembly, or system. This set of activities includes using the engineering deliverables to prototype the manufacturing process, material costs, finishing operations, and much more. All this helps the supplier to generate pricing with confidence.

Both the TDP and the quotes from suppliers become a part of the Digital Thread.





# USING MBD FOR TOOLING DESIGN

In the product development process, companies design and develop tools to manufacture components that go into the product. Such tooling includes molds for plastic injection modeling, dies for metalworking, and forms for sheet metal work. Development of this tooling must occur before the manufacture of product components.

The process starts when a tool designer receives engineering deliverables describing the part. Because the shapes and contours of the tooling must form the component, tool designers use the 3D model of the product component to generate the geometry of the tool. Tooling designers subtract the component 3D model from the middle of a block for a mold to get the cavity geometry. That tooling is then split and further manipulated to produce the final tooling geometry.

Application of an MBD in this space is new and compelling. While engineers now commonly use 3D models of parts to generate the geometry of tooling, tool designers would often refer to tolerancing, surface finish, and other annotations on drawings to determine the traits of corresponding surfaces of the tooling. With an MBD, such characteristics can be inherited directly from the 3D model. This practice automates the process and reduces human error.

Once complete, the tooling 3D model joins the Digital Thread.

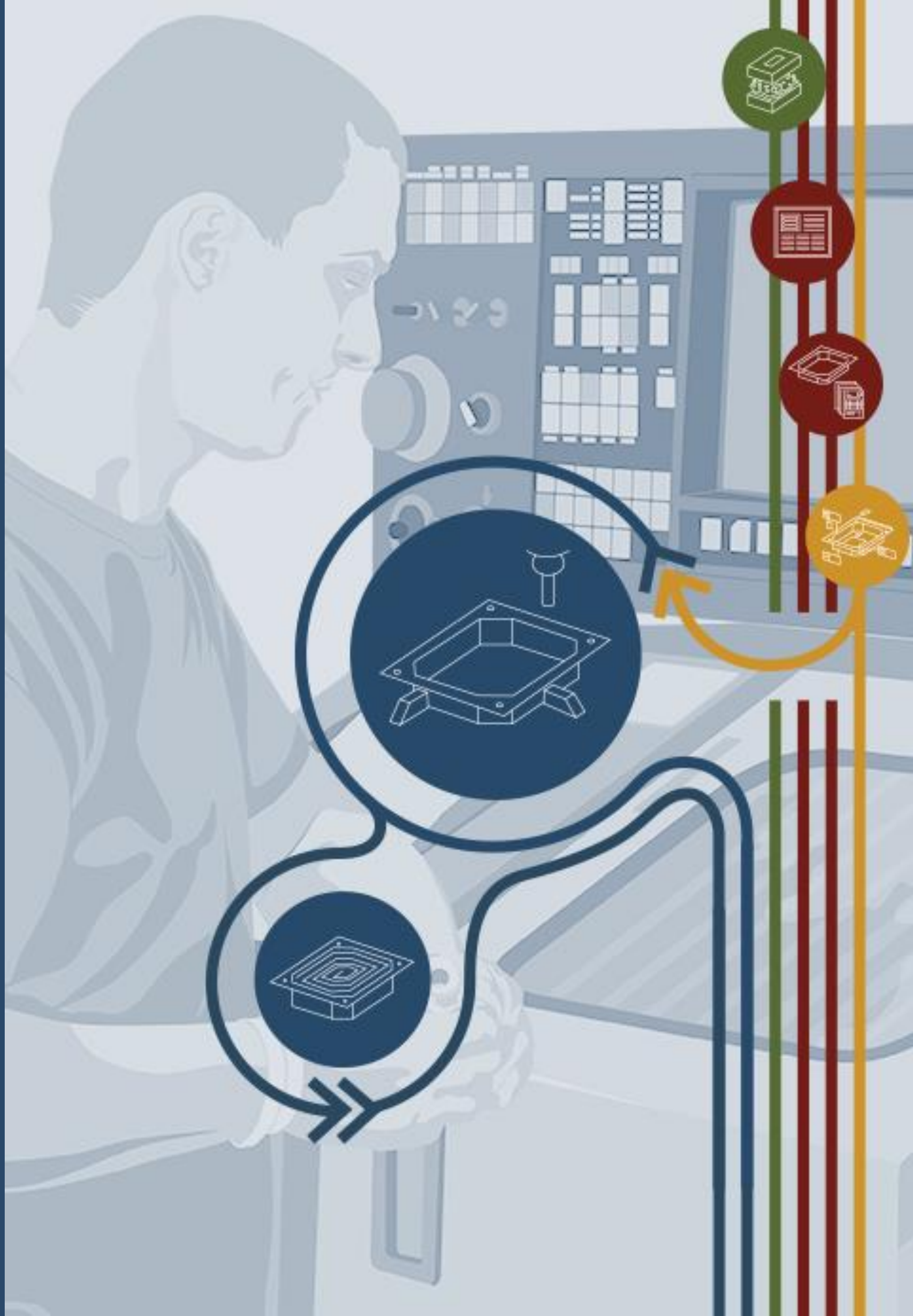
# APPLYING MBD TO MACHINING

As a next step in the development process, machinists need to generate toolpaths to drive machining equipment. They do this by creating a machining model, often composed of a 3D model of a block of material with the 3D model of the design embedded within it. They use this model to produce toolpaths based on design geometry. Once ready, those toolpaths are transferred to the shop floor to cut material.

Traditionally, machinists use the 3D model of the design to develop volumes to remove. They build toolpaths to cut away that volume. As part of that process, they analyze 2D drawings for other information, like surface finishes and tolerances, to specify toolpath parameters like speeds and feeds. Issues arise when the drawing and 3D model are not in agreement, leading to high rates of scrap and change orders.

An MBD conveys both 3D geometric information and annotations in a single, unambiguous source of the truth. Furthermore, machining software can interpret non-geometric information such as surface finishes and tolerances, automatically determining the toolpath's speeds and feeds based on pre-programmed best practices.

The machining model, with a reference to the design model, as well as the toolpaths all join the Digital Thread.



# DEFINING INSTRUCTIONS WITH MBD

The development and operation of products require a wide range of instructions. In production, manufacturing planners document manufacturing steps for repeatability. In service, service planners define specific procedures, step by step, to fix broken products. For complex products, engineers specific sequences of tasks for product startup, operation, and shutdown.

For all of these instructions, technical documentation teams use engineering deliverables as a starting point. Illustrators create new models based on the design. Traditionally, they then augment it with information from 2D drawings as well as other items, ranging from tools to consumable materials. They use all of this information to create the illustrations and animations in instructions.

However, use of an MBD eliminates the need to reference 2D drawings because the information is included directly in the model. Illustrators can display PMI in figures or animations. This application of an MBD specifically circumvents the issue where a 3D model and 2D drawing may not entirely agree.

Once completed, the instruction model and any exported deliverables—such as animations or documents—join the Digital Thread.

# EMPLOYING MBD FOR QUALITY AND INSPECTION

When it's time to inspect a part, coordinate measuring machines (CMM) can ensure items are within the specified tolerance. Alternatively, technologies such as 3D scanners can create a cloud of information points for comparison with the original CAD model.

In the traditional process, 3D models play a vital role in both of these inspection approaches. Engineers use the design to define inspection paths for CMM machines, automating the task tremendously. They can then compare inspection results, either from a CMM machine or a 3D scan, to the 3D model. In either case, inspectors must analyze 2D drawings to know when the part is or is not compliant.

Use of an MBD in inspection results in a very different process. Instead of referring to separate 2D drawings, inspectors use the annotations, tolerances, and surface finish annotations in the MBD to produce CMM toolpaths. This approach not only automates toolpath creation, it improves results analysis. Some software applications can automatically recognize when such information is associated with surfaces. They can incorporate that information into pass or fail tests.

All of the digital deliverables from this stage, including inspection models, 3D scans, CMM toolpaths, and more, join the Digital Thread.



# SUMMARY AND RECOMMENDATIONS

The Digital Thread is the interconnected set of deliverables produced throughout the product development process. An MBD in the Digital Thread provides a single unambiguous definition of a design's geometry and non-geometric information such as annotations, tolerances, surface finishes, and more. Different functional departments can use this single definition throughout the development process, including:

- Procurement provides an MBD to suppliers in a TDP for the RFQ process.
- Tooling leverages an MBD to create the geometry and non-geometric details of molds, dies, and other tools.
- Machining uses an MBD to generate toolpaths based on a design's geometry and non-geometric information.
- Illustrators reuse the geometry and non-geometric information in an MBD to produce instructions that include illustrations and animations.
- Inspectors use an MBD to produce CMM toolpaths and compare results for manufacturing conformance.

An MBD and all of the deliverables produced during the development process are part of the Digital Thread.

LIFECYCLE INSIGHTS

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Lifecycle Insights is a research and advisory publishing firm. Our mission is to empower executive's ability to reap more value from technology-led engineering initiatives in less time, with more surety and less disruption.



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