Product Manufacturing Information Provides a Base for the Digital Twin

CIMdata Commentary

Key takeaways:

- *Product Manufacturing Information (PMI) is a foundational building block for the Digital Twin and digital transformation.*
- *Siemens Digital Industries Software's NX solution is at the forefront of PMI implementation.*

PMI provides a foundational base for the establishment of the Digital Twin and digital transformation. CIMdata defines PMI as data pertinent to manufacturing a product including information such as tolerances, reference dimensions, datum points for quality processes, surface finish, material specifications, etc. This data has historically been included in 2D drawings to be used for design validation and in manufacturing operations. MCAD solutions may also store the PMI in the 3D CAD model, from where it can be added automatically to drawings or accessed directly by viewing the 3D CAD model. Because PMI is a semantically (computer interpretable) annotated 3D product definition, downstream applications such as machining and inspection programming can take advantage being part of the model. This is how digital transformation happens.[1]

CIMdata defines Digital Twin as a physics-based description of a system resulting from the generation, management, and application of data, models, and information from authoritative sources across the system's lifecycle. The Digital Twin must be more than just a descriptive model or collection of related digital information (e.g., a SysML model). It is a complete physical description including all behaviors. PMI forms an initial base for the Digital Twin 3D model.

PMI as a Baseline

PMI sits as a starting point for other model-based concepts including Model-Based Definition (MBD) and Model-Based Enterprise (MBE). Figure 1 depicts this relationship.

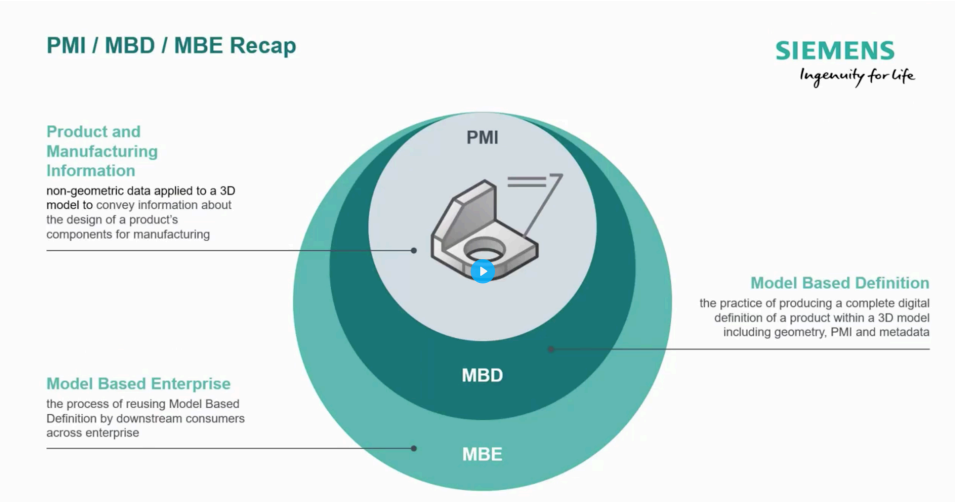

Figure 1—PMI's Relationship to MBD and MBE
(Courtesy of Siemens Digital Industries Software)

[1] Research for this commentary was partially supported by Siemens Digital Industries Software.

In the last few years, CIMdata has observed a substantial increase of product definition companies moving their design strategies forward using PMI. Because PMI is computer interpretable, MCAD solution providers are increasingly leveraging that data for their downstream applications. The industry is seeing PMI-driven applications in design analysis, tooling design and analysis, NC machining, and inspection. A 3D MCAD model with PMI annotation offers an unambiguous product description when shared with the supply chain. All these benefits add up to a reduction in product development time and reduced errors in design and manufacturing. As this trend continues, CIMdata believes the industry will see an increase in PMI-driven applications.

Siemens Digital Industries Software's flagship MCAD solution, NX, has a rich history of supporting PMI. The PMI capabilities in NX reach as far back as twenty years with expanding enhancements each new year. Today, CIMdata views NX as a leading supporter of PMI for product development and manufacturing.

PMI a Digital Transformation Enabler

At CIMdata we often hear and read about companies initiating digital transformation programs that do not address product information and the associated product lifecycle. We do not understand how such a program will materially improve the company, especially when their products are manufactured.

For most products, the geometric definition is critical, and it is described using 3D solid models. These 3D models are exact, but the manufacturing processes that transform the models into a physical item produce to a tolerance. The product parts themselves need to be within a tolerance to meet overall product performance requirements. Manufacturing information historically was added to drawings as notes, dimensions, tolerances, and symbols after modeling was complete, when this information then was added to 2D CAD drawings, usually much later in the process. Design validation and manufacturing planning could not take place until those drawings were developed adding to the timeline. An engineering rule of thumb is that 3D modeling and 2D drafting each take about 50% of the time to develop a design and are done serially.

Proper use of PMI can be the foundation of an enormous digital transformation to the legacy design and drafting process. As an engineer models a product, manufacturing information can be added inline. That is, GD&T and datums can be assigned as a feature is created such as adding a flatness requirement to a mating surface, noting the absolute and relative position tolerance of a hole pattern, or adding an assembly note for a product reference dimension.

As the model is created, PMI checking software can validate GD&T syntax, and analysis tools can assess critical tolerance stack ups and note which tolerances have the biggest effect, enabling the engineer to make tolerances as loose as possible to minimize cost while still meeting performance requirements. The cycle time for the legacy process can be days or weeks yet with the modern process it can happen in real time. Verification and validation still need to happen, but because data is connected and validated with software applications more time can be spent on design functions not clerical tasks.

The semantic nature of the information has even greater impact in manufacturing. With product information stored as metadata on the part item, and computer readable PMI on the item model, automation can be applied. When a part is released manufacturing planning software can assess the part based on shape, size, material, dimensions, and tolerances and an appropriate manufacturing strategy developed. Additive or subtractive processes can be specified based on the part attributes and business requirements such as manufacturing location, cost, volume,

and capacity. Once the strategy is set, CNC programs can read geometry, GD&T, manufacturing resources (work cells, cutters, etc.), and CNC programs and digital work instructions created. CNC validation software proves out programs on digital twins of factory machines minimizing rework.

The benefits of this type of manufacturing transformation are huge. The complete set of manufacturing information can be defined in minutes instead of days or weeks, and the bottleneck becomes factory capacity, maximizing capacity utilization. Furthermore, the information generated becomes more consistent since it is software generated and repeatable.

Conclusion

PMI stands as a basic building block for MBD and MBE design approaches. As such PMI enables the concept of the Digital Twin and lays the foundation of a company's digital transformation. CIMdata strongly supports and encourages companies undertaking a journey toward their digital transformation to leverage modern design and engineering technology. For those that are not moving in that direction, CIMdata predicts they will likely fall to their more progressive competitors.

Establishing a ground-level design methodology using 3D PMI is the first step. It enables significant process improvement and automation opportunities Because of their forefront position in support of PMI, companies would do well to consider the capabilities offered in NX by Siemens Digital Industries Software.

About CIMdata

CIMdata, an independent worldwide firm, provides strategic management consulting to maximize an enterprise's ability to design and deliver innovative products and services through the application of Product Lifecycle Management (PLM). CIMdata provides world-class knowledge, expertise, and best-practice methods on PLM. CIMdata also offers research, subscription services, publications, and education through international conferences. To learn more about CIMdata's services, visit our website at http://www.CIMdata.com or contact CIMdata at: 3909 Research Park Drive, Ann Arbor, MI 48108, USA. Tel: +1 734.668.9922. Fax: +1 734.668.1957; or at Oogststraat 20, 6004 CV Weert, The Netherlands. Tel: +31 (0) 495.533.666.