PLM Enabler: BOM Management Across the Enterprise

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VARIATION DRIVES SALES

In a world that caters more and more to individual wants, the drive toward mass customization of products must be reasonably balanced by a product manufacturer’s ability to leverage a common-base product model. Variation may drive sales, but fully customizing each product sold destroys profitability. Delivering a product with variations to the marketplace relies on a foundation of modular product designs, Bill of Material (BOM) management, and the ability of production processes to handle deviation. Manufacturers recognize that product variants or multiple product configurations, managed with the proper tools during engineering and production, are critical to their business success.

Multiple configuration products include not only “part families” that vary solely in dimension, but more importantly, products that include both functional and cosmetic differences. Aerospace manufacturers deliver both standard and elongated commercial passenger configurations of their airplanes, as well as cargo freighter and military variations. In automotive, vendors flood the market with customer-selectable options, including engine size, in order to entice their buyers. The same holds true in the high tech electronics, industrial machinery, and medical devices industries.

BOM management of product designs impacts the full range of Product Lifecycle Management (PLM) domains from engineering to sourcing, manufacturing, and service. The proper product definitions organized around the multiple configurations of the product, together with strong BOM management tools to visualize, control, and change those configurations, provide leading edge manufacturers with valuable ammunition to compete more effectively.
BUSINESS CHALLENGES

The downturn in the world economy over the past two years has heightened the need to manage risks inherent in new product development. Tight money has created a number of unexpected shifts in how global corporations deal with their worldwide supply chain partners. In a fiercely competitive environment, reducing cycle time from product concept to delivery becomes ever more critical and the ability of the supply chain to deliver often gates time to market. Yet because of the global economy, companies face added risk of weaknesses – or worse, bankruptcy failures – in the supply chain. New forces in place within global companies force a reevaluation of marginal performers in their supply chains and they even to give consideration to “de-globalization” – pulling back from reliance on suppliers around the globe and turning to on-shore providers.

Many product development companies also face a growing challenge to their cost structure. Margins are shrinking due to increased raw material costs and rising transportation expenses. Companies are reducing their staffs because of economic pressures while simultaneously pushing aggressively to increase productivity. Mistakes are not an option. Scrap, re-work, and missed opportunities of reuse all increase costs. Companies recognize they need to work more intelligently and search for both process and product opportunities to streamline.

Without a doubt, the market is now hyper-sensitive to quality, both in reality and perception. We have seen that it takes only one stumble to call into question years of a company’s hard fought reputation for quality. Every product manufacturing company drives relentlessly to improve and protect their quality record. Yet the pressure to deliver product variations and product options tuned to divergent customer demands is also increasing. Product developers must carefully control requirements and dependencies across any number of product configurations or they risk introducing quality issues. Managing change...
during the product development process and analyzing its impact across product variants is central to that control.

**BILL OF MATERIAL MANAGEMENT**

The complexity and diversity of product engineering data alone forces the need to organize and structure that data. The resultant engineering Bill of Material (eBOM) represents design engineering’s definition of a product into a well defined and ordered hierarchy of objects. Each product subsystem, such as electrical, hydraulics, and mechanical, may require specific fields of information, its own data models, and a special view of the product structure. As the eBOM moves through product development, additional data specific to manufacturing must be added. Even more challenging, the eBOM’s hierarchical BOM structure may need to change to better fit the needs of manufacturing and assembly processes. This creates a manufacturing Bill of Material (mBOM) that is the result of often complex data mappings between engineering objects and their realization in production. The coordination of these potentially conflicting approaches between eBOM and mBOM must be supported in a coherent, overall product definition.

Figure 3 depicts a simple example of an eBOM mapping to its associated mBOM. The eBOM reflects the way the product was functionally designed and the mBOM depicts how the product will be manufactured. Assembly A is only a logical grouping put together by the designer; it plays no role in manufacturing. Additional items, such as paint or grease, may appear in the mBOM.

Over the past decade, Collaborative Product Development Associates, LLC (CPDA) has consulted with numerous leading manufacturers in industry verticals across aerospace and defense, automotive and transportation, large machinery, medical devices, and consumer products. Invariably, these leaders have reached the conclusion that their best practices center on three key aspects for staging
product development: single source product data; attention to process interactions that integrate different product silos; and providing each contributor to the product development process the correct data and tools to empower decision making.

THE NEED FOR SINGLE SOURCE MANAGEMENT

Product development leaders have grown to understand that a major eBOM best practice is to explicitly record the composition of multiple product configurations as a single source data structure and work with it to define and manage dependencies, requirements, and the effects of change. In this context, “single source” does not imply only one physical file or even one location of all the data. Product variants are single source if any one product configuration “knows” of the existence of all other configurations and can access those differences when needed without human intervention. This contrasts with the traditional practices of using spreadsheets to structure product configurations, or defining all configuration options overlapping each other in a single database, where human intervention is required to define and separate the pieces of one valid configuration from another.

Without proper tools to record and manage the definitions of the product configuration, numerous problems can arise not only in engineering itself, but further downstream in manufacturing and product support. For highly complex products found in aerospace and automotive transportation, the design and manufacture of product subsystems are often outsourced to multi-tiered supply chain partners. When the control of differences in product configurations is left to human intervention, there is an increased potential for errors to be introduced, leading to confusion downstream and lost productivity. Engineering may find conflicts and interferences between components that arise between configurations due to untracked information, adding to corrective time delays. Too many or too few product components may be produced in the manufacturing phase, driving costs up and adding to delays. Missed conflicts will result in quality problems, and potentially even worse issues in terms of warranty exposures.

CPDA conducted an in-depth interview on the topic of BOM management for multiple configurations with Mike Christian, Teamcenter Mfg. CPAST Project Leader at Boeing Defense, Space and Security. Mike stated, “Our thinking starts with data models, whether they involve indentured BOM or flat product structure. Both play a huge role downstream. Based on capturing the configuration of a product, the entire bill or a piece of the bill, we find that turning different things off in the COTS tool enhances that activity greatly. At Boeing we call it effectivity control. It is a key piece for us. Without that, we consider the data model as not configuration managed.”

Mike explained that without configuration management there was the potential to have flaws in downstream MES, MRP, or ERP systems that can cause shortages or overages (duplicate parts) and wasted time, effort, and component costs. He further added, “Searching abilities are also key. If we are looking for a specific subassembly within a giant assembly – and all the pieces in between – with a flat
product structure we have a hard time doing that. People spend way too much
time and manpower doing research, even on the shop floor.”

A strong BOM management tool should permit easy capture of the definitions of
multiple product configurations, including the lifecycle status of its individual
components throughout the full product development process. The tool can then
allow audit of product information and provide visual feedback so that users can
easily see the level of progress for each product component. A proper BOM
management solution can enable comparisons and verification of the
configuration build status for testing, compliance reporting, and warranty
verification. Most importantly, a strong BOM management tool enhances
collaboration between individual contributors to the product development
process, as well as between teams of contributors including supply chain partners.

PROCESS INTERACTION

The capture of eBOM and mBOM data for multiple product configurations
provides the foundation for product developers to interact with their processes.
Whether that process involves iterating the definitions of the product design
between model designers and CAE simulation analysts to optimize the solution,
or it relates to designers and manufacturing process planners in validating
manufacturability, the managed BOM must not only integrate with a company’s
processes, it should enhance those processes. One vital process in product
development across all industry verticals relates to change management. Being
able to incorporate a product change as the product definition evolves and to
assess the impact of that change across product variants and downstream
operations is significant to assure smooth shop floor production.

On the topic of change management, Mike Christian of Boeing commented on
their use of the Siemens PLM Software’s Tecnomatix manufacturing solution:
“The ability to visualize is a key point. At least with a BOM management tool, it
is such a joy to see every piece, every aspect of the e-bill and m-bill. It changes
everything. The basic flow-down of the product lifecycle from the very beginning
is the solid model, and seeing the entire product. That includes handoffs between
functions, including product support.”

Mike added, “Designers who looked at the BOM management solution say, ‘I like
that I have the ability to see in that space so I can understand, so I can help myself
downstream. Then when I have to make changes, I understand the build process.’”

EMPOWERMENT

The third major aspect of a strong BOM management solution relates to its
ability to empower individuals who contribute to the new product development
process and launch. The product data structures and content, together with a
suite of BOM management tool functions for visualization, comparison, and
control, all contribute to enhanced decision making. Enabling timely decisions
based on accurate information moves a new product launch steadily forward to meet expected product release schedules.

Mike Christian again related an example that reinforces this aspect. He disclosed that years ago manufacturing engineers at Boeing often saw problems on the shop floor. They could see that certain product components would not work in the context of where they had been defined for product assembly. The root cause was often traced back to manufacturing work instructions that did not reflect changes that had occurred in the engineering definition of the product and its components. Mike noted that now with BOM management tools, design teams who make those changes have a “line of sight” into the manufacturing and assembly process that allows such problems to be found and addressed upfront.

He stated, “Process simulation and product simulation – those are key phases to manufacturability and producibility. We define that process to make sure the design is effective. We typically bring in the operators to do a virtual review of the design.” He continued, “Decisions are made in an IPT (Integrated Product Team) environment, consisting of tool engineers, designers, manufacturing engineers, mechanics, and quality engineers converging on the solutions together. It is human intervention, but using the tools to help decide and define what you are looking at – whether it is a build process, a new design, or a change in flow. The tool enables the decisions.”

**SUMMARY AND OPINION**

Each product manufacturing company must decide for itself what products and product variants it will design and produce for their market. However, based on CPDA’s assessment of companies across numerous industry verticals, the most successful companies employ advanced BOM management tools to define and control their engineering and manufacturing efforts. Case after case of the product development process at manufacturers around the world, as Boeing testifies, shows that the use of BOM management tools is critical to success.

The proper BOM management tool enables PLM across the enterprise. Each of the three most recognized best practices for dealing with product variants – single source, process interactions, and empowerment in decision making – rely on a strong foundation in BOM management. As Mike Christian of Boeing Defense, Space and Security has affirmed, BOM management allows the capture, visualization, and manipulation of product data needed during the development cycle for multiple configuration products, and is vital to assessing a product’s “manufacturability and producibility.”