ptc

Establish a BOM Centric Approach: Ten Ways to Organize Your Data and Become a Digital Leader

WHITE PAPER

Executive Summary

Your Digital Transformation Starts with BOM Management

Quicker to market, faster iterations, lower costs—these are goals of most product development organizations. Product lifecycle management (PLM) is a key enabler of meeting these goals, but most manufacturers already have PLM. So, what's the problem? While PLM is pervasive, many manufacturers find themselves with multiple disconnected legacy systems that simply can't keep up with their business processes. Many organizations don't have an accurate, up to date, part-centric bill of materials (BOM)—an authoritative source of truth upon which to depend.

Here's how it looks when systems are disconnected. Engineering teams, working from drawings, are faced with non-value-add work, such as quadruple data entry because they have to reenter information from drawings or continuously pull data from drawings and CAD for manufacturing, supply chain, service, and customers. Finding the right information when there is a change becomes almost impossible as data can be scattered across many locations. Purchasing managers order wrong parts because they have no way to determine preferred suppliers and components to negotiate volume discounts. Supply chain managers make wrong inventory decisions, which lead to low part reuse and high inventory levels. Factory planners don't adjust their machines in time to satisfy product release dates. They get started on process updates—such as setting up the assembly line and developing work instructions—and are soon behind schedule, missing customer delivery dates. Technical publication writers produce user manuals with incorrect instructions, resulting in an overabundance of service calls.

Transform your BOM for organizational improvement

With the right BOM strategy and system, organizations can capture, configure, and manage product information during every step of the product lifecycle with a complete digital product definition. They can increase efficiency without compromising their ability to release high-quality, innovative products to the market. A complete digital product definition acts as a digital representation of a product (or products) and a single source of truth to all related artifacts (i.e., CAD models, drawings, requirements, part structures, and other relevant information). It can reduce complexity in data, processes, systems, and organization—resulting in greater efficiencies and shorter lead times.

A holistic product definition that goes beyond digital drawings helps effectively optimize key business processes. Simply put, it enables an organization to collaborate around a product's BOM, aligning product development with strategic corporate goals and improving business results.

While this approach can be truly transformative, the effort doesn't require a complete overhaul of the organization's PLM practices. Instead, organizations can achieve this transformation in increments by implementing digital product definition capabilities based on priority and business need.

This white paper covers ten ways an organization can gain immediate benefits from a digital product definition while in the process of moving toward a comprehensive BOM, which leads to ultimate product development transformation.

Value in Action

Value Realized in Medical Device

Philips, based in the Netherlands, is a leading health technology company providing diagnostic imaging, image-guided therapy, patient monitoring, and health informatics, as well as consumer health and home care products. Philips builds and maintains complete eBOMs, providing flexibility and agility in production (design anywhere, build anywhere). Standardizing on Windchill BOM management best practices has driven higher quality and lower costs with more predictability/fewer delays in time to market.

Value Realized in Federal, Aerospace, and Defense

The United States Navy, an organization with over 300,000 active duty personnel, hundreds of ships, and thousands of suppliers, is leveraging Windchill SaaS to expose an integrated and model-based view of all the information (BOMs and part documents) needed to maintain, support, and operate ships. Its enterprise-wide digital transformation project will improve fleet availability and readiness, reduce IT expenses, and create efficient processes for logistics, services, and other areas.

Value Realized in Industrial

Nidec Global Appliance, the largest manufacturer of compressors for refrigeration, leverages Windchill BOM management for product and process governance and traceability. Its digital transformation project has delivered a 48% decrease in time to market and a 284% increase in the number of large projects, with only 78% of the resources. With better first pass yields, and fewer line failures and warranty claims, the overall cost of non-quality was reduced by 40%.

Value Realized in Electronic and High Tech

Seagate, the leading global data storage company, leverages Windchill BOM management as their backbone for an enterprise-wide digital thread—spanning 30M records (parts, BOMs, change notices, docs), 35+ upstream/downstream systems, multiple business units and functional groups, as well as internal and external suppliers. Through BOM standardization and streamlining between design centers and products, they have been able to reduce task completion time, error rates, rework, and time to find information, driving performance (quality of work) and productivity (efficiency and scale).

Value Realized in Automotive

BMW Group, one of the largest automotive companies in the world, leverages Windchill as its PLM backbone for production and sourcing bill of materials. Windchill is the key enabler for globally configuring and releasing cars to production.

Introduction

Introduction: Build the Foundation for Future Success

Most manufacturing organizations work with multiple disciplines within the enterprise and extended supply chain to communicate and collaborate on product development. Digital data created by the various teams involved in a product's lifecycle is as diverse as those involved. Requirements engineers, mechanical and electrical designers, software developers, test engineers, factory planners, quality inspectors, regulators, service technicians, design and manufacturing partners, and sales all have different data requirements. This digital data is not only rich and varied, it evolves over time—and quickly. To ensure each product satisfies requirements and is high quality, each stakeholder needs access to current product information.

In most organizations, this product information is commonly called the BOM. The BOM is used and adapted by many different stakeholders throughout the product's lifecycle. When these stakeholders are forced to work outside the PLM system to access upstream deliverables, enterprise processes and data management become extremely fragmented and ineffective.

Moreover, these variations (or views) of the same BOM information are frequently managed in different systems. Sharing these BOMs across teams is inefficient and introduces the risk of errors if information is not properly distributed. Consider that if the product design changes, downstream teams will be using information that is no longer current.

One way to overcome these issues is to optimize the use of the BOM in a way that enables an organization to realize a complete digital product definition. A digital product definition essentially configures, manages, and stores all product-related content—from final assembly structures to individual components—in a single, central repository. "Digital thread" is the term used to describe how the product definition weaves its way through all these downstream data sets. The digital thread is literally a connection between the major systems in the company. For example, an engineering BOM becomes the material master in the factory ERP system.

By evolving beyond drawings, to incorporate parts design, engineers spend less time disseminating product information and more time developing products. Part-centric BOMs help ensure a product is configured accurately, resulting in less rework and waste, and faster time to market. The part is also where all departments across the enterprise agree on what the customer will get in their products. Manufacturing engineers, knowing the exact part, can create a manufacturing BOM (mBOM), enabling factory planners to set up machines according to part tolerances. Manufacturing engineers can also develop work instructions in parallel to design engineering.

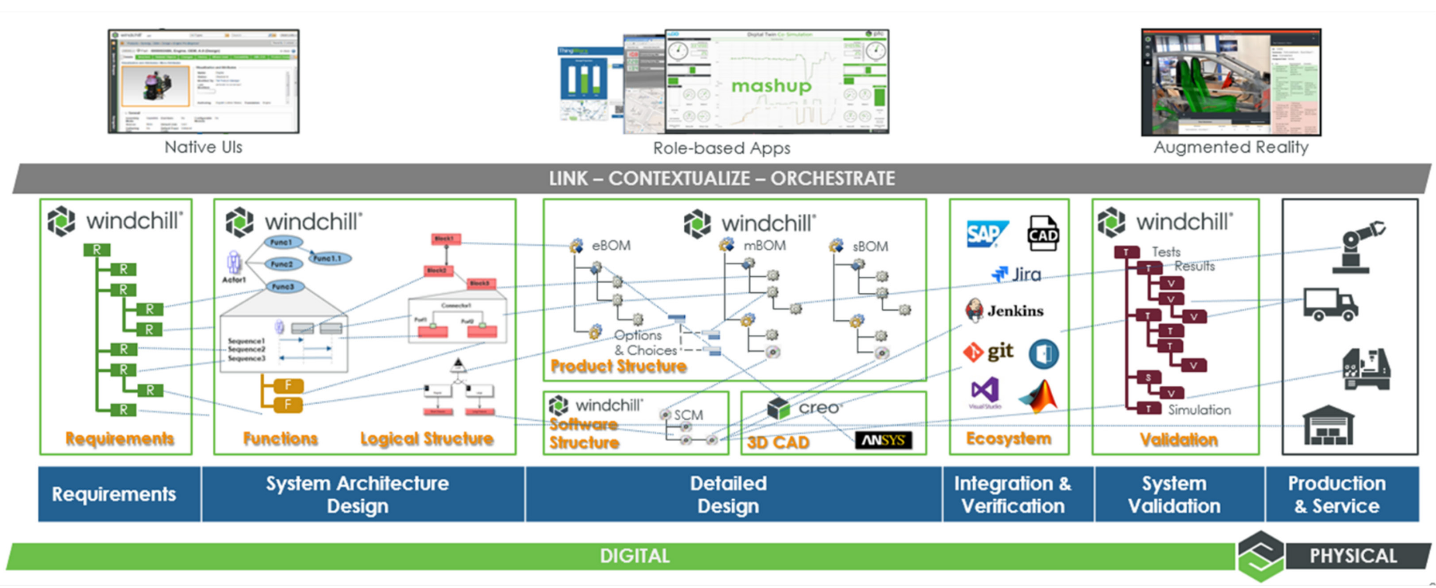
By becoming part-centric, engineering can give quality personnel early and ongoing visibility into compliance, performance, and risk. They can plan for and predict problems earlier in the product development lifecycle and reduce the number of issues by continuously improving product and process quality. With accurate details about parts, procurement can identify preferred suppliers and components and negotiate volume discounts. There is no way engineering can be elevated to the enterprise level if they are not talking "parts."

The 10 ways to BOM management bliss

Product information is constantly changing during the development lifecycle. The core of product information is contained in the BOM, which is used to define the product, the parts needed to build it, and the related information across a broad spectrum of disciplines. This related information includes definitions for mechanical and electrical parts, the embedded software that make up the product design, and more.

Parts form the foundation of the BOM structure. A part can be a single item, such as a bolt, or an entire product, such as a commercial aircraft with hundreds of thousands of parts. Together, they define the overall BOM and provide critical data, such as part quantity, unit of measure, and other key product characteristics.

Yet companies increasingly need to manage more than the BOM—they need to manage a complete product definition, including everything related to the electronic, mechanical, and software aspects of a product. This definition needs to be understood across all disciplines, including the interdependencies, that contribute to a product's development. Ideally, organizations can manage their complete digital product definition with a multidimensional, multidisciplinary BOM that extends back to requirements management processes, and out to service and use.



Traceability of the digital product across the digital thread

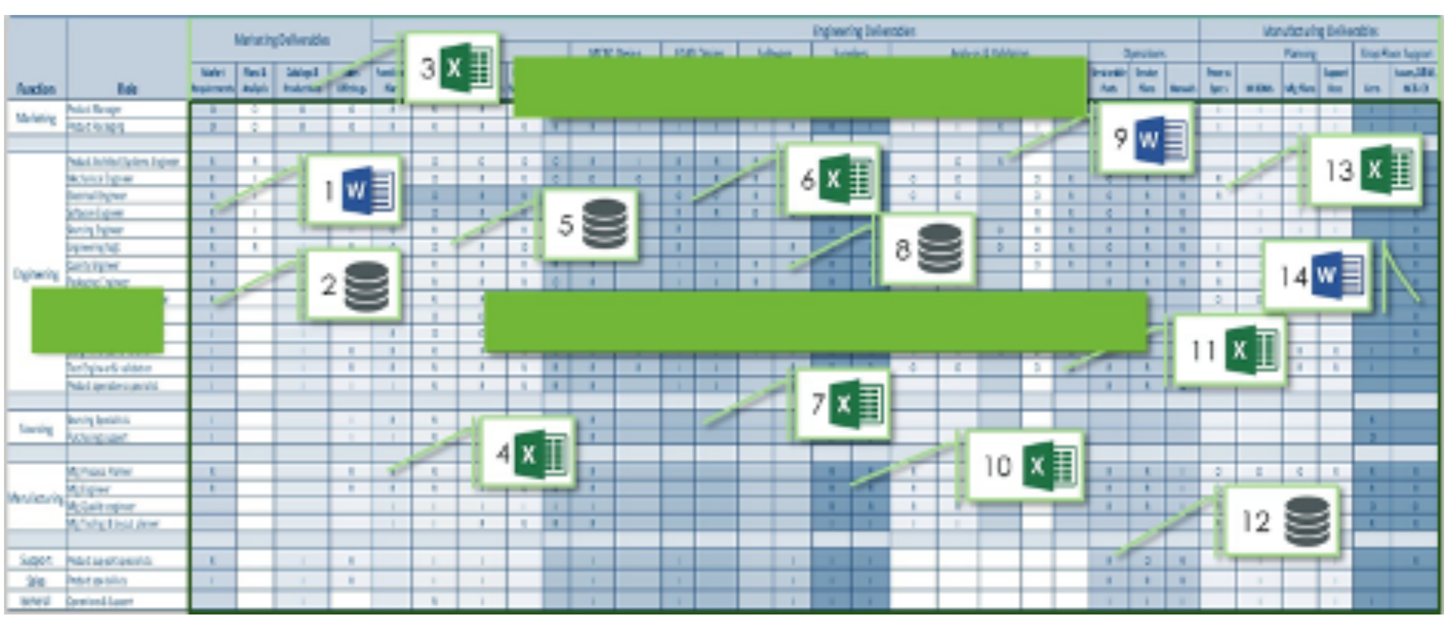
Here are ten ways an organization can realize immediate benefits from their digital product definition while undergoing a complete BOM transformation.

1. Provide early visibility to stakeholders.

The process for getting a product to market involves multiple stakeholders completing numerous tasks and deliverables. Many organizations still rely on a methodology where information from the part design, BOM, manufacturing, and suppliers are placed on a drawing. Embedded software developers work on entirely different timescales and lack bills of software. To access this information, stakeholders across the enterprise must play the "waiting game"—that is, wait for the drawing, review, and release of the drawing—before understanding software dependencies. This introduces cascading issues:

- Functions, such as manufacturing, quality and regulatory, supply chain, and service are unable to move forward until the drawing is released and software is updated, especially when they are performing local production, compliance, and service adaptations.
- These functions must then pull information from the drawing or source code repository to use in their own systems, resulting in silos of information that are often outdated and are laborious to maintain. Manual and demanding work is required to create/update work instructions.
- This in turn causes issues, such as part proliferation and duplicate BOMs, which can lead to cycle delays, quality issues, increased project risk, and poor reuse. Parts are changed or updated with no notification to other communities. The whole thing degenerates quickly, creating administration and compliance nightmares.

Another approach is to maintain two separate processes for work-in-process (WIP) and release management. The challenge with this is determining how early and how often to synchronize data. Stakeholders throughout the enterprise need access to information as early as possible to increase cross-departmental collaboration and ensure the company remains competitive in the marketplace. But, because early phases of a new product introduction (NPI) are very dynamic, this approach requires frequent synchronization of the systems used to enable WIP and release management. This synchronization is further complicated by the fact that WIP management includes managing single pieces of data, along with complex relationships between data, such as BOMs (embedded software modules and hardware), visual representations, supplier certifications, reference documentation, and more.

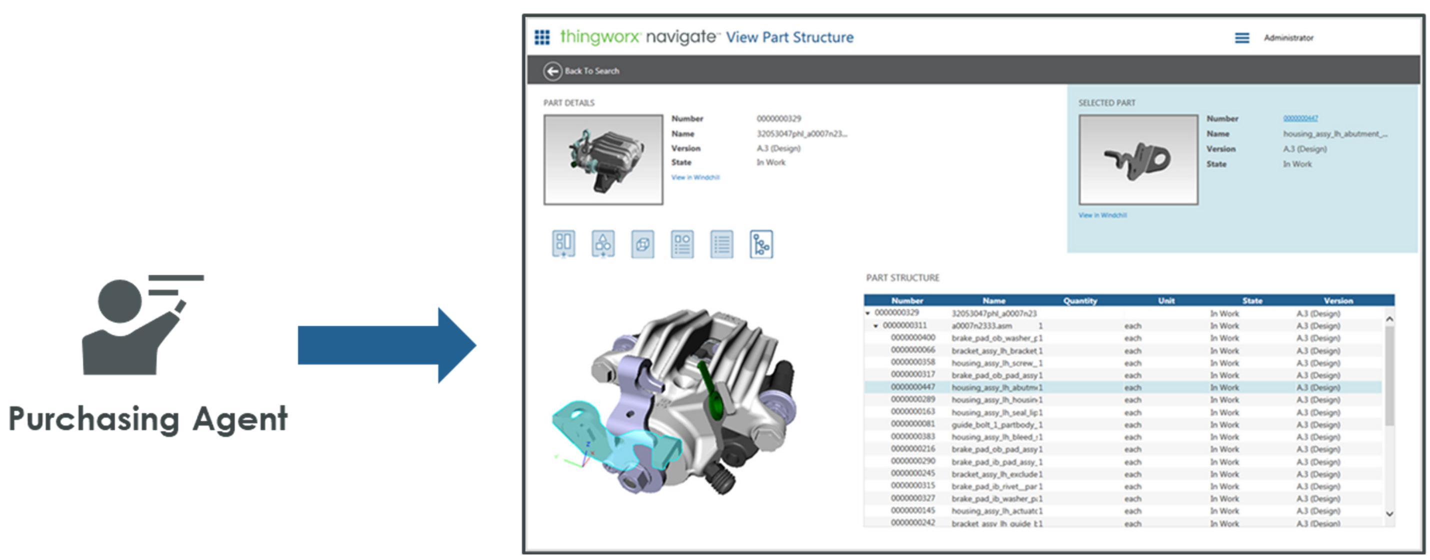


Pervasive Example: Early involvement of supply chain management

Early, continuous access to a single source of product information enables better collaboration between cross-functional engineers in early development phases. Complete visibility and one global process allow stakeholders to complete tasks on time. Further, providing feedback is easier when changes can be incorporated with a full understanding of interdependencies.

Let's consider a case in which supply chain management (SCM) wants to get involved early in the NPI process. At that point, information might be too ambiguous for involvement from anyone outside the core product development team. PLM software addresses SCM's requirements at this phase with simple lifecycle or maturity management access control that allows the organization to share select information based on the role of the user.

Once the product development team feels that the design is ready for downstream collaboration, it is critical that the relevant design data is shared in a digestible way. With a digital product definition, organizations can simply "promote" information to a state suitable for collaboration. As a result, enterprise participants, including manufacturing and design partners, can access up-to-date information with related data that is both traceable and accurate. In addition, a PLM system can deliver information to stakeholders based on their role. As illustrated below, purchasing agents can easily log on directly to a web-based application—from any device that is convenient—and see the part information they need.



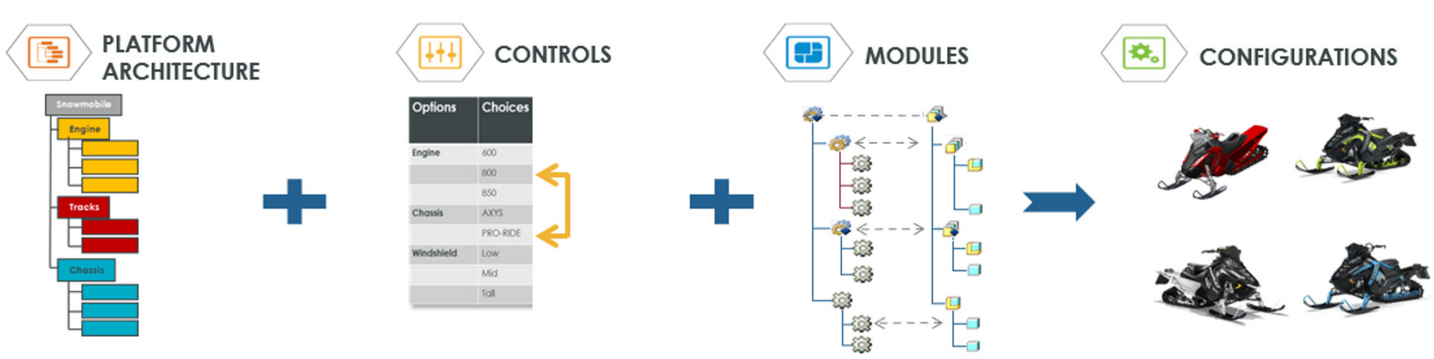
2. Support a range of BOM structures.

Organizations can take more than one approach to create BOMs. Product development can create and update the BOM using many sources, including manual part creation, CAD drawings, outside sources (such as spreadsheets), and by reusing existing BOMs. From these sources, parts are structured together to form the BOM.

The BOM then becomes the “recipe” of the digital product definition, which is used throughout the organization to understand what to analyze, test, manufacture, sell, and service. This “recipe” helps everyone understand how to realize the product that is being created.

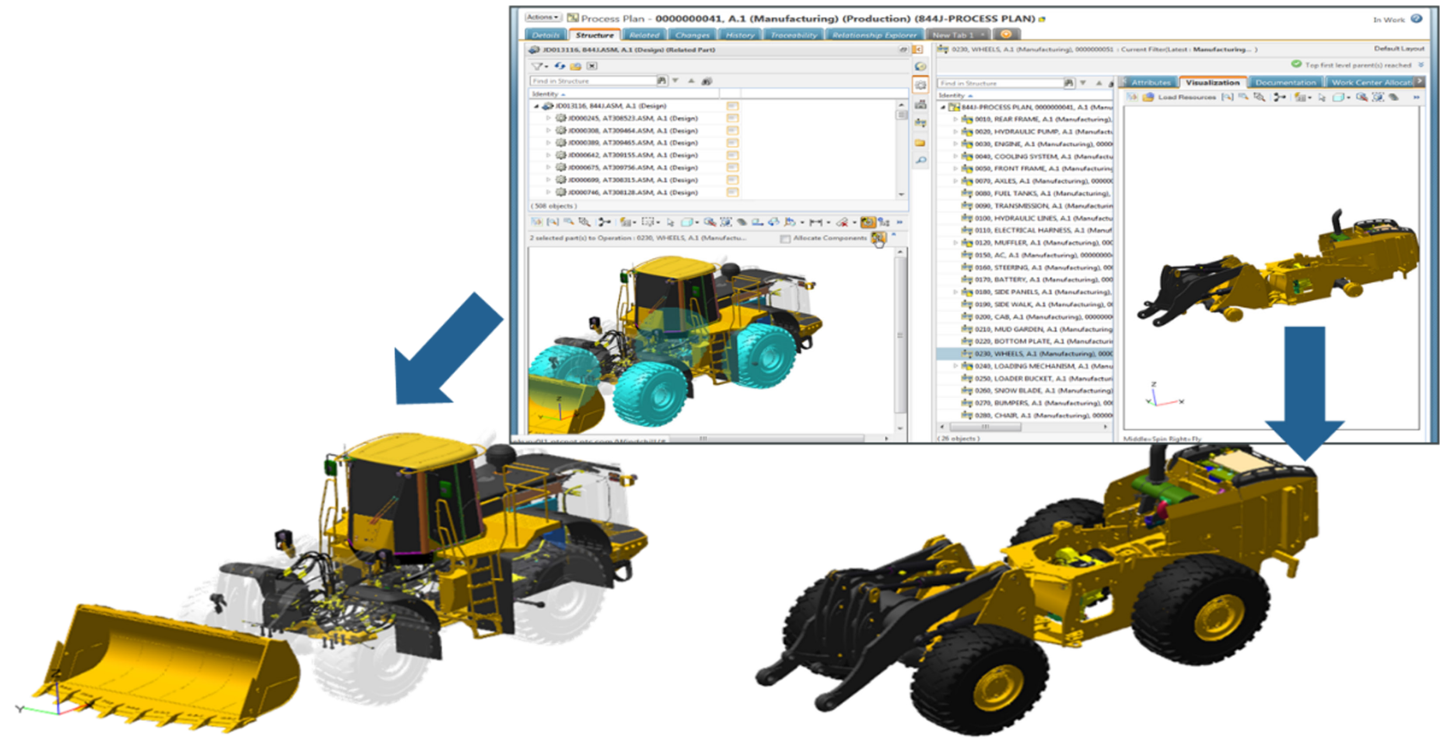
Additionally, organizations can structure a BOM in different ways based on the types of products they sell and the sales strategies they use to bring their products to market. Examples include assemble to stock, assemble to order, and engineer to order. In the product development phase, BOMs must be capable of supporting these strategies. BOMs should also be able to take on multiple forms, for example, a static BOM for a one-off product, or a BOM that can be configured to satisfy a unique customer order and/or a whole market.

Developing products is more than just creating a product to offer. Many times, it includes creating a range of product offerings that can be tailored to meet a diverse range of customer needs. A modular, configurable BOM approach allows a company to tie its BOM structure to logic driven from requirements to deliver a configurable product that can scale to meet a broad range of market needs. Logic and features can be managed enabling reuse of modules and subsystem within and across product families allowing one to maximize reuse of product design, manufacturing, and supply chain throughout the product lifecycle. A modular methodology allows engineering to rapidly validate designs to check interference or environment compliance across a range of offerings while reducing manual effort increasing product quality and improving time to market. This modular design can be leveraged for downstream needs delivering a common definition for manufacturing planning, service, and supply chain. Finally, the modular platform and logic is no longer hidden in many spreadsheets. It is managed and available across the enterprise and can be shared with downstream systems such as CPQ or ERP.



Establishing a common data model

By providing specific BOM views for departments, each view is associated with the others, ensuring traceability between parts (CAD, electrical, mechanical, software, and so on). Everyone gains a deeper understanding of the digital product definition. This reduces the number of late loopbacks, the number of design churns, and the lead-time in problem identification. Teams across the enterprise have a holistic, accurate view of all product data, enabling concurrent engineering across projects, parts of the organization, and product lines.



Platform Visualization & Design

3. Comprehensively manage configurations.

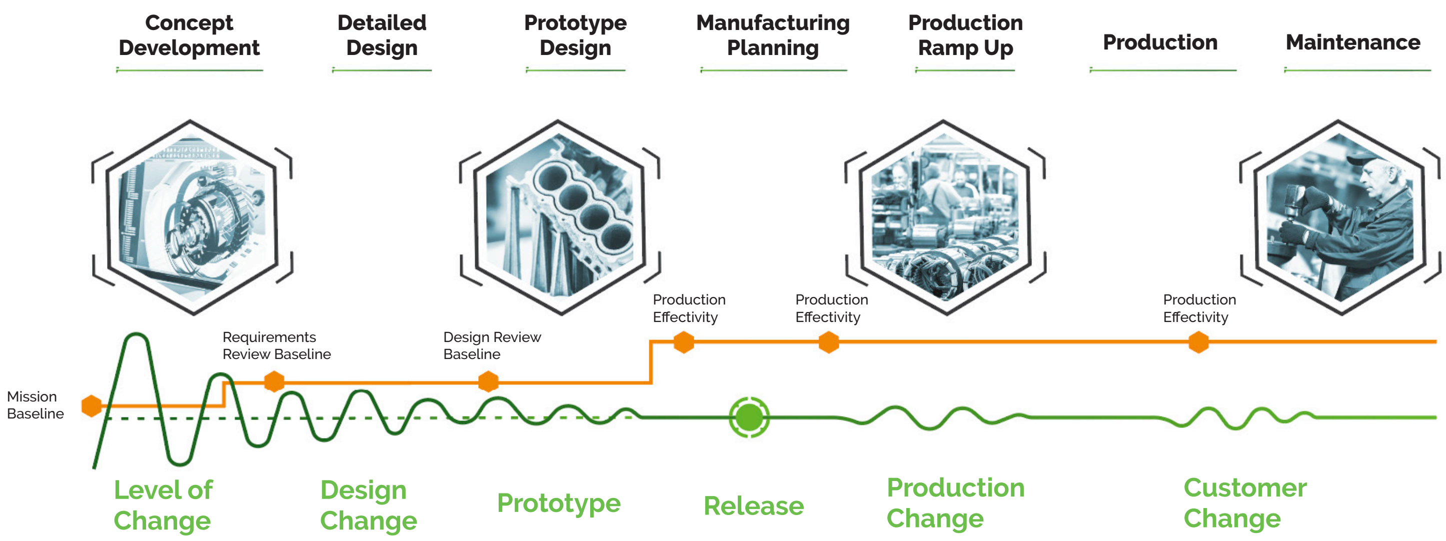
As mentioned earlier, product information is constantly changing during the product development process. When relying on disconnected systems managed by different disciplines, it's impossible to take a snapshot of data and adequately capture the needs of all process participants or begin to understand the interdependencies.

A PLM system makes it possible to capture how the product matures, and it shows what digital product information is available to engineering, manufacturing, supply chain, and others. This enables any participant to get accurate information and collect all relevant data related to that information. For example, assume the manufacturing group needs to view a frame weldment revision. It would be important for that team to also see any information related to the revision, such as the CAD drawing, testing document, and change notices. With the right PLM system, it's easy to find the right information, both current and historical. It's possible for this information to be available throughout the organization. For example, the latest release information can be provided to the shop floor, giving the supply chain visibility into what is effective for the BOM a few months or quarters out.

Configuration management is not isolated simply to managing BOMs, and with good reason. Effective product development cannot occur simply by managing "latest" or "released" data. That's why any "relationship" managed in a PLM system, such as historical content related to the product, is considered part of configuration management. It's also why being able to trace back to the correct versions of related information is as critical as accessing the BOM itself.

The connection between parts, documents, CAD, viewables, and other deliverables is often described as the "traceability" of a product and is used as the basis for the design master record (DMR) and design history file (DHF).

The digital thread, with the BOM at the foundation, creates "closed-loop" lifecycle system consolidation by combining regulators, manufacturers, and connected product data. Based on the associative concept, the configuration flow from upstream definitions are automatically incorporated into downstream configured BOMs.



Shorten time to production (and to market)

4. Enable pervasive visualization.

A picture is worth a thousand words, and a product visual is critical when product information is being shared across the enterprise. Part numbers and cryptic structures provide little value to users who are not intimately engaged in product design work. Additionally, snapshots or derived images don't sufficiently support complex product development. Digital models are powerful, but require advanced configuration management, similar to BOMs, as described above. Simply put, if people can't trust the models and viewables, they can't use them.

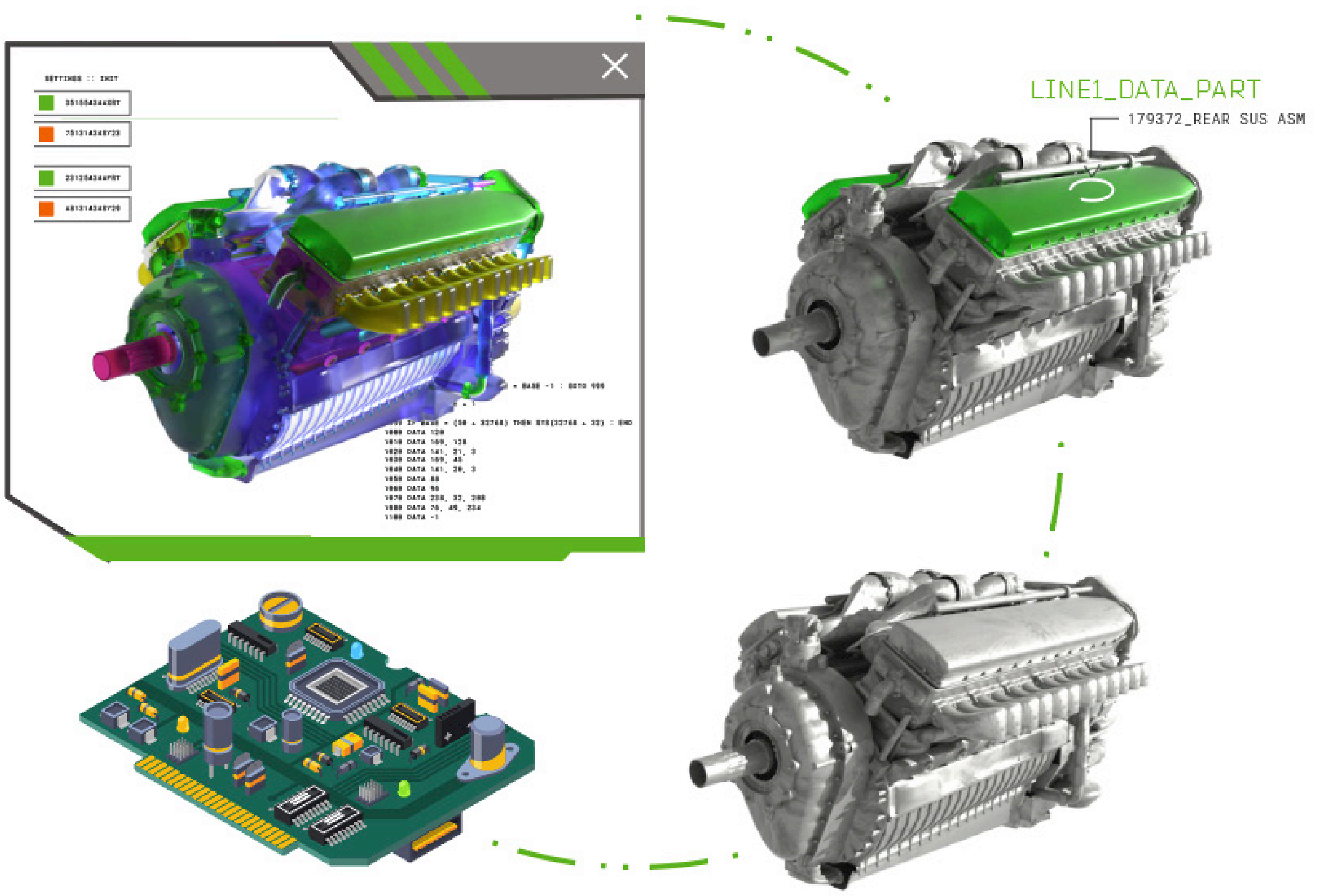
Pervasive visualization is making visualizations/ digital models available to be used throughout the product development process.

Visualization helps with part recognition, while also making it possible to leverage digital models throughout product development and optimize downstream processes and deliverables. Stakeholders can "touch" the part while it's digital, as well as virtually understand and validate how they can build and service the product during the virtual planning.

Visualization can be a game changer for an enterprise, but to ensure visualizations deliver the most value possible across the enterprise, the data they represent must be accurate and complete. This is essential, yet challenging, as product data is constantly changing, and different roles require different configurations.

Poorly managed visualizations spread bad information at record speed.

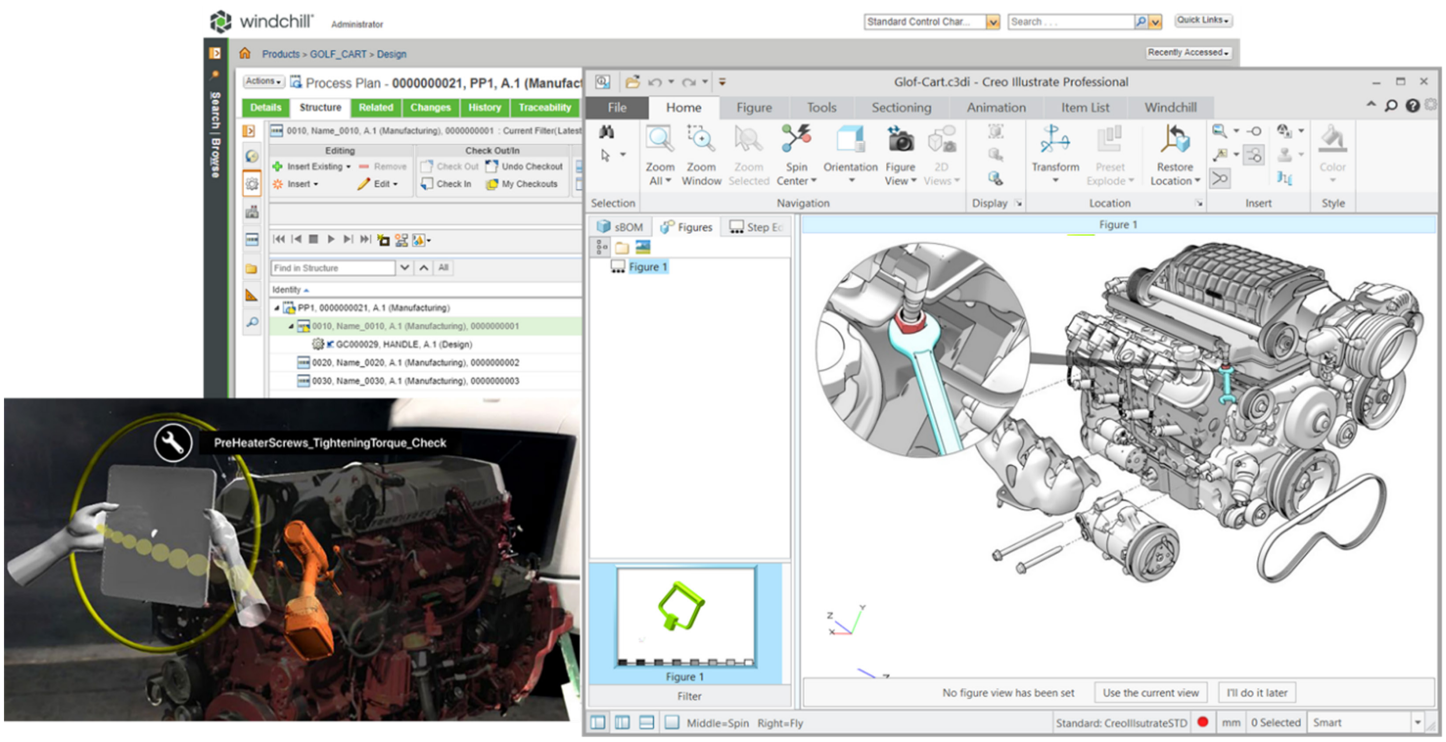
Example: Accessing 3D and augmented reality visualization of an assembly:
Consider a component that is being used across many assemblies. If this component changes, the change must be reflected in all assemblies that use it or people will be working with incorrect, outdated data.



Any PLM system using a "snapshot" approach requires a "trigger" when changes take place, along with complete where-used traceability for impact analysis. In addition, the organization must republish every assembly affected by the change to ensure proper traceability. Passing snapshots at release (such as what is done in ERP systems) requires that the data has been reviewed and locked to ensure its accuracy.

However, this is not practical during the early part of NPI or re-engineering, when WIP is continually changing. With a digital product definition, all users see updated visualizations throughout the product development process as the CAD drawing is updated. Pervasive visualization is foundational for many aspects of PLM, including providing early visibility to stakeholders, comprehensively managing configurations, and ensuring complete traceability. It also enables key processes downstream.

Example: Improved visual decision-making, work instructions, and quality inspections: The visual content generated from CAD, and kept current in the BOM, is also available in augmented reality (AR) for downstream usage for manufacturing, and creation of technical illustrations for service manuals and other deliverables. AR provides a new way of engaging with and collaborating around your product definition. By visually interacting with product variants filtered by lifecycle state, and effectivity for design reviews, users can view designs at actual size, superimposed over the real world. AR can also transform your existing BOM and related CAD data into detailed experiences that provide critical information to front-line workers when and where they need it most—during training, quality inspection, repairs, and more.



5. Improve component and supplier management.

New parts can cost thousands or even tens of thousands of dollars. That's why part reuse becomes a key driver in helping reduce costs and increase efficiency across the enterprise. Part reuse can help reduce inventory complexity, improve supply chain utilization, and lessen complexity in aftermarket serviceability; for example, when determining which version of a M6-1.0 x 25mm bolt to use or which supplier has the part.

Assume a company creates a high volume of parts each year. Even with a low rate of duplicate parts, the opportunity for costs savings through reuse is very high as illustrated by the following formula:

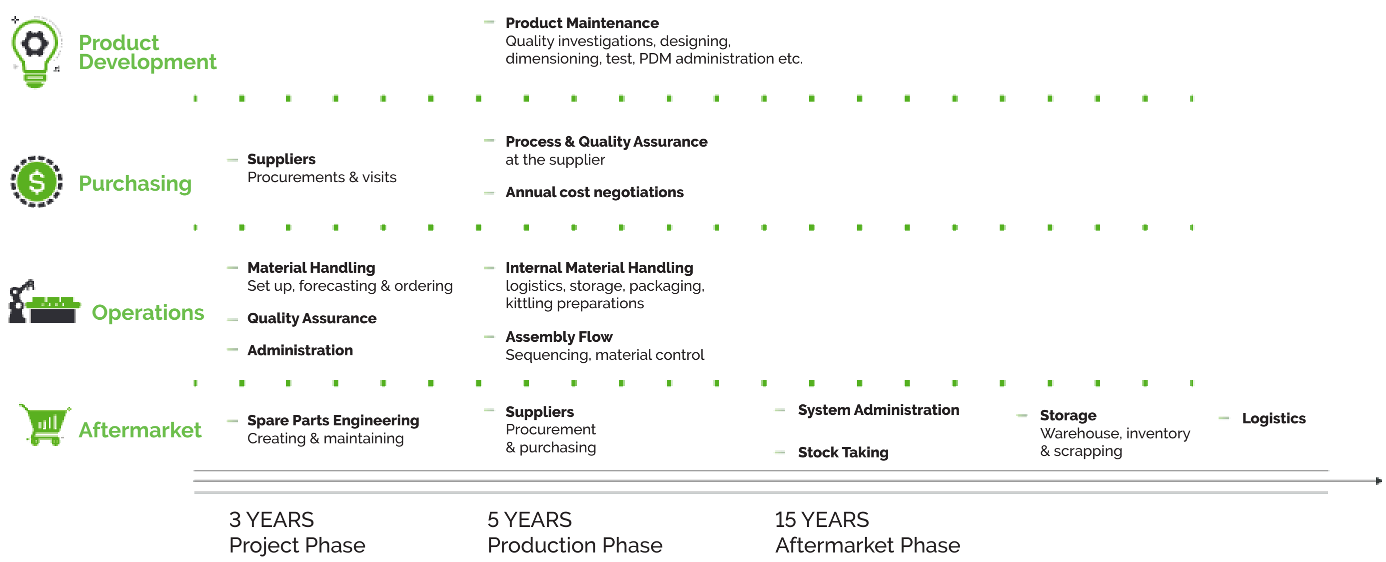
Pi x 12 x D% x Pic = $2,880,000 / year

- Pi - Part introduction rate (3000)
- 12 - Time period (months)
- D% - Duplicate part percentage (2%)
- Pic - Cost to introduce a new part ($4000)

PLM supports two approaches to help solve the challenge of part reuse in the enterprise. The first of these methods is called classification. With classification, additional information is added to the part's description to make it easy to break parts down by category. These categories could include hardware, electrical, sourced components, and more.

Examples might be a bolt in the hardware category and classified as a "HEX HEAD, HEAVY" with attributes that include the length, thread pitch, and finish, or a capacitor might be categorized as a "FILM, SURFACE MOUNT" with attributes that describe its capacitance, voltage, temperature rating, and more.

With access to this type of information, users can easily find existing parts that meet their design needs, which eliminates the need to create new parts. This information provides value to the engineering team designing the product, along with those on downstream teams that need the data. This enables the supply chain to better communicate around available parts. At the same time, the manufacturing group can prepare appropriate tooling and verification while the service department can plan for field service needs.

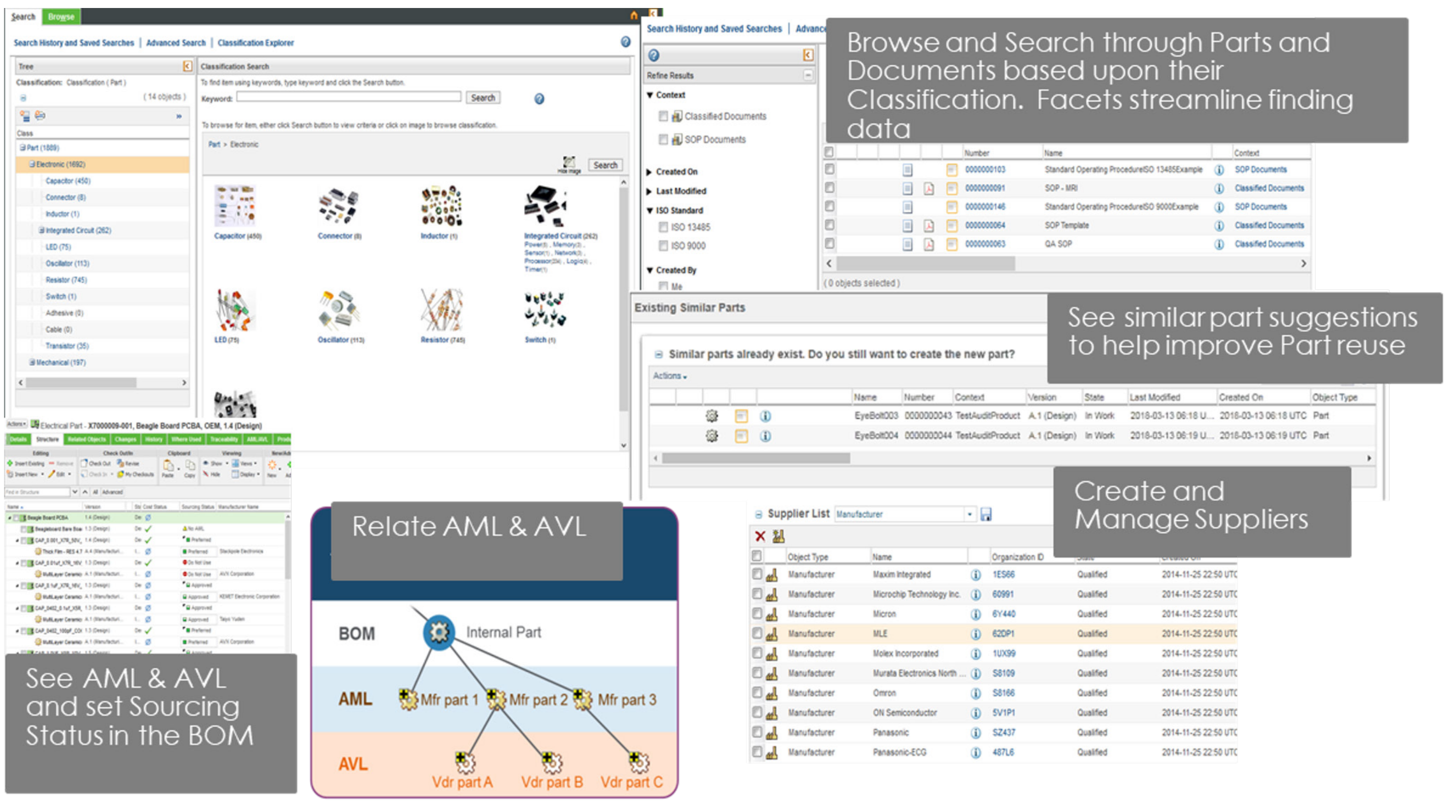


Lifetime Value of a Part

Another way to better manage product reuse is through supplier management. Numerous parts are often sourced from external suppliers. In many cases, the same bolt or capacitor can be sourced from a range of suppliers based upon region, availability, cost, or compliance. To optimize product reuse, the enterprise needs to understand which parts can be sourced from which suppliers as a product is being defined.

A PLM system makes it possible to list and track vendors and manufacturers and the parts each offers. The bolt in the above example might be available from three companies. To better understand the product definition, the BOM can show the relationship between the part and the supplier(s). This can even include specific information associated with each supplier, such as cut sheets, specification documents, compliance certifications, and more. Leveraging related product information, users can dig into a part to see the product requirements and CAD drawing, along with relevant supplier documentation. Further, users can indicate preferred or approved suppliers and even define that based on location. A plant in the United States might work with a certain approved supplier, while a plant in Europe may work with a different supplier.

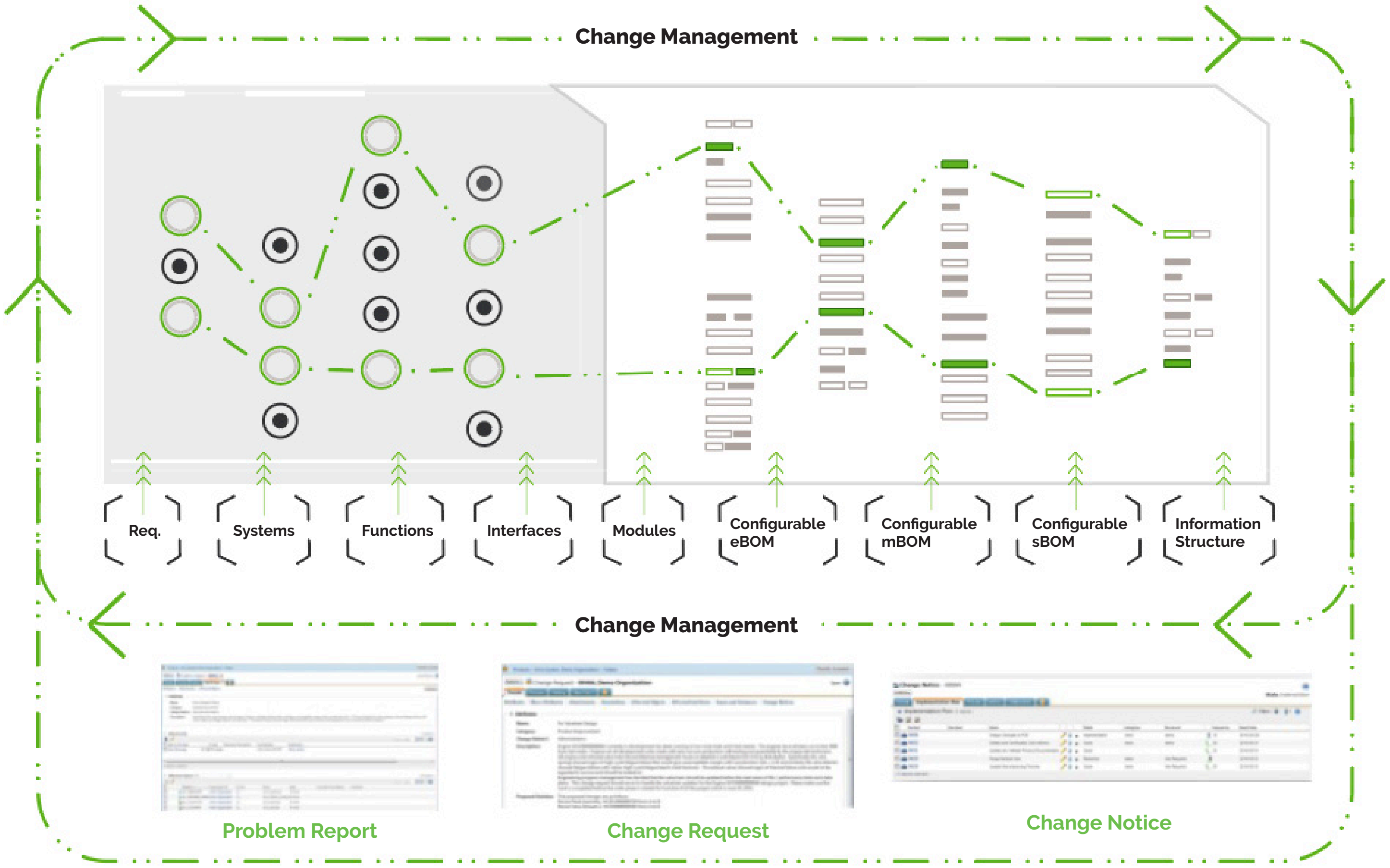
The example below shows how organizations can use a PLM system to relate supplier parts and their status (i.e., Approved or Do Not Use) to a BOM.



The combination of support for classification and supplier management in a PLM system helps improve part reuse. It also provides the enterprise with better information about the parts being used, enabling users to quickly find the parts they want.

6. Ensure complete change management and traceability.

In today's modern environment, products evolve rapidly. Users need a way to easily manage changes to a product's definition and share those changes across the enterprise. Product development teams tend to capture changes in BOMs, as these are viewed as the document of record for products being developed. However, deliverables across many disciplines must reflect any product development changes to ensure that all changes are proactively considered and managed during execution. As such, systematic access to related information and access to the correct versions and configurations is critical.



How the enterprise can participate in change processes

Digital product traceability goes hand in hand with change management. Traceability across product development deliverables establishes a hierarchy of control to propagate changes across the entire design, so teams are not working in silos, and can share and maintain design intent between sub-assemblies. No matter where a change originates—whether within engineering, supply chain, or manufacturing—product changes ripple across cross-discipline deliverables.

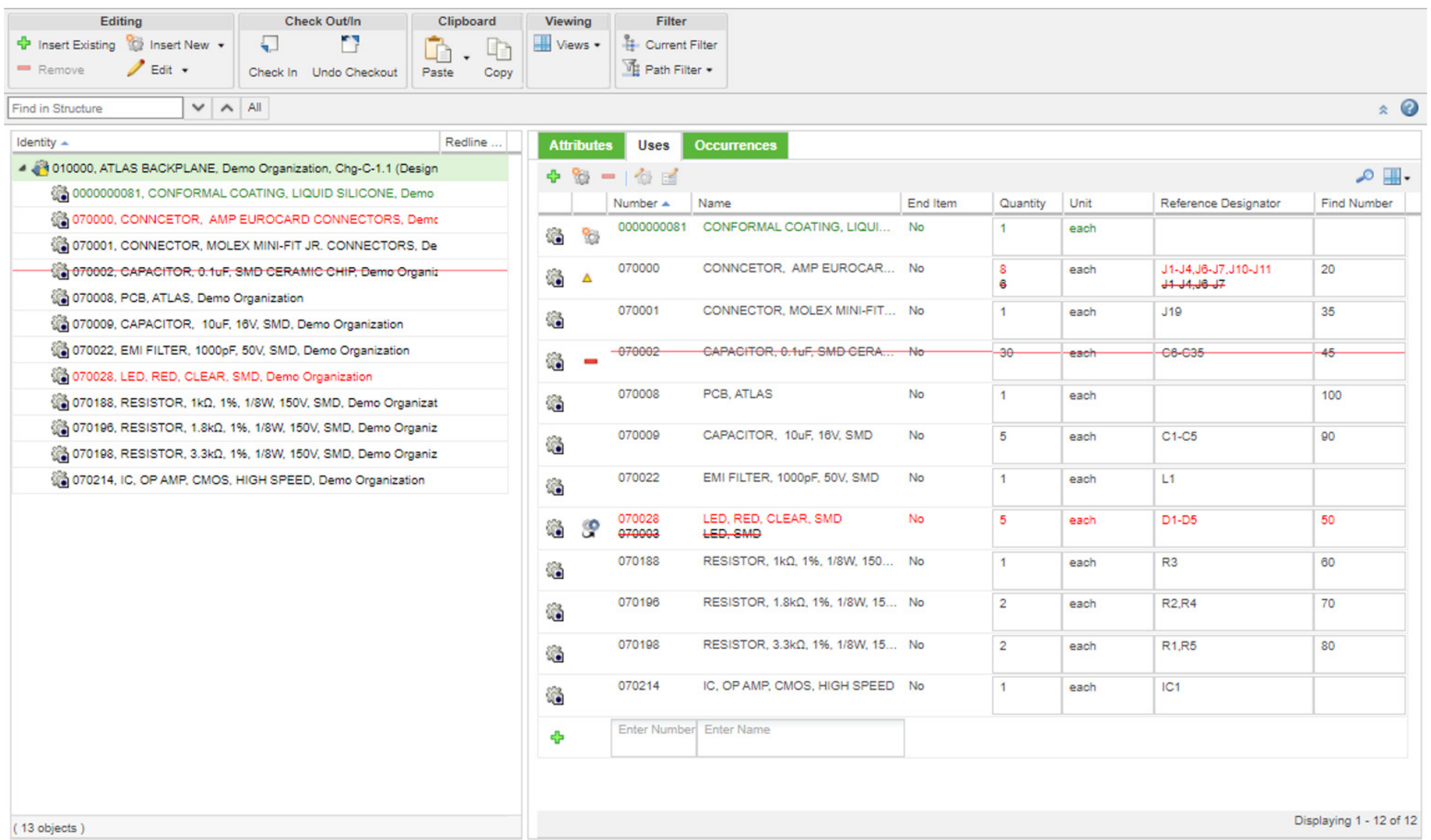
However, developing and monitoring key deliverables—and analyzing the impact of changes in one deliverable on others—can be extremely challenging if information is scattered across systems. Manual efforts to aggregate the information not only distract from strategic work, they increase the likelihood of mistakes and associated cost implications. If there is a redline on a particular version, it could be outdated. Change intent and planning ensures that redlines are automatically refreshed to the latest iteration, keeping the redline up to date. Change quality is improved, and frustration and rework are reduced, by enabling planning and approval before a user pulls a revision.

PLM and comprehensive configuration management can greatly assist in ensuring traceability throughout the change process. A PLM system can enable the organization to identify, collect, and execute changes across all disciplines in the digital product definition. Just as important, it can then feed those changes to enterprise systems, such as ERP and manufacturing execution (MES), greatly simplifying and improving product development.

Example: Leveraging BOMs to optimize changes:

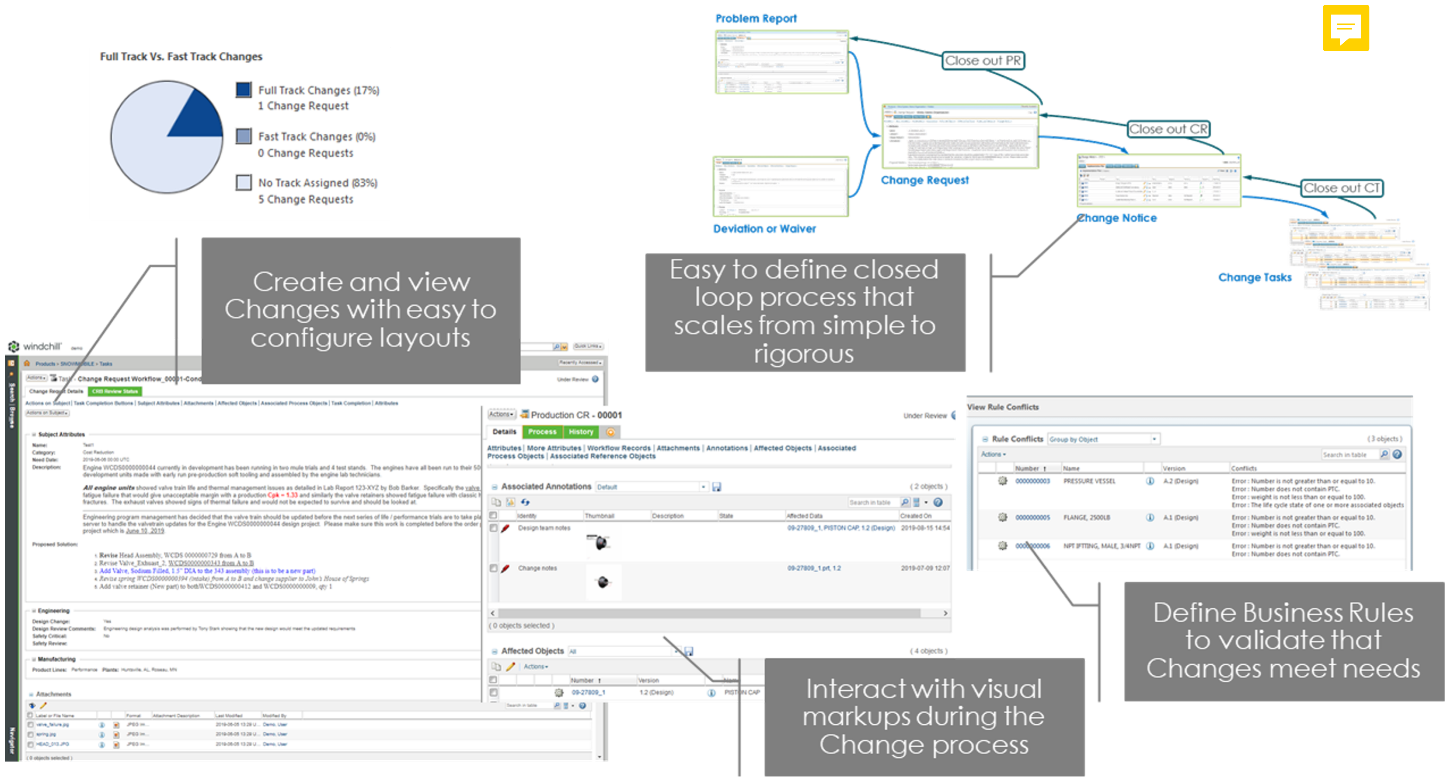
When product changes occur, the organization needs to analyze the technical and business implications. For instance, if a frame weldment changes, the organization must determine what else might need to change, such as the CAD drawing and requirements document. Moreover, if that frame is used in two other assemblies, all documents related to those must also be updated. This requires the ability to collect and analyze dependent and related data when making the change. It also requires the ability to identify those who need to be involved in the change, such as supply chain, manufacturing, etc., to properly scope out the change and its impacts.

Impact analysis helps ensure all aspects of changes are considered and executed appropriately across the organization. Impact analysis is most effective when resulting changes can be easily identified, planned, and accounted for as part of the enterprise change process. Enabling users to plan changes, using tools like redlines, as illustrated below, and have those reviewed and understood across the enterprise is key towards delivering high quality changes the first time.



To enable effective impact analysis, all related data needs to be collected, based on an understanding of product configurations, so the organization can be sure it is using the right versions of data. With a digital product definition, the organization can call on solid configuration management methodologies that ensure they are accessing the right related information.

The graphic on the next page shows how a complete digital product definition leverages different types of information and relationships to easily collect "sets" of information. This "collection" approach can also be leveraged in additional areas, including change impact analysis and to enable collaboration, among others.



Collaborative Change Management

7. Optimize downstream utilization.

A PLM system that can help ensure data accuracy and configurations of upstream and downstream deliverables can optimize workflows and processes across the organization. Cross-departmental collaboration and the ability to run parallel processes require early visibility to consumable information. Early access makes it possible to reduce development times but is not sufficient alone to support parallel efforts.

Downstream functions, such as supply management, manufacturing planning, and services can accelerate their own processes by using data from the engineering BOM to create their own respective deliverables in parallel. Visualization is a perfect way to make downstream functions more efficient and effective. For instance, accurate and complete visualization enables downstream teams, such as manufacturing, to author deliverables, including plant specific MBOMs or work instructions and product support to develop technical service information and procedures.

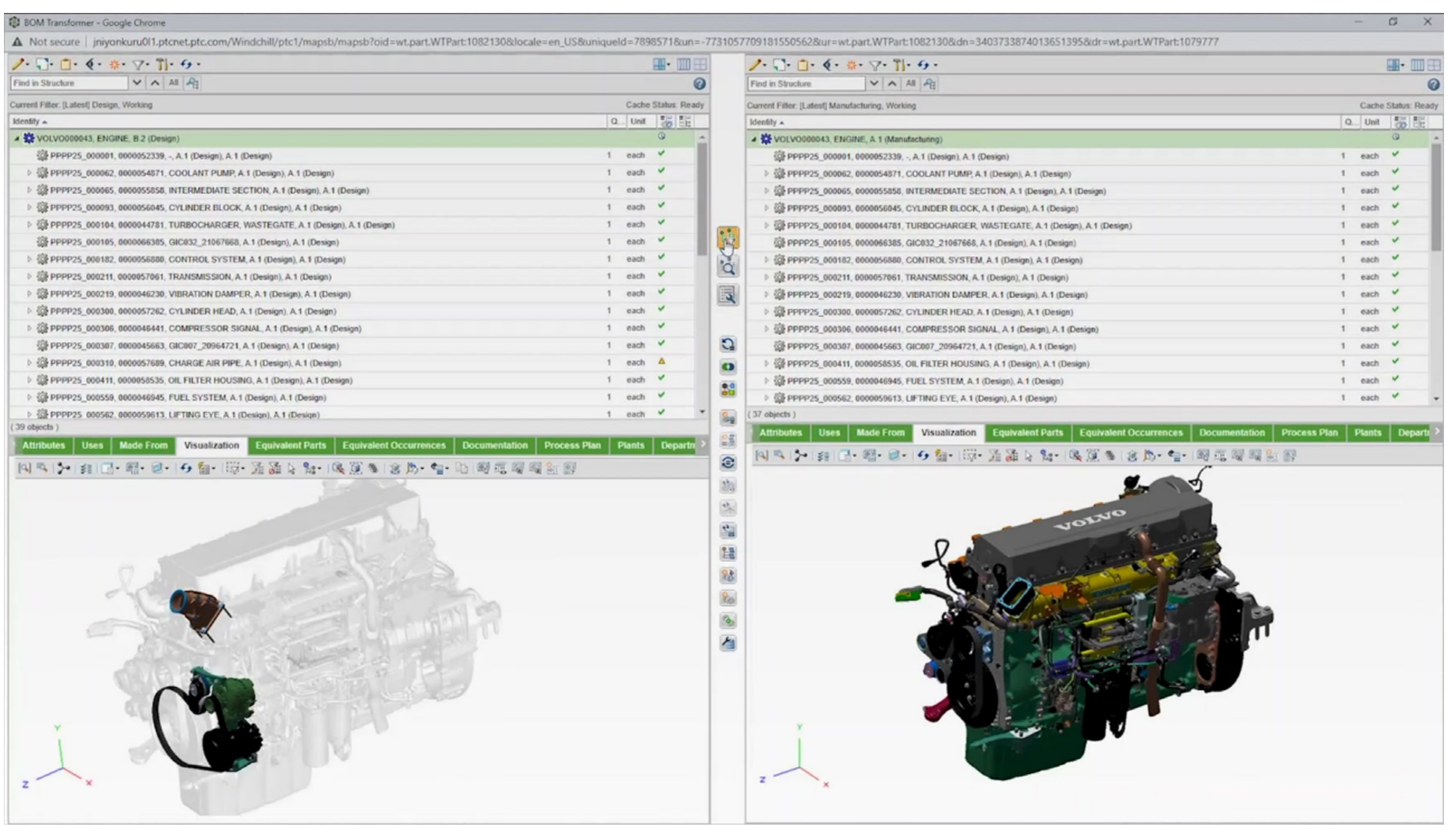
The resulting benefits are considerable. Since downstream deliverables leverage the digital product definition, organizations can dramatically reduce rework, while speeding product development release cycles and decreasing time to market.

> **“The Digital Thread begins by focusing on product design data and effectively managing the digital engineering content. Once that foundation is in place, organizations can realize significant value by extending information access between projects, divisions, partners, and customers.”**

Example: Leveraging visualization for manufacturing and service planning:
Many companies are pursuing "design anywhere, build anywhere, service everywhere" strategies. This requires close collaboration between product, manufacturing, and service engineering. These three groups typically focus on different aspects of product development. Product engineering is focused on designing products that meet the form, fit, and function requirements for end customers. Manufacturing engineering is focused on planning how the company will build, assemble, and fabricate the physical products. Service engineering is focused on planning how to source parts and repair the physical products in the field. To accommodate their similar, yet different, goals, these three groups often organize data differently.

3D visualization, as part of a complete digital product definition, can serve as a universal translator between these organizations. Regardless of how product engineering organizes the product structure (i.e., BOM), manufacturing and service engineering can easily view and understand the 3D design. As manufacturing and service engineering call upon product engineering deliverables and information to create their deliverables, the PLM system keeps track. This "equivalency" creates an association that allows upstream changes to easily be reconciled in downstream deliverables. Visualization and full configuration management of upstream/downstream structures are the mechanisms for making this happen. This downstream transformation process can also be used by product support for technical illustrations, parts lists, and procedures.

The figure below shows how visualization plays a key role in managing upstream and downstream structures and maintaining "associativity" between two sets of data. Visually centric PLM tools allow users to select and manipulate data from the 3D viewer to accommodate the needs of downstream teams.



3D visualization not only delivers for single BOMs or designs but can scale to simplify delivering 3D for modular configurable products. The power of configurable platforms not only helps deliver a diverse range of product offerings; it gives users access to accurate 3D viewables for those configurable platforms. Users no longer need to find a CAD designer to get correct 3D viewables for a design. By selecting the configuration needed, the users will get the 3D model with the parts in the correct locations. Further, for a family of products the enterprise can access what they need for any given configuration. This includes 3D viewables. This information can be used to open the correct configuration in CAD, as well. An organization can save a lot of time by having access to 3D visualizations, with correct configurations that span a huge range of product offerings.

8. Enable effective collaboration and IP protection.

Both internal and external participants are involved in the product development process of an NPI. To maximize the productivity of these resources, it is critical to share relevant, accurate, up-to-date data that can be accessed and used with minimal rework—all while protecting intellectual property (IP).

Internal collaboration often seems simpler than external collaboration since all participants can typically access the PLM system directly. However, even then, IP policies must be in place to ensure access privileges are consistent with regulatory or other internal policies.

IP protection is critical for global companies that want to optimize collaboration without introducing the risk of losing IP or failing to meet regulatory requirements. Comprehensive IP protection must address multiple dimensions of criteria to effectively support the combination of different rules and permutations to access any object. When the concept of dimensional access is scaled to all product development data, traditional access control list (ACL) policies or folder-based approaches are simply unsustainable.

Additionally, IP protection must be at the foundation of the security model so mandatory policies are adhered to regardless of how data is accessed (whether via user interface, during collaboration, via API, etc.). However, it can be extremely challenging to enforce standard IP policies across multiple access points. Each application may administer IP policies differently. Maintaining policy synchronization across multiple systems can be complicated, time consuming, and error prone, and IP protection is only as strong as the weakest link.

To enable streamlined, effective collaboration with external participants, the organization must collect and provide access to sets of related data. When data is collected manually for these purposes, it must be done to enable the initial interactions and throughout the entire collaboration process with external participants—however long that may take. If information becomes outdated, the participants cannot make informed decisions or recommendations.

To enable effective collaboration, information must be shared in a format that can be used in its native form. For example, detailed designs often involve working directly in the CAD format to co-develop the design or to create supporting deliverables.

Simply providing snapshots in the form of PDFs, derivative viewables, or drawings puts the onus on downstream participants to recreate the data to suit their purposes. CAD assemblies, such as these are also of little use during collaboration without supporting documentation, such as requirements or specifications that include all components, family parts, and drawings.

To ensure optimal collaboration, while minimizing risks, organizations must be able to easily collect and appropriately share all types of data, while adhering to access controls and IP policies. By calling upon a PLM solution that can effectively manage all elements of collaboration, organizations can avoid duplication of siloed data, and the associated costs related to rework, scrap, or loss of IP.

Ensure protection of intellectual property

9. Create BOM-based reports.

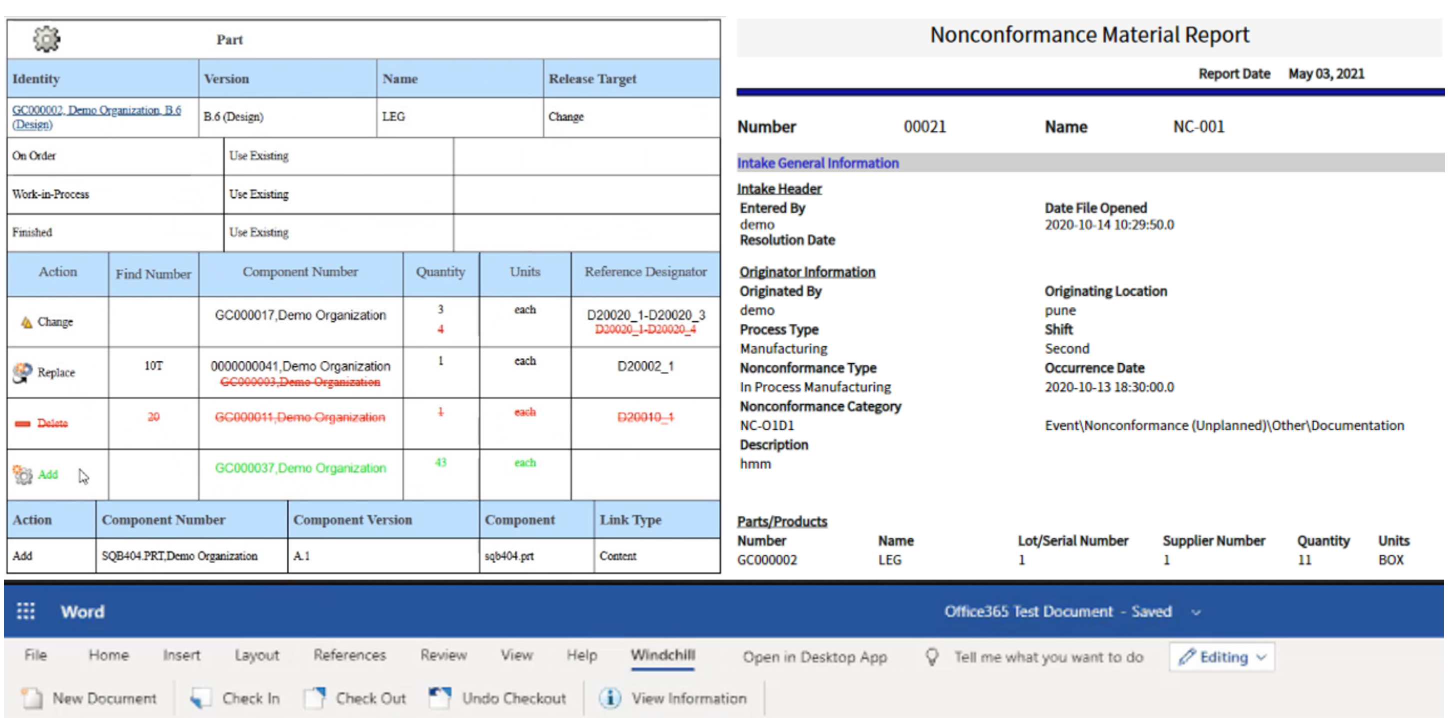
As mentioned previously, product development is dynamic, with changes occurring constantly. Users across the organization need to get information from the digital product definition for a variety of needs. Many times, this can take the form of a report or even simply allowing the user to control what information is shown when looking at a BOM.

> Organizations will realize the most value from a BOM by tailoring it to effectively manage and deliver product information to various roles and participants across the enterprise.

As digital product definitions mature, it is important that stakeholders (from many disciplines) have visibility into the design and can integrate it with their respective job functions. Organizations can share product data and designs in many ways, including via a standard user interface, ad hoc reports, 3D visual reports, and advanced reports created by administrators.

A key enabler of a PLM system is the ability to provide a wide range of reports for the organization. These reports enable users to better understand the digital product definition, allow them to query and find specific information and understand patterns, and analyze the products. Organizations can deliver this information through a PLM tool or as a report that can be accessed offline by those who need to conduct analysis, present reviews, or share with others.

PLM systems can also satisfy demands for more interactive ways to understand and work with data. By delivering both tabular and graphical data, they give users easier and more powerful ways to get insight to their digital product definition. This facilitates more informed decisions in the development process, such as determining what areas of the product need focus or identifying opportunities for cost reduction.



Reporting and Document Management

10. Make BOM transformation a reality.

While a BOM unlocks many benefits across the enterprise, different disciplines in the enterprise may need to see it in different structures.

Many enterprises rely on just one view of the BOM (the engineering view), forcing those outside of product development to manually copy and restructure the BOM to suit their needs. This leads to outdated data and a laborious process to keep both upstream and downstream changes aligned.

The way a BOM is structured to deliver the system and engineering design might not make sense for manufacturing or for service. Manufacturing will want to structure the BOM in a way that facilitates efficient production planning and validation, while service will want to structure it in a way that helps with service planning.

Within PLM lies the concept of BOM transformation—that is, allowing a group to manipulate the original BOM to a view that works for them. For example, the manufacturing group could manipulate the engineering view for production planning, while the service group manipulates it to satisfy their needs.

Those organizations that arrive at a digital product definition can enable this transformation through a concept of equivalency. Whereby, the parts transformed to the new view understand what they were equivalent to in the original view. This enables downstream users—such as those in manufacturing and service—to plan their BOMs earlier in the process rather than wait for engineering to finish their drawings. In other words, they can start planning their work as the engineering BOM is evolving.

This BOM transformation enables manufacturing to deliver not just one plan, but multiple plans specific to different production plants or even different lines within the plant. Because these downstream plans are tied back to the engineering view, all upstream changes can be easily understood, reconciled, and tracked in downstream views. This saves both the upstream and downstream user time and lessens the potential of errors when trying to keep different plans current.

Comprehensive digital product definitions enable users to easily transform both BOM structures and visualizations and keep them organized. This gives powerful visual feedback so manufacturing engineers and service planners can better understand their tasks. A robust digital product definition can also make it easy for users to see and track any discrepancies as they perform their BOM transformation.

BOM transformation is not just for engineering and manufacturing. The same concepts can be applied when creating a view of the product to be used by the service department for planning a Service BOM and parts lists. Service can then take advantage of the same benefits of concurrent planning and feedback afforded to manufacturing.

BOM transformation can also be used for other needs, such as creating an analysis view of the BOM for verification activities, like simulation or material compliance. BOM transformation provides different users with a BOM that fits their needs, while ensuring alignment and consistency in the BOM data. Add to this earlier access to data, true concurrent design and feedback, and organizations can improve time to market while delivering higher quality products.

Achieve a long-term vision in incremental steps

It's important to remember that any transformation is a journey. When striving to realize a complete digital product definition and more product development capabilities, organizations can take the journey in manageable phases.

Even by taking small steps toward realizing a digital product definition, an organization will immediately begin to reap the benefits. This can include anything from better organized product data in an eBOM, to easy consolidation of relevant information for external stakeholders.

With the BOM at the foundation of the digital thread, the next move is to the mBOM and sBOM. Though quick wins are important for driving increased organizational confidence and adoption of a PLM system, it is important to keep a viable long-term vision in mind. Ideally, organizations should strike a balance: while they may find it hard to realize a long-term vision if they only pursue one best practice at a time, they need to avoid short-term decisions that will limit long-term value. Simply put, to maximize the value and ROI of a PLM implementation, an organization must be sure they can create a digital product definition capable of supporting their short-term needs and long-term goals.

It may be challenging to gain initial traction with one or a few of the PLM best practices covered in this paper. However, with each win, an organization will see tangible, positive business outcomes that help grow internal confidence. By embracing these best practices, an organization can set the stage for a mature approach to PLM, revolving around a complete digital product definition and comprehensive BOM.

Remember: meaningful change does not happen overnight. Be targeted, be patient, and keep in mind that PLM and a digital product definition will ultimately drive an enterprise into the digital era.

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