



White Paper Series

Process Based Change Control and Bill of Materials Management

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Introduction

When a company is on a roll, it is easy to make profits. In the late 90's, Sun Microsystems could do no wrong. Everybody wanted a Sun box to host their company portal on the Internet. When profits are rolling in, people don't spend a lot of time determining how efficient their processes are.

After the burst of the high-tech bubble, however, companies were left scrambling to make profits on lower revenues. The initial reaction of companies was to look to layoffs to improve the bottom line. Realizing that they cannot cut headcount anymore without hurting themselves, companies are now looking at their processes to see how improvements can impact their bottom line.

The objectives of Engineering Change Control include the capability to perform the following activities:

- verify what is to be changed
- determine the estimated cost of changes in advance so as to enable the most cost effective decision
- determine when the change is to be made, i.e., if the change is mandatory/immediate, or if it can be implemented at a later time, e.g., as existing stock of the item being replaced is depleted; and
- communicate change information efficiently and effectively throughout the organization so as to avoid the manufacture or purchase of items no longer needed, as well as to avoid the loss of production through late arrival of new parts.

This white paper will show how companies using Ingenuus software are finding that they can verify, make determinations, and communicate engineering changes more quickly and effectively saving time and money.

Overview of the Process

The main task of a manufacturing company is to build something. Each product that is built has a product lifecycle that might look like this:



Being able to manage the product lifecycle is the goal of Product Lifecycle Management. But too often the goal is rarely realized.

Why Make Changes?

Reasons for making an engineering change are many.

Market/Customer driven change

A mandatory customer requirement may lead to a customer driven change. In many situations, the cost of the change is frequently negotiable as a charge back to the customer. Thus, the timeliness and accuracy of data used to estimate item availability and cost of change must be precise.

The engineer reviews the product definition data for each usage of an affected item and obtains existing item costs, commitments and stock levels. This information provides an accurate basis for decision making and approval of the change. It answers such questions as: which end items are affected, what is the effect on end item costs, what material losses would be caused by the change, what orders currently in production are affected. Problems arising from late or incorrect communication of changes are reduced or eliminated. For example, Purchasing is informed that an item is about to be made obsolete. Purchase Orders about to be placed can then be withheld and work on purchase orders already placed can be halted, minimizing cancellation charges. At the same time, production on released shop orders can be halted, minimizing rework.

During the implementation stage the users will be monitoring the status of activities to planned effectivity dates, serials or seiban numbers so as to coordinate the discontinuance of use of the old method or material with the start of use of the new method or material. This information enables the responsible user to monitor the change process. Measurement of planned to actual time and cost will improve the estimating of future engineering changes.

Product improvements/Technological advances

On-going product development and feedback from industrial engineers and field service engineers cause changes affecting the bills of material and routings.

Safety Considerations

Changes made for reasons of safety are generally considered mandatory and must be implemented immediately. If they also apply to products already in service with customers, the engineering change level, that is, item Rev or serial, as well as the customer site location of these products must be known.

Cost reduction

Improvements to process efficiencies may yield changes to routings that affect item costs, leadtimes, tools and work center loads. Projected need dates and estimated costs will be reviewed by the individual responsible for making the change. This will be accomplished by examining the effect of a single, proposed change, as well as many alternative changes. For example, alternate materials can be introduced for an item, or a class of items, to obtain comparative cost effects. The date at which a proposed change will be implemented can be varied to discover the date yielding the lowest total cost, based on existing stocks and open purchase orders and work orders.

The Product Lifecycle

Manufacturers use many different software packages during the product lifecycle, but we will limit our discussion primarily to office documents, CAD, EDM, PDM/PLM and ERP.

Managing Bills of Materials In A Product Lifecycle

Managing product information, and changes to that product information are critical for manufacturing companies. So why is it that the technology analysts at Gartner say that less than 10% of companies using sophisticated product lifecycle management (PLM) tools have automated the product change process known as engineering change?

There are many factors to consider before answering, and some of them are technical while others remain cultural. We will look at both the technological and cultural aspects of managing product changes.

The Many Faces of a BOM

Most manufacturing CEOs will say that they only have one bill of materials. What they really mean is that there is one that is effective today for manufacturing and only one. However, the BOM evolved over time from design to manufacturing. In an effort to identify the BOM in these many stages some have envisioned different types of BOMs. Some examples include:

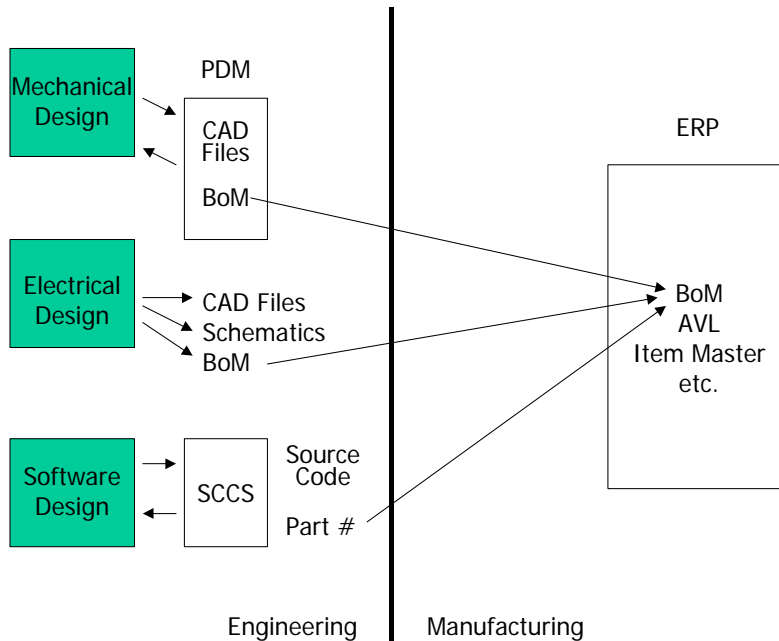
AS DESIGNED - An engineering bill of materials is commonly referred to as the 'as designed' bill of materials. Engineering designed the palm device using these parts.

AS PLANNED - Manufacturing is planning to manufacture product and may be they found a better supplier for screens. They will reflect the change in the bill to the 'as planned' form.

AS MANUFACTURED - This bill of materials should reflect what the factory actually built. This may also be called the 'as shipped' bill of materials.

AS MAINTAINED - This bill of materials will reflect the palm device as it sits in my (the consumer) hand.

We know of one company that has 7 bills of materials. Theirs include: As Designed, As Planned, As Customized, As Manufactured, As Tweaked, As Accepted, & As Maintained. These BOMs represent the BOM lifecycle and for companies that desire the ability to manage their BOMs electronically, they have had to use this type of nomenclature. This could be eliminated using a single, unified BOM approach.



All of this activity surrounding product data usually breaks down into two major camps – engineering and manufacturing. We have heard the jokes about engineering throwing their data “over the wall” to manufacturing neither caring if the data is useful or indeed even able to be manufactured! Manufacturing must rework much of the information, and requests for changes that would make their lives easier are ignored.

As a result both sides contend that they must control the product master. Such attitudes have hindered the progress of product information automation for many years. The time and energy in maintaining multiple BOMs is not recouped in increased clarity, productivity or efficiency. Instead, it usually serves to deepen the divide between engineering and manufacturing.

Many consultants work on helping companies change these anti-productive attitudes but find many returning to old ways because corporate processes do not support a new way of doing business that would facilitate change, collaboration, and cooperation.

In most cases there are two BOMs – one for engineering (EBOM) and one for manufacturing (MBOM). The EBOM is a list of the parts that define the design of the palm device. The MBOM is the EBOM plus all the materials and tools required to manufacture the palm device

In a perfect world, everyone would use the same BOM – design, purchasing, materials, tooling, manufacturing, field service, etc. Early access to the EBOM for departments beyond design and manufacturing mean better collaboration and efficiency.

We will look at both sides of this issue.

Communicating Changes

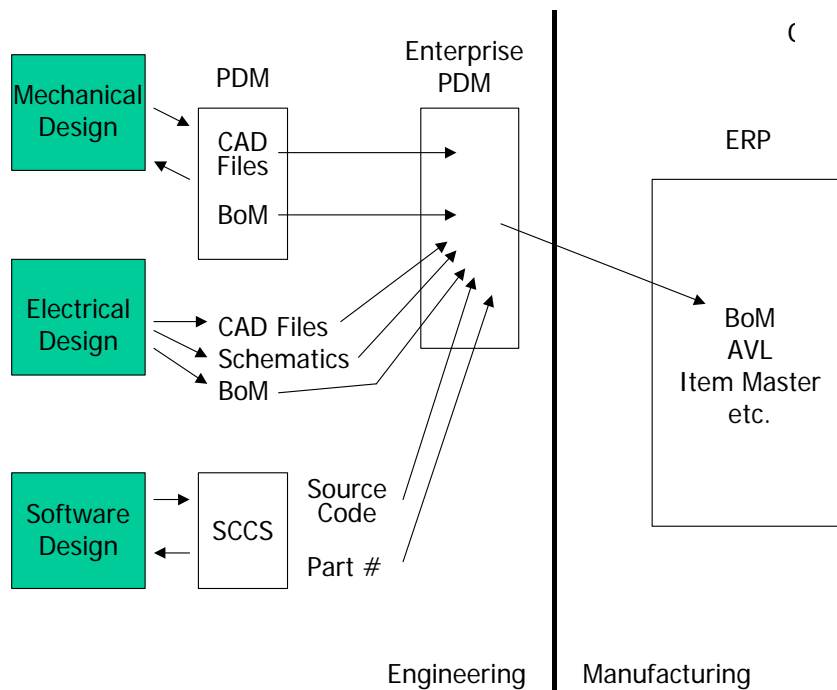
Failure to reflect engineering changes in the product definition promptly and accurately can result in some or all of the following issues:

- the end product may not correspond to the product specified. This leads to customer dissatisfaction and the possible loss of future sales.
- the product may be incorrectly costed and thus sold at a loss.
- obsolete parts may be made, resulting in scrap or rework.
- subsequent engineering changes may be designed using inaccurate information. Correction of this situation often requires yet another engineering change.
- purchase commitments for discontinued parts are placed, resulting in cancellation costs.
- orders for the new parts are placed late, resulting in expediting costs or material shortages.

Control of engineering changes is complicated by the number of different departments involved in the planning for and implementation of each change. The volume of changes being made also impacts the user's ability to control those changes. Communicating the change, and easily providing the information needed to implement the change can be done by the system, thus reducing the total time (and cost) required to implement an engineering change.

Engineering Centric Change Control

Engineering usually feels very strongly that they should be managing the product configurations. This claim has excellent support. It is clear that they should manage the pre-released configurations of their designs. For many companies, that is the assumption and data sharing with others might look like this:



A typical engineering approach to product management would have the enterprise PDM/PLM located in the domain of engineering but attempting to service the entire organization. In this scenario, the EBOM and its documents are in the enterprise PDM/PLM. But the AVL and Item Master are in the ERP. Upon release, many companies are forced to manually enter the engineering information into their ERP. Engineering would prefer changes to the product to be managed by the enterprise PDM/PLM. This requirement means that the Enterprise PDM must be implemented to perform the task of integration to ERP as well as be able to do configuration management.

Note: This is when PDM/PLM implementations take from 1-5 years to implement.

The diagram above addresses technology, it does not address the process. The actual processes don't care about the wall between engineering and manufacturing or where the bill of materials resides.

Manufacturing Centric Change Control

Most of the manufacturing companies that we have talked to want to have the master BOM in the ERP. If anyone asks what is being manufactured today, they go to the ERP to see the bill (not the PDM/PLM). The manufacturing organization believes that it should own the configuration management task because:

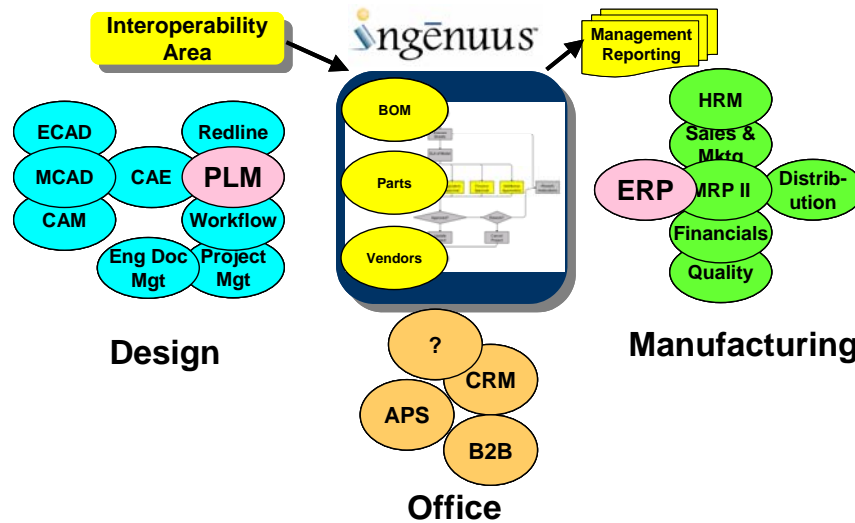
- The master bill of materials resides in the ERP

- ERP software was written specifically to provide configuration management
- Manufacturing is responsible for the MBOM
- The AVL will be managed in the ERP
- The Item master will be managed in the ERP

As you might guess, each party will feel strongly that they should be managing the configurations. So let's examine another approach.

The Unified BOM

Ingenuus has developed software that enables manufacturers to manage a product more like a process instead of simply managing the product data and do this in a data neutral role. Our approach to BOM unification assumes that the MBOM in the ERP



Source: D. N. Frank Associates

system is the corporate “master”. It is, for many, the BOM of record. Companies who want to extend the life of the BOM to field support using an “As-Maintained” can easily add information to the MBOM as we will describe. In fact, any of the “AS” BOMs can be views of the unified BOM.

The secret to making the unified BOM work is to provide an interoperability area where BOMs can be exported from ERP, manipulated with additions, deletions, and corrections, and then later uploaded back to the ERP system. This middle ground allows for multiple views of the BOM eliminating the need for many BOMS reducing errors and improving efficiency.

The interoperability area can also serve other departments by automating processes that require collaboration between departments and even vendors, suppliers and partners. It is the perfect place to invite contract manufactures to participate in the product lifecycle without leaving critical internal systems exposed. Many companies have spent millions on creating internet portals to provide this capability, but Ingenuus makes it available for much less and can be deployed quickly.

The interoperability area provided by the Smart Expediter eliminates the need for high priced user seats to department focused software tools like CAD or ERP. Lower cost user seats for the interoperability area mean that participants from all over the enterprise can now participate in the creation, review, modification, and update of company information. This includes information effected by the BOM but not traditionally part of the BOM.

Change Control Made Simple

Ingenueus provides an interoperability area that sits between major creation and management tools providing a data neutral area for change to be managed. Our interoperability area is process centric and designed to optimize collaboration and data sharing.

From a process point of view, the BOM is one of the data elements that are part of the process. In this respect, a BOM is treated like another document or information. But because a BOM is a very special type of information “bundle”, special tools are required

to manage it.

It doesn't matter which CAD package or PLM system you use. Choose the ERP software that provides your company with the functionality required to run your

business. But manage changes, release and distribution of your critical corporate data using the interoperability area provided by Ingenuus. Import BOMs from ERP or PDM/PLM into Ingenuus. The Ingenuus Smart Expediter provides an indented BOM view for easy navigation.

Bulk addition, deletion, and changes are imperative components of BOM management. Configurable reports, BOM edits, BOM comparisons, and other BOM management capabilities are critical to making the change management process more efficient and productive.

The screenshot displays the Ingenuus Manufacturing Change Manager interface. At the top, there is a navigation bar with 'Inbox | Log Out | Help' and a search box. Below this, the 'Manufacturing Change Manager' title is visible. The main header area includes 'Reports | Library | Advanced Search' and a search input field. The central panel shows the 'Revision: B' and 'Description: Palm Device B' with a 'Number: 151-0000' and 'Status: Defined'. A left sidebar contains a 'Rev History' menu and a 'Navigation' section with 'Page Size: 20' and various comparison options. The main content area features a BOM tree with categories like 'General', 'Factory Attributes', 'Approved Vendor List', 'Revised Documents', 'Attachments', and 'Where Used'. Below the tree, a table lists 13 items with columns for Item, Rev. No., Line No., Description, Qty, UOM, Eff. Date, Dis. Date, EC, Alt. Sub, and Seq. #. The table shows various components like screens, manuals, warranty cards, screws, PCBs, buttons, cradles, and packaging, along with their quantities and effective dates.

Item	Rev. No.	Line No.	Description	Qty	UOM	Eff. Date	Dis. Date	EC	Alt. Sub	Seq. #	Des.
D 131-0001	A	6	Black & White Screen	1	EA	2/1/2001			N N	0 1	
A 131-0002	A	6	Color Screen	1	EA	10/30/2001		01-0001	N N	1	
= 141-0001	A	8	Manual for Palm Device	1	EA	2/1/2001			N N	0 1	
= 141-0002	A	9	Warranty Card for Palm Device	1	EA	2/1/2001			N N	0 1	
= 127-0004	A	4	Screws for PCB inside Palm Device	4	EA	2/1/2001			N N	0 4	
= 139-0001	A	7	PCB for Palm Device	1	EA	2/1/2001			N N	0 1	
= 125-0000	A	2	Buttons	1	EA	2/1/2001			N N	0 1	
= 128-0000	A	5	Cradle	1	EA	2/1/2001			N N	0 1	
= 143-0000	A	10	Packaging	1	EA	2/1/2001			N N	0 1	
C 127-0001	A	3	Pen for Palm Device	1	EA	2/1/2001			N N	0 1	
C 127-0001	A	3	Pen for Palm Device	2	EA	2/1/2001			N N	0 2	
C 123-0000	A	1	Palm Device Housing	1	EA	2/1/2001			N N	0 1	
C 123-0000	A	1	Palm Device Housing	1	EA	2/1/2001			N N	0 1	

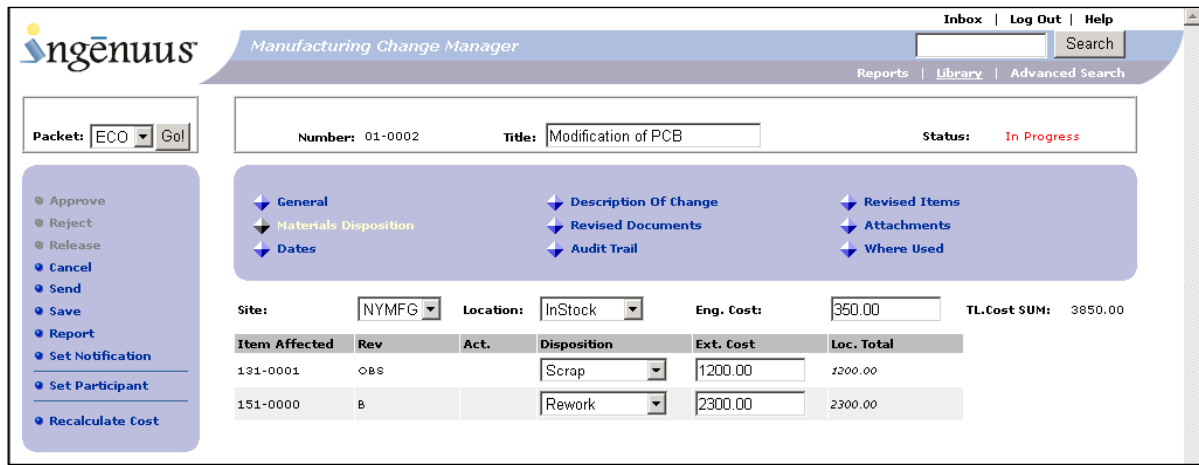
Ingenuus provides Master Item/Part capabilities that make it easier for companies to standardize on a global part number scheme after acquisition or merger.

Users can query the Smart Expediter using the part number they are familiar with and the system is smart enough to find the part and then show what other part numbers are used to describe the part.

In addition to Master Part numbers, Ingenuus Smart Expediter also provides for approved vendor lists (AVL) that are maintained in the interoperability area then uploaded into the ERP.

No interoperability area would be complete without integration middleware to make exchange of information with external systems easy. Ingenuus Smart Expediter comes with the Integration Gateway option that makes integration easy to do and maintain.

Using the Integration Gateway, companies can import data into any Smart Expediter process. To improve the change process, product cost information can be imported to help make material disposition decisions and allow engineers and other participants to understand the impact of the change proposal.



The Integration Gateway is also used to publish information back to the ERP system. If a company elects to import the entire MBOM into Ingenuus, then all participants can view the same MBOM information in Ingenuus that was published to the ERP system.

The Value Proposition

This approach will save you time and money.

Your company likely already owns some kind of document management software, a PDM/PLM solution, and some kind of ERP [or possibly MRP software]. It may not be easy to manage changes in any of these software packages. Ingenuus Smart Expediter is designed to manage processes, and does a particularly excellent job of managing the change process. Leverage your existing software by implementing Ingenuus to effectively manage your change process. This solution requires no customization of your document management, PDM/PLM, or your ERP software. Eliminate the need for additional user licenses for access to legacy systems or more expensive software by importing the data into the interoperability area for collaboration and change. Then publish the information back to the system of record.

Generally, the most expensive process within any manufacturing company is change control. The industry average cost of managing a change from request to incorporation is \$2,500. If your company does 50 changes a month, the cost becomes \$1.5 million annually. Companies automating this process have shown improvements greater than 50%. If you could achieve only get a 50% improvement, you would be saving \$750k annually.

Contact sales@ingenuus.com for more information.

Revision History

Date	Version	Author	Comment
1/10/2005	0.5	Scott Cleveland/Vivek Prasad	Draft for initial review
1/10/2005	0.7	Scott Cleveland/Vivek Prasad	Incorporate Changes
2/24/2005	.10	Chris Williams	Final Edits, release.