THE IMPORTANCE OF CONFIGURATION MANAGAMENT IN INDUSTRIAL EQUIPMENT MANUFACTURING

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- **Reid Paquin,** Research Analyst, Manufacturing, Product Innovation & Engineering (PIE)
- **Tracy Woo,** Research Analyst, Product Innovation & Engineering (PIE)

Report Highlights

This report identifies how top performing companies in the industrial equipment manufacturing industry use configuration management to organize their engineering bill of materials (eBOM) and drive product profitability.

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The road to successful product development starts by using configuration management tools. Top performing companies have shown implementing a PLM tool, to automate the configuration and requirements process, has helped them ascend above their peers.

In the age of smart products, digitization, and the Internet of Things, products are increasing in complexity and part counts. This idea especially rings true in industrial equipment manufacturing (IEM), where component lists easily reach up into the hundreds or thousands. In a product with so many variables, mistakes are bound to occur. To prevent these errors from occuring, many companies use configuration management in order to establish consistency with requirements, ensure accuracy of meeting targets, and maintain performance throughout a product's entire lifecyle. For many, configuration management is largely a manual, handwritten process. This report will explore what Leaders in the industry are doing to optimize that process, and the benefits they are receiving because of it.

The Demand for Customized and Complex Products

New products are the lifeblood for most companies, in particular, discrete manufacturing, where almost half of their total revenue comes from new products (44% of total revenue, as identified in a recent Aberdeen study). With the complexities in today's business environment, organizations in these industries face many challenges that have a direct impact on the ability to create innovative and unique offerings to the marketplace. The top driver that Aberdeen consistently sees is the need to launch products quickly and to be first to market, especially in the case of industrial equipment manufacturing (Figure 1).

However, at the same time, the customer's voice is rising. Consumers want a product that meets their individual needs, or to put it simply, less product standardization and more customization. Customers want to take the design out of the hands of a marketing specialist and into their own. This shift means increasing pressure for mass customization, a change

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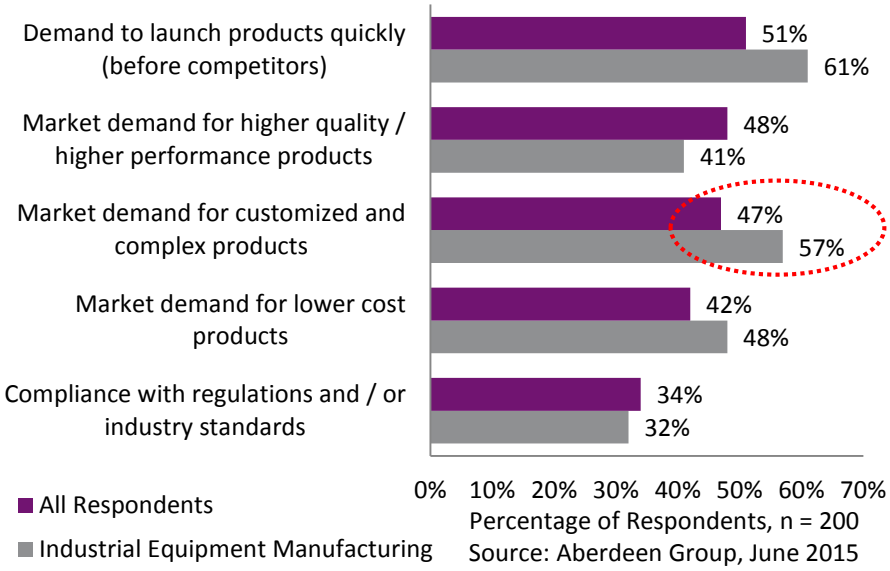
that adds more variables — namely, an increased part count, added specific requirements, and higher functionality. In fact, it was found IEMs were 21% more likely than all other industries to face this demand for complex and customized products.

Figure 1: Top Pressures Among IEM



A tight schedule with many moving parts, topped with increasing customization and the constant need to reduce costs, creates an environment rife with error. A design that is not clearly defined or that adds many "one off" features to the product, requiring unique qualification or testing beyond the original design scope, will come across painful delays and potentially larger consequences of rising budget and costs. Frequent engineering changes, in addition to being the source of the delays, can be costly and can have a lasting impact on a company's bottom line (see sidebar). Unfortunately, these changes occur even more with IEMs. These companies are 46% more likely to see engineering changes as a top challenge than companies in other industries. Challenges in product creation also occur outside of customization and inherent complexity. There are internal

Top Challenges During the Development Process

Respondents were asked to select the top two challenges they encounter during the development process – for IEM's it comes down to changes, collaboration, and complexity (IEM respondents):

Frequent engineering changes (ECOs / ECNs) – 38%

Collaboration (locations, suppliers, internal, etc.) – 35%

Product Complexity – 31%

Disconnected processes / siloed departments – 29%

Staffing / Talent – 22%

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The Hidden Impact of Being Understaffed

In a recent Aberdeen study of over 500 companies, the issue of understaffing in engineering or high skill positions was explored. **Over 60% of companies currently feel understaffed in their technical positions.** Companies that indicated they were understaffed in these positions saw the following negative impacts.

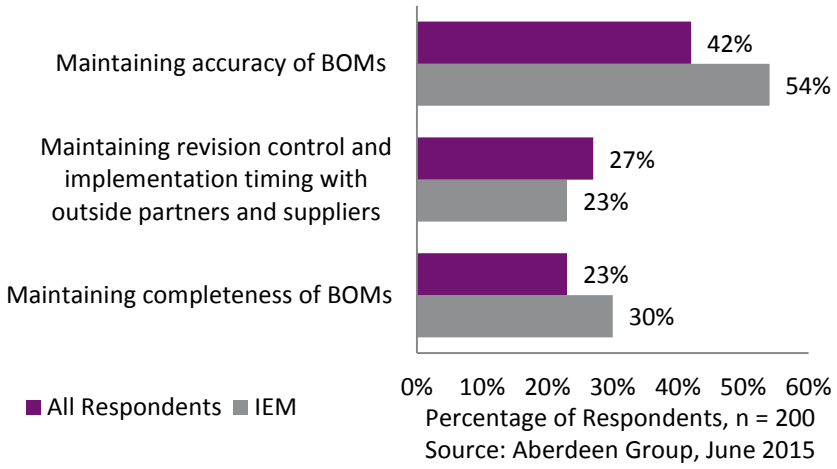
- **Product launch dates hit: 16% decrease**
- **Product cost targets met: 11% decrease**
- **Quality targets hit at design release: 10% decrease**
- **Product revenue targets met: 11% decrease**

Engineers play a critical role in the success of any company that designs and delivers products. Being understaffed or lacking talent is detrimental to success.

aspects that make product design a challenge as well. For one thing, development is often hamstrung by limited resources. In fact, over 60% of surveyed companies feel understaffed in their technical positions. Engineers play an important role in the success of any company that designs and delivers products. Focused efforts should be made by companies to address their limited design resources and create a more efficient workforce. Another growing challenge is the need to improve collaboration across distributed operations.

It only gets worse for IEMs. Complexity of their designs has been steadily rising, over the past two years industrial equipment manufacturers have reported double digit increases in the number of mechanical and electrical components, and lines of software code. Increased component counts have pushed the importance of Bill of Material (BOM) accuracy to the forefront for IEMs. The BOM defines the entire product and its relationship to each component. The problems from an inaccurate BOM can range from reducing departmental efficiency, to creating massive recalls on the end product due to a missing part. Managing BOMs and related product data effectively can be a challenge (Figure 2).

Figure 2: Top Challenges for Managing the BOM



Source: Aberdeen Group, June 2015

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Keeping BOMs up-to-date for all product configurations requires attention from multiple participants in design and the value chain, particularly at the processing or materials level. As products pass from design to manufacturing and are, ultimately, put into service, configuration management responsibility crosses organizational boundaries, increasing the complexity of keeping BOMs accurate and synchronized. In particular, miscommunication of the ongoing product changes throughout the lifecycle can lead to inaccurate data. This, in turn, can result in decreased quality, increased costs, and delayed time-to-market. The more accurate and complete a Bill of Material is, the more informed decisions can be made about how to get a product created from idea to market. These decisions can fall in the catergory of material requirements, parts locating, associating critical spares to specific assets, and identifying opportunities for parts standardization. For an IEM, accuracy is especially essential.

"One of our largest challenges has to be the human factor. You have to build a good skilled workforce that appreciates the importance of configured items – and when things change and the process is circumvented – bad things happen."

~ Product Development / Engineering Manager, Medium Industrial Equipment Manufacturer

The culmination of these issues ultimately point back to – the need to improve the configuration management (CM) process. Why is configuration management critical for industrial equipment manufacturers? CM provides the blueprint by which products will be produced and services delivered. Without good configuration management, manufacturing, and service processes will be inefficient at best, and in some cases can evolve to one-off design and build exercises, which most IEM's are not equipped to handle from a resource, delivery, and cost perspective. At worst, mistakes due to poor configuration information can lead to severe quality and product performance issues, impacting a company's reputation as well as driving service or warranty costs out of control. Also, there is the yearly cost to the business of maintaining increasing part numbers. A clear, current, and accurate product definition is critical to

ensuring that products meet quality, time to market, and cost targets — the targets that ultimately lead to profitability.

Defining IEM Leaders

Despite all of the pressures and challenges IEM's face on a daily basis, some companies are finding ways to succeed. To identify best practices for configuration management, Aberdeen measured participants' ability to meet product launch dates, quality targets, cost targets, revenue targets, and change in development time. Aberdeen categorized industrial equipment manufacturing respondents into two groups: Leaders (Top 33%) and Followers (Bottom 67%). Table 2 summarizes the aggregate performance of each category.

Table 2: Top Performers Earn Leader Status

Definition of Maturity Class	Mean Class Performance
Industrial Equipment Manufacturing (IEM) Leaders: Top 33% of aggregate performance scorers	80% of product launch dates met 81% of product revenue targets achieved 82% of product cost targets met 90% of product quality targets met at design release 20% decrease in the length of development time
Industrial Equipment Manufacturing (IEM) Followers: Bottom 67% of aggregate performance scorers	66% of product launch dates met 66% of product revenue targets achieved 70% of product cost targets met 70% of product quality targets met at design release 5% decrease in the length of development time

Source: Aberdeen Group, June 2015

Clearly, with their performance level in all areas near or above 80%, IEM Leaders are doing a much better job overcoming the challenges identified earlier, such as maintaining BOM accuracy. They are effectively managing configurations despite ongoing engineering changes, the difficulty of managing the impact of change on multiple configuration variants, and the resulting

Additional Metric Performance

Leaders are also outperforming their peers on the following metrics (over the past 12 months):

Overall Product Cost:

- *IEM Leaders – 17% Decrease*
- *IEM Followers – 3% Decrease*

Change in ECOs after Release to Manufacturing:

- *IEM Leaders – 4% Decrease*
- *IEM Followers – 3% Increase*

Warranty Costs:

- *IEM Leaders – 9.8% Decrease*
- *IEM Followers – 0.7% Decrease*

Operating Margin vs. Corporate Plan:

- *IEM Leaders – +8%*
- *IEM Followers – -4%*

work of synchronizing BOMs across the value chain as engineering changes are executed. Followers cannot say the same, their poor performance on new products reflects itself in their overall business performance, as they ultimately miss corporate margin goals by 4%. This raises the question: what are the Leaders doing differently to enjoy such superior performance?

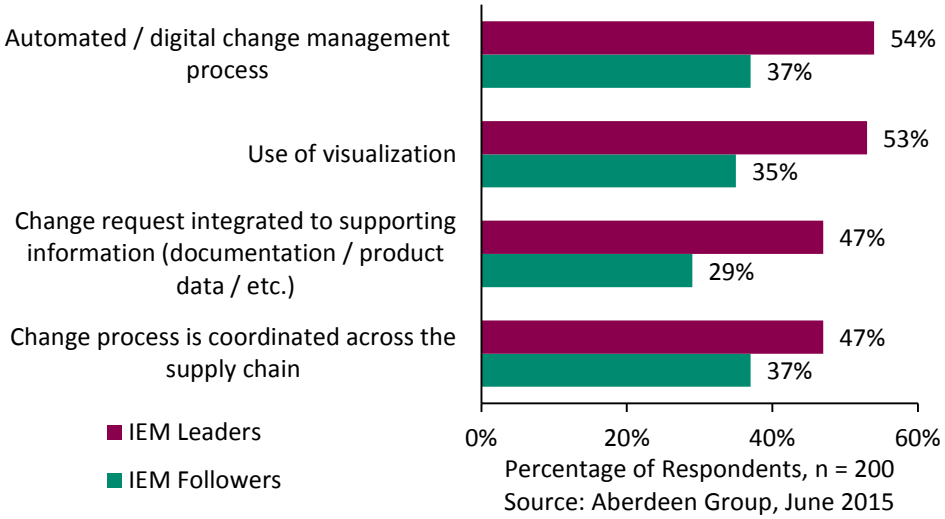
Building the Configuration Management Process

When it comes to improving the configuration management process it all starts with combatting the top challenge listed earlier, frequent changes. Leaders are more likely than Followers to have put in place various controls and organizational structures to monitor and manage configuration and change processes. Leaders start by being 46% more likely than their peers to automate or digitize their change management process. This is an important first step because it eliminates inefficent manual processes and provides a single process that can support change across product planning, engineering, manufacturing, and the supply chain.

Adopting Best Practices

IEM Leaders are 38% more likely than Followers to possess certifications from a standards board for configuration management best practices (CMII, etc.)

Figure 6: Change Management Capabilities



Is the Process 'Working Well'?

IEM respondents were asked to grade the effectiveness of their CM and requirements management processes, while Leaders are doing a much better job, the entire industry has room for improvement:

Management of Requirements:

- *IEM Leaders – 42%*
- *IEM Followers – 18%*

Configuration Management:

- *IEM Leaders – 38%*
- *IEM Followers – 20%*

Also important is making sure that change is communicated and coordinated across the supply chain. This helps to ensure that BOMs stay in sync and that all affected parties know of the change, hopefully well in advance, so they can minimize disruption. In addition, this ensures that the downstream parties affected by the change will have the opportunity to review it and provide feedback to minimize the disruption of the change itself, and to improve their subsequent decisions about how and when changes will be implemented.

The area of change management where IEM Leaders have the largest advantage is in the integration of supporting information. Leaders are 62% more likely than Followers to take this step, however, what exactly should be included? With the importance of maintaining the accuracy and completeness of the BOM it is no surprise to see both Leaders and Followers incorporate this into their change management program (Table 2).

Table 2: Product Data Managed through Change Management

Data Type	IEM Leaders	IEM Followers
Bills of material - mechanical	85%	81%
Bills of material - electronic	71%	56%
Product documentation	70%	56%
Component design (geometry, specs)	68%	56%
Quality specifications and inspection plan	61%	45%
Service procedures / checklists	52%	30%
Product Requirements	50%	34%
Approved material and vendor list (AML, AVL)	45%	40%
Embedded software configurations	41%	29%

Source: Aberdeen Group, June 2015

This action helps to reduce issues and eliminate BOM errors. Even more important is the Leaders extension of CM upstream in the product lifecycle. IEM Leaders are 47% more likely to

incorporate product requirements into their change management process. This ensures that the impacts of changes to upstream information are understood downstream.

However, a commercial product — even a complex mechatronic product – is more than just its technical design. The product definition may include information such as manufacturing instructions and quality specifications, helping to ensure that it gets produced efficiently and to requirements. It also may include approved material lists (AML) and approved vendor lists (AVL), which can help reduce product costs and ensure quality. Changes to the product outside of the basic configuration may require qualification of new suppliers or testing to validate/verfiy form, fit, or function. In a strong configuration management process, enabling the application/design teams that are customer facing, with a strong understanding of the configuration management, can go a long way towards keeping an order on schedule and minimizing delays due to untimely changes. Guiding the customer through the configuration process, and identifying the timing needed for decisions, can save significant time and cost.

Consider the example of standardization that a customer might have for a brand of valve/switch, etc., that they wish to leverage in the design would need to be known upfront rather than later in the process (i.e. after material has been purchased and some assembly has already occurred). Strong configuration management will identify the timing and impact of these key decisions to avoid “late in the process” changes. Product documentation is also important though extrinsic components of the final product, necessary to its proper use, function, and maintenance. Given the role these kinds of data play in ensuring product quality, reducing product cost, and supporting launch dates, it’s not surprising that leading companies are extending

configuration management beyond BOMs to cover much more richness in the product definition. By associating more information with the product, the impact of product changes is no longer limited to the component materials, but extends to the entire commercial product offering.

Utilizing Technology for Success

While extending configuration management to include more product information and more lifecycle phases pays off in quality, cost reduction, and time to market, it also makes the day-to-day job of managing configurations more complex. To handle the complexities, Leaders turn to technology to manage and automate the process. A primary technology enabler of configuration management — in fact the foundation — is centralized product data (see sidebar). A centralized data repository makes up-to-date BOMs in all their forms, as well as product-related data, visible — and accessible with authorization, security, and version controls — to the appropriate people involved in any lifecycle phase. In fact, IEM Leaders are more than 2.5X more likely than Followers (41% versus 16%) to leverage centralized product data to improve control of product configurations.

IEM Leaders follow this up by automating the configuration management process through Product Lifecycle Management (PLM) software. In fact, Leaders are 21% more likely than followers to have PLM implemented and configuration management automated through a PLM system. PLM drives natural growth by linking a company's ideas to its buisness strategy. It empowers management to improve time to market, drive costs down, and complements creativity and growth. Also, Leaders use PLM as a system of record for their product information. Among the items that leaders outpace followers in using PLM are managing their BOM across all departments.

Centralized Product Data

When examining how IEM's manage their product data, two different approaches jump out when looking at Leaders and Followers.

Product data is stored in a centralized database:

- *IEM Leaders – 41%*
- *IEM Followers – 16%*

Product data is stored in multiple databases, with the potential for conflicting data in each system:

- *IEM Leaders – 23%*
- *IEM Followers – 45%*

Leaders are more than twice as likely to use PLM as a system of record to manage their engineering BOM, and more than three times as likely to use the system for managing the rules, logic, etc. for their configurations (see sidebar).

Just as important, is extension into release to manufacturing. This is a key transition stage – from the "as designed" BOM, representing the various systems of a product, to the "as built" BOM, representing assembly and/or production sequences and manufacturing information. This juncture is where the product is transformed from a virtual entity to something that needs to be produced in the physical world. At this point, changes become more costly because finished products, component inventory, product plans, purchase orders, and plant capabilities must be considered before a change is made. It is also important to include the service lifecycle for "as maintained" bills of material. This final phase in a products lifecycle is becoming increasingly important with the new shift towards preventative and predictive maintenance. The main takeaway is the Leaders extend CM throughout the entire product lifecycle and use PLM as the backbone to manage this process.

Key Takeaways

In industrial equipment manufacturing, the complexity of the product and business is inherent and growing. The rising demand for customization, along with shortened timelines, creates more opportunities for error. Leaders in the industry have turned to configuration management to combat these issues. These companies also more frequently support CM processes with centralized product data, and PLM that automate CM processes. In fact, it is by adopting these practices and technologies that these companies have achieved their superior level of success in configuration management and, therefore, the metrics that matter to drive product profitability. Following in

PLM as the 'System of Record'

Respondents were also asked which system serves as the master or "system of record" for their design related data. Leaders are again more likely to rely on PLM.

Engineering BOM:
- *IEM Leaders – 88%*
- *IEM Followers – 42%*

Configurations (rules, logic, etc.):
- *IEM Leaders – 75%*
- *IEM Followers – 22%*

CAD (mechanical & electrical):
- *IEM Leaders – 67%*
- *IEM Followers – 25%*

Manufacturing BOM:
- *IEM Leaders – 56%*
- *IEM Followers – 8%*

As Built BOM:
- *IEM Leaders – 38%*
- *IEM Followers – 13%*

As Maintained BOM:
- *IEM Leaders – 30%*
- *IEM Followers – 17%*

Software code:
- *IEM Leaders – 22%*
- *IEM Followers – 9%*

the steps of IEM leaders will enable the development of concepts that align with the company's strategic goals of satisfying the customer. These steps are:

- **Formalize and standardize configuration management processes**. Educate your company on the importance of data accuracy and configuration management. Formalize and standardize processes for developing product data, analyzing changes, and communicating changes to all affected parties.

- **Implement a change management process that stretches across the supply chain**. Consumer preferences change, engineers find better ways to design, and mistakes need to be avoided. Either way there will be a need for change during development. How a company addresses that issue separates the Leaders from the Followers. By having a robust change management process that extends across the supply chain, Leaders are able to ensure that their BOMs are accurate and complete.

- **Centralize your product data management**. Leaders ensure that CM processes are supported by a foundation of accurate, readily accessible product data. The data may be centralized in a common repository or managed across multiple repositories in a logical or "federated" approach.

- **Use a PLM tool as a system of record across the entire product lifecycle.** IEM leaders are more than twice as likely to use a PLM tool for their engineering BOM. However, Leaders also focus on extending CM downstream, particularly into release to the manufacturing process, which is prone to error. Consider

extending to service management as well, to reduce total product lifecycle costs.

In today's IEM market, product complexity, the demand for customization, and shortened timelines creates a tough environment for success and innovation. Companies that are focused on improving configuration management are in a better position to hit each of the product development and lifecycle targets that drive product profitability.

For more information on this or other research topics, please visit www.aberdeen.com.

Related Research

Putting the C in CPQ: Configuration Management in High Tech; (June 2015)

As-Built vs. As-Designed: Untangling the Web of Inefficiency and Waste Around Product Verification; (July 2014)

NPI Velocity in Discrete Manufacturing: The Hidden Cost of Late Products; (November 2014)

Overcoming Aerospace and Defense Systems Design Complexity with Configuration Management; (March 2013)

Author: Reid Paquin, Research Analyst, Manufacturing (reid.paquin@aberdeen.com)
Tracy Woo, Research Analyst, Product Innovation & Engineering (PIE) (tracy.woo@aberdeen.com)

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