# Configuration Management: Configuration Integrity is a Core Driver for Business Success

***CIMdata Commentary***

*Key takeaways:*

- *Configuration management is a fundamental capability requirement for any product produced in series and any complex machine.*
- *Poor configuration management guarantees business failure in the long-term and often in the short-term.*
- *Teamcenter supports lifecycle configuration management at scale from requirements through as-maintained serialized configurations. Advanced Machine Engineering focuses on requirements through the as-designed state and is directly compatible with other lifecycle extensions including advanced simulation, manufacturing, and service.*

## Introduction

A complete configuration for an industrial machine is incredibly complex for a number of reasons. The variety of design elements used in the different technical domains such as mechanical, electrical, hydraulic, pneumatic, and software. Requirements that impact across domains and systems, the evolution of part and assembly designs, technical and business requirements which drive the design, components and systems purchased from 3rd-parties, designed-in variations to support different products and customers, installation and service information, all kinds of documentation and instructions and regulatory rules. All of these must be managed, and this is the role of configuration management (CM) capabilities.[1]

CIMdata believes that doing things right the first time is much more efficient than doing them over. During our consulting practice we see many errors that trace back to incorrectly defined or poorly managed configurations. This results in problems such as the wrong version of a part or software causing a malfunction or failure. In the days when the majority of design concentrated on managing the mechanical aspects, a change needed to be documented only when form, fit, or function (FFF) was affected. It was not uncommon to have failures that traced back to an undocumented change that violated the FFF rules. With the complexity of today's products, the supply chains that produce them, operating condition variability, and the massive increase in design items that come from non-mechanical domains, companies are finding that product configurations are much more complex and more difficult to understand. Configurations have many more interdependencies that have to be managed and understood. Some issues that are common follow.

## Regulatory Issues

Machine builders can face many different regulatory requirements often dependent on the industries of their customers and the uses of their machines. For highly regulated industries such as food processing and medical devices, the product configuration must be controlled, and the configuration of equipment within the manufacturing process must be controlled. If the as-maintained configuration is not well documented and controlled, often with serialized parts,

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

regulatory violations may easily occur. The impact might be the inability of the customer, the machine's user, to continue manufacturing or selling their products.

## Safety Issues

Even within low regulation industries, safety is always critical. Occupational Safety and Health Administration (OSHA) and other requirements must be validated and tracked for compliance. If a component has a known flaw, it must be corrected and the correction proven and traceable. Machinery is dangerous. Many hazards—physical, electrical, chemical, biological, and others—can injure or kill workers or bystanders. Evaluating safety issues that may occur in a machine may require ergonomic simulations and analysis combined with machine operational analysis.

## Customer Satisfaction Issues

A simple definition of customer satisfaction is "the customers come back and the products don't." Products that don't perform as expected quickly discourage customers. Delivering machines on time that work as specified when installed is the first step to a satisfied customer. Ensuring that the machine continues to work as planned will keep them happy. A big part of keeping equipment working is being able to resolve problems quickly, sending and installing the right replacement part every time, and being able to answer customer questions quickly go a long way to pleasing customers.

## Cost Issues

While satisfied customers are critical, keeping them happy while meeting business requirements is critical for a successful machine builder. Poor CM leads to duplicate parts, overly complex products and product lines, excess inventory, more scrap, more rework, and incorrect machines and repair parts being shipped to customers. All items that have significant impact on margins. Without good solutions to support CM, more people are required to manage configuration data, adding cost, and inevitably increasing mistakes.

Machine CM can easily get out of control, leading to variants of variants. There are tools companies can use, like shape search to identify similar parts, but it takes discipline to properly balance the addition of another variant and adapting a current configuration to handle additional custom functionality.

Engineer-to-order (ETO) machine builders often need to be very creative in their solutions to meet specific customer requirements. This often means developing innovations, that can be very profitable if captured and aggressively pursued. Without strong configuration management, even if the engineering work is not patentable, the innovation can be lost to history, becoming tribal knowledge, and must be re-created or re-invented for future opportunities.

The impact of uncontrolled development and lack of re-use is an increase in new parts, with new part numbers, lower volumes, higher unit costs, and higher inventory expenses. This impact occurs regardless of whether the business model is build-to-stock (BTS), configure-to-order (CTO), or ETO.

## Cost of Late Changes

It is well understood that the cost of a change goes up by an order of magnitude as a product progresses through each phase of the product lifecycle. A change that costs $1,000 in the design phase, costs $10,000 in the manufacturing phase, and costs $100,000 in service.

During the early phases, most of the cost is in people's time. Once product manufacturing starts, investments in raw materials and tooling dwarf the early development costs. Field changes are worse because of the cost of travel to the machine's location, time to audit the current state of a machine in service, time to discover which parts and subsystems can be replaced or repaired, getting the parts and equipment to the location, and executing the repair. Furthermore, changes later in the product lifecycle impact delivery time which damages customer credibility and may negatively impact repeat business. Finally, late changes are usually rushed which adds risk.

## Managing the Digital Thread

To improve effectiveness and efficiency industrial companies and PLM solution providers are collaborating to create a complete digital representation of products, the processes that create the products, and the operation of the products in the field. This manifests itself in a complete end-to-end representation of the product's configuration and related information throughout its lifecycle. A platform approach and synchronization tools ensure that the data from the various lifecycle states e.g., as-designed, as-manufactured, and as-serviced, fully represent the product. An integrated change management capability in the platform ensures that changes are properly managed across the lifecycle. This representation is known as the digital thread. The digital thread allows the creation and maintenance of a digital twin of a product.

IoT, one of the recent technology additions to many machines provides machine builders with two fundamental digital thread capabilities. IoT enables improved product performance monitoring and support. Operational data can be used to support condition-based and predictive maintenance when combined with artificial intelligence or machine learning. Furthermore, operational data can be used to provide machine builders with insights that drive requirements to improve the next version of the product—closing the product lifecycle loop. As companies start to adopt new technologies like IoT, their need to have traceability and impact analysis further increases.

BOM integration has several different technical approaches but based on CIMdata research[2] the state of the art is using a multi-view BOM approach. This usually requires a single PLM configuration management solution to manage the core BOM structures, but by doing this, common capabilities are used to maintain associativity among all of the BOMs and robust traceability can be established. With traceability each item in the BOM is connected to its upstream and downstream item versions in the digital thread.

### *Impact Analysis*

From an innovation viewpoint, impact analysis is perhaps the most useful capability enabled by the digital thread. Product improvements, retrofits, and new options are common strategies used to improve customer satisfaction, enhance product capabilities, and increase revenue. These strategies are all dependent on a clear understanding of existing configurations and what the impact of a change will be. Common impact analysis questions include:

- What are the cost and inventory impacts if a change is made?
- What population of in-service machines will this change be compatible (or incompatible) with?
- What technical documentation will be impacted?
- Are any requirements violated?

[2] https://www.cimdata.com/en/aerospace-and-defense#

- What simulations will need to be re-run?
- How will this impact the manufacturing process?
- Do we need to notify any suppliers?

Change impact analysis is painful in most companies because data is not fully connected in a digital thread. This lack of connection forces the change team to search manually to identify issues and reduce risk, a time consuming and error prone process. Once a digit thread is created and a comprehensive digital twin is established, change processes improve dramatically in speed and quality. People are more confident that their decisions are accurate and won't have unintended consequences.

### *Configurators*

In addition to variations brought about during the machine design process, there is also the need to support machine sales configurators in ETO and especially in CTO businesses. In the CTO case, the configuration needs to identify and manage all of the combinations of machine systems that can be built into a working, saleable solution for a customer—and exclude combinations that will not result in a valid, workable product. In these cases, the configurator has to be capable of managing a 150% BOM and the relationships that tell it how to create 100% BOMs for each desired configuration. In the case of ETO, a CTO baseline is often augmented with custom engineering to meet special requirements.

## Siemens Solution

Siemens Advanced Machine Engineering (AME) is a subset of the Xcelerator portfolio focused on supporting machine building companies by providing all the appropriate portfolio technologies to support the three capabilities all machine builders need—multi-disciplinary design, configuration management, and virtual commissioning, in a single package. It uses Teamcenter, a robust product innovation platform, to support configuration management. Many of CIMdata's industrial clients, including many machine building companies use Teamcenter to manage product configurations containing data from a wide variety of authoring solutions. The tightly integrated change management solution enables effective change impact analysis and ensures traceability and configuration integrity.

## Conclusion

Properly configured product data is a gift that keeps on giving. When all the constructs necessary to describe the nuances of configurations are available and properly used, data reuse can be optimized, improving product quality, shortening design time, and shortening time to market. These same benefits are available for managing change. Strong CM enables faster and more confident decisions on what needs to change, when a change can be implemented, and how costs can be minimized. Teamcenter, the product innovation platform and CM core of the Siemens Xcelerator portfolio and AME solution has proven its value to the machine builder industry for more than two decades. Machine builders looking to improve their business should explore AME and its Teamcenter platform.

For more information please see Siemens Digital Industries Software at:
siemens.com/plm/advancedmachinery

## About CIMdata

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