

Collaborative Manufacturing: Critical for Success in Today's Complex Heavy Equipment Industry

CIMdata Commentary

Key takeaways:

- *Increasingly, heavy equipment manufacturers must produce custom configurations, often in small quantities, while simultaneously managing increasing product complexity.*
- *Effective collaboration between product engineering, manufacturing planning, production, and service operations, leveraging closed-loop manufacturing, is required to compete and win in today's complex heavy equipment industry.*
- *A comprehensive collaborative manufacturing environment is essential to analyze the impact of a product mix on production, allowing companies to optimize overall throughput.*
- *Xcelerator from Siemens Digital Industries Software is a comprehensive, integrated suite of software, services and an application development platform designed to help customers define, sell, produce, and service today's complex products more efficiently.*

Introduction

Heavy equipment manufacturers today are being challenged by their customers, the competition, and government regulators, to develop smarter, more eco-friendly equipment in an increasingly difficult economic climate. Key factors driving these challenges include tougher emissions standards, higher performance requirements, ever-increasing safety standards, electrification, and the application of new technologies such as augmented reality and artificial intelligence. Additionally, companies realize the safest place for their operators is outside the mine or construction site, so remote teleoperation and autonomy are often sold as a safety asset.¹

As a result, heavy equipment is getting smarter. Much of today's equipment is software- and electronics-driven, can connect with other machines and systems, and is able to operate autonomously. Manufacturers have a fundamental requirement to manage the rapidly increasing complexity of hardware, software, and electronics integration within heavy equipment to drive product development, product performance, and differentiation. To do this, competitors in the heavy equipment industry must create collaborative manufacturing environments that enable them to:

- Ensure compliance, based on more stringent requirements around quality, noise, and emissions.
- Find ways to more quickly introduce new, complex products with multiple attachments and sensors.
- Deliver expected manufacturing efficiencies despite the need to continuously improve and innovate.

¹ Research for this paper was partially supported by Siemens Digital Industries Software

- Achieve the expected quality no matter where or at what volume their products are produced.

Two key challenges that heavy equipment makers face in today's environment are: 1) increasing product development complexity and variation, and 2) globalized production—being able to simultaneously produce multiple product variations at different production plants around the world. Further, customer demands for “personalized” products increase product and process complexity of both development and production as well as long-term service. The resulting requirement to support the definition and management of a massive number of configuration alternatives drives the need for improved collaboration between product engineering, manufacturing engineering, production, and service management. Companies therefore need integrated information flows and processes that are highly flexible and can adapt to product and market changes. Implementing integrated Manufacturing Enterprise Innovation Platforms² to address these issues can help achieve faster ramp-up to production and reduced time to market, while improving response to changes in global and local customer demand.

CIMdata believes that companies that address these issues will position themselves to more quickly deliver the complex Configure-To-Order (CTO) products heavy equipment customers are demanding and will be better able to make more efficient use of their distributed manufacturing facilities and service resources. This translates into winning market share from competitive offerings and increased customer loyalty.

Efficiently Producing Complex Products

To efficiently realize global design and production, manufacturing enterprises must design, manufacture, and service multiple configurations and variants of a product family in a cost-effective manner. This means:

- Improved collaboration in planning and scheduling that starts earlier during product engineering instead of later when the design is released and transferred to manufacturing.
- Better leverage and re-use of corporate IP, expertise, and lessons learned as well as stricter compliance with company standards and applicable regulations.

Enabling this is closed-loop manufacturing (CLM) to manage changes between engineering and manufacturing (and service) and incorporate feedback from the shop floor. Built on seamless integration between PLM, ERP, and MES, CLM enables synchronization and optimization along the entire value chain. It supports direct cross-domain feedback loops from downstream to upstream activities and vice versa, enabling processes such as change management and issue and defect tracking.

To achieve individual plant production goals, companies must distribute operations to specific workstations, perform line balancing, and assess machine utilization in real-time. Historically, this has been done using highly manual methods; however, visual process planning and line balancing software tools are now available to help planners more easily identify and resolve shop floor issues.

² <https://www.cimdata.com/en/news/item/13796-cimdata-publishes-an-enterprise-innovation-platform-for-manufacturers>

Leading manufacturers integrate planning and simulation tools for up-front validation of manufacturing processes to develop right-first-time manufacturing plans, reducing the risk of errors in manufacturing and improving quality.

Companies also require collaborative manufacturing capabilities so that they can analyze the impact of product mix on production to optimize overall production throughput. Such analysis identifies and reduces non-value-added work and optimizes material flow and logistics. Manufacturers can also better plan to optimize equipment usage and more easily evaluate alternatives to determine, early on, how optimized throughput can be realized under typical mixed-model production scenarios.

To work more efficiently and be more competitive, heavy equipment manufacturers require configured, intuitive, and up-to-date information available on the shop floor via online electronic work instructions. These work instructions contain assembly sequences, visual data, and animations that can be automatically retrieved for any given production order based on a plant-specific process definition. Having direct access from the production work context, with information about assembly station layouts, parts, and tools to be used, helps production personnel report non-conformance issues on the shop floor—another example of effective CLM.

Siemens Digital Industries Software’s Strategy for Collaborative Manufacturing

Siemens Digital Industries Software (Siemens) has recognized the industry’s need for a collaborative manufacturing approach to help their customers manage the increasing product and process complexity, as discussed above. Siemens has taken a holistic solution approach to address how product engineering and manufacturing must collaborate to manage highly configured products produced globally. Fundamental to their strategy is that companies need to be better able to deal not only with product complexity (CTO with increasing variations) but also manufacturing environment complexity (global sourcing and production with different processes at each plant) and the ability to deliver service both on-site and remotely.

Figure 1 illustrates a comprehensive digital twin as a key element in closed loop collaborative manufacturing.

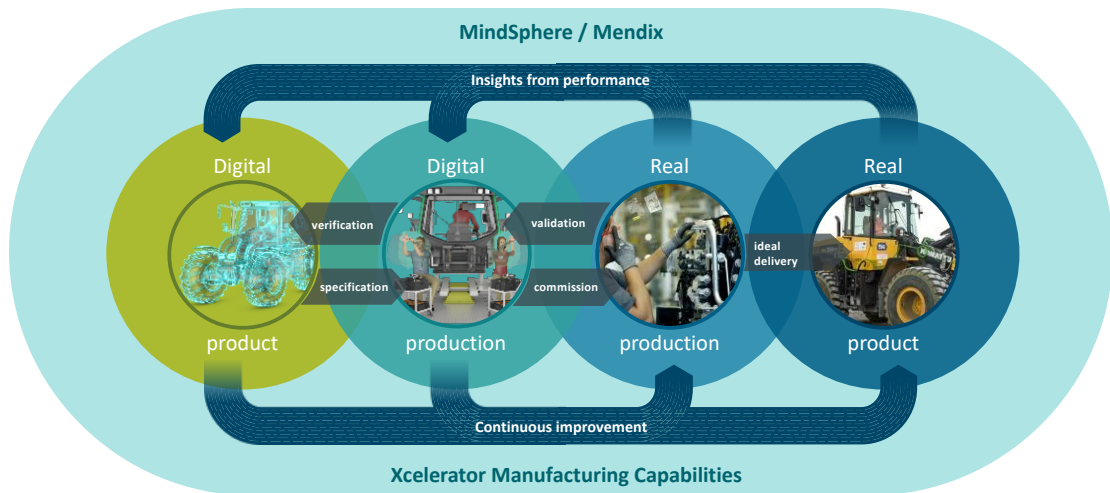


Figure 1—Siemens’ Xcelerator Portfolio Supports a Comprehensive Digital Twin for Manufacturing
(Courtesy of Siemens Digital Industries Software)

Siemens' Xcelerator portfolio is a comprehensive, integrated suite of software, services, and an application development platform providing the foundation for collaborative manufacturing. Xcelerator³ helps businesses leverage complexity as a competitive advantage and transform themselves into digital enterprises faster. Characteristics of this portfolio particularly pertinent to the manufacturing of CTO products are:

- **Comprehensive digital twin** comprising a digital fabric of information from product design, manufacturing, and in-field utilization data, enabling cross-domain engineering, virtual validation, and continuous product and process improvement through a closed-loop feedback system.
- **Personalized, adaptable solutions** created from Xcelerator adapted to each heavy equipment maker's digital roadmap and uniqueness.
- **Open, modern, ecosystem** that heavy equipment makers can adapt as technologies and their business strategies evolve.

Figure 2 shows what is needed to bridge the gap between design and execution.

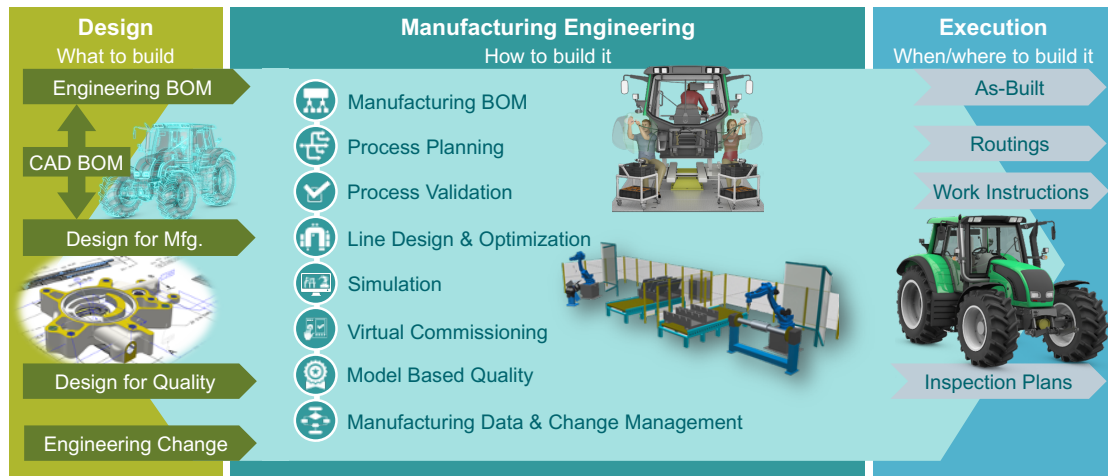


Figure 2—Siemens Solutions Help Heavy Equipment Manufacturers Enable the Digital Thread
(Courtesy of Siemens Digital Industries Software)

To enable efficient collaborative manufacturing that closes the digital gap from product design to production execution and makes digitalization a reality in the heavy equipment industry, Xcelerator includes the following key capabilities:

- **Product Configuration** provides the ability to configure a Manufacturing Bill of Materials (MBOM) into a specific customer order in a CTO business.
- **Manufacturing Planning** for the design and implementation of the Manufacturing Bill of Process (BOP).
- **Design & Validation** that enable virtual validation of product assembly and related process plans to eliminate potential shop floor issues.
- **Production Support** tools for optimal workplace layout development and electronic work instruction creation and automated delivery.

³ <https://sw.siemens.com/portfolio>

- **Optimization & Execution** integration with manufacturing execution systems enabling creation of a comprehensive digital twin used to continuously optimize production.
- **Data & Change Management** to handle the large amounts of data and changes that occur throughout the product, production, and service lifecycles.

In addition, using IIoT platforms like MindSphere, production machines and systems can provide direct, immediate feedback from the shop floor to engineering and process planning users and systems.

Summary

Heavy equipment manufacturers are confronted with increasing complexity—both in product variations and global production operations. They need effective collaborative manufacturing capabilities that integrate their product development, production, and services processes and environments. Siemens is addressing this need with its Xcelerator portfolio. Its capabilities are designed to enable heavy equipment manufacturing enterprises to efficiently manage highly complex, CTO product variations, enabling them to plan, produce, and service products as required to meet global, local, and specific customer requirements.

Siemens' Xcelerator portfolio helps companies enable closed-loop manufacturing environments that more quickly and efficiently manage change between product engineering and manufacturing so that product and production changes are kept in sync, and issues are identified and resolved earlier in the lifecycle when costs and risks are lower.

CIMdata believes that Siemens' approach and solutions for collaborative manufacturing provide a very effective platform that can help heavy equipment manufacturers build better, more effective, and more profitable businesses; improve their overall product engineering-to-production efficiency; and improve their market competitiveness. Manufacturing enterprises facing today's complexity challenges should include Siemens in their evaluation of solutions for collaborative, closed-loop manufacturing.

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.