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Improving time to industrialization, increasing resiliency, and enhancing overall product and customer experience are primary digital transformation goals for organizations across industries. What role does manufacturing play in enabling these goals?

Accelerating Time to Industrialization Through Concurrent Manufacturing

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Questions posed by: PTC

Answers by: Jeffrey Hojlo, Program Director, IDC Manufacturing Insights and Product Innovation Strategies

Q. How do you address challenges in design for manufacturing to ensure products are launched without delays?

A. Design for manufacturing (DFM) combines modeling and simulation of product and part specifications, production processes, and tooling early in the design engineering phase. Manufacturers that integrate manufacturing engineering processes into the design phase can attain goals such as reducing costs, decreasing downstream errors and waste, and achieving consistently high-quality products, assets, and processes.

Mitigating the classic organizational barrier between design, engineering, and manufacturing is the first step toward DFM. However, many organizations aren't motivated to share data and knowledge or work collaboratively, nor do they possess the technical capacity to enable these activities. Engineering domain leaders across mechanical, electrical, software, systems, and manufacturing ask why they should share data with others outside of their area. But as businesses have collectively accelerated toward a digital world in the past year, with pervasive remote work, these barriers are starting to fall. Organizations realize they need to work in a connected, platform-based way so that they have the flexibility to respond to disruption.

Technically, manufacturers must unify customer and demand data, plant information, resource libraries, and process information. They must justify this data and information with upstream design and engineering data. Building a digital thread across data silos becomes the foundation of collaboration, digital twins, engineering change, DFM, and other initiatives. PLM excels in the creation and management of the digital thread: enabling eBOM/mBOM connectivity, leveraging 3D models across the organization, and providing structured data for engineering and manufacturing collaboration. Yet many organizations, with old on-premises design and product data tools, continue to work in siloed fashion, resulting in high process and quality costs and slow time to market. However, we are seeing a shift away from siloed working processes in recent years, a change that accelerated during the pandemic, as manufacturing organizations leverage cloud infrastructure and applications to work across their organization and industry ecosystem more easily. These companies are beginning to realize the benefits of unified decision support through a cloud-based platform approach where data can be shared securely and easily and then combined with other data models for a cross-domain view as required.

Q. How do manufacturers build the information technology/operational technology (IT/OT) bridge to ensure the right product data is managed and available on the shop floor at the right time?

A closed-loop digital thread connecting design, engineering, and manufacturing is foundational for DFM.

A. IDC forecasts the continued massive growth of operational data across industries between 2021 and 2025. For example, the food and beverage and pharmaceutical sectors will see a 150% increase in terabytes of data per day, and the medical device and automotive industries will see a 250% increase. This data expansion is the result of connected assets and products, edge devices, and multiple manufacturing sites that need to meet dynamic customer demand. It is critical to have a real-time, predictive view of information across domains and sites. Achieving this view is possible with a product innovation platform enhanced with digital technologies, such as cloud, IoT, AI, and analytics. Digital twins also play an important role in the consumption and communication of information in concert with simulation for initial and ongoing product and process validation.

IT/OT connectivity that enables concurrent manufacturing starts with data ownership. IDC sees organizations creating digital engineering teams — IT, engineering, manufacturing, and data analytics experts working together — that establish the processes, tools, and security necessary for the global organization to integrate IT and OT systems. A view of data and knowledge across this IT/OT digital thread should be available for the various groups across an organization with PLM centrally: Engineering views relevant data in PLM, business leadership and finance view information in ERP, and manufacturing views information in SCADA or MES. There also should be an ability to share expert knowledge through the unified platform and other tools that are in place, such as augmented reality (AR). When an engineering change is required, a connected asset enables data within manufacturing to be updated through a closed loop that ties back upstream to the design and engineering team.

Q. How do you implement enterprisewide collaborative change management and closed-loop quality?

A. According to IDC's survey research, more than 50% of manufacturing executives cited quality as the top reason for IT investments, whether PLM, SCM, MES, and SLM or digital technology such as cloud, analytics, mobile, or cognitive systems. Digital transformation and investment in advanced digital technology are critical to supporting innovation and the move to an evidence-based culture. However, it is important to remember that quality is still a key reason for this investment and transformation.

Developing and implementing an enterprise quality approach is not easy because a quality data model is multifaceted, inclusive of product, supply chain, production, service, and customer information. This approach is supported by multiple systems, including quality management systems that manage the influx of product and production quality data. The ideal place for consumption of this quality data is within PLM or ERP systems (or a combination) so that quality information can

be viewed in context, whether product, process, supply chain, or service related. When a single system encapsulates data from quality management systems and other quality information sources, then problem reporting, change orders, and nonconformances can be addressed more quickly. Moreover, when manufacturing processes are designed and developed in PLM (i.e., DFM) and easily transferred to operations and execution systems through a concurrent manufacturing approach, greater quality and change management are assured and the cost of quality declines.

Connection between design, engineering, and manufacturing is the foundation for enterprise quality as well as predictive and rapid engineering change. Implementing a concurrent manufacturing approach, or digital thread, enables visibility into and optimization of key KPIs, such as development time, time to market, overall equipment effectiveness (OEE), and time to engineering change. The result is a unified enterprise quality data model that yields greater, consistent quality across product, supply chain, manufacturing process, and service.

Operational data will increase between 150% and 450% TB/day across industries between 2021 and 2025, a challenge and an opportunity for manufacturers.

Q. How can manufacturers break down barriers between product development and operations?

A. There must be an open, flexible digital thread between design, engineering, and manufacturing. According to IDC research, the percentage of manufacturing and engineering workforces working at home/remotely rose from approximately 2% before the pandemic to 60%+ in the past year. We think that post-pandemic, this trend will settle at 30–40% of manufacturing industry workforces working remotely, which naturally breaks down the classic product development/operational barrier. Or it at least opens a digital door between the two domains that may not have previously been there. The pandemic has made manufacturers realize that disruption is a normal part of business that they need to be ready for and that dealing with disruption requires collaborating across domains and having the digital platform and tools in place to enable such cooperation.

Continued investment in digital technologies, even in the midst of the pandemic, that enable digital collaboration is critical. IDC research shows that organizations that had invested in digital pre-pandemic began to see organizational growth sooner than those that did not. This indicates a "digital divide" between manufacturing organizations — and it is not always large companies versus small companies. In our analysis, about a third of those mature companies were SMBs in the $500 million–$1 billion range (not very small companies). The digital investments that organizations make establish the open platforms necessary for product development and operations to collaborate. The following technologies enable this effort in various ways:

- SaaS, cloud-based PLM can be flexibly consumed, as required, by product development organizations.
- IoT, AI, analytics, and AR are used for data collation, analytics, federation, and visibility/knowledge sharing on the shop floor.
- Digital twins can be used for a 2D/3D model-based virtual view of products, assets, and processes.
- Generative design (CAD + AI + big data + analytics) can be used for predictive decision making in engineering at the front end of concurrent manufacturing.

A combination of digital technologies working together with existing IT investments, such as PLM, breaks down barriers, enables collaboration across engineering and manufacturing, and ensures digital transfer of product data and information to drive innovation in manufacturing. Of course, connecting product development and manufacturing operations for digital manufacturing is perhaps more of an organizational challenge than a technical challenge. The benefits of early collaboration between design, engineering, and manufacturing, before a BOM and a BOP are set in stone, need to be communicated and proven to all parties involved by executive, business line, and functional leadership. Multiple manufacturers across industries are adopting or planning to adopt this cross-enterprise approach, which is being driven by executive leadership.

Q. How do manufacturing organizations get started on digital transformation for the factory and Industry 4.0?

A. The starting point often begins simply with digitization of work processes and instructions and evolves from there. Once this "bridge" between upstream development and downstream operations is established, manufacturing and engineering teams can mature their processes and tools, depending on their product, customers, and markets. Keep in mind that Industry 4.0 encompasses the entire organization, not only the manufacturing plant. A digital thread needs to be established that connects sales and marketing, design, engineering, and manufacturing to unify data for the engineering and manufacturing teams. IDC includes sales and marketing within this strategy as an important driver of Industry 4.0: Manufacturing organizations are adopting an Industry 4.0 approach so that they can understand the needs of global customers and whether they have the capability and capacity to meet those needs.

Given today's global demands, design, engineering/R&D, and manufacturing must work together closely so that customer needs are met quickly and accurately, with high-quality products. Complex, connected products that are increasingly prevalent today require involved processes and a platform approach to innovation that extends across the entire development and production team. This intersection of design, R&D, engineering, and manufacturing operations (process planning and modeling, manufacturing execution systems, distributed control systems, and data historians) is the first step to establishing Industry 4.0. Closed-loop collaboration through this Industry 4.0 digital platform enables visibility for the cross-domain team and the ability to flex engineering and manufacturing output to meet whatever challenge or disruption arises — pandemic, weather, market strife, or fluctuating customer demand.

About the Analyst

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As Program Director, IDC Manufacturing Insights and Product Innovation Strategies, Jeff Hojlo leads IDC research and analysis of the collaborative innovation market, including topics such as the development of an innovation platform and the intersection of product design, development, and digital manufacturing. Mr. Hojlo is also responsible for research on business and IT issues related to discrete and process manufacturing across industry.

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- Weave collaborative change management and quality into the manufacturing process.
- Connect with other enterprise systems, such as ERP/MRP.
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