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Manufacturers Go Digital to Stay Competitive

Producers worldwide are implementing Digital Manufacturing software-based solutions to strengthen their competitive position in meeting the increasingly challenging demands of global manufacturing.

By Ed Miller
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The relentless pressures to continuously improve productivity, lower costs, compress delivery times, and enhance the quality of products must be met by manufacturers, while at the same time, internal business objectives must be achieved. Shareholders demand steadily-growing revenues and profitability while the market expects innovative products that provide aesthetic appeal, expanded functionality, improved performance, enhanced usability, and a longer, useful life.

Major challenges impede executives, managers, planners, and workers while they are striving to meet these demands from shareholders and the market. Resources of people, time, and funding are limited. The huge amounts of time is spent locating relevant information and sharing data throughout the enterprise is often ineffective. Visualizing and optimizing future production processes is difficult. Moreover, problems may not be caught until late in the cycle when changes are costly and time-consuming.

As if these challenges weren't enough, competing in the global manufacturing arena compounds difficulties as companies in all areas of the world vie for customers. At the same time, there is more and more pressure to operate as an integral component in product supply chains. Global supply chains are increasingly critical to a manufacturer's well-being, and they typically include multiple firms from many different regions around the world. These supply chains are often complex networks with diverse global composition, interdependence of one supplier upon another, competition among suppliers, and the intense pressure to meet customer requirements.

Given these substantial challenges, manufacturing is a worldwide race favoring those firms that are cost-efficient, agile, lean, structured, process-oriented, technology oriented, and have created a culture that incessantly strives for excellence. Manufacturing productivity must be ever increased and producers must constantly look for ways to meet the faster, better, cheaper mantra of today's economy. To meet these pressures and remain competitive, leading manufacturers are going digital.

Software-Based Solutions

In going digital, manufacturing companies are implementing software-based solutions that enable Digital Manufacturing. Digital Manufacturing can be defined as a proven software-based solution that supports effective collaborative manufacturing process planning between engineering disciplines, particularly design and manufacturing. This requires access to the full digital product definition, including tooling and manufacturing process data. Integrated tool suites working with this product definition are used to support visualization of simulation, validation, and other analyses necessary to optimize the product and manufacturing process design. Requirements from across different engineering disciplines are also supported through this process.

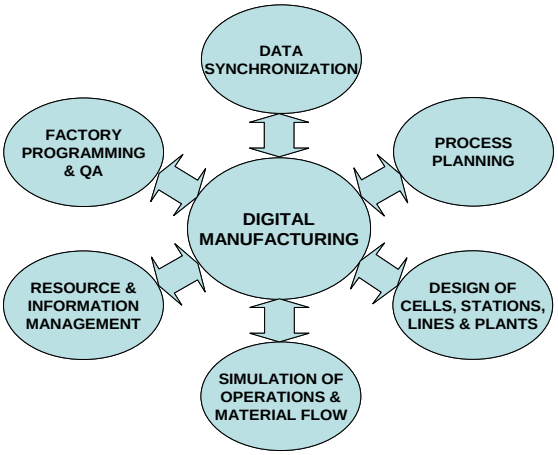

Figure 1. Major Functions in Digital Manufacturing

As shown in Figure 1, the six major Digital Manufacturing functions typically include:

- Data synchronization from design through manufacturing in an enterprise information management environment, including linkage and data integration among CAD, CAM, tool design, ERP, MES, and other software applications.
- Computer-aided process planning to obtain an optimal process solution. Establishing and cataloging manufacturing constraints, costs, throughputs, and best practices is also performed.
- Detailed line, cell, station, and task design for part manufacturing and assembly process management, including plant design and creation of mechanical assembly-line layouts.
- Discrete event simulation of manufacturing operations and material flows to visualize, validate, and optimize processes. Simulation and assessment of worker movement, ergonomics, safety and performance is provided to assure compliance with standards.
- Maintaining and managing information on manufacturing resources, including software to support commonization and re-use of parts, assemblies, equipment, and processes. The software also provides manufacturing documentation, shop floor instruction, improved visualization, effective communication, and collaboration among workers.
- Programming of robots, welding, painting, coordinate measuring machines, and other factory equipment, as well as creation, testing, optimizing, and managing printed circuit boards and product assemblies. Quality planning, product inspection, control of dimensional variation, and continual assessment of production quality is also provided.

Using these capabilities, manufacturing engineers determine how best to build products, synchronize engineering and manufacturing operations, and unify the production environment. An optimized production environment is established by more automated and effective process planning, plant design, and workflow simulation. At the same time, the cost of inventory, direct labor, manufacturing engineering, plant and equipment is reduced.

Integral Component of PLM

A common digital model is employed in Digital Manufacturing to bring together information on products, processes, plants, tools, and resources to enhance operational efficiency, establish best practices, and provide a consistent manufacturing solution. Utilization of a digital model provides a basis for collaboration, synchronization of processes, and highly efficient workflows.

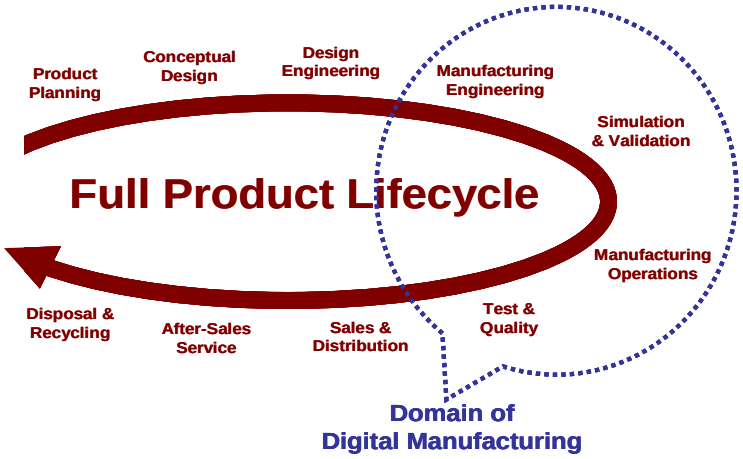

Figure 2. Digital Manufacturing as a Component of PLM

Digital Manufacturing is an integral component of a full PLM (Product Lifecycle Management) solution, as shown in Figure 2. Maximum integration of product design, manufacturing engineering, and production operations is achieved and effective use of information is established up and down a supply chain. PLM-based capabilities for collaboration, change management, document management, workflow management, process management, resource management, and version and product variation management can be implemented and integrated with Digital Manufacturing to create a highly effective enterprise-wide product lifecycle solution.

Key Management Drivers

Digital Manufacturing plays a critical role in execution of important management initiatives, including improving production efficiency, commonizing components and processes, assuring compliance with regulations and standards, and implementing enterprise data management. These themes drive the use of the technology and have a significant influence on the continued viability of manufacturing firms worldwide.

Improving Production Efficiency. The design of the product and the design of the process continually evolve as design and manufacturing processes are optimized within a Digital Manufacturing environment, so improving production efficiency is a continuous process. Several key aspects of Digital Manufacturing primarily contribute to this improved efficiency. Benefits enabled by computer-aided process planning include a better response to market opportunities by reducing the time-to-market, establishing common business and information systems, permitting knowledge and process re-use, and improving cost competitiveness through product cost management and organizational efficiency. Through virtual manufacturing simulation, the “what if’s” of production are considered quickly and completely to evaluate and optimize plant and process designs before mockups and prototypes are produced. Discrete event simulation of material flow, part manufacture, and assembly operations permits visualization of processes, verification of cell and plant design, obtaining time and cost measurements for all functions, and operation optimization. An interactive environment is provided for quality management in controlling dimensional variation, improving product quality, and communicating quality data throughout an enterprise.

Commonizing Components and Processes. Key aspects of Digital Manufacturing provide for commonization, standardization, and re-use of components, assemblies, and equipment in multiple contexts. Processes are commonized by establishing best practices, creating templates, and re-using the

processes as appropriate. The ability to quickly locate the right information when needed saves considerable time for manufacturing engineers, who would otherwise spend 30-40% of their time searching through massive amounts of production data for the right information. Electronically capturing best practices in manufacturing minimizes production risk, reduces lead time in planning and production, lowers product cost, provides consistency of production, minimizes product variation, improves overall product quality, and further promotes a lean operation. Digital manufacturing provides a single source for accessing manufacturing resource information so that proper resources are readily identified and available for re-use as components or in a process. A Director of Manufacturing Planning at a Tier One automobile supplier stated, "A guiding principle in our firm is to commonize, standardize, re-use, and analyze within our operations." This supplier uses a single integrated, global system for all product lines and commonizes the approach for use of the system.

Assuring Compliance. In many ways, Digital Manufacturing helps manufacturers assure compliance with government, industry, and company standards at minimum cost. Risk is mitigated through automated process planning, simulation, and visualization to ensure that production flexibility, performance, and quality objectives are met, that processes will achieve the desired business result, and that compliance is achieved. Ergonomic considerations are addressed with by simulating conditions to assure that factory worker visibility, lifting, and movement can be accomplished without undue physical strain. A major electronics firm ensures that compliance with standards is being met by utilizing tolerance analysis to measure the degree of dimensional variation and the source of variation. A Lead Dimensional Engineer at the company commented, "Through the Digital Manufacturing program, we have been able to eliminate manufacturing bottlenecks, reduce tooling and metrology costs, and establish looser tolerances on most parts."

Implementing Enterprise Information Management. Experience has shown that implementing Digital Manufacturing in combination with other applications in an enterprise information management environment and as part of a broad PLM initiative is more effective than employing Digital Manufacturing as a point solution. Bringing together a proven knowledge management foundation with Digital Manufacturing is a uniquely powerful combination. All applications throughout a PLM environment (including conceptual design, product design, tool design, engineering analysis, digital manufacturing, numerical control, quality assurance, and collaborative product data management) are integrated. Tools are available for workflow management, change management, integrated visualization options, configuration management, collaboration, and product data management. Management and synchronization of product and process information throughout the product life cycle from idea conception to the end of life is accomplished, as shown in Figure 3. Continued support of legacy manufacturing functions is often desired or required. With open architecture information management systems, integration of these functions within a new or updated manufacturing process is accomplished.

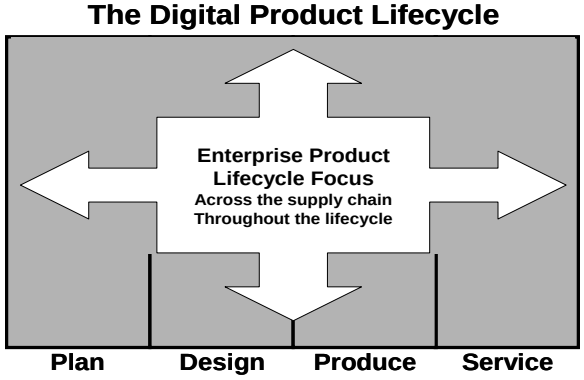

Figure 3. The Expanding Scope of PLM

Demonstrated Value

Digital Manufacturing has already demonstrated its value in many manufacturing companies around the world, and has provide payback in some relatively short times. For example, one large aerospace firm employs Digital Manufacturing as part of a broad PLM environment within their aircraft engine operations. Their Digital Manufacturing environment is used to manage approval, notification, and tracking of documents, establish routings and work instructions, and manage process templates. A head of manufacturing engineering at the firm stated that, "Through commonization, reduction in design changes, quality improvements, and productivity gains, we were able to obtain payback on our investment in less than one year."

But the example just described is not unusual. Research conducted by CIMdata in reviewing and evaluating Digital Manufacturing implementations indicates that companies around the world have achieved very positive results and have validated the potential value for organizations to make Digital Manufacturing a fundamental part of their overall product program. Figure 4 illustrates the range of benefits achieved by the surveyed companies with Digital Manufacturing implementations of various sizes.

Factor	Implementation Size		
	Small	Medium	Large
Initial Investment	$200K	$1M	$5M-$10M
Annual Investment	$200K	$1M	$5M-10M
Annual Savings	$1M	$8M	$50M-$100M
Annual Return on Annual Investment	5 to 1	8 to 1	10 to 1

Figure 4. Return on Investment for Digital Manufacturing

From Figure 4 it is easy to see that substantial benefits are available for companies that make the investment in Digital Manufacturing. However, a challenge is for companies to comprehend the role that Digital manufacturing can play in their operations and to clearly understand the changes that must be made in business operations in order to take most advantage of this valuable suite of technology-based solutions. But for those companies that do understand Digital Manufacturing, and that take the initiative to implement it broadly across their enterprise, the value is in their enhanced ability to successfully compete in the global market. These are the companies that will be considered winners in the coming years.

About PLM

CIMdata defines PLM as a strategic business approach that applies a consistent set of business solutions in support of the collaborative creation, management, dissemination, and use of product definition information across the extended enterprise from concept to end of life—integrating people, processes, business systems, and information. PLM forms the product information backbone for a company and its extended enterprise.

About CIMdata

CIMdata, an independent worldwide firm, provides strategic consulting to maximize an enterprise's ability to design and deliver innovative products and services through the application of Product Lifecycle Management (PLM) solutions. Since its founding more than 25 years ago, CIMdata has delivered world-class knowledge, expertise, and best-practice methods on PLM solutions. These solutions incorporate both business processes and a wide-ranging set of PLM enabling technologies.

CIMdata works with both industrial organizations and suppliers of technologies and services seeking competitive advantage in the global economy. In addition to consulting, CIMdata conducts research, provides PLM-focused subscription services, and produces several commercial publications. The company also provides industry education through international conferences. CIMdata serves clients worldwide from locations in North America, Europe, and Asia Pacific.

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Ed Miller president of CIMdata, is an internationally recognized authority on PLM and a frequent keynote speaker at conferences and seminars around the world on trends, directions, strategies, methods, and technology issues. He welcomes reader comments and can be reached at e.miller@CIMdata.com.