Tech-Clarity

making the value of technology clear

Digital Manufacturing

The PLM Approach to Better Manufacturing Processes

Introduction

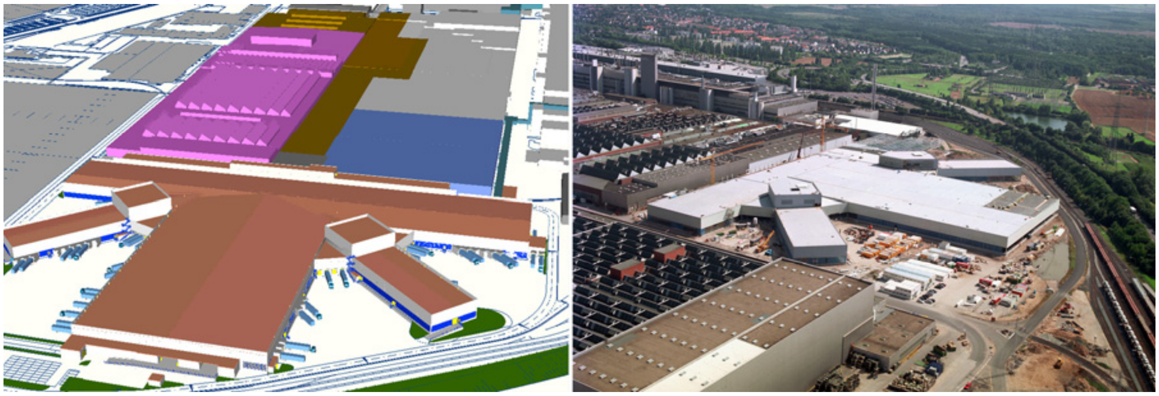
Product Lifecycle Management (PLM) is a business strategy that enables manufacturing companies to achieve greater profitability from their products. Within PLM, there are a number of tools designed to accomplish this, with a lot of attention historically placed on the design of the product itself. A new and fast growing discipline within PLM is Digital Manufacturing, a strategic approach to developing and deploying optimal manufacturing processes. Digital Manufacturing consists of new business processes, design methodologies, organizational approaches and software tools that help manufacturers improve their competitiveness and product profitability by planning, designing and implementing better manufacturing processes.

A new and fast growing discipline within PLM is Digital Manufacturing- a strategic approach to developing and deploying optimal manufacturing processes

Let's step back and look at the modern design environment to understand why Digital Manufacturing is becoming increasingly important to manufacturers. Ideally, we could all visualize a product in our heads and communicate the design to each other in verbal or simple written form. This may be possible for a simple object, but today's products are far too complex for that. To communicate complex designs, product engineers have turned to visual design and communication tools to translate the product in their imagination into a digital representation. Once digitized, the design can be shared, communicated and collaborated on electronically with others. Today's Computer Aided Design (CAD) systems reduce the burden on verbal and written communication, allowing product designs to transcend differences in location, time and even language. As CAD tools have become more powerful and have incorporated 3D Modeling, the communication has improved dramatically. Even complex products with thousands of components can now be modeled accurately and communicated effectively to other engineers, customers, suppliers, and manufacturing personnel.

Now that a complex product can be created in a digital format that comes very close to matching reality, it would be nice to simply hit the "*Print*" button on the CAD tool to produce the product. Although there are some very nice tools that generate prototypes of simple parts out of polymers, we are a long way away from the "*Print*" feature in CAD. In the real world, complex manufacturing environments, intricate production processes and dispersed production facilities are utilized to produce increasingly complex products.

As hard as it is to verbally describe a complex product in detail, imagine trying to describe the production line, equipment, material flow, tooling, processes and work instructions to manufacture that product. According to General Motors, the amount of information required to describe the production of a product is 1,000 times greater than the information represented in the product design itself. This explosion of data is required to properly document and communicate manufacturing complexities. Unfortunately for many engineers, the digital communication and visualization environment stops with the product design. When it is time to develop plant layouts, work cells, production processes, material flow paths and other manufacturing process designs, many engineers must rely on older, disconnected technology. Manufacturing and Process Engineers have been left to sort out their design work without the advantages that have helped Product Engineers produce more complex and robust product designs.



Graphic 1: Virtual Factory Simulation Created by DELMIA Digital Manufacturing Solutions
Source: Courtesy of Opel

Some leading manufacturers are addressing the manufacturing engineering design tool gap by providing engineers with robust tools to plan, design, simulate and communicate manufacturing processes. These manufacturers are producing virtual, digital products in virtual, digital plants in order to perfect manufacturing processes before the physical plant investments have been made. What's more, some manufacturers are seeing even greater leverage by combining the power of the digital product with the power of digital processes and resources—creating a "*Digital Manufacturing*" environment. By simulating production in a "*Digital Factory*", companies can evaluate multiple plant and process designs before investing in even a prototype—leading to the development of production facilities and processes in a much faster, more efficient, cost effective and error free way. Further, by simulating production of virtual products in virtual plants early in the product design process, designs for the products themselves can be enhanced to make manufacturing and assembly more efficient—leading to significant product cost reductions.

Table of Contents

Digital Manufacturing in a PLM Strategy

Digital Manufacturing is a critical element in a PLM strategy. The value of even the most innovative product designs is deflated if the intended product can't be manufactured effectively. The goal of the product—to produce a profitable return for the company that brings it to market—is hampered if the intended product can't be manufactured efficiently. Digital Manufacturing is a critical element of a PLM Strategy that ensures product designs can be turned into profitable products. Together with Computer Aided Design (CAD), Product Data Management (PDM) and other PLM-related applications, Digital Manufacturing helps to improve production-related processes and ultimately product profitability. Digital Manufacturing elevates the importance of manufacturing processes in relation to the lifecycle of a product and offers tangible improvements to the planning, design and deployment of manufacturing processes.

Digital Manufacturing is a critical element of a PLM Strategy that ensures product designs can be turned into profitable products

---

Digital Manufacturing concepts have been developed to address increasing demands on manufacturing to meet corporate objectives. Demand for higher quality products and more rapid introduction and ramp-up of new product innovations has been an executive-level mandate for many manufacturers. At the same time, continued market pressures have dictated that companies must continue to improve efficiency, drive out cost and increase throughput of facilities. Additionally, manufacturers are now working in a much more disperse, complex supply chain—typically including contract manufacturers or contract design firms—that demands faster responsiveness and higher levels of shared information. These factors have all influenced the demand for Digital Manufacturing, as well as the potential value available from adopting these concepts.

Digital Manufacturing elevates the importance of manufacturing processes in relation to the lifecycle of a product

---

One particular corporate objective worth noting is "*lean manufacturing*." Many manufacturers have adopted lean manufacturing techniques designed to identify and eliminate waste. Lean is not always associated with PLM, but is another corporate strategy that can benefit from the use of Digital Manufacturing concepts. A lean manufacturing approach involves a systematic elimination of non-value-added efforts. Digital Manufacturing provides the right environment and information to accelerate, strengthen and institutionalize lean programs in addition to PLM programs.

The results that have been achieved by applying Digital Manufacturing concepts are compelling, as highlighted in reports such as "The Benefits of Digital Manufacturing" published by Ann Arbor, Michigan firm CIMdata in March, 2003. Advantages gained from Digital Manufacturing include faster time to market, faster time to volume for product launch, reduced product costs, reduced manufacturing costs, improved product quality and ultimately a much better ROI for new and existing products. Manufacturers shouldn't expect a "*Plant Print*" button within the Digital Manufacturing software any time soon, though. Digital Manufacturing software is an enabler to implement a better approach to developing manufacturing processes within the overall context of the product lifecycle, but implementing Digital Manufacturing requires organizational and process change to realize the full benefits.

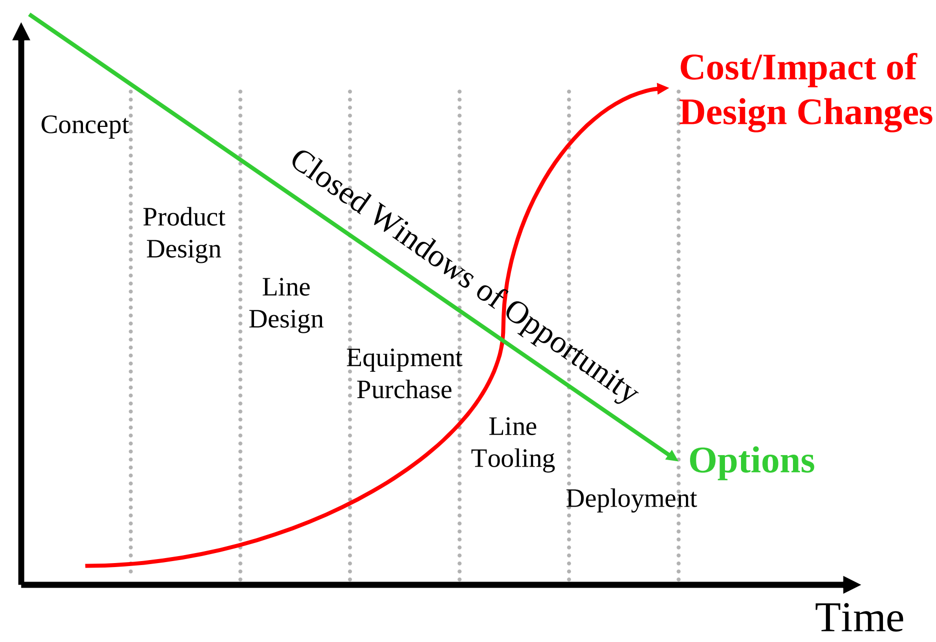
Produce it Digitally – Before Investing

Digital Manufacturing provides manufacturing and design engineers the benefit of enhanced visualization. In product design, powerful tools are frequently available for developing electronic product mockups, allowing engineers and non-engineers alike the ability to interact with a product before the design has been committed. Tools that allow 3D visualization replace sketches and drawings with something that comes much closer to the real world. By simulating the actual product that will be produced, countless mistakes are avoided and many improvements made. Time and expense have been reduced by reducing the number of physical prototypes that must be created in order to validate a product design in the physical world.

By simulating the actual product that will be produced, countless mistakes are avoided and many improvements made

Beyond validating the product design, however, engineers must validate that the product can be manufactured and assembled both effectively and efficiently. Digital Manufacturing extends visualization beyond the product into manufacturing—providing the ability to simulate manufacturing processes before the plant or production line may even exist. By proving out plant level considerations such as manufacturing approaches and material flow in the early stages of product development, the product concept can be analyzed to determine the best approach to manufacturing the product. Digital Manufacturing concepts work at the detailed level as well, allowing tooling, weld paths, ergonomic considerations and other critical details to be designed and analyzed in advance.

By simulating the manufacturing process, the physical infrastructure that is deployed will be several iterations ahead of what would have been deployed with physical prototyping and mockups. The benefit this provides is the ability to make changes in the virtual environment before physical infrastructure has been committed. Once physical infrastructure is deployed—whether it's a brand new, "*greenfield*" site or modifications to existing assets—flexibility begins to decrease rapidly (See Graphic 1). By moving many of the choices about how the product will be produced forward in the time, Digital Manufacturing allows changes to be made much more readily—providing for optimized manufacturing processes and a significant reduction in engineering changes after deployment. Automotive leader DaimlerChrysler, for example, says that no decisions are taken without simulation in their truck and cabin assembly operations, resulting in time savings, optimum processes and "*almost 100% accuracy*."



Graphic 2: Cost/Impact of Design Changes

Another benefit of simulating production before investment is that it not only helps with the design for the product and the processes by providing feedback on product manufacturability and designing optimal processes, but it also allows for the new manufacturing assets to be developed and deployed more rapidly because they have been pre-validated and don't run into the same level of redesign and retrofit of the production assets them selves.

Daikin Industries, a global leader in the manufacture of commercial and industrial air conditioning systems highlights this benefit, stating that by deploying simulation, they shortened their construction period by 30% and investment by 50%. By applying Digital Manufacturing techniques to better plan and design process and production facilities, Daikin achieved significant improvements that impacted both time to market and the bottom line.

Simulation Encourages Innovation

Another of the benefits of making as many decisions as possible in the virtual environment is allowing manufacturing engineers to evaluate multiple—potentially radically different—scenarios without committing to the expense of physical equipment or even mockups. Simulation leads to innovation because the penalty for being wrong in the virtual environment is a very simple learning exercise. The same mistake in the physical environment would cost the manufacturer for years to come in terms of retrofit, redesign or inefficient manufacturing. The likely result would be that the innovative approach would never be seriously considered and manufacturing would use an existing approach that may not be as efficient. The more innovative path, without the ability to visualize and prove the potential results, will appear too risky for the business—and for the individuals involved.

Simulation leads to innovation because the penalty for being wrong in the virtual environment is a very simple learning exercise

Simulation provides a safe environment for manufacturers to develop new and improved business processes. Interestingly, it also makes the incorporation of existing best practices much easier by allowing for reuse. General Motors, for example, reports that they were able reuse 80% of a powertrain production facility model when building a new facility in Eastern Europe, resulting in significant time and cost savings. This is potentially the best of both worlds, where tried and true methods can be easily simulated and compared in a "*what-if*" manner to more innovative ideas—resulting in either the adoption of best practices or the development of better practices when new, more promising methods emerge.

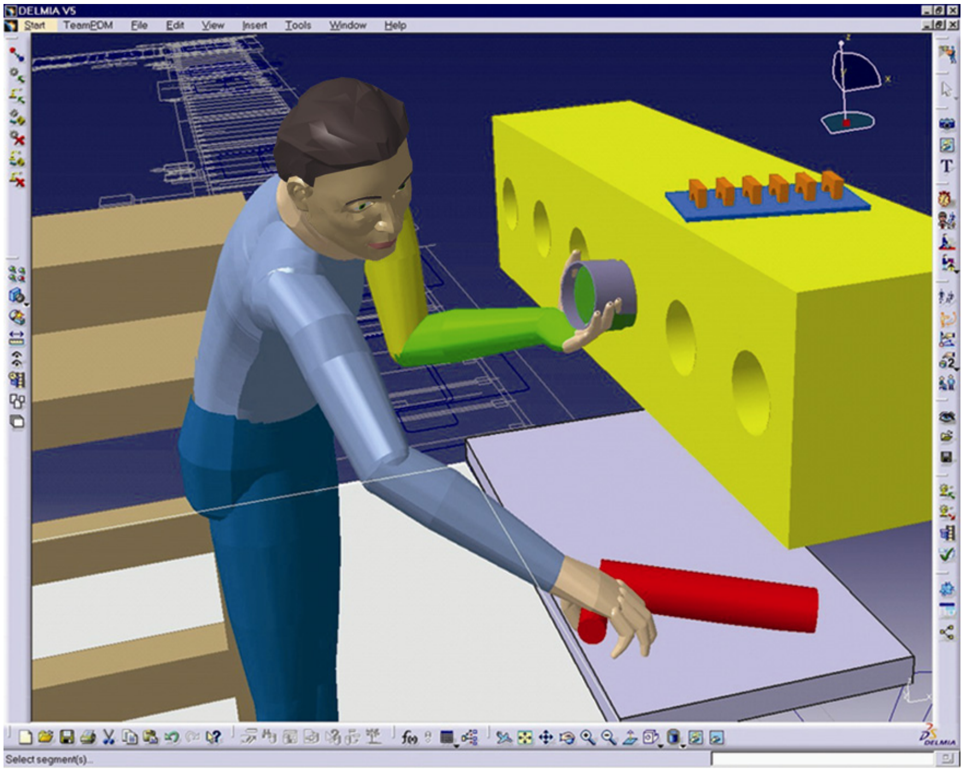
General Motor reports that they were able reuse 80% of a powertrain production facility model when building a new facility in Eastern Europe, resulting in significant time and cost savings

Find the "Gotcha" Before Design Freeze

The most powerful Digital Manufacturing tools enable better manufacturing processes, but also provide feedback to optimize product designs. By allowing product design information to be incorporated directly into a simulated manufacturing process, design errors that disrupt manufacturing efficiency can be identified and corrected in advance. Validating manufacturability and developing production processes earlier in the product design process, or "*concurrent engineering*," allows the company to leverage the combined knowledge of product engineers, manufacturing engineers and manufacturing personnel to design better and more profitable products. This approach reduces the occurrence of late design changes to accommodate manufacturing needs. Reducing changes results in the prevention of delays, slower ramp-ups and reduced throughput. Not surprisingly, concurrent engineering reduces product introduction lead-times as well. Sumitomo Wiring Systems (SWS) designs and assembles wiring harnesses for the automotive and industrial machinery markets. SWS reported that Digital Manufacturing resulting in over 33% reduction in the time period to develop manufacturing processes and an 80% reduction in the time required to validate processes.

By allowing product design information to be incorporated directly into a simulated manufacturing process, design errors that disrupt manufacturing efficiency can be identified and corrected in advance

To provide optimal results, production simulation should work on real product designs, incorporating the CAD geometry directly into the analysis. This allows the different components and assemblies to be view in context of their manufacturing and assembly requirements. For complex products like automobiles, simulating the assembly and disassembly processes is crucial to understand the ability for the product to be produced and maintained, enhancing the value of the product further into the product lifecycle. Automotive leader Toyota Motor Corporation, for example, virtually assembles their vehicles at design stage, and reports that they have "*drastically improved*" the ability to identify problems in advance. Again, surfacing potential problems early prevents the need for costly design changes later, assuming that design changes are possible at all.



Graphic 3: Assembly Operation Showing Constraint Violation
Source: Courtesy of DELMIA Corporation

Examples of problems that can be identified and eliminated in the design phase are clashes and interferences between components. Often, these problems are not found in the design process when production sequences have not yet been defined. It is possible, for example, for the parts to fit perfectly in a digital mockup. But the digital mockup only analyzes the final fit, and not collisions that occur during the assembly process itself. Sometimes, the clashes are not even visible from the outside, which makes the problem very difficult to detect without appropriate simulation or expensive prototypes and mockups. DaimlerChrysler reported that simulation can be more effective than a physical model, because process engineers can view processes from the point of view of the tool for tight spots, or insertion into components.

Toyota describes that before they began to use simulation, problems were identified too late—or not identified—using paper and prototypes. What may fit with one order of assembly may not fit with another. Early in the design process is also a good time to identify the need for manufacturability features that may need to be added to the product itself to ensure that the product can be produced effectively.

Reduce the Need for Physical Prototypes and Mockups

Prototypes are expensive, but the cost may be justified if they prevent problems and late design changes. Prototypes come with a time penalty in addition to cost. Toyota, in fact, invoked a strategy to remove mockups in order to reduce lead-times. Just as CAD has been used to reduce the need for physical product prototypes, Digital Manufacturing is being used to reduce the need for prototypes and mockups for lines, fixtures, tooling, material handling equipment and other production resources. Manufacturing Engineers must prove manufacturability, assemblability and ergonomic factors before making significant investments—but doing this in the virtual environment saves both time and money.

DaimlerChrysler reported that simulation can be more effective than a physical model

The goal of prototypes is to catch errors as early in the process as possible. Digital Manufacturing allows the expense and time drag of physical prototypes to be replaced by fast, cheap digital prototypes. Catching errors early results in fewer engineering changes, with General Motors reporting a goal to reduce these changes by 60%—a significant savings in time and expense. DaimlerChrysler went beyond saying that digital prototypes were as good as physical prototypes, claiming that digital prototypes allowed them to visualize dynamic factors and connections, better detecting potential problems such as collisions.

Catching errors early results in fewer engineering changes, with General Motors reporting a goal to reduce these changes by 60%—a significant savings in time and expense

Build the Process in Parallel

The development of production processes is not a one-time event, it is a process that starts with rough concepts in the beginning and ends with detailed instructions on how to produce the product. In the end, Digital Manufacturing helps at every step of the way by providing a common design environment to develop and detail processes. In manufacturing pre-planning, the amount of information available on the product to be produced may be minimal. The product designers may have some rough drafts and potentially a product structure, but most likely have not committed anything to 3D drawings. This is the time to start developing conceptual manufacturing processes. While there is certainly not enough information to develop detailed plans, this is the time to begin reviewing various manufacturing alternatives. Production locations can be compared to rough ideas of resource requirements and basic material flow and logistics ideas can be developed. Production strategies, such as whether to manufacture the product on dedicated lines or flexible work cells, can be evaluated. Different scenarios can be defined, evaluated and documented based on the information available.

Toyota reports that they have shortened lead-times from design fix to production launch by 2/3 to 13 months

Digital Manufacturing can also give early insight into the space, time, investment, product cost and throughput which are critical to analyzing the business case for a product. As the product design matures, detail from the design can be incorporated into the manufacturing processes. If the manufacturer is using a consolidated data model that represents both product and processes, the Manufacturing Bill of Material (MBOM) can be developed as a natural progression of the Engineering Bill of Material (EBOM) by adding manufacturing details as they become available. As more information on geometry and placement of fasteners becomes available, for example, engineers can begin to select robots, conveyor approaches, alternate methodologies and other manufacturing approaches. As the design begins to reach stability, engineers can narrow down which process looks the best, narrow down to right robots, tools and fixtures needed to produce the product. Digital Manufacturing is an approach that allows everything from the most detailed work instructions and program code for automated plant equipment to validating the overall throughput with material flow simulation provides to be developed in parallel with the product design—allowing manufacturers to ramp up production of new products much more rapidly, with higher quality, and at a lower cost. Toyota, in fact, reports that they have shortened lead-times from design fix to production launch by 2/3 to 13 months.

Optimize the Production Line – Before Deployment

The first iteration of a production line will not be ideal. When a new line is brought up or a new product is introduced on an existing line, there are lessons that need to be learned that will help to improve the efficiency of the manufacturing process. Digital Manufacturing provides tools and techniques to help analyze the need and effectivity of adjustments to the line. By applying these tools, manufacturing and process engineers can identify bottlenecks, spot inefficiencies and develop corrective action. Unfortunately, once the product is in production and the line has been tooled up, the ability to actually implement those changes is limited.

Digital Manufacturing allows engineers to tune the line in a virtual environment—increasing early efficiencies to levels unachievable by deploying and continuously improving physical deployments

Digital Manufacturing, in addition to optimizing existing processes, also provides the ability to start the learning curve early for new processes. By simulating and analyzing the manufacturing processes and resources in advance, the first time the product is produced physically can be a more refined, optimized iteration of the process. In essence, Digital Manufacturing allows engineers to tune the line in a virtual environment—increasing early efficiencies to levels unachievable by deploying and continuously improving physical deployments that are constrained to change.

Evaluating different production equipment layouts in advance allows engineers to recognize potential resources constraints, allowing them to remove manufacturing bottlenecks before they even appear

Daikin uses Digital Manufacturing to model entire lines and simulate them with different manufacturing scenarios before deployment. Before using advanced capabilities and simulation, Daiken found it impossible to evaluate line design at the early stages of design. Now, optimizing the line can start very early in the process, starting from a block layouts and diagrams. Manufacturers can use techniques such as discrete event simulation to determine impact on material flow, throughput and utilization for a product under various scheduling and product mix conditions—validating how robust the design will be under various manufacturing scenarios. Evaluating different production equipment layouts in advance allows engineers to recognize potential resources constraints, allowing them to remove manufacturing bottlenecks before they even appear.

Optimizing product lines before deployment works on different levels, as well. In addition to macro level decisions—like line layout and material flows—engineers can develop the early, rough concepts and develop them to a full 3D representation of the line. DaimlerChrysler, for example, identifies problems and analyzes manufacturing in lifelike 3D animation—simulating everything from material flows to the actions of individual robots. By reviewing automated assembly equipment, such as robots, in context with the component design, material flow and human resources, a very realistic representation can be leveraged to make better design decisions.

DaimlerChrysler, for example, identifies problems and analyzes manufacturing in lifelike 3D animation—simulating everything from material flows to the actions of individual robots

Digital Manufacturing can help by providing better tools and information to make design decisions. Before deploying a line, engineers face many tough choices. Whether it is proving out mock-ups of production tooling and fixtures in a virtual environment or building better workstations, Digital Manufacturing offers support. For example, one of the critical elements in obtaining efficiency on a production line is balancing the work across workstations. In this case, time studies and line balancing tools must analyze individual work processes in context with the operators and their workstation to determine the best way to distribute the work. Again, early analysis can allow for the addition of a workstation to avoid a bottleneck if the situation is found in advance, and multiple scenarios allows for a much better deployment on day one of manufacturing.

Optimize Assembly Sequences and Steps

Visualizing how a product will be assembled in the plant, particularly for complex products, is a difficult task for most engineers. The interplay between the parts being assembled, fixtures, tooling, robots and operators is by its nature a three dimensional problem. Simulation can play a large role in streamlining the work, by allowing the process engineer to "*see*" the process in action to identify potential problems, advanced tools can even automatically flag problems through analysis of the simulation. If an engineer is able to identify a potential problem in advance, they can change the layout to make it easier for worker to assemble parts and streamline the work process.

Automotive Supplier SWS described that before they used the Digital Manufacturing approach they performed physical assembly validation events. The validation events involved developing physical mockups that operators would use to test the assembly steps in conjunction with the parts and jigs. During these events, they were able to identify problems and document issues to be addressed for the next design iteration. The problem, they reported, is that the mockups were very costly and they could only run a limited number of them.

By converting the process to a digital format, they were able to run many more validations to detect interference with jig movements and identify optimal assembly processes. While not everybody has to deal with 4,000 individual parts in a wiring harness like SWS, these techniques work for everything from fully automated workstations to very detailed, labor-intensive assembly operations.

Automotive Supplier SWS described that before they used the Digital Manufacturing approach they performed physical assembly validation events that were very costly, and that they could only run a limited number of them

DaimlerChrysler also reported the benefits of simulating assembly operations. DaimlerChrysler detailed their ability to spot superfluous movements easily so they can be eliminated. In addition, simulations of manufacturing operations serve as the foundation for developing detailed assembly instructions to give to shop floor. At this point in the design process, additional comments about the assembly can be captured and documented to provide more rich instructions so operators can quickly understand the intent of the designed processes.

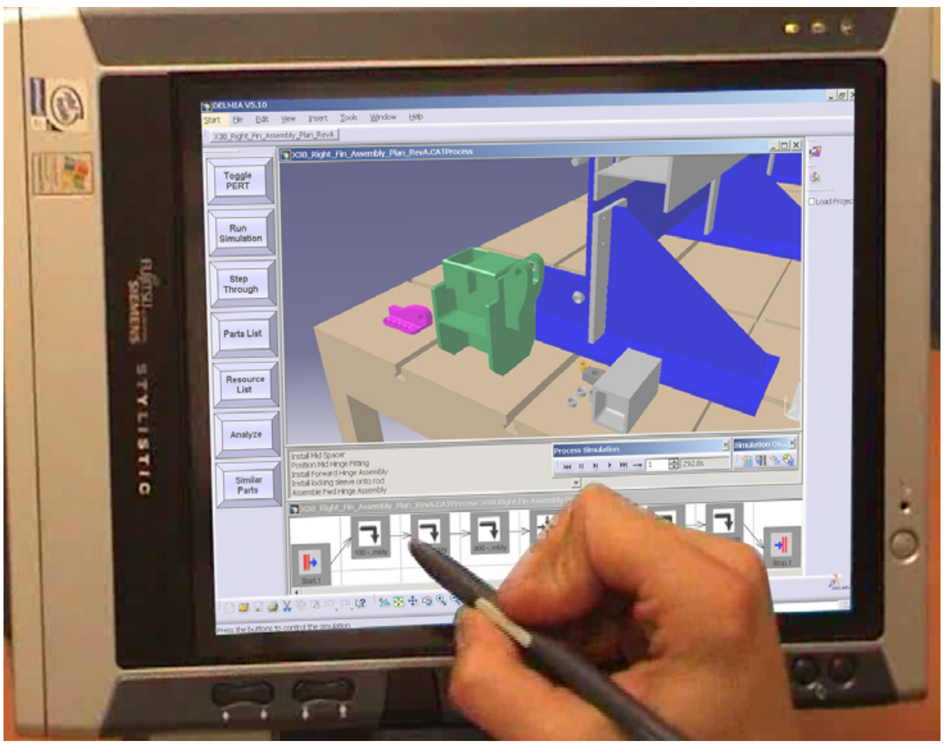
Communicate Processes to the Plant

It is important for engineers to communicate design information to manufacturing so operators clearly understand their role in efficiently producing a quality product. Even more important in an era where components are often manufactured remotely, ensuring that products are produced according to design requires that operators learn the processes in an intuitive way. 2D drawings and sketches are not enough to communicate complex processes because they are subject to interpretation and rely too heavily on the skill of the operator to read the drawings. 3D simulations, on the other hand, provide a much more natural context for learning because they show the full process in context—including parts, equipment, and operators.

2D drawings and sketches are not enough to communicate complex processes because they are subject to interpretation and rely too heavily on the skill of the operator to read the drawings

2D drawings often require a person—either an engineer or a highly skilled operator—to interpret the processes. Even the best drawings can leave some ambiguity. On the other hand, three dimensional simulations are not only more intuitive, they can also be enriched with multimedia. For example, assembly instructions can combine multiple viewing angles, text information, zooming in on detailed operations, supplemental video and other rich communication methods.

Using simulations, the product processes can be more informative, but can also be presented to the operator in a more engaging way so that they are more likely to retain the information. And, unlike the drawings that require some assistance to review at a later date, simulations can be stored and made available to the operator on demand—regardless of time, operator location and language—and allows the ability to share this information outside of engineering in an efficient, effective way. With portable, wireless technology like a tablet PC, instructions can be brought directly to the shop floor where they are needed. These instructions can be critical later in the product lifecycle as well, for example to communicate three dimensional maintenance and repair instructions.

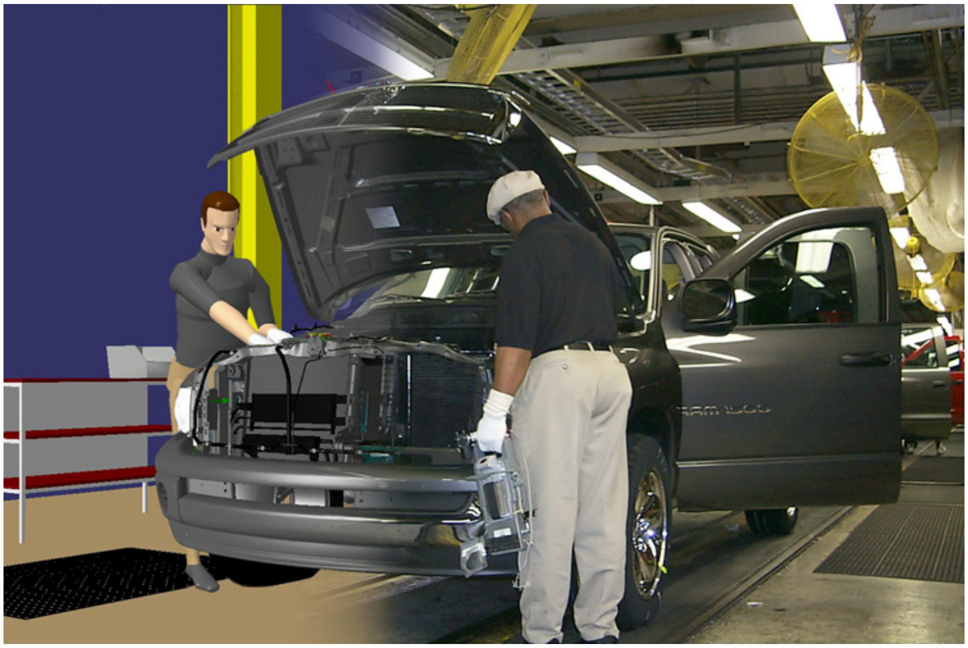


Graphic 4: Mobile, Wireless Instructions
Source: DELMIA Corporation

Not all operations are complex enough to require multi-media three dimensional work instructions, of course. Simple text instructions can be effective in many cases. Many companies, however, don't have a central repository to store, communicate and share work instructions. Many manufacturers can benefit from Digital Manufacturing concepts in order to design consistent, best practice work instructions for operators by accessing templates and common libraries of operations. This can reduce the time and effort required to develop work instructions, improve the standardization of processes and make it easier for the operators to understand and learn new processes quickly. Even for less complex operations, quality initiatives can be greatly enhanced by reducing the learning curve and providing easy to comprehend instructions.

Don’t Forget the People Factor – Ergonomics

It is important not to forget the human factor when developing assembly processes. The interaction of the operator with the parts, work aids and other manufacturing resources is critical to a safe and efficient manufacturing environment. As operations are defined, ergonomic factors should be evaluated to ensure that regulations and company standards are met to protect the workers. In addition, the overall efficiency can be improved by ensuring that operators are working in an optimized environment. By analyzing these factors in advance, manufacturers can avoid employee problems or the need to make costly, late changes to the line that can impact profitability and throughput. Ergonomics are important to consider for manufacturing, but also for the maintenance and operation of the product. For some industries, the operation and maintenance lifecycle may be more important to optimize than the initial manufacturing process.



Graphic 5: Virtual Ergonomic Simulation Created by DELMIA Digital Manufacturing Solutions
Source: Courtesy of Dodge Truck Advanced Design & Packaging Group

Digital Manufacturing supports different methods of ergonomic design, from simple checklists and guideline analysis for simple operations to complex simulations. For complex simulations, Digital Manufacturing utilizes life-like digital mannequins to simulate the human operator. By reviewing movements, reachability, load factors, viewpoints and other impacts on the operator potential issues can be avoided while operations are designed to best utilize the human resource. To fully understand the human factors, Digital Manufacturing calls for the ability to review and analyze mannequins and assembly equipment in context with parts—a full view of the manufacturing process and the relationship with the person. Toyota, for example, reviews posture, visibility, interference between operator and assembly trajectory for their assembly operations in order to improve manufacturing and maintenance operations. The interaction between the product, manufacturing equipment and the human operators is critical to deploying profitable manufacturing processes.

Digital Manufacturing calls for the ability to review and analyze mannequins and assembly equipment in context with parts—a full view of the manufacturing process and the relationship with the person

---

Keep Production Equipment in Production

Automated production lines, workstations and operations must also be designed with efficiency in mind. Many manufacturing processes today have been automated through the use of intelligent robotics, machining, inspection and material handling equipment. Digital Manufacturing provides the capability to program and simulate the use of automated manufacturing operations in context with the parts they are producing. There is distinct advantage in simulating these processes early in design. DaimlerChrysler, for example, develops and validates programs for their automated workstations before the robots are even installed. Particularly for multi-device workstations, this allows for potential collisions and inefficiencies to be identified before equipment is deployed—or in some cases even purchased—so that the design can be adjusted appropriately to ensure maximum efficiency of the operations.

Digital Manufacturing allows manufacturers to shift non-production activities to the virtual world

---

In addition to improving efficiency, Digital Manufacturing can also help with utilization. Production equipment only earns value when it is producing real products. Time spent preparing production equipment to manufacture new parts is non-value-added time, and should be reduced or eliminated if possible.

When new equipment is deployed, manufacturers must get it working quickly to start generating revenue. For existing equipment, manufactures must reduce the need for downtime so existing products can be produced. Digital Manufacturing allows manufacturers to shift non-production activities to the virtual world by programming welding equipment, CNC Machines, programmable logic controllers (PLC), robots, gantries and other automated equipment offline in a simulated environment. Making changes in digital factory means that real-world factory can stay online and make a return for the business.

Don't Leave Manufacturing in a Vacuum

Digital Manufacturing is not aimed at just improving manufacturing processes, it is aimed at improving manufacturing processes in the context of a product's lifecycle to ultimately improve profitability. There are clearly strong interactions between the product design, process design and production equipment. Changes to products impact process and changes to processes impact resources. Digital Manufacturing must manage beyond the processes and into the relationships between products, processes and resources. Managing manufacturing processes is not enough, it has to be done in context of the other production and production information—within a in a Product Lifecycle Management (PLM) context. Every PLM initiative should consider Digital Manufacturing a compelling opportunity, and recognize that an integrated approach that combines product information with manufacturing process information will provide greater synergy.

***Managing manufacturing processes is not enough, it has to be done in context of the other production and production information—
within a in a Product Lifecycle Management (PLM) contextText***

Adopting Digital Manufacturing Concepts

Digital Manufacturing, as we have discussed, is a compelling undertaking. Many manufacturers, however, may feel overwhelmed by the breadth of the concept if they are not yet operating in the way that a company like DaimlerChrysler or Toyota operates in their most advanced facilities. Fortunately, Digital Manufacturing is not an "*all or nothing*" prospect. For most companies, Digital Manufacturing is best approached as an evolution. Most effective change initiatives are viewed as a program with a series of improvements, not an event. A structured initiative should be developed that paints a picture to obtain the highest benefits available from Digital Manufacturing, but starts with some tangible, practical projects to prove the concepts. A series of incremental projects—often called a Digital Manufacturing Program—that provide a tangible business improvement and return on investment will not only be easier to justify for most manufacturers, it is also the more effective.

Picking an area of the business—either a physical location like a line or plant or a functional area like 3D work instructions—allows the company to learn from experience while solving a real problem. Focus on critical processes, and look for areas that are ripe for improvement. The initial projects don't have to be new, "*greenfield*" facilities, but also shouldn't be operations that are already working efficiently or the effort won't justify the investment.

Digital Manufacturing is not an "all or nothing" prospect

As with any business change, Digital Manufacturing is a journey. If a manufacturer is using 3D CAD modeling, they have already taken a first step along the path. By developing a Digital Manufacturing Program based on a strong vision and improvement goals, manufacturers can ensure that they are setting themselves up for long term success. By adopting a program that provides rapid value and payback, they are also providing a tangible benefit to the business in a short period of time—allowing for additional initiatives. Over time, the benefits will begin to be more than incremental. As Digital Manufacturing concepts become the new way of design manufacturing processes, new projects will be able to leverage work and lessons learned from previous implementations and provide even faster and more compelling returns for the business.

No two Digital Manufacturing Programs will be alike

No two Digital Manufacturing Programs will be alike, because not all of the concepts outlined above apply to every manufacturer. Some companies with a high level of automation may required detailed plant layouts to prove material flow sequences, for example, while other companies with less complex environments may be able to solve their problems with a simple block diagram. Care must be taken not to over-design the solution to a problem. For example, detailed 3D CAD models are not required for everything. For less complex operations, an approximation may work if no 3D CAD models are available. The level of detail for the models and simulations should be based on the problem to be solved. For a machining simulation, for example, an accurate model of the product geometry is essential. For material handling, a courser model that outlines the rough dimensions may be more appropriate. In short, there is no arbitrary need to design everything in 3D before you can apply Digital Manufacturing. The tools exist to simulate intricate operations, simply follow good engineering guidelines and don't develop an elegant solution to a simple problem.

Managing the Digital Manufacturing Program

To ensure a successful program, don't forget to demonstrate executive support and provide the business with a clear set of objectives. Without strong executive-level support and an understanding of the benefits of Digital Manufacturing, the company will have challenges successfully adopting the new business processes.

A partner with domain expertise can offer ideas and best practices developed through experience

Change is not always easy. Digital Manufacturing will require new business processes and some level of cultural change. But help is available. Look for help from a company that has deep experience in providing simulation and optimization of manufacturing processes for complex manufactures. A partner with domain expertise can offer ideas and best practices developed through experience. Digital Manufacturing is not a software suite, although it requires strong software application support. A Digital Manufacturing Program requires a strategy, proven methodology, an organization aligned with the objectives and the knowledge to apply Digital Manufacturing Concepts to your manufacturing operations. Adopting Digital Manufacturing is not an overnight task, but with the right management support and leadership it can provide significant paybacks.

Adopting Digital Manufacturing is not an overnight task, but with the right management support and leadership it can provide significant paybacks

Recommendations

Digital Manufacturing can help manufacturers develop more profitable products by optimizing the planning, development and deployment of manufacturing processes. The benefits of Digital Manufacturing are compelling and obtainable, and when addressed in a managed Digital Manufacturing Program can provide significant business results.

- Increased complexity in products and production environments, coupled with business needs for reduced cost and increased quality, make Digital Manufacturing a valuable opportunity for most manufacturers
- To deploy Digital Manufacturing concepts, develop a strategy and a program that includes strong goals and vision for the future state, but accomplishes this through tangible, manageable projects that provide a positive, rapid return to the business.
- Recognize that for Digital Manufacturing to be effective, there is a change effort involved that crosses organizational boundaries. The change process must be addressed and managed.
- To ensure the change effort is successful, obtain support and buy-in at the executive level so that changes to business processes, organizational structures and incentives can be made as required
- To get started, choose a pilot project to prove the value of Digital Manufacturing. Start small to prove the value of the concepts and then expand to address other areas of improvement.
- Partner with a company that has deep experience in Digital Manufacturing business processes, methodology and process as well as software.
- Choose a partner that can support the current phases of the Digital Manufacturing Program, but also one that can support future demands for solutions at later phases of the program to avoid the need to integrate and maintain multiple point solutions over time.
- Don’t overbuild the solution. Apply the right level of detail to solve the problems, and recognize that a full 3D CAD deployment is not required to obtain Digital Manufacturing value.

About the Author

Jim Brown has over 15 years of experience in management consulting and application software focused on the manufacturing industries. Jim is a recognized expert in software solutions for manufacturers and has broad experience in applying enterprise applications such as Product Lifecycle Management, Supply Chain Management, ERP, and Customer Relationship Management to improve business performance. Jim began his professional experience at General Electric before joining Andersen Consulting (Accenture), and subsequently served as an executive for software companies specializing in PLM and Process Manufacturing solutions.

Jim is the president of Tech-Clarity, a research and consulting firm dedicated to making the value of technology clear to business, where he is a frequent author and speaker on applying software technology to achieve tangible business benefits. Jim also serves as the PLM Analyst for Technology Evaluation Centers and The PLM Evaluation Center.

Jim can be reached at jim.brown@tech-clarity.com.