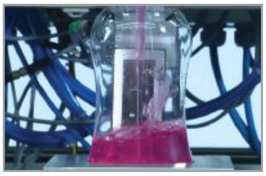
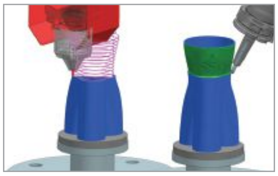
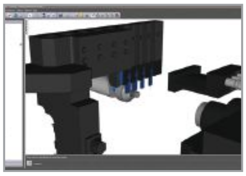

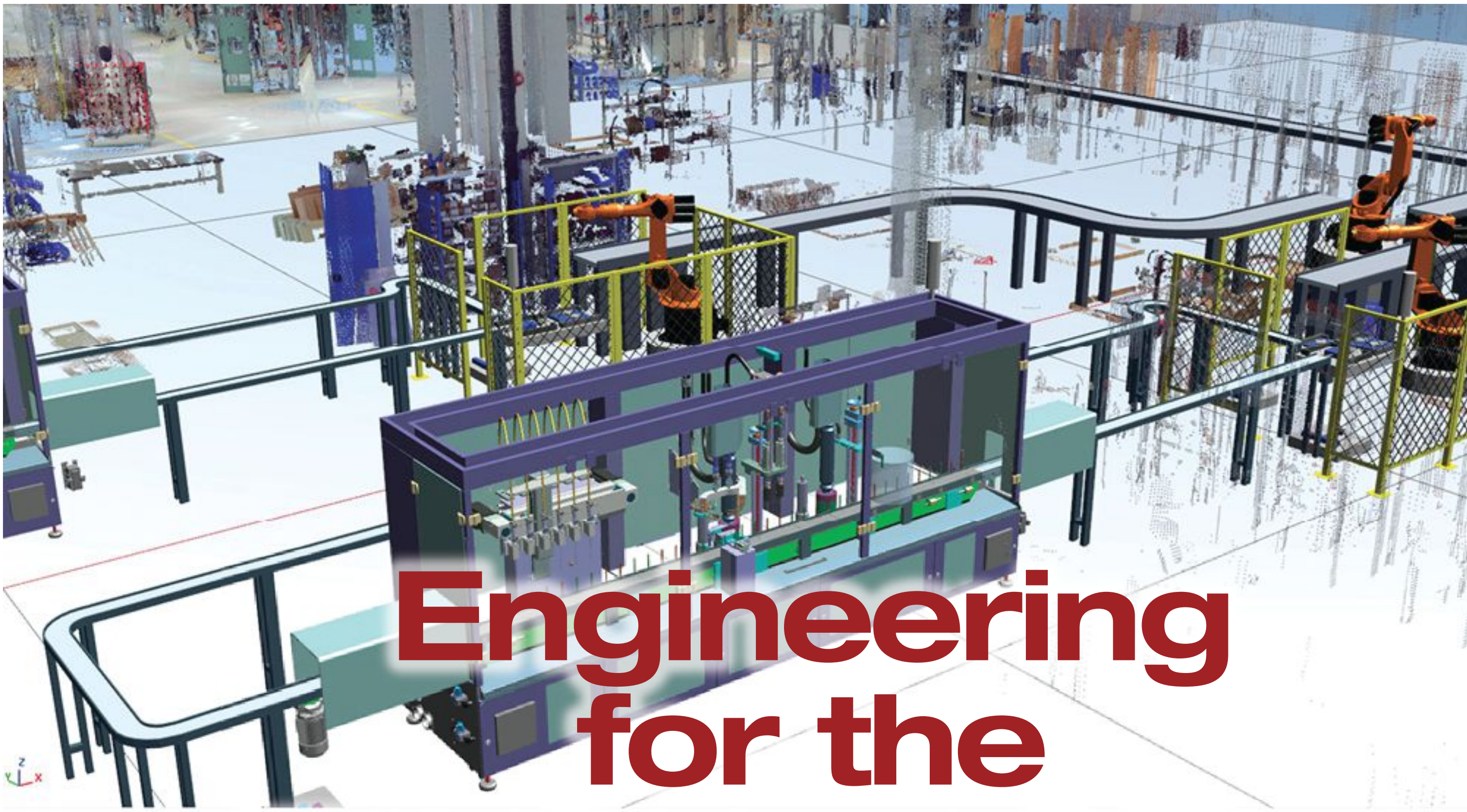

Engineering for the Factory of the Future

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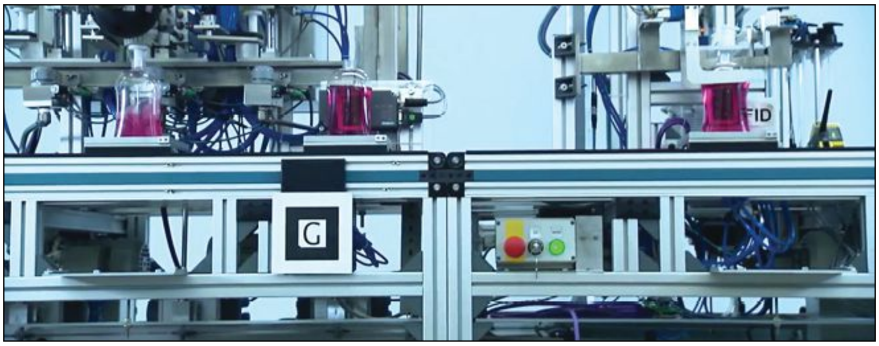

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welcome

Design for the Future

Depending on where you work, the factory floor may be so far downstream that you might be lucky to ever see it, or you may walk it every day. If it bears little resemblance to the highly automated, connected factory of the future detailed in this issue, just wait. Change of the magnitude of what some are calling the next industrial revolution will take time, but the benefits are so attractive that many manufacturers are already investing heavily in Industry 4.0.

What difference does it make how the products you design are made? Plenty. Small design changes can have big production payoffs in automated environments. Many traditional design restrictions are falling to the wayside as improved toolpath simulations, additive manufacturing and digital twins are adopted. Connected, automated machinery can log every manufacturing movement and communicate that data back upstream to help design engineers create products that can be made more efficiently.

Even if you don't see the manufacturing process, you're bound to be affected by technologies that are disrupting it. Read on to see what's in store.

Jamie Gooch, Editorial Director, *Digital Engineering*
Peerless Media
Comments? E-mail me at jgooch@digitaleng.news

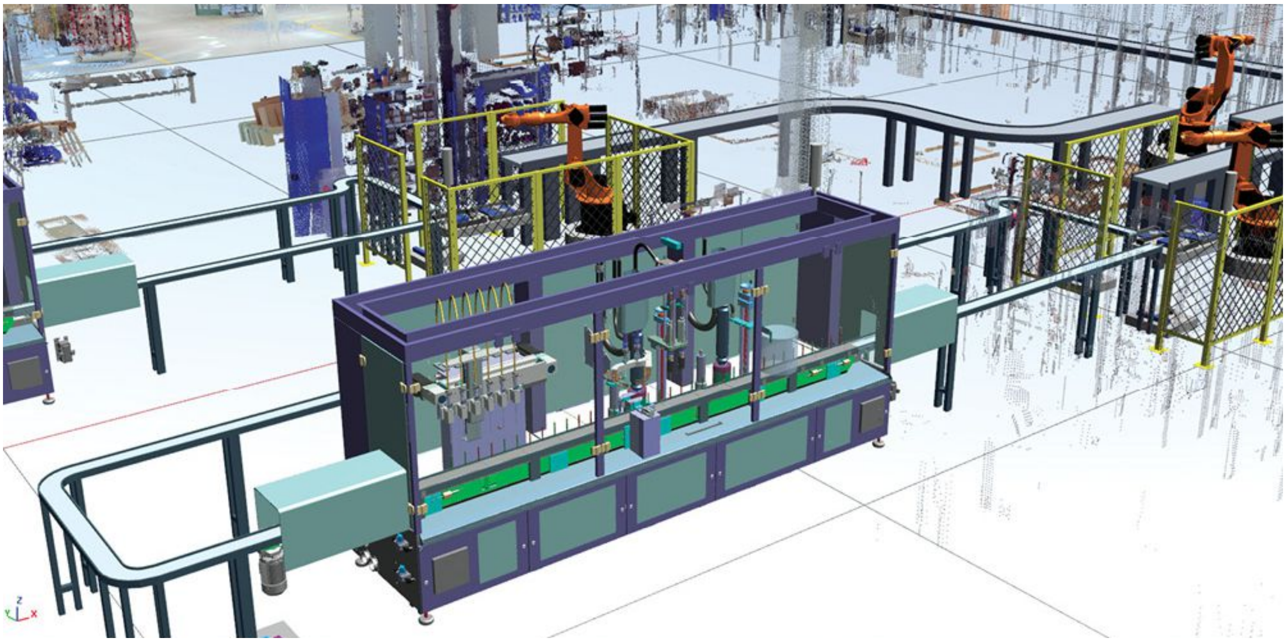
Manufacturing in the World of Industrie 4.0

By Pamela J. Waterman

If Germany has anything to say about it, the Factory of the Future is really the Factory of the Very Near Future. Formal, repetitive assembly lines will be obsolete by 2025, replaced by flexible, smart manufacturing systems that act and react according to a two-way digital data-stream. That's a pretty bold vision to accomplish in less than 10 years, but both the impetus and the solutions seem to be keeping pace.

Driving this radical change are worldwide demands for improved quality, lower labor costs, individualized products, and shorter product lifecycles. Enabling the changes are complementary technologies that affect the entire value chain. Manufacturing equipment can now share highly detailed, two-way status information through Internet of Things (IoT) technology, both with other equipment and with the parts themselves. High-speed networks and cloud-based computing resources already analyze data to direct the next move. And in the coming years, fixed assembly lines will be replaced by flexible, modular systems including 3D printers that reconfigure themselves as needed. This connected approach would help companies save production time while adding more value (especially customization) to their offerings.

Companies, and countries, that embrace this scenario will be leading a global manufacturing revival. *Digital Engineering* takes a look across the pond at German efforts to network humans, objects and systems for tomorrow's smart factory revolution, with Siemens PLM Software in a lead role.



Software products from Siemens let engineers simulate and test the digital twin of a current or proposed production line to evaluate manufacturing flexibility. Image courtesy of Siemens PLM Software.

At the German Research Center for Artificial Intelligence, the RFID chip (seen close up on the back of the bottle being filled) and Siemens hardware are used to communicate instructions to the production equipment for proper processing and quality verification. Image courtesy of Siemens PLM Software.

Shaping the Next Wave of Industry

Historians have labeled significant eras of manufacturing after disruptive technologies. Steam-powered machinery, electrified equipment and computer-controlled systems each changed production methods forever. Though still in its infancy, a new, fourth industrial revolution promises to do the same, and it already has a general name: Industry 4.0.

In the U.S., support for the transition to Industry 4.0 comes from groups such as the Smart Manufacturing Leadership Coalition and its program to create the Open Smart Manufacturing Platform. In Germany, a country with a long history of manufacturing expertise, a coordinated government initiated project for intelligent production operates under the variant name, Industrie 4.0.

Both nomenclatures give a not so subtle nod to the world of software revisions, reflecting the fusion of manufacturing equipment, control systems, and data collection made possible in large part by the technology behind the Internet of Things (IoT). Small, inexpensive sensor hardware combined with targeted application software has enabled explosive growth in smart devices. Adding this capability to industrial equipment, processes and inventory has created an industrial IoT (IIoT) sub-domain of cyber-physical systems that is already helping companies monitor, communicate, analyze and apply digital manufacturing information in close to real time.

New Business Models, New Tactics

Why is this important? One perspective comes from manufacturing engineering executives at Siemens PLM Software, a company whose products are directly relevant to the interconnected world. “Next generation manufacturing offers a way to meet customer demands for new, high-quality customized offerings at ever-shorter time intervals. It also has the potential to reduce resource utilization, which will help manufacturers cope with growing cost pressures,” Zvi Feuer, senior vice president of Siemens PLM Software, wrote in a recent corporate blog post.

Siemens PLM Software is an industry partner in the Industrie 4.0 initiative, which began in 2005 and formalized in 2011 as a forward looking project under the German Federal Government High-

Tech Strategy. Dual goals are to maintain market leadership by integrating smart technologies into traditional production industries such as electronics and chemicals, and to create and serve new markets enabled by cyber-physical systems.

Feuer says that German manufacturing is already seeing use of equipment that can react to parts tagged for RFID (radio frequency identification) and assemblies in advanced industries such as automotive. "When a partially assembled vehicle is moving on the assembly line, it carries a sensor and in there is a code of what needs to be done next," he says. "When it comes into a station, the station can react automatically and show the assembly workers who are going to operate this station what needs to be done for this specific vehicle.

"This is not rocket science, but still it requires a lot of pre-planning, making sure the robotics, tools and controllers all work in synch," Feuer continues. "You will also see more of this in the process industry, for example, with bottling. The RFID tag on a bottle will tell the machine what kind of formula to fill, like in shampoo production or perfume. We're going to see this in combination with the more advanced robotic facilities."

Equipping both the parts and the manufacturing equipment with sensors supports a number of other steps critical for the smart factory evolution. First, capturing detailed information lets robotic vision systems inspect, measure and compare as-built parts to the original CAD-defined dimensions for automated go/no-go decisions. Second, information can be sent back to the design engineers, who can learn from mistakes made in part design or assembly processes. And third, real-time or near real-time data gives feedback on how the equipment operation may be deviating from the perfect virtual plan. Such digitally recorded information lets motion-control programmers know that a machine needs to be tuned, offers various ways to improve process quality and supports tooling certification (an increasingly important aspect of cradle-to-grave tracking and certification requirements).

Setting up such production lines, particularly as consumers demand more customized, one-of-a-kind products, requires rapid, integrated planning. Feuer says that the Siemens PLM Software toolset is a crucial part of the Siemens Digital Enterprise Software Suite. Combining simulation, automation and data management, the suite offers a complete solution aligned with all the requirements of Industrie 4.0.

RFID Tag, You're It: Defining Unique Identities

The original Universal Product Code (UPC) bar code system (begun in 1963) is slowly being replaced with the Electronic Product Code (EPC) consisting of a bar code plus numbers, whose definition has already gone through several iterations.

The basic technology used to support the EPC as a global, end-to-end supply chain standard is the radio frequency identification (RFID) tag and reader, based on the newest EPC Gen 2 definitions. Globally, such systems operate over the 860MHz to 960MHz band. North American Gen 2 uses 902MHz to 928MHz while European Gen 2 uses 860MHz to 868MHz; equipment based on EPC Global tags work across the full EPC spectrum.

In order for products to have a unique identity from birth and be traceable cradle-to-grave components, assemblies and final products from smart factories will undoubtedly be labeled with RFID tags throughout the manufacturing process. To accommodate different types of products, materials and pricing needs, subsets of the EPC bands are assigned to different power levels and capabilities. Various types of RFID tag/reader systems operate with active, semi-passive and passive tag technology as well as different read/write data structures and content.

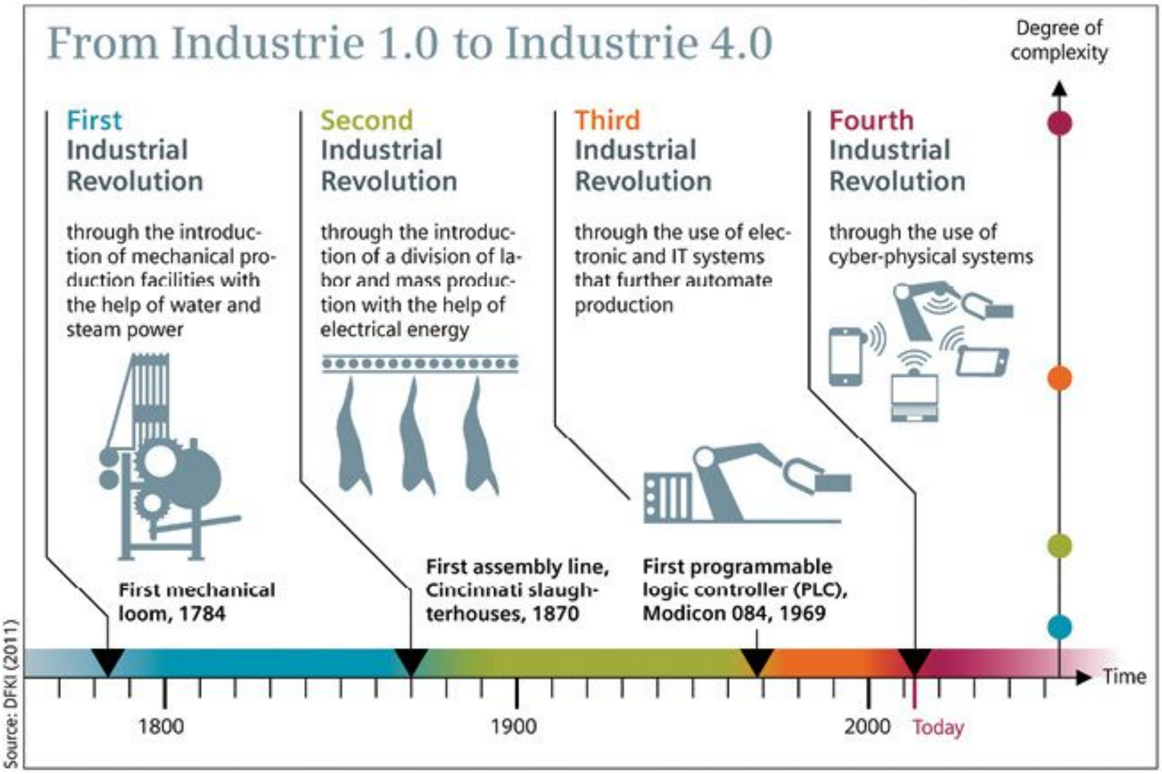
For a good discussion of the possibilities, visit SkyRFID.

— PJW

"All of our tools work on top of the PLM Teamcenter backbone," he says. "You start by designing the product then store the design information in Teamcenter. You then do the analysis, do the manufacturing process, and then go and design the production facility that can put together this product. Today all of this is done in parallel that used to be sequential."

Cooperation and Standards

Within the Industrie 4.0 effort, Feuer says there is an unbelievable open market attitude of both cooperation and competition. "Our Sinumerik CNC (computer numerically controlled) machine controls



Internet-connected autonomous systems have jump-started a fourth industrial revolution that includes big data mining, customer-driven designs and modular assembly lines. Image courtesy of Siemens PLM Software.

are extensively used to operate robots," says Feuer. "Each vendor has its own control system but some customers prefer to use the Siemens control because of its agility, versatility and ability to connect with various simulations of line programming and virtual commissioning (system setup) software."

With all the equipment and processes in use within any given industry segment (automotive, electrical, chemical, etc.) no single vendor can supply every type of system. It's no wonder that equipment based on a variety of engineering and industrial standards gets used concurrently and must work together. To support widespread implementation of the Industrie 4.0 vision, these standards must be coordinated, modified or consolidated.

Areas with multiple possible standards include Ethernet implementation, data exchange related to automated manufacturing equipment and data exchange of part files created in different CAD programs. Profinet is an industrial Ethernet implementation that adds real-time performance and robustness to everyday Ethernet use and is becoming a worldwide industry standard.

Automation Mark-up Language (AutomationML) is a neutral data format based on XML that enables information exchange between cross-disciplinary automated equipment. It actually incorporates several different standards that deal with topology, geometry, kinematics and logic control. Eventually, this approach will let users connect different devices and display all process information within one system.

And Siemens PLM Software's own JT file format is seeing growing use for lightweight visualization of 3D product data. Since its beginnings in 1997 and formal publication in 2007, the JT format has supported digital collaboration at many levels, making it easier and faster to move 3D data within a company or enterprise, or between a company and vendors. Accepted as the world's first ISO International Standard for lightweight 3D visualization, JT allows multiple parties to exchange 3D information even if they do not use the same CAD programs.

Practical Steps, Long-Term Strategy

Implementing Industrie 4.0 tactics will not be a linear process, but companies can — and are — taking steps right now to bring their manufacturing processes into this new era. Adding sensors and software to equipment and components forms the first step for factories to become data-driven and responsive. Active monitoring of this information in real time allows tracking individual parts through their entire production cycle, so problems during manufacturing can be quickly identified and corrected. Step two compiles the data gathered over the course of building thousands of parts, or running machinery for thousands of hours, providing insight into deviations or faults; such information can then guide improvements to both processes and part design. A third step will require translating this data at a higher level into new product concepts offering capabilities that weren't previously possible or identified.

Siemens' long-term strategy may take 15 to 20 years, but Feuer believes many aspects of Industrie 4.0 factories will come sooner. The benefits will go beyond improving manufacturing efficiency and satisfying discerning consumers. "Industrie 4.0 is not a slogan to generate more revenues," he says. "It's a strategy started by the government and adopted by Siemens and some other big players in the industry because we want to make sure we are doing something good for the society as well as making a profit. We want to create jobs, create opportunities. Even though it sounds a bit strange because we're talking a lot about automation and robotics — yes, the types of jobs on the shop floor are going to change — but we still will be creating jobs and they are well paying jobs."

More Info

- [Industrie 4.0]
- [Open Smart Manufacturing Platform]
- [Siemens PLM Software]

Contributing Editor Pamela Waterman, *Digital Engineering's* simulation expert, is an electrical engineer and freelance technical writer based in Arizona. This article was originally published here: digitaleng.news/de/manufacturing-in-the-world-of-industrie-4-0/

Manufacturing Goes Digital

By Jess Lulka

Production-level additive manufacturing (AM) is entering the industry spotlight. In September 2016, GE announced its intent to acquire industrial AM companies Arcam AB and SLM Solutions Group AG for $1.4 billion. (Editor's note: It has since dropped its bid for SLM Solutions and acquired Concept Laser.) Siemens also stepped up its stake in the technology by becoming a major stakeholder in Materials Solutions Ltd., a provider of AM processing and production. More companies are beginning to invest in AM because they see them as integral to their digital manufacturing plans.

"Additive manufacturing is a key part of GE's evolution into a digital industrial company," said Jeff Immelt, chairman and CEO of GE, via a press release. "We are creating a more productive world with our innovative world-class machines, materials and software. We are poised to not only benefit from this movement as a customer, but spearhead it as a leading supplier."

Digital manufacturing integrates the use of design, simulation and data analytics software to simultaneously produce products and develop best practices for manufacturing. Its goals include increased collaboration between design and production as well as collecting usable information for both departments.

"As you're producing parts [with digital manufacturing], you're learning more and more about how that part is made … so by the time that individual product rolls off the production line, you have a tremendous amount of information of how that part was designed and how that part was produced," says Dean Bartles, chief manufacturing officer and executive director at the Digital Manufacturing & Design Innovation Institute (DMDII).

GE says it expects to grow its new additive business to $1 billion by 2020 and also expects $3-5 billion of product cost-out across the company over the next 10 years. Other examples of advancing the industrial integration of AM include Siemens PLM Software partnering with Stratasys and DMG MORI; 3D Systems linking up with PTC; and the DMDII expanding its grants and research projects.

According to DMDII, 81% of U.S. manufacturers recognized digital manufacturing as an element of competitiveness, but only 14% believed that they were adequately equipped with related technology and expertise. The factory of the future will include three main things: intelligent automation, robotics and additive manufacturing, according to Aaron Frankel, marketing director for Manufacturing Engineering Software at Siemens PLM Software. "A digital environment unites the digital and the physical–and it does it in such a way to create a digital twin," he notes. "We're at the very beginning of seeing additive being used in industrial processes."

Bringing Systems Up to Speed

One way AM vendors are advancing their products is by integrating robotics to automate the process. Over the past several months, 3D Systems and Stratasys have announced new technologies to address manufacturers' needs: Figure 4 from 3D Systems and an Infinite-Build 3D Demonstrator and Robotic Composite 3D Demonstrator from Stratasys.

All three of these systems leverage robot tech-

The Robotic Composite 3D Demonstrator from Stratasys uses a robotic arm with an extruder for greater motion control. Image courtesy of Stratasys.

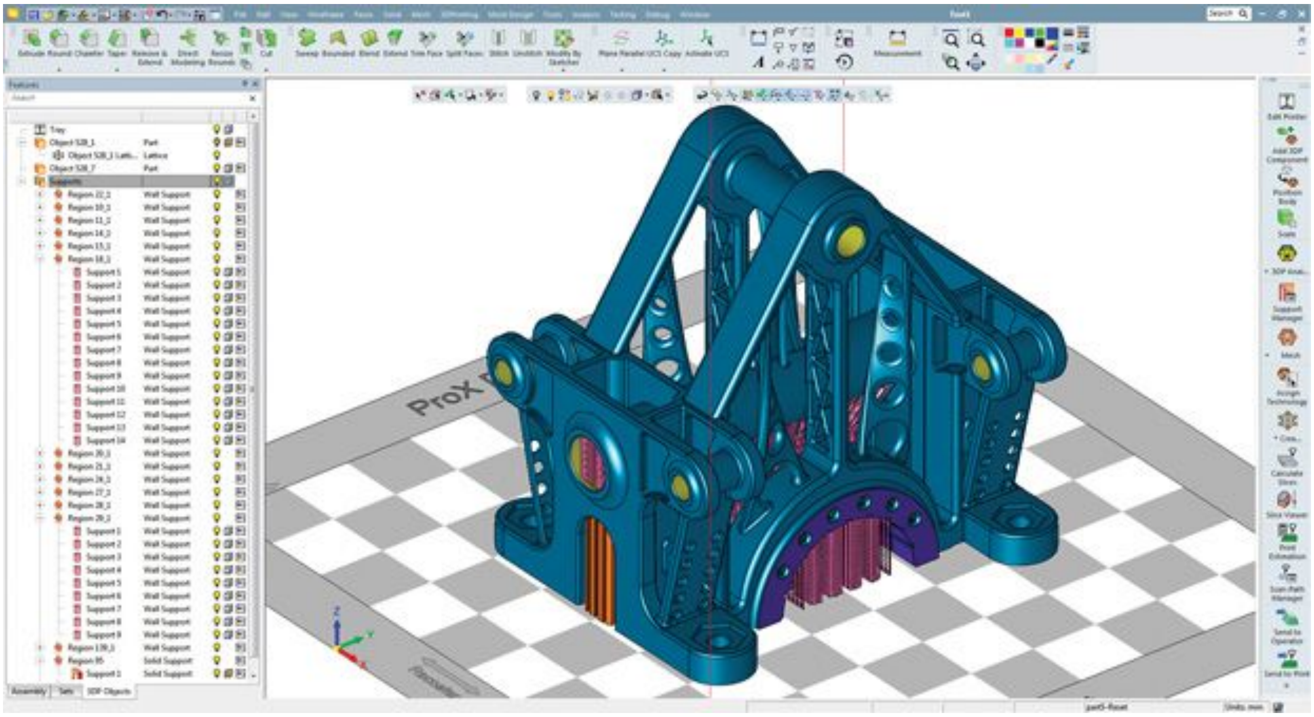
nology for more flexible, faster and larger builds. 3D System's Figure 4 technology builds on an original patent from co-founder Chuck Hull. The vat-based stereolithography system uses multi-mode polymerization and robotics to complete production, material recovery and curing. To produce a part, the build plate is pulled up from the material and cured through a chemical process.

Stratasys' systems rely on its FDM (Fused Deposition Modeling) process. The Infinite-Build 3D Demonstrator creates parts on a vertical plane, for increased scale and greater part size. A robotic arm is used to automated material replacement during the build. The Robotic Composite 3D Demonstrator brings greater design capabilities by attaching an extruder to an 8-axis robotic arm motion system driven by Siemens PLM Software's NX, eliminating the need for support structures.

In addition to the announcements from 3D Systems and Stratasys, this year's International Manufacturing Technology Show (IMTS) brought many other systems into the spotlight. ExOne, Renishaw and EOS North America were among the companies sporting new production-level and metal-based systems.
In 2015, ExOne announced its Exerial additive manufacturing system, which is designed for simultaneous, large-scale printing. It is equipped with two job boxes for greater print capacity and sports a total build platform of 3,168 liters using binder jetting technology.

Renishaw showcased its RenAM 500M production system, which uses metal alloys for end-use level products. Functions such as powder sieving and recirculation are all automated, and it is designed to reduce handling of materials.

EOS introduced its FORMIGA P 110 system that directly uses CAD data to produce polymer parts in a build space of 7.8×9.8×13 in. The company says it has a high degree of automation for material handling and integration, allowing for "minimal downtimes and increased productivity."



3DXpert provides an all-in-one toolset for metal 3D printing and production. Image courtesy of 3D Systems.

One key common feature in these systems is an increased degree of automation. For example, 3D System's Figure 4 would be slowed down by manual intervention. "Because of the velocity at which it can produce recurring geometry, and with the scale we can get to using multiple modules, automation is just a natural part of it," says Scott Turner, senior researcher at 3D Systems. "Having labor trying to handle hundreds of parts an hour can be difficult."

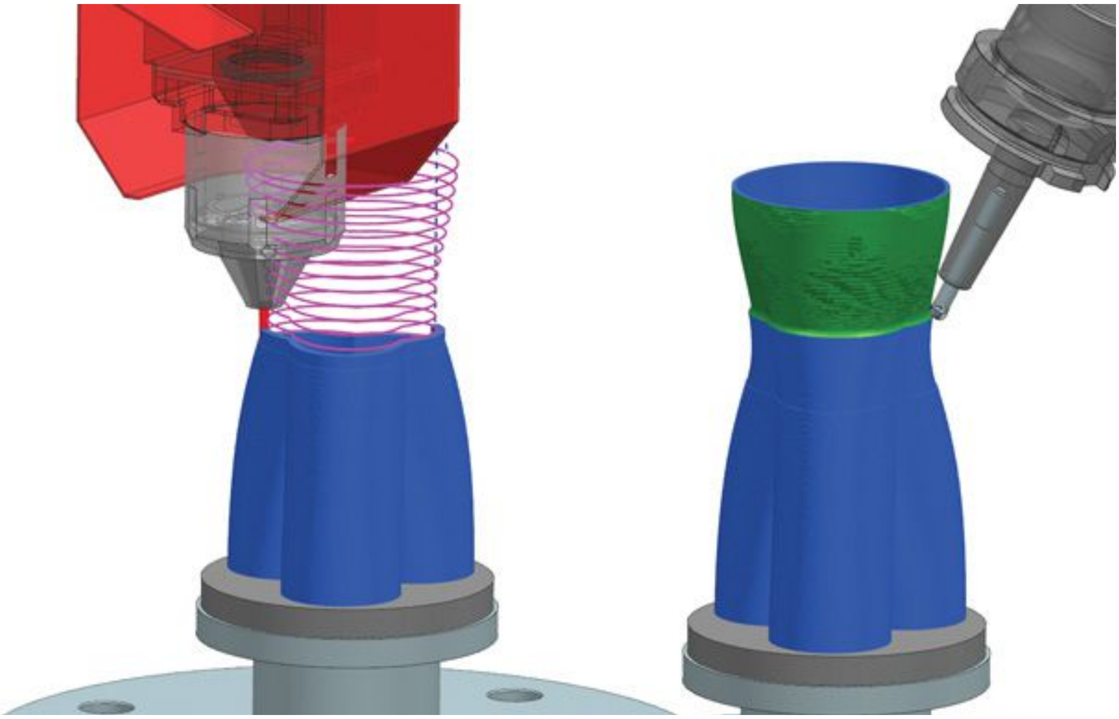
Software Provides AM Time Savings

AM hardware is only part of the digital manufacturing solution. Software integration and design-to-production collaboration is only possible via a digital thread that connects the product lifecycle. With the two-way connection between manufacturing and engineering design, any changes throughout the design process or in the original CAD files can be implemented in real-time.

When it comes to creating support structures, converting files and selecting post-processing settings for AM, "the software tools will enable [engineers] to optimize the printing process," says Sridharan Hariharan, director of Applications Engineering & Training, Software Business Unit at 3D Systems.

3D Systems introduced 3DXpert last month to provide an end-to-end process for design, pre-printing preparations (support generation, topology optimization) and post-printing processes (subtractive manufacturing or finishing, for example). It uses an original CAD model as the basis of the AM-made part and provides complete control of the printing process, including zoning

"Especially for [engineers] using additive manufacturing and having post-printing operations, [3DXpert] will enable them to be more efficient, more productive," Hariharan says. This ability to access various manufacturing methods within one software suite will



Siemens' NX Hybrid Additive Manufacturing provides laser and NC programming with simulation for the DMG MORI Lasertec machine tool series where metal deposition is incorporated with machining on a single machine. Image courtesy of Siemens PLM Software.

help integration of metal additive manufacturing into traditional manufacturing environments, he adds.

Additionally, having a digital copy of the part for production allows for easier reproducibility, and the ability to capture the most optimized design. This almost makes it a self-improving process, Frankel says. With a software-based backbone, manufacturing environments can predict performance and accumulate knowledge to capture the best way to do things. It's also easier to transmit new workflow changes because the environment is completely connected to a software infrastructure.

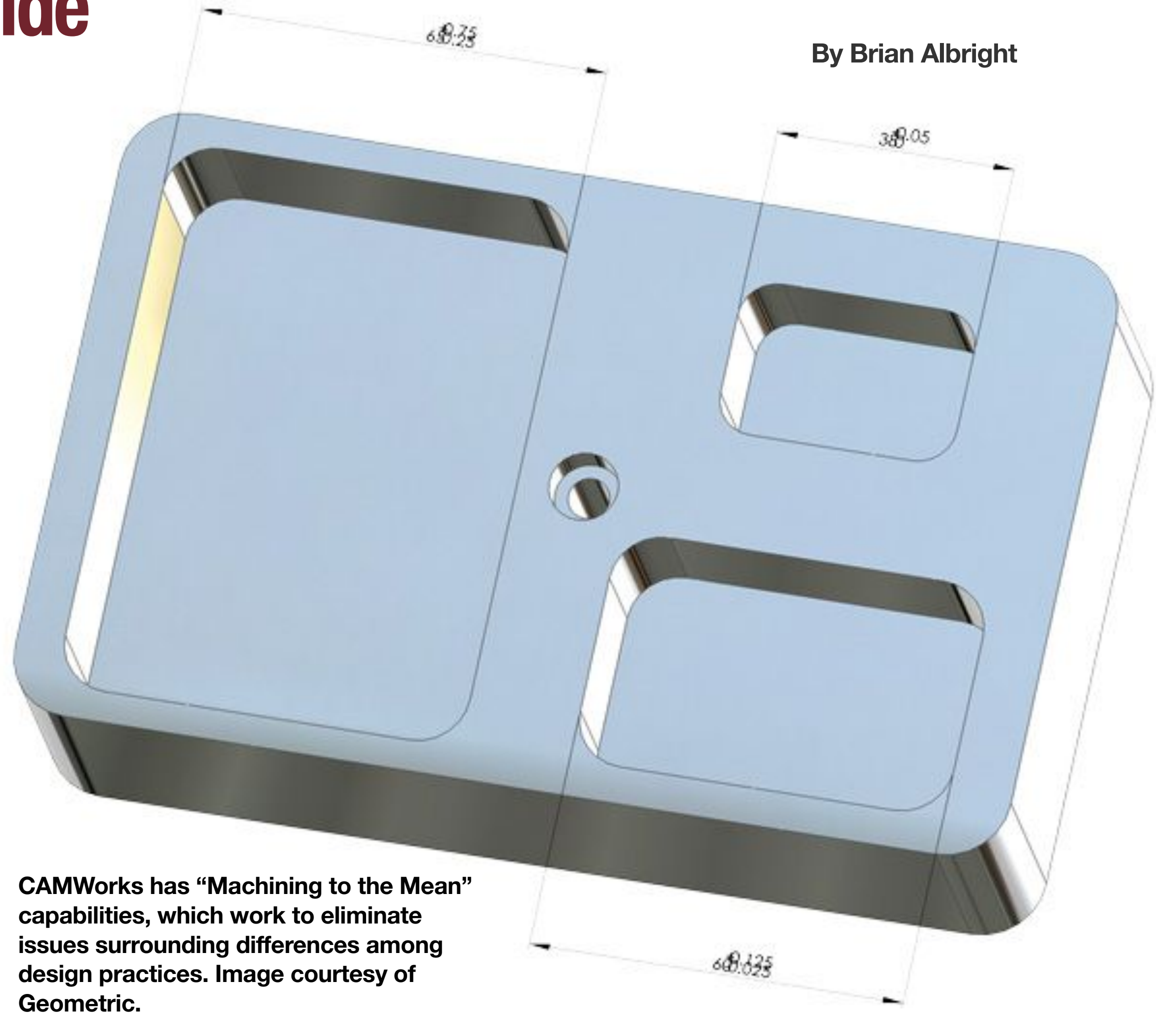
This combination of hardware, software and industry partnerships is just helping set the stage for next-gen manufacturing. "Technology developers and adopters need to continue to stay open and work together to figure out what works best," Frankel says.

More Info
- 3D Systems
- Arcam AB
- Digital Manufacturing & Design Innovation Institute
- EOS
- ExOne
- GE
- Siemens PLM Software
- SLM Solutions
- Stratasys
- Renishaw

Jess Lulka is a former associate editor for *Digital Engineering*. This article was originally published here: digitaleng.news/de/manufacturing-goes-digital/

CAM Bridges the Design-Manufacturing Divide

By Brian Albright



CAMWorks has "Machining to the Mean" capabilities, which work to eliminate issues surrounding differences among design practices. Image courtesy of Geometric.

The CAM industry is undergoing various changes that have affected the number of vendors in the market, as well as the types of tools available. Merger and acquisition activity, as well as tighter integration with design tools and the development of new features, are expanding the options companies have when it comes to programming and machining.

Over the past several years, CAM companies have been targeted for acquisition by other CAM providers, by CAD systems vendors and other companies–accelerating consolidation. In 2014, 3D Systems acquired Cimatron (which had already acquired GibbsCAM). In 2013, Autodesk acquired Delcam (and previously acquired HMSWorks), which has since been treated as an independently operated subsidiary. Hexagon, meanwhile, bought Vero Software, providing a link between metrology and manufacturing planning, and HCL Technologies bought Geometric earlier this year.

Initiatives such as Industry 4.0, or smart manufacturing, are driving design-focused companies to more closely integrate with manufacturing technologies, but what effect the acquisition activity is having on CAM is unclear. In some cases, these acquisitions have not necessarily led to any sort of closer integration between the design side of the business and the manufacturing tools.

There is an evolution in CAM software, however, that will result in closer integration with CAD, more automation and multi-tasking, and greater efficiency in programming and machining.

At the IMTS 2016 conference, Autodesk plans to outline a broader vision and software portfolio to support manufacturers. The portfolio will include its CAM tools along with Autodesk's 3D design and manufacturing offerings.

FeatureCAM 2017, for instance, has been updated to reduce programming time while increasing consistency. The new version includes the ability to import and view product and manufacturing information directly from a model to help visualize design specifications, in addition to other features. The previous release incorporated Autodesk 360, which improved project collaboration. PartMaker 2017, which enables high-precision part manufacturing with Swiss-type lathes, is available within the FeatureCAM 2017 Ultimate product tier.

Efforts to combine CAD and CAM have met with mixed success, but according to Mike Galinac, senior vice president of GTI Precision Components, having a CAD interface to use when healing models, moving holes and building geometries can make a world of difference in a machine shop. "When you see the power of the two systems working together under the same roof, it's incredible," he says.

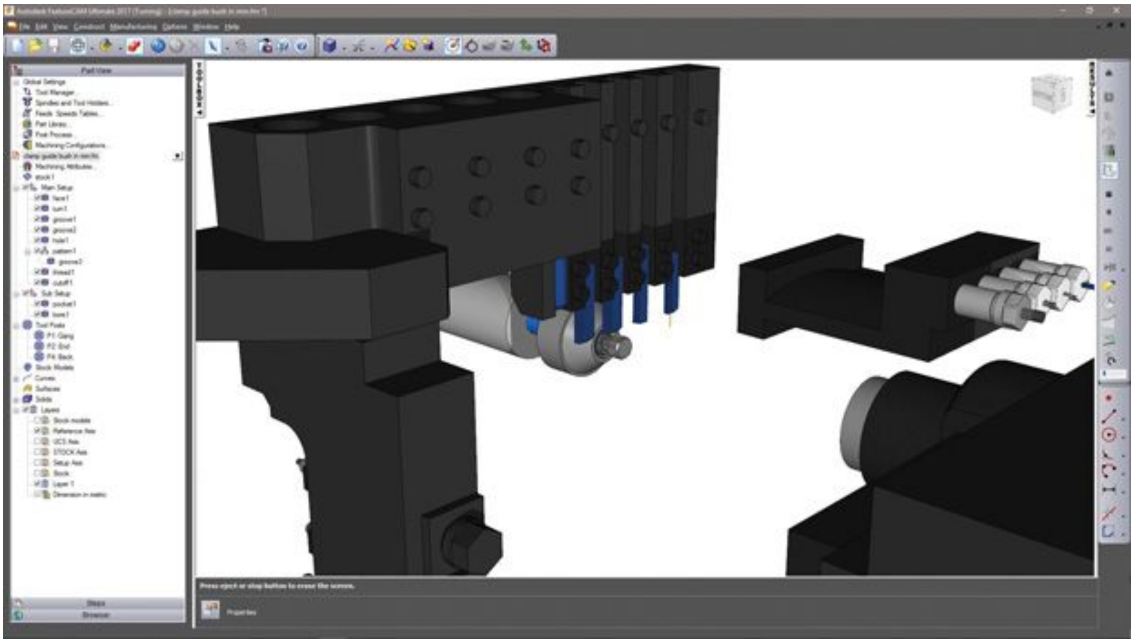
Still, the two systems are very different animals. "There's a natural benefit to combining some of these [CAD and CAM] functions, but there are some natural drawbacks as well," says Ben Mund, senior market analyst at CNC Software. CNC's Mastercam is primarily focused on CAM functionality, but the company does offer a CAD tool as part of its Mastercam X8 offering. "CAM, despite what anyone wants to tell you, requires a tremendous amount of skill at the machine."

Mund says CNC has focused on forging partnerships with CAD vendors and tool manufacturers. "We have to be open to everybody," Mund says. "Whatever CAD system they use, we have to be able to flawlessly machine those parts because that's what the shops have to do. Even with our own CAD product, we are really focused on getting the part off the machine quickly."

According to Jim Foster, VP of Global Channel Sales & Marketing at Geometric, one area where greater interaction between the CAD and CAM world is beneficial is in enabling companies to go drawing-less. Instead of relying on the drawings to get information about critical dimensions, tolerances and other data, machine shops could manufacture directly from the CAD model.

In 2016, Geometric demonstrated this functionality at SOLIDWORKS World. Called "Machining to the Mean," the feature helps eliminate issues surrounding differences among design practices and machining needs. "Instead of making a 2D drawing, you can put the critical information on a 3D model and ship that off. With SOLIDWORKS, we can read the critical data off the SOLIDWORKS model for tolerances, surfaces and other information, and use that to directly drive automated toolpath generation," Foster says. "That's a big change. You aren't doing all that extra work for documentation, and you can save huge amounts of time."

The new feature extracts manufacturing features from the model, and then automatically picks the tools and sets the feeds and speeds to automate toolpath



FeatureCAM 2017 has been updated to reduce programming time while increasing consistency. Image courtesy of Autodesk.

generation. "It automates that entire aspect of manufacturing," Foster says. "It reduces the time it takes to program the part and improves quality and consistency. Having that information in the model that can go directly to a manufacturing tool, it's easy to see the value in that. Otherwise, someone has to keep notes next to them to figure out what they are doing to do when they select the tools for the project. With automation, none of that is required."

CAD Capabilities Improve Machining

Atlanta-based GTI specializes in complex aircraft parts and high-tech applications, and operates two five-axis machining centers. When the company first invested in five-axis machines, they used a less expensive CAM system that unfortunately did not provide enough toolpath accuracy and lacked the sophisticated CAD capabilities that Galinac was looking for. The shop had difficulty creating, modifying and repairing models.

GTI switched to a high-end CAD system that was too expensive and too complex given the size of the shop, and lacked enough CAM functionality to make it workable. "It was killing me that CAD systems had such a nice interface, and CAM just didn't keep pace," Galinac says. "I wanted a modern, CAD-like feel but in the CAM solution so we could stay in one environment."

Eventually, the company deployed TopSolid, which includes design features as well as the postprocessors GTI needed in the shop. "One of the things that attracted me was the approach you have in programming the process," Galinac says. "You have real-time stock model updates."

One key advantage is also that it is relatively easy to bring the model back into the process if there is a major design revision. "When you start a job you are immediately into the machine," Galinac says. "From the moment you put down the first toolpath, you can see things like travel limits and material removal. You get immediate feedback and can make decisions based on where the part is relative to the stock. We're getting something useful so much faster. We are making fewer mistakes."

Improved Efficiency

Both Mund and Foster agree that the industry is focusing on reducing the time it takes to program and machine a part.
Mund says there is a rapidly growing interest in mill-turn machines that allow shops to finish an entire part with one setup, which is a huge time saver. That is evident in the multitasking machining support available in products like SINUMERIK Operate 4.7 from Siemens.Improved simulation is also improving efficiency, in much the same way they do in design. "Simulation gives the machinist the ability to turn more parts because they can run a complicated part through a variety of setups quickly to see how they can do a portion of a part that might not be obvious," Mund says.

Using TopSolid, Galinac at GTI says he is able to use the simulation features in the programming environment. "You get all of the feedback right from the beginning," Galinac says. "It can make decisions based on the condition of the stock relative to the finished part model. When you combine that with the simulation of the tools and the machine, you really have a different experience than just seeing the tools zipping around a model."

There are also advances that can make the machining process itself more efficient. CNC Software has introduced a concept called dynamic motion that leverages advances in computing power to develop complex, almost erratic looking toolpaths to increase the speed of the machining process. "The motion is always changing to make sure there is a constant chip load on the tool," Mund says. "It's much faster and much easier to use."

And while CAM is associated with subtractive processes, 3D printing and additive manufacturing capabilities are also having an impact. "You can produce things that were un-producible before," Mund says. "That's the beauty of additive." Some hybrid applications are emerging that use additive processes to create a rough shape, while incorporating subtractive techniques to finish a part. "The machine programming is not very problematic, because at its core the basic concepts are really the meat and potatoes of what CNC manufacturing has been doing, which is controlling the motion of a head," Mund says. "Whether that head is laying down material or removing material doesn't make a difference."

These innovations, and the transition to smart manufacturing, will drive what Business Advantage Group says is a 37% usage increase in CAM software according to the company's 2016 CAD Trends Survey. According to the survey, 70% of CAM users think the use of 3D CAD models to automatically generate machining instructions will be important, and 60% want to see software developers to better integrate CAD and CAM.

"There are significant efforts in smart manufacturing and Industry 4.0," Foster says. "Companies are trying to change manufacturing to be more modern and effective in many areas. The industry is pushing for more integration and really trying to change the status quo. That's going to be a good thing for end users."

More Info

- Autodesk
- CNC Software
- Geometric
- GTI Precision Components

Brian Albright is a contributing editor for *Digital Engineering*. This article was originally published here: digitaleng.news/de/bridging-the-design-manufacturing-divide/

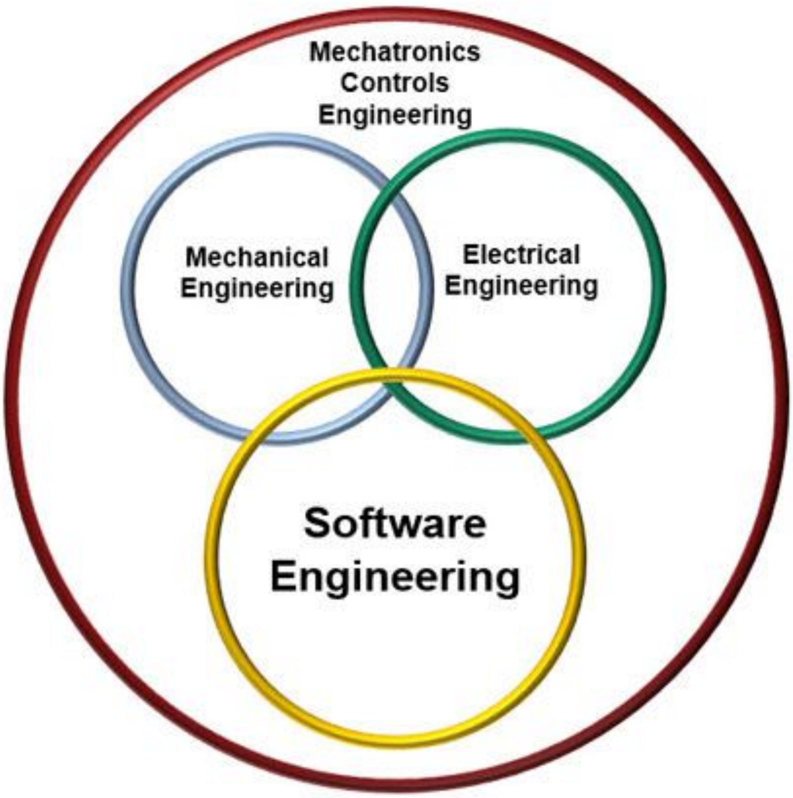
How Smart Industry is Changing Our Way of Developing

By Philipp H. F. Wallner, industry manager at MathWorks

The industrial world is rapidly changing with the emergence of smart industry. Today's production machines and handling equipment have become highly integrated mechatronic systems with a significant portion of embedded software. This fact requires engineers of all three mechatronic domains – mechanical engineering, electrical engineering and software engineering – to work together concurrently and evolve the way of designing, testing and verifying machine software to reach the expected level of functionality and quality.

The Role of Embedded Software

As smart industry evolves, software components provide a significant part of the entire added value of machine or production plants. Embedded software running on PLCs, industrial PCs, or FPGAs (field programming gate arrays) involves closed-



Today's production machines and handling equipment require that engineers of all three mechatronic domains work together concurrently – with software engineering playing the dominant role. Image courtesy of MathWorks.

loop control functionality that ensures product quality as well as predictive maintenance algorithms for increased uptime without service intervention. Furthermore, supervisory logic for — in many cases even safety critical — state machine and error handling and automatic generation of optimized movement trajectories are all implemented in embedded software.

The growing trend to increase the size and complexity of the code based on production machinery is a challenge for classically trained machine builders. Many are mechanically focused and need to maintain experience with elaborate workflows and toolchains for mechanical construction. When it comes to software design, machine builders rely on traditional methods for programming and testing on hardware – but are often unaware of tools for modeling, simulation, automatic testing and code generation, which are widely used by their engineering peers in aerospace and automotive industries.

While it may be obvious for serious mechanical engineers to use a CAD tool and run simulations before physically building the mechanical structure of a machine, in the case of embedded software, it is entirely different. A major portion of machine software is still programmed manually and comprehensively tested when the machine is available.

Data Proliferation — Extracting Valuable Insight

Another major driver of smart industry is the growing amount of data. Vision sensors, electric and hydraulic drives, production machines and power plants all collect a growing amount of measured data during production operation. However, merely collecting data does not provide any value. It is the information inside the data that has to be extracted and analyzed in order to gain knowledge about product quality, energy consumption, machine health status and other economically relevant parameters.

This is where the use of analytical and statistical algorithms for condition monitoring and predictive maintenance is beneficial; they can be used to derive actionable insights from data that has been collected and stored in files, databases or in the cloud. This concept is taken one step further with model-based predictive maintenance, when an observer model is installed that is capable of deriving states of factors that cannot be measured directly.

The large amount of measured data needed is enabled by powerful sensor hardware, which execute complex algorithms often under harsh conditions and using minimal space. The sensor hardware often provides preprocessing and then forwards the results to the controller or to another data collection point. The sensors act together to form a dense network known today as the Industrial Internet of Things (IIoT).

The Use of Model-Based Design

Providing sophisticated sensor networks presents one of the essential prerequisites for realizing the efficiency, cost and, therefore, competitive advantages that smart industry promises. To become innovative leaders in their market, equipment manufacturers need to rapidly develop skills and expertise in these new design approaches and technologies.

As mechanical engineers typically are not experts in software engineering, they can increase their productivity and system reliability by using Model-Based Design tools like MATLAB and Simulink. These tools facilitate modular development of automation components, hardware independent testing, and automatic code generation, which can implement algorithms for specific hardware platforms at the touch of a button.

Models enable the intuitive and clear construction from predefined building blocks and continuous verification. With this approach, design flaws are corrected early on, which considerably shortens design cycles. Next, the algorithms need to be implemented, which can be considerably challenging using traditional methods. Historically, algorithms typically had to be developed by experts in IEC 61131-3, C/C++, VHDL or Verilog. This practice is not only time consuming, but is also prone to errors with the ever-increasing complexity of the algorithms used in machinery. Manually implemented functions that have already been verified through simulations potentially do not behave the way they were intended to, may contain errors, and therefore can cause missed deadlines and problems that are only noticed on-site.

In contrast, real-time functionality is directly generated from simulation models using automatic code generation; this avoids the aforementioned sources of errors. The tested algorithm is directly translated into real-time C, C++, VHDL or Verilog code. Doing so not only saves time but also enables the creation of innovative solutions in small development teams. Model-Based Design with automatic code generation enables engineers to fully leverage their expertise in construction to build a machine or plant without worrying about programming language details.

The Race to Smart Industry Realization

Keeping up with and being a leader in the worldwide smart industry requires companies to offer increasingly efficient and cost effective products, as well as keep an open mind to the new business opportunities that smart industry and the IIoT present. Today's production equipment has a lifespan of more than 20 years. During this time, these systems are rarely modified in order to avoid production loss. Being able to design and test new software separately from the machine will enable companies to offer revenue-generating upgrades to their customers in order to expand the capabilities of the machine. For instance, the software upgrades could offer improved controls strategies not available on standard machines. Innovative machine builders have already started to offer predictive maintenance service contracts to their customers to reduce production line standstills.

Smart industry encompasses the growing complexity of software and an ever-increasing amount of data. In the long term, the evolving trend will challenge engineers to become proficient in using new methods and tools in order to embrace this complexity. For now, industrial companies who manage to shift their focus towards interdisciplinary design thinking (rather than production thinking) will emerge from the transformation as leaders in their areas and with new business models for their market. Those who do not will likely not make it through this transformation and risk being left behind.

Philipp Wallner is industry manager, Industrial Automation and Machinery at MathWorks. This article was originally published here: digitaleng.news/de/how-smart-industry-is-changing-our-way-of-developing/

Integrate Embedded Software

As embedded software and control systems become a dominant part of a product's overall makeup, manufacturers are turning to embedded software engineering services and new types of design tools to ease the burden of embedded system design.

According to VDC Research, about half of companies across industries opt for some level of outsourcing of embedded software development tasks—a figure that has held pretty steady over the last few years. Manufacturers are bullish on outsourcing these functions for a variety of reasons—from taking advantage of low-cost labor pools in foreign markets to gaining access to talent and experience they simply can't replicate in house in any affordable manner, according to Chris Rommel, executive vice president at VDC Research.

Beyond lack of talent or inability to handle growing product complexity, many engineering teams are driven to outsource embedded software development simply because they are under pressure to get product to market quickly and a third-party partnership is the most expedient way to get work done. "As all products become much more complex, it's not that organizations don't have the talent internally to do things, it's that they are expected to create much more complex products in a shorter amount of time," Rommel says. "Sometimes having enough horses in the stable is the real challenge."

Being able to apply more man hours to get a product to market gives an organization far more agility to responding to the ebbs and flows of project demands without as much liability or the need to carry significant overhead, he adds. It also allows for better utilization of design talent—for example, not overcommitting to hiring engineers with a specific skill set that might go out of vogue once a project is finished, he says.

Read more here.

Smart Manufacturing is a Dumb Idea

By Steven Blue, president and CEO, Miller Ingenuity

Someone asked me my thoughts on smart manufacturing. The so-called IT revolution in the factory. They couldn't believe I didn't see smart manufacturing as the salvation of American manufacturing.

Don't misunderstand me. Smart manufacturing has a place in reviving American manufacturing. I have a smart factory. We employ the latest in pick-to-light systems, automated CNC machines and seamless integration from order inquiry to accounts receivable. But that isn't where I started my revolution. And you shouldn't either.

The problem with many CEOs today is they have turned away from the astonishing potential of the workforce and turned toward automation instead. Big mistake, but I hear it all the time.

What is the sense in spending millions on automating your factory if our workforce could care less? What is the sense in buying expensive machine tools if your workforce can't wait to get to the bowling alley, yet drag themselves to work?

I'll tell you why. Because too many CEOs view their employees as expandable assets. They should view them as renewable resources. And renew them.

Don't bother with smart manufacturing if you have a dumb workforce. And if your workforce is dumb, it's your fault, not theirs. Don't bother with an IT revolution. Your revolution has to start with a "smart workforce." You have to make a new compact with your employees. You need to ignite the human spirit in your workforce. Imagine this. What would happen if every day your employees came to work excited to do better today than they did yesterday? Imagine how your company would soar if your employees were absolutely dedicated to supporting the mission and each other in attaining it?

This is the place where I get blank stares from many CEOs. They don't like the soft stuff. "Tell me how to build a smart factory, not a smart workforce," is what I often hear.

It has to be the other way around. Start by building a smart workforce. A workforce that is engaged, enlightened, and empowered. A workforce that trusts in its leadership. A workforce that believes in its leadership. It's a tall order to be sure—especially if the leadership is a bunch of boneheads that care more about depreciation than employee engagement.

Here are four key ways to start:

1. At the top. Build leadership credibility. The only way to have leadership credibility is if your leaders demonstrate key values of respect and integrity.

2. Leaders need to treat their employees with respect. But many don't. In a recent Harvard Business School study of 20,000 employees half of them did not feel respected by their leaders. And respect was rated by the participants as more important than anything else, including compensation.

3. Leaders have to demonstrate integrity. In study after study, integrity is a key attribute in leaders that people admire-and want to follow. So integrity is a key part of building credibility. But leaders also need integrity in everything they say. You can't be like many leaders and "tell half the truth, hoping the other half doesn't show up". You have to be bone honest all the time. You have to tell them what they need to know. If the company is headed for trouble, tell them. If the company needs to pivot into new markets or products, tell them. And tell them why. Tell them everything. You would be amazed at how smart your workforce can be if you give them half a chance. I always say "trust in truth."

4. This is not just for the top. Your entire workforce has to embrace the values of respect and integrity. But you cannot expect "people below to do what the top will not." You may have leaders who lost credibility long ago. They can't get it back. Replace them.

Smart manufacturing starts at the top, not the bottom. Smart manufacturing starts with creating a new compact with the workforce. Smart manufacturing starts with people, not machines.

Steven L. Blue is the president and CEO of Miller Ingenuity, a global supplier of mission-critical solutions in the transportation industry and author of the new book, American Manufacturing 2.0: What Went Wrong and How to Make It Right. This article originally appeared here: digitaleng.news/de/why-smart-manufacturing-is-a-dumb-idea/

The Future of Obsolescence Management

By Jonathan Wilkins, head of marketing, EU Automation

In 10 years' time, robots will cease to be subservient, manufacturing won't exist as we know it and we'll be 3D printing our own clothes before we go out. Do any of these sound like familiar predictions? I thought so. With this in mind, I'll tread lightly when talking about what the highly interconnected future has in store for industrial automation. Oh, did I mention that this factory could be ordering your replacement parts for you?

At this point, it's worth explaining the Gartner Hype Cycle, a theory that says a new technology first experiences a period of speculation and excitement, followed by a trough of disillusionment before settling into a plateau of actual use.

Sometimes this excitement manifests itself in the form of ambitious predictions that probably won't become widespread in the near future. More than 30 years ago, GM dreamed of creating factories where robots made robots with minimal human supervision. Lights out manufacturing, the stuff of sci-fi, was going to revolutionize the manufacturing industry. In the 1980s there was a buzz of anticipation.

Fast forward three decades and we've only recently starting seeing advanced automated systems that need minimal supervision. This is hardly the norm though, with many manufacturing facilities still exhibiting minimal levels of industrial automation.

Concepts such as the Internet of Things (IoT) and Industry 4.0 are driving industrial connectivity to profound new levels, aided by the standardization of communications protocols and a collapse of traditional automation architecture.

Don't crack open the bubbly to celebrate just yet. There is still a long way to go before we'll start seeing the fully automated smart factories of the future.

Not everyone is in the position to upgrade their entire manufacturing line. We're hardly living in a world where every factory looks like a snapshot of the future. In fact, the majority of plants currently rely on obsolete parts to keep critical systems up and running, which is where higher levels of connectivity can really help plant managers in future.

Current computerized maintenance management systems (CMMS) are an invaluable platform for plotting when replacement parts need ordering. They analyze best outcomes with regards to risk and generally aid a human supervisor in keeping track of thousands of components.

All Hyped Up

Now comes the part I promised not to do: the hype. With increasing interconnectedness—thanks to the wonder of the internet, smarter sensors and deep machine learning—is it wrong to believe replacements and upgrades will soon be taken out of human hands?

This would be at the stage whereby a smart factory lived up to its name—an automated cyber-physical system. A central computerized brain—a super CMMS—would contain analytics on all systems and know where they are on the maintenance lifecycle. Replacements or upgrades would be scheduled just in time to ensure efficiency, which in turn would minimize downtime. When the plant's analytics on average part lifespan, wear and product lead times dictate there's the likelihood of downtime, spare parts could be ordered automatically from suppliers. It certainly is the lean manufacturing dream—realized through combining the art of obsolescence management with highly interconnected and intelligent machines.

I don't think this is too preposterous. Maybe not today or tomorrow, but in 20 years' time we could see similar systems in place as the one described above. Because if it's one thing we've seen over the last decade, it's how important obsolescence management is becoming to an increasing number of industries. Just because new and advanced technology is being manufactured all the time doesn't mean everyone is able or willing to buy it. If anything, it's making perfectly good products obsolete at a faster rate.

If you're looking for a concrete prediction, here it is: Obsolescence management will not become obsolete anytime soon. It will however, become more automated and technologically intelligent as engineering and IT advance. But don't trust your factory to order that obsolete drive just yet.

Jonathan Wilkins is head of marketing at EU Automation, a supplier of industrial automation solutions to industries worldwide. This article originally appeared here: digitaleng.news/de/the-future-of-obsolescence-management/