Given the complexity of the entire production chain for designing and building cars and trucks, it’s no surprise that the automotive industry has been in the forefront of adopting new technologies. Each March, Auto Manufactures, System Integrators, and the larger manufacturing sector gather in Detroit for Manufacturing in America to share best practices and new technologies. The stated purpose of this group is to promote community, collaboration and innovation in this important industry.

To keep the conversation active during the rest of the year, the Automotive Manufacturing Forum meets regularly on a less formal basis and in a smaller venue to promote those three core values. Participants represent experts from all sides of the industry, and they choose the discussion topics for each meeting as a group. In June, the topic chosen was digital manufacturing, and the discussion opened with a comprehensive question: what is digital manufacturing, and how can manufacturers implement the technology to meet automotive industry objectives?

Jeff Hall, Siemens’ global account manager for Ford, was the moderator for June’s meeting, and launched the discussion by suggesting one possibility developed over years working with manufacturers, suppliers and integrators around the world. He defined digital manufacturing as the following: Digital manufacturing means using new technologies like data analytics, the cloud and the Internet of Things to merge the virtual and real worlds. This enables manufacturers to increase productivity across their entire value chain, from design and engineering to sales, production and service. In concrete terms, this means faster time-to-market, greater flexibility and enhanced availability of systems on the plant floor.
Since most in the room were more deeply involved in manufacturing than product design, the emphasis quickly turned to the issue of “greater flexibility and enhanced availability of systems on the plant floor.”

Imagine these scenarios suggested by participants:

- A technician from a system integrator sits on an overturned bucket next to an open controller cabinet with a laptop balanced on his knees. He’s been sitting there sweating for the last six hours trying to fix programming problems on an assembly line that his company built. He’ll be there again tomorrow and maybe the day after, continuing the job and costing his company valuable time and money.

- A plant manager has just finished a project to rearrange a production line in his plant in an effort to create more manufacturing flexibility. On paper the floor plan looked good, but it was all done from old two-dimensional specifications. In the real-world application, some of the machinery doesn’t fit together all that well.

Maybe you’ve witnessed or experienced similar situations. Fortunately, as the discussion acknowledged, digital manufacturing offers solutions that can mitigate or even eliminate these types of problems and many others. For manufacturers, it’s the ability to perform a wide variety of manufacturing operations from product design through production, including production equipment design, programming and even plant layouts. With a digital manufacturing strategy, engineers can perform a wide variety of tasks from virtual prototyping to machine design and PLC programming on a workstation with much of the tedious work automated.

**What exactly is digital manufacturing in the real world?**

Ask a group of manufacturing people to describe what digital manufacturing is and how it works and they are all likely to emphasize different areas based on their experience and specific job responsibilities. Digital manufacturing is a whole range of technologies that have been evolving over the last 20 to 30 years, and each individual begins with a different starting point. For the most part, all the different capabilities contained under this umbrella developed in silos and only recently have manufacturers realized the benefits of connecting and integrating the different parts.

As the experts compared views and experiences, a consensus emerged that supported Hall’s opening statement. Within the forum, digital manufacturing meant a series of processes capable of encompassing the entire manufacturing lifecycle, from the earliest product design work using virtual modeling, prototyping and simulation, to automated manufacturing and assembly, and even to field service.

All aspects of the process are connected and taken into consideration at each stage. For example, those involved in service can have input into the product’s initial design to ensure that repairs in the field are not hampered by the configuration. The digital manufacturing concept can also extend to designing the manufacturing process and facility itself. Even controller programming can be built and simulated in a virtual environment. The product is designed for manufacturing efficiency in a given facility, and placement of the machinery in a plant can be analyzed using computer modeling.

**Programming from a bucket**

One element of the discussion that came heavily from the system integrator community related to writing programs for controllers and PLCs driving manufacturing machinery. To those people, the ability to simulate how a new piece of equipment will perform when installed at the customer’s site is a huge advantage. Creating the models necessary to perform such a simulation can be time consuming and load more cost into the early stages of a project, but the savings at the back end can be huge.

The first scenario described earlier was mentioned by one integrator where he talked of many hours he had spent in customers’ facilities sitting on a bucket, laptop on his knees, connected to a PLC that his company had programmed trying to sort through problems with the ladder logic. He reflected on how much better it was to write programs in the comfort of his office, sleeping in his own bed at night, rather than being sent to the field to fix things. And his experience is not unique, as it is getting increasingly difficult to get young engineers to spend days or weeks at a time in the field. Digital manufacturing provides opportunities to run that machine while it’s still on the computer screen making sure all the code works as expected. Virtual commissioning has become far more practical, rapidly reducing the number of changes that must be performed on site, and reducing the time to startup.

Of course accurate simulations require reliable data and analysis. Others in the conversation characterized such simulations as a “leap of faith.” Those performing the analysis, whether they’re integrators or manufacturers, are spending more money early in the project in hopes of making it back later when there are fewer changes and everything works more easily.

An end user observed that the ability to do good simulations hinges on the ability to generate good models. He recounted one situation, also cited earlier, where a company was trying to create a virtual plant layout, but found it a struggle because designers only had two-dimensional information on the equipment involved. While he endorsed the advantages of exploring a variety of layout iterations on a screen rather than trying to move conveyors and robots, he was clear that accuracy of the models is paramount.
The role of data
Interfacing with legacy equipment was a key topic of discussion. New machines built today may use all the advantages of digital design and simulation, but they have to work in an environment where the next manufacturing section upstream or downstream may be 20 years old and was designed using only traditional two-dimensional techniques. Digital manufacturing integrates legacy systems with new advanced technologies by using the available data, and extending the new capabilities to the older equipment.

Another integrator said that he has had to solve the legacy problem many times. The solution begins by looking at the available data, comparing it with the data that is available, and then delivering the data. As long as the data flow is seamless, the rest is easy to resolve. Programming code from the older machines can be brought into a simulator and connected virtually to the new machinery. Such an approach makes integration far easier.

Using data for machine-to-machine integration is only part of the picture. Process improvements depend on having data to indicate how things are working and to identify where there are weaknesses and bottlenecks. The number of connections between machinery on the plant floor and enterprise-level networks are also growing, which increases the need for connectivity using IT techniques and is far easier with the current generation of controllers. In addition, manufacturing management wants cost information, and the demands for more granular data are increasing.

Making the investment case
Making the case to invest in digital manufacturing is a universal challenge. Finance people in large manufacturing companies can be hard to convince when it comes to implementing new technologies. Financial decision makers expect a proven track record before approving purchases. Since digital manufacturing is new for so many companies, it is difficult to show where and how the technology has saved money in ways the company will find compelling. That aspect of the discussion, more than any other, was the most difficult to resolve. A possible answer called for incremental steps with careful documentation of gains to prove the case.

Likewise, multiple system integrators agreed it was a hard sell for customers to accept the addition of virtual commissioning to a project as worth the cost.

Most participants felt the overall picture was improving. The advantages of digital manufacturing are beginning to filter through to even the most hard-nosed financial managers. The potential for significant savings, even without many years of cost history, makes for a compelling argument.

Building on the three-legged stool
Perhaps the strongest argument for digital manufacturing came from a participant from one of the big-three auto manufacturers. Those companies have spent enormous amounts of time over many years studying and developing their manufacturing techniques to the point of having the most complex and optimized manufacturing chains ever created. Digital manufacturing offers some of the most major advances they have seen in many years.

He characterized the situation as a three-legged stool. The first leg of cost reduction and cost avoidance got the companies’ attention initially. Given the competitive nature of producing vehicles, anything that can cut costs even a small amount will be considered and implemented if proven.

But that was only the start. The second leg of product quality improvement soon emerged: designing with virtual prototyping shortened testing time and made improvements far faster and less expensive. New ideas could be tested more easily allowing for different approaches to solving manufacturing problems.

This played right into the third leg: flexibility. The nature of the auto industry has changed enormously over the last decades. Producers have to offer far more models with greater options. This means smaller manufacturing lots and more frequent changeovers. Flexibility, adaptability, and reconfigurability of all manufacturing lines have become the biggest drivers, and the companies have responded. Multiple vehicle platforms are being built on the same lines to keep up with customer demand, and digital manufacturing is a key enabler of that flexibility. Changes can be made to vehicles quickly and with minimal disruption because all aspects of the process, from design to customer service, are connected and integrated. When a component is redesigned and prototyped virtually, it can be produced and moved into the larger assembly seamlessly. All documentation can be updated automatically and related manufacturing operations, even down to specific PLC programming, can be adjusted to make the implementation essentially invisible.

Improvements as a closed-loop system
The head of a system integration company offered an observation that was a good summary of digital manufacturing’s capabilities: it provides data able to support improvements as a closed-loop system. Every time there is an advance in one area, it can loop back to the beginning of the process and launch the next improvement. When products can be designed, prototyped and tested virtually, there are few limits to the number of possibilities that might be considered. When manufacturing processes are changed on a screen, new approaches can be tested and verified without disrupting any existing production. These changes can be documented automatically, eliminating traditional steps.
In a recent presentation to auto industry executives, John Billings, Vice President, Siemens Digital Factory U.S., Aerospace and Automotive Business, offered a similar idea:

The hallmark of advanced manufacturing is taking a holistic approach from product design through the rest of the phases of the manufacturing process. This is how we’ll get to a point of autonomous, self-correcting production processes. The linchpin of this approach is the data. Globally, you’re able to make better decisions because you’re no longer guessing about what’s going on in your operations.

These improvements are being realized today in the automotive industry, and they are quickly moving into other areas where there are still many gains waiting to be taken.

Ongoing discussion
The Automotive Manufacturing Forum will continue its meetings, promoting community, collaboration and innovation. Each session will consider a topic chosen by the participants, moving toward the next Manufacturing in America Symposium in 2016. This group welcomes all those who want to work toward a stronger and more dynamic automotive industry, including manufacturers, suppliers, system integrators, industry organizations, academia and government.

Join the discussion at the next Automotive Manufacturing Forum.