

Lean Automation Through Digital Manufacturing

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Faster, better, cheaper – the push is still on and the allure of new global markets combined with increased global competition is keeping the pressure high on every manufacturing front.

Manufacturing systems must be able to meet production demands, but must also be efficient and flexible to handle the increased customization of shorter product life cycles.

Whether it's developing a brand new manufacturing system from the ground up or upgrading an existing manufacturing system to accommodate faster throughput or a changed product mix, companies are hesitant to invest any money without assurance that the investment will be maximized and recovered as quickly as possible.

Because of this, process simulation and digital manufacturing continue to evolve as the best tools for “dialing in” the best possible system before committing capital.

The challenge starts, according to Andy Jones, Automotive General Manager at Applied Manufacturing Technologies (AMT), in the design of production systems. “There is a multitude of factors to consider when designing automated systems and the complexity of options available today make process design a critical stage in building lean systems”.

More often than not, complex production systems suffer from unwanted or unexpected behavior, as well as space constraints and material flow problems. Enormous cost is associated with tweaking these systems to run as intended after they are built. Digital manufacturing tools such as discrete-event simulation and 3D factory layout are used on the front line to anticipate the behavior and layout of complex systems, ensuring a sound design and timely installation.

Manufacturing Project Flow and the Importance of Processing



As shown in the preceding diagram, a typical manufacturing project follows a fairly predictable flow of activity. Everything starts with a demand for a product in a given marketplace. With estimated production numbers in mind, a preliminary process is sketched out, incorporating all the necessary operations. A general feel of material flow through the system and the amount of capital equipment becomes readily apparent. Taking into account the constraints of the manufacturing facility, this information is then used to create a general layout.

Now, budgeting for the system depends on the accuracy of the estimates that went into the concept. And, the risk can vary depending on the project scope and the amount of historical knowledge available. At this point, digital manufacturing tools become essential for reducing risk and making sound decisions based on minimal information.

Although product design may be far from complete and equipment suppliers have not yet been selected, simulation and layout tools can be used to create a remarkably accurate representation of the production system and help identify any issues with the concept. Based on this information, detailed specifications can be written to improve the equipment bidding process and minimize the amount of overlooked or unnecessary items for equipment suppliers. Overall, this tremendously compresses the planning process and yields better efficiency and time savings prior to production implementation.

Systems can be modeled in simulation to various levels of detail to correctly represent resources and processes. As more information becomes available, the model can be updated to reflect changes and improve its accuracy. Once a system is properly modeled, discrete-event simulations can, in a matter of hours or minutes, produce statistical data representing years of running the production system.

Once the system design is stabilized, remaining engineering activities can take place. Long lead items can be ordered with confidence in their ability to perform at the required levels. Because the system has been tested for performance ahead of time, large savings in startup costs will be realized.

Proper processing upfront means shortening the design and commissioning phases of a project, when the cost of time spent is the highest, and the deadlines are looming.

Going Lean

The move to Lean Manufacturing means using the best available resources, increasing the efficiency of operational resources, and minimizing storage resources. Often, in the push to maximize utilization, a lack of backup mechanisms will lead to failures crippling the production capacity of the system. Discrete-Event simulation allows the streamlining of processes while anticipating and accounting for failures, and minimizing their impact to the production rate. Additionally, resource sharing to keep operational resources functioning (e.g., maintenance personnel) can also be optimized using the simulation.

Storage resources and material flow can be examined more in-depth with advanced layout tools, ensuring adequate floor space allocation and aisle sizes. Utilizing the latest 3D layout tools also facilitates the examination of feasibility and safety concerns that are not typically identified using traditional 2D methods.

Case Studies

Bottleneck Identification

The slowest or least efficient operation in a production system is often referred to as the bottleneck. Finding a bottleneck in a large or complex production system can be a challenge, and is often not intuitive. Discrete-Event simulation takes the guesswork out of the equation, as statistical data gathered over months of simulated production make the problem obvious. Changing the system and re-running the production to see results is a simple matter of a few hours or less. Without simulation, the focus of those attempting to optimize the system is often stuck on the wrong solution, treating a symptom instead of the root problem. Such haphazard approaches move the symptoms around the production system, and are most often a significant waste of time and capital.

A specific case within a large volume medical device part producer revealed this in practice. Efforts were focused on adding an additional trim and finishing machine to the system to increase capacity when upstream forming operations were sped up. Simulation showed that not only was an additional (13th) machine – at an additional \$500,000 – unnecessary, but that one of the machines they currently had was not being fully utilized due to poor distribution logic in the conveyance system.

Throughput Analysis with Shared Resources

Complex interaction of resources, such as operators and robots, can lead to situations where significant performance is lost when things get out of sync. Most of the time, these situations are analyzed in Gantt and timing charts for the first ideal cycle only; problems that can creep into the system are missed entirely. These problems do not usually surface until Controls debug, or even worse, in production.

Such a case involved an automotive part assembly system where an operator was required to load two different robotic turntables in sequence. These stations were then unloaded by robots specifically designed to work cooperatively to present the parts to a third welding robot.

Everything in the system worked as intended until a breakdown or shift changeover occurred. When either of these occurred, the operator got out of sync with the robots, virtually every time, and the system fell into a limping mode at half the production rate (from 90 pph to 45 pph) because they were unable to run the cooperative sequence required to make rate. Simulation revealed that in real production, the operator must execute a specific routine to consistently achieve the target cycle rate. At this early stage, HMI considerations for controls were successfully identified before any hardware or software was designed.

Where to Go From Here

The benefits of proper processing upfront are obvious. Determining how to implement them in your manufacturing system may not be so obvious. Siemens PLM Software offers the digital manufacturing tools and expertise to address your specific needs, and to help your organization realize the benefits of processing technology on your next project. At AMT, we use tools such as Plant Simulation, FactoryCAD, and Process Simulate from within the Tecnomatix Brand of Siemens PLM Software, across our customer base in the automotive, aerospace, defense, medical, food and beverage, public service, and construction industries. We continue to find them adaptable to most any of our customers' manufacturing processing needs and continue to realize value through their use within our business.