SANMINA

The ROI of Digital Supply Chains – Industry 4.0 Beyond The Factory Walls

By Gelston Howell, Senior Vice President, Sanmina Corporation

A year ago in i4.0 Today, Sanmina described some of the benefits of implementing Industry 4.0 and cloud technology in its manufacturing facilities. The company reached a major milestone when it surpassed 25,000 pieces of manufacturing equipment connected to its cloud manufacturing execution system (MES). Connecting its equipment to the cloud enabled real time, M2M (machine-to-machine) communication for a significant portion of Sanmina's manufacturing equipment. This M2M communication, along with relatively simple real time analytics, deliver on the promises of Industry 4.0; tangible ROI, higher product quality and manufacturing efficiency in Sanmina's factories. Perhaps more compelling though, the approach has delivered benefits well beyond the walls of a single factory.

Supply chains for complex mission critical products are often global, with components, sub-assemblies and finished products manufactured in different locations and countries. Even when SMT manufacturing, systems assembly and test are co-located, they may take place in different buildings. Delays and technical issues encountered at the component or sub-assembly level can have a ripple effect, negatively impacting finished product quality and on-time delivery. The global distributed nature of supply chains for mission critical systems poses two challenges: managing global supply chains with a high degree of complexity and ensuring that sub-assemblies and systems are manufactured according to product design and manufacturing process specifications.

Sanmina is a tier one Electronics Manufacturing Services provider producing about 1 million sub-assemblies and systems per day in 75 factories worldwide. In our manufacturing operations, we face complex challenges across a range of industries including the communications, computing, storage, industrial applications, medical, automotive, defense and aerospace markets. In many cases Sanmina manufactures components, sub-assemblies and systems in different buildings, often located in different countries. There are examples where more than 10 of Sanmina's worldwide facilities contribute to the manufacture of a single system.

Here are two examples of the benefits of digital supply chains beyond the walls of a single factory. In the first

Sanmina has 75 factories and 25,000 pieces of manufacturing equipment connected to the cloud, giving executives real-time manufacturing and supply chain visibility, anywhere in the world.

A forced quality framework implemented in cloud based virtual factories ensures process compliance in Sanmina's facilities worldwide.

example virtual factories are created in the cloud MES replicating physical production flow. Validation rules and a forced quality framework ensure that each product is manufactured in accordance with the defined bill of materials, approved manufacturer list and product specifications. In the second example the availability of real-time data from equipment and scanners in multiple factories allows more efficient management of global supply chains.

Digital Factories, Process Compliance and Forced Routings

Ensuring that each product is manufactured in compliance with the product design and manufacturing specifications is a challenge when multiple factories are involved. However, compliance is essential for mission critical systems, particularly in highly regulated industries including medical, aerospace and automotive. Components are specified in a bill of materials and must be purchased from manufacturers on the approved manufacturer list. Printed circuit boards (PCBs) are manufactured according to a design specification in one factory. PCBAs are produced by assembling components onto the PCBs in surface mount technology (SMT) manufacturing facilities. Other sub-assemblies including cable systems, enclosures, RF and optical modules, are manufactured in specialist facilities.

Think of a simple manufacturing process having 15 steps. Five may involve inspection or testing. If the sub-assembly or system fails an inspection or a test, it is routed out of the main process flow and is repaired. Repaired assemblies are then reinserted in-line at the point just before the failure occurred. This practice ensures that each repaired sub-assembly and system passes the test it originally failed. Now think about managing the flow of product through the defined manufacturing process at a rate of one PCBA per second. That's the requirement when the volume increases to more than 10 million units per year. The number of permutations of valid process paths that could occur as a result of pass/fail results for an individual PCBA is enormous.

In our implementation of this high volume production line, we connected bar code scanners, equipment and operator's actions to our 42Q cloud-based MES system. The defined physical manufacturing and test process flow is replicated in the cloud-based MES and pre-programmed rules validate all activity. At every step of the manufacturing process, each product is scanned and the MES forces it through the defined process flow, ensuring process compliance. Another result of this approach is a searchable database of thousands of electronic travelers, each having a complete record of every production operator (name, time, date) who worked on the product, hyperlinks to lot codes for all components requiring traceability, and electronic upload of critical optical inspection and electrical test data files.

This approach has been used in a number of Sanmina locations where PCBAs are manufactured in one building and the system is assembled and tested in another facility. The system not only ensures that the systems are manufactured in accordance with the product design and manufacturing process specifications, it also provides a complete traceability history of both

Feature Continued...

> “I can see in real-time what happens in production and I can optimize the process. It’s a complete game changer.” - Senior Vice President of Operations at a Fortune 500 telecoms company.

system and PCBA manufacturing records.

Global Real-Time Data Visibility and Pro-Active Intervention

Risk in managing global supply chains can be reduced if you have real time visibility throughout the supply chain. WIP visibility can indicate whether sub-assembly and product manufacturing have started on time. Yield data is a good indicator of component and sub-assembly quality and whether there are any technical issues with the manufacturing process. Knowing this information in real-time is invaluable for Operations and Supply Chain Management. It prompts them to allocate resources to resolve issues as they occur, maintaining quality and on-time delivery performance. Here is an example of how Industry 4.0 has been applied to provide real-time visibility and control to complex, global supply chains.

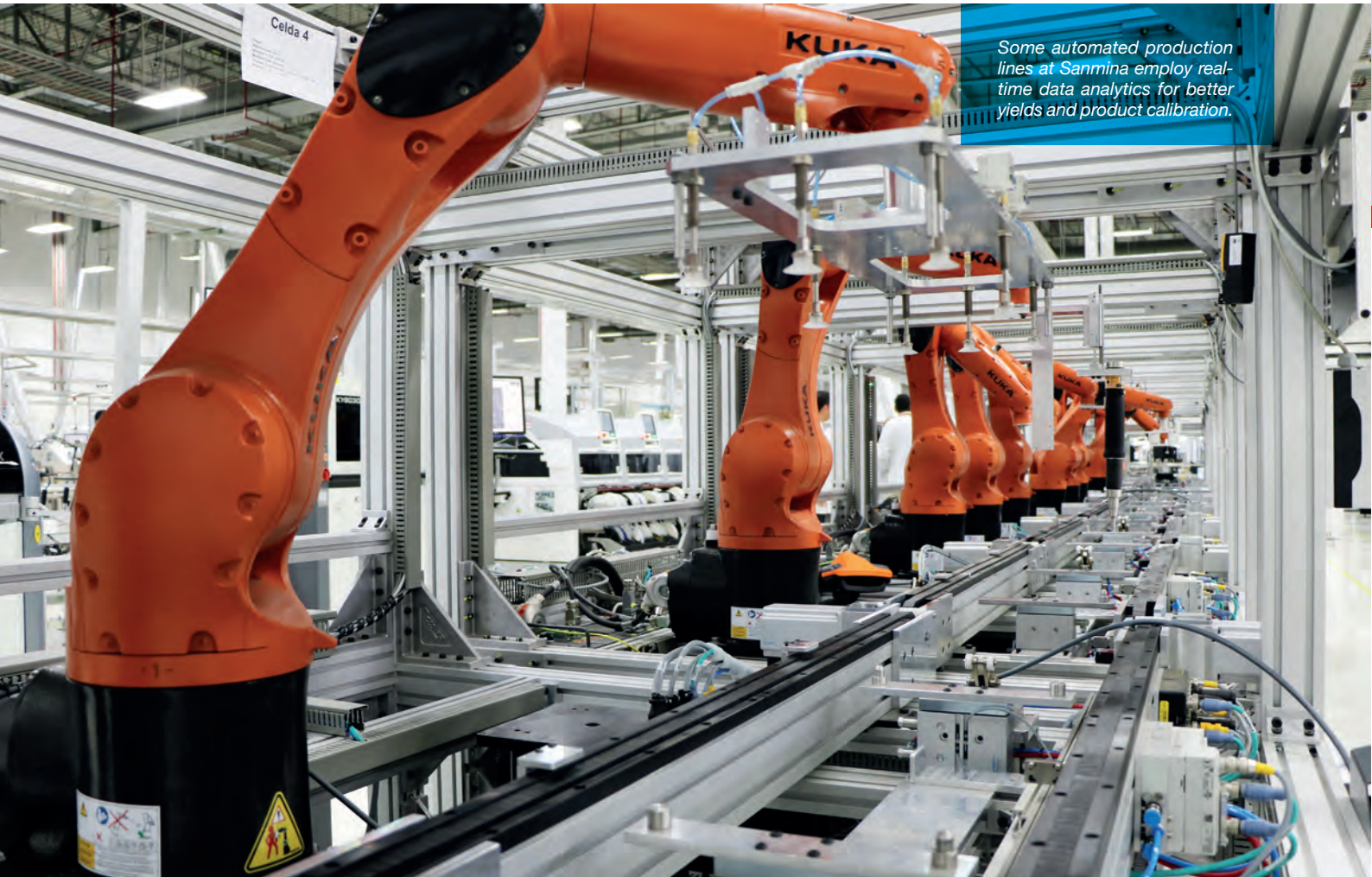
Sanmina employs 44,000 people who operate over 1,000 production lines in 75 factories worldwide. Many of these lines operate 24 hours a day. Managing and analyzing the high volume of data generated from facilities in different regions that are manufacturing hundreds of different products is extremely complex. In addition, our executives and plant managers travel frequently to meet with customers and suppliers. We needed a system to streamline the entire process and ensure that the right people had the data they needed to proactively address issues or solve problems as they occurred on our production lines.

We use the same cloud-based MES described in the previous section to convert data into a virtual representation of the factory and production. This provides supply chain managers and operations executives with access to a virtual factory floor via laptop, enabling them to view information on the status of component inventory, production problems and delivery schedules in real time. MES data is converted by the system into visual signals that provide real-time status at product, workstation, production floor, plant, regional and global levels.

The system monitors yield, throughput, work-in-process (WIP) ageing, labor efficiency and productivity against predefined targets. If production or yields fall below target, the system sends real-time alerts to technicians. If a problem is not solved within a defined time period, automatic text and email escalation messages are initiated. For example, one of our executives may land after an extended flight, and he or she receives notifications on their mobile device, alerting them of ‘out of control’ conditions for a specific factory or product line based on how they programmed their alerts. This cloud-based MES platform enables more efficient and cost-effective management of complex manufacturing processes, with real-time data visibility from anywhere in the world.

These examples demonstrate the benefits that Industry 4.0 techniques and machine to IT communication can have beyond the walls of a single factory. Use of a cloud-based MES platform can also be extended beyond a manufacturer’s own operations to third party suppliers that agree to use it, providing insight into the status of their operations and component availability. While still in early stages at Sanmina, broadening the scope and use of our cloud-based MES platform to more suppliers automates the flow of critical data to us in real time, providing comprehensive global supply chain visibility that allows us to react and adjust to potential problems at suppliers.

www.sanmina.com



Some automated production lines at Sanmina employ real-time data analytics for better yields and product calibration.