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Developing a Strategy to Implement Smart Manufacturing

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Industry 4.0 and smart manufacturing revolve around leveraging advanced technologies to maximize productivity, quality and responsiveness, minimize waste, and meet market demands for rapid delivery and product individualization. Only a smart infrastructure, with digital communications at its core, is capable of networking and adapting continuously.

This revolution is happening first in territories that depend on advanced technology to maintain competitiveness, typically where labor costs are high and customer expectations are even higher. A manufacturer planning capital investment must balance short-term needs with a future that will demand higher levels of intelligence, automation, and communication capabilities at every point to make the transition from value chain to value network.

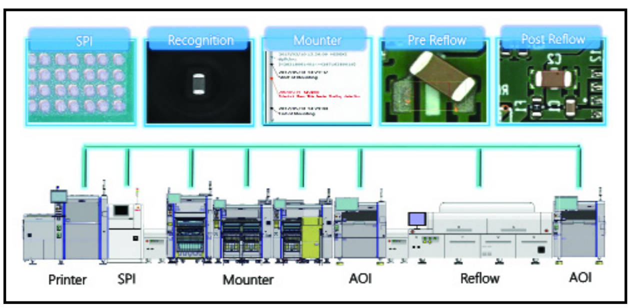
The goal is to create value at all points in the network. For assembly lines, this calls for smart equipment that is capable of self-monitoring and self-analysis, as well as communicating status and decision-making information in real time to supervisors and business managers. The traditional boundary between factory floor and back office is disappearing, as computing brings the power to convert manufacturing data into information that has value at multiple points throughout the organization and among trusted partners.

This industrial revolution will be the catalyst to unifying all business activities into a seamless cohesive enterprise, from designing and manufacturing to marketing, selling, accounting, and directing. The move to smart manufacturing is a major force driving the decisions of manufacturing managers. Today's typical capital investments must now factor in how they will support a company's overall smart manufacturing roadmap.

Industry 4.0 SMT Assembly

SMT is a prime example of technology that is ready to go smart. Advanced technology and automation is driving a resurgence of activity in areas where labor costs have traditionally been the highest, such as Western Europe, North America and Japan. Businesses must take the next step if they are to expand market share and sustain profitability.

A typical SMT line may combine equipment that includes a dispenser or printer, mounters, and optical inspection systems from a range of different manufacturers. Although the interfaces and protocols used to support communication between machines can take advantage of industry standards, the differences in the underlying data structures present a barrier to the rich information exchanges needed to support smart manufacturing.



SMT line with closed-loop feedback of SPI data to printer, AOI data to the mounter and the correlation of all data with traceability software.

A complete line solution sourced from a single supplier, however, does not necessarily guarantee an easy solution. The way the data is organized is critical. Some manufacturers are able to demonstrate data structures that are well-suited to making detailed information readily available to analytical software.

Yamaha Motor Intelligent Machinery (IM) has devoted considerable resources over several product generations to establish a protocol for real-time data exchanges between in-line SMT equipment, and software capable of capturing and analyzing the data. These capabilities are now critical to supporting smart manufacturing.

Smart Beginnings

In the past, SMT lines have been unable to capture useful information about the performance of processes, such as solder paste printing or component placement. This is because there has been no existing communication standard capable of supporting the detailed feedback required.

In order to overcome the limitations of in-line SMT equipment and harness the power of data to drive continuous improvement, Yamaha developed its own machine communication interfaces. These interfaces facilitate the collection of rich data from machines in the production line and enable analysis and reporting or alerting in real time.

Yamaha has helped manufacturers improve quality control and boost productivity by identifying defects, such as missing components or incorrect alignment. This enables them to take remedial action immediately. Yamaha's initiative also makes it possible to collect information capable of driving preventive maintenance, which is becoming an important part of smart manufacturing.

Feeding solder paste inspection data to the printer enables auto-correction of print alignment and auto initiation of stencil cleaning. AOI data gathered in-line, immediately after component mounting, enables quick diagnosis of component placement errors or solder paste defects, down to the level of individual mounter nozzles or stencil apertures.

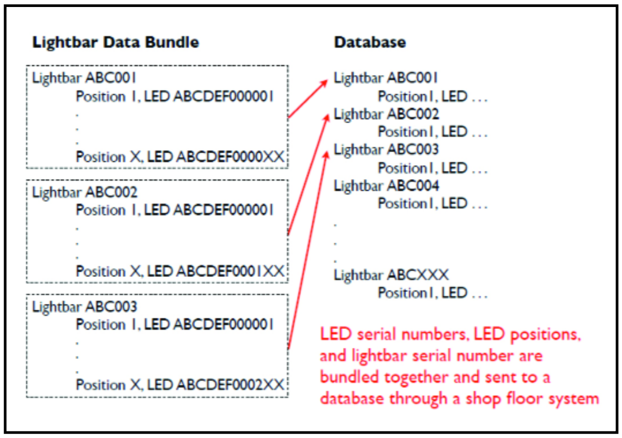
Machine software is able to diagnose the exact causes of errors and send alerts to a mobile terminal, such as the supervisor's smartphone, to help accelerate fault resolution, minimizing line stoppages. This mobile decision application is only one part of Yamaha's extensive Y.Fact software suite for optimizing setup and performance at machine, line, and factory level. Combined with individual machine capabilities, this software provides a platform from which a smart manufacturing strategy can be launched and continuously expanded and improved.

Y.Fact Software

The four modules that make up Y.Fact software are known as P-Tool, M-Tool, S-Tool, and T-Tool. They handle data programming, line monitoring, set up navigation, and traceability, respectively. The P-Tool for data programming carries out actions that include CAD data conversion and reverse engineering of Gerber files to help save preparation time. Eliminating trial runs dovetails well with smart manufacturing ideals by saving materials and supervisor time and automatically optimizing and balancing the line.

The line monitoring capabilities of the M-Tool represent perhaps the most obvious area for software to support smart manufacturing. Displaying line and factory status with a web-based interface makes detailed information, such as efficiency, operating ratios and pickup rates, available to supervisors in real time.

Color-coded status indicators enable simplified monitoring of the line. Data can be consolidated automatically into reports for storage and analysis by higher-level applications running in the cloud.



Data collected in real time and stored in the traceability database can support activities that range from customer relations to equipment maintenance or product design.

By facilitating set up, the S-Tool utility helps manage materials that could deteriorate over time. Automatically monitoring stock age and condition, for example by observing time limitations on moisture-sensitive devices (MSDs) and checking use-by dates of components or solder paste, helps prevent out-of-date or unsuitable materials from being incorporated into finished products. A component tower storage system, connected with the mounter's parts-remaining counter, helps minimize stoppages for reel and feeder changes and enables continuous operation if used to coordinate tape splicing.

The system records data that includes board code, solder paste type and the identities of component feeders and reels, all of which can be collected by a handheld barcode reader. A typical example might be recording barcode information such as brightness (BIN), color temperature and illumination pattern of LEDs to block components with dissimilar characteristics from being used in the same assembly.

The T-Tool supports traceability by recording each individual assembly identifier with its associated board identity and component data for every placement on the board. This is one area where the underlying data structure of the SMT equipment is critical for handling detailed component-level information. Yamaha's proprietary data structure is able to record component serial numbers as well as position data and the PCB serial number, and transfer the information through a shop-floor system into a traceability database.

This database can be queried for numerous purposes, such as tracking inventory and materials throughout the production flow to assist purchasing for just-in-time (JIT) assembly, to demonstrate conformity with customer requirements or to verify the origin of components.

Comparing traceability data with production test data can help to identify recurring problems with components or machinery. Ultimately, if delivered units fail in the field, the ability to trace the serial numbers of components affected can guide troubleshooting and assist with product recall.

Smart Manufacturing Principles

By collecting and exchanging rich data sets, and interfacing smoothly with analytical software tools that cover the end-to-end flow of delivering components and building assemblies on the factory floor, Yamaha's intelligent line supports the principles of smart manufacturing:

- High-quality, network-centric communication between humans and systems, in the entire value network that includes end users.
- Digitization of information and communication among all value chain partners and in the production process on all levels.
- Flexible, intelligent manufacturing technologies, adjustable on-the-fly to meet highly specific end user demands.

Smart manufacturing is the future. It is rapidly becoming the most effective way for businesses to deliver competitive products to global markets. The benefits of smart manufacturing, including inter-machine communication protocols, real-time monitoring and analytical tools, are already well-established in SMT assembly. The transition to smart manufacturing is happening now, bringing improvements all across the factory floor.

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