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Does Your Contract Manufacturer Have a Quality Improvement Focus?

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By Curtis Campbell

Every company in the electronics manufacturing services (EMS) industry talks about quality. But a point of differentiation among EMS providers is often the internal resources in place to ensure that quality issues are identified and addressed. SigmaTron International, an EMS provider with a global network of facilities, sees four core areas that help identify EMS providers with a quality improvement focus. Those are:

- Engineering resources
- Continuous improvement methodology
- Systems support
- Equipment investment.

Engineering Resources

OEM engineering teams are typically focused on product fit, form and function. When an OEM outsources all manufacturing, it is easy for engineering teams to work in a silo that insulates them from the production consequences of the design decisions they make.

As experts in manufacturing, EMS providers routinely provide manufacturability and testability advice designed to eliminate the issues that create defect opportunities or added processing cost. They may also make recommendations on approved material list (AML) selections to minimize availability or obsolescence issues. Collectively, this review and recommendation process is referred to DFX.

In SigmaTron's business model, comprehensive product development engineering assistance is available for new products, design for manufacturability and testability (DFM/DFT) recommendations are made when projects are started and continuing engineering support is available over the life of the product.

DFM analysis is performed using a combination of Valor and proprietary software tools. The documentation review process also uses a Valor parts library (VPL) to verify the footprint of all components specified in the BOM against the land patterns used in the layout. This helps eliminate both the opportunity for defects caused by manufacturability issues plus eliminates the non-value added time that can be spent reprogramming machines or re-spinning the printed circuit board layout if the component packaging specified in BOM doesn't match the land patterns used in the layout.

SigmaTron can also perform PLM as part of its new product introduction (NPI) process. Additionally, it has an experienced materials team that works closely with suppliers to identify potential availability and obsolescence issues as early as possible and recommend the most appropriate solution. The Company can also provide product redesign recommendations.

When OEM and EMS provider engineering teams set up a framework for collaboration in product development, a number of efficiencies are realized:

- Design iterations are reduced as DFX recommendations are incorporated earlier in the process
- Defect opportunities are reduced as a result of more manufacturable designs
- Test cost may be reduced if collaboration in the design process optimizes the product for test
- Obsolescence risk and availability issues can be reduced through collaboration on component choices.

Continuous Improvement Methodology

The complex nature of electronics assembly ensures that most outsourced projects have opportunities for improvement over time, even when NPI is done flawlessly. Having a robust continuous improvement methodology helps ensure those improvement opportunities are identified and acted upon. At SigmaTron International, each facility's continuous improvement methodology is aligned with the industries and typical volumes it serves. Its Tijuana, Mexico facility utilizes Lean Six Sigma as its primary framework for driving continuous improvement.

A recent continuous improvement project involved reducing quality defects on a rapidly growing project in the SMT area. The Green Belt teams use a DMAIC (Define, Measure, Analyze, Improve, Control) methodology to identify each improvement opportunity and strategize the appropriate solution. They are mentored in their continuous improvement projects by their facility's Yellow Belts.

In the Define phase teams develop a problem statement, identify critical to quality (CTQ) and defect metrics, create project objectives, determine the business case and financial impact of the desired improvement, determine customer impact, set milestones and a timeline, define the project scope and boundaries, and assign team responsibilities. In the Measure phase, the teams measure the variances they associate with the problem they have identified, utilizing core tools such as cause and effect diagrams and Gage R&R measurements. In the Analyze phase, the teams analyze the data they have collected to determine trends and possible corrective actions. In the Improve phase, the teams implement improvements and then utilize design of experiments (DoEs) to determine if the proposed solutions are correcting problem. In the Control phase, measures to ensure continued achievement of desired metrics are implemented.

This production project was selected by the Green Belt team because defects were substantially higher than defects in other projects in the SMT area. It involved a rigid flex PCBA assembly. The goal was to decrease the defective parts per million rate (DPPM) by 70 percent. In SigmaTron's process, defects are measured at the individual solder joint level. The team determined that there were four primary improvement areas: solder paste deposition height, printing process parameter, squeegee maintenance and standardization of operator inspection criteria. They looked at two failure modes: solder defects and placement defects. They also did Gage R&R measurements of the accuracy of operators identifying defects.

The end solution involved a combination of adjusting solder paste height, replacing solder paste squeegees more frequently, re-calibrating some feeders on placement machines, providing additional IPC-A-610 workmanship standard inspection training to production operators and developing a manual to better explain the inspection process. The result achieved the defect reduction target and significant cost savings by eliminating associated rework.

Utilizing a focused continuous improvement process ensures:

- Rapid identification of issues that impact quality
- A thorough investigation of the root cause of the issue
- A DoE-driven approach to testing assumptions related to the optimum corrective action
- Standardization of the corrective action across all impacted processes.

Systems Support

Advances in information technology have automated quality data collection and provided tools to minimize variation in manufacturing processes. However, harnessing systems technology to drive quality improvement requires a user-driven focus. SigmaTron uses a combination of proprietary and internally-developed systems for enterprise and shop floor management. All facilities utilize a common ERP system plus third-party Product Lifecycle Management (PLM) tools.

The Company's IT department takes a distributed approach to continuous improvement in its systems by letting teams at individual manufacturing facilities identify specific gaps in shared systems and develop appropriate software tools. Some of these software tools are deployed to all facilities, while others support unique requirements within that factory. For example, the IT department has taken a phased approach to development of its proprietary manufacturing execution system (MES), standardizing the core MES with some specialized programming for unique processes at individual facilities.

The IT team in SigmaTron's Taiwan office has developed a trends analysis database app, known as the PDCA tool. Built around J. Edward Deming's Plan, Do, Check, Act framework, the tool supports trends analysis, continuous improvement activities and corrective and preventive action (CAPA) tracking. Working in conjunction with data collected by the proprietary MES, it tracks first pass yield (FPY) by customer, group or model number. It also tracks major defect by process and its raw data enables tracking of defects by part type. It sends emails to the relevant team members when a defect exceeds the control plan limits to signal the need to open a PDCA project. Its summary section can provide FPY information by week, month or year.

In initiating corrective action, the team starts in the Plan phase performing failure analysis, planning for the corrective action and setting a goal to achieve. In the Do phase the team implements the corrective action plan. In the check phase, the team reviews process data such as first pass yield to see if the corrective action has reduced the identified defect and if any new defects have appeared. In the Act phase the team documents the corrective action to ensure the process change is standardized across all relevant processes. The PDCA tool tracks this activity and provides dashboards that incorporate yield trends and defect pareto analysis.

In a controlled process, the root cause of drops in yields can often be difficult to identify. A recent project illustrates the benefits of the PDCA process in rapidly identifying these issues. The cumulative FPY failure rate on an SMT printed circuit board assembly (PCBA) had climbed to 1.23 percent. The team opened PDCAs on the top two defects: misaligned components and lifted parts. Their analysis determined that the root cause of the misaligned components was an issue with a pick and place machine. A smooth part package was not being uniformly placed because the nozzle pressure wasn't sufficient to hold it in place and placement speed was contributing to the problem. The pressure and placement speed were adjusted and yield improved. That process change was documented to be incorporated in future production activities involving that part. In the case of the lifted parts, analysis showed the part was not performing to specification under reflow and the vendor was contacted. It appeared to be a transitory issue, as it did not show up in other production lots. The result of both corrective actions was that combined FPY failure rates dropped to 0.61 percent. The team is now analyzing a new top defect list to achieve further improvement.

Aligning internal systems with continuous improvement:

- Helps organize data in a way that simplifies trends analysis
- Can integrate exception based notifications that ensure timely response to changes in metrics
- Makes it easier to share quality trends information in customer-preferred formats
- Aligns information access with internal continuous improvement processes.

Equipment Investment

Smaller product footprints have driven smaller component packages and more densely packed printed circuit boards (PCBAs). That narrows process windows and increases the opportunity for defects. Integrating inspection processes into the manufacturing line helps address this issue by ensuring that production process control limits are continually monitored. The earlier in the process that an issue is identified, the less costly the issue is to correct.

SigmaTron regularly invests in inspection equipment. In higher volume production this equipment is in line. In lower volume production, it may be offline.

For example, SigmaTron's facility in Suzhou, PRC is predominately high volume production. Its SMT lines have been optimized to include a higher level of in-process inspection, utilizing 3D solder paste inspection (SPI) following paste or glue deposition and automated optical inspection (AOI) both pre- and post-reflow. The MES collects yield data at those points as well as at in-circuit and functional test. The MES also tracks assemblies through each production step in the routing to support traceability requirements. The PDCA app discussed earlier is utilized for continuous improvement activities based on the data provided to the MES by these inspection and test stations.

Conversely, SigmaTron's facility in Elk Grove Village (EGV), IL utilizes offline 3D SPI and x-ray inspection.

The 3D SPI system is used for PCBAs deemed most critical based on past test history and to validate process setup for all PCBAs.

The 3D x-ray system is being used for defect detection in blind lead parts such as BGAs and crystals, and first article process validation. It is an improvement over an existing 2D system in terms of processing speed and the fact that it inspects x, y and z axes. It also identifies defects within the programmed-defined inspection area, requiring less operator interaction.

Shortly after the 3D x-ray inspection system was installed, it helped the EGV team correct a significant quality issue. A PCBA was consistently failing test and the team could not determine the root cause. The customer suggested the team focus on a BGA placed over a via in pad. When 3D modeling was done using the x-ray system it showed that the PCB fabrication house had drilled two via holes that merged into one under the pad. The system provided a clear enough image that it even showed the drill marks, making it easy to document and correct the situation with the PCB fabricator.

Developing a robust inspection strategy helps:

- Reduce scrap/rework costs by identifying quality issues early in the production process
- Address hard-to-identify root causes related to issues outside the production process.

Aligning systems, processes and equipment with well-trained continuous improvement teams helps force multiply personnel resources. This holistic approach also ensures quality issues are rapidly identified and corrected. A mix of standard and proprietary systems helps optimize continuous improvement activities. Evaluating the degree to which a contract manufacturer has aligned these resources helps determine the level of quality improvement focus.

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