Improving SMT component alignment by transferring to an existing, upgraded production line

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Abstract

High reject rates caused by misaligned SMT components were negatively impacting quality and efficiency at the Collins Aerospace manufacturing site in Santa Isabel. These defects were traced to limitations in an aging pick-and-place machine used in PCB assembly for aerospace and military applications. This project aimed to improve alignment accuracy and increase throughput by transferring operations to an upgraded production line featuring a high-speed pick-and-place machine and an integrated automated optical inspection system. A structured approach was used to assess the current process, implement the transition, and validate results through quality checks and performance monitoring. After implementation, misalignment defects decreased by 90%, while productivity improved by 35–40%. The results confirm that modernizing SMT equipment can deliver substantial gains in quality and efficiency without compromising compliance with strict industry standards.

Introduction

Collins Aerospace, a Raytheon Technologies subsidiary, manufactures high-reliability PCBs for aerospace and military use. The facility uses SMT and through-hole technologies, requiring strict precision to meet industry standards. The objective of this project was to improve production efficiency and reduce reject rates by transferring component placement operations to an upgraded machine with greater precision and speed. The new setup was expected to enhance alignment accuracy and support throughput goals while maintaining product quality and compliance with aerospace standards.

Figure 1
Collins Aerospace - Santa Isabel, Puerto Rico

Literature Review

Accurate component placement is critical in SMT assembly to ensure PCB reliability, especially in aerospace and military applications. Misaligned components can lead to serious defects such as tombstoning, solder bridging, and detachment, ultimately affecting performance and causing failures. Regular calibration of pick-and-place machines is necessary to maintain precise alignment and prevent issues like short circuits and reduced functionality [1]. Advanced pick-and-place machines equipped with multiple nozzles allow simultaneous component placement, significantly increasing throughput while reducing cycle times and reject rates [2]. Improved hardware and software configurations in modern machines enhance accuracy and overall process reliability [3]. Additionally, automated optical inspection (AOI) systems support quality control by detecting defects early in the assembly process, including misalignment and poor solder joints [4]. High-speed placement systems further improve precision and minimize defects such as overhanging, tombstoning, and skewed placements, especially when dealing with small or wafer-level components [5].

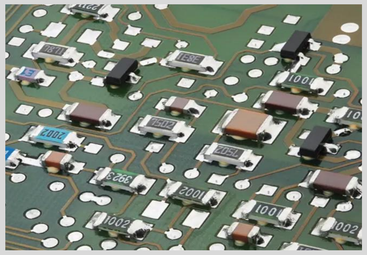

Figure 2
PCB with SMT components installed

Methodology

The project followed a structured approach to ensure a smooth transition to the upgraded production line while maintaining quality and improving productivity. The steps were as follows:

- **Initial Assessment**: The performance of the existing pick-and-place machine was evaluated by documenting misalignment issues and analyzing their impact on reject rates. A baseline for installation time was established by measuring the current operator charging time.
- **Transfer to Upgraded Line**: The upgraded production line was prepared with a calibrated pick-and-place machine and an integrated AOI system capable of meeting product specifications without compromising speed or accuracy.
- **Programming for AOI System**: All relevant part numbers were programmed into the AOI system to enable accurate inspection of component placement. This task was carried out in collaboration with the engineering and quality teams to ensure proper setup.
- **Change Management**: A management of change (MOC) document was prepared and submitted. This document detailed the production transfer, adhesive dispenser relocation, and other relevant changes for approval by the appropriate teams.
- **Implementation**: Production was transferred to the upgraded line. The adhesive dispenser was relocated, and all necessary equipment was integrated. The pick-and-place machine and AOI system were calibrated to ensure proper operation
- **Delta FAI**: A delta FAI was conducted for each affected assembly to confirm that no new defects or misalignments had been introduced by the upgraded equipment and processes.
- **Productivity Monitoring**: Operator charging times were measured before and after the transition. These metrics were compared to evaluate improvements in component installation time and overall efficiency.
- **Post-Implementation Review**: The upgraded line was monitored to verify improved productivity and reduced reject rates. Metrics such as reject rates, throughput, and operator charging time were tracked to assess project success and identify opportunities for further improvement.

Results

Following the implementation of the upgraded SMT production line, quality and productivity metrics were tracked to evaluate the effectiveness of the transition. Quality data was reviewed daily to measure changes in SMT component alignment. Table 1 demonstrates that misalignment defects have been significantly reduced. The results showed a 90% reduction in misalignment defects, indicating a significant improvement in placement accuracy. This improvement is attributed to the upgraded pick-and-place machine's higher precision and the integration of the AOI system, which provided real-time inspection and defect detection.

Table 1
Misalign rejects comparison from 2024 and 2025

Month	2024 Defects	2025 Defects
Apr	20	1
May	27	2

Productivity was also analyzed by comparing operator charging times before and after the transition. Figure 3 demonstrates the reduction in charging time, which corresponds to a 35–40% increase in productivity due to the improved speed and efficiency of the new system.

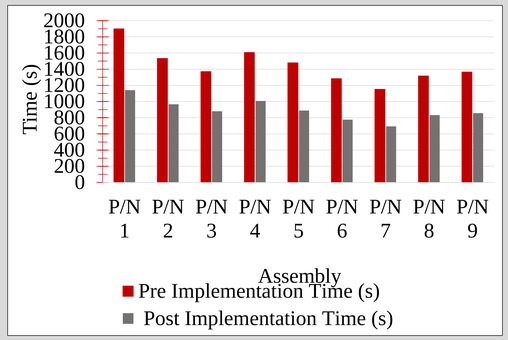

Figure 3
Operator charging time before and after process change

Conclusion

The successful transfer of SMT component placement operations to an upgraded production line at Collins Aerospace in Santa Isabel led to significant improvements in both quality and productivity. By overcoming the limitations of outdated equipment, the project achieved a 90% reduction in misalignment defects and a 35–40% increase in productivity key outcomes for meeting the strict standards of aerospace and military applications. The addition of automated optical inspection enhanced process control through real-time defect detection, further ensuring product quality. This project highlights how strategic investments in advanced manufacturing technology, combined with effective change management and cross-functional collaboration, can deliver measurable gains in performance. The results support the potential for expanding this approach to other lines, promoting standardized, high-efficiency practices across the facility.

References

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