Placement optimisation in a lean manufacturing environment

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Tier 2 and Tier 3 EMS companies face increasing pressure from competition in low-cost manufacturing countries to produce assembled boards at lower cost, with increased complexity and to tighter deadlines. They also face an increasing amount of high-mix, small-to-medium-volume production runs. Even OEMs find it hard to predict what products they will be manufacturing in three to five years time, driving the need to invest in highly flexible production tools that will cater to their needs over the lifetime of the equipment.

This paper examines methodologies for optimising the process, improving stock control and providing greater traceability using lean manufacturing techniques. The author examines Europlacer's new iineo pick and place system and how its Integrated Intelligence contributes towards a lean manufacturing environment.

Keywords: Lean Manufacturing, Placement, Traceability, Stock Control

Introduction

Minimizing lost production time is a key objective of most production managers. Production equipment requires fast setup, fast changeover and optimised running. These managers have an array of different tools at their disposal to assist them in analysing the process, placement accuracy, inventory control and stock management.

Ensuring that there are sufficient components in stock to meet production needs without building excess and potentially redundant inventory is critical to the success of an efficient lean manufacturing operation. More especially today, with lead-free components that have a reduced shelf-life compared to their SnPb counterparts, the difference between an efficiently run stock room and a fully optimised placement system can have a significant impact on the profitability of the job.

Lean manufacturing

Lean manufacturing embodies the principals of maximising value by increasing productivity, while decreasing production costs and reducing waste[1]. This is achieved largely through a series of measuring techniques that are compared against known benchmarks. This information empowers users to strive for continuous improvement, maximizing productivity.

The technology tools used to optimize placement machines can be divided into two areas: hardware and software, which combine to form Integrated Intelligence.

Integrated Intelligence uses a bus based system, as opposed to individual feeders positions. The combination of the bus system, turret placement head and software programme structure provides an architecture that is designed to use intelligence to optimise productivity.

Hardware

Most modern placement machines use direct drive motors and linear encoders to achieve optimum speed and accuracy. The key differentiators between placement machines are feeder technology, type of placement head, vision system and nozzle technology.

Another consideration when specifying placement machines is that machines with a modular construction can assist servicing and simplify future upgrade paths.

Feeder Trolleys

In a total traceability environment, feeder trolleys need to be intelligent. To optimise job sequence and feeder position, it is important that the stock management software can communicate with the machine operating software and be fully aware of the location and component inventory on every feeder trolley.

Intelligent feeders

Intelligent feeders were first pioneered by Europlacer in 1990. Since that time, feeder technology has developed considerably. Today's feeder has a built-in memory that slots into a bus with an RS232 link to the feeder. The feeder location is automatically identified by the machine. An LED indicates that the machine has recognised the location of the feeder and the component type on the reel. Fiducials on each feeder are read to automatically optimise the picking position.

A flexible feeder range is also important to handle the wide range of components available. The system under test has label feeders, die placement feeders, belt feeders, vibratory feeders, and ball placement feeders for reballing or attaching shielding covers. The belt feeders are particularly flexible as they can be configured to accommodate any size of component and can feed stick components at rates close to normal tape feeder .

Placement heads

There are two principal types of placement head: the turret head and the pipette head. The turret head is considered the most reliable because the entire head revolves, but the nozzles remain in a fixed position. It, therefore, has less moving parts and requires less maintenance. When compared against the IPC tac time specification, pipette heads are also considerably slower. This is because pipette heads rely on multi-picking for IPC speeds, and this is not feasible in a real world, high-mix fast changeovers environment.

The Europlacer iineo is fitted with an 8- or 12-head turret that is capable of picking very large QFPs with every second nozzle. The heads can adjust in the x, y or z axis, which enables more accurate component pickup than systems that move the tape only (eg pipette system with multi-pick)(*Figure 1*).

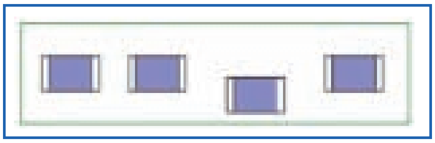

Figure 1. Placement heads that move in the x, y and z axis can make corrections more easily for accurate component pickup.

The placement force in the *z*-axis is important. An automatic adjustment of ±5 mm allows the iineo placement head to also compensate for warped boards, reduce 'bounce' and adjust pick-up height

Vision systems

Camera technology has advanced considerably in recent years, and modern placement machines have taken full advantage of these developments. Cameras that can operate 'on the fly' enhance processing speed because they do not affect cycle time. In the iineo system, the first camera measures the fiducials and barcodes, if present. The second camera is 'on the fly' and analyses the component for planarity and can identify lifted leads. The key metrics are the pixel count (field of view) and the processing system, which determines the cycle time.

Nozzle technology

The majority of nozzles are steel construction with a vacuum pickup. The iineo uses a 'Smart Nozzle' constructed from plastic to significantly reduce replacement cost and prevent ESD against fragile components. The Smart Nozzle concept has vacuum pickup and an identity encoded into the pickup tool that verifies the correct nozzle is being used. This avoids potential mispicks and improves the quality of placement. The Smart Nozzle handles a wide range of components from 01005s to 70 x 70mm odd-form components and up to 100mm long connectors. It can also be fitted with grippers and other custom pickup tools.

Software

There are four principal areas we will examine for optimisation of the placement operation within the pcb assembly process (*Figure 2*).

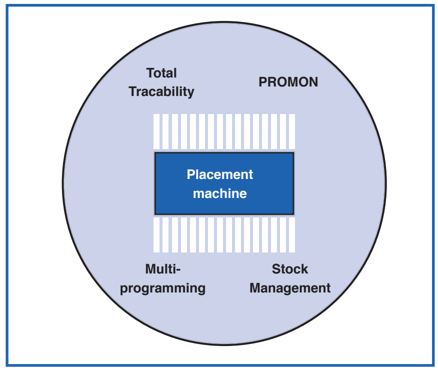

Figure 2. Four principal software-driven functions provide machine optimisation.

Figure 4. Reels can be scanned offline to register the relocation of the reel to the feeder trolley, or back to the storage system.

Stock Management

Stock management is the first critical step on the traceability path. 3-D barcodes are attached to each reel at goods inward. Information can be imported from the ERP system or manually scanned into the stock management system. The information should include the following:

- Reel code
- Item code
- Batch number
- Quantity

The shop floor component storage system should also be barcoded at each reel location. The stock management system can scan the reel location and then scan the 3-D barcode on the reel to enter a record into the inventory (*Figure 3*).

When the component reels are removed from the component storage area, the destination feeder should be scanned first, followed by the 3-D barcode on the reel. This will move the reel from inventory onto the feeder trolley, sending a restocking order if necessary.

In offline mode, the feeder trolley can be connected by WiFi or by a cable to the stock management system for further setup or optimisation instructions as to which order the job should be prioritised to optimise production uptime and component availability, or it may be overridden to prioritise a particular job (*Figure 4*).

When the trolley is connected to the placement machine, it switches on an LED to denote it has identified the feeder and the reel.

The feeder counts the number of component picks and takes into account mispicks and missing components to reduce inventory and give an accurate report on the number of components used. Each board is identified by its own barcode. The component database automatically updates the inventory after each board has finished its placement cycle.

At the end of production runs, when part reels are removed, the destination in the component storage area should be scanned first, then the reel itself, updating the record in the inventory.

The inventory can be searched by location, part number or reel code. It can also be automatically exported at five-minute intervals if necessary, to the ERP system to provide a closed-loop stock management system. The system has the ability to print out 3D barcode labels that can be used with the ERP system or manual stock control.

Multi-programming

Further optimisation of the manufacturing efficiency can be achieved using multi-programming software to produce the optimum production schedule for manufacture. A GUI-driven software system shows an image of each board/job and enables the operator to choose jobs and choose the machine or line. The system then optimises the jobs based on throughput and changeover time, providing an accurate time readout that can be used in job quotations.

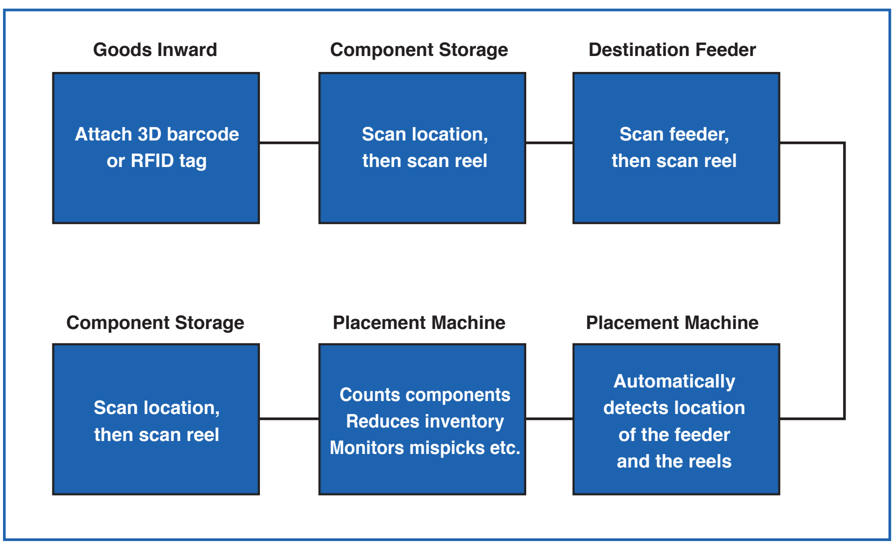

Figure 3. Flowchart showing the information flow from goods inward to post-placement.

Machine software optimisation

Intelligent software on the system under review is able to view the following live or statistical information:

- Uptime
- Efficiency (according to categories specified)
- Placement rate
- Component reject rate

PPM rates can be set to flag component reject rates below a predetermined level. Operators then can mine down through these data to establish the reason for these rejections.

In statistical mode, the machine can use a calendar to report details of the machine's performance on a daily, weekly or monthly basis. The data can be gathered in a zip file and sent to the machine manufacturer for analysis and possible recommendations for performance optimisation.

Traceability

Total traceability is critical to minimize batch recalls and improve quality[2]. Placement machines should have the ability to monitor each individual component from goods inward to placement on the board, tracking real component activity, rather than assumed activity. Software systems should be capable of tracking which batch of boards contained the defective components, which head placed it and which reel it came from[3]. In certain safety critical applications it is important to record the actual electrical value of each placed component together with the other standard date stamp and batch traceability data.

Conclusion

Integrated Intelligence is essential

Figure 5. The storage area should have 2D barcodes that should be scanned before any reel is removed or replaced into the storage rack.

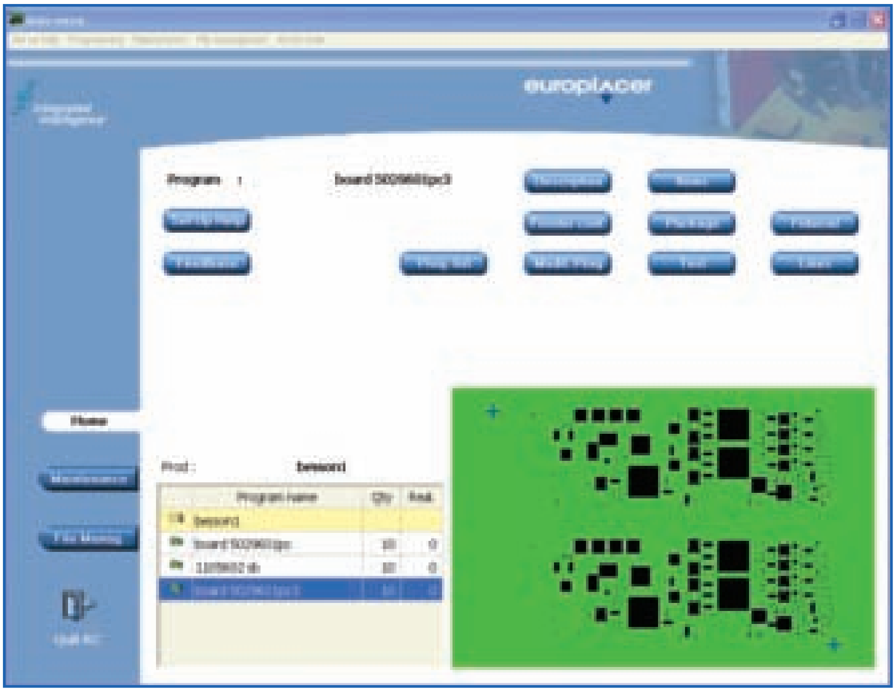

Figure 6. GUI representation of a board being setup for multi-programming.

to capture the critical data from the component inventory and placement machine and accurately interpret it to contribute towards a lean manufacturing environment. By taking a holistic approach to the manufacturing process, manufacturers can reduce waste, minimize machine downtime and improve the narrow operating margins that characterize today's manufacturing environment.

It is clear that optimising production performance to increase yields and reduce downtime comes from a combination of a bus-based architcture, a turret design placment head and optimised software. Used in conjunction, these parameters will combine to form an Integrated Intelligence system.

References

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