VISION INSPECTION: MEETING THE PROMISE?

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Introduction
Automated Optical Inspection systems have reached a price/performance point at which they can be used in-line to detect several important assembly defects. Systems using visible light are among the fastest and least expensive. They can replace human inspection of circuit assemblies, and provide data to improve control over assembly processes.

Vision System Alternatives
Just as with electronic test equipment, there are several classes of vision inspection equipment.

• The machine-vision industry has a wide range of equipment vendors and systems integrators for 'rack and stack' vision systems. Software tool-kits provide an extensive suite of image-processing algorithms and graphical tools to simplify the programming of inspection tasks. They are suitable for low-cost, very specific inspections of a device or assembly. But users must be well-versed in vision systems design to build an effective inspection system. Just like rack-and-stack test systems, these inspection systems tend to be customized for an individual application and require considerable re-programming for each new board design.

• General-purpose PCB inspection and gauging systems are fully-integrated systems containing XY stage, cameras, flexible lighting and board transport. They are capable of operating in-line to measure and inspect components on circuit boards, using a variety of inspection techniques. These types of systems offer precise measurements, flexibility and speed.

• Specialized PCB inspection systems, designed to be operated in-line immediately after a solder paste or part placement operation, that are optimized for detecting assembly defects from that operation at the highest throughput possible. These types of systems offer low cost and fast, simple, CAD-driven programming for new circuit board designs. However their measurement capabilities may not be as precise or as flexible as general-purpose machines. These systems are the ‘Manufacturing Defect Analyzers’ (MDAs) of the vision inspection world.

Defect Coverage
Vision systems used after a placement process are capable of detecting the following defects:

• Missing part.
• Non-resident part present by mistake.
• Mis-oriented (backwards) part.
• Part offset and rotation measurement.
• Location of odd-form components and hardware.

When used after a solder process, vision systems can detect solder bridges. However, attention is shifting to vision inspection of solder paste immediately after the paste is printed, since many solder defects can be attributed directly to printing defects and are more easily detected at this stage.

Economics
For a vision inspection system to be economically justifiable in a high-volume PCB assembly operation, it must:

• Operate in-line at line beat rates (30 seconds or less).
• Offer a high degree of defect coverage for the targeted defects (90% or more).
• Provide measurement data to data-collection systems.
• Have low initial purchase cost.
• Offer fast, simple programming for new board designs (a few hours to generate an initial inspection plan), and allow fast re-programming for design changes. Ideally the programmer should not require any specialized vision knowledge.
• Be tolerant of normal manufacturing variations (for example, component color and marking changes caused by components from different vendors). It should not be necessary for the programmer to ‘tweak’ the inspection plan to cope with such changes.
• Have very low false-accept and false-fail rates. False-accepts can lead to potentially bad product being shipped. Failures are diverted to a repair loop, so a high proportion of false failures wastes resources and brings the system’s trustworthiness into doubt. Some parts just cannot be inspected reliably. Ideally the system should detect this to prevent false calls on such parts.