Test Coverage
Manual Inspection vs. AOI-AXI

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Overview

• Goal of this presentation is to outline these inspection strategies
• Point out strengths and weaknesses
• Inspection Defect Capture Comparison
• Discuss what we need from equipment suppliers
Manual Visual Inspection

• Industry relies on this inspection technology for board quality
• Studies show only about 50% effective
• High degree of variation
• As a CM, if I don’t find a defect, does it exist?
  – I can only find what I have tools to find
  – My quality and reputation relies on finding and fixing
• Can I replace this with automation?
Production Flow

- Board Bottom assembly
  - First Article Inspection
  - SMT Bottom Inspection
  - AOI Inspection
- SMT Top Assembly
  - First Article Inspection
  - SMT Top Inspection
  - AOI Inspection
- Hand Load /Through hole
- AXI
- 2nd OP
- Final Inspection
First Article Inspection

- Manual Visual Inspection Step to Verify SMT Program
- Inspect for
  - Placement Location
  - Value
  - Correct Part
  - Polarity
  - BOM Match
  - This board should be used as “Gold Board” for AOI Program and SMT inspection. This “gold board not required for AXI
SMT TOP BOTTOM Inspection

About

- Inspection results depend on the ability of the inspector
  - Each inspector will be different
  - Daily results will vary
  - Adding additional capacity can be difficult
  - No program required
SMT TOP BOTTOM Inspection Capability

- Coverage
  - Can only inspect what they can see
  - Not under BGA, QFN, RF Shield
  - Repeatability can be a problem
  - Good inspection coverage will be slower than line throughput
AOI Inspection

- My experience is with the Agilent SJ50. Results will be different with other vendors equipment.
AOI Inspection Capability

- Fast Inspection Time
- Single sided inspection, inspect top and bottom separately
- Inline or batch works fine
- Depends on first article board for correct polarity, value etc.
- Repeatability good requires very little tweaking
AOI Strengths / Weakness

**Strength**
- Optical Character Recognition/ Verification (OCR OCV)
- Library can contain OCR/OCV information
- Correct Component / Value
- Polarity
- Presents Absence
- Programming time

**Weakness**
- Requires First Article board for Polarity
- Solder joint coverage (compared to AXI)
- Requires visual access for test
- Through hole
AXI Inspection
About

• My experience is with Agilent 5dx and X6000, other equipments capabilities will be different
AXI Capability

- Does not require a perfect board for programming
- Requires experienced programmer for good results
- Requires experienced repair operator for good results
- 1 machine 2 shifts, 2 PLR operators per shift can test about 8 million solder joints / week
- Repeatability very good, programs require tweaking
**AXI Strengths**

- Strengths
- Solder joint inspection
- Hidden Solder Joints
  - BGA, QFN, RF Shield

**Weakness**

- Weakness
- Programming time
- Parts library
- False Call levels
What Won’t the AXI Detect?

- Wrong components
- Rotated (wrong polarity) on QFPs, SOICs, TSOPs, PLCCs, SOJs
- Bad parts (electrically)
- Microcracks on BGAs
- Resistors that are broken off (after a good solder joint was formed)
- Capacitors, Under BGA’s can be tough
Combined Test Strategies for Best Coverage

- By combining the best of the different technologies, can we eliminate the manual inspection?
- AOI, presents absence, polarity and value
- AXI Solder joint coverage
My Results

- These are the combined results from about 50 different assemblies using all three inspection technologies.
- Lot sizes of 5-2000 boards.
- About 5000 boards total.
- AOI inspection has fewer opportunities - duplicates SMTQC.
- SMTQC /AOI do not inspect TH.
- We have just started inspecting certain boards without SMT QC – Results not in yet.

<table>
<thead>
<tr>
<th>Defect</th>
<th>Process</th>
<th>SMT Bottom QC</th>
<th>SMT Top QC</th>
<th>AOI</th>
<th>5 DX/PLR</th>
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What We Need From Suppliers

- Less dependence on highly trained Programmers and Inspectors
- Fast Time to Test
  - Better Programming tools
  - CAD conversion
  - Program generation
  - Board Revision
  - Program Verification
  - Libraries