As quality control emphasis has shifted from finding and rejecting defective boards during final inspection to using process control to reduce the number of defects occurring, in-process inspection has become more crucial. Instead of relying on visual methods and in-circuit testing to identify defects on completed boards, in-process inspection finds defects before additional value has been added and creates an opportunity to correct the process before any more defective boards are completed.

It is now generally recognized that solder paste printing is the most critical process step for controlling solder joint quality on finished boards. Manufacturing engineers are turning to in-line, post-print inspection equipment for implementing process control systems for their board assembly lines.

One contract assembler reported that on a run of two thousand boards using 352-pin BGAs, after all boards passed post-printing inspection with known good solder paste prints, they had no defects on a run of two thousand 352-pin ball grid array packages at final test.

Obviously, completed boards still need to pass through all steps in final test. Solder paste inspection does not eliminate the need for final testing, but when properly used, post-print inspection can substantially reduce the number of defects showing up at final test.

**Solder Paste Volume is Key to Quality**

Solder paste printing is the critical assembly process step for controlling the quality of finished solder joints. But despite our technical advances, solder paste printing is still considered somewhat of a “black art”. One technical expert noted that there are 39 variables in the solder paste printing process.1 The interrelationships among all of these variables are not fully understood.

Solder paste volume has been identified as the single best predictor of finished board quality. The challenge is to keep printing consistent volume time and time again.

**Defect Repair versus In-Process Defect Detection**

Finished boards which are rejected at final test are usually either discarded or reworked. When a completed board is scrapped, the cost includes not only the materials (minus any salvageable components) but also the time and labor which went into that board.

Most solder joint defects can be repaired by reworking, but reworked solder joints are known to be brittle and more vulnerable to field failure, leading to expensive warranty repairs.

The high cost of rework and the desire to reduce cycle time has taken defect reduction programs back to the source, looking for ways to reduce or eliminate defects by locating and fixing process problems.

Using post-print solder paste inspection produces lower production costs by detecting printing defects early in the process, before additional cost has been added to the board. Poorly printed boards can be taken out of the process, cleaned and re-used.

**Early Defect Detection Reduces Costs**

The later a defect is caught, the more expensive it is to repair, so catching a defect early in the process is inherently cheaper. Correcting a defect after reflow produces a more brittle joint and increases risk of field failure. Therefore, finding a defect before reflow is an opportunity to save money and increase reliability. A defect found early in the process should not be viewed as a penalty, but rather an opportunity for savings.

The “10X Rule” is a commonly-accepted quick formula for estimating the cost of a defect or failure at each stage in the process:

<table>
<thead>
<tr>
<th>Stage</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Print Failure</td>
<td>$0.50</td>
</tr>
<tr>
<td>After Reflow</td>
<td>$5.00</td>
</tr>
<tr>
<td>In-Circuit Test</td>
<td>$50.00</td>
</tr>
<tr>
<td>Field Failure</td>
<td>$500.00</td>
</tr>
</tbody>
</table>

**Conclusion**

As quality control for SMT electronics assembly shifts from final inspection/final test to production line monitoring and process control, there is a greater emphasis on post-print solder paste inspection as a means of reducing the number of defects appearing on finished boards.

Automatic post-print inspection systems provide operators with the continuous information required to implement in-line continuous process control, identifying out-of-spec trends so that printing problems can be corrected before defective boards are produced.

As one contract manufacturer noted, “An assembler looks to increasing margin not by increasing price or lowering its standard of quality, but by increasing process quality.”2

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1 Clothier, Richard, Nepcon West '97, Solder Paste Printing Seminar.