New tools are automating print and placement analysis without performance tradeoffs or retrofits.

To do their jobs on assembly lines, SPI machines generate huge quantities of valuable data that often go underutilized. The information they gather on deposit heights, volumes and locations to pass or fail a print can also be used for a variety of engineering purposes. Documented applications include print parameter optimization, paste selection, board support analysis, and stencil evaluation and verification. Many of these uses have been discussed in this series of articles (see editor's note).

Until recently, application of the data has been based solely on the engineering department's ability to utilize it – their intellectual, analytical and creative abilities, as well as their general availability in this era of Lean staffing. But that's changing, as the equipment suppliers are producing new applications for the data, often at the behest of assemblers. These new applications are software-based and use the data generated during print inspection to automatically control and improve the overall SMT process.

Automatic print offset feedback to stencil printers. Measuring print offsets is anything but new; SPI machines have always measured print offsets, and those offsets could always be fed back to the printer – by a human.

It's easy to query paste-to-pad alignment data through the machines' SPC interfaces and use the information to tweak printer alignment when necessary. Historically, this had been a good, albeit inefficient, way to dial in the process to compensate for PCB shrink or lot-to-lot positional variation. The inefficiency stems from the need for human intervention; a person has to decide to query the database (in real time, not the next day), determine if an adjustment is needed, and then physically make the adjustment on the printer. Adding to the variability of this process, the person would need to query the SPC at critical times: for example, when different lots of PCBs reach the assembly line. So although the SPI systems have always provided powerful offset measurement capability, they historically relied on what is often the weakest link in a production system: the operator.

Eliminating the human element eliminates a major source of variation. Now, with the link between the SPI and printer completely automated, PCB assemblers can instantly realize more value from their inspection equipment. Small process deviations can be addressed before they grow into out-of-control situations, and SPC on PCB positional accuracy can actually serve as an early warning system for other bare board-related issues.

Automatic wipe triggering. Stencil underwiping is still a bit of an ambiguous science, despite all the technology that's been applied to solder paste printing over the past two decades. Variables like wipe frequency, wet/vacuum/dry sequences, solvent selection, wiper design and paper quality all affect printer output, but are not studied nearly as often as items like print

parameters, stencil designs or tooling supports. As an industry, we are largely uneducated about the nuances of the stencil underwipe process, often setting wipe parameters somewhat arbitrarily.

An automatic underwipe can be triggered by a number of print problems. Insufficient volumes may indicate clogged apertures, while excessive paste volumes, bridges or smears may indicate residual paste on the bottom of the stencil. In either of these situations, the underwipe is needed to remedy the issue and regain control of the process.

Automatically triggering the underwipe eliminates line downtime waiting for an operator to respond to a print failure, judgment calls on whether an underwipe is needed, and eventually, arbitrary guesses at what regular production wipe intervals should be.

Automatic placement adjustments. Feed forward controls can now communicate component positional offsets to the placement machines. As components get smaller or more complex, they become less forgiving to offsets or skews. Placement accuracy for 0201s, 01005s and certain bottom termination components like DFNs or QFNs is critical to end-of-line yields. The often unpredictable shrink (or stretch) in PCBs can now be captured at SPI and communicated to pick-and-place automatically, shoring up the PCB-induced slop in the placement process.

Just like print offsets, placement offsets could be queried at key times by humans and manually translated to the pick-and-place machines. Production line placement tweaks have typically been frowned on by our industry, because when they're executed haphazardly, they can easily ruin the integrity of the placement program's CAD data. Automatic adjustments, however, are more accurate than human ones, protect the centroid data, and record the modifications for future reference and analysis.

Automatic data review. Database sharing with AOI systems correlates SPI results with AOI results. Solder defects flagged at AOI, and their ultimate pass/fail status, are linked with SPI volume and position readings. Trend reports indicate the adequacy of the SPI tolerance settings in preventing defects, and enable data-driven adjustments to those settings.

Again, this function simply automates what a human could do, if they wanted to. Most process engineers far prefer to be on the shop floor studying problems and implementing fixes rather than sitting in a cubicle querying databases and searching for trends. The link between AOI and SPI databases makes the trends obvious, eliminating the need for custom queries and encouraging process owners to take data-driven action on their SPI control limits.

It was only about a year ago that leading SPI and stencil printer manufacturers introduced the first closed-loop communications between their machines. Since then, the concept of using existing data to automate feedback control loops has blossomed into a suite of available features that provide extremely practical use with very little engineering intervention.

Not all SPI machines incorporate these new features or communicate with all the other available SMT printers or placers. Printer feedback control is currently the most common tie-in, with the greatest availability across the array of SPI-printer combinations. Placement feed forward

control is relatively new, but expected to grow quickly. Database integration is the newest software feature, and is only available from a few manufacturers that design both SPI and AOI equipment. As the popularity of these features grows, expect the introduction of even more clever new apps that work with more machines. If the growth rate of the past year continues, a myriad of new uses should be readily available soon. Hopefully one of the new apps will be the SPI machine's ability to provide PBC scaling factors for the stencil manufacturer.

Perhaps the most attractive characteristic of these new tools is that they use data that already exist. Applying them doesn't add cycle time, or require performance tradeoffs or costly hardware retrofits. They use what's already there to automate engineering tasks that otherwise might not get done. Will these tools replace process engineers? No way. To the contrary, they enable higher-level analysis, and will make better engineers out of all of us.

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She wrote this article on behalf of CGI Americas (cgi-americas.com).

Ed.: This is the latest in a series of articles by Shea on SPI.
Others include: "What Used to be Old is New Again?" February 2012.
"Why Does SPI Have Such Huge Tolerances?" October 2011.
"Man vs. Machine," September 2011.
"Using Automated SPI to Qualify SMT Stencil Suppliers," June 2011.