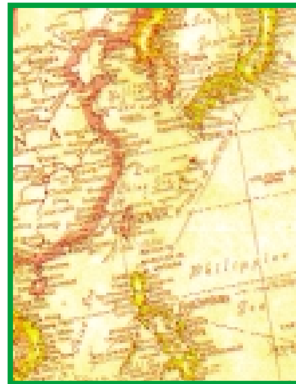
Asia Pacific: The New Launching Pad for Surface-Mount Technologies

By Mukul Luthra

Asia Pacific is fast becoming the hot bed for new surface-mount technologies. The region has become the foremost manufacturing arena with possibly 80% of the world's installed capacity for electronics assembly. This region is also where most of the new investment in surface-mount assembly lines is taking place. Driving factors impacting technology acceptance here stem largely from the shortening of product life cycles and manufacturing cost reductions. Manufacturing efficiency is paramount, and time to market is the key parameter in determining product success in a highly competitive field. This environment has caused the up-front role played by the Asian assembler to change, becoming far more dominant than ever before. This environment is also impacting both product design and the requirements imposed on supporting assembly technology and equipment and the manner and timeliness of assembly technology's introduction to Asian markets.

Past Perceptions

Five years ago, seeing end products designed offshore at a parent company's headquarters and then transferred for assembly, with the Asian assembly company's role perceived as a "sweat shop," was common. The product designer and equipment supplier worked somewhat removed from their manufacturing counterpart. In turn, the assembler's needs in the specific operating environment remained understated and neglected.



As time-to-market pressures mounted, immature product transfers resulted. Ironically, these transfers led to a situation in which refining and troubleshooting product issues had to be done during assembly, adversely affecting manufacturing efficiency and time to market. To counteract an intolerable situation, the closing of the gap between product design, assembly technology and the manufacturing site's needs was inevitable.

Today's View

Over the last few years, the "sweat shop" image has changed dramatically because of many complex, interrelated factors. Labor has become expensive in many regions. An interregional movement is afoot involving transfer of low-value-added products to lower operating cost regions. Increasing reliance on automation exists. The assembler has become more demanding and is actively involved in determining product design for cost-effective volume manufacturability. With increased product complexity, the assembler has become selective in the choice of equipment and autonomous in its qualification. When these factors are combined with the growing demand for high-density, high-performance products used not just for export but within fast-expanding Asian markets, the fact that equipment, service and material suppliers are targeting Asia as a prime market for new launches is not surprising.

Perceptions about Asia are changing, as indicated by suppliers' increased presence at Asian trade shows and the numerous supplier-sponsored conferences and seminars in the region. The changing view of Asia can also be seen through the early introduction and availability of new technologies, innovations and sophisticated pieces of equipment geared toward the Asian manufacturing environment. Support infrastructure has been strengthened as many companies set up regional operations in Asia to gain direct access to local markets and customer sites. I will examine some of the interesting developments as they arrive, starting this month with the newer solder deposition innovations recently introduced in Asia.

Solder Deposition Innovation

Those in the day-to-day task of churning out tens of thousands of surface-mount assemblies recognize why solder paste printing assumes such importance in any surface-mount process. Printing defects show up at a higher value-added downstream stages of product assembly. The resulting pileup of inventory exemplifies the extreme sensitivity of the entire process to solder printing-related defects. Unless rapidly addressed, this buildup can be the nemesis of the manufacturer. While equipment suppliers have been improving their solder paste printer operating windows in conjunction with material suppliers, the mainstay of these improvements has hovered around squeezing more price-performance quality out of existing methods.

Among the noteworthy innovations in solder deposition to arrive in the Asian market are the latest offerings by DEK (Flemington, NJ) and MPM (Franklin, MA). Both companies' approaches offer a fresh look at the manner of solder deposition on substrates.

DEK's ProFlow™ DirEKt Imaging System was launched in early September at a live teleconference that covered the product's

release simultaneously in the U.K., Germany and Singapore (representing the Far East); the U.S. followed within a few hours. Excited at the invitation, I attended the DEK launch in Singapore. The fact that DEK's U.K. team answered my questions live during the teleconference illustrates the importance accorded by DEK to the Asian region.

To learn more about MPM's Metal Jet Technology™, I visited Bob Stevens, vice president of MPM-Singapore, and Roland Tew, general manager of MPM-Singapore, and was provided with a paper on the subject. Stevens and Tew informed me that their Metal Jet was beta-sited at a PCB assembly facility in Korea.

While the information I present here is available to the user and is in the public domain, its initial availability has been the privy of selected audiences. My findings are for the wider dissemination among readers of *Circuits Assembly Asia*.

The standard approach to solder paste printing relies on solder paste "packing" forces derived from squeegee pressure, orientation and translation over the stencil as show in Figure 1. The resultant force on the solder paste material is nonvertical and skewed in the direction of squeegee travel. Complete filling of the stencil aperture relies on paste flow dynamics. In this scenario, maximum squeegee speed is limited by paste rheology. The noncomplementary nature of high print speed and high squeegee pressure, as required for fine-pitch printing definition and paste volume control to required standards, limits the process window. Wear from high squeegee pressure, frequent stencil underwiping of paste bleeding due to inadequate stencil to substrate gasketing, paste wastage, air exposure and operator contact are known drawbacks. Paste removal, replenishment and paste residues further add an unpleasant and messy dimension to the process.

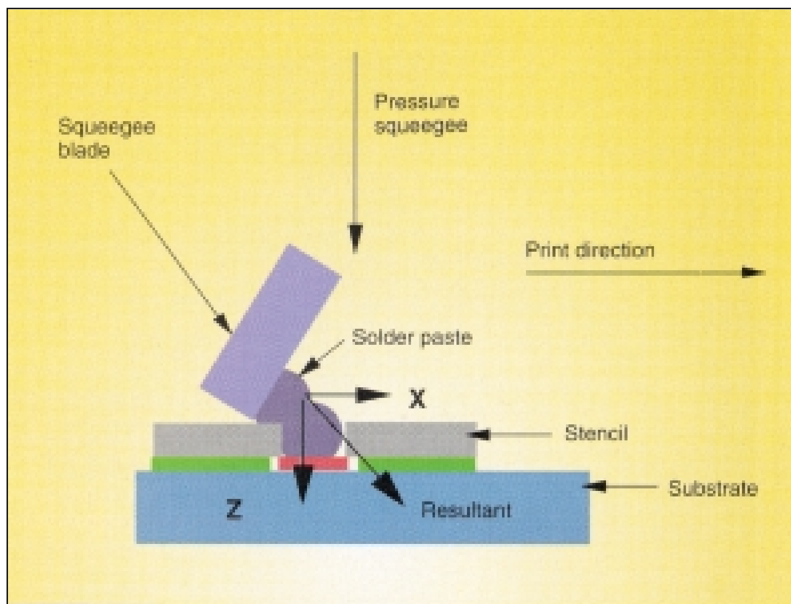


FIGURE 1: Standard approach to solder paste printing.

Transfer Head Approach

DEK's approach replaces conventional squeegees with a "transfer head," within which solder paste is pressurized via a system-controlled, pneumatically actuated piston (Figure 2). This approach decouples the pressure on the solder paste, making it independent on the downward force applied by the transfer head. Solder paste pressure, termed "transfer pressure," can be made significantly higher than in a conventional squeegee-based system, while only a small force needs to be applied to the head-stencil interface to ensure paste containment. Printing is bidirectional; since the paste "rolls" within the retention system, hop-over is eliminated. What happens if the transfer head is lifted? DEK claims that the paste will be retained and will not drop out. The answer lies in the paste's high viscosity and the perforated plate separator within the retention system.

The system works in conjunction with a DEK specific solder paste sealed cassette, DISC (DirEKt Imaging System Cassette, Figure 3), co-developed with and supplied by Multicore Solders (Richardson, TX). The compliant paste holding "bubble" allows kneading, if required, of its contents while it is still sealed, excluding direct paste-human exposure. At press time, DISC availability is only from Multicore and DEK, though the two companies expect that, with wide-scale acceptance, the cassette will become an industry standard. DISCs are not refillable but are "green" to an extent because they are made of recyclable materials.

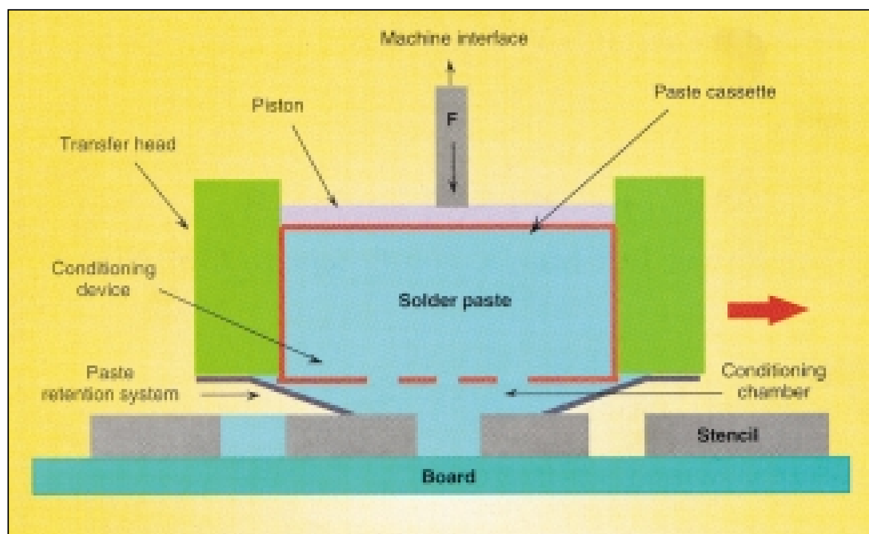


FIGURE 2: ProFlow™ system sectional view.

The overall combination of cassette, transfer head and paste retention system claims several advantages: minimal paste-to-air and paste-to-human exposure; avoidance of paste residues; and clean operation with negligible paste wastage and ecological friendliness. When you run out of paste, just put in a new DISC!

From an engineering standpoint, DEK's system appears to answer the industry's need for concurrent engineering—the transfer head is retrofitable to several of DEK's existing printers and the use of standard stencils and materials is retained.

FIGURE 3: DirEKt Imaging System Cassette.

In terms of performance, ProFlow™ claims ultrafine-pitch printing at speeds up to 150 mm or more per second at 0.3 mm pitch, while reducing stencil underwiping by a factor of four to five.

Drop-On-Demand

In contrast to DEK's new technology, MPM's Metal Jet™ approaches solder deposition from quite another viewpoint. MPM's technology uses a more direct approach to apply molten solder to a wafer, die or other substrate. "Drop-on-Demand" (DOD) was launched worldwide in August and has been introduced selectively in Korea and Singapore. Further seminars are planned for the end of 1997 in Malaysia, the Philippines and Shenzhen, China.

Figure 4 illustrates DOD operation. The system releases a molten solder droplet from an orifice 1 mm directly above the target substrate. Solder drop separation is via a low frequency, high-energy mechanical pulse generated from an annular piezo electric transducer surrounding a capillary above the orifice. The pulse disturbs the meniscus, and the drop is gravity fed; the drop's trajectory is supposedly unaffected by external forces due to the close proximity of the release point. The drop dispensing region remains bathed in nitrogen to prevent oxidation and assist droplet formation. Target positioning is executed by moving the substrate around on an XY platform. In terms of performance, solder ball sizes in DOD range from 2.5 mil to 4 mil and rate from 1 to 500 balls per second with positioning accuracy in a ±10-micron range. DOD applications are the emerging areas of flip chip and direct chip attach (DCA) site preparation, requiring miniature solder ball attachment to wafers or dies.

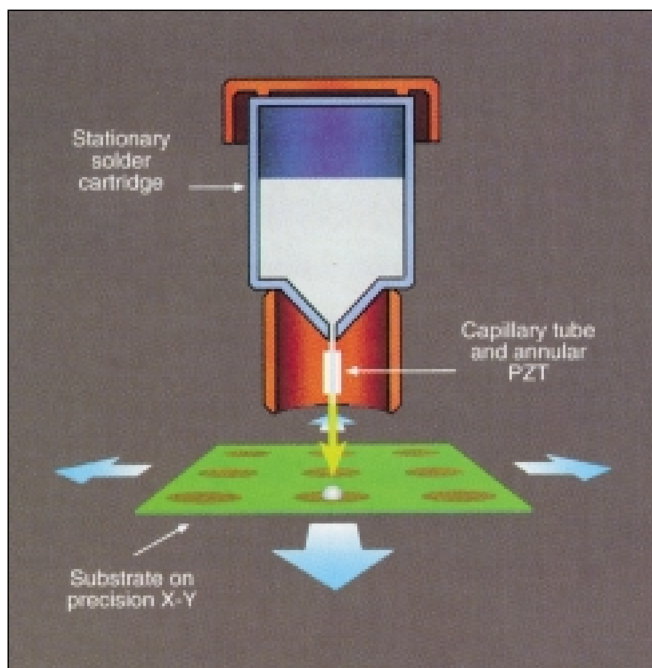


FIGURE 4: "Drop-on-Demand" operation.

Some of the most exciting and innovative developments in solder deposition to come our way in a long time are now occurring. DEK's ProFlow™ addresses the areas of fine pitch, high-speed printing requirements of PCB assembly processes using packaged parts, while MPM's DOD addresses miniaturization in assembly markets and the related needs of semiconductor chip makers in the area of packaging. Obviously, these processes will compete against other technologies in their respective segments. Whether these innovations will be ultimately successful in Asia remains to be seen because a "sure bet" does not exist in this industry. Wide-scale industry adoption of the two products will provide the most essential credential for demonstrating success.

References:

1. DEK's DirEKt Imaging System ProFlow™ Launch kit.
2. Godin, Richard. "A New Method of Producing Solder Spheres for CSP and Wafer Bumping Utilizing Metal Jet Technology," MPM Corp., Franklin, MA.

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