COVER ARTICLE

表面贴装的预置技术在最近十年快速进步。现在，组装人员发现数量小、混合度高的组装也要求低风险和低资本金；这一向是由半自动机器提供的。同时，在初级设备和具有多种生产力选项的高度自动化机器之间出现断层。初级网板印刷机的主要买主是产量低到产量中等的制造商，他们一直以来都接受这些设备的性能限制。但是，有些设备制造商已重新调整了产品范围，以便向半自动市场提供新的灵活性。成功实现这一重新调整的关键在于模组化。

The New Need in Screen Printing

Craig Brown

Achieving flexibility in entry-level pre-placement.

The technology supporting pre-placement for surface-mount assembly has advanced rapidly over the last decade. This advancement has been driven by Western manufacturers to raise their levels of automation and improve cost-effectiveness in response to the rapid migration of assembly business to low-labor-cost regions in China and other Asian nations. As high-volume contracts continue to migrate inexorably eastward, assemblers are finding that the remaining low-volume, high-mix business, as well as original design work, demands the low risk and low capital outlay that semiautomatic machines have traditionally offered.

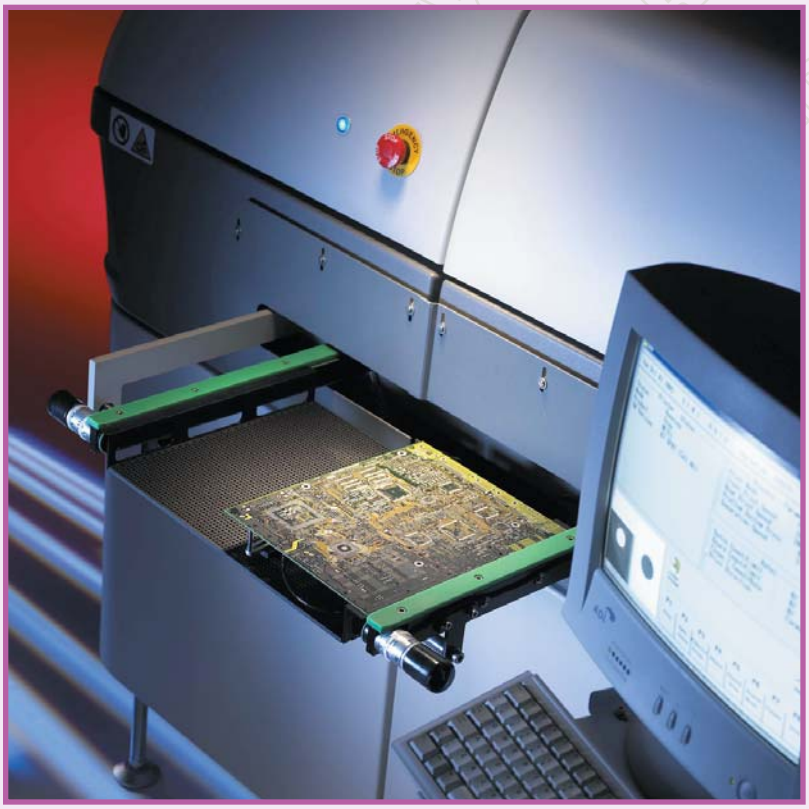

FIGURE 1: The ability to implement pass-through capability on an entry-level screen printer allows automation to be increased in response to business growth without investing in additional equipment.

At the same time, a chasm has opened up between entry-level equipment—characterized by semiautomatic machines equipped with basic vision inspection and demanding a relatively high level of operator intervention—and highly automated machines bristling with productivity options such as enclosed print heads, networking software, on-board diagnostics, post-print inspection and more. Historically, low- to mid-volume manufacturers, the primary buyers of entry-level screen printers, have accepted some of the performance restrictions that sometimes limit the range of business demands such equipment could satisfy.

When production requirements outstrip equipment capabilities, however, demands for inspection capability, greater productivity, faster throughput or tighter process control can force these manufacturers to face a performance barrier, one that requires them to contemplate investing in higher-performing equipment. Although the first machine may be reassigned, traded in or sold, many owners wish they could simply upgrade their original machine incrementally, in response to business growth.

This problem is particularly acute for companies seeking to make the transition from stand-alone screen printing to in-line pre-placement.

Even prototyping specialists or in-house design and development departments can expect a need to extend the performance of a simple, semiautomatic machine, if only to enhance process control or print larger boards.

Equipment suppliers who recognize the needs of this sector—populated by small original equipment manufacturers (OEMs) and contract assemblers, design and prototyping specialists, and the product development departments of original design manufacturers (ODMs) and mid-size electronics manufacturing services (EMS) businesses—have realigned their product ranges to deliver new flexibility for the semiautomatic market. The key to accomplishing this realignment successfully has been modularity.

If a vendor's mid-range and high-end solutions are designed to provide modular solutions across a series of machine platforms, this same concept can be used to meet the low- to mid-volume manufacturer's need for entry-level pricing. At the same time, modular equipment can extend individual machine capabilities as needed, allowing the equipment to evolve in response to changing business requirements.

The result can ease the performance restrictions somtimes imposed by the economics of the semiautomatic market, while creating an extendable and configurable platform on which the owner can base a long-term business strategy. Manufacturers seeking such flexibility need to evaluate the ability of entry-level pre-placement equipment to accept upgrades for pass-through capability, automatic vision alignment, productivity tools and networking software.

Breaching the Barrier to Pass-Through

When chassis features and mechanical subsystems can be transferred from higher-end machine platforms to the entry level, several key objectives are accomplished. With a strong, rigid chassis that incorporates high-end motion control systems, accuracy and repeatability are enhanced. In addition, owners can upgrade this type of machine relatively easily.

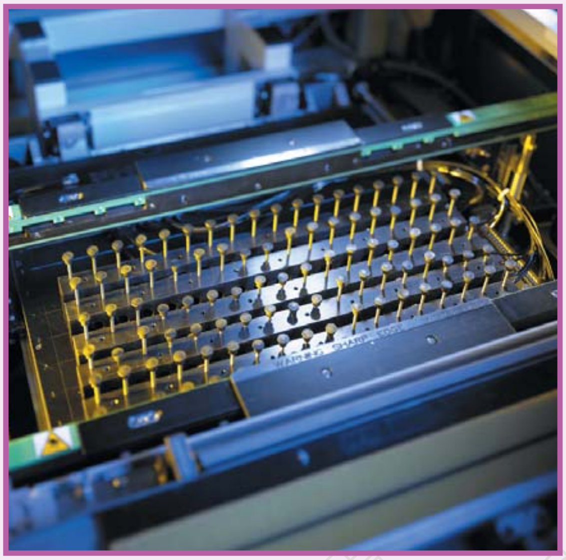

FIGURE 2: When a semiautomatic screen printer has a standard-size tooling bed, manufacturers can use a range of configurable tooling options and reuse existing tooling.

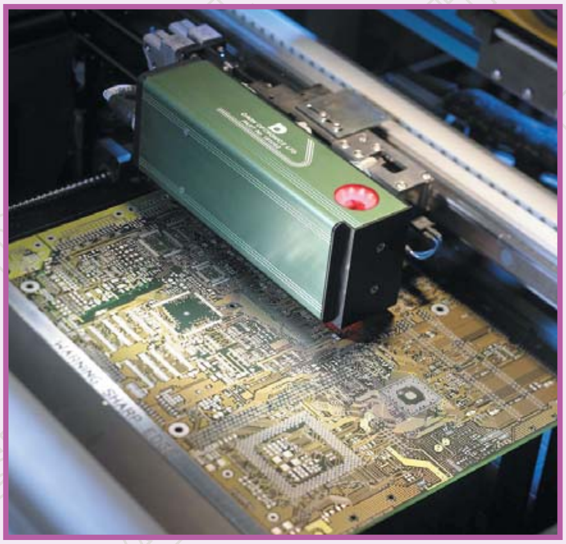

FIGURE 3: The option of a roving camera gantry on a semiautomatic screen printer allows two-dimensional inspection and real-time monitoring of print performance.

An important upgrade option is the ability to implement pass-through capability (Figure 1). This capability allows owners to achieve a greater return on their initial capital investment. They can save the expense of buying a new machine as business growth leads them to seek cost-effective ways to meet higher production demands by raising the level of automation.

When mechanical commonality exists with high-end equipment, owners will also benefit from a standard size tooling bed, enabling them to choose from a range of configurable tooling options. Some may be quick to set up, while others may deliver more paste volume consistency in return for a longer setup time (Figure 2). Owners who may already operate pre-placement equipment in another division of their business can also reuse their existing investment in tooling, including magnetic tooling pins, various arrays or custom tooling.

Another advantage would be a machine's ability to accept stencils up to 29 x 29 in. Owners can then reuse existing stencils where available, but, more importantly, those size limitations are removed that prevent users from processing certain boards, especially the larger-than-average panels frequently found in telecom, networking and industrial applications. Nearly any board that can be processed on a high-speed line can now be accepted by this type of semiautomatic platform. If an adjustable stencil mount is also available, this facilitates changeovers between boards requiring different stencil sizes.

Fully Automatic Vision Alignment

Typically, machine vision capabilities at the semiautomatic level have been provided to support rapid alignment of the board and stencil. If a roving camera gantry is an option, fully automatic vision alignment may be possible, which helps to make product changeovers easier (Figure 3).

A roving camera gantry also makes two-dimensional inspection possible, enabling real-time monitoring of print performance and leading to a higher level of confidence in the pre-

placement process. When all parameters, settings and limit levels are fully programmable, the system may be instructed to invoke a stencil cleaning cycle automatically if predefined limits are breached, as well as issue an alarm to warn the operator that process limits have been exceeded. Semiautomatic owners may, then, be able to close the loop and achieve "process in control" nearly all the time.

If this semiautomatic system includes software-controlled programmable lighting and telecentric lenses, the lighting system helps to ensure that features including fiducials and pads are clearly recognizable, even when inspecting low-cost, hot air solder leveled (HASL) boards. These can easily confuse machine vision systems since surface contours and reflectivity characteristics can vary widely over the surface of a single board. The enhanced lighting of two-dimensional inspection, combined with advanced pattern recognition algorithms, also enhances fiducial recognition for faster alignment.

Productivity Options

The platform concept can also make high-end productivity tools available as special options. Mechanical and electrical interfaces mean each of these options is a self-contained module that can be fitted—or retrofitted at a later stage—to a compatible platform, regardless of the base configuration of the machine.

For instance, a standard machine may be fitted with a motorized squeegee drive compatible with bonded polyurethane, clamped metal or diamond squeegees. An optional addition is an automatic paste dispenser, which allows the paste volume on the stencil surface to be controlled automatically, maintaining a constant head of paste while minimizing waste due to deterioration from drying or contamination.

Another option may be to upgrade to an enclosed print head. The benefits of such a system—enhanced paste volume repeatability, reductions in wasted paste and reduced cycle time—have been discussed often but have been available previously only on higher-level equipment.

Software

As screen printing has made the transition from arcane art to precision technology, software tools have played an increasing role in assisting this progress. Owners of high-end machines are already familiar with applications such as off-line editing (OLE), remote event monitoring (REM) and statistical process control (SPC).

OLE allows programmers to originate, compile, edit and maintain programs in several languages from a remote desktop personal computer (PC), leading to savings in planned downtime. REM collects machine utilization data, then analyzes and fine-tunes process parameters away from the machine. It also makes SEMI-E10 data from the machine's event log accessible at a remote desktop PC via a network connection, if available. SPC can be run as a standalone application alongside the printer control system.

Certain Microsoft® Windows operating systems can now make each of these tools available as needed to users of semiautomatic equipment. The media interfaces and APIs required to support them are all native to Windows or readily available as existing, vendor-supplied macros. Just as in the mechanical and electrical domains, careful attention to software interfaces allows compatibility with these productivity software options.

The advanced networking features native to Windows can help easily connect a semiautomatic machine to an existing factory-wide network such as a corporate 10/100 Mbps Ethernet. Programs generated and stored on a remote, networked desktop can be loaded directly onto the machine when needed, without requiring the user or programmer to visit the machine and transfer the program manually using a floppy disk or other removable storage. Connecting to the corporate Ethernet also allows operators to make best use of the REM package to analyze and optimize machine utilization.

If network interface cards (NICs) are not standard, they are often readily available and easy to fit on the machine. Furthermore, since some Windows systems support Web protocols including TCP/IP, machine data can be accessed across a WAN or VPN via a remote browser. This access is extremely valuable if the machine has been upgraded to pass-through operation and opens opportunities for remote control or "lights-out" operation.

The ideal system would also have a diagnostic module that enables calibration and aids fault diagnosis by allowing individual access and control of modules and access to the machine inputs/outputs (I/Os). The user can then control the sequence of the machine to exercise major components—the camera, rail system, paste dispense or print head system—as well as cleaning, alignment or print carriage modules. The user can also access system-level modules to change passwords, cycle the tricolor beacon and access digital or analog I/Os.

Conclusion

As a result of the product range realignment that has occurred in pre-placement equipment, semiautomatic machines can now include features previously available only to owners of more expensive equipment. In effect, if budget restrictions or production levels dictate the purchase of an entry-level machine, that decision no longer implies a limited future potential for the equipment. An entry-level machine that can be configured with specific upgrades when and as they are needed ensures long-term flexibility. This roadmap is a more cost-effective one for many users, who can now extract a longer useful life and greater returns from their entry-level investment. Risk is reduced, overhead is streamlined and business planning and cost projections are assisted. ■

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