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SEPTEMBER 2014

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Automation's Influence on Assembly Quality p.34

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A ROBOT'S PLACE IN SMT

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SMT

September 2014 Featured Content

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What is the true impact of automation on PCB assembly, from quality concerns to cost savings? What is the role of robots? These questions and more are examined this month by feature contributors from Yamaha Motor IM America, Mentor Graphics, Zentech, and more.

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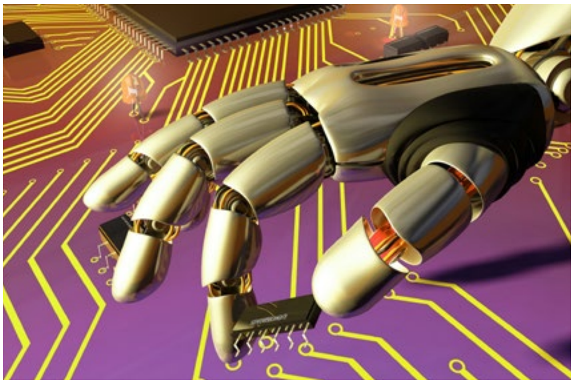

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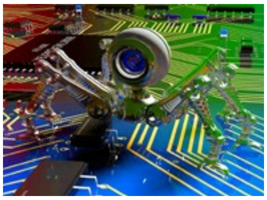

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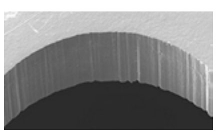

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THE SHAUGHNESSY REPORT

Goodbye, Dieter

by Andy Shaughnessy
I-CONNECT007

A lot of people love their jobs; I do, and I bet you feel the same way. But Dieter Bergman was different. He devoted most of his adult life to IPC, and to PCB design. His heart belonged to Bannockburn.

Many of you knew Dieter, or knew of him and his history, so I don't need to rehash his biography. He was in on the ground floor of the modern PCB and EDA industries, and he helped shape IPC into what it is today. All of this made him a rock star among PCB designers. Designers always wanted a piece of Dieter, and he did his best to accommodate them.

I didn't know Dieter that well, but I always enjoyed talking to him, and, more importantly, listening to him. It was a good idea to pay attention when Dieter was speaking; you could learn quite a bit from his stories. And what a storyteller he was.

And he told some of the funniest jokes, both clean and dirty, that I've ever heard. He was a child when his family moved from Europe to

Dieter Bergman with Bob Neves at the 2011 IPC Midwest Show.

GOODBYE, DIETER *continues*

Philadelphia in the 1930s, and his first words of English were curse words. He loved to tell the story about a store owner who paid him to stop cussing in front of her store. The more he swore, the more money he made.

I first met Dieter at a trade show when I started covering the industry in the 1990s. I mentioned that I was still learning about the technology. He laughed and said, "So am I!" He was so down-to-earth about himself, and barely impressed with his dozens of awards and industry accolades. I think he found the "living legend" badge mildly amusing.

No, Dieter was usually much more interested in talking about an upcoming DFM presentation. He enjoyed working with PCB designers, identifying their challenges, and helping them stay ahead of the game. That's what really animated him.

I last interviewed Dieter a few years ago on the last day of IPC APEX EXPO. We were supposed to talk after his Design Forum keynote speech on the morning of the first day of the show. Unfortunately for me, he was surrounded by designers after his presentation and entertained questions until he was late for his next meeting, so he took off at a trot.

I finally found Dieter on the last day of the show, rolling his bag down the hall, trying to get to the airport. I tried to catch up to him, walking, then power-walking, but to no avail. He may have been 30 years older than me, but Dieter was pulling ahead! After a week at a trade show, I was exhausted, but Dieter seemed energized. He was walking faster and faster, as if he had eyes in the back of his head, and he really didn't want to be interviewed. I finally ran and caught him, and then, of course, he did a great interview.

It's hard to believe Dieter's gone now, because he seemed to defy the laws of aging. He shook your hand like he was 50 years younger. He was always quick-witted, always on the ball, and very sharp, even after a week at a trade show.

Dieter moved fast because he always had somewhere to go. One year, I saw Dieter at APEX, and a few weeks later I ran into him at a conference in Quebec. He was everywhere. Who wants to travel that much? He even joked about how he might keel over in an airport one day.

I see this a lot in the PCB community, especially in the design world. People just keep on working well after they reach 65. Some things just get into your blood and become part of your DNA.

The design world needs more people like Dieter, people who are willing to devote their lives to PCB design, and to IPC. We'll miss him. **SMT**

Andy Shaughnessy is managing editor of *The PCB Design Magazine.* He has been covering PCB design for 15 years. He can be reached by clicking here.

PARC: 3D Printing Electronic Components Within Objects

Typically, chips are made in bulk on semiconductor wafers and then cut into individual units and placed on motherboards inside computers and other devices. But researchers at PARC, in Palo Alto, California, envision doing something different with the wafers: chopping them up into hairs-width "chiplets," mixing them into an ink, and guiding the tiny pieces electrostatically to just the right spot and orientation on a substrate, from which a roller could pick them up and print them.

The technology could lead to novel kinds of computing devices, such as high-resolution imaging arrays made from tiny ultrasensitive detectors assembled by the million.

The technology marshals chiplets into place using software-controlled electrical fields generated by arrays of wires beneath an assembly substrate. For a printing system to handle different kinds of chiplets, PARC envisions differentiating them with unique charge-based bar codes or creating multiple printing steps, with one type of chiplet set down at each step.

SMT PROSPECTS & PERSPECTIVES

Tin Whiskers, Part 6: Preventive and Mitigating Measures—Strategy and Tactics

by Dr. Jennie S. Hwang
CEO, H-TECHNOLOGIES GROUP

"Strategy without tactics is the slowest route to victory. Tactics without strategy is the noise before defeat... If you know the enemy and know yourself, you need not fear the result of a hundred battles. If you know yourself but not the enemy, for every victory gained you will also suffer a defeat. If you know neither the enemy nor yourself, you will succumb in every battle."

—Sun Tzu, celebrated strategist and author of *The Art of War* (ca. 500 BC)

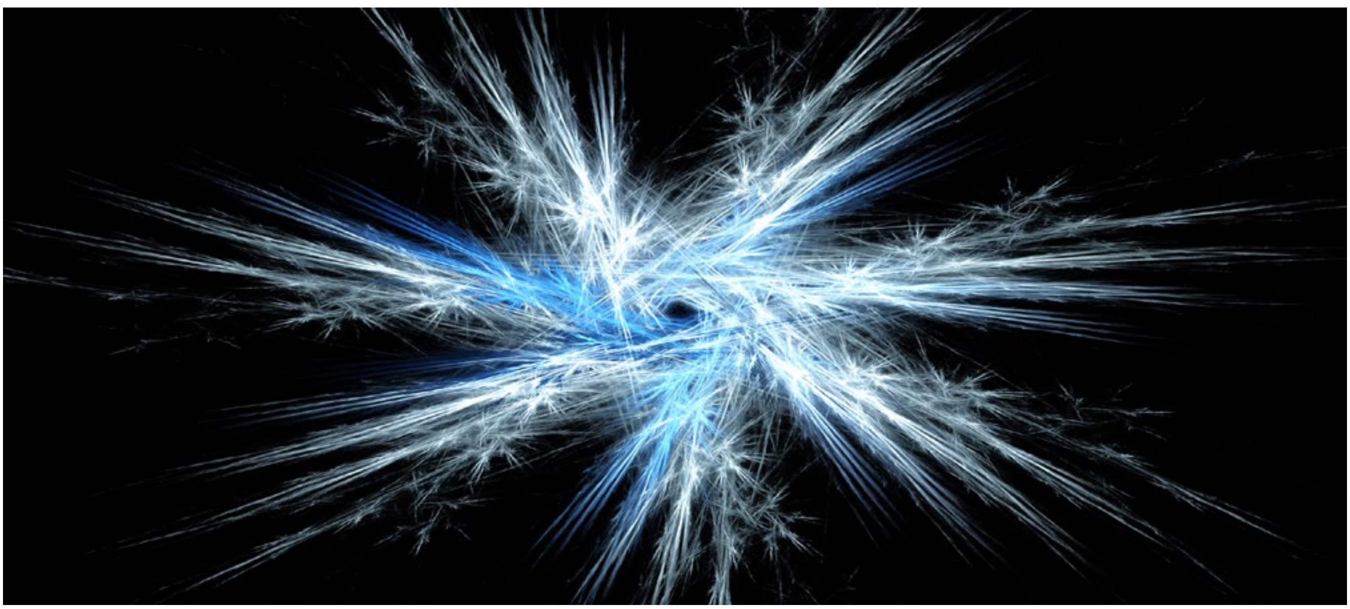
In this installment of the tin whisker series, we'll take a look at the preventive and mitigating measures— strategy and tactics. An effective strategy for prevention and mitigation starts with a good understanding of the causations of tin whiskers (the enemy). Part 4 of this series summarized the causes and contributing factors (March 2014).

The tin whisker phenomenon is a thermodynamically and kinetically controlled process. The process requires the formation of whiskers as well as their continued growth, which poses challenges to "taking the bull by the horns."

Nonetheless, the confluence of test data, field experience, and the fundamental material crystal growth theory can lead to a working path. Fifteen tactics are listed here. This smorgasbord of material and technique options serves as a guide to prevent or retard tin whiskers.

1. Minimize organic impurity content

The level of organic impurities introduced to the coating closely is dependent upon the plating chemistry and the plating process, including the type of electrolyte, additive/brighteners, current density, process temperature, and the process control. Thus, the source of the coating (i.e., the plating house) makes a difference. The rule of thumb is to keep the organic content in the metallic coating to a minimum—nominally below 0.05% by weight (as represented by the carbon content).



2. Control coating grain size

Tin plating process parameters control the lattice defects incorporated in the tin layer. The initial coating grain size is also determined by the coating process. For pure tin, the objective is to avoid the formation of ultra-fine grains, producing a grain size in the range of 1–10 mm.

3. Control coating thickness

To achieve the proper stress management ability, the thickness of the tin coating plays an important role, which is associated with the plating process. The tricky thickness to be desired falls either thin, at around or below 2 mm, or thick (more than 8 mm).

4. Direct crystal (phase) structure of the coating layer

The crystal or phase structure also depends upon the coating process. Albeit with delicate control, the desired structure can be accomplished. Its practicality varies with the manufacturer. The target structure must be equivalent to an equi-axed structure, as exhibited in tin-lead coating.

> ***"The uncertainties associated with tin whisker growth make it difficult to predict if or when tin whiskers may appear, nonetheless, this list of tactics provides options and approaches for reducing the risk of tin whisker-induced failures."***

5. Modulate substrate surface topology

Physically maneuvering the surface roughness of the substrate on which the coating is to be deposited to a rougher state can improve the properties of the interface between the coating and the substrate, which in turn contributes to the reduction of the overall driving force of whiskering.

6. Use of underlying barrier for Cu substrate

An Ni layer with nominally 0.5 to 2 micron thickness is found to be effective in reducing (not eliminating) the whiskering propensity.

7. Minimize mechanical deformation

Avoid imposing external mechanical force on the coating surface.

8. Minimize heat excursion

Although the intermetallic compounds at the interface of the tin coating and substrate, or in the bulk of the tin coating, are not necessary for the occurrence of tin whiskers, intermetallic compounds may exert additional effects in grain structure and stress distributions. The presence of intermetallics in SnAgCu and the absence of such in SnPb account for most of the phenomenal and property differences between SnAgCu and SnPb, including tin whiskers.

9. Keep coating surface intact

Make sure that the exposed surface is free of contamination and corrosion. Also, avoid creating surface notches, scratches, and grooves.

10. Monitor metallic or non-metallic particulate inclusions

As metallic particles enter into the tin lattice (or tin matrix), they may or may not lead to the formation of intermetallic compounds or other phases, depending on the metallurgy of the elements involved. These particles can change or distort the lattice spacing in tin structure, potentially serving as nucleation sites.

11. Minimize CTE mismatch of the system

The relative coefficient of thermal expansion (CTE) between the tin plating and the lead material (e.g., alloy 42 vs. Cu) is a factor. But the whisker propensity is not necessarily proportionate to the degree of CTE mismatch.

12. Add additional stress-relief steps

This can be done by melting the coating through fusion or reflow process. A heat treatment, annealing at an elevated temperature (e.g., 150°C, for one hour) can also achieve the goal. The caveat is that this is not a permanent cure.

13. Choose a proper conformal coating

If needed, conformal coating can help. However, the material and thickness of the conformal coating need to withstand the environmental exposure without degradation and to resist the protruding force of whisker growth.

14. Consider dipping process

For low-volume production, an additional dipping process to convert pure tin coating into a less whisker-prone coating composition can work. Exercise prudence by not creating undue damage to the parts.

15. Change to a composition that is less prone to whisker

When using the alloying tactics in a lead-free environment, among the likely working elements including Bi, In, Ni, Pb, Sb and Zn, bismuth offers the most effectiveness. In terms of working alloys, I anticipate that the compositions of SnBi and SnZn alloys are most effective in mitigating tin whiskers and SnCu and SAC are most vulnerable to producing tin whiskers.

Among these 15 tactics, 1–4 are directly controlled by the plating process; 5 and 6 are directly related to the substrate base; and 7–9 are associated with the subsequent handling and the end-use environment. Ten and 11 are the result of system design including the material selection, and 12–14 are alternate steps that can be adopted. The alloy selection shown in 15 is the most fundamental approach.

It should be noted that the industry testing methods described in the published documents do not guarantee that whiskers will or will not grow under field life conditions. The uncertainties associated with tin whisker growth make it difficult to predict if or when tin whiskers may appear, nonetheless, this list of tactics provides options and approaches for reducing the risk of tin whisker-induced failures.

So, which tactic(s) should we adopt to best formulate an effective strategy?

By considering both practicality and the intrinsic effectiveness of the tactics, selecting the tactics to craft an effective strategy depends on three things:

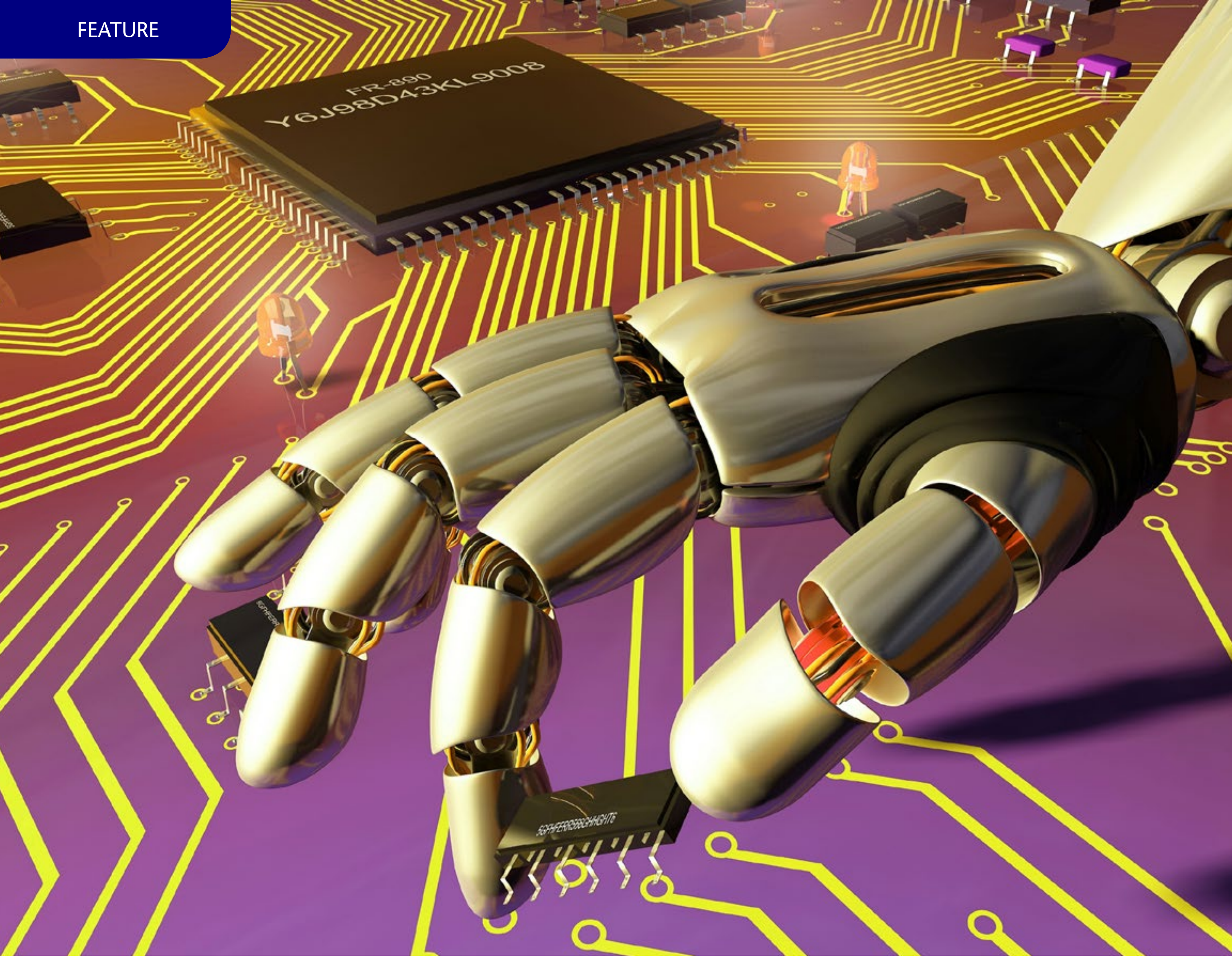
- The specific system
- The service environment
- The criticality of end-use applications

The bottom-line objective is to suppress the driving forces to a level that falls below what I call the "whisker threshold"; in other words, the objective is to reduce tin whisker propensity to an acceptable level for a given system. The Sun Tzu philosophy is right: "The supreme art of war is to subdue the enemy without fighting."

Appearances

Dr. Hwang will present a lecture on "Tin Whiskers – What is Important to Know" at the SMT International Conference and Exhibition on September 28 in Chicago. **SMT**

Dr. Hwang, a pioneer and longstanding contributor to SMT manufacturing since its inception, as well as to the lead-free development and implementation efforts, has helped improve production yield and solved challenging reliability issues. Among her many awards and honors, she is a member of the WIT International Hall of Fame, elected to the National Academy of Engineering, and named an R&D-Stars-to-Watch. Having held senior executive positions with Lockheed Martin Corp., Sherwin Williams Co., SCM Corp, and IEM Corp., she is currently CEO of H-Technologies Group, providing business, technology and manufacturing solutions. She has served on U.S. Commerce Department's Export Council, various national panels/committees, and the boards of Fortune 500 NYSE companies and university, as well as civic boards. She is the author of 400+ publications and several textbooks, and an international speaker and author on trade, business, education, and social issues. Her formal education includes four academic degrees (Ph.D., M.S., M.A., B.S.) as well as Harvard Business School Executive Program and Columbia University Corporate Governance Program. To read past columns, click here.



A Robot's Place in SMT

by Scott Zerkle
YAMAHA MOTOR IM AMERICA INC.

Issues in the SMT Process

The SMT industry's one constant is change. Standards are continually updated and components are miniaturized for space savings. In addition to the changes that come, the industry is also faced with continuing to deal with areas that fail to change and update. A typical PCB manufacturer lays out a line based on the need to put solder paste on a PCB, place parts in the paste, and then reflow the product (Figure 1). The board size, typical components placed, and the required speed for the line are then considered.

Eventually, a SMT manufacturing line is purchased that can handle a large majority of the process needs. In almost all cases, there will be a component that cannot be handled by the automated process currently in use on the factory floor. This problem is not caused by the engineer who specified the line, nor is it the chosen vendor's false advertising. This problem plagues virtually all PCB manufacturers because it is not cost-effective to purchase a specialty machine to handle a component that is expected to go away and not be used any more, or the component that is through-hole and was expected to be replaced by a SMT component soon.

Manufacturers are expected to build as demanded and very often that demand is outside

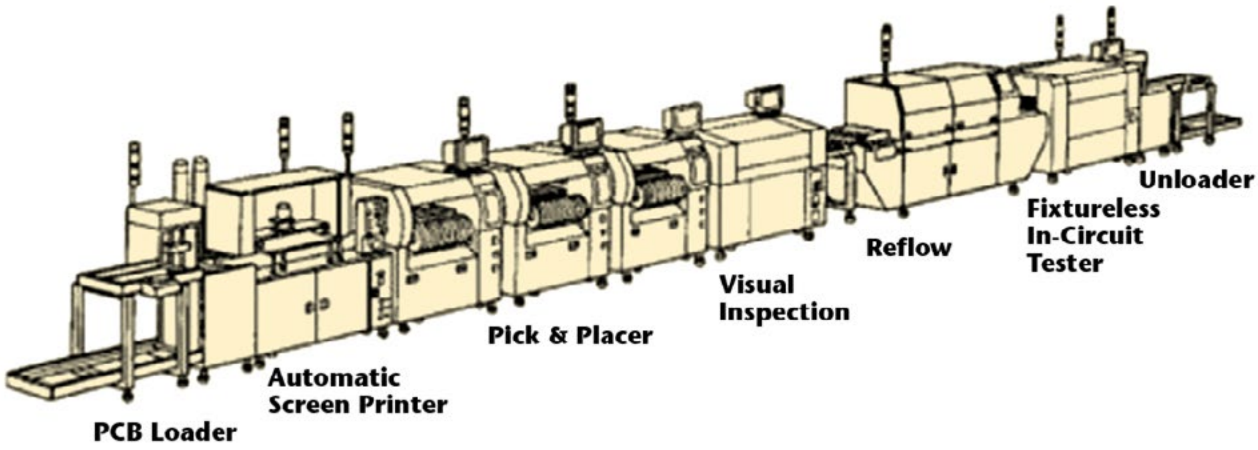


Figure 1: Typical SMT manufacturing line.

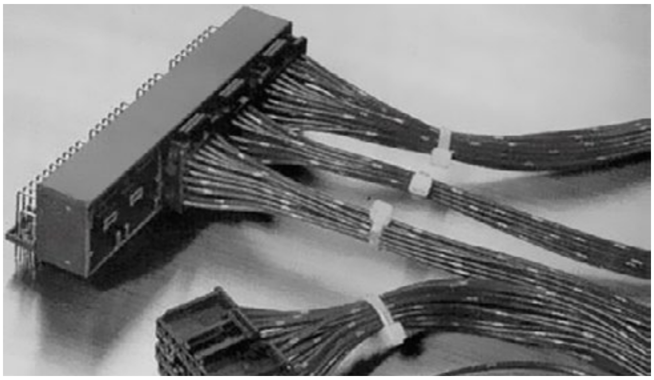


Figure 2: Large connectors are often outside spec for SMT machines.

Figure 3: Plated through-hole components.

of the specifications which they thought were adequate, but the quantity does not justify new special equipment. PCB manufacturers, for example, face the challenge of placing very large connectors, whose size is outside the specifications of SMT machines (Figure 2). Some manufacturers use through-hole components in products (Figure 3), though not enough need exists to justify purchasing a through-hole machine.

Infrequently used components may fail to justify standard packaging for use, and oddly shaped parts may simply be beyond the scope of what a standard SMT machine can handle. In addition to the difficulty in managing the changes in size and type of component for placement, manufacturers must also consider the cost-effectiveness of any solution they devise for managing these "out-of-spec" placement issues. Rarely do these issues justify the expense of purchasing a specialty machine. Rather, the manufacturer finds it more cost effective and more realistic to manage these processes with human resources. These manufacturing difficulties are not caused by poor engineering design, or by the chosen vendor's inattentiveness to customer needs. At the end of the day, manufacturers have come to accept that they will purchase a SMT line that is capable of handling a large percentage of their process needs, but those out-of-specification parts will always exist.

Current Solutions

Today's most common solution is the implementation of a manual operator station (Figure 4). At this station, a human places that large connector, odd-shaped part, or thru-hole component in the line. The expectation is that the human be as accurate, efficient and productive with this manual process as the rest of the automated line. However, we all know this is not possible. Human production is not as predictable as automated production, and humans get sick, take vacations and need rest breaks. Employee overhead is also an ongoing, ever-increasing cost. Though a robot would normally be a capital investment, the cost is over a 3–5 year range and becomes maintenance only. The cost of hiring is an ongoing expense that only increases year after year.

A second common option for managing manufacturing out-of-spec items is through outsourcing, though this comes with its own unique challenges. Specialty companies charge a premium for their services, yet the manufacturing company must give up control of the production quality when they make the decision to outsource a process they are accustomed to owning. In some cases, sending a unit to a specialty shop for partial assembly may be the only option, but the cost and knowing that the quality are not within your control make this a difficult decision.

If the customer of the final project has tight deadlines and outsourcing causes a delay, the company who outsourced is then in jeopardy of losing business. Much time and effort must be spent when looking for an outsourcing partner who can complete the out-of-spec work. The quality standards must be checked along with how timely they complete the work. When looking at the cost of outsourcing the price of paying for the work completed is only part of the total.

How Robots can Solve These Problems

Today's robots can solve these manufacturing issues, allowing for more productive and efficient lines. In addition, the robots themselves are more cost effective than the ongoing costs of human labor. The cost of a robot is normally a capital investment that is analyzed by management for return on investment (ROI). To do this, you must look at the overall cost of the operator, their production speed, and any quality deficiencies. The purchase of a robot is normally a 3–5 year payoff, after which the expense is reduced to maintenance and utilities. A robot that matches the cycle time of the manual

Figure 4: Manual operator station.

operation will most certainly surpass a human in efficiency over time. Robots are mechanical machines that are computer or PLC (programmable logic controller) controlled.

Calibration routines allow them to be tuned for accuracy and they are sold based on the repeatability. Properly maintained robots will run processes they are designed to perform for thousands of hours without any change in accuracy or cycle time changes. When a process requires vision, robots use camera systems that are far beyond the capabilities of the human eye and can ensure better accuracy and quality. The majority of SMT machines in the market today are designed to pick and place from tape, tray, and sticks. There are also parts without packaging that must be part of the line's process. Robots can handle these unique placements far more efficiently than an operator working on his own.

These components without packaging can be placed on a pallet. The robot then brings in the pallet and finds the parts that can be placed, using a camera system. The robot then picks and places all possible parts. Afterward, the operator can shuffle or rearrange any parts left and retry. This eliminates the costly attempts to design packaging and feeding mechanisms for these parts. Some parts are presented for placement with leads parallel to the PCB surface rather than perpendicular. This poses a problem for the standard SMT machine's capability. This problem is easily overcome using a robot with a swing nozzle. The swing nozzle can pick a component and then swing the leads up to ninety degrees to make them perpendicular with the PCB for placement. This eliminates the need for an operator at a hand placing station or expensive repackaging of the part. Stick feeding is common for SMT, but large or unique components in stick have often required expensive and one off designs.

Since robots have started to be used in the SMT process stick feeders that allow for the stick handling portion to be adjustable and only the actual component track to be customized have been developed. These stick feeders are less expensive and make it more possible for PCB manufactures to handle a larger range of stick components. SMT machines are built for speed and accuracy. With that in mind, the SMT machines typically have height restrictions as well as only moving in X, Y, R, and Z.

A robot, on the other hand, can have less height restrictions and more moving axis. With the added height those tall or overly large parts can now be placed. Additional axes allow robots to do more than pick and place. Robots can pick

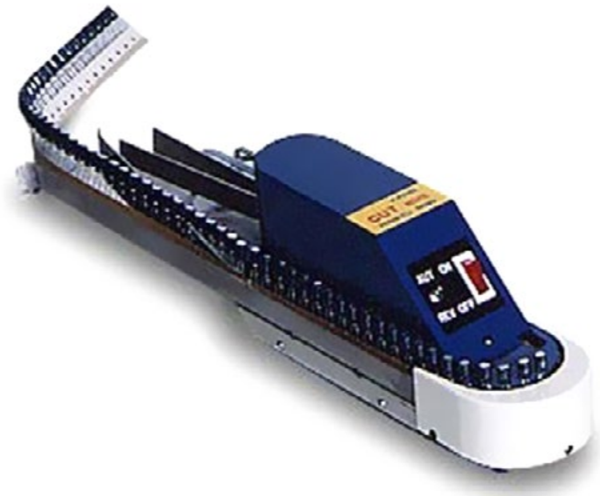


Figure 5: Radial cut feeder.

up screws from a feeder and torque the screw into position; they can assemble cases in final assembly areas. Another solution robots in SMT have brought about is finding lead tips of plated through-hole (PTH) parts, which typically give SMT machines difficulty with vision. New camera technology now can find the lead tips of

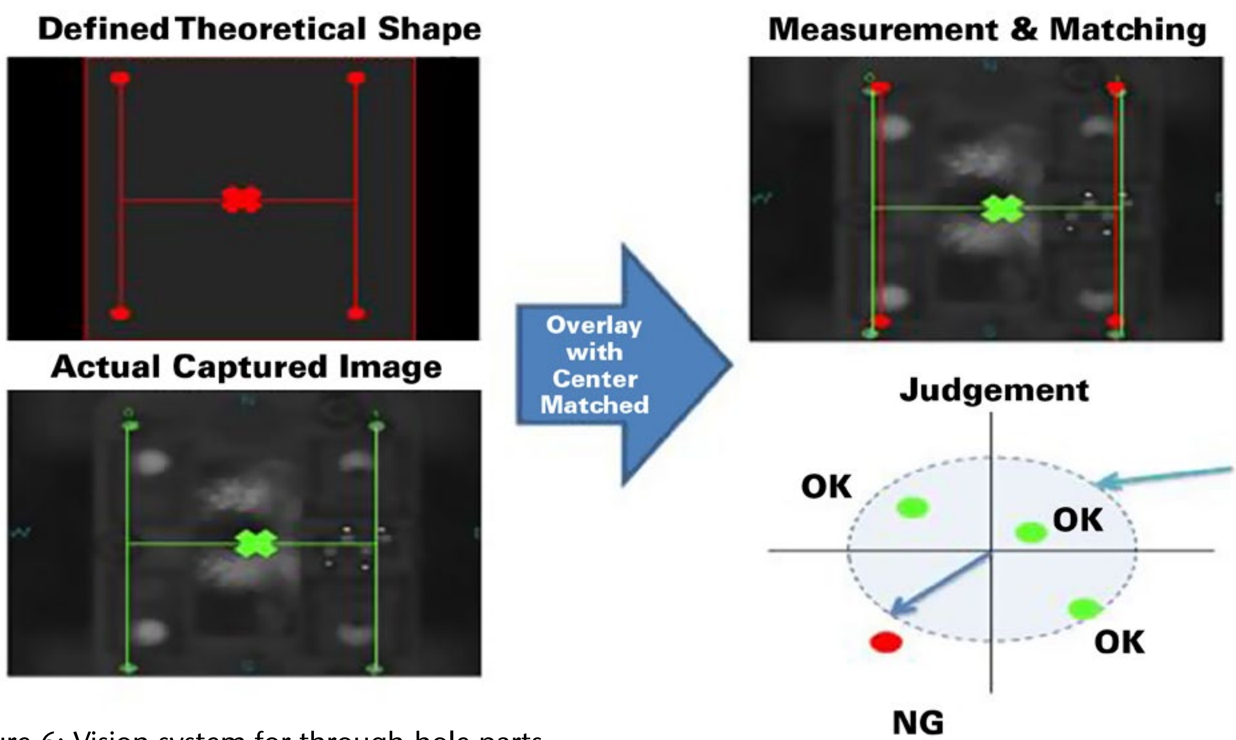


Figure 6: Vision system for through-hole parts.

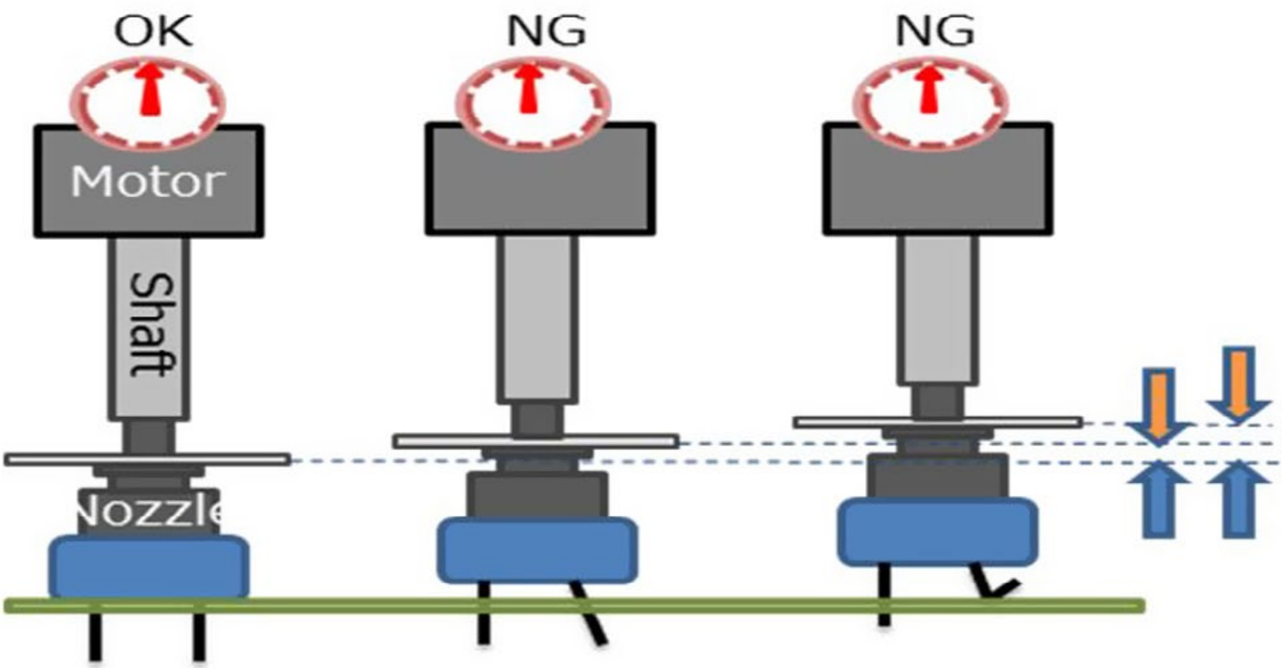


Figure 7: Ensuring proper insertion.

PTH parts significant distances from the component body, allowing insertion without damage to the leads.

Case Study 1

A customer had plated through-hole capacitors that required two persons at manual stations to trim, form, insert and clinch the leads. This process cost the company not only time on the line, but the expense of two operators who cannot do any other jobs. The equipment vendor was asked if they could provide a machine that was capable of completing the process. After an investigation period, the vendor responded with a quotation for a machine and feeder that could perform the process. The investigation required finding a feeding solution where through-hole components could be fed and trimmed for the robot to pick and place and then forming of the leads could occur (Figure 5). Creating a nozzle to pick the component from the feeder, and finally a method to clinch the leads on the underside of the board was the key to the vendor's solution. A small machine with a camera system to identify through-hole leads accurately and a feedback system indicating proper insertion matched with the feeding system were an ideal solution for this customer (Figures 6 and 7).

Case Study 2

A customer had a mass production requirement of placing many connectors on a board of the same size and shape but different colors (Figure 8). The customer was experiencing many problems with this process. Manual operator stations were being used and the quality was not to standard. The operators for this station did not stay long so newly employed persons were making mistakes and having to be trained. If the product was changed many accidents by the operator occurred with incorrect placement. The proposed solution was to replace the manual operator station with a flexible robot that could have many different component inputs, and high quantity supply. A stacking stick feeder that allowed for adjustment to varying sizes of sticks was provided (Figure 9). A robot that could accept multiple stick feeders and was flexible enough to handle many variations and could be quickly programmed with offline software was proposed to the customer. The result of this proposal was the customer saw pro-

Figure 8: Problem board and components.

ductivity increase, quality increase, and costs were contained to the cost of the robot and the feeders.

Case Study 3

A customer had a process where a very large metal jig needed to be attached to the PCB. Accurate placement of this jig was critical. Based on the size of this jig, the customer assumed that it needed to be manually processed by a human, and suffered slow production and poor quality results. A proposal for an accurate robot capable of handling this large size jig and communicating with the SMT line was submitted. The resulting solution was a robot being placed in the SMT line that accurately placed the large jig with a human only needing to supply the jigs to the robot in quantity. The customer saw that automation of this process was not only possible but resulted in higher productivity and higher quality for the product. A side benefit was later realized that the robot was also capable of placing SMT components and could help speed up other production needs.

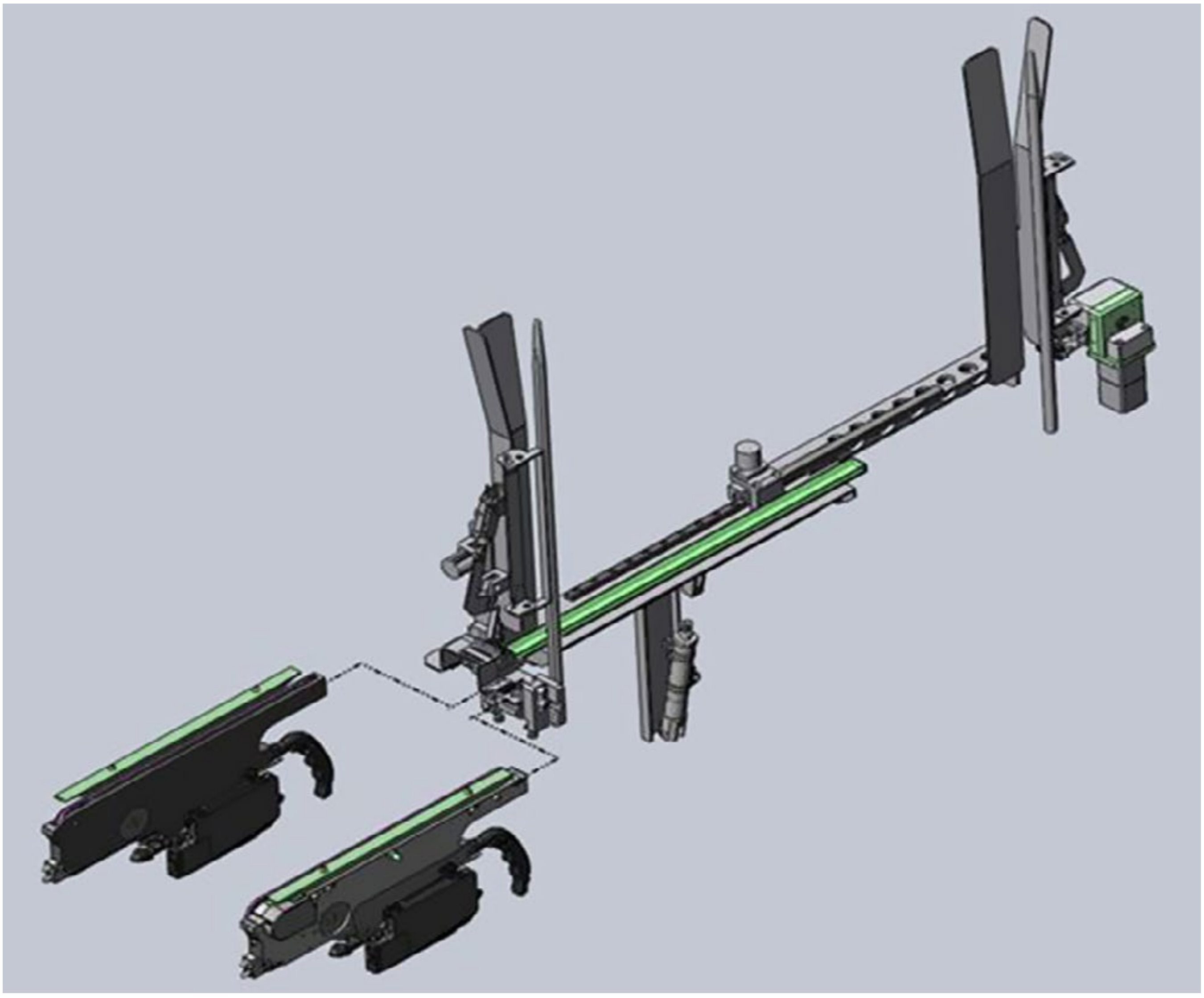


Figure 9: Adjustable stack tube feeder.

Conclusion

SMT machines are robots, but normally with a very specific set of specifications, allowing the machine to be fast enough for SMT production. These specifications keep SMT robots from being able to do the out-of-spec processes. The robots that have been discussed are robots that have very large component range, specialized software that allow them to be used for hybrid uses and many variable component inputs. Robots have shown the ability to increase production and increase quality of many processes; still human operators will be needed to supply the components to the robot. Robots have a place in SMT production and with increased capabilities being innovated; many companies can begin to see the reduction in overhead costs, the increased production, and the increase in quality. Robots have a correct place in SMT. SMT

Scott Zerkle is general manager of Yamaha Motor IM America. He has been in the surface mount industry for 20 years, in positions that include SMT equipment instructor, applications engineer, and engineering manager.

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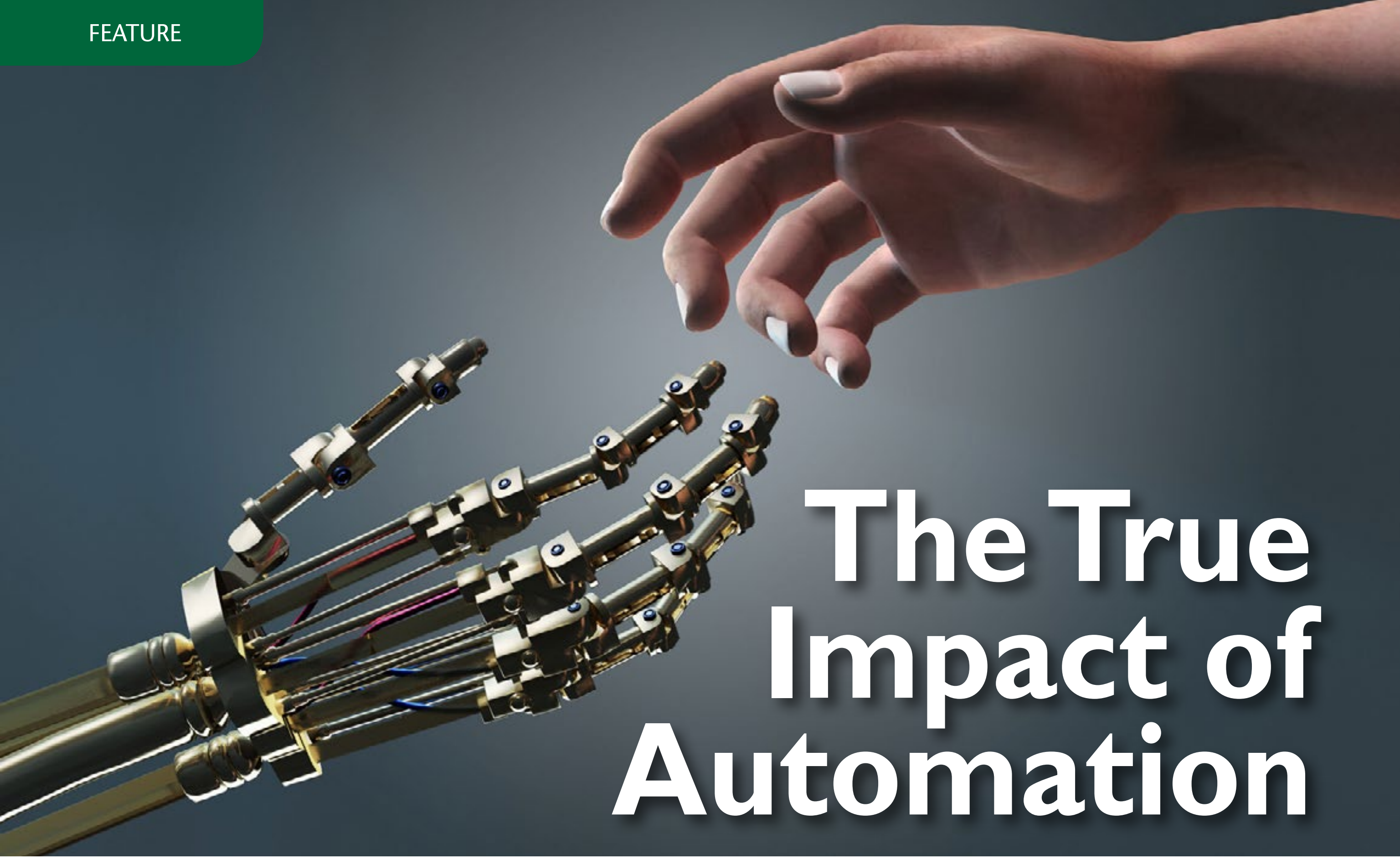

The True Impact of Automation

by Michael Ford
MENTOR GRAPHICS

Automation is a relative term. To many, manufacturing automation implies the reduction of cost and a guarantee of repeatability. SMT machines are in themselves automated processes, as opposed to the manual placement of materials, but the automation in the SMT process as a whole can be extended. The feedback from inspection of SMT placements can automate the adjustment of placement parameters to improve quality. Determination of operational parameters together with an intelligent maintenance regime is critical.

Extended automation, however, often leads to processes that are dedicated to specific tasks, and they need significant change to accommodate different products. This is not a welcome feature because the market continues to demand greater flexibility, and it has significantly limited the adoption of automation to date. A breakthrough opportunity may exist with the increase in effectiveness of software and electronics, where we are likely to see a rise in the use of more sophisticated robots, which are easier to program, easier to maintain, and are almost as flexible as current manual operations. Will this be the end of the manual operator, or is there more to the story?

When it comes to automation in PCB electronics manufacturing, a lot should have been learned already from the SMT processes. These are, after all, fully automated machines, following a programmed sequence of operations. In fact, three valuable lessons should have been picked up on by now—my three laws of automation.

Three Laws of Automation

The first lesson is related to optimization versus flexibility. From the earliest days of SMT, the race was on to make machines that can place smaller parts faster, and more reliably. The performance of SMT machines has been measured in terms of, for example, the cost per SMT placement or the number of SMT placements per square metre of floor-space per month. The theoretical placement rates of SMT machines are almost impossible to realise, however, because constraints imposed by the PCB size and design layout, together with the number of different materials needed at each machine, mean that, for much of the time, the machines are

performing movements beyond their minimum cycle time.

Optimisation software for the reduction of excess machine travel works on material positioning and placement sequence order so that the maximum throughput of the machine for a specific product can be achieved. Although this may be relatively simple when considering one machine program for one product, the reality is that with the increase in the mix of products produced by SMT, the saving of time through program optimisation is almost insignificant compared to the time taken to change the machine between products, even if the product is changed only once per day. Most of this changeover time is for the teardown of old materials for the previous product, followed by the setup and verification of the new material for the next product.

When considering overall SMT productivity, the shift to creating material setups where locations were common across sequentially running products reduced the changeover time dramatically. However, the compromise was a reduction in machine performance for each product because materials could no longer be located at optimum positions. The lesson learned is a simple one. Optimization of processes extends beyond the actual machine itself, often all the way, as this SMT example shows, to shop-floor planning and scheduling.

"The lesson learned is a simple one. Optimization of processes extends beyond the actual machine itself, often all the way, as this SMT example shows, to shop-floor planning and scheduling."

This first lesson had not been learned in the 1990s, when technology advances brought the first real opportunity of automated assembly production lines into electronics. In most cases, lines of so-called robots were set up to make simple products, such as remote key fobs for cars. When the product model changed, however, the line had to be retooled and reconfigured, which in some cases led to the teardown and reassembly of the whole line itself. Automation at the time, although technically possible, faced significant challenges in flexibility. Today, the need for flexibility is an order of magnitude greater, as manufacturing trends toward lower volumes, higher mix, and the need to support sudden demand changes.

This first lesson is a fundamental issue of automation, but it was the second lesson that arguably has ultimately caused the failure of most attempts at automation. Going back to SMT, one of the key criteria for machine performance is placement accuracy and quality, so much so, that inspection is required in most production lines to confirm consistency of placement. This started out as simple human sight-based visual inspection, based on feedback from in-circuit testers (ICT) and subsequent repair processes. Issues that were detected on a regular basis were highlighted and specifically visually checked on every PCB, with no time to check every placement.

Causes of defects ranged from changes in material's shapes or sizes between vendors, to variations in the PCB positioning, contamination of materials or PCB, nozzle wear, and feeder positioning and wear, among many others. These various causes fell into three main categories: ones that are setup-dependent, such as different materials shapes; some "random" one-off defects; and some that are trending defects, which appear and worsen over time. It is this latter kind of defect that is the most difficult to recognize with inspection because the criteria of what is acceptable and what is not is hard to apply.

The development of AOI machines brought a solution, allowing specific control criteria to be set and measured against by a computer. At least, that was the theory. In practice, most defects detected by the AOI machines were later dismissed as acceptable when inspected by a repair operator, which led to sophisticated networks of AOI machine results being funnelled in real-time to a repair operator who could remotely over-ride AOI detected defects with a simple push of a button. With a huge effort by AOI machine vendors, the visual defect detec-

tion routines are today much more sophisticated and much less prone to false errors. Confidence has risen to the level where statistical process control (SPC), especially 6-Sigma, can be used to predict exactly when placements are inside or outside of control specification, even before an actual defect happens.

Taking this information back to the SMT machines in real-time to adjust or manipulate machine parameters to correct the trends toward defects has been achieved. But this has been limited by the communication options available between AOI and SMT machines, as well as the abilities of the software to be able to link symptoms to specific causes, and on the SMT machine, the interface to enable remote adjustment of key parameters while the machine is working.

And here is our second lesson. When is adjustment acceptable, and when should maintenance be done? Adjustment is always compensation for an issue. That an issue exists raises questions about the processes, as well as the level of adjustment that should fundamentally be necessary. The issue is that elements of the machines need to be maintained and continuously adjusted to ensure optimum performance, which often takes the machine out of service. This then is a quality versus productivity question.

This second lesson had also not been learned in the 1990s, where our early adopters of automated assembly could not understand why the new automated line broke down so frequently. The vendor stated that critical maintenance regimes had not been performed.

The manufacturer said that maintenance could not be done because the line performance was less than expected, which meant that the line had become the bottleneck process for the factory.

Figure 1: Baxter the robot is an example of what automation can mean for the future.
(Photo courtesy of Rethink Robotics.)

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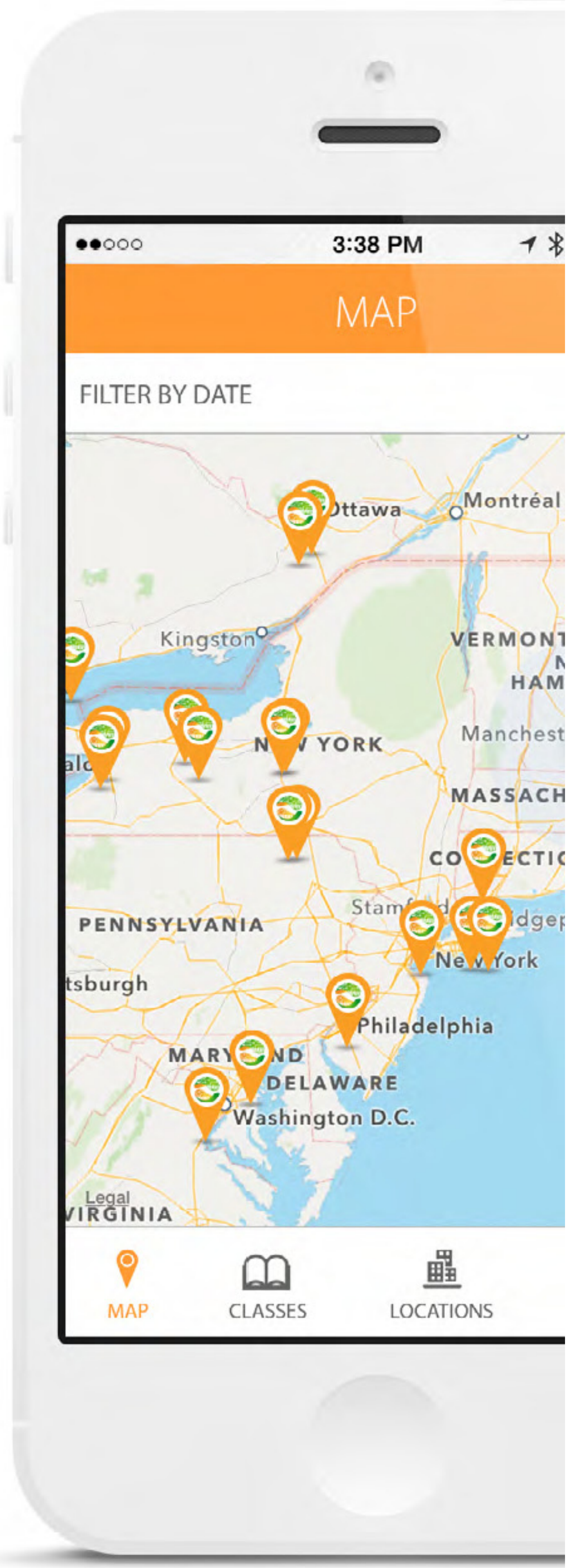

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The vendor said that the line would perform as expected if it had been maintained correctly. Maintenance, whether driven simply by time, the number of units produced, or by more sophisticated calculation of work-load analysis or SPC trend analysis, is clearly a major issue relating to the automation of production.

The third lesson that should have been learned is related to data preparation for the automated processes. In the case of SMT, the machines obviously follow their programs. These programs are generated based on the design of the PCB, plus details about materials used, with regard to shape and other physical attributes.

The real pain in the process, however, is the many different formats into which the data needs to be converted and subsequently maintained for each of the many machine platforms potentially in a line setup or across a shop-floor. Inconsistency of performance caused by differences in material shape definitions is common, which results in significant line down-time whenever a new product is introduced or an existing product moved.

As more automation is introduced, the level of data preparation and conversion across different formats increases, extending to the three-dimensional space of assembly. Human operators have quite advanced built-in dexterity when it comes to assembly, compared with robots that need to have every movement defined precisely.

Automation for the Future

Coming forward to 2014, we see that there is one final lesson to learn from the other three. We now have the overhead of specialised engineers in automation. Some are assigned to the optimisation of the automated line, ensuring that the line performs at maximum efficiency yet is flexible for the changes needed. Others are assigned to the analysis of performance in terms of quality and maintenance. Yet more prepare the precise process data that generates the instructions for the automation to execute.

The decision to purchase automation is usually based on the replacement of operator headcount, especially in higher cost labour areas in the United States and Western Europe. Seldom is the cost justified on the basis of repeatability and quality alone. How about the cost though of the additional teams of specialist engineers? The cost of an engineer is a great deal more than production-line operators.

Our final lesson then is to understand the true cost of ownership of automation. Simple automation, which may be perceived as being cost-effective with an attractive ROI, may hide a lot of costs. More complex automation may represent significantly higher investment, but may be far more cost-effective, even within the medium term.

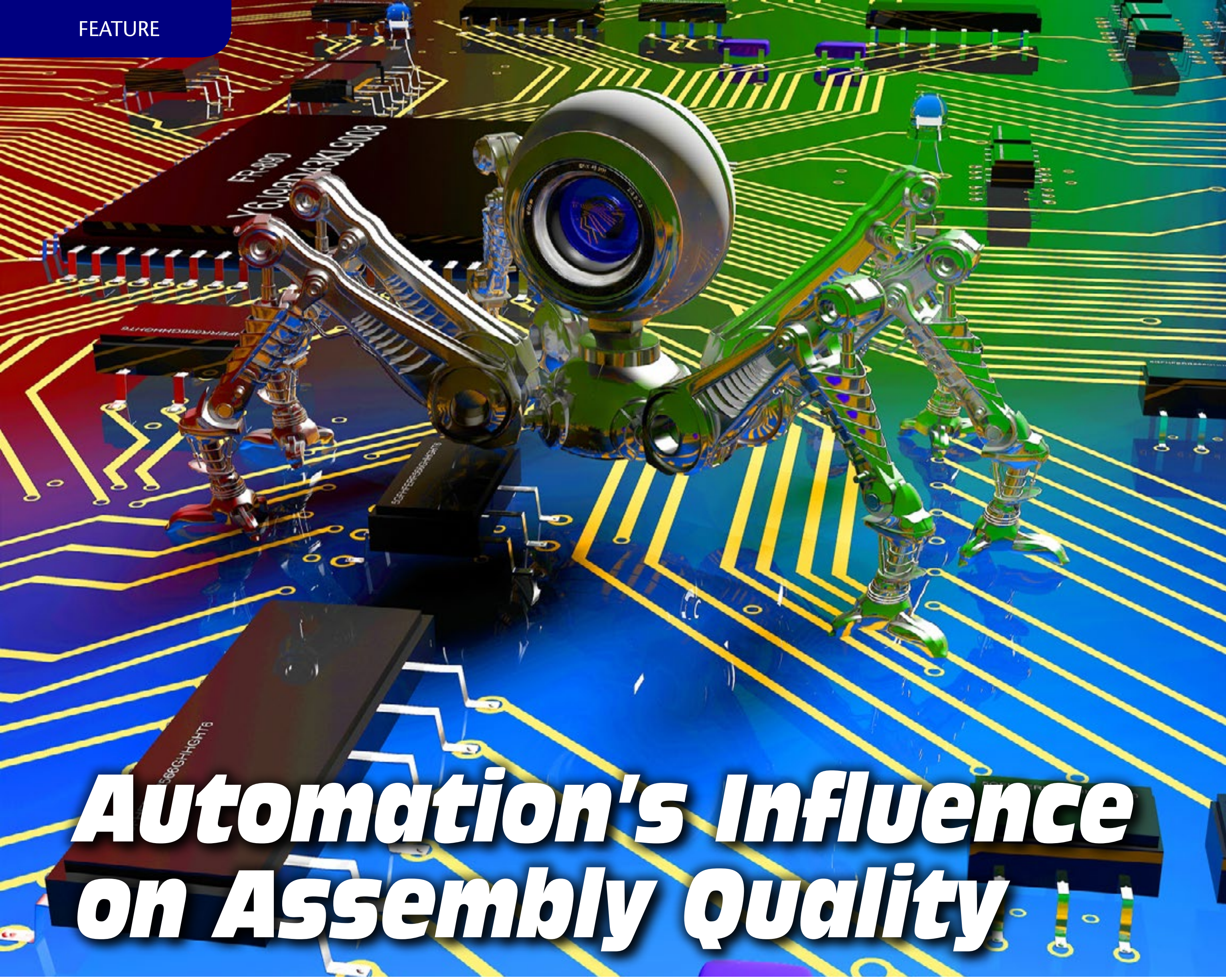
One example of newer, more advanced automation technologies is the Baxter production robot. This example, perhaps looking a little immature to some, represents a far more realistic direction for automation. Robots need to be adaptable, have more sensors, degrees of freedom, and sophisticated software so that they can eliminate the tedious detail of information required for them to operate. In turn, this also brings more ability for the production operators to program the robots with simple instructions.

This leads to flexibility in adapting robots to many forms of assembly, thus reducing the need for extensive work at changeover. As with the higher-end SMT machines today, the inspection for quality can be engineered into the automation itself.

I like the direction that industrial robots such as the Baxter example represents, other than the moving eyes on the screen which really creep me out.

The future then for automation is certain; production of this kind of advanced industrial robot is on its way. How soon it will be until we see mass adoption? I am not sure, and who will be involved to set up, maintain, and operate the robots again needs to be seen. For now though, keep it coming; we are not quite there yet, but I want it! **SMT**

Michael Ford is senior marketing development manager with Mentor Graphics.



Automation's Influence on Assembly Quality

by Waleid Jabai
ZENTECH MANUFACTURING

Beginning in 2011, it became apparent to our team at Zentech Manufacturing that the advanced technology requirements of the mil/aero sector in our primary market, the Pentagon Region of the Mid-Atlantic that includes Washington, D.C. and the high-technology corridors of Northern Virginia and Baltimore, were beginning to challenge our capabilities. Driven by Defense Advanced Research Projects Agency (DARPA) initiatives, coupled with extreme pressures to reduce size, weight and power (SWaP) on military programs, our core customer base of military prime contractors began to deliver designs that utilized advanced packaging sizes that were coupled with extreme layer counts and circuit densities.

The decision was made by our team to make significant capital investments in our SMT equipment set to both support our customers and to differentiate ourselves from other CMs in a highly competitive market space. When most people think of advanced SMT processing equipment, their focus is normally on the throughput advantages and attendant labor savings attained from a highly automated process. From our perspective and analysis, we saw an opportunity to dramatically improve product quality through advanced automation of the SMT process and those processes closely linked to it.

Advanced automation has improved quality and reliability by reducing variability in the SMT process. Machine improvements in each of the fundamental SMT processes; solder paste application; and component placement and

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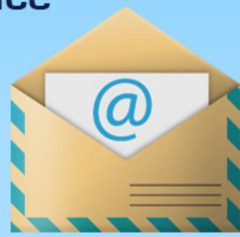

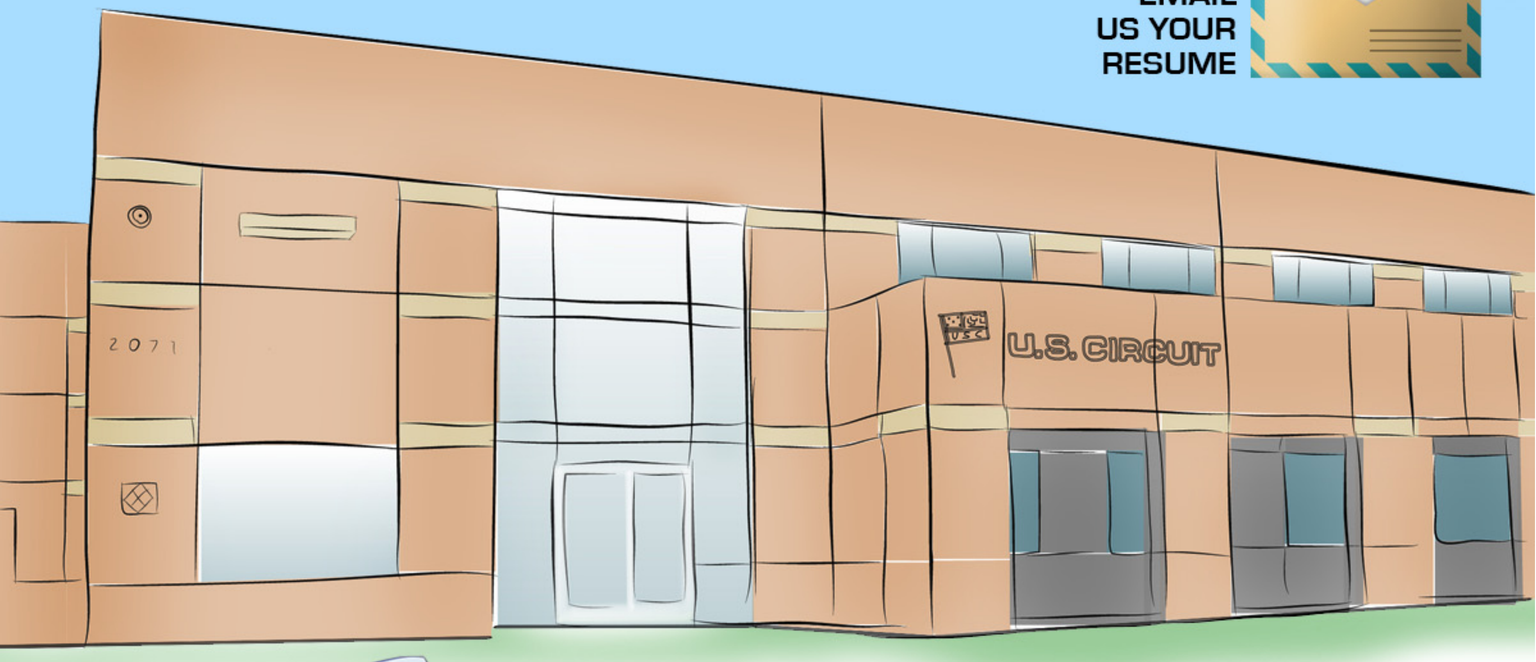

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ITAR Registered | ISO 9001:2008 | MIL-PRF-55110G solder reflow, have systematically pushed variation out of the process. With all of this improvement, SMT subject matter experts assert that 60% or more of all anomalies detected in this process are directly or indirectly attributable to solder paste application. Ongoing component miniaturization and mixed technologies across the surface of the PWB make this rate impossible to refute, contributing to the growing science of solder paste application.

While emerging technologies for solder paste application, such as the jet-type printers, offer tantalizing possibilities for the future, the screen-print process continues to be the industry standard. The physics of maintaining proper area ratio on the stencil aperture is critical in this process. The area ratio of an aperture is a function of the aperture opening and stencil thickness. Modern solder paste chemistry (introducing the smaller type-5 and type-6 powder sizes) and the introduction of nano coatings on the stencils are improving the process, but a relatively high area ratio (>0.66) must be maintained to ensure consistent release of the solder paste from the stencil aperture to ensure a high reliability solder joint.

"The physics of maintaining proper area ratio on the stencil aperture is critical in this process. The area ratio of an aperture is a function of the aperture opening and stencil thickness."

Today's state-of-the-art screen printers offer edge-locking of the PWB, quick tooling for back support and automated wet and dry stencil cleaning. These technologies improve the interface between the stencil and the PWB ensuring each of these components remain flat relative to each other. Adding a compatible automated 3D solder paste inspection (SPI) system will enhance this interface by reporting minute variations in coverage, thickness and density triggering the stencil cleaning process at the optimal frequency. Analyzing the data collected by the SPI will provide information that may be used to validate stencil modification guidelines.

Additional process and/or automation may be required to overcome flux starvation, area ratio below .66 and mixed technologies such as FPGAs adjacent to micro-BGAs (<65 micron ball diameter) where two-stencil or step-stencil processes are impractical due to assembly density.

Modern component placement machines perform at incredible speeds while interrogating each component to pre-programed specifications confirming proper type, value and orientation. An interface between the SPI and the pick-and-place machine may ensure adequate placement offset for component stability while maintaining proper paste formation. Consistent paste form, coverage, volume, density and registration to the pads will yield consistent results through the solder reflow oven.

The solder reflow oven is the final critical step in this process. Board material type and the physical build (number and content of each layer) demand very specific temperature profiles unique to each assembly type. Component type and maximum exposure and solder paste chemistry also play a vital role in designing the reflow profile. Mixed component types (tin-lead vs lead-free) have exposure limitations to consider and the chemistry and volatility of the paste and flux combinations will influence the timing and ramping of the profile. Having

enough controllable zones in the reflow oven allow for controlled escalation to reflow temperature, exposure time in the reflow zone and a controlled return to ambient temperature. All of these elements must be accounted for in designing the reflow profile.

Placing an automated X-ray inspection (AXI) station in-line following reflow will provide the data to tie the entire process together. The AXI offers real-time feedback for process adjustments throughout the SMT process. AXI systems with automated inspection software will meet the industry requirements for high accuracy and high speed at the same time. Traditional X-ray processes are manually intensive and subject to interpretation. Interpreting the data collected by the AXI will provide information that may be used to validate stencil modifications, pick-and-place processing and reflow oven profiles. Relying on human inspection for this feedback will prove valuable only to the point of fatigue where advantages will decrease to the point of creating issues and defect escapes rather than contributing to their solutions. Automation, when properly maintained, is not subject to the same fatigue, virtually eliminating the human error factor. Comparing results before and after a modification to a process becomes more reliable when facts and data are accurately recorded and do not depend on human recollection.

Automated optical inspection (AOI) is utilized to detect solder defects, component presence and position, verify the correct part is installed, polarity, solder paste uniformity and fine pitch lifted leads. The data is linked to our quality management system (QMS) and features direct statistical process control (SPC) outputs.

This advanced automation is not inexpensive. A highly automated SMT line like ours will exceed $3 million in machine cost and implementation, and qualification manpower will add significant cost to this investment. Rudimentary ROI analyses will prove that the speed and consistency resulting in higher quality and reliability in the end item will easily offset the implementation cost. This saving is the result of dramatically reduced manpower required to duplicate what automation is capable of achieving through reduced operator intervention, inspection effort and reduced or eliminated rework cycles that drive up cost and throughput times.

From an organizational perspective, our investments in advanced automation equipment and processes have paid tremendous dividends. We were recently recognized in our market place for manufacturing superior quality products that are utilized in mission-critical military C4ISR systems in support of our nation's defense, and our success has provided us the opportunity to continue to grow and add additional customers and employees. **SMT**

Waleid Jabai is vice president of manufacturing at Zentech Manufacturing Inc.

Reducing Total Manufacturing Cost with Automation

by Michael Hansson
INTEGRATED MICRO-ELECTRONICS

For years, the production line back ends at most EMS companies have been primarily manual. While board assembly technology has undergone many improvements in terms of equipment automation, from faster pick-and-place machines and smarter reflow ovens to 3D inspection and flying probers, the back-end operations for final assembly and testing have remained largely non-automated.

Many reasons have been proposed to explain this reticence, including the high up-front cost of automation, a lack of standards, the wide variety of components and processes required, and decreasing product life cycles. There are, however, numerous reasons for EMS providers to look more closely at automating their back-end production lines—if not completely, at least partially. Not only are labor costs rising worldwide but quality requirements are getting more stringent as well. OEM customers continue to demand single-digit DPPM (defective parts per million) and continuous cost reduction programs.

Adding Value with Automation

In the end, the value of automation boils down to decreasing costs and increasing revenue. Let us look a little closer at both, starting with costs. If implemented judiciously, automation will increase throughput, improve quality, increase repeatability, and reduce labor-related costs.

The traditional reason that manufacturing engineers have long offered when attempting to justify automation has been the reduction in the number of manual operators. But this is no longer sufficient. Not only is it unfair to the project proponent, since the project might actually be more attractive than he is able to present it, but it is also unfair to the company, since it cannot reap the benefits of an automation project that is wrongly pushed aside.

At Integrated Micro-Electronics, we developed a financial tool for evaluating the return on investment on proposed improvement projects such as the automation of an assembly station, taking into account also the reduction in cost of non-quality due to factors such as yield improvements, lower inspection costs, lower rework costs, and fewer field returns. One challenge with such a tool is often the availability


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of reliable data from the departments involved, but we continue to improve the tool as we use it.

One example of a partially automated production line is a rotary assembly machine we developed and deployed at our factory in Jiaxing, China (Figure 1). It combines eight different production steps into a single, compact footprint. It checks the sub-assemblies after loading, performs the final assembly, does an optical test and a functional test, laser marks the finished assembly, checks the marking, and identifies and sorts bad parts from the good ones. Not only is there no manual handling of the parts during the entire final assembly sequence, but there is also an added high-resolution 3D inspection step.

We continuously evaluate the benefit of automation at our manufacturing facilities, including those in traditionally low-cost China. Automation strongly supports our zero-defect program in China by improving quality and repeatability at critical process steps where a high turnover of staff would otherwise have had a particularly debilitating effect. Typically, however, we continue to use manual operators for noncritical steps and for loading and unloading parts in and out of any automated equipment.

Looking now at the revenue side, automation will often enable a manufacturer to take on customer projects for which a demanding OEM or Tier 1 customer would otherwise not have considered them as a supplier due to the volume, the quality requirements or the complexity involved. For our high-volume quotations, investment alternatives with and without automation are compared as a matter of course. Automotive and medical-grade products likewise warrant close evaluation together with the customer, while complex products involving critical process steps such as precision press-fitting or selective soldering are also considered for automation.

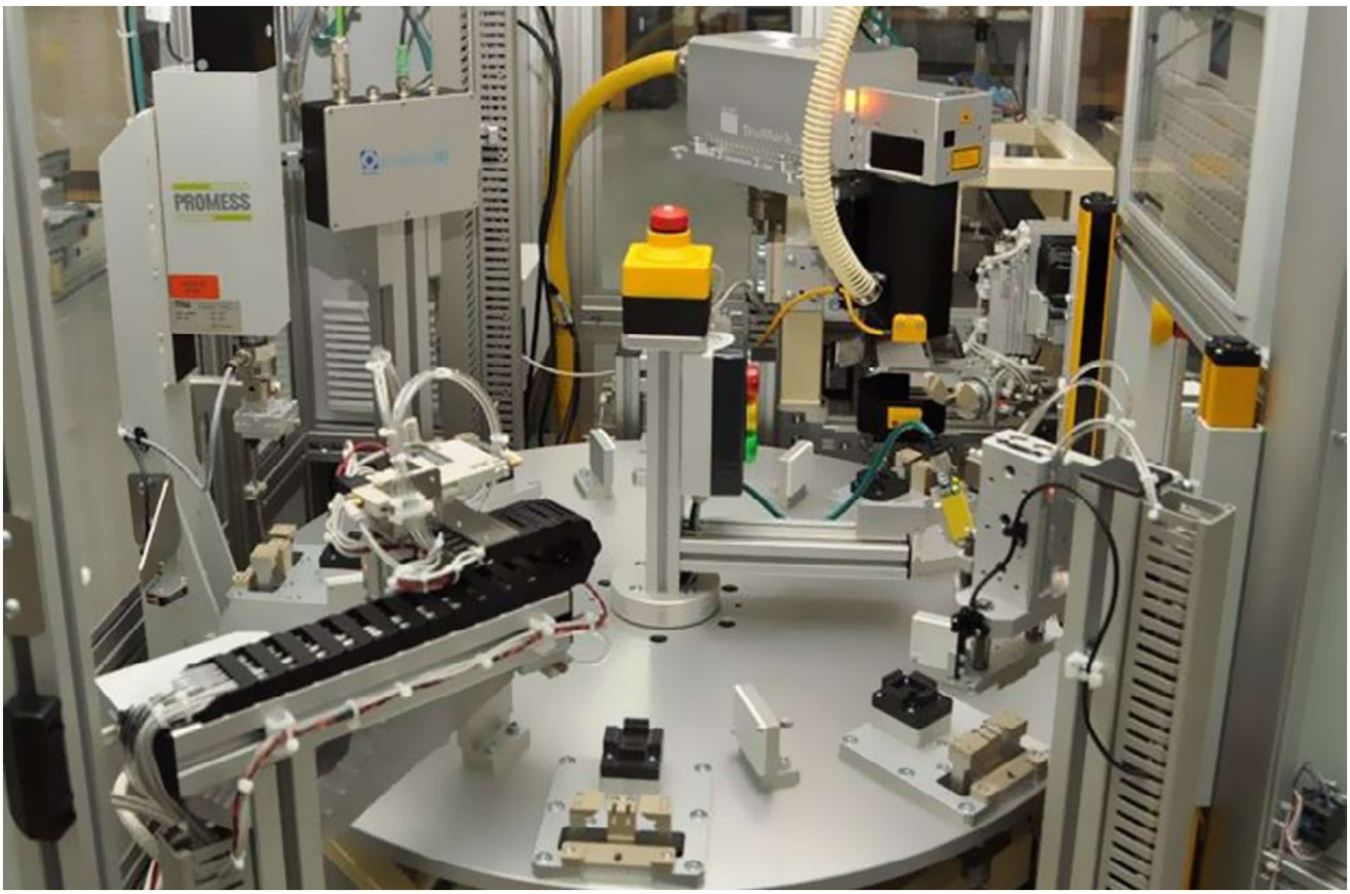

Figure 1: Rotary back-end assembly machine.

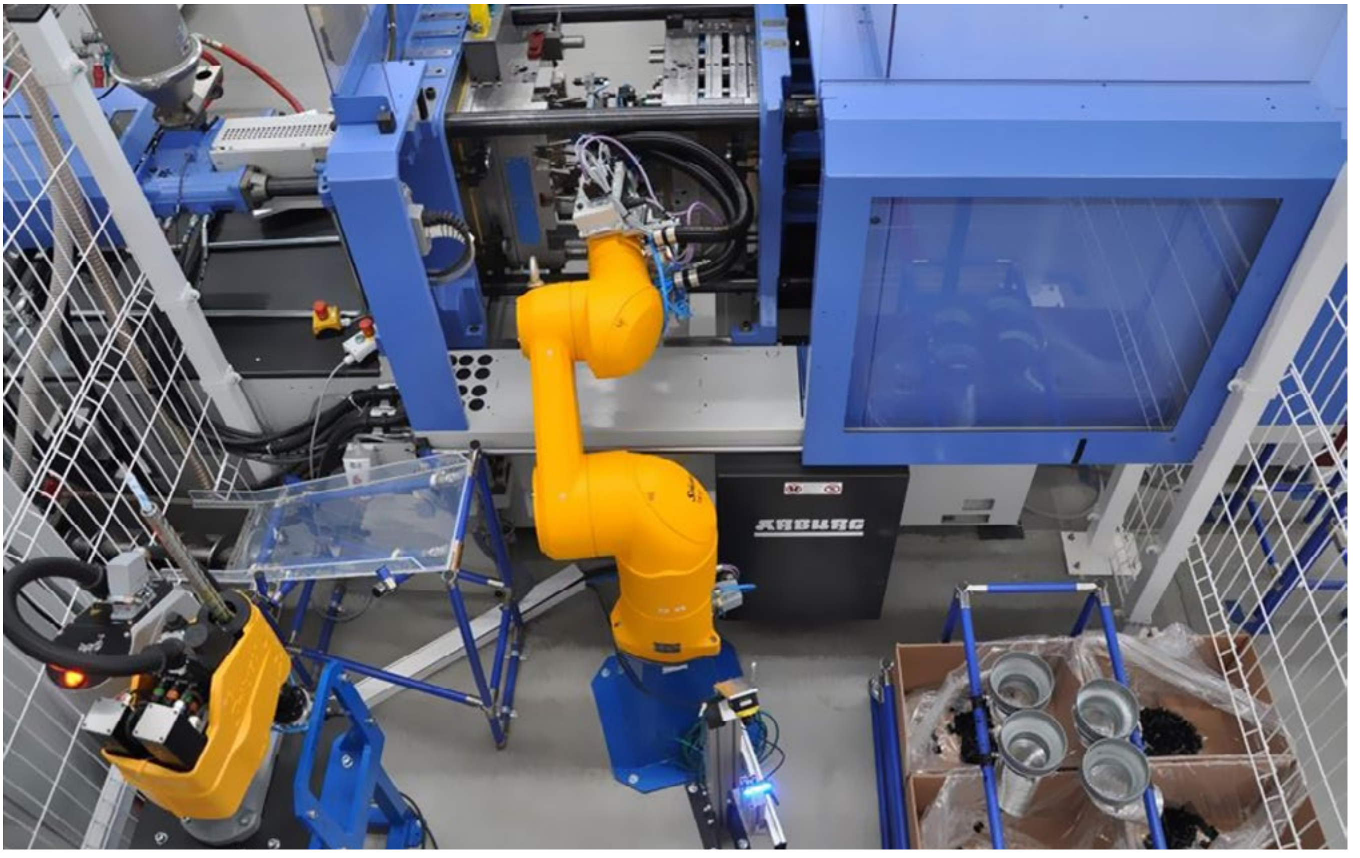

Figure 2: Robot handler for injection molding machine.

One example of a technology-enabled production line is the plastic injection molding operations at our factory in Guadalajara, Mexico (Figure 2). We developed a dual-robot handler to automatically stamp pin inserts from a reel, insert the pins in multiple cavities in the injection molding machine with high accuracy, remove the finished parts, inspect them and finally sort them. Without automation, it would have been impossible to attain the tight tolerance in the insertion process, the high repeatability in the cycle time, and the high uptime of the injection machine. In addition, the unique system is designed with a minimum of mechanical hardware in order to decrease setup time, maximize reliability and minimize maintenance costs.

An additional source of revenue for an EMS provider could also be the automated equipment itself. The design, supply and support of customized assembly and test equipment could be a valuable revenue stream for any manufacturer. We have a group dedicated to the development of customized equipment, with teams present in all geographies in which we operate. Together with our design and development and advanced manufacturing engineering groups, we are able to provide a wide range of engineering services beyond just standard manufacturing.

The market for industrial automation equipment (IAE) is growing. It is set to grow 7% in 2014 to approximately US$185 billion from $173 billion in 2013, due in part to the recovery of global manufacturing, according to IHS. I am excited to note that the use of industrial robots in electronics manufacturing is on the rise.

Traditionally, there have existed two types of automation: 1) hard automation, with fast hardware-heavy machines optimized for the assembly of one type of product; and 2) flexible automation, with slower, reconfigurable cells designed to assemble a wider range of

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products. Robots are typically used in flexible automation.

One theory is that the increasing use of robots among EMS companies is due to the decreasing costs and increasing functionality of industrial robots. Robot manufacturers appear to be recognizing that the limited space available on a typical electronics production line, especially at a low-cost location, limits the selection of robots that can cost-effectively be used. Some of the newer robots such as the FANUC M-1iA are designed to be relatively easily integrated side-by-side with human assembly operators.

Even more exciting is the coming wave of collaborative robots, which can operate within the same workspace as human operators without any safety fence. Collaborative robots are available now from manufacturers such as KUKA, Universal Robots, and Yaskawa Motoman. One impressive display at the recent Automatica Trade Fair for Automation and Mechatronics in Münich showcased an upcoming dual-arm collaborative robot from ABB with 14 axes, flexible grippers and camera-based part location, specifically designed for small-part assembly operations common in the electronics industry.

At the same trade fair, the European Commission and the euRobotics umbrella organization launched the world's largest civilian R&D program in robotics, with a total investment of €2.8 billion.

Automation may not be a panacea to an electronics manufacturer's dilemmas, but is a valuable tool in any manufacturing engineer's tool chest, and a valuable weapon in the fight against rising costs and shrinking profit margins. **SMT**

Michael Hansson is director of automation for Integrated Micro-Electronics.

Sanmina: Automation in Production Lines

by Richard Ayes
I-CONNECT007

There has been much discussion about the increasing amount of automation in the world of electronics assembly. SMT Editor Richard Ayes recently asked Gelston Howell, senior vice president at Sanmina, to provide perspective on the state of manufacturing automation. Sanmina knows something about automation: The company is a $6 billion integrated manufacturing solutions provider with extensive experience in helping OEMs design and manufacture complex electronic products.

In this interview, Howell discusses the current state of automated electronics assembly systems, the inherent risks and challenges, and the future of robotics in manufacturing.

SMT: Which production operations can be easily automated?

Gelston Howell:

Products as diverse as automobiles and consumer products have been produced using various levels of automation for more than 40 years. What's new is that more complex electronic products, such as some smart phones and sophisticated medical devices, are being produced using factory automation. Apple's phenomenally successful iPhones and notebook computers for example, traditionally assembled using primarily manual processes, are now beginning to employ more automated assembly lines.

The medical device industry has been going through a similar transition, with disposable medical device manufacturers designing machines to automate complex and precise operations. Of course, driving down costs is a iNEMI · MEPTEC THE NEXT GENERATION · SMTA Surface Mount Technology Association · Oregon Bioscience Association

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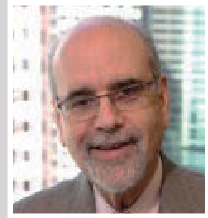

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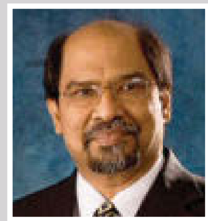

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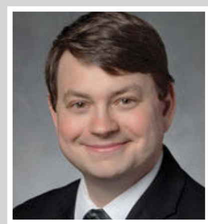
Ensuring Quality Medical Devices Meet Regulatory Scrutiny in the Face of Industry Cost Pressures



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priority, but the evolution is partly due to the desire to improve quality and reduce costs for products with increasing complexity. For example, until recently a respiratory inhaler would have consisted of only mechanical parts, but now electronics are embedded in the product, improving functionality. As a result of the increased complexity, automated lines are being developed to manage costs and produce devices with extremely high quality.

Industrial sectors, such as clean technology and automotive electronics, are also exploring how automation can help them get products to market at lower costs and with better quality. Regardless of the industry segment, applying automation for products manufactured in high volumes can result in substantially reduced costs.

SMT: Conversely, which operations are difficult to automate?

Howell: Automated assembly can be used to produce new products or replace an existing manual manufacturing process, but not all products will benefit from automation. When evaluating which products are a good fit for automation, there are numerous variables, including financial analysis, time to market, product design and operations considerations.

SMT: How quick is the return on investment?

Howell: A $6 million investment in capital equipment, designed to output over five million units per annum, with an ultimate savings of $1 per unit in reduced labor costs, would offer a return on investment (ROI) in less than 15 months. When comparing the ROI on manual vs. automated assembly, here are some other factors to consider:

- Time available before start of series production
- Number of product variants
- Work content per assembly or subassembly
- Advantages of repeatability and process control
- Manual handling of parts and impact on product quality
- Labor costs (total work content of operations, techs and engineers)
- Cost of capital equipment
- Running costs of equipment (maintenance, spare parts, etc.)
- Equipment flexibility and reusability
- Life cycle remaining after installation and release of equipment
- Raw materials in facilities and reduced inventory turns

SMT: What risks and challenges must be considered when a decision has been finalized to automate certain assembly processes?

Howell: To begin analyzing the feasibility of an automation project, OEMs need to consider production volumes, labor content and the time needed to develop automated production equipment.

Typically, annual volume targets should be in the hundreds of thousands or millions of units because of the financial investment required to set up an automated line. The analysis includes the takt time (time per production step), which is the target rate of output from the manufacturing system. Depending on planned shift patterns, for an annual output of five million units, a target takt time of six seconds may be required (or one unit produced every six seconds). The cumulative process time, requiring the presence of a person, drives the operating direct labor cost for a manual operation; in contrast, a fully automated equivalent operation has a reduced or eliminated direct labor cost.

Additionally, part-tolerance stack-up analysis and the inclusion of design features for ease of component assembly serve to "de-risk" the implementation of automated assembly solutions. Manual assembly processes are much more forgiving of component tolerance issues. For example, plastic components that are slightly warped pose no problems for manual assembly. However, these same components may not be usable with an automated component feeder or with pick and place equipment. The worst-case scenario would be damage to the assembly equipment due to a part collision.

SMT: Does your company have actual experiences regarding automating your production/assembly processes?

Howell: Yes, we have implemented several hands-off, fully automated system assembly lines over the past eight years. We work with OEMs and product designers along with several automation equipment providers to create the most cost-effective and reliable automation solutions possible.

Due to the complexity of manufacturing platforms and industry best-practice requirements, automation solution providers tend to specialize in discrete market segments, such as consumer, medical or automotive. These providers then will typically have a core competency or be able to demonstrate greater experience in an area such as the following:

- Challenging operating environments such as Class 8 clean rooms
- Niche skills such as plastics, odd-form mechatronic assembly, electronic testing, and final packaging
- Integration of advanced technologies such as vision systems, precision screwing, dispensing and curing
- Laser systems suitable for high throughput and precise material handling, welding, cutting and marking products, especially for the assembly of miniature components, within the medical device and pharmaceutical industries

SMT: Why does implementing an automated assembly line take so much time?

Howell: Automation requires custom tooling, additional design features in certain components and often some custom equipment—one size does not fit all. It can take from six months to three years to develop, implement and validate complex automated processes and equipment for system assembly and test. This investment can pay off. Once running, products can be produced at lower costs, and often the same automated production equipment can be used for the next generation of products.

SMT: Why don't companies jump straight into automated assembly?

Howell: Automation can and does save money, but there are risks involved and financial and time commitments required to make automation successful. And certainly, not all products benefit from manufacturing automation. Basic considerations include both a time to market and financial analysis. That is, is there enough time to implement automation and will it pay off based on product complexity, volumes, the availability of suitable automation cells (that can be customized) and other factors?

Another factor for successful assembly automation is designing the product for automation. Involving equipment builders in the early design phase of a new product offers the greatest opportunity and flexibility to include design features in the product and components so that assembly automation can be kept as simple as possible. This investment in time and effort will pay off when closing in on the product launch date.

Products that have been designed in accordance with DFAA (design for automated assembly) and DFT (design for testability) principles enable the engineering team to identify and eliminate unforeseen issues, which would later result in efficiency or quality issues during the volume manufacturing phase.

SMT: What are some of the pros and cons of robotics replacing human workers in an assembly line?

Howell: Images of futuristic-looking robots rapidly and efficiently assembling products permeate modern advertising. And, the reality is that automated assembly can save money and improve quality for a growing number of product types. This is an area that will continue to advance. On the other hand, there is a significant number of complex, high-mix, low-volume products such as large format printers, industrial and complex medical equipment where the lower volumes and high complexity do not justify a fully automated solution. **SMT**

Richard Ayes is an editor with I-Connect007.

SMTonline Supplier/New Product News Highlights

EasyBraid Unveils Latest Soldering Iron Handpieces

The SHP-K and SHP-KM soldering iron handpieces can be used in competitive OKI/Metcal soldering systems, designated PS-800, PS-900, MFR-PS1100, or MFR-PS2200. The handpieces allow the use of EasyBraid EK series cartridges (tips) which do not need the heating elements necessary with the OKI/Metcal design, since the EasyBraid cartridges include the heater.

Indium Debuts New Lead-free Solder Paste

RMA-155 was designed for balanced performance, making it ideal for high-complexity boards with a variety of component sizes, as well as simple assemblies. Compatible with both SnPb and SAC alloys, RMA-155 delivers consistent transfer efficiencies, excellent response-to-pause, and a strong oxidation barrier, even for long and hot profiles.

Dymax Launches New Encompass Technology

Adhesives formulated with new Encompass technology incorporate the company's patented See-Cure color-change and Ultra-Red fluorescing technologies into one light-curable product. As a result, manufacturers gain efficiencies from rapid, on-demand curing with easy cure confirmation and post-cure bond-line inspection.

NCP Material Helps Advance Flip-chip Designs

The Electronics Group of Henkel has developed a non-conductive paste (NCP) material, LOCTITE ECCOBOND NCP 5209, which can enable the move toward fine-pitch flip-chip architectures. Moreover, LOCTITE ECCOBOND NCP 5209 delivers comprehensive underfill protection that overcomes the challenges associated with conventional capillary underfill materials.

BTU Enjoys 40.7% Sales Increase in Q2

"We are pleased with the strong showing of our electronics equipment business. This, combined with extra strength in our margins due to a favorable product mix and expense reductions, allowed us to get to the first profitable quarter since the sharp decline of the solar business," says Paul J. van der Wansem, chairman and CEO.

Panasonic Names REStronics Southern CA Sales Rep

Panasonic Factory Solutions Company of America has announced the selection of REStronics Southern California as a sales representative.

Intertronics Launches DYMAX Medical Device Adhesive

DYMAX MD Medical Device Adhesive 1072-M from Intertronics is a UV- and visible-light-curing adhesive particularly suited to rapid bonding of cyclic olefin polymers/copolymers (COP/COC) which have become popular choices in the point-of-care device industry because of their many advantages, including high strength, hardness, low water absorption, and excellent biocompatibility.

Firstronic Launches Greenfield Facility in Mexico

The new facility is only five minutes away from the Mexican border, ensuring a convenient commute for customers choosing to stay in El Paso, Texas while visiting the facility. Initially, it will have two SMT lines, with plans to eventually expand to seven lines as the business continues to ramp up.

Essemtec Appoints Salmhofer Global Service Leader

Essemtec AG is pleased to introduce its new global service leader who joined the company at the beginning of February 2014. Klaus Salmhofer brings excellent qualifications to further drive expansion of the company's Global Service.

Ellsworth Now Offers Dymax's BlueWave LED System

Summer 2014 has seen a number of product launches at Ellsworth Adhesives Europe and the Dymax Corporation is the latest company to add a brand new product to its existing portfolio.

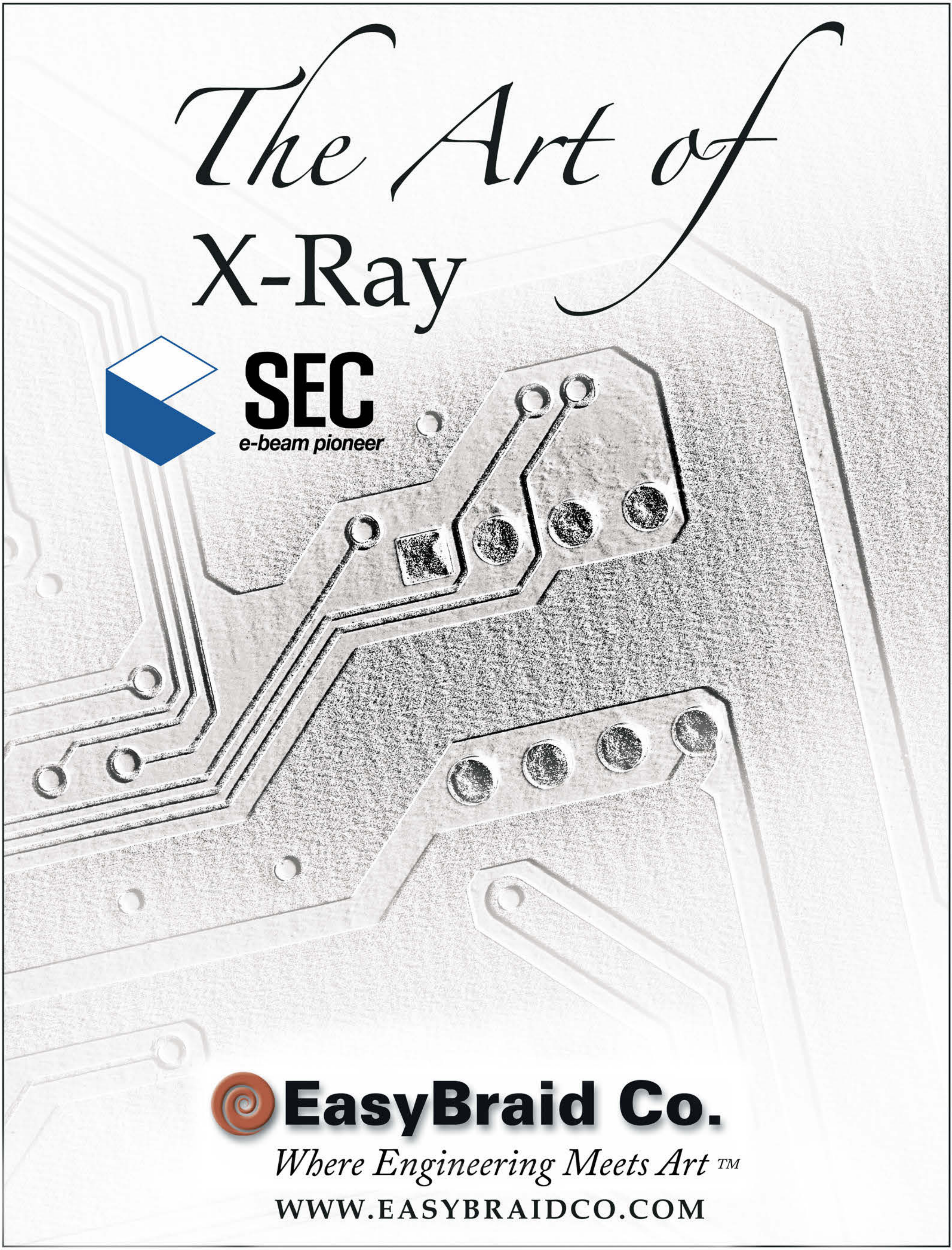
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Figure 1: The Comau Smart Pal is used for palletizing and logistics operations.

Robotics in Manufacturing: A Primer

by Comau Robotics

Those who have worked in the world of manufacturing for years consider robots to be a commodity. These people have witnessed many different robots executing the most diverse operations.

Robots move quickly in production departments of various sizes and within various applications, sometimes in large spaces, sometimes in very narrow areas. Yet the diffusion of robots is not at all similar to that of a commodity good, even though robots share many of the same characteristics. So why not robotize your departments for good?

The answer could be quite simple. Perhaps, despite their efforts, robotics developers have not made their case clearly enough. It's time, then, to do justice to this futuristic technology.

Why should you consider robotizing factory departments? Let's start with the hard variables. It may seem counterintuitive, but robots cost less than other technologies used for the same tasks, such as cutting, welding, and palletizing. Robots cost less when compared to the cost of specialists or other personnel who perform tough work in hostile environments, such as machine tending, foundry operations, etc. And robots use less in terms of energy consumption: Robots can work in the dark, for example, and do not need heating.

Robots cost less, work better and ensure higher quality. A robot does not have muscles to get tired, nor does it get distracted. The accuracy and repeatability of operations are almost unlimited—millions and millions of cycles—and this leads to products of an extremely high standard, which stays constant over time. But there's more. If the finished product is constantly of high-quality, then waste and rework costs are reduced to a minimum. Lower costs equal higher revenue.

Moreover, let's not forget that robots do not go on vacation, get the stomach flu, and, let's face it, they do not have families. So they work, work, work. Every shift, tirelessly and repeatedly, leading to increased production and sky-high productivity.

Production speed means responsiveness. You can work with a smaller warehouse, because the manufacturing precision and reduction of waste and rework allows you to reduce your inventory. It also means that you will always deliver finished or semi-finished products to your customers with the maximum precision. Schedules are respected and guaranteed.

Robots never complain; they're the most flexible workers you will ever have. Once the processes have been programmed, you can quickly switch from one program to another, using the same machine to perform various tasks in various positions, environments and spaces. The robot system is set up very quickly every time, and it can start again almost immediately. The cost of technology conversion is close to zero, since the robot is reused in full. The possibility of not having to change the layout of your departments may be an additional source of savings. Space is money.

Let's not forget the soft variables either. Robots replace workers in the all the production phases of the most hostile, dangerous and harmful environments. Dust, acids, high temperatures, stress, fatigue, weight... let's leave them all to the robot. Staff members will be able to engage in other phases of work, thus further improving your products. They can retrain and increase their skills, learning to manage and program a robot cell (the complete system that includes the robot, controller, and other peripherals), and perform more skilled tasks, becoming added value for the company.

And, thanks to robots, the number of accidents and frequency of illness caused by repetitive or heavy work decrease. Furthermore, robots eliminate the long time required to search for new personnel, as well as training.

Leave it to robots. **SMT**

Comau Robotics is a division of Comau, a manufacturer of automated systems based in Italy.

Scientists Propose New Kind of Quantum Computer

A team of researchers from TU Wien (Vienna) the National Institute for Informatics (Tokyo), and NTT Basic Research Labs in Japan has now proposed a new architecture for quantum computing, based on microscopic defects in diamond.

For decades, scientists have been trying to use quantum systems for logical calculations. Each system—made up of mirrors, diamond, and a nitrogen defect—can store one quantum bit of information: zero, one, or an arbitrary superposition of both. But usually such a quantum bit is very unstable. Error correction procedures are needed to build a quantum computer that works reliably.

The researchers calculated how resonators, diamonds and nitrogen atoms can be assembled to create an error resistant two dimensional quantum system, a so-called "topologically protected quantum computer." According to the calculations, about 4.5 billion such quantum systems would be sufficient to implement the algorithm "Shor-2048," which is able to calculate prime factors of a 2048-bit-number.

There may still be a long way to go before algorithms like Shor-2048 run on a quantum computer. But scientists believe that it should become possible to entangle quantum building blocks, creating larger cluster cells, within the next few years.

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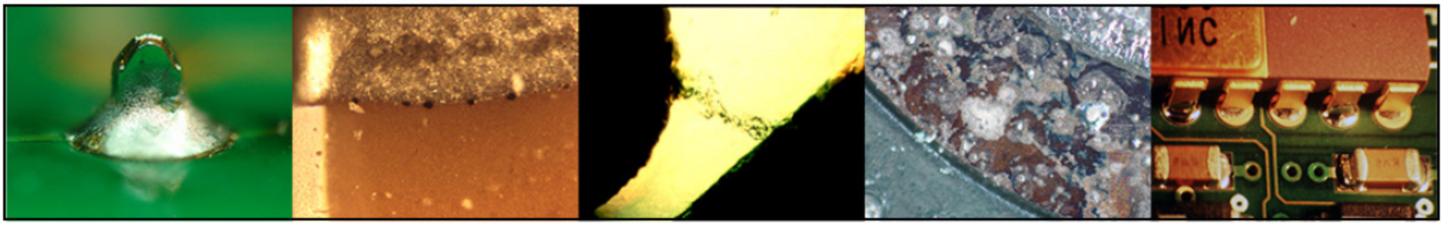

Seminars will be held on the show floor in the High Temperature Electronics feature area. Each presentation will run for 15-20 min. A copy of each of the presentations will be available when visiting the feature area as well as the two new reports produced by NPL on the use of high temperature alloys for conventional board assembly and the die attach.

Schedule

Tuesday September 30th

11:00 am Pb-Free Alternatives for High Temperature Soldering - Indium Corporation

1:30 pm Solving the High Temperature Interconnect Challenge - NPL

2:30 pm Low Temperature Sintering Silver Paste Using MO Technology – NAMICS Corporation

3:30 pm Selective Soldering, Laser & Robotic Iron Soldering with High Temperature Alloys – NPL

Wednesday October 1st

10:00 am Manual Soldering/De-soldering with Sn/Ag,Sn/Cu, HMP and SnSb solder alloys - NPL

11:00 am Soldering & Cleaning Materials for High Operating Temperature Applications – Inventec

12:00 noon Challenges of Power and High Temperature Electronics for Connecting Technologies – Seho Systems

1:30 pm High Temperature Process and Failure Analysis – Universal Instruments

2:30 pm Cleaning Flux Residue from High Temperature Soldered Assemblies – Kyzen

3:30 pm Process Failures in High Temperature Assembly - NPL

To attend the seminar, email Emmy Ross or call (952) 920-7682

Sponsored by:

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Mil/Aero007 News Highlights

Plexus' New Facility Strengthens Aero & Defense Offering

The company commemorated the recent completion of its $50 million manufacturing facility in Neenah, Wisconsin, which contains the new Plexus Aerospace and Defense Manufacturing Center of Excellence. The event was held in conjunction with the Second to None Coalition, an ongoing effort by the AIA to preserve America's role as a global leader in the aerospace and defense industries.

TT Electronics-IMS Expands UKAS Accreditation Portfolio

TT Electronics Integrated Manufacturing Services (IMS) has extended the scope of its UKAS accreditation for HALT & HASS within its regional Testing Solutions facility in Rogerstone, South Wales.

Dynawave Achieves AS9100 Certification

Dynawave Cable Incorporated is pleased to announce certification to the AS9100 quality management system by accredited audit firm UL DQS Inc.

Nortech Posts Sequential Growth in Q2

"We're encouraged by the sequential improvement in revenue and profits," said Rich Wasielewski, president and CEO, adding that profitability was aided by leveraging, continuous improvement activities, and product mix. "New order activity is rising and our backlog levels have posted year-over-year increases the past two quarters."

Probe Inks $1.1M LTA with Aero Solutions Provider

Specific to this contract, Probe will be supplying components that will be incorporated into innovative and highly-affordable compact broadband applications.

PartnerTech Posts 6% Decline in 2Q Sales

PartnerTech AB has reported second quarter sales of SEK 539.6 million, down by 5.9% from the same period last year. Sales were 6.7% lower for comparable units and in local currencies than the year-ago period. Sales for the first half of the year were SEK 1,087.2 million, which represents a decrease of 3.6%.

Sparton JV Wins $166M U.S. Navy Sonobuoy Contract

Sparton Corporation's Joint Venture with Ultra Electronics Holdings plc (ULE), ERAPSCO, has been awarded a contract valued at $166 million for the manufacture of sonobuoys for the United States Navy.

Sypris' Electronics Segment Posts Q2 22% Increase

Revenue for our Electronics Group was $9.4 million in the second quarter, an increase of $1.7 million, or 22%, from $7.7 million for the comparable prior year quarter, primarily due to higher product sales including our data systems branded products.

Kitron Nets Orders from Kongsberg Protech Systems

Kitron ASA has, through its subsidiary Kitron Inc in Johnstown, Pennsylvania, received orders from Kongsberg Protech Systems related to electronic modules that are part of Kongsberg Protech's Remote Weapon Station.

NATEL EMS Nets Military Contract for Satellites

NATEL EMS will use its most advanced equipment to manufacture wideband detectors and converters as part of a recently awarded contract from a Military Prime Contractor.

SMT Engineers Declare Technica Tech Day a Success

by Barb Hockaday
I-CONNECT007

In the field of electronics manufacturing, the demand for void-free soldering is increasing due to changes in technology and processes. Lead-free soldering has a tendency to produce more voids in solder joints than the tin-lead solder process. BGAs and micro-BGAs with smaller ball size and pitches are more susceptible to the negative effects of voiding. The reliability of power electronics depends on homogenous solder connections to ensure proper dissipation of heat from power devices. Newer technologies such as LED lighting and solar concentrators require low-void or void-free solder connections.

The company's recent technical seminar, "Void-free Soldering," was attended by some of the top electronics companies in the Silicon Valley. The feedback was positive, with several expressing a high level of interest in learning more about this process.

Co-sponsored by Rehm Thermal Systems, with collaboration from Technica's other partners, ASM-Siplace and Heraeus Assembly Materials, and participation from Asys Group/Ekra Printing Technologies, LaserJob Inc. and Viscom AG, a live demonstration of void-free soldering was part of the day's agenda.

Technica USA opened up its West Coast Demo & Training Center at their San Jose, California, location last July in cooperation with ASM-Siplace, along with contributions from its other key partners Heraeus and Rehm. As the home of ASM-Siplace's West Coast Demo and Training Center, every calendar quarter ASM conducts three consecutive weeks of training and continuing education for existing and new users of their placement equipment. Customers from all over the Western U.S. have attended these sessions to participate in this value-added benefit. The center has also been used to conduct other applications work at the request of OEM and SMT customers over the last year.

The Tech Day was the first of planned annual events for Technica. "I believe as a major supplier to the SMT market that we are incumbent to bring value to our customers each and every day," explained Frank Medina, president of Technica USA. "We believe the Demo and Training Center is one way to accomplish our objective. We also believe that providing information on technology trends, market trends and other pertinent topics is another way we can fulfill our obligation as a value-added supplier. The industry offers many venues for providing information but it's not reasonable to think our customers can afford to send everyone who would benefit. Our approach to the annual Tech Day should provide more flexibility and opportunity

for our customers to gain knowledge that should directly benefit their operations."

Sanmina Process Engineer Manuel Castro said he attended the seminar to expand his knowledge on vapor phase equipment capabilities and voiding reduction.

"There seems to be a proven solution to the voiding phenomenon regardless of which paste chemistry or vendor you're using. Vapor phase will give you better wetting characteristics, and using the vacuum option in the vapor phase will reduce your voiding to almost none," he said.

The first part of the seminar was held at the CAS Event Center in San Jose, where Helmut Ottl, head of product management and deputy head R&D for Rehm, and Joerg Trodler, process engineer of interconnect technologies and materials at Heraeus, provided detailed technical information on the subjects of vapor phase soldering and the materials and processes that influence solder joint void formation.

The SMT and packaging industries are very familiar with the extensive and cooperative studies that are conducted each year in Germany. Heraeus, Rehm, and ASM-Siplace are typically at the center of these collaborative studies with others. Ottl and Trodler provided much of the data and results that have been gleaned from their collaborative efforts.

Han Jun Cho, engineering manager at Paramit Medical Device, also attended specifically to learn about the conduction reflow with vacuum process.

"I attended this event because of the topic: conduction reflow with vacuum," said Cho. "It is an interesting, newer process, and I wondered if it could be applied to several process challenges my team faced. Learning all the pros and cons of this new process and equipment will enable me to open the discussion with my management to see if we are ready to explore new process capabilities."

The afternoon workshop was held at the nearby Technica USA facility. Sample boards were assembled for a live demonstration of void free soldering. Customers were able to observe the entire process and equipment that was employed for this demonstration. The venue enabled customers to engage in conversation with the participants as it related to their own interests and challenges.

David Smith, a senior manufacturing engineer with General Motors (Kokomo) said, "I attended this seminar more for the purpose of looking at a particular piece of equipment rather than the general topic of void-free soldering, so the afternoon session focusing on equipment was especially interesting and pertinent to my needs."

Most in attendance agreed with Smith when he said there is no substitute for a face-to-face, in-person seminar; the environments could never be compared.

Based on the positive response received from the attendees and the participants, Technica is looking forward to organizing the next technical event. **SMT**

Barb Hockaday is the director of sales and marketing at I-Connect007.

SMTonline Market News Highlights

The Conference Board: Strong Job Growth Sustained

"The economy generated a gain of 209,000 jobs in July, very close to the average of more than 200,000 per month over the past year. This means that the trend in employment growth, which supported stellar second quarter GDP growth and strong consumer and business confidence, is holding up for now," said Gad Levanon, director, Macroeconomic and Labor Market Research.

Semiconductors in Health, Fitness to See Growth

Semiconductors providing wireless connectivity in health and fitness devices are set for solid double-digit growth in 2014 and beyond, especially as a clutch of wireless technologies make their way into a growing number of wearable devices, according to a new report from IHS Technology.

Chinese Vendors Lead Q2 Smartphone Shipments

The worldwide smartphone market grew 23.1% year over year in 2Q14, establishing a new single quarter record of 295.3 million shipments, according to preliminary data from the International Data Corporation (IDC) Worldwide Quarterly Mobile Phone Tracker.

3D Printers Market in India to Witness Growth

3D printers are emerging as key growing printers in global landscape. Although the market for 3D printers is in the nascent stage in India, it holds immense growth potential in the coming years. These printers are used for designing 3D models of engineering designs, objects, prosthetics, implants, dentures, fashion accessories, art, and decoration items.

Top 20 Semiconductor Suppliers' 1H Sales Up 10%

In total, the top 20 semiconductor companies' sales increased by 10% in 1H14 as compared to 1H13, three points higher than IC Insights' current 7% forecast for total worldwide semiconductor market growth this year.

Wireless Power Transmission Market: $17B by 2020

Wireless power transmission has gradually started developing in the market and poses a huge potential in the future. The market is mainly driven by the consumer electronics segment for the near terms, where it is mainly used for charging the portable device which includes smart phones, tablets, and wearable electronics.

Industrial Electronics Chip Industry Reports Positive Q1

Industrial electronics semiconductors made small, but important, gains in the first quarter this year, affirming continued strength for a sector that had been battered only two years ago. Given a heartening start, industrial electronics semiconductors could finish 2014 with $35.42 billion in annual revenue, up 9.4% from $32.39 billion last year.

U.S. Unemployment Rate Drops to 6.2% in July

Total nonfarm payroll employment increased by 209,000 in July, and the unemployment rate was little changed at 6.2%, the U.S. Bureau of Labor Statistics reported. Job gains occurred in professional and business services, manufacturing, retail trade, and construction.

Smartphone Shipments to Reach 322M in 3Q14

Smartphone shipments are expected to reach 322 million in the third quarter of 2014, up 13% on quarter, and see flat shipment growth on year in the fourth quarter, while overall shipments in 2014 will reach 1.2 billion, up 29.2% on year, according to market intelligence firm TrendForce.

Demand Uncertainty Pressures Wafer Makers

PV cell manufacturers' utilization rates continued to drop in June. "Market demand will remain weak in July before the result of the U.S.-China anti-dumping preliminary verdict is announced. Those optimistic about future demand have decided to continue with production; others have decided to focus on inventory control," said Arthur Hsu, research manager at EnergyTrend.

KRAMER ON COUNTERFEITS

U.S. Military Tools to Prevent Counterfeit Electronics

by Todd Kramer
SECURE COMPONENTS LLC

By now, it should come as no surprise to those who are involved in electronics procurement that the industry is facing an epidemic of counterfeit parts. In order to stem the tide of fake electronics, both private and military supply chains are taking action through the implementation of new authentication and testing programs.

To reiterate the severity of this issue, I point to a case that made headlines because it exposed an area with the potential to impact U.S. nuclear submarines. Massachusetts resident Peter Picone was charged recently convicted of importing counterfeit semiconductors and then selling them to customers throughout the United States. Many of these parts were intended for use on U.S. nuclear submarines. This is but one of many reports on counterfeit components entering our military's supply chain, and it comes at a very important time.

The announcement of Picone's guilty plea comes nearly one month after the Defense Federal Acquisition Regulation Supplement (DFARS) Case 2012-D055 was finalized. This final rule will have a huge impact on prime contractors and will ultimately flow down to any supplier doing business that involve parts which end up in the hands of the government. Had these requirements been in place from 2007–2012, it is highly unlikely that Picone's organization could have committed the fraud and deceit that it did.

This ruling provides a much needed framework for how prime defense contractors should go about mitigating their exposure to counterfeit components. The Department of Defense has also recently officially adopted the AS6081 Counterfeit Avoidance Standard for distributors. AS6081 is an internationally accredited standard developed by SAE International. It is the result of the aerospace and defense industries uniting to both provide a solution to the problem of counterfeiting and to prevent additional counterfeit components from entering the military supply chain.

Figure 1: The Defense Logistics Agency requires the use of signature DNA technology.

The Defense Logistics Agency (DLA) implemented its own program to proactively address the risk of counterfeits in the defense supply chain via its Qualified Testing Suppliers List (QTSL) program and DNA marking requirements. The combination of these two programs allows the DLA to establish a new form of traceability on items that are needed, but have become obsolete and no longer have the required traceability paperwork. If the component can't be traced to the original component manufacturer (OCM), the QTSL program requires the component be tested for authenticity. Once the component has been tested, it is then marked with specialized DNA to establish forensic traceability back to the supplier.

In order to further explain the DNA marking program, I have included this excerpt from a DLA document titled "Frequently Asked Questions for DNA Marking":

"The Defense Logistics Agency's (DLA) top priority is warfighter support. As a U.S. Department of Defense (DoD) combat support agency, we are firmly committed to a robust counterfeit mitigation strategy that protects our warfighters and the vital missions that they perform. The DLA is modifying microcircuit technical requirements to help prevent counterfeits from entering DLA's Supply Chain by requiring deoxyribonucleic acid (DNA) marking of authentic products. The DLA procures and supplies microcircuits for a broad range of applications within weapons systems and support equipment. This new requirement will help to protect DoD weapon systems. Many items which DLA manages are used in more than one weapon system. The specific list and number of parts which will be subject to the requirement is being defined by DLA using a phased-in approach. While the initial commodity being targeted is microelectronics, the technology could be utilized with other commodities. DLA appreciates our supply chain partners' recognition of the significant risk that counterfeit semiconductors pose to the men and woman serving our country. It is a threat that demands immediate and thoughtful countermeasures. We welcome contributions by our industry partners, including groups such as the Semiconductor Industry Association, in our efforts to prevent counterfeit semiconductors from entering the DLA Supply Chain."

The unique SigNature® DNA mark is created by Applied DNA Sciences, a New York-based biotech company that has developed proprietary DNA marking and authentication platforms to mitigate the risk of counterfeit escapes by assuring authenticity, establishing provenance and providing supply chain integrity.

This process works in the following manner: Applied Sciences' SigNature DNA are applied to parts that have been tested in accordance to a minimum testing protocol as outlined in SAE's AS6081. Once applied to a component, this mark cannot be washed off, even by the most aggressive industrial treatments. These marks have also proven extremely resilient to extreme conditions such as heat, cold, abrasion and radiation, among others. An additional benefit of DNA marking is the fact that only a minute amount of the original mark is needed for analysis. As DNA is one of the most dense data storage mediums, large amounts of information can be stored in very small samples. Once these marks are applied, they can be scanned via ultraviolet light or sampled and authenticated by a chemical swab to determine the supplier and the part's provenance from that point forward.

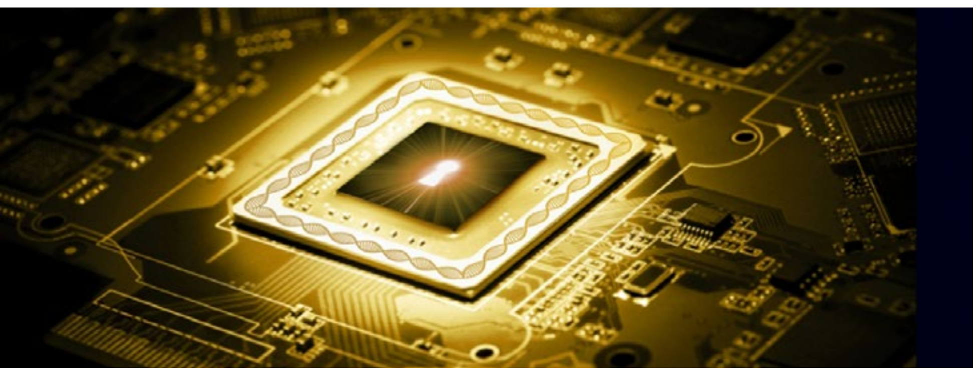
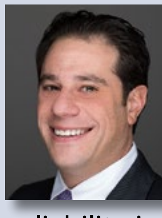


Figure 1: The Defense Logistics Agency requires the use of signature DNA technology.

A U.S. Senate Armed Services Committee investigation led by Senators John McCain and Carl Levin concluded that the U.S. military supply chain is potentially contaminated with more than 1 million counterfeit components. That investigation and others lead to President Obama signing into the law the National Defense Authorization Act. Section 818 of this act specifically addresses the need for counterfeit avoidance regarding electronic components. The lesson that all companies should take away is this: If this can happen to the finest military in the world, it can certainly happen to any supply chain.

What counterfeit avoidance measures has your company put into place to support your supply chain? Are you familiar with standards that address this issue, such as AS6081, AS5553-A, AS6174 and others? These standards can act as a guide to ensure your firm is not impacted by the catastrophic results of a counterfeit component polluting your supply chain.

In addition to incorporating the aforementioned standards, I strongly suggest that you closely evaluate your supply chain. The final DFARS rule mentioned here should serve as a clear and unmistakable indication for you and your supply chain professionals that supply chain negligence will not go unpunished. The risks and liabilities (both criminal and civil) are such that every organization must closely evaluate how it goes about procuring parts. Do not wait for a catastrophic event to occur before a counterfeit avoidance plan is implemented. Seek out trusted suppliers who can partner with your organization. **SMT**



Todd Kramer is CEO of Secure Components LLC, an AS6081 & AS9120 certified independent distributor of electronic and mechanical components to the aerospace, defense, and high-reliability industries. To contact Kramer or to read past columns, click here.

Video Interview

Supply Chain Management Update

by Real Time with... IPC APEX EXPO 2014

Mentor Graphics' Michael Ford and Editor Andy Shaughnessy discuss the need for supply chain management software that can replace the aging ERP platform. He gave a presentation at IPC APEX EXPO that explains the current state of materials management and offers a path for the future.

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THE SHORT SCOOP

Improving Stencil Printing Results

by Rachel Miller-Short
PHOTO STENCIL LLC

As a continuation of my July 2014 column, this month I am providing some possible answers to the frequently asked question, "Why am I getting poor printing results?"

There are a myriad of causes of poor print performance. The problem may stem simply from an inferior or worn-out stencil, which is typically the first place people focus when troubleshooting. However, the issue may also be caused by an improper aperture design or stencil thickness. Additionally, poor print performance might not be caused by the stencil itself, but rather an improper printer set-up, a non-optimal squeegee blade, or the rheology of the solder paste being used during processing.

To shed light on this month's topic, I have compiled a list of some of the problems our users encounter and possible solutions..

To find the cause of the problem, it is helpful to break the stencil printing process into two phases. The first is the fill phase, when the aperture is filled with solder paste. The second phase is the transfer process, during which the paste is released from the aperture and transferred to the pad on the PCB.

PROBLEM: Insufficient solder volume transfer

Potential causes for insufficient solder transfer are often associated with:

1. Rough aperture walls that cause poor solder paste release, particularly as aperture sizes decrease

This problem has become more prevalent as board densities have increased and component sizes have shrunk. It is one situation that is directly related to the fabrication of the stencil. Different stencil fabrication techniques, such as laser cutting and electroforming, yield different levels of aperture roughness. Before selecting the stencil, evaluate the type of layout and configuration of the board, the types of components you are working with, and the board application. Then find the type of stencil that will give the paste release to meet those needs. The easiest to find and least expensive is an off-the-shelf laser-cut stencil. However, for more stringent applications where components are close together and very small, you might have to get a chemetch, NiCut, or electroform sten-

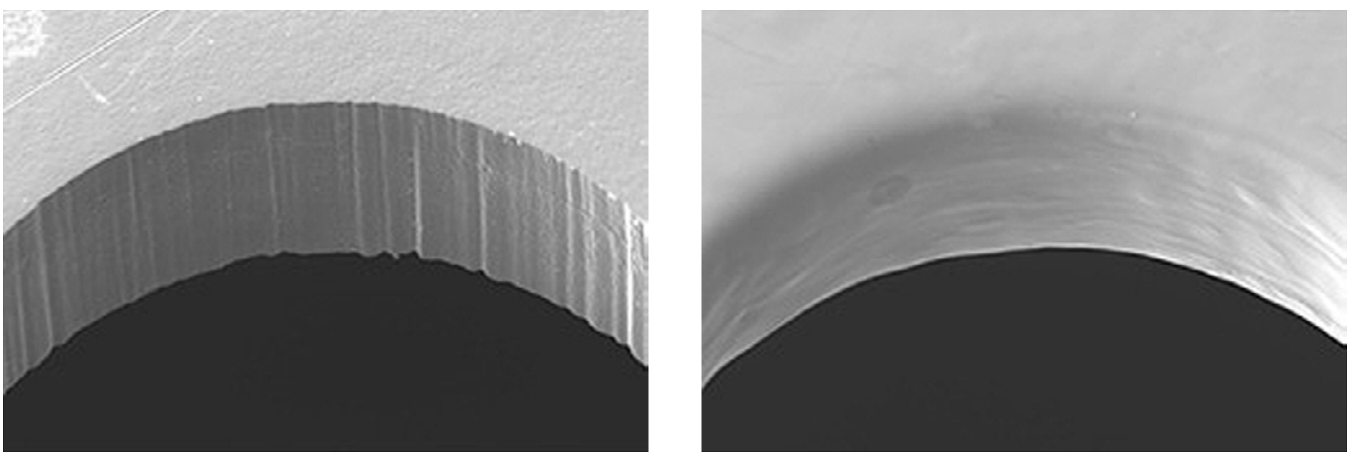

Figure 1: Aperture wall comparisons.

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IWLPC EVENT SCHEDULE

Nov. 11 Keynote Address

Nov. 11-12 Exhibition, Panel Discussion and Technical Presentations on 3D, WLP and MEMS.

Nov. 13 Professional Tutorials
T1: Wafer Level Packaging for MEMS and Microsystems Challenges and Opportunities, **T2:** Wafer Level-Chip Scale Packaging (WL-CSP), **T3:** 3D IC Integration and Packaging, **T4:** Achieving High Reliability for Lead-Free Solder Joints — Materials Consideration

IWLPC CONFERENCE SPECIAL EVENTS

KEYNOTE ADDRESS
Living Connected Through Trillions Sensors
Dr. Janusz Bryzek, Chair, *TSensors Summit*

EXHIBITOR RECEPTION Brought to you by KLA Tencor
Join us in the Bayshore Ballroom for the Exhibitor Reception on Tuesday, November 11th (5:30pm - 7:00 pm) where the 50 + exhibitors will showcase the latest products and technologies offered by leading companies in the semiconductor packaging industry. The evening reception offers attendees numerous opportunities for networking and discussion with colleagues.

PLENARY SPEAKERS
Wearable, Wireless Health Solutions and Related Packaging Challenges
Mehran Mehregany, Ph.D., *Case Western Reserve University*

Wafer-Level Packaging Innovations to Enable Wearable Electronics
Theodore (Ted) G. Tessier, *Flip Chip International, LLC*

PANEL DISCUSSION
System Level Advantages of 3D Integration
Hosted by Françoise Von Trapp from 3DInCites

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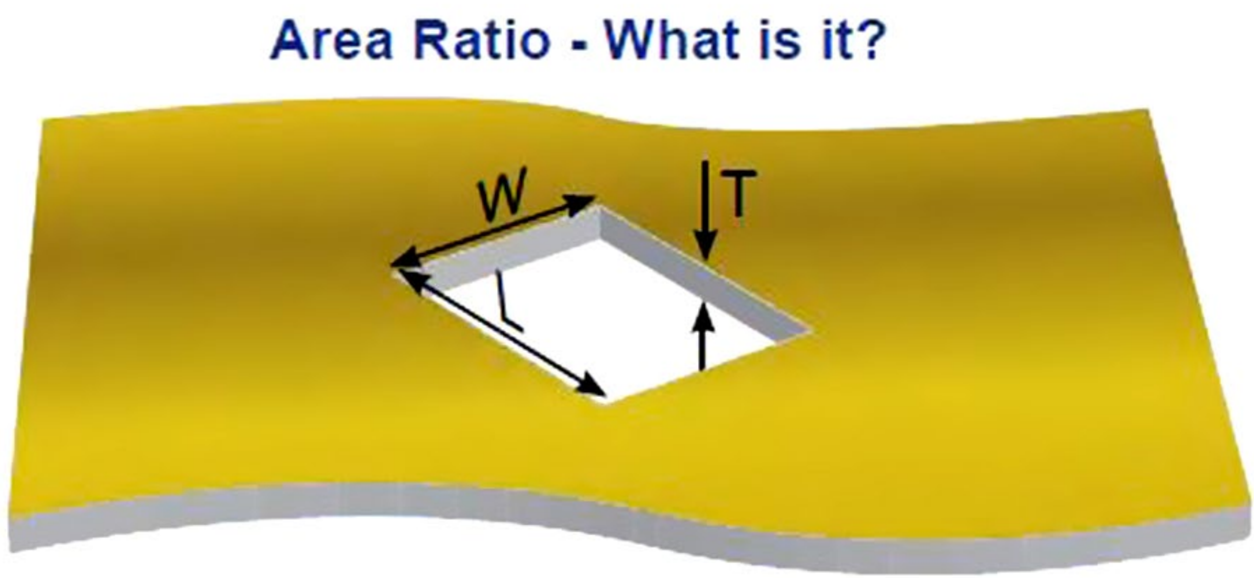
For more information on the conference, or exhibit and sponsorship opportunities please contact **Patti Coles** at **952-920-7682** or **patti@smta.org** cil to get side walls that are smooth enough for proper solder transfer, and therefore volume.

2. Poor aperture design with area ratios that are too small for the stencil technology chosen

Area ratio is a good tool to predict solder paste transfer. The area ratio is the area of the aperture opening divided by the area of the inside aperture wall. In the solder paste printing process, the squeegee blade delivers solder paste into the stencil aperture as it travels across the stencil surface. When the board separates from the stencil, the solder paste in the stencil encounters a competing process: solder paste will either transfer to the pad on the PCB or it will stick to the inside aperture walls. The smaller the area ratio, the more difficult it is to achieve complete paste release. However, with the introduction of electroformed stencils, it was discovered that the smoother walls associated with this stencil technology provided better paste transfer, and good paste transfer could be achieved at lower area ratios. In fact, good paste transfer has been achieved with area ratios as low as .50 with electroformed stencils. If you're not getting enough paste transfer to give you the solder paste volume you need and well-formed bricks, check to see that the aperture size you are using is appropriate for the stencil fabrication method and verify the area ratio suitability for the stencil type being used.

3. Insufficient aperture paste fill caused by squeegee speed, squeegee pressure, a poor squeegee blade, inadequate paste roll, or poor or outdated solder paste

The quality, condition, and use parameters for squeegee blades play a huge role in successful paste transfer. A quality blade in top condition is a must. Additionally, the quality and condition of the paste cannot be underestimated when investigating potential problem areas.



$$\text{Area Ratio} = \frac{\text{Area of Aperture}}{\text{Area of Aperture Walls}} = \frac{L \times W}{2 \times (L + W) \times T}$$

Figure 2: Area ratio explained.

4. Clogged stencil apertures or poorly formed apertures

Dirty apertures will limit the effective paste fill and release of the aperture. Paste that binds to the aperture edges will reduce the effective aperture opening, add surface roughness, and change the effective area ratio. Regular cleaning is a must for proper transfer and release of the solder paste.

5. Stencil thickness

If the stencil thickness doesn't meet the exact target for thickness, the volume of the paste that is transferred will be inaccurate. For smaller pattern features, a small variation in the stencil thickness can make a big difference in the effectiveness of the stencil.

PROBLEM: Inconsistent paste transfer across the board

Potential causes of inconsistent paste transfer across the surface of the board include:

1. Inadequate support of the board

Good under-board support is a must in order to keep the board flat and achieve high-quality stencil printing. Particularly when there are components on both sides of the assembly, there can be trouble due to flexure of the board as paste is applied. For proper support, the PCB must be locked into position absolutely parallel to the stencil. To do this requires positive support, particularly when printing the second side of a double-sided board, to eliminate any downward movement and flexure when the squeegee blade moves across the board. The edge of the support tool should be flat to the PCB edge, or the stencil will coin. Over time, that will result in a shortened stencil life.

2. Non-homogeneous application of solder paste

This is most often attributed to reused or dried-out solder. Application can have localized swaths where the paste is not consistent over the full application area.

Below are some other commonly encountered problems, possible causes, and potential cures.

Solder Balls

Possible Causes

- Excess solder paste applied to the assembly
- Excess solder paste under the chip component
- Outgassing of solder paste in a confined area
- Misprint leaving excess solder paste
- Poor gasketing of the stencil to the board

Potential Cures

- Special apertures for chip components
- Adjusting the reflow profile

Tombstoning

Possible Causes

- Unequal wetting of pads for chip components
- Too little solder paste on one pad of chip or possible solder thieving
- Excess solder paste on the chip pad
- Reflow profile too steep which will typically cause one pad to reflow before the other
- Shielding of a chip pad by a larger component causing uneven heating
- Spacing between chip pads is too big or there is an unbalanced pad geometry

Potential Cures

- Change to a C-shaped chip component stencil aperture
- Characterize the board and make adjustments to the reflow profile
- Review and correct the pad layout design and look for solder thieving off of the component pads
- Decrease solder paste volume on the chip pads

Bridging or Shorts Between Leads

Possible Causes

- Bad stencil aperture pad alignment
- Smeared solder bricks
- Good brick, but too much volume
- Contaminant, like fiber, lies across the leads
- Excess solder paste left on squeegee side surface of the stencil
- Excess insertion pressure at pick-and-place

IMPROVING STENCIL PRINTING RESULTS *continues*

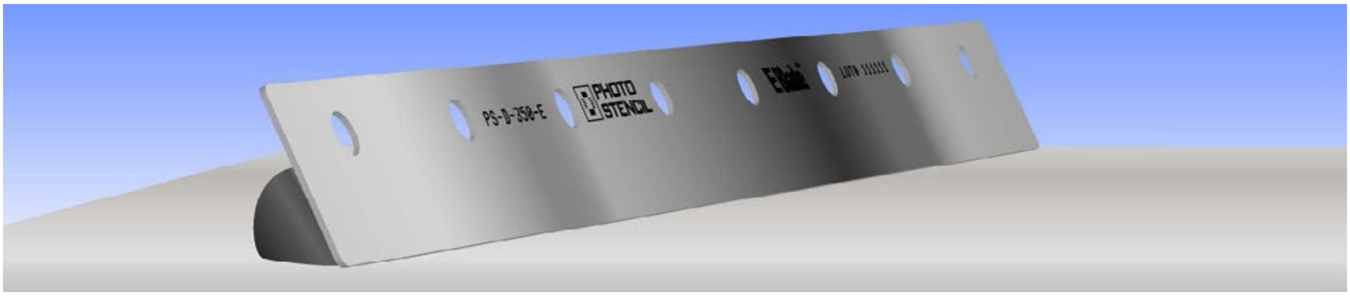


Figure 3: Adjust your print pressure down to benefit from improved stencil life.

Potential Cures

- Improve stencil and/or stencil design
- Improve blade wiping
- Adjust pick-and-place pressure

The problems described so far relate to issues with the stencil and the equipment, but not the process. If you believe the problems are associated with the process itself, here are some general guidelines you can follow:

Squeegee Pressure or Printing Speed

- The pressure on the squeegee blade should be adjusted to the smallest pressure you can have and still wipe the stencil surface clean during printing. While you may see a layer of flux on the top of the stencil after the blade passes over, you should not see solder paste. If you see streaking, take a look at the blade to make sure it is not damaged or worn, and think about replacing it rather than turning up the pressure.
- The printing speed should usually be adjusted to between ½ and six inches per second. The print speed must be set so the solder paste rolls perfectly on top of the stencil. Using too high of a speed will cause insufficient fill of the stencil apertures resulting in substandard print quality.

Summary

If you are not getting the results you want, try to determine if the problem is occurring when you apply the paste or when the paste is released. Make sure your stencil is an optimal one for your application and is designed with the apertures and the area ratios that you need. Check the equipment and the board support, the squeegee blades, the printing process, and don't forget to consider the solder paste you're using. **SMT**

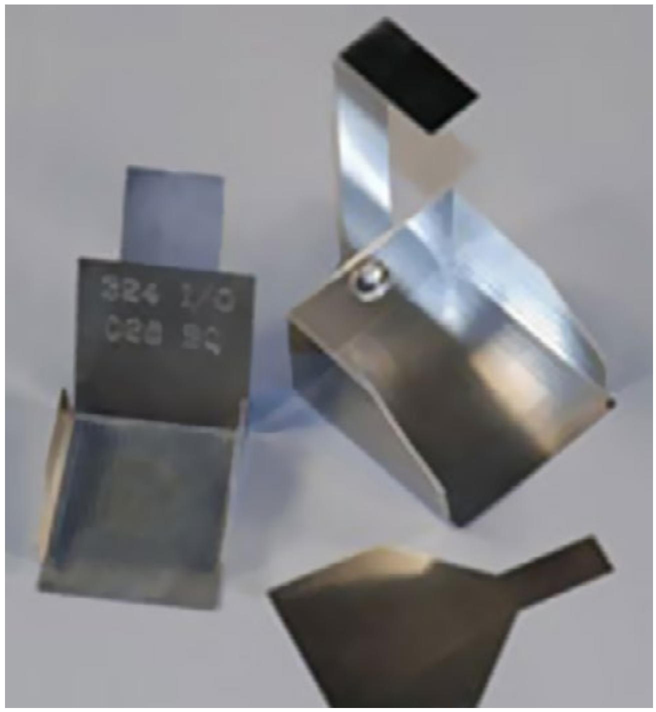


Figure 4: BGA/LCC/QFN/QFP package repair tooling can be used when spacing is limited between components already on the board.

Rachel Short is vice president of sales and marketing at Photo Stencil LLC. To read past columns or to contact the author, click here.

TOP TEN

News Highlights from SMTonline this Month

1 Conflict Minerals Case Faces Setback on Ruling

Legal experts believe that the rationale embraced by the court could apply in other cases in which business interests object to regulations on free speech grounds, such as the SEC requirements that companies disclose whether the conflict minerals in their products could be determined to have financed violence in the Democratic Republic of the Congo (DRC) and adjacent countries.

2 Libra Acquires Tetrad; Aims to Boost Revenues

Libra Industries has announced the acquisition of Tetrad Electronics, a competing Ohio-based EMS company with 2013 sales of $10 million. Libra Industries will assume full ownership of Tetrad Electronics, effective immediately.

3 Sanmina Reports Solid Q3 Results; Revenue Up 8% YoY

"We delivered a solid third quarter. Revenue was up 9% sequentially and 8% year over year. Each of our end-market segments grew on a sequential basis, with notable performance from our industrial, medical, and defense segment," stated Jure Sola, chairman and CEO.

4 Benchmark's 2Q14 Revenues Up 12% to $717M

Contract manufacturer Benchmark Electronics has posted revenues of $717 million in the second quarter, up by 12% from the previous quarter and up by 18% from the same period last year.

5 SMART Group to Address Reliability and Standards

This informative, one-day seminar will focus on how the use of international standards can increase the reliability and quality of PCB manufacturing and assembly processes, leading to reduced costs and increased profits. “Reliability and Standards in Real Life: An IPC and SMART Group Perspective” takes place Thursday, September 11, in Swindon, UK.

6 Flextronics Develops UBB Automation System

Flextronics has pioneered the first of its kind Universal Box Build (UBB) system, a fully-automated, state-of-the-art equipment outfitted with Internet of Things (IoT) connectivity via smart sensors, actuators, and cameras.

7 SMTA to Hold Evolving Technologies Summit

The association has announced the “Evolving Technologies Summit” will be held September 29, 2014 as a focused symposium at SMTA International in Rosemont, Illinois. The purpose of the summit is to present key issues in printed electronics, advanced packaging technology, and materials innovations to gain insight regarding technology changes in the future.

8 IPC Releases Training Video on FOD Prevention

The reliability and functionality of electronic devices can be severely affected by foreign objects and debris (FOD). To help industry eliminate FOD issues, IPC has released a training video, DVD-172C, “FOD Prevention in Electronics Assembly.”

9 Elecsys Enjoys 20% Sales Growth in FY 2014

“We are pleased to report a very successful year with continuing revenue growth, enhanced gross margins, and a substantial increase in earnings. Sales increased over 20% compared to the prior year driven by shipments of our proprietary M2M products and solutions,” said Karl B. Gemperli, CEO.

10 IPC, HKPCA Renew Partnership

Following a highly successful 2013 International Printed Circuit & APEX South China Fair (HKPCA & IPC Show), IPC and HKPCA are extending their alliance to host the event for another four years. The 2014 event will be held December 3–5 at the Shenzhen Convention & Exhibition Center in Shenzhen, China with an anticipated 500 exhibitors covering 42,000 square meters.

EVENTS

For the IPC's Calendar of Events, click here.

For the SMTA Calendar of Events, click here.

For the iNEMI Calendar, click here.

For a complete listing, check out *SMT Magazine's* full events calendar here.

World Engineering Expo (WEE)
September 1–3, 2014
Singapore

IMTS 2014
September 8–13, 2014
Chicago, Illinois, USA

Capital Expo & Tech Forum
September 9, 2014
Laurel, Maryland, USA

Hybrid & Electric Vehicles Forum 2014
September 17–18, 2014
Munich, Germany

Medical Electronics Symposium 2014
September 18–19, 2014
Portland, Oregon, USA

FUTURA
September 18–21, 2014
Salzburg, Austria

MEDIX Osaka
September 24–26, 2014
Osaka, Japan

SMTA International 2014
September 28–October 2, 2014
Rosemont, Illinois, USA

Standards Development Meetings
September 28–October 2, 2014
Rosemont, Illinois, USA

CEA Innovate!
September 30–October 2, 2014
Litchfield Park, Arizona, USA

World Energy Engineering Congress (WEEC)
October 1–3, 2014
Washington, DC, USA

NEPCON Vietnam 2014
October 9–11, 2014
Ho Chi Minh, Vietnam

Austin CTEA Expo & Tech Forum
October 14, 2014
Austin, Texas, USA

Long Island SMTA Expo and Technical Forum
October 15, 2014
Islandia, New York, USA

Connecticut Expo & Tech Forum
October 21, 2014
Waterbury, Connecticut, USA

Intermountain (Utah) Expo & Tech Forum
October 23, 2014
Salt Lake City, Utah, USA

Industrial Automation Conference 2014
October 23–24, 2014
London, UK

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NOVEMBER:
Rework & Repair

DECEMBER:
TBA